OPERATING MANUAL

CLEAN SURFACE
DRY ICE BLASTER SYSTEM
CSL2000 (SMC Version)

INSTRUCTION MANUAL FOR CLEAN SURFACE
DRY ICE BLASTER SYSTEM CSL2000 (SMC Version)

CONTENTS

1. ESSENTIAL INFORMATION

Clean Surface dry ice Blasters provide a portable and flexible system for the removal of dirt, contamination and unwanted coatings from many types of plant, process equipment, tooling or finished parts.

The process is suitable for performing regular maintenance cleaning as well as restorative deep cleaning. It may be put to use "on-line", or "in-process" or isolated from other activities. It may be used during normal working periods and in "shut-down" periods. The system can also be incorporated into automated or robotic cleaning environments as well as being used in a hand held manual mode.

All of these aspects greatly influence the manner in which the system can be safely and reliably deployed. Once purchased for a specific application the potential for use elsewhere may be realised, and the equipment applied other than originally planned. These instructions are therefore constructed in such a way as to ensure that a proper examination and consideration of all of the factors affecting the use of the equipment can be made.

The major hazards presented by the use of this equipment arise from:

The use of compressed air potentially causing dangerous flying objects, debris re-circulation and inhalation and noise either through planned or unplanned release. See Appendix A.

The use of dry ice (solid carbon dioxide), a substance of extreme cold capable of causing burns and death by asphyxiation. See Appendix B.

Other hazards arising from the application of the equipment to specific cleaning tasks where each task needs special consideration.

IMPORTANT

ALWAYS READ THESE INSTRUCTIONS BEFORE USE.

ONLY OPERATE THE EQUIPMENT AS DESCRIBED.

NEVER FOOL AROUND WITH THIS EQUIPMENT AND NEVER POINT THE BLAST NOZZLE AT YOURSELF OR OTHERS.

2. DESCRIPTION OF EQUIPMENT

2.1 SCOPE OF SUPPLY

The System 2000 is supplied unassembled as follows:

- **Blast Control Unit:** A housing incorporating the dry ice hopper and feed system, main compressed air valves and pneumatic system controls.
- **Blast Hose Assembly**: A compressed air and a dry ice feed hose banded together with a dual pneumatic signal control pipe with a standard length of 5 m.
- **Blast Nozzle:** Either of straight or right angled design.
- **Compressed Air Supply Hose:** Standard hose supplied has max. WP of 20 bar.
- **Standard Accessory Pack:** Containing 1 dry ice scoop, 1 pair protective gloves, 1 set eye protectors, 1 set ear defenders and 10 sets disposable ear plugs
- **Instruction Manual and Operating Guidelines**.

Equipment excluded from the standard supply:

- Dry ice pellets.
- Bulk storage facilities for dry ice pellets.

Optional equipment:

- Alternative Blast Nozzles.
- Alternative Blast Hose Assemblies with different lengths.
- Blast Air Pressure Regulator.

Whilst it is the objective of Clean Surface to supply all equipment necessary to complete a general cleaning task without exposure of the equipment operator to undue risks it is the responsibility of the equipment user to ensure that adequate personal protection equipment (PPE) is provided for the safe execution of each specific application of the equipment.

2.2 EXPECTED USE

The equipment is intended for use only as a blast cleaning system.

It is expected that the equipment will be used on target materials, equipment and plant for which prior suitability has been determined, or where appropriate tests and examination have proved it to be suitable. The Company or its accredited Agents and Distributors may have given advice on general suitability for a purpose, but unless detailed information on which to base this advice has been given, it is the users responsibility to ensure that all relevant checks are made on the suitability of the process, and that these instructions and guidelines are followed.

With such a wide range of potential uses for the equipment Clean Surface cannot be held responsible for any damage caused by dry ice blast cleaning to users equipment or personnel unless the Company has reviewed the specific application and given firm written guarantees in advance of the commencement of work.

2.3 LIMITS OF USE

The equipment is intended for use in an industrial environment that is well lit, adequately ventilated and within normal working levels of temperature and humidity.

The operators who use the equipment must be familiar with the hazards specific to this type of equipment. They are expected to be familiar with the system controls and have read and understood these instructions, particularly those sections relating to safety.

The equipment requires a clean dry compressed air supply of 5.5 bar minimum pressure. The volume of compressed air required is determined by the chosen nozzle size and operating pressure. For a standard TV250 nozzle at the design rating of 5.5 bar the compressed air requirement will be 2.5 m3/min.

The equipment is rated at 15 bar maximum working pressure.

The equipment requires to be supplied with dry ice pellets specifically manufactured for blast cleaning purposes. The required pellet diameter is 3mm.

The pneumatic control circuit requires to be lubricated with proprietary oil designed for the purpose. The initial fill is with a vegetable oil that presents no hazard.

The floor space required for the operation of the system is approximately 2.5 m x 2.5 m.

The performance of the equipment is not expected to deteriorate with age nor with usage or hours run.

Wear and tear arising from the portability of the equipment may render parts of the equipment suspect. Parts so exposed must be checked for integrity and be replaced as necessary.

2.4 HISTORY

Equipment of this type has been in use for over 10 years.

Clean Surface Limited has experience in the design, construction and operation of this type of machinery since 1995

There is no evidence of misuse of this equipment other than the potential as referred to in these instructions.

The manufacturer has no knowledge of serious accidents arising directly from the use of this equipment.

3. REVIEW OF APPLICATION - PREPARING FOR FIRST USE

3.1 GENERAL CONSIDERATIONS

The equipment is designed as a general tool for cleaning purposes and will be used in applications defined by the user and outside the control of the equipment supplier.

The user must provide safe application of the equipment and consider the following broad topics, which must be read and accepted only as an incomplete guide.

