FLYABILITY

# ELIOS

## CASE STUDIES

CATALOG

FLYABILITY SA
+41 21 31 55 00 - SALES@FLYABILITY.COM
EPFL INNOVATION PARK BLDG C | 1015 LAUSANNE | SWITZERLAND

# TABLE OF CONTENT

ELIOS IN ACTION | INFRASTRUCTURES

# INDOOR DRONES IN BRIDGE INSPECTION: BETWEEN BEAMS AND INSIDE BOX GIRDER

ELIOS IS USED FOR BRIDGE INSPECTIONS IN MINNESOTA, USA, NAVIGATING THE DIFFICULT TO REACH SPACES UNDER BRIDGES BETWEEN BEAMS AND INSIDE OF BOX GIRDERS.

Elios is used for two different types of missions: flying under smaller bridges to check for potential issues, including accessing the difficult spaces between beams; and flying in the confined spaces of box girders on larger bridges. Both missions save the company significant time, money and resources while contributing to the safety of the engineers.

"IF WE CAN FIND THINGS EARLIER, WE CAN SAVE OUR CLIENTS MONEY AND TAKE CARE OF PROBLEMS BEFORE THEY BECOME LARGER."





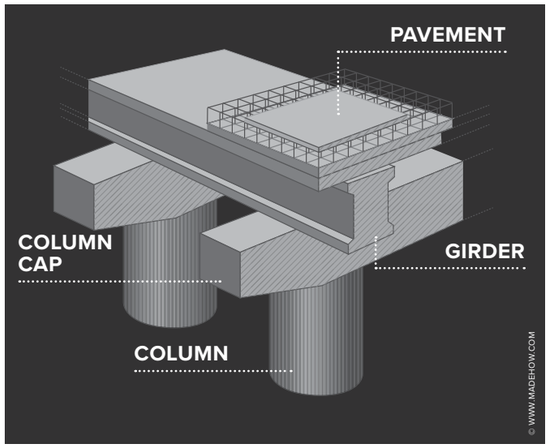
## CUSTOMER NEEDS

Minnesota has nearly 13,000 bridges crossing the state's thousands of rivers and lakes. More than 1 in 10 of these critical infrastructure pieces were built prior to 1948. For the experts at Collins Engineering who inspect a number of these bridges, efficiencies in time and costs must be accompanied by excellent data.

The inspection company's primary concern is providing thorough and accurate data to their client. Bridges must be inspected at regular intervals – those considered most vulnerable are inspected every year, but most bridges are inspected every two years. Engineers inspect the bridges to detect issues like cracking in concrete, problems with bearings, or movement of the bridge. Corrosion, paint loss, and rust are other indications that the bridge may require further examination. Without a drone, inspecting the underside of structures or confined spaces can be prohibitively expensive.

The work is typically performed with a bucket truck designed for extreme terrain including the ability to operate in up to 9 feet of water and to climb 45 degree slopes. These trucks can cost over $600,000 to purchase, and are rented for more than $2,500 per day. When the vehicle is procured, it often requires traffic control along the truck's route, and a significant time investment to get the truck to the site of inspection. The truck must be staffed with a vehicle operator in addition to the bridge inspector in the bucket of the truck. Even with the specialized truck, the spaces between girders under the bridge are extremely challenging to reach and accurately assess. Additionally, because the cost of inspecting smaller bridges with a truck is high, these bridges are often not prioritized for inspections.

As part of the inspection of larger bridges, Collins Engineering experts are also responsible for inspecting confined spaces like the inside of box




girders. Without a drone, this is performed by setting up ladders and scaffolding inside of the girders so that inspectors can perform a visual inspection. The process of set up and inspection is time consuming, requires 2 or 3 people, and can be dangerous for inspectors.

"WE'RE GETTING A BETTER LOOK AT THE BRIDGE – WE'RE GETTING INTO AREAS THAT ARE DIFFICULT TO ACCESS."

—

*Barritt Lovelace, Regional Manager at Collins Engineering*

## SOLUTION

The inspectors at Collins Engineering use Flyability's Elios drone to fly underneath bridges, in spaces between girders and other areas difficult to reach by traditional methods. They have also used the Elios to fly inside of box girders on large bridges, capturing relevant data without a team of engineers accessing the space on ladders or scaffolding.

Engineers save the video for future referral, but provide a detailed inspection report including still images and actionable insights to their client.

## RESULTS

Using Elios instead of a specialized truck for inspecting the underside of bridges provides a major savings for the company, and allows them to provide more information at more frequent intervals to their clients. The drone requires no traffic control to transport, no additional time to reach the site, and can be operated by a single inspector compared to the 2 or more personnel required to operate the truck. Adding together the $2,500 per day cost of renting the truck, the cost of a driver in addition to the bridge inspector, and the cost of traffic control and the Elios is able to save over $3,000 on a small bridge inspection.

Additionally, the drone allows the inspector to see inaccessible areas like the spaces between beams. "For a smaller bridge this is a really good way to be thorough without adding a lot of costs," says Barritt Lovelace, Regional Manager at Collins Engineering. "And, we're getting a better look at the bridge – we're getting into areas that are difficult to access."

For inspections inside box girders, the Elios solution results in at least a 25% reduction in inspection time. The time savings increases when setup time is included: Elios eliminates the need for scaffolding and ladders. The drone can be operated by a single person rather than the 2 or 3 required to inspect on a ladder.

The savings in time and personnel translate to cost savings. The average annual salary of a bridge engineer in the U.S. is $84,140[1]. Saving a day-long setup process and the time of two extra inspectors adds up to a savings of around $1,000 per single inspection in personnel savings alone.

**1** U.S. Bureau of Labor Statistics (May, 2016) Occupational Employment and Wages, Civil Engineers, retrieved from BLS.gov



**ELIOS IN ACTION** | Indoor Drones in Bridge Inspection: Between Beams and inside Box Girder

The additional inspections that can be performed by freeing up the workforce is an additional boost to productivity. "It's significant," says Lovelace.

The firm is monitoring costs moving forward to get more accurate information. They also recognize a significant value in safety and quality factors. Beyond the time and cost savings in inspections, Lovelace says that the drone allows them to provide a better service for their customer and more savings down the road. While Collins always adheres to national standards, "Elios gives us a much higher quality inspection."

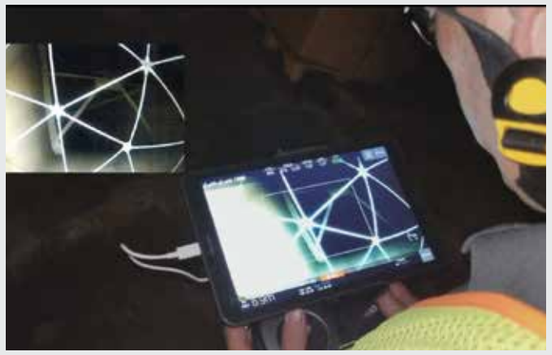
"If we can find things earlier, we can save our clients money and take care of problems before they become larger."

## CONCLUSION

Drones provide bridge inspectors with a significant savings in time and costs, while providing customers with more thorough data for effective resource allocation. Lovelace points out that while safety is a big part of bridge inspections, it is also a critical tool for managing valuable infrastructure assets. Better data allows customers to manage resources and plan maintenance and repairs, providing further efficiencies.

Ease of use, speed and lower costs give drones the potential to transform the way bridge inspections are done across the globe.

## MISSION PICTURES TAKEN BY ELIOS



**FLYABILITY SA**
AV. DE SÉVELIN 20
CH-1004 LAUSANNE
+41 21 311 55 00
SALES@FLYABILITY.COM

FLYABILITY | SAFE DRONES FOR INACCESSIBLE PLACES

UNMANNED AERIAL SERVICES INCORPORATED

**SEPTEMBER 2017**

ELIOS IN ACTION | UNDERGROUND MINING INDUSTRY

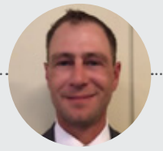
# ACCESSING THE INACCESSIBLE IN UNDERGROUND MINES

## USING DRONES WHERE THERE IS NO GPS, NO LIGHT, AND HUMANS CAN'T GO

Flyability's collision tolerant Elios drone has performed multiple missions in the North American Palladium (NAP) Lac des Iles mine near Thunder Bay, Ontario.

