

**MOKOLO AND CROCODILE  
WATER AUGMENTATION PROJECT  
PHASE 2 (MCWAP-2)**

**TENDER NO 054/2024/PMID/MCWAP2/RFB**

**PART C3.1  
SPECIFICATION**

**SECTION 12**

**BLASTING**

# PART C3.1 SPECIFICATION

## SECTION 12 BLASTING

### TABLE OF CONTENTS

	PAGE
<b>SECTION 12</b> .....	<b>1</b>
<b>12.1 SCOPE</b> .....	<b>1</b>
<b>12.2 DEFINITIONS, ABBREVIATIONS AND REFERENCES</b> .....	<b>1</b>
<b>12.2.1 Definitions</b> .....	<b>1</b>
<b>12.2.2 Abbreviations</b> .....	<b>2</b>
<b>12.2.3 References</b> .....	<b>3</b>
<b>12.3 REGULATIONS</b> .....	<b>3</b>
<b>12.4 SAFETY PRECAUTIONS</b> .....	<b>3</b>
<b>12.5 GENERAL REQUIREMENTS</b> .....	<b>4</b>
<b>12.5.1 Programme and Methods</b> .....	<b>4</b>
<b>12.5.2 Blasting</b> .....	<b>5</b>
<b>12.5.3 Record of Excavations</b> .....	<b>6</b>
<b>12.6 QUALITY OF EXCAVATED SURFACE AND BLASTING TRIALS</b> .....	<b>6</b>
<b>12.7 MONITORING OF BLASTS</b> .....	<b>7</b>
<b>12.8 NOTIFICATION OF BLASTS</b> .....	<b>7</b>
<b>12.9 ENVIRONMENTAL MANAGEMENT</b> .....	<b>8</b>
<b>12.10 BLASTING NEAR PIPELINES AND OTHER INFRASTRUCTURE</b> .....	<b>8</b>
<b>12.11 DISPOSAL OF EXPLOSIVES AND ASSOCIATED MATERIALS</b> .....	<b>10</b>
<b>12.12 CONTROLLED BLASTING METHODS</b> .....	<b>10</b>
<b>12.12.1 Controlled Blasting</b> .....	<b>10</b>
<b>12.12.2 Drilling</b> .....	<b>10</b>
<b>12.12.3 Pre-splitting</b> .....	<b>11</b>
<b>12.12.4 Trim Blasting</b> .....	<b>11</b>
<b>12.13 CHECKING AND CORRECTING THE EXCAVATED PROFILE</b> .....	<b>11</b>
<b>12.14 MEASUREMENT AND PAYMENT</b> .....	<b>12</b>
<b>12.14.1 General</b> .....	<b>12</b>
<b>12.14.2 Explosive Materials</b> .....	<b>12</b>
<b>12.14.3 Checking and Correcting the Excavated Surface</b> .....	<b>12</b>
<b>12.14.4 Scheduled Items</b> .....	<b>12</b>

**LIST OF TABLES**

**TABLE 12/1 MAXIMUM PEAK PARTICLE VELOCITIES (VIBRATION)..... 8**  
**TABLE 12/2 SAFE GROUND VIBRATION LEVELS FOR FRESHLY POURED CONCRETE ..... 9**  
**TABLE 12/3 DAMAGE LIMITS FOR AIR BLAST..... 9**

## SECTION 12

### BLASTING

#### 12.1 SCOPE

This Section deals with the planning, design and execution requirements for blasting, and blasting methods to be used for bulk surface and trench excavation and excavation underground associated with pipe jacking operations.

This Section is a performance specification where the Contractor is responsible for the design of the blasting techniques required to excavate hard rock material and shall be read together with the approved Health and Safety Plan.

The following specification sections shall be read in conjunction with this Section 12:

- a) Section 1 – General;
- b) Section 2 – Occupational Health and Safety;
- c) Section 4 – Integrated Environmental Management;
- d) Section 8 – Dealing with Water;
- e) Section 9 – Bulk Surface Excavations and Trenching;
- f) Section 15 – Backfilling and Bedding; and
- g) Section 33 – Laying and Testing Steel Pipes.

