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Simultaneous Operations Risk Assessment

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Simultaneous Operations (SIMOPS) occur when two or more potentially conflicting activities are being executed in the same location at the same time.
The present paper describes the SIMOPS risk assessment process carried out during commissioning of new petrochemical complex in order to properly manage additional risks deriving from concurrent activities.
The SIMOPS risk assessment was conducted through several dedicated meetings, with participation of multidisciplinary attendees by all project's involved parties. The resulting hazards were assessed and proper preventive and protection measures identified to reduce the related risks to As Low As Reasonably Practicable (ALARP) level. The mitigation actions were continuously reviewed according to work site progress and their implementation on field was punctually monitored.
Thanks to SIMOPS risk assessment process, together with daily implementation of "safety first" program, the project finally reached 65 mil worked manhours without LTI (Lost-Time Injury), a remarkable achievement in this field.

1. Introduction

Simultaneous Operations (SIMOPS) is the execution of two or more tasks by two or more functional groups on the same location at the same time.
In the Oil&Gas and Petrochemical industries SIMOPS takes place specifically when activities from construction, commissioning, start-up and production operations are being carried out simultaneously. In this regards, in addition to hazards concerned to each single task, additional risks can be generated due to simultaneous execution in the same area.
In order to identify potential hazards and to eliminate, minimize or managed the risk associated with SIMOPS, dedicated risk assessment process shall be put in place involving all project actors, typically: plant owner, project management consultant (PMC), main contractor, subcontractors and vendors.

2. Project Overview

Tecnimont, Italian company leader in Engineering and Construction part of Maire Tecnimont Group, in joint venture with a Korean E&C company, was awarded by a Middle East leading provider of plastic solutions for turnkey EPC (Engineering, Procurement and Construction) megaproject in UAE. The project, with an approximate value of 1.65 USD billion, represented the largest Polyolefins plant ever built by the Italian company and one of the largest in the world.
The plant was composed by five process units, in particular:

- Two Polyethylene Units (PE) of 540,000 t/y each;
- Two Polypropylene Units (PP) of 450,000 t/y each;
- One Low Density Polyethylene Unit (LDPE) of 350,000 t/y through an high pressure technology with unique high quality requirement to achieve an extremely clean product for high technology applications.

The new complex, with a total surface of about 1 km^2, involved more than 11,000 workers at the peak of site lifetime.
In the fourth quarter of 2013, when the first unit reached the commissioning milestone "hydrocarbon-in", the site changed skin. From pure construction site, it becomes commissioning and construction site, with huge impact on organisation and management of the activities to be carried out both inside the unit ready for hydrocarbon introduction and in the adjacent ones.

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Figure 1: Plant overview

The introduction of hazardous substances like hydrocarbons, in five adjacent process units at different stages, required advanced detailed SIMOPS analysis to prevent any possible accident, putting in place all the necessary countermeasures to allow construction, commissioning and start-up activities to be carried out simultaneously in the same area.

3. SIMOPS Risk Assessment Process

Purpose of the SIMOPS risk assessment process was to review and evaluate in detail the simultaneous construction, commissioning, start-up and operations activities planned, with the final aim of:

- Identifying the additional hazards introduced by the SIMOPS;
- Assessing the relevant level of risk;
- Verify the adequacy of the planned control measure;
- Identifying additional risk reduction measures;
- Provide input to Permit To Work process for embedding additional controls.

All the project's parties as plant owner, PMC, main contractor, subcontractors and vendors were actively involved in the entire SIMOPS risk assessment process.

3.1 SIMOPS Assessment Study Workshop

The SIMOPS assessment study workshop is the initiator event of SIMOPS risk assessment process, the key moment to share necessary information and to proper coordinate the involved parties.

Participation of a multidisciplinary study group from all project's actors was a mandatory requirement. Presence of following roles was requested: construction manager, commissioning manager; operations representatives, site HSE manager, process and process safety specialists. The workshop was led by SIMOPS facilitator, having the responsibility to moderate and to stimulate the discussion between participants.

Due to the fact that SIMOPS assessment is strictly related to the plant area where simultaneous operations are carries out, different SIMOPS workshops were executed according to planned simultaneous activities and related plant location.

During each SIMOPS workshop the below steps were undertaken under the guidance of the SIMOPS facilitator:

- Identification of the SIMOPS scenarios, means identification of the concurrent activities to be carried out during hydrocarbon introduction;
- Identification of the related hazards;
- Evaluation of the risk of simultaneous execution of the activities;
- Identification of control measures and/or operating procedures already planned and consequent assignment of the responsibility for their implementation;
- Evaluation of the residual risk with risk control measures already in place;
- Identification of additional risk control measures, if required;
- Assignment of responsible person for the implementation of identified countermeasure.