- Control of the work at the target, ensuring ergonomic comfort of the operator and his safe access to the work area.
- Control of the means of access by others to the target, ensuring necessary isolation of the target when cleaning.
- Control of the work by a method statement, including procedures and handling instructions.
- Control of, and access to the worksite, being the zone within which actions or inaction can have a direct influence on the cleaning task.
- Control of, and access to the area affected by the work, being the zone within which the activity of carrying out cleaning work can be said to have an effect.
- Attention to local Laws and Regulations that apply to the operation of equipment, the use of compressed air and dry ice.

3.2 SYSTEM REQUIREMENTS

Compressed Air The Blast Nozzle behaves as a simple orifice and the compressed air consumption will follow a set curve governed by the laws of fluid flow. Increasing the compressed air supply pressure will require a given Blast Nozzle to pass a greater volume of air to sustain that pressure. If the compressor system cannot make the increased volume available then the system will stabilise at a lower pressure that matches the available volume.

Typical pressure volume relationships for the standard TV range of nozzles are:

LP Nozzle (TV250/LP/00 or /90)

	1.1 m3/min at **2.0** bar	**40** ft3/min at **30** psi
DESIGN RATING	**2.4** m3/min at **5.5** bar	**85** ft3/min at **80** psi
	4.1 m3/min at **10** bar	**145** ft3/min at **145** psi

HP Nozzle (TV750/HP/00 or /90)

	5.0 m3/min at **6.0** bar	**180** ft3/min at **90** psi
DESIGN RATING	**7.5** m3/min at **9.5** bar	**265** ft3/min at **140** psi
	10.0 m3/min at **12** bar	**355** ft3/min at **175** psi

See Appendix D for more detailed pressure/flow relationships.

Dry Ice The system can only use dry ice pellets of max. 3 mm diameter. At the design rating a standard TV250 Nozzle uses up to 30kg/h of pellets if operated continuously and a TV750 uses approximately 45 kg/h depending on the application.

Ventilation Adequate facility for natural or forced ventilation must be available in the blasting area for dispersal of gaseous carbon dioxide concentrations that can build up from the storage and handling of dry ice and the separation of CO_2 gas after blasting.

The concentration of carbon dioxide within the blast stream is related to the flow rates of dry ice and compressed air applied during blasting. The blast stream exiting a standard blast nozzle using 2.4 m3/h of compressed air and 30 kg/h of dry ice contains approx. 9.2% CO_2 gas by volume. Due to the high exit velocity of this stream from the nozzle dilution air from the atmosphere is rapidly entrained thus greatly reducing the average concentration of CO_2 in the work area.

Guidance on the permissible concentration levels are given by suppliers of dry ice as follows:

Long term exposure :	Less than 0.5%	(standard first alarm setting)
Short term exposure :	Less than 1.0%	(standard second alarm setting)
Maximum exposure	5%. where continuous exposure will cause headaches and dizziness.	

To ensure adequate personnel protection it is advisable to fit a CO_2 detector with audible alarm in all areas where dry ice is stored and used and to provide operators with portable monitors.

More information on the hazards associated with the use of dry ice are incorporated in Appendix B.

Equipment Settings The initial setting of the working pressure and dry ice feed rate is possible from knowledge of the use of the process in similar conditions elsewhere, from trials or from estimates from similar applications. The settings will usually dictate the speed of cleaning. If the settings are too low, cleaning may be too slow or in some cases may not be sufficiently powerful to remove the contamination at all. If the settings are too high the target may be damaged or the process may become excessively expensive or the conditions of use may become unacceptable.

To control the blasting pressure a pressure regulator may be inserted in the compressed air supply at the connection to the compressed air source (Inlet Regulation) or on the outlet from

the Blaster supplying the Blast Nozzle (Outlet Regulation). Outlet regulation ensures that the Blaster control system is not starved of air. **Note:** Inlet regulation should not be used if blasting pressures of less than 5.5 bar (80 psi) are required.

Nozzle Stand Off According to the cleaning conditions, blast pressure selected and the fragility of the target being cleaned, the nozzle to work distance required can vary from 30 to 600 mm. Using standard Nozzles in the range 5 to 7 bar it is usual to commence blasting at a stand off of approx 200 mm and then close in until the desired rate of cleaning is achieved. See nozzle related operator guidelines in Appendix E for more details.

Directionality Dry ice blasting is a very directional process. As soon as the dry ice particles make impact after leaving the nozzle the impacted surface is cleaned. There is no cleaning effect from rebounded particles as there are too few, and those that exist are too slow.

Speed of progress After finding the required stand off distance the blast stream should be moved systematically across the work. If moved too fast cleaning will be ineffective, but if moved too slowly, dry ice and time will be wasted. Only experience can select the right speed of progress and it should be noted that going over the same area twice at high speed to get the desired result will be slower and less economical that cleaning once at the correct speed.

3.3 SAFETY REQUIREMENTS

It is of vital importance that the system is applied in controlled circumstances with clear control over authorisation to deploy the process.

In circumstances where the equipment is permanently installed, dedicated to one application and used regularly by the same operators who are also in control of the target to be cleaned it will be adequate for them to follow a simple work routine and to carry out only specific safety checks.

In circumstances where the equipment can be used by a number of people, on differing targets and in differing circumstances a more rigid approach is required.

The list of hazards that might arise and the corresponding list of circumstances that cause the risk can be found in Appendix A.

3.3.1 HEARING PROTECTION

Each Blaster is supplied with a set of high attenuation earmuffs, type LM77 and several soft disposable Max earplugs.

To ensure that operators and all persons in the near neighbourhood of the blaster are properly protected against the blast noise it is essential that both the soft earplugs and the ear defenders are worn.

