1000983006 Ontario Inc o/a Autostem Manufacturing NA

Safety Manual

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INTRODUCTION

Autostem cartridges are the world's first rock breaking technology which does not require any stemming or tamping of stemming material. Autostem is a drop and go cartridge designed to "auto-stem" upon initiation of the cartridge. This feature allows for faster loading times, less labour, and less equipment and material requirements.

Autostem cartridges has numerous applications in the field of rock and concrete breaking and presents itself as a viable alternative to conventional high explosive use, chemical agents, and mechanical means of rock breaking

Favourable legislation governs the use, transport, and storage of Autostem cartridges, classified as 1.4S in terms of the UN recommendations on the transport of dangerous goods, making Autostem a safe and accessible product to use for rock and concrete breaking.

Autostem applications include but are not limited to:

- Secondary breaking, both in the surface and underground mining environment
- Underground mining works like stoping, development (tunnelling), slyping etc.
- Civil construction earthworks like bulk excavations, foundations and trenching, road cuttings, bases etc.
- Demolition work
- Breaking in sensitive areas
- Underwater breaking of rock and concrete

NON DETONATING TECHNOLOGY

The AutoStem Non-Detonating Cartridges are the World's Safest, most Advanced, and High-Performance Rock Breaking Technology available today. Non Detonating technology is based on a non-detonating propellant compound enclosed in a cartridge, which causes and instant chemical reaction when ignited, to produce high volumes of harmless gas, mainly consisting of nitrogen, carbon dioxide and steam.

1.1 High Explosives vs Low Explosives

Explosives can be divided into two general types based upon their rate of decomposition, namely:

“High Explosives” – which are characterised by detonation, the extreme rapidity with which its decomposition reaction occurs, characterised by Velocity of Detonation (VoD) measured in meters per second. Conventionally, high explosives used in rock breaking applications will exhibit a VoD of 2000m/s to 7000m/s depending on the product and hole diameter. This supersonic VoD gives rise to the defining characteristic of high explosives. A detonation wave propagates at supersonic velocity, releasing high levels of heat and gas pressure energy at the wave front.

“Low Explosives” – are mostly solid combustible materials that undergo a relatively fast decomposition reaction when ignited but do not detonate. This action is known as “deflagration” and is characterised by a VoD of less than 343m/s, the speed of sound.

Deflagration

Deflagration

Are the thermal processes that proceed radially outward in all directions through the available fuel away from the ignition source.

As the volume of the reaction zone expands with every passing moment, the larger surface area contacts more fuel, like the surface of an inflating balloon.

The reaction starts small and gathers energy with time. This process occurs at speeds depending largely on the chemistry of the fuel, from:

1 to 10 meters per second in gasoline vapours mixed with air

to hundreds of meters per second in black powder or nitrocellulose propellants.

These speeds are less than the speed of sound in the fuel. The speed of sound through a material is not constant, but dependent on the density of the material, the higher its density, the higher the speed of sound will be through it.

Deflagrations, then, are thermally initiated reactions propagating at subsonic speeds through materials like:

mixtures of natural gas and air, LP gases and air, or gasoline vapours and air and

black powder or nitrocellulose (single base) propellants or rocket fuels.

The pressures developed by deflagrating explosions are dependent on the fuels involved, their geometry, and the strength of a confining vessel or structure, if any.

Pressures can range from:

0.1psi to approximately 100psi for gasoline-air mixtures to

several thousand psi for propellants.

Times of development are on the order of thousandths of a second to a half-second or more.

Maximum temperatures are on the order of 1000-2000 degrees Celsius.

The effects of detonations are very different from those of deflagrations.

Deflagrations tend to:

- push, shove, and heave, often with very limited shattering and little production of secondary missiles (fragmentation)
- Building components may have time to move in response to the pressure as it builds up and vent it.
- The maximum pressures developed by deflagrations are often limited by the failure pressure of the surrounding structure.

