

GENERAL SPECIFICATION

HVAC

GS EP HVA 204

Anti-Blast Damper(s)

03	10/08	Let-through updated – Position after explosion
02	10/05	General Updating – Addition of "EP" root to GS identification
01	10/04	General Updating
00	12/03	First issue
Rev.	Date	Notes

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1. Scope

This specification indicates the minimum requirements for the design and construction of anti-blast Heating, Ventilation and Air Conditioning (*HVAC*) systems.

This specification shall be used by the *HVAC* Engineer or the Project Engineer of a *CONTRACTOR* who designs an anti-blast *HVAC* system for a building.

This specification addresses the following points:

- The recommendations for defining blast dampers,
- The recommendations regarding the technology of the blast dampers and the pipe/cable penetration sleeves to be selected,
- The recommendations for equipment installed downstream of the blast dampers in order to control the overpressure from the let-through blast wave.

This general specification may be modified or supplemented by particular project specifications.

The words and expressions in capital characters are defined inside the general specification **GS EP HVA 801**.

When other words require a definition only for using within that document, the definition is given in a paragraph of that document and the defined word is marked in small and *italic* letters.

2. Reference documents

The reference documents listed below form an integral part of this General Specification. Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and supplements, is the latest revision published at the **EFFECTIVE DATE** of the **CONTRACT**.

Equipment and installations must be in accordance with (in order of precedence):

1. The country local regulations where equipment and/or installations shall be operated
2. Total General Specifications as listed in **GS EP HVA 000**
3. The International Standards
4. The French Regulation (when Country local regulation does not exist).

Notes:

- In case of discrepancy between documents the more stringent requirements shall apply.
- The *HVAC VENDOR* or *CONTRACTOR* may propose proven improvements to the reference documents but shall obtain written approval of the *COMPANY* prior to implementation.
- An International Standard is a good "engineering practice" which shall be recognised and taken into consideration by *VENDOR*, *SUPPLIER*, *MANUFACTURER* and / or *CONTRACTOR*. If required, the translation of the standards must be included into *HVAC* scope.
- The latest revision of Standards, codes, regulations and the published errata if any must be used and applied by *VENDOR*, *SUPPLIER*, *MANUFACTURER* and *CONTRACTOR*.

Standards

Reference	Title
EN 1886	Ventilation for buildings. Air handling units. Mechanical performance.

Professional Documents

Reference	Title
ADC	Air Diffusion Institute (All documents)
AFI	American Filtering Institute (All documents)
AGA	American Gas Association (All documents)
AICVF Codes	Association des Ingénieurs de Chauffage, Ventilation Français (All codes)
AMCA	Air Moving and Conditioning Institute (All document)
ASHRAE	American Society of Heating, Refrigeration and Air Conditioning Engineers (All documents)
SMACNA	Sheet Metal and Air Conditioning CONTRACTORS' National Association (All documents)

Regulations

Reference	Title
Not applicable	

Codes

Statutory by law or recognised professional body approved by COMPANY.

Reference	Title
Not applicable	

Other documents

Reference	Title
W. E. Baker	Explosions Hazards and Evaluation, Elsevier Science (1983).

Total General Specifications

Reference	Title
GS EP HVA 000	List of HVAC specifications (all applicable)

3. Definition of terms

The following expressions are used in this specification or may appear in the context of projects involving blast proofing requirements.

Blast Wave: A blast wave can be defined as the air wave set in motion by an explosion. The most significant feature of an explosion is the sudden release of energy to the atmosphere which results in a pressure transient, or a blast wave. The blast wave propagates outwards in all directions of the source at supersonic or sonic speeds. The magnitude or shape of the blast wave depends on the nature of the energy released and on the distance from the explosion epicentre. The characteristic shapes are shown in Figure 1. The two types of blast wave are:

- a) **Shock Wave:** A shock wave propagates at supersonic velocity relative to the gas immediately ahead of the shock and is denoted by a sudden, almost instantaneous rise in pressure above ambient atmospheric conditions to a peak free field (side-on or incident) overpressure. This side-on overpressure gradually returns to ambient with some highly damped pressure oscillations. This results in a negative pressure wave following the positive phase of the blast wave.
- b) **Pressure Wave:** A pressure wave propagates at sonic velocity and has a gradual pressure rise to the peak side-on overpressure followed by gradual pressure decay and a negative phase similar to that for a shock wave.

