



Standard

Technology

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BLASTING IN SUBSTATIONS**

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1. Introduction

Excavation forms an integral part of the construction program on substations. From time to time and depending on ground condition blasting is required during excavation.

This document is intended to standardise the blasting process on substation construction sites.

2. Supporting clauses

2.1 Scope

This document standardises the requirements for blasting on substation construction sites.

2.1.1 Purpose

This document standardises the process and manner in which blasting is to be carried on Hard Rock or Boulder excavations as set out in SANS 1200 D and SANS 1200DA under material classification. This process will be applicable to all substation construction sites.

2.1.2 Applicability

This document shall apply throughout Eskom holdings limited its divisions.

2.2 Normative/informative references

Parties using this document shall apply the most recent edition of the documents listed in the following paragraphs.

Suppliers are responsible for obtaining the latest copies of the South African national standards (SANS) and international standards referred to in this document. Copies of the latest revision of Eskom documents will be supplied by the purchaser and will form part of the enquiry documentation.

2.2.1 Normative

- [1] SANS 1717-1: The design of detonator initiation systems for use in mining and civil blasting applications Part 1: Electronic initiation systems.
- [2] SANS 1717-2: The design and approval of detonator initiation systems for use in mining and civil blasting applications Part 2: Electric initiation systems - Shot exploder based.
- [3] SANS 1717-3: The design and approval of detonator initiation systems for use in mining and civil blasting applications Part 3: Controlled blasting systems.
- [4] SANS 10325-1: The safe application of detonator systems for use in mining and civil blasting applications Part 1: Electronic detonator systems.
- [5] SANS 10325-2: The safe application of detonator systems for use in mining and civil blasting applications Part 2: Electric detonator systems - Shot exploder based.
- [6] Explosives Act 26 of 1956
- [7] Explosives Act 15 of 2003
- [8] SANS 1200D: Standardized specification for civil engineering construction Section D: Earthworks
- [9] SANS 1200DA: Standardized specification for civil engineering construction Section DA: Earthworks (small works)
- [10] Occupational Health and Safety Act, 1993 (No. 85 of 1993)

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2.2.2 Informative

None

2.3 Definitions**2.3.1 General**

Definition	Description
Assistant	A person, who renders, gives aid, supports or supplements another person with work.
Blaster	A person who holds the responsibility of carrying out blasting on site.
Contractor	A person or firm that undertakes a contract to provide materials or labour to perform a service or do a job.
Employee	An individual who works part time or full time under a contract of employment
Explosives	Material that causes a sudden, almost instantaneous, release of gas, heat, and pressure.
Misfires	Fail to produce the intended result.
Operator	A person who operates equipment or machinery.
Surveyor	An official inspector of something, especially for measurement and valuation purposes
Tramming	To travel/move in a conveyance used for heavy loads.
USBM	United States Bureau of Mines

2.3.2 Disclosure classification

Controlled disclosure: controlled disclosure to external parties (either enforced by law, or discretionary).

2.4 Abbreviations

Abbreviation	Description
PPE	Personal Protective Equipment
SHE	Safety, Health, Environment
SHEQ	Safety, Health, Environment and Quality

2.5 Roles and responsibilities

Contractors who are involved in construction at substations shall adhere to this standard during construction.

2.6 Process for monitoring

Not applicable.

2.7 Related/supporting documents

Not applicable.

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3. Substation Construction sites

Substation construction sites can clearly be defined in two categories i.e. Green-field and brown-field sites. Green-field sites are defined as new substation whereas brown-field sites are defined as existing substations. Brown-field sites that require blasting should ensure that special consideration be taken due to the close proximity of equipment. Green-field sites that require blasting and are located near commercial or residential sites should also ensure that special consideration be taken into account. The following highlights the special considerations that need to be taken into account at all times:

3.1 Flyrock:

Flyrock can cause serious injury or damage when it travels outside the blast area. Flyrock can be caused by improper blast design; unanticipated geologic features such as voids, soft seams, and other planes of weaknesses; borehole deviation; insufficient burden; and poorly distributed explosives.

