

PRE-START UP SAFETY REVIEW BY THE EPC CONTRACTOR

Rigolio Maurizio
Design HSE Head of Department

Federica Di Vito
Design HSE Manager

Month, Year





SUMMARY

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 3. PSSR by the EPC Contractor: a case study
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 7. PSSR findings and close-out
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INTRODUCTION

In March 2005, during the startup of an isomerization unit, the BP Texas City refinery suffered a major disaster that killed 15 and injured 180 others.

BP hadn't properly conducted safety critical checks.

The U.S. Chemical Safety and Hazard Investigation Board investigators found:

- an inoperative pressure control valve,
- a defective high-level alarm,
- an uncalibrated sight-glass level transmitter,
- portable trailers with non-essential personnel located too close to the process.

Properly performed **Pre-Startup Safety Review** would have prevented this event.



INTRODUCTION

Pre-Startup Safety Review (PSSR) is a formal process to ensure that plants and facilities conform to HSE requirements, that relevant safety, operating, maintenance and emergency procedures are in place and that all process hazard analyses recommendations have been implemented, before startup.



Effectively conducted PSSRs can prevent incidents and the resultant harm to personnel, equipment damage and loss of production and profits.
PSSR is a critical element of the process safety management.

The PSSR is not for the purpose of checking fundamental design parameters.

E.g., PSSR does not answer the question “is fire protection adequate?”, it can and should check that fire protection was considered in the design, that any recommendations made in respect of fire protection in previous design and process hazards reviews have been implemented, and it should sample the coverage and condition of fire protection as installed during the plant walkthrough.



PSSR: THE RESPONSIBILITY OF THE EPC CONTRACTOR

WHERE PSSR FITS WITHIN THE PLANT MODIFICATION PROCESS?

For simpler projects

PSSR typically sits after construction completion and before the introduction of hazardous substances. Normally it is associated with handover from the construction organization to plant operations.

For larger capital projects

Several PSSRs may be required where different modules of process and utilities are brought into operation at different stages of commissioning.

For example, a PSSR before commissioning (“RFC - readiness for commissioning”), between commissioning and startup (“RFISU - readiness for initial startup”) and between startup and full hand over (“RFSU - readiness for startup”).

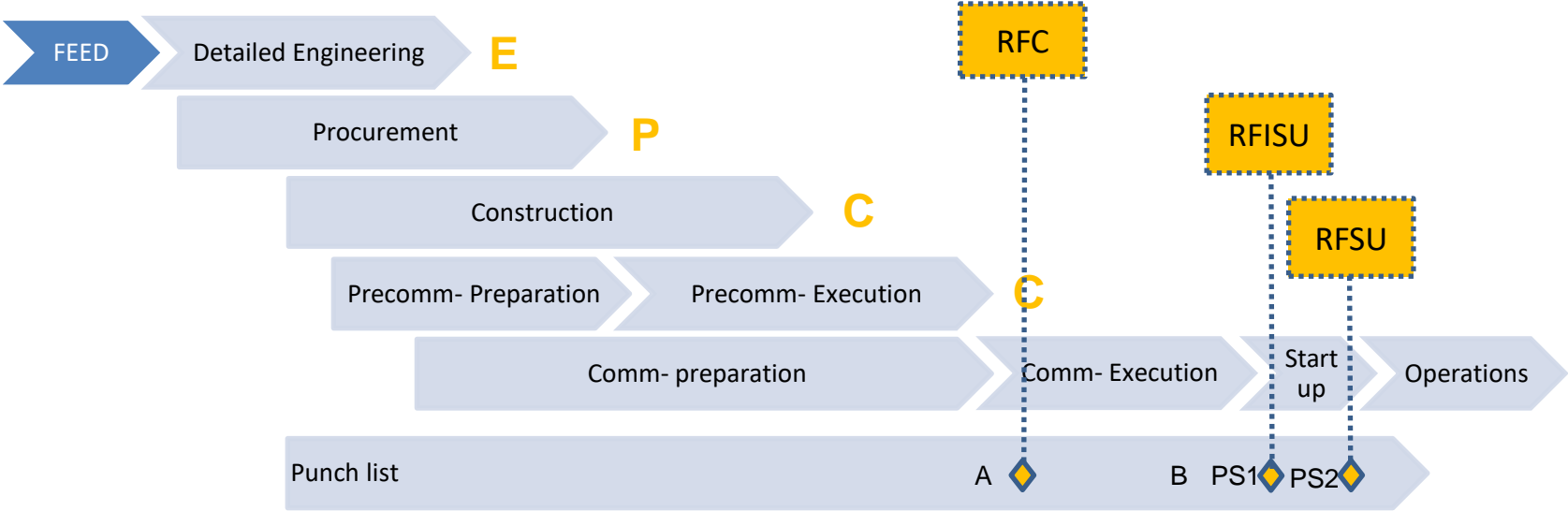
For complex projects a PSSR should be carried out before utilities are allowed into the plant. Steam and electricity, for example, are both hazardous and sources of energy.