Shock waves in the near and far fields usually result from strong explosions such as from condensed phase detonations or extremely energetic vapour cloud explosion. Most vapour cloud deflagrations will give rise to pressure waves in the near field which may propagate as a shock wave, or "shock-up" in the far field.

Blast Load: The load (or force) exerted on an object when the outward pressure of an explosion strikes it and moves around it. It results from both the static and dynamic pressures.

Blast Wave Front (shock or pressure wave front): The boundary between the pressure disturbance created by an explosion and the ambient medium.

Blast Waves Reflection: The usual case of loading of large, flat surfaces such as building walls is represented by waves that strike at oblique angles of incidence, rather than normal. Also blast waves originating from sources distant from the ground and reflecting from the ground, the angle of incidence must change from normal to oblique. The effect of this blast wave reflection is that the surface will experience a pressure much more than the incident side-on value. The magnitude of the reflected pressure is usually determined as an amplifying ratio of the incident pressure i.e. a reflection coefficient. The reflection coefficient depends on peak overpressure, the angle of incidence of the wave front relative to the reflecting surface, and the type of blast wave.

Pressures: The terms pressure and overpressure are generally used to describe the physical phenomena relating to blast waves. These terms may apply to static as well as dynamic effects. Overpressure is generally understood to mean an increase in pressure above the normal ambient atmospheric pressure. Such a pressure increase always comprises of a positive phase and a negative phase. For blast waves, the terms side-on (incident) and reflected (applied) pressures are also used. The side-on pressure is measured perpendicular to the wave and is the static pressure behind the wave. The reflected pressure is measured when the wave hits an object, such as a wall head-on.

Impulse: The time period that the blast wave's positive overpressure occurs for is referred to as the positive phase duration, or simply duration. The area under the pressure-time curve is usually referred to as impulse per unit area or specific impulse.

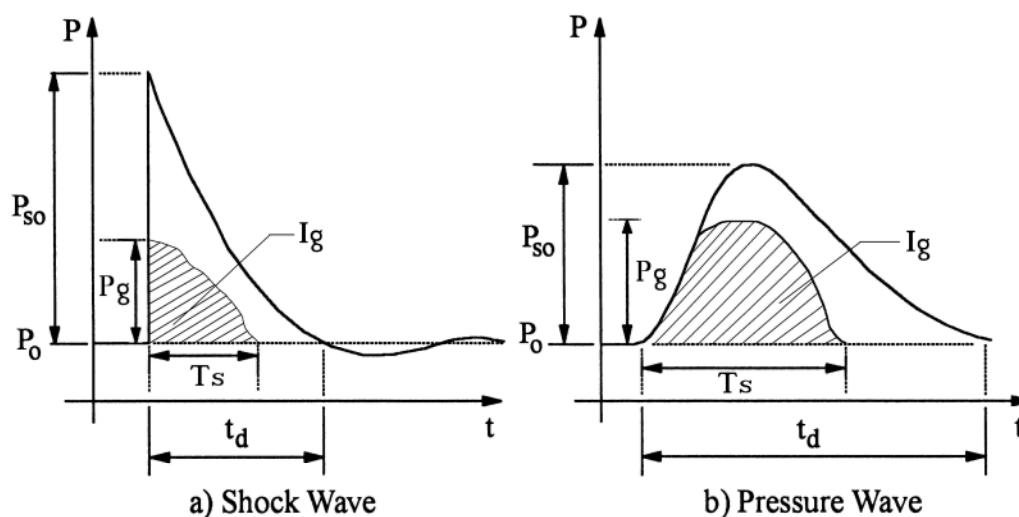


Figure 1. Characteristic Shapes of Blast Waves

Symbols:

P: Pressure

t: time

P_{so}: Maximum Reflected Pressure of the Blast Wave

P₀: Ambient Atmospheric Pressure

t_d: Positive Duration of Overpressure

P_g: Maximum Let-through Pressure of Blast Wave

T_s: Valve closing time

I_g: Let-through Impulse per unit area (specific impulse) of Blast Wave

For estimating purposes, the following approximations can be used:

$$1 \text{ atm} = 1 \text{ kg/cm}^2 = 10 \text{ Nm}^2 \text{ (Pa)} = 1 \text{ bar}$$

$$1 \text{ kg/cm}^2 = 1.10^4 \text{ kg/m}^2 \text{ or } 1 \text{ kg/m}^2 = 1.10^{-4} \text{ kg/cm}^2$$

4. Building blast proofing

In case of an explosion occurring in an installation, all the buildings or specific sections of buildings (like control room, laboratory, platform area, electrical substation etc) would be subjected to the resultant mechanical effects.

