

Technical Report

for
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Consenting and Environmental Projects Coordinator
OceanaGold (New Zealand) Limited

Mining Vibration Assessment – Coronation Project Macraes New Zealand

I am a mining engineer who has specialised in explosives technology and commercial blasting applications for my 40+ year career. As outlined in my CV (Appendix) I work in most areas of civil and mining blasting including opencut and construction blasting. A major portion of my work in the past 20 years has been in managing Risk Assessments, blasting project evaluation, auditing blasting performances and training engineers and shotfirers in safe & efficient blasting.



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8 April 2013

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Coronation Pit - Macraes

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1. Report Objectives

In this report I have conducted simple modeling of expected blast designs similar to those used at the current OceanaGold New Zealand Limited Macraes gold project because the same blasting parameters will be use for the Coronation project. From these designs I have calculated anticipated vibration and airblast levels. I then consider the implications of these predicted blasting effects on the nearest sensitive sites and particularly residential houses not owned by OceanaGold.

2. Executive Summary

- The AS / NZ Standard AS/NZ 2187.2 (2006) states that a ground vibration level of 5 mm/s is acceptable for human comfort and well below any level of damage to housing. The closest residences (~ 1km) are owned by OceanaGold. The predicted level of vibration is 0.2 mm/s. This is well below the acceptable 5mm/s level for 95% of blasts. The two residences beyond one kilometre will experience predicted vibration levels of 1.9mm/s at Howard's residence (2.3 km) and 1mm/s at Longdale station (3.5 km). These levels are well below the acceptable 5mm/s vibration limit for 95% of blasts.
- An airblast level of 115 decibels is acceptable for human comfort and well below any level of damage to housing. As above, the closest two residences are owned by OceanaGold and are not at risk of airblast damage. The two private residences beyond one kilometre have predicted airblast levels of 108 decibels and 104 decibels at Howard's residence (2.3 km) and Longdale station (3.5 km) respectively. These levels are well below the acceptable 115 decibel level.
- Other consequences of blasting, such as flyrock and dust generation, will need to be managed. Potential hazards can be adequately addressed by implementing best practice along with suitable elimination measures.

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3. Blast Requirements

Mining activity will revolve around development of the new Coronation openpit and associated waste rock stack. This activity will be similar in nature to the activities already taking place at Macraes gold project. Drilling and blasting will cause some noise, vibration, flyrock and dust events. Best blasting practices and appropriate mitigation measures will greatly assist in reducing the impacts of these activities. Mitigation measures will include the following:

- Designing the blast initiation sequence to avoid excessive timing overlaps
- Accurate survey and layout of drill hole positions
- Checking depths and angles of holes after drilling
- Rechecking hold depths immediately before charging
- Suitable priming practices including the location of primer
- Continuous monitoring of explosives charging
- Checking explosives, column rise
- Ensuring stemming quality and quantity are as per design
- On-bench attention to initiation delay detonators

4. Sensitive Areas

In assessing blasting impacts I have considered which residences might be considered the most sensitive. Two residences owned by OceanaGold are closest to the open pit (~ 1km). Two privately-owned residences have been identified within a range of 3.5 kilometres from blasting activities. These are:

- i. Longdale Station = ~ 3.5 km from Coronation Open Pit
- ii. Howard's residence = ~ 2.3 km from Coronation Open Pit

5. Blast Design Characteristics

Blast designs for the Coronation openpit, including drilling, charging, stemming and firing procedures will be essentially the same as those used at the Macraes goldmine so I have used these values to calculate predicted environmental effects for the Coronation openpit. The following table gives an indication of typical blast design parameters and explosives charge weights per hole, and per delay interval (Maximum Instantaneous Charge) for the types of blasting employed at OceanaGold open pits at Macraes gold project.

	Ore	Waste
Diameter (mm)	102mm	200mm
Explos/hole (kg)	50 kg	450 kg
Explos MIC (kg) to 3 holes / delay	200 kg	1350 kg

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5.1.a Existing resource consent conditions Macraes:

OceanaGold holds resource consents for mining operations at Macraes gold project which impose conditions upon blasting activities. OceanaGold proposes that the same parameters and conditions (appropriately modified) will apply to the Coronation project. The conditions include:

“Blasting shall be restricted to within the following hours:

- Monday-Friday 9am to 5.30pm
- Saturday and Sunday 10am to 4.30pm.”