IN BOTH CASES THE EPC CONTRACTOR PLAYS A FUNDAMENTAL ROLE IN PROPERLY
PLANNING, REFERENCING, PERFORMING, REPORTING AND FOLLOWING UP THE PRE-START
UP SAFETY REVIEWS



PSSR: THE RESPONSIBILITY OF THE EPC CONTRACTOR



RFC = Ready for Commissioning
RFISU = Ready for Initial Start up
RFSU = Ready for Start up



PSSR: THE RESPONSIBILITY OF THE EPC CONTRACTOR

Tecnimont Organizational Procedure PR-D12 “*Design HSE Health at Work, Safety and Environmental Protection*” defines the responsibilities and the criteria to be followed in the development of the project design, as far as health at work, safety and environmental protection (HSE) are concerned, as well as the activities to be performed by Design HSE Department to ensure that HSE criteria are duly implemented and incorporated.





According to PR-D12, the Pre-Start up Safety Review for each project shall be included in the HSE Plan

A dedicated guideline to perform the review, including a sample check list, is provided by the internal Work Instruction S1-PM-023 “*Pre-Startup Safety Review*”.



PSSR: THE RESPONSIBILITY OF THE EPC CONTRACTOR

 Tecnimont S.p.A.	Organizational Procedure	PR-D12 Is.11 Page 1/16
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 SICIM	Work Instruction	S1-PM-023 Rev 1 Page 1/19
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DESIGN HSE HEALTH AT WORK, SAFETY AND ENVIRONMENTAL PROTECTION

PRE-STARTUP SAFETY REVIEW (PSSR)

MOD-PR-E-IN-5




11	28-Dec-15	General Revision	 M. Rigollo	 S. Pagli	 E. Rolandelli	 F. Bosia
10	30-Jun-2011	Revised where indicated	E. Kulot		G. Natali	F. Bosia
Issue	Date	Revision Description	Prepared SICIM	Approved TEIPA	Authorized DIREP	Issued QUAS

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Rev. 1 Issued by QUAS
S. Pagli

The present WI supersedes the SZ-SR-100

MOD-WI-E-IN-2

2					
1	30-06-2015	First Issue	 D. Marucco	 M. Rigollo	 S. Pagli
Revision	Date	Revision Description	Prepared	Approved	Authorized

