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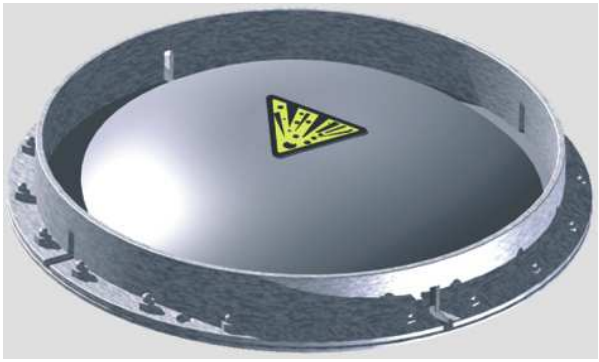
riziku dáváme hranice

Operation Instructions and User Manual

EXPLOSION PANELS



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1) INTRODUCTION - GENERAL

This documentation has been written for a safety device with a domed safety explosion panel (further VMP). This is safety pressure relief equipment. This device is intended to relieve explosions that originate inside protected areas, like reservoirs, silos, separators, filters, sorting machines etc., where the explosion danger environment according to CSN 33 20 00-3 occurs.

It is necessary for the customers to study this documentation and other written materials in detail in order to pass this information on their employees with appropriate qualifications (electric, machine, technology and safety technicians). Certain parts from the operation and maintenance chapters should be included in the customer's operational regulations, maintenance schedules etc.

Customers should pay increased attention especially to Chapter 7 that concerns safety, since the explosion panel is a device, from which it is necessary to maintain a safety distance according to the CSN EN 14491 standard.

2) TERMINOLOGY

a) *Domed Explosion Panel* (VMP) is a relief mechanism that enables to relieve explosion pressure – overpressure or other operational over and underpressure, at a low value determined by so called safety overpressure, from inside areas of protected equipment. This reduces explosion pressure to a low value, lower than allowed pressure resistance of the protected equipment. The protected equipment inside area is closed under designed operational conditions.

b) *Flat Explosion Panel* (VMP) is a relief mechanism that enables to relieve explosion pressure – overpressure or other operational over and underpressure, at a low value determined by so called safety overpressure, from inside areas of protected equipment. This reduces an explosion pressure to a low value, lower than the allowed pressure resistance of the protected equipment.

c) *Explosion Pressure* is a fast physical and chemical process during which a large amount of energy is released that is represented by increased pressure and accompanied by light and heat effects.

d) *Reduced Explosion Pressure* is a lowered explosion pressure that originates after explosion relief by escape openings with installed explosion panels inside of protected equipment. The reduced explosion pressure is marked P_{red}.

e) *Maximum Speed of Reduced Explosion Pressure Increase* is the highest speed of pressure increase during the explosion relieved from a protected space through VMP. This quantity is marked $(dp/dt)_{red\ max}$.

f) *Allowed VMP Loading Pressure* is the highest explosion pressure that does not result in damage and rupture of the frame, tearing of anchoring device and release of explosion panel covers and endangering of the surroundings by released parts of the explosion panel equipment. The allowed VMP loading pressure is limited by the value $(p)_{red,max}$. The allowed VMP loading pressure is marked p_{dov} of VMP. From the safety point of view the following inequality must be met:

$$p_{stat} < p_{dov}\ \text{VMP} \geq p_{dov}\ \text{of the protected object}$$

g) *Safety Panel Static safety Pressure* is the lowest pressure (overpressure or underpressure) that during static load (dp/dt) = 0 releases the panel from the frame completely. This is labeled as p_{stat}. From the operational safety point of view the following inequality must be met:

$$P_{stat} > P_{operational}$$

The static safety pressure is the lowest pressure at which the safety panel is released.

h) *VMP escape area* is the inside VMP area.

3) EXPLOSION PANEL FUNCTION PRINCIPLE

Under normal operating conditions the protected equipment relief opening is covered by an explosion relief panel. If an operational pressure is exceeded inside of the equipment, a panel on its surface opens and relieves pressure from the endangered area. The technology equipment is thus exposed to smaller pressure than is its pressure resistance, and therefore it will not be destroyed.

Pressure relief panels are designed with the circular (drawing no. 1) or rectangular (drawing no. 2) shape. The circumference of a panel is provided with cuts ended with small holes ∅ 2mm. Using the hole distances A, depicted in the mentioned drawing's detail D, the panel is held in the closed position. The pressure occurring under the panel overcomes the force needed to rupture the material filling the space between holes A and the panel is released. The released covers are anchored by the way depicted on the Fig. 1.

