



Exploration & Production

GENERAL SPECIFICATION

PIPING VALVES VESSELS

GS PVV 116

Model Review Checklist

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Contents

1. Scope	4
2. Reference documents.....	4
3. Legend	5
4. Model line by line check	5
5. Design safety engineering.....	5
6. Package units	5
7. Model layout	6
8. Exchangers.....	6
9. Fired heaters.....	7
10. Instruments.....	8
10.1 P&IDs checks	8
10.2 Accessibility (*).....	8
10.3 Orifice Flange Sets and In-line Equipment (*)	8
10.4 Level displacers	8
10.5 Temperature and Pressure Tappings (*)	8
10.6 Control valves (*)	8
10.7 Local Panels (*).....	9
10.8 Analyser Houses (*)	9
10.9 Dial Thermometers (*).....	9
10.10 Relief Valves.....	9
10.11 Conduits/Cables.....	9
11. Pumps	9
12. Compressors	10
13. Other mechanical equipment	10
14. Piping	11



15. PSVs.....	13
16. Utilities	13
17. Vessels.....	14
18. Miscellaneous.....	15
Appendix 1 Model review comments.....	16



1. Scope

The object of the Model Review Checklist is to provide guidelines for checking the model both on a continuous basis and during the formal Model Review. This review shall take place after Engineering and Design have completed their checking to the latest issued P&Ids. Minimum changes are expected at this stage since the model has been under review by the Project. Engineering Co-ordinator and specialists as an on-going function during the construction.

The checklist is general in nature and may require modification for specific Projects.

It should be particularly noted that many of the checklist items relate to fundamental tasks which should have been carried out during the conceptual layout and plot plan stage to comply with Process requirements, and during the on-going review of documents extracted from the model. They are included in the list to assist Engineering Groups during this review but are indicated by an asterisk. To make changes at final model review based on these fundamental checks is far too late and must be avoided.

2. Reference documents

The reference documents listed below form an integral part of this General Specification. Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and supplements, is the latest revision published at the EFFECTIVE DATE of the CONTRACT.

Standards

Reference	Title
Not applicable	

Professional Documents

Reference	Title
API RP 520	Sizing, Selection and Installation of Pressure-Relieving Devices in Refineries

Regulations

Reference	Title
Not applicable	

Codes

Reference	Title
Not applicable	

**Other documents**

Reference	Title
Not applicable	

Total General Specifications

Reference	Title
Not applicable	

3. Legend

SCRN	Check during the Screen Review
DOCT	Check during the Document Review
COMM	Commissioning Engineer
CONST	Construction Representative
ELC	Electrical Equipment Engineer
MEC	Mechanical Equipment Engineer
INS	Instrument Engineer
PROC	Process Engineer
PROJ	Project Engineer
SEV	Project Design Safety Engineer
TE	Thermal Equipment Engineer
TCS	Piping/Vessels/Welding Engineer
UTIL	Utilities
(*)	Fundamental check to be carried out during layout development, plot plan review, and on-going review

4. Model line by line check

The model shall be checked against the P&IDs. Note the Utilities Engineer has the Process and Project Engineer's responsibility for certain utilities system.

5. Design safety engineering

The model shall be separately reviewed against safety requirements applicable to the Project.

6. Package units

Package Units are not normally modelled in detail and are usually shown as a block. Ensure adequate space is available for access and for removal of components of the package units.

7. Model layout

1. (*) Check that model shows economic and efficient use of the area allocated to the plant.
2. (*) Check that electrical equipment is located in accordance with the area hazard classification.
3. (*) Check that access ways and roads provide ample headroom for vehicles, mobile equipment, etc. required for efficient and safe construction, operation and maintenance of the plant.
4. (*) Check location of particularly noisy equipment, valves etc. in relation to the frequency of visits by operating and maintenance personnel to the area.
5. (*) The policy of access to valves, blinds, manways, instruments, etc. should have been established during layout stages and before model work commenced. Check model for consistency of approach.