Palladium is a precious metal critical to automobile manufacturing, and NAP is one of only two pure palladium producers in the world. With both an open pit and underground mine, their extensive operation requires frequent inspections to monitor ground conditions and ensure both the safety and productivity of their workers.

The expert team at Unmanned Aerial Services Inc. (UAS Inc.) were asked to perform drone inspections in NAP's most challenging environments. Matt MacKinnon and Jason Carignan, UAS Inc. founders, are drone and mining professionals who use Flyability's Elios drone to perform difficult underground inspections in GPS and light -denied areas with little or no accessibility.



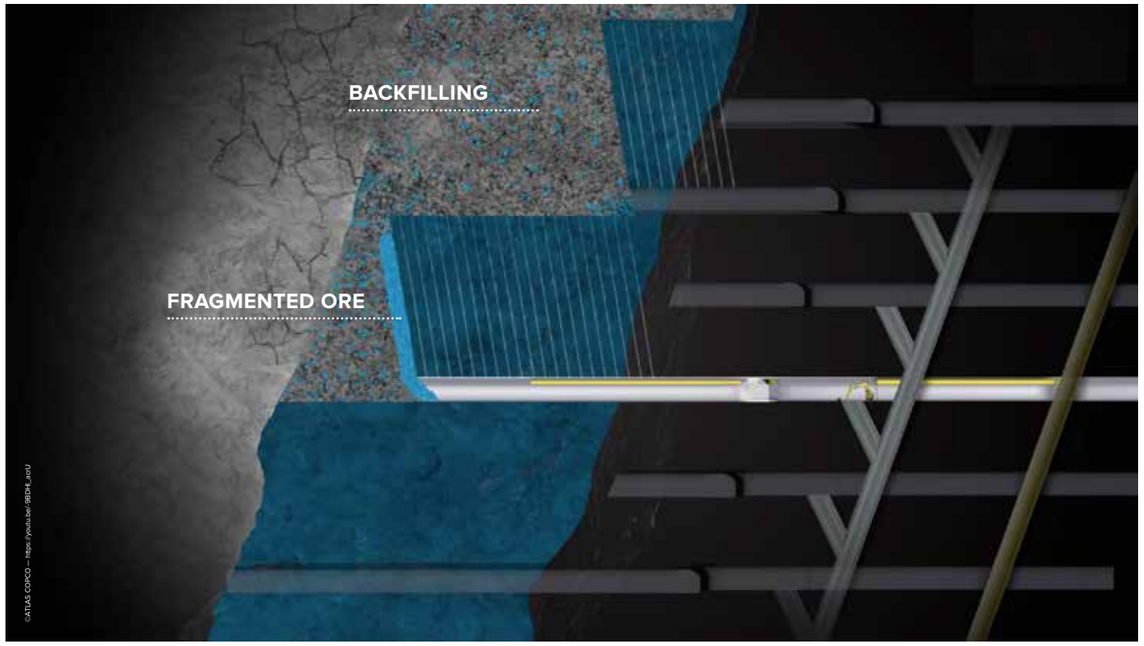
"IT'S AN EXTREMELY HOSTILE AND DANGEROUS ENVIRONMENT TO BE IN. "BEING ABLE TO REMOVE THE HUMAN ELEMENT IS KEY... THIS IS SOMETHING THAT WILL HELP MAKE THE INDUSTRY SAFER."

—

*Matt MacKinnon*
*UAS Inc. founder*







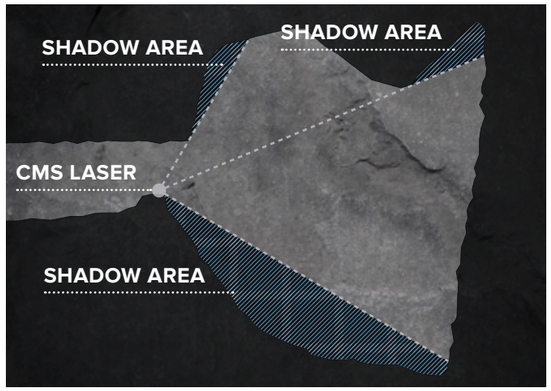

## CUSTOMER NEED: INFORMATION FROM INACCESSIBLE SPACES

Underground mines can be dangerous places, especially after excavation. One need for more information, is in the open cavern resulting from the mining and excavation, called an open stope. Once all the recoverable ore has been extracted from the stope, the removed material must be replaced – a process known as "backfilling" - in order to prevent caving in the surrounding area and ensure the safety and continuity in the mine. The areas, which can be unstable, are completely inaccessible by law to employees because of their extreme danger. Before the introduction of the Elios drone, the only tools available to assess conditions before backfilling was a Cavity Monitoring Survey (CMS) on a cart or boom arm: ineffective at getting through the tall piles of muck on the floor, or in going around corner, or seeing beyond a deep brow. The other method used for accessing a large stope area is a borehole camera which can be lowered into the stope through an existing drill hole: which can also be ineffective at completely inspecting the area due to being limited to the actual location of the hole and where it exits into the stope from above.

Determining the condition of the area is critical to the efficient mine planning and continued development ~~at~~ of the mine. "Ground conditions in a mine are very important," says Jason Carignan. "The ground can actually start to give way if there is nothing around it to support it." Without sufficient data to determine how large the space currently is, it is difficult for mines to determine how much backfill material is required to fill the void and ensure the surrounding ground is stable.

Backfilling is both time consuming and expensive. “In the past, it was a guessing game even at the most modern mines,” says Matt MacKinnon. “A very, very expensive guessing game.” That lack of information ultimately resulted in the mines backfilling the areas by simply guessing at the amount of material required.

Another need for inspection arises when the company needs to evaluate the height and condition of a stope ceiling (known as the back.) Normally performed by a CMS laser on a cable – an imperfect or sometimes unavailable solution, depending upon the conditions of the stope – experts need to know what the back of the stope looks like after blasting in order to prevent future problems on other levels of the mine, which could potentially threaten lives and production.




## THE ELIOS SOLUTION

The team at UAS Inc. flew Flyability’s Elios drone in both cases, providing the company with information previously unavailable to them. Standing safely under supported ground, well outside of the restricted areas, the team was able to operate the drone to gather information about the ground conditions, geological features, and dikes (fault lines) that may indicate where walls are likely to fall.

Again, standing safely under supported ground, well away from the restricted area, the team flew the Elios against the back of the stope despite the presence of explosives, and were able to accurately evaluate the height and condition. Using this data, the company can use AutoCad to create a rough model of the stope, used to evaluate risks and plan work.

## RESULTS: A FRACTION OF THE COST

In contrast to the full day – or longer, depending upon the availability of equipment – that it would normally take to evaluate a stope for backfilling, the Elios was able to perform the mission in an onsite visit of 1 hour, a time difference that results in the Elios inspection being “a fraction of the cost,” says Jason.

But the real savings don’t come from just the time spent on the inspection. The otherwise unavailable data that the Elios provides allows planning and significantly better decision-making tools. “How do you put a price on that?” says Matt. “You’re in the hundreds of thousands, or even millions… you can spend millions to access an area only to find that it’s beyond rehabilitation.”

## CONCLUSION

Mining is a critical industry, but it can be a dangerous one. Because of the environment, ground-based robots can’t always provide a solution. Flyability’s Elios drone allows data gathering and inspections in places unsafe for humans, and provides the mining industry with tools to maintain safety, reduce waste, and increase production.

“WE HOPE TO MAKE THIS STANDARD OPERATING PROCEDURE IN MINING,”
—
*Jason Carignan*
*UAS Inc. founder*



**ELIOS IN ACTION** | ACCESSING THE INACCESSIBLE IN UNDERGROUND MINES

TIME

In contrast to a full day, Elios performs the mission in 1 hour.

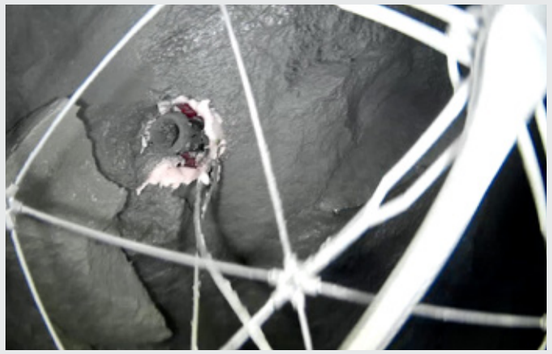
COSTS

“The Elios allows planning and significantly better decision-making, how do you put a price on that?” – Matt.