The Blaster should inspect any free rock faces for irregularities and geologic conditions that may affect the blast and adjust the drill hole locations accordingly. Profiling the rock face using simple measuring tapes, conventional surveying techniques, or more advanced laser profiling may be warranted. Driller's notes and logs should be kept and used by the Blaster to make adjustments to explosives loading to account for geologic conditions and borehole deviation in order to minimize Flyrock.

3.2 Vibrations

Blasting generates vibrations and can damage underground and aboveground structures. Thus contractors should make use of a seismograph to monitor vibration on substation site, the United States Bureau of Mines (USBM) criteria for safe blasting for ground vibration and recommendations which is well accepted in South Africa should be adhered to unless otherwise specified by the Substations Engineering Department. In the absence of seismic monitoring equipment, the explosives loading limits shall be based upon the scaled distance formula as specified in the USBM. In certain circumstances, monitoring of buildings/structures may be required depending on restrictions of vibrating levels. Even when vibrations are not at a level sufficient to cause damage, they can disturb individuals and result in complaints. Therefore proper placement and operation of the seismograph is critical for obtaining accurate readings.

3.3 Mitigating factors for Flyrock and Vibrations

The following factors may be applied to mitigate the risk of Flyrock and Vibrations due to blasting:

3.3.1 Flyrock

- a) Controlled/delayed blasting.
- b) Blasting mats to retain the exploded rocks.
- c) Similar to a blasting mat, soil cover may also be used.
- d) Monitoring of drilling operations will also provide feedback to the drillers so that they may make adjustments to their methods.

3.3.2 Vibrations

- e) Controlled/delayed blasting.
- f) Adjusting the weight of explosives per delay.
- g) Altering the loading densities.
- h) Varying the delay pattern.

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3.4 Blasting Approvals

Blasting Method Statements as well as an Inspection Plan shall be developed and submitted to Substation Engineering for approvals prior to blasting.

4. Blasting on site

The following clauses should be adhered to at all times.

4.1 Contractor employees and equipment

- a) All contractor employees shall undergo a pre-employment medical examination, site induction and security screening.
- b) Contractor employees shall make use of the following Personal Protective Equipment (PPE) and record all PPE issued:
 - o Hardhats
 - o Safety shoes / gumboots
 - o Gloves
 - o Overalls
 - o Safety glasses / goggles - where applicable
 - o Dust masks - where applicable
 - o Welding helmet - where applicable
 - o Welding gloves - where applicable
 - o Hearing protection device
 - o Life jackets
 - o Reflective vests
 - o Dark sun glasses – Operators

4.2 Transporting plant and equipment to site

- a) Transportation of Drill Rigs to site shall be done with a low bed.
- b) The low bed shall lower its front end to the level of the ground so that equipment can be trammed from the low-bed.
- c) Supervisor shall be present to ensure safe off-loading of equipment.

4.3 Drill and Blast Plan

- a) The drill area shall be cleaned and rock is exposed before drilling is started.
- b) The drill rig operator (referred to as operator from here on) or hand drill operator (also referred to as operator from here on) shall be in possession of all valid certificates of competency.
- c) The drill rig/hand drill equipment shall be pre-inspected before use and a Pre-shift checklist shall be completed before commencing with work.
- d) Fire extinguishers shall be inspected daily by the operator and monthly inspections with a register must be kept. Fire extinguishers shall comply with SANS 10150-1.
- e) No person shall be allowed closer than 5m for hand drilling and maximum reach of boom plus 5m for drill rig operations except the drilling assistant (referred to as assistant from here on), mechanic and supervisor. No unauthorized persons allowed within the operations.

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- f) No vehicles shall be parked within 20m of the drill operations.
- g) Operators shall not be allowed to abort or alight from a moving drill rig.
- h) The operator and assistant must clearly be visible to each other at all times whilst the drill rig/hand drilling is in operation.
- i) The operator shall give right of way to other construction equipment when moving between drill areas.
- j) The operator shall position the mast in lower position when tramming and use mast as counter weight when travelling over uneven surfaces.
- k) For drill rig operation the, assistant shall warn the operator of uneven surfaces and the operator should move slowly over uneven surfaces.
- l) For drill rig operation, the operator and assistant shall be aware/watch out for pedestrians and a reverse hooter should be sounded to warn persons of drill rig movement.
- m) For drill rig operations, the assistant's signals shall be followed by the operator at all times.
- n) In case of breakdown in equipment the following procedure shall be adhered to: Report breakdown to the supervisor/operator, direct traffic if necessary and barricade drill area with cones/drums and/or chevron tape to make it visible to other road users.

