Electronic Blasting Systems a new tool for Geophysical Exploration

CAGC Blasting Committee

May 1, 2006

Calgary, Alberta

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- Geophysical data acquisition is a complex process. Programs have many activities being carried out in parallel (drilling, loading, surveying, slashing).
- Electronic Blasting Systems are a new tool that may used to help improve the safety and security of geophysical programs

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A Brief History of Initiating Systems

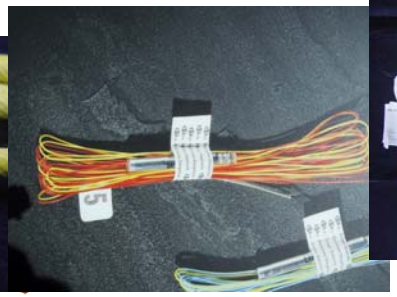
1836 - Black Powder / Safety Fuse
1900s - First Non-electric Detonators
- First Electric Detonators
1920s - First LP Electric Detonators
1940s - Detonating Cord Production
- MS Electric Detonators
1950s - Igniter Cord Production
1960s - Anoline Detonators
1974 - Nonel Detonators
1990s - Electronic Blasting Systems

Increasing Control







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Electronic Blasting Systems- the Players

Austin Powder

ElectroStar

Davey Bickford USA

Daveytronic®

Dyno Nobel

Digidet®

hotshot®

Orica

i-kon™

UNI Tronic™

OSEIS ™

Systems shown are currently used in North America.
Other Electronic Blasting systems are available and
In use in other parts of the world.

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I don’t want to be first!

The 24 countries listed below have been the site of blasts initiated with the i-kon™ Digital Energy Control System.

Asia- Pacific


Australia


New Zealand


Indonesia


Korea


Hong Kong


India


Philippines

Europe


Austria


Belgium


Germany


Spain


Sweden


U.K.


U.A.E.


Ireland


Norway


France

North America


Canada


U.S.A.

Latin America


Brazil


Chile


Mexico


Argentina


Peru

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What's happening in North American?

- **Electronic Blasting Systems are in daily use in the USA and Canadian mining industries**

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Why are Electronic Blasting Systems being Used?

- **They are solving customer problems!**

i-kon DIGITAL ENERGY CONTROL

Case Studies

Gibraltar Mine

Hard Copy
Printable PDF

Gibraltar Mine has low-grade ore which forced it to close for 5 years. On re-opening, Management had to look at every way possible to maximize mill throughput and overall pit productivity. They tried i-kon™ and never looked back. Better fragmentation led to major improvements of both shovel and mill productivity and cleaner pit walls and floors also helped to reduce maintenance costs. To top it all off, the increased cost of i-kon™ was paid for by an expanded drill pattern alone.

Hagen Bank

Hard Copy
Printable PDF

Watch the Video:
Windows Media

When P&Z, an expert demolition company based in Europe, were contracted to bring down the 100m high bank tower in Hagen, Germany, they looked to the capabilities of the i-kon™ System. There was no room for error, and only one opportunity to get it right. i-kon™ was used on critical blasts to collapse the tower safely within the 70m landing zone. Prior to the blast, the functionality of the System was checked repeatedly, right up to the last moment, assuring that the demolition would take place exactly as designed. The results were extemely successful, with the i-kon™ System making a critical contribution to the achievement.

Chuquicamata

Hard Copy
Printable PDF-English
Printable PDF-Spanish

Watch the Video:
Windows Media-NorthAmerican
Windows Media-Australian
Windows Media-Spanish

The SAG mill at Chile's giant Chuquicamata Mine, the world's largest open pit, has very specific fragmentation requirements for the ore that it processes. Mine management introduced electronic detonators to their blast program to improve blasting fragmentation in the pit, maximize productivity through the new mill and increase copper

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Key Points to Remember . . .

