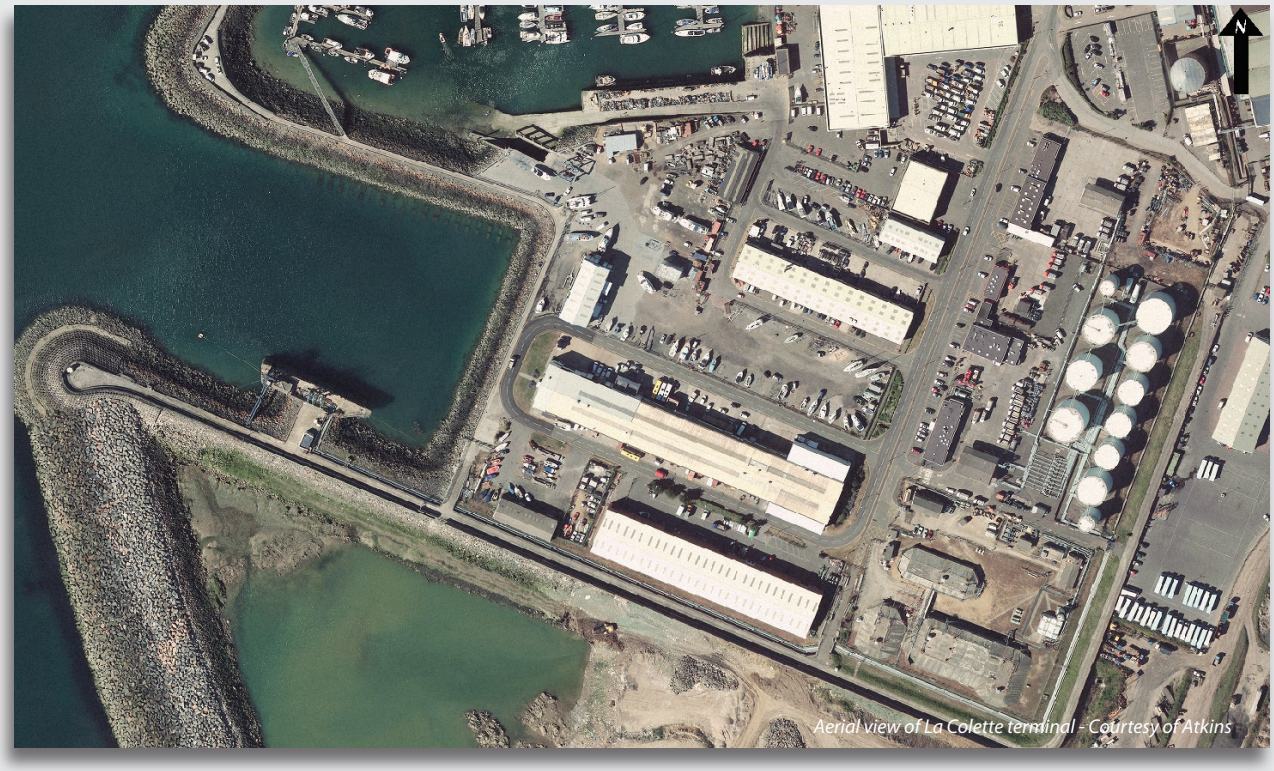
States of Jersey Fire Fighting Protection System

upgrade of the seawater supplied fire protection system for the La Collette fuel terminal, St Helier, Jersey

by Owen Elson BEng

The Buncefield Oil Storage Depot located near the M1 motorway outside the town of Hemel Hempstead, Hertfordshire, was one of the largest facilities of its kind in the United Kingdom. On 11 December 2005, an explosion at the facility was of such force that it triggered seismic detectors, and produced a recorded reading equivalent to a 2.4 magnitude earthquake. The impact fire that ensued following the explosion – the largest on UK soil in peacetime - took two days to extinguish, and the subsequent plume of smoke covered much of the south-east. However, the wider implications were to be felt far into the future. In the wake of the incident, the storage of anything explosive came under close scrutiny. Not only is the destruction of inflammable material a distinct health hazard, but it is likely to ruin the asset and cause problems downstream.



Aerial view of La Colette terminal - Courtesy of Atkins

In the aftermath of the Buncefield incident, the issue of storage of anything potentially explosive was brought into sharp focus, and on the Island of Jersey, this led to a £5 million, highly complex, technically rewarding project for Atkins.