Detonations, on the other hand, tend to:

- shatter, pulverize and splinter nearby materials with fragments propelled away at a very high speed.

- There is no time to move and relieve pressure, so damage tends to be much more localized (seated) in the vicinity of the explosive charge (and its initiator) than a deflagration whose damage is more generalized.

Damage from a deflagration tends to be more severe away from the ignition point, as the reaction energy grows with the expanding reaction

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“Detonation”

Are very different, while a detonation is still chemically an oxidation reaction, it does not involve a combination with oxygen. It involves only special chemically unstable molecules that, when energized, instantaneously splits into many small pieces that then recombine into different chemical products releasing very large amounts of heat as they do so.

High explosives are defined as materials intended to function by detonation, such as TNT, nitro-glycerine, C4, picric acid, and dynamite.

The reaction speeds are higher than the speed of sound in the material (i.e., supersonic).

Since most explosives are roughly the same density, a reaction speed of 1000 m/s is set as the minimum speed that distinguishes detonations from deflagrations.

Due to the supersonic reaction speed, a shock wave develops in the explosive (like the sonic boom from supersonic aircraft) that triggers the propagating reaction.

Detonation speeds are on the order of 1000-10000 m/s, so times of development are on the order of millionths of a second.

Temperatures produced can be 3000-5000 degrees Celsius

Pressures can be from 10000 psi to 100000 psi.

It should be noted that a few materials can transition from deflagration to detonation depending on their geometry (long, straight galleries or pipes), starting temperature, and manner of initiation.

Double-base smokeless powders (containing nitro-glycerine), perchlorate-based flash powders, hydrogen/air mixtures and acetylene (pure or with air) can detonate under some conditions

The Autostem Cartridge

The Autostem Cartridge resides under the category of low explosives. The cartridge consists of a propellent/ammonium nitrate mixture which once ignited undergoes a chemical reaction to form high volumes of harmless gas, mainly oxygen, nitrogen, carbon dioxide and steam (water vapour). When the cartridge is confined within a blasthole, these gases exert radial forces within the rock, exceeding the tensile strength of the rock, causing it to break or split.

Autostem cartridges avoid the intense shattering effect close to the charge on the rock, instead, the rock is generally broken more consistent. This is a significant advantage when dealing with valuable ore containing precious minerals for example, gold, where losses due to fines are a significant reality.

The reason why an Autostem cartridge does not detonate, is because the velocity of deflagration or burning of the propellant is almost directly proportional to the degree of confinement of the chemical reaction. Since the rate of gas emission from either the detonation of explosives or the ignition of propellant, confined in a blast hole, is proportional to the rate of burning, it follows that the build-up of pressure in the hole will also be directly related to the burning or detonation rate. Therefore, this deflagrating nature of Autostem facilitate a stronger heaving effect, pushing the rock fragments apart rather than troughing it considerable distances, therefore fly rock are kept to a minimum reducing danger areas considerably.

Ground vibrations are also significantly reduced as the reaction energy grows with the expanding reaction front avoiding shockwaves which makes the product ideal for sensitive sites.

The automatic self-stemming element within the Autostem cartridge eliminates stemming requirements when used within the prescribed drilling parameters.

Cartridge components are:

Lead wires – lead wires with the instantaneous cartridge versions comes in various lengths to cater for various blast hole depths.

Detonator holder – the detonator holder manufactured into the sequential cartridges can receive and hold in place most standard electrical and non-electrical detonator assemblies.