“Vibration due to blasting or any other activity associated with the mining operation, when measured at any point within the notional boundary of any dwelling not owned by the consent holder, school or church outside the Macraes Mining Project Mineral Zone as defined by the Waitaki District Plan, deemed operative on 23 August 2010 shall not exceed a peak particle velocity measured in the frequency range 3-12 Hz of 5 mm/sec provided this level may be exceeded on up to 5% of the total number of blasts over a period of 12 months. The level shall not exceed 10 mm/sec at any time.”

“Airblast overpressure from blasting associated with the mining operation, when measured at any point within the notional boundary of any dwelling not owned by the consent holder, school or church outside the Macraes Mining Project Mineral Zone as defined by the Waitaki District Plan, deemed operative on 23 August 2010 shall not exceed a peak non-frequency-weighted (Linear or flat) level of 115 decibels (dB), provided this level may be exceeded on up to 5% of the total number of blasts over a period of 12 months. The level shall not exceed 120 dB (Linear peak) at any time. For the purpose of this consent, C-frequency- weighting may be considered equivalent to the Linear or Flat-frequency- weighting.”

At the two closer private residences (Howard’s residence (2.3 km) and Longdale station (3.5 km)) the above resource consent conditions for times of blasting, vibrations and airblast are able to be met for the Coronation project.

5.1.b Blast-induced Vibrations

Vibration levels are calculated and stated as a peak particle velocity (‘PPV’) value and measured in millimetres per second (mm/s).

Predicted vibration levels for properly designed, drilled and charged blasts in medium strength rock can be calculated but these can only be verified and calibrated by taking actual site readings of pilot-scale or actual blasts in-situ.

The formula used for vibration is:

$$V = K \times \left(\frac{\sqrt{W}}{D} \right)^{1.6}$$

where:

V = peak particle velocity (PPV)

W = explosives charge per delay (kg)

D = distance to damageable “target” (m)

K is a constant related to rock & blast design

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5.1.c What Vibration are acceptable?

The following extract is from the Aus / New Zealand Standard: 2187.2 (2006)

APPENDIX J **TABLE J4.5(A)**
GROUND VIBRATION LIMITS FOR HUMAN COMFORT

Category	Type of blasting operations	Peak component particle velocity (mm/s)
Sensitive site*	Operations lasting longer than 12 months or more than 20 blasts.	5 mm/s for 95% blasts per year 10 mm/s maximum unless agreement is reached with the occupier that a higher limit may apply
Sensitive site*	Operations lasting for less than 12 months or 20 blasts.	10 mm/s maximum unless agreement is reached with occupier that a higher limit may apply
Occupied non-sensitive sites, such as factories and commercial premises	All blasting	25 mm/s maximum unless agreement is reached with occupier that a higher limit may apply. For sites containing equipment sensitive to vibration, the vibration should be kept below manufacturer's specifications or levels that can be shown to adversely affect the equipment operation

* Sensitive site includes private houses & low rise residential buildings, theatres, schools, etc occupied by people.

5.1.d Vibration predictions for Coronation Project

The following Table has been calculated using the AS/New Zealand 2187.2 Standard formula, using a 'K' value of 1450 which is a suitable value for the type of blasting to be employed in the Coronation project and is higher than the site constant of K = 1140 referred to in the standard to *"provide an estimate of vibration levels in 'average' conditions"*.

Typical blasthole designs and configurations are likely to have up to 3 holes per delay Maximum Instantaneous Charge and I have used the explosives charge mass for waste blasting as this mode of blasting employs more explosives than for ore shots.

MIC# (kg)	Distance (metres)	ppv (mm/s)
1350	500m	22.3
1350	1000m	7.3
1350	1500 m	3.8
1350	2000 m	2.4
1350	2300 m *	1.9
1350	3500 m **	1.0

(MIC = maximum instantaneous charge)

* Howard's residence = ~2300m

** Longdale Station = ~3500m

It is clear that expected vibration levels for any sensitive residences beyond ~1500m are less than the 5 mm/s safe limits stated in the Standard. I understand that there are no sensitive sites (not including OceanaGold-owned property and services) within 1000m of the blasting locations.

