European Shotfirer Standard Education for Enhanced Mobility

– ESSEEM –
ESSEEM Work Package Initiation Systems

worked out and giving a lecture by ORICA Mining Services Germany
Competencies
Qualification required in Initiation Systems

• Different Initiation Systems [Electric, Nonelectric & Electronic].
• Their characteristics, components, accessories and application.
• How the Initiation Systems and Detonators are constructed.
• How to handle them safe in the area of operation.
• Advantages and disadvantages of the different systems.
• Which Delay Numbers are available?
• How to transport and store Detonators.
• Risk of misfires.
• Maximum amount of detonators in a circuit.
• Procedures for connecting detonators.
• Connecting the charged holes (Sequence of Tie up) and controls.
• Visual control.
Competencies
Qualification required in Initiation Systems

• Surface connectors.
• How to locate damage in a nonelectric circuit.
• Electric detonators resistance and current in the firing circuit.
• Operational problems through:
  - current leakage,
  - stray current,
  - lightning,
  - magnetic induction and
  - damaged insulation while blasting in conductive material.
• Equipment and technique to measure Leakage
• Equipment and technique to measure Short Circuit to Earth.
• Locating current leakage when coupling electric detonators in serial.
• Locating current leakage when coupling electric detonators in parallel.
• Blaster, Logger, Scanner & Tester.
• Firing Cable, Connecting Wire, Harness, Bus wire.
• Detonating cord.
Symbols to help Students

Fundamental knowledge

Supplementary knowledge

Danger
<table>
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<th>Contents</th>
<th>Time (1 day)</th>
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<td>1 hr</td>
</tr>
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<td>2. Nonelectric Initiation</td>
<td>1 hr 30 min</td>
</tr>
<tr>
<td>3. Electric Initiation</td>
<td>1 hr 30 min</td>
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<td>4. Electronic Initiation</td>
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<td>5. Detonating Cord</td>
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Definition

An Initiation System …

… is a means of detonating high explosive charges reliably, at the specified time and in the correct sequence ….
WP 5 - Initiation Systems
WP 5 - Initiation Systems

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History

From Alfred Nobel’s patent of detonator... 

... to Electronic Initiation
History

- 1831  Miner’s Safety Fuse - William Bickford
- 1863  Detonator for Safety Fuse - Alfred Nobel
- 1895  Electric Firing - Julius Smith
- 1907  Detonating Cord - Louis L’heur
- 1950s  Millisecond Delay Detonators - Nitro Nobel
- 1960s  VA - system - Nitro Nobel
- 1970s  Nonel – system - Nitro Nobel
- 1980s  Electronic Detonator - Dynamit Nobel
- 1990s  NPED – Technology - Nitro Nobel
History - The 1st Detonator
The Introduction of Electric Initiation gave a higher degree of Safety for the People involved in Blasting Operations.
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NPED – Technology
What NPED stands for?

Non

Primary

Explosive

Detonator

1. Steel Element
2. Al Cup
3. Crystalline PETN
4. Granulated PETN
5. Pyrotechnic Mixture

1. RDX
2. PETN
3. NPED I-element
4. Delay mixture
5. Rigid Al element with delay mixture
6. Al Shell

5. Pyrotechnic Mixture
4. Granulated PETN
3. Crystalline PETN
2. Al Cup
1. Steel Element
NPED – Technology

Conventional vs. NPED

Conventional

Leg Wires
Seal Plug
Fuse Head
Delay Element
Primary Expl.
Base Charge

NPED

DDT*-Element

* DDT = Deflagration to Detonation Transition
NPED – Technology
Conventional vs. NPED
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Nonelectric Initiation

Mode of Operation

Shockwave travelling thru Shock Tube

Initiation of Pyrotechnic Element

Detonation of Primary Charge or DDT Element

Detonation of Base Charge
Nonelectric Initiation

Shock Tube Functioning

Shock Tube

Flame Front

Shock Wave preceding Flame Front

HMX / Al dust
Nonelectric Initiation
Shock Tube Construction

- Multiple Layers Tubes
- HMX / Al Dust Mixture
- Coreload Limits \( \approx 15 \text{ mg/m} \)
Nonelectric Initiation
Shock Tube – Live & Fired

