TESTING INSTRUMENTS FOR ENERGETIC MATERIALS LABORATORIES
OZM RESEARCH is a knowledge-based company formed by experienced explosives scientists and engineers with advanced academic degrees in this very special branch of chemical engineering. The company’s core business consists of testing instruments, technologies and expert services for energetic materials – explosives, propellants, pyrotechnics, and ammunition. The company is fully licensed in handling explosive materials and ammunition, as well as in foreign trade with these highly explosive materials.

CUSTOMER SUPPORT
Customer-oriented approach regularly involves modifications and adaptations of the standard products for fitting the customer’s needs. Frequently, the products are manufactured type-specifically for providing optimum parameters to the customer. The company’s services do not end with sale and delivery of a product. Having the high expertise in the field of explosives and munitions, we are able to provide full assistance to the customer with fitting the products into the customer’s operations, with permission by the authorities, standard operation procedures, testing methodologies, personnel training and other expert services.

WE ARE EXPORT-ORIENTED
Since 1997 the company exported its products to many countries of the European Union, the United States, Asia and Latin America. Our major clients include military research & development and testing centres, forensic institutes, universities, explosives and ammunition manufacturers, nuclear power plants and other related industries.

OZM RESEARCH is ready to help you with your tasks in energetic materials.

PRODUCT DEVELOPMENT HIGHLIGHTS

OTHER NEWLY INNOVATED PRODUCTS
STABIL 21    DTA 55-Ek    FSKM-10    AET 402    BMF-10
OTHER NEW PRODUCTS
DR. MÜLLER INSTRUMENTS    EXPLO-S SOFTWARE

OZM RESEARCH is a leading manufacturer of special instruments for the testing of energetic materials. The manufactured instruments cover testing of stability and compatibility, sensitivity, and explosive performance of energetic materials in various testing programs.

Explosion-Resistant Containers
Explosion-resistant containers serve for safe transport and storage of highly sensitive explosive samples, improved explosive devices and unexploded ordnance. These products include modular magazines for explosives minimizing necessary safety distances, reinforced mobile magazines for fireworks, mobile stores for explosives and ammunition or mobile bunkers for dangerous operations with explosives or ammunition.

Detonation Chambers
Industrial detonation chambers resistant against repeated detonations as part of manufacturing process and with a service life of 10³ – 10⁵ detonations are technologies that have served several of our industrial clients. Laboratory detonation chambers are similar products specially developed for scientific experiments, research work and testing in explosives laboratories.

Ammunition Dismutation Technologies
Mobile ammunition demilitarization technologies are designed for safe and environmentally-friendly disposal of ammunition outside of industrial facilities. Application of mobile demilitarization technologies eliminates the costs and risks connected with transport of dangerous, obsolete or unservicable ammunition for disposal.

APPLICATION
Vacuum stability test is frequently used for determination of chemical stability and compatibility of energetic materials and for quality tests of energetic ingredients. The test is able to discover chemical instability of energetic materials due to the presence of destabilizing impurities, incompatibility with surrounding materials, or aging, with high sensitivity, precision and reproducibility. Vacuum stability test finds its wide application in qualification, surveillance, manufacture, quality control and research & development of a wide range of energetic materials.

PARTS & ACCESSORIES
Pressure transducer and testing tube
Pressure and temperature sensor for ambient conditions

FEATURES
• Fully replaces old apparatuses with mercury-containing manometer tubes.
• User-friendly software WINSTAB, automatic measurement and evaluation.
• Continuous volume-time record as a result of testing.
• Adaptable design of instrument and software according to customer’s needs.
• Collimated volumes of the test tubes and pressure sensors.
• Automatic temperature calibration.
• Up to 20 simultaneous independent measurements in two heating blocks.

Designed to comply with the requirements of the following standards of testing:
• STANAG 4556, 4147, 4022/4, 4023, 4230, 4284 and 4566

TESTING INSTRUMENTS

STABIL 21
VACUUM STABILITY TESTER FOR EXPLOSIVES

UNIQUE DESIGN OF TEST TUBES AND TRANSDUCER CONNECTIONS.

LONG TRADITION – FIRST ELECTRONIC VST TESTER DEVELOPED OVER 40 YEARS AGO.

AUTOMATIC MEASUREMENT AND EVALUATION.

HIGH PRECISION AND LONG TERM ACCURACY OF PRESSURE MEASUREMENT.

WINSTAB Test Site

WINSTAB software - Examples of experiment evaluation
Electrostatic discharge is one of the most frequent and the least application sensitive to initiation by electrostatic discharge is one of the main safety parameters crucial to the handling, processing and transportation of explosives. A small-scale electrostatic spark sensitivity test determines the amount of energy required for an electric spark to cause a tested sample to initiate. This testing method is used in the quality control of manufactured explosives, characterization and qualification of new explosives, the surveillance of in-service explosives, research & development, and in many other testing programs.

SEVERAL MODELS OF SPARK GAP ASSEMBLIES DESIGNED ACCORDING TO REQUIREMENTS OF DIFFERENT STANDARDS OR TESTING METHODS.

APPLICATION
Electrostatic discharge is one of the most frequent and the least characterized causes of accidental explosions of energetic materials. Sensitivity to electrostatic discharge (spark) is one of the main safety parameters crucial to the handling, processing and transportation of explosives. A small-scale electrostatic spark sensitivity test determines the amount of energy required for an electric spark to cause a tested sample to initiate. This testing method is used in the quality control of manufactured explosives, characterization and qualification of new explosives, the surveillance of in-service explosives, research & development, and in many other testing programs.