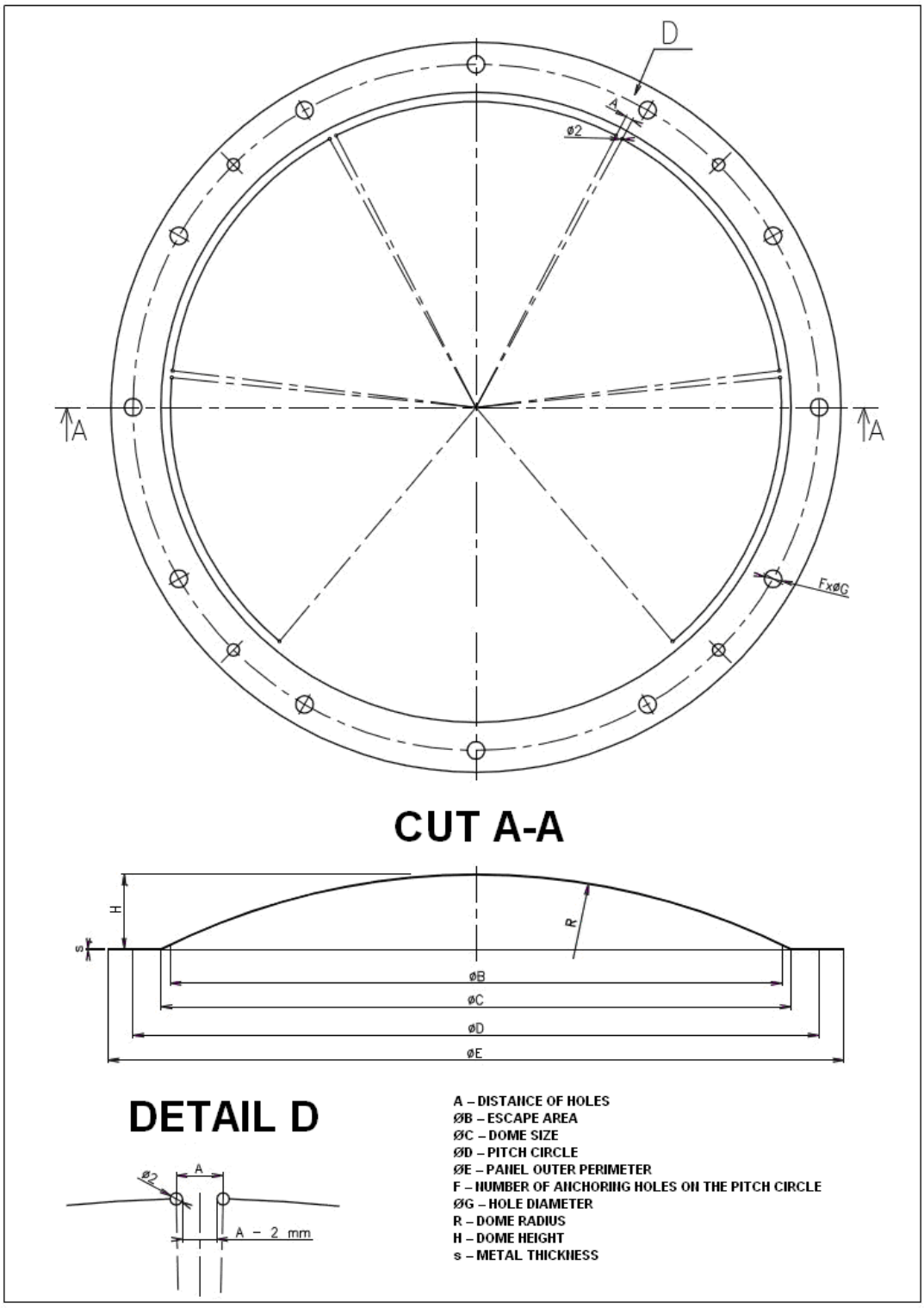


Fig. 1 – The circular panel

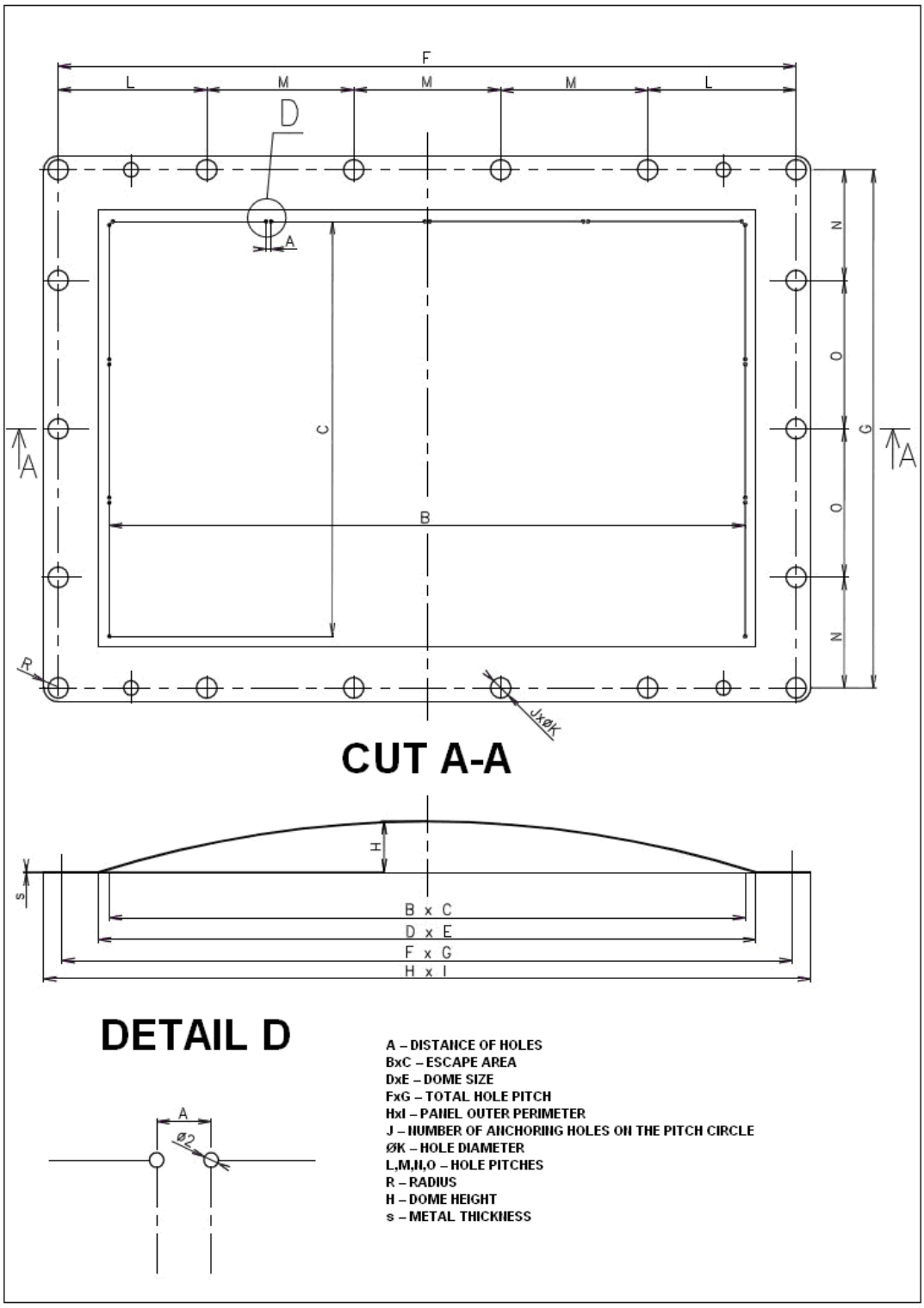


Fig. 2 – The rectangular panel

4) TECHNICAL PARAMETERS

4.1 VMP COMPONENTS

Each VMP consists of the following parts (Fig. 3):