Shock Tube - Live

Shock Tube - Fired
Nonelectric Initiation
Shock Tube vs. Detonating Cord

≈ 2,000 m/s

≈ 6,500 m/s
Nonelectric Initiation
Components

**Starter Unit:**
initial signal to start the blast remotely

**Surface Connector:**
distribute signal & delay timing across surface

**Downline Unit:**
transmission of signal down the hole, delay timing and det energy
Nonelectric Initiation

3 Areas of Initiation System

Starter
the key....

Surface
the distributor....

In hole
the transmission....
Nonelectric Initiation
Surface Delay vs. Detonator Strength

Surface Delay

Detonator MS - LP

#2
0.2 g Pb Azide

#8
0.125 g Pb Azide
0.78 g PETN
Nonelectric Initiation
Surface Delay vs. Detonator
Nonelectric Initiation
Detonator Assembly

- Delay Detonator
- Ultrasonic seal
- Colour coded J-Hook
- Shock Tube

Non-electric Detonator

45 metre
EXPLOSIVE DANGER
Initiating Explosives Systems Pty Ltd
Non-electric Detonator
ENDURADet™
Nonelectric Initiation
Detonator Assembly

![Detonator Assembly](image-url)
Nonelectric Initiation
Lead In Line - Connection

To first hole

Tape
Nonelectric Initiation
Surface Delay

- 6 or 8 Tube Block
- Delays 9 to 200 ms
- Lengths 3.6 to 18 m
- Colour coded Tube

Low strength Lead Azide or NPED Cap
Nonelectric Initiation
Surface Delay - Construction

- Base Charge
  (e.g.: ≈ 200 mg of Lead Azide)
- Delay Element
- Isolation Cup
- Free Space
- Crimp
- Rubber Bush
- Shock Tube
Nonelectric Initiation
Surface Delay - Construction
Nonelectric Initiation
Combination Surface Delay & Detonator
Nonelectric Initiation
Function Surface Delay

+ 17 ms

+ 17 ms
Nonelectric Initiation

In Hole Timing

- 500 ms + 17 ms = 517 ms
- 500 ms + 17 ms = 534 ms
- 500 ms + 17 ms = 551 ms
- 500 ms + 17 ms = 568 ms
- 500 ms + 17 ms = 585 ms
Nonelectric Initiation
Detonator Shrapnel
Nonelectric Initiation
Electric Initiation of Nonelectric Blast
Nonelectric Initiation

Nonelectric Initiation of Nonelectric Blast
Nonelectric Initiation

Nonelectric Initiation of Nonelectric Blast
Nonelectric Initiation

Principal of Initiation - Trenchblasting
Nonelectric Initiation
Principal of Initiation
Nonelectric Initiation
Principal of Initiation

Surface delay

Final delay 500 ms 525 550 575 ...

0 ms 25 50 75 ...
Nonelectric Initiation
Example – Firing Pattern
Nonelectric Initiation
Detonation & Burning Front

110 Boreholes / 8 Rows / 13 t Bulk Emulsion

Lead In

Control Row

Blast

Between the Rows – Delay Backwards
Nonelectric Initiation
Detonation & Burning Front

In the Row 17 ms / Between the Rows 42 ms / Down the Hole Delay 200 ms
Nonelectric Initiation
Nonelectric Initiation vs. Initiation via Detonating Cord

NONEL

Detonating cord
Nonelectric Initiation

Nonelectric Initiation vs. Initiation via Detonating Cord
Nonelectric Initiation
Surface Hook Up Sequence on the Bench

A
Connect Echelons

B
Start here

C
Connect control row

D
Rear of Shot

E
Last!

