

DARCHEM THERMAL PROTECTION

PASSIVE FIRE PROTECTION TESTING & CERTIFICATION

When comparing Darchem's Darmatt and Darshield Passive Fire Protection Enclosures to other similar systems available, it is essential that careful consideration is given to 3rd party testing and certification by independent accredited bodies – such as Lloyds Register, DNV and ABS. Furthermore, an understanding is required as to the type of certification provided, from a simple 'Witness Test certificate' to a 'Type Approval Certificate'.

PASSIVE FIRE PROTECTION

The purpose of Passive Fire Protection (PFP) systems is to protect critical flow, process and safety equipment against fire damage and to allow safe controlled plant shutdown in the event of a fire. This means that critical equipment, controls and instrumentation must be able to operate throughout a specified protection period.

Specifications for PFP usually demand that "Equipment shall be protected against a 'fire type' for a period of 'x' minutes". This means that the equipment must be protected appropriately with a PFP system to enable it to remain below its failure temperature during the specified protection period.

FIRE SCENARIOS

There are 2 main fire scenarios for testing. Hydrocarbon Pool Fire, the common standards being ULI709, BS476 Pt 20 Amdt 6487 and ISO 1363-2; and Hydrocarbon Jet Fire, the common standards for which are ISO 22899-1 and OTI95-634. OTI is a testing method agreed by the Jet-fire Test Working Group whose members include major oil & gas operators as well as health & safety organisations. In most cases, OTI has now been replaced and ISO22899-1 forms the basis of the international standard.

NOTE

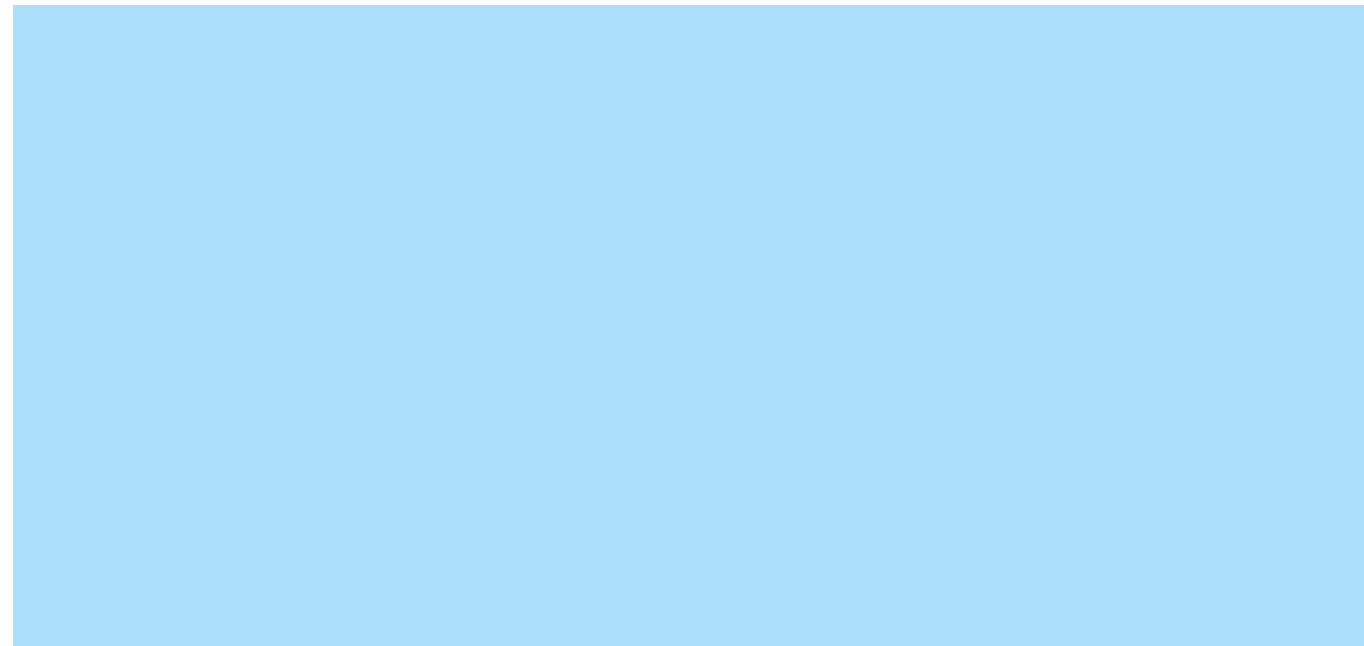
It should be understood that all of these standards (ULI709, BS476Pt20 Amdt 6487, ISO1363-2, ISO22899-1 and OTI95-634) refer specifically to the testing of structural steel, and not specifically for flow or process equipment and there are a variety of pass/fail criteria. For Hydrocarbon Pool Fire the most common standard used is ULI709 and this has a higher pass/fail criterion than some of the other standards. The Jet-fire test OTI 95-634 records the temperature of a steel plate and takes note of the maximum temperatures during the test based on the average temperature of the thermocouples and there is no pass/fail temperature, only an integrity requirement. The new international standard ISO 22899-1 has a pass/fail criterion of maximum temperature of any thermocouple as opposed to the average temperature of the thermocouples on the steel plate and this must not exceed 400°C.

