HAZOP REQUIREMENTS AND INTENTS

INVESTMENT

Project code

AL 000000

Issued: date

30.13.1900

Issued:	Orlen Unipetrol RPA s.r.o.
Coordinators in sense of 61882:	
Manager (BO resp. customer representative):	*Zdeněk Novák*
Manager (Project manager/PBM):	-
Study leader - Unipetrol (Project manager/PEM):	Stanislav Novák
Study leader - Supplier/sub-supplier:	Pavel Novák

Enter the variable part according to color		***Will verify***
Subject of the study:		
DCPD unit	JAGR - DCPD	
Is the revision of HAZOP study requested in realization stage before commissioning?	No	
Intent of the study		
Intent of the HAZOP study is to evaluate all risks connected with hazards and operability of the equipment during normal operation (including utility failure) and abnormal operation (start-up, shut down). The study has to be proceed in accordance with the last edition of ČSN EN 61882 and fulfil requirements stated in this form. It is requested to proceed the approximate evaluation of the risks with use of the risk matrix. The HAZOP study results (including worksheets) have to be clear, simple and understandable. The general understanding have to be possible without knowledge of annexes. It is allowed to use references, but only to original text. Reference must not lead to another reference. The study output will include final report and the annexes (described below) in detail, allowing to anybody with basic knowledge of HAZOP methodology to use the output. The study output have to be in form, which allow to anybody with knowledge of HAZOP methodology proceed revision and extension of HAZOP study.		

The defined representatives of UNIPETROL RPA will have defined number of workdays for the revision of the output before acceptance. If any rejections of comments, then it must be stated with reasoning in extra annex. The final output of the study will be provided in hardcopy in defined number and also in electronic version (editable and locked version).					
Type of record: Full record	**Time for comments: 30** days	**Hardcopies**: **5** copies			
Basic description of the studied subject					
DCPD unit will be provided by company (XY) with planed build up and start up in year (XY) DCPD will be isolated from inlet crude material – gasoline from pyrolysis by four step distillation with atmospheric and vacuum part. DCPD will be separated as final product in two purities – 80 and 94 %. Separation was evolved by ORLENUnipetrol RPA company in cooperation with VŠCHT Prague. Crude material for separation will provide the ethylene unit. Separated DCPD (dicyclopentadiene) will be stabilized by BHT (Butylhydroxytoluene) and it will be stored in storage tanks (Hxx – Hxy) within unit area. Remaining material will be pumped back to the ethylen unit through tank XY. Detail description of unit is in document Basic design, zak.č. AL000000, rev. 0A from 12/2020					
Crude material: **Light gasoline from pyrolysis** Light gasoline for pyrolysis is low boiling fraction for next separation. It is highly flammable yellowish liquid with boiling point in range between 35 – 185°C, low explosion level 0,7%, high explosion level 6,5%. It is mixture with acute, chronical and environmental toxicity (more then 0,1% benzene within) For more details look to attached document. **BHT (Butylhydroxytoluene)** It is additive for the product stabilization. It decompose during oxidation or burning. It is environmentally toxic.					
Products: **Dicyclopentadiene (DCPD)** DCPD (dicyclopentadiene, $C_{10}H_{12}$) is bicyclic diene. It exists in two configuration (endo, exo). The both are in the product and will not be separated. Stabilized DCPD is highly flammable colourless liquid with boiling point at 166°C, LEL 0,8 % and HEL 6,3 %. The decomposition begin at 170°C. It reacts with oxidation agents, strong acids and leaches. It may polymerise. It is environmentally toxic. Further details in attached MSDS.					
Utility:					

The following utility are necessary for the unit – nitrogen, process air, cooling water, steam, natural gas, electric energy.

Scope of study

HAZOP study have to meet as minimum the scope defined in following text. Team proceeding the realization have to receive expected requirements and intents in advance as well as background documents in defined advance.

Study must cover defined boundaries. The utility supply failure, change of inlet quality and another key defined points will be always evaluated even they are over the boundaries to keep sense of study. The equipment within the boundaries will be completely evaluated including the key safeguards elements.

HAZOP study boundaries: Battery limits of connected units including the new pipeline track.

Above the boundaries: The quality of inlet and outlet material will be evaluated above range in the stated bounderies.

Safeguards check during study: Key safeguards – offgas pipline, sump, combustion unit

Minimal requirements on properties, guide words, elements

HAZOP study have to cover normal operation (including utility supply failure), and also start-up, shut down and emergency shut down. Study have to cover at least scope defined below, adapted to evaluated whole (including manual operations). The basic stated properties and guidewords combinations have to be used at least – see following table.

