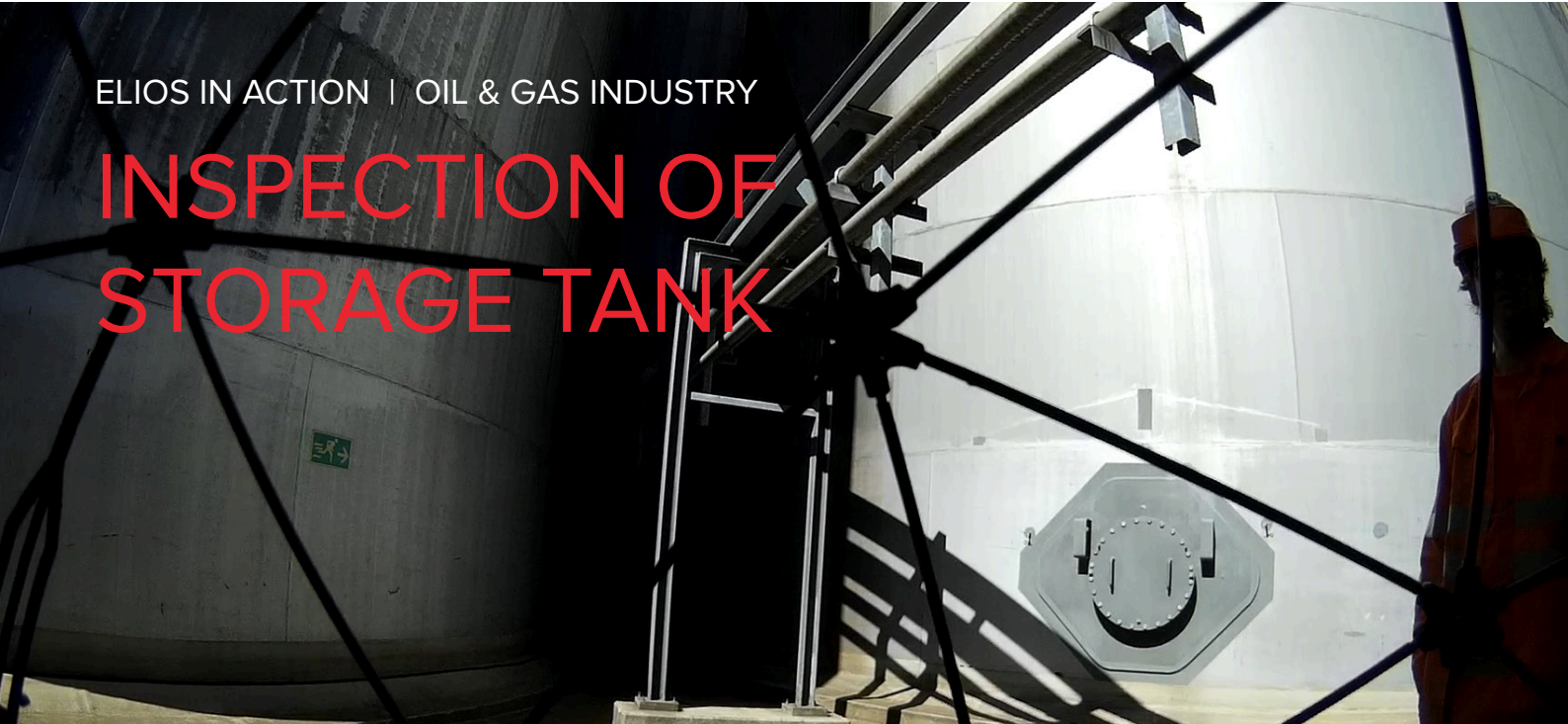


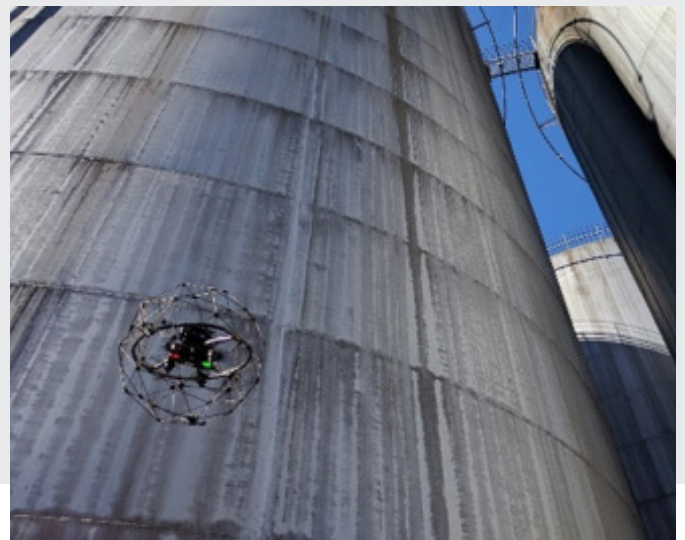
ELIOS IN ACTION | OIL & GAS INDUSTRY

# INSPECTION OF STORAGE TANK



## INTRODUCTION

TAU AG, an asset manager in charge of a tank farm in Muttens Switzerland for the BP and Avia oil companies, required the internal inspection of above-ground hydrocarbons and other chemicals storage tanks. Elios, the world's first collision-tolerant UAV, provided them with a safer, faster inspection method and a greater quality of data than they had ever been able to gather using rope access, scaffolding, or visual inspection from the ground with binoculars.



