

ENGINEERING MODEL REVIEW**JGS 210-120-1-51E**

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CONTENTS

	<u>PAGE</u>
1. SCOPE	2
2. WORK PROCEDURE	2
2.1 Review Steps	2
2.2 Review Procedure	3
3. RESPONSIBILITY OF PROCESS ENGINEER	3
4. DETAILED REVIEW POINTS FOR ENGINEERING MODEL	4
4.1 Safety, Maintenance and Operability	4
4.2 Elevation of Equipment	6
4.3 Piping - General -	9
4.4 Piping - Thermal Expansion -	11
4.5 Piping - Flow Stability & Vibration -	11
4.6 Instruments	13
4.7 Valves	16
4.8 Heat Exchangers and Reboilers	17
4.9 Pumps and Compressors	17
4.10 Furnaces and Boilers	20
4.11 Vessels, Columns and Tanks	22
4.12 Relief Valves and Flare Lines	25
APPENDIX-1 EXAMPLE OF CHECK LIST FOR 25% MODEL REVIEW	27

1. SCOPE

This standard practice covers the procedures to review engineering models of petroleum refineries, petrochemical plants and similar plants.

Engineering models are three-dimensional and scaled-down models of actual plants under construction. Reviewing engineering models at the design stage, therefore, produces effects equivalent to the review of actual plants, not only on the improvement of design quality, but also on the reduction in the project schedule. Reviewing three-dimensional engineering models also enables us to easily detect conservatively or uselessly routed lines, thus bringing cost reduction.

An engineering model integrates the results of designs including vendors' designs, prepared by various discipline engineers, with each other. Therefore, it proves difficult and unpractical to classify the model reviewing work into each discipline' responsibility. This practice covers points that process engineers consider it necessary to review, from the standpoints of process performance, plant safety, and plant maintenance, regardless of process engineers' responsibility. Process engineers' responsibility for engineering model review is described in Section 3 of this practice.

Engineering models are prepared based on the piping layout as in the case of actual plant construction. The major source of information in preparing a piping layout is P&ID's. However, all requirements for the piping layout on process performance, plant safety, operability and plant maintenance are not shown in P & ID's, and it is left to the piping engineers to consider any additional requirements other than those indicated in P & ID's so as to provide complete piping layouts. During piping layout review, model review, or line checks, it should be confirmed that all the requirements for piping layout are reflected into the piping layout.

This practice is also applicable to the guideline for piping layout review and line checks.

In order to minimize revision work in the detail design including engineering model design, both piping and process engineers must fully understand the piping layout requirements shown herein.

2. WORK PROCEDURE

2.1 Review Steps

Engineering models are normally reviewed in two stages ----- the first stage when the model construction progress status reaches 25 % and the second when it comes to 75 %.

The points to be reviewed in each stage are described below.

(1) 25 % model review

Model review in the first stage when the construction status of 25 % is conducted to assess the overall layout and to finalize the plot plan, highlighting the following points:

- Gravity requirement
- Layout of the major equipment
- Structure arrangement

- Safety in general (including escape way)
- Routing of major piping

(2) 75 % model review

Model review in the second stage when the construction status of 75 % model review is conducted to confirm the detailed points, highlighting the following points.

- Almost all of the process and utilities lines
- All instrument connections
- Safety, operability and maintenance
- Heater duct arrangement

2.2 Review Procedure

- (1) Check the model against the latest issue of the P&I diagrams. However, if the latest P&I diagrams are updated from base P&I diagrams of the model constructed, updated points should be listed up.
- (2) In advance of the model review, review points should be marked up on the P&I diagrams and be listed in a table, highlighting the requirements of:
 - Elevation difference of equipment
 - Free drain portion
 - No pocket piping
 - Mixing point distance

By summarizing these check points, the engineer could concentrate on the review work.

Attached Table-1 shows a sample check list for a typical process unit, which was prepared for the 25% model review on a typical project. Update this check list for subsequent progress reviews.