The design and construction of the building mechanical structures shall ensure:

- Occupants' survival,
- Continuation of the specific activities carried out in these structures.

The following items must be taken into account in the preliminary design:

- The energy and duration of the anticipated explosions,
- The minimum distances from the centre of the potential explosion,
- The purpose, use, value and content of the building,
- The level of protection sought or needed.

During an explosion, a blast wave propagates and the mechanical effect of a blast wave induces:

- An immediate increase in static pressure (static overpressure),
- An immediate increase in dynamic pressure (dynamic overpressure),
- Drag (or thrust) effects and changes in density (reflection-impulse).

The classification of anti-blast protection can cover the range of blast wave reflection overpressures, durations and therefore impulses per unit area. The range of reflected blast wave overpressures and durations depend on the nature of the energy released and the distance from the explosion epicentre. Overpressures could range between 0.1 to 50 bars (and more) and overpressure durations could range between milliseconds to tenths of a second. Strong explosions such as condensed phase detonations or extremely energetic vapour cloud explosion depending on distance will have high overpressures yet shorter overpressure durations in comparison to lesser explosions such as vapour cloud deflagrations that give rise to smaller blast wave overpressures, yet longer durations.

In some scenarios, although usually infrequent, repeated explosions could be conceived where the total duration could last more than a second. From a structural point of view, repeated explosions to the protective device or the object being protected could be deemed to be structurally separate events. A consequence and risk analysis of each explosion scenario should be conducted as well as a structural analysis of the buildings and structural components involved.

For HVAC installations, it is necessary to protect all the openings in structures against penetration by predicted blast waves. This protection is provided in the form of (anti-) blast dampers. The degree of protection provided by these dampers must match the building's degree of protection. It would be deemed to be bad practice installing anti-blast devices to protect against overpressures in excess of the buildings structural capacity.

Anti-blast dampers are designed to eliminate the damaging effects of the blast wave inside the building and to ensure that the ventilating capacity will not be affected. They shall protect the

internal systems and people against high and low overpressure loads, of both short and long duration.

5. Anti-blast dampers

Any opening is always a vulnerable part of a structure. It is essential that the number and size of openings are reduced to a minimum to limit the total exposure risk.

Closure of a blast damper fitted with moving parts shall be automatic. It shall take place in response to the blast wave alone without use of a detector or electrical contacts. A small fraction of the wave, (or a "let-through overpressure (P_g) and impulse per unit area (I_g)"), will pass through the damper before the damper fully closes. Ideally the closing time shall be short in comparison to the overpressure duration of the blast wave¹, the let-through overpressure and impulse per unit area shall be small in magnitude and shall not be harmful to people and/or equipment located inside the premises. For each type of damper used, on the basis of the data provided by the engineering contractor, the damper *MANUFACTURER* shall derive and specify the let-through overpressure and impulse per unit area and closing time values for the range of events it is designed to protect against. Whenever possible such let-through overpressures and impulses per unit area shall be withstood by persons and/or equipment placed very close to the blast damper. The dampers shall remain closed after the blast event and be re-opened manually.

Duration of the let-through impulse shall not exceed 30 ms (milliseconds). The overpressure (P_g) resulting from the let-through impulses, behind the damper, must never exceed 30 000² Pa (0,30 bar). It may be necessary to add a decompression plenum placed behind the anti-blast damper(s) to reduce the overpressure to this value or less.

All the blast dampers shall be designed and tested to withstand a minimum of six consecutive blast loads with no measured degradation of their performances. For these consecutive tests, the time taken to re-open must also be measured and the worst case scenario re-opening time must be quoted by the *MANUFACTURER* if they are self re-opening. They can be designed and tested for a single, much more substantial load, but in this case their ventilation performance must not be reduced by more than 10% of its original value.

Due to the range of explosion scenarios at any one location in an installation, the anti-blast dampers may have to protect against a range scenarios with no restrictions of overpressure or duration of overpressure, either individually or as part of a repeated series of explosions. The anti-blast dampers should be designed and tested to withstand several different loads including different overpressures and impulses per unit area, up to the maximum values quoted by the *MANUFACTURER*. All blast dampers will be tested to withstand a series of explosion blast loads which increase in severity up to the maximum value quoted by the *MANUFACTURER* (minimum 5 and equally spaced in overpressure) without physical measurable degradation of their performances. In these tests information such as the applied blast loads and let-through load characteristics will be measured and quoted by the *MANUFACTURER* including such

¹ Closing time: the time after which the pressure behind the damper becomes null. It is the time measured from the start of the pressure increase in front of the damper.

