InterDam

Blast ratings

For fire and blast protective products

Index

Introduction to blast registant design

Blast resistant design, or the structural strengthening of buildings, is one of the measures an owner may employ to minimize the risk to people and facilities from the hazards of accidental explosions in a plant.In on- and offshore oil and gas facilities many potentially dangerous fuels, such as hydrocarbons, are handled. These fuels may produce accidental fire outbreaks and explosions.

Although such incidents are rare, the consequences can have severe impact on the building, personnel and even public safety. The probability of accidental fire outbreaks and explosions is taken into consideration in the design of petrochemical facilities and offshore platforms, to mitigate the risks. In the past, a number of explosions have taken place at oil & gas facilities. Strict standards have been developed over the years for blast resistant design and are still being used today. On the 1st of December 2016, a huge explosion followed by a fire occurred at one of the largest oil refineries in Italy, in the south of Milan, of which the consequences to public health are still begin assessed.

Another notable explosion incident occurred on the Deepwater Horizon in the Gulf of Mexico in 2010. The explosion and subsequent fire resulted in the sinking of the Deepwater Horizon and the deaths of 11 workers; 17 others were injured. The same blowout that caused the explosion also caused a massive offshore oil spill in the Gulf of Mexico, which is considered to be the largest accidental marine oil spill in the world, and the largest environmental disaster in U.S. history. These examples once again emphasize the needs for designing structures to withstand explosions in order to protect people.The blast wave overpressure is usually the most damaging aspect of an accidental explosion. When air bust effects are added to this, incidents such as fires, projectile and ground transmitted shocks may occur which also can damage the structure.Due to historical explosion accidents, blast resistant design rules and regulation have evolved to more stringent specifications. 3Blast ratings for fire and blast protective products

Blast resistant design objectives

According to the ASCE standard (www.asce.org), which provides guidance in blast resistant design, the primary objectives for providing blast resistant design for buildings are

- Personnel safety;
- Controlled shutdown:
- Financial consideration.

Personnel safety

Just like fire resistant design, blast resistant design should in any event provide safety for the people inside the structure. Past incidents have shown that many deaths or injuries were caused by the collapse of the building onto people inside the facility. Architectural envelopes should therefore keep their function during severe events for a predetermined period.

Controlled shutdown

Explosions or fires should not result in the closure of the entire operation of the facility. An incident in one area or unit should have a minimum effect on operations in other units. By assessing the potential risk of each unit separately one can apply blast resistant product such as walls, doors and windows to each area specifically. This is also known as compartmentalization and is very important in securing the safety of people within oil & gas production facilities. This type of design also allows for proper and safe evacuation when necessary. And provides a time window to shut down operations and minimize consequential damage.

