TECHNICAL SPECIFICATION T-0515-OZM4

STORAGE MODULES FOR EXPLOSIVE MATERIALS

Storage modules have been designed and tested to **prevent transfer of explosion** (deflagration or detonation, action of shock wave, fragments or sharp flame) between modules. Modules are rectangular-shaped boxes with connecting points for mounting them together creating blocks with user-defined heights and lengths.

Storage modules **minimize safety distances** of explosives magazines because despite total number of the modules and total weight of the explosive materials stored inside, the maximum hazard event from them is limited to a content of a single tube only. Thus, despite storing e.g. tons of explosives inside these modules in one magazine, safety distances shall be calculated from the maximum unit content (e.g. 2.5 kg TNT).

This minimization of safety distances **improves logistics**, which is especially visible in manufacturing operations. Available rooms in manufacturing buildings can be modified to intermediate stores with maximum capacity corresponding to size of the room but with very low safety distances (defined by unit content of one tube, i.e. max. 2.5 kg TNT). Such solution shortens transport distances in industry.

Storage modules provide for possibility to **separately store normally incompatible materials** together in a single storage room. Even if one module with a sensitive or unstable material explodes, contents of the other modules are left unreacted.

Modular construction of the storage modules allows to create **walls of the modules of different heights and lengths**. Being only screwed together, the modules can easily be mounted, dismantled, moved to different location or reconfigured in case of need.

Design of the storage modules

A single storage module for 2x 2.5 kg TNT eq. capacity is a rectangular box containing **two steel tubes** placed above each other and welded at their ends inside a steel box. Each tube is closed by a welded steel lid at its back and a hinged lid at its front.

The **front lid** closes the tube water-tight using a lever lock. The locking mechanism is designed to be bimanual so that operators cannot attempt to open the boxes while holding explosive materials in their hands. A brass pin on a brass chain fixes the handle of the lever lock in a closed position and clearly shows the closed position for quick control. The front lid opens on self-lubricating brass hinges down on non-sparking retainers (covered by rubber) showing the interior of the tube, which contains two steel trays with retainers centering the stored materials inside the tube. Water-tight joint of the lid with the tube is achieved by compressing a rubber sealing in the internal groove of the lid.

All moveable parts are designed for **preventing intensive impacts or friction** of two sparking metals. Non-sparking self-lubricating brass hinges, brass parts or electrostatic-conductive rubber are used in the friction points. The modules contain shaped protective barriers ensuring that accidental explosion in one tube does not damage lids of the surrounding tubes by shock wave or flying parts of the lid.

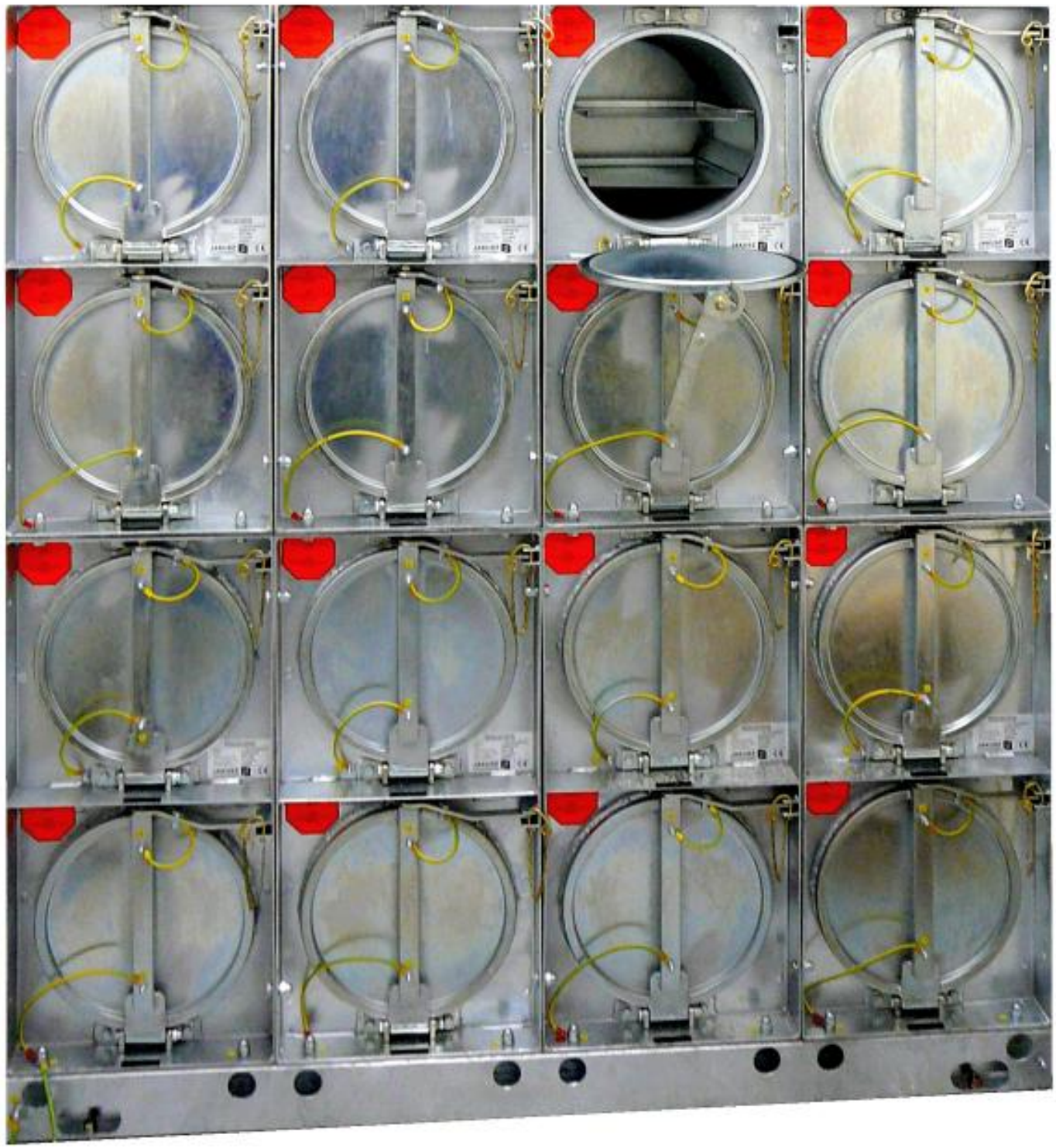
Each module has **grounding connectors** for grounding of the whole setup to a common potential. Fully conductive joints are made between lids, steel box, tubes and internal trays of the module. All rubber sealing in lids that keep the internal space of the tubes watertight are electrostatic conductive. All steel parts are galvanized for increasing protection against corrosion.