#### 12.2 DEFINITIONS, ABBREVIATIONS AND REFERENCES

##### 12.2.1 Definitions

In this Section the following words shall have the meaning given:

- a) **“Blasting”** means the careful design and blasting, executed under the specific supervision of an approved blasting specialist, the Explosives Manager, to manage the general risks of blasting operations including the risk of damaging sensitive infrastructure near the blasting operations.
- b) **“Controlled blasting”** comprises the use of a drilling and charging pattern that has the purpose of limiting overbreak and damage to the rock outside the payment line (i.e. theoretical excavation line) and comprises closer spacing of the perimeter holes plus reduced *decoupled* charges in these holes. It also comprises the use of delays in detonating the various rows of holes in the drilled pattern to limit vibration velocities. The four principal techniques of controlled blasting are smooth blasting, pre-splitting, line drilling and trim blasting. Normally, only smooth blasting is used underground and the other techniques are used in surface excavations.
- c) **“Covered blasting”** means blasting where the deposition of flyrock on adjacent undisturbed areas shall be controlled by either placing blast mats or through placing a suitable layer of soil cover over the area to be blasted. The soil used for covered blasting shall not be topsoil or fertile soil as defined in Section 7 – Clearing Site.

## PART C3.1 - SPECIFICATION

- d) **“Decoupling”** means that the diameter of the charge is smaller than the diameter of the hole so that an annular air space is provided around the charge. This air space absorbs some of the initial explosive energy and reduces the magnitude of the initial high-pressure impact that is responsible for the crushing of the rock immediately surrounding the hole.
- e) **“Payment line”** means the excavation profile shown on the Drawings or determined by the Engineer, within which no unexcavated or loose material shall occur after the excavation is complete, except as allowed within the specified tolerances. It is also the line to which payment for excavation will be made.
- f) **“Pre-splitting”** comprises drilling a line of closely spaced parallel holes of appropriate diameter, spaced not more than ten times the hole diameter or 600 mm, whichever is the smaller, charging the holes with an appropriate amount and type of explosive (decoupled if necessary) to shear the rock, to form a surface along the line of drill holes. The pre-splitting holes will be initiated first prior to the main production blast.
- g) **“Post-splitting”** comprises the drilling of a number of closely spaced parallel holes along the required excavation surface, with a suitable burden/spacing ratio, loading all the holes lightly with a uniform continuous charge of small diameter explosive and detonating all these charges simultaneously after the detonation of the main production blast, to form a surface along the line of drill holes.
- h) **“Line drilling”** comprises drilling a line of holes of appropriate diameter spaced not more than twice the hole diameter to form a surface of weakness along which the rock will break. Blasting is not permitted in the line drilled holes, and the first line of production holes next to the line drilled holes shall be lightly charged to avoid damage to the line drilled break surface.
- i) **“Smooth blasting”** comprises the drilling of a number of closely spaced parallel holes along the required final excavation surface, with a suitable burden/spacing ratio, loading all the holes lightly with a decoupled, uniform continuous charge of small diameter explosive, and detonating all these charges simultaneously, after the detonation of the main production blast.
- j) **“Trim blasting”** comprises the separate removal of a protective zone of rock which has been purposely left within the specified limits of excavation for flat areas and shallow slopes. Drilling for trim blasting shall consist of a regular pattern of holes at appropriate spacings and angles and to accurate depths. The holes shall be lightly charged and detonated in relays to lift the rock progressively to form the final excavated surface without damaging the surrounding rock.
- k) **“Overbreak”** means any excavation which extends beyond the payment line, irrespective of the reason for such excavation. Overbreak shall be minimised by using an approved controlled blasting technique.
- l) **“Public structures”** means any structure or building not associated with the project, i.e. houses, kraals, culverts, roads, water troughs, irrigation pipes, etc.
- m) **“Enlargement”** means the additional excavation carried out to enlarge an existing excavation to a new payment line.

### 12.2.2 Abbreviations

dB	:	Decibel
NGL	:	Natural Ground Level
PDF	:	Portable Document Format
PPD	:	Peak Particle Displacement
PPV	:	Peak Particle Velocity
SANS	:	South African National Standard
USBM	:	United States Bureau of Mines

### **12.2.3 References**

When reference is made to a Code of Practice, Specification or Standard, the reference shall be taken to mean the latest edition or replacement at time of tender of the Code, Specification or Standard; including addenda, supplements, modifications and revisions thereto. Where a previous version is intentionally used, it will be indicated as such. Where reference is made to a Code, Specification or Standard that has subsequently been withdrawn and not replaced, the intended content will remain relevant unless confirmed otherwise in writing by the Engineer.

