

Drones up for inspection

Drone-based tank inspections could help to reduce risks to surveyors, while also offering coverage of typically difficult-to-access areas. Tim Walsh, FRINA examines how technological advances are enabling inspections that meet stringent class society inspection requirements

There has been an increasing use of unmanned aerial vehicles (UAVs), or drones, for tank inspections on floating offshore installations over the last five years, and, with seemingly constant advances in the technology, it can be difficult to understand the current capabilities and true potential.

The Hull Inspections Techniques & Strategy (HITS) JIP encouraged industry to develop methods for unmanned tank inspections that would satisfy classification society requirements. Over the last few years, HITS has evaluated UAVs and various robotic solutions against the class standards.

This article reviews the current and potential capabilities of UAV solutions by looking at class requirements; discussing the capabilities and

limitations of current UAV technology; and considering the future potential of UAVs as well as alternative methods for unmanned tank inspections.

Inspection requirements

Inspection requirements for floating offshore installations are largely defined by the classification societies to the standards laid down by the International Association of Classification Societies (IACS). The main defects to which these structures are subject are cracking, coating breakdown, corrosion and structural deformation. Therefore, inspection schemes are designed to find and quantify these defects before they become critical.

The basic tank inspection scope for floating installations comprises general visual inspection (GVI), close visual inspection (CVI) and

ultrasonic thickness measurements (UTMs) of structural elements. Other non-destructive testing (NDT) techniques can also be used to detect and quantify defects such as cracking in known hotspots.

Tank inspections were traditionally carried out by class society surveyors or owners' inspectors. Access to remote parts of the structure was always difficult: typical cargo oil tanks on FPSOs can be 15-25m in height. Access methods included scaffolding and the use of rafts in flooded tanks.

Over the past few decades, remote inspection techniques (RITs) have been developed as an alternative means of providing inspection data to the surveyor. Initially, this took the form of rope access inspections, sometimes with helmet-mounted cameras, and, more recently, the use of UAVs and



Before UAVs and similar technologies, RITs for tanks largely took the form of rope access inspections, using helmet-mounted cameras



other remote inspection technologies. The use of all RITs is governed by class society/IACS rules and the required performance standard is clearly defined: the RIT deployed should provide the equivalent standard of survey results “normally obtained by the surveyor”.

To achieve this standard, the task facing all RITs, and UAVs in particular, is twofold: firstly, they must be able to operate effectively in the tank environment; and secondly, they must be able to gather, store and transmit the required inspection data to an equivalent standard to a conventional class survey.

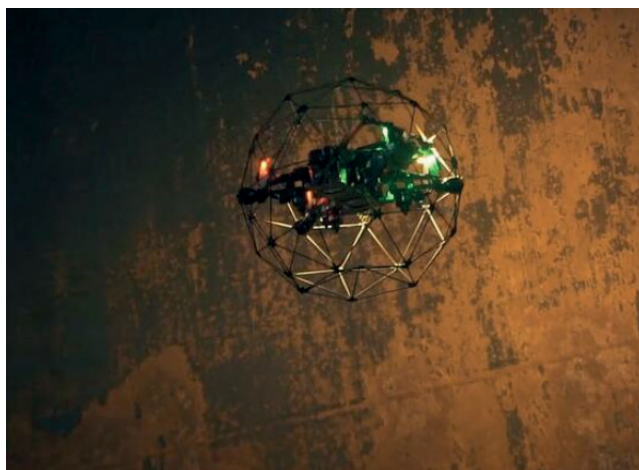
Stakeholders are keen to reduce or remove the need for manned entry to tanks and confined spaces for reasons of safety, cost and operational efficiency.

To operate in a tank environment the UAV (and its pilot) must be able to navigate its way around the structure, in a GPS-denied environment, and most of the time out of the direct line of sight of the pilot, known as ‘beyond visual line of sight’ (BVLOS). The UAV must be able to locate the areas for inspection; operate in low and very low ambient light; have a flight duration which is practical; be able to access tight spaces; be able to withstand contact with the vessel structure without damage and without fire risk; and, finally, be recoverable, in case of its inability to get ‘back to base’.

It must also be able to perform a full unmanned tank inspection scope (including CVI, structural deformation surveys, coating assessments and thickness measurements) and deal with any local cleaning requirements (such as scale removal). All inspection data must be securely recorded, tagged and stored to the ‘surveyor equivalent’ standard.

These requirements have been around for some time and underpin the traditional approach to integrity assurance and classification. With the continued progress of digital technology, operators and classification societies are developing new approaches based on digital twins and risk-based inspection, so future inspection and monitoring techniques will need to provide more and better data to support this.

The caged Elios 2 UAV has become a popular choice for offshore companies conducting tank inspections



Current capabilities

The most commonly used UAV for tank inspections is the Elios 2 from Flyability. This is a caged unit specifically designed for confined-space inspections, with BVLOS capability. Other systems used include the Matrice from DJI, and more are under development, like the Scout 137 unit from Scout DI.

The basic operational parameters with respect to a UAV’s ability to operate in the tank environment are flight duration, hazardous environment capability, navigation, collision resistance, lighting and reliability.

Flight duration, dependent on battery life, remains one of the ongoing challenges in the use of UAVs. Typical flight durations are 10-20 minutes, depending on the service, which necessitates frequent battery changes during the inspection.

While some operators do not consider this to be a great issue, with battery changes being built into the flight plan, others regard it as a major limiting factor, particularly in more confined and complex structures such as water ballast tanks. Battery performance will doubtless improve in the future but, for now, increased duration comes at the cost of additional weight.

