

PASSIVE FIRE PROTECTION – TESTING & CERTIFICATION

When comparing Darchem's Darmatt and Darshield Passive Fire Protection solutions 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 equipments 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 remain below its failure temperature during the specified period.

Fire Scenarios

There are 2 main fire scenarios for testing. Hydrocarbon Pool Fire, the common standards being UL1709, 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 Jetfire Test Working Group whose members include major oil & gas operators as well as health & safety organisations) which has now been introduced as the basis of an international standard in the form of ISO22899-1).

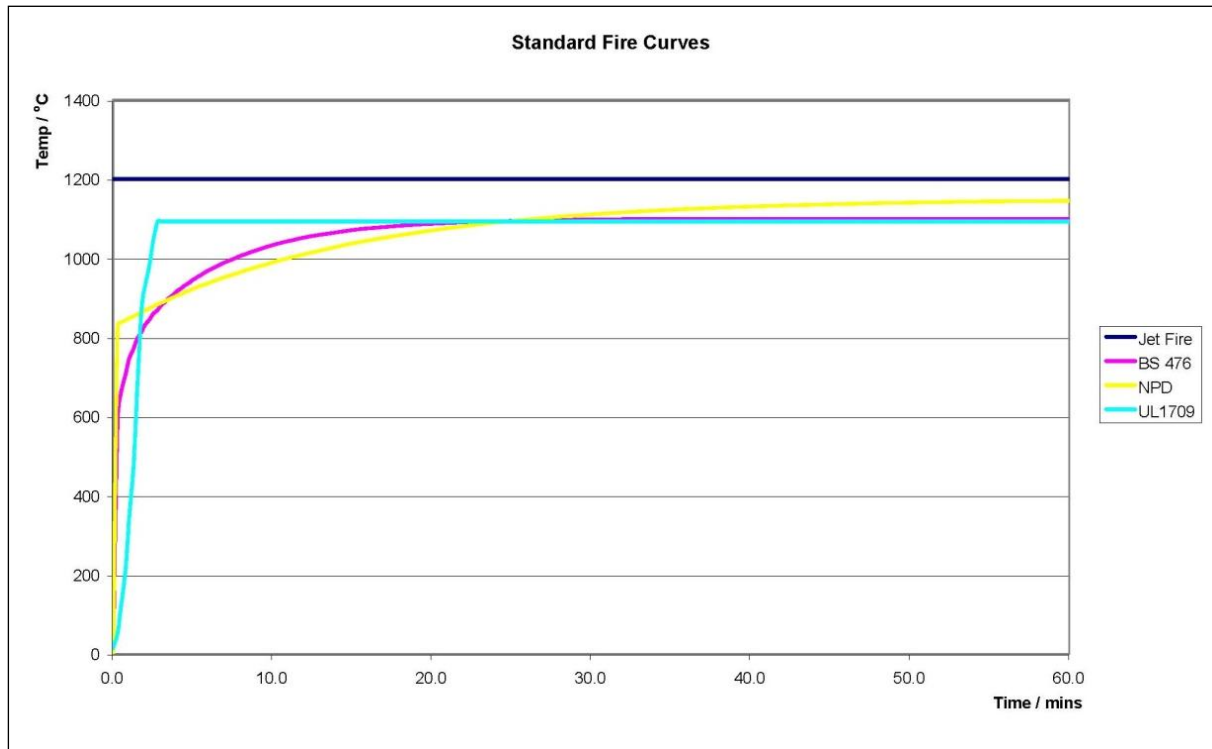
NOTE - It should be understood that all of these standards (UL1709, BS476Pt20 Amdt 6487, ISO1363-2, ISO22899-1 and OTI95-634) refer specifically to the testing of structural steel, and not specifically for flow or process equipments. There are a variety of pass/fail criteria's. UL1709 is for structural steel and therefore has a higher pass/fail temperature than BS476 Pt20 AMD 6487 or ISO1363-1 & 2. The Jetfire test OTI 95-634 records the temperature of a steel plate and takes note of the maximum temperatures during the test. 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 not exceeding 400°C. This standard also requires the system under test to form corner joints in addition to the usual planar feature.

The aforementioned 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

FIG. 1



Pass / Fail Point and PFP system design

It should not be 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 the equipment being protected will have reached its failure temperature and hence cannot operate as required in case of emergency. The failure temperature (or maximum permitted temperature) for actuators (usually a maximum of 110°C) 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.