SAFETY

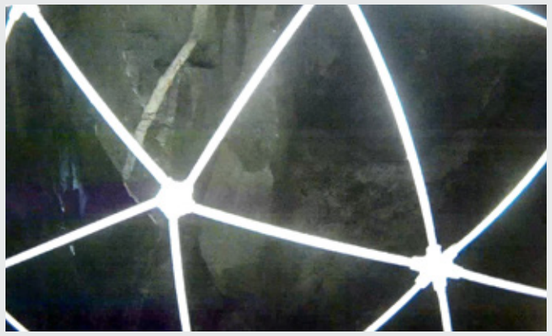
Allows to remove the human element in a hostile and dangerous environment.

## MISSION PICTURES TAKEN BY ELIOS

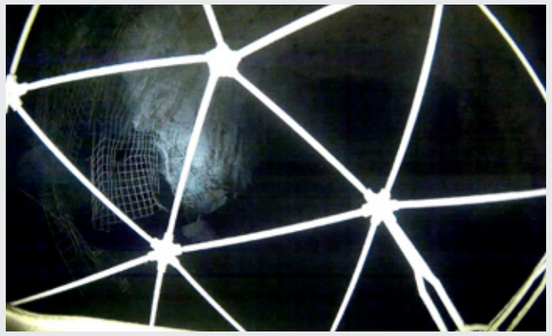


**DRILLING HOLE WITH EXPLOSIVE EMULSION LEFT**

**MUCK PILE SEEN FROM THE NO-GO ZONE**



**WHITE DYKE BELOW UNSUPPORTED GROUND**



**UNSUPPORTED GROUND IN A NO-GO ZONE**

**FLYABILITY SA**
AV. DE SÉVELIN 20
CH-1004 LAUSANNE
+41 21 311 55 00
SALES@FLYABILITY.COM

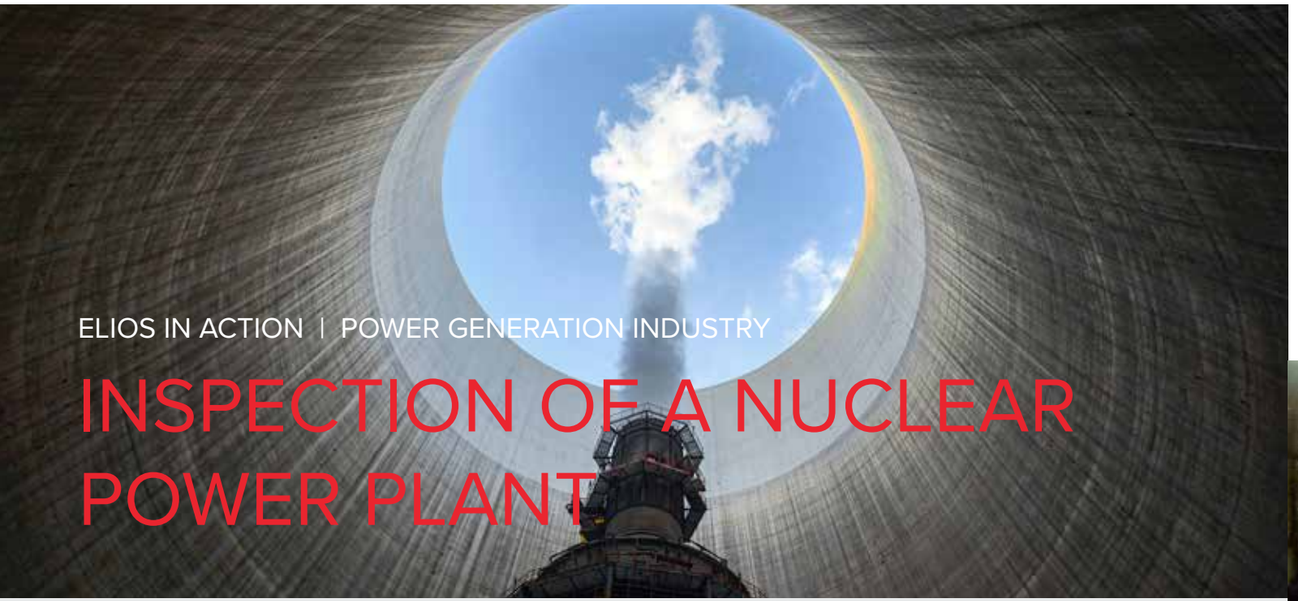
TIME – COSTS – SAFETY

Flyability builds **safe drones for the inspection of inaccessible, confined, and complex places**. Focusing on the Energy, Oil & Gas, Chemicals & Maritime industries, Flyability enables end-users to save time, costs and reduce risks during visual inspections.

FLYABILITY

SAFE DRONES
FOR INACCESSIBLE PLACES

JUNE 2017



ELIOS IN ACTION | POWER GENERATION INDUSTRY

# INSPECTION OF A NUCLEAR POWER PLANT

## INTRODUCTION

Flyability's collision-tolerant Elios UAV has been used at a major nuclear power plant, proving the case for Elios in the normally inaccessible spaces of a nuclear reactor building.

Elios was used for two different missions: to perform the required annual survey of underground tank rooms at the plant, and to investigate a suspected leak inside of the reactor building. Both missions were critical to the safety of the staff, minimizing their exposure to harmful radiation. Elios' ability to fly in confined spaces to capture high resolution videos makes it the ideal tool for the job.

## CUSTOMER NEED

Nuclear energy plants are some of the most highly regulated and safety conscious worksites in the world. A leak or an accident could have serious consequences, and the inspection processes in place to avoid problems are time-consuming and costly.

The customer's primary concern is safety: personnel must follow detailed processes to avoid unnecessary exposure to radiation. For a routine annual inspection of three underground tank rooms, inspectors must access each of the three rooms by a ladder, passing from low dose areas (safe areas) at the top of the ladder to higher dose areas (protected by locked doors and shields.) The process requires that inspection personnel dress in a full suit of disposable anti-contamination clothing before entering each room, take pictures of various points inside the space to evaluate the condition of the assets, and remove the anti-contamination clothing again after leaving each room. In addition to

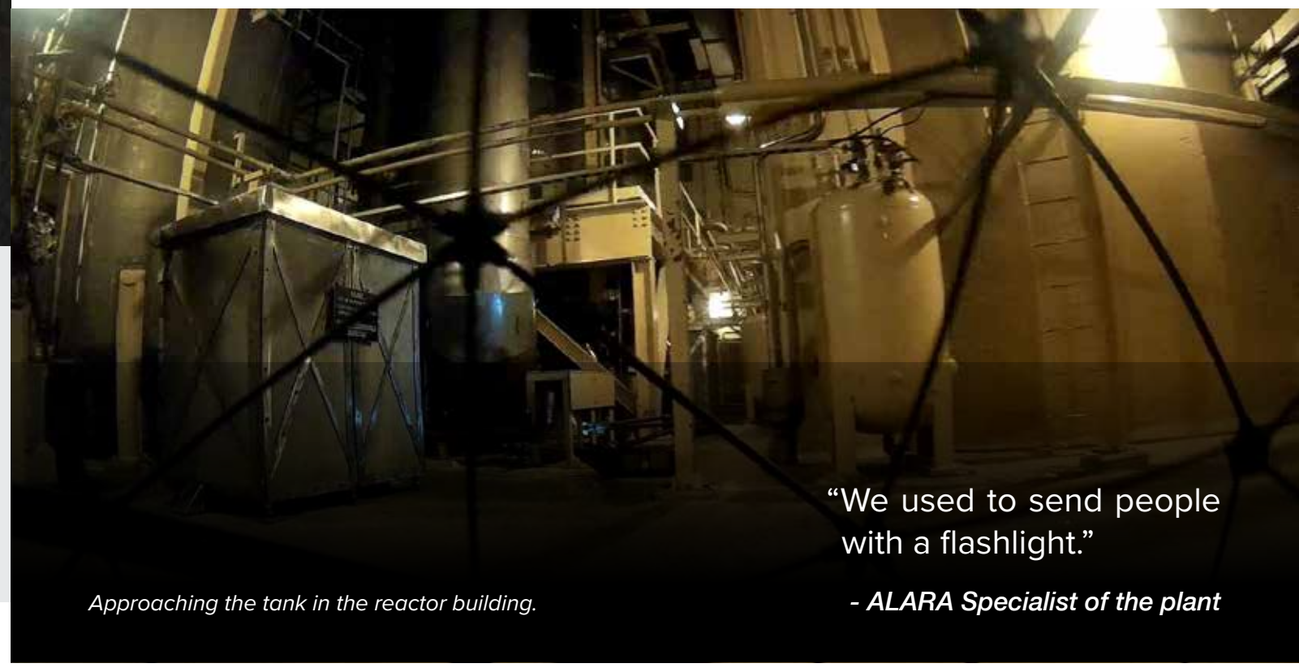




the inspector, a radiation monitor is required to accompany him, exposing two people to radiation during each inspection. After the inspection of 3 tank rooms is performed, six sets of anti-contamination clothing must be stored as waste and shipped for disposal.