The soft earplugs should be inserted as shown on the packaging before putting on the earmuffs.

IMPORTANT NOTE:

If users wish to use their own earplugs and defenders then they must have the same or better standard of attenuation than those supplied with this equipment.

The minimum standards required are:

Earplugs : SNR 31 dB

Ear Defenders: SNR 32 dB

Failure to comply with these instructions will result in operators being exposed to higher than acceptable noise levels.

Please refer to Appendix F for more details.

Users must by law ensure that all personnel able to hear the blast noise are adequately protected.

3.3.2 COMMUNICATIONS DURING BLASTING

Using high levels of attenuation in ear defenders reduces the awareness of operators to verbal instruction or alarms. To remove this risk ear defenders with earplugs and a radio communication system can be used to ensure maintenance of verbal contact.

3.4 ASSEMBLY AND DISASSEMBLY OF THE EQUIPMENT

The equipment is portable in nature and is best assembled permanently for the same work in the same location, or assembled repeatedly for different work in different locations.

Accordingly and as necessary:

- Check that the positioning of the equipment allows safe access to the worksite.
- Check that the equipment is not damaged or parts excessively worn or otherwise potentially faulty.
- Assemble the equipment correctly referring to these instructions. Check that only components supplied by Clean Surface Ltd are used.

The System 2000 Blaster is supplied in three major parts (see Section 2.1):

Blast Control Unit
Blast Hose Assembly
Blast Nozzle

Before using the equipment the three components must be connected. If these instructions are followed **without the use of any additional hose adapters** the hoses will connect correctly as the thread sizes and types of fitting are designed so that the only way to connect them is the correct way.

Description of components and their orientation:

- The compressed air hose in the Blast Hose Assembly is fitted with screwed 1" BSP connections at each end.
- The ice feed hose in the Blast Hose Assembly is fitted with a screwed 3/4" BSP connection at each end.
- The dual colour coded trigger control pipes in the Blast Hose Assembly are plain ended for insertion into 4 mm push fit pneumatic connectors.
- The front of the Blast Control Unit is the end to which the Control Panel is fitted.
- The compressed air inlet connection is on the front of the Blast Control Unit below the Control Panel.
- The rear of the Blast Control Unit is the end to which two male outlet pipes, one central dry ice outlet and one 1" off centre compressed air outlet are fitted.
- The dry ice outlet terminates in either a screwed ¾" BSP connection or is fitted with an adaptor to suit a ¾" screwed connector. The adaptor should never be removed.

Connecting the Blast Hose Assembly

Connect one end of the Blast Hose Assembly with two female connectors to the Blast Control Unit. Choose the end with the longest trigger pipe to fit to the Blast Control Unit.

Fit the 1" compressed air hose to the 1" off centre male outlet located at the rear of the Blast Control Unit. First hand tighten the connectors to ensure the threads are not crossed and then fully tighten with a suitable spanner or pipe wrench.

Fit the ¾in dry ice hose to the ¾in dry ice outlet located at the centre rear of the Blast Control Unit. First hand tighten the connectors to ensure the threads are not crossed and then check tighten with a suitable spanner or pipe wrench.

Split the dual trigger control pipes and connect to the Blast Control Unit ensuring the correct colour orientation in accordance with the Interlock Blast Nozzle Guidelines below. The connections to the Blast Control Unit are made just under the dry ice hose connection point. Push the control pipes firmly home and check they will not pull out. If the tube ends are worn or damaged trim back to undamaged material before fitting.

If the system is fitted with a static control system fit the single red cable to the blaster body using the bayonet connector located near the trigger pipe connectors. Ensure that the earthing strap from the rear of the blaster body is making contact with the floor.

Connecting the Blast Nozzle:

Connect the Blast Nozzle to the free end of the Hose Assembly.

i. Fit the Blast Nozzle directly to the 1 in compressed air hose end. First, hand tighten to ensure the threads are not crossed, but only fully tighten with a suitable spanner or pipe wrench as described in step iv. below:

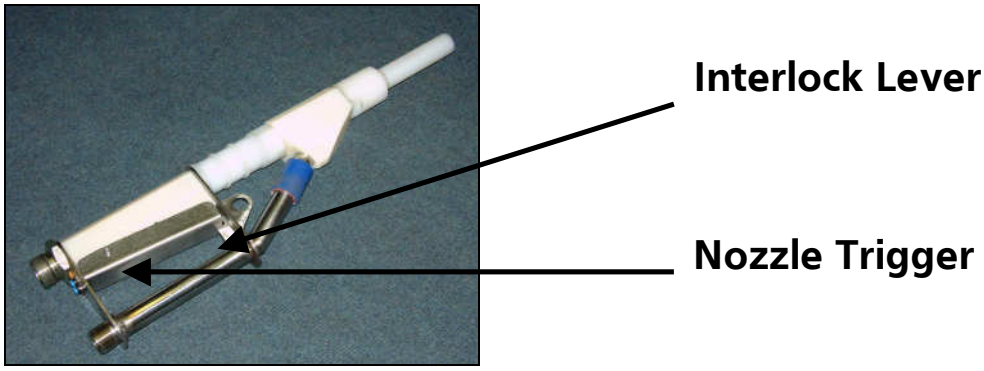
ii. Push fit the dual trigger control pipes to the pneumatic connector located between the Blast Nozzle inlets on the nozzle. Ensure the colour orientation is correct and in accordance with the Interlock Blast Nozzle Guidelines below. If fitted also connect the single red earthing cable to the nozzle using the bayonet connector.

iii. Fit the dry ice hose to the Blast Nozzle. First hand tighten to ensure the threads are not crossed and then fully tighten with a suitable spanner or pipe wrench.

iv. Rotate the nozzle assembly around the still un-tightened air hose connection until the hoses are untwisted and in a comfortable arrangement for blasting. Finally tighten the air hose connection with a suitable spanner or pipe wrench.