Island of Jersey

Jersey, the largest of the Channel Islands, is home to a resident population of just under 100,000 inhabitants. This ranks it as a similar size to Cheltenham, but the island is also popular with tourists who come for the sunshine and beaches.

Storage

All of the island's motor spirit for cars, kerosene for aeroplanes and heavy fuel oil are all brought into the harbour by sea at the La Colette terminal. The island has no natural oil reserves of its own to exploit. Storage for LPG is also provided at this location with facilities for transfer to road tankers for distribution.

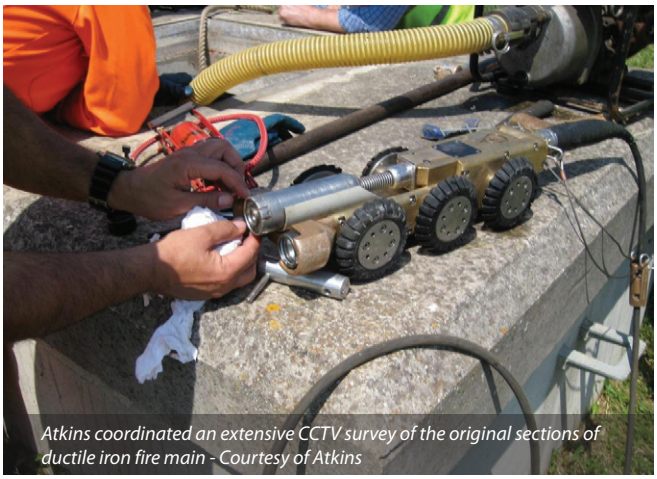
Should the area suffer a catastrophic incident, not only would there be a large and potentially lethal explosion, but the island's critical infrastructure would rapidly grind to a halt. The impact on Jersey's reputation could also be deep and long lasting.

Assessing hazards and safety systems

The island's municipal authority wanted to ensure its fuel terminal and bulk storage facilities were safe and protected by suitable systems in accordance with current standards.

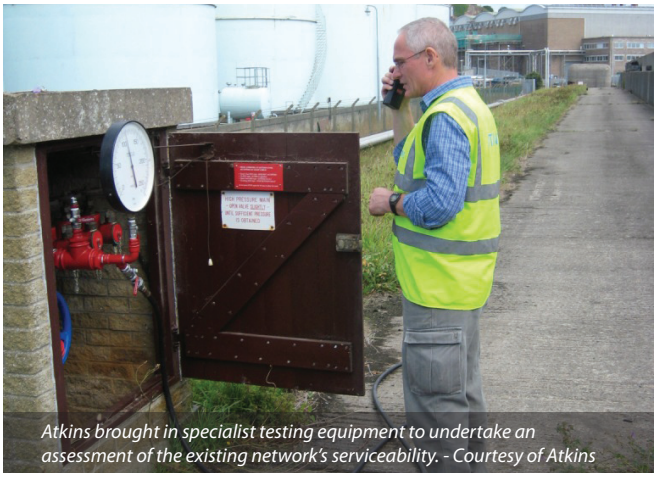
In 2007, Atkins Oil & Gas were commissioned to review the potential hazards and safety systems at the La Colette terminal and on the sites of its third party operators that have fixed tanks where the fuels are stored. If there is no offloading from these tanks, then the island would run out of petrol and diesel in a matter of days.

The jetty where the tanker ships dock is itself a *"substantial old structure",* according to Owen Elson, mechanical engineer for the project, who says a collision would be more likely to sink any visiting ship than damage the infrastructure, but the operation of transferring both high and low flashpoint fuels means risk of fire remains a serious consideration.