- **Electronic Blasting Systems are a tool to provide Drillers and Shooters with new level of control over the loading and shooting process.**

- **Good blasting fundamentals are required to take full advantage of electronics:**
  - **Skilled Shooters**
  - **Drilling accuracy**
  - **Hole loading**
  - **System hook-Up**

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OSEIS™ Detonator

- **Two-way communication with detonator**
- **Unique detonator ID**
- **Testing of functionality after loading**
- **Detonator can ONLY be fired with the unique digital protocols**
- **Cannot be fired by a car or truck battery**
- **Electronic record of loaded detonator IDs**
- **Constant firing time: 20ms ± 0.1ms after receipt of trigger signal**
- **Legwire lengths: 5,10, 15, 20, 30, 40 & 50 m**
- **Tensile strength of lead wires > 20 kg**
- **Water tightness: 25 bar / 7 days**
  5 bar / 28 days
- **Shipping Classification: 1.4S UN0456**

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OSEIS™ TESTER

- **Inherently Safe Device**
- **Self-test of hardware and firmware**
- **Testing of detonators**
- **Recording of:**
  - **Detonator IDs**
  - **Line and Shotpoint Numbers**
  - **Leakage**
- **Viewing detonator IDs**
- **Check of leakage current**
- **Upload of Tester data to PC**
- **Rechargeable Batteries**

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OSEIS™ Tester – Memory

- **OSEIS™ Tester memory may be downloaded to a PC to provide a permanent record of the loading process.**

Hole #	Detonator ID	Line #	Shotpoint #	Leakage
1	776A47	00353	00560	0.1 mA
2	77677A	00353	00561	0.0 mA
3	77677D	00353	00562	0.3 mA
4	776780	00353	00563	0.0 mA
:	:	:	:	:
:	:	:	:	:
300	776ACB	00353	00860	0.2 mA

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OSEIS™ SHOOTER

- **Self-test of hardware and firmware**
- **Unique security PIN to avoid unauthorized use**
- **SHOOTER is triggered by voltage pulse from a Pelton ShotPro (I or II)**
- **Rechargeable batteries**
- **External power supply**
  - **Vehicle 12V adapter**
  - **ATV**
  - **Pelton battery**

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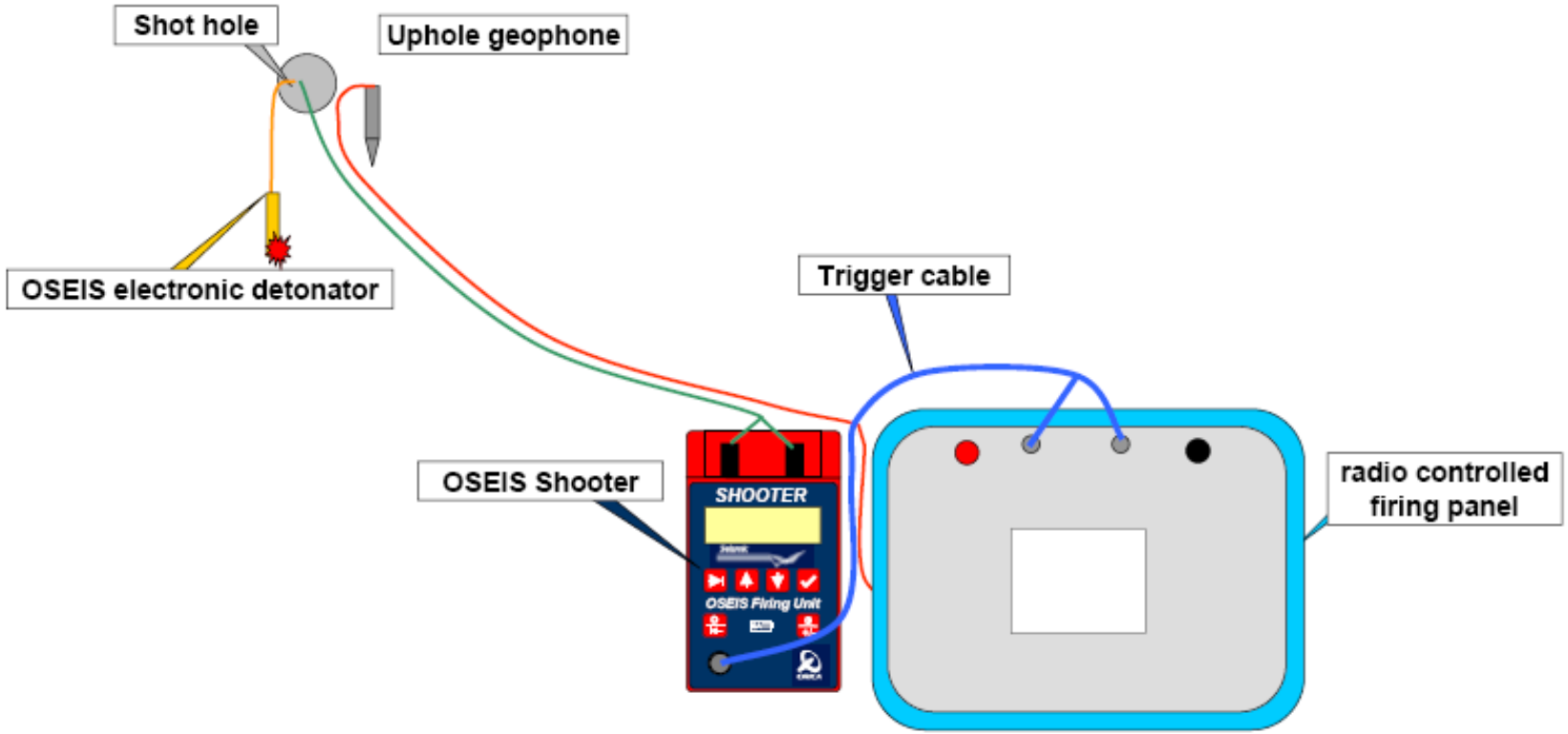
OSEIS™ System - Shot Layout