PASSIVE FIRE PROTECTION TESTING & CERTIFICATION

THE VARIOUS FIRE STANDARDS DEFINE:

- Fire Curve
- Pass / Fail point
- Test sample geometry
- Jet Velocity (for Jet Fires) – including shape of nozzle, fuel type and flow rates

FIRE CURVES



TEST TYPES

There are 2 different test types for each standard, a tubular test and a planar test and the type of test will be detailed on the certificate.

TUBULAR TEST

A tubular test is testing the PFP against a standard pipe and covers structural steel, cylinder vessels, pipes and tubular sections only and does not qualify any corners or edge features. The typical method to calculate the PFP thickness for this application is approved Proprietary Software or HP/A.

PLANAR TEST

A planar test is testing the PFP against a flat plate and covers vessels and bulkheads. Additional features can be built in to the planar test geometry and this test will then cover corner joints and edge features and can be used for enclosures. This will usually be detailed in the "Type" and "Description" on the certificate and detailed that the system is applicable for enclosures. The typical method to calculate the PFP thickness for this application is approved Proprietary Software.

PASSIVE FIRE PROTECTION TESTING & CERTIFICATION

PASS / FAIL POINT AND PFP SYSTEM DESIGN

IT IS NOT ACCEPTABLE FOR A SUPPLIER OF PASSIVE FIRE PROTECTION TO SIMPLY SAY THAT THE QUOTED SOLUTION MEETS WITH THE REQUIREMENTS OF UL1709, ISO 22899-1 ETC.

A PFP system can pass a fire test but it should be noted that the test geometry and description in the certificate should cover the equipment being protected. For most items such as valves, actuators, flanges, controls, instrumentation etc, a corner joint and edge feature will be required, therefore an "Enclosure" will be required to protect the equipment. In addition to corner joints and edge features, other features that are required in the PFP design should also be tested and detailed such as access doors and ventilation grilles.

A PFP system can pass a fire test by keeping the sample below 400°C, but the equipment being protected may have reached its failure temperature and hence cannot operate as required in case of emergency. The failure temperature (or maximum permitted temperature) for actuators is usually between 70°C and 110°C (as advised by the OEM) and is much lower than the failure temperature for structural steel at 400°C. This basically means that a greater thickness of fire protection is required to keep an actuator below its failure temperature at the end of the test period, than is required for structural steel work

A PFP system should consider ambient conditions and operating temperatures and the start temperature or "Initial temperature" of the test should be noted. If a project ambient temperature or the process temperature is above the initial temperature detailed in the certificate or calculation, then the system will fail before the duration detailed. An example of this is as follows :

CERTIFICATE DETAILS

"Initial temperature" detailed in certificate = 20°C

Duration of certificate (test reached 400°C) = 60 minutes

Temperature rise or temperature range = 400°C - 20°C = 380°C

EXAMPLE PROJECT DETAILS

Maximum ambient temperature = 45°C

Maximum operating temperature = 100°C

Maximum allowable temperature of equipment = 250°C

Duration of PFP = 60 minutes

Temperature rise or temperature range = 250°C - 100°C (maximum operating temperature or maximum operating temperature, whichever is higher) = 150°C

In some cases, where a protected item does not have an operating temperature (actuator), but is connected to equipment that is operating above the project ambient temperature (valve), then an allowance for radiated heat and heat transfer should be made in the calculation.

