H2020-ICT-25-2016-2017

HYbrid FLying rollIng with-snakE-aRm robot for contact inSpection

HYFLIERS

D6.2

Prototype HRA test protocol, test report, data analysis and conclusions

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Abstract:

This document is related to the site tests of the HRA prototype to be organized in TotalEnergies Oleum plant near Dunkerque (France).
These site tests contribute to the qualification of the HRA robotic system and the demonstration of its capabilities in an industrial environment.
The document provides the following information:

1) Presentation of TotalEnergies Oleum plant
2) Description of the HRA prototype
3) First outdoor tests in Seville
4) Site test objectives in TotalEnergies Oleum Dunkerque and end users requirements
5) Specifications for the test protocol and selection of the test locations on site
6) Risk assessment to identify and mitigate the risks associated with the HRA operation
7) Pre-requisites prior to organize the site tests in Oleum (HRA outdoor bench tests validation, French civil aviation authorization, TotalEnergies site authorization, safety plan…).

The outdoor tests in Seville shall demonstrate the key functionalities and the safe operation of the HRA integrated system on a mock-up bench under outdoor conditions before allowing HRA site tests in an industrial plant. The detailed planning of the HRA site tests at TotalEnergies Oleum plant will be defined once the WP5 outdoor tests are completed and validated.

Keywords:

Hybrid Robot with Arm, prototype, site test, protocol, TotalEnergies, Oleum, Dunkerque

Executive summary

This document D6.2 is the second deliverable of the work package WP6.

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Abbreviations and symbols

ATEX	Explosive Atmosphere
NDT	Non Destructive Testing
UTM	Ultrasonic Testing Measurement

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1. Introduction

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6) Risk assessment to identify and mitigate the risks associated with the HRA operation
7) Pre-requisites prior to organize the site tests in Oleum:
    - Outdoor bench tests validation in Seville of the HRA integrated system,
    - Accreditation of the HRA prototype by the French civil aviation (DGAC/DSAC),
    - Certification and registration of the HRA telepilot
    - Flight plan registration
    - TotalEnergies Oleum site authorization, Safety plan ("Plan de Prévention").

2. Presentation of TotalEnergies Oleum site

TotalEnergies Oleum site is located in the North of France near Dunkerque. It was a former refinery operated by TotalEnergies. It is now converted into a technical platform where training and experimentation related to safety, production, maintenance and inspection take place, in a full-scale oil and gas industrial plant.

Figure 1. A view of the TotalEnergies Oleum plant.

Figure 2. A view of the TotalEnergies Oleum plant.

Figure 3. A view of the TotalEnergies Oleum plant.

3. Description of the HRA prototype

The Hybrid Robot with Arm (HRA) is a robotic system designed for the following operations:

- fly to zone,
- land on pipes,
- crawl over pipes to reach the inspection area
- and deploy a robotic arm equipped with ultrasonic probe to perform wall thickness measurements on specific locations of piping systems (pipes, bends, tees, reducers).

The HRA is made of different sub-systems as shown in Figure 4.

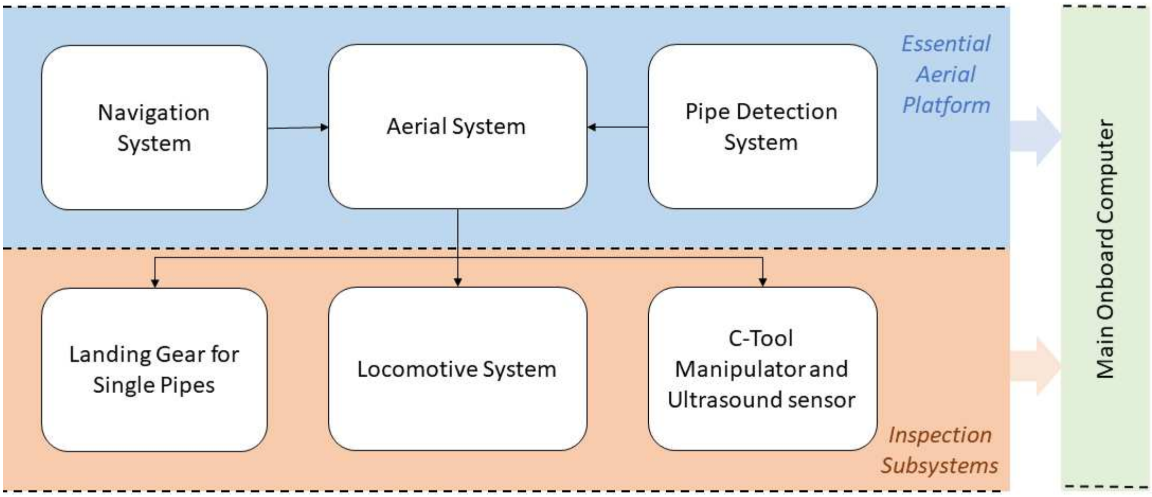


Figure 4. Main sub-systems of the HRA.

Several modular concepts were developed for the HRA to target some specific functionalities in term of piping arrangement and measuring points locations (single pipes, pipes-rack, straight pipes, vertical, horizontal, bends, tees, reducers). Each concept has its own capabilities and limitations.

The prototype planned to be tested at TotalEnergies Oleum plant is the HRA robotic system with the highest technology readiness level (TRL). It consists of the following sub-systems as shown in Figure 4 to Figure 8:

- aerial platform with 8 propellers
- landing gear for both single pipe and pipe-rack
- locomotive crawler system
- C-tool arm for the manipulation of ultrasonic sensor.

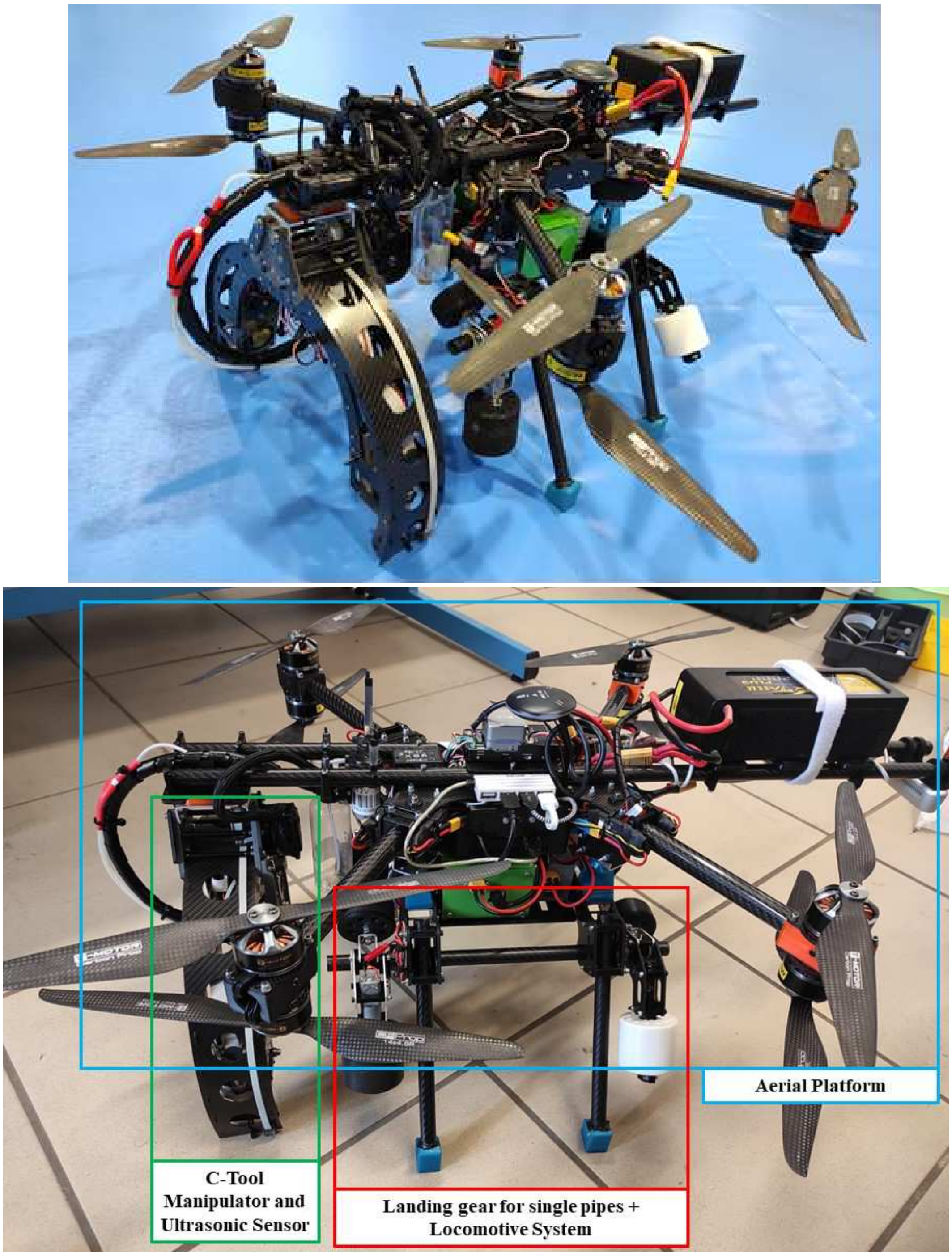


Figure 5. HRA prototype (top) with its main sub-systems (bottom).

Figure 6. Aerial platform (without propellers).

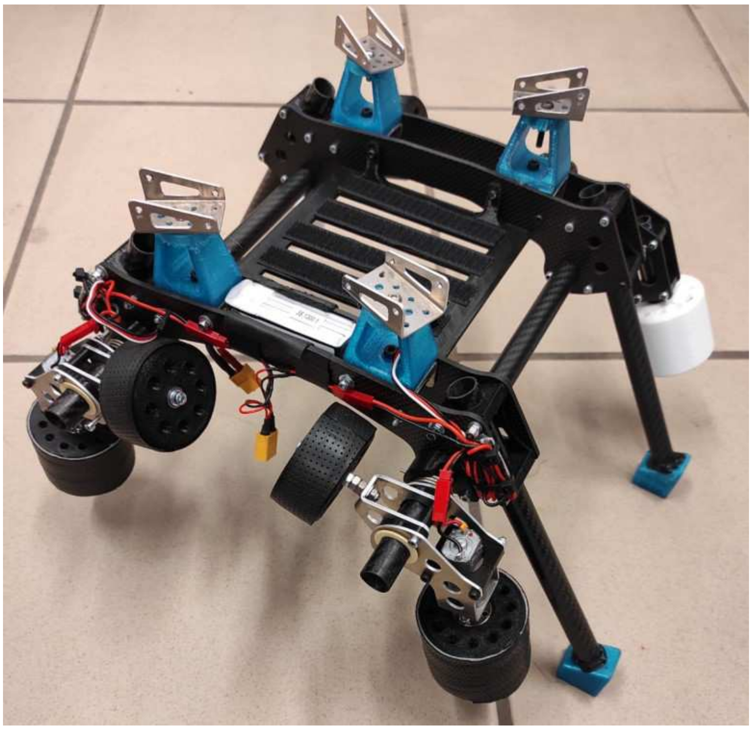


Figure 7. Landing gear and locomotive system with active and passive wheels.

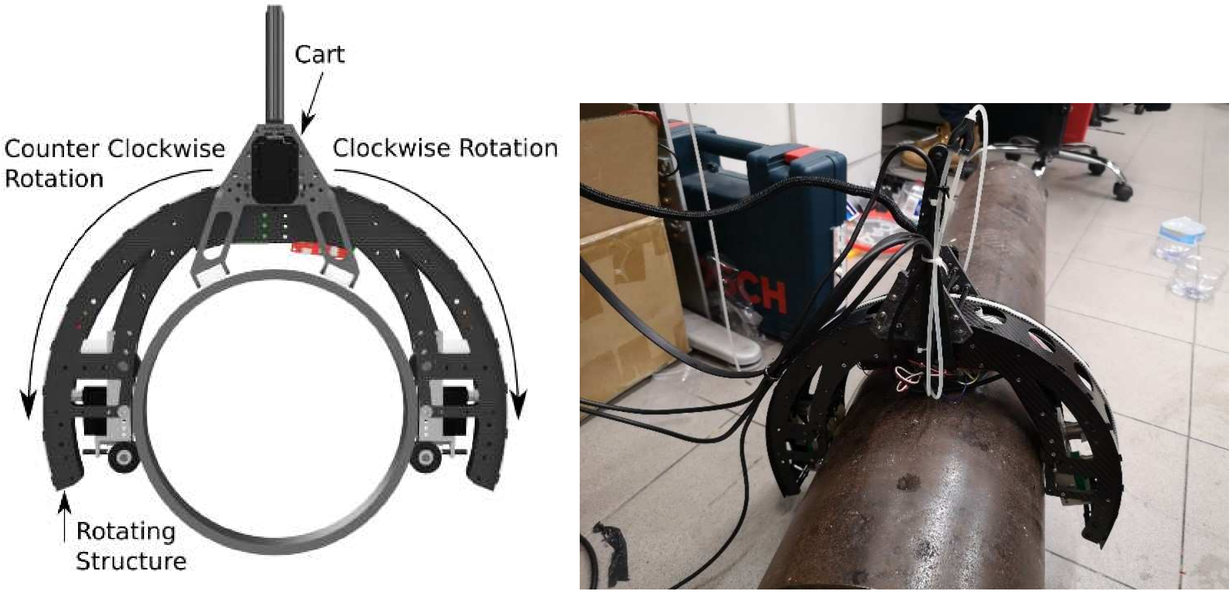


Figure 8. C-Tool.

This HRA prototype with C-Tool can only meet part of the end user requirements. It is designed to perform ultrasonic thickness measurements on horizontal straight pipes but will not be able to achieve thickness measurements on bends, reducers, tees and vertical pipes.

Local indoor evaluation of the C-Tool by CREATE:

The C-Tool has been tested in an industrial mock-up of the CREATE indoor facility. In particular, the Tool has been placed on a damaged pipe (Figure 9) and the measures of the two probes placed at the extremity of the tool are used to create a B-scan image. To create the B-scan image, we have combined the instant thickness measurement with the rotation of the probes around the pipe. It is worth noticing that, thanks to the design of the proposed inspection tool, the creation of such a representation comes very easy, because it is directly generated as consequences of the rotation of the inspection tool around the pipe. To generate the B-scan, a set of points to inspect has been considered to reach also the bottom part of the pipe.