Place Dets at holes
Nonelectric Initiation
Initiation via Detonation Cord
Nonelectric Initiation
Initiation via Detonation Cord
Nonelectric Initiation
Clip Technology
Nonelectric Initiation
Clip Technology
Nonelectric Initiation
Bunch Connector
Nonelectric Initiation
Bunch Connector
Nonelectric Initiation
Development - Sections
Nonelectric Initiation
Development - Sections
Nonelectric Initiation
Development - Sections
Nonelectric Initiation
Sublevel Stoping/Caving

- Caved hanging wall
- Blasting and hauling
- Production drilling
- Development of new sublevels
Nonelectric Initiation
Sublevel Stoping/Caving
Nonelectric Initiation
Demolition Blasting - Foundation

38. Row  35.  30.  10.  5.  Lead In

1 Surface Delay for 3 Detonators

> 500 Boreholes
Nonelectric Initiation
Demolition Blasting – Smoke Stack – Chimney
Nonelectric Initiation
Demolition Blasting – Smoke Stack – Chimney

VBU Magdeburg – Espenhain 1998
Nonelectric Initiation
Demolition Blasting – Bridge

Detonating Cord 5 g/m

det 1

det 2
Nonelectric Initiation
Demolition Blasting – Bridge
Nonelectric Initiation
Demolition Blasting – Building

TVF Altwert – Lübbenau 1999
Nonelectric Initiation
Demolition Blasting – Building

Nonelectric Initiation
Demolition Blasting – Building

Nonelectric Initiation
Demolition Blasting – Building

Nonelectric Initiation
Demolition Blasting – Building

Nonelectric Initiation

Pro´s and Con´s

Pro:
+ easy handling,
+ no extra tool required,
+ ruggedized,
+ safe against stray current,
+ no risk of Leakage,
+ no system limits,

Contra:
– no Circuit Testing,
– additional element: Surface Delay,
– Calculation of the real firing time,
– accuracy,
– Shock Tube can not be shortened/cut,
– Shock Tube waste in muck pile.
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Electric Initiation
Detonator Construction

- Fusehead
- Pyrotechnic Delay Element
- Base Charge
Electric Initiation
Mode of Operation

Instantaneous Detonator
- Initiation of Fusehead
- Detonation of Primary Charge
- Detonation of Base Charge

Delay Detonator
- Pyrotechnic Delay
- Detonation of Primary Charge
Electric Initiation
Detonator Classes

Class 1
Class 2
Class 3
Class 4
# Electric Initiation

**Detonator Groups – Wire Colours**

<table>
<thead>
<tr>
<th></th>
<th>A/S/NT - Type Class 1</th>
<th>U - Type Class 2</th>
<th>VA - Type Class 3</th>
<th>HU/XS - Type Class 4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Instantaneous</strong> (0 ms)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>MS Short Period</strong> (25 ms)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>LP Long Period</strong> (100 &amp; 250 ms)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Electric Initiation

Electrical Data – Class 1 (Type A/S/NT)

Fuse head resistance \(0,9-1,4 \, \Omega\)
No fire current \(< 0,25 \, \text{A}\)
Recommended firing current (single) \(\geq 0,6 \, \text{A}\)
Recommended firing current (series) \(\geq 1,0 \, \text{A}\)
Firing impulse \(3-5 \, \text{mJ/}\Omega\)

Colour coded
NT-instantaneous
NT-MS
NT-HS

Leg wire colours
Yellow/white
Yellow/green
Yellow/red
Electric Initiation
Electrical Data – Class 2 (Type U)

Fuse head resistance: 0,4-0,9 Ω
No fire current: < 0.45 A
Recommended firing current (single): ≥ 1,0 A
Recommended firing current (series): ≥ 1,5 A
Firing impulse: 8 - 16 mJ/Ω

Colour coded
U-instantaneous
U-MS
U-HS

Leg wire colours
Red/white
Red/green
Red/red
Electric Initiation

Electrical Data – Class 3 (Type VA)

Fuse head resistance 0,15 – 0,25 Ω
No fire current < 1,2 A
Recommended firing current (single) ≥ 2,2 A
Recommended firing current (series) ≥ 3,5 A
Firing impulse 80 - 140 mJ/Ω

