



**Rockbreaking  
Solutions**

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# **Penetrating Cone Fracture (PCF<sup>TM</sup>)**

## **Frequently Asked Questions and Answers**

**July 2002**

# GENERAL INFORMATION

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**Q. WHO ARE ROCKBREAKING SOLUTIONS?**

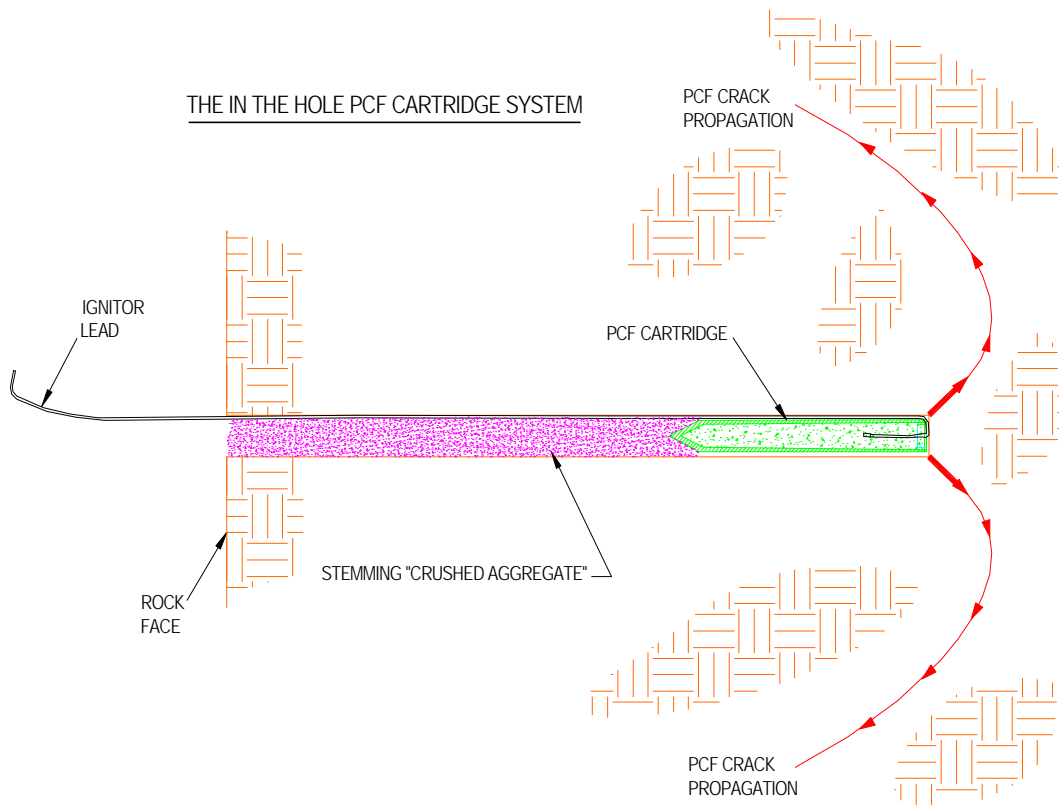
A. Rockbreaking Solutions is a wholly owned subsidiary of Brandrill Limited committed to finding innovative, safer and cheaper solutions for clients' rock breaking needs. Rockbreaking Solutions holds the worldwide patents for PCF™ technology.

**Q. WHAT IS PCF™?**

A. The abbreviation PCF™ stands for Penetrating Cone Fracture. It is a new environmentally friendly rock breaking technology from Rockbreaking Solutions that involves the energy efficient breakage of rock using a high pressure gas pulse.

**Q. WHY IS IT CALLED PCF™?**

A. The PCF™ rock breaking process creates a spherical fracture that propagates 45 degrees from the base corner of the drill hole developing a characteristic cone shaped fracture pattern – hence its name Penetrating Cone Fracture.



**FIGURE 1**

# GENERAL INFORMATION

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**Q. HOW DOES PCF™ TECHNOLOGY FRACTURE ROCK OR CONCRETE?**

A. Rock or concrete is fractured by the introduction of a pulse of high pressure gas at the base of a short drill-hole. The generated gas penetrates into small microfractures created from the percussive drilling process. These microfractures are forced to expand and propagate into tensile cracks (as shown in Figure 1 above) causing the rock to fail.

**Q. WHAT PRODUCES THE HIGH PRESSURE GAS?**

A. A cartridge filled with a specially formulated propellant produces gas by deflagrating when the propellant is ignited. Because the gas is confined down the hole in a very small volume, very high gas pressure is generated when the propellant is ignited.