Interlocking Blast Nozzle Guidelines:

This blaster is supplied with an Interlocking Blast Nozzle to provide added safety. If the nozzle trigger is inadvertently depressed when the nozzle is handled it cannot fire up.



To activate the nozzle the Interlock Lever must be disengaged before the nozzle trigger can be fully depressed. The blaster will not fire up if the nozzle trigger is depressed without first disengaging the interlock.

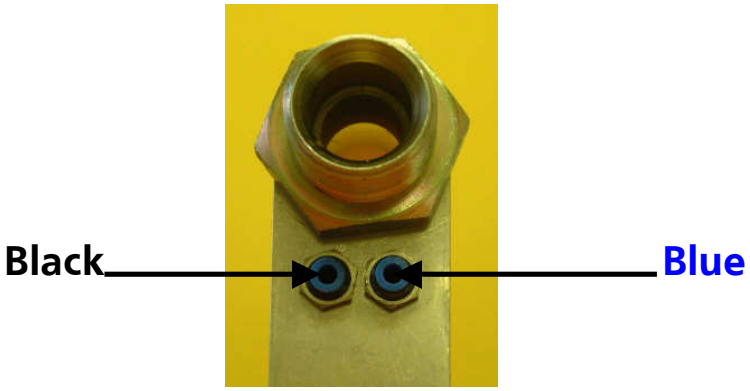
With a little practice operators will find it easy to disengage the interlock with the forefinger prior to depressing the trigger.

The trigger operates a small pneumatic micro-switch that returns an air signal from a 4 mm supply pipe back to the blaster. On reaching the blaster the signal air opens the main blast air valve and starts the ice feed auger motor. The signal air is carried to the blast nozzle by the blue pneumatic pipe and returned to the blaster by the black pneumatic pipe. Both blue and black pipes are twinned, except at the ends where they are connected to the blast nozzle and the blaster.

It is important that the blue and black trigger signal pipes are connected correctly. The blaster will not function correctly with crossed signal pipes.

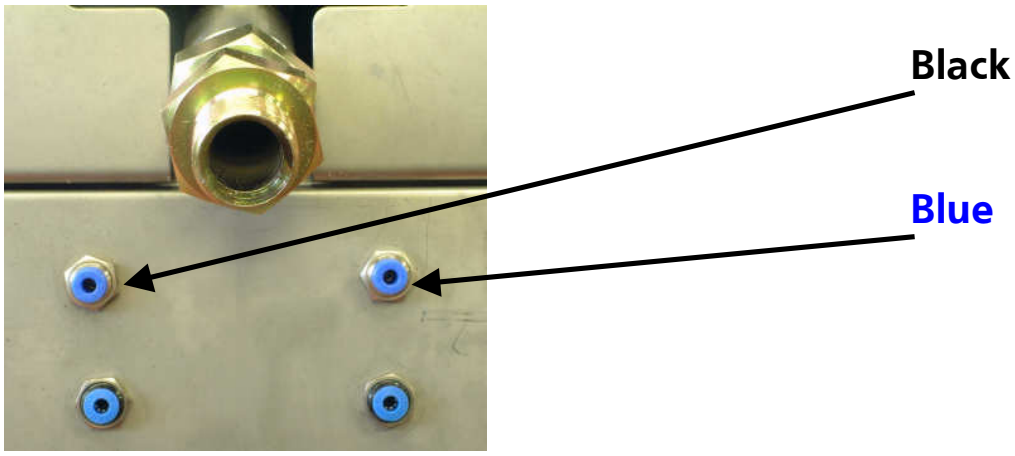
Fitting the signal pipes to the Nozzle:

Hold the Blast Nozzle in the normal operating position with the pneumatic connectors nearest to the body. The blue signal pipe should be fitted to the right hand connector (see photograph on page 11).



Fitting the signal pipes to the Blaster:

The blue signal pipe is fitted to the top right hand connector and the black signal pipe to the top left hand connector.



Remote Emergency Stop:

The two lower pneumatic connectors allow an emergency stop to be located external to the blaster. Please refer to section 4.6 of this manual for details on fitting a Remote Emergency Stop. The blaster is not supplied with these connectors ready for immediate use.

Disassembly is the reverse of the assembly process described in section 3.4.

4. BLASTING OPERATIONS

Assembly of the equipment, if not already completed, should be carried out in accordance with Section 3.4.

Depending upon the circumstances of use all of the following steps may not always be necessary. However, all the safety requirements and checks listed in Sections 3.3 and 4.1.3 must always be reviewed and executed prior to Blasting whenever the system is redeployed.

4.1 PREPARING TO BLAST

4.1.1 CONNECTION TO THE COMPRESSED AIR SUPPLY

The assembled Blaster may now be connected to a compressed air supply that must provide filtered, dry air not in excess of 15.0 bar (215lbf/in^2). The connecting hose should have at least the same maximum working pressure and internal diameter as the compressed air hose in the Blast Hose Assembly fitted between the Blast Unit and Blast Nozzle. A standard Blast Hose Assembly supplied by Clean Surface Ltd will have a 1" compressed air hose with a maximum working pressure of 20 bar (290lbf/in^2) and it is recommended that 1" compressed air supply hoses with a maximum working pressure of 20 bar should also be used. The supply hose should be fitted with a swivel connector or union to facilitate connection. Quick fit bayonet connectors are not recommended as these often restrict the airflow and the resulting pressure drop will reduce cleaning efficiency.

Check that the equipment is being used in an appropriate application and under appropriate controls.