	Property	Guide word					Element (example)	Deviation (example)
Normal operation								
1	Pressure	Low/ lower		High/ higher			*Furnace XY*	*Pressure low furnace XY*
2	Temperature	Low/ lower		High/ higher			*Reaktor AB*	*Temperature lower reactor AB*
3	Flow	Low/ lower	High/ higher	Reverse	Other than	As well as	*Gasoline*	*Flow as well as gasoline + water*
4	Level	Low/ lower		High/ higher			*Tank CD*	*Level low tank CD*
5	Composition/ Qualitative	Other than					*Tank EF*	*Composition other than EF*
6	Maintenance	No		Late	Other than		*Pipeline xyz*	Maintenance *no pipeline xyz*
Utility supply failure								

Cooling water	Electric energy	Process air	Nitrogen	Steam	Natural gas	*Heat exchanger AB*	*Water supply failure heat exchanger AB*
Start – up, shut down, emergency shut down							
1	Pressure	Early	Late	Other than		*Pipeline AB*	*Tlak other than pipeline AB*
2	Temperature					*Catalyst D*	*Temperature other than catalyst D*
3	Flow					*Line to XY*	*Flow early to XY*
4	Level					*Column GH*	*Level late column GH*
5	Composition					*Reactor JK*	*Composition reactor JK other than*
Emergency shutdown							
1	Emergency shutdown node AB	Late				*Valve before furnace AB*	*Emergency shutdown late valve before furnace AB*

Evaluated manual operation:	Zvolte položku.

Documentation

Inlet documentation in described detail necessary for understanding of evaluated process will be used. It may depend on requested intent. Always will be available:

- HAZOP requirements and intents (this form - finalized)
- Node description
- Drawings (like P&ID etc.)
- Available process documentation

-	Minimal time for preparation of the team on the study: 5 days

Time estimation

State the requested deadline. Provider estimates time on realization with requested requirements and intent without mitigation of the study quality. It must be set maximum length of the workshop and frequency of the breaks with accordance with availability and ability of the team and type of realization.	Realization: combined

Max length of workday: 7 hours	Break after: 2 h
Number of workdays estimation:-	Deadline:-

Node and element definition:	
The HAZOP leader (supplier) splits the whole to smaller logical parts and he will define the studied elements. He has to check the accuracy of basic list of properties and guidewords meanwhile. The representative of the customer check this splitting from point of view of logic and understandability. If necessary the HAZOP Leader (Supplier) have to finalize splitting in sense of accurate representing of the system. The nodes have to be defined in independent list or on beginning of a worksheet. In the node definition have to be stated node number, name of node, basic node description, basic design parameters, used background documents, all evaluated elements and date of realization – see example of node definition in annex B1. It need to be included to the node definition additional properties and guide words, if relevant.	
Minimal requests on structure of HAZOP study output	
The worksheet study output structure has to follow at least the structure in annex B2, then any software may be use to creation. The electronic editable version of the final output has to be editable in common software and it has to be clear enough for revision by anybody with knowledge of HAZOP methodology. For each deviation must be different causes stated independently and the rest of record as well.	
Risk Matrix	
The risk matrix (see annex A1, A2 and B2) must be use for approximate evaluation of the risks during realization of the study. The frequency of the failure will be stated based on table of equipment reliability or based on experience of the team with studied whole. The consequences will be described for worst realistic outcome of event without current safeguard and in accordance with that team will choose at least one category and they will quantify the described consequences severity. The classification must be consistent through the all study and all team must participate on it. The team leader have to understand the use and sense of use of matrix and support the team effort during stating of frequencies and severities. The two evaluations are requested. First evaluation states unmitigated risks without consideration of current safeguards. The second evaluation states estimation of mitigation of risks in consideration of stated current safeguards and their reliability. It evaluate, if the current safeguards mitigates risks on acceptable level. If the mitigated risk evaluation state risk above tolerable-acceptable level (TA), then team must define recommendation for mitigation of risk at least to this level.	
Minimal structure of the work team	
The study workshop may be realized only if the minimal team is available at least. The study realization must be suspended if any mandatory member must leave the session for more	

than 15 minutes. The defined specialists will be available on request for solving of specific problems during realization of the study. The mandatory team is minimally:			
Role	Name	Position	
Process engineer	Vilém Novák	Vedoucí technologií/výzkumu I	
Process employee (operator, chief operator)	František Novák	Inženýr údržby výrobního týmu	
Study leader	Vedoucí pracovní schůzky	Pavel Novák	
Scribe	Zapisovatel	Alfréd Novák	
Designer	David Novák		
Designer	Otokar Novák		
Designer	Vít Novák		
Specialists on request:		in person	
Role	Name	Position	
Maintenance	Radek Novák	Vedoucí oddělení údržby strojů Agro	
Maintenance	Jiří Novák	Ved. odd. stroj. a stav. údržby Agro	
Maintenance	Jaroslav Novák	Ved. odd. stroj. a stav. údržby Agro	
Maintenance	Václav Novák	Vedoucí odboru životního prostředí	
Safety	Martin Novák	Specialista OSH III	
Process Safety	Jiří Novák	Specialista procesní bezpečnosti	
Designer	Dan Novák	Technolog	
Designer	Vladimír Novák	HIP	
Designer	Pavla Nováková	IP	
acceptable substitute in case of absence			
Role	Name	Position	
Process engineer	Jaroslav Novák	Specialista technologií/výzkumu III	