**Q. WHAT IS A PCF™ CARTRIDGE?**

A. A PCF™ cartridge consists of a hollow plastic tube that holds the propellant. It is initially open at one end allowing the tube to be filled with propellant. The open end is then closed with a small cap. The other end of the tube is machined into a wedge to lock into the stemming and seal the hole when the cartridge is initiated.

The tube and cap are made of an injection moulded high-density polypropylene (HDPP).

**Q. HOW IS A PCF™ CARTRIDGE INITIATED?**

A. The PCF™ cartridge may be initiated by either an electric match, or a “NoMatch” system which utilises standard shocktube.

There is a small entry port in the centre of the cap (about 3 mm in diameter) which allows insertion of the initiator into the cartridge and propellant.

# GENERAL INFORMATION

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## Q. WHAT ARE THE CARTRIDGE SPECIFICATIONS?

A. PCF™ cartridges come in a range of sizes and weights depending on the job

CARTRIDGE DIAMETER (mm)	CARTRIDGE MASS (grams)	RECOMMENDED HOLE DIAMETER (mm)	APPLICATION
27.5	10	32	Mining and Civil works
	30		
	60		
42	60	45	Mining and Civil works
	100		Narrow-vein Mining; Civil Tunnelling
60	100	64, 76	Mining works
	200		
	300		

PCF™ cartridges are further classed under trademarks (see following).

TRADEMARK NAME	APPLICATION	EXAMPLES
PCF™ RockStik	Mining Works	<ul style="list-style-type: none"> <li>▪ Boulder breaking</li> </ul>
PCF™ EnviroBreak	Civil Works	<ul style="list-style-type: none"> <li>▪ Concrete pre-conditioning (mass and reinforced)</li> <li>▪ Tunnelling</li> <li>▪ General rock breakage</li> </ul>
PCF™ Stopesafe	Narrow Vein Mining Civil Tunnelling	<ul style="list-style-type: none"> <li>▪ Narrow-vein Mining</li> <li>▪ Civil Tunneling</li> <li>▪ Dimension Stone Breakage</li> </ul>

# ADVANTAGES OF PCF™ OVER CONVENTIONAL EXPLOSIVES

## Q. How do the fracture characteristics of PCF™ differ from explosives?

- A. The fracture characteristics of PCF™ differ in comparison to explosives because PCF™ allows a more controlled breakage of rock or concrete material due to the rock being fractured in tension rather than compression. The tensile breakage mechanism of PCF™, which produces the characteristic penetrating cone fracture, allows PCF™ to use a much lower amount of energy than detonating explosives. This results in low vibration, low noise, reduced overpressure and minimal fly rock compared with explosive blasting.