Flyability's customer uses extremely sensitive leak detecting equipment in order to identify possible seepages before they become a problem. Any potential leak detected must be evaluated. Without Elios, this means bringing the output of the plant down to 20% in order to make the inspection humanly feasible. The powering down process takes about six hours – half a shift – to accomplish safely, with another six hours used to bring power back up slowly after the inspection.

The inspection itself is a difficult process. "We used to send a person with a flashlight," explains the customer. That person and the required radiation monitor could each receive up to 250 millirem (2'500 µSv) of radiation – about 10% of the annual limit for radiation exposure - during a 1-2 minute inspection of the inside of the reactor building, even with the power reduction. The exposure time is increased by the time it takes to enter the space and climb the ladders to reach critical areas.



"We used to send people with a flashlight."

***- ALARA Specialist of the plant***

*Approaching the tank in the reactor building.*

## SOLUTION

To inspect the underground tank rooms, operators flew Elios down the ladder to the rooms while remaining above in a low dose area. Elios flew inside of the room for about 1 minute, gathering a panoramic video of the entire space for later evaluation. An operator retrieved the drone at the top of the ladder using only a glove for protection against potential contamination and the team moved on to the next room.

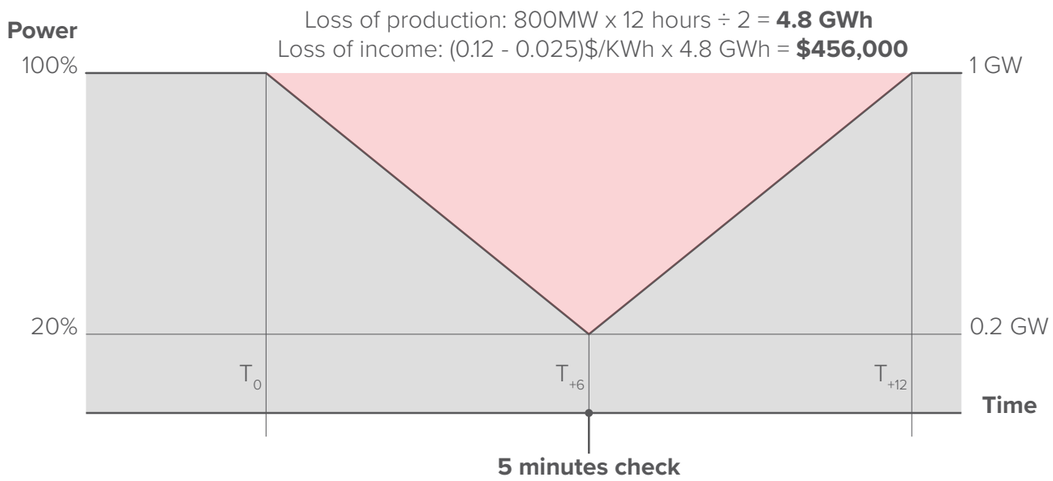
In the second mission, the inspector flew Elios inside the reactor buildingto investigate the suspected leak located 20 feet (6 meters) off the ground at the top of a tank while remaining in a lower-risk area. The Elios flew for about 10 minutes and took video of the critical valve, which was then evaluated by a team of inspectors and managers. The Elios cage allowed the operator to fly even in narrow or confined spaces.

## RESULTS

Inspectors found that the data gathered during the one-minute flight inspections of the tank rooms was more comprehensive than that gathered by traditional methods, while avoiding the need to send personnel into a high-risk area. The inspection team did not need to do anti-contamination clothing or travel down the ladders, bringing the total time investment to inspect three rooms from 1.5 hours down to less than 15 minutes.

The team of inspectors and managers evaluating the footage for a possible leak concluded, based on a frame-by-frame review, that a leak did not exist. The high-value images allowed for a minute examination of a valve at the top of the tank in the reactor building. Personnel were not required to climb to the critical areas and significantly reduced radiation exposure.

**Loss of income related to a 5 minutes maintenance operation**




## CONCLUSION

Elios saved the customer 6 hours for the powering-down process, 6 hours to power back up, and the costs associated with reduced output during evaluation of the reactor building. The average power production of a nuclear reactor is about 24GWh per day; at the average wholesale price of electricity per KWh ($.12) and the average production price per KWh ($.025) a nuclear reactor generates about $2.3 M USD net per day. Using that estimate, the savings generated by retaining full output for approximately 12 hours approaches $456,000.

Additionally, using a drone allows for more time in the reactor building. Elios was able to fly for 10 minutes to gather data and could have performed multiple flights if the problem had to be further investigated. Comparatively, the danger of radiation exposure limits human inspections to 1 -2 minutes which already represents 10% of the annual limit for radiation exposure. The precise video that Elios generates made it possible for the customer's inspection and management team to obtain detailed information about their assets. The inspection of tank rooms by drone also offered the customer savings in time and personnel costs.

Most importantly, Elios significantly reduced personnel exposure to radiation, while obtaining superior data.



**ELIOS IN ACTION** | Inspection of a nuclear power plant

Plant Engineering staff determined that the low weight (1.6 lbs, 720 g) and the low RF power output (100 mW) pose an acceptable risk for use inside the building during operation. The proven success of Elios in the nuclear environment opens up the possibility for more applications. In some plants, turbine rooms or other high dose areas may be surrounded by protective shields of about 10 meters high, open at the top. While risky for inspectors to enter the spaces, Elios could easily fly over the top of the shield to gather information from gauges or other equipment in high exposure areas. Many of the routine inspections required at the plant could be performed by the Flyability solution, offering further time and cost savings while providing significant gains in safety.

TIME

Inspection of tank rooms reduced from 1.5 hours down to less than 15 minutes.

COSTS

About 456'000 USD of loss of income saved in a single use.

SAFETY

Exposure to radiation representing up to 10% of the annual dose avoided.

## MISSION PICTURES TAKEN BY ELIOS

*Reaching the top of the tank in the reactor building*

*Suspected leaking valve*

**FLYABILITY SA**

Av. de Sévelin 20
CH-1004 Lausanne
+41 21 311 55 00
sales@flyability.com

TIME – COSTS – SAFETY

Flyability builds **safe drones for the inspection of inaccessible, confined, and complex places**. Focusing on the Energy, Oil & Gas, Chemicals & Maritime industries, Flyability enables end-users to save time, costs and reduce risks during visual inspections.

FLYABILITY

SAFE DRONES
FOR INACCESSIBLE PLACES

**NOVEMBER 2016**

ELIOS IN ACTION | AERONAUTICAL INDUSTRY

# INSPECTION OF A JET ENGINE TEST FACILITY

## INTRODUCTION

The jet engine test beds used in the aeronautical industry for Quality Control and R&D require strict maintenance. Traditional methods of inspection involve lengthy and inefficient operations, which in turn result in high costs and downtime. Elios offers a cheaper, quicker and safer way of inspection by capturing quality data of all the key elements within minutes.

