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WHITE PAPER / **LNG FACILITIES AND DRONES**

DRONE TECHNOLOGY REVOLUTIONIZES MAPPING OF LNG TANK COLD SPOTS

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Thermal surveys of the walls of a 200-foot-tall liquefied natural gas (LNG) tank can be challenging. Traditional thermal detection methods are costly, time-consuming and potentially dangerous. By using unmanned aerial vehicles (UAVs) instead, thermal LNG tank inspections can be conducted safely and efficiently, while collecting more and better data.

Within the past decade, UAVs have revolutionized how design and construction projects collect useful images and data. Equipped with video cameras, thermal imaging technologies and other specialized equipment, UAVs are now flown to inspect solar farms and transmission lines, create 3D models of various facilities and refineries to perform hundreds of other tasks previously accomplished other ways — only faster, cheaper and better.

As a result, UAVs are being integrated into workflows to help solve difficult challenges and create new efficiencies. New geospatial, mapping and inspection applications emerge almost weekly. LNG peak shaving facilities are among the many places that UAVs are being utilized to revolutionize tank insulation inspections.

Consider the giant tanks where LNG is stored under low pressure at a very frigid minus 260 degrees Fahrenheit. Similar to a giant thermos bottle, these tanks must be designed with the thermal efficiency needed to prevent LNG from boiling off into vapor.

Built of concrete and steel, the tanks can be as large as 200 feet high and 180 feet across. The double-walled storage tanks contain LNG within an inner wall. To maintain LNG's cold temperature, the space between the inner and outer walls is filled with loose insulation materials.

Over time, the insulation materials tend to settle, creating "cold spots" in tank walls. These trouble spots allow heat to leak into a tank, reducing the thermal efficiency of the LNG storage vessel, which in turn increases the internal boil-off rate of the LNG. To restore thermal efficiency, additional insulation can be injected into these cold spots through nozzles distributed along the top of a tank. But first, the cold spots must be located.

Pinpointing cold spots has traditionally been a difficult and cumbersome process. LNG facilities have typically sought to locate them by measuring the temperature variances across the surface of the LNG tank's outer wall. Often they relied on thermal scans taken from the ground to measure these temperatures.

Given the great height of many LNG tanks, maintenance teams also sometimes used riskier methods to elevate their imaging devices so tanks could be assessed from a higher perspective. In some cases, that meant mounting thermal cameras on lifts that slowly moved up and down, capturing images of the tank surface as they circled the tank.

A DRONE CHANGES EVERYTHING

One benefit of UAV technology is that it gives the drone pilot the ability to tailor each flight to the project's particular needs. Cameras and other remotely operated equipment can be switched in and out, depending on the mission. Computer software directs the aircraft, telling it how high to fly, what direction to go and where to capture images. After capturing the images and data, software logs coordinates for each flight for future reference.

To inspect an LNG tank for cold spots, a UAV would be equipped with a thermal imaging scanner or an even more advanced radiometric thermal camera, which measures

AUTHORIZATION TO FLY

A drone license is not enough when working in the high risk, mission-critical areas. Additional waivers and exemptions are also commonly needed.

Burns & McDonnell was one of the first AEC firms in the country granted authorization to legally fly drones for commercial purposes under the FAA's Section 333 exemption. The firm's understanding of the Section 333 waivers and authorizations process has helped it gain authorization to fly in restricted airspace, conduct flights for emergency operations and receive waivers for night flying.

Procedures for commercial drone use continue to evolve. Knowledge of the newer LAANC System (Low Altitude Authorization and Notification Capability) and the FAA Drone Zone web-based waiver system, for example, allows Burns & McDonnell to gain authorization for drone missions in restricted airspace, sometimes within seconds.

surface temperature by interpreting the intensity of the infrared signal reaching the camera. Radiometric imaging enables drones to capture temperature data in every pixel of an image. Millions of data points can be combined to create a comprehensive mosaic or model of the tank surface that tracks temperature to the tenth of a degree. The entire mission to collect this data would likely take less than a single workday. The data collected can also be leveraged to support large geospatial projects.