A PFP system should be designed as per the test sample, replicating the construction and the fixing method, including the required pitch of the fixings.

PASSIVE FIRE PROTECTION TESTING & CERTIFICATION

WHEN SOURCING PASSIVE FIRE PROTECTION, PLEASE ASK THE FOLLOWING QUESTIONS:

- How is the thickness of the fire protection calculated?
 - For example, how is the difference between the starting temperatures of a project specification to that of any test starting temperature taken into account when calculating PFP thickness?
 - How the maximum allowable temperature is calculated and is this based on information from OEM's?
 - Is the final temperature detailed in the certificate below the maximum allowable temperature for the equipment against the required duration?
- What will be the temperature of the protected item at the end of the protection period?
- How does the mass and heated surface area of the equipment to be protected compare to that of the test sample?
- Will the supplied PFP be designed as per the test sample?

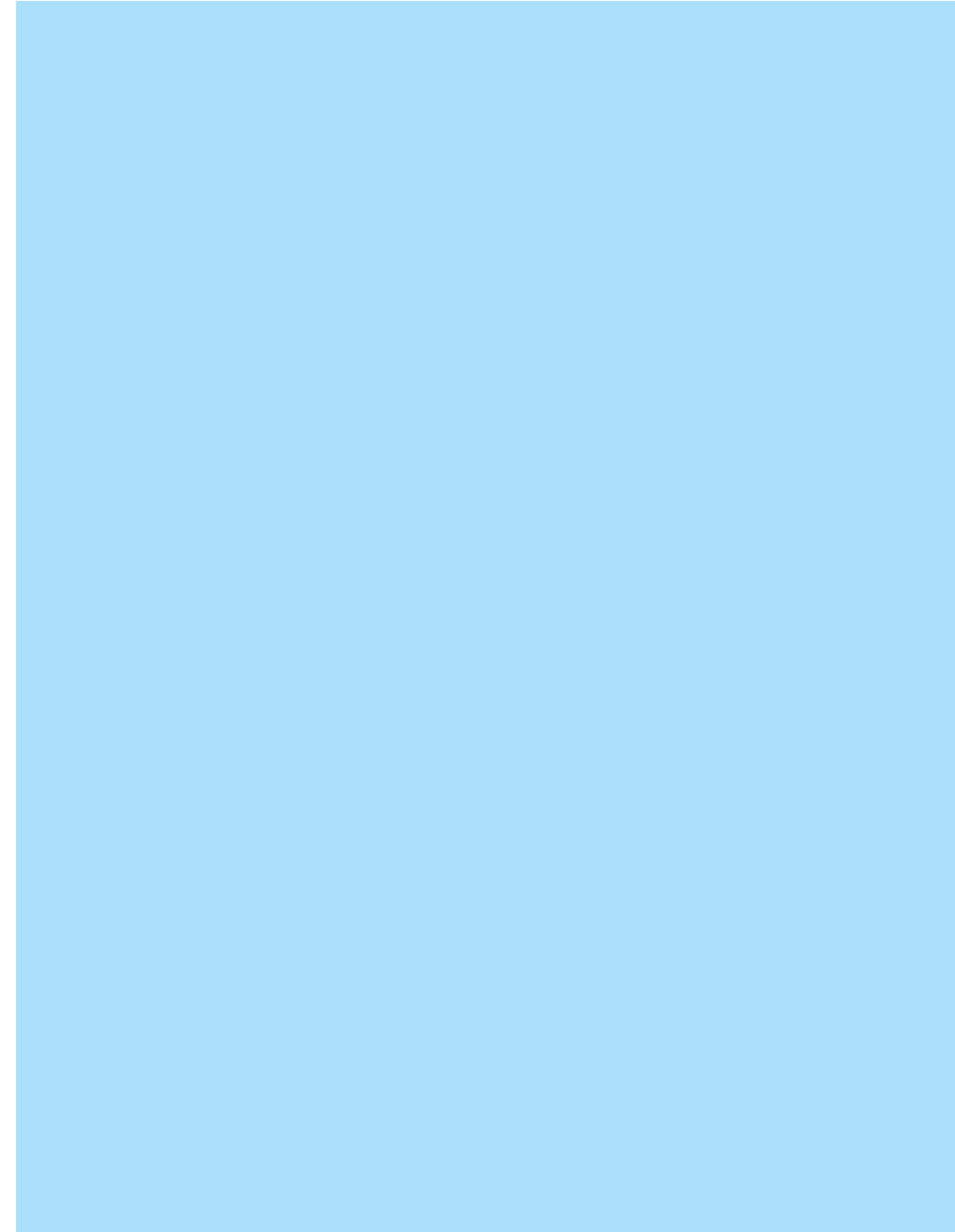
All of Darchem's fire protection solutions are designed and supplied as per the test that is detailed on the appropriate certificate. The thickness of Darchem's fire protection solutions is computer generated using a unique Lloyd's certified program, Offtranp, which determines the optimum insulation thickness for each bespoke fire scenario and equipment being protected. The Offtranp Thermal Transient program is:

- Fully certified by Lloyds Register and included within our Type Approval Certification
- Calculates the required thickness of fire protection
- Calculates the temperature of the equipment at the end of the protection period

A sample print-out of an Offtranp calculation for Jet Fire 60 minute protection required for a typical actuator can be seen in FIG. 2 opposite.

PASSIVE FIRE PROTECTION TESTING & CERTIFICATION

FIG. 2



This particular example of an Offtranp calculation shows that a 5 layer Jet Fire Darmatt system is necessary to ensure that the Temperature Rise of the actuator in question does not exceed failure (limiting) temperature. Ambient or Operating Temperature (whichever is higher) is considered as the start temperature and the Fail Temperature is based on the equipment manufacturer specifications. For example, actuator Fail Temperatures are usually between 70°C and 110°C depending on the seals and controls; whilst valves are usually around 200°C depending on process temperatures. For Pipe Work and Vessels a Fail Temperature of 400°C is often used, again depending on the process.

PASSIVE FIRE PROTECTION TESTING & CERTIFICATION

OTHER CRITICAL PARAMETERS CONSIDERED BY OFFTRANP INCLUDE:

- Fire scenario – Hydrocarbon Pool Fire or Hydrocarbon Jet-Fire
- Fire temperature – 1093°C or 1250°C
- Duration of fire – up to 180 minutes
- Size and mass of equipment
- Ambient temperature
- Operating temperature of the equipment
- Fail / Limiting temperature of the equipment

The difference between the Operating Temperature and the Fail Temperature is the Temperature Rise or Temperature Range and along with the other parameters is used to determine the PFP thickness. Since the software is approved by Lloyds Register, all calculations and resulting outputs are therefore approved and ensures the system design will be as necessary to meet customer fire protection specifications.

IMPORTANTLY

Offtranp demonstrates that 'one size does NOT fit all' and that a supplier cannot propose the same thickness PFP for different fire scenarios and equipment types!

TEST SAMPLE GEOMETRY

Test samples should represent as closely as possible the type of equipment to be protected as well as incorporating all parts that make up the complete PFP system. Unfortunately many test samples only represent the main body of the enclosure system (i.e. a panel section), but do not include fixing methods (belts'n'buckles or Velcro) or edge / corner features, access doors etc that would feature in actual installations. Test samples can be tubular sections of piping or flat plate depending on the type of test.