8. Exchangers

1. (*) Check that the number of shells matches the P&IDs.
2. (*) Check the arrangement of exchangers and associated piping.
3. (*) Check if adequate space is allowed for bundle removal and that lifting beam, davits and pull beams are provided as necessary. Check that flangeless butterfly valves still isolate on tube pulling.
4. (*) If a thermosyphon reboiler, check the elevation difference between the draw-off pan and the reboiler for driving force.
5. If a vent is required on the exchanger for periodically purging non-condensable vapours, it should be readily accessible. The vent should be shown on the model.
6. (*) The cold side fluid must enter the exchanger from the bottom and exit from the top.
7. (*) Piping for a true counter-current exchanger must be properly shown as counter-current.
8. (*) If different shells of multi shell exchanger have different metallurgies, check if shells are properly arranged and labelled.
9. (*) For air coolers or water coolers, both single and mixed phase, in service where it is important that the outlet temperature be maintained, the piping arrangement must be symmetrical. For air cooled or water cooled condensers, pockets must be avoided in the outlet piping and hot vapour by-pass lines. See that elbows rather than tees are used at the ends of the headers. Dead legs on capped headers should be reduced to a minimum. Check configuration against Process Department specifications and Licensor's requirements.
10. (*) Temperature sensing point for exchangers with hot gas by-pass is to be located in the combined process stream outlet manifold.
11. (*) All instrument louvre controls should be located at grade.



12. Check adequate clearance and maintenance access is provided for motors, fan belts and A/V hub of air coolers.
13. (*) Check access for plug removal and tube-cleaning on air coolers.
14. (*) Check hot equipment/lines under air coolers, e.g. fire risk from hot pump, hot lines which could affect air temperature to bundle.
15. (*) Check crane access for removal of bundles.
16. Check escape routes from each bank of air coolers are consistent with Engineering Company/Total standards.
17. Consider access ways between air cooler platforms and adjacent structures to save operator's time climbing ladders and provide a safe means of escape.
18. Check location of break flanges on piping at Shell and Tubes exchangers and air coolers to facilitate bundle removal.

9. Fired heaters

1. (*) For fired heaters that have removal spool pieces, temperatures indicators must be placed upstream of the removal spool piece on the header outlet side and downstream of the removable spool piece on header inlet side.
2. (*) Check that the correct number of passes are shown, and if necessary, check that they are symmetrical.
3. (*) Check that all auxiliary lines are shown and that they are accessible to the operators.
4. Check that all fired header instrumentation is shown and TRC primary element is close to heater.
5. Check that the snuffing steam and isolating valves are located minimum of 15 meters from the heater at grade and are accessible.
6. (*) For reboilers that are fired headers, check that the total pressure drop in the reboiler return line does not exceed the pressure drop that was originally allowed (usually 0.7 bars).
7. (*) In vacuum units, the vacuum transfer line shown on the model must be checked against the original layout issued to Process for final hydraulic check.
8. If decoking is required, check to see if all associated equipment is shown and that decoking pipework can be securely blinded during normal operation. Check if steam/air decoking manifold interferes with access to control valves, burners, etc.
9. (*) Emergency steam lines to process inlet lines for fired heaters must be installed to prevent process fluid from setting up and blocking steam line. This means that the check valve on the steam line must be as close as possible to process line juncture. Line should be steam traced. Steam and individual pass valves must have clear access.
10. Check that burner firing valves are located such that burner flames can be observed.
11. Check access to all inspection doors, man way covers over U-bends in convection section, blinding flanges, soot-blowers and stack damper bearings.
12. Check adequate escape routes.



13. Check clearance for burner gun removal.

14. (*) Check to eliminate dead-legs in heavy fuel oil lines and waste gas lines.

10. Instruments

10.1 P&IDs checks

Check that all instruments shown on the P&IDs are present on the model and identified by tags number (except for TIs and PIs indicated by coloured tag only). Apart from identifying presence of instrumentation, the points covered by the following paragraphs should be considered.

10.2 Accessibility (*)

Ensure that all instruments shown are accessible both from an operator's point of view and that of a maintenance engineer. Ensure instruments are not located such that they are liable to be damaged or form a tripping hazard. Specific requirements are detailed in the Engineering Standard applicable to the Project.

10.3 Orifice Flange Sets and In-line Equipment (*)

Check that Orifice Flange Sets are in the correct line and accessible. Orifice sets with close coupled transmitters should be accessible from grade, platform or by ladder. Access height above grade or platform may be determined by the Project Specification. If the access is by temporary ladder, check that the area beneath the orifice assembly is not too congested. Review the straight runs provided for orifice plates. If flange sets are in vertical runs, check that the flow direction is correct. Check orientation and piping connections for rotameters. Ensure all other in-line instrument equipment is correctly orientated and is accessible.

10.4 Level displacers

Check the orientation of Level Displacers and Level Gauge Glasses with respect to access/platforms or ladders. Where possible, access to level displacers should be from a platform. If an access ladder is provided, check that the instruments are visible and serviceable from the ladder.