Check that any authorisation or permits to work or procedures for work are to hand and understood by the operator, and the necessary steps to comply with these are undertaken.

Prepare the blast equipment by carrying out the following in the order written:

- Ensure that the Blast Unit air supply isolation valve on the side of the Blaster is in the OFF position (handle vertical).
- Ensure that the Blast Control Unit key switch is in the OFF (0) position.
- Locate the connection to the compressed air supply that is to be used. Use only connections of 1" nominal bore or more. Check that the supply cannot exceed the maximum pressure rating for the equipment, (normally 15 bar).
- Under appropriate control, crack open the isolation valve controlling the supply to the connection to expel any foreign matter or water that may have collected in the main. Beware that allowing full flow through a fully open valve may be dangerous and unacceptably noisy. Close the valve when satisfied.
- Connect the compressed air supply hose between the Blaster and the compressed air supply connection. Do not use adaptors or quick fit connectors with less than 16 mm internal diameter. Fully tighten all joints.
  With the Blast Unit air supply isolation valve still in the OFF position, slowly open the main compressed air supply valve and check for air leaks. If leaks are detected, immediately shut the main supply valve, exhaust the system and refit

or replace the faulty component(s). The compressed air supply hose may be exhausted by partly opening the Blast Unit air isolation valve on the Blaster. Repeat this instruction until the supply system is air tight.

- Open the compressed air supply valve.
- With the compressed air supply valve fully open, open the Blast Unit air isolation valve on the Blaster. Initially, an exhaust valve will be activated and compressed air will escape. On moving the valve lever further to the fully open position the exhaust valve will close and no further air escape should be detectable.
- If air leaks are detected, close the Blast Unit air isolation valve and the compressed air supply valve, exhaust and remedy the fault.
- Once satisfied with the integrity of the system close the Blast Unit air isolation valve.

IMPORTANT: On no account subject the Blaster to more than 15.0 bar even if a Hose Assembly with a higher rating is fitted. More than 15.0 bar will damage the pneumatic control system and is dangerous.

4.1.2 PRESTART CHECKS

Before proceeding ensure that all compressed air lines and hoses are in good condition, properly connected and fully tightened and ensure:

- The Blast Unit air isolation valve is in the OFF position (lever vertical).
- The Key Lock on the Blast Control Panel is in the OFF (0) position.

4.1.3. BLASTER FUNCTION AND SAFETYCHECKS

The Blaster may now be activated and its functions checked as follows:-

- Open the dry ice hopper lid. Dry ice should **not** be placed in the hopper at this stage.
- Open the Blast Unit air isolation valve.
- Turn the Key Lock to the ON (1) position.
- Unlock the EMERGENCY STOP button by rotating the knurled knob if it in the depressed position.
- Press the RESET button.

- Turn the FUNCTION CONTROL to the ICE ONLY position. Pressing the Blast Nozzle Trigger will activate the auger, or worm drive, in the base of the hopper and a mechanical hammer which knocks the outside of the hopper to prevent ice bridging. This proves the function of the ice feed mechanism.

  Ensure all personnel in the blasting area are wearing Hearing Protection and that the Operator is fully protected for Blasting. See Section 3.3.1 of these instructions.

- Turn the FUNCTION CONTROL to the BLAST ONLY position and activate the Blast Nozzle Trigger. Ensure the Blast Nozzle is firmly held and pointed away from personnel or unsecured articles when the trigger is activated. Compressed air will be released through the Blast Nozzle without operation of the auger and hammer. This proves the function of the blast system.

- Turn the FUNCTION CONTROL to the RUN position and taking the same precautions as in the previous test, activate the Blast Nozzle Trigger. Compressed air will be released through the gun with simultaneous operation of the auger and hammer. This proves the normal operating or RUN condition.

- With the System operational and the Blast Nozzle Trigger depressed, operate the EMERGENCY STOP button. The System should cease to operate and only restart after release of the EMERGENCY STOP button (by twisting) and pressing the RESET button.

- With the System operational and the Blast Nozzle Trigger depressed, turn the Key Lock to the OFF position. The System should cease to operate and only restart after returning the Key Lock to the ON position and pressing the RESET button.

- With the System operational and the Blast Nozzle Trigger depressed, turn the Blast Unit air isolation valve to the OFF position. The System should cease to operate and only restart after returning the Blast Unit air isolation valve to the ON position and pressing the RESET button. This simulates a downstream air failure.

- With the FUNCTION CONTROL in the RUN condition, activate the Blast Nozzle Trigger and set the ICE FEEDER air pressure using the ice feed rate regulator to 0.8 bar (12 lbf/in^2). Note the blast air pressure when operating (dynamic) and not operating (static) the Blaster. Where possible, adjust the compressed air supply pressure to give the maximim possible dynamic pressure.

These safety checks are carried out to confirm the correct functioning of the safety control circuits. They are simple to execute and should be carried out as frequently as considered necessary for the circumstances of use.

Important Note: When running the Blaster from plant air systems a dynamic blast air pressure considerably lower than the static reading may be recorded. Any pressure drop from static to

dynamic confirms that the compressor or the supply system is unable to provide the full volume of compressed air required to run the Blaster effectively. A pressure drop will mean that the Blaster is being starved of air resulting in slower, but not necessarily poor quality cleaning. The addition of an air receiver to the plant air system will help alleviate the loss of pressure over short blasting periods, but will not prevent a pressure drop when blasting continuously.

4.2 LOADING WITH DRY ICE & TESTING

When handling Dry Ice by removing it from the delivery or storage container to load the blast unit:

There is a risk of the operator suffering cold burns by dry ice coming into contact with the skin.
WEAR GLOVES AND PROTECTIVE CLOTHING WHICH DOES NOT ALLOW DRY ICE PELLETS TO BECOME LODGED IN FOLDS OR POCKETS.