Darchem however ensure that for Hydrocarbon Pool Fire and Jet Fire conditions, the test samples include all features such as different joint configurations, access doors, ventilation and lacing to truly represent a PFP enclosure as actually installed in the field:

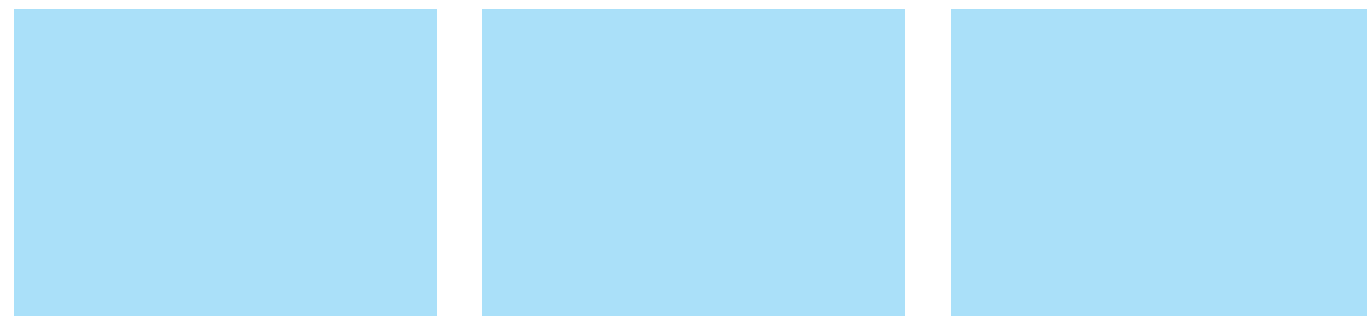


FIG. 3 – Before, during, and after a 180 minute Jet Fire Test – Flat Panel protected with Darmatt Jet Fire jackets - with corner and edge features, lacing and Darvent

PASSIVE FIRE PROTECTION TESTING & CERTIFICATION

FIG. 4 – Darmatt Furnace test for Hydrocarbon Pool Fire



FIG. 5 – Darshield Fire Test



TYPES OF FIRE TEST CERTIFICATE

There are 2 types of Fire Test Certificates: "Witnessed Fire Test Certificate", and "Certificate of Fire Approval or Type Approval Certificate".

A Witnessed Fire Test Certificate is applicable only to the exact situation tested. This means that if the exposed surface area, shape, weight or failure temperature is changed from that used during the test, the test certificate does not cover any other application other than the tested item. In some case a range of sizes may be covered in a certificate, but is still not applicable for equipment with irregular geometry and varying parameters.

A "Certificate of Fire Approval" or Type Approval Certificate" on the other hand is the testing of the design principles of a system, and the certificate is valid for any changes within the wording of the certificate.

- Unless the certificate states that it covers "Enclosures", then it is not valid for enclosures.
- Unless the certificate allows the thickness of the fire protection to be calculated, then the certificate is only valid for the thickness, starting temperature, and final temperature at the end of the test identified within the test report.

PASSIVE FIRE PROTECTION TESTING & CERTIFICATION

PASSIVE FIRE PROTECTION TESTING & CERTIFICATION

EXAMPLES

Please note FIGS. 6 & 7 that show text taken from a 'Lloyds Certificate for Structural Steel'. This is an example of a Type Approval Certificate for a system that does NOT allow for changes to the thickness or final temperatures away from the test standard, nor does it cover enclosures. It is really only suitable for jackets banded around tubular or structural steel sections, yet is still offered and even accepted as a certificate to cover PFP for valves and actuators.

Also condition 3 refers to a HP/A factor for calculating the material thickness. As this is generally used for structural steel work or cylindrical items, it does not consider any irregular shapes with a reduced mass, and hence further invalidates any design used for protection of flow control equipment.

Note that condition 3 in FIG. 7 advises that this system should not be considered for systems with 'corners or edge features', hence rendering the certification invalid for real-world scenarios, i.e. protection of ESD valves, actuators and either critical equipment.

