Fig. 1. Intertec's built 'peri' shelter.

Novel enclosures simplify plant upgrades

Automation systems are becoming more complex, due in a large part to ever more sophisticated safety technology. Adding such equipment into already crowded plant areas –often close to the process in hazardous areas – is a major challenge. The problems that result can contribute significantly to project cost overruns, a situation that some industry insiders describe as a crisis. This article discusses an evolution of process enclosures that is helping to deliver significant cost reductions for upgrades.

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The alternative automation implementation possibilities afforded by a novel new form of enclosure technology from Intertec provides a platform that is currently helping one EPC to reduce the costs of a major upgrade to a refinery's burner systems by around 90%. The alternative automation strategy that this EPC has currently adopted –thanks in part to this enclosure platform – is avoiding substantial additional costs that would have been incurred if more conventional automation implementation architectures had been employed.

The advance is based on an outdoor shelter concept for housing process control and instrumentation systems where all the system components that are required for normal operation are accessible via the exterior of the building (Figs. 1 and 2). The concept can be considered as an 'inside out' building something like the Pompidou Centre in Paris, France (https://en.wikipedia.org/wiki/Centre_Georges_Pompidou). The design approach massively reduces the size of the shelter, as well as greatly simplifying implementation. Among many design problems and costs that can be avoided are the need to make buildings blast proof and fire-resistant (because personnel might be inside), major reductions in size by eliminating desks, control panels, door opening spaces, aisles/walkways/escape routes etc, and much simpler internal atmospheric control requirements. The concept aligns perfectly with the continuing development of electronics - radically shrinking the size of the protection envelope in the same way that the electronics equipment itself shrinks via continued integration.

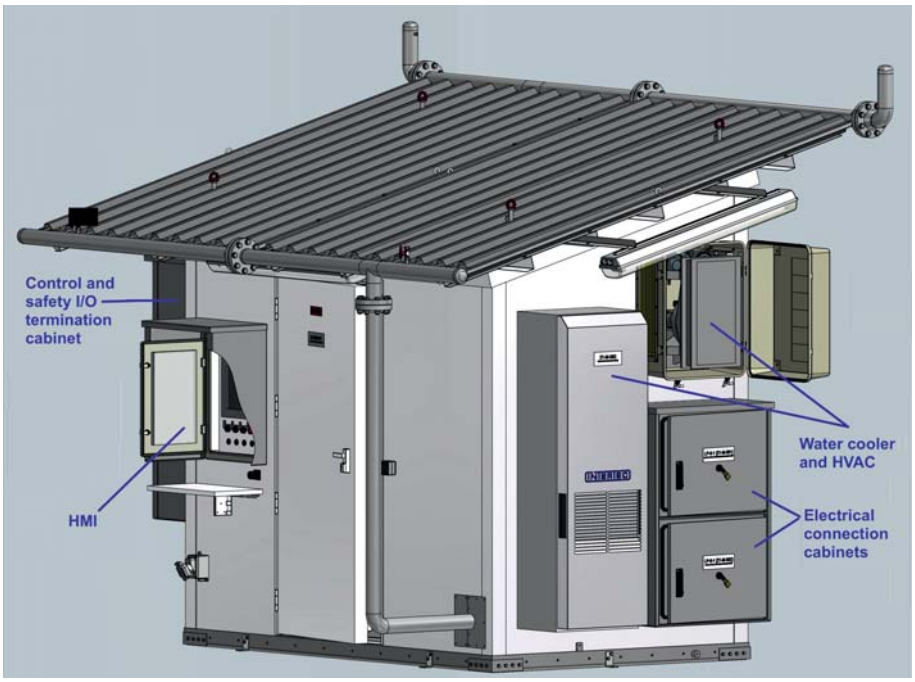

Fig. 2. Intertec's 'peri' shelter design features a novel inside-out construction style, with all elements for installation and normal operation accessible from the exterior. The actual shelter can be seen in Fig. 1.

The field shelter shown is one of eight that have been developed to house PLC-based control and safety systems for a forthcoming upgrade of burner systems at a Middle Eastern refinery. Panel-mounting enclosures on the exterior provide access to electrical connection and I/O termination points. The PLC is fitted with a touchscreen HMI panel that sits on an external wall –allowing operators on the ground to make adjustments to the control programs locally via an inspection door. The active parts of the cooling system, which involves three separate cooling technologies for reliability, is also accessed from the exterior. Although there is a door, this is always locked and is there purely for access during plant shutdowns or under other special strictly controlled circumstances.