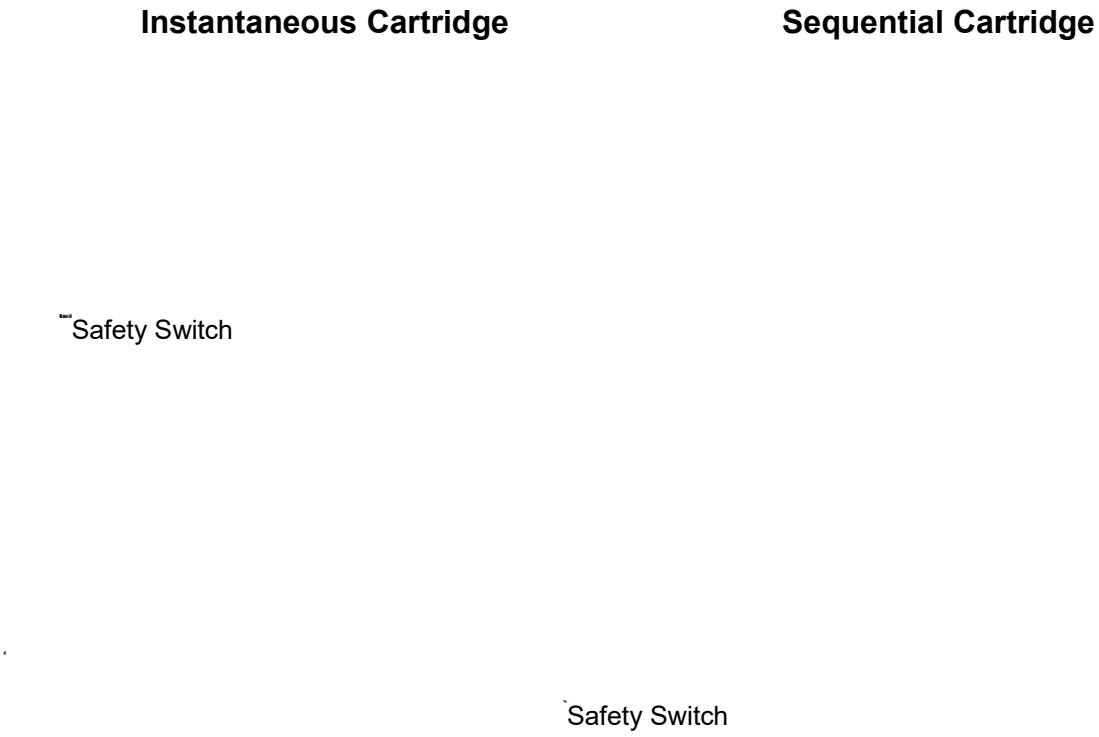
The tube – the cartridge tube consists of polymer, specifically designed for optimum performance.

Sliding safety switch – the sliding safety swich is designed as an additional safety feature manufactured into the instantaneous cartridges. If the swich is not in the fire position, the cartridge will not initiate, even when the igniter is ignited. The safety switch is not part of the sequential cartridges because the initiation device (detonator assembly) is carried separate from the actual cartridge and is only inserted when a blast hole is ready to charged.

Top cap – the top cap is found only on instantaneous cartridges and contain the safety switch and igniter head with lead wires. Although sequential cartridges are not manufactured with a top cap, the top of the cartridge contains the detonator holder.

Igniter – the igniter has a specific electrical characteristic to prevent accidental ignition through electrostatic discharge. Instantaneous cartridges are manufactured with the igniter build into the top cap.

Proprietary mixture is specifically formulated to prevent the emissions of noxious fumes and gasses.



Safety Instructions for Handling and Storing 1.4S Explosives

1. General Safety Guidelines

Training

Only authorized and trained personnel should handle 1.4S explosives. Personnel must be familiar with the specific hazards and safety protocols.

Personal Protective Equipment (PPE)

Wear appropriate PPE, such as protective gloves, eye protection, and flame-resistant clothing.

No Smoking or Open Flames:

Smoking, open flames, or any source of ignition are strictly prohibited near explosives.

Clear Signage

Areas where explosives are handled or stored should be clearly marked with appropriate warning signs.

Limit Quantities

Handle and store only the minimum amount of explosives necessary for operational purposes.