FIG. 6

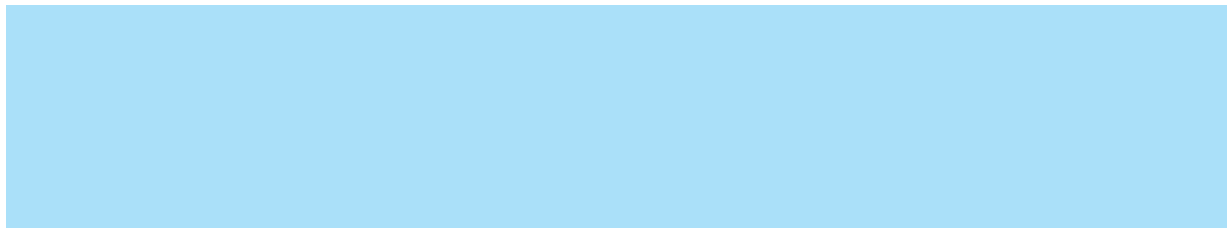


FIG. 7

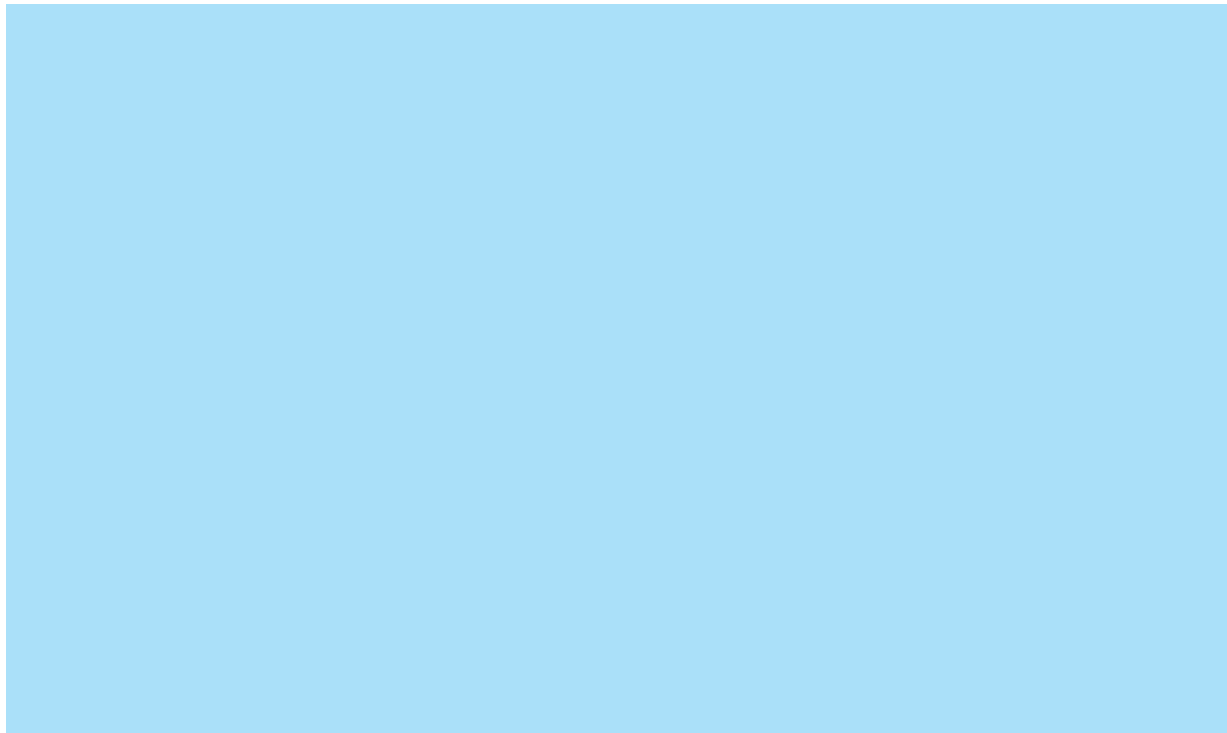
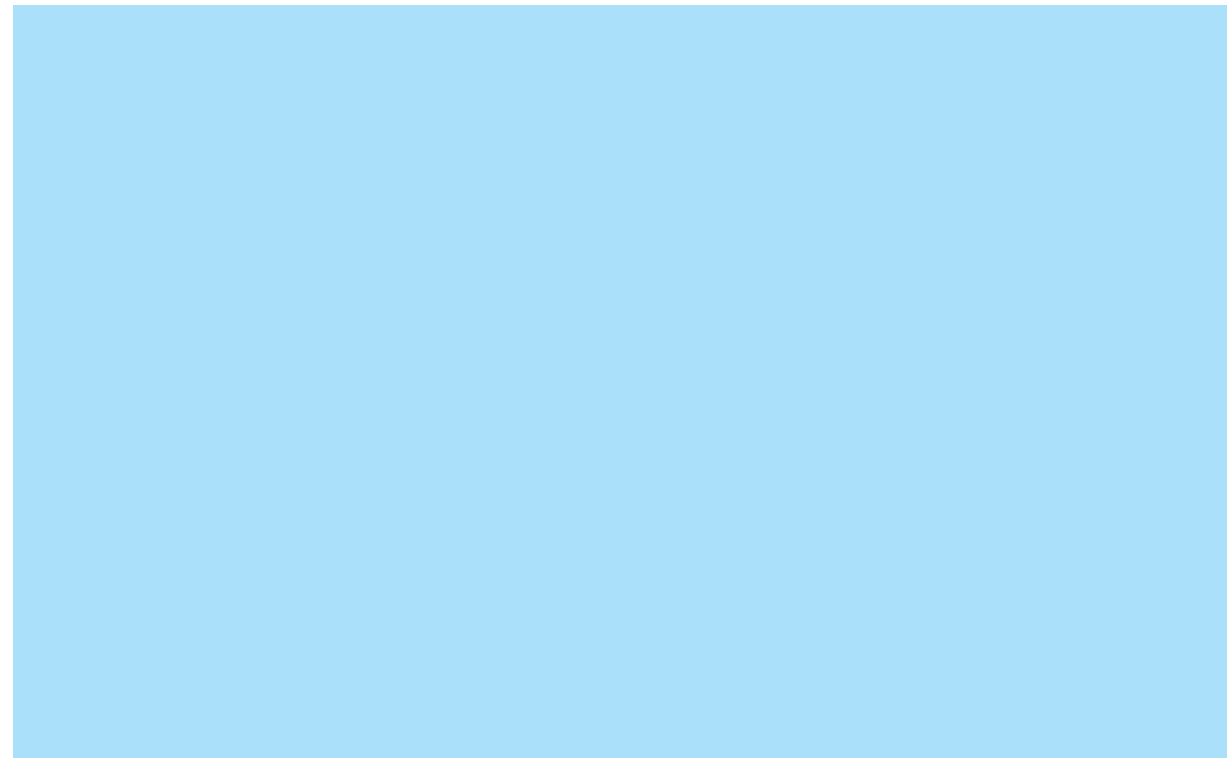