PARTS & ACCESSORIES

Set-up of testing container

Remote control

High voltage probe

Featuring

Allows for the precise measurement of both the total spark energy discharged into the sample and the fraction of this energy that is absorbed by the sample to initiate its explosion. This feature allows for the exact determination of the minimum energy sufficient for an accidental initiation of the sample.

- Designed to measure sensitivity of crystalline high explosives, propellants, pyrotechnics, as well as primary explosives to electrostatic discharge.
- Two automatically operated testing stands designed for measurement by different spark gap assemblies:
  - first testing stand designed for fixed distance of electrodes;
  - second testing stand designed for approaching anode.
- External testing assemblies designed for testing a higher amount of samples of explosives.
- Two testing modes for samples according to their susceptibility to shock wave or thermal mechanism of initiation by the spark.
- Gas tight protection cap for simple collection and analysis of gaseous decomposition products.

Designed to comply with the requirements of the following standards of testing:
- EN 13938-2 Explosives for civil uses – Propellants and rocket propellants – Part 2: Determination of resistance to electrostatic energy.
- EN 13763-13 Explosives for civil uses – Detonators and relays – Determination of resistance of electric detonators against electrostatic discharge.
- STANAG 4490
- MIL-STD-1751A Methods 1031, 1032 & 1033

APPLICATION
Sensitivity to initiation by electrostatic discharge is one of the main safety parameters important for the handling, processing or transportation of explosives. These testing methods are used in quality control of manufactured explosives, characterization and qualification of new explosives, surveillance of in-service explosives, R&D and many other testing programs.

PARTS & ACCESSORIES

Remote control

Set-up of testing container

High voltage probe

FEATURES

- Allows measurement by two basic different testing modes:
  - For large-scale testing of sensitivity to electrostatic discharge;
  - For testing to determine resistance of explosive materials, ammunition or electronic elements against electrostatic discharge generated by the human body.
- Remote controlled operation of the apparatus using optical communication.
- Simple reversion of electrical polarity of the high voltage output.
- Robust case with IP54 protection for easy handling and outdoor applications.
- Testing samples weighing up to several kilograms by a series or individual discharges with constant spark energy of up to 17 J.
- The instrument can be used for evaluation of influence of temperature on the spark sensitivity.
- Simple and safe operation.

Designed to comply with the requirements of the following standards of testing:
- STANAG 4235, STANAG 4239, STANAG 4499,
- AECTP-500, AECTP-250
- MIL-STD-331B
- MIL-STD-1751A

TESTING INSTRUMENTS
TESTING INSTRUMENTS

**FSKM-10**
**BAM FRICTION SENSITIVITY TESTER**

*DESIGNED FOR DETERMINATION OF FRICTION SENSITIVITY OF ENERGETIC MATERIALS IN A WIDE RANGE OF FRICTION LOADS (FROM 0.1 TO 360 N) IN ACCORDANCE WITH THE BAM PROCEDURE.*

**TWO LOADING ARMS ARE AVAILABLE – FOR SENSITIVITY TESTING OF HIGHLY SENSITIVE EXPLOSIVES (FRICTION LOADS UNDER 5 N) AS WELL AS LESS SENSITIVE EXPLOSIVES (FRICTION LOADS UP TO 360 N) WITH ONE APPARATUS.**

**HIGH PRECISION IN MOVEMENT CONTROL ENSURED BY DIGITALLY-CONTROLLED STEP MOTOR.**

**APPLICATION**
Friction of explosives between hard surfaces is one of the most frequent causes of accidental explosions. Determination of friction sensitivity is thus a necessary part of characterization of new explosives, modified formulations or manufacturing conditions, as well as for defining influences of impurities or ageing. It is also used in quality control of manufactured explosives, surveillance of in-service explosives and transport/storage classification of explosive materials.

**FEATURES**
- Completely stainless-steel design (friction apparatus, weights and table frame).
- A unique ability to interchange the entire loading arm.
- 6-position loading arm along with a set of 9 standard weights loads from 5 to 260 N.
- 3-position loading arm along with a set of 14 light weights loads from 0.1 to 10 N.
- Digitally-controlled step motor allows to achieve high precision and control of the porcelain plate movement.
- Simple operation via coloured touch-screen panel.
- Working table covered by electrostatic dissipative rubber.
- Wide range of accessories.
- Consumables at reasonable prices.

Designed to comply with the requirements of the following standards of testing:
- UN Recommendation on the Transport of Dangerous Goods
- EN 13631-3:2004 Explosives for civil uses – High explosives – Part 3: Determination of sensitiveness to friction of explosives
- STANAG 4487: Explosives, Friction Sensitivity Tests

**PARTS & ACCESSORIES**
- Touch panel guide
- Light 3-position loading arm PEx-3A
- Sampling spoon 10 mm³ made from conductive plastic
- Standard set of 9 weights

**BFH-10**
**BAM FALL HAMMER IMPACT SENSITIVITY TESTER**

*DESIGNED FOR DETERMINATION OF IMPACT SENSITIVITY OF ENERGETIC MATERIALS IN ACCORDANCE WITH THE BAM PROCEDURE.*

**SPECIAL ATTENTION PAID TO PRECISION (LOW-FRICTION BRASS GROoves FOR WEIGHTS AND NICKEL COATED GUIDES, CALIBRATED SET OF WEIGHTS) AND SAFETY (REMOTE CONTROL, PNEUMATIC-CONTROLLED RELEASING DEVICE, SHIELDED PROTECTIVE BOX).**

**APPLICATION**
Impact sensitivity is one of the most important characteristics of energetic materials defining their safety in handling, processing or transportation. Its determination is a necessary part of characterization of new explosives, modified formulations or manufacturing conditions, as well as for defining influences of impurities or ageing. It is also used in quality control of manufactured explosives, surveillance of in-service explosives and transport/storage classification of explosive materials.