In addition to the above, during the workshop propaedeutic documentation was made available as follows:

- Updated schedule of construction, pre-commissioning, commissioning and start-up activities;
- Process Flow Diagrams (PFD) and Piping & Instrumentation Diagrams (PID);
- Plant layouts and equipment layouts;

- Material Safety Datasheet (MSD) of handled substance;
- Hazardous areas classification drawings;
- Detail regarding manning level and worker distribution on area involving SIMOPS;
- Layout showing Permit To Work areas;
- Layouts showing location of temporary construction devices as: crane, diesel generator, welding machines, scaffolding, etc.;
- Quantitative Risk Assessment (QRA) and consequence analysis developed during detailed design.

3.2 SIMOPS Scenario Identification

First step of the SIMOPS workshop is the identification of the SIMOPS scenario, type and schedule of activities to be performed simultaneously is the key information to be shared and discussed.
According to starting date of hydrocarbon introduction in a certain process unit, specialists from construction and commissioning pointed out the activities planned to be executed in the same area involved by the introduction of hydrocarbons. Example of typical site activities is reported in below Table 1.

Table 1: Typical site activities

Construction Activities	Pre-Commissioning Activities	Commissioning Activities
Excavation	Energisation / Motor solo run	Hydrocarbon-in
Hydro tests	Water Flushing	Run-in
Insulation	Air blowing	Inerting / Purging
Road construction / asphalting works	Air blasting	Leak test
Cold work (pipe fitting, mechanical works, etc.)	Steam blowing	
Hot works (welding, grinding, etc.)	Leak test	
Scaffolding	Oil flushing	
Painting	Chemical cleaning	
Lifting operations	Alarm testing / Instrument check	
Tie-in work / Hot tapping		
Electrical & Instrumentation works		
Vehicle entry		
Confined space entry		
Non destructive testing		
Civil Works		

3.3 SIMOPS Hazard Identification

Dedicated hazard identification was carried out per each SIMOPS scenarios. Discipline specialists provided detailed information regarding the planned activities concurrent with hydrocarbon-in, as: starting date, special tools to be used, manpower involved, affected area, duration, etc.
Thanks to above information, together with structured guidewords approach leaded by SIMOPS facilitator, the discussion was stimulated to proper indentify hazards associated to each SIMOPS scenario. Particular attention was aimed to the additional hazards coming from the contemporary execution of the two activities. The below Table 2 reports a list of hazards considered during the workshop.

Table 2: SIMOPS hazards

Transportation	Toxic handling / Toxic release	Noise
Dropped object	Chemical and catalyst handling	Electrical
Crane operations	Gas leak	Ignition source
Heavy lifting	Working at height	Explosion
Severe weather conditions	Confined spaces	Communication
Desert conditions (dust, mud)	Welding / Grinding	Access / Escape Route
Misoperation	Uncontrolled person entrance	

3.4 SIMOPS Risk Evaluation and Risk Assessment

In accordance with HSE (Health Safety Environment) management system of the plant owner, the risk associated to each identified SIMOPS scenario was evaluated through semi-quantitative risk assessment method as per below risk matrix.

					Probability				
					A	B	C	D	E
Severity	**People**	**Assets**	**Environment**	**Reputation**	Improbable 1 in 100,000 years	Remote 1 in 10,000 year s	Occasional 1 in 1000 years	Probable 1 in 100 years	Frequent 1 in 10 years
5. Catastrophic	Multiple fatalities or permanent total disabilities	Extensive damage	Massive effect	International impact			HIGH RISK		
4. Severe	Single fatality or permanent total disability	Major damage	Major effect	National impact					
3. Critical	Major injury or health effects	Local damage	Localised effect	Considerable impact			MEDIUM RISK (ALARP REGION)		
2. Marginal	Minor injury or health effects	Minor damage	Minor effect	Minor impact					
1. Negligible	Slight injury or health effects	Slight damage	Slight effect	Slight impact		LOW RISK			

Figure 2: Semi-Quantitative Risk Assessment Matrix

The risk matrix is divided into three risk categories as defined below:

- High Risk – this level of risk exposes to intolerable losses to people, assets, environment or reputation; the hazard should be eliminated or its risk reduced to tolerable levels immediately.
- Medium Risk – acceptable but must be managed at ALARP; the hazards must be managed to reduce the frequency and/or the severity of the hazardous events to ALARP (as low as reasonably practicable), the words “reasonably practicable” imply that the solution must be capable of implementation and that the benefits should be greater than the disadvantages and costs.
- Low Risk – acceptable without requiring further action; corrections may be applied as resources allow.