5.1.e Airblast

It is difficult to accurately predict airblast levels because of a diversity of blasting configurations and the effects of orientation, weather and topography. According to AS/New Zealand 2187.2 an airblast level of 115 to 120 dBL is considered reasonable for human comfort.

The following table gives an indication of calculated air over-pressure values for waste blasting using the AS/New Zealand 2187.2 formula:

$$P = K \times \left(\frac{\sqrt[3]{W}}{D} \right)^{1.2}$$

(MIC = maximum instantaneous charge)

MIC (kg)	Distance (metres)	Airblast (dBL)
1350	1000m	117
1350	1500 m	113
1350	2000 m	110
1350	2300 m *	108
1350	3500 m **	104

* Howard's residence = ~2300m

** Longdale Station = ~3500m

It is worth noting that the airblast levels, measured in dBL, are based on a logarithmic scale. This means that an increase in 6 dBL represents a doubling of the absolute air over-pressure as measured in kilopascals. Even if the air over-pressure at 2300m was double the predicted value, the measured airblast would go from 108 dBL up to about 114 dBL and would still conform to the environmental requirements. As such the expected airblast levels are less than the 115 dBL safe limits stated in the Standard. It is unlikely that this level will be exceeded under normal operating conditions.

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6. Blasting Risk Assessment - Blast activities and Hazards

Blasting activities have risks that must be eliminated or mitigated by exercising best practice and procedures. Best practice will ensure safety and environmental assurance. The following table indicates most of the more common blasting hazards and steps to control them.

Activity	Potential hazards & effects	Recommended elimination measures
Flyrock – to 50 m	Mild damage to facilities	Use earth cover buffer Control stemming
Flyrock – to 200 m	Personnel injury	Specified clearances and enforced QA procedure
Airblast damage	Break windows @ 75m (150dBL)	Stemming and charge controls
Airblast – Surprise neighbours	Complaints, objections, Anxiety	Levels at privately owned houses will be below limits (<115 dBL) Apply normal Stemming and controls
Vibration – blasting at zero to 1000m	Houses will experience acceptable levels of vibration under 5 mm/s	Initiation systems designed to achieve not more than 3 holes / delay
Blast initiation	Premature initiation, unauthorised vehicles on bench or within zone	Control of firing line location Effective blast clearance
Overcharged holes QA	Flyrock bursts, vibration	Managed onsite charging procedure
Uncontrolled Spectators	Injury	Supervision, controls, communication
Misfires	Explosion, digging problems	Procedures
Severe weather Lightning	Difficulty charging correctly Initiation of blast	Procedure No fire if lightning closer than 7 km - Check weather
Explosives Handle / Store	Injury, tampering Unapproved quantities transport	Regulations, Approvals, Licensing Establish approved site

7. CONCLUSIONS

I have not identified any environmental impacts of the proposed blasting program that are likely to cause adverse effects or discomfort to specified neighbouring houses or sensitive sites. Issues concerning vibration, airblast and flyrock can be managed using best practice techniques to ensure that significant adverse effects do not arise.

Yours faithfully



Nick Elith B.E. (Mining)
Explosives Engineer
Special Blasting Applications



8. References

- a) Coronation Project Description April 2013.
- b) Plans showing the location of the proposed development in relation to the current Macraes gold project and sensitive residences in the broader locality.
"M_A1_Coro_ConsentingBasemap_20130327.pdf" and
"M_A3_CoronationDesigns_20130326.pdf"
- c) Map distances to nearest residences from the perimeter of proposed openpit.
- d) Report: "Macraes Phase III Vibration and Air Blast Assessment Orica 2010"
- e) Australian / New Zealand Standard AS/NZ 2187.2 (2006)

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9. APPENDIX - Nick Elith - Qualifications and Experience

NAME NICK ELITH

Bachelor of Engineering (Mining)

University of Sydney 1971

POSITION Principal Blasting Consultant

TechNick Consulting P/L. - Consulting Mining Engineers

DATE OF BIRTH 1948

AFFILIATIONS Member; Australasian Institute of Mining & Metallurgy
Member; International Society of Explosives Engineers

EXPERIENCE Over 38 years involvement with explosives and blasting practices.