2. **Handling Procedures**

Gentle Handling

Avoid dropping, striking, or applying excessive pressure to explosives. Handle with care to prevent any accidental initiation.

Static Electricity Prevention

Ensure grounding of personnel, tools, and equipment to prevent static discharge, which could ignite explosives.

Separation from Other Materials

Explosives must be kept separate from incompatible materials (e.g., flammable liquids, corrosives) to avoid accidental reactions.

Transportation

Use proper containers and packaging to transport explosives. Ensure that transportation follows all regulatory guidelines, including securing the load to prevent shifting during movement.

3. **Storage Guidelines**

Designated Storage Area

Store explosives in an approved, secure, and well-ventilated magazine or storage facility. The area must be designed to prevent unauthorized access and protected against fire and impact.

Separation of Explosives

Store different types of explosives in separate compartments if possible, and ensure that incompatible items are not stored together.

Temperature and Humidity Control

Maintain the storage area within the recommended temperature and humidity range for the specific explosives to prevent degradation.

Inventory Management

Maintain an up-to-date inventory of all explosives stored, and inspect storage areas regularly for signs of damage, deterioration, or leaks.

Emergency Equipment

Ensure that fire extinguishers, first aid kits, and other emergency equipment are readily available near storage areas.

4. **Accident Prevention**

Routine Inspections

Regularly inspect all areas where explosives are handled or stored to detect any potential hazards (e.g., leaks, damage, fire risks).

- Fire and Explosion Risk Mitigation:
- Install fire suppression systems in storage areas.
- Maintain clear access routes to firefighting equipment.
- Keep the area around the storage clear of vegetation and other combustibles.
- Housekeeping: Ensure that the area is clean and free of unnecessary materials to reduce the risk of accidental ignition.
- Training on Emergency Procedures: Conduct regular safety drills and ensure all personnel know what to do in the event of a fire, spill, or explosion.

5. **Emergency Response Procedures**

Evacuation Plan

Develop a clear evacuation plan in case of an accident or fire, and ensure all personnel are familiar with it.

Firefighting

Do not attempt to fight a fire involving explosives. Evacuate the area immediately and contact emergency services.

First Aid

Train personnel in basic first aid, specifically in treating burns, injuries from explosions, and shock.

Reporting Incidents

All accidents or near-miss events should be reported immediately to the supervisor and documented.

Instructions for the Destruction of 1.4S Explosives

1. Preparation

No person other than a blaster with an accredited licence or certificate in the province in which the explosives are being destroyed, or a person specifically authorized in writing by an inspector shall destroy or attempt to destroy or be allowed to destroy any blasting materials

Only perform destruction during favorable weather conditions. Avoid extreme heat, high winds, or thunderstorms.

Have firefighting and first aid equipment readily available at the site

2. Destruction Site

Choose an isolated, secure location away from people, buildings, and flammable materials. Ensure the site is approved for explosive destruction.

a) Blasting – A minimum distance of 100m from personnel and infrastructure should be maintained.

b) Burning – Destruction of Autostem cartridges by burning should be limited to a sand or gravel bed away from dry brush and trees. A minimum clear radius of 5 meters is required. A minimum safety distance of 50 meters must be maintained from all personnel, equipment and infrastructure.

3. Handling Before Destruction

Before destruction, inspect explosives for damage or leakage. Any compromised explosives should be handled with extreme caution and can not be destroyed by blasting.

Transport explosives to the destruction site in approved containers, ensuring minimal movement or friction during transport.

4. Destruction Methods

Depending on provincial regulations, destruction of Autostem Cartridges & related Ignitors and Detonating cord can be done through controlled burning or detonation.