Colour coded
VA-instantaneous Grey/white
VA-MS Grey/green
VA-HS Grey/red

Leg wire colours
### Electric Initiation

**Electrical Data – Class 4 (Type HU/XS)**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuse head resistance</td>
<td>0.04 – 0.09 Ω</td>
</tr>
<tr>
<td>No fire current</td>
<td>&lt; 4.0 A</td>
</tr>
<tr>
<td><strong>Recommended firing current</strong> (single)</td>
<td>≥ 6.0 A</td>
</tr>
<tr>
<td><strong>Recommended firing current</strong> (series)</td>
<td>≥ 25.0 A</td>
</tr>
<tr>
<td>Firing impulse</td>
<td>1100 - 2500 mJ/Ω</td>
</tr>
</tbody>
</table>

**Colour coded**
- XS/HU-instantaneous: Blue/white
- XS/HU-MS: Blue/green
- XS/HU-HS: Blue/red
Electric Initiation
Equation following Ohm

Current = \frac{\text{Voltage}}{\text{Resistance}} \quad I = \frac{U}{R} \left[ \text{Ampere} = \frac{\text{Volt}}{\text{Ohm}} \quad \text{or} \quad A = \frac{V}{\Omega} \right]

1. Example

Connecting a Class 2 Detonator [e.g.: U-Type Detonator having a Resistance of 3 Ohm] to a Battery with 4.5 Volt;

This will generate a current of: \( I = \frac{4.5 \text{ V}}{3 \text{ \Omega}} = 1.5 \text{ A}. \)

This current will initiate the U-Type Detonator safely
2. Example

But, placing a Firing Cable [having a resistance of 10 Ohm] between the Detonator and the Battery, so that the Firing Cable and the Detonator have a total resistance of 13 Ohm; there will be only a current of: \[ I = \frac{4.5 \, V}{13 \, \Omega} = 0.35 \, A \]

The U-Type Detonator will \textbf{not} be initiated by this current.
For Calculation of the total Resistances of a Firing Circuit

1 m steel wire  0,4 Ohm
1 m Cu wire  0,06 Ohm
1 fuse head U-Type Detonator [Class 2]  0,6 Ohm
HU-Type Detonator 4 m [Class 4]  0,6 Ohm
HU-Type Detonator 5 m [Class 4]  0,7 Ohm
Firing Cable T/4 DDK (red)  10 Ohm/100 m
Firing Cable T/4 DDK (yellow)  3,6 Ohm/100 m

Example
How to calculate the resistance of a U-Type Detonator [Class 2] on 3 m steel wire?

Detonator Wire:  \(2 \times 3 \, m = 6 \, m\)  \(\Rightarrow\)  \(6 \, m \times 0,4 \, Ohm = 2,4 \, Ohm\)
Detonator Resistance:  \(0,6 \, Ohm\) (Fuse Head) \(+\)  \(2,4 \, Ohm\) (Steel Wire) = \(3,0 \, Ohm\)
To check an electric firing circuit only approved Circuit Testers are allowed to use; to avoid a premature initiation.

Depending on the design You can use the circuit tester to check the Resistance and Leakage.

Analog Circuit Testers have to be adjusted to 0 or ∞; prior to use.
Electric Initiation
Circuit – in serial
Electric Initiation
Circuit – in serial

Calculation of the total Resistance of a Firing Circuit

\[ R_a = R_{Z1} + R_{Z2} + R_{Z3} + \ldots + R_{Zn} + R_S + R_V \]

or

\[ R_a = R_Z \times n + R_S + R_V \]

with:

- \( R_a \) = Total Resistance of the Firing Circuit
- \( R_Z \) = Single Resistance of a Detonator
- \( n \) = Number of Detonators
- \( R_S \) = Resistance of the Firing Cable
- \( R_V \) = Resistance of Detonator Wires & Harness
Electric Initiation
Circuit – in serial

Calculation of total Resistance

1. Example
The Firing Circuit contains 150 U-Type Detonators [Class 2] with 5 m steel wires, harness wire over 20 m and 200 m Firing Cable (Type T/4 DDSK).