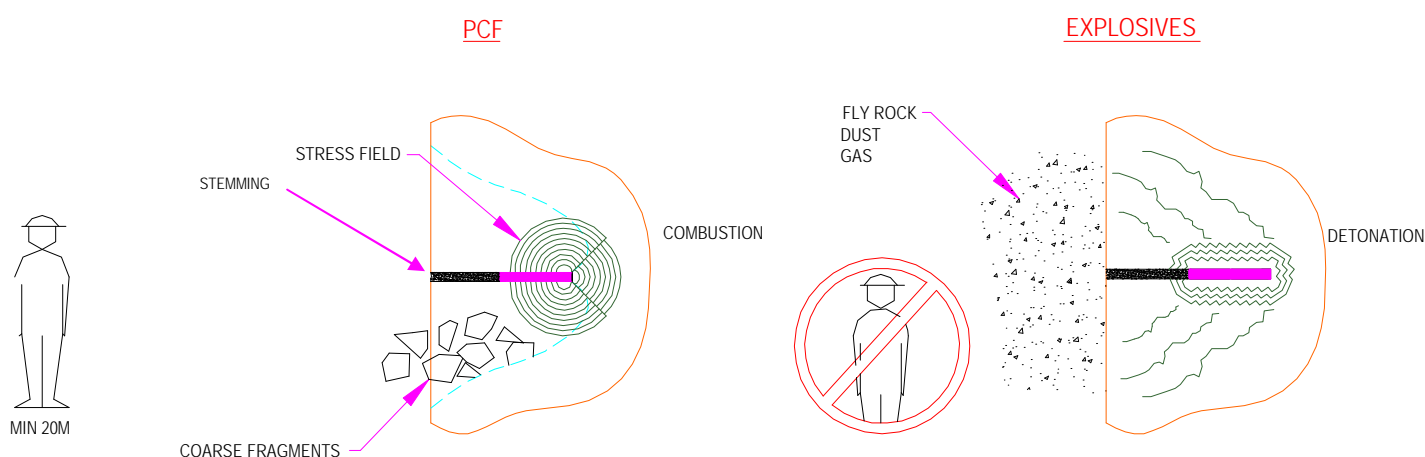


FIGURE 2

## Q. WHAT IS THE ENERGY EFFICIENCY OF PCF™ COMPARED TO CONVENTIONAL EXPLOSIVES?

- A. A direct comparison between similar weights of explosive and propellants has indicated that the energy released by a PCF™ cartridge is approximately 45% that of the energy of a similar size explosive charge. The difference in energy required to break the same amount of rock between PCF™ and conventional blasting is because PCF™ utilises tensile breakage rather than compressive breakage, which is more energy efficient.

# ENVIRONMENTAL IMPACT EVALUATION OF PCF™

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## Q. WHAT ARE THE ENVIRONMENTAL ADVANTAGES THAT PCF™ OFFERS?

A. Because PCF™ utilises pressurised gases from deflagrating propellant to break rock, the method does not produce a shock wave that is characteristic of high explosives. PCF™ cartridges are described as deflagrating products rather than detonating explosives. It is this fact that contributes to the excellent environmental performance of PCF™. The following are key environmental factors that PCF™ excels in:

### 1. Vibration

Vibration levels induced by PCF™ are particularly low when compared to explosives of the same weight. This enables the PCF™ method to be used in close proximity to built-up, populated areas. PCF™ technology becomes particularly attractive for vibration sensitive sites where conventional blasting is prohibited or impractical.

An example of one such site is the “Canning Dam”. The dam is located on the outskirts of Perth, Western Australia. PCF™ technology was approved for use by the State Water Authority to facilitate the excavation of an Adit through (30-50 MPa) concrete into the dams lower gallery on the down stream side of the dam wall.

Conventional explosives were prohibited from use on this project due to concerns that vibration created would damage and further weaken the 70 year old structure.

ABT Engineering were engaged to independently monitor vibration on the project and results relating to the vibration created when using PCF™ cartridges are detailed on the following page.

The measurements were taken from three temporary stations. The sensors were situated on the floor of the lower gallery within the dam wall at the following distances from the point where PCF™ cartridges were initiated.

Station No.1	-	6 metres
Station No.2	-	8 metres
Station No.3	-	12 metres

The focus of these measurements was on the vertical vibration component.

The following table provides a summary of vibration and frequency (Hertz) measurements monitored at the Canning Dam adit excavation

# ENVIRONMENTAL IMPACT EVALUATION OF PCF™

**Table 1.0 VERTICAL VELOCITY MEASUREMENTS IN mm/Sec**

<i>Shot ID</i>	<i>Station No 1.</i>	<i>Station No 2.</i>	<i>Station No 3.</i>	<i>PCF™ Cartridge Charge (grams)</i>
1	2.12	1.32	0.45	100
2	1.90	1.83	1.45	80
3	1.27	0.80	0.68	100
4	1.73	1.55	0.90	100
5	1.84	1.27	0.91	100
6	2.45	1.55	1.33	100
7	2.31	1.67	0.84	100
8	0.85	0.56	0.38	100
9	1.62	0.89	0.84	100
10	1.11	0.95	0.84	100
11	0.81	0.91	0.87	100
12	0.91	0.92	0.62	100
13	2.25	1.47	1.28	2*80
14	2.65	1.58	1.25	2*80
15	2.43	1.25	0.98	2*60

**Table 2.0 TYPICAL FREQUENCY IN HERTZ**

<b>Shot ID</b>	<b>Station No. 1</b>	<b>Station No. 1</b>	<b>Station No. 1</b>
1	500	1100	350
2	150	150	200
3	350	350	350
4	1550	1350	1000
6	1600	550	450

In general, vibration level from the monitoring program in terms of velocity was below 2.7mm per second peak velocity.