- (3) Follow the line-up systematically and pay attention to details. Start, for instance, with the unit feed system, check furnaces as a separate block, then proceed to the internal circulation and product rundown circuits and complete with checks on the utility systems.
- (4) Check the list and mark the points on the P&I diagram which have been checked and accepted.
- (5) Indicate the points which have not been accepted. These points should be summarized in follow-up sheets.
- (6) When a modification is proposed, make sure that it is practical and also economic. When this modification is in doubt, consult the appropriate specialists of other disciplines.
- (7) After this review, summary sheets of commented points should be prepared and should be distributed to the engineering manager. In subsequent progress reviews, reconfirm that the commented points were followed or not.

3. RESPONSIBILITY OF PROCESS ENGINEER

Detailed review points for engineering models are described in Section 4 of this practice. Of such points, only those affecting process performance and plant safety should be reviewed under the responsibility of process engineers; this practice shall also be applied to piping layout review and line checks.

4. DETAILED REVIEW POINTS FOR ENGINEERING MODEL

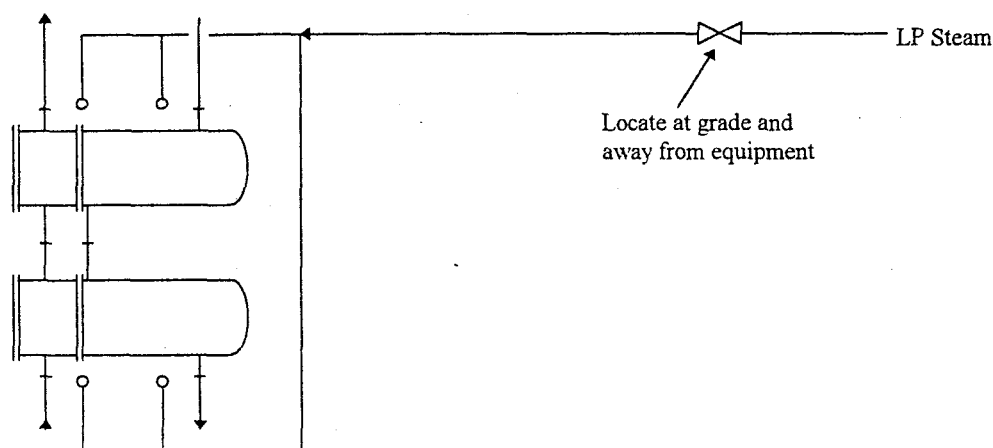
4.1 Safety, Maintenance and Operability

- (1) Check whether **fire fighting facilities** are adequately provided in accordance with the applicable standard or specification. For example, depending on the project standard, water spray systems should be provided for the following services.

- For the pumps operating higher than its auto-ignition temperature.
- For the non-insulated vessels, containing large amount of LPG(*)

(*) Limitation for volume should be confirmed with applicable specification.

- (2) Confirm that the **ladders for escape** are provided at platforms and structures in accordance with clients' requirements.
- (3) Confirm the **remote switches** of emergency valves are installed at safe locations, away from the possible hazardous source. They should be located at grade and 15m or more away from the valve concerned. It is preferable that they are grouped together with in a collective area.
- (4) Confirm that the **safety shower and eye washer** are provided near caustic, acid and amine-containing equipment.
- (5) Confirm the installed location of units for **fire-fighting** and rescue work is accessible.
- (6) Check for possible piping and cable, etc., which might cause **head bumping** or tripping.
- (7) For leak consideration of **hydrogen service** with high pressure and temperature, confirm that the valves on emergency and smothering steam headers are accessible and located at a safe distance from these items of equipment, whenever this system is applied.



Emergency/Smothering Steam for H₂ Service

- (8) **Utility stations** should be provided thoroughly to cover the plot area. Confirm that the nitrogen hose station is available on the platform of the reactor for catalyst unloading operation.

