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Preliminary communication
Prethodno priopćenje

DETERMINATION OF CRITICAL PARAMETERS ON TESTING METHODS OF ELECTRIC DETONATORS ACCORDING TO EUROPEAN STANDARDS

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Keywords: testing of electric detonators, thermal stability, hydrostatic pressure stability, impact sensitivity, mechanical strentgh, European standards

Abstract

In the paper are presented results of testing electric detonators according to New European Standards.

In order to establish real, marginal values, testing have been performed on suggested devices with extreme parameters applied.

Consequently, sensitivity on impact of bridge wire, primary and secondary explosive charge, thermal stability, resistance to water and resistance to hydrostatic pressure of electrical detonators have been measured with wider range that proscribed by the standard.

The results obtained by the research were used to evaluate reality of proposed values in New European Standards.

Ključne riječi: ispitivanja električnih detonatora, toplinska stabilnost, otpornost na hidrostatski pritisak, osjetljivost na udar, mehanička čvrstoća, Europske norme

Sažetak

U radu su dani rezultati laboratorijskih ispitivanja električnih detonatora prema zahtjevima Europskih Normi. Kako bi se odredile stvarne, granične vrijednosti ispitnih parametara, u odnosu na parametre propisane normama, ispitivanja su izvedena na normama predloženoj ispitnoj opremi. Tijekom ispitivanja primjenjivani su maksimalni ispitni parametri ograničeni tehničkim mogučnostima ispitne opreme. Osjetljivost na udar električnog mostića, primarnog i sekundarnog punjenja; toplinska stabilnost i otpornost prema hidrostatskom pritisku vode električnih detonatora ispitivani su vrijednostima većim od zahtjeva normi. Dobiveni rezultati služe za ocjenu realnosti zahtjeva EN i određivanje maksimalnih otpornosti električnih detonatora.

1. Introduction

Modern methods for attesting and control examinations of explosives, detonators, electrical detonators and pyrotechnical materials are executed according to Croatian regulations and standards, while new European standards are in process of approval.

If Republic of Croatia becomes a member of CEN (European Committee for standardization), examination of explosive materials will be done according to methods regulated by European standards.

The technical board CEN/TC 321 gave suggestions to EN about field of examination of explosive materials.

This paper brings a critical review on suggested European standard, Explosives for civil uses-Detonators and relays:

prEN 13763-12: 2000 Determination of resistance to hydrostatic pressure, DRAFT.

EN 13763-2: 2002 Determination of thermal stability, European standard (doa 2002-12-31).

EN 13763-3: 2002 Determination of sensitiveness to impact (doa 2002-12-31).

prEN 13763-7: 2000 Methods for determination of mechanical strength of leading wires, shock tubes, connections, crimps and closures, DRAFT.

Electric detonators were tested. The testing instruments were constructed and examinations took place in the "Laboratory for testing of explosives for civil uses, detonators, electrical detonators and pyrotechnical materials" at the Department for mining and geotechnics of the Faculty of mining, geology and petroleum engineering, University of Zagreb.

Respecting the standard examination methods, critical values of testing parameters were defined. According to the results, one of the methods will be recommended as well as test parameters that correspond to real values of detonator sensitivity.

2. Description of instrument and testing procedure

2.1 Instrument for the determination of resistance to hydrostatic pressure

It consist of water tank (with 0.5 m depth water), which is closed with steel cap. On the cap are valve, pressure gauge and exhaust pipe. Water tank and compressor are connected with air hose for rising of pressure in water tank (fig. 1.).

1. Compressor
2. Valve
3. Water tank
4. Valve and exhaust pipe
5. Cap
6. Pressure gauge
7. Sealing plug

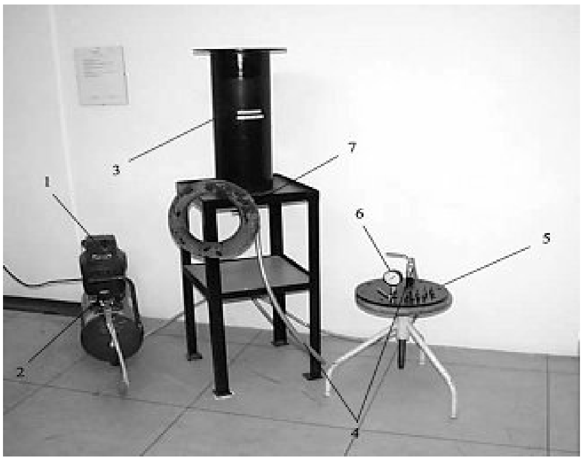

Figure 1. Parts of the instrument for determination of resistance on hydrostatic pressure

Slika 1. Dijelovi uređaja za ispitivanje hermetičnosti

2.2 Determination of resistance to hydrostatic pressure

Seventy-nine detonators have been prepared for hydrostatic pressure sensitivity testing.