The data was processed and analysed to determine frequency response. The vibration signal was digitised at the rate of 15,000 samples per second and the signal was then processed using the NUVIB vibration package. It exhibits frequency spectra between 450Hz and 1600Hz. However, shots No. 2 and No. 3 presented a lower frequency range of 150 –350Hz

# ENVIRONMENTAL IMPACT EVALUATION OF PCF™

Table 1. Transient vibration guide values for cosmetic damage			
Line (see figure 1)	Type of building	Peak component particle velocity in frequency range of predominant pulse	
		4 Hz to 15 Hz	15 Hz and above
1	Reinforced or framed structures Industrial and heavy commercial buildings	50 mm/s at 4 Hz and above	
2	Unreinforced or light framed structures Residential or light commercial type buildings	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above

NOTE 1. Values referred to are at the base of the building (see 6.3).  
NOTE 2. For line 2, at frequencies below 4 Hz, a maximum displacement of 0.6 mm (zero to peak) should not be exceeded.

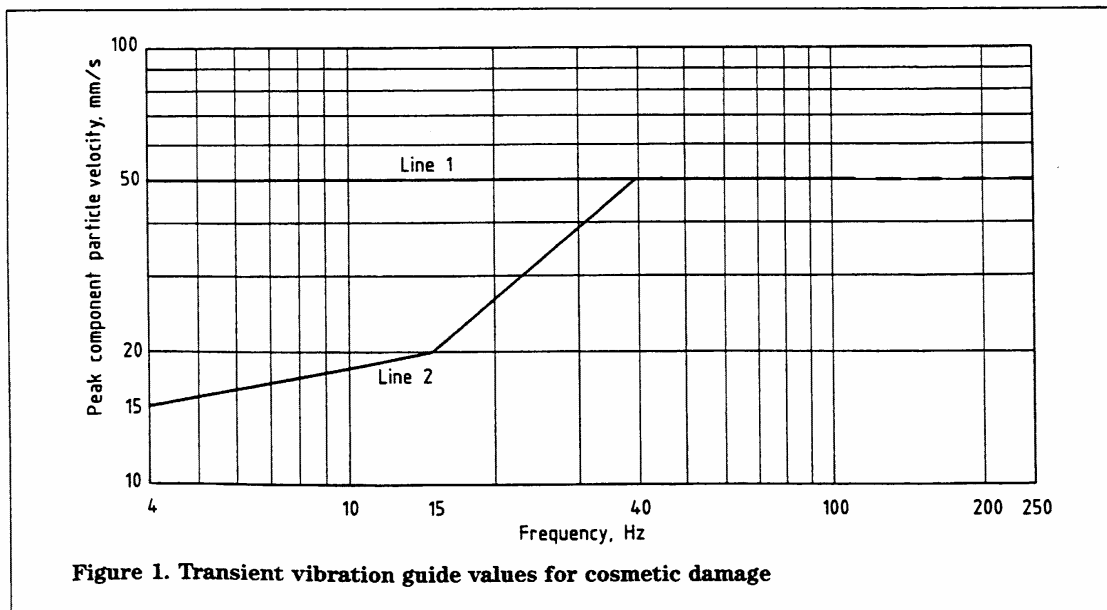
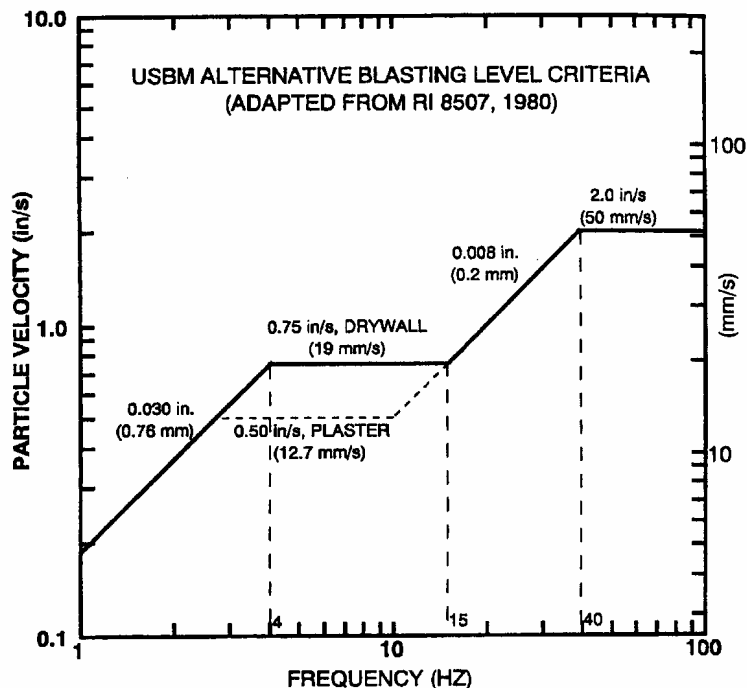