### **12.3 REGULATIONS**

The storage of explosives, use of explosives, personnel, transport of explosives, and other matters related to explosives shall be governed by the relevant sections of the Explosives Act (Act 15 of 2003), the Mineral and Petroleum Resources Development Act (Act 28 of 2002), Mine Health & Safety Act (Act 29 of 1996) and the Occupational Health and Safety Act (Act 85 of 1993), together with their associated regulations, or such subsequent acts and regulations as may be promulgated.

No explosives of any kind shall be used without the prior approval in writing of the Engineer, in terms of the approved Health and Safety Plan. Once this approval is granted, the Contractor shall be solely responsible for proper storage, transport, importation, security arrangements both during transport to the Contractor's storage magazine(s) on Site as well as during blasting activities, and the correct possession and use of explosives.

The Contractor shall keep records in respect of receipt, storage and use of explosives. The Engineer shall have the right to inspect explosives magazines and records kept therein in respect of the storage, receipt, issue and use of explosives.

The Contractor shall display in his Site office, and all his explosives magazines, a copy of any applicable statutory regulations, and the applicable section of the approved Health and Safety Plan and shall supply a copy of the same to the Engineer.

A copy of all certificates issued to workmen to permit them to undertake blasting, and to the Contractor to cover the purchasing, storage, transport and use of explosives shall be handed to the Engineer before any blasting work is undertaken.

### **12.4 SAFETY PRECAUTIONS**

The Contractor shall store, transport, possess and use explosives in accordance the relevant sections of the Acts and regulations referred to in Clause 12.3.

Furthermore, the Contractor shall take particular precautions with respect to lightning, such as the use of non-electric detonators or electric detonators specially manufactured for use in such circumstances coupled with the use of lightning warning equipment or other appropriate measures.

The power circuit used for electric firing of explosives within underground works shall be hung on supports other than those used for electric power or communication lines and on the opposite side of the tunnel. Control of this circuit shall be by means of a locking switch with one key.

All electrical equipment, cabling, pipework, ducting, rails and the like used underground shall be grounded to an approved installation extending throughout the underground workings and connected to ground outside the entrance to the Works.

PART C3.1 - SPECIFICATION

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The Contractor shall install and operate a siren of sufficient volume to be easily heard above the general site noise from all points within a radius of 1.0 km of surface blasts. Hand operated sirens will only be accepted in areas of restricted access such as with underground works where access is fully controlled. Communicate blasting and after-hours construction work on farms where tourism and hunting takes place.

Blasting operations should be controlled to ensure sound pressure levels are kept below the generally accepted 'no damage' level of 140 decibels.

The Contractor shall employ industry standard methods to control the impact of blasting and limit the risk of damage to buildings and structures by reducing blast vibrations induced in the rock mass, eliminating fly rock and limiting air-blast and noise to acceptable levels. This should include pre-blast inspections of infrastructure.

## **12.5 GENERAL REQUIREMENTS**

Controlled blasting shall be used for all excavations, inclusive of any stage-excavations such as top headings, central top headings, side drifts, benches, etc., in both surface and underground works.

The Contractor shall employ a blasting specialist for the design of controlled blasting patterns for the anticipated rock conditions in the various sections of the Works. This blasting specialist shall be retained by the Contractor for the duration of the excavation of the Works and shall submit new designs to suit encountered rock conditions as and when required by the Blasting Supervisor. The name and CV of the Contractor's blasting specialist shall be submitted for approval to the Blasting Supervisor, prior to the commencement of the Works.

### **12.5.1 Programme and Methods**

In general, the Contractor shall observe and demonstrate willingness to observe the requirements of this Section. In the event of a situation arising in which the Explosives Manager or any Blasting Supervisor demonstrates consistent non-compliance with the requirements of this Section, incompetence and/or false representation, they shall, on the instruction of the Engineer in terms of Sub-clause 6.9 of the Conditions of Contract be summarily removed from site and be replaced by a competent person approved by the Engineer at no additional cost. Any delays caused as a result of this shall be for the Contractor's account.

Prior to commencing with blasting activities, the Contractor should submit a Method Statement which should comply with the Explosives Regulations and all relevant SANS standards and health and safety standards for mitigating blasting. The Contractor shall submit to the Engineer at least 28 days before the commencement of any excavation work, full details of his proposed methods and sequence of excavation and programme for the use of explosives. The work shall be programmed so as to minimise blasting adjacent to already constructed sections of the Works.