- Pos. 1 – LOWER FLANGE
- Pos. 2 - PANEL
- Pos. 3 – UPPER FLANGE
- Pos. 4 – CONNECTING FLANGE
- Pos. 5 – INDICATOR
- Pos. 6 – CABLE BUSHING

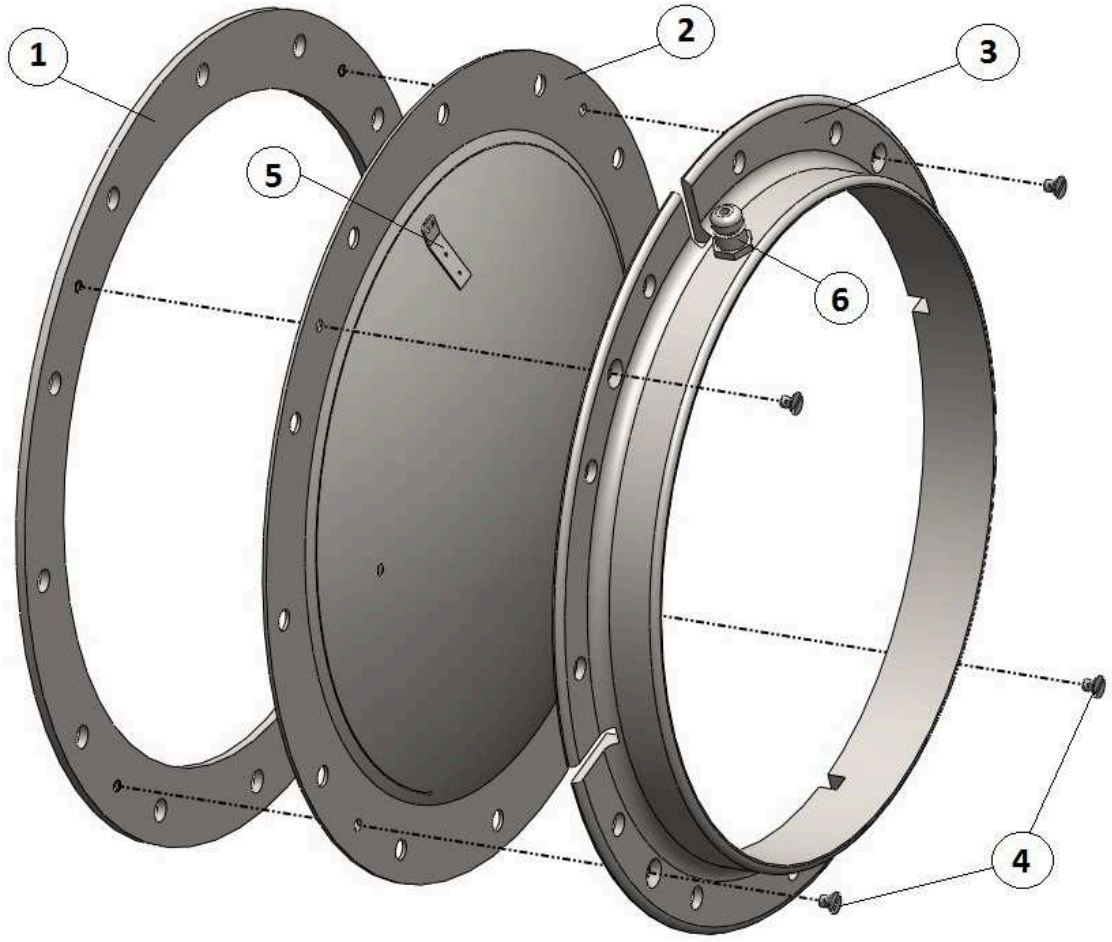


Fig. 3 - VMP Composition

The VMP flanges (pos. 1 and 3) are made from stainless steel and are not painted, or they are made from galvanized construction steel. Flanges do not use seals. The connecting bolts (pos. 4) are made either from classic construction steel according to ISO 2009 or stainless steel. VMP is attached to protected equipment by bolted connections (see Chapter 4. 1 Installation).

The domed panel itself (pos. 2) is made from stainless steel or galvanized steel of various thicknesses. The panel is held between the upper (pos. 3) and lower flanges (pos. 1) by connecting bolts (pos. 4). The domed panel is shaped according to prescribed value. Cuts specific for given static opening pressures are made along the panel circumference. These cuts are sealed by a sealing tape to ensure that the whole safety device is dustproof. Anchoring of a domed panel is designed by not cutting a certain part of the panel. In case of tearing out of the panel parts intended for relief, this part is held by its uncut side.

A single domed safety panel can be made, as mentioned before, from two types of material - stainless steel or galvanized finish construction steel. Then there are also so called three-layer ones that consist of two panels and PTFE safety foil between them. This type of panel can also be of the underpressure type.

A safety panel can also be equipped by an indicator (pos. 5) that monitors the panel position and in case of change its contacts are disconnected. The indicator cable is going through a bushing (pos. 6) that is attached in the upper panel flange. Its disconnection breaks the safety circuit and this is monitored by a control unit and means that the panel position has changed.

Fig. 4 – VMP with the indicator

4.2 VMP BASIC DIMENSIONS

Circular domed panels

The circular panels are made with diameters from the 300mm to 1100mm. Custom sizes can be made according to specifications.