Figure 1. Transient vibration guide values for cosmetic damage

Ref: British Standard (BS) 7385.2 - 1993



# ENVIRONMENTAL IMPACT EVALUATION OF PCF™

As can be seen from the data represented in the previous graphs, the damage potential of vibrations as recommended by the USBM and BS are very similar. The USBM criteria is summarised as follows:

Frequencies above 40 Hz

- PPV < 50 mm/s – safe zone
- PPV > 50 mm/s – damage zone

Frequencies below 40 Hz

- PPV < 13 mm/s – safe zone (old wooden house)
- PPV < 19.5 mm/s – safe zone (modern house)

Typical vibration levels for PCF™ are shown to be very low and independent studies have revealed a frequency well in excess of 40 Hz (on average 663 Hz). Therefore it can be concluded that PCF™ is ideal for vibration sensitive sites, although local laws and restrictions should be investigated prior to the use of PCF™.

## 2. Overpressure

Overpressure or air blast is simply the pressure over and above that of atmospheric pressure. Overpressure is caused by air transmitted vibrations or compressional waves (similar to ground vibration waves). Overpressure levels produced by PCF™ are low when compared to conventional explosives. This allows PCF™ to be used in environmentally sensitive areas where explosives are prohibited.

		<b>PCF™ Overpressure Levels (dBL)</b>	
<b>Charge Weight (g)</b>	<b>Distance (m)</b>	<b>Unattenuated (No Canopy)</b>	<b>Attenuated (Canopy, barrier and shroud)</b>
60	10	107	55
	20	100	48
	30	96	39

*(Measured from 60 g PCF™ cartridge trial at Canning Dam Remedial Works project)*

The general recommended limit for overpressure is 134 dBL as stated by US Bureau of Mines. This is a general guide, however, State and local laws may supersede this recommendation.

# ENVIRONMENTAL IMPACT EVALUATION OF PCF™

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### 3. Noise

Noise measurements should not be confused with overpressure measurements. Noise measurements are made with standard sound level meters, which record air vibrations falling in the audible frequency region only. There are times when relatively high overpressures are not audible because their frequency is outside the audible frequency region.

The following table illustrates the low noise levels emitted by PCF™ .

	<b>dBA (@ 50m)</b>
<b>Range</b>	50 - 68
<b>Mean</b>	59

*(Measured from 60 g PCF™ cartridge trial at Canning Dam Remedial Works project)*

As can be seen from the above table, noise emitted by PCF™ is low when compared to other industrial processes. As for overpressure, State and local laws regarding permitted noise levels should be investigated prior to use of PCF™ .

### 4. Fly Rock

The PCF™ breakage process drastically reduces the potential for fly rock due to the controlled manner in which the rock is broken. The minimal fly rock that does occur is of low velocity and is normally confined to a distance within 10 metres of the hole. As a result, PCF™ technology can be used with a minimal clearance zone from the point of initiation. A minimum personnel clearance zone of 20 metres is normally sufficient although PCF™ operators are instructed to use their own discretion when choosing safe clearance zones.

### 5. Dust

Due to its tensile breakage mechanism, PCF™ produces a much coarser fragmentation when compared to the smaller particles produced by the crushing effect of explosives. A major advantage of the coarse fragmentation is that the dust emitted is significantly reduced.

# ENVIRONMENTAL IMPACT EVALUATION OF PCF™

## 6. Fume Characteristics

The amount of noxious fumes produced from the ignition of a PCF™ cartridge are normally minimal due to:

- (a) the nature of the propellant mix itself and
- (b) the size and number of PCF™ cartridges required for the work.

This often enables immediate re-entry to the work area (depending on the level of ventilation flowing within the specific work zone) and ensures that production activities in the vicinity of the PCF™ operations are uninterrupted or stopped for only a minimum amount of time.

The products of the deflagration process have been analysed and are detailed below. The results have been calculated to represent the fume concentrations of 100grams of propellant, as contained within a volume of 100 cubic metres.