'Peri shelters': a novel concept

This particular project – part of a plant turnaround – adds new high-reliability PLC-based systems and software to provide more advanced control, as well as new safety functions, for the management of eight separate burners.

If a simple upgrade to the existing automation architectural layout had been followed, the project could have involved the replacement of existing satellite instrument houses –very large blast-proof buildings with large HVAC systems attached – located close to the burners deep inside the refinery. As a result, this traditional style of plant automation upgrade would have been extremely costly.

However, following discussions with the operator, EPC and PLC vendor during the early engineering period, the chosen enclosure supplier Intertec proposed a radical alternative to the conventional field shelter: in the form of an unmanned building with all critical resources installed so that they are accessible externally.

Thanks to the possibilities opened up by the shelter concept, the engineering group decided to install the control/safety functionality in the new style of compact shelter. As all the shelters have the same compact footprint of around 2 x 3 metres, they can be sited easily in existing free spaces close to the burner processes - minimising cabling. Making all of the I/O connections available at the exterior of the building further helps with installation, as it means that the shelter and its sensitive electronics equipment can remain sealed and protected against the local corrosive atmosphere throughout installation and commissioning.

This novel concept, dubbed the Peri Shelter, reduces the size and complexity of the enclosure specification by a large margin. It also eliminates costly functions that would otherwise be required for traditional manned shelters, such that the overall project budget was reduced by some 90%.

The enclosure design

The physical location of the systems – deep inside the process – and the harsh coastal desert location of the refinery, posed considerable protection challenges. To meet these, Intertec's design response incorporates two major features in addition to the 'inside-out' layout. The first is custom IP65-rated and purged shelters based on composite GRP materials. These construction materials protect against the many environmental challenges of the application including very high levels of UV, extremes of temperature, and dust and sand abrasion.

The second major part of the protection solution is a regulated internal environment that provides the essential cooling required for the reliable operation of electronics equipment in the very hot Middle Eastern climate.

To ensure extreme reliability of the burner control systems, which are of course central to keeping the refinery running, the shelters' internal atmospheres are controlled via two main protection mechanisms. The plant's instrument air service is used, after drying and filtering, to provide a slight positive pressurisation of the interior atmosphere for safe operation in a hazardous area, and to ensure there are no corrosive chemicals in the atmosphere. Secondly, the shelters are cooled – a critical requirement to ensure the reliability of the electronics –using a combination of three techniques to provide redundancy against failure.

The cooling technologies are a water-based passive cooling system, supported by an electrically powered water cooler and air cooler. In normal operation, the water cooler and passive cooler systems operate in combination to decrease the internal operating temperature of the shelters. The aluminium heatsinks of the PLCs and cases are installed directly onto conductive mounting plates, in contact with the liquid-based cooling media. This conductive heat transfer provides a much more efficient cooling mechanism in addition to conventional air convection.

Passive cooling works by exploiting the large temperature swing over the climate's daily cycle, using water as a medium to store the coolness of the night and moderate internal temperatures during the day. Natural convection moves the water around the system and its heat exchangers. As there are no moving parts, the possibility of failure is extremely small.

If the night temperature is below 28°C, which it usually is in this part of the Middle East during the winter months, the passive cooling circuit can provide the required cooling on its own. In the summer, when the ambient temperature can be hot even during the night, the water cooler fills the gap and keeps the temperature of the water tank/energy buffer below 30°C. If the powered water cooler should fail for any reason, passive cooling can still maintain the electronic equipment below specified maximum temperatures – even through a night temperature of not less than 44°C and a day temperature of 60°. This gives refinery staff plenty of time to effect repairs.

Effectively, this provides the best of two worlds: passive cooling is reliable and operates independently of an electrical power supply. And the water cooler keeps the electronics at an optimal temperature (the maximum operating temperature of modern PLCs is quite high, but MTBF and lifecycle is improved if the PLC is maintained at moderate temperatures).

The third cooling technology, the air cooler, is provided as an independent back-up that is sized to be able to cool the system alone.

The combination means that the operational hours per year of the active coolers is much lower than with a traditional HVAC unit, which would need to run almost all the time –reducing maintenance costs.

A key advantage of this multi-faceted cooling approach is a reduction in size of the protection solution, a design goal for systems which are installed close to the process. If passive cooling alone had been chosen, the system would need to be sized to deal with the hottest days of the year, which would necessitate a very large water tank for this harsh location. The inclusion of active water cooling allows both cooling components to be reduced in scale, and cost, as the systems can work in combination to handle occasional extremes of duty cycle.