The basic circular panel production series:

TYPE	ESCAPE AREA (m^2)	ØD1 - Flange inner dimension (mm)	ØD2 - Flange outer dimension (mm)
VMP 300	0.07	320	380
VMP 350	0.08	342	422
VMP 400	0.12	410	490
VMP 450	0.14	450	530
VMP 510	0.19	510	590
VMP 600	0.26	600	680
VMP 630	0.29	630	710
VMP 750	0.43	770	850
VMP 800	0.53	820	940
VMP 880	0.58	880	960
VMP 900	0.61	900	1000
VMP 1000	0.75	1000	1100
VMP 1100	0.91	1100	1200

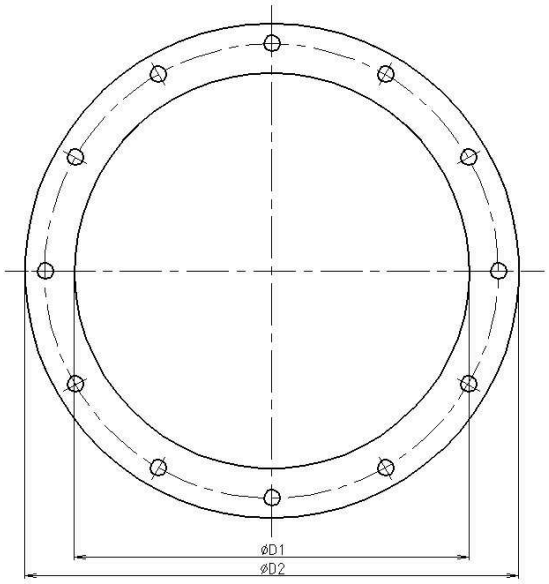


Fig. 5 – The circular panel flange dimensions

The panel temperature resistance: Sandwich with PTFE foil 240°C

Rectangular domed panels

Rectangular domed panels' sizes are 150x600mm to 1020x1020mm. Custom sizes can be made according to specifications.

The basic rectangular panel production series:

TYPE	ESCAPE AREA (m^2)	A - Flange outer dimension (mm)	B - Flange outer dimension (mm)
VMP 150x600	0.08	230	680
VMP 305x457	0.12	385	537
VMP 450x800	0.34	535	885
VMP 490x590	0.27	570	670
VMP 586x920	0.51	666	1000
VMP 610x290	0.16	370	690
VMP 2x610x290	0.32	390	1390
VMP 630x310	0.18	390	710
VMP 2x630x310	0.36	410	1410
VMP 915x1118	0.98	995	1198
VMP 920x920	0.81	1000	1000
VMP 1020x1020	1.00	1100	1100

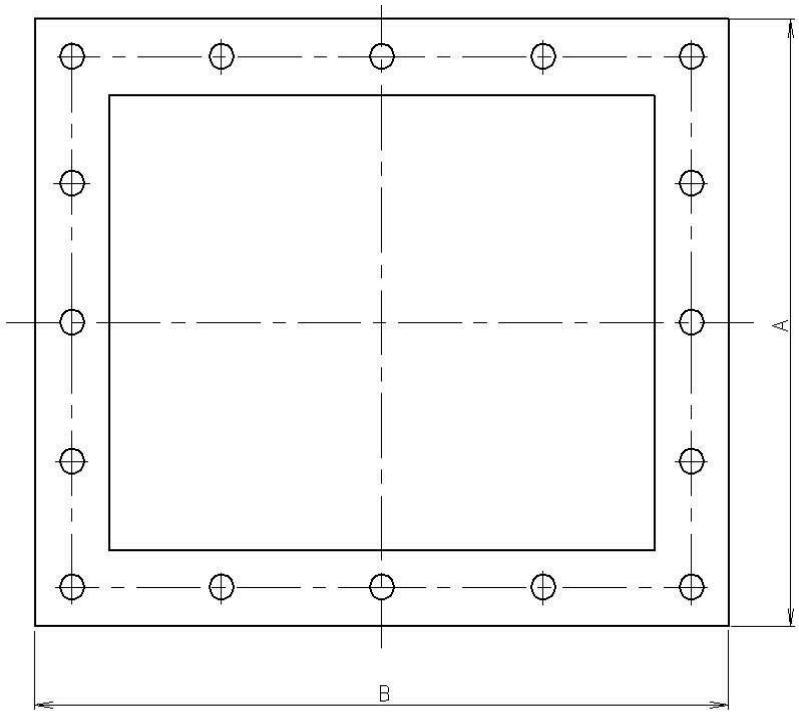


Fig. 6 – The rectangular panel flange dimensions

The panel temperature resistance: Sandwich with PTFE foil 240°C
Single with EPDM seal 100°C

4.3 VMP-F COMPOSITION

These explosion panels are designed as single rectangular ones (see Fig. 7). The panel material is stainless steel according to DIN 1.4301. Material thickness depends on the panel size. A flat EPDM seal is glued to the bottom side of these panels. Flat panels are suitable for low operational pressure applications (up to 50% of the safety opening pressure), for equipment with the temperature up to 100°C, and equipment with low pressure pulses. The panels can be installed without a frame (the panels are attached to equipment by bolts with washers).