² The above 0,30 bar can be justified by the fact that the usual threshold for long duration pressure damage for both mechanical equipment / systems and human eardrum is 0,35 bar. If the duration of the impulse (and pressure) is restricted to 30 ms, there is absolutely no risk on equipment and personnel damage. The 0,35 bar threshold can be found e.g. in Samuel Glasstone's "The Effects of Nuclear Weapons" and in the U.S. "Bible" manual "Structures to Resist the Effects of Accidental Explosions TM5-1300"

criteria as overpressure, duration, impulse per unit area as well as the associated damper closing times.

It shall be a requirement of the manufacturer to provide an equipment data sheet in the attached format. (See addendum 1) This data sheet shall detail performance, testing, quality verification and accreditation details with full supporting evidence from recognised certification and insurance bodies.

6. Testing of anti-blast dampers

The dampers shall be type tested by the *MANUFACTURER* in an approved laboratory of its own choice and verified by an independent certified body. The test certificates shall clearly indicate the actual performances of the equipment and shall be available upon request.

7. Corrosion protection

The dampers shall be protected by corrosion-proof paint in accordance with *COMPANY* specifications.

8. Information to be given to MANUFACTURER

The following parameters shall be issued to the *MANUFACTURER*:

- Maximum reflection pressure (in bar)³ and impulse per unit area (in bar-sec)³
- Number of impulses considered³
- Minimum interval between two impulses³
- Duration of overpressure impulses (in milliseconds or seconds)³
- Type of application (operation in fresh air ducts, in flue or diesel exhaust ducts)
- Type of serviceability expected (e.g. serviceable from exterior or from interior)
- Nominal flow rate (in m³/h) and maximum allowable pressure loss (in Pa)
- Temperatures of the air passing through the damper (steady state)
- Nature and concentration of any pollutant which might pass through the damper
- Special precautions to be taken against corrosion.

9. Information required from the MANUFACTURER

Based on the parameters detailed in Section 8:

- The *MANUFACTURER* must supply the following information:
 - o The damper type
 - o Fully detailed data sheet including pressure drop
 - o Number of dampers to be installed

³ Parameter defined by the Safety/Environment department

- o Layout drawing and installation details
- o Installation and maintenance requirements.
- The *MANUFACTURER* must confirm all the parameters given in Section 8, item by item.
- The *MANUFACTURER* must verify, during *HVAC* design, that the dampers will operate under project design conditions and shall draw Engineering's attention to possible problems linked with utilisation of the selected dampers.

10. HVAC Systems

In an *HVAC* system either an inlet plenum space or suction duct for decompression shall be placed downstream of the blast damper in order to limit the overpressure to a maximum of 12,000 Pa or 0.12 bar unless the *CONTRACTOR* can prove and demonstrate analytically, numerically and/or experimentally otherwise (also see Section5).

The volume of this plenum shall be calculated to suit all of the following:

- The maximum reflection pressure, (P_{so})
- The pressure corresponding to the let-through blast wave, (P_g)
- The time during which this let-through wave acts, (T_s)
- The shape of the blast wave waveform,
- The pressure desired downstream of the blast damper to a maximum of 12,000Pa or 0.12 Bar.

If for any reason it is impossible to place the said decompression plenum in the system, the following precautions shall be taken:

- Option 1:
 - Install a suction duct between the blast dampers and the central air conditioning plant and use this duct as the decompression.
 - The duct itself, the connecting flanges and seals must be designed to withstand the minimum of the "let-through" overpressures, durations and impulses per unit area of anti-blast damper to be used.
 - Do not use screw fasteners without a nut system (fixed or movable) on any part of the duct.
 - The duct volume must be calculated in the same way as the volume of the plenum.

- Option 2:
 - Modifications of the central air conditioning plant.

If it is impossible to install the decompression plenum or the connecting duct within the *HVAC* equipment room, (if the central air conditioning plant is located directly behind the blast dampers), then the air conditioning plant itself must be built in accordance with prEN 1886 Rev. 2006 (E) and the overpressure (P_g) and impulse (I_g) per unit area corresponding to the let through blast wave.