The *B-Scan* graphic resulting from the inspection of the damaged pipe is reported in Figure 10, in which the damaged part has been detected and it is highlighted with a red rectangle. These graphic reports the wave propagation into the inspecting material. It shows the rotation of the tool around the pipe (on the *x-axis*) and the propagation time of the wave (on the *y-axis*) respectively. When the section of a material is intact (i.e. it has the same thickness), the periodicity of the waves and their amplitude over the time is similar during the tool rotation. Differently, as it can be seen in the right part of the Figure 10 the wave response changes.

Figure 9. The damaged pipe used to test the inspection capabilities.

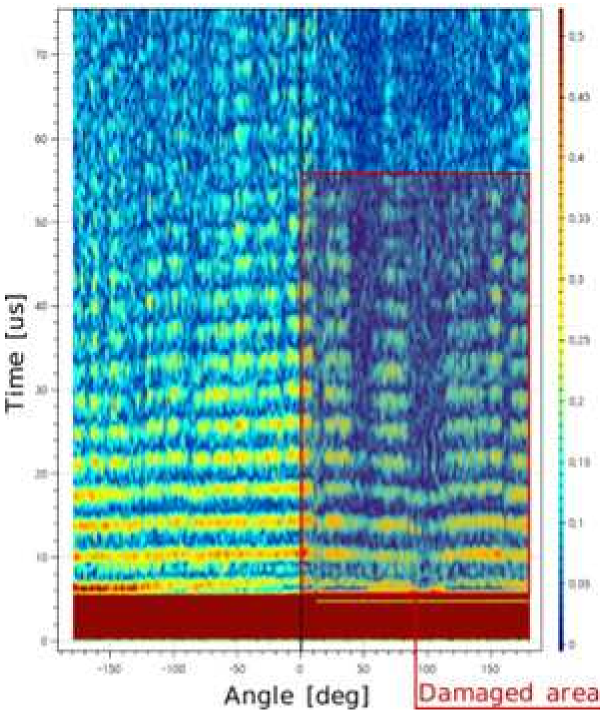


Figure 10. B-Scan graphic generated after the inspection. The rectangle marks the corroded section.

4. Test protocol and validation plan

The HRA validation was split in two experimental campaigns. The first phase was accomplished in Seville and the second one will be planned at the TotalEnergies Oleum plant. The objective is to do a preliminary internal review of the system by TotalEnergies and Chevron in the first set of experiments before testing the system in the actual scenario. The consortium aims to minimize the risk of the refinery experiments then, this first validation round was specifically focused on the analysis of the safety of the different systems of the HRA and their potential risks. The HRA integrated systems or functionalities that would be acceptable to be used in the actual refinery will need to pass a second validation in Seville on a mock-up outdoor bench and then in Dunkerque TotalEnergies Oleum plant in an industrial environment.

4.1. HRA functionalities for the outdoor first validation phase in Seville.

The tests in the outdoor first validation phase in Seville have been designed to show and validate several functionalities of the HRA. Table 1 summarizes the functionalities tested for outdoor environments.

Table 1: List of HYFLIERS technical functionalities of the HRA robot for outdoor environment

ID	Functionality	Description
Fun-01	Autonomous flying in GNSS (global navigation satellite system)-denied environments	Robust navigation in industrial environments where GNSS signals can be degraded. However, the validation will be performed in a qualitative level, due to the difficulty to implement a ground-truth system that allows us to have a quantitative metrics of this functionality in an industrial scenario.
Fun-03	Autonomous landing on pipes	Land on different pipe sizes but with an active supervision of the operator (due to safety reasons coming from the requirement of the facility owners).
Fun-07	Autonomous navigation of the HRA over the pipe	Drive HRA autonomously along pipes of different sizes but with an active supervision of the operator (due to safety reasons coming from the requirement of the facility owners).
Fun-09	Advanced modelling and control techniques for HRA	Model aerodynamics and land autonomously on pipes of different sizes using the perception relative localization system, but with an active supervision of the operator (due to safety reasons coming from the requirement of the facility owners).
Fun-10	Advanced human-machine interface (HMI) for the system operator	Mobile support platform (MSP) functions will include: Developing compliant systems for power storage and charging functions, especially battery switching/charging can have environment specific requirements to be performed safely; Networking support compatible with industrial environments. HMI will include: Incorporating necessary hardware between the

		hybrid robot (HR) operating platform, its operators, and the industrial inspection site systems.

5. HRA first validation phase in Seville

This plan is based in D1.4, but in this case it has been reorganized in order to compress in one single day all the tests to be shown to the end-users.

5.1. Description of test location and conditions

Figure 11 HRA in Seville outdoor mockup scenario.

The mock-up scenario created for the first validation phase consists of a metallic structure, which is the same used in the HMR tests. In this structure there are placed several pipes of various diameters (6”, 8” and 10”) that can be moved to reproduce different pipe configurations. Those pipes aim to simulate a realistic pipe distribution and the main goal of this scenario is to enable testing of the complete version of the HYFLIERS robots safely before moving to the actual refinery. During this phase, the goal was mainly focused on analysis the HRA safety and decide which kind of systems are safe enough to be used in the plant.

5.2. Complete sequence of the operation

The complete sequence of the operation of the experiments for the first validation phase of the HRA is presented in Table 2.

Table 2: First validation phase experiments, steps of the operation

Step	Linked functionality		Description	Involved Partners	Test validation
1	Fun-10		The aerial robot will be turned on and all the systems and information needed to perform the operation should be	USE	Yes

			visualized at the ground systems on real time. Drone status and telemetry, cameras and control electronics working.		
2	Fun-1		The aerial robot will take-off and fly in assisted mode commanded by the pilot. The drone will arrive near the structure.	USE	Yes
3	Fun-1 Fun-3		Once close to the pipes, the operator will switch to approximation mode, entering the aerial robot into the structure with autonomous stabilization and approaching it to the identified landing spot on the pipe. Once it is located over the pipe, it will command the landing operation.	USE	Yes
4	Fun-1 Fun-3		The operator will proceed to land the drone on the pipe with autonomous stabilization once all the stability conditions are validated. The landing operation is the most critical part of the flight. Maximum wind limitations will apply.	USE	Yes
5	Fun-7		Once landed, the HRA will be driven along the pipe with autonomous stabilization to maintain it on the top line of the pipe.	USE	Yes
6	Fun-1		The navigation system telemetry should be checked again before taking-off from the pipe. The robot will take-off and fly in assisted mode commanded by the pilot. The pilot will take the drone to the ground and land.	USE	Yes

The experiment described in the sequence of Table 2 has been done in Seville in the presence of the end-users. The target pipe had a diameter of 8 inches and landing on it was successful. A sequence of images is presented in Figure 12 showing steps 2 to 6 of the experiment.

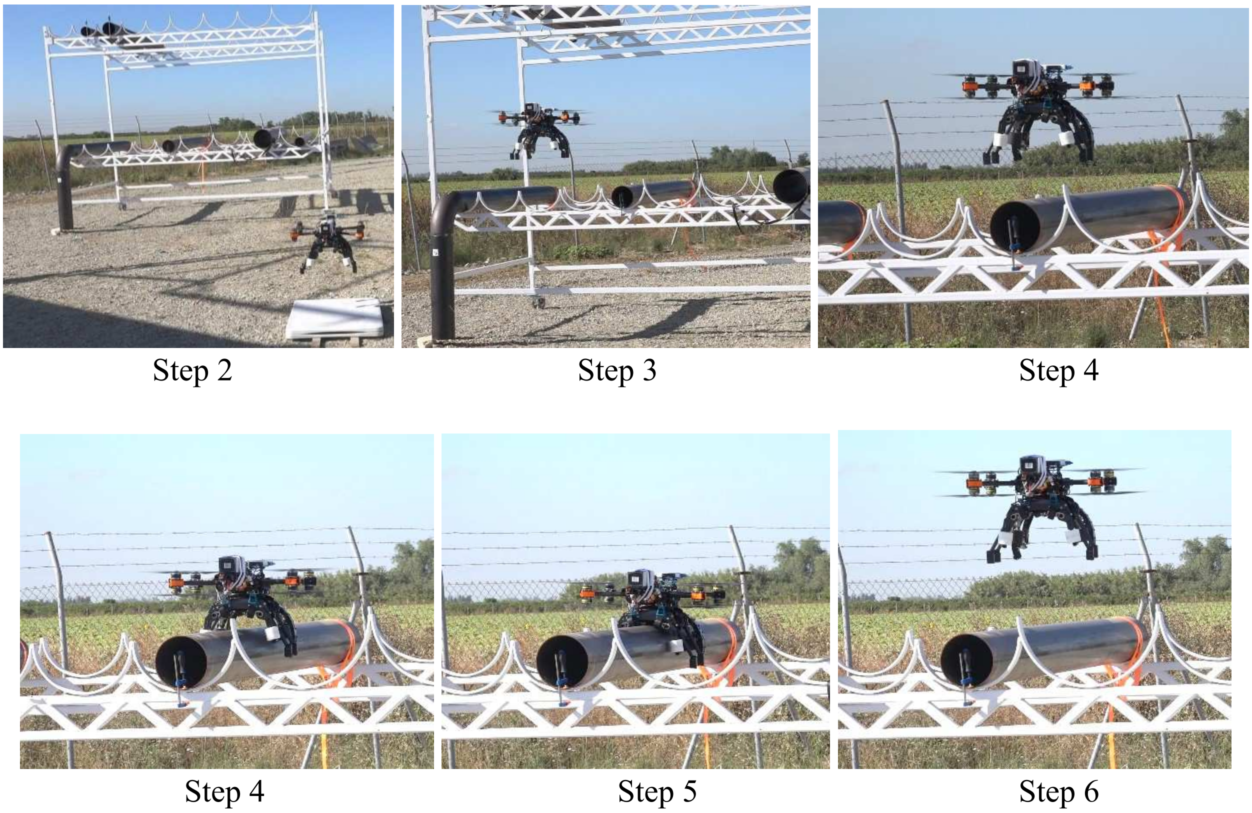


Figure 12 HRA experiment in Seville for the first validation phase.

6. Second validation phase in TotalEnergies Oleum

6.1. Site tests objectives

The HRA prototype (C-Tool) will be submitted to site tests to demonstrate the end user requirements and the functionalities of the HRA integrated system in an industrial environment.

The end user requirements, as specified in WP1, are reminded in **Appendix 1**.

The last column of the table Appendix 1 will be completed to report the validation results based on the outcome from the HRA site tests at Oleum.

Some requirements are considered not achievable due to the design limitations of the HRA (C-Tool).

6.2. Site tests protocol

The test locations selected for the site tests at TotalEnergies Oleum are described in **Appendix 2**.

The following scenarios will be considered during the site tests to demonstrate the key functionalities and the safe operation of the HRA prototype in an industrial plant:

6.2.1. Loss of communication

1) Take off from safe zone
2) Simulate loss of communication
3) Check stand-by / hovering steady position
4) Check "Return to Home" function (if relevant)
5) Land on safe zone.

6.2.2. Loss of control

1) HRA prototype landed on safe zone with propellers on
2) Simulate loss of control (HRA prototype kept on the ground with propellers running)
3) Check emergency shutdown of the propellers.

6.2.3. Gas detection

Pre-check of gas detection sensor and alarm:

1) Simulate gas cloud near the gas detector (with lighter or equivalent)
2) Check detection by gas detector and alarm displayed on the ground control pilot interface.

Gas detection scenario:

1) Take off from safe zone
2) Land on pipe
3) Activate C-tool
4) Simulate gas detection
5) Recover C-tool
6) Take off from pipe and fly to safe zone.

Indicator to be recorded:

- Time needed to evacuate HRA from hazardous zone (including C-tool recovery, take off and evacuation to safe zone).

6.2.4. UTM (quadrant) on straight pipe 8" (single pipe)

1) Take off from safe zone
2) Land on 8" pipe (single pipe)
3) Crawl on 8" pipe over 5 m
4) Activate C-tool
5) Perform UTM at 12, 3, 6, 9 o'clock
6) Check real time measurement and A scan displayed on the ground control interface
7) Recover C-tool
8) Take off from pipe
9) Land on safe zone.

Indicators to be recorded:

- Battery utilisation (%)
- Remaining autonomy (time in minutes)
- Time spent to perform the mission from steps 1 to 9 (minutes)
- Inspection data acquisition (% of missing data)
- Inspection data quality: cross-check UTM by HRA with UTM by Inspector and assess gaps (mm)
- Inspection points positioning: cross-check UTM points position by HRA with UTM points position by Inspector and assess gaps (mm).

6.2.5. UTM (grid) on straight pipe 8" (single pipe)

As per scenario 5.4 above but with step 5 changed as follows:

5) Perform UTM on grid (5cm x 5cm step, 360° around the pipe, 50cm along the pipe)

6.2.6. UTM (quadrant) on straight pipe 8" (pipe rack)

As per scenario 5.4 above but on pipe rack (instead of single pipe).

6.2.7. Land & Crawl on straight pipe 6" (single pipe)

1) Take off from safe zone
2) Land on 6" pipe (single pipe)
3) Crawl on 6" pipe over 5 m
4) Take off from pipe
5) Land on safe zone.

6.2.8. Land & Crawl on straight pipe 6" (pipe rack)

As per scenario 5.7 above but on pipe rack (instead of single pipe).

Depending on the capabilities of the HRA prototype that will be tested in TotalEnergies Oleum, some additional scenario can be considered to cover the following:

- UTM (quadrant / grid) on vertical pipes
- UTM (quadrant / grid) on elbows (horizontal, vertical upward, vertical downward)
- UTM (quadrant / grid) on tees
- UTM (quadrant / grid) on reducers.
- …

6.3. Risk assessment related to HRA operation

A Risk Assessment is required as part of the job preparation before HRA mobilisation and operation on site.

Objectives of the risk assessment:

- identify the different risks associated with the utilisation of the HRA prototype in an industrial plant
- define mitigations to reduce these risks at acceptable levels.

The Risk Assessment methodology will be based on TotalEnergies standards using the Company risk assessment template and risk matrix.

A risk assessment related to drone operations in TotalEnergies oil and gas plants is provided for reference in **Appendix 3.**

6.4. Pre-requisites

Preparation of the site tests is key and shall include the following validation and authorizations before deciding mobilisation and operations at site:

6.4.1. Outdoor test validation

Further outdoor tests in Seville shall demonstrate the key functionalities and the safe operation of the HRA integrated system on a mock-up bench under outdoor conditions before allowing HRA site tests in an industrial plant.