## CUSTOMER NEED

Every 3 - 15 years, depending on the substance they have contained, TAU AG performs a thorough inspection of each storage tank. After having been properly cleaned, a tank is inspected following a procedure which includes the visual inspection of fire protection piping, overflow protection, gaging system, roof pre-determined points as well as a general visual inspection of the roof. At 25 meters above ground, in pitch-dark conditions, these inspections require working at height and implies having humans entering the inner confined space of tanks. Usual methods such as scaffolding or rope access are costly and time-consuming. With these aspects in mind, TAU AG requested the intervention of Flyability and Elios for the inspection a 25m tall, 18m diameter fixed-roof storage tanks.

## ELIOS IN ACTION | Inspection of a storage tank

### SOLUTION AND PROCESS

Between five and ten flights with Elios, each flight taking about ten minutes, were necessary to complete the inspection of a single tank. The tanks being cleaned and degassed, the pilots decided to enter the tanks to fly the drone, however, inspections could have been performed entirely from the outside of the structure. The fact that Elios is collision-tolerant allowed it to navigate safely, directly in contact with the walls of the tanks when required. Thanks to its powerful onboard LEDs, the inspection of the tanks with Elios did not require the installation of any additional lighting source.



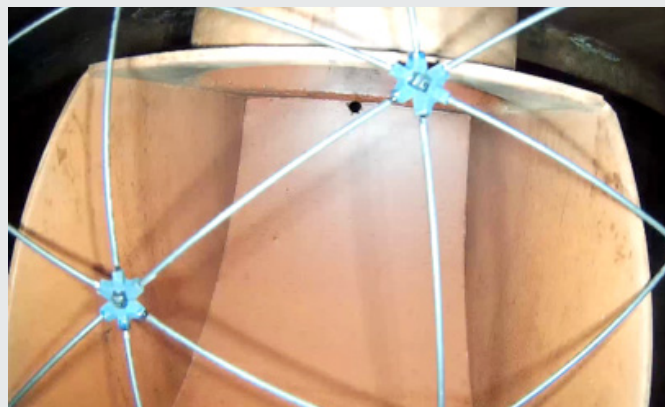
### RESULTS

All structures of interest were inspected in less than two hours after deployment. The visual gathered with Elios proved the fire protection piping to be in excellent condition, the welds and overall roof corrosion conditions were satisfactory. With over 100 tanks to look after in the tank farm they manage, TAU AG is now in a position to increase the quality and level of documentation of the data generated during inspections. Most importantly, the company keeps its workers out of harm's way and has lowered the cost imputed to inspections.

### MISSION PICTURES TAKEN BY ELIOS



Corrosion and welds



Checking piping clogging



Roof visual inspection

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### TIME – COSTS – SAFETY

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ELIOS IN ACTION | MARITIME INDUSTRY

# INSPECTING THE BALLAST TANK OF A CONTAINER SHIP

## INTRODUCTION

CMA CGM required the internal inspection of a ballast tank of one of its container ships, the CMA CGM ANDROMEDA. Flying in complex and pitch-dark confined spaces, Elios has demonstrated its capacity to deliver a quicker and safer method to inspect ballasts.



## CUSTOMER NEED

CMA CGM required an inspection for one of its container ships, the CMA CGM ANDROMEDA, a 323 meters vessel. They needed to inspect one ballast tank for general integrity, corrosion status as well as the monitoring of the anodes within the ballast. The ballast was 15 meters long and 12 meters deep. Two manholes located at the top of the ballast served as entry points and the ballast was divided in 2 floors with 3 sections each. Floors and sections were connected by manholes with dimensions of 600mm by 400mm. Usually, the inspections of ballasts require three to four men and extensive safety equipment such as gas and oxygen monitoring detectors, ropes, flashlights, and harnesses.

**SOLUTION AND PROCESS**

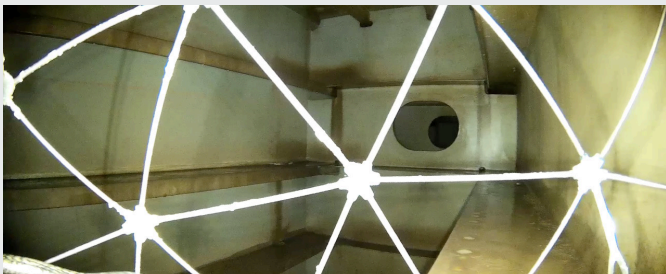
Three flights of 10 minutes each with a single pilot were carried out for the inspection of one tank. All the flights were performed entirely from above the ballasts with the pilot controlling Elios beyond line of sight (BLOS). The robot's collision-tolerance allowed it to navigate safely in contact with the structures, rolling on the walls when required. The onboard LEDs allowed performing the inspection without any external lighting.



