

Optimum Design of Packaged Skid for Oil & Gas Plant

HWANG-KEUN CHOI* AND H. SHIN**

*Hyundai Heavy Industry Co. Ltd., Ulsan, Korea

**Institute of e-Vehicle Technology University of Ulsan, Ulsan, Korea.

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ABSTRACT: *The use of packaged skid in oil and gas plant has increased dramatically over the decades, replacing loose supply equipment. Most equipment is installed on structural skid in manufacturer's shop. As Oil and Gas Plants are constructed at inaccessible area, the demands of packaged skids are increased. The packaged skid have advantages comparing to loose supply equipment in inaccessible area. The packaged skid is small complex plant consists of process, mechanical, piping, instrument, electrical and structural steel. This paper examines advantages and problems of packaged skid, based on previous experience. EPC company consider key factors such as manufacturing period, construction periods, equipment quality and costs.*

1.Introduction

The past few years have shown an increase in the number of user request for packaged skids. As oil price is higher, the demand of oil & gas plant market is increased and as oil resource is depleted in easy access area, most facilities are constructed in inaccessible area, swamp, island and deep sea. The purpose of packaged skid strategy is to enable the unit or system to be assembled as complete as possible and to minimize strip down of the assembled package prior to delivery such that subsequent re-assembly is minimized and to shorten construction period in bad site condition and to minimize problems during/after installation of equipment. The packaged skid is a single unit with all auxiliaries mounted on or within a structural skid. The equipment is fully piped and wired to the extent possible with piping terminating in skid edge flanges and instruments wired to skid edge junction boxes. In most package skid, a package consists of equipment, piping, electrical items, instrumentations & controls and steel structures. There are many engineering codes, design requirements, regulations and etc. that engineers and manufacturers should deal with when engineering or manufacturing of a packaged skid. The battery limit of packaged skid in an oil & gas plant is defined in early design stage prior to place contract with manufacturer. Manufacturer designs a packaged skid and fabricates or procures each components & equipment and then assembles each components & equipment on structural skid, then perform inspection & test as fully assembled packaged skid in manufacturer shop.

2.Design Philosophy

2.1 Design Philosophy

The design philosophy is to design , fabricate and install equipment that is ;

- Safe to operate,
- Exposes personnel on or off-site to the minimum level of hazards to health & safety
- Uses best available technology not entailing excessive cost with respect to environment emissions,
- Has a high level of availability and reliability
- Can be readily maintained by either skilled local operators or specialists available in the region.

2.2 The Procurement Strategy for Equipment is :

- To implement an execution strategy which will minimize the extent of erection, installation and commissioning work to be performed at site.
- This strategy has been formulated on the basis of experience gained on previous Projects and in recognition of the remoteness and inaccessibility of the Project site.
- In outline, the strategy requires that the equipment is constructed to the extent possible in pre-assembled packages and delivered to site requiring minimal site hook-up and commissioning.

2.3 Design Objectives

The design philosophy is defined by the following design objectives that have been set for items and packages of equipment:

- Equipment design and selection shall prioritize robustness over

technical sophistication. It shall preferentially select equipment requiring low levels of intervention, on the ease of and simplicity of operation and requiring the minimum use of consumables.

- Due to remote site locations, good reliability is preferential to high efficiency in the design and selection of equipment. The emphasis for equipment items and packages is to minimize the need for maintenance through selection of inherently reliable equipment.

- The design shall ensure that maintenance, when necessary, can be accomplished with minimum impact on production and with minimum exposure of personnel to health and safety hazards.

- The design shall incorporate features to ensure that the life cycle cost of the equipment is minimized.

- Design is to maximize off-site fabrication, construction, pre-testing and commissioning, and thus minimize on-site construction and commissioning time e.g. through application of integrated package design of facilities that can be fully tested off-site.

- The design shall ensure adequate flexibility to allow for future expansion of facilities.