Half second detonators with aluminum capsule were tested, no. 2, PSED-Al, "Pobjeda" Goražde, BiH. Total charge of detonator is 1 g, composed of 200 mg of initiation charge-led azide and 800 mg (in two levels of 300 and 500mg) of high explosive charge-pentrite.

Detonators are prepared, numerated and photographed; testing procedure is carried out according the procedure described in Croatian standards and European standard.

Croatian standard demand hydrostatic pressure which is equal to the pressure caused with 2 m water height (eq.~19 613 Pa or~ 0.2 bar) during 6 h (State Office for Standardization and Metrology/DZNM, Zagreb, Croatian standard: HRN.HD8.112.).

According to EN pressure is 300 000 Pa or 3 bar during 48 h (European Committee for Standardization, Brussels, European standard, draft: prEN 13763-12: October 2000).

Values of testing parameters were changed from values prescribed by standards up to extreme hydrostatic pressures, limited with construction properties of testing device.

2.3Instrument for determination of thermal stability

Testing was performed in heating cabinet with temperature range from environmental up to 220 °C- MEMMERT TYP UP 400 capable for maintained temperature in range of ± 2 °C.

In the main heating cabinet was chamber made of steel plate (15-20 mm). That chamber has protection purpose for main heating cabinet against mechanical damages of detonator parts and gases released in moment of detonation of tested detonator.

Chamber is consisted of two sub chambers with same volume. Left sub chamber is for testing detonator and right is for temperature resistance sensor (fig 2.).

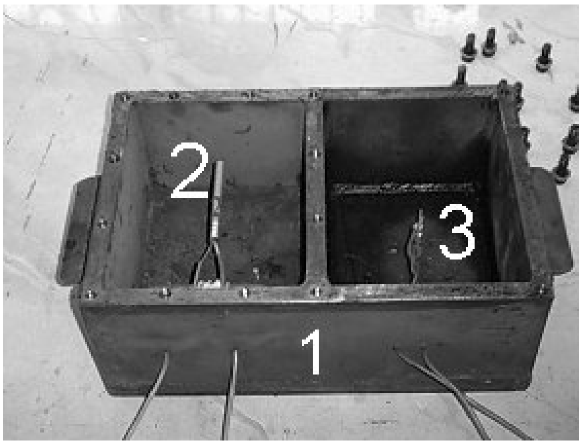

Figure 2. Chamber

Slika 2. Komora

1-Chamber with two sub chambers
2-Detonator
3-Temperature resistance sensor

Figure 3. Testing equipment
Slika 3. Ispitna oprema

Because of different heating conditions in cabinet and chamber there is need for measuring actual temperature in chamber in order to established real temperature in moment of detonation. After the calibration of resistance temperature sensor the output electrical resistance is functionally depend on inner chamber temperature.

Temperature in main heating cabinet is controlled manually or by the computer program „Celsius for windows". Testing equipment is given on fig. 3. Fig. 4. shown screen plot of „Celsius for windows" with parameters that are basic for testing (Celsius for Windows, Operating instructions, Memmert; 2000).

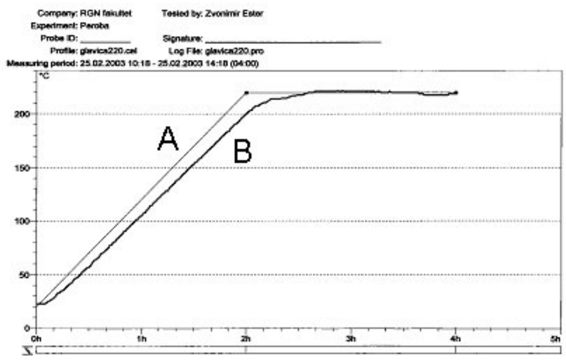

Figure 4. Screen plot "Celsius for Windows"
Slika 4. Izgled ispisa programa "Celsius for Windows"

A-programmed temperature
B-actual temperature in heating cabinet

2.4 Determination of thermal stability

Four half second electric detonators with aluminum capsule were tested, no. 2, PSED-Al, "Pobjeda" Goražde, BiH. Total charge of detonator is 1 g, composed of 200 mg of initiation charge-led azide and 800 mg (in two levels of 300 and 500 mg) of high explosive charge-pentrite. Also, four ignition head of detonators of same type have been tested and one ignition head in empty detonator capsule.
The aim of testing was determination of critical parts of detonators in subjection of heat and temperature in the moment of detonation.