The scenarios to be considered for the outdoor tests should be based on the main scenarios defined for the site tests in TotalEnergies Oleum, as per section 5.

6.4.2. Prototype accreditation by the French civil aviation

The HRA prototype shall be accredited by the French civil aviation authority.

6.4.3. Pilot certification and registration

The HRA telepilot shall be qualified and certified in accordance with the applicable regulation.

6.4.4. Flight plan registration

The flight registration shall be done in the ALPHATANGO site at least 7 days before the site test.

6.4.5. TotalEnergies Oleum authorization and Safety Plan

A site authorization shall be given by TotalEnergies Oleum in compliance with the Company rules and the French regulation.

A dedicated form shall be used in order to prepare and approve the safety plan (so called “Plan de Prévention”). A template is provided for reference in **Appendix 4**.

Annex 1 – End User Requirements

For Importance (C, M, S), see definitions at the bottom of the table.

ID	Description	Rationale	Importance	Success criteria & Validation method	Validation results (on completion of second tests at Seville)	Validation results (on completion of site tests at Oleum)
UR-01	The system must be small enough to be transported by van or pallet	The system needs to be transported to the refinery	M	The system can be transported in a regular van		
UR-02	System could be small enough to be transported by helicopter	In case the system is used in an offshore facility	C	The system can be transported in a regular helicopter boxes that can fit inside a helicopter The system will have the dimensions required to be transported in a regular helicopter		
UR-03	The system must be small enough to be transported by airfreight cargo	It is envisioned that the system will be transported by cargo to different refineries all over the world	M	The system will be able to be packed in a pallet		
UR-04	Recharging and maintenance must be done within a safe area	These activities could be dangerous in an explosive atmosphere area	M	The system is designed to have a separate recharging and maintenance station than the operational one		
UR-05	A gas detection system must be installed on-board the robotic vehicle	It is one of the safety mitigations measurements already identified by Total and Chevron	M	A gas detection system is installed and operational on the robotic vehicle. The alarm needs to be transmitted to the ground control station		
UR-06	If gas is detected, the aerial robot must start a getaway operation in less than two seconds	As the aerial robot is not going to be ATEX, it has to fly away from the hazardous area	M	The operator is able to command the getaway operation in less than 2 seconds		

UR-07	Batteries must be protected against impacts	For safety reasons, in case of a fall, the batteries are required to be protected so they are not exposed to the atmosphere	M	Batteries protections bear impacts of 100N		
UR-08	Maximum weight of transporting box 30 kg	So, it can be transported by a single person (due to Health and Safety regulations from Total and Chevron)	S	Once the transporting box is fully loaded, it is weighted, and the result is less than 30 kg		
UR-09	Flight plan including emergency paths must be approved before the operation	Required to get the permit to perform the inspections on the refinery	M	Flight plans following the established format will be designed before each operation		
UR-10	The risk assessment must consider safety mitigations plan ahead and approved taking into consideration the possibility of loss of communication	Required to get the permit to perform the inspections on the refinery	M	The system has integrated a Return To Home (RTH) function, and it is automatically activated when the communications are lost		
UR-11	The risk assessment must consider safety mitigations plan ahead and approved taking into consideration the possibility of collision with obstacles	Required to get the permit to perform the inspections on the refinery	M	The system has integrated a Collision Avoidance System		
UR-12	The risk assessment must consider safety mitigations plan ahead and approved taking into consideration the possibility of the drop of the robotic vehicle while flying	Required to get the permit to perform the inspections on the refinery	M	The cable stop when it detects that it is an abnormal deployment not controlled	Not applicable to HRA	Not applicable to HRA
UR-13	The risk assessment must consider safety mitigations plan ahead and approved taking into consideration the possibility of gas detected (explosion).	Required to get the permit to perform the inspections on the refinery	M	The system has a gas sensor on-board		
UR-14	In ATEX areas it is needed to follow standard procedures	Required to get the permit to perform the inspections on the refinery	M	During the experiments, Total and Chevron will apply the standard procedures to perform the experiments		

UR-15	The system should be designed taking into consideration major restrictions to be able to extend its capabilities to operate in ATEX zone 2 areas in the future	Although the project experiments will be performed in real refineries but in controlled areas, it is important for the future exploitation of the system to take into consideration the requirements to operate in ATEX zone 2 areas	C	The experiments are performed as if the system was in an ATEX zone 2 area, so the same requirements will be applied		
UR-16	Only brushless motors must be used	Non-brushless motors are not safe to operate in ATEX environments	M	The robotic system only incorporates brushless motors		
UR-17	Robotic vehicle must be collision-proof (for example mechanical protection around propellers)	In case of contact with the structure of pipes, the robotic vehicle has to be able to continue operating, and also no damage has to be generated	M	The robotic vehicle will incorporate mechanical protection mechanisms		
UR-18	The flight envelope and clearance requirements around the aerial vehicle must be provided for flying and landing	The end-user requires this information to plan and decide which pipes can the robotic system inspects, and which ones not.	M	This information is incorporated into the specifications of the robotic system		
UR-19	The system must incorporate sensors to determine if the landing area is clear of obstacles or not	Before landing, it is important to confirm if the landed area is clear of obstacles	M	The system can decide and distinguish between a clear and a not clear landing area		
UR-20	The combination of both robotic systems must be able to operate on pipes from 8 to 20 inches of diameter	The first priority is to be able to operate on pipes from 8 to 20 inches of diameter	M	The robotic system lands on pipes from 8 to 20 inches and can operate on it		
UR-21	The combination of both robotic systems must be able to operate on 6 inches diameter pipes	The second priority is to be also able to operate on pipes with 6 inches of diameter. It will be explored the impact in the design of being able to operate on 6 inches diameter pipes	S	The robotic system lands on 6 inches diameter pipes		
UR-22	The combination of both robotic systems must be able to operate on pipes from 20 to 24 inches of	It would be nice to also be able to inspect pipes from 20 to 24 inches of diameter	C	The robotic system lands on pipes from 20 to 24 inches and can operate on it		

	diameter					
UR-23.a	The HMR Aerial Platform must be able to land by means of a magnetic landing platform	HMR must be directly attach to the pipe once it has landed on the pipe. All the pipes considered in the project will be magnetic /carbon steel since these are the ones that Total and Chevron are most interested in	M	The force created by the HMR landing platform is at least the 15% of its weight.	Not applicable to HRA	Not applicable to HRA
UR-23.b	The HRA Aerial Platform must be able to land and stabilize itself on the pipe during the inspection procedure	During the inspection performed by the robotic arm, the aerial platform must be stable over the pipe	M	The HRA add-ons include somehow an attachment procedure once the movement over the pipe has been completed		
UR-24	The system must operate only on non-insulated pipes	All the pipes considered in the project will not have insulation since these are the ones that Total and Chevron are most interested in	M	The considered pipes within the ConOps are only non-insulated pipes		
UR-25	The system magnets must operate on a surface with a non-magnetic layer of 1 mm or less	Important information for the design of the magnetic elements of the robotic system Maximum non-magnetic layer thickness, less than 1 mm	M	The force created by the landing gear is at least the 15% of its weight on a pipe with a non-magnetic layer of 1 mm	Not applicable to HRA	Not applicable to HRA
UR-26	The system magnetics should operate with a non-magnetic layer of 2 mm or less	Important information for the design of the magnetic elements of the robotic system Maximum non-magnetic layer thickness, less than 2 mm	S	The force created by the landing gear is at least the 15% of its weight on a pipe with a non-magnetic layer of 2 mm	Not applicable to HRA	Not applicable to HRA
UR-27	The system magnetics could operate with a non-magnetic layer of 3 mm or less	Important information for the design of the magnetic elements of the robotic system Maximum non-magnetic layer thickness, less than 3 mm	C	The force created by the landing gear is at least the 15% of its weight on a pipe with a non-magnetic layer of 3 mm	Not applicable to HRA	Not applicable to HRA

UR-28	The robotic system should be able to cross 5 mm high welds	Welds are usually max. 5 mm high and it is required to cross them to complete the inspection	S	The robotic system crosses welds during an operation		
UR-29	The robotic system should be able to cross horizontal elbows of OD>12"	Required to complete elbow inspections	S	The robotic system crosses horizontal elbows during an operation		
UR-30.a	The satellite installed on the HMR aerial robot must be able to move along the pipe	Required to get to the inspection area from the landing point	M	The robotic system moves along a pipe a minimum of 1 m	Not applicable to HRA	Not applicable to HRA
UR-30.b	The HRA aerial robot must be able to move along the pipe	Required to get to the inspection area from the landing point	M	The arm is able to reach the inspection point		
UR-31	The system must incorporate sensors to allow the pilot or automatically the system to assess the condition of the pipe	Before starting the inspection, it is important to assess the surface condition of the top of the pipe	M	The system allows the assessment of the condition of the top of the pipe by using a video camera visualized by the operator		
UR-32	The system must incorporate sensors to allow the pilot or automatically the system to assess the condition of the whole pipe	Before starting the inspection, it is important to assess the surface condition of the pipe	C	The system allows the assessment of the condition of the whole of the pipe		
UR-33	The system will incorporate the sensors to allow the pilot or automatically the system to locate the weld of the pipe	After landing it is important to locate the weld	M	Once landed, the system can localize the weld on the pipe.		
UR-34.a	The system must allow positioning relative to a feature (e.g. weld) with an accuracy of 2 cm at 3, 6, 9 and 12 positions.		M	The system can be positioned relative to a feature, e.g. a weld, with an accuracy of 2 cm with at 3, 6, 9, 12 positions		
UR-34.b	The system should locate itself, autonomously, with respect to the weld in 3, 6, 9 and 12 positions with less than 2 cm of accuracy		S	The system locates itself automatically with respect to the weld in 3, 6, 9 and 12 positions with less than 2 cm of accuracy		

UR-35	The system must allow positioning relative to a feature (e.g. weld) with an accuracy of 1 cm at 3, 6, 9 and 12 positions.		S	The system must be positioned relative to a feature (e.g. weld) with an accuracy of 1 cm at 3, 6, 9, 12 positions.		
UR-36.a	The system must perform an ultrasonic inspection for wall thickness from 3 mm to nominal	The ultrasonic inspection needs to have good quality in order to complete the inspection	M	The quality of the inspection will be assessed by a qualified ultrasonic operator provided by Total and/or Chevron		
UR-36.b	The system must perform an ultrasonic inspection for wall thickness from <2.5 mm to nominal	The ultrasonic inspection needs to have good quality in order to complete the inspection	S	The quality of the inspection will be assessed by a qualified ultrasonic operator provided by Total and/or Chevron		
UR-37	The system must be able to save and display in real-time A-SCAN data on the ground	Required to assess in real-time or acceptable low delay time the quality of the inspection	M	The system allows to save and display real-time A-SCAN data		
UR-38	The system must allow the operator to control the ultrasonic sensor from the ground	Required to be able to perform good quality inspections during the operation	M	The operator has similar control and configuration capabilities as in regular inspections without the robotic system		
UR-39	The system must be able to operate on surfaces at 60ºC	This is the most usual temperature range on pipes	M	Components of the system which will be in contact with the pipes have an operative temperature of more than 60ºC		
UR-40	The system must be able to operate on surfaces at 100ºC	This temperature is also possible but it is the second priority for Chevron and Total	C	Components of the system which will be in contact with the pipes have an operative temperature of more than 100ºC		
UR-41	Robotic system MTOW must be less than 15 kg	Maximum weight that Total and Chevron safety departments allow to operate in their facilities	M	The system is weighed just before the take off and it weighs less than 15 kg		
UR-42	Robotic system MTOW should be less than 12 kg	Maximum weight that Total and Chevron estimate as safe even in case of an accident during operations	S	The system is weighed just before the take off and it weighs less than 12 kg		

UR-43	Robotic system MTOW could be less than 8 kg	Maximum weight that Total and Chevron estimate as safe even in case of an accident during operations	C	The system is weighed just before the take off and it weighs less than 8 kg		
UR-44	The system could be able to measure height of corrosion deposit or depth (at least with 0.5 mm relative accuracy)	It would be a nice feature in order to add value to the robotic system	C	The system incorporates the sensors that allow the pilot or automatically the system to measure height of corrosion deposit or depth		
UR-45	The system must be able to perform ultrasonic inspection at 3, 6 , 9 and 12 positions in the first, middle and second welds in horizontal elbows	Required to complete an elbow inspection. First priority for Total and Chevron	M	The system performs a quadrant horizontal elbow inspection: 4 points (3, 6, 9 and 12 positions) close to first weld, 4 points close in the middle and 4 points close to second weld	Not achievable by HRA/C-tool	Not achievable by HRA/C-tool
UR-46	The system must be able to perform ultrasonic inspection at 3, 6 , 9 and 12 positions in the first, middle and second welds in vertical elbows	Required to complete an elbow inspection. First priority for Total and Chevron	M	The system performs a quadrant vertical elbow inspection: 4 points (3, 6, 9 and 12 positions) close to first weld, 4 points in the middle and 4 points close to second weld.	Not achievable by HRA/C-tool	Not achievable by HRA/C-tool
UR-47	The system must be able to perform ultrasonic grid inspections on elbows following Total and Chevron inspection procedures	Required to complete an elbow inspection. First priority for Total and Chevron	M	The system performs grid inspection on elbows.	Not achievable by HRA/C-tool	Not achievable by HRA/C-tool
UR-48	The system should be able to perform ultrasonic grid inspections on horizontal T joints (in 1 and 3 areas)	Second priority of required inspections for Total and Chevron	S	The system performs grid inspections on horizontal T joint in 1 and 3 areas (including impact area).	Not achievable by HRA/C-tool	Not achievable by HRA/C-tool
UR-49	The system should be able to perform ultrasonic quadrant inspections on horizontal T joints (in 1 and 3 areas)	Second priority of required inspections for Total and Chevron	S	The system performs horizontal quadrant T joint inspection in 1 and 3 areas (including impact area)	Not achievable by HRA/C-tool	Not achievable by HRA/C-tool