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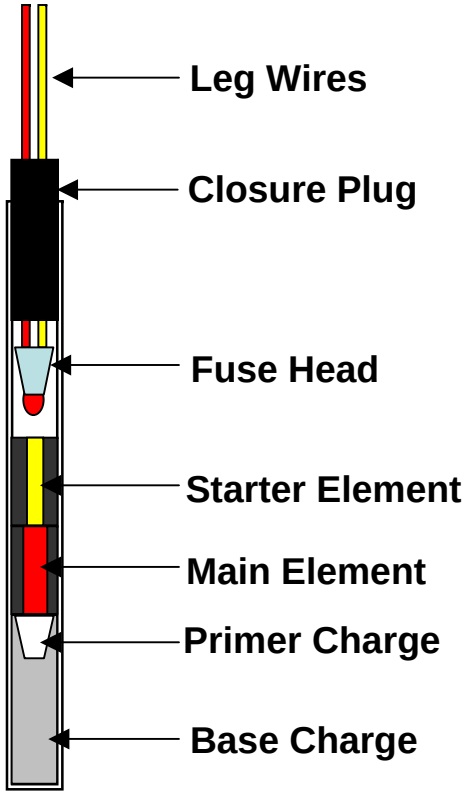
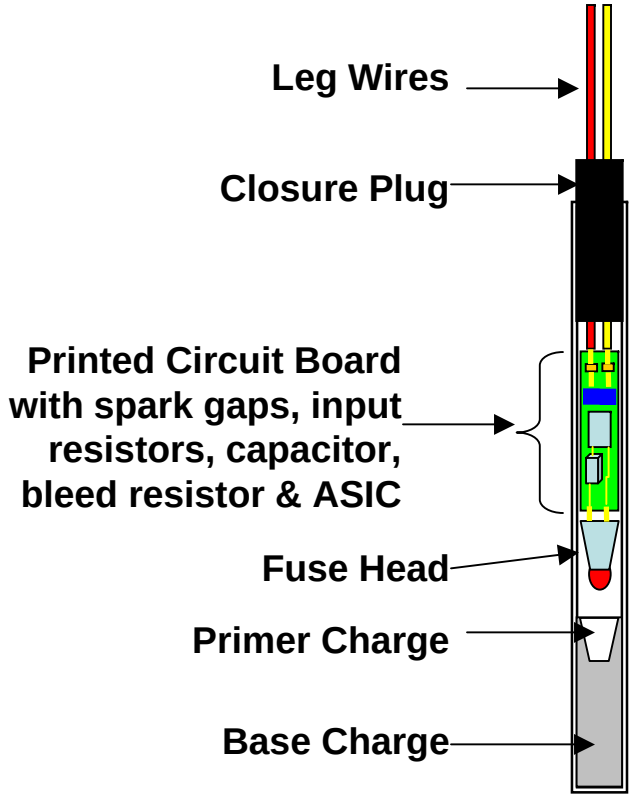
Electronics are Not Electrics!