4.1 Autostem Cartridges

a) Blasting

Destruction of Autostem cartridges by blasting must be under the guidance of a licenced or certified blaster and the "Operating Instructions" section of this manual must be followed. Expired or damaged Autostem Cartridges are prohibited from being destroyed by this method. The minimum recommended distance for destruction by blasting is 100 meters. Ensure guards are placed to prevent unauthorized persons from entering the danger area.

b) Burning

Destruction of Autostem cartridges by burning must be under the guidance of a licenced or certified blaster. The raw materials that make up the Autostem Cartridges have a flammable composition which will burn fast when confined but will burn at a moderate rate when unconfined. All Autostem cartridges set for destruction by fire must adhere to the following steps;

1. Ensure the burn bed has a composition of gravel or sand and a clear radius of 5 meters. If more than 5KG is to be destroyed at one time, additional burn beds can be used if a minimum separation distance of 5 metres is achieved and a 5m clear radius can be established around the additional bed. The long side of the bed must lie parallel to the direction in which the wind is blowing.
2. Establish a safe zone perimeter for each burn bed of a minimum of 50 meters from all personnel, equipment or infrastructure.
3. For all "Instantaneous Autostem" cut the lead wires a suitable length from where the wires exit the cartridge to allow you to twist the wires to close the circuit. For all "Sequential" Autostem Cartridges, cut the tubing 10mm from where the tubing enters the cartridge. The excess should be destroyed in a manner set out by the manufactures recommended guidelines.
4. Using a knife or multi purpose snips approved for use on the site, cut ¾ of the circumference of the tube about 50mm from the top of the cartridge
5. Separate the top of the cartridge from the body by bending the cut area back
6. Empty the cartridge contents in a straight line of no more than 50mm wide and 20mm thick.
7. Ensure that the entire content of the cartridge was removed by tapping the tube with your finger on the side to release any mixture that maybe stuck to the sides.

8. Cut the remaining quarter of the tube and separate the igniter or detonator assembly whichever may be the case from the tube for separate destruction. Dispose of tubes in a recycling bin.

9. When the guards have been set and everybody has moved to a safe distance, the licensed or certified blaster may light the bed of combustible material, downwind, by means of a safe ignition source suitable and long enough to give him or her time to walk to safety.

10. Rinse the burn site with water to neutralise any remaining agent.

4.2 Igniters

Destruction of Igniters by burning must be under the guidance of a licenced or certified blaster. Ignitors removed from the Autostem cartridges are destroyed by burning on a bed of combustible material such as wood shavings or well-crumpled newspaper. The combustible material used in the bed must burn for long enough to fully destroy the igniters.

1. Ensure the burn bed has a composition of gravel or sand and a clear radius of 5 meters. If more than 5KG is to be destroyed at one time, additional burn beds can be used if a minimum separation distance of 5 metres is achieved and a 5m clear radius can be established around the additional bed. The long side of the bed must lie parallel to the direction in which the wind is blowing.

2. Scatter loosely and individually on the bed in a single layer and ignite from the downwind side of the bed.

3. Saturate the beds with illuminating paraffin (lamp oil). Do not use diesel or gasoline.

4. When the guards have been set and everybody has moved to a safe distance, the blaster may light the bed of combustible material, downwind, by means of an igniter train suitable and long enough to give him or her time to walk to safety.

5. Maximum Quantity

Maximum Quantity refers to the maximum amount by weight or units that can be burned in one burn bed each time.

Autostem cartridges – 5KG of

Ignitors – 100 Units

4. Post-Destruction

a) Confirm Destruction

Ensure that all materials have been completely destroyed. If any remnants remain, follow procedures to neutralize them safely.

b) Site Clean-up

Once destruction is complete, remove any debris, ash, or explosive residue. Dispose of waste according to environmental regulations.

c) Documentation

Record details of the destruction, including date, quantity of explosives destroyed, method used, and personnel involved.

5. Emergency Procedures

Evacuation Plan

Have an evacuation plan in place if something goes wrong during the destruction process. All personnel should be briefed on this plan.