## CUSTOMER NEED

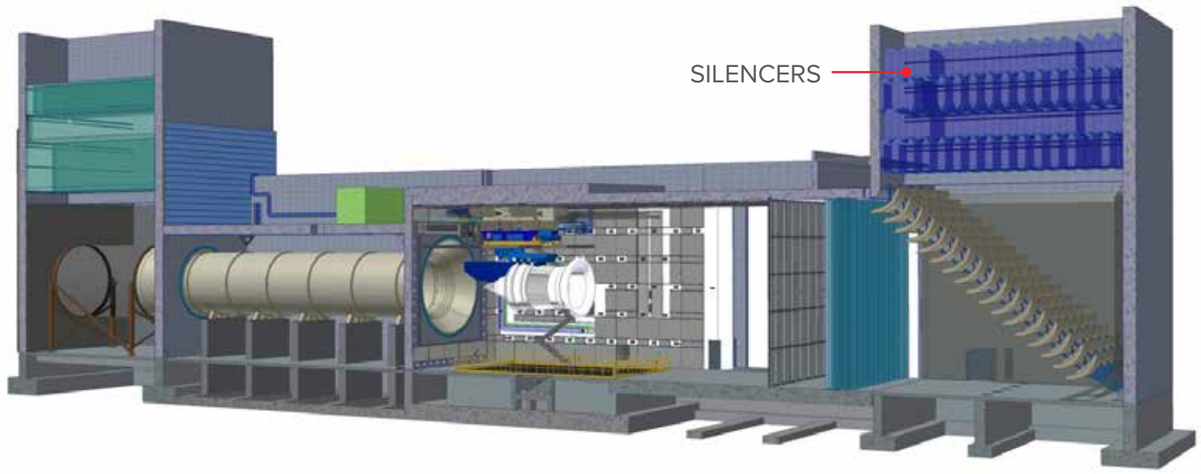
A world-leading manufacturer of jet engines together with its equipment supplier required a general visual inspection of metallic supports in one of their test facility. A jet engine test cell is essentially composed of three sections: the air inlet stack, several stories high; a large central room where the jet engine is tested; and the air outlet stack, also several stories high. To stabilize the airflow and reduce the noise level, silencers are placed at a height of approximately 15 meters, both at the inlet and the outlet stack, in a staggered manner. Control vanes are also installed at the bottom of the inlet stack to control the air flow. The presence of those vanes represents a significant obstacle to easily access the silencers. Traditional inspection methods would require a complete disassembly of this structure to allow the use of a crane or ropes to access the silencers. This process would typically take several days if not weeks and is not foreseen as an alternative by the jet engine manufacturer.





The major concern for the operators of this type of construction is the risk of having any debris, bolt or nut being sucked in by the engine during testing. This may cause serious damages to the latter and the test facility itself. Additionally, the resulting downtime would have a huge financial impact, especially during the final quality checks of a production batch.

With these critical issues in mind, and no time and cost efficient solution, Elios seemed to be a good alternative for the jet engine manufacturer.




> “The presence of control vanes at the bottom of the inlet stack represents a significant obstacle to easily access the silencers.”

## SOLUTION AND PROCESS

The inspection took place in one of the test cells of the world-leading manufacturer and was performed by a dedicated and experienced Flyability pilot. Flyability was appointed to fly through the control vanes and check the structural integrity of the metallic brackets holding the silencers together.

Ten flights of 10 minutes each were carried out for the inspection in various parts of the facility.

Most of the flights were performed beyond line of sight (BLOS) with the camera looking at 90° up. The inspection could easily be carried by Elios with its ability to navigate around unknown, complex and very reduces spaces.

## CONCLUSION

All the key elements were inspected in less than 4 hours at the cost of only one drone operator. The test cell was quickly back to operation after the inspection, allowing for an optimized maintenance operation minimizing downtime and an increase of quality assurance. The customer and its supplier were very pleased with the collected high-definition footage. Elios revolutions the industrial inspection market as well in the aeronautic industry by allowing access to inaccessible places.

### TIME

Only 4 hours. The facility got back to operation shortly after the inspection.

### COSTS

Only one drone operator needed for the inspection. No means of access to deploy.

### SAFETY

No work at height during the inspection. Preventing risks of damage to the jet engine under test and the facility.

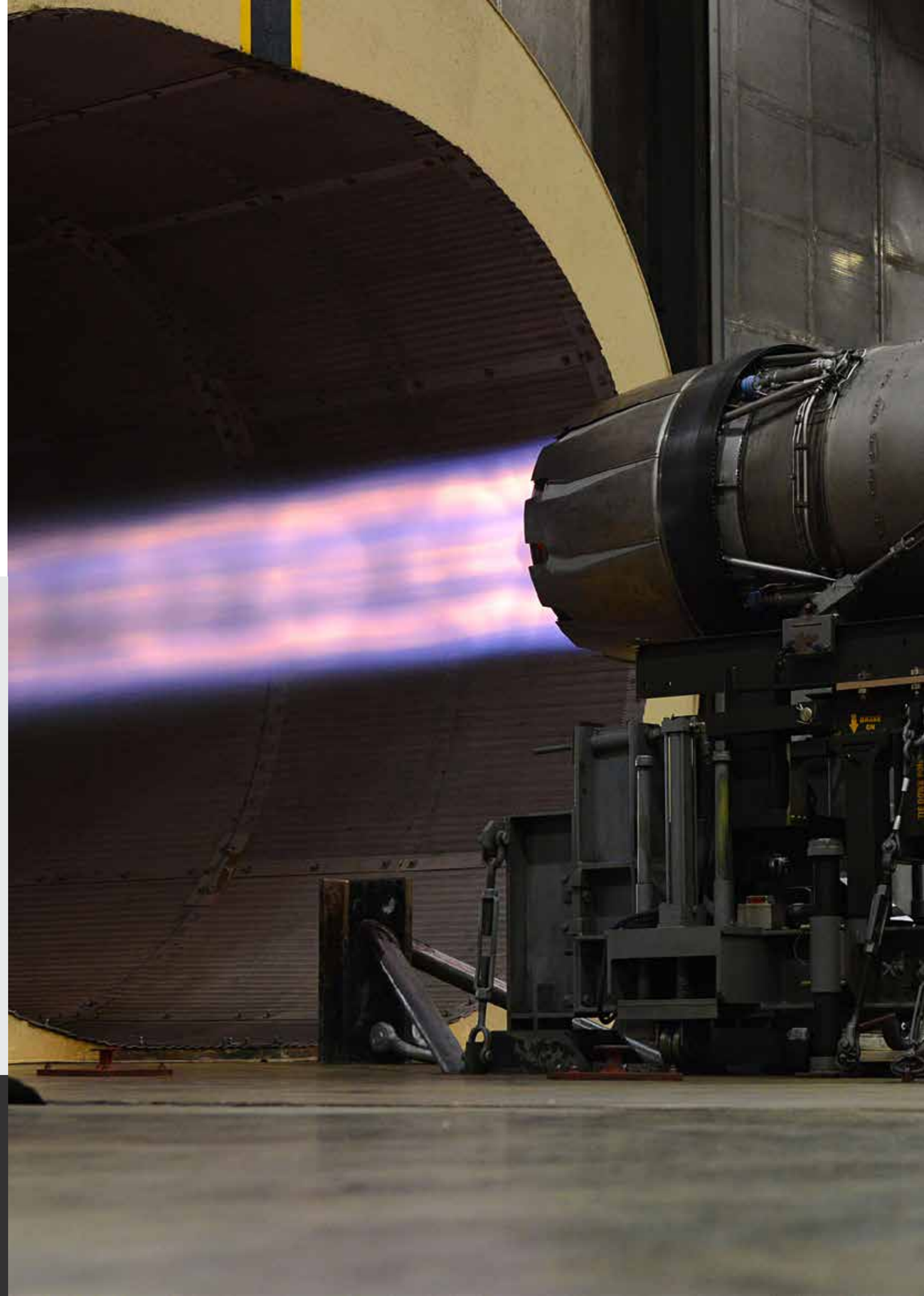
## MISSION PICTURES TAKEN BY ELIOS

**FLYABILITY SA**

Av. de Sévelin 20
CH-1004 Lausanne
+41 21 311 55 00
sales@flyability.com

TIME – COSTS – SAFETY

Flyability builds **safe drones for the inspection of inaccessible, confined, and complex places**. Focusing on the Energy, Oil & Gas, Chemicals & Maritime industries, Flyability enables end-users to save time, costs and reduce risks during visual inspections.



SAFE DRONES
FOR INACCESSIBLE PLACES

**AUGUST 2016**

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

**FLYABILITY SA**

Av. de Sévelin 18
CH-1004 Lausanne
+41 21 311 55 00
sales@flyability.com

TIME – COSTS – SAFETY

Flyability builds **safe drones for the inspection of inaccessible, confined, and complex places**. Focusing on the Energy, Oil & Gas, Chemicals & Maritime industries, Flyability enables end-users to save time, costs and reduce risks during visual inspections.