Electric Delay Detonator



Electronic Delay Detonator



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Detonator Performance Differences

- **In electric detonators, the legwires are connected directly to the fusehead**
  - **Regardless of the source, the detonator will fire given a sufficient amount of electrical energy**
  - **Sources may include (but not limited to):**
    - **AC/DC voltages**
    - **Stray currents**
    - **Electrostatic Discharges**
    - **RF energy (di-pole antennae)**
    - **Induced fields**
- **In OSEIS detonators, a printed circuit board and electronic components separate the legwires from the fuse head. The on board components provide protection against electrical hazards**

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Design Philosophy - Safety

- **Fifth Generation Electronic Detonator System**
  - **Magna (mining applications)**
  - **Dynatronic™ (mining applications)**
  - **Smartdet™ (mining applications)**
  - **i-kon™ (mining applications)**
  - **OSEIS™ (seismic applications)**
- **Extensive Hazard & Operability studies completed**
- **ASIC Chip is not something that can be purchased “off the shelf” and used**

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Design Philosophy - Safety

- **Inherent Safety**
  - **The OSEIS TESTER is unable to fire OSEIS Detonators even if fault conditions occur**
- **Basis of Safety**
  - **Detonator Culling Test performed during manufacturing**
    - **✓ Test Passed: The chip is assigned its unique Detonator ID and ONLY then does the hybrid goes to final assembly**
    - **⌦ Test Failed: The fusehead fires and the hybrid is scrapped**
- **Electromagnetic & Stray Current interference:**
  - **Electronic components and circuitry provide protection against these environmental hazards**

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Electrical Hazards - Design Considerations

- **Transient Voltages (short duration, μs → ms):**
  - **Electrostatic discharge**
    - **Passed French and German Tests**
  - **Lightning Induced Currents**
    - **Evacuate blast pattern as per good blasting practices**
  - **Electromagnetic Pulse (EMP)**
    - **Electronic components & circuitry provide protection**
- **Quasi steady-state (long duration, seconds+):**
  - **AC & DC Voltages**
    - **Electronic components & circuitry provide protection**
  - **Radio Frequency Interference (RFI)**
    - **Electronic components & circuitry provide protection**

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System Development Testing

- **Electrostatic Discharge (ESD)**
  - **Human Body model**
  - **Machine / Equipment model**
- **Radio Waves (RFI)**
- **Electromagnetic Interference (EMI)**

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ESD Test – Human Body

Simulating body static discharged onto leg wires and shell of the detonator

- Testing :
  - Detonator subjected to discharge of the maximum electrostatic energy which can be held on the human body
- Results :
  - The detonator safely discharges the energy to ground via the built-in spark gaps between the individual leg wires and leg wires to shell