Within 2 weeks of receipt of the proposals, the Engineer shall indicate approval in part or in whole, in writing, to the Contractor. The Engineer reserves the right to reject the proposals if, in his opinion, undesirable damage to permanent rock surfaces or existing structures will result from carrying out the blasting as proposed. If approval is withheld, new proposals in whole or in part shall be submitted. No drilling or blasting shall be carried out in areas for which the proposals have not been approved by the Engineer, and any changes to the accepted methods shall be subject to the Engineer's approval.

## PART C3.1 - SPECIFICATION

The work shall be programmed so as to minimise blasting effects adjacent to previously constructed sections of the Works. Furthermore, the work shall be programmed considering, amongst others, the hunting season, tourists, breeding camps, breeding seasons, and sensitive areas as defined in Section 4: Integrated Environmental Management.

### 12.5.2 Blasting

Unless otherwise detailed on the Drawings or instructed by the Engineer all blasting work shall be carried out using carefully managed blasting techniques to minimise damage to the final excavation profile.

Use shall be made of approved special explosives and/or blasting techniques which will minimise blasting-induced fractures, or disturbance, on the rock faces outside the excavation line so preserving the rock in the soundest possible condition and most importantly to minimize damage to nearby infrastructure.

The Contractor shall incorporate a series of blasting trials in his initial blasting operations to substantiate his proposed methods of blasting and methods of monitoring impact. As a minimum, four (4) trial blasts shall be conducted by the Contractor at the start of the Contract and, if required by the Engineer, continued until consistent seismographic results are obtained. Monitoring for these trials shall be both taken on existing pipe (to be exposed) or other structure and in the ground above it – both at the same distance from the blast. Details of all proposed blasting trials and procedures shall be submitted to the Engineer for scrutiny in the normal manner (refer to Clause 12.10).

In underground work at least one of the trial blasts shall incorporate the full extent of the face to be excavated and maximum round length. In surface work the maximum depth and length of each trial section shall be 5 m and 10 m respectively or as otherwise directed by the Engineer. The site for the trials shall be agreed with the Engineer.

Once the results of the trials are approved, such results shall form the basis for deciding whether future controlled blasting is achieving the required standard.

Where blasting is necessary, the Contractor shall, in particular, note the requirement that he must limit to the maximum extent practicable the occurrence of flyrock, which may include, inter alia, the use of blasting mats, covering the rock prior to blasting with sufficient loose material to prevent the blasted material being thrown excessive distances from the blasting zone, timber boarding or other means to protect the Works and persons, animals and property in the vicinity of the Site. The Contractor shall accept responsibility for all injury or damage occasioned by any blasting operations and shall make good such damage without any additional payment.

Blasting methods shall be developed such that the weight of charge to be detonated at any precise moment is minimal and to include the use of time-delay detonators in order to reduce the extent of the overall impact of detonation.

The Contractor shall, in particular, note the requirement that he must limit to the maximum extent practicable the spillage of material from surface excavations, whether by blasting or other means, down adjacent hillsides. To this end the Contractor shall take all necessary precautions including, if necessary, covered blasting, i.e. covering the rock prior to blasting with linked, anchored mats or sufficient loose material to prevent the blasted material being thrown down the adjacent hillside. If, during the course of excavation on a hillside, the Engineer is of the opinion that insufficient precautions are being taken to minimise the spillage of material, he may instruct the Contractor to adopt further measures to reduce the spillage. No separate payment will be made for any such measures required.

## PART C3.1 - SPECIFICATION

Each separate blast shall be designed in accordance with modern blasting practice to break out the rock with the minimum explosive force. Full details of each blast shall be submitted to the Engineer for scrutiny not later than 24 hours prior to the commencement of drilling for that blast. The details shall include the location, depth and area of blast holes, the type, strength, amount, column load and distribution of explosives to be used per hole, per delay and per blast, the sequence and pattern of delays, the maximum expected amplitude of vibration on adjacent structures taking cognisance of the requirements in Clause 12.10, and the description and purpose of any special methods to be adopted by the Contractor.

The approval by the Engineer of any blasting proposals shall not relieve the Contractor of his responsibilities under the Contract and the Law.

Should the Contractor excavate to dimensions in excess of those specified or instructed by the Engineer, whether to remove damaged material or for reasons of safety or for his own convenience, he shall at his own expense and when required by the Engineer, fill in the excess excavation with concrete of approved quality or with other material approved by the Engineer, or carry out additional trimming to the satisfaction of the Engineer.