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PSSR: THE RESPONSIBILITY OF THE EPC CONTRACTOR

 SICIM	Pre-Startup Safety Review (PSSR)	S1-PM-023 Rev 4 Page 7/19
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CHECK ITEMS	DESCRIPTION / SUGGESTIONS
Safety equipment	Check installation of Safety Equipment (eg. safety points, fire suits, first aid kits, breathing apparatus) against HSE Equipment Layout.
	Check availability of Personal Protective Equipment for operators and visitors.
	Check provision of windsocks installation.
	Check that MSDSs are available in control room.
Signage and TAGs	Check provision of safety warning signals (e.g. Forbidden access to enclosure/equipment having potential inert gas atmosphere, ear protection requirement, eye protection requirement, etc.).
	Equipment and Piping Marking for hazards identification of contained materials.
	Routine Fire Notices displayed at all Fire Extinguisher Points/Manual Fire Alarm Operating Points.
	Pipe line/equipment color coding provided & correct.
Transformers	Check that equipment / vessels / plant / utilities etc. are correctly labeled / tagged.
	Check guards installation to protect personnel from accidental contact with energized parts.
	Fencing Completed.
Assemble Points Identified	Gate Secured and provided of Warning Notices Displayed (including Emergency Numbers).
Layers/Paving/Slopes	For both fire and toxic gas releases.
	Check that no bituminous layers under tanks containing flammable or oxidizing liquids.
	Check that no incompatible paving material under tanks containing acids or alkalis.
	Check provision of slopes under or around the tanks (towards impounding basin or drainage pits) and in the process area (from center to the trench or drainage pits).
Containment	Check that floor is rubberized (where required).
	Check prevention of spillage over passing of the curb: storage height, curb height, distance storage-curb and if necessary, provide for supplemental guard around the tank bottom.
	Inquiry of areas requiring any sort of additional containment (loading racks, loading/unloading areas, vessels).
	Confirm that storm water sewer is directed to evaporation basin or to Effluent Treatment Plant.
	Bund/dike wall around equipment/tank installed.

MOD-MS-E-Rev.2

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PSSR: THE RESPONSIBILITY OF THE EPC CONTRACTOR

Based on WI S1-PM-023, the PSSR must confirm the following:

- Construction and equipment are in accordance with design specifications;
- Safety, operating, maintenance, and emergency procedures are in place and are adequate;
- Process hazard analyses have been performed, recommendations have been resolved or implemented before startup, and modified facilities meet the management of change requirements;
- Training of each employee involved in operating a process has been completed.

EPC Contractor shall ensure accomplishment of the following operational steps of Pre-Startup Safety Review:

- Step 1 Planning (project schedule, participants, etc.)
- Step 2 Referencing (standards, codes, project specifications, etc.)
- Step 3 Performance
- Step 4 Reporting (subject, action, responsibility, etc.)
- Step 5 Follow up.



PSSR: THE RESPONSIBILITY OF THE EPC CONTRACTOR

Timing

The PSSR shall be performed at Site as close as possible, but prior to the Mechanical Completion, when the following systems are in place:

- Fire Protection Systems,
- Fire/Gas Detection Systems,
- Emergency Blow Down and Flare Systems.

According to the construction progress and contractual requirements it may be decided to cover the PSSR in a single session or in two or even more sessions.

Review Team

The PSSR shall be conducted by a Review Team, including as a minimum the following participants:

- HSE Review Coordinator, also responsible for the final reporting;
- Process Manager/Engineer;
- Project Engineer or Field Engineer;
- Any representative of the Licensor/Owner, on the basis of contractual requirements.



PSSR: THE RESPONSIBILITY OF THE EPC CONTRACTOR

Performance

During the PSSR session it shall be ensured that both the “Field Review” and “Documentation & Operating Procedure Review” are covered.

The Check List template to be used during the review should be provided to the Review Team in advance, to allow familiarization with the covered topics.

Each subject shall be covered by the Review Team through the assigned specialist, according to experience and competences. Assistance to the Review Team shall be ensured by the Site personnel.

Follow Up

According to project specification and to Licensor/Owner requirements, the EPC Contractor shall define how to record and how to manage the raised recommendations and the concerned follow-up and close out.



PSSR BY THE EPC CONTRACTOR: A CASE STUDY

Tecnimont S.p.A., international leader in the field of petrochemical plant engineering, in joint venture with a Chinese contractor, was appointed by the national oil & gas company as EPCC contractor of a 400,000 tons per year High Density Polyethylene (HDPE) licensed plant in Malaysia.

The HDPE Plant was a fundamental component of the overall 27 billion USD investment made for a world scale integrated refinery and petrochemicals complex, designed to meet both domestic and Asia's energy and chemicals demand, yielding an estimated annual production capacity of 3.6 million tons of petrochemical products.