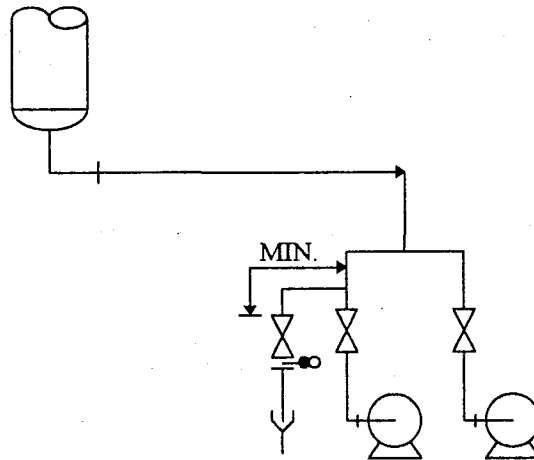
(9) Location of Manual Shut-Off Valve around Heater

The following manual shut-off valves should be located at grade and 15 meters or more away from the heater. It is preferable that they are grouped together in a collective area.

- Isolation valves of fuel oil supply and return
- Isolation valve of fuel gas supply
- Isolation valve of snuffing steam
- Isolation valve of heater coil purge gas

(10) Manual shut-off valves for hot oil service should be located at an accessible position and away from the possible source of fire.

(11) Drain valves should basically be located so that operators can see the drain effluent while manipulating the valve. However, length of the dead end above the drain valve should be minimized to avoid sludge accumulation. Provide drain lines as straight as possible upstream of the drain valve. In the case of drain valve at the vessel bottom and pump suction, locate the drain connection at the lowest position of the either side of the pump suction, and upstream of the isolation valve.



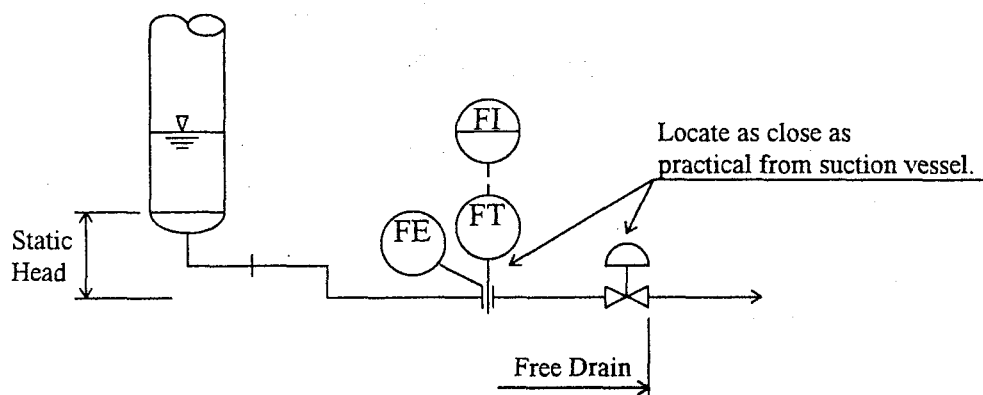
Drain Connection of Tower Bottom

- (12) Direction of the steam exhaust should be reviewed carefully, to avoid spray of live steam and hot water droplets on personnel.
- (13) Difference of thermal expansion should be considered when a continuous platform is supported by more than one structure.
- (14) Make sure insulation for personal protection is provided on the accessible part of hot lines such as the overhead vapor line and steam trap outlet to the return line.