From this imagery and data, software can create a rendering of the tank, visually illustrating the precise location of individual cold spots. The model provides the direction staff need to install new insulation to address the cold spots and improve thermal efficiency. It can also draw attention to anomalies in the concrete and other potential maintenance concerns, which can be precisely located for future repair.

LNG plants wishing to optimize UAV technology may choose to take the mission a step farther. By flying a UAV high above the plant site, onboard cameras can create 3D point clouds consisting of millions of data points that can be assembled into a 3D site map. Known also as a "digital twin," this 3D model can provide a bounty of topographic information that will come in handy when the plant undertakes an expansion or upgrade. Everything from structures to landscape contours and vegetation can be documented in 3D form.

Whether performing thermal imaging, inspections or geomapping, the results are more accurate and performed more quickly and economically than those achieved with conventional approaches. Fewer safety risks are created as well.

WHO PILOTS THESE DRONES, ANYWAY?

Identifying cold spots in an LNG tank wall using a UAV involves a step not required by conventional detection methods: Federal Aviation Administration (FAA) clearance.

Since 2016, persons wishing to pilot UAVs for commercial purposes have been required to complete the FAA's remote pilot certification program. To obtain a remote pilot license, UAV operators must demonstrate an understanding of the regulations, operating requirements and procedures for safely flying UAVs.

Burns & McDonnell currently employees more than 20 certified drone pilots. Our company also provides additional training on safety and flight and crew management. That is in addition to the technical skills needed for the hundreds of inspections, mapping, modeling and other missions we fly each year.

Accuracy — Handheld imaging technologies report results from where a technician is standing. They cannot capture images and data from every conceivable location and angle, including a birds-eye view — at least at a reasonable cost. The sheer volume of data produced by a UAV-mounted camera makes it possible to create models and measure temperatures with accuracy tolerances not previously considered possible or practical.

Speed — A UAV can collect all the imaging and data needed to create a complete 3D model of an LNG power plant in as little as a day, compared to the weeks it might take to assemble comparable information using traditional methods. Time savings extends beyond just the hours saved in collecting the needed imagery. Use of UAVs simplify site logistics. No lifts or other equipment must be mobilized to and moved around the site. Everyday work activities can continue unimpeded.

Cost savings — Because massive amounts of data can be collected quickly, the cost of a UAV mission is typically far less than the cost of conventional detection approaches. Because the data collected is more accurate, design and construction activities will likely involve fewer surprises and require fewer changes.

Safety — LNG tanks can present dangers to technicians who have been elevated above them to obtain imagery. UAV technology eliminates the risks associated with the constant movement of people and equipment when imaging a single tank. UAVs place machines, rather than workers, at risk.

In the near future, UAVs are likely coming to an LNG plant near you. To fly successful missions, it is necessary to retain professionals with dual skills in both UAV operation and LNG plant design, construction and operation.

BIOGRAPHIES

BRIAN HILLER, 1898 & CO., part of Burns & McDonnell, is a geospatial technologies manager. He has more than a decade of experience helping utilities and governmental organizations make efficient use of technology to better manage and maintain the assets they are responsible for. Currently, Brian is heavily involved in the implementation of GIS technology within the municipal sector, including water, wastewater, stormwater and public works organizations. He has a Bachelor of Arts in geography GIS from the University of Kansas and a Master of Business Administration and Management from Baker University, as well as certifications from Esri for Enterprise System Design and Enterprise System Administration.

STEVE TESTA, PE, BURNS & McDONNELL, brings more than 27 years of experience in engineering, strategic initiatives, and program and construction management to his work as a construction project manager for LNG and natural gas projects. In addition to the engineering, consulting and project delivery services he has provided for natural gas and electric infrastructure projects, operational systems, and LNG and liquified petroleum gas facilities, he has a lead role in bringing services to LNG plants and other energy facilities.

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