UR-50	The system could be able to perform ultrasonic grid inspections on reducers and horizontal T joints (in area 2)	Third priority of required inspections for Total and Chevron	C	The system performs grid inspection on reducers and T joint in area 2	Not achievable by HRA/C-tool	Not achievable by HRA/C-tool
UR-51	The system could be able to perform ultrasonic quadrant inspections on reducers and horizontal T joints (in area 2)	Third priority of required inspections for Total and Chevron	C	The system performs quadrant inspections on T joints in area 2	Not achievable by HRA/C-tool	Not achievable by HRA/C-tool
UR-52	The system must be able to perform quadrant inspection of a horizontal pipe	This inspection must be always possible to be performed due to its importance for the end-users	M	The system performs horizontal pipe quadrant inspection until the first weld whatever the configuration		
UR-53	The system must be able to inspect racks of pipes of 75 cm distance between pipes	Since these pipes are already very difficult to inspect even with a human operator and regular means (scaffolding, rope access, etc.)	M	The system is able to inspect at least two pipes that are close to each other no more than 75 cm		
UR-54	The robotic system should be able to perform A-scan type of inspection in straight pipes and in areas close to welds	Chevron and Total are very interested in scan type of inspection	S	The system performs scan-type of ultrasonic inspections in straight pipes close to welds		
UR-55	The system could be able to perform A-scan type of inspections in straight pipes with elbows	This would be ideal and very nice to have for Chevron and Total	C	The system performs scan-type of ultrasonic inspections in straight pipes with elbows	Not achievable by HRA/C-tool	Not achievable by HRA/C-tool
UR-56	The system should incorporate similar ultrasonic sensor user interface on the ground as regular ultrasonic sensor systems	The operator should have a similar way of interaction with the ultrasonic sensor software interface even if it is on-board the robotic system	S	A qualified operator will evaluate the ultrasonic sensor user interface		
UR-57	In single points measurements, the system must log: identification number, and wall thickness value	Defined following Total and Chevron inspection procedures	M	A qualified operator will evaluate the log information		

UR-58	In grid measurements, the system must log: identification number of the area and for each point it must log: the position (relative to the grid) and the wall thickness	Defined following Total and Chevron inspection procedures	M	A qualified operator will evaluate the log information		
UR-59	In A-scan type inspections, the system could log: identification number of the area, minimum wall thickness, and an image (using standard colour coding) that contains position (relative to the grid) and thickness for each point	Defined following Total and Chevron inspection procedures	C	A qualified operator will evaluate the log information		
UR-60	The system must be able to change or recharge batteries onsite (in safe areas only)	Since it is foreseen that these types of operations will be required to continue with the operation during one day of work	M	The system allows to change or recharge batteries onsite		
UR-61	The system must be able to reload ultrasonic coupling onsite (if applicable)	Since it is foreseen that these types of operations will be required to continue with the operation during one day of work	M	The system allows to reload the ultrasonic coupling onsite		
UR-62	Gas detection alarm must be clearly communicated to the pilot	Important from the safety point of view	M	The safety personnel of Total and Chevron will check this requirement		
UR-63	The system must incorporate a clear and fast interface to start the emergency procedure after gas detection	Important from the safety point of view	M	The safety personnel of Total and Chevron will check this requirement		
UR-64	The operator must be able to perform small repairs and maintenance onsite (in safe areas only)	No need to send back the robotic system after minor malfunctions occur	M	The project partners must be prepared in the experiments with spare parts so that they can continue the operation even in cases of minor malfunctions		

UR-65	The operator must have a detailed plan for obtaining the permit to flight one year in advance of the experiments	Important for the success of getting the permits to flight in Total and Chevron facilities	M	A detailed plan of the experiments will be completed one year in advance		
PR-01	The HMR must be able to land autonomously with an accuracy of 5 cm with respect to the landing position	This includes the automatic detection of the pipe and the accurate relative estimation of the position of the aerial robot with respect to the pipe using on-board sensors	M	The HMR lands autonomously on the previously set landing point no farther than 5 cm from it	Not applicable to HRA	Not applicable to HRA
PR-02	The satellite robot must be able to navigate autonomously over the pipe, and within a tolerance band of 1 to 5 mm at the 12 o'clock	It is related to the construction of an exact corrosion map	M	On a representative pipeline on land, the linear advance and retraction should be repeated 10 times in 50 cm and there should be no deviation at the end greater than 2 mm. This test must be done at a 45º interval.	Not applicable to HRA	Not applicable to HRA
PR-03	Coupling of the ultrasonic sensor must enable continuous thickness measurement between the first and second back-wall echo	This is related to the precision of the measurement and its SNR ratio. Which must be measured at intervals of different degrees (0, 90, 180, 270º)	M	The system must keep a SNR better than 20 dB (between the backwall echo and the electronics noise).		
PR-04	The HRA must autonomously control and stabilize itself while moving along the pipe with an accuracy of 2 cm per pipe meter (longitudinal) with respect to the landing position	The HRA has to be able to reach different points of the pipe, keeping the needed accuracy in order to identify the location of the defect	M	The HRA navigates over the pipe, and it can move along staying on the longitudinal axis of the pipe with 2cm per pipe meter of accuracy		
PR-05	The HRA must be able to land autonomously with an accuracy of 5 cm with respect to the landing position.	This includes the automatic detection of the pipe and the accurate relative estimation of the position of the aerial robot with respect to the pipe using on-board sensors.	M	The HRA lands autonomously on the previously set landing point no farther than 5cm from it.		

PR-06	The following parameters will be measured which must be in the environment of deviation of 5% (range, amplitude, bandwidth, etc.)	The results must be contrasted with the standard deviation of a commercial ultrasound equipment		Compliance of an ultrasonic instrument to a standard means all stipulations of the standard have to be fulfilled based on EN 12668 standards		
PR-06	Calibration velocity with a UT block must result in a thickness measurement with no more than an error of 3%	A calibration block will be used to allow: 1) Verifying the overall functioning of the unit of measurement 2) Obtaining the two main calibration parameters a) Sound path inside the transducer 2) Calibration of the ultrasound speed in the material	M	The measurements taken by the UT sensors, once it is calibrated, have an error less than 3% of the thickness wall		
PR-08	Inspect different pipes on a rack with the hyper-redundant (snake) robot arm	The aerial robot is supposed to be already landed on a pipe and the robot arm is unfolded	M	The robotic arm has to reach multiple points of the pipe and avoid obstacles along the path without physical contact.	Not achievable by HRA/C-tool	Not achievable by HRA/C-tool

Convention for the end user requirements

Must (M):	Must be fulfilled: Defines a requirement that has to be satisfied for the final solution to be acceptable.
Should (S):	Should be achieved: This is a medium-priority requirement that should be included if possible within the agreed delivery time. To be targeted at, shall be reviewed at each milestone. It needs justification if included or discarded, and there is a strong incentive to include it in a (later) industrialization, but not a Must for HYFLIERS.
Could (C):	This is a nice-to-have requirement (time and resources permitting) but the solution will still be accepted if the functionality is not included.

Annex 2 – Tests locations at TotalEnergies Oleum site

See appended document further below.

Annex 3 – Risk assessment related to HRA operation

Annex 4 – Safety Plan (Plan de Prévention)

HYFLIERS Field tests
TotalEnergies Oleum (Dunkerque)

Selection of tests locations
(agreed during site visit on 10th Dec. 2021)

Stéphane CORBINEAU (OT/TL/OPS/INS)

10/12/2021

Site Tests of HYFLIERS prototypes – Background (WP6)

- Hybrid Mobile Robot (HMR) to be tested in Chevron Oronite plant (Gonfreville)
- Hybrid Robot with Arm (HRA) to be tested in TotalEnergies Oleum (Dunkerque)

- Tests protocols to be developed, considering:
  - Piping arrangement: Single pipe / Piperack
  - Components: Straight pipes / Elbows (horizontal, upward, downward) / Tees (horizontal, vertical) / Reducers
  - Diameter: 6'' to 24''
  - Operations: landing / movements / take off
  - UT measurements:
    - UT1 (12 o'clock position)
    - UT4 (3,6,9,12 o'clock positions)
    - UT Grid (50 mm grid 360° around pipe)
    - UT Scan (full scan of area)

Tests location at Chevron Oronite

Site Tests in TotalEnergies Oleum (Dunkerque)

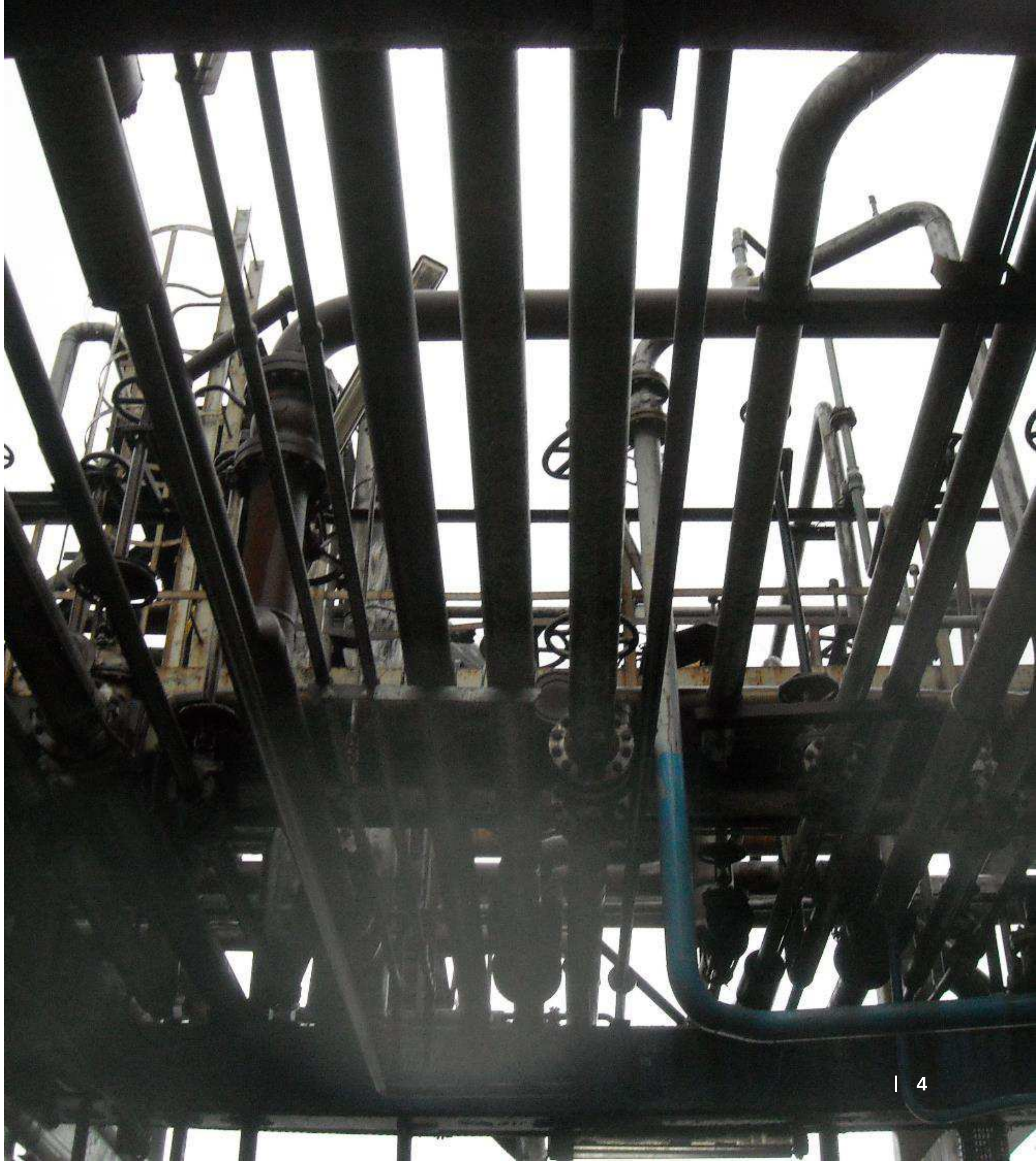
- TRL of HRA prototypes with Anthropomorphic Arm and Snake Arm are not high enough for site tests
- HRA prototype with C-Arm (version with 8'' C-Arm) will be site tested in TotalEnergies Oleum (following successful WP5 mock-up tests)
- Site tests protocols to be based on the following minimum requirements:
- Pipe Ø: 8''
  - Piping arrangement: Single pipe and Piperack
  - Operations: landing / crawling / take off
  - UT measurements on straight pipe: UT4 (3,6,9,12 o'clock) / UT Grid (50 mm grid 360° around pipe)
- Pipe Ø: 6''
  - Piping arrangement: Single pipe and Piperack
  - Operations: landing / crawling / take off
  - No UT measurements (6" C-Arm will not be available but design and functions are similar to 8" C-Arm)

TotalEnergies

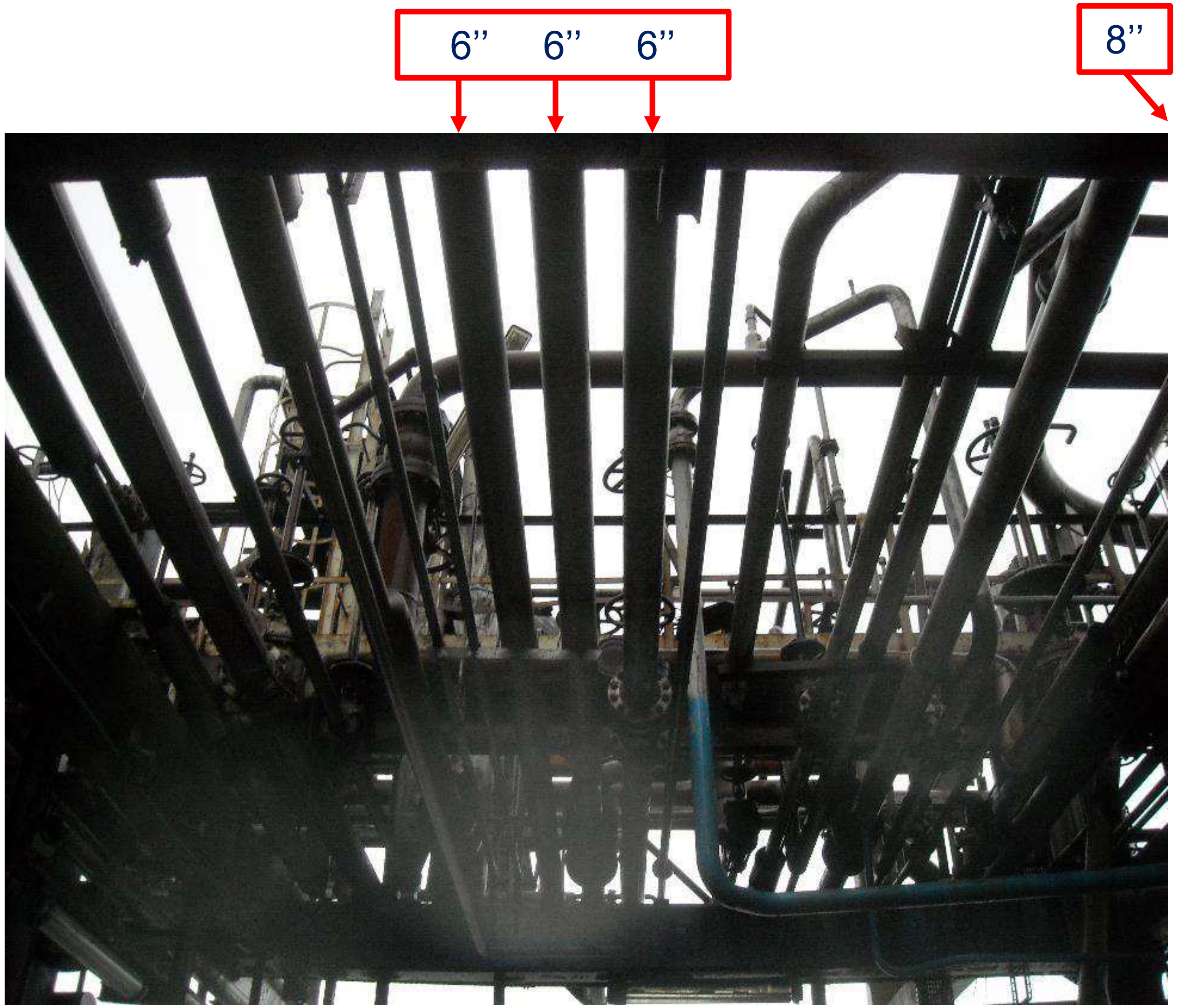
01.