The Pre-Startup Safety Review (PSSR) process for the HDPE Plant started in the second quarter of 2019, after the achievement of 80% mechanical completion and continued up to the end of the year, when the Ready for Start-Up (RFSU) certificate for Hydrocarbon-In was released.



PSSR BY THE EPC CONTRACTOR: A CASE STUDY



HDPE Plant aerial view



PRE-START UP SAFETY REVIEW PROCESS

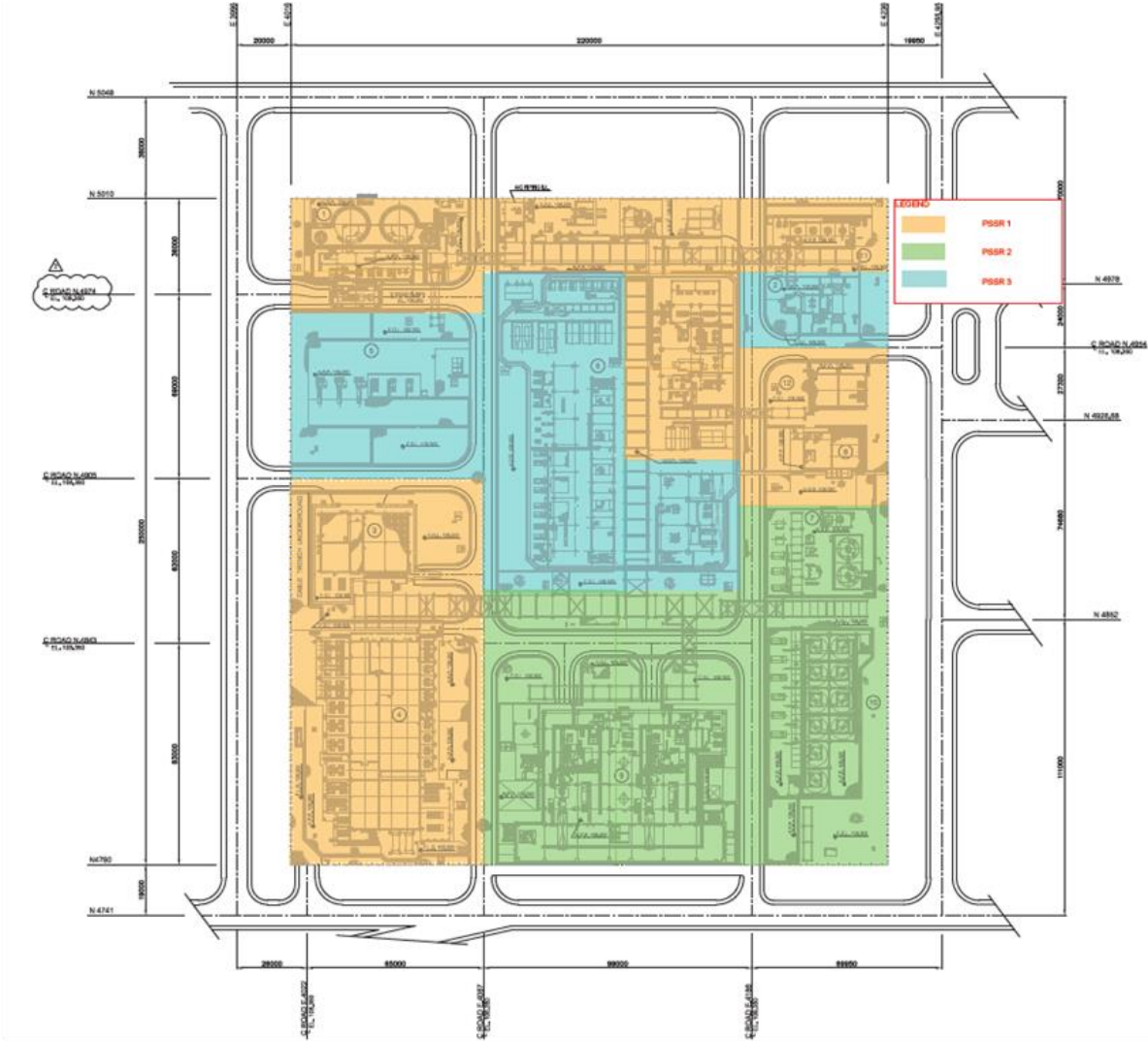
In compliance with contractual requirements, two different PSSR Reviews were performed in series, both managed by multidisciplinary Review Teams: the first one involved Licensor's representatives and Contractor's representatives, while the second one involved Owner's representatives and Contractor's representatives.