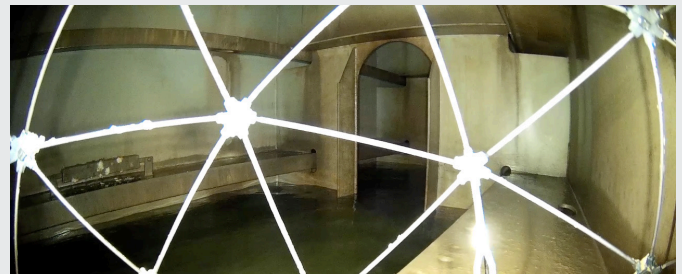
**RESULTS**

The two ballast tanks, as well as their corrosion monitoring anodes, were inspected in less than 2 hours from deployment. The general integrity of the tank, as well as the states of the anodes, were assessed to be satisfactory. With over 25 similar ballast tanks per vessel and a fleet of several hundred vessels, a substantial increase in workers' safety and efficiency of inspection are achievable with Elios.

**MISSION PICTURES TAKEN BY ELIOS**



General Visual Inspection



General Visual Inspection



Exhaust Funnel Inspection



Anode integrity checking

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ELIOS IN ACTION | PAPER INDUSTRY

# INSPECTION OF TANKS IN A PULP AND PAPER MILL

## INTRODUCTION

Pulp, which is the raw material used in the manufacture of paper, is prepared by chemically or mechanically separating cellulose fibers from wood, fiber crops or waste paper. At an industrial scale, this process is performed in large tanks that need recurrent inspections. Inspection? That sounds like Elios' specialty.



## CUSTOMER NEEDS

One of Europe's leading manufacturer of pulp and paper possesses a large paper mill in the north of Poland. The plant counts more than 50 chemical tanks used for the production of pulp and paper. Every year, the company proceeds to a plant shutdown in order to perform a thorough inspection of all infrastructures. This operation includes the inspection of the 50 chemical tanks. Part of the method consists of a general visual inspection of the assets as well as an integrity check of the welding. To perform these inspections the company uses traditional methods such as the use of rope accesses and scaffoldings. Motivated by the potential gain relative to the rapidity of execution but as well the potential benefit of not having to send people inside the tanks to do the job, the company requested the intervention of Flyability, and its polish partner Inspectios, to perform a pilot project with Elios.



**SOLUTION AND PROCESS**

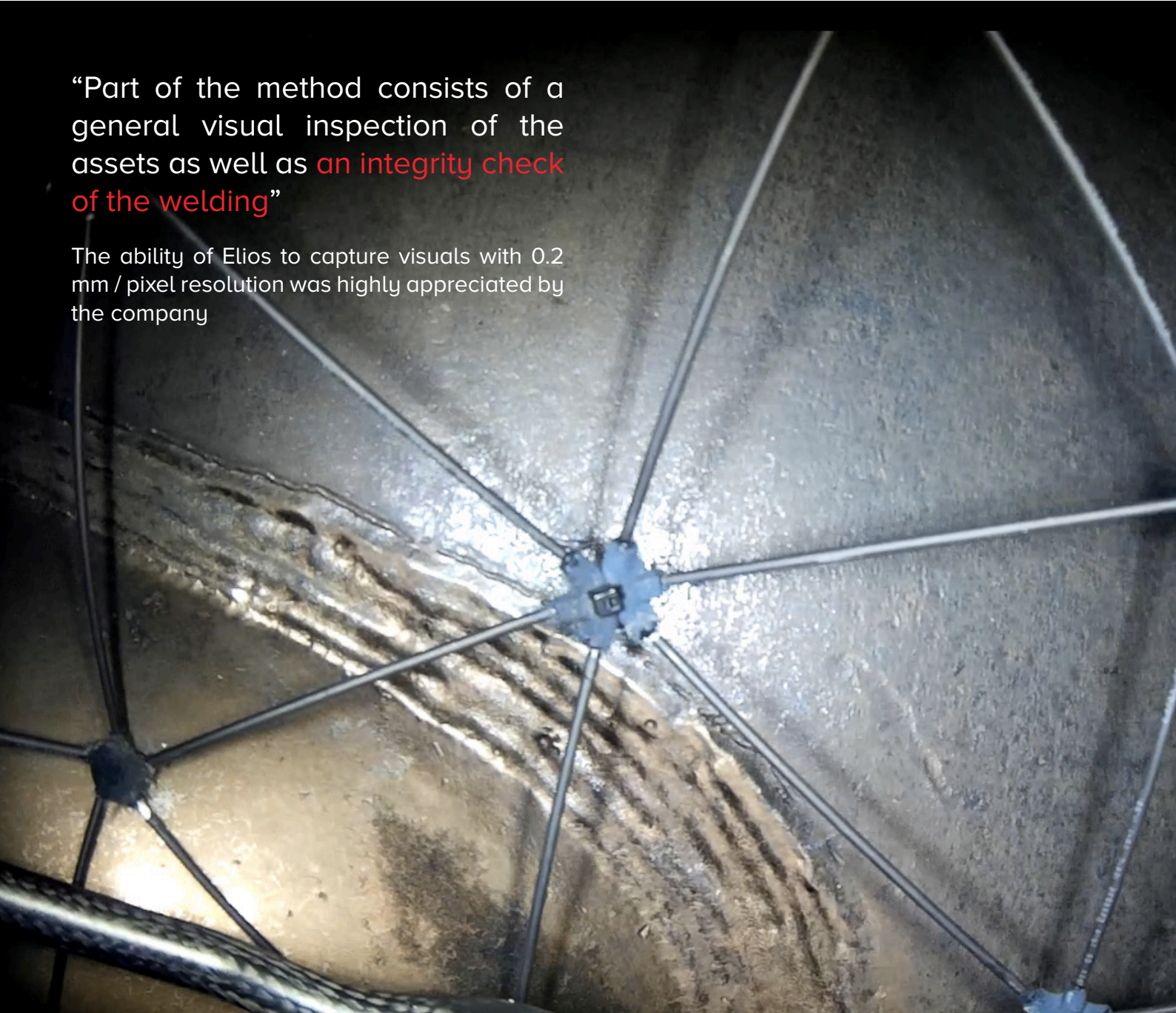
For this pilot project, it was decided to limit the intervention to 2 tanks, each having a diameter of 6 meters for a height of 25 meters. The inspection was also limited to the inside part of the tanks. Prior to deploying Elios, the tanks had been properly cleaned and degassed. 3 flights of 10 minutes each were necessary to perform the complete inspection of one tank, making the overall inspection worth 60 minutes of flight. Elios was piloted by a Flyability employee who was supported by inspection engineers to help conduct the inspection according to their