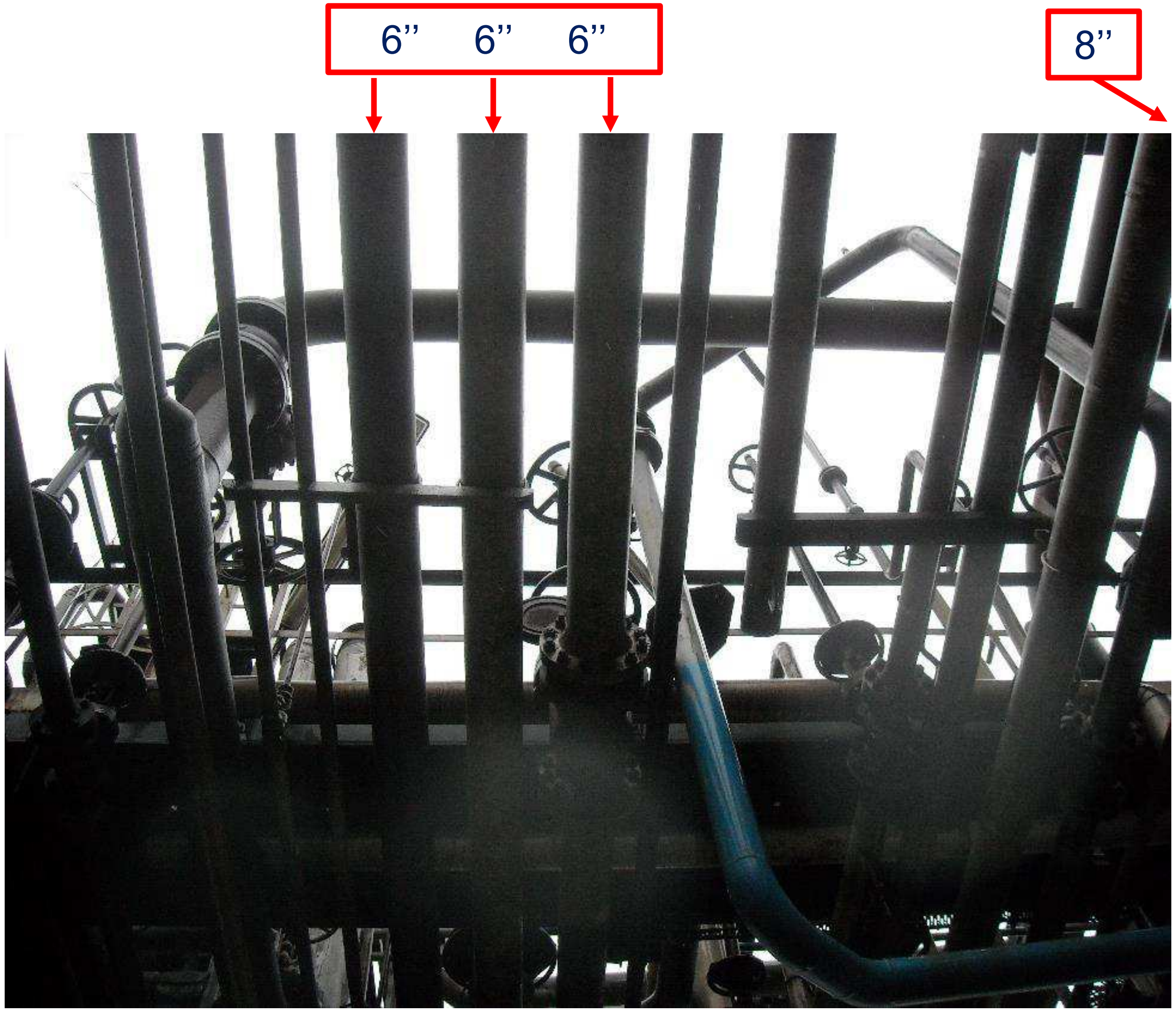
OLEUM test locations

Zone 1 – Piperack (tank area)
Piperack 1 layer – open area



Piperack – 1 layer – open area





02.

OLEUM test locations

Zone 2 – Piperack (column area)
Piperack 2 layers – congested area

Piperack – 2 layers – congested area

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Piperack – 2 layers – congested area

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03.

OLEUM test locations (option)

Zone 3 – 21B201 area

Single pipes + Piperack

Single pipes – open area

See virtual tour: Pano_sol_1, 2, 9, 10

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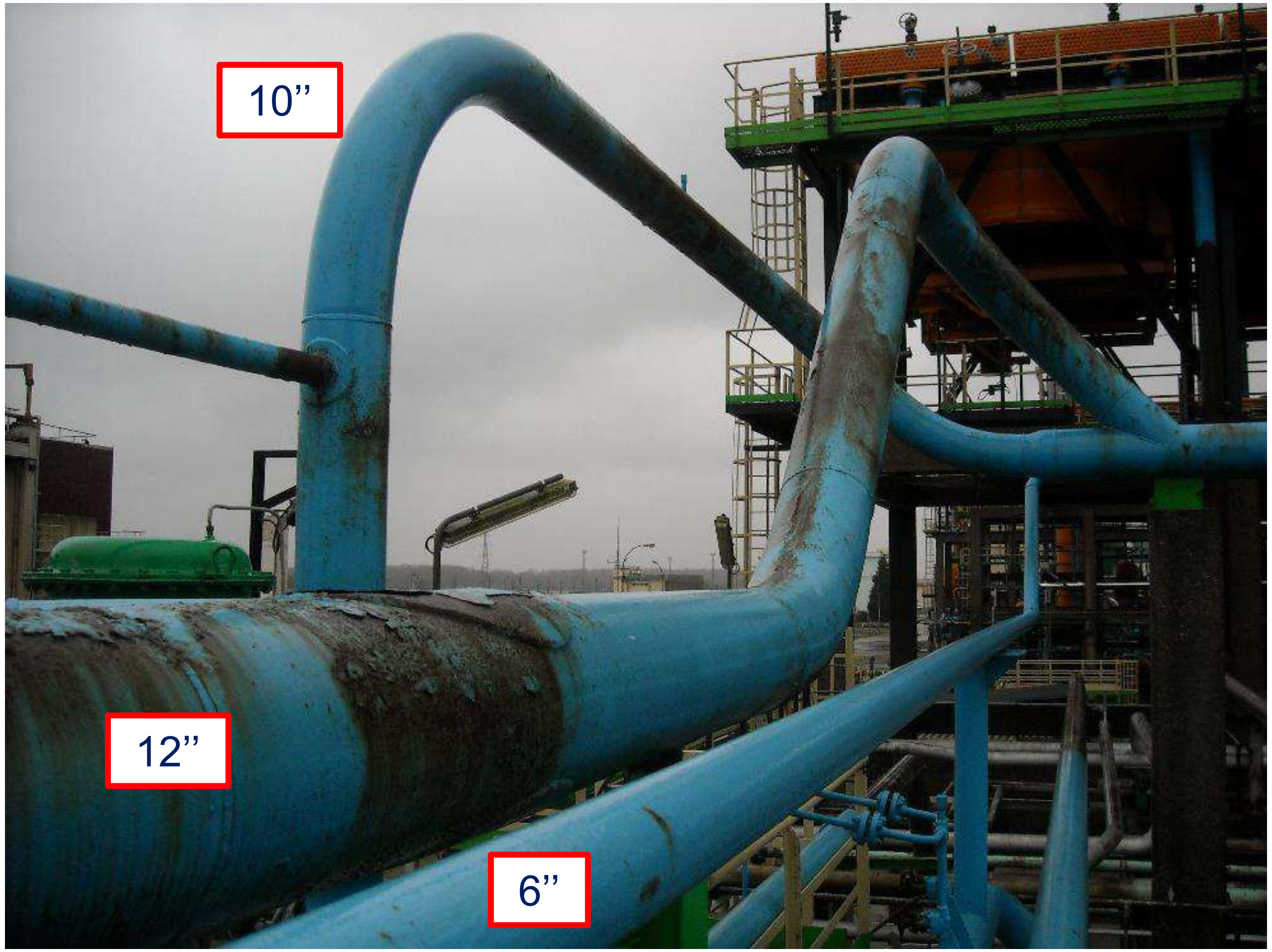
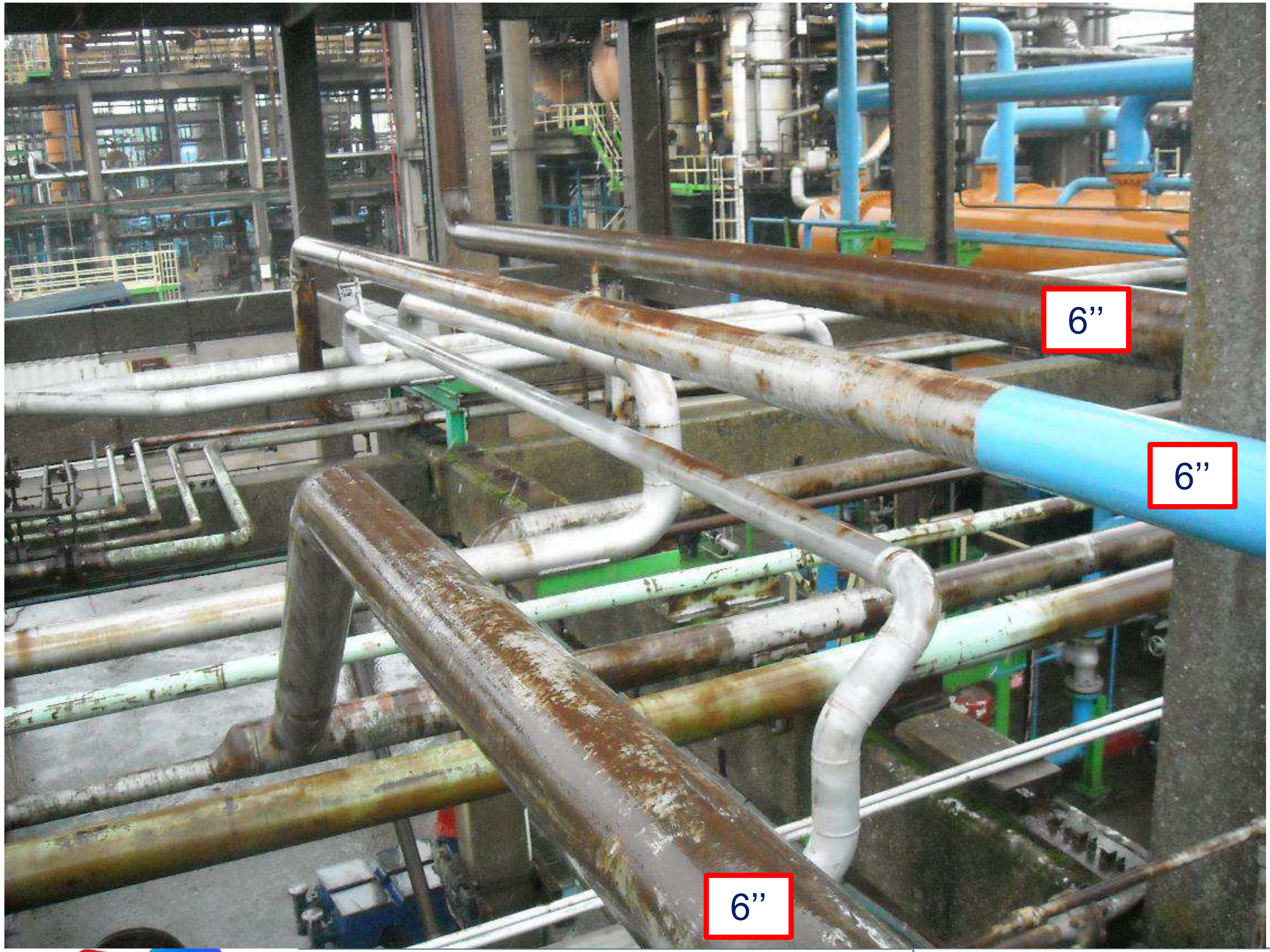
Single pipes – open area