What is the total resistance?

\[2 \times 5 \text{ m} \times 0.4 \text{ Ohm} + 0.6 \text{ Ohm} = 4.6 \text{ Ohm}\]
\[150 \times 4.6 \text{ Ohm} = 690.0 \text{ Ohm}\]
\[2 \times 20 \text{ m} \times 0.4 \text{ Ohm} = 16.0 \text{ Ohm}\]
\[2 \times 100 \text{ m} \text{ T/4 DDSK} = 20.0 \text{ Ohm}\]

Total Resistance = 726.0 Ohm
**Electric Initiation**

**Circuit – in serial**

**Calculation of total Resistance**

2. **Example**

A Firing Circuit contains 10 Class 4 Detonators [HU Type] with 4 m wires, 200 m Firing Cable T/4 DDSK [Fe] or T/4DDK [Cu].

1. Calculate each total resistance in serial connection,
2. Which is the right type Blaster?

1. **Type of Firing Cable**

<table>
<thead>
<tr>
<th></th>
<th>T/4DDSK</th>
<th>T/4DDK</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 x 0,6 Ohm</td>
<td>= 6 Ohm</td>
<td>= 6 Ohm</td>
</tr>
<tr>
<td>200 m Firing Cable</td>
<td>= 20 Ohm</td>
<td>= 7,2 Ohm</td>
</tr>
<tr>
<td>Total Resistance</td>
<td>= <strong>26 Ohm</strong></td>
<td>= <strong>13,2 Ohm</strong></td>
</tr>
</tbody>
</table>

2. Using T/4DDSK [Steel] min. ZEB/CU 400/HU80
   Using T/4DDK [Copper] min. ZEB/CU 200/HU20
Due to poor insulation [e.g.: Connections] or damaged Insulation Leakage can occur.

Wet conditions, [plus AN in water], steel reinforcement in demolition blasting makes Leakage even worse

To avoid misfires Leakage has to be tested.
With proper Insulation the total resistance may not below 10,000 Ω.
Electric Initiation
Connection in Parallel
Electric Initiation
Connection in Parallel

Calculation of total Resistance

\[
\frac{1}{R_p} = \frac{1}{R_{Z_1}} + \frac{1}{R_{Z_2}} + \frac{1}{R_{Z_3}} + \ldots + \frac{1}{R_{Z_n}}.
\]

In a Firing Circuit with Detonators connected in parallel, the resistance of each Detonator has to be approximately the same

\[
\frac{1}{R_p} = \frac{n}{R_{Z_1}} \quad \text{or} \quad R_p = \frac{R_z}{n}.
\]

With:

- \(R_p\) = total Resistance of the Firing Circuit
- \(R_z\) = Resistance of a single Detonator
- \(n\) = Number of the Detonators
Electric Initiation
Connection in Parallel

Calculation of total Resistance

The Resistance of the Firing Cable \([R_S]\) has to be added in serial to the total Resistance of the Firing Circuit \([R_p]\)

\[
R_a = \frac{R_z}{n} + R_s
\]

Example:

A Firing Circuit contains 80 Class 2 Detonators [U-Type with steel wires] with a Resistance of 3.5 \(\Omega\) each; the Resistance of the Firing Cable is 4 \(\Omega\).

\[
R_a = \frac{3.5 \Omega}{80} + 4 \Omega = 0.04375 \Omega + 4 \Omega = 4.04375 \Omega
\]
Electric Initiation
Connection in Parallel – Development

Min. 10 m rubber hose to protect Firing Cable against Fly Rock
Electric Initiation
Connection in Parallel – Shaft Sinking

Firing Cable
Min. 10 m rubber hose to protect Firing Cable against Fly Rock

Connection in principal
Electric Initiation
Electrical Hazards – What to fire a Detonator?

- Batteries, power sources
- Electric equipment, cables
- Steel pipes, rail, conductors
- Lightning, ground currents
- Static, Radio energy, Cell phones
- Firing cables, leads near power lines
Electric Initiation

Electrical Hazards – What to fire a Det?