expectations. Between each flight, the team gathered in a meeting room to check the videos produced by Elios and debrief on the best way to proceed.

The 5 first flights were conducted from the inside of the tank giving time to the team to getting used to the technology and reaching the appropriate level of confidence to finally perform the last flight directly from the outside of the tank.

“Part of the method consists of a general visual inspection of the assets as well as **an integrity check of the welding**”

The ability of Elios to capture visuals with 0.2 mm / pixel resolution was highly appreciated by the company



**RESULTS**

All the point of interest were inspected over a very short period of time without having to expose anyone to risk. The quality of the images, the rapidity of the inspection and the substantial benefits of not having to do the job using rope access or scaffolding were all points that made the team that had requested the inspection extremely satisfied by the use of Elios.



Once the inspection was completed and while the whole team was debriefing, an interesting point was raised relatively to the possibility to provide quick a response for emergency cases. The team that had requested the inspection foresees Elios as a quick-to-deploy solution in the case of unexpected situations; for example when a problem is suspected or detected within a tank. Indeed, not having to fully clean the tank before proceeding to an inspection, with possibly some non-explosive gas remaining inside, would provide considerable time savings.

**TIME**

The 50 tanks can be inspected in a single day with the help of 2 Elios.

**COSTS**

No need for any additional equipment such as scaffolding or rope access.

**SAFETY**

The entire inspection can be safely performed from the outside of the tanks.

**MISSION PICTURES TAKEN BY ELIOS**



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ELIOS IN ACTION | CHEMICAL INDUSTRY

# INSPECTION OF ENZYME FERMENTER TANKS

## INTRODUCTION

Novozymes, a world leader in biological solutions, is looking for solutions improving the quality of its infrastructure's maintenance process while reducing cost and downtime due to inspection. Novozymes officials' curiosity piqued by Elios' abilities, they requested Flyability to perform a pilot project in their enzyme production facility in Blair, Nebraska, USA.