### **12.5.3 Record of Excavations**

Where blasting has taken place, the Contractor shall provide the Engineer each day with a copy of the record for the previous day's excavations. Where applicable the following data shall be recorded for each working area together with such other data as the Engineer may request:

- a) Location of the excavation and position within the excavation;
- b) Drilling pattern;
- c) Type and amount of explosive used, including blasting pattern and delays used;
- d) Details of rock conditions and rock support installed;
- e) Number and classification of labour and Equipment;
- f) Unusual occurrences, rockfalls, unstable or soft ground and inflows of water;
- g) Blasting results and measured vs. predicted vibration levels;
- h) Progress, delays and reasons for delays; and
- i) Name and certification of the Explosives Manager.

### **12.6 QUALITY OF EXCAVATED SURFACE AND BLASTING TRIALS**

The surface, after blasting, shall exhibit a regular fracture plane between barrels without back break and with half barrels visible over the major portion of the surface. The surface shall be scaled down of all loose and hollow sounding rock to leave a solid, intact surface. Light charges shall be used for enlarging or correcting the excavated profile and also for excavating trenches. For example "Fox holes" are required approximately at 19 m centres along the new pipeline to provide access for welding and coating repairs.

For trench blasting, the width of the trench shall not exceed the limits specified in the Contract. In the case of overbreak resulting from highly weathered surface rock, agreement must be reached with the Engineer in terms of acceptable results. Particular care must be taken not to disturb any existing pipeline.

PART C3.1 - SPECIFICATION

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If, in the opinion of the Engineer, the methods of blasting are at any time causing excessive or undesirable disturbance of the rock mass surrounding the excavated space, he may order the Contractor to change his methods of blasting and/or carry out further blasting trials until the desired results are achieved. No additional payment will be made for any change or further trials ordered by the Engineer or any delays resulting there from.

## **12.7 MONITORING OF BLASTS**

The Contractor shall supply and operate at least one approved blasting seismograph, which shall be used where necessary or where directed by the Engineer to monitor blasting work. The personnel responsible for the operation of the seismograph(s) shall satisfy the Engineer that they are experienced and competent in the setting up of all of the equipment in accordance with the standards required and in the downloading of the data files for printing and analysis immediately after blasting. For the trial blast (refer Clause 12.5.2) and during supplementary and controlled blasting, the Contractor shall locate a sensor above the buried pipe at least 0.5 m below natural ground level (NGL), firmly coupled to the ground. This shall be achieved by casting a cement block of 0.3 m diameter and depth with a threaded bolt projecting from the top to take the seismic sensor. The concrete shall be located in a hole and tamped down with soil and buried. All the readings during trial and normal blasting shall be accumulated and plotted in order to build up a knowledge base for propagation, if any.

The setting up and production of useful/informative records of the blasts will be reviewed and agreed between the Engineer and Contractor. These records shall accompany the daily records as described in terms of Clause 12.5. The RAW data files and .pdf printouts shall show the time and location of each blast, the type and amount of explosive used, rock type, together with any other relevant data. Copies of these records shall accompany the required daily records. The Contractor shall have access to a second instrument either for:

- Occasional measurement on an existing pipeline;
- Where surface structures need to be monitored; and
- As back up to the first.

The software necessary for viewing and analysing the files, including derivation of displacement and frequency components, shall be made available to the Engineer.

All blasting near structures and boreholes shall be monitored and recorded. The levels of vibration shall not exceed that specified in Clause 12.10.

## **12.8 NOTIFICATION OF BLASTS**

The Contractor shall notify the Engineer of his intention to blast at least 24 hours before that operation is carried out. The notification shall show the location of and the intended time of each blast and the name of the Blasting Supervisor and shift foreman responsible.

The Contractor shall distribute written notification to the Engineer and all affected parties, as well as suitable signage to adjacent communities and the public in the vicinity of the blast, prior to undertaking surface blasting in accordance with the relevant legislation. Any delay or postponement of any blast shall immediately be notified to the Engineer and all affected parties, adjacent communities and the public in the vicinity of the blast. The firing of explosives above ground and in underground works shall be restricted to hours of daylight, daily with the exception of Sundays when no blasting shall be permitted unless authorised in writing by the Engineer.

The Contractor shall prepare a method statement for approval by the Engineer on notification of affected parties, adjacent communities and the public in the vicinity of the blast.

## PART C3.1 - SPECIFICATION

**12.9 ENVIRONMENTAL MANAGEMENT**

The Contractor shall ensure that dust and noise control measures specified in Section 4 – Integrated Environmental Management, as well as all pollution control measures as specified in Section 4 – Integrated Environmental Management and Section 8 – Dealing with Water are implemented during drilling and blasting operations.