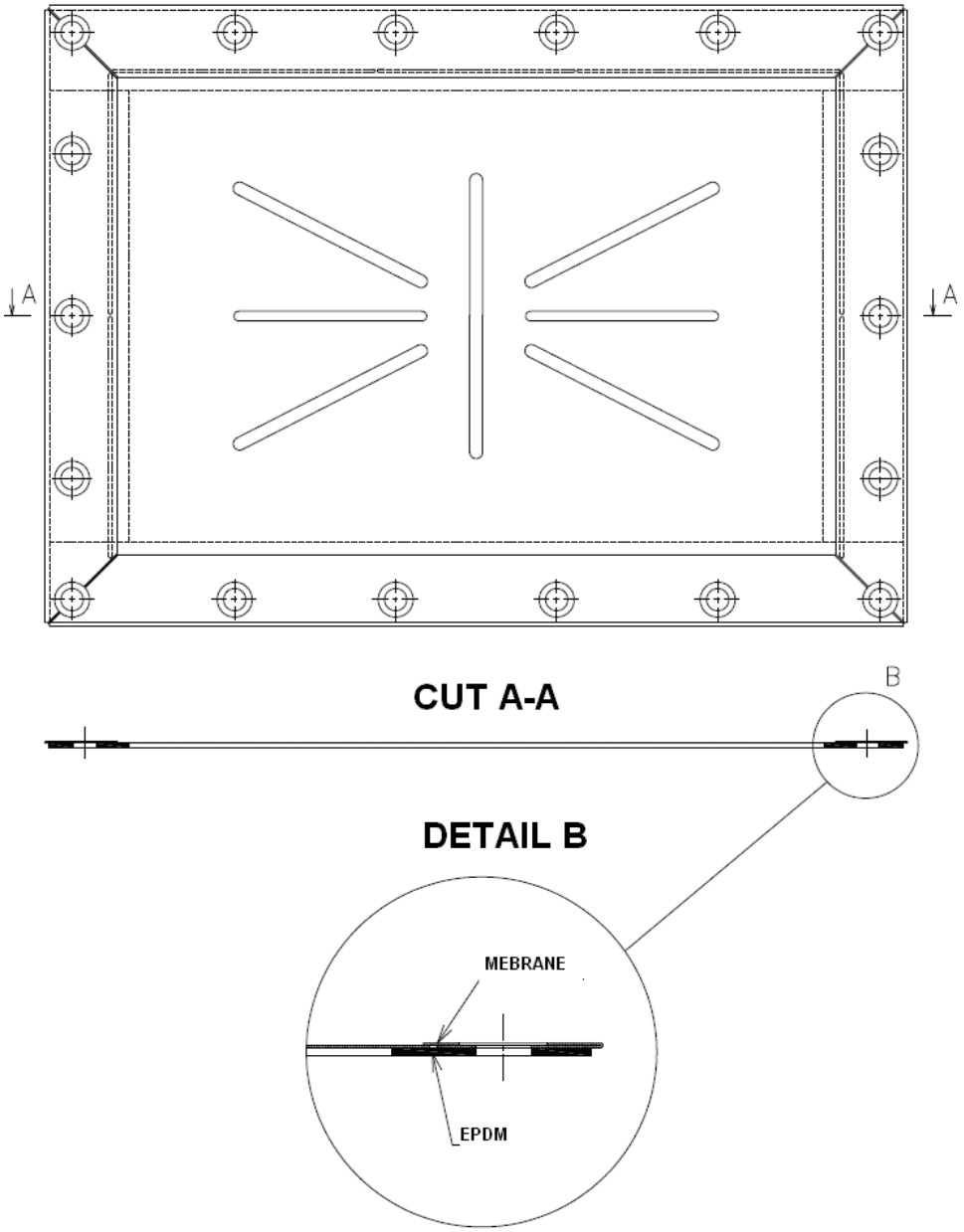


Fig. 7 – The flat panel

4.4 VMP-F BASIC DIMENSIONS

Flat rectangular panels

Flat rectangular panels are made from the size 305x457mm to 1020x1020mm. Custom sizes can be made according to specifications.

The basic flat rectangular panel production series:

TYPE	ESCAPE AREA (m^2)	A - Flange outer dimension (mm)	B - Flange outer dimension (mm)
VMP-F 305x457	0.12	390	541
VMP-F 410x410	0.18	490	490
VMP-F 630x310	0.18	385	705
VMP-F 490x590	0.27	573	673
VMP-F 450x800	0.34	550	900
VMP-F 600x600	0.36	650	650
VMP-F 586x920	0.51	670	1005
VMP-F 800x800	0.64	850	850
VMP-F 685x1100	0.78	765	1178
VMP-F 920x920	0.81	1005	1005
VMP-F 915x1118	0.98	1007	1210
VMP-F 1020x1020	1.00	1110	1110

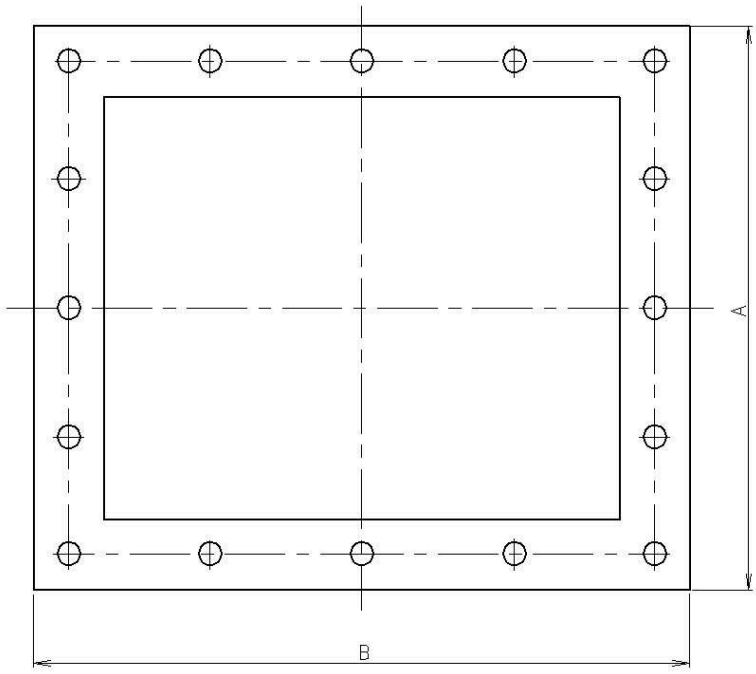


Fig. 8 – The dimensions of flat rectangular panels

4.5 CONNECTING MATERIAL

A) Circular VMP

TYPE	Number of bolts and nuts (pcs)	Bolt type acc. to ISO 4017 galvanized	Self-locking nut type acc. to ISO 7040 galvanized	Torque ($N.m^{-1}$)
VMP 300	12	BOLT M8x30	M8	15
VMP 350	12	BOLT M10x35	M10	21
VMP 400	16	BOLT M10x35	M10	21
VMP 450	12	BOLT M10x35	M10	21
VMP 510	12	BOLT M10x35	M10	21
VMP 600	20	BOLT M10x40	M10	21
VMP 630	20	BOLT M10x40	M10	21
VMP 750	28	BOLT M10x40	M10	21
VMP 800	24	BOLT M10x40	M10	21
VMP 880	24	BOLT M10x40	M10	21
VMP 900	32	BOLT M10x40	M10	21
VMP 1000	36	BOLT M10x40	M10	21
VMP 1100	40	BOLT M10x40	M10	35