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 aditional equipment such as scafolding or rope access.

### SAFETY

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

## MISSION PICTURES TAKEN BY ELIOS

**FLYABILITY SA**

Av. de Sévelin 18
CH-1004 Lausanne
+41 21 311 55 00
sales@flyability.com

TIME – COSTS – SAFETY

Flyability builds **safe drones for the inspection of inaccessible, confined, and complex places**. Focusing on the Energy, Oil & Gas, Chemicals & Maritime industries, Flyability enables end-users to save time, costs and reduce risks during visual inspections.

FLYABILITY

SAFE DRONES
FOR INACCESSIBLE PLACES

novozymes
Rethink Tomorrow

NOVEMBER 2016

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

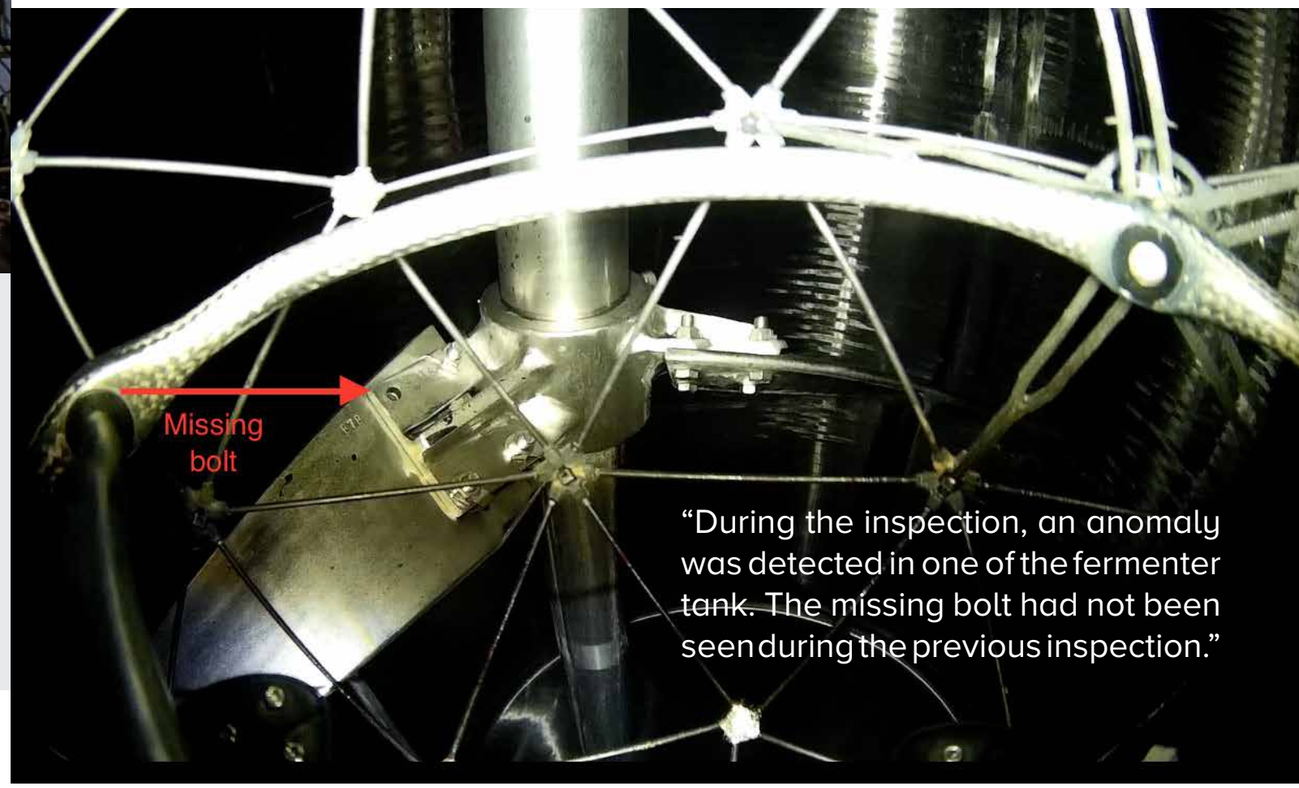
Novozymes, a world leader in biological solutions producing industrial enzymes and microorganism, possess a large enzyme production facility in Blair, Nebraska, USA. The production facility has multiple production tanks that they use to inspect systematically after the production of every batch of enzymes. 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.





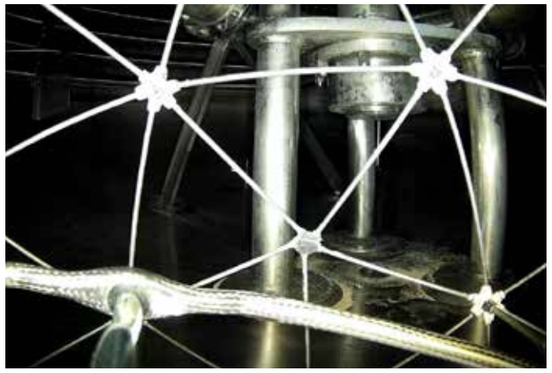
## SOLUTION AND PROCESS

The trial inspection took place directly in Novozymes' facility in Blair, Nebraska. As usual, Flyability sent a dedicated and experienced 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.



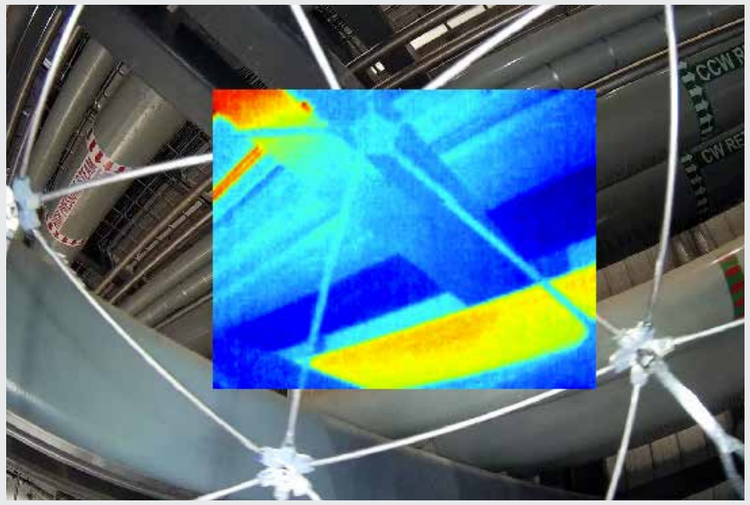

Looking for innovative ways to solve recurring challenges in their facility and leveraging the presence of Elios within the facility, Novozymes tested the ability of Elios to provide information on containers stored in their storage warehouse. Once a year, Novozymes cross-checks the information of their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



**FLYABILITY SA**

Av. de Sévelin 18
CH-1004 Lausanne
+41 21 311 55 00
sales@flyability.com

TIME – COSTS – SAFETY

Flyability builds **safe drones for the inspection of inaccessible, confined, and complex places**. Focusing on the Energy, Oil & Gas, Chemicals & Maritime industries, Flyability enables end-users to save time, costs and reduce risks during visual inspections.

FLYABILITY

SAFE DRONES
FOR INACCESSIBLE PLACES

AUGUST 2016

ELIOS IN ACTION | OIL & GAS INDUSTRY

# INSPECTION OF STORAGE TANK

## INTRODUCTION

TAU AG, an asset manager in charge of a tank farm in Muttenz 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, overfill 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.





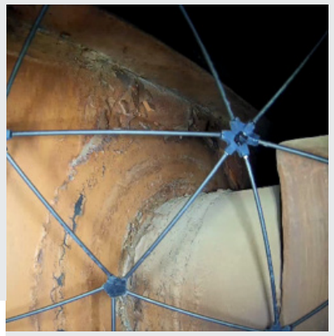
## SOLUTION AND PROCESS

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.