## CUSTOMER NEEDS

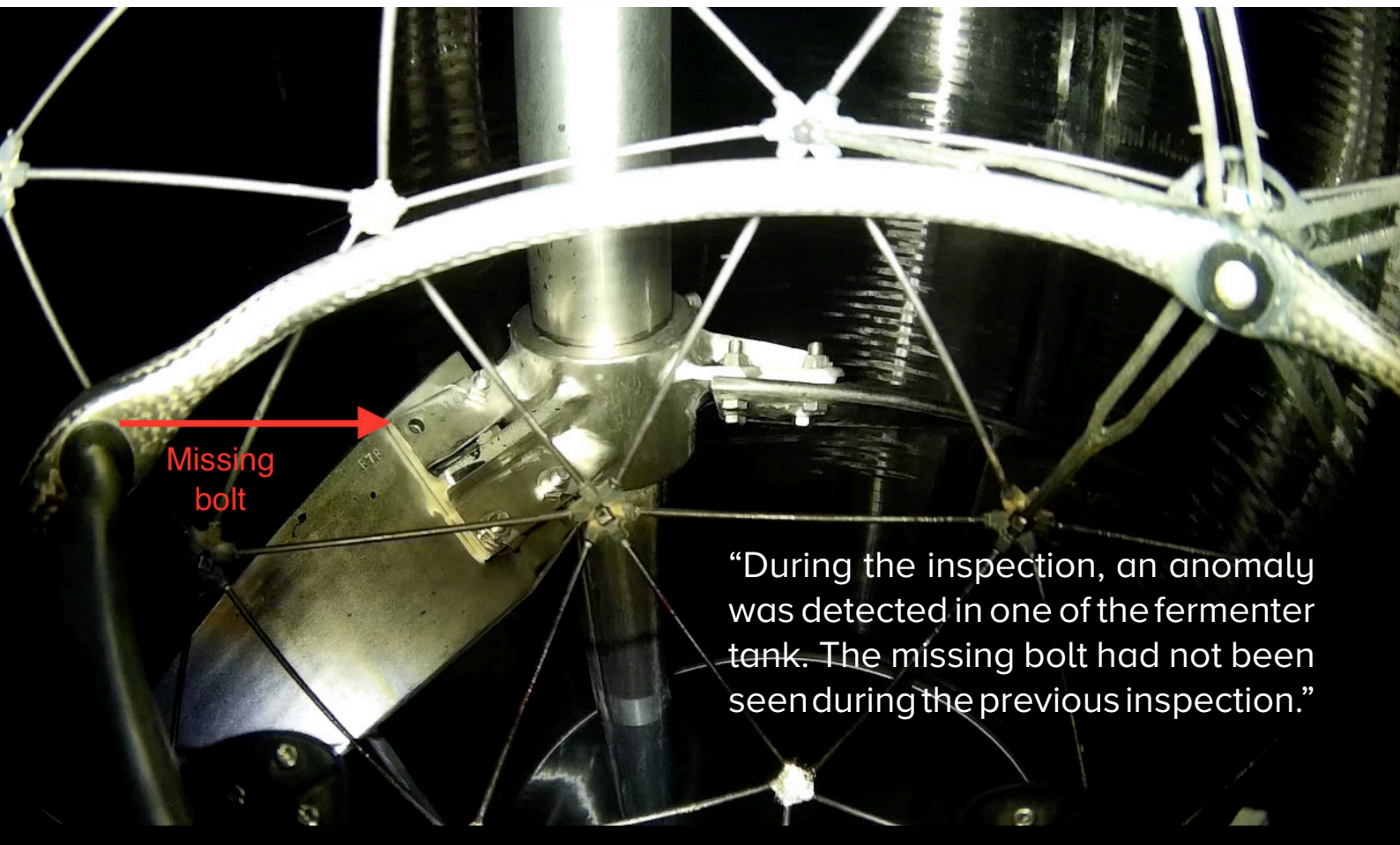
Novozymes, a world leader in biological solutions producing industrial enzymes and microorganism, possess a large enzyme production facility in Blair, Nebraska, USA. The production facility has multiple production tanks that they use to inspect systematically after the production of every batch of enzymes. One batch taking between 7 to 10 days to produce, the rate of the inspection was pretty high and this costly process was making them lose a lot of time. Concerned by it, Novozymes changed the rate of inspection of its fermenter to an inspection every 10 batches. However, finding ways to get back to a systematic inspection after every batch is an important quality aspect that they are actively working on improving. When they learned about Flyability Elios, Novozymes felt this would potentially be a solution to their pressing issue.



**SOLUTION AND PROCESS**

The trial inspection took place directly in Novozymes' facility in Blair, Nebraska. As usual, Flyability sent a dedicated and experimented pilot to collaborate on the real use case. For Novozymes' trial, three fermenter tanks were targeted, two of them being located indoors while the third one is being located outdoors. Three flights of eight minutes each were necessary to inspect the first indoors fermenter tank. During these flights, it was possible to thoroughly check the overall cleanliness of the dome and the dosing legs. The integrity of the

agitator shaft and blades, line of vertical bolts on the four baffles, and integrity of the pedestal at the bottom of the tank were as well visually assessed. The second indoors fermenter tank required a shorter inspection. A single flight of eight minutes was sufficient to inspect in detail the integrity of the agitator blades as well as the overall integrity of the fermenter. The last fermenter, located outdoors, was also inspected for general integrity in a single flight of eight minutes. All the flights were conducted by the pilot, beyond the line of sight, from the outside of the tanks, thus, preventing anyone from entering them.