This problem is entirely avoided by tethered units, but tethers introduce other issues. Tethering reduces flight duration limits; allows for failsafe powering down, recovery and improved data connectivity; and enables electrical grounding. However, this comes at the cost of greater entanglement risk

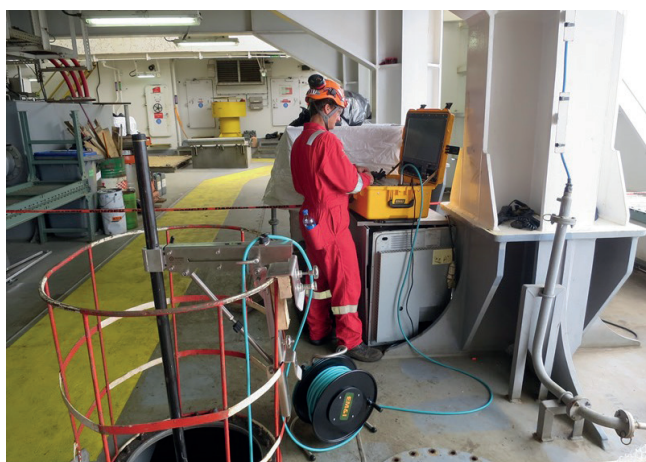
and limits on the flight distance from the base station.

No UAVs are currently Ex-rated, so their use is limited to spaces that have been made safe beforehand. There are significant technical challenges to adapting UAVs to achieve Ex rating, but perhaps the biggest issue is economic; the market for such units is considered to be limited, especially given that effective workarounds exist. So, it seems unlikely that Ex rating will be addressed in the near future.

Some UAVs are said to be capable of navigating around tank structures and out of direct line-of-sight, but this would be highly dependent on the skill of the pilot and a good understanding of the layout of the structure. Experience has also underlined the importance of flight planning and robust procedures for successful operations, and the importance of having an experienced surveyor or tank inspector working with the pilot to aid navigation and ensure inspection data quality. Caged units, such as the Elios 2, are able to come into contact with the structure, but non-caged units must be closely monitored in line-of-sight of the pilot to prevent contact.

UAV lighting has greatly improved over the last few years and is now capable of supporting CVI and stand-off inspections, with the use of oblique lighting to enhance defect detection and reduce backscatter from airborne particles. System reliability has also improved in recent years but control communication between the unit and





EM&I's NoMan system uses remotely deployed, HD optical cameras and a synchronous laser system to provide a full class scope tank survey without sending personnel into the structure

the pilot can still be vulnerable in some environments.

In terms of basic inspection parameters, CVI is seen as the UAV's greatest capability, although most units do have difficulty in accessing some critical areas, such as under suction pipes. GVI and stand-off views can be more challenging due to the greater lighting requirements, but recent claims suggest this can now be performed successfully, possibly with additional lighting in the tank.

Thickness measurements remain a problem for UAVs, although some units are now starting to take readings on vertical surfaces such as bulkheads, but other orientations, reliability and surface conditions remain difficult. No units currently have the ability to perform other forms of NDT, such as eddy current inspection for crack detection.

Some units can use LIDAR to assist navigation and to generate coarse point cloud models, but more detailed scanning by UAV (for example, for distortion surveys) has currently not been performed on tank structures.

Stakeholder views

Among the various stakeholders, particularly the classification societies and asset owners, there is a general acceptance that anything that reduces the need for tank entry and working at height is a good thing, but that alternatives must provide the required data quality. Classification societies need data to assess the ongoing condition of the vessel, and by and large see UAVs as an enabling technology, or in other words 'a useful tool in the box'.

They provide guidance and standards for the use of the technology by third parties to support class inspections (good examples of this guidance are provided by ABS and Lloyd's Register). DNV GL has taken a slightly different approach, using third party providers but also operating its own UAVs and developing the technology together with Scout DI in Norway, including the incorporation of DNV GL defect assessment AI and software.

For asset operators, greater use of UAVs depends on them being safer, quicker and cheaper than the alternatives, whilst also delivering the same or better results. Many see the potential, and are starting to use UAVs as part of the tank inspection toolkit, primarily as a means of reducing working at height. Current experience suggests reductions of between 20-25% compared to visual inspections carried out by rope access, but limitations mean that humans are still required to conduct thickness measurements, structural deformation checks and close examination of some critical areas.

There is one recent example of a UAV GVI/CVI carried out without manned entry, in the UK North Sea, but the inspection scope did not include thickness measurements or structural deformation surveys.

Apart from the technical obstacles to the greater use of UAVs, there are inevitably non-technical barriers. In a difficult operating environment, such as offshore, there can be inertia behind tried and trusted methods, and alternative approaches are seen to carry risks as well as benefits. It is notable that where this technology has

been deployed successfully, great effort has gone into stakeholder engagement and much attention given to detailed planning and preparation together with the use of skilled operators.

Looking to the future

So, what of the future? To progress further, the current limitations of the technology must be addressed, particularly: the ability to carry out thickness measurements and coating, pitting and structural surveys; flight duration times; navigation; suitable surface preparation; and Ex rating. Even then, older assets will remain more challenging for the application of UAVs.

The focus of this article has been on the use of UAVs for tank inspections, but there are also other remote inspection technologies being deployed and developed in this area. Notable among these are the use of high-power camera systems, such as EM&I's NoMan system, which uses a combination of remotely deployed HD optical cameras and a 'synchronous' laser system to provide a full class scope tank survey including GVI/CVI, distortion surveys, coating surveys, pitting surveys and thickness measurement, with no man entry required.

The GVI/CVI part of the NoMan technology has received class acceptance and has been used around the world since 2017. NoMan's potential could extend further than the basic unmanned tank inspection brief: for example, the high-density point cloud data could be used to inform digital twins, finite element models, tank volumetric calculations and so forth. **OMT**