B) Rectangular VMP

TYPE	Number of bolts and nuts (pcs)	Bolt type acc. to ISO 4017 galvanized	Self-locking nut type acc. to ISO 7040 galvanized	Torque ($N.m^{-1}$)
VMP 150x600	20	BOLT M10x35	M10	21
VMP 305x457	18	BOLT M10x35	M10	21
VMP 450x800	24	BOLT M10x35	M10	21
VMP 490x590	26	BOLT M10x35	M10	21
VMP 586x920	34	BOLT M10x35	M10	21
VMP 610x290	18	BOLT M10x35	M10	21
VMP 2x610x290	34	BOLT M10x35	M10	21
VMP 630x310	18	BOLT M10x35	M10	21
VMP 2x630x310	34	BOLT M10x35	M10	21
VMP 915x1118	42	BOLT M10x35	M10	35
VMP 920x920	40	BOLT M10x35	M10	35
VMP 1020x1020	40	BOLT M10x35	M10	35

C) Rectangular VMP-F

TYPE	Number of bolts and nuts (pcs)	Bolt type acc. to ISO 4017 galvanized	Self-locking nut type acc. to ISO 7040 galvanized	Washer type ISO 7090-8	Torque ($N.m^{-1}$)
VMP-F 305x457	18	BOLT M10x35	M10	Washer 10	21
VMP-F 410x410	12	BOLT M8x35	M8	Washer 8	21
VMP-F 450x800	24	BOLT M10x35	M10	Washer 10	21
VMP-F 490x590	26	BOLT M10x35	M10	Washer 10	21
VMP-F 630x310	18	BOLT M10x35	M10	Washer 10	21
VMP-F 600x600	16	BOLT M8x35	M8	Washer 8	21
VMP-F 800x800	20	BOLT M8x35	M8	Washer 8	21
VMP-F 586x920	34	BOLT M10x35	M10	Washer 10	35
VMP-F 685x1100	34	BOLT M10x35	M10	Washer 10	35
VMP-F 915x1118	42	BOLT M10x35	M10	Washer 10	35
VMP-F 920x920	40	BOLT M10x35	M10	Washer 10	35
VMP-F 1020x1020	40	BOLT M10x35	M10	Washer 10	35

4.6 PANEL LABELING

Panels are labeled by three labels. The first label (Fig. 9) shows the manufacturer, the second marks the explosion danger (Fig. 10) and the third describes the panel basic technical data (Fig. 11).

Fig. 9

Fig. 10

Fig. 11

5) INSTALLATION OF VMP ON PROTECTED EQUIPMENT

During specification of the number of VMP onto protected equipment the latest knowledge in the field of explosion protection needs to be taken into account and the design should be left to professionals. A professional company should evaluate the details that will unequivocally determine whether the safety equipment (VMP) can be safely used under the expected operational conditions.

The installation of VMP onto protected equipment is done according to the manufacturer documentation for specific use. The installation procedure needs to be determined by the installation technologist. All installation work must be performed while keeping to all operation safety regulations.

A domed safety panels is placed on the lower flange centrally. The upper flange is then placed on this domed panel. Countersink screws are inserted into four holes in the upper flange to firmly attach the upper flange, panel and the lower flange together. Thus prepared safety assembly can be manipulated during the installation of VMP onto the protected equipment (see Fig. 12). Caution is necessary during installation in order not to damage the domed panel or other VMP parts. The connecting bolts for connecting VMP to the protected equipment must be equipped by fan washers for grounding. After the panel is installed onto the protected equipment an optional panel position indicator can be connected to a spark safe electric source.

A written note must be made by a responsible person about each installation of a domed safety panel into the appropriate documentation (The product quality and completeness certificate).