Technolog	Simona Nováková	Vedoucí technologií/výzkumu I			
Process employee (operator, chief operator)	Marie Nováková	Vedoucí výr. týmu čpavku a KaDP			
Designer	Petr Novák	MaR			
Designer	Roman Novák	Elektro			
Designer	Patrik Novák	Stavební			

Revision

The output will be revised by stated departments. The revision is mainly intended to check of crucial parts of the HAZOP study output, which could be reason to rejection of output, if they would be in insufficient quality.

Department	Name		
Development department	Zdeněk Novák		
Operation department	René Novák		
Investment department	Stanislav Novák		
Safety department	Martin Novák		
Environmental department	Václav Novák		
Maintanance department	Jan Novák		

Final report and study outcome

The final report have to include all parts and information defined in this form. It will include at least following sections with stated details:

- Summary – who, for who and why is the study processed by
- Introduction – information about project, evaluated unit and processed material
  - Short summary of HAZOP methodology
- Scope of study
  - Detail information about requirements and intents (scope, type of record, boundaries…)
  - List of basic properties and guide words
  - List of studied elements
  - Used risk matrix with explanation
- Team structure
  - Information about team structure – role, name, position
  - Attendance list
- Mandatory annexes (if the information are not in incorporated in final report))
  - HAZOP worksheets
  - List of recommendation (see annex B3)

- List of nodes descriptions (if the detail descriptions are not in head of the each worksheet) - Attendance list - HAZOP requirements and intents (this form) • Conclusions				
Organization of realization				
Check days	No	Zvolte položku.		
Organization: To fulfill antipandemic measures will be study realized by cooperation on several places with videoconference connection. The maximal group on one place will be 6 people. The groups will have identical backgroung documents. The on-line sharing of screen must be provided.				

Annex A Risk matrix

Annex A.1 Risk matrix

Frequencies of consequences 1/year (P) / Category of consequences (S)		Number marking	*Negligible*	*Minor*	*Moderate*	*Major*	*Catastrophic*
			1	*2*	*3*	*4*	*5*
Very frequent	$<10^{0} – 10^{-1})$	*1*	TA	TNA	NA	NA	NA
Frequent	$<10^{-1} – 10^{-2})$	*2*	TA	TNA	TNA	NA	NA
Possible	$<10^{-2} – 10^{-3})$	*3*	TA	TA	TNA	TNA	NA
Sporadic	$<10^{-3} – 10^{-4})$	*4*	A	TA	TA	TNA	TNA
Rare	$<10^{-4} – 10^{-5})$	*5*	A	A	TA	TA	TNA
Very rare	$<10^{-5} – 10^{-6})$	*6*	A	A	A	TA	TA
Almost impossible	$<10^{-6} – 10^{-7}>$	*7*	A	A	A	A	A

Note:

A **A**cceptable Risk (theoretically no recommendations are requested, but they may be defined and highlighted)

TA **T**olerable – **A**cceptable Risk (ALARP, revision of alternatives)

TNA **T**olerable – **N**on**a**cceptable Risk (must be defined recommendation/s including the defined date of realization)

NA **N**on**a**cceptable **R**isk (process must be stop immediately)

Categories of the consequences (S)

Consequences	People	Citizens	Environment	Asset	Reputation
Negligible	no injury	no injury	no effect	to 10 000 €	no impact
Minor	minor injury *(not affecting of work performance or without days away from work)*	bed smell, noise *(no evacuation or first aid)*	minor, reported (unit report) *(small pollution on equipment site)*	to 100 000 €	minor impact *(maintaining trust – the possibility of quick trust reinstate with low costs; public awareness may exist)*
Moderate	moderate injury, single severe injury *(limitation of work performance or absence for few days for full recovery; small, reversible health effects, for example: skin irritation, food poisoning)*	minor injury *(no evacuation, but first aid needed)*	moderate effect *(damage or emission to environment, but no lasting effect; violation of single law limit or complaint)*	to 1.000 000 €	limited impact *(breach of trust – the trust reinstate with long term cooperation with PR, negative attention in local media or attention of political parties)*
Major	multiple severe injury *(irreversible health effect with large impact to work ability, for example: caustic burs, noise / explosion induced hearing loss, burns)*	intermediate injury *(limited health impact, without evacuation, medical treatment in single cases)*	major effect *(necessity of major action from Company to environment recovery; violation of law limits)*	to 10 000 000 €	national effect *(significant breach of trust - trust can be reinstated, but with significant costs. Negative national media attention)*
Catastrophic	fatality *(one or more fatalities)*	severe injury *(irreversible health effects, necessity of evacuation and medical treatment for multiple of people)*	ecological catastrophe *(persistent, severe damages on environment with large financial consequences for Company; consequences significantly violates law limitations)*	more than 10 000 000 €	international effect *(permanent significant breach of trust – impossible to fully reinstated; international public attention; large, negative international media attention)*