Basic testing procedure is carried out according the procedure described in Croatian standards and European standard with extreme parameters, limited with construction properties of testing device. Croatian standard demand temperature of 60°C during 24 h (State Office for Standardization and Metrology/DZNM, Zagreb, Croatian standard: HRN.HD8.110.).

Demands of EN are: temperature 75°C and 105°C for products intended for use in hot emulsion for a period of 48 h (European Committee for Standardization, Brussels, European standard: EN 13763-2: November 2002).

2.5 Instrument for testing detonators sensitivity to impact

It consists of an anvil with a cylindrical holder for a detonator. In the cylindrical holder there are a piston director and the piston itself. On the cylindrical holder there is a guide pipe with a weight and a scale. Beside the guide pipe there is a releasing mechanism placed on steel holders (fig. 5).

1 - impact piston
2 - additional weight
3 - piston director
4 - cylindrical holder
5 – anvil
6 - guide pipe with weight
7 - releasing mechanism

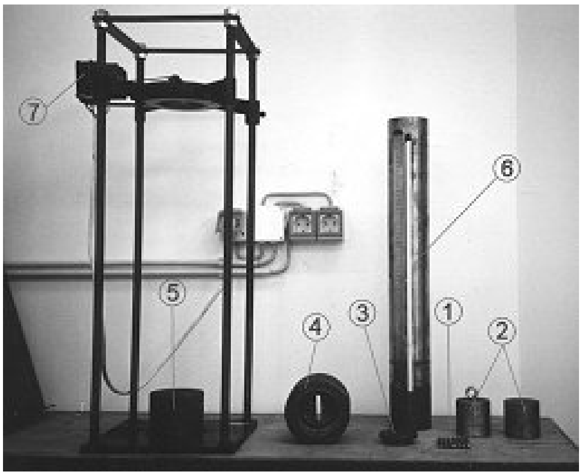

Figure 5. Parts of the instrument for testing of shock sensitivity

Slika 5. Dijelovi uređaja za ispitivanje osjetljivosti na udar

1 - frame holder
2 - holder of electrical detonator
3 - electromagnet for releasing of weight
4 – rectifier
5 - voltage regulator
6 – weights

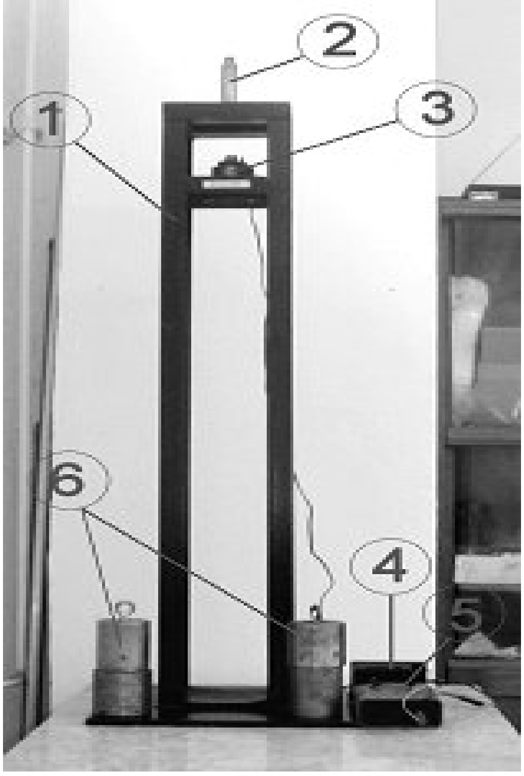

Figure 6. Elements of an instrument for testing of construction strength

Slika 6. Dijelovi uređaja za ispitivanje čvrstoće konstrukcije

2.6 Determination of sensitiveness to impact

One hundred detonators have been prepared for testing of sensitivity to impact. Half-second detonators were tested, no. 2, PSED-AL, "Pobjeda" Goražde, BiH. Total charge of a detonator is 1 g, composed of 200 mg of initiation charge - led azide and 800 mg (in two levels 300 and 500 mg) of high explosive charge – pentrite

Detonators were prepared and numerated, photographed and x-rayed. Shock sensitivity of ignition head, primary charge and secondary charge of an electric detonator were tested. Croatian standard demand 2 kg drop weight and drop height of 0.1 m for ignition head. For primary charge drop height is 0.5 m (State Office for Standardization and Metrology/DZNM, Zagreb, Croatian standard: HRN.HD8.109.).