EMISSION COMPONENT	MASS EMISSION (grams)	CONCENTRATION (ppm)
Carbon Monoxide	63.5	350
Hydrogen	1.5	105
Carbon Dioxide	15.0	50
Ammonia	0.4	3
Hydrogen Sulphide	0.3	1
Nitric Oxide	0.2	1
Nitrogen Dioxide	< 0.2	< 1
Sulfur Dioxide	< 0.2	< 1
Hydrogen Cyanide	< 0.1	< 1
Formaldehyde	< 0.01	< 0.05

*(Values obtained from independent testing at Mt McClure Gold Mine,  
Leinster, Western Australia - September 2000)*

Computer modeling has also been undertaken and shows the production rates of the following additional components:

EMISSION COMPONENT	MASS EMISSION (grams)	CONCENTRATION (ppm)
Water	18.6	232
Nitrogen	15.3	122

# APPLICATIONS

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**Q. WHAT APPLICATIONS IS PCF™ USED FOR?**

- A.
1. Civil excavation and demolition on environmentally sensitive sites.
  2. Narrow vein stoping in underground mining
  3. Boulder breaking and quarrying i.e. secondary breaking of oversize.

**Q. WHERE HAS PCF™ PREVIOUSLY BEEN USED SUCCESSFULLY?**

A.

COUNTRY	LOCATION	CLIENT	APPLICATION
Australia	Canning Dam, Perth, WA	Walter Bau Construction	Concrete pre-conditioning and demolition
	Alcoa, Pinjarra, WA	Alcoa	Bauxite cap rock pre-conditioning/ tank de-scaling
	Melbourne, VIC	Boulderstone Hornibrook	Concrete dolphin demolition
	Newcastle, NSW	Gardner Perrott	Newcastle Steelworks demolition
	Surface and Underground mines Australia-wide	Olympic Dam Stawell North Parkes	Oversize breakage in mining, stripping
South Africa	Impala mine #4 and #11 shafts, Rustenburg Joel Mine, Welkom, Free State	Impala Platinum Anglo Gold	Narrow Vein Mining
Hong Kong	Festival Walk North Point Station		Basement Excavation
Singapore	LTA North-East Line	Nishimatsu Construction Co	Civil tunnelling

# ADVANTAGES OF PCF™

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**Q. WHAT ARE THE ADVANTAGES AND STRENGTHS OF PCF™?**

A.

1. PCF™ is environmentally sensitive:
  - a) minimal fly rock;
  - b) minimal vibration (less than ½ that of same size conventional explosives);
  - c) lower noise emissions than conventional explosives;
  - d) controlled perimeter breakage.
2. Similar yields to conventional blasting can be achieved using similar sized PCF™ cartridges and explosives (depending on application).
3. PCF™ involves a flexible cycle – the process steers away from a set blasting pattern allowing each shot to be inspected and assessed before proceeding to the next.
4. Only localised clearance of personnel is required with PCF™. Production is optimised as no downtime is experienced due to site evacuation during initiation.
5. PCF™ is a simple process that can be used after completion of the accredited PCF™ training course. Possession of a shotfirer's ticket is a prerequisite for personnel to become accredited in the use of PCF™.
6. PCF™ can be used with low capital, lightweight equipment – in its most basic form, one small hand-held drill rig is all that is needed to drill the hole.

# GENERAL REQUIREMENTS FOR PCF™

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**Q. CAN ANYONE USE PCF™ ?**

A. Personnel can use PCF™ after undergoing the required training. Possession of a shotfirer's ticket is a prerequisite for personnel to become accredited in the use of PCF™ outside of an underground mine environment ie Civil operations.

**Q. HOW EASILY CAN PCF™ BE MOBILISED?**

A. 27.5mm and 42.0mm PCF™ cartridges do not require the use of a drill rig as these are designed for 32mm and 45mm drill holes. PCF™ products can be mobilised quickly with minimal logistical problems.

Either hand held methods or any drill rig capable of drilling the required size hole (32mm, 45mm and 64mm) can be used for PCF™ operations.

**Q. HOW LONG IS A TYPICAL CYCLE TIME TO DRILL AND INITIATE A CARTRIDGE IN A HOLE?**

A. Approximately 6 – 10 minutes if each hole is sequentially drilled and initiated. If holes are drilled in advance, the initiation cycle can be reduced to approximately 4 minutes per cartridge.

**Q. WHAT IS INVOLVED IN THE DRILLING AND BREAKING CYCLE?**

A. Six easy steps is all it takes

1. A short hole is drilled (length will depend on site conditions and size of cartridge used, usually < 1.5 m)
2. Initiation match is inserted into the base of the cartridge and secured.
3. The PCF™ cartridge is placed at the bottom of the hole, wedge end last
4. Stemming (crushed aggregate 3 mm all in) is manually or pneumatically loaded behind the PCF™ cartridge
5. The initiation match is attached to the firing box using either shocktube or a firing cable, depending on the type of initiator being used.
6. When all PCF™ product and site specific PCF™ firing procedures have been complied with the product is initiated.