Financial consideration

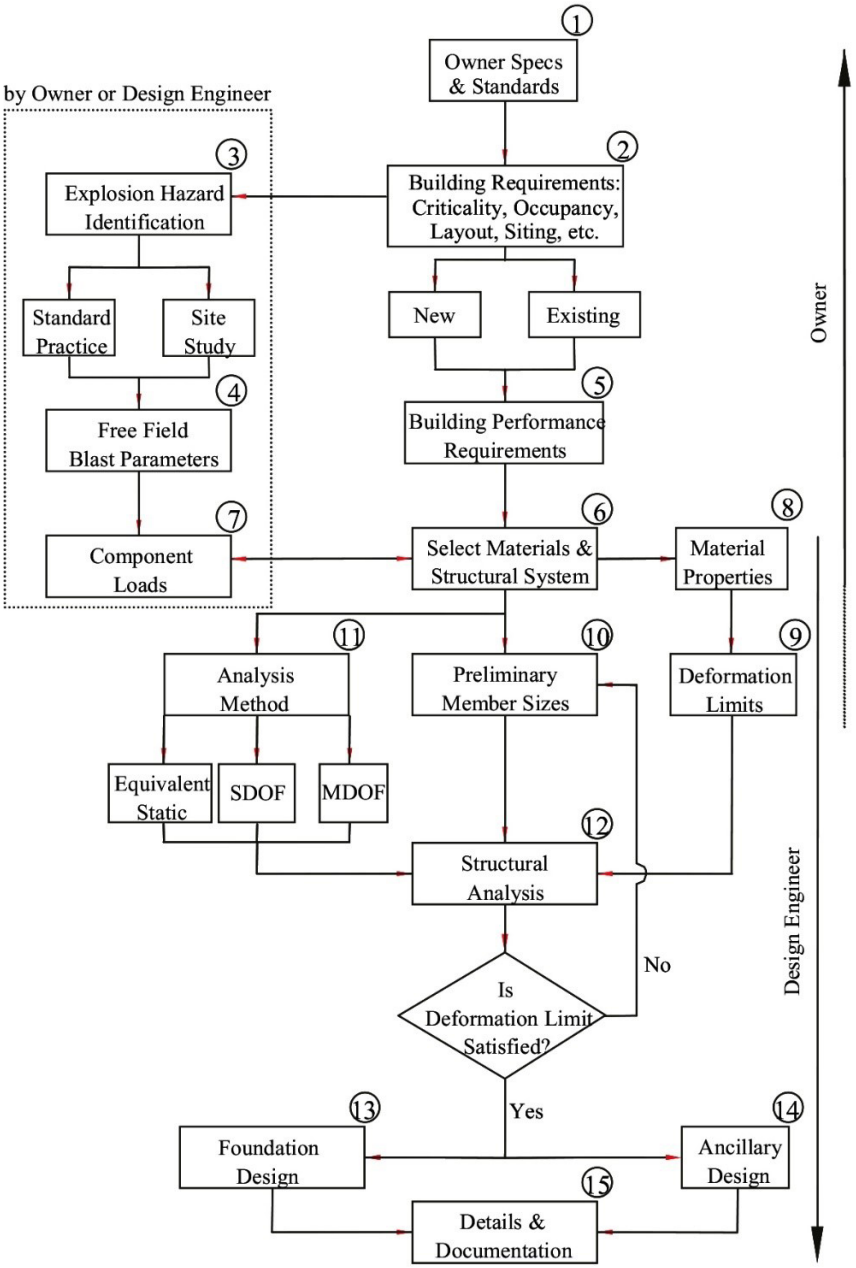
Explosions also pose danger to material and critical or essential equipment. Therefore, the final objective for blast resistant design is preventing or minimizing financial losses. The project owner should therefore always be aware of the potential risks the structure is facing and whether these risks can be mitigated by blast resistant design.

Blast resistant design can vary considerable in complexity, accuracy, cost and efficiency. During the design phase of the structure it is of key importance to address all these aspects of blast design and finalize the project accordingly. A good structural design protects equipment and personnel against a blast and fire event in an optimal form.

Blast resistant design process

Once it is decided that blast resistant design is necessary for a specific project, the next step is the design process. The ASCE standard " Design of blast-resistant building in petrochemical facilities" has outlined 15 steps in this process. Although specified for petrochemical facilities, these steps can be applied on structures, such as offshore oil and gas platforms, as well.

Steps 1 to 5 should be followed by the project owner and step 6 to 15 by the design engineer.



The characteristics of an explosion

Explosions are described in characteristics, such as blast wave type, blast overpressure, duration and impulse.

The severity of a blast is determined by the blast wave, which is created by the sudden release of energy of an explosion. This energy is then propagated in all directions from the source. There are several types of blast waves distinguishable, based on the characteristics of the blast. Shock wave and Pressure wave are the most common in oil and gas industry

1. Shock wave: This blast wave type suddenly and almost instantaneously rises in pressure to a peak overpressure, which causes the structure to undergo a pressure which is in the “worst case” 2 times higher than the maximum overpressure.

2. Pressure wave: This blast wave type rises gradually to a peak overpressure, and consequently decreases gradually.

The architectural outfitting of a structure is to be designed according to these parameters in order to provide the right level of protection.