Free space between the tubes in the steel box of the module shall be filled with **dry sorted sand** in the first installation of the modules. The sand helps to attenuate shock wave loading and increases structural stability of the complete setup of the modules. The sand shall be supplied by the user of the modules.

Modules can be horizontally and vertically connected together to sets (blocks) containing 2 modules (4 tubes) on each other and unlimited number (defined by available space in a room) of modules on sides. Each module contains assembly holes for anchoring and mutual connecting. The sets of modules are placed on a steel frame of required length, which is anchored to the ground. Back side of the modules is anchored to the walls of the structure to increase stiffness at static and dynamic loading. The steel frames on which the modules are placed ensure at least 150 mm minimum height of the lowest tray in the modules from the floor.

Storage capacity	2.5 kg TNT in one tube = 5 kg TNT per module
Tube internal dimensions	Diameter x length = 300 x 500 mm
Module outside dimensions	Height x width x length closed (open) = 803 x 400 x 588 (959) mm
Empty weight of the module	135 ±5 kg
Weight of sand to fill one module	100 – 110 kg
Total weight of the filled module	230 – 250 kg

Example of a block set up with 8 modules (40 kg TNT storage capacity):



Storage capacity of the modules for different classes of explosive materials

The storage modules were especially designed for safe storage of mass detonating (hazard class 1.1) explosive materials such as high explosives and deflagrating pyrotechnic mixtures causing transfer of explosion by shock wave, sharp flame or thermal impulse.

The storage modules were subjected to detonation tests by the manufacturer and found resistant against transfer of explosion from one module to another in these weights and configurations of stored explosive materials:

1. A single tube of the module can contain maximum of 2.5 kg of high explosives with detonation heat equivalent to TNT or lower.

2. The maximum allowed quantity per one tube is reduced to half, i.e. to 1.25 kg net weight, for high explosives with detonation heat higher than TNT, unless the module resistance is proven by the detonation experiments with the modules carried out by the user (see the following paragraph).

3. When shock sensitive high explosives or primary explosives having shock wave sensitivity higher than commercial dynamite or plasticized PETN (Semtex 1A) are to be stored within the modules, the user has to carry out the detonation experiments for module resistance before first use of the modules. The detonation experiments shall be carried out in test configurations representing the worst-case scenario for storage of the explosive materials for the user.

4. Alternatively it is allowed to store a maximum of 2.6 kg of pyrotechnic mixtures Type A in a single tube of the module. Pyrotechnic mixtures Type A are defined for this purpose as pyrotechnic mixtures capable of explosive reaction generating shock wave with TNT equivalent higher than 50%. This category typically covers powdered mixtures containing chlorates or perchlorates together with metal powders (tested on $KClO_4$/Zr mixture). Pyrotechnic mixtures Type A must be placed in separate boxes not containing more than 70 grams of pyrotechnic mixtures per box and the boxes must be placed inside a pallet providing for even distances between the boxes. The pallets with the boxes are then put on the trays of the modules.

5. Alternatively it is allowed to store a maximum of 3 kg of pyrotechnic mixtures Type B. Pyrotechnic mixtures Type B are defined for this purpose as pyrotechnic mixtures not capable of explosive reaction generating shock wave with TNT equivalent higher than 50 % TNT (tested on B/KNO_3 mixture).