Two different risk levels were assessed. The first was set without considering any risk reduction measures, and the second one taking credits from control measures and operating procedures existing or planned to be carried out during the execution of the concerned activity. If the risk level mitigated by planned countermeasure was still high or in ALRAP region of the above risk matrix, additional risk reduction measures were identified by workshop members in order to further control and reduce the associated risk.

To each identified countermeasure the subject responsible for its implementation was defined and agreed by all team member. Its name was clearly written down in the SIMOPS worksheet. Clear responsibility assignment is a key step for successful execution SIMOPS.

Table 3: List of typical risk reduction measures for SIMOPS

Scaffolding removed or if necessary wood boards to be replaced with metal type
Antispark tools to be used
Barricade and Access Control / Signages
Commissioning Permit To Work properly in place
Commissioning awareness
Emergency Response Plan
Permanent Firefighting equipment and Fire&Gas detection system in service
Provide temporary firefighting devices if the permanent ones are not yet ready
Provide temporary Fire&Gas detectors if the permanent system is not ready
Equipment / tools periodically checked (colour coding to be ensured)
Housekeeping, escape way not obstructed
Identification of focal points for the activity
Live Lines Identified
LOTO isolation procedure and register under LOTO Coordinator responsibility
Risk notification (Safety Alert, STARRT, Tool Box Talk)

3.5 SIMOPS Worksheet and SIMOPS Layout

Discussion and results carried out during SIMOPS assessment workshop, as per steps described above, were recorded in dedicated SIMOPS worksheet reported in below Figure 3.

SIMOPS IDENTIFICATION						
Id. No.	**Main Operation Description**	**Planned Date**	**Main Operation Hazard ---------- Consequence**	**Involved Area**	**Concurrent Operations**	**Concurrent Operations Hazard ---------- Consequence**
5. Hydrocarbon Introduction in PP Refrigeration and PP Common Units						*[continuation →]*
5.6	Hydrocarbon Introduction in PE4 Unit-41	05-Oct-14	Hazard: HC Release ---------- Consequence: Fire / Explosion Scenario Hazard: Low temperature due to Propylene expansion ---------- Consequence: Frost bite	Main Piperack EL. 8.2m ----- PP Purification Area ----- PP Refrigeration Area	COMM - Leak Test	1) Hazard: Hand tools. Consequence: personnel injury, mechanical damage. 2) Hazard: Drop of material from height. Consequence: personnel injury, mechanical damage. 3) Hazard: Unchecked personnel access. Consequence: Misoperation, operator not ready in case of emergency. 4) Hazard: Overpressure. Consequence: Operator injury / Mechanical Damage. 5) Hazard: Release of Nitrogen Consequence: Operator asphyxiation.

SIMOPS RISK ASSESSMENT					
Initial Risk Evaluation	**Control Measures / Operating Procedures**	**Action By**	**Residual Risk Evaluation**	**Additional Recommend ations**	**Action Implemented (Y/N) & Signature**
[→ continuation]					
C - 5	1. Commissioning PTW.	COMM OPER	**B - 4**	-	
	2. Live Lines Identified.	COMM			
	3. LOTO isolation procedure and register under LOTO Coordinator responsibility.	COMM			
	4. Emergency Response Plan.	HSE			
	5. Wind socks.	HSE			
	6. Commissioning awareness.	HSE			
	7. Regular check for battery limit valves hydrocarbon isolation integrity and recording. Twice per shift.	HSE			
	8. Risk notification (Safety Alert, STARRT, Tool Box Talk).	HSE CONSTR			
	9. Barricade and Access Control / Signages.	HSE			
	10. Removal of all temporary facilities, mainly electrical devices / housekeeping	CONSTR			
	11. Firewater U/G and related FF equipment in service.	COMM			
	12. Fire&Gas Detection System in service.	COMM			
	13. Scaffolding removed or if necessary wood boards to be replaced with metal type.	CONSTR			
	14. Antispark tools	CONSTR			
	15. Pre-Commissioning/Commissioning detailed procedure / Work Method Statement to be followed	COMM			
	16. Equipment / Tools colour coding to be ensured.	COMM			

Figure 3: SIMOPS Risk Assessment Worksheet

In addition, dedicated SIMOPS layout was discussed and refined during the workshop. As per below Figure 4, it consists of plant layout showing concerned information and countermeasures identified for safe SIMOPS execution as: areas affected by hydrocarbon-in, prevailing wind direction, distribution of expected manning level, barricade areas, access control plan, traffic control philosophy including access available for rescue team, muster points, etc.

Both above documents were tailored for the subject project with the aim to provide site personnel and site management with quick and easy readable reference tool.