According to EN drop weight is 2 kg and drop height is 2 m (European Committee for Standardization, Brussels, European standard, draft: prEN 13763-3, November 1999).
The largest impact height of a weight was 515 mm. Several weights of various masses were used: 1805, 1820, 1839, 1862, 2000, 2001, 2040, 3932 g, connection screws of 7 and 8 g, and connection hook screws of 21 and 24 g.

The figure 7 shows the detonators before testing on shock sensitivity (samples 1 to 25, remaining 75 samples were prepared in the same way). The figure 8 shows their x-rays.

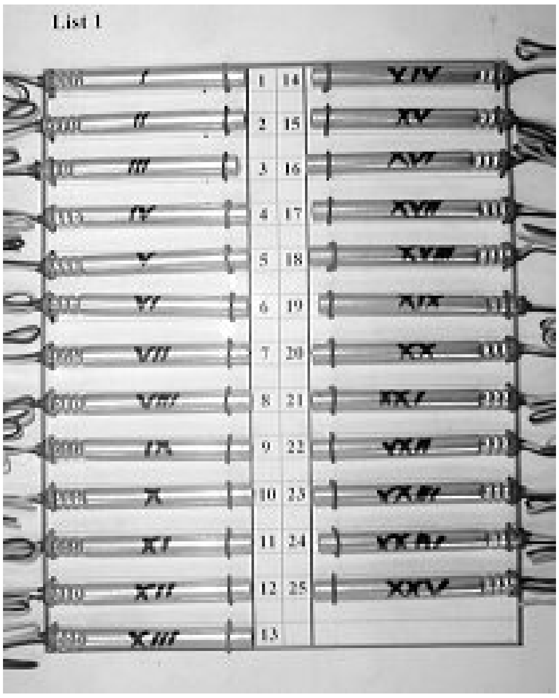

Figure 7. Electric detonators before testing

Slika 7. Električni detonatori prije ispitivanja

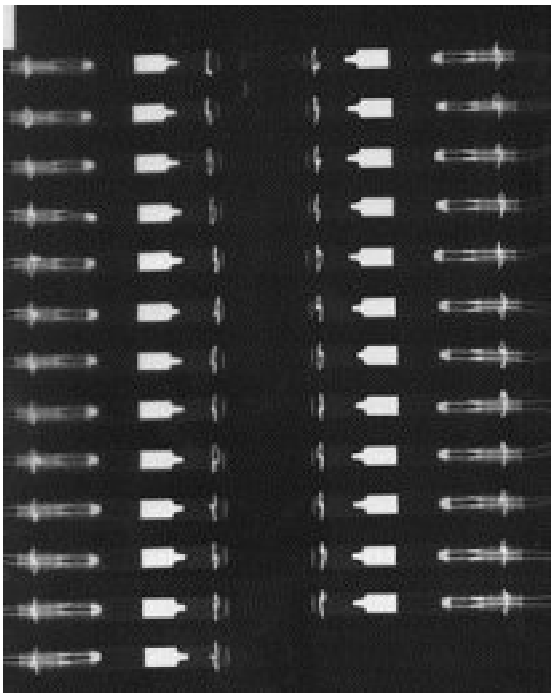

Figure 8. X-rays of electric detonators before testing

Slika 8. Rentgenska snimka električnih detonatora prije ispitivanja

2.7 Instrument for testing of construction strength of electrical detonators

The instrument consists of a frame holder with a detonator holder and an electromagnet for releasing a weight. The electromagnet is connected to a rectifier and a voltage regulator. The instrument is shown on fig. 6.

2.8 Determination of construction strength of electrical detonators

The 45 detonators have been tested (37 half-second detonators, no. 2, PSED-AL, "Pobjeda" Goražde, BiH; and 8 detonators type "Austin detonator", Vsetin, Czechoslovakia) on a dynamic load. Also, 14 have been tested on static load (PSED-AL, "Pobjeda" Goražde, BiH).

Croatian standard demand in static load test mass of 2x2 kg and length of leading wires is 0.5 m (load time-120 s). In sudden release test (dynamic) mass is 0.5 kg and length of wires is 0.5 m (State Office for Standardization and Metrology/DZNM, Zagreb, Croatian standard: HRN.HD8.114).

According to EN in first case demands are: mass of 4 kg, length of 0.5 m, load time is 10s; in second case: mass of 10 kg, length of 0.5 m and load time is 120 s (European Committee for Standardization, Brussels, European standard, draft: prEN 13763-7, October 2000).

Several weights of various masses were used: 2000, 3848, 5661, 5934 and 7781 g during 300 s for static load test. In case of dynamic load test, energy was in range from 9.810-25.243 J. That values are reached with load mass of 2000 and 3676 g with fall height 0.5- 0.9 m.