1971 - 1976 Explosives Engineer with ICI Australia (Australia's largest explosives supplier)
working as a blasting engineer throughout Australia in:

- Opencut and Quarry Blast Design and improvement
- Civil engineering, Construction, Roadworks and Excavations
- Initiation Systems design and development
- Underground blast design, Tunnelling, Shaft sinking, Stopping
- Safety and skills Training
- Submarine blasting, Harbour deepening, Offshore Oil-III operations
- New explosives development and field testing

1977 - Present:

Principle Blasting Consultant : technick Consulting Pty. Ltd.

Consulting to the mining, quarrying and construction industries in :

- ✓ Blasting principles and Blasting Physics applications
- ✓ Safety and Cost Efficiency in blasting; Opencut and Underground
- ✓ Blast Design and implementation - Opencut and Underground
- ✓ Conducting On-site drilling & blasting Operational Audits
- ✓ Initiation Systems application and design
- ✓ Field evaluation of new explosives and Initiation Systems technologies
- ✓ Technical writing: Blasting manuals, Operational Procedures
- ✓ Training resources, graphics, Safety / promotional materials
- ✓ Competency-based Shotfirer training
- ✓ Author of Opencut and Underground blasting manuals
- ✓ Demolitions: Structures, Buildings, Machinery (steel, concrete etc.)
- ✓ Submarine / Underwater blasting and demolitions
- ✓ Environmentally sensitive blast design, analysis and supervision
- ✓ Investigation of explosives accidents and Incidents
- ✓ Legal "Expert Witness" representation

Qualifications and Experience

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Bachelor of Engineering (Mining)
University of Sydney 1971

POSITION Principal Blasting Consultant
Technick Consulting P/L. - Consulting Mining Engineers

DATE OF BIRTH 1948

AFFILIATIONS Member; Australasian Institute of Mining & Metallurgy
Member; International Society of Explosives Engineers

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- Underground blast design, Tunnelling, Shaft sinking, Stopping
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- ✓ Submarine / Underwater blasting and demolitions
- ✓ Environmentally sensitive blast design, analysis and supervision
- ✓ Investigation of explosives accidents and Incidents
- ✓ Legal "Expert Witness" representation

ADVANCED BLASTING ENGINEERING & TECHNIQUES

Summary 1971 - present

- Opencut and Quarry Blast Design and improvement
- Civil engineering, Construction, Roadworks and Excavations
- Initiation Systems design and development
- Underground blast design, Tunnelling, Shaft sinking, Stopping
- Underground Coal Mine Shotfiring, Training, Risk Assess, Design
- Accredited Safety and Blasting skills Training
- Submarine blasting, Harbour deepening, Offshore Oil-III operations
- Advise, design, execute unusual / sensitive construction / demolition projects:
- Control vibrations, air blast, flying fragments, underwater concussion
- Buildings, foundations, underwater, mechanical equipment,
- Recovery of jammed drill rods, pipes, liners, slag, operating equipment
- Calculate, predict environmental effects of blasting in critical areas
- Feasibility studies for controlled explosives applications
- Legal investigations, reporting and representation

Mining & Quarry Blasting

Current: All Aspects of Opencut blasting

- ✓ Tender Assistance, Safety, Risk management,
- ✓ Establish Blast Management Plans
- ✓ Designs, Cost Estimations, Product Recommendations,
- ✓ Auditing of Mine Drill & Blast Safety, Procedures and Optimisation
- ✓ Problem Solving, Incident and Misfire Response Management
- ✓ Special Methods, Wall Control, Fragmentation
- ✓ Productivity, Optimisation, Mine-to-Mill Studies

ONGOING: optimisation design and controls – critical environments

1971 – current: Design Blasting methods, Initiation, Optimisation

1971 – current: Advanced technical support to Mining / Quarry industries Aust-wide

1971 – current: Quarry blast designs NSW, VIC, WA, SA, NT, Tas, ACT, QLD

Civil Engineering, Construction Blasting & Tunnelling

Current: All Aspects of Civil Works incl. Tunnelling

- ✓ Tunnelling Designs, Cost Estimations, Environmental
- ✓ Foundations, Abutments, Spillways D&B Excavations
- ✓ Tender Assistance, Safety, Risk management,
- ✓ Designs, Cost Estimations, Product Recommendations,
- ✓ Auditing of Drill & Blast Safety, Management Plans, SWPs and Optimisation
- ✓ Problem Solving, Incident and Misfire Response Management
- ✓ Special Methods, Wall Control, Fragmentation
- ✓ Blasting Vs Mechanical Productivity, Optimisation Studies