Topsoil and fertile soil shall be stripped and stockpiled before the commencement of drilling for the setting of charges. The Contractor shall prevent damage to special features and the general environment, including measures to limit flyrock. Measures to reduce flyrock shall include use of blast mats or the technique of “covered blasting”. Blast mats should be used wherever fly-rock may result in damage to any infrastructure or where it could result in death or injury of animals, livestock, game, or where damage could be caused to sensitive environmental features. Flyrock greater than 50 mm in diameter, which falls beyond the cleared Site and/or construction servitude, shall be collected and removed at no additional cost to the Employer. No blasting shall take place in the defined sensitive areas, as specified in Section 4: Integrated Environmental Management.

**12.10 BLASTING NEAR PIPELINES AND OTHER INFRASTRUCTURE**

The unrestricted use of explosives will generally not be permitted in any part of the Works.

The Contractor shall be responsible for avoiding damage to adjacent infrastructures from flyrock by erecting barricades and/or the use of covered blasting or blast mats or other means acceptable to the Engineer. Should any damage be caused by his operations this shall be made good without any additional payment.

The amount of energy released shall not result in a ground vibration with a peak particle velocity in excess of those recommended by USBM (see Table 12/1 below). The dominant blasting frequency for PPV's in excess of 25 mm/s should be in excess of 15 Hz, and any tendency to lower frequencies must be agreed with the Engineer.

**TABLE 12/1  
MAXIMUM PEAK PARTICLE VELOCITIES (VIBRATION)**

<b>Maximum Peak Particle Velocity (mm/s)</b>	<b>Effect on People and Buildings</b>
0,5	Threshold of human perception unlikely to cause damage of any type
5	Limit for blasting adjacent to historical monuments
25	Limit for blasting near private dwellings in order to reduce disturbance to residents to a minimum
50	Limit for blasting adjacent to residential structures on good foundations
84	Limit for property owned by concern doing the blasting (i.e. minor plaster cracks acceptable)
120	Recommended maximum level for blasting adjacent to sturdy reinforced concrete structures

## PART C3.1 - SPECIFICATION

Where circumstances dictate, such as when blasting near to partially cured concrete, the peak particle velocity shall not exceed that specified in Table 12/2. These limits are to be applied in conjunction with those applied to any adjacent structures.

**TABLE 12/2  
SAFE GROUND VIBRATION LEVELS FOR FRESHLY POURED CONCRETE**

<b>Aged of Concrete (Days)</b>	<b>Maximum Peak Particle Velocity (mm/s)</b>
< 3 Days	5
3 - 7 Days	51
8 - 10 days	102
10+ Days	203

Air Blast should be controlled by proper stemming control and cover blasting on shallower holes. The Air Blast Limits should not exceed 134 dB which is the current recommended South African limit as indicated in Table 12/3 below.

**TABLE 12/3  
DAMAGE LIMITS FOR AIR BLAST**

<b>Air Blast Level</b>	<b>Descriptions</b>
125 dB	Complaints Start
>130 dB	Resonant response of large surfaces (roofs, ceilings)
134 dB	Recommended South African Limit
150 dB	Some windows break
170 dB	Most windows break
180 dB	Structural Damage

Blasting shall not be carried out within 5 m of the Permanent Works or other permanent infrastructure, unless otherwise agreed to in writing by the Engineer. Also refer to blasting in the proximity of Transnet, road authorities and Eskom infrastructures and cables, Clause 33.8 and Annexures 33/2, 33/3 and 33/4.

Within 250 m either side of existing infrastructure boundaries, the Contractor shall, prior to commencement of blasting activities, assess and update the records of the Assets and Infrastructure Baseline Survey and use the results to mitigate social, environmental and other impacts, and undertake a crack survey and prepare a photographic record of each structure, especially houses, buildings, ruins, farm dams, water troughs etc., of the local communities within 250 m of any Works, whether on the surface or underground, prior to any blasting taking place. The owner shall approve the record. A copy of this approved record shall be provided to the Engineer prior to any blasting taking place. A crack survey of all structures will again be undertaken three days after the blasting operation, compared with the pre-blast survey, and the owner shall approve the post blast survey. A copy of this approved record shall be provided to the Engineer within 21 days of completion of the survey. In densely populated areas, a representative sample of dwellings agreed to by the Engineer shall be surveyed.