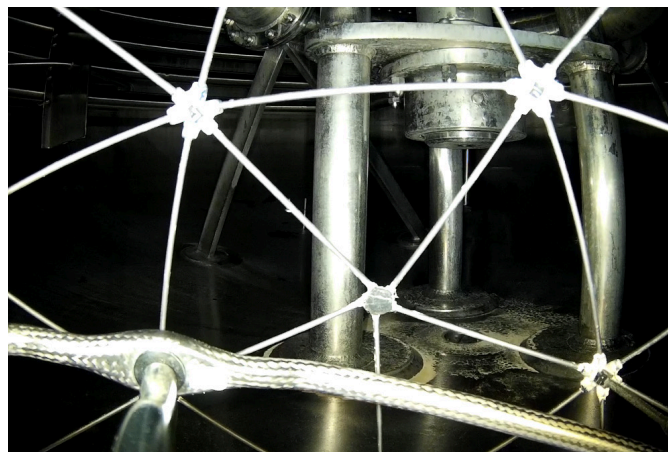


Looking for innovative ways to solve recurring challenges in their facility and leveraging the presence of Elios within the facility, Novozymes tested the ability of Elios to provide information on containers stored in their storage warehouse. Once a year, Novozymes cross-checks the information of their inventory software with the

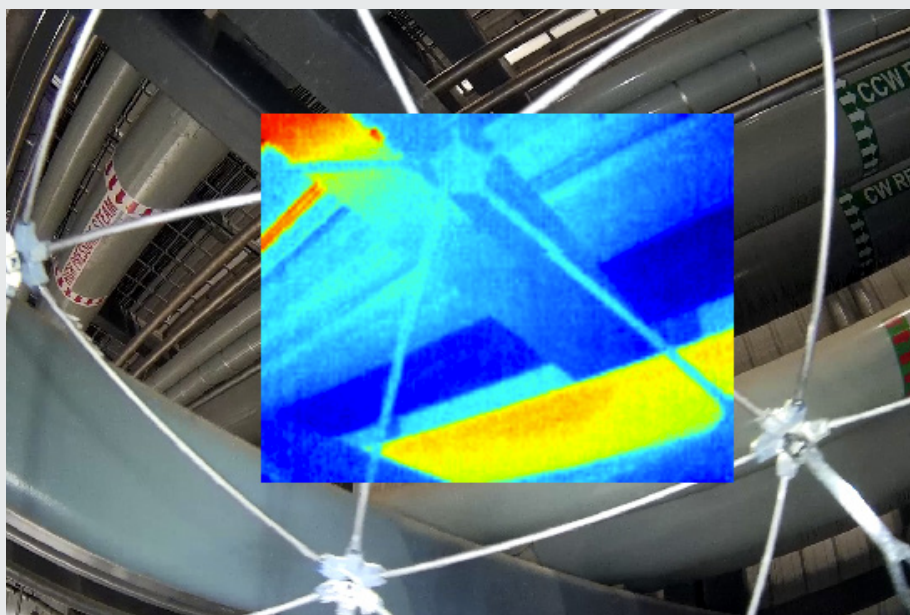
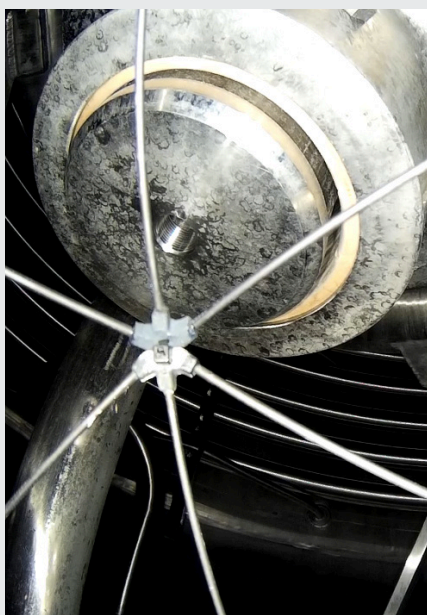
actual state of the containers. For that, they use a crane that they deploy in the warehouse and, one container after the other, they capture the serial number of the container and check whether it is open or closed. This process is really time-consuming and it took only a few minutes to Elios to perform what is usually performed in hours.

### RESULTS

Novozymes was really pleased by the results the pilot project provided. The goal was for Novozymes to assess the possible use of Flyability's technology and the results exceeded their expectations as per the quality of the video, and the ability to inspect and provide valuable information on the points of control they apply to their infrastructures. During the inspection, an anomaly was detected in the first fermenter tank. A piece of fabric that was stuck in a bolt and that had nothing to do there was found. The tanks had been inspected a few weeks before and this piece of fabric had not been detected. A missing bolt on the agitator shaft of the second tank was as well detected. Again, this fermenter had been inspected only a few days before and the anomaly had not been detected. For Flyability the result of the trial is highly promising and the lessons-learned prove a possibility to run a complete inspection of a fermenter tank in a single flight thus lowering the inspection time, including HSE procedures, to less than 10 minutes from deployment with Elios which do not require any preliminary preparation.



### MISSION PICTURES TAKEN BY ELIOS



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ELIOS IN ACTION | POWER GENERATION INDUSTRY

# INSPECTION OF A COAL-FIRED BOILER SUPERHEATER

## INTRODUCTION

Ronik Inspectioneering, a Dutch inspection company, together with Flyability performed the general visual inspection of the boiler of a coal-fired power plant near Amsterdam. It was carried out with Elios: the world-first collision-tolerant UAV, especially well suited for the exercise.