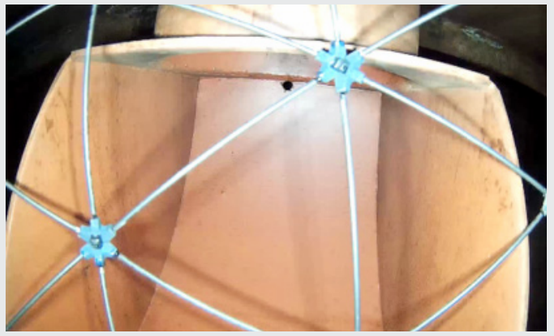
## RESULTS

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

**FLYABILITY SA**

Av. de Sévelin 18
CH-1004 Lausanne
+41 21 311 55 00
sales@flyability.com

TIME – COSTS – SAFETY

Flyability builds **safe drones for the inspection of inaccessible, confined, and complex places**. Focusing on the Energy, Oil & Gas, Chemicals & Maritime industries, Flyability enables end-users to save time, costs and reduce risks during visual inspections.

FLYABILITY

SAFE DRONES
FOR INACCESSIBLE PLACES

RONIK Inspectioneering B.V.

OCTOBER 2016

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.

## 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.

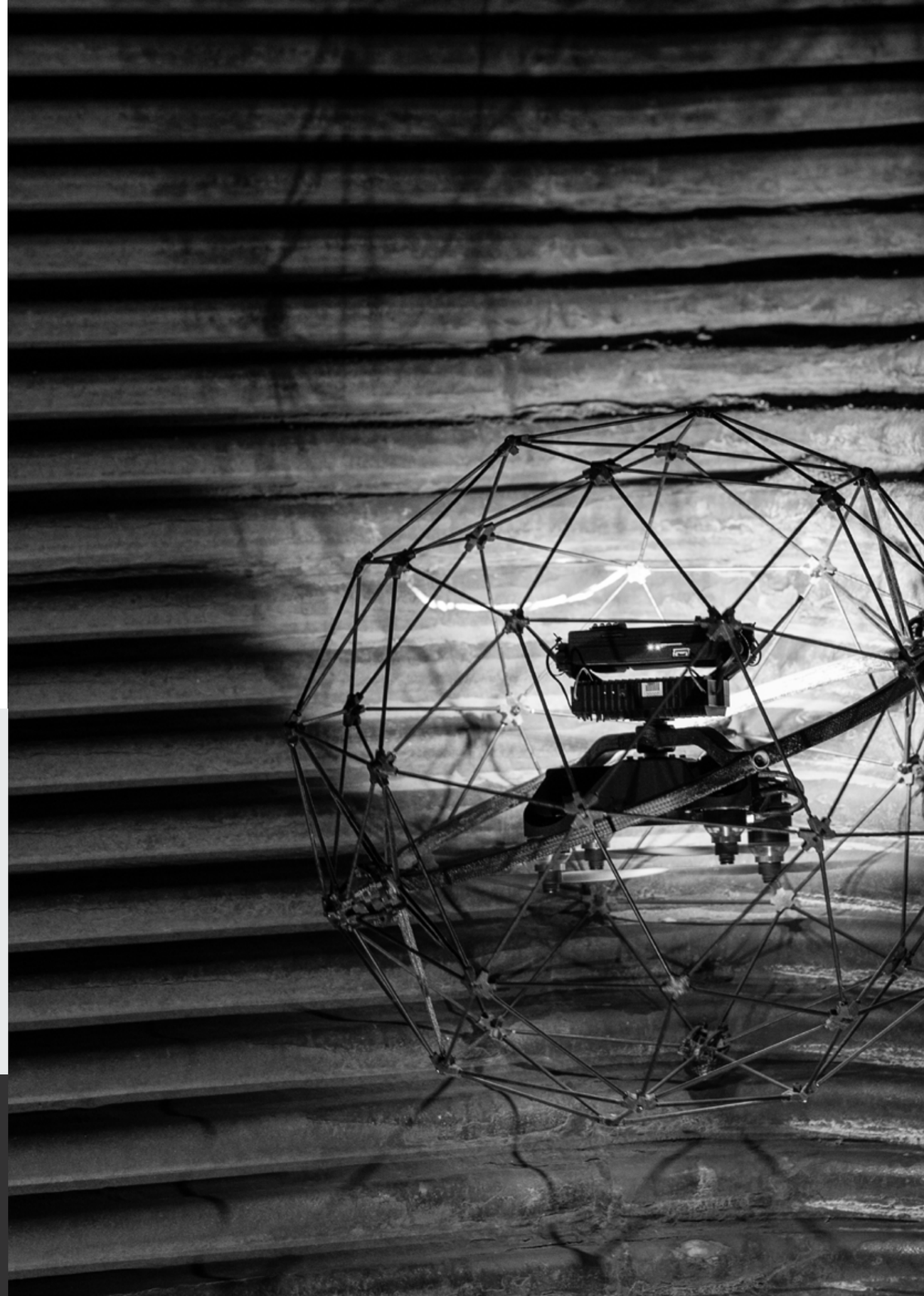
## MISSION PICTURES TAKEN BY ELIOS

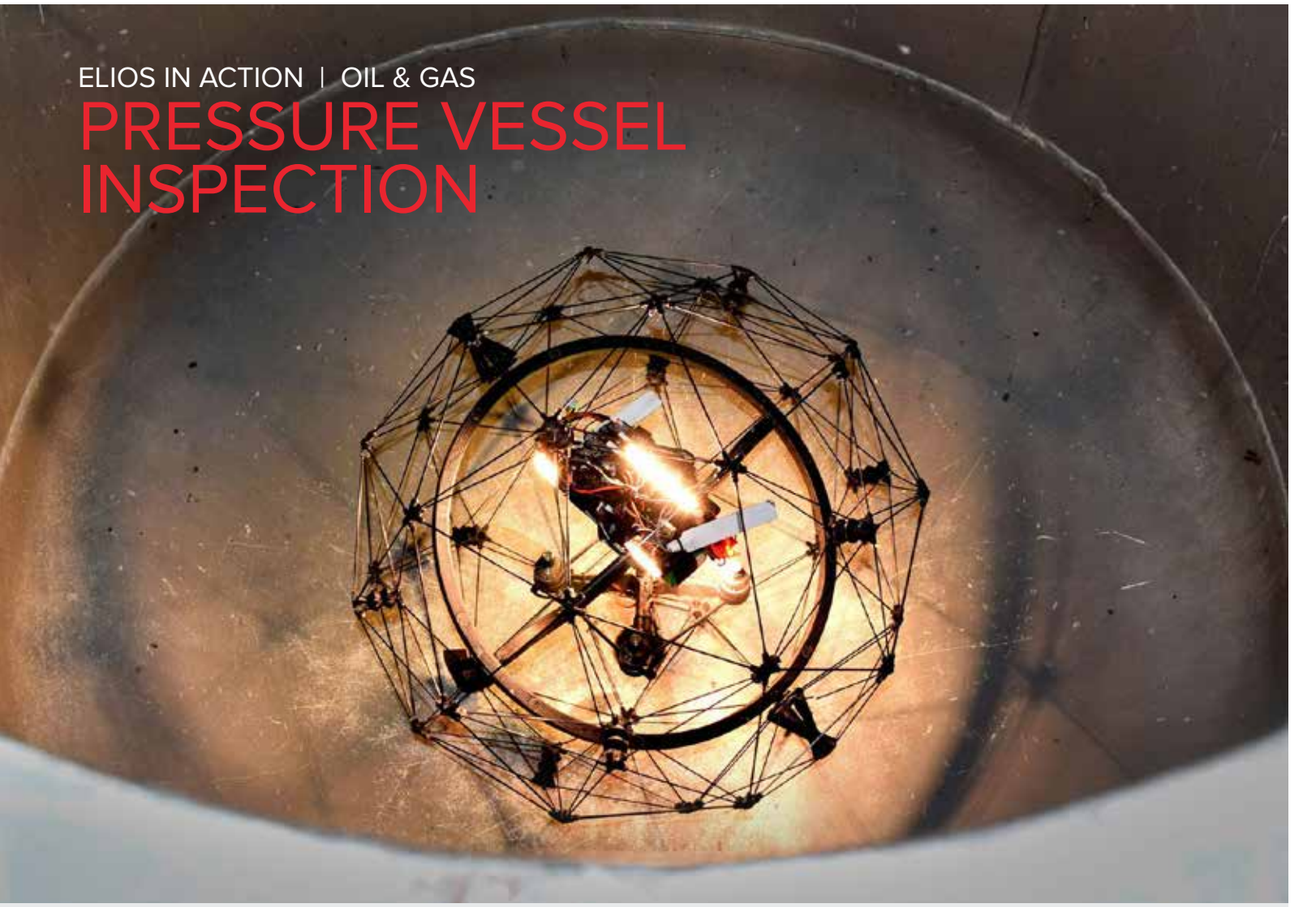
**FLYABILITY SA**

Av. de Sévelin 18
CH-1004 Lausanne
+41 21 311 55 00
sales@flyability.com

TIME – COSTS – SAFETY

Flyability builds **safe drones for the inspection of inaccessible, confined, and complex places**. Focusing on the Energy, Oil & Gas, Chemicals & Maritime industries, Flyability enables end-users to save time, costs and reduce risks during visual inspections.