PART C3.1 - SPECIFICATION

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The Contractor shall also obtain from the owners, records of the yields of all boreholes located within 50 m of any blast. A copy of the record, approved by the owner, shall be provided to the Engineer prior to any blasting taking place.

Should a record not be available, the Contractor shall arrange for the necessary yield tests to be performed before and after each blast event. The test shall be pre-approved by the Engineer.

### **12.11 DISPOSAL OF EXPLOSIVES AND ASSOCIATED MATERIALS**

Should the Contractor be granted permission by the relevant statutory authority to retain outdated explosives in a site magazine or storage place he shall immediately inform the Engineer and if requested to do so, furnish the Engineer with a copy of such authorisation. When any explosives are to be destroyed, the Engineer shall be informed at least 24 hours before the destruction is due to take place.

Under no circumstances may explosives be destroyed in any part of the underground works. Explosive wastes may only be destroyed legally and in all cases care shall be taken to avoid fire risks. This would include burning of waste in a contained area cleared of vegetation and where appropriate firefighting equipment is in attendance. Cognisance shall be taken of the wind directions and the burning operation shall be appropriately supervised until the fires are fully extinguished.

Associated materials, such as detonator wire shall at all times be removed after each blast and disposed of appropriately.

### **12.12 CONTROLLED BLASTING METHODS**

#### **12.12.1 Controlled Blasting**

Controlled blasting methods shall comprise pre-splitting, post-splitting or trim blasting.

Both cartridge and bulk explosives may be used where appropriate.

In controlled blasting the type, size, decoupling and charge concentration of perimeter and bulk charges shall be within established parameters unless otherwise proven acceptable by site trials.

All charges shall be accurately made up and inserted into the holes at the correct spacing, and all holes shall be correctly stemmed and connected in the correct sequence, with detonators being correctly delayed.

If, at any time, the methods of drilling and blasting do not produce the desired results of a uniform profile and shear face without overbreak, all within the tolerances specified, the Contractor shall be required to undertake further tests as specified in Clause 12.5.2 until a technique is arrived at that will produce the optimised results commensurate with the rock conditions.

Controlled blasting shall be used on the perimeter of all excavations in rock for the Permanent Works, designated excavations and otherwise where called for by the Engineer.

#### **12.12.2 Drilling**

In all controlled blasting, drilling accuracy of perimeter holes is of prime importance and the Contractor shall take particular care and make use of sight lines and guide rails in surface work to control the alignment and depth of blast holes. In underground works, use shall be made of drilling

PART C3.1 - SPECIFICATION

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equipment with parallel arm controls or such other method of control acceptable to the Engineer. Holes which are likely to protrude more than 100 mm beyond the excavation profile (including any tolerances specified) shall not be charged up, but shall be re-drilled.

In both surface and underground works the blast pattern shall be accurately set out and holes shall be collared within 50 mm of the required position. Holes which are over-drilled shall be fully stemmed to the required depth before charging up takes place.

In surface work, the depth of perimeter holes for any individual blast/round shall not exceed 10 m or any lesser depth detailed on the Drawings unless the Contractor can demonstrate to the Engineer that he can stay within the required tolerances, produce a uniform surface, and provide suitable access for all the subsequent necessary scaling, inspection, mapping and installation of the required rock reinforcement and support. In this event the length of holes may be increased to a maximum of 15 m upon written approval of the Engineer. All perimeter holes for surface blasting shall be drilled to a depth of 10 hole diameters below the bottom of any production holes adjacent to the perimeter plane.

### **12.12.3 Pre-splitting**

Critical to split formation is the instantaneous initiation of pre-split holes using either detonating cord, or electronic detonators. No down-hole pyrotechnic delay detonators are acceptable, but the split may be broken into runs of not less than 8 holes separated by a short delay where vibration is an issue.

Either all the holes in a pre-split line shall be drilled, charged and detonated simultaneously prior to drilling the production holes for the excavation adjacent to the presplit line, or pre-splitting shall be accomplished by delaying detonation in the production holes to allow the presplit holes to fire first. For this latter option, which may yield worse results than pre-splitting as a separate blast, agreement must be obtained from the Engineer. The first line of production holes next to the pre-split face shall be lightly charged to ensure that the presplit face is not damaged when the charges in the production holes are detonated.

The bottom charge of a pre-split hole shall not be larger than the line charges unless otherwise directed. The top charge of the pre-splitting hole shall be placed far enough below the collar to avoid over-breaking the final profile. In general, to prevent cratering and excessive movement, pre-split holes shall not be stemmed, but, where there is need to contain noise, the pre-split line shall be covered with adequate layer of soft soil or soil like material free of potential projectiles, placed on top of the tied-in blast and in sufficient depth to prevent flyrock.