Deepwater Horizon fire following an explosion, Getty Images

Blast resistanct products

Blast resistant walls, doors and windows are tested and analyzed according to stringent rules and regulations according to the required level of protection. In general, the analyses are based on the following standard

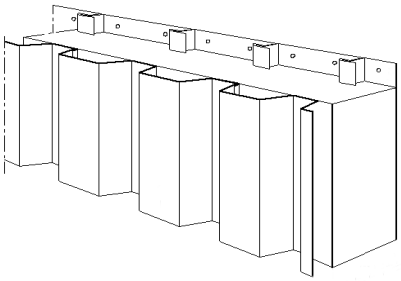
- Design Guide for Stainless Steel Blast Walls, Technical Note 5, (FABIG)
- Design of Blast-Resistant Buildings in Petrochemical Facilities (ASCE)
- Blast resistant Building Design Criteria, Process Industry Practices (PIP)
- API Recommended Practice 2A-WSD (RP 2A-WSD)

In order to perform a blast analysis it's important that all required blast parameters are defined. If these parameters are not known, the following most common values are used:

- Dynamic load (instead of static equivalent load)
- Pressure wave (maximum DLF of 1.5)
- Ductility ratio of 1
- Isosceles blast wave shape
- Blast duration of 200 ms

Walls

Blast resistant walls are part of structures which may be exposed to (hydrocarbon) explosions. It is required that these walls retain their integrity during such events to protect personnel and critical equipment within and outside the structure.Currently the lower range blast wall are constructed from sandwich panels and the higher range walls are generally build up from corrugated welded walls, due to their excellent mechanical properties against blast loading.



A comparison based on CAPEX of 4 types of blast walls is made in this table.

They also provide good fire and corrosion resistance properties. Blast resistant walls can be constructed of mild steel, stainless steel or duplex, according to the specific requirements of the project.

For a lightweight design of corrugated blast walls, the following control parameters are used:

- Total wall thickness
- Thermal insulation value
- Fire resistance
- Material typewith respect to durability
- Plasticity (energy absorption)

One of the most critical design parameters, is the wall deflection limit. Strict requirements apply to the deflection of blast walls, to prevent the damage of equipment.7Blast ratings for fire and blast protective products.

Doors

Generally, doors are the largest opening into a building. Consequently, they provide the largest potential source of blast wave propagation when the structural integrity of the door is compromised. In order to prevent blast doors from failure to operate, doors need to comply with the project specified, blast load, allowable damage, and operability requirements.

As per FABIG newsletter Issue 72, January 2018: categorization of blast and fire rated doors. Blast resistant doors should be able to withstand a high pressure shock wave of short duration. Therefore, ductile materials (e.g. Stainless Steel) are used and the doors are certifiably tested to maintain their structural integrity. The structural integrity of the door can be controlled with the main components, i.e. the number of hinges and shoot bolts, type of hardware and material thickness. Each component of the door is designed to comply with the specified blast requirements.

The purpose of the blast doors will be defined at the project's design stage. For instance, the type of protection required should be specified, as well as whether the door(s) should remain operational after a blast event or not. All the specifications should be mentioned in the door schedule.

According to ASCE Design of Blast Resistant Buildings in Petrochemical Facilities, based on the desired end-use of the door, guidelines for acceptance have been classified into four categories

Category I - After a blast event the door should be operable and the pre-established design criteria for stress, deflection, and the limitation of permanent deformation should not be exceeded. The specified ductility ratio (elastic range) should be 1.0 or less and the door edge rotation should be not exceed 1.2 degrees. The door(s) should be designed according to this category when there is a possibility of repeated blasts or when entrapment of personnel is of concern and the door is a primary exit of the building.

Category II - Similar to Category I, for this Category the door should remain operable after a blast event. Yet, significant permanent deformation to the door is permitted. The allowable ductility ratio is in the range of 2 – 3 and the allowable edge rotation is to be less/equal than 2.0 degrees. Doors designed according to this Category should remain operable to prevent entrapment of personnel

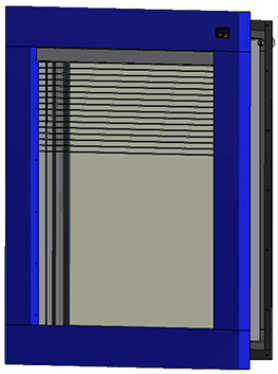
Category III - Non-catastrophic failure of the door is allowed, however the door assembly should remain in the opening. No major structural failure of door panel, restraining hardware system and frame is permitted. The allowed ductility ratio is in the range of 5 to 10 and the edge rotation is not to exceed 8 degrees. This category should only be specified when entrapment of personnel is not a possibility.