Pano_sol_1, 2, 9, 10

Single pipes + Piperack



Pano_sol_1, 2, 9, 10

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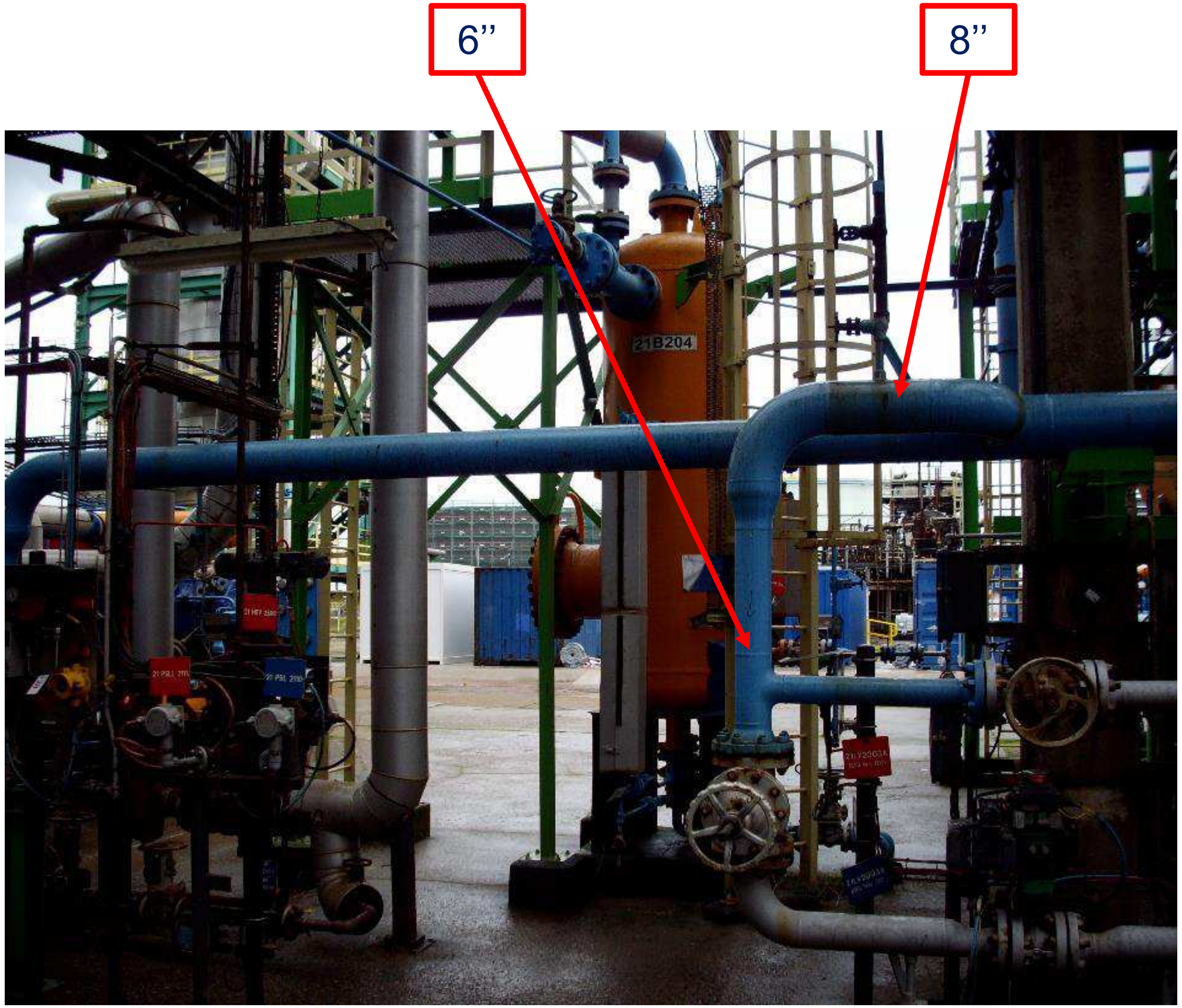
Single pipes – congested area



Pano_sol_1, 2, 9, 10

TotalEnergies

Field Tests preparation

- TotalEnergies OLEUM: virtual tour

http://www.isotour.fr/Visite_Virtuelle_Total/Visite_virtuelle_Total.html

Field Tests preparation and authorizations

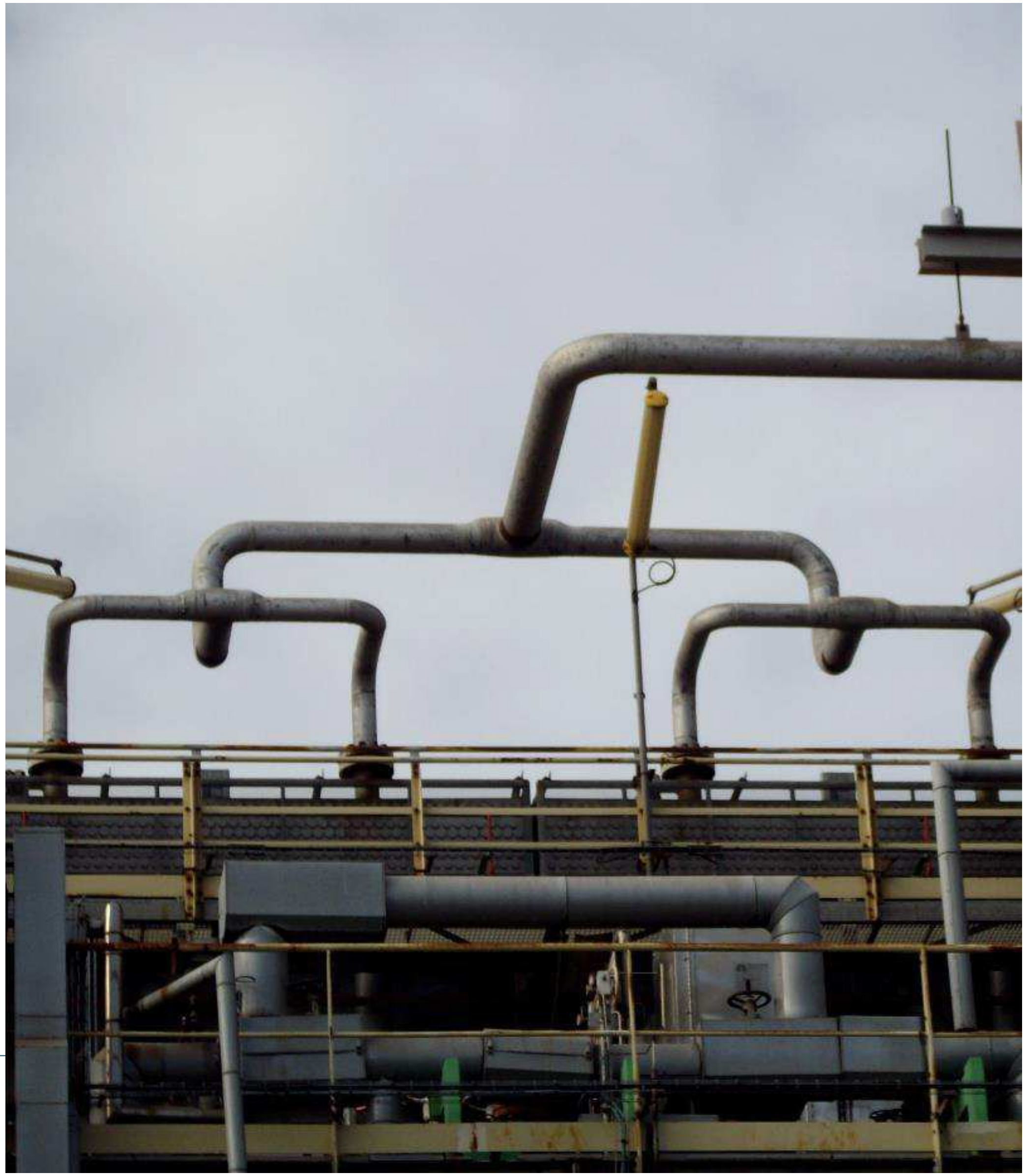
- Prototype's Operator to be nominated:
  - CATEC for the HMR
  - CATEC or USE? for the HRA

- The prototype Operator is responsible for preparing the following documents & authorizations with the support from Chevron/TotalEnergies:
  - Prototype approval by DGAC (french aviation authority) as per EU drone regulation (Dossier, SORA…)
  - Telepilot accreditation by DGAC
  - Site approval by Chevron/TotalEnergies (Company aviation authority, Job Risk Assessment…)
  - Flight Plan…

TotalEnergies

Annexes

Single pipes - open area (upper platform)



Single pipes - open area

TotalEnergies

Single pipes & Piperack – semi congested area

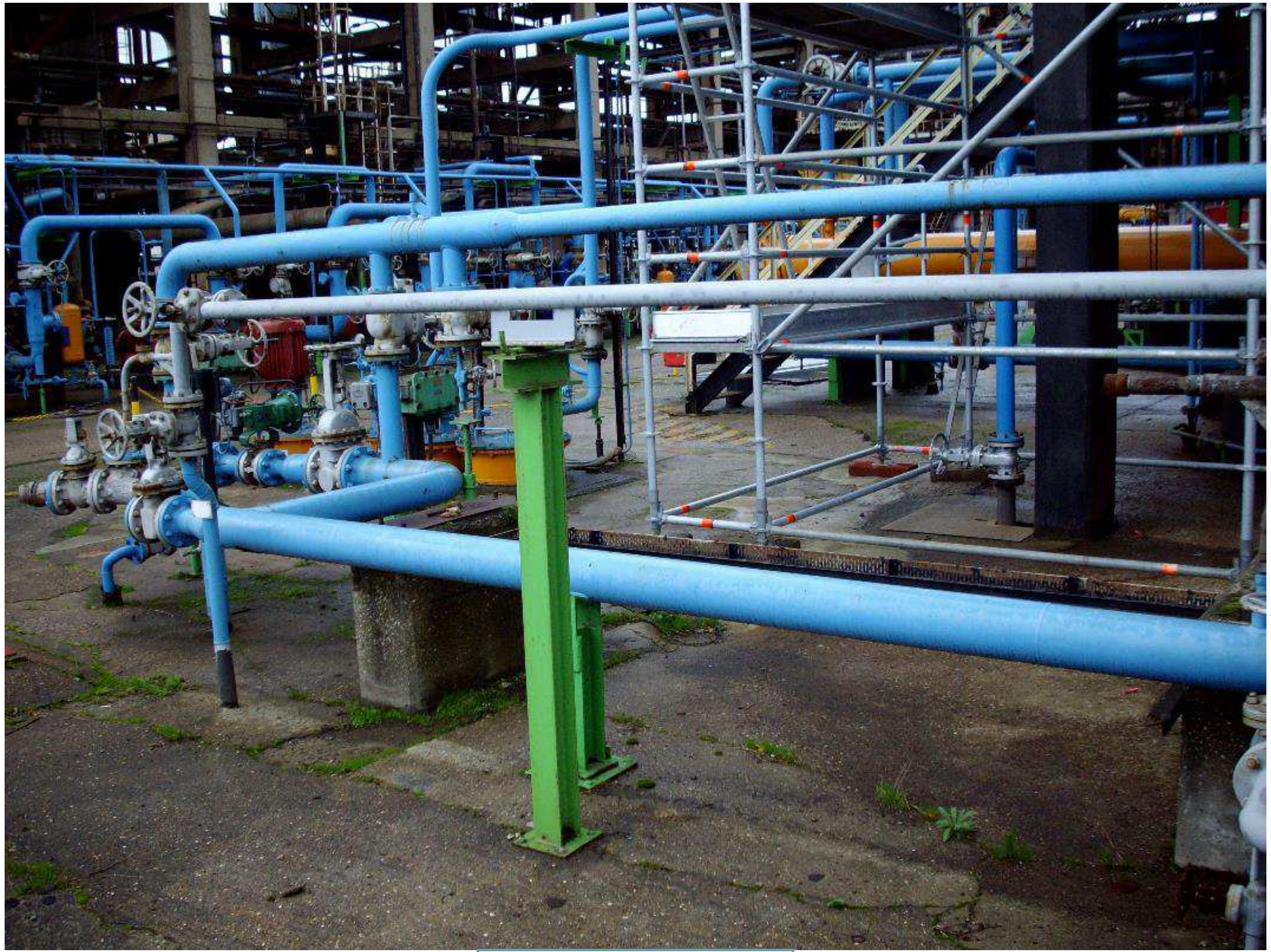
6''

8''