Figure 9 show electrical detonators and leading wires after testing on construction strength.

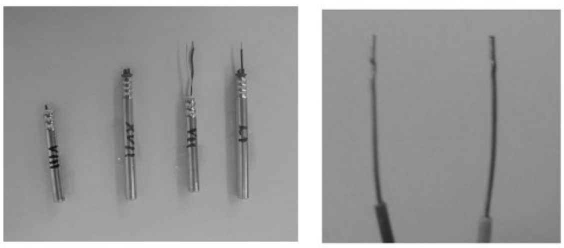

Figure 9. Electric detonators after testing on construction strength

Slika 9. Električni detonatori nakon ispitivanja čvrstoće konstrukcije

Table 1.Pressure values

3. Results of testing

3.1Hydrostatic pressure

First sixty electric detonators are divided in twelve groups with five detonators. Each group of detonators is brought into subjection of different pressures in range from 0.5 up to 6 bar, eq. 0.05-0.6 MPa. Hydrostatic pressure of 0.5 m high water column was constant. Total pressure values are shown in table 1.

Extra pressure up to 6 bar was reached wit compressed air.

Hydrostatic pressure of water:

$$p_H = \delta \times g \times h \qquad [Pa] \qquad (1)$$

p_H -hydrostatic water pressure [Pa]
δ – water density 1000 [kg/m^3]
g – gravity 9.80665 [m/s^2]
h – water column height [m]

Detonator is in subjection of entirely pressure

$$p_{UK} = p_H + p_Z \qquad [Pa] \qquad (2)$$

p_{UK} - entirely pressure [Pa]
p_H - hydrostatic water pressure [Pa]
p_Z -compressed air pressure [Pa]

After 30 min detonators are taken out of water tank. In order to examine function of detonators and possible damages they are fired. Same procedure is carried out for next five detonators with difference in employment time and pressure. According to demands of standard detonators were 48 hours in water exposed to pressure of 6 bar.

Water pressure did not caused damage and initiation of all 65 detonators was carried out successful. During the firing of detonators, whistling sound was notified (with raising of air pressure in water tank above 2.5 bar – entirely pressure on detonator was 257 400 Pa). That sound was imputed to water that may have penetrated in detonator capsule, initiation head or under the isolation of leading wires.

Because of that, five new detonators are tested without isolation on leading wires.(fig. 10.) They were fired too, with whistling sound. Test results are given in table 2.

Initiation of tested detonator pointing on conclusion that penetrated water had not caused serious damage for detonator function.

Nine ignition head are tested according the same procedure (6 bar, 48 h) and they were initiated normally (fig. 11.). Test results are given in table 3.

Tablica 1. Tlakovi

Detonator No.	Electrical resistance (Ω)	Water column hight (m)	Water pressure (Pa)	Air pressure (Pa)	Entirely pressure (Pa)	Eq. water column height (m)	Time (min)	Initiation	Notice
1-5	4.1	0.5	4900.3	50500	554000.3	5.7	30	yes	
6-10	4.0	0.5	4900.3	101000	105900.3	10.8	30	yes	
11-15	4.1	0.5	4900.3	151500	156400.3	16.0	30	yes	
16-20	4.1	0.5	4900.3	202000	206900.3	21.1	30	yes	
21-25	3.9	0.5	4900.3	252500	257400.3	26.3	30	yes	whistling
26-30	4.2	0.5	4900.3	303000	307900.3	31.4	30	yes	whistling
31-35	3.9	0.5	4900.3	353500	358400.3	36.6	30	yes	whistling
36-40	4.2	0.5	4900.3	404000	408900.3	41.7	30	yes	whistling
41-45	4.2	0.5	4900.3	454500	459400.3	46.9	30	yes	whistling
46-50	4.0	0.5	4900.3	505000	509900.3	52.0	30	yes	whistling
51-55	4.2	0.5	4900.3	555500	560400.3	57.2	30	yes	whistling
56-60	4.2	0.5	4900.3	606000	610900.3	62.3	30	yes	whistling
61-65	4.1	0.5	4900.3	606000	610900.3	62.3	2880	yes	whistling

Table 2 Test results-detonators without isolation on leading wires
Tablica 2. Rezultati ispitivanja- detonatori bez izolacije električnih vodiča

Detonator No.	Electrical resistance (Ω)	Water column hight (m)	Water pressure (Pa)	Air pressure (Pa)	Entirely pressure (Pa)	Eq. water column height (m)	Time (min)	Initiation	Notice
1-5	3.9	0.5	4900.3	606000	610900.3	62.3	30	yes	whistling