2.7 Strategies for Achieving Design Objective

Objectives	Strategies
To ensure that the HSE standards are complied with	- Strict Compliance with Standards and guidelines - Comply with Safety & Health program
High Availability and Reliability	- Incorporate the project Analysis into the equipment specifications. - Use robustness design & equipment
Operability and Maintainability	- Simplicity of facilities by duplicating existing configuration to promote standardization. - Accessibility to perform inspection and maintenance by ensuring adequate spacing as well as work platform.
Minimum Onsite Construction, Testing and Commissioning works	- Procure equipment on Packaged basis - constructed to the extent possible in pre-assembled packages and delivered to site requiring minimal site hook-up and commissioning.
Minimize failures during equipment construction	- Carry out prevention inspection in manufacturer's shop. - Perform factory acceptance test as fully assembled packaged skid.
Interchange-ability of equipment	- Install standardized equipment where applicable

3. Packaged Skid

3.1 Types of Packaged skid

The skid fabricated with structural steel is the foundation frame of the equipment. Steel Structural Skid is designed and constructed to accommodate all equipment/items of package systems such as equipment, driver, piping, instrumentation and auxiliary system.

Types of Skids are selected based on equipment features, skid size limitation, transportation limitation, available lifting equipment, installation limitation and local regulation .

Most common types of skid are as follows ;

- Single skid
- Bolted skid
- Separate skid

In case of a single skid with dimensions or weights outside the limits, bolted skid or separate skid is used.

3.2. Skid Size Limitation

Generally, a structural skid is based on a single lift package not exceeding the following weight and dimensions for road transportation:

- Weight (shipping) 45 tonnes
- Length 9.0 m
- Width 3.7 m
- Height 4.6 m

3.3. Strength Calculation for Structural Skid

Mechanical skid calculation is performed to verify the soundness of structural skid in transportation, lifting, Test & operating conditions.

3.4. Arrangement and Package Layout

Package layout is optimized to achieve an arrangement with good access for operation, inspection and maintenance of all equipment, valves, instruments and other facilities and to compact arrangement of all equipment within skids.

1) The Package skid layout shall meet the following criteria:

- The equipment shall be arranged on the skids to provide maximum accessibility and safety for operations personnel during routine operation and maintenance.

- Meet local statutory safety standards
- Skid edge terminal points and junction boxes
- Full visual display of local gauge boards /panels

2) As far as feasible no part of the equipment, piping, instruments etc. shall overhang the edge of the skid.

3) Direct mounted instrumentation, (such as temperature & pressure gauges & Transmitters) will be self supported.

4) Run on-floor piping under the floor

Lines on the floor will be run under the floor grating to provide improved operating and maintenance access.

3.5. Supplement Design Requirement

- 1) Skids have floor grating covering the entire top surface.
- 2) Grating is in removable sections.
- 3) Skid mounted pressure vessels will either be welded or bolted to the skid base
- 4) Lifting lugs is attached to the skid.
- 5) A drip pan is installed and sloped to drain trough installed across the center of the skid and drained on each side.

Table 1 Specification of Packaged Skids

Applications	3rd Stage Reciprocating Compressor	Surge/Booster Reciprocating Compressor
Numbers of equipment & skid	Four(4) skids ; Compressor skid, Driver skid, Cooling skid, Auxiliary cooler.	One(1) skid ; All equipment including compressor, driver, scrubbers, cooler, cooling system, oil system, etc.
Fabrication Periods in shop	11 months FOB, Italy	13 months FOB, Canada
Transportation	Inland & ocean transportation	Inland & ocean transportation
Onsite Construction	Install each skid on foundation. Install interconnecting piping between skids. Install interconnecting wiring between skids.	Install a skid Install monorail hoist & its supports(shipped loose)
Advantages	Easy transportation, loading and unloading.	Inspect in fully assembled packaged skid. The volume of site installation is minimized. Consequently, reduced construction period.
Problems during Onsite Construction	Miss matching at tie-in points. Missing instruments installed on interconnecting piping	stolen material after installation
Site location	Island	swamp area