- High Voltage
- Lightning
- Power Cable
- Induction
- Radio
- Mobiles
- Earth Leakage
- Electric Pump
- Stray Current
- Batteries

Electric Initiation – What to fire a Det?
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6. Initiation Systems – Safety
Electronic Initiation
Principal Design & Functionality

• Delay is achieved electronically - not pyrotechnically.
• More than 10 different designs, worldwide.
• Fundamental structure basically the same:
  • Computer chip used to control delay timing,
  • which uses electrical energy stored in one or more capacitors to provide power for timing clock and initiation energy.
Electronic Initiation
Fundamental System Differences

- Some systems are basic programmed at the factory and have fixed delay range – this gives accuracy but no flexibility to produce maximum benefit from timing.
- Others chose a digital 2-way talk-back with computerised on-bench adjustment and verification before firing – this gives maximum security and control, but is more expensive.
- Because of these differences in design and handling shotfirers have to be trained individually on the use of each system.
Electronic Initiation
Detonator Construction

Wire

Sealing Plug

Safety

Chip on Board

Capacitor

Fuse Head

Shell

Base Charge
Electronic Initiation
Precision & Value

Good precision, right value

Good precision, wrong value

Bad precision, right mean value

Bad precision, wrong mean value
Electronic Initiation
Scatter: Pyrotechnics vs. Electronics

Pyrotechnic delays

1 %

0.01 %
High frequency – Choppy
Ship is smooth - Don’t feel anything

Low frequency – Swell
Ship rolls - Unpleasant
Electronic Initiation

Benefits of Electronic Initiation

- Smooth walls - reduced back break
- Improved fragmentation - reduced fines
- Improved vibration control
- Precise control over rock pile heave
- Unlimited timing possibilities
- Opportunities to open up patterns
- Reduced drilling metres / costs
Combined Initiation
Electric, Nonelectric & Electronic

In some cases it makes sense to combine different kind of Initiation Systems (e.g.):

Accuracy:
In Tunnelling the high precision of electronic Detonators helps to avoid overbreak in the Perimeter; the major [centre] part of the whole circuit contains nonelectric Detonators.

Electricity:
Stray Current [or the probability of lightning] forces to use nonelectric detonators – for testing prior to Blasting the nonelectric round will be initiated thru an electric firing circuit.

Testability:
In Demolition the 2 Way Communication of Electronic Initiation offers testing the most important part of the whole Circuit.
Combined Initiation
Tunnelling & Development – Smooth Blasting
Combined Initiation
Demolition – Stray Current

Due to Stray Current of a close by Power Plant, the major part of the circuit contains nonelectric detonators; the nonelectric detonators are initiated via an electric firing circuit.
Combined Initiation
Demolition – Stray Current

Due to Stray Current of a close by Power Plant, the major part of the circuit contains nonelectric detonators; the nonelectric detonators are initiated via an electric firing circuit.
Due to Stray Current of a close by Power Plant, the major part of the circuit contains nonelectric detonators; the nonelectric detonators are initiated via an electric firing circuit.
Combined Initiation
Demolition – Stray Current

Due to Stray Current of a close by Power Plant, the major part of the circuit contains nonelectric detonators; the nonelectric detonators are initiated via an electric firing circuit.

TVF Altwert - Hagenwerder 1999
Combined Initiation
Demolition – Stray Current

Due to Stray Current of a close by Power Plant, the major part of the circuit contains nonelectric detonators; the nonelectric detonators are initiated via an electric firing circuit.