Table 3 Test results-ignition head
Tablica 3. Rezultati ispitivanja-zapaljiva glavica

Fuse head.	Electrical resistance (Ω)	Water column hight (m)	Water pressure (Pa)	Air pressure (Pa)	Entirely pressure (Pa)	Eq. water column height (m)	Time (min)	Initiation	Notice
1-3	3.3	0.5	4900.3	202000	206900.3	21.1	30	yes	-
4-6	2.7	0.5	4900.3	404000	408900.3	41.7	30	yes	
7-9	2.5	0.5	4900.3	606000	610900.3	62.3	30	yes	

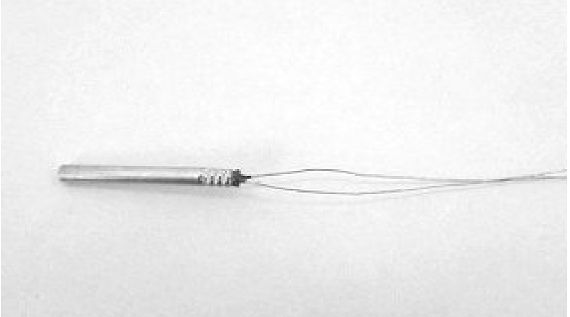

Figure 10. Detonator without isolation on leading wires

Slika 10. Detonator bez izolacije električnih vodiča

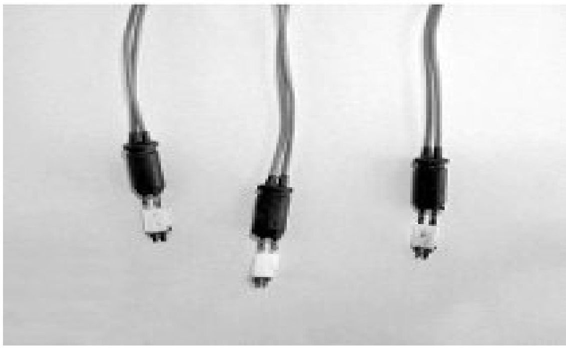

Figure 11. Initiated ignition head

Slika 11. Aktivirana zapaljiva glavica

1.2 Thermal stability

Ignition heads were hold in heating cabinet without sub chamber during 3.5, 4,24 hours. Reached temperatures were 120, 180, 200 and 220°C. After the heating period, temperature was maintained constant for period of 2 and 24 h. During that time ignition head has not initiated. Demands of Croatian standard for thermal stability of electric detonator are temperature of 60°C for the period of 24 h. According to that demands one ignition head was tested on double temperature value (120 °C) during the 24 hours. There was no initiation of ignition head. Damages that had occurred on sealing plug and electrical conduits were melted plastic isolators. One of ignition head was set in empty detonator shell in purpose of simulating thermodynamic condition in detonator, also initiation was missed. In other case when detonators were tested, temperature was rising from room temperature up to 220°C in two hours. Each detonator was fired on temperature above 160°C (table 4).

Table 4 Temperature
Tablica 4. Temperatura

Detonator no.	Temperature (°C)
1	164.5
2	163.5
3	176
4	163.5

3.3 Sensitivity to impact

The testing on sensitivity to impact of electrical detonators included the following procedures: detonator's resistivity was measured by ohmmeter "Mesko IM 11C", certain mass was released from a certain height and activation was monitored, detonator's resistivity was measured afterwards again and shock energy was calculated. The testing showed the importance of position of the ignition cap at the moment of impact. If it is horizontal to a piston, lower energy is needed to cut off the electrical bridge, while the higher energy is required if it is in vertical position (table 5). The energy that induced the activation varied between 37.815 J to 39.374 J (table 6). If the impact energy was increased above the activation energy (up to +20J), activation of electrical bridge occurred without activation of initial charge or activation of delay element. When the impact energy would decrease below the activation energy (down to -5 J) activation of the bridge occurred without transition to initial charge.