FIG. 8



FIG. 9



Now compare this with the wording from Darchem's Lloyds Type Approval certificate (FIGS. 8 & 9) which allows for changes in design, shape and final temperatures at the end of the test period through use of Darchem's own "Offtrap" programme (FIG. 6 Condition 2), and fully covers enclosures. It certifies both Hydrocarbon Pool Fire and Hydrocarbon Jet Fire for up to 180 minutes and includes a quick release access door.

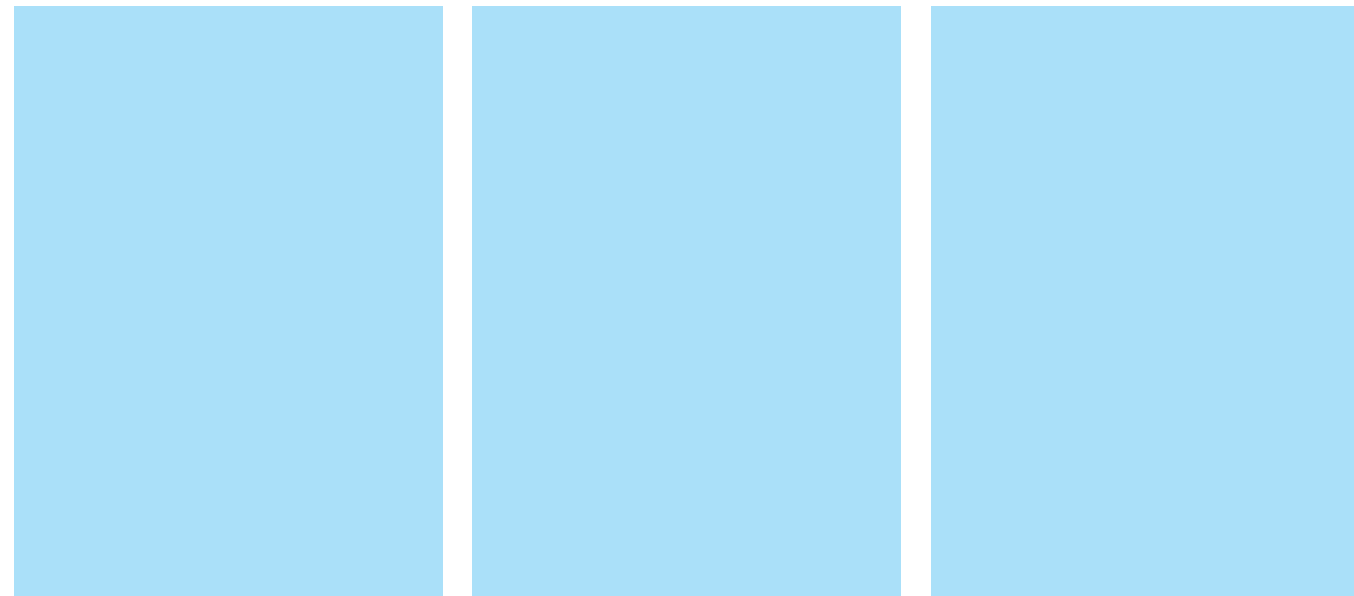
PASSIVE FIRE PROTECTION TESTING & CERTIFICATION

The Type Approval Certification achieved for both Darmatt and Darshield PFP enclosures, in conjunction with the use of the Offtranp program, means that for any solution provided by Darchem:

- It is valid for structural steelwork and enclosures
- The surface temperature of the protected equipment at the end of the specified fire period is calculated and certified
- The required thickness of the jackets is calculated and certified
- The protection period is calculated and certified

CERTIFICATES

Copies of Darchem's Lloyds Type Approval certification for Darmatt and Darshield PFP systems, as well as ISO9001:2008 Quality and ISO 14001:2004 Environmental certification can be downloaded from the Darchem website www.darchem.co.uk or are available on request at dtpsales@darchem.co.uk



PASSIVE FIRE PROTECTION TESTING & CERTIFICATION

SUMMARY

The critical importance of Passive Fire Protection performing to (or better than) the quality and safety levels required in engineering or HSE specifications is such that genuine and appropriate product certification should be issued by an accredited third party. The pressures of legislation and compliance mean that the in the event of a failure of the fire protection, it can be shown that all reasonable efforts have been made to ensure the quality of a certified product or system, and that it is 'fit-for-purpose' when installed correctly.

- Actual ambient or operating temperatures should be considered as start temperatures in the calculation and the test and test certificate should account for this.
- Actual fail temperatures detailed by the oem's should be considered in the calculation and the test and test certificate should account for this.
- The temperature rise or temperature range should be considered in the calculation and the test and test certificate should account for this.
- The geometry of the supplied pfp should be as per the test sample and for most removable items this is an enclosure that includes corner joints and edge features.
- Additional features used in pfp enclosures such as access doors and ventilation should be tested and covered in the certification
- Type approval certification for enclosures is necessary to ensure that the product is 'fit-for-purpose'.



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