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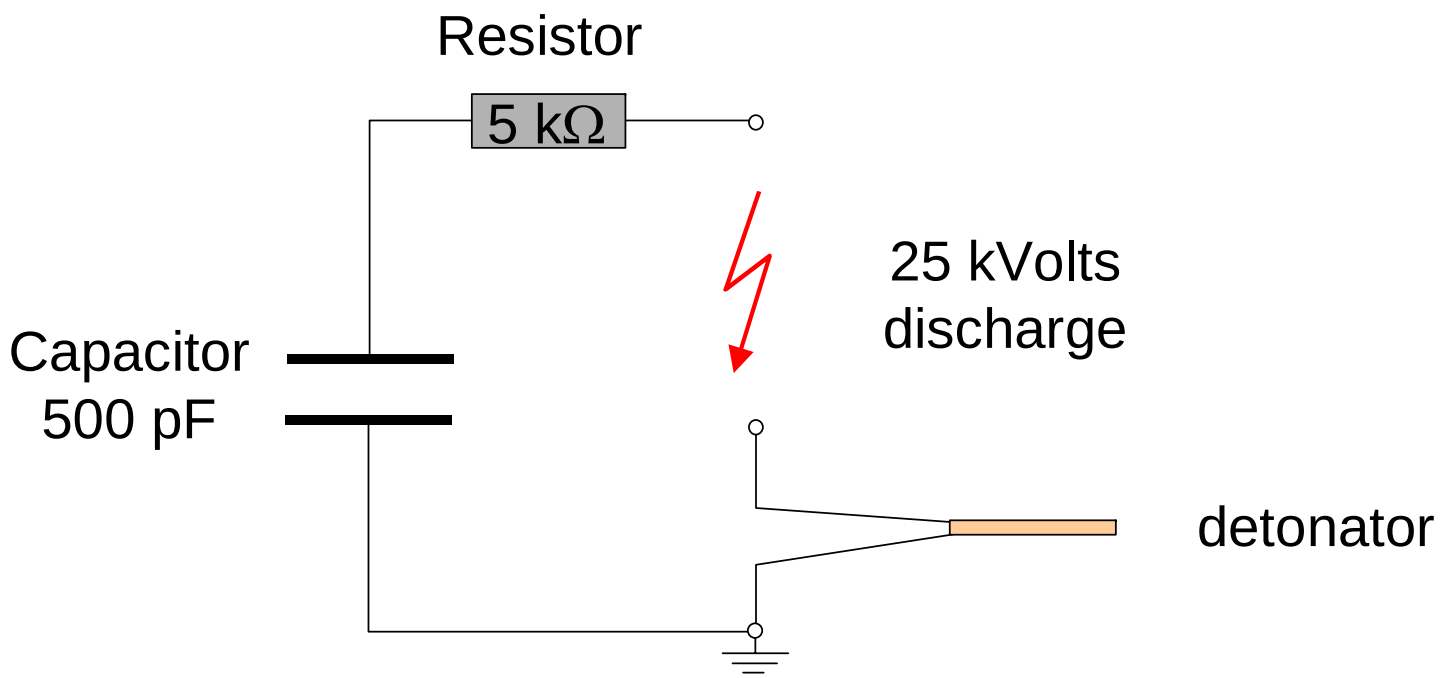
ESD Test - Human Body



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ESD Test – Machine / Equipment

Simulating direct static discharge onto leg wires and shell of the detonator ('German test')

- Testing :
  - Detonator subjected to discharge of a defined electrostatic energy (30 kV, 2500 pF) .
- Results :
  - The detonator safely discharges the energy to ground via the built-in spark gaps between the individual leg wires and leg wires to shell

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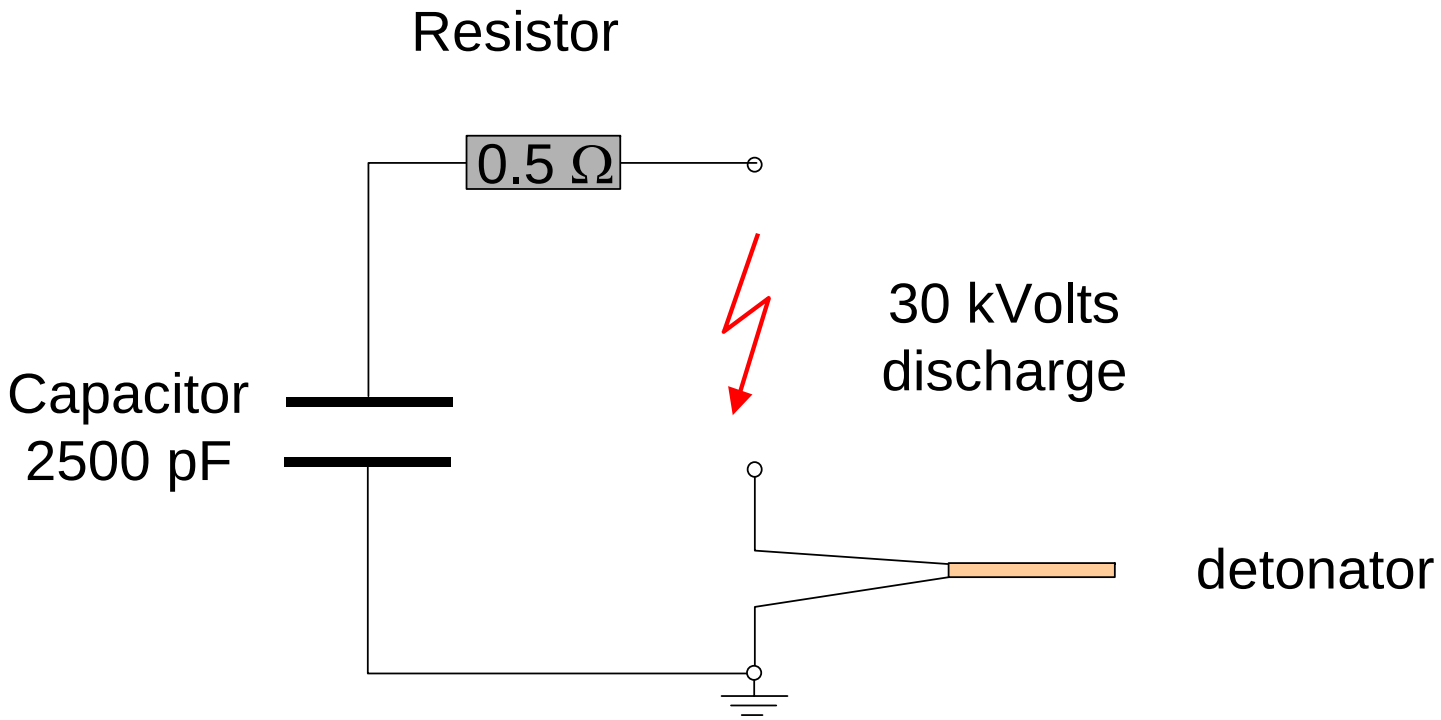
ESD Test – Machine / Equipment