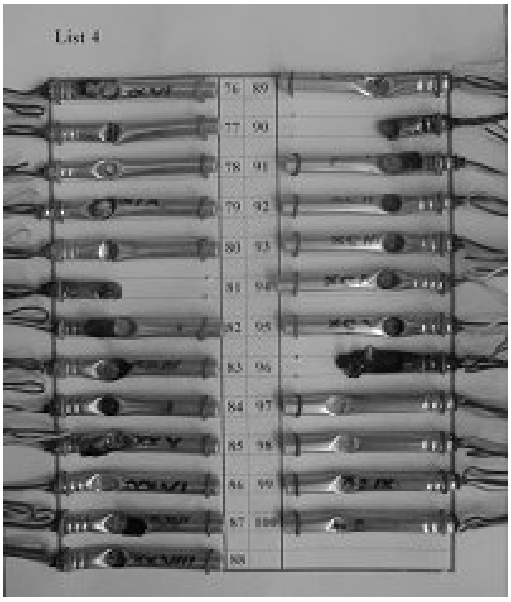

Figure 12. Electrical detonators after testing on sensitivity to impact

Slika 12. Električni detonatori nakon ispitivanja osjetljivosti na udar

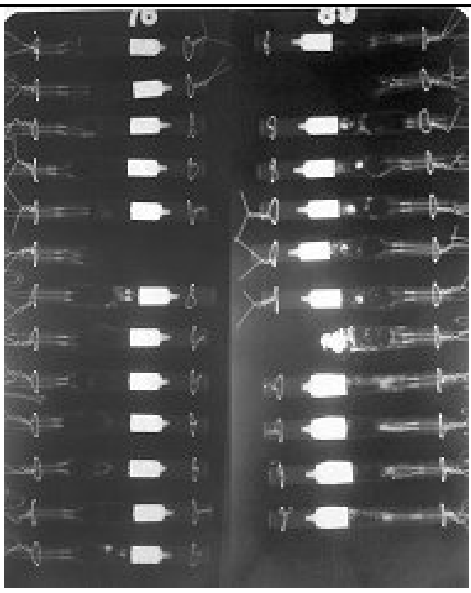

Figure 13. X-ray of electrical detonators after testing

Slika 13. Rentgenska snimka električnih detonatora nakon ispitivanja

In the process of testing the sensitivity to impact of primary and secondary charge, the energy was increasing up to a maximum limit of the instrument (57.655 J).Those parameters did not initiate the activation of an electrical detonator.

In all three variations of testing a shape of a impact piston has been changed (flat-circular, chisel-shaped, pointed) and activation occurred only with flat one when hit the ignition cap. Chisel-shaped or pointed pistons cut off or pierce the detonator - its tested part. At impact on an ignition cap (the only part of a detonator which activates on impact) the flat circular surface of piston transfers the impact energy equally on pyrotechnical material, and by stress increase gives enough energy for activation without cutting off the pyrotechnical material placed near a contact surface with the piston, as it seams to be the case with the other two types of a piston.

Table 5 Critical energy for cut bridge wire
Tablica 5. Kritična energija za prekidanje električnog mostića

No. of tested detonator	Electrical resistance (Ω)	Fall height (m)	Mass (kg)	Activation	Energy (J)	Bridge wire	Position of impact	Piston shape
18	2	0.178	2.040	no	3.562	horizontal	bridge wire	flat-circular
65	2.2	0.220	2.040	no	4.402	vertical	bridge wire	flat-circular

Table 6 Critical activation energy
Tablica 6. Kritična aktivacijska energija

No. of tested detonator	Electrical resistance (Ω)	Fall height (m)	Mass (kg)	Activation	Energy (J)	Bridge wire	Position of impact	Piston shape
90	1.9	0.485	7.948	yes	37.815	horizontal	bridge wire	flat-circular
96	2.1	0.485	7.948	yes	37.815	horizontal	bridge wire	flat-circular
81	2	0.505	7.948	yes	39.394	horizontal	bridge wire	flat-circular

3.4 Construction strength

Before and after testing of construction strength of an electrical detonator versus dynamic loads, resistivity of a detonator was measured. The height of weight release was kept constant, but the weight mass was changing. Any kind of damage that occurred on a detonator was detected after testing procedure. Testing was executed on two types of electrical detonators from two different producers.

Comparison of collected data clearly showed that the load limits which produce damages of various types of detonators are very different. As for the mater of energy, testing of construction strength of a detonator versus dynamic loads showed that complete breaking of leading wire on "Pobjeda" detonators occurs with energy of 11.772 J, and on "Austin" detonators at 25.243 J, which is more than double energy and thus a double resistivity to a dynamic load.

When resistivity to a static load was tested, detonators have been prepared the same way. Leading wires were loaded with different weights in different time intervals. While testing, a limit mass value was noticed 3.848 kg when even after 300 s mechanical damages of a detonator did not appear. Mass of 5.661 kg caused extrusion in three cases out of five. Mass load of 7.781 kg caused extrusion or breaking of leading wires in all tested detonators.