ONGOING: optimisation design and controls – critical environments

Current Advanced technical support to Civil Construction industries Aust-wide

- 2011 Sub-station proximity blasting, environmental specifications – ACT
- 2011 Gas plant construction proximity blasting, wall control, specifications – Gorgon NWWA
- 2011 Underwater proximity blast design, Risk definition, costings - Qld
- 2011 Pipeline construction -proximity blasting, blast design – Water Authority NSW
- 2011 Water pipeline proximity blasting, Audit blast designs – Murrumbidgee NSW
- 2011 Dam construction Proximity blasting, Audit blast designs - Cotter ACT
- 2010 Pipeline Risk Assessment, Procedures, blast designs – Moomba Gas pipe QLD
- 2010 Dam Procedures, Expert Reviews, Audit blast designs Keepit Dam NSW
- 2010 Dam construction Procedures, Reviews, Audit blast designs - Cotter ACT
- 2010 Dam Procedures, Expert Reviews, Audit blast designs Googong Dam NSW
- 2010 Dam Procedures, D&B Reviews, Audit blast designs Dam 2 - NSW
- 2010 Rail extension project - Procedures, Reviews, Audit designs - VIC
- 2010 Pipeline trench blasting adjacent to old existing pipelines – Specifications QLD
- 2010 Satellite dish foundations Procedures, Reviews, blast designs - ACT
- 2009 Pipeline excavation blasting onshore to offshore Design, Risk Assess - NWWA
- 2009 Pipeline excavation blasting onshore to offshore Design, Risk Assess - Perth
- 2009 Water pipeline relocation near major Communications facilities - Townsville
- 2008 -10 Protection of Ancient Rock-Art - Procedures, Reviews, Audit blasts - NWWA
- 2008 Highway Roadworks expansion, Cuttings - Design, Risk Assess - S NSW
- 2008 Ocean outfall / Desalination pipeline feasibility- Design, Risk Assess - SA
- 2007 Pipeline excavation blasting onshore / offshore Design, Risk Assess - SWWA
- 2007 Foundations Industrial Estate D&B Procedures, Reviews, blast designs - ACT
- 2006 Industrial Estate foundations D&B Procedures, Reviews, blast designs - ACT
- 2006 Foundations Industrial Estate D&B Procedures, blast designs, Misfires - VIC
- 2006 Road widening, Cutting project - Procedures, Reviews, Designs NWWA
- 2000 to 06 Jammed auger near city hospital – blast free Melbourne - VIC
- 2000 to 06 Hydro dam tunnel blast designs NSW
- 2000 to 06 Underground shaft risk assess, design approvals – City Melbourne - VIC

Environmental Blasting and Controls

Current: Regular assessment and prediction of blasting effects & impacts

Environmental calculations & design near optics, cables, pipes, shafts, liquid tanks, bridges, 'green' concrete and sensitive sites