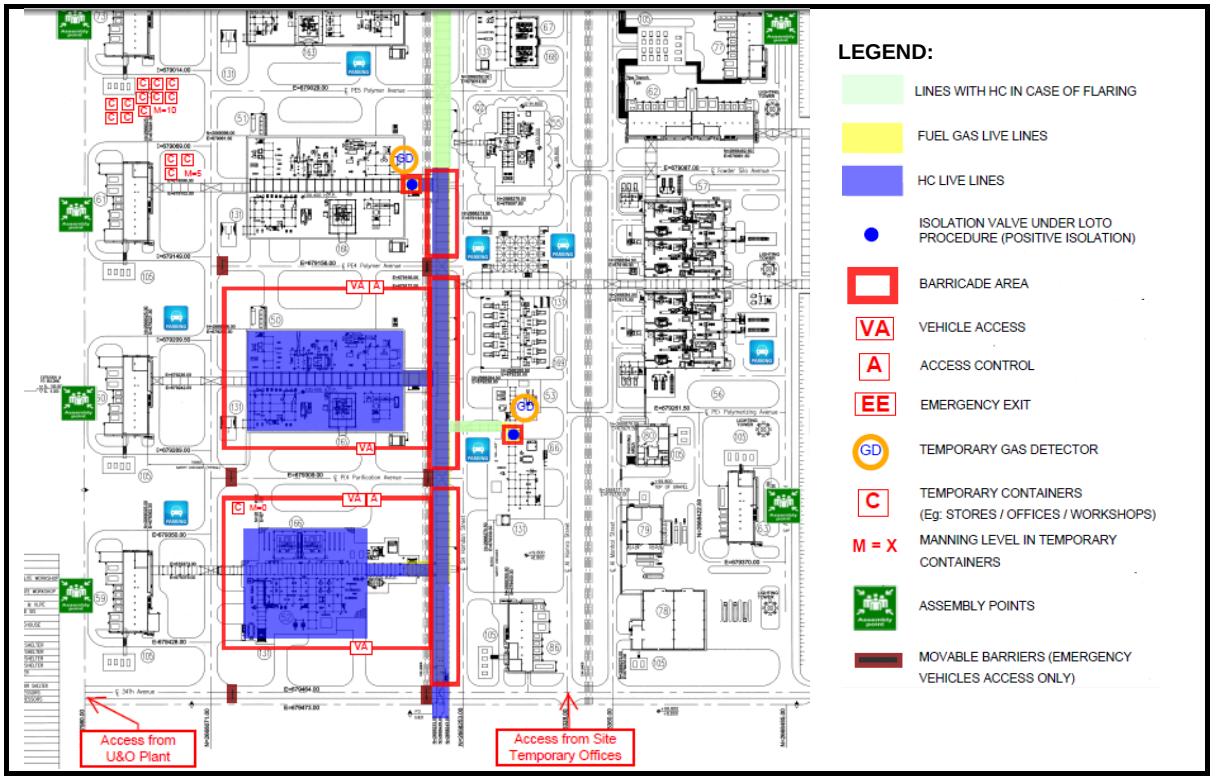

Figure 4: SIMOPS Layout (partial)

3.6 SIMOPS Risk Assessment Process Follow-up

The SIMOPS's action follow-up status was updated daily by the SIMOPS facilitator. As soon as all the SIMOPS actions were solved, dedicated joint field walk down was called in order to demonstrate to project's involved parties that all actions identified during the SIMOPS workshop together with the listed countermeasures were proper implemented by the responsible person, as defined during the workshop.
After closure verification, hydrocarbon introduction received the green light. The concerned area was pressurized with hydrocarbon and unit start-up operation finally took place.
It has to be noted that SIMOPS risk assessment is a living activity, it shall be updated regularly according to the project status and according to the sequence of incoming site activities. SIMOPS related documentation shall keep update so that the site users can use the current version of documents. In the same way, the mitigation actions shall be continuously reviewed according to work site progress and their implementation on field must be punctually monitored.

4. Conclusions

Thanks to SIMOPS risk assessment process, together with daily implementation of "safety first" program from the beginning of site activities, the project finally reached 65 mil worked manhours without LTI (Lost-Time Injury) a remarkable achievement in this field, considering the involved manpower.
In particular the avoidance of any significant hazard during almost one year of simultaneous activities between construction and commissioning after the first ingress of Hydrocarbons in area of plant, to whom the systematic application of SIMOPS risk assessment process gave a great contribution, was highly appreciated by the Top Management of the Project.

References

Marucco D., 2015, SIMOPS Risk Assessment, Tecnimont Work Instruction.