4.4 Setting out of drill holes

- a) Drill holes position shall be set out and marked by a certified Surveyor.
- b) Depth of each hole shall be supplied by the supervisor to operator according to the drill plan.
- c) Holes shall be set in accordance with a pre-determined blast plan.
- d) A hole shall be clearly marked with spray paint giving the hole number and depth.
- e) When working near the drill area and drilling is in process, wearing of dust mask, ear protection, eye protection and hand protection shall be enforced.

4.5 Drilling of holes

- a) The supervisor shall ensure the drill area is barricaded prior to starting of drilling operations
- b) The Supervisor shall see that all vehicles leave the area and close the temporary barricade placing a Safety sign board "Drilling in Progress" 5 meters in front of the barricade warning machinery and vehicles in the vicinity.
- c) The operator shall check that dust hood & dust collectors are in working order.
- d) Assistants shall wear the recommended PPE. No person shall be wearing any loose clothing whilst working nearby rotating machine parts.
- e) The operator and the drill mechanic shall check all hydraulic pipes for damage to fittings & basic wear & tear.
- f) The supervisor shall inform the operator as to the required drill bit to be used, for the correct hole size and depth for the blast to be successful.
- g) When a hydraulic pipe bursts;
 - o Drill rig/hand drilling equipment shall be switched off immediately.
 - o Notify supervisor & mechanic.
 - o Lock out drill rig/ hand drilling equipment until mechanic arrives.
 - o Contain spill immediately and report the spill to the supervisor who will report it to the SHEQ department (the use of drip trays are essential).

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- h) Misfires shall be reported immediately to blaster & supervisor and drilling must be stopped.
- i) Regular inspection by the drill mechanic on equipment, boom, nuts, bolts, rivets & potential crack areas shall be undertaken as well as checks by the operator during pre-start inspection.
- j) For drill rig operations, the operator shall, when so indicated by the assistant, stop the drill rig and start the following procedure
- Ensure the drill boom is on the marked hole.
 - Put out the jacks of the drill rig levelling the rig.
 - Lift the boom with the rod and drill bit from a horizontal position to a vertical position onto the degrees of angle that the supervisor has instructed him/her to drill the hole.
 - The drill rig operator shall first activate the rotation on the rod and the drill bit before lowering the rod onto the ground surface.
 - The Assistant shall ensure that the rotating rod is placed on the marked area where the Supervisor marked the hole to be drilled.
 - On completion of the hole, the operator shall lift the jumper upwards and lower the boom when the rod has been lifted all the way into the boom.
 - Before lowering the boom, the operator shall stop the rotation on the rod till it stops then lowers the boom for the drill rig to manoeuvre safely to the next hole that needs to be drilled.
 - The operator shall then lift up the jacks so that the drill rig stands on its wheels and or tracks.
 - The operator shall then manoeuvre the drill rig to the next hole to be drilled and repeat steps mentioned above
- k) For drill rig operations, the following shall be adhered to when changing rods:
- The correct procedure for changing of rods must be followed.
 - Check the drill rig is fitted with a rod catcher.
 - Check coupling clamp is in working order.
 - Operator ensures that rod coupling is secure on the rod before changing or moving the rod.
 - Inspect state of coupling for cracks & thread thickness in pre-shift inspection.
 - Ensure all hydraulic cylinders are fitted with hydraulic crossover switches.
- l) After drilling and blasting in stable formations, excavations shall be done up to 6 m faces. Barricading shall be used to keep out unauthorised personnel and ladders to be used with safety harness connected to an anchor point.

4.6 Re-fuelling of drill rig

- a) No engine or machine shall be left unattended.
- b) Only fire extinguisher shall be used to extinguish fire.
- c) No smoking in the vicinity of refuelling.
- d) All engine cover plates shall be in position.
- e) During the re-fuelling process, drip trays shall be used in the event of any spillage.
- f) In case of spillage:
 - Call for immediate assistance.
 - Create temporary bund walls to contain spillage.