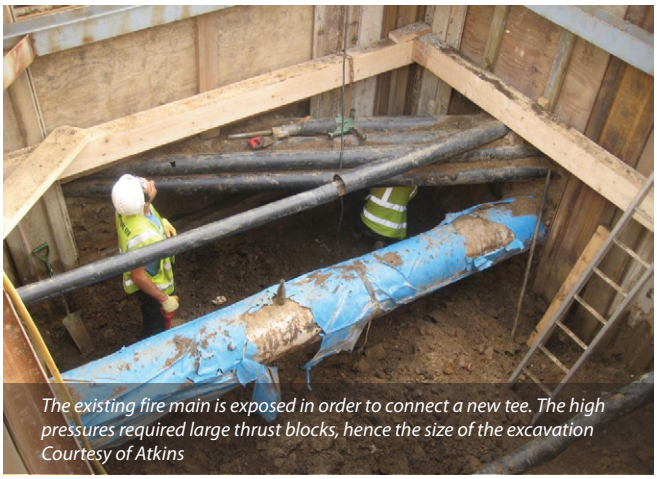


Atkins coordinated an extensive CCTV survey of the original sections of ductile iron fire main - Courtesy of Atkins

One of the fixed monitors on the tanker jetty discharging during a periodic test - Courtesy of Atkins



Atkins brought in specialist testing equipment to undertake an assessment of the existing network's serviceability. - Courtesy of Atkins



The existing fire main is exposed in order to connect a new tee. The high pressures required large thrust blocks, hence the size of the excavation Courtesy of Atkins

Critical review

Atkins undertook a critical review, and found that the seawater-supplied fire fighting system was lacking in various areas. The pumps used to pump seawater in the event of a fire via the dedicated site mains were old and no longer supported for spare parts. Though they were operational, the pumps were obsolete and maintenance would soon become very problematic.

The team also examined the network and considered what upgrades could be made to improve for resilience and hydraulic performance. Initially six configurations for new fire pumps were investigated, using a mix of heavy civils, mechanical and electrical solutions, and two or three network configurations, and the realistic benefits they would bring. Projections were made over a 30 year design life.

As part of the condition assessment of the existing network infrastructure, much of which was installed in the 1970s, Atkins pressurised the main to monitor the decay in pressure. Combined with the findings of a hydraulic model, they concluded that some new sections of main should be installed to supplement the more recent sections of existing pipework.

Cost estimates were produced for options that including varying quantities of new network mains along with the benefits they would bring.

Pumping station planning

The engines for the newly chosen diesel pumps needed a new building on the quay side and this required an upfront planning application before the main construction contract could be let.

Beyond the physical infrastructure, the natural elements had to be carefully considered. At around 12m, the tidal range in Jersey is extreme. Given the criticality of the system, Atkins had to consider the full spectrum of operational scenarios.

The pumps need to be fully available at the lowest possible tidal levels, but In addition to the astronomical tides, the potential impact of meteorological conditions had to be taken into account.

Very high pressure weather systems can depress sea levels, and the location on the Channel also meant that the area was prone to tidal surges. Using data provided by the National Oceanographic Centre, Atkins analysed tidal data from the last 25 years as well as onward forecast data and extrapolated the potential number of tides below LAT.

Using specialist subsea civil engineering methods and an industrial diving team, the pump bench for one of the pumps was lowered to mitigate the risk posed. A timetable for these potentially dangerous tides was also added to the pump stations control system so the operators would be aware of an approaching extreme low tide.

Computational fluid dynamics (CFD) were used to check that there would be no undesirable hydraulic effects and to assess the chances of vortices forming. CAB techniques were also used with an accurate representation of the pump and bench geometry of the pump taken from the tender drawings.

To establish pump duty, Atkins looked at the required flows and pressures around the network and worked backwards from there.

The new pumps are configured duty/assist/assist delivering a duty of 275l/s at 12 bar with 50% redundancy. The design basis assumes the worst, and it is of course hoped that the system will never run in anger.

Undertakings

For the new pumping station, Atkins compiled a full tender design and administered the tender process. Of the tendering contractors,

May Gurney were successful and immediately started on the detailed design and pump procurement contract.

On the client's behalf, Atkins retained detailed design responsibility for some of the more involved items. Chief among these being a piled slab for the building, a floating pontoon to protect the submerged pumps from ship impact (which proved to be an interesting case, where Atkins were able to offer the client real value as they could deliver the impact assessment in-house), and a computational fluid dynamics (CFD) assessment of the pump intake area.

Pump supply

Clyde Union were awarded the pump supply contract. They partnered with, Fischcon, a Dutch diesel engine specialist.

The pumps are submersible type line shaft pumps with duplex stainless steel impellers to move water up the duplex riser pipes. Operation is triggered when the pressure within the fire main network drops below the 6 bar maintenance pressure. It takes around 12 seconds for the pumps to reach full capacity, with large accumulator vessels furnishing flow in the interim. If the pressure continues to drop, then the second and third pumps will come in as their cascaded start setpoint is breached.