**FEATURES**
- Protective box with standard instrument parts.
- Wide range of impact energies from 0.5 to 100 J.
- Maximum drop height of 1 m.
- Set of five drop weights from 0.5 kg to 10 kg.
- Drop weights with brass grooves for friction reduction.
- Pneumatic or electromagnetic releasing device operated via remote controller.
- Steel file plates for testing of combined impact and friction stimuli.
- Wide range of accessories.
- Consumables at reasonable prices.

Designed to comply with the requirements of the following standards of testing:
- UN Recommendation on the Transport of Dangerous Goods
- EN 13631-4:2002 Explosives for civil uses – High explosives – Part 4: Determination of sensitiveness to impact of explosives
- STANAG 4489: Explosives, Impact Sensitivity Tests

**PARTS & ACCESSORIES**
- Steel guide rings and cylinders
- File plate holder
- Set of 5 drop weights
AET 402
AUTOMATIC EXPLOSION TEMPERATURE TESTER

APPLICATION
Explosion (ignition) temperature is defined as the temperature at which an explosive sample explodes (deflagrates, ignites) when heated with constant rate. AET 402 can also be used for determination of time-to-explosion. It is defined as the time needed for ignition of a sample at a given constant temperature. The tester consists of a temperature controller and a heating block with multiple holes.

FEATURES
• Measures up to 5 samples simultaneously
• Automatic determination of the explosion temperature using an explosion sensor.
• Saves operator’s time by eliminating the need to continuously watch the whole experiment and manually record the explosion temperature.

Designed to comply with the requirements of STANAG 4491.

HEATING BLOCKS
FOR STABILITY TESTING

APPLICATION
Several traditional tests for determination of chemical stability of energetic materials (mainly propellants) are based on heating samples at elevated temperatures and detecting their reactive decomposition products (NOx). This detection can be based on visual identification of coloured gases above the sample (65.5 °C Surveillance Test; Heat Storage Test at 100 °C), colour change of indicator papers (Abel Test, Methyl Violet Test; Heat Test), titration of acidity in water extract of the samples (Holland-Methyl Violet Test, Heat Test), determination of time-to-explosion. It is defined as the time needed for the explosive sample to explode (deflagrate, ignite) when heated at a constant rate.

FEATURES
• High precision of temperature control.
• High safety (independent limit controller including switches against exceeding safety temperature).
• Robust design and long-term reliability.

The instruments comply with the respective standards for particular heat tests and can be further modified upon customer’s request or designed type-specific.

Instruments for the heat tests consist of temperature controllers and heating blocks, each containing multiple (4 – 45) holes for the test tubes of appropriate size. Glass test tubes used for each different test are supplied with the instruments as well.

DTA 552-Ex
DIFFERENTIAL THERMAL ANALYZER

APPLICATION
The Differential Thermal Analyzer DTA 552-Ex was developed specifically for evaluation of thermal stability, purity, compatibility and decomposition parameters of energetic materials, which explosion may cause damage to standard commercial analyzers.

DTA as a method is applied for evaluation of thermal stability of explosive materials, their purity (melting point, solidification point), compatibility, thermal decomposition parameters. It is used in quality control of manufactured explosives, characterization and qualification of new explosives, surveillance of in-service explosives, research & development, and many other testing programs. Several other customer-defined instruments are manufactured, e.g. large-scale or high-pressure DTA.

FEATURES
• EN 13631-14 Explosives for civil uses – High explosives – Part 14: Determination of velocity of detonation
• Low costs of investment and operation.
• High precision and accuracy.
• Large variety of accessories.
• User-friendly software for data acquisition, analysis and archiving.
• Low costs of investment and operation.

Designed to comply with the requirements of STANAG 4515.

VOD-8
DETONATING VELOCITY MEASURING SYSTEM

APPLICATION
Detonation velocity is one of the main explosion parameter. The determination of the detonation velocity is based upon the measurement of the time interval needed for the detonation wave to travel a known distance through the explosive being tested.

This method is based on the ability of the optical fibre to accept a light signal when the detonation wave arrives, and to transmit that signal to the fibre without excessive distortion over the time interval between the two signals. From the measured time interval and the corresponding distance travelled by the detonation wave, the detonation velocity is calculated.

FEATURES
• Battery charged instrument equipped by internal memory for storage of 100 results, 4-line LCD display and water proof keyboard.
• Impact resistant and water proof transport case.
• 7 independent timers measuring the time intervals between the illuminations of 8 optical probes in two operation modes.
• Simple operation.

Designed to comply with the requirements of the following standards of testing:
• EN 13631-14 Explosives for civil uses – High explosives – Part 14: Determination of velocity of detonation
PREWAQ
PRESSURE WAVE ANALYZER AND QUANTIFIER

APPLICATION
The measuring system PREWAQ offers measurement of pressure wave parameters generated by any kind of explosion. This universal tool could be applied not only under open sky but could be also designed for measurement in closed space (e.g. explosion chamber).