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- o Use oil spillage kit and remove contaminated soil immediately.
- g) Diesel fuel shall be stored and transported in an approved trailer of 1000 lt.
- h) All spillages shall be reported to the SHE officers immediately.

4.7 Plant and Equipment

- a) All plant and equipment to be used shall be inspected and inspection reports shall be made available on request.
- b) Plant and equipment operations shall be operated according to a maintenance Schedule.
- c) Daily visual inspections shall be carried out by the SHE officers and findings shall be recorded.
- d) Keys to plant and equipment shall be managed by means of the operator handing the plant keys to the supervisor for safe keeping. No operator shall take possession of keys after hours.

4.8 Transportation of Explosives

- a) The following Acts must be adhere to at all times:
 - o Explosives Act, 1956 (No. 26 of 1956)
 - o Explosives Act, 2003 (No. 15 of 2003)
 - o Occupational Health and Safety Act, 1993 (No. 85 of 1993)
- b) Temporary or continuous permit to transport explosives to site must be obtained from the Inspector of Explosives.
- c) Delivery vehicles must be a registered explosive vehicle and will be road worthy and checked on a monthly basis. Registration of explosive vehicle, Certificate of compliance to roadworthy inspection and transportation permit will be within the vehicle at all times.
- d) The Supervisor, Blaster and driver are responsible for the conveyance of explosives and shall adhere to the following:
 - o Be trained according to a works instruction for the transportation of explosives; Person will be in possession of a valid driver's license.
 - o Count the number of cases or containers issued and endorses the number on a consignment note.
 - o Ensure that the explosives are conveyed with all due diligence to their proper destination.
 - o Where the explosives are delivered endorse the consignment note with the number of explosives delivered.
- e) No person shall load and unload explosives closer than 30 m of a fire or naked flame.
- f) No person shall smoke within a distance of 30 m of where explosives are handled or off loaded.
- g) Local authorities must be informed of hazardous chemical materials been transported to the area.

4.9 Charging up of blast

- a) Pre inspection of surrounding buildings and concerned property shall be inspected by the Blaster, Supervisor and a Client Representative.
- b) Appointed blaster shall take charge of the danger blasting area, clearly indicating the boundaries and danger to personnel and public road users close by blasting area by means of appropriate signage (Blasting Area) and red flags.
- c) Red marker flags in the blasting area shall ONLY signify:
 - o Areas in which charging of explosives is, or has, taken place.

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- d) Entry by persons or vehicles not assisting in charging shall be forbidden, unless allowed by the blaster.
 - e) Areas where a dangerous situation exists shall remain an unauthorized entry until the blaster confirms otherwise.
 - f) The charging up area shall be demarcated with red flags and notice boards.
 - g) A persons not assisting in the charging up operations or not having permission from the responsible blaster shall not enter areas where charging is taking place.
 - h) Blast holes shall be checked, primed and charged by the appointed blaster or persons under his supervision for that purpose.
 - i) Holes shall be primed as soon as is practically possible after the delivery of the explosives.
 - j) Sample of bulk emulsion shall be taken at regular intervals to ensure correct densities of the explosives are achieved.
 - k) The quantity of charge per hole shall be calculated and the amount of explosives shall be recorded on a charge sheet.
 - l) Explosives and accessories shall be kept within the charge up area. Check explosives and accessories received against quantities invoiced. No storage of any excess explosives or accessories is allowed on site, and all discarded explosives have to be destroyed after the blast. The blaster shall ensure that all explosives are accounted for either in blast holes or left overs.
 - m) During charging up operations, no vehicle used during charging nor explosives shall be nearer than 15 metres from drill rig or machinery.
 - n) A complete record shall be completed after the blast and a copy thereof forwarded to the site agent for record purposes.
 - o) After all holes are tied up in a blast, the blast shall be "walked" by the blaster and another competent person to ensure that all the holes are tied into the blast and in the correct sequence according to the blast design.