When sourcing Passive Fire Protection, please ask the 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?**
- **What will be the temperature of the actuator at the end of the protection period?**
- **How can the length of protection be confirmed?**

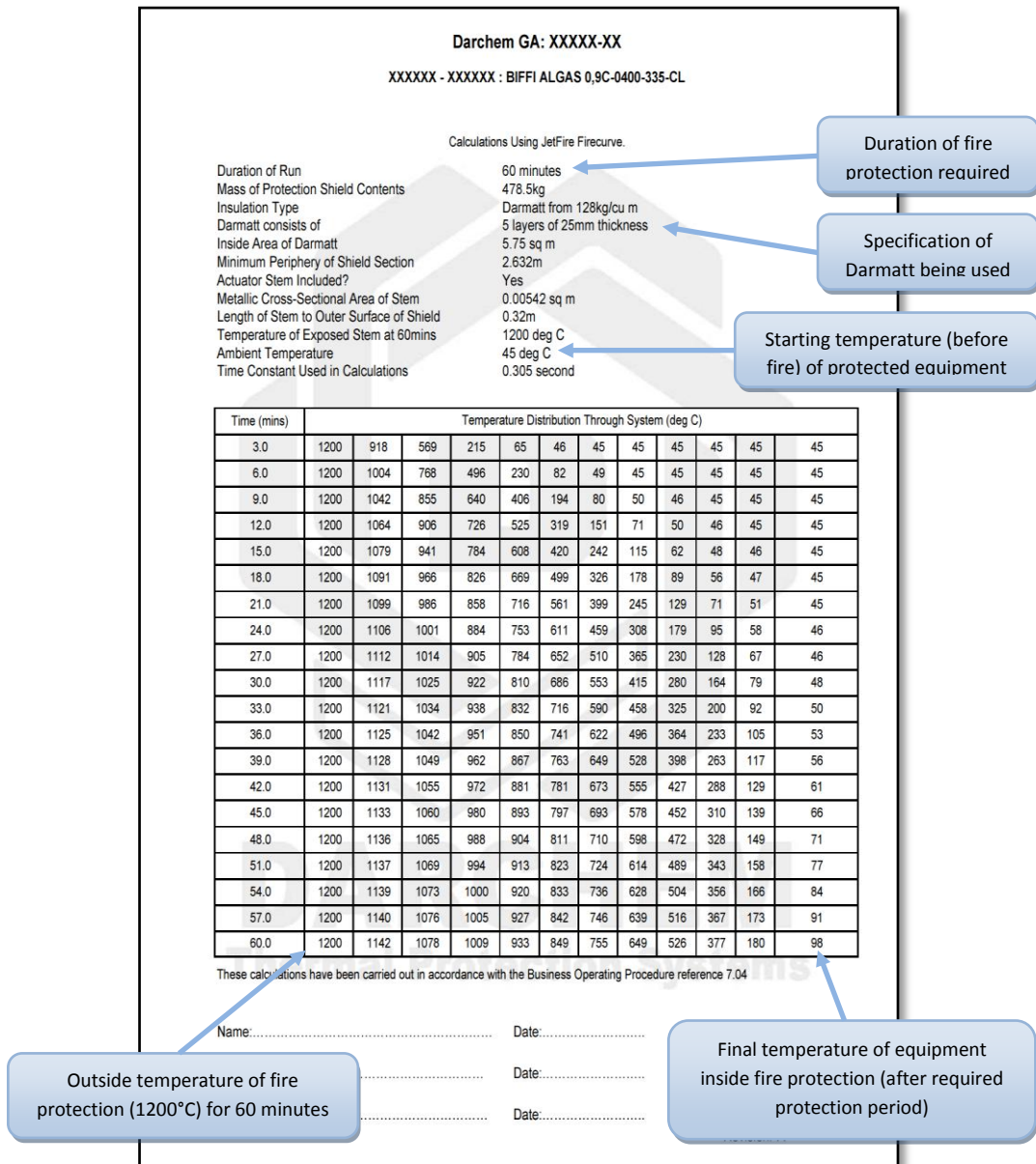
- How does the mass and heated surface area of the equipment to be protected compare to that of the test sample?

The design of Darchem’s fire protection solutions is computer generated using a unique Lloyd’s certified program, Offtranp, which determines the optimal insulation thickness for each 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 below.

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) 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.

Other critical parameters considered by Offtranp include:

- **Fire scenario**
- **Fire temperature**
- **Duration of fire**
- **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 and along with the other parameters to determine the Darmatt jacket thickness. Since the software is approved by Lloyds, all calculations and resulting output 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 that would feature in real-world installations. Test samples can be tubular sections of piping or flat plate.

Darchem however ensure that for Hydrocarbon Pool Fire and Jet Fire conditions, test samples include features (such as corner joints and lacing) to truly represent a PFP enclosure as actually installed in the field:

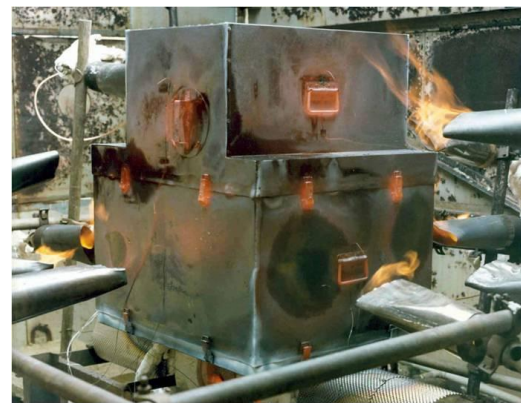
FIG. 3 – Before, during, and after a 180 minute Jet Fire Test – Flat Panel protected with Darmatt Jet Fire jackets - with corner and edge features, lacing and Darvent



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.