**Q. WHAT IS THE MINIMUM CLEARANCE DURING INITIATION?**

A. A minimum of 20 metres is recommended. A greater clearance distance can be chosen by the PCF™ operator depending on site conditions encountered. It is the responsibility of the user to determine suitable safety exclusion zones.

# GENERAL REQUIREMENTS FOR PCF™

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**Q. DOES THE PCF™ METHOD VARY WITH DIFFERENT APPLICATIONS?**

A. Each cycle is the same regardless of where PCF™ is applied. Each application or job is different and has its own site-specific requirements but the general method or cycle, when applying PCF™, is the same.

**Q. WHAT IS THE NUMBER OF PEOPLE REQUIRED TO USE PCF™ ?**

A. Generally 1 person is sufficient to load and initiate PCF™ into the drilled holes, although 2 persons are recommended for work share and safety reasons.

**Q. HOW DEEP IS THE DRILL HOLE?**

A. This depends on the application but a general rule of thumb suggests ↓ – ½ of the depth of the rock when drilling oversize boulders or generally < 1.5 m when drilling insitu rock or concrete.

**Q. WHAT IS THE MISFIRE PROCEDURE OR PCF™?**

A. In the event where a cartridge is retrieved from a misfired hole, the cartridge is opened and propellant emptied onto the ground in a thin line. The propellant is then disposed by igniting it. It is important to choose a hazard free environment when undertaking this task.

In the event where the cartridge cannot be retrieved an additional cartridge should be placed on top of the first cartridge in the hole, stemmed and initiated as per standard operating procedures.

In the event where a cartridge is jammed in a hole during insertion, stemming material should be placed on top of the cartridge and the cartridge should be fired in the normal manner. Under no circumstance should the cartridge be forced down the hole.

# GENERAL REQUIREMENTS FOR PCF™

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**Q. IS PCF™ AUTHORISED IN MY AREA?**

A. Current authorisation status is shown in table below.

CARTRIDGE DIAMETER (mm)	CARTRIDGE MASS (grams)	AUTHORISATION	LOCATION
27.5	10	ARTICLES EXPLOSIVES N.O.S UN 0349 1.4S	Australia (all states and pending in ACT)
	30		
	60		
42	60	Awaiting UN authorisation and classification 1.4S	Australia (All States except 1.4C NSW and SA)
	100		
60	100	Awaiting UN1.4S authorisation and classification	Australia (All States except 1.4C NSW and SA)
	200		Australia (All States except 1.4C NSW and SA)
	300		Australia (All States except 1.4C NSW and SA)

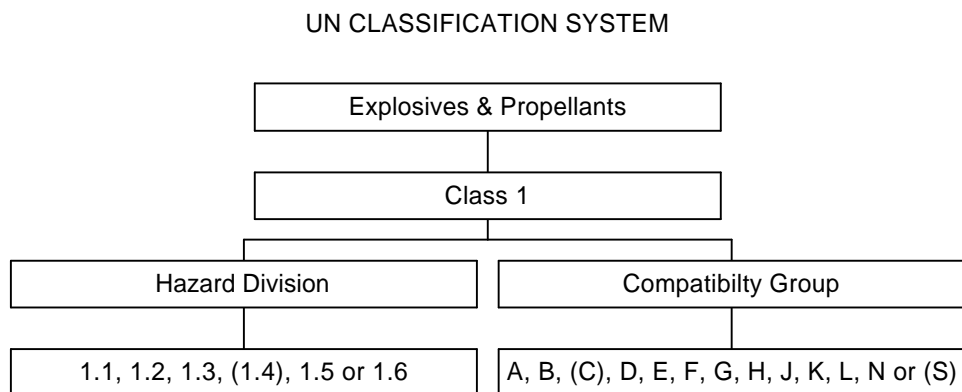
Authorisation to trial PCF™ products can be sought from the appropriate competent authority, therefore allowing temporary usage of the product.

# GENERAL REQUIREMENTS FOR PCF™

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## Q. WHAT DOES UN CLASSIFICATION 1.4S MEAN?

A. The UN classification system comprises of nine classes of which class 1 covers explosives and propellants. Class 1 is divided into six hazard divisions in accordance with the behavior of the product when initiated. Each product is also allocated a compatibility group which refers to whether different kinds of explosives or ammunition can be mixed for storage and transport. A summary of the classification process is shown in the diagram below.