The reviews were covered in three sessions each, focused on the three macro-areas identified based on the planned start-up sequence of the different process units:

- Hexane Storage and Hexane Distillation Section
- Extrusion and Dry-end Section
- Polymerization and Polymer Drying Section



PRE-START UP SAFETY REVIEW PROCESS



PSSR Macro areas



PRE-START UP SAFETY REVIEW TEAM AND GUIDELINES

The **LICENSOR'S PSSR** was conducted by a Review Team including HSE, Design and Operation Specialists from both Contractor and Licensor, led by **Licensor's Process Safety Manager**.

As-built facilities were checked against Licensor's General HSE Design Criteria and Criteria pertaining to the specific licensed HDPE technology.



The **OWNER'S PSSR** was performed by a Review Team including HSE, Design and Operation Specialists from both Contractor and Owner, led by **Owner's Central Directorate Operations Manager**.

A multidisciplinary PSSR checklists, was developed by Owner, to help in guiding the discussions.



PRE-START UP SAFETY REVIEW TEAM AND GUIDELINES

Each subject was covered by the Review Team through the assigned Specialist, according to experience and competences and with Site personnel assistance.

The following design documentation was made available to support the Review:

- Active and passive fire protection philosophies and layouts,
- Fire and Gas philosophy and layouts,
- Hazardous Area Classification philosophy and layouts,
- Quantitative Risk Assessment,
- P&IDs,
- Management of Change log,
- PHA's action items close-out.



PRE-START UP SAFETY REVIEW TEAM AND GUIDELINES

- | | |
|------------|--|
| Host.6.1.6 | The TEAL dilution vessel shall be installed in a bund and separated with a fire resistant wall from the TEAL unloading building. |
| Host.6.1.7 | The relief valve discharge of the TEAL dilution vessel shall not be routed to the flare. In case this is really the only possibility, the discharge of the TEAL dilution vessel relief valve, in case of fire, shall be minimised by installing high quality fire proofing around the vessel (see API 521). |
| Host.6.1.8 | <p>For the reactors, fast EDP valves shall be installed, air failure closed, to depressurise from the control room in case of the mechanical seal leakage and not for bleve. The reactors shall have the following safe guards to protect against bleve in addition to the already foreseen cooling water jacket;</p> <ul style="list-style-type: none">- safety valve calculated for the fire case.- fire and hydrant proof insulation provided also for the bottom and for all the parts that may be exposed to the fire. |
| Host.6.1.9 | All other equipment in the Hostalen process, except for the Butene recovery tower in ACP, shall be considered as exceptions to the general requirement Gen.11.51 (EDP valves to protect against Bleve). I.e. EDP valves to protect against bleve are not required due to other safe guards. |

Sample of Licensor's guidelines checked in as-built



PRE-START UP SAFETY REVIEW TEAM AND GUIDELINES

Pre-Start up Safety Review Checklist

Package/Unit

Date :