- 2011 Proximity blast design, Risk definition, underwater near jetties - Qld
- 2011 Sub-station proximity blasting, environmental specifications – ACT
- 2011 Pipeline nearby Review, Risk Assess blast design – ACT dam construction - ACT
- 2011 Gas plant construction proximity blasting, wall damage, specifications – Gorgon NWWA
- 2011 Underwater proximity blast design, Risk definition, costings - Qld
- 2010 Pipeline Risk Assessment, Procedures, blast designs – Moomba Gas pipe QLD
- 2010 Pipeline nearby Review, Risk Assess blast design – QLD
- 2010 Foundations near Satellite dish Procedures, Reviews, blast designs - ACT
- 2010 Review / Approve blast design damage Risk – Cotter Dam - ACT
- 2010 Bridge nearby, Review blast design damage Risk – Mackay QLD
- 2010 Review / Approve blast design damage Risk – Keepit Dam - NSW
- 2009 - 10 Review blast damage Risk – Googong Dam refurbishment - NSW
- 2009 Blasting near ventilation services –Tunnel development Narrabri NSW
- 2009 Blasting near critical services – UG Coal mine - New Zealand
- 2009 Environmental impacts of blasting underwater near marine habitats (SA, WA)
- 2009 Blasting near critical underground pipes – Tunnel development coal mine - NSW
- 2009 Blast design & Risk Assessments – Dam construction near infrastructure ACT
- 2008 Blast design & Risk Assess – construction near infrastructure WA, NSW
- 2006 - 2010 Risk manage / Design / Audit proximity blast proc - Heritage sites Karratha WA,
- 2005 Design & environment calcs for blasting near Melb city hospital - VIC
- 2002 /06 Various mine extension EIS supporting reports: Drilling & Blasting effects
- 2001 Mine extension environmental effects, blast designs New Zealand
- 2000 /06 Guest lecturer – Melbourne University “Environmental Risk” - VIC
- 2000 /04 Conduct Risk Assessment studies for sensitive blasting near dams, electronic switchgear, sensitive facilities, overhead / underground services - various
- 2001 Blast mine Portal Tasmania, 5m from pipelines, 30m from workshops - TAS
- 1998 Close proximity blasting 3 metres from highway; Wollongong NSW
- 1998 Blasting consultant to Botany underground LPG tanks study - NSW
- 1998 Controlled blasting amongst major LPG tanks - Woodside Petroleum; WA
- 1996 Investigation / Clearances at Canberra Hospital Implosion - ACT
- 1993, 94 Blast design, vibration, air blast monitoring of tunnelling works - homes, school, temples, within tens of metres in - Taiwan
- 1971 – 2008 Design blasting to optimise productivity and minimise disruption to locality - various

Underwater Blasting

Design & Risk Assess – near structures, preserve marine life/habitat

- 2011 Underwater Berth pocket proximity blast design, Risk definition, costings - Qld
- 2010 Risk Assess Design, Blast demolition of concrete bridge Pylons Mackay QLD
- 2009 Environmental impacts of blasting near marine habitats (Perth & NWWA)
- 2009 Environmental impacts of blasting underwater near marine habitats (SA)
- 2008 Designs & Risk Assessments – Blasting underwater outfall – Perth WA
- 2008 Designs & Risk Assessments – near structures, marine habitat NWWA
- 2006 / 07 Risk, Design assessment UW blasting sheetpiles next to wharf (New Zealand)
- 2004 Design Underwater marine pile blasting next to wharves (NWWA)
- 2003 Risk, Design assessment Underwater blasting next to facilities (WA)
- 2001 Coral channel blasting design / environmental calculations - Micronesia
- 2001 Risk, Design assessment blasting next to operating wharf (New Zealand)
- 2000 Underwater boulder blasting to clear shipping channel Mackay Qld
- 1994 Train and supervise divers in Submarine Blasting Licences; Qld
- 1990 Marine pier demolition - Underwater; Port of Melbourne. Concussion research, calculations - safety of personnel, shipping, port facilities.
- 1986 Underwater demolition training; Principles, Demonstrations and Practical
- 1986 Develop “Advanced Demolition and Underwater Blasting Course” for NSCV
- 1974 – 1976 Underwater harbour deepening, blast monitoring - Bunbury WA.
- 1971 – 1995 Developed deep ocean explosives Ill-cutting techniques:
 - Cutting ‘Ill Heads’ below ocean bed - Bass Strait, New Zealand, Timor Sea
 - Train explosives engineers for underwater and offshore steel demolition

Demolition and Precision Materials Blasting

Current: Blast structures of; reinforced concrete, cast iron, steel, brickwork

- Cutting Steel ‘Ill Heads’ below the ocean bed - Bass Strait, New Zealand, Timor Sea
- Train explosives engineers for underwater and offshore steel demolition
- Cutting of steel, cast iron, steel alloys, aluminium, brass
- Cutting bars, pipes, rail track, "I"- beam, angles, massive blocks
- Metal forming, deforming using explosives
- Fabrication and firing of basic ‘shaped charges’
- Demolition of suburban chimneys - to over 50m , built-up areas - Melb / Perth.
- Demolition of major industrial site facilities at city chemical complex;- work done inside buildings, control vibrations, air blast, flying fragments
- Demolish Furnace & storage kilns ~ 8 structures to 20m high
- Demolish Chimneys and tolrs near operating facilities