“(d) Division 1.4 *Substances and articles which present no significant hazard*

This division comprises substances and articles that present only a small hazard in the event of ignition or initiation during transport. The effects are largely confined to the package and no projection of fragments of appreciable size or range is to be expected. An external fire shall not cause virtually instantaneous explosion of almost the entire contents of the package;

**Note:** *Substances and articles of this division are in Compatibility Group S if they are so packaged or designed that any hazardous effects arising from accidental function are confined within the package unless the package has been degraded by fire in which case all blast or projection effects are limited to the extent that they do not significantly hinder fire-fighting or other emergency response efforts in the immediate vicinity of the package.”*

**Ref.: The Australian Explosives Code (AEC) transport by road and rail**

# GENERAL REQUIREMENTS FOR PCF™

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## **Q. WHAT ARE THE LICENSING REQUIREMENTS?**

- A. A series of United Nations tests (test series 6 in the United Nations Recommendations on the Transport of Dangerous Goods Manual of Tests and Criteria 2000) are performed by Rockbreaking Solutions personnel in the presence of the competent authority (Western Australian Mines Department – Explosives and Dangerous Goods Division). Packaging, for which the cartridges will be offered for transport, must also be tested as part of the requirements. After completion of tests the competent authority will issue a formal letter detailing the UN number, classification and UN shipping name of the product. This documentation can then be used to apply for authorisation of the product elsewhere.

## **Q. WHAT IS A UN NUMBER AND UN SHIPPING NAME?**

- A. The UN number is a serial number assigned to the article or substance under the United Nations system for transport and storage of dangerous goods. The UN number defines the proper shipping name, which briefly describes what the packaged articles or substances are.

The UN number is used to identify dangerous goods in fire fighting and other emergency situations.

The UN number that has been allocated to PCF™ is 0349 (Articles Explosive N.O.S.)

Although, in South Australia and New South Wales a full box (42) of 60g or 100g x 42mm PCF™ cartridges are accorded the UN number UN0276 – Cartridge (Power Device) 1.4C.

In New South Wales a box with 28 of 60g x 42mm PCF™ cartridges are accorded the UN number UN0349 – Articles Explosives.

# GENERAL REQUIREMENTS FOR PCF™

## Q. WHAT ARE THE TRANSPORT REQUIREMENTS FOR PCF™

A. PCF™ cartridges are ranked as a low risk category. The transport requirements for PCF™ cartridges are shown in the following table, which also shows the transport requirements for conventional explosives.

TRANSPORT REQUIREMENTS	PRODUCT		
	PCF™ 1.4S	PCF™ 1.4C	Explosives
Risk Category	1 (low)**	1 (low)**	3 (high)
Quantity per vehicle	Unlimited	Unlimited	Restrictions apply
Shotfirer's Ticket or Dangerous Goods Transport Licence	Recommended	Mandatory	Mandatory
Licensed Vehicle	Not required	Mandatory	Mandatory
Explosive Vehicle Signs	Not required	Mandatory	Mandatory
Safety Equipment	Fire Extinguisher	Fire Extinguisher	Mandatory
Public Risk Insurance	Not required	Mandatory	Mandatory (\$1,000K)
Emergency Procedure Guide	Not required	Mandatory	Mandatory
Shipping Document	Mandatory	Mandatory	Mandatory

\*\* **NB:** If the total weight being transported is greater than 250kg the Risk Category is automatically increased to "2 Moderate".

PCF™ cartridges are approved for transport under the following codes:

1. The Australian Explosives Code (AEC) transport by road and rail.
2. Dangerous Goods (Transport)(Explosives by road and rail) Regulations 1999 (reg. 2.2).
3. United Nations Recommendations on the Transport of Dangerous Goods Model Regulations.
4. IATA Dangerous Goods Regulations for airfreight.

## Q. WHAT ARE THE STORAGE REQUIREMENTS FOR PCF™ CARTRIDGES?

A. Because PCF™ has a classification of UN 1.4S, unlimited quantities (independent of NEQ – Net Explosives Quantity) can be stored in secure magazines, locked containers in its original packaging. A licensed storage facility is required unless an exemption from this requirement is provided by the relevant competent authority.

Australian Standard 2187.1 (1998) is cited as a reference.

# **GENERAL REQUIREMENTS FOR PCF™**

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**Q. WHAT ARE THE PERSONAL PROTECTIVE EQUIPMENT (PPE) MINIMUM REQUIREMENTS FOR PCF™ OPERATIONS?**

- A.
1. Helmet
  2. Boots
  3. Safety Glasses
  4. Gloves
  5. Hearing Protection (As approved by Australian standards.)