Category IV - Outward rebound force and resulting hardware failure is acceptable.

Category I doors are deemed to keep their fire resistant properties after a blast event. If Category II doors are required to be fire resistant after a blast event this should be proven by a representative fire test following a blast test as per As per FABIG newsletter Issue 72, January 2018: categorization of blast and fire rated doors

Category	Door Condition after Blast	Panels	Ductility Limit	Edge Rotation (deg)	Door Function
I	Operable	Elastic	1.0	1.2	Primary Exit or Repeated Blasts
II	Operable	Significant Damage	3	2	Prevent Entrapment
III	Inoperable	Substantial Damage	10	8	Prevent Blast from Entering Building
IV	Inoperable	Failure in Rebound	20	12	Prevent Door from Becoming Debris Hazard

Windows



Windows are not recommended to be installed in walls where fire and blast risks involved. However, when windows are required, the design should be in line with the blast (and fire) loads of the walls and doors.

The total window structure should properly tested and certified according to the project specifications and the glass packeage should be able to cope with all requirement at the appropriate time. The main cost driver of higher range blast proof windows is the size of the window as the total pressure caused by an explosion will be transferred from the glass pane to the window frame. Different layers can and will be used for different specifications.

For example: a Fire-Post-Blast resistant window, for arctic use, so with a proper thermal insulation value, no splinters allowed will require a pane that is build up of – external layer of toughened glass to absorb the specified explosion – spacing filled with a thermal insulating gas to reach the required U value – Fire resistant layered glass to reach the required fire resistance – anti-splinter foil on the inside of the internal layer. If required blinds could be added or heat tracing etcetera.

About InterDam

InterDam creates the safest area possible for people and equipment working in hazardous environments. We are a market leader in our field due to our innovative character and offer a broad and complete portfolio of fire and blast architectural products. We set new standards and raise our shield for fire-post-blast protection. Your shield in the field.

We innovate and can define new standards. We can offer a wide scope of solutions to our clients and become the best certified partner with the most up-to-date and fit-for-purpose solutions available in the industry. At the same time, we build a true leader in the field worldwide. InterDam presents you the pros in protection. We will not settle for anything less.

Our field

Protecting priceless human lives and saving essential resources and capital property with our fire and blast resistant doors, walls, windows and cladding. We optimize choice of welded, built-up or sandwich panels for people's safety. This expertise has become indispensable for areas where shielding is key.

Our products protect people and assets at offshore wind substations, LNG and petrochemical installations, offshore oil and gas platforms, at defense ships and installations and at infrastructural objects. In our production and delivery process we cover the total scope: from setting new standards, to production, to installing, to maintenance and repair.

Our shields

We join forces and can now offer the broadest and most complete portfolio of fire and blast architectural products in the entire world.

Walls – Generation II, Generation III, Generation IV (G21)
Doors – Medium duty and heavy duty, single hinged, double hinged, sliding and specials, heavy duty, gas and watertight
Windows – Fire-post-blast resistant (G21)
Cladding – Heatshield, windshield, explosion relief
Roofs – Generation IV (G21)
Transportable prefabricated buildings – Road transportable dedicated fire-post-blast resistant units.

Services

As InterDam we offer a wide range of services to our clients. Not only 24/7 maintenance and repair, but also installation support, upgrades, refurbishment, replacement, supervision, quality inspections, surveys, spare parts, EPC and turn-key execution, offshore and voyage repairs. So either onshore, at a yard, quayside or offshore, our clients rely on us to keep their shields up.

Location

The heart of the office is located in Ridderkerk, The Netherlands, where the global production and sales network is being managed and maintained. A genuine project organization where all departments contribute to the successful completion of a quest: to provide protection and shield from harm.

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