The DT modification of the system is used for measurement of extremely fast explosions driven by detonation mechanism and parameters change in order of tens microseconds.

The DF modification is intended for measurement of explosions driven by deflagration mechanism so the change of parameters happen in order of tens of milliseconds.

According to required measurements (type, speed and maximal measured values) the PREWAQ is equipped by the set of sensors together with appropriate cables and perhaps even with stands or holders.

FEATURES

- Measurement of up to either 4 or 8 input channels according to PREWAQ version.
- Simultaneous measurement of pressure, temperature (heat radiation), velocity of detonation and/or light.
- System is intended for measurement, storage and evaluation of explosion parameters.
- Recording and control system is protected by case with IP54/20.
- Battery supply for up to two hours of operation and optional armor covering.
- Graphical output of measured data in formats suitable for spreadsheet and database editors are a standard.
- User-friendly software for apparatus operation, data recording and evaluation.

OZM Research has signed a distribution agreement with Dr. Müller Instruments for Eastern Europe. Product program consists of state of the art measurement technologies for measurement of pressure in liquids and gases, measurement of pressure distribution with Fuji Prescale Film, measurements of temperature and heat flux, and measurement of fluid motion. With its unique sensors for high frequency measurements, with rise intervals of only a few nanoseconds, Müller is the choice for shock and blast wave experiments. Pressure sensitive films, shapeable thermocouples with respond times in the range of a few microseconds, thin film gauges and hot wire anemometers, together with periphery devices, complete the product instrument portfolio.

PRESSURE MEASUREMENT
Fast sensors for pressure measurements in gaseous and liquid medium. State of the art device for measuring high frequency pressure changes with rise intervals of only a few nanoseconds in gases and liquids.

Piezoelectric PVDf Pressure Gauge series M60
Müller-Platte Needle Probe

Pressure Sensitive Film - Fuji Prescale Film
Can be used in almost all sorts of measurement of surface pressure, or simply to show the pressure distribution. The films may be used in both air and water.

FLUID MOTION MEASUREMENT
Micro Hot Wire Anemometers
Thermal anemometers for 1-, 2-, or 3-dimensional air flows

Dr. Müller Instruments Piezoelectric PVDf Pressure Gauge series M60 for use with PREWAQ

TEMPERATURE AND HEAT FLUX MEASUREMENTS

Coaxial Thermocouple MCT
High frequency measurement for heat flux determination adaptable to any surface shapes.

Thermocouple with Increased Sensitivity MTIS
Coaxial thermocouple of TIS type with highest sensitivity of about 180 µV/K.

Thin Film Thermometer MTFT
Measurement of static to high transient surface temperatures with response times in the range of microseconds. The Thin Film Thermometer is recommended for measurements in clean conditions and moderate heat fluxes.
ClosEd vEssEl rb-400
MEasurEMEnt oF ballistiC propErtiEs oF propEllants

APPliCation
Determination of burning rate of solid rocket propellants is usually carried out in a Crawford Bomb or in a small-scale rocket motor at constant pressures. With a classic Crawford Bomb, about 10 individual shots are necessary to get the required burning rate plot in the whole pressure range, while using very complicated and expensive instrumentation. The newly developed Stojan Vessel is a much simpler and safer instrument applying advanced mathematical procedure for calculation of burning rate - pressure plot from experimental data of a single shot only. The mathematical procedure has proved to be in very good correlation with experimental results from multiple-shot measurements in the Crawford Bomb or in the small-scale rocket motor.

FeAtuRes
• Quick assessment of ballistic behavior of new or modified rocket propellant formulations in their research, development and testing.
• Quality control during manufacture of rocket propellants.
• Determination of ageing influence on ballistic behavior of rocket propellants.
• Surveillance of in-service rocket propellants.

The principle of this method is based on the most modern computational and ballistic procedures for determination of burning behavior of solid rocket propellants.

A single shot is sufficient for plotting burning rates in the whole pressure range.

Stojan vEssEl sv-2
advanCEd instruMEnt For MEasurEMEnt oF thE burning ratE oF solid roCkEt propEllants

NieRvoWov vEssEl sv-2
advanCEd instruMEnt For MEasurEMEnt oF thE burning ratE oF solid roCkEt propEllants

appliCation
Stojan Vessel is used for the measuring of pressure increase curve during burning of different propellant types in constant volume. The behavior of the propellant tested is predicted. Thus, by using the Closed Vessel, the number of shots from a real weapon is minimized. Data obtained from tests in the Closed Vessel are also used for the development of new propellants and for the control of regular powder types.

From the values measured it is possible to obtain information about the tested propellant using recording and evaluation device with special software. Propellant characteristics calculated from measured values are e.g. max pressure, vivacity, pressure gradient, cavolume, burning rate, etc.