First Aid:

Ensure first aid is administered promptly in case of an accident. Report any injuries or incidents immediately.

Following these steps ensures the safe and compliant destruction of 1.4S explosives.

Lost or Stollen Explosives

If you have a licence, permit or certificate for explosives, including fireworks and ammunition, from Natural Resources Canada, you must inform an inspector as soon as the circumstances permit of any of the following incidents that involve an explosive under your control:

- theft, attempted theft or loss of an explosive
- a fire, spill or accidental explosion
- an injury or death
- any accidental property damage

There are two ways to report:

- use the hyperlink to the electronic licence management system (ELMS) https://www.nrcan.gc.ca/maps-tools-and-publications/tools/electronic-licence-management-system-elms/19434?_gl=1*kxhf2q*_ga*NzA4MTI2ODY2LjE3MTg4OTM3Nzc.*_ga_C2N57Y7DX5*MTcyOTY5NDgyMC4zMC4wLjE3Mjk2OTQ4MjAuMC4wLjA.

- use the following form (includes the email address or mail address where you must send the form): https://www.nrcan.gc.ca/sites/nrcan/files/mineralsmetals/pdf/mms-smm/expl-expl/pdf/F07-01_Incident_Report_EN.pdf?_gl=1*1s4nny4*_ga*NzA4MTI2ODY2LjE3MTg4OTM3Nzc.*_ga_C2N57Y7DX5*MTcyOTY5NDgyMC4zMC4wLjE3Mjk2OTQ4MjAuMC4wLjA.

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1. PURPOSE

To provide a work instruction to minimize or eliminate the risk of incidents, injuries & fatalities from charging up operations.

2. SCOPE

This work instruction will only be applicable for persons who has been trained & found competent for this task.

3. AUTHORITY, RESPONSIBILITY & ACCOUNTABILITY

a) This work instruction has been established & approved by NDS Head of Technical ops.

b) It's the responsibility of all employees to strictly adhere to this work instruction, also ensure all service providers are aware & adhere to this work instruction.

c) Any changes to this work instruction must be approved in writing by Management, only after a risk assessment has been done on requested changes to work instruction.

4. REQUIREMENTS

4.1.1 The employer must take reasonable measures to ensure that no AutoStem charge is initiated where there is a risk of injury, due to flying debris as a result of overcharging, or misue of product due to incorrect borehole sizing.

4.1.2 All persons not required to assist the Certified Autostem User in charging-up should be removed to a safe distance of at least 50 meters, however this distance might be extended depending on rock size, rock layout and cartridge size used.

4.1.3 The Certified Autostem User shall charge only the holes or prepare only the charges that are intended to be fired at the next shot and, while cartridges are awaiting firing, he shall ensure that they are not interfered with and left in the “safe” position;

4.1.4 Wires shall be Shunted “twisted off”, at all times, until wiring up takes place to ensure avoiding risk of static.

5. PROCEDURE

5.1 GUIDELINES

All Persons must use the following PPE listed below:

a) Hard hat with reflective strips

b) Eye protection

c) Gloves

d) Gumboots

e) Full length overall (one or two piece) with reflective strips

Any additional site specific PPE as determined by environment or location.

5.1.1 Assistance:

A person assessed and found competent against a skills programme recognised by NDS for this purpose with regard to the activities specified may assist an appointed certificated AuotStem user in the preparation of charges by:

a) Drilling holes in the rock area;

b) Testing cartridges for continuity;

c) Unlocking cartridges, inserting cartridges into boreholes and wiring up product in series

d) Connecting a series of AutoStem Cartridges to an extension lead wire.

5.1.2 Conditions:

An assistant can carry out such work under the immediate supervision of such authorised user and within the sight and hearing of such authorised user, or he has been assessed and found competent in the Shooting assistant skills programme.