No	PSSR Questions	Check?		
		No	Yes	NA
A	FIRE SAFETY			
1	Has BOMBA inspection been conducted? Has the CCC been approved and issued?			
2	Have the fire protection systems been provided and tested at site? These includes smoke, fire and gas detection, manual call point, fire alarm panel, fire damper, beacon light and sounder.			
3	Have manual deluge valves, hydrant isolation valves, and hydrant nozzle valves been opened and closed under operating pressure?			
4	Has the hydrant pressure-regulating devices been calibrated and tested?			
5	Have firefighting equipment, manual call points, abort switches, fire and gas detectors been labelled correctly?			
6	Have bund walls, dikes and remote impounding basins been isolated? All rainwater drain valves are in CLOSED position?			
7	Have access to Fire Alarm Panel, INERGEN Panel, INERGEN cylinders and Fire & Gas controls been restricted / locked?			
8	Are certified fire doors provided as per the required rating?			
9	Have the fire extinguishing systems been provided and tested at site? These includes portable fire extinguishers, wheeled DP extinguishers, hose reels, water curtains, INERGEN, dry powder, monitors, deluge/spray/sprinkler systems, and foam systems.			
10	Have access to all fire extinguishing systems been cleared of obstruction e.g. scaffolding, plastic cover, construction debris?			
11	Have high risk rooms such as battery room, electrical room and ENMC room been cleared of combustible material? Are these still being used as temporary storage?			
12	Have traffic barricades and security gates been installed to control vehicle access into Hazardous Classified Areas?			
13	Have escape routes (including exit doors, staircase and landing area) been cleared of obstruction, illuminated and marked?			
14	Has the inventory inside fire hose boxes and fire extinguisher cabinets been checked against its equipment list and its door sealed against theft and abuse?			
15	Are portable fire extinguishers provided with valid certificate of inspection?			
16	Have all roadside hydrants and monitors been provided with traffic bollard and paved grade for CEFS PIC accessibility?			
17	Has a joint site inspection been conducted with CEFS for occupied buildings and high risk buildings e.g. substation?			
18	Have all plastic cover for smoke, gas or flame detectors been removed? These plastic covers were used to protect against damage and debris during construction.			
19	Has KELUAR/EXIT signs and other safety signage been installed? If these were lighted, has emergency power supply been tested?			
20	Has the foam inventory been provided in the right amount and concentration? Has it been sighted and acknowledged by CEFS?			
21	Has hydrants and firewater ring mains been hydrotested?			
22	Has the surface drainage and oily sewers been cleared of debris?			
23	Has fireproofing coating/concrete been inspected and is intact?			
24	Has the fire truck and dry riser connections been tested by CEFS?			
25	Has an emergency assembly area or a muster point been designated? Can it be accessed directly by fire truck and ambulance?			
26	Are sufficient escape set or SCBA provided as per design?			

Owner's PSSR sample checklist



PRE-START UP SAFETY REVIEW EXECUTION

The PSSR sessions started with a tabletop discussion, aimed at the clear identification of session's scope, the review of related design documents and the planning of site visit.

The site visit focused on actual implementation at site of items discussed tabletop and on verification of physical readiness of the units in terms of, but not limited to:

- availability and adequateness of escape routes throughout the Plant,
- review of fire protection and fire detection systems installation,
- review of safety equipment installation i.e., safety showers, eye washes, first aid boxes, escape packs, self-breathing apparatus, fire suits etc.
- check of other critical installations, such as process safety devices discharging to atmosphere, sampling points, air intakes, Public Address General Alarm system, etc.
- check of housekeeping.

For each item the Review Team determined implementation adequateness to allow the unit to be safely started-up.



PRE-START UP SAFETY REVIEW FINDINGS AND CLOSE OUT

When substandard conditions were identified during the PSSR, the Review Teams proposed corrective actions, called **RECOMMENDATIONS**, to be properly addressed to ensure that all potential hazards were eliminated.

For each session, reports were prepared by the Review Team Leader and issued with the photographic evidence reference of the items not in compliance with guidelines i.e., findings, and the indication of the recommendations to be applied.

All PSSR recommendations were categorized based on Severity as per Risk Assessment Matrix (RAM).