Complexities

Given the complex nature of the project - designing an advanced emergency system Atkins were mindful of the need to enable the system to cope with the worst case scenario, and applied principles that are familiar to engineers in the nuclear or offshore energy industry.

The system is required to offer *'availability'* in accordance with the requirements of SIL2 (Safety Integrity Level) basis. Component level reliability and redundancy and how they might impact upon the probability of failure of demand had to be considered. All the relevant information was passed over to an independent external assessor to undertake the required calculations and validate the system design.

Control system

The system incorporates two stand-alone programmable logic controls (PLCs). Each controller runs the same code but has its own dedicated inputs/outputs. Various parameters are permanently monitored by a range of instruments. The controllers operate a 'one out of two' voting system in order to initiate key functions such as the starting of the main fire pumps.

In the case of monitoring the fire main pressure, three field instruments are installed on the pump stations discharge manifold. Both controllers run triple validation code based on the outputs from all three. If one instrument goes 'out of range' it is forced to zero and ignored by both controllers. In the unlikely event that one controller fails, the other will report this to be the case via telemetry and continue to perform its function in isolation

Progress

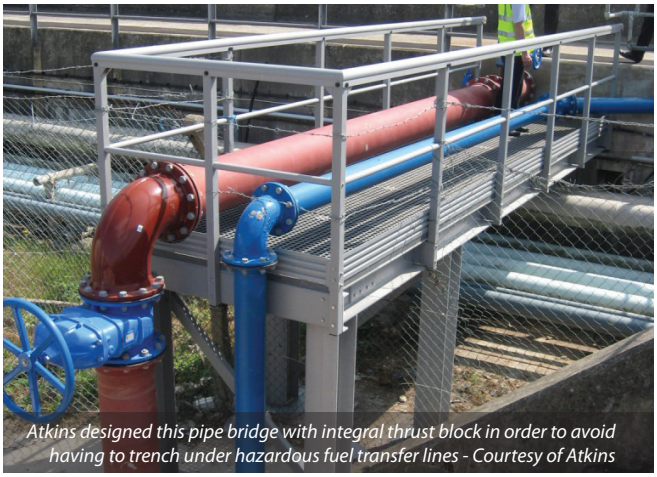
Construction work on site completed earlier this year, and the pumps are in the process of undergoing factory acceptance tests before being sting tested in Holland and shipped to Jersey for installation this September.

Despite some delays with the pump supply, Atkins has maintained an excellent relationship with both the client and the contractor and the new system is sure to exceed the expectations of the island's key stakeholders and maintain the safety of the facility for many years to come.

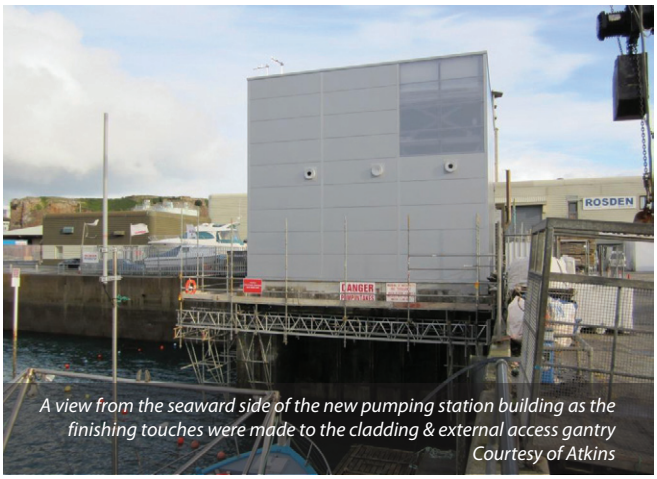
The editor & publishers would like to thank Owen Elson, Senior Mechanical Engineer with Atkins, for providing the above article for publication.

The specially designed CFA piles being put in before the new slab was poured - Courtesy of Atkins

The steel reinforcement being fixed for the new Atkins designed slab for the pumping station building - Courtesy of Atkins



Atkins designed this pipe bridge with integral thrust block in order to avoid having to trench under hazardous fuel transfer lines - Courtesy of Atkins



A view from the seaward side of the new pumping station building as the finishing touches were made to the cladding & external access gantry Courtesy of Atkins

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