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.**

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 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.

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.

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

FIG. 6

Type	STRUCTURAL STEEL JET FIRE PROTECTION SYSTEM
Description	Planar Structural Steel, Cylinder Vessels, Pipe or Tubular Sections protected with [REDACTED]

FIG. 7

CONDITIONS OF CERTIFICATION

1. Applications to be based on two 120 minute jet fire exposure tests performed on a Tubular Section (Hp/248) and a Panel Specimen, both fitted with a flexible fire resistant insulation jacket (61mm total nominal thickness).
2. Suitable approved insulation is to be applied to any other part of the protected fire exposed surfaces not covered by the jacket, in all cases. In particular, attention is to be paid to means of securing jacket boundaries and the prevention of heat bridging; an overlap of at least 150mm should be provided between the two systems.
3. May be considered for applications on tubular sections, pipes or cylindrical vessels of any diameter, but not with corners or edge features (see OTI 95 634 Section 5.2) and not exceeding an Hp/A factor of 248. (Where 'Hp' is the outside circumference and 'A' is the cross-sectional area)
4. Applications in each case to be approved by Lloyd's Register at the design stage.
5. Production items are to be manufactured in accordance with a quality control system which shall be maintained to ensure that items are of the same standard as the approved prototype.

NOTE

No additional hydrocarbon fire tests were submitted by the manufacturer to demonstrate the relationship between hydrocarbon and jet fire test results, to enable variations in time/temperature criteria, jacket thickness or Hp/A values to be assessed.

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 "Offfranp" programme (FIG. 6 Condition 2), and fully covers enclosures.

FIG. 8

CERTIFICATE OF FIRE APPROVAL	
This is to certify that	
The product(s) detailed below will be accepted for compliance with the applicable Lloyd's Register Rules and Regulations for use on offshore installations classed with Lloyd's Register, and for use on offshore installations when authorised by contracting governments to issue the relevant certificates, licences, permits etc.	
Manufacturer	Darchem Engineering Limited
Address	Ironmasters Way Stillington Stockton-on-Tees Cleveland, TS21 1LB United Kingdom (UK)
Type	FIRE PROTECTION ENCLOSURE SYSTEM
Equipment Description	Fire Resisting Enclosure System – Type: "DARMATT FIRE PROTECTION WRAPS" for Hydrocarbon and Jet Fire Exposures
Specified Standard	British Standard BS 476: Part 20, EN 1363-2, UL 1709 (Hydrocarbon Fire Exposures) and AMD 6487, Health & Safety Executive, Offshore Technology Report – OTI 95 634 "Jet Fire Resistance Test of Passive Fire Protection Materials"

FIG. 9

CONDITIONS OF CERTIFICATION	
1.	"Darmatt Fire Protection Wraps" for hydrocarbon fire exposures consists of various layers of "Insulfrax" insulation encapsulated into a flexible weatherproof jacket. All joints to be secured by stainless steel wire lacing through the full jacket thickness. For jet fire exposures the external facings have an additional layer of stainless steel mesh and either an overlap joint or cover strip 300mm wide of the same jacket material is secured by stainless steel wire over all joints and through the full jacket thickness.
2.	Thermal Insulation thickness and density is to be determined by Darchem Engineering Limited using their computer program "Offfranp" and a print-out of the computer calculations used to complete the thermal insulation thickness are to be submitted for approval at the design stage. For Jet Fire exposures the program is to be based on the maximum temperatures derived from jet fire tests described in the Appendix to this certificate.
3.	Suitable insulation arrangements for any other part of the protected fire exposed surfaces not covered by the jacket are to be approved by Lloyd's Register, in all cases. In particular, attention is to be paid to means of securing jacket boundaries and the prevention of heat bridging; an overlap of at least 150mm should be provided between the two systems.
4.	Drawings for each enclosure are to be submitted to Lloyd's Register for approval at the design stage.
5.	Production items are to be manufactured in accordance with a quality control system which shall be maintained to ensure that items are of the same standard as the approved prototype.

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



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 is provided that is issued by an accredited third party. The pressures of legislation and compliance mean that 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.

**TYPE APPROVAL CERTIFICATION FOR ENCLOSURES IS NECESSARY
TO ENSURE THAT THE PRODUCT IS 'FIT-FOR-PURPOSE'.**

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