Pressure - time \( p(t) \) plots measured

Burning rate - pressure \( dp/dt \) plots calculated from experimental \( p(t) \) data

Comparison of calculated burning rate - pressure plots from the Stojan Vessel (green line) with experimental data from a Small-Scale Rocket Motor (green datapoints)

Pressure - time \( p(t) \) plots measured

Pressure gradient \( dp/dt \) - pressure \( p \) plots calculated from experimental data

Vivacity - \( p/p_{\text{max}} \) plots calculated from experimental data

RB400 is high-pressure closed vessel - volume of 400 ccm, pressure range of up to 500 MPa (5000 bar) – constructed from high-strength steel with cooling jacket on the outer surface. It is equipped by temperature sensor, by piezo-electrical pressure transducer, by two outlet valves and by specially sealed breech screw. The breech screw is equipped by ignition device - either electrical or mechanical – providing possibility of both types of ignition. Closed vessel is settled in stand, which allows its position change and fixation in the range of 180°.

Other versions of closed vessels with combustion chamber volumes 10, 40, 80, 500 and 700 ccm are available.

Designed to comply with the requirements of the following standards of testing:
• MIL-STD-286
• STANAG 4115

Pressure - time \( p(t) \) plots measured

Burning rate - pressure \( dp/dt \) plots calculated from experimental \( p(t) \) data

Comparison of calculated burning rate - pressure plots from the Stojan Vessel (green line) with experimental data from a Small-Scale Rocket Motor (green datapoints)
OZM Research has recently developed a new series of testing instruments for combustion, explosion and detonation calorimetry. They allow to measure combustion heats of pyrotechnics and propellants, explosion heats of combustible dust dispersions and detonation heats of high explosives in closed bombs of 5 - 20 liter volume and in different gaseous atmospheres (air, nitrogen, argon, oxygen).

All the calorimeters apply highly precise calorimetric baths equipped with multiple non-linear thermistors with 0.0001 K resolution and good thermal regulation, providing an estimated experimental error in 0.1 % range. Simultaneous dynamic pressure - time measurements for the deflagration and detonation processes are integrated in the control panel of the equipment.

Special stainless steel types of the calorimetric bombs allow to measure highly energetic metalized or corrosive substances and to repeatedly detonate explosive charges up to 25 g TNT equivalent. The calorimeters are PLC-controlled and equipped with touch-panels with user-friendly software for experiment preparation, data acquisition, processing and archiving.

Explo5 software

EXPLO5 is a thermo-chemical computer code that predicts detonation properties (such as composition of detonation products, detonation velocity, pressure, temperature, heat, etc.) of high explosives, and combustion properties of propellants under constant volume or constant pressure conditions (such as composition of combustion products, pressure in closed vessel, heat and temperature of combustion, specific impulse, force, etc.). As such, EXPLO5 is important tool in synthesis, formulation, and numerical modelling of energetic materials.

The calculation of detonation parameters in EXPLO5 is based on the chemical equilibrium, steady-state model of detonation. The equilibrium composition of detonation products is calculated applying free energy minimisation technique. The program uses Becker-Kistiakowsky-Wilson (BKW) equation of state for gaseous detonation products and Murnaghan or Cowan-Fickett’s equation of state for solids products.

Together with the calculation results the running calculation are displayed in the Preview / Run window. An example of the calculation results is shown in the screenshot on the left.

The calculation results are automatically stored in MS Excel format so as to allow the user to evaluate and manipulate the data by the MS Excel program.
**LABORATORY DETONATION CHAMBERS**

Laboratory detonation chambers allow to safely carry out detonation experiments directly inside explosives laboratories. They can be used for scientific investigations, research, development and testing in the area of energetic materials, confined explosions and related applications such as explosive forming of metals or safe disposal of laboratory explosive wastes.

Laboratory detonation chambers are designed to withstand repeated detonations of up to 250 g TNT. The explosive charges are installed on a working table inside the chambers and safely fired by electric detonators connected to firing contacts at the chambers. Gas-tight valves on the chamber body enable creating different gas atmospheres within the chamber, as well as sampling, evacuation and flushing of the post-explosion gases. The chambers are furthermore equipped with multiple windows, which can be used for installing various optical or electrical measuring instruments for investigations of the detonation processes.

Different types of full scale performance and sensitivity tests can be executed within the chambers such as measurement of detonation velocity, pressure-time and temperature-time records of confined explosions, brisance and explosive power tests (Hess, Kast, PDT, Trauzl), high-speed optical and X-ray photography, gap tests, cook-off tests, electrostatic discharge sensitivity tests, etc.

**INDUSTRIAL DETONATION CHAMBERS**

Industrial detonation chambers are automated machinery designed to withstand repeated detonations with equivalent of 2 – 16 kg TNT and applied in serial manufacturing operations, such as:
- Large-scale or frequent scientific detonation experiments.
- Quality control tests in explosives or ammunition manufacture.
- Manufacture of artificial diamonds and nanocarbon.
- Explosive working of metals (hardening, cladding, welding, cutting, pressing).
- Environmentally friendly disposal of ammunition and explosive wastes.
- Forensic investigation and safe disposal of improvised explosive devices.

During more than 40 years of service, these industrial detonation chambers have proven to have a long service life (> 100,000 detonations) and reliable, safe and simple operation with low investment and operating costs. The industrial detonation chambers are manufactured in three design lines – vertical, horizontal and special-purpose – all equipped with hydraulic systems, control panels for fully automatic remote operations and, where required, with appropriate pollution abatement systems for off-gases.

**VERTICAL DETONATION CHAMBERS**

(For 2 – 5 kg TNT) Designed type-specifically for the required application (e.g. manufacture of artificial diamonds).

**HORIZONTAL DETONATION CHAMBERS**

(For 8 – 16 kg TNT) They open and close by a cover moving on rails and are more suitable for elongated charges.