Pano_sol_24, 25

TotalEnergies

Single pipes - open area



Pano_sol_29

Pano_sol_31

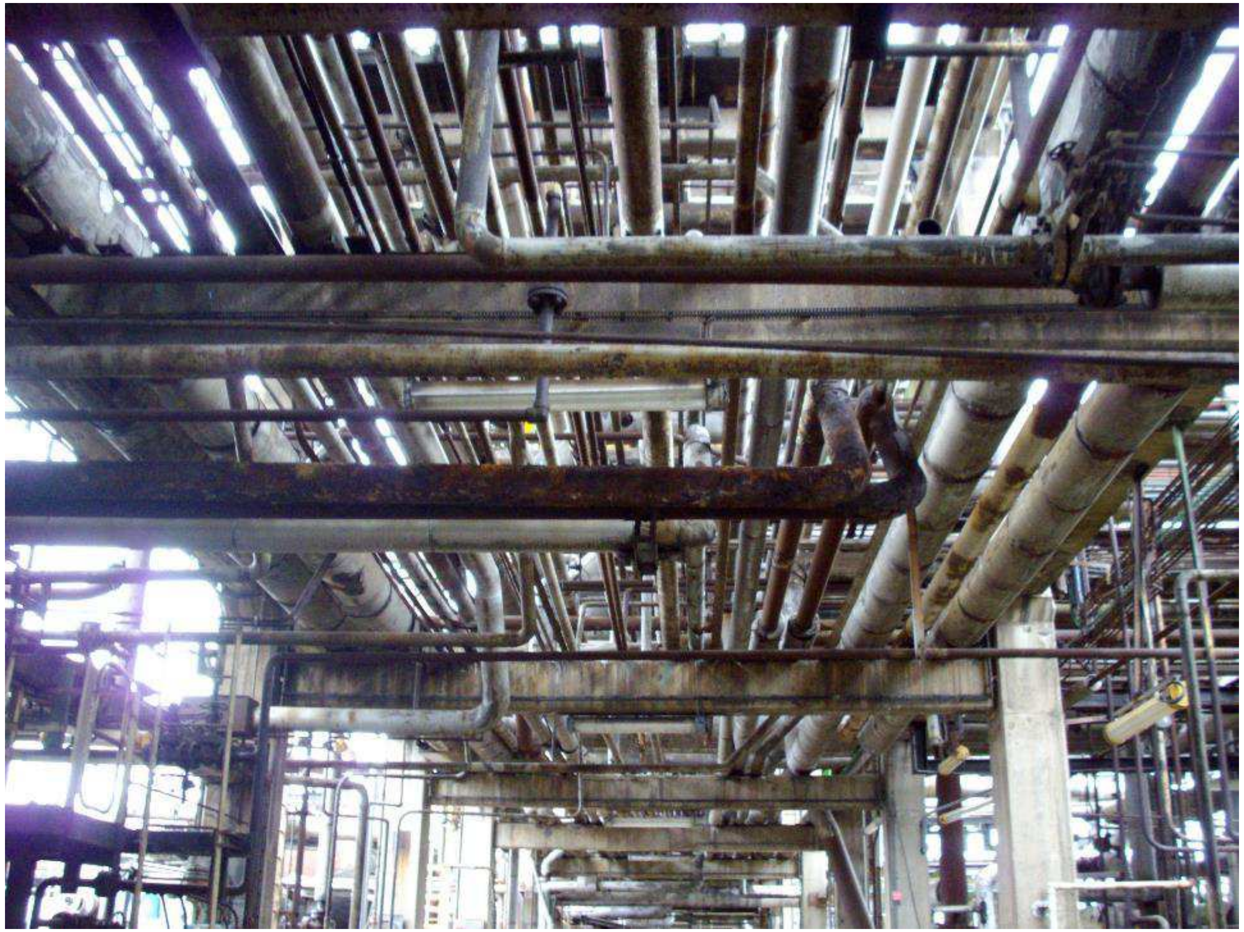
TotalEnergies

Single pipes – dirty condition - open area

Pano_sol_36

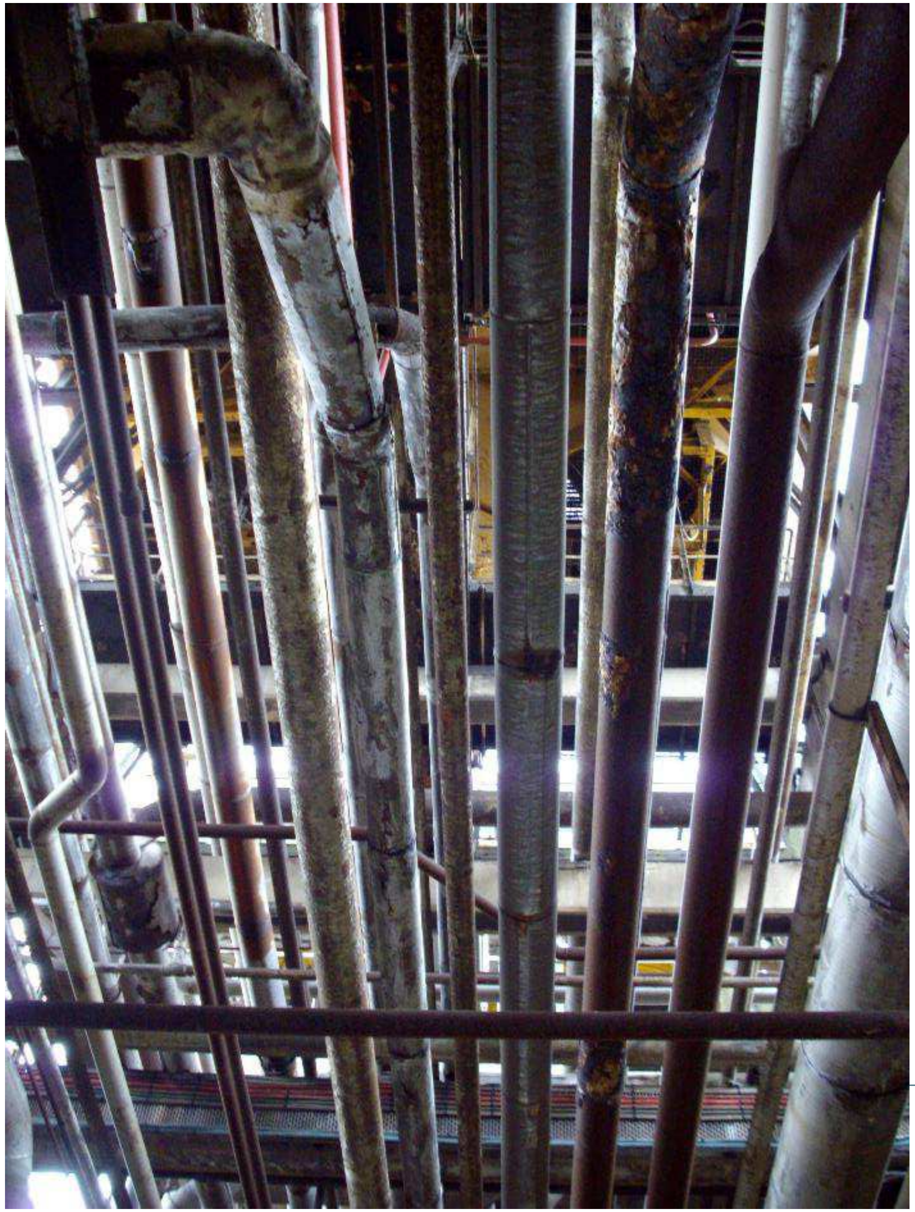
Pano_sol_40

Piperack – dirty condition - congested area



Pano_sol_22

Piperack – dirty condition - congested area



JRA Form

PRD - HSE/GEN - M04 - 63 - Rev 1

Job Risk Assessment	Description of the job: INSPECTION BY DRONES (Multicopter type under VLOS - Visual Line of Sight) (JRA to be customized depending on Site, Scope of Work, Tools and local constraints…)
	Facilitator: / Site/Platform/Location: / Date : 25th April 2022

Participants:

#	Task	Personnel involved	Equipment Involved	Hazard / Event Risk and consequences	Initial Risk S	Initial Risk P	Initial Risk R	Risk Reduction Measure(s)	Residual Risk S	Residual Risk P	Residual Risk R*	Action Party	Deadline	% prog.	Completion date	Follow up
1.1	MOBILISATION TO SITE AND INSTALLATION															
2.1	TAKE OFF	Pilot and Copilot	Drone	**Hazard** • Collision with structure/equipment **Consequence** • Damage to drone • Damage to structure/equipment	3	5	15	• Take-off zone defined during preparation (clear area) • Flight plan defined during preparation (no obstacles) • Flight controller with GOTO/GOHOME mode to be activated in case of anomaly or hazard (SAFE area and HOME area to be defined during preparation. GOTO/GOHOME mode to be tested before operation). • Pilot certified • Surveillance of the area by pilot and copilot • Flight within visual light of sight • Flight within operating envelope (meteo, wind, visibility...) • No coactivity by lifting, rope-access, other drone flying... • Mechanical protection of propellers • No simultaneous movements by remote control (rotation and translation motions are separated) • See and Avoid system (option?)	2	4	8					
2.2		Pilot and Copilot	Drone	**Hazard** • Collision with Personnel **Consequence** • Personnel injury	3	4	12	• As per 2.1 • No flight permitted over Personnel • Restricted area for Personnel (barricade + warning signs). • Public Address before take-off.	3	3	9					
2.3		Pilot and Copilot	Drone	**Hazard** • Collision with aircraft (helicopter…) **Consequence** • Personnel injury, fatality • Aircraft damage, crash • Drone damage, crash	5	4	20	• As per 2.1 • No flight permitted when aircraft in the surrounding area	5	2	10					
2.4		Pilot and Copilot	Drone	**Hazard** • Drone falling **Consequence** • Damage to drone • Damage to structure/equipment • Personnel injury, fatality	4	4	16	• As per 2.1 • Parachute (only relevant if altitude >50m). • Redundant motor/propeller (the drone shall keep flying if one motor/propeller fails). • If no redundancy, no flight permitted over hazardous equipment. • If redundancy, flight over hazardous equipment shall be avoided as far as possible. If not, risk reduction measures shall be assessed, such as: • Mechanical protection of weak components (small bore lines, nozzles...) • Depressurization of HC lines.	3	3	9					
2.5		Pilot and Copilot	Ground Control Station	**Hazard** • Ground Control Station not ATEX in explosive atmosphere **Consequence** • Fire / Explosion • Asset damage • Personnel injury	5	4	20	• Hot Permit To Work. • Take-off zone defined out of Zones 1/2 as far as possible. • Gas detectors with Pilote and Copilot. • Fixed Gas Detectors on the plant. • Radio communication with Pilot/Copilot and Control Room. • Permanent surveillance of the area by Pilot and Copilot. • In case of gas detection, immediate evacuation of the area, with the Ground Control Station. • Coactivity control (no SIMOPS with potential HC release).	5	2	10					

2.6		Pilot and Copilot	Drone	**Hazard** • Drone not ATEX in explosive atmosphere **Consequence** • Fire / Explosion • Asset damage • Personnel injury	5	4	20	• As per 2.5 • Hot Permit To Work • Flight plan defined during preparation (out of Zones 1/2 if possible). • Flight controller with GOTO/GOHOME mode to be activated in case of anomaly or hazard (SAFE area and HOME area to be defined during preparation. GOTO/GOHOME mode to be tested before operation). • Gas Detector onboard the drone with notification to the Pilot in case of gas detection. • Fixed Gas Detectors in the plant (consider additional spider gas detectors if needed). • Remote monitoring of the atmosphere (gas detection) with specific cameras (SENSIA, FLUKE...) (Option). • Radio communication with Pilot/Copilot and Control Room. • Permanent surveillance of the area by Pilot and Copilot. • In case of gas detection, immediate evacuation of the drone to the SAFE area. • Mechanical protection of the battery to prevent damage, heat and fire in case of impact (drone falling).	5	2	10					
2.7		Pilot and Copilot	Drone and Ground Control Station	**Hazard** • Loss of communication / Loss of control **Consequence** • Loss of drone • Damage to equipment/structure (collision) • Personnel injury (collision)	3	5	15	• Flight plan defined during preparation (free of equipment that could affect communication with drone). • FAIL SAFE mode automatically activated in case of loss of communication => hovering mode activated to keep drone at fixed position. (FAIL SAFE hovering mode to be tested before operation). • Ultimate FAIL SAFE mode activated in case of loss of communication / loss of control and loss of FAIL SAFE hovering mode => engine shutdown activated	3	3	9					
3.1	**FLIGHT**															
3.x	**(As per TAKE OFF)**															
4.1	**INSPECTION / MEASUREMENTS**															
4.x	**(To be defined depending on insp/measurements)**															
5.1	**LANDING**															
5.x	**(As per TAKE OFF)**															
6.1	**DEMOBILISATION**															
6.x	**(As per MOBILISATION)**															

JRA Approbation by - Name & Signature:
(draft prepared by Stephane CORBINEAU - OT/TL/OPS/INS)

Date:

DOSSIER POUR

PLAN DE PREVENTION SIMPLIFIE

CADRE RESERVE A HSEIQ - Au préalable, dossier d'intervention entièrement rempli

N° PDP SIMPLIFIE :

SITE D'INTERVENTION : DPCO MARDYCK : ☑ DPCO GRAVELINES : ☐

ZONE D'INTERVENTION : Plateau technique Oleum

NATURE DE L'INTERVENTION : Essai du prototype de drone HRA/C-Tool pour mesures d'épaisseur sur tuyauteries

ENTREPRISE EXTERIEURE INTERVENANTE :

DATE DEBUT VALIDITE : 01/06/2022 **DATE FIN VALIDITE :** 31/12/2022

NOM CORRESPONDANT HSEIQ : **SIGNATURE :**

DATE DE PRISE EN COMPTE :

[illegible]

INFORMATIONS GENERALES DE SECURITE DE L'ETABLISSEMENT

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DOSSIER D'INTERVENTION

DEFINITIONS - ABREVIATIONS

TERME	ABREVIATION	DEFINITION
Entreprise Utilisatrice	**EU**	Entreprise (donneur d'ordre) qui confie par contrat la réalisation d'un travail à une entreprise intervenante ou qui lui met à disposition ses installations suite à accord par commande ou convention
Entreprise Extérieure Intervenante	**EEI**	Entreprise tierce à qui est confiée par contrat la réalisation d'un travail pour le compte de l'entreprise utilisatrice (donneur d'ordre) ou qui y utilise des installations selon les termes d'une commande ou d'une convention
Entreprise Extérieure Principale	**EEP**	Entreprise tierce qui sous-traite à une Entreprise Extérieure Intervenante un travail à réaliser pour le compte de l'entreprise utilisatrice
Tâche	-	Travail élémentaire réalisé par une et une seule EE
	PDP	Document établi par le site en tant qu'Entreprise Utilisatrice et la (ou les) Entreprises Extérieures concernée(s) par la (ou les) tâches, traçant les informations échangées et les mesures prises par chaque Entreprise en vue de prévenir les risques liés aux interférences entre activités, installations et matériels lors des travaux exécutés dans le cadre de cette (ces) Opération(s). Chaque Entreprise Extérieure participant à l'Opération reçoit un exemplaire du Plan de Prévention
Dossier d'Intervention	**DI**	Document établi entre EU et EE pour une zone géographique définie et précisant les pré-requis et conditions d'intervention pour une tâche simple identifiée
	BI	Document faisant référence à un Dossier d'Intervention valide pour l'EE et dont la signature chaque jour par EU et EEI après visite préalable de la zone conditionne le début de l'intervention pour la tâche simple stipulée
Analyse de risques	-	Identification des risques résultant : • des moyens et des matériels mis en œuvre, • des installations, et de l'environnement, • de leurs interactions avec les Travaux (incluant les étapes de mobilisation et de démobilisation), Définition des mesures à mettre en œuvre afin de supprimer ou réduire ces risques à un niveau acceptable, Définition des entités chargées de mettre en œuvre les mesures.
	-	Personnel d'entreprise intervenante qui réalise les tâches mentionnées sur le bon d'intervention
Donneur d'ordre	**DO**	Personne de l'Entreprise Utilisatrice, interlocuteur métier de l'Entreprise Extérieure en charge d'une l'intervention
	EXP	Responsable exploitation de la zone géographique où se déroule l'intervention. Peut dans certains cas être le Donneur d'Ordre de l'EEI
Prévention	**SECU**	Correspondant sécurité de la zone géographique où se déroule l'intervention. Valide la concordance entre la tâche à effectuer et les mesures de prévention définies

INFORMATIONS GENERALES DE SECURITE DE L'ETABLISSEMENT

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DOSSIER D'INTERVENTION

PROCESSUS PERMIS TRAVAIL APPLICABLE SUR EF

Intervention avec processus travaux standard EF

- **PDP annuel**
  Visite préalable sur zone
  Intervention avec AT et BV
- **PDP spécifique**
  Visite préalable sur zone
  Intervention avec AT et BV

Intervention avec processus travaux simplifié EF

- **PDP simplifié**
  Visite préalable sur zone
  Intervention avec Dossier et Bon d'intervention

DOSSIER D'INTERVENTION

VERIFICATIONS INITIALES

A renseigner par DO

1. REGLEMENTATION ET PROCESSUS EF

L'utilisation du processus travaux simplifié implique le strict respect des conditions suivantes :

- ☑ L'Entreprise Extérieure Intervenante en charge de la tâche à effectuer n'est pas au Plan de Prévention annuel en cours de l'Etablissement des Flandres
- ☑ La tâche à exécuter est éligible au PDP simplifié
- ☑ La durée d'intervention est estimée inférieure à 400 heures sur 12 mois consécutifs

Cochez obligatoirement les 3 cases. Dans le cas contraire, utilisation du plan de prévention simplifié interdite.