5.1.3 Where shot holes are to be charged with Autostem Cartridges in two or more working faces at the same time, the following instructions shall be adhered to:

a) The distance between the any working area shall be such that the authorised user is able to visit the rock within a period of 10 minutes without due exertion.

b) There are no explosives or accessories required when using AutoStem product – however, AutoStem Cartridges themselves should be accounted for and safetly stored in an area where limited access to product is managed (to avoid theft and wastage). Usage of product and transport on site is typically done in a heavy-duty bag, in the AutoStem box or in the inner woven bag provided along with the AutoStem product in its packaged state.

c) When the authorised user arrives, he shall open the bag and commence with testing continuity on AutoStem product.

d) If satisfactory, he should rotate the roational safety lock in an anti-clockwise direction until a clicking sound is heard, to ready the product for use.

e) He will proceed to insert cartridges into the drill holes with the wires shunted.

f) Care must be taken that the wires are shunted at all times when using AutoStem product from a safety standpoint – this is best practice and endorsed by NDS, until such time as actual wiring up is carried out.

g) Once the authorised user is satisfied that the work is being conducted safely, he may proceed to the next working area.

h) No explosive accessories are required when using AutoStem Cartridges.

i) The authorised user shall not leave the face where charging up is taking place until he is satisfied with the manner in which the work is proceeding. He shall exercise supervision in particular that wiring up is done in series and retest for continuity.

5.2 BEFORE CHARGING UP

5.2.1 Ensure all PPE is in order

5.2.2 It may be necessary to declare area safe by:

a) Test for flammable gas

b) Bar down work area

5.2.3 AutoStem will only be taken to the face at a reasonable time before charging up, to avoid misplacing product and theft.

5.2.4 AutoStem rotational safety lock will be kept in a safe position under the supervision of the authorised user not less than 10m from drilling and scraping operations.

5.2.5 Bar the rock face if necessary to remove potential rocks which could fall and cause injury.

5.2.6 It is not necessary to remove excessive water from holes, AutoStem is water proof

5.2.7 It is important that the specified hole diameters are adhered to.

5.2.8 Only persons directly responsible for charging up should be in the direct vicinity.

5.3 CHARGING UP

5.3.1 The authorised user must remember to unlock the product, by rotating the rotational safety lock in an counter clockwise direction.

5.3.2 At time of wiring up, there should be a maximum of two wires emanating from each hole.

5.3.3 AutoStem Cartridges should thus be wired up in series with the circuit wired to an extension cable for initiation from a safe distance.

5.3.4 No detonators or shocktube is required in using AutoStem and such accessories should be removed from the area.

5.3.5 Repeat process until all holes have been charged up

5.4 AFTER CHARGING UP

5.4.1 Remove all extra Cartridges & accessories to dedicated storage facilities.

5.4.2 Clear area by at least 50m. Ultimately the distance cleared will be a function of the rock layout, size and product size used.

5.5 SHOOTING CAN TAKE PLACE DURING SHIFT

5.5.1 Remove all people from workplace

5.5.2 Connect AutoStem initiator to wires

5.5.3 Ensure all people are accounted for, before initiating product

6. QUALITY

NDS assures quality of all Autostem Product delivered

7. ENVIROMENT

Caution to be taken to prevent spillage or wastage of product

8. HEALTH & SAFETY

a) Slipping & falling

b) Handling

9. RECORD

It is recommended that AutoStem daily usage record book to be filled in daily & should be kept for record keeping inside Authorised users log when book is to be replaced.

10. DEFINITIONS

None

11. ABBREVIATIONS

a) PPE – Personal Protective Equipment

b) SHERQ – Safety health Environmental Risk & Quality

12. DOCUMENTS

For detailed instruction and accompanying illustration for use, please see AutoStem user manual or request manual from Tom@alternativeblastingco.com at 619-210-5925. The AutoStem Manual referred to here includes the above Standard Operating Proceudre and is dedicated to advising AutoStem end-users how to use AutoStem product in a simple way with illustration.