There is a risk of asphyxiation to the operator by excessive leaning into the dry ice storage container.
DO NOT LEAN INTO STORAGE CONTAINERS AND DO NOT INHALE WHEN OPENING THEM.

There is a risk of spillage of dry ice causing potential risk of cold burns to others not directly involved with the blasting.
CLEAR UP ANY SPILLAGE IMMEDIATELY.

There is a risk of spillage causing a hazard by reaction of other materials from contact with dry ice.
HANDLE THE DRY ICE IN DESIGNATED AREAS ONLY.

After completion of all set up tests ensure that the internal surfaces of the hopper, the auger and the auger tube are dry and free of condensation. Remove any traces of water or moisture droplets by blasting into the hopper with the Blaster function control in the RUN condition, but without any dry ice. When dry, fill the hopper with one scoop of dry ice and with the Blaster function control in the RUN position, make a test blast on a test component.

Initially, it takes a few seconds for the dry ice to reach the nozzle and a few minutes for the system to cool down and become fully effective. Once the system has cooled, water vapour from the atmosphere will condense on the internal and external surfaces of Blaster components in contact with the dry ice and then frost. This is a normal operating phenomenon.

4.3 BLASTING

Alert the surrounding area that blasting is about to commence. Ensure they all have the necessary PPE in place.

Under normal blasting conditions risks arise from, but not exclusively::

- flying objects
- raising particles into the air for inhalation
- unintentional blasting
- reaction forces causing loss of balance
- awkward access
- static
- noise
- dry ice bounce back
- dry ice blowback
- tripping, especially over excessively long supply hoses
- rupture of supply hoses
- incorrect blaster settings
- using excessive amounts of dry ice

Further details on likely risks can be found in Appendix A. The control of these risks should be achieved by detailed management of the job site, a specific work instruction or by fully training a responsible operator who is familiar with all of the relevant potential risks.

Before blasting delicate surfaces and materials, test a small unimportant area. For normal applications using a standard TV250 nozzle, the blasting efficiency is at its peak when the Blast Nozzle is at 90° to and 30 mm to 40 mm from the working surface. Less aggressive cleaning is achieved simply by moving the nozzle away from the surface. Generally at 100 mm to 200 mm distance, greasy deposits can be removed from coated surfaces without damage to the coating.

With the ice feed rate set at 0.8 bar, the Blaster uses approximately 30 kg per hour dry ice. This is a good general-purpose setting, but the rate may be increased or decreased to suit the application. The most effective and economical rate is best established by slowly increasing the dry ice feed rate from 0.8 bar until cleaning performance drops off. Visible CO2 gas clouds and rebounding dry ice particles will be visible when the setting is too high. The rate should then be turned back down to the point where cleaning performance returns to its peak to prevent unnecessary wastage of dry ice.

See the Operating Guideline Sheets for specific information on any nozzles provided with the equipment not designated TV250.

4.4 CLEARING ICE FEED BLOCKAGES

Failure of the ice delivery system may occasionally arise due to a number of factors.

- Holding up of the dry ice in the hopper by bridging in the hopper. Clear the bridge by turning off the Blast Unit air isolation valve and inserting a wooden or plastic poker through the fixed mesh hopper guard. When cleared reopen the air supply, press RESET and continue blasting.

- Jamming of the dry ice feed auger by a foreign object that has fallen in the hopper or was loaded with the dry ice. Clear by shutting down the system as described in Section 4.5 b), disconnecting the blaster from the air supply and removing the fixed mesh

- hopper guard. When cleared reassemble, reconnect the air supply and follow the start procedure.

- Blinding of the dry ice feed auger by compacted dry ice usually combined with ambient water ice. This is a rare occurrence that would usually be caused by leaving the blaster loaded with dry ice but unused for a long period especially in warm humid conditions. If not severe the binding can be freed by simultaneously blasting and increasing the dry ice feed rate until the auger begins to move. Once free return the feed rate to its original setting. If this action does not free the binding the blaster must be placed in a warm environment to thaw out. Depending on the severity of the problem thawing can take several hours. **NO ATTEMPT SHOULD BE MADE TO CLEAR THE BLOCKAGE BY USING THE BLAST SYSTEM EITHER IN THE HOPPER OR THE AUGER TUBE EXIT. THIS WILL RESULT IN A DANGEROUS BLOW BACK OF DRY ICE.**

  Blockage of the dry ice hose through mechanical restriction and, or, the build up of internal frost. The blockage can be cleared by temporarily damming the Blast Nozzle outlet thus reversing the airflow through the dry ice feed hose. This action leads to blow out of dry ice from auger outlet at the rear of the blaster causing potential danger of cold burns to those in the area immediately behind the blaster. **CAUTION:** If the older type blast hose is being used (Blue Silicone Ice Hose) the blast nozzle must be placed no closer than 1mm to the flat surface. The pressure rating for the silicone ice hose is much less than the latest ice hose and could blow off the end of the fitting if the nozzle is fully dammed.

- **DO NOT TAKE THIS ACTION WHEN ANY PERSONNEL ARE BEHIND OR NEAR TO THE REAR OF THE BLASTER.**

4.5 LIMITING STATIC DISCHARGE

During blasting a static charge can build up. This is generally noticeable when the target or work piece is not naturally earthed and can cause discomfort to the operator when discharge takes place through the body. The static is generated by several mechanisms:

The rapid expansion of compressed air within the nozzle system.
The flow of dry ice pellets within an enclosed insulated system.
The rapid flow of compressed air and dry ice pellets over a surface.
The creation of low temperature fluid masses that are forced rapidly into moist ambient air masses similar to the events that occur in thunder storms.