Control Hardware - EMI Testing

Testing of the Tester and Shooter response to Electrostatic and Radio Wave induced energy

- Testing : European Norm tests
  - EN 55011: RFI (Radiated Frequency Intensity) voltage, RFI field strength
  - EN 61000: Contact discharge, Air discharge, Electromagnetic fields (10V/m), Electrical fast transience (burst), High energy pulses (surge), Conducted RF disturbance
- Results: Hardware passed all tests and is CE approved by an independent testing Institute

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Electromagnetic Interference (EMI)

Simulating radio transmitter / hand held radio / cell phone induced energy in the detonator or lead-in system:

- Testing :
  - Detonators and Testers in harness placed under a “Stripline” through which strong radio signals at a wide range of frequencies are transmitted.
- Results :
  - Radio waves generating 400 volts per meter in the leg / harness wires and over a frequency range of 10kHz to 1GHz caused no problems with the detonators or Testers.
  - Note: this level of energy is very high and would be damaging to the human body

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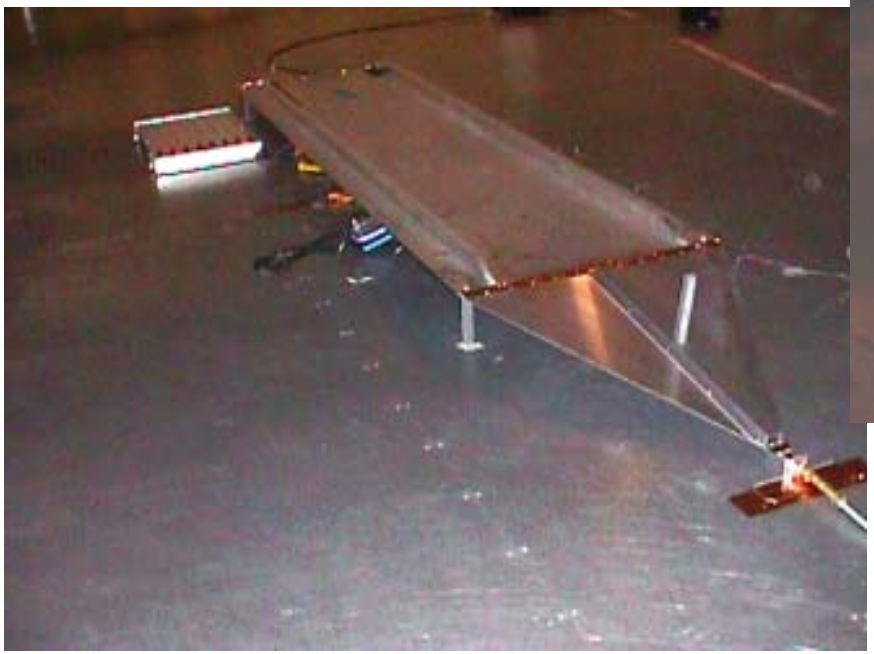
EMI Test Set Up