Firing Circuit: 8 electric Class 4 Detonators + 1,900 nonelectric Detonators

- 6 s 250 ms
- 4 s 250 ms
- 2 s 250 ms
- 0 s

Cooling Tower

Cooling Tower

Cooling Tower

Cooling Tower

Delay Time

Interval

Delay No

Electric Detonator

Detonating Cord 5 g/m
Combined Initiation
Demolition – 2 Way Communication

- "Frame" Circuit
  - Electronic Detonators
  - 12 g/m Detonating Cord
  - 5 g/m Detonating Cord
  - Connector

- Main Firing Circuit
  - Nonelectric Detonators
  - Delay No 1
  - Delay No 2
  - Delay No 3
  - Delay No 4
  - Delay No 5

- Logger
- Harness
- Linear Cutter

“Frame” Circuit

Main Firing Circuit

Combined Initiation
Demolition – 2 Way Communication
Combined Initiation
Demolition - Benefits

- High Number of Detonators [> 1.300]
- Short Period Increments even in high firing times
- 3 Blasting Levels
- 10 d charging the Blast
- Reliability
- Testability
WP 5 - Initiation Systems

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Detonating Cord
Cord Construction

PETN Core
Centre Cottons

PP Yarns
Plastic Over Extrusion

Overwrap Yarns
Waxed Overcoat

[Image of cord construction diagram with labels for PETN Core, Centre Cottons, PP Yarns, Plastic Over Extrusion, Overwrap Yarns, and Waxed Overcoat]
Detonating Cord

Cord Types

‘Cordtex’ 3.6 ‘W’
  Uniflex
3.6 g/m

‘Cordtex’ 5 ‘W’
‘Cordtex’ 5 ‘P’
5 g/m
5 g/m

‘Cordtex’ 10 P
  Redcord
10 g/m

‘Profiler’
70 g/m
Detonating Cord

Cord Knots

Double Clove Hitch

Reef Knot
Detonating Cord
Cutting Detonating Cord

Plastic Jaw

Correct: Use a plastic jaw cutter.

Incorrect: Do not use a metal jaw cutter or a hammer.

WARNING: Be careful when handling detonating cord.
Detonating Cord

Cord Properties

- Strength: $\approx 70 - 100$ kg
- Stretch: $\approx 10\%$
- Impact Resistance: $\leq 20$ kg/m
- VOD: $\approx 7,000$ ms
- Water Resistance (Type ?!)
- Oil Resistance (Type ?!)
Detonating Cord
MS Connector

Detonating cord

Millisecond Connector (MSC)

to Fire detonating cord ONLY
Detonating Cord
MS Connector

Plastic Cleat Blocks

25ms

Yellow EXEL signal tube

Nonelectric delay detonator

# 8 Strength cap

to Fire detonating cord ONLY

Delay Range
- 9ms
- 17ms
- 25ms
- 42ms
- 65ms
- 100ms
- 125ms
- 150ms
- 175ms
- 200ms
Detonating Cord

Cord Misfires

- Shrapnel
- Wet
- Wet
Detonating Cord
Cord Connect Up

Cut out and re-make factory joins

recommended
Detonating Cord
Nonelectrics & Cord – Poor Handling

Not connected

Shrapnel damage to tubing.
Detonating Cord
Nonelectrics & Cord – Poor Handling

Tubing Cut-off
Detonating Cord
Nonelectrics & Cord – Poor Handling

Near Knots

Not within 200 mm
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Initiation Systems – Safety

Blast Mats
Initiation Systems – Safety

Blast Mats
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Initiation Systems – Safety
Blast Mats
Initiation Systems - Safety

FISH

Friction
Impact
Static
Heat
Initiation Systems - Safety

What Impact can a fire a Det?
Initiation Systems - Safety

What Impact can a fire a Det?

Intact Detonators - 20 kg/m
Where's the go signal?

- Tube is NOT Conductive
- Conductive potential via Aluminium in powder
- Not conductive even at twice normal Al level
- Note: a lightning strike may initiate signal tube
Initiation Systems - Safety
What Heat can a fire a Det?

- Hot Blastholes - reactive ground
- Hot exhaust
- Fires, welding
- PETN 120 -130 °C
Initiation Systems - Safety
Damaged Detonator
Initiation Systems - Safety
Snap, Slap & Shoot
What would happen if a detonator fired in a 150mm tin can?
Initiation Systems - Safety

Detonator fired in a tin Can
What would happen if a detonator fired in your hand?
Detonator fired in Your Hand
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Initiation Systems

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