Most of the static generated within the system is discharged through the nozzle and transferred to the work piece. The build up of most of the discharge can be prevented by earthing the work piece. In extreme cases earthing the nozzle may also be necessary. Nozzles that are prone to develop excessive static are fitted with an earthing brace and a bayonet connector for attachment to a grounding system built into the hose assembly, which is earthed to the floor at the rear of the blaster. If the floor is insulating in nature then a cable from the earth strap to a suitable ground may be necessary.

Sound earthing of both nozzle and target will remove the risk of discomfort to operators but it cannot be guaranteed that earthing will totally eliminate the creation of a spark or discharge in the gap between target and nozzle. Users must evaluate the hazard of using a dry ice system in potentially explosive atmospheres in the same way they must evaluate the risks of any spark creating process.

4.6 SHUTDOWN

a) Emergency

Once set up, all functions of the Blaster operate simply by activating the Blast nozzle Trigger. All that is necessary to stop blasting is to release the trigger. In an emergency, blasting can be stopped by pressing the red EMERGENCY STOP button on the Blaster Control Panel, by closing the Blast Unit air supply isolation valve, or turning off the main compressed air supply.

A remote EMERGENCY STOP button may also be located away from the Blaster, e.g. on the operators belt. The pneumatic connections for the extension are located at the rear of the Blaster below the trigger control connectors. To activate the connectors remove the loop marked with the reference 50 to be found on the top half of the bulkhead connector block (not pictured below) and attach the two free pipes loosely held in the spare bulkhead connectors in place of the loop (see photo below).

Two 4 mm pipes slipped into redundant 8 mm connector.

Once the Remote Emergency Stop is connected internally the blaster will only work with either a remote stop fitted or a loop on the remote stop connectors.

b) After Blasting

Before closing down the system after use, it is preferable first to use up the dry ice in the hopper and then:-

Shut the main compressed air supply valve.

- Partly close the Blast Unit air supply isolation valve. This will exhaust the compressed air supply lines and the internal Blaster feed systems.

- Press the EMERGENCY STOP button to exhaust the internal Blaster control system.

The system may now be disconnected. If the dry ice hopper still contains dry ice do not store in a closed room and be aware that it will contain condensate on its next deployment.

5. DISMANTLING

Exposure to dry ice remaining in the Blaster after shutdown can cause cold burns, asphyxiation and/or dry ice spillage.

Compressed air remaining trapped in supply hoses may release unexpectedly on dismantling.

To avoid these risks:

Ensure all dry ice is consumed before shutdown.

Before dismantling equipment leave standing until all components have returned to ambient temperature

Ensure that compressed air supply hoses are fully vented prior to their disconnection. The air supply hose can be vented by setting the Blast Unit air supply isolation valve to the halfway position.

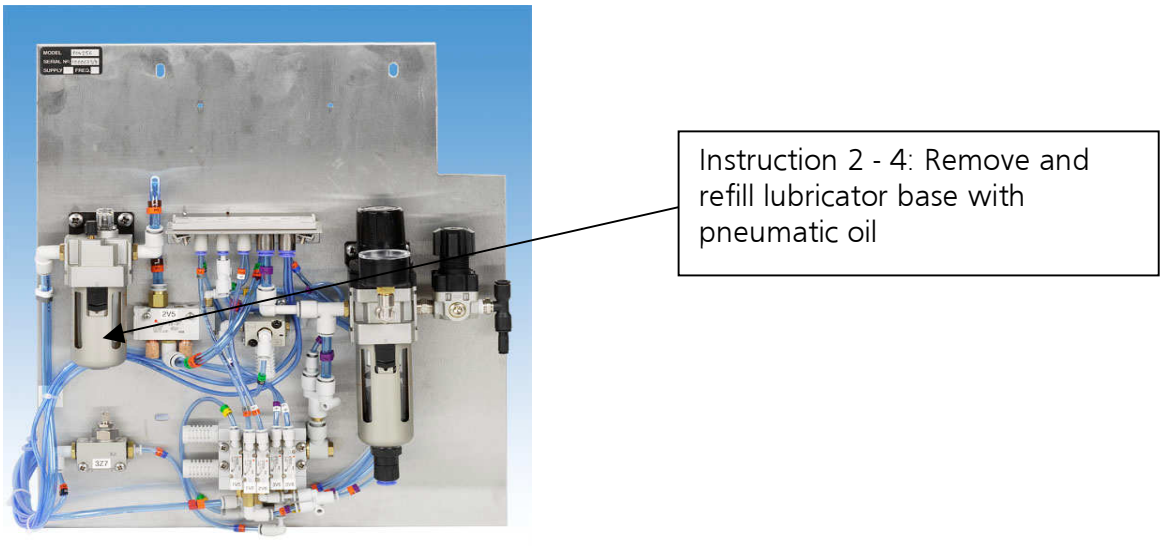
6. MAINTENANCE

6.1. BLAST UNIT

Although the blast unit has been designed for minimum maintenance, Clean Surface recommends the following service schedule be carried out on a regular basis to ensure trouble free operation. The period between checks should be 100 operating hours, which is about. four weeks if the unit is in regular daily use, 6 weeks if used intermittently and 3 months for occasional use.

SERVICE SCHEDULE

To be carried out with the Blaster NOT connected to a compressed air supply.



3. Remove the four retaining screws that hold the front control panel in position and lift off the control panel maintaining the loom connection to the interior panel.

2. Remove the lubricator base positioned on the left of the interior panel (Bayonet fitting).

3. Check oil level and refill as necessary with a proprietary brand of pneumatic oil.

4. Replace lubricator base and check all visible internal connectors are firmly in place.

5. Refit the front panel.

6. Turn the Blaster onto its side so that the Blast Unit air isolation valve is on the upper side.

7. Check the serviceability of the two toothed auger drive belts and the mechanical cam driven hammer. Replace worn belts or cams as required. Use only recommended spare parts.