**SPECIAL-PURPOSE DETONATION CHAMBERS**

(For 2 – 5 kg TNT) Designed type-specifically for the required application (e.g. manufacture of artificial diamonds).
20 – 500 g TNT eq. STORAGE
SAFE STORAGE OF SMALL EXPLOSIVE SAMPLES INSIDE LABORATORIES

PORTABLE GAS-TIGHT EXPLOSION-RESISTANT CONTAINERS
• Full protection of life and property in case of accidental explosion.
• All explosion effects contained inside, no release of shock wave, fragments, flame or toxic gases.
• Overpressures of gases safely released after explosion through manually opened valves.
• Possibility of repeated use after accidental explosion inside.
• Zero safety distances: can be stored directly inside laboratories.
• Portable for transport of the explosive samples outside laboratories on public roads.
• Inserts made of antistatic rubber for eliminating risks of friction or spark discharge.
• Quick opening and closing mechanisms.

10¹ – 10³ kg TNT eq. STORAGE
STORAGE MODULES FOR EXPANDING THE CAPACITY OF STORAGE ROOMS

• Storage modules protecting from mutual transfer of explosion.
• Minimization of safety distances / maximization of storage capacity of existing storage rooms.
• Safety distances corresponding to content of one module (up to 2.5 kg TNT) despite total stored amount in the storage room (up to several tons).
• Storage of otherwise incompatible classes of explosive materials in one room.
  • e.g. detonators together with high explosives
• Modules designed for mounting to walls with variable heights and widths.
• Non-sparking and watertight lids, antistatic rubber tightening.

5 – 10 kg TNT eq. STORAGE
SAFE STORAGE OF EXPLOSIVE STOCKS NEARBY LABORATORIES

• Small stores for 5 – 10 kg TNT eq. of explosive samples attached directly to laboratory buildings.
• Safety distances from 2 meters to buildings and public roads.
• All fragments caught, shock wave reduced to safe levels and overpressure released through ventilating chimneys, without moving the container from its position.
• Tested to full TNT capacity and fragment resistance (122 mm - 152 mm cal. HEF projectiles).
• Containers can be transported on trailers or light trucks (applied also to IED/UXO transport).

<table>
<thead>
<tr>
<th>Storage module</th>
<th>J005</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity [kg TNT]</td>
<td>2 x 2.5 kg</td>
</tr>
<tr>
<td>Maximum weight [kg]</td>
<td>245</td>
</tr>
<tr>
<td>Maximum outside dimensions L x W x H [mm]</td>
<td>588 x 400 x 803</td>
</tr>
<tr>
<td>Internal dimensions of one tube Ø x L [mm]</td>
<td>324 x 500</td>
</tr>
</tbody>
</table>
EXPLORATION RESISTANT MAGAZINES
UP TO 1000 KG OF ENERGETIC MATERIALS

EXPLOSION RESISTANT MAGAZINES WITH SHORT SAFETY DISTANCES FOR INSTALLATION INSIDE COMPLEXES OF TESTING LABORATORIES.

STANDARDIZED SHAPE FOR EASY TRANSPORT AND INSTALLATION.

PYRO MAGAZINES
• Storage of non-detonating materials of HD (hazard division) 1.3 and 1.4.
• Made of high-strength fire-resistant concrete panels.
• Large pressure-venting areas (ceiling, doors), steel grid in ceiling, light metal sheet roof, steel doors.
• Smooth internal surfaces for easy maintenance.
• Storage capacity of 1 ton of HD 1.3 materials (pyrotechnics, propellants).
• Without storage limit for HD 1.4 materials (small arms ammo).
• Safety distances from 1 meter (HD 1.4) to 50 meters (HD 1.3).
• PYRO-2: The modified design with an internal wall for section of storage of non-detonating materials of HD (hazard division) 1.3 and 1.4.
• Designed to resist internal explosion of up to 10 kg TNT or cal. 152 mm HEF projectile.
• Can store up to 120 kg TNT and keep structural integrity if equipped with storage modules.
• Trapping all fragments and debris from internal explosion, attenuating the shock wave.
• Minimum safety distances (from 2 meters) allowing storage of explosives in urban areas.
• Allowing common storage of otherwise incompatible materials.
• Customer-tailored design with variable length, door types, armored windows and cable inputs.
• Applicable also as protection bunkers for high-risk remote operations and ballistic tests.
• Resistant against burglary, small arms fire, hand grenade attacks.
• Designed to resist internal explosion of up to 10 kg TNT or cal. 152 mm HEF projectile.

AMMO MAGAZINES
• Armored structures for storage of detonating materials of HD 1.1 and 1.2.
• Designed to resist internal explosion of up to 10 kg TNT or cal. 152 mm HEF projectile.
• Can store up to 120 kg TNT and keep structural integrity if equipped with storage modules.
• Trapping all fragments and debris from internal explosion, attenuating the shock wave.