Table 7 Critical mass at static load test
Tablica 7. Kritična masa pri statičkom ispitivanju

No. of tested detonator	Electrical resistance (Ω)	Length of wires (m)	Mass (kg)	Time (s)	Electrical resistance after testing (Ω)
145	2.2	0.500	3.848	300	2.2
140	2.9	0.500	5.661	1	-
141	2.3	0.500	5.661	300	2.5
142	2.0	0.500	5.661	10	-
143	2.1	0.500	5.661	300	2.4
146	2.0	0.500	5.661	1	-
147	2.1	0.500	7.781	2	-

4. Conclusion

The starting points for determination of limiting parameters at both testing procedures have been taken from relevant Croatian standards and suggested European standards in order to recommend a methodology of laboratory testing, execution and usage of test instruments, and to define parameters of influencing factors (hydrostatic pressure, temperature, time of exposition, mass, fall height - impact energy).

4.1 Determination of resistance to hydrostatic pressure

Test results are pointing on next conclusion:

Required pressure in European norm was chosen good. Pressure in Croatian norm is too low. Customary deep of blast holes in quarries are approximate 20-25m. In case that the whole hole is saturated with water, water pressure is 2 bar. Testing of detonators on water pressure of 3 bar give 1.5 safety coefficient for ordinary electric detonators. In case of under water blasting with highest water pressure detonators are specialty constructed.

Duration of pressure influence is too long in booth standards. After testing with pressure of 6 bar all detonators were detonated no matter how long they were exposed. In ordinary conditions on blast field, 12 hours is maximal time of detonator exposition in hole with water (working shift time).

4.2 Determination of thermal stability of electric detonators

Usually, detonators may be subjected to temperatures up to 70°C (temperature in vehicle parked on sun influence) or 80°C (in hot pumped emulsion explosives). Exposure period shall not be more then 12 h (working shift time). According to that 24 h testing period is acceptable. Safety coefficient in that case is 2. European norm is in this matter too rigorous. EN makes difference in testing ordinary detonators and detonators intended for use in hot emulsions. Values of selected temperature are adequate for laboratory testing with enough safety coefficient.

4.3 Determination of sensitiveness to impact

The critical energy which takes to activate detonation of electrical detonators (testing by impact on ignition cap) varies between 37.815 and 39.374 J, which recalculated into fall height equals weight mass of 2 kg released from 1.9274 m, or 2,0068 m (table 6 and table 8). These values correspond to maximum requirements of European standards. As these represent the limit energy values (detonation occurs), they are as such too high to regular testing of detonators.

In case of monitoring the variations of electrical resistivity after mechanical damage, it is visible from the presented results of the influence of position of the electrical bridge at impact, it is necessary for testing to place it horizontal because it takes lower energy to break. It can be noted that between 2.5 and 4.4 J it is unreliable, while at lower energies it does not break at all, and above it surely breaks the electrical bridge. It was found out that impact on initial or high explosive charges does not activate detonation even with the maximum energy allowed. Therefore, we can point out that the ignition head is the most critical part of a detonator, and more concern should be taken in its testing.

Table 8 Fall height for critical energy
Tablica 8. Visina pada za kritičnu energiju

No. of tested detonator	Mass (kg)	Energy (J)	Fall height (m)
90	2	37.815	1.927
96	2	37.815	1.927
81	2	39.394	2.007

4.4 Testing of construction strength of electrical detonators

The critical energy of 5.49 J was noticed during dynamic part of testing. It is nearly twice higher than required by Croatian standards, and nearly twice lower according to European standards. Based on results of comparison of tested detonators "Pobjeda" and "Austin" (limiting energy 25.243 J) we can conclude that the connection of leading wires of "Austin"detonator is more firm and satisfies the requirements of both standards, while the detonators "Pobjeda" do not satisfy the European standards.

The results of static testing showed that difference between a mass load that causes breakage of leading wires (5.661 kg) and mass load that does not cause breakage (3.848 kg) equals 1.813 kg, in other words nearly the load mass accepted in Croatian standards. It is necessary to define the critical mass by more precise testing procedures, and this result gives only the frame for further testing.

An overall conclusion is that testing of detonators in laboratory conditions give information on product quality, in other words their resistivity to various impacts produced in such limited testing conditions. These condition are different at manipulation and usage of detonators, as well as possible impact types and loads are different.

As a matter of transport security and usage of detonators on a blast field, it can be noticed that only strict obeying of the rules in manipulation and usage of detonators can guarantee safety.

In order to give recommendation regarding testing parameters regulated by standards, it is necessary to test more samples of different producers and that way determine the variations in resistivity to various types of loads, and thereafter regulate limits of testing values by obeying the critical and tested values of the same, in other words by obeying the safety requirements and required quality of products.

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