See details over page

Coronation Pit - Macraes

Demolition and Precision Materials Blasting

Current: Designs, Risk Assessment & Supervision – various structures

- 2012 Risk Assess Design, demolition of concrete in-pit crusher - QLD
- 2011 Risk, Design, demolition of steel / concrete pylon – Crinum Qld
- 2010 Risk, Design, Blast demolition of Post-stressed concrete bridge Canberra ACT
- 2010 Risk Assess Design, Blast demolition of concrete bridge Pylons Mackay QLD
- 2010 Review blast design methodology – Port concrete blasting - NWWA
- 2009 Review / Approve blast design & Risk – Dam refurbishment blasting - NSW
- 2009 Blasting near ventilation services –Tunnel development Narrabri NSW
- 2009 Blasting near critical services – UG Coal mine New Zealand
- 2009 Design, RA. demolition of reinforced concrete crusher station – PNG
- 2009 Blasting near critical underground pipes – Tunnel NSW coal mine - NSW
- 2009 Blast design & Risk – Dam construction near existing facilities ACT
- 2008 Designs & Risk Assessments – Bridge, River pylons, Adjacent structures - QLD
- 2007 Risk, Design, Blast demolition of Post-stressed concrete bridge Canberra - ACT
- 2006 Risk Assess, Design Shaft & Tunnel Adit – Inner city Bne 15m from bldg - QLD
- 2006 Design, gain approval for collapse of failed steel shiploader conveyor - QLD
- 2006 Blast Eastlink tunnel electronic dets under houses – Suburban Melb - VIC
- 2006 Design, Procdrs & calcs to blast selr shafts – VIC roads, Melb Water - VIC
- 2005 Risk manage, Design & calcs to blast hot, solid slag in furnace - WA
- 2005 Risk manage, Design & calcs to collapse elevated conveyor - Indonesia
- 2005 Design & calcs for blasting jammed 400 mm auger near Melb city hospital - VIC
- 2004 Demolition of reinforced concrete silos – near Canberra - NSW
- 2003 Underwater steel pylon Risk Assess & design for demolition harbour - W.A.
- 2001 Reinforced Concrete Dam intake tolr demolition design & Risk Assess VIC
- 2001 Blast 55 m concrete bunker building – Newcastle steelworks - NSW
- 2001 Blast mine Portal, Tasmania, 5m from main pipelines, 30m from workshops - TAS
- 1999 Precision blasting rock outcrop, 4 metres from swimming pool – Cairns - QLD
- 1999 Demolition of mine headframe structure at Cobar - NSW
- 1999 Demolition of 2 reinforced concrete chimneys in Brisbane suburban area - QLD
- 1998 Controlled blasting amongst major LPG tanks - Woodside Petroleum; WA
- 1996 Investigation / Clearances at Canberra Hospital Implosion - NSW
- 1996 Demolition of reinforced concrete silos - Mt Isa - QLD
- 1996 Demolition of New Zealand dam bulkhead, internal to dam. - New Zealand
- 1996 Subsurface demolition of NSW dam floodgates, internal to dam. - NSW
- 1994, '95 Blast-furnace demolition within factory complex; BHP Whyalla - SA
- 1994 Controlled blasting of concrete foundations within factory complex; Brisbane city - QLD
- 1991 Demolition 900 t steel Bucket wheel excavator - Electricity Commission - VIC
- 1990 Demolition of two 4-storey buildings - Wiluna Mine, Ist Australia - WA
- 1987 Concrete Crusher demolition - within mine office area; Wattle Gully mine. - VIC
- 1973 Research project International demolition blast formulae with 'Plastic' explosives - VIC
- 1972 Blasting concrete, steel, brick foundations inside factory complex; Melbourne - VIC
- 1970's Developed deep ocean explosives Ill-cutting techniques and systems - VIC
- 1970's Explosives metal hardening of steel rail tracks other components - VIC