Annex B

Annex B.1 Node example

Node number	Description and design condition	Background documents	Equipment	Realized
4. Pyrogas compression GB-201 (1./2./3. stage)	GB-201 provides compression of pyrogas prior to separation. Pyrolysed gas cooled after water separator DA-103 to 25-35 °C (max 45°C) and with overpressure 30-60 kPa continua to separator FA-201. In FA-201 are separated remainings of the liquid before first stage of compressor suction of GB-201. GB-201 has 5 compression stages and final pressure is approximately 3,5 MPa. The minimal flow is set on 141 t/h on third stage of compressor discharge. The compression heats gas and it must be cooled in heat exchangers. Maximal temperature on any stage discharge is 110°C. Polymers formation is rising with rising temperature. Some amount of gas condensate after compression and cooling. The liquid is separate in separator prior next stage of compression. FA-201 – p=0,263 MPa; T=200°C FA-212 – p = 3,8 MPa; T=150°C EA-203A/B/C – shell: p = 0,39 MPa; T=120°C; tubes: p=0,9 MPa; T=60°C FA-202 – p = 0,39 MPa; T=120°C FA-203 – p = 0,65 MPa; T=120°C EA-204A/B – shell: p=0,65MPa; T=120°C tubes: p=0,9MPa; T=60°C GA-207/R – p=0,49 MPa; dp=0,197MPa; Q=15m3/h GT-201X – p=10MPa; T=500°C; Q=215t/h GB-201 (1°) – p=3,64 MPa, dp=3,6MPa; Q=166800m3/h GA-202/R - p=0,66MPa; dp=0,15MPa; Q=45m3/h GB-201 (2°a 3°) – p=3,64 MPa; dp=3,6 MPa; Q=166800m3/h	PID-E7638-6F-0; HAZOP-2016-Doc No: &AE-S-RX 1002 (EN); HAZOP-2011-Příloha 2.1; TR-EJ	FA-201 FA-212 EA-203A/B/C FA-202/FA-203 EA-204A/B GA-207/R GT-201X GB-201 (1°) GA-202/R GB-201 (2° a 3°)	7/12/2020

Node example

Annex B.2 Example of minimal worksheet structure

The deviation need to have stated always what it is combined from – property, guide word and element see example. Any software is allowed, if the final output will have structure as in this example at least.

Identified cause

Categories (cat.): P – People; C - Citizens; E - Environment; A –Asset; R- Reputation

Node n. 4. Compression of pyrogas GB-201 (1./2./3. stage)/ Stripper DA-201															
N	Deviation	Cause	Consequence	Risk				Current safeguards	Reduced risks				n	Recommendation	Comment
				Kat	F	K	R		Kat	F	K	RR			
1	Pressure lower GB-201	1. Compressor surge	1. potential damage of the machine	A	2	3	TNA	1. Internal vibration monitoring at GB-201	A	3	3	TNA	46.	Install a low pressure trip at the inlet of GB-201 to trip GB-201	
							–	2. Monitoring of rotor displacement				–			
		2. Closed inlet to GB-201	Potential for formation of vacuum at the suction side, potential for damage of upstream equipment leading to loos of containment	P	3	4	TNA		P	3	4	TNA	46.	Install a low pressure trip at the inlet of GB-201 to trip GB-201	
							–		P	3	4	TNA	47.	Perform a SIL allocation for this low pressure trip	

Example of worksheet

Annex B.3 Example of minimal recommendation list structure

The team doesn´t fill in the responsible person and deadline (the team may suggest). The sorting of recommendation must do after realization of the study UNIPETROL customer representative and in case of investment on meeting of UNIPETROL customer representative, UNIPETROL project manager and design supplier. The reduced risk provides information for quicker orientation in recommendations. The NA and TNA risks have to be mitigated.

Node n. 4. Compression of pyrogas GB-201 (1./2./3. stage)/ Stripper DA-201									
Č	Reduced risks				Č	Recommendation	Comment	Responsible person	Deadline
	Cat	F	K	RR					
1	A	3	3	TNA	46.	Install a low pressure trip at the inlet of GB-201 to trip GB-201			
	P	3	4	TNA	46.	Install a low pressure trip at the inlet of GB-201 to trip GB-201			
	P	3	4	TNA	47.	Perform a SIL allocation for this low pressure trip			

Example of recommendation list