## CUSTOMER NEED

During an annual plant shutdown, metal rings and connectors were found on the floor of a boiler. These elements are used to hold in place the horizontal piping located in the superheaters at the uppermost part of the boiler. The purpose of the mission was to determine the root cause of failure which made these elements fall on the boiler's floor.

For similar inspections involving work at height, rope access, sky climbing, or scaffolding would normally be used. In this case, due to the very narrow space (1.5 to 0.4 m) between the plates of the superheater, sky climbers were not an option. If rope access and scaffolding had been used, several days would have been necessary to setup and perform the inspection. Indeed, implementing safety measures, bringing in and installing inspection equipment as well as performing the actual inspection manually are lengthy processes which expose workers to high risks.

## A FOCUS ON SAFETY

The plant operator was particularly sensitive to worker safety as a serious accident took place with the collapse of a scaffolding in a boiler during a maintenance in 2003.

“We needed a very fast and safe option. Sky climbers and scaffolding were out of the question.”

- Ronik Inspectioneering



## PROCEDURE

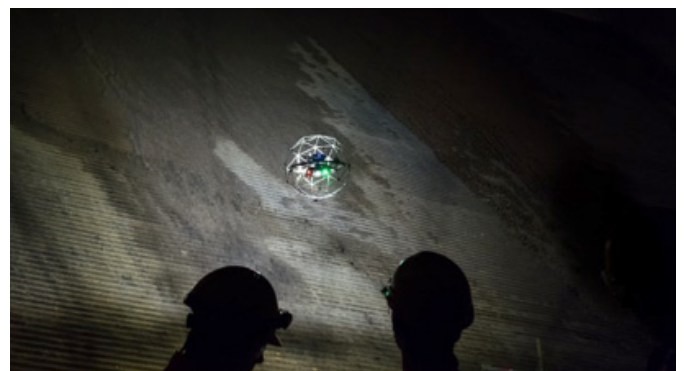
The mission was carried out overnight to accommodate the tight schedule of the power plant shutdown. After briefly preparing the inspection with the plant technical team, Flyability started the flights. The very short setup time needed to deploy Elios on a mission was particularly appreciated by the team because it offered flexibility in such a tight schedule.

The option to have a camera operator in addition to the pilot was chosen to increase the operation's efficiency. While the pilot was responsible to fly Elios 70m up, beyond line of sight, the camera operator was in charge of tuning lighting settings to ensure an optimal image quality was delivered to the technicians carrying the inspection in real time.

In total, Elios performed 15 flights over 4 hours. For each flight, it took about 1 minute to reach the superheater, the rest of the flight being focused on the inspection of the sections. When needed, Elios was flying directly in contact with the inspected structure to catch more details.

With its on-board LEDs, Elios captured high quality visuals and continuously transmitted its live video feed. This feed was then displayed simultaneously on multiple screens enabling a collaborative operation where the pilot, the camera operator and the technicians could work in parallel without perturbing each other.

Elios' ability to fly safely close or in contact with humans made possible for a team to keep working in the boiler while Elios was flying. Being able to parallelize tasks had been very beneficial for the plant team as it allowed to shorten even more the whole operation.





## ELIOS IN ACTION | Inspection of a coal-fired boiler superheater

### RESULTS

The potential provenance of the missing elements found on the boiler floor were rigorously checked and a complete close visual inspection of the superheater was conducted. As a result, it provided sufficient visual proofs for the engineers to conclude, at the end of the mission, that no maintenance work for this part of the structure was needed, The plant was operational the next day, saving more than 12h of downtime over a standard manned inspection.



### CONCLUSION

This mission has proven the ability of Elios to evolve in difficult confined spaces, beyond line of sight, replacing a manned intervention at a fraction of the cost. Collision-tolerant Elios UAV allowed important savings:

#### TIME

Between 12 and 24 hours of downtime saved compared to a regular manned inspection.

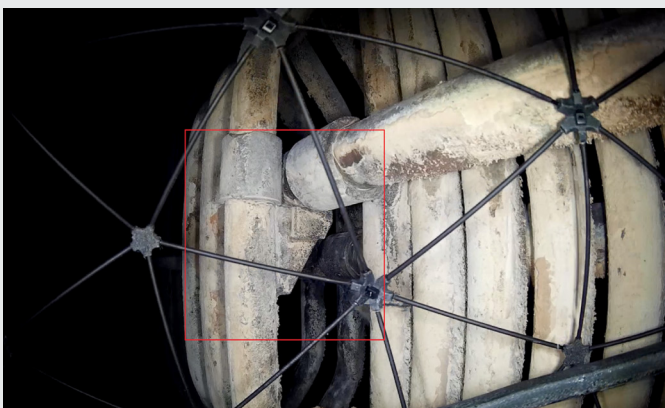
#### COSTS

Only 4 hours with 2 engineers needed to perform the mission.