Check the height of platforms relative to displacer cases, bearing in mind that the instrument case associated with a rotatable head displacer is approximately 30 cm above the top side connection of a displacer. Mark up Materials Requisitions with the handling required for the instrument case, i.e. L.H. or R.H. (facing the instrument) and the orientation of the connection on the displacer chamber.

10.5 Temperature and Pressure Tappings (*)

Check the location of TWs and PIs for accessibility and TI removal. Location of these instruments on top of tall columns should be avoided if possible. Check location against vessels data sheet.

10.6 Control valves (*)

Check that control valves are installed in the correct line and check their location. Control valves should preferably be installed at grade with the pneumatic operator in a vertical position. Check



access for removal of large valves by lifting equipment. For angle and 3-way valves, check for correct direction of flow.

10.7 Local Panels (*)

Check positioning of local panels. Consider operational access and effect on maintenance of machine.

10.8 Analyser Houses (*)

Check the location of analyser houses or analysers with respect to the sampling points. These distances should be kept to a minimum. The position should have previously been agreed with the instrument engineer, but check to ensure that it has been positioned correctly. Measure sample line length for calculation of sample lag times. Check position and orientation of sample taps for a good representative sample. Check routing of fast circulating loop lines.

10.9 Dial Thermometers (*)

Mark up requisitions with connection position required, e.g. back or bottom.

Check access and headroom for removal of winterisation enclosures and sunshields. Ensure visibility from platform and from any globe or control valve associated with the temperature measurement.

10.10 Relief Valves

Check location and accessibility for servicing.

10.11 Conduits/Cables

Ensure space required for cable trays and conduits is indicated.

11. Pumps

1. (*) Pumps and their spares or common spares should be arranged together in a group and should be located reasonably close to the vessel supplying the suction.
2. (*) Suction line length to be a minimum, with no pockets.
3. Check location and orientation of valves, non return valves and fire isolation valves in suction and discharge lines.
4. Check inlet configuration for double suction pumps to ensure equal distribution of flow to both suctions.
5. Check symmetry of piping on pumps operating in parallel.
6. Check adequate drains are provided on suction/discharge lines and/or pump. Pay particular attention to light ends/corrosives pumps and allow for safe removal of drained material.
7. Check permanent strainers are correctly located and sufficient clearance allowed for cleaning. Check that removable spools and correct support locations are provided on temporary strainers.
8. Check that all instrumentation associated with pumps is shown, is accessible and readable.

9. (*) Check NPSH on pumps where this is critical.
10. Check cleaning, flushing, warmup and recirculation facilities.
11. (*) Check accessibility to the pump for maintenance. Check any special lifting tackle required.
12. Check consistency of piping configuration at pumps throughout the plant.

12. Compressors

1. (*) Liquid in compressors suction lines must be avoided. Suction lines should have no pockets. Steam tracing should be considered. The suction line should be self-draining back to the knockout drum if possible.

Where pockets are unavoidable, provisions must be made for automatic draining of the liquid.
2. Check atmospheric suction intake location regarding hazard, contamination, reliability, area classification, temperature, etc.
3. On reciprocating compressors, safety valves must be located upstream of discharge block valve.
4. On reciprocating compressors, pulsation dampeners should be shown on the model.
5. Check location and orientation of swages, valves, non-return valves and fire isolation valves in suction and discharge lines.
6. Check adequate drains are provided on suction and discharge lines and machine.
7. Check instrumentation including panel associated with the machine;
8. Check suction and discharge line tracing, acoustic insulation, etc.
9. Check suction and discharge filters, strainers, knockout vessels, coolers, pulsation dampers, pressure relief systems, expansion bellows, etc.; location and access for operation and maintenance.
10. Check anti-surge and recycle lines, blow-off line and silencer.
11. (*) Check machine location in relation to other operating or spare machinery and to its control panel.
12. (*) Check space, headroom and lifting tackle for maintenance of the machine and its auxiliary equipment.
13. (*) Check layout of auxiliary systems and pipe work such as Lube Oil, seal oil, filtration, cooling water and instrument panels in relation to adjacent equipment, structures, pipe work, dust work, underground systems, etc.
14. Check acoustic hoods, enclosures, silencers and their removal.

13. Other mechanical equipment

For other types of mechanical equipment, it is not possible to be specific on the type of checks to be carried out on the model. For some equipment, e.g. blowers, some or all of the checks listed under pumps and compressors will apply. For other more specialist equipment, the model

should be reviewed bearing in mind the function of the equipment and considering operation, maintenance, access and safety aspects of the design.