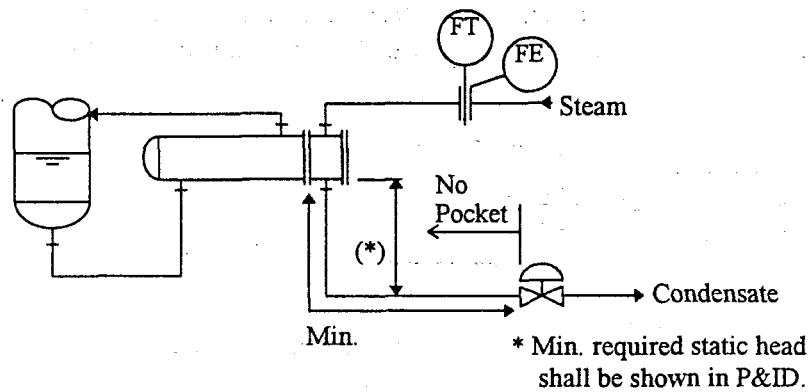
- (15) Sampling points should not be provided near firing facilities such as furnaces, boilers, incinerators, etc., and preferably grouped together so that sampling could be done easily.
- (16) Venting lines should be adequately extended to high elevation for safe discharge. Area classification sometimes requires the extension of a venting line more than 7.5 meters above the vessel. Confirm the applicable code and practice for the area classification on the vertical distance requirement. These venting points include;
- Chemical drum vent
 - Sump pit vent
- (17) Platforms should be designed to meet its function for maintenance work as well as operators' daily work. For instance, platforms for catalyst loading and unloading should be designed so that part of platform is removable to enable catalyst withdraw apparatus, such as a spout, to be installed.
- (18) **Chemical Loading**
- Spaces should be reserved for accesses by fork lift, carrying chemical drums.
- (19) Head of a coalescer, which cartridges are packed, should be directed to the open access area for cartridge maintenance.

4.2 Elevation of Equipment

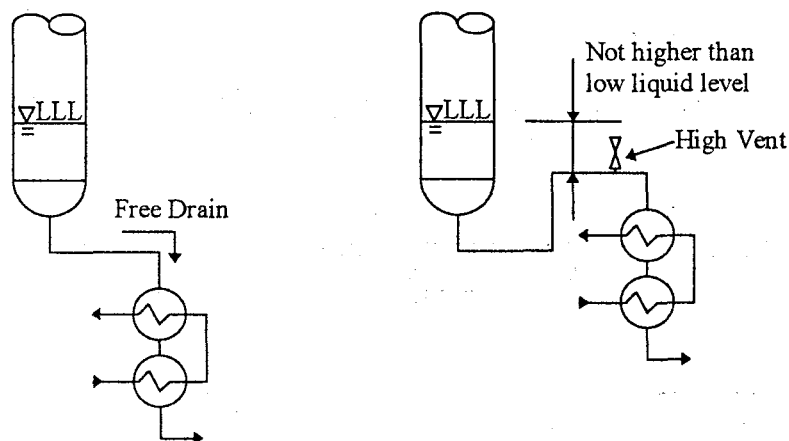
- (1) Check on the elevation of equipment and instruments so that it meets the process function.
- (2) **Static Head for Instrument**
- Provide sufficient static heads to avoid cavitation in the control valve and flow meter for handling of saturated liquid service.



- Control valve downstream of the steam reboiler should be located low enough and at a minimum distance from the reboiler so that flashing should not occur between the reboiler and control valve.



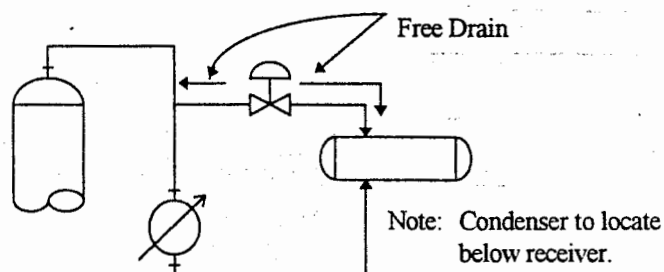
- (3) Free drain piping is desirable from tower bottom to heat exchanger. If there is a high loop, the maximum height of the loop should be limited to the low liquid level of the vessel. (Do not forget a high vent valve for liquid filling operation at start up)



Piping Layout around Tower BTMS Line

- (4) Confirm the elevation difference between the tower bottom and thermo-siphon reboiler to be provided to maintain the stable circulation of boiling fluid.