To consider such option, the following characteristics shall be imposed:

- Frame resistance to withstand the minimum of the “let-through” overpressures (P_g), durations and impulses per unit area of anti-blast damper to be used,
- No fixation with screws without a nut system (fixed or movable) of any part of the casing,
- Requirement to have a filter carrying platform of the same strength as the casing,
- Requirement to hold the bottom and top of the batteries in continuous guide rails fitted on the casing frame uprights by welding or riveting,
- Two-position (carrying/operating) safety lugs between the frame of the motor/fan unit supported by anti-vibration springs and the installation cross members,
- Port-less doors with reinforced hinges and locks. Fitting of doors with compensating springs for the safety valve function,
- Fitting of panels when appropriate using spring washers beneath the screw heads,
- Panel construction with mineral wool insulation allowing the inside wall to deform temporarily when the let-through wave comes through (no rigid foam that would transfer all the force to the outside wall),
- Reinforced flexible sleeve on suction duct (double casing or fine-meshed outer strength net). Notice: free length of sleeve should be as short as possible.

11. Airflow Limitations

The damper device shall be designed in a range of sizes up to a maximum single module airway size of 1500 mm x 1500 mm that shall be capable of operating at duct velocities up to 15 m/s as a worst case system design. Normal system design velocities shall be not exceed 8 m/s. The damper device shall have a pressure drop (See Table 1) in a range that does not have a detrimental effect on the overall efficiency of the HVAC system. The system shall be designed to incorporate the number of dampers that shall provide the minimum pressure drop.

12. Responsibility

Responsibility for correct installation and inspection of blast dampers lies with the **CONTRACTOR**.

13. Service cable and pipe penetrations

Service cables and pipes are typically fed into installations through the outside walls, or through the various gas-tight blast walls. These penetrations shall be done with transit sleeves. As the number and type of pipe or cable penetrations are not exactly known during the initial building design, margins must be taken to estimate the number and type of sleeves. The sleeves shall be encapsulated in the structure during the construction phase. When the pipes and cables will be laid, they shall then be equipped with suitable cable glands or packing to meet the blast-proofing, liquid tightness and gas tightness requirements.

All unused transits shall be plugged and kept available for future needs.

The transits installed shall permit damaged cables or pipes to be replaced.

The sleeves may be selected for single or multiple cables or pipes. They shall withstand an unlimited number of loading at an overpressure of 50 Bar. The transit inlets shall be delivered in the dimensions appropriate for the cables or pipes they will accommodate. The penetrations themselves shall be of blast, gas and fire resistant design.

Velocity (m/s) across the damper	Pressure Drop (Pa) across the damper
3	250
5	600
7	1200
10	2500
15	6000

Table 1 Velocity and Pressure drop

		Anti-Blast Damper Data Sheet (Addendum 1 GS EP HVA 204)	Page 1 of 1
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Project:	Doc. No.	Rev. 0
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Supplier:			Enquiry No.	
Damper test laboratory:			Quote No.	
Damper Test report No:			Purchase Order No.	
Damper Test Certifying Authority:			Job No.	
Approved FAT Procedure No:				
Product Liability Policy No:				

1 Technical Data			
2			
3 Damper type		Blast Damper	
4 Duct connection	Size: W (mm) x H (mm)		
5 Method of Operation	Type		
6	Ref: Data Sheet No		
7 Damper manufacturer			
8 Open/closed indication	Visual	Yes/No	
9			
10 Flange drilling standard			
11			
12 Materials			
13 Casing	Material		
14	Thickness	mm	
15 Blade	Material		
16	Thickness	mm	
17 Shaft	Material		
18	Thickness	mm	
19 Linkage	Material		
20	Thickness	mm	
21 Bearing	Type		
22			
23 Operation and Performance			
24 Damper Pressure Drop		Pa	
25 Duct Velocity		m/s	5
26 Maximum Blast Pressure		Bar (g)	3
27 Blast Duration (Milliseconds)		ms	
28 Maximum Let-through Pressure of Blast Wave		Pa	12000
29 Operating Temperature Range		C°	-40 To 70
30			
31			
32 Notes:	Schedule abbreviations:	Method of Operation	S: Yes/No Mechanical Spring
33			G: Yes/No Gas Strut
34			M: Yes/No Manual Reset
35			
36	Airflow:	H: Yes/No	Horizontal
37		V: Yes/No	Vertical
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