Fig. 3. A shelter undergoing extended functional testing in the environmental chamber.

Test validation

As part of the factory acceptance testing process, Intertec's 'hybrid cooling' system was tested in a very sophisticated facility, a climate chamber in Germany normally used for new automobile designs (Fig. 3). Over a period of nine days, the shelters' normal operation, as well as numerous variations in environmental conditions and failure test scenarios, were trialled. The unique cooling system passed all tests, with the thermal capacity of the water tank and the passive cooling system providing back-up cooling for many days in the event of a failure of either or both of the electrically-powered cooling technologies.

Fig. 4 shows that following a failure of the active (electrically-powered) water cooler, the thermal capacity of the passive cooling water tank will maintain the internal temperature below 35°C for four days, and continue to maintain shelter temperatures below approximately 38°C thereafter.

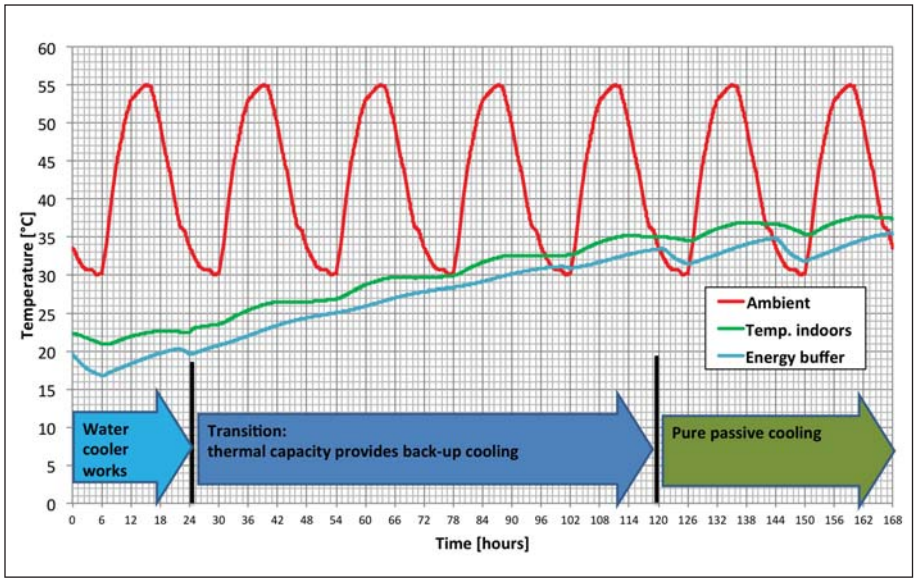

Fig. 4. Testing verified the shelters' intrinsic ability to deal with the failure of active cooling systems.

The peri-shelter concept is believed to offer a significant new platform for reducing the size and cost of processing plant upgrades. It allows more expensive manned satellite instrument houses and remote instrument enclosures to be replaced with much smaller and less complex enclosures. The use of GRP construction materials also supports the growing trend to site control and instrumentation systems closer to the process, deep inside corrosive and hazardous areas.

As this early application illustrates, the enclosure protection systems that need to be designed for plant upgrade applications can be complicated. The key resources needed to support such an evolution of the outdoor process enclosure business is design know-how, plus systems integration capability. Designing and building the custom shelters, and assembling and testing them including all the control, safety and other electronics, can only be handled by an enclosure company that has invested heavily in high-end engineering and technician skills, in combination with advanced manufacturing automation to handle custom enclosure shapes, sizes and specifications. www.intertec.info

About the authors

Martin Hess

After studying process engineering in Munich, Martin Hess worked for Linde as an instrumentation and project engineer. In 1997 he became general manager and president of Intertec. Intertec was founded in 1965 by Martin's father Dr.-Ing. Joachim Hess - a former director of a petroleum refinery - in response to the corrosion problems of sheet metal outdoor enclosures. Intertec utilises glass reinforced polyester (GRP) with composite layers to add insulation and other properties to enclosures. Today, Martin manages a global organization with two manufacturing plants and two system building centres in Germany, Russia, Canada and the USA. Over half of Intertec's output is shipped as turnkey solutions.

Keith Wood

Keith Wood joined Intertec's UK operation in 2007 and works in global project sales and application engineering roles, specialising in major projects. After studying instrumentation engineering in London, he worked in contracting on a variety of construction and commissioning projects in instrumentation sectors including pharmaceuticals, oil and gas. He also has extensive experience in the process valve actuation sector in engineering sales management roles, having spent 10 years as projects sales manager with a leading manufacturer of instrumentation fittings, valves and manifolds.