		SEVERITY	1 Insignificant	2 Minor	3 Moderate	4 Major	5 Catastrophic
		People	Slight Injury	Minor Injury	Major Injury	Single Fatality	Multiple Fatalities
		Environment	Slight Impact	Minor Impact	Moderate Impact	Major Impact	Massive Impact
		Asset	Slight Damage	Minor Damage	Local Damage	Major Damage	Extensive Damage
		Reputation	Slight Impact	Limited Impact	Considerable Impact	Major National Impact	Major International Impact
LIKELIHOOD	E Almost Certain	Incident has occurred several times per year	E1	E2	E3	E4	E5
	D Likely	Incident has occurred more than once per year	D1	D2	D3	D4	D5
	C Possible	Incident has occurred more than once per year in industry world wide	C1	C2	C3	C4	C5
	B Unlikely	Incident has occurred in industry, world-wide	B1	B2	B3	B4	B5
	A Remotely likely to happen	Never heard of in industry world-wide but could occur	A1	A2	A3	A4	A5

* For chronic health effects



PRE-START UP SAFETY REVIEW FINDINGS AND CLOSE OUT

The overall **832 RECOMMENDATIONS** were prioritized by assigning risk ranking in accordance to the following criteria:

- all PSSR recommendations under Severity Rating 3, 4 or 5 were categorized as **PS1 i.e., to be closed before start-up**
- all PSSR recommendations under Severity Rating 1 or 2 were categorized as **PS2 i.e., to be closed after start-up.**



LICENSOR'S PSSR RECOMMENDATIONS SUMMARY

PSSR Session	PS1 Nos	PS2 Nos
Session 1	23	-
Session 2	26	-
Session 3	35	10

OWNER'S PSSR RECOMMENDATIONS SUMMARY

PSSR Session	PS1 Nos	PS2 Nos
Session 1	189	58
Session 2	144	42
Session 3	228	77



PRE-START UP SAFETY REVIEW FINDINGS AND CLOSE OUT

PSSR recommendations were tracked and monitored internally through Contractor's mechanical completion database management system, using the existing punch-list template, and through a dedicated register.

17. 400 – Teal Feed Pump Gen.10.1.18 At least two means of egress, 75 cm minimum width, shall be provided from all process areas handling flammable materials larger than 20m ² (200ft ²) or where direct egress is hampered by equipment containing flammable materials.	Teal feed pumps are installed in an enclosure with only one mean of egress. The area is around 40m ²	A	PSSR 2: Client added a second mean of egress on the opposite side. Reference on Appendix 2	CLOSED
18. 400 – Teal Unloading arms: PDP note: Necessity of the nitrogen blanketing of the weep holes on swivel joints (to prevent product leakage to the atmosphere) shall be verified by vendor	Nitrogen blanketing is strongly recommended by Licensor but it has not been provided. TCM to confirm that it has been verified with vendor	A	Client reported that Nitrogen blanketing has been provided as per Licensor request.	CLOSED

Sample close-out register from Licensor's PSSR

Status of all PSSR recommendations, PS1 and PS2, was updated on weekly basis. Licensor and Owner respectively confirmed closure of recommendations upon provision of relevant evidence.

The PSSR was officially closed out once all findings were closed out through specific agreed resolution.



PRE-START UP SAFETY REVIEW FINDINGS AND CLOSE OUT



After PSSR



PRE-START UP SAFETY REVIEW FINDINGS AND CLOSE OUT



Before PSSR



After PSSR



PRE-START UP SAFETY REVIEW FINDINGS AND CLOSE OUT



Before PSSR



After PSSR



CONCLUSIONS

The Pre-Startup Safety Review is a powerful tool to allow for proper identification and filling of gaps related to HSE requirements.

More than 800 recommendations were identified for the Licensed HDPE Plant and the performance and close-out of the PSSRs required the effort of the overall Project's Team.

The HDPE Plant RFSU certificate for Hydrocarbon-In was achieved once all PS1 were closed-out and the Hydrocarbon-In was safely performed with no incidents and no equipment damage on 31st December 2019.



PSSR Team

Maire Tecnimont Group's Headquarters

*Via Gaetano De Castillia, 6A
20124 Milan
P. +39 02 6313.1
F. +39 02 6313.9052
info@tecnimont.it*



tecnimont.it