4.10 Clearing of an area prior to blasting and reblasting

- a) The blaster shall determine the extent of the danger area should the safety distance need extension.
- b) The blaster shall position guards and danger signs at all entry points into the danger area to prevent entry.
- c) Under no circumstances whatsoever, may anyone ignore guards placed around the blasting area.
- d) No person so warned shall remain in or enter the unsafe area surrounding the place where the firing is to take place.
- e) The blaster shall clear the danger area of all men, machinery and equipment.
- f) The blaster shall switch the blasting siren on 3 (three) minutes before the blast.
- g) The blaster ensures that all guards who are positioned with red flags are instructed that they do not leave their positions until told to do so by the blaster.
- h) When the blaster is satisfied that all men and machines are out of the danger area and that all access points are manned properly and that it is safe to do so, he may connect the detonator to the blasting cable.
- i) The blaster shall connect the blasting wire to the shot exploder after final clearance is given by radio from all guards.
- j) After final clearance is given, the blaster shall give the count down from 5 to 1 and fires the blast.

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4.11 Re-entry after blast

- a) The appointed blaster shall wait until all dust and fumes are settled, while the guards are still in place.
- b) The blaster shall examine the blast for any misfires or signs of it.
- c) If any misfires are encountered, guards shall be kept in position until the area is declared safe.
- d) The blaster shall declare the blast area safe and call the guards to open up the area.
- e) Post inspection shall be done of the Buildings and relevant properties in concern by the Blaster, Supervisor and Client.

4.12 Treatment of misfired blast holes

- a) The appointed blaster shall take due care to deal with misfired holes in accordance with the latest regulations as a matter of urgency.
- b) No misfires shall be uncovered unless under the direct supervision of the blaster or appointed licence holder.
- c) In the event of there being visible detonating cord protruding from the hole, the misfire shall be handled by clearing the area in the normal manner, attaching a detonator to the detonating cord, and when safe, blasting a misfire.
- d) In the event of there being no detonating cord, but slurry only, the hole shall be cleared of stemming and misfire to be reprimed. Thereafter, proceed as in above.
- e) Notwithstanding anything to the contrary, misfires may be destroyed together with a blast provided that the blast to be done is in the vicinity of the misfire, and that the blast will be carried out within a reasonable period of the misfire being found, and that the presence of the misfire in no way affects production or is a danger to persons or property.
- f) No misfire may be destroyed during the hours of darkness.
- g) Misfires and cut off shall be dealt with in accordance with the Explosives Act. 26 of 1956.

5. Safety Requirements

The following safety requirements in conjunction with the Occupational Health and Safety Act, 1993 (No. 85 of 1993) shall be adhered to at all times:

- a) Risk Assessment should be completed prior to task commencing and communicated to all personnel.
- b) Supervisors shall ensure that inspections are carried out daily and defective / damaged plant is not used.
- c) Holes shall be set out under the supervision of the appointed blaster and or checked by the blaster.
- d) Constant supervision shall be undertaken.
- e) Good communication between operator and assistant – use radio or standard hand signals.
- f) The assistant shall direct operator when positioning rig and to warn fellow workers.
- g) Personnel shall stand clear from rig when positioning.
- h) The operator, assistant and other operational personnel working in the close proximity must wear the correct PPE.
- i) Rods shall only be manually aligned once rotating unit is at a complete stop.
- j) Engine of plant shall be switched off when refueling.
- k) Site traffic rules shall be adhered to at all times.

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- l) Registered blasting vehicle shall be used to transport explosives.
- m) Only personnel assisting in charging up operations may enter areas where charging is taking place.
- n) Blasting warning boards and red flags shall be placed in a conspicuous position before charging operations commence. Safety perimeter shall be identified and set out and communicated to guards and safety officers, the morning of the blast prior to charging operations commence.
- o) Electric detonator may be connected to the detonating fuse only after the danger area has been cleared.
- p) Only a certified blaster may make any electrical connections to the shot exploder, electric detonator or blasting wires.
- q) The blaster shall check quantities against invoice and amount required. All explosives shall be accounted for either in blast holes or left overs. Leftover shall be destroyed with blast.
- r) In the event of inclement weather, no operations to do blasting will be started.

6. Authorization

This document has been seen and accepted by:

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7. Revisions

Date	Rev	Compiler	Remarks
Feb 2016	1	A Kaka	A standard was required for Blasting

8. Development team

The following people were involved in the development of this document:

- Abdullah Kaka

9. Acknowledgement

Not applicable.