#### SAFETY

Risks of a manned intervention avoided and HSE procedures shortened.

### MISSION PICTURES TAKEN BY ELIOS



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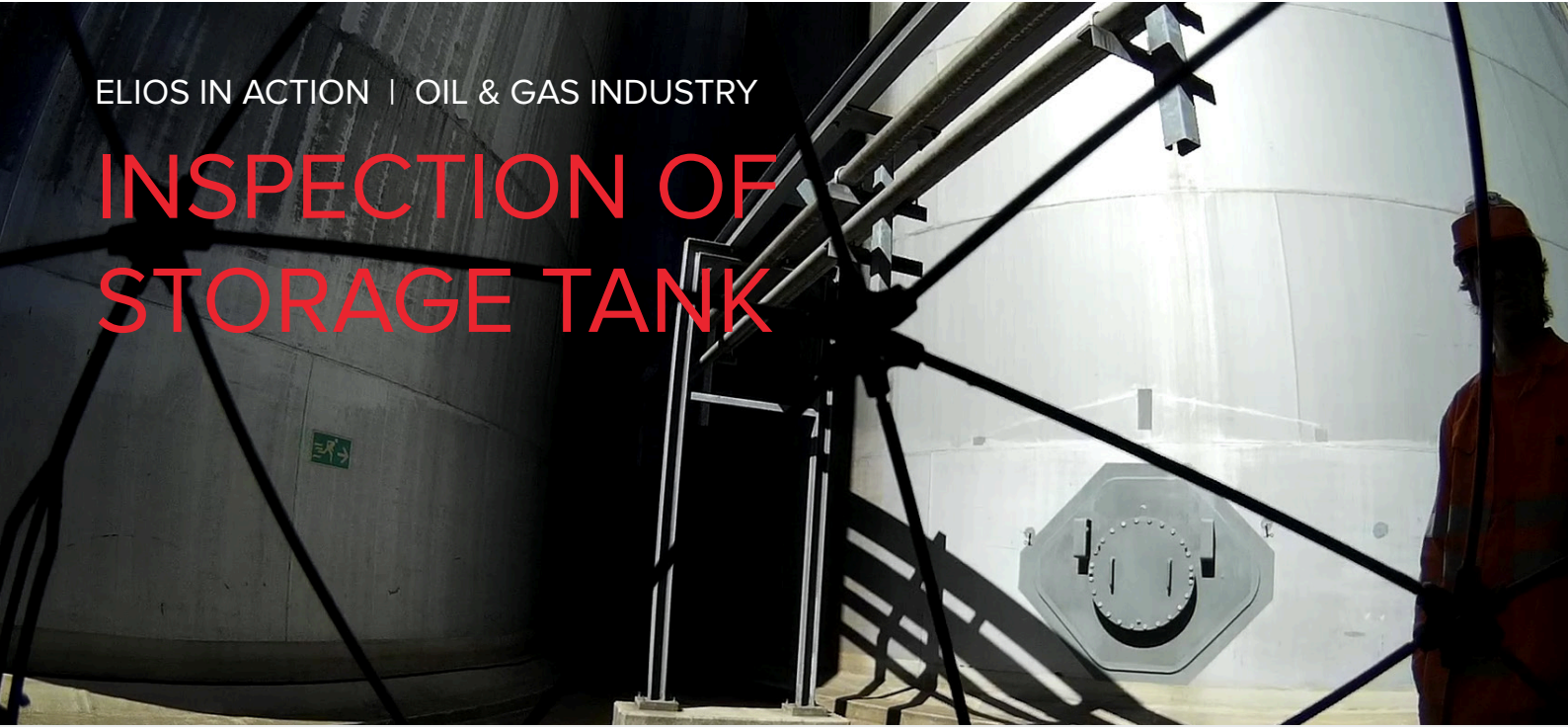
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ELIOS IN ACTION | OIL & GAS INDUSTRY

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## ELIOS IN ACTION | Inspection of a storage tank

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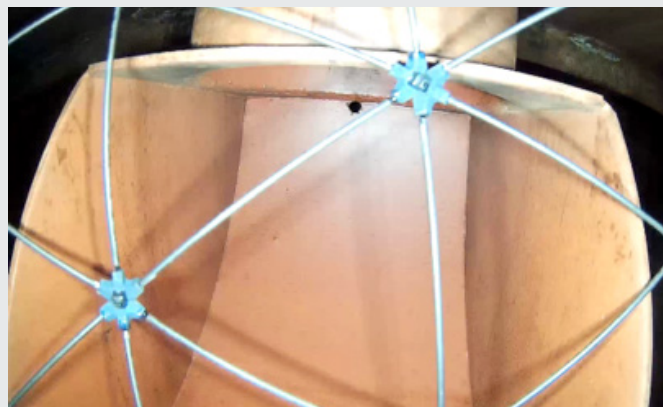
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