14. Piping

1. All process lines on the model must be checked to see that they agree with the latest issue of the P&IDs.
2. (*) In the critical services listed below, it may be necessary to conduct a detailed hydraulic check of the model to ensure against excessive pressure drop. These checks must be made initially on layouts and the model reviewed for conformity to the approved layout:
 - Pump Suction Lines
 - Thermosyphon Reboilers
 - Compressor Recycle Loops
 - Certain Vacuum Systems
 - Inlet Lines to Safety Valves
 - Tower Overhead Systems operating at low pressure, where there may be a limited allowable overhead systems pressure drop
 - Low Pressure Condensate Systems
 - Other critical systems where allowable pressure drop may be limited.
3. (*) Although several pipe fittings may at times be required for thermal expansion, be alert to check for cases where it may be possible to reduce what appears to be an excessive amount of pipe fittings. Optimise fittings in suction lines.
4. (*) Special attention must be given to “vapour-liquid” mix points in compressor systems. Piping must be arranged to avoid backflow of liquid to the compressor. A recommended procedure is to have the vapour line taken off the top of the liquid pipe. Avoid loops or pockets downstream of mix point for first 50 pipe diameters.
5. (*) Special attention must be given to process lines that require “no pockets” such as two-phase flow, flurry or overhead vapour lines.
6. (*) Check access to valves and blinds in accordance with frequency of operation and the project standards. Where possible, make all valves and blinds accessible from grade or platforms.
7. Check that literal translation of P&IDs has not produced excessive pipe lengths.
8. A tundish and piping to drain is necessary for some process materials from vents and drains, as specified on P&IDs.
9. Check that piping does not constitute trip or head hazard, nor does it block access as far as practical.
10. (*) Special areas requiring very detailed attention:
 - Slurry lines
 - Corrosive fluids

- Fluids which freeze or become very viscous at ambient temperature
 - Flammable hydrocarbons above their boiling point
 - Fluids close to crystallisation point
 - Saturated vapours (e.g steam, overhead systems)
 - Solids conveying systems (e.g catalyst transfer)
 - Two phase flow, especially in vertical lines
 - Lined piping
 - Lines subject to coking.
11. Check that a suitable length of pipe is provided where adequate mixing is required (e.g. steam and gas before reformers).
 12. Review start-up recirculation lines to ensure valving is reasonably adjacent.
 13. Check that all atmospheric vents and manhole vents have been piped safe location.
 14. Check that sample points are accessible from grade or a platform. Check also for dead legs.
 15. Check that geographic arrangement of lines agrees with P&IDs.
 16. Check location and adequacy of flushing, oil, slop oil and steam-out purging connections. Avoid dead legs where practical.
 17. (*) Review location of control valves; particularly, check that:
 - Control valves not normally operating are free draining
 - Valves in flashing services are close to downstream equipment, i.e. minimum length of larger bore piping
 - Valves which would cause major process upset if they failed are at grade.
 18. (*) Check that vapour-disengaging space has been provided on column side draws-offs.
 19. (*) Check that alloy, large carbon steel, jacketed and hazardous materials pipe runs are kept to a minimum.
 20. (*) Check that flanged connections required for dismantling and maintenance are provided and are accessible.
 21. (*) Check routing of underground piping and location of fire-fighting hydrants, monitors and hose reels.
 22. (*) Review steam and utilities piping, especially distribution systems from common headers with particular reference to valving of sub-headers and take-offs to ensure an economical and practical arrangement is provided. Agree standard hook-ups for utility stations at an early stage of the model. Ensure utility headers are independent for independent units.
 23. (*) Check hose connection locations and access, especially those handling hazardous materials.
 24. (*) Check that hazardous materials lines have minimum number of flanges.

25. (*) Check if chain can be removed from chain operated valves by angling the valve or a slight change of position, whilst still meeting Project standards requirements. Ensure chains do not obstruct access ways. Avoid chains if possible.
26. (*) Check that blinds are on the correct side of the valve and accessible.