AMMO-3
• Capacity up to 50 kg TNT in modules.
• Dimensions 4.3 x 2.5 x 2.6
• Maximum weight 10

AMMO-4
• Capacity up to 10 kg TNT in modules.
• Dimensions 4.3 x 2.4 x 2.6
• Maximum weight 13

AMMO-5
• Capacity up to 10 kg TNT in modules.
• Dimensions 3.0 x 2.4 x 2.6
• Maximum weight 9

AMMO-6
• Capacity up to 10 kg TNT in modules.
• Dimensions 4.3 x 2.4 x 2.6
• Maximum weight 18

PYRO-1
• Capacity up to 1000 kg HD 1.3
• Dimensions 4.3 x 2.5 x 2.6
• Maximum weight 10

PYRO-2
• Capacity up to 45 kg HD 1.1
• Dimensions 4.3 x 2.5 x 2.6
• Maximum weight 11

AMMO-1
• Capacity up to 10 kg HD 1.1
• Dimensions 3.0 x 2.4 x 2.6
• Maximum weight 9

AMMO-2
• Capacity up to 50 kg HD 1.1
• Dimensions 3.0 x 2.4 x 2.6
• Maximum weight 13

CNC MACHINING CENTERS
OZM Research develops and supplies multifunctional CNC machining centers for cutting, milling, turning and drilling of energetic materials such as rocket propellants and high explosives. These techniques are typically used for:
• Cutting of large rocket propellant grains to smaller blocks for artificial ageing or mechanical properties tests.
• Machining of the propellant blocks to “dog-bones” or other specific shapes for mechanical, sensitivity and performance tests (gap tests, spark tests, Stojan vessel tests).
• Turning of the rocket propellant samples for removal of insulation layers and obtaining chips for chemical stability testing.
• Precise sampling of the rocket propellants by automated drilling from predefined spots for plasticizer migration.
• Precise sampling of high explosives from the warheads and grenades by automated drilling in predefined spots.

The multifunctional CNC machining centers are developed with consideration of all risky situations leading to accidental initiation such as excessive friction on moving parts, electric or mechanical sparks and hot surfaces. All the electrical components used are appropriately protected, hard friction areas or moving contacts of sparking metals are minimized, explosive dust is continuously removed, tool temperature is continuously measured and operation carefully observed by cameras, fire detectors and automatic fire extinguishers. The CNC machining centers can be installed within mobile explosion-proof bunkers, with a control room and auxiliary equipment located in nearby buildings or mobile containers.

PRESSING TOOLS
Several sensitivity or performance tests (gap tests, brittleness tests, detonation velocity, etc.) require the use of samples of high explosives or pyrotechnics in a form of pressed pellets. OZM Research offers a wide range of pressing tools for preparation of the charges, ranging from 3 mm to 100 mm charge diameter and creating pellets with flat surfaces, detonator entries, central holes or conical shapes. We can also provide a complete pressing station equipped with remote control hydraulic press and installed within an explosion-proof bunker. Design of the pressing tools and complete station originates from long-term experience with these manufacturing tools in the explosives and ammunition industry.

REMOTE SAMPLING & SAMPLE PREPARATION
Sampling of explosive materials from live ammunition and preparation of compact samples for mechanical, sensitivity or performance tests are integral parts of many research & development, quality control and surveillance programs for new, regularly manufactured or in-service energetic materials and ammunition. These sampling and sample preparation procedures are however one of the most dangerous operations with inherent risks of accidental explosions. This is why these operations shall be carried out remotely without direct presence of personnel and with protection of surroundings against effects of eventual explosions.

STORAGE CONTAINERS
EXPERT SERVICES

QZM Research is a knowledge-based company formed by a group of experienced explosives scientists and engineers with advanced academic degrees in this very special branch of chemical engineering. Our Expert Services cover a wide range of activities where deep and very specific knowledge and experience of our experts in energetic materials and industrial safety can be beneficial for our clients. Since the company’s establishment we have successfully dealt with topics so diverse as:

- stability, sensitivity and performance testing of military energetic materials;
- analysis of thermal stability of radioactive wastes;
- modeling of explosion effects of explosives, gas and dust clouds and physical explosions (e.g. BLEVE);
- experimental evaluation of risks of compressed gas explosions;
- risk analyses of industrial accidents involving explosions and other physical effects;
- air blast shock wave and heat measurements in open field, tunnels and closed structures;
- development of insensitive military explosives;
- development of enhanced blast explosives;
- methods for neutralization and safe disposal of improvised explosives;
- technologies for explosive forming of metals;
- methods for preparation of pure standards of explosives;
- complex technology analysis of ammunition demilitarization programs;
- development of type-specific technologies for recovery and recycling of demilitarized explosives and propellants;
- preparation of permitting documentation and SOPs for the explosives technologies.

SPECIALIZED SERVICES

- preparation of permitting documentation
- development of type-specific technologies
- complex technology analysis of ammunition
- methods for preparation of pure standards
- technology analysis of ammunition demilitarization programs
- development of type-specific technologies for recovery and recycling of demilitarized explosives and propellants
- preparation of permitting documentation and SOPs for the explosives technologies.