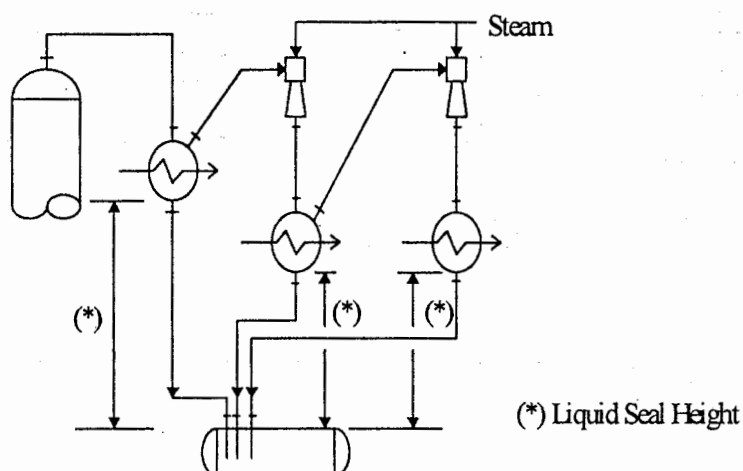
- (5) When a hot bypass control system is applied to the total condenser, elevation of the condenser should be low enough to meet the differential pressure between the tower top and overhead receiver. Free drain layout should be applied to the inlet and outlet lines of the control valve located on the hot bypass line, since allowable pressure drop of the control valve is small and accumulation of condensate will cause control malfunction.



Elevation of Total Condenser with Hot Bypass Control

(6) **Barometric Leg for Vacuum System**

Carefully review barometric seal height in the vacuum system which is liquid seal height between the ejector condenser and overhead accumulator as shown below.



4.3 Piping - General -

- (1) Check on applicable general rules.

- Are all instruments and valves accessible to the operator?
- Is there a drain at a low point and a vent at a high point?
- The plot plan has been prepared, based on the safety distance between equipment items as provided for in regulation and project specification.

However, it is not practical to incorporate all requirements for safety distance into the plot plan, for example, the location of shut-off valves at an emergency as shown in item 4.1-(9) & (10).

Such requirements should be confirmed by using the piping layout or engineering model.

- (2) Arrange **valves, blinds and instruments** at easy accessible and safe locations for maintenance.

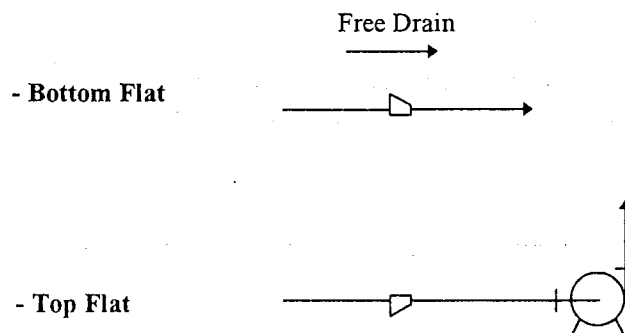
Connections for venting, draining, purging, flushing, etc., should be provided at the adequate positions where those work well.

Especially, in the complicated area where the large-scale valve manifolds and control valves are provided, pay the following attention to the maintenance space.

- The piping system having no spectacle blind is flexible to enable temporary blinds to be inserted.
- In the case of spectacle blinds, they should be accessible and easy to turn.

- (3) Arrange **gravity lines** to make liquids flow as smoothly as possible. Avoid high points.

- (4) Type of the **eccentric reducer** at the horizontal line should be checked to avoid accumulation of condensate or vapor.



Bottom Flat - Use at free drain lines such as flare header, to avoid liquid pockets.

Top Flat - Use at lines such as pump suction, where vapor pocket is not desirable.

Usage of Eccentric Reducer

- (5) In the case where **pocket piping** could not be avoided on the vapor line and there is the possibility of accumulation of liquid by condensing, overfilling or entrainment, consider the following improvements;

- Provide the boot with LG, and drain out accumulated liquid into flare
- Provide steam traces, if liquid would be easily vaporized by heating.