15. PSVs

1. (*) PSV will usually be provided on the discharge line from turbines and reciprocating equipment upstream of any block valves to protect the casing. Check requirements with P&IDs.
2. (*) All PSV discharge lines going to flare must be self-draining to the flare header, which may be indicated by an arrow. The length of the discharge line should not be excessive.
3. (*) For safety purposes and for consistency between equipment design pressure and PSV set pressure, the PSV must be located reasonably close to the primary item that it is protecting.
4. Check all PSV inlet lines for pressure drop and conformity to the "3 Percent Rule" given in [API RP 520](#). For situations, which may appear to be very tight, it may be necessary to perform a detailed piping "take-off" of the model in which each length of line is measured and every fitting is accounted for.
5. (*) Check that all PSV discharging to the atmosphere are vented in a safe location. Drain (weep) holes to be provided on atmospheric discharges where liquid can accumulate. Consider piping drain to safe location.
6. In an all-liquid system, the set pressure of the safety valve is determined by its actual location relative to grade. If the valve is located close to grade, the set pressure will be higher than if it is mounted high in the air. The model should be checked for consistency between the PSV location and its set pressure.
7. Where PSV is relieving hazardous (hot, corrosive, noxious) material to atmosphere, be very careful in defining safe location and consider effect on area classification.
8. (*) Check line size where several PSV discharges are combined into one sub-header.
9. Check platform access is provided for operation and maintenance of PSVs. Ensure davits are provided for heavy PSVs at elevated positions. Ensure space available for drop out at grade.
10. Check snuffing steam valves for PSVs are located at grade.

16. Utilities

1. Check the Utility Systems shown on the model against Project standards and Utilities P&IDs latest masters.
2. Review the routing of exotic, hazardous and large diameter utility lines.
3. (*) Check utilities/instruments location and access.
4. (*) Check utilities valves type, location and access.
5. Check location of flange snuffing steam valves.



6. Check Desuperheaters upstream and downstream runs.
7. Check access to utility equipment.
8. Check location of utility stations relative to user points.
9. Check condensate line arrangement.

17. Vessels

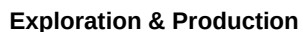
1. (*) Check that the vessel, including its support, ladders and platforms, is correctly modelled.
2. (*) Check for correct nozzle orientation.
3. Check attached piping, structures and equipment regarding vessel's design loading, and any bellows connecting vessel to other equipment.
4. Check davit's location and consequent vessel's loading.
5. (*) Tan line elevation is not shown on the model but can be roughly measured. Check for consistency with elevation shown on the P&IDs.
6. (*) Check methods of access to manaways and handholes. Should manaways be hinged? Check direction of cover swing. Beware of adjacent instruments.
7. (*) Check erection aspects of the vessel. Will it arrive at site in one or more pieces? How will it be fitted into any structure? Are lifting attachments adequate and correctly positioned?
8. (*) Level gauges and other instruments must be readable from either grade or platform and where necessary, readable from a globe or control valve. Check access is provided for isolating valves. Check relative elevations of LG, LC, LAH and LAL.
9. Check symmetrical piping for tower inlet and reboiler trap-out and return lines where applicable.
10. (*) Drums, which have a water boot, must be sloped towards the boot. This is indicated by a slope label. Check that location of the boot is opposite from the feed inlet on the vessel.
11. (*) For reactors, which require catalyst dumping, check the elevation for suitable access and space for dumping vehicle.
12. (*) For horizontal vessels, check which is sliding and fixing saddle and relationship with main nozzles.
13. Check if the vessel can be conveniently drained. Check that outlet valves are located outside the vessel's skirt.
14. Stripping steam piping to have block valve located on the horizontal and next to inlet nozzle; any small section of line between valve and nozzle must slope towards vessel. This valve must be accessible from a platform.
15. (*) Check that adequate access and escape routes are provided on vessels platforms.
16. (*) Check access to vessel vent, steam-out and any nozzle requiring permanent access. Steam-out connections do not require permanent access.
17. Check location of vent in relation to manhole and steam-out to permit vapour to be swept out.



18. Ensure steam-out connection is as close as possible to bottom tan line and at opposite end to vessel vent.
19. Ensure fuel gas connections are above high liquid level.
20. (*) Ensure adequate platform area is at location where vessel internals or packing is loaded.

18. Miscellaneous

1. (*) Review extent of fireproofing and consider any effects on adjacent piping or equipment.
2. (*) Ensure that all bracing shown on steelwork drawings is shown on the model and that piping, equipment, access ways and maintenance areas are not fouled by bracing.
3. Review locations of convenience outlets.
4. (*) Review locations of electrical junction boxes and switch racks, and ensure they are accessible but do not restrict access to other equipment.
5. Review problem areas, which may require additional or special lighting fittings.
6. Review locations of underground drainage and any open drainage trenches. Consider effect on area classification.
7. Review locations of electrical/instrument cable trenches and consider their effect on adjacent equipment.



General Specification

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Appendix 1

Appendix 1 Model review comments

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GS PVV 116.doc Page 16/16