Table 2 Dimensions and Weight of Packaged Skids

Description	Type of Skid	Dimension (L x W x H, in m)	Weight (Tone)
Surge/Booster Compressor	Single Skid	13.7x6.7x5.7 (shipping HT ; 4.6m)	79.6
3rd Compressor	Separate skid	6.9x2.5x3.5	36
		2.2x1.6x2.5	11
		3x2.3x1.7	2.3
		3.8x1.3x3.6	1.3
Export Pump	Bolted Skid	32 x 10 x 3.8	25.5
		Sub-skid	40.8
		13.7 x 5 x 4.2	25.5
		14.6 x 5 x 2.1	33.7
		10 x 3.6 x 3.8	13.9
Air Compressor Package	Single Skid	8.5 x 3.7 x 4.7	22.3
Fuel Gas Coalescing Separator	Single Skid	3.1 x 2.3 x 3.2	3.2
Portable Water Treatment	Bolted Skid	7.8x6x2.1	62
		4x6x2.1	
		1.9x6x2.1	
Chemical Injection	Single Skid	6x4x1.9	25
Service Water Pump	Single skid	6.1x4.5x2.7	10.4



Photo 1 Fully Assembled Packaged Skids - Surge/Booster Compressor Package ; ready for packing.

3.6. Problem Analysis

The investigation was conducted to identify and evaluate the factors that contribute to problems raised during oil & gas plant construction. The data were taken from Non-Conformance Reports of three(3) projects, issued from Quality Management Department.

The results of this investigation is summarized below in Figure 1.

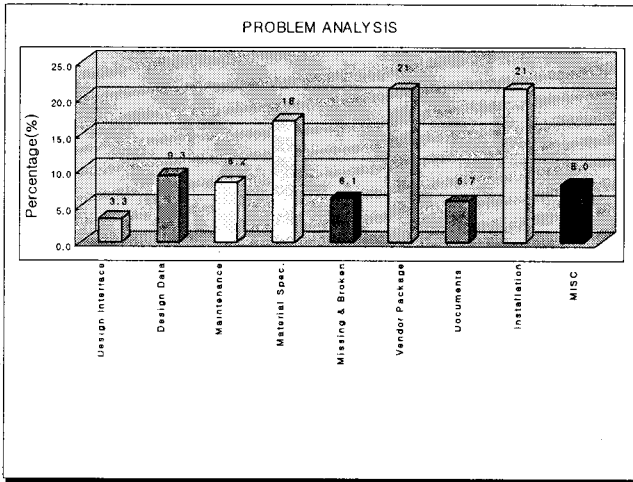


Figure 1 Problem Analysis of a Gas & Oil Plant

As illustrated, vendor package was identified to be a main cause of problems during oil & gas plant construction.

Table 3 Kinds of Problems in Packaged Skids

Category	kinds of problems	How to inspect
Operability and Maintainability	Not accessible to instruments. Platform & ladder is not installed	by visual inspection
Material	Galvanic corrosion	by visual inspection
Customer Spec. & requiremen	Different reservoir capacity. Different design philosophy	by functional test
Interference & Dimension	Miss Matching tie-in point	By dimensional inspection together with check list
Missing & Broken	Instrument was not installed	By visual inspection
Documentations & As-Built	Modified part at vendor shop was not reflected	by prevention inspection

4. Results and Discussions

In actual project, there are so many factors and variations impacts to schedule, mechanical soundness and performance

of equipment. These factors and variations will results in delayed progress and problems.

we pursue both reduced construction volume/periods and decreased defects of delivered machinery and equipment for oil & gas plant. This purpose can be achieved by design of packaged skid when proper inspection & tests are provided.

The increased inspection and test are quite essential factors for packaged skid in order to meet the purpose of packaged skid.

A Economic justification for complete packaged skid ;

- Reduce construction periods in Project site,
- Enhance quality of complete packaged skid,
- Reduced new procurement or re-procurement,
- Reduced modification, repair works in project site, consequently, cost save.

5. Conclusions

As indicated in this paper, the problems are still happened in packaged skid. But when properly applied together with increased inspection & tests, package design can result in the resolution of chronic field problems, reduced installation periods & costs, and improved equipment reliability and availability.

The design philosophy for packaged skid is applicable to most oil & gas plant, but each package should be evaluated on a case by case basis in provided conditions to achieve better applications.

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