### **12.12.4 Trim Blasting**

Drilling for trim blasting shall consist of a regular pattern of holes at appropriate spacings and angles and to accurate depths. The holes shall be lightly charged and detonated in relays to lift the rock progressively to form the final excavated surface without shattering the surrounding rock.

## **12.13 CHECKING AND CORRECTING THE EXCAVATED PROFILE**

The excavated profile shall be checked for line, level and underbreak using methods approved by the Engineer. No projections of rock shall protrude within the payment line, except as allowed within the specified tolerances.

## PART C3.1 - SPECIFICATION

The Contractor shall submit his proposals for removing any underbreak to the Engineer for his approval prior to carrying out any such work. Any work executed or delays, which are due to the Contractor having to re-excavate underbreak and then re-install support shall be carried out without additional payment, and no extension of time will be allowed for this work.

## **12.14 MEASUREMENT AND PAYMENT**

### **12.14.1 General**

The rates tendered under this Section shall not include for the general obligations, Contractor's Equipment and work deemed to be covered by the items included in Section 1 - General.

Drilling and blasting will not be measured separately for payment, except as specified below. The various operations of setting out, drilling, charging, and blasting, making safe, barring, etc., and removal of underbreak if required will not be measured separately for payment. The Contractor shall be deemed to be covered by the rates tendered in the Bill of Quantities for the relevant excavation items.

The construction of and maintenance of the magazines and the storage of explosive materials shall be deemed to be covered by the items provided in Section 1 - General.

### **12.14.2 Explosive Materials**

The provision of explosive materials will not be measured separately (refer to Hard Excavation dealt with under Section 9 - Bulk Surface Excavation and Trenching). The acquisition, transport, storage and the use of explosives materials shall be included in the rates tendered in the Bill of Quantities for the relevant excavation items.

### **12.14.3 Checking and Correcting the Excavated Surface**

No separate payment will be made for checking or correcting the excavated profile. The rates for such work shall be included in the applicable excavation rates under Section 9 – Bulk Surface Excavations and Trenching or Section 15 – Trench Backfilling and Bedding.

### **12.14.4 Scheduled Items**

<b>12.001</b>	<b>Controlled blasting (pre-splitting and post-splitting)</b>	<b>Unit: square metre (m<sup>2</sup>)</b>
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Controlled blasting will only be measured for payment in designated excavations or as ordered by the Engineer for the Permanent Works.

Measurement will be the net area of rock measured on the payment line. Payment will only be made for excavations carried out in accordance with approved blasting patterns.

The rate tendered shall be additional to the excavation items and shall include for blasting trials, any additional work for setting-up drilling equipment, any additional setting out and control measures, limited spacing and diameters of perimeter holes, any additional uncharged holes and any additional explosives.

Payment for excavation will be made under Section 9 - Bulk Surface Excavations and Trenching.

PART C3.1 - SPECIFICATION

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The rates for excavation as well as for controlled blasting shall be deemed to include for the provision, operation and maintenance of a fully compliant blasting seismograph and software for analysis of the RAW files and for any restrictions which may be imposed by the Engineer in terms of blasting near structures.

In the case of trench and confined excavation the cost of smooth blasting techniques shall be included in the rates for such excavation.

**12.002 Trim blasting****Unit : square metre (m<sup>2</sup>)**

Trim blasting will only be measured for payment in designated excavations or as ordered by the Engineer. Should the Contractor take no special measures no payment will be made.

Measurement will be the net area of rock face (at right angles to the direction of drilling) measured on the payment line. Payment will only be made for excavations carried out in accordance with approved blasting patterns and which result in half barrels being visible over the major portion of the surface unless it is agreed that the geology prevents this.

The rate tendered shall be additional to the excavation items and shall include for blasting trials, any additional works for setting-up drilling equipment, any additional setting out and control measures, limited spacing and diameters of perimeter holes, any additional uncharged holes and any additional explosives.

Payment for excavation will be made under Section 9 – Bulk Surface Excavations and Trenching.

The rate for trim blasting shall be deemed to include for the provision, operation and maintenance of an approved blasting seismograph and for any restrictions which may be imposed by the Engineer in terms of blasting near structures.

In the case of trench and confined excavation the cost of smooth blasting techniques shall be included in the rates for excavation.