Training, Courses, Blasting Handbooks, Manuals

Current; Competency training courses for most blasting applications

- ONGOING Explosives Awareness, Underground Coal Shotfirer courses to new QLD and NSW legislation – Conduct Accredited Shotfirer Competency training
- 2012 Conduct Underground COAL Shotfiring Competency assessments – various NSW
- 2011 Present seminar P-1 UG COAL Shotfiring insights – DEEDI Inspectorate Qld
- 2011 P-1 explosives for Underground COAL Shotfiring – RA, design & reviews –NSW
- 2011 Conduct Underground COAL Shotfiring Competency assessments – various NSW
- 2011 Opencut / UG, Coal, Metal, Misc Blast training & Optimisation – New Zealand / Aust
- 2011 Upgrade Underground COAL Units to RIIBLA standards Practical assessment
- 2010 Conduct Underground COAL Live Shotfiring Competency assessments – Clarence NSW
- 2010 Upgrade UG COAL Units to RIIBLA standards & associated Shotfiring courses
- 2010 Opencut / UG, Coal, Metal, Misc Blast training & Optimisation – New Zealand / Aust
- 2009 Opencut / UG, Coal, Metal, Misc Blast training & Optimisation – New Zealand / Aust
- 2007 / 08 Opencut & UG Blasting training & Optimisation – China, Mongolia
- 2007 Upgrading Underground, Opencut, Metals, Coal, Extractive and specialised / Advanced courses in all aspects of blasting
- 2006 Opencut / UG, Coal, Metal, Misc Blast training & Optimisation – New Zealand / Aust
- 2005 Opencut Blasting training & Optimisation – Mongolia / New Zealand / Aust
- 2005 Opencut Blasting training & Optimisation - China
- 2005 /06 Underground Coal Shotfirer courses - MNCU48, MNCU49 NSW & Qld
- 2004-06 Opencut Shotfirer courses Coal & Metal – Nationally Accredited Training
- 2004 Underground Coal Shotfirer courses – Accredited Competency training
- 2003 Prepare, present O’Cut courses in Russian language – Kyrgyzstan
- 2003 MNC 98 Coal Shotfirer course training & Assessment – O’Cut and UG
- 2002 Shotfirer courses - Produce & deliver Nationally accredited for O/C and UG
- 2000 – 2004 Guest lectures – Melbourne University “Risk Management”
- 2002 Conduct Quarrying and Advanced Training courses
- 2001 Create & conduct Avalanche / Snow Control Blasting course (New Zealand)
- 2001 – 2004 Conduct National Competency Shotfirer Training courses
- 2000 Produce National Underground Shotfirer Training course & manual
- 1999 Certificate 4 in Workplace Training, Assessor
- 1999 New Zealand Extractive Industries Training Organisation; Registered Assessor
- 1995 Advanced Efficient Blasting training – Quarry, Construction, Mining:
- 1986 Author Underwater demolition training course; Principles, Demonstrations and Practical - National Safety Council of Aust. / Victoria
- 1986 Develop “Advanced Demolition and Underwater Blasting Course” for NSCV
- 1983 – 1987 Conduct training courses “Handling, Use of Explosives”; (NSCV)
- 1983 – 1987 Joint Author of textbook “Handling and Use of Explosives” National Safety Council of Aust. / Victoria; (NSCV)

Legal Investigations, Reporting, Expert witness

Current: YES

2011 "Expert" report - Explosives transport prosecution case New Zealand
2010 "Expert" report - Underwater blasting dispute NWWA
2010 "Expert" witness - Blasting Flyrock fatality – VIC Workcover
2006 "Expert" witness - Blasting flyrock incident – VIC Workcover
2005 "Expert" report - Explosives Storage & Handling Incident – VIC
2005 "Expert" report - Potential terrorist structural blasting hazard NSW
2005 /06 "Expert" report - Blasting flyrock incident – VIC Workcover
2004 /06 "Expert" report - Mining environmental dispute NSW
2002 /06 "Expert" report - Blasting Flyrock fatality – VIC Workcover
2003 "Expert" report - Fireworks Storage Incident – Qld
2003 "Expert" report - Alleged Explosives Incident – NT Police
2001 "Expert" report - Alleged Bomb Device – VIC Police
2001 "Expert" report - Airblast damage dispute - Tas
2000 "Expert" witness - Flyrock damage dispute - Tas
1999 "Expert" report - Flyrock damage dispute - Tas
1999 "Expert" report - Underwater blasting dispute - WA
1996 Investigation / Clearances at Canberra Hospital Implosion ACT
1995 "Expert" report - Shaft sinking dispute - QLD
1990 "Expert" report - Civil engineering blasting dispute
1990 Damage to equipment by flyrock claim - QLD

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