Ce dossier d'intervention vaut plan de prévention pour la tâche définie dans ce document aux conditions suivantes :

1. La prise en compte par HSEIQ du dossier, avec l'affectation d'un numéro de PDP
2. La visite préalable à l'intervention sur la zone concernée
3. L'exécution de la tâche avec un Bon d'intervention et dans le respect de l'analyse de risques qui y figure

VERIFICATIONS INITIALES VALIDEES → PASSAGE A LA DESIGNATION DE L'OPERATION

INFORMATIONS GENERALES DE SECURITE DE L'ETABLISSEMENT

TOTAL SAFETY FOR ME, FOR YOU FOR ALL

RISK

333

TotalEnergies

DOSSIER D'INTERVENTION

DESIGNATION DE L'INTERVENTION

A renseigner par DO en relation avec l'EEI

2. ENTREPRISE UTILISATRICE (EU)

Délimitation zone d'intervention : Plateau technique Oleum

Donneur d'ordre (DO) : Rohart Romain

Libellé de la tâche : Essai du prototype de drone HRA/C-Tool pour mesures d'épaisseur sur tuyauteries

Descriptif complet de la tâche : Essai du drone HRA/C-Tool développé dans le cadre du projet européen HYFLIERS, permettant de se poser sur tuyauteries et d'effectuer des mesures d'épaisseur (voir document D6.2).

3. ENTREPRISE EXTERIEURE INTERVENANTE (EEI)

Raison sociale :

Responsable EEI :

Adresse :

Téléphone :

E-mail :

Nombre de salariés dans l'agence :

Nombre d'accidents avec arrêt depuis 3 ans :

Effectif prévu :

Intervention en sous-traitance : ☐ OUI ☐ NON **Si OUI, remplir le paragraphe suivant**

Numéro de SIRET :

4. ENTREPRISE EXTERIEURE PRINCIPALE (EEP)

Raison sociale :

Responsable EEP :

Adresse :

Téléphone :

E-mail :

Inscription au PDP annuel : ☐ OUI (*)

Numéro de SIRET :

(*) Champs ou cases à renseigner obligatoirement. Dans le cas contraire, utilisation du plan de prévention simplifié interdite

DESIGNATION DE L'OPERATION VALIDEE ⇒ **PASSAGE A L'ANALYSE DE L'OPERATION**

INFORMATIONS GENERALES DE SECURITE DE L'ETABLISSEMENT

TOTAL SAFETY FOR ME, FOR YOU FOR ALL

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DOSSIER D'INTERVENTION

ANALYSE DE L'OPERATION

A renseigner par DO

5. MODE OPERATOIRE POUR INTERVENTION

Existence d'un mode opératoire pour l'intervention : ☑ OUI Si NON, motif :

6. ANALYSE DES RISQUES GENERAUX

A mettre en œuvre par l'Entreprise Extérieure Intervenante :

ETAPES	RISQUES IDENTIFIES	MESURES DE PREVENTION A APPLIQUER
Toute tâche sur site	Méconnaissance environnement de travail	Accueil sécurité simplifié du site Information sécurité spécifique zone d'intervention Visite préalable zone en début d'intervention
Toute tâche sur site	Chute lors de déplacements	Utiliser les chemins et voies appropriés pour accéder à la zone de travail
Toute tâche sur site	Fuite ou odeur suspecte	Arrêt de la tâche Prévenir EU
Circulation avec véhicule	Accident ou collision	Respect du code de la route Respect des règles de circulation du site
Manutention manuelle de matériel	Lombalgie, choc, heurt	Gestes et postures appropriés à la charge Portage manuel limité à 20 kgs Coordination des mouvements

A mettre en œuvre par l'Entreprise Utilisatrice :

ETAPES	RISQUES IDENTIFIES	MESURES DE PREVENTION A APPLIQUER
Toute tâche sur site	Plusieurs interventions sur une même zone géographique	Gestion préalable de la coactivité sur la zone Information des EE concernées de l'intervention planifiée avec un PDP simplifié

DOSSIER D'INTERVENTION

ANALYSE DE L'OPERATION

A renseigner par DO et EEI avec contribution EXP et SECU

7. ANALYSE DES RISQUES SPECIFIQUES

A mettre en œuvre par l'Entreprise Extérieure Intervenante :

ETAPES	RISQUES IDENTIFIES	MESURES DE PREVENTION A APPLIQUER
Décollage/atterissage	Risque coupure par helice du drone	Port de gants anti coupure et 1 seul intervenant dans la zone Balisage de la zone de décollage
en vol	Crash du drone	Balisage de la zone de vol, aucun intervenant dans cette zone
Cheminement	chute de plein pied	Sensibilisation des intervenant, controle complet de la zone d'intervention avant travail
Transport/ manutention	Risque TMS	Port de charge supérieur à 20kgs se feront a deux personnes
en vol	Perte de controle	Procedure de failsafe (à consolider)
A COMPLETER		

A mettre en œuvre par l'Entreprise Utilisatrice :

ETAPES	RISQUES IDENTIFIES	MESURES DE PREVENTION A APPLIQUER
Toute tâche sur site	Coactivité de plusieurs interventions	Visite préalable zone avant signature du bon d'intervention

Choix des EPI pour l'intervention (*) ☐ Sans EPI ☑ EPI standards ☐ EPI selon liste ci-dessous

(*) Champs ou cases à renseigner obligatoirement. Si non cochés, utilisation du plan de prévention simplifié interdite.

INFORMATIONS GENERALES DE SECURITE DE L'ETABLISSEMENT

TOTAL SAFETY FOR ME, FOR YOU FOR ALL

RISK

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DOSSIER D'INTERVENTION

VALIDATION DU DOSSIER

A renseigner par SECU, DO, EEI et EXP

Documents annexes pour l'intervention (*) ☐ Sans objet ☑ Selon liste ci-dessous

Autorisation de vol réglementaire / procedure d'intervention / procedure Failsafe

Consultation du préventeur de la zone concernée : ☑ OUI Nom du préventeur : **yohan LACROIX**

Signature du préventeur :

8. DUREE DE VALIDITE

Date de début de validité : 01/06/2022 Date de fin de validité : 31/12/2022

Ne peut excéder la date de fin de validité du PDP annuel en cours
Validité 12 mois, sans excéder 400 heures de travail sur site

9. CONDITIONS D'INTERVENTION

Par bon d'intervention chaque jour ouvré ☑ Par bon d'intervention pour la durée du PDP simplifié ☐

Justification :

10. ACCES VEHICULE

☑ OUI ☐ NON

11. EMARGEMENTS : NOM, DATE & SIGNATURE

Entreprise Extérieure Intervenante :

Si sous-traitance,
Entreprise Extérieure Principale :

Donneur d'ordre : **Rohart Romain**

(Dernier signataire)
Exploitant zone :

DOSSIER D'INTERVENTION RENSEIGNE → ENVOI A HSEIQ

INFORMATIONS GENERALES DE SECURITE DE L'ETABLISSEMENT

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BON D'INTERVENTION

PRE-REQUIS – PDP N°

A renseigner par EXP et EEI

Nature de l'intervention	:	Essai du prototype de drone HRA/C-Tool pour mesures d'épaisseur sur tuyauteries
Raison sociale de l'EEI	:	
Raison sociale de l'EEP	:	
Fin de validité du PDP	:	31/12/2022

12. PROCESSUS ACCES SITE

Accueil sécurité valide pour l'ensemble des intervenants : ☐ OUI (*)

Badge temporaire d'accès délivré pour l'ensemble des intervenants : ☐ OUI (*)

13. VERIFICATIONS FINALES AVANT INTERVENTION

EXP : Information portée aux autres intervenants de la zone de la présence de l'EEI : ☐ OUI (*)

EXP : Rappel des aspects sécurité spécifiques à la zone d'intervention et causerie règles d'or : ☐ OUI (*)

EEI : Règles d'or TOTAL concernées par l'opération. **A cocher par le responsable de l'entreprise intervenante** : ☐ OUI (*)

Case	N°	Règle	Case	N°	Règle
☐	1	**SITUATIONS À RISQUES** Pas de démarrage ni d'arrêt d'installation sans respect d'un mode opératoire écrit précis.	☐	7	**TRAVAIL SUR DES SYSTÈMES ALIMENTÉS EN ÉNERGIE** Pas d'intervention sans contrôle préalable de l'absence d'énergie ou de produit.
☐	2	**CIRCULATION : Engin/véhicule/cycliste/piéton** Pas de dépassement des vitesses autorisées.	INTERDIT	8	**ESPACES CONFINÉS** Pas de pénétration en espace confiné sans vérification des isolations et sans contrôle d'atmosphère.
☐	3	**GESTES / POSTURES / OUTILLAGES** Pas d'intervention sans outils adaptés à la tâche et à son environnement.	INTERDIT	9	**TRAVAUX DE FOUILLE** Pas de travaux de fouille sans permis établi avec plan du sous-sol.
☐	4	**ÉQUIPEMENTS DE PROTECTION** Pas d'accès aux installations et pas de travaux sans port des EPI généraux et spécifiques.	INTERDIT	10	**TRAVAUX EN HAUTEUR** Pas de travaux en hauteur sauf sur P.I.R, marche pied ou en présence de protections collectives permanentes
☐	5	**PERMIS DE TRAVAIL** Pas de travaux sans permis validé.	☐	11	**GESTION DU CHANGEMENT** Pas de modification technique ou organisationnelle sans autorisation préalable.
INTERDIT	6	**OPÉRATION DE LEVAGE** Pas de passage sous la charge en cours de levage.	☐	12	**OPÉRATIONS SIMULTANÉES OU CO-ACTIVITÉS** Pas d'opérations simultanées ou co-activités sans visite préliminaire.

PRE-REQUIS EFFECTUES → **PASSAGE AU LANCEMENT D'INTERVENTION**

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TotalEnergies

BON D'INTERVENTION

LANCEMENT INTERVENTION – PDP N°

Le bon d'intervention est à remettre au poste de garde à la fin de chaque intervention journalière

A renseigner par EXP et EEI

14. EFFECTIFS SUR SITE

Effectif EEI prévu pour intervention :

Responsable intervention pour EEI : Si sous-traitant, responsable pour EEP :

Responsable EU pendant intervention :

15. REVUE DOSSIER D'INTERVENTION

Dossier d'intervention valide et en possession de l'entreprise intervenante : ☐ OUI (*)

Documents annexes éventuels en possession de l'entreprise intervenante : ☐ OUI (*) ☐ Pas de documents annexes

Prise de connaissance du dossier d'intervention avant le début d'intervention : ☐ OUI (*)

Intervention en phase avec l'analyse de risques du dossier d'intervention (6. et 7.) : ☐ OUI ☐ NON

→ Si « NON » : ajout de risques et mesures de prévention si autorisés pour un PDP simplifié

ETAPES	RISQUES IDENTIFIES	MESURES DE PREVENTION A APPLIQUER

Validation HSEIQ ou délégataire si modification de l'analyse de risques (Nom, date et signature) :

16. ACCORD INTERVENTION [illegible]

Visite commune zone d'intervention : ☐ OUI (*) Date de la visite commune préalable :

Exploitant zone : Responsable EE intervention :

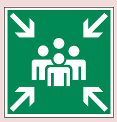
Date et heure de début (*) : Date et heure de fin (*) :

(*) Champs ou cases à renseigner obligatoirement. Si non cochés, utilisation du plan de prévention simplifié interdite

INFORMATIONS GENERALES DE SECURITE DE L'ETABLISSEMENT - A COCHER

TOTAL SAFETY FOR ME, FOR YOU FOR ALL ☐

☐



☐

333 ☐

TotalEnergies **Etablissement des Flandres**	**FEU VERT SECURITE**	

AVANT DE COMMENCER LE TRAVAIL, les intervenants prennent le temps nécessaire pour :

- Observer l'environnement de chantier et identifier les risques éventuels
- Prendre connaissance des risques et mesures de prévention figurant sur le BV
- Vérifier que toutes ces mesures soient mises en place

	OUI	NON	SANS OBJET
QUEL EST LE TRAVAIL A FAIRE ?			
....			
• Ai-je bien compris mon rôle ? Suis-je formé et habilité pour ce travail ?	0	0	
• Le repère de l'équipement sur lequel j'interviens correspond à celui inscrit sur le BV.	0	0	
• M'a-t-on expliqué le mode opératoire et le permis de travail ?	0	0	
• Ai-je les outils / équipements de protection adaptés ?	0	0	
QUE POURRAIT-IL M'ARRIVER DE GRAVE ?			
....			
• Est-ce que j'interviens sur un équipement alimenté en énergie ?	0	0	
➢ Si oui, la consignation / condamnation a bien été effectuée ?	0	0	0
➢ Si oui, le contrôle d'absence d'énergie a bien été effectué ?	0	0	0
• Est-ce que j'effectue un travail à chaud ?	0	0	
➢ Si oui, les mesures de prévention demandées sont-elles en place ?	0	0	0
➢ Je travaille en zone ATEX, la mesure d'atmosphère a été réalisée et la balise est présente.	0	0	0
• Est-ce que je travaille à plus de 1,50m de hauteur ?	0	0	
➢ Si oui, les moyens de protection / EPI sont-ils adaptés ? (Garde-corps sécurisés / Système de retenue / Système antichute)	0	0	0

QUE DOIS-JE FAIRE EN CAS DE MODIFICATION ?

....

- En cas de modification (environnement, coactivité, besoin d'un outil non prévu, mode opératoire ou risque non identifié au départ, etc.) JE STOPE IMMEDIATEMENT MON TRAVAIL, et je contacte l'exploitant.
- Chaque intervenant déclare avoir compris le travail, les risques et les mesures de prévention :

Je suis prêt pour commencer en sécurité ☐

J'ai des doutes, STOP je contact l'exploitant ☐

Nom des intervenants	Signatures	Nom des intervenants	Signatures	Nom des intervenants	Signatures