REFERENCES

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- Australia: ORICA
- Austria: ORICA
- Azerbaijan: Ministry of Defence
- Belgium: Royal Military Academy
- Brazil: IBQ Industries Quimicas
- Bulgaria: Arcus Co.
- Canada: Canadian Explosives Research Laboratory ORICA
- China: China Academy of Safety Science and Technology Beijing National Registration Center for Chemicals, SNVFS (CNRC) Shaanxi Fireworks Inspection Station Shenghua Group Zhejiang Energy Co. Xi’an Modern Chemistry Research Institute
- Croatia: Ministry of Defence University of Zagreb
- Egypt: Ministry of Defence
- France: CNRS French-German Research Institute of Strasbourg Iners STPE Division Scientifique
- Georgia: Express Diagnost
- Germany: BWB DHEI Fisher Scientific Frenzyhpf Institut für Chemische Technologie JCI Ludwig-Maximilians University of Munich
- Greece: National Technical University of Athens
- Hungary: HM Arzaval
- India: HEAML TBLR Vikram Sarabhai Space Centre
- Italy: AVIO Aerospace Propulsion
- Jordan: Ministry of Defence
- Malaysia: STRIDE Weapons Technology Division
- NATO: NAMSA
- Netherlands: TNO Prima Mauritius Laboratory
- Pakistan: National University of Science & Technology
- Poland: Institute of High Energy Physics and Nuclear Research MESKO Warsaw University of Technology
- Romania: Military Technical Academy
- Serbia: Evaco International
- Singapore: Advanced Material Engineering Nanoscale and Nanotechnology University National University of Singapore
- Slovakia: Konštruktia Defence Ministry of Defence VOF Novaky ZTS Imnant ZVH Holding
- South Africa: African Explosives Limited Denal Land Systems
- South Korea: Agency for Defence Development Hamwha Poongson
- Sweden: Dyno Nobel Sweden AB
- Switzerland: Armassina
- Turkey: Roketsan Missile Industries Tubitak Man Tubitak Sage
- UK: Chemistry Energy UK University of Warwick
- UN: International Atomic Energy Agency
- Vietnam: Military Technical Academy Institute Of Propellant And Explosive Chemical Manufacture 21 of General Department of Defense Industry Industry Explosive Material Centre
INTERNATIONAL SALES REPRESENTATIVES

CHINA (1)
StrongWave Technologies
Xi’an City, P. R. China
Tel.: +86 29 8793 8709
Mobile: +86 139 091 880 35
Fax: +86 29 8793 8010
E-mail: strongwave@strongwave.com
www.strongwave.com

CHINA (2)
Idea Science Technology Corporation
Beijing, P. R. China
Tel.: +8610 84775602, 84775603
Fax: +8610 84786587
E-mail: info@idea17.com
www.idea17.com

EGYPT
Noor Scientific & Trade
Cairo, Egypt
Tel.: +202 432 9148
Fax: +202 203 4350
E-mail: survey@noor-scientific.com
www.noor-scientific.com

FRANCE, ALGERIA, MOROCCO
Contact: Mr. Jean-Marie Morand
Tel.: +33 160 26 26 52
Mobile: +33 619 39 63 40
E-mail: jemamorand@aol.com, stpediv@aol.com

GERMANY
Dr. Müller Instruments
Oberursel, Germany
Tel.: +49 6172 380 37 27
Fax: +49 6172 177 077 4
E-mail: info@mueller-instruments.de
www.Mueller-Instruments.de

INDIA
Venture Technologies
Bangalore, India
Tel.: +91 80 65 72 7320
Mobile: +99 720 17793
Fax: +91 80 25 25 0772
E-mail: vijprasad@vnl.net
www.venturetechnologies.net

INDONESIA
PT Radin Nusa Diga
Malang, Indonesia
Contact: Widyanta Budihardjo
Tel.: +62 341 320 090, 321 626
Mobile: +62 813 3470 9360
Fax: +62 341 321 626

MALAYSIA
Sil Malaysia
Subang Jaya, Malaysia
Tel.: +60 3 5633 1432
Fax: +60 3 5633 0811
E-mail: steven.simalaysia@gmail.com

PAKISTAN
Blue Chip International
Karachi, Pakistan
Tel.: +92 21 4310009
Mobile: +92 300 522 1637, 314 200 2393
Fax: +92 21 4532635
E-mail: Taufiq@BlueChipIntl.com
www.BlueChipIntl.com

POLAND
JAKUSZ
Kościerzyna, Poland
Tel.: +48 58 686 5053
Fax: +48 58 686 4909
E-mail: handlowy@jakusz.com.pl
www.jakusz.com

ROMANIA
BIP Tel ecom
Bucuresti, Romania
Tel.: +40 21 327 2602
Mobile: +40 722 242 126
Fax: +40 21 320 0815
E-mail: dragos.iorgu@bip.ro
www.bip.ro

SERBIA, BOSNIA & HERZEGOVINA, MONTENEGRO
ANALYTICS
Beograd, Serbia
Tel.: +381 632 895 66
E-mail: analytics@sezampro.rs

SINGAPORE
InterTech Alliance
Singapore
Tel.: +65 9732 2893
E-mail: leenor_totu@yahoo.com.sg

SOUTH KOREA
ENSOL Co.
Daejeon, Republic of Korea
Tel.: +82 42 477 7465
Mobile: +82 16 565 0526
Fax: +82 42 477 7466
E-mail: hong@ensol.co.kr, hyhong26@hanmail.net
www.ensol.co.kr

VIETNAM, CAMBODIA, LAOS
Hienquang Co.
Hanoi, Vietnam
Tel.: +84 4 761 77 53
Mobile: +84 913 537 940
Fax: +84 4 761 76 91
E-mail: hienquang@ptf.vn, hienquang@viettel.vn

OZM RESEARCH s.r.o.
Blížňovice 32
538 62 Hrochův Týnec
Czech Republic
European Union
Tel.: +420 469 692 341
Mobile: +420 608 742 777
Fax: +420 469 692 882
E-mail: ozm@ozm.cz
www.ozm.cz