ELIOS IN ACTION | OIL & GAS

# PRESSURE VESSEL INSPECTION

A prevalent tool in energy production and storage are pressure vessels, which hold gases and liquids at high pressures. Vessels are subject to regular inspections, as a ruptured unit can give rise to more fatal risks. Current inspection methods are time consuming and prone to risks; our all-in-one UAV solution Elios can inspect vessels without the risk of injury.

Operating and maintaining pressure vessels presents considerable health and safety concerns for the Energy industry. Consequently, the regularity of maintenance inspections is to avoid leaks or explosions, this requires extensive preparation and caution by human workers.

WHILE DOWNTIME IS REDUCED, INSPECTION PERSONNEL ARE ABLE TO CONTROL THE DRONE REMOTELY OUTSIDE THE STRUCTURE, AVOIDING THE RISK OF INJURY





Current approaches to evaluating pressure vessel integrity are through Non-Destructive Testing methods such as observing deterioration indicators and visual inspection. Preliminary visual inspection is a fundamental aspect of the process, other NDT methods such as ultrasonic thickness measurement are compliments to an overall assessment. The larger issue at hand is the extensive training and preparation needed for accessing and inspecting these confined areas, specialized permits, presence of multiple trained personnel, rescue teams and ventilation are a few aspects that add to the costly nature of pressure vessel inspection. Shell states that “98% of the costs are related to EHS and preparation, only 2% to the inspection itself”, which emphasizes the need for a solution that is able to perform the inspection and reduce costs related to preparation and risk.

## CONVENTIONAL INSPECTION METHODS

– Robotic Arm
– Visual inspection
– Magnetic-wheeled robots

## UNMET NEEDS

– Avoid confined space access
– Rapid inspection in emergency cases
– Minimize downtime during inspection
– Complete coverage, even in hard to access areas

Practical robotic solutions exist for pressure vessel inspection; this includes a controllable robotic arm or magnetic-wheeled robots. However, most are limited by their locomotive capabilities when faced with obstacles or different environments. Flyability’s collision-tolerant UAV Elios is designed to reflect off obstacles with an external rotating cage, the same mechanism protects any human operators from harm.

A pilot test was organized in collaboration with Chevron’s energy sector, whose objective is to prevent all human entry into confined areas by

## ELIOS IN ACTION | PRESSURE VESSEL INSPECTION

2020. Flyability performed vertical and horizontal pressure vessel inspections. While one of our pilots was controlling the drone itself, another adjusted the live video transmission to ensure the best quality material, even in difficult lighting situations. When in contact with structures, it transmits visuals at 0.2mm/px resolution, in being able to adjust the ISO+, exposure time and LED intensity, assuring the most accurate close-proximity visuals.

To ensure downtime is reduced during our inspections, Elios can be deployed in under a minute and the batteries exchanged in under 30 seconds. inspection personnel are able to control the drone remotely outside the structure, avoiding the risk of injury, reducing overall asset downtime.

### MISSION ACHIEVEMENTS

– Complete inspection of vertical and horizontal pressure vessels
– High image quality in difficult lighting conditions.

### ELIOS BENEFITS

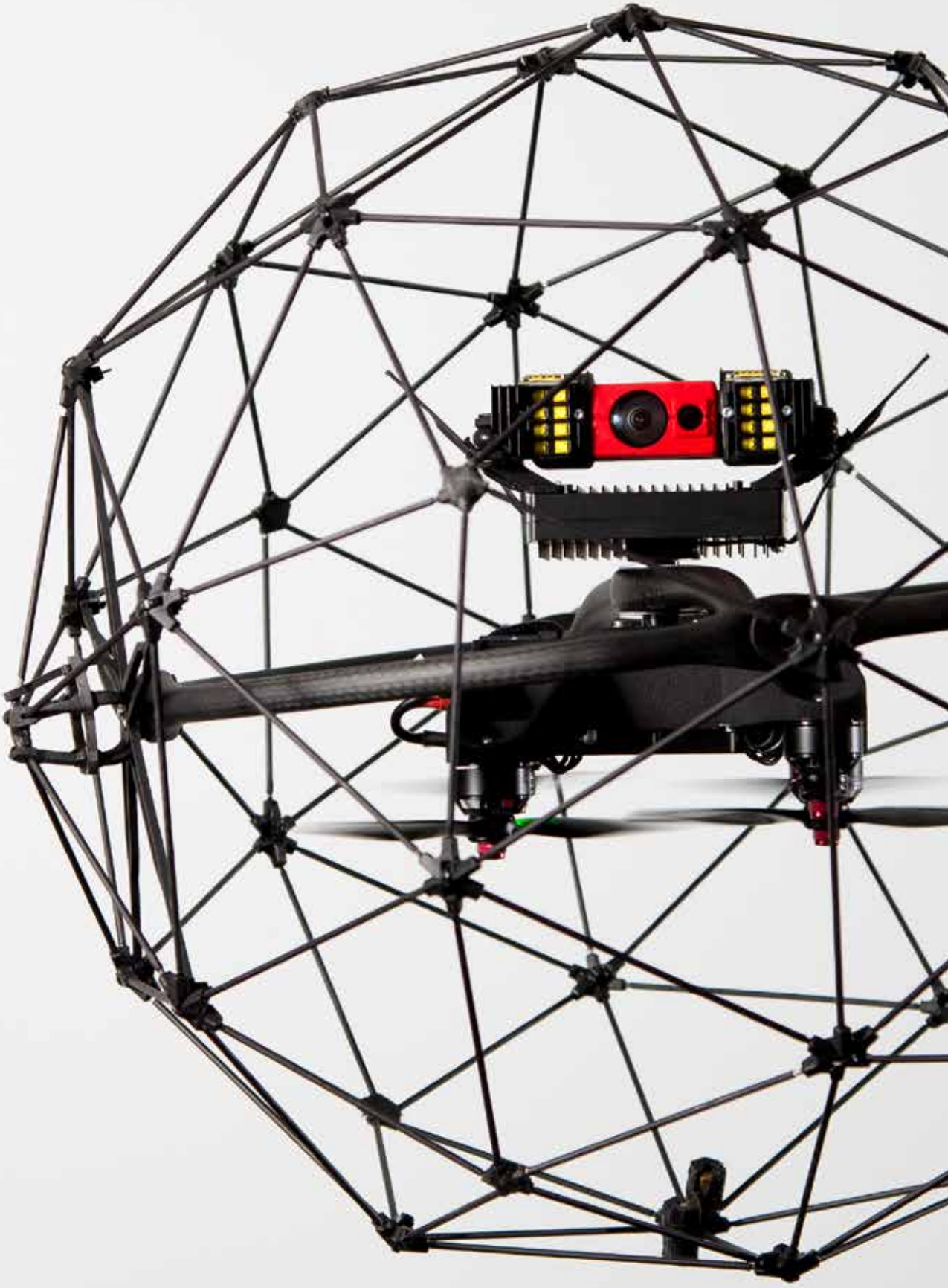
– No confined access required
– Review mission data on provided SD card.
– Inspector can become trained operator after 2 days training.
– Little preparation required
– No risk of crashing
– No regulatory burden as operations are indoor and not in public airspace

### MISSION PICTURES TAKEN BY ELIOS


**FLYABILITY SA**
AV. DE SÉVELIN 20
CH-1004 LAUSANNE
+41 21 311 55 00
SALES@FLYABILITY.COM


TIME – COSTS – SAFETY

Flyability builds **safe drones for the inspection of inaccessible, confined, and complex places**. Focusing on the Energy, Oil & Gas, Chemicals & Maritime industries, Flyability enables end-users to save time, costs and reduce risks during visual inspections.



FLYABILITY SA
+41 21 31 55 00 - **SALES@FLYABILITY.COM**
EPFL INNOVATION PARK BLDG C | 1015 LAUSANNE | SWITZERLAND