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EMI Test Results

Run No.	Field strength	Frequency range	Result
1	100 V/m	10kHz - 1 GHz	No influence
2	200 V/m	10kHz - 1 GHz	No influence
3	500 V/m	10kHz - 1 GHz	MINOR influence
4	500 V/m	30 MHz - 300 MHz	MINOR influence
5	500 V/m	280 MHz - 330 MHz	MINOR influence
5A	500 V/m	280 MHz - 330 MHz	MINOR influence
6	**400 V/m**	**10kHz - 1 GHz**	**! NO INFLUENCE !**

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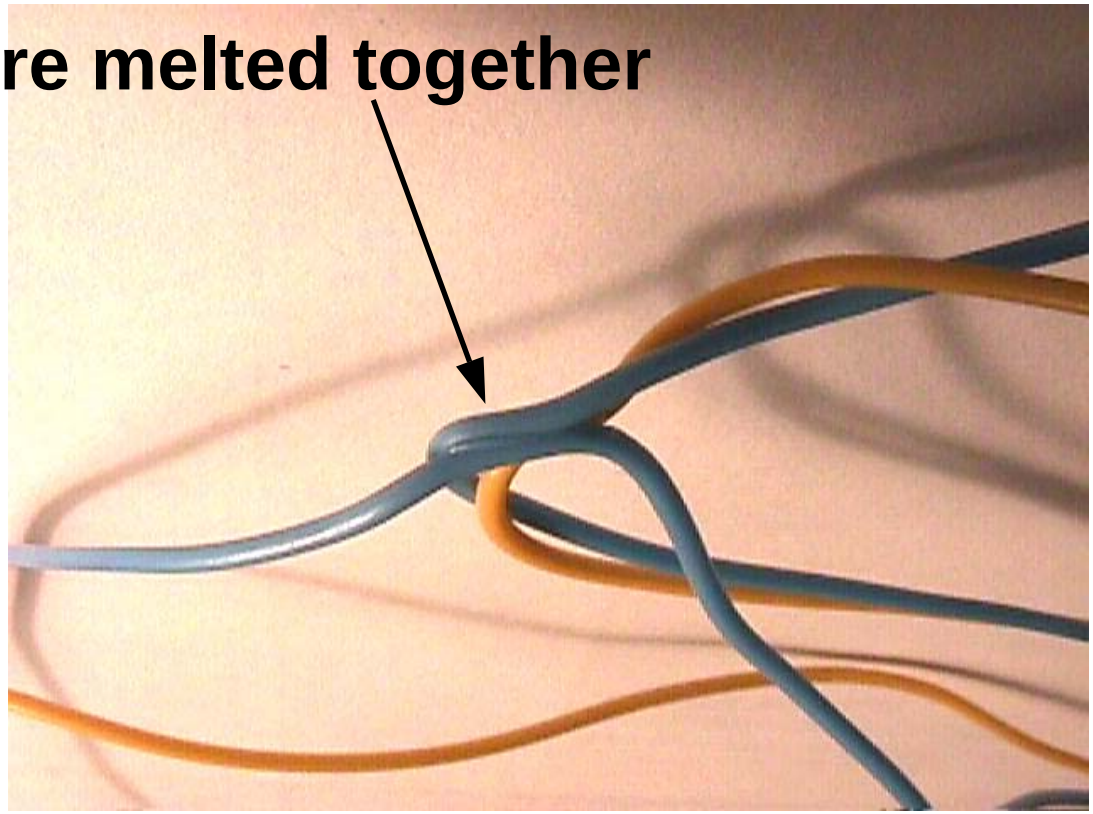
EMI Test Results

Wires were melted together



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- **Geophysical data acquisition is a complex process.**
- **We've talked about:**
  - **The acceptance of Electronic Blasting Systems into the mining industry**
  - **The characteristics of the OSEIS system**
  - **How improved safety and security is achieved through Electronic Blasting System design**
- **Do you think you colleagues would like to find out more about EBS and OSEIS? To set up a meeting, please contact Richard Randall at:**
  - **Office: 406-933-8680 / Mobile: 406-459-5765**
  - **e-mail: richard.randall@orica.com**

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Thank-you!

Any questions?

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