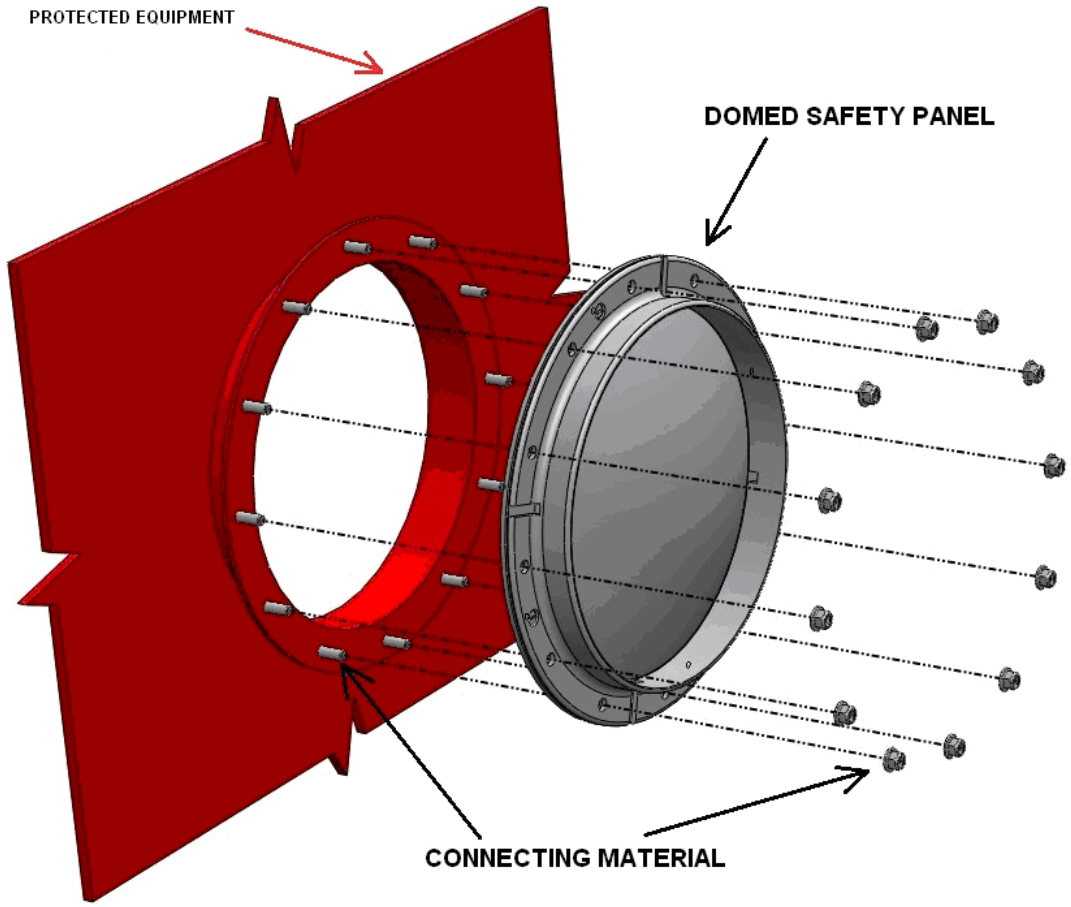


Fig. 12 - The installation of VMP on protected equipment

6) INSTALLATION OF VMP-F ON PROTECTED EQUIPMENT

The installation of VMP-F onto protected equipment is done according to the manufacturer documentation for specific use. The installation procedure needs to be determined by the installation technologist. All installation work must be performed while keeping to all operation safety regulations.

The flat safety panel is placed onto the protected equipment centrally (see Fig. 13). It is attached using the appropriate bolts, washers and nuts (see Chapter 4.5). Caution is necessary during installation in order not to damage the flat panel or other VMP-F parts. The connecting bolts for connecting VMP-F to the protected equipment must be equipped by fan washers for grounding.

A written note must be made by a responsible person about each installation of a flat safety panel into the appropriate documentation (The product quality and completeness certificate).

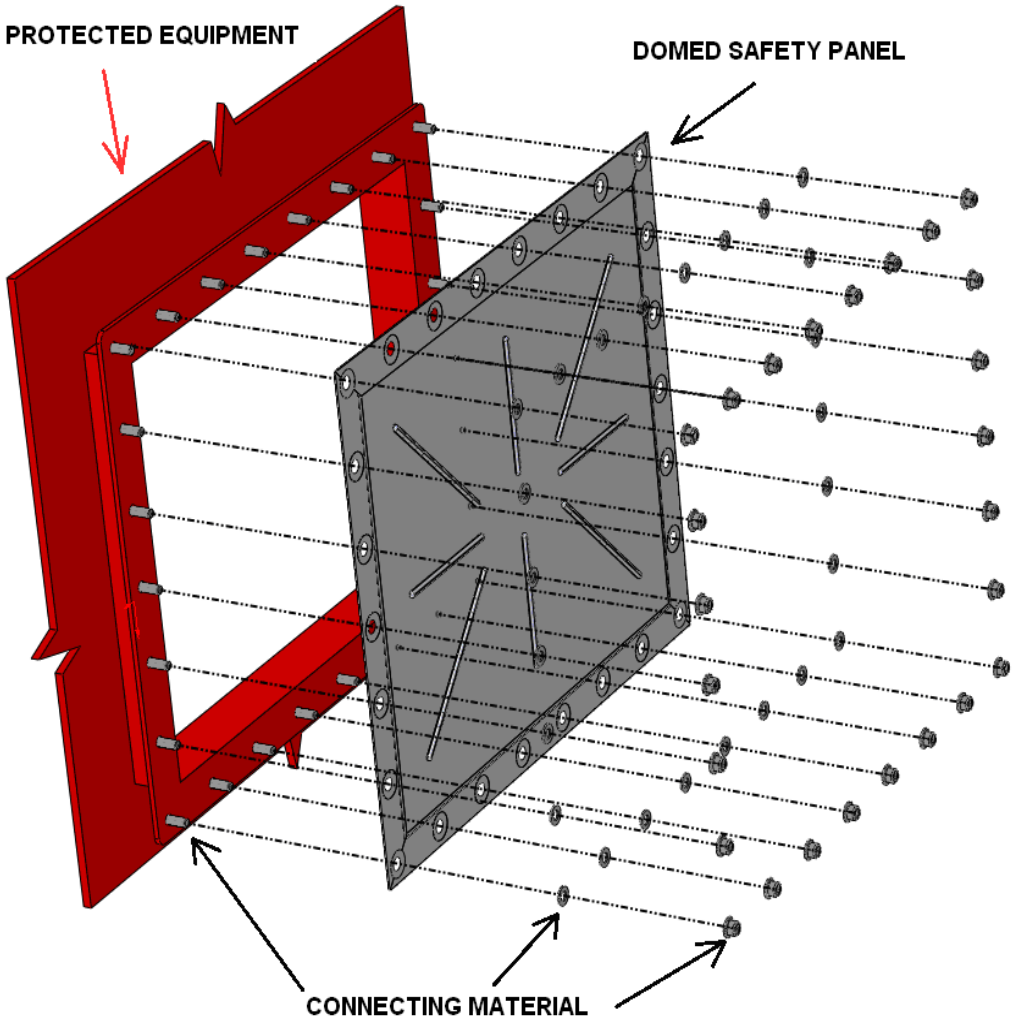
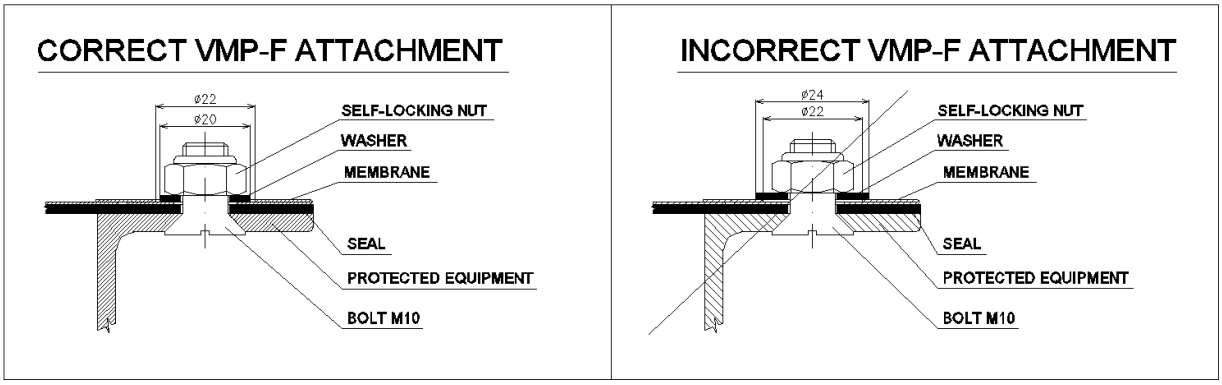


Fig. 13 - The installation of VMP-F on protected equipment

6.1 THE DETAIL OF CORRECT ATTACHMENT OF THE FLAT PANEL TO THE PROTECTED EQUIPMENT



The washer under the nut may not overlap the upper bent panel material (see Fig.), since it would affect P_{stat} !!!

7) ELECTRIC WIRING

If the position indicator is a part of the panel, then it is necessary to connect it to a spark safe relay. The position indicator is the isolated conductor CSA 0.15mm^2 firmly threaded through and brought out through the VMP frame, where it is attached by the cable bushing type SKINTOP MS-M (M12x1,5). The conductor is fixed in the bushing by 30Nm torque. The position indicator is connected to the separating spark safe relay made by STAHL – type 9170 that creates the interface between safe and dangerous (zone 20) zones. The spark safe relay requires 230V/50Hz voltage, secured at a minimum by 1A circuit breaker (with B or C characteristic). The spark safe relay contains a switching contact, where a position of the panel is indicated (open/closed). The power supply and connection of the control wiring to the spark safe relay is not a part of delivery and is covered by a customer (unless contracted otherwise).

In the case of connecting several panel position indicators on one spark safe relay (serial connection) it is necessary to maintain the principles of designing spark safe circuits. The appropriate state laws (e.g. approval by authorized body) need to be followed.

8) SAFETY, MAINTENANCE AND OPERATION

VMP and VMP-F do not need any operator's care, they work automatically. They are disposable and functionally dependent on increase of pressure in the protected area. On the other hand any personnel are prohibited to move or stay in the area where this equipment is installed with the exception of prescribed inspections. A safety zone according to CSN EN 14491 is 30m. The panels are devices that could be life threatening if these safety instructions are not followed, and beyond technological damages can cause injuries with permanent consequences or death. The danger threatens especially during explosion and consequent release of it to the space behind the panel. These dangers need to be eliminated to zero.

Maintenance instructions:

For VMP:

a) Continuously follow instructions that prohibit entrance to the area of explosion panels during operations
b) Perform regular shift inspections
c) Perform regular quarterly inspections
d) Exchange safety panels regularly
e) Keep the equipment continuously clean
f) Regularly instruct workers that come to these areas about work safety

The regular shift inspection means a visual inspection of equipment surface from safe distance, its cleanliness, dust accumulations, snow and ice deposits during winter months, also whether the equipment is not mechanically or otherwise damaged at least once every shift. It is not permissible to start operations or operate the equipment with snow and ice accumulations on its domed panel. Any accumulations must be mechanically and without damaging of the explosion panel removed while operations are stopped.

The regular quarterly inspection means an inspection on shut down equipment, at a minimum once every three months, during which an outside condition of the domed explosion panel is checked.
The equipment may not be damaged or deteriorated. The whole device must be rid of a possible dust accumulation. Bolt connections must be tightened and bolt threads protected by sealing.

The regular panel exchange means adhering to the panel minimum functional lifetime. A recommended cycle is 1 year. After this time a complete control of the safety equipment should be performed that would consist of a disassembly and following reassembly of the safety equipment. In case that a domed or flat panels show any signs of damage or changes (of dimensions or thickness) the panels need to be replaced by new ones.

The continuous maintenance of cleanliness means prevention of dust accumulations, especially flammable ones, both on the panel surface and in the safety zone.

The regular workers instruction means notifying them about dangers of accidental or prescribed movement in the area of these safety devices and instructions concerning these dangers (about protection), at least one time a year including newly hired personnel.

Instructions specified in this chapter must be included in operational safety regulations.

9) INSPECTION AND SERVICE

Inspections and service of VMP on protected equipment can be done by the RSBP spol. s r.o. company and persons that the manufacturer issued the certificate to perform these activities (authorized personnel) only.

The regular panel inspections mean following the panel minimum functional lifetime. This means that the inspection is performed by RSBP spol. s r.o. every year. In case that a domed or flat panels show any signs of damage or changes (of dimensions, thickness or corrosion) the panels need to be replaced by new ones.

REMARK: The length of operational lifetime will be determined in detail according to operational experience, always accompanied by a written note to the appropriate documentation by a technician.

All performed activities mentioned in the chapters 8 and 9 must be recorded in writing by a responsible person in the appropriate documents.