8. Check for any loose pneumatic connections and refit any defect items.

9. Return Blaster to upright position

To be carried out with the Blaster connected to a compressed air supply

Carry out the BLASTER FUNCTION AND SAFETY CHECKS given in Section 4.1.3. of this manual.

If any functions fail to operate use the pneumatic circuit diagram in Appendix C to identify which valve(s) could be at fault. Check the valve(s) performance and replace any faulty units. Ensure that only valves with the same reference as those removed are installed to prevent malfunction of the Blaster. If in doubt call Clean Surface for assistance.

6.2 HOSES

Whenever the Blaster is used the Air Supply Hose and Blast Hose Assembly should be examined for damage and wear before start-up.
THE SYSTEM MUST NOT BE STARTED IF ANY HOSES ARE DEFECT.

The most critical elements are the hoses which carry compressed air. If there is any doubt that these might be damaged or worn they must be immediately replaced.
WORN COMPRESSED AIR HOSES ARE DANGEROUS AND MUST NEVER BE USED.

The dry ice hose works under suction and therefore if this is damaged or worn no danger will result but air will be drawn into the system and cleaning efficiency lost. At each service interval the dry ice hose should be checked for damage.
IF THE DRY ICE HOSE IS PRESSURE TESTED FOR INTEGRITY DO NOT EXCEED 3 BAR (44LBF/IN^2).

The trigger control pipes are self checking. Any break in this pipes prior to operation of the Blaster will result in an inactive Blast Nozzle trigger and the system will fail to operate. Any break in the pipes during blasting will result in an immediate shutdown of the system. It is good practice to replace the trigger pipe ends if they appear untidy or worn.

6.3. BLAST NOZZLE

Remove the Blast Nozzle from the Hose Assembly and clean as appropriate. Check the compressed air and dry ice inlets for any signs of wear and ensure that the removable outlet nozzle is free of any obstruction. On refitting the outlet nozzle ensure that it is fully screwed in and tight enough not to come loose in service. Take care not to damage any of the internal bores.

6.4. GENERAL

The most effective way to clean the Blaster is to use the system on itself. Neither the control panel, the Hose Assembly nor the instrumentation will be damaged.

APPENDIX A - POTENTIAL HAZARDS AND ASSOCIATED RISKS

arising from the use of dry ice blast cleaning processes.

DURING BLASTING:

Under normal blasting conditions risks arise from:

Inappropriate settings of the equipment including:

Compressed air pressure setting too high leading to damage to the target.
Dry ice rate set to high leading to bounce back of dry ice pellets.
Dry ice rate set too high or dwell too long causing excessive cooling and fracture of the target.

Inadvertent disturbance of:

parts beyond the target area.
parts and materials hidden from view.
liquids at free surfaces.
liquids and powders from troughs or containers.

Flying objects resulting from:

Raising the cleaned debris into the atmosphere.
Dislodgement of parts of the target.
Breakage of parts on the target.

Inhalation of particulates arising from:

Raising the cleaned debris into the atmosphere.
Dislodgement of parts of the target.
Release of materials through damage to containment structures.

Unintentional blasting by poor control of the direction of blasting leading to:

Changed circumstances requiring (re-)assessment.
Injury to others within the blast envelope.

Operator falling due to failure to anticipate changes in nozzle reaction forces:

Interruption to the compressed air supply, through active or passive intervention.
Interruption to the compressed air feed, through a fault in the control circuit.
Sudden re-establishment of the compressed air supply.
Inadvertent operation of the nozzle trigger.

Operator tripping over Hose Assembly containing compressed air and dry ice hose.

Operator suffering injury from contact with parts of the work target whilst unsighted, especially with respect to personal protection equipment design.

Static discharge arising from the dynamic operation of the cleaning system causing:

minor shock to operator during blasting.
minor shock to others touching the nozzle or target when not discharged.
potential source of ignition between the nozzle and the target (where the latter is effectively insulated from earth by, for instance, an insulating coating)

Noise leading to:

hearing loss of the operator.
hearing loss of others involved in the work..
hearing loss of others not involved in the work.
interference with verbal communication within the areas affected.

Dragging of the blast unit under the influence of movement of the blast operator leading to:

Inadequate support for the blast unit.
Excessive tension on the compressed air supply hose.

CLEARING OF DRY ICE BLOCKAGES

Holding up of ice in the hopper by bridging across the dry ice feeder inlet; cleared by use of unofficial "poker" through the fixed mesh guard.

Jamming of the ice feed auger by a foreign object in the hopper; cleared by removal of fixed guard with risk of finger entrapment.

Blinding of dry ice feed auger by compacted dry ice, combined possibly with ambient water ice; with attempted clearing by blasting of the dry ice outlet orifice, leading to rebound of dry ice, blow past of dry ice and eruption of dry ice in the hopper, lifting of the hopper lid and discharge of dry ice pellets.

Blockage of ice hose, being cleared by temporarily damming the nozzle outlet thus reversing the compressed air flow through the ice feed hose leading to blow out of dry ice from the ice feeder auger outlet.

UNAUTHORISED INTERVENTION

Horseplay with regard to inappropriate handling of dry ice and / or reckless use of compressed air.
Unauthorised use of the blasting equipment.
Unauthorised adjustment of the controls.

APPENDIX B - IMPORTANT INFORMATION ON HANDLING DRY ICE

Safety Considerations

Always consult your suppliers safety data sheet before use. Keep it in the area where the dry ice is being used.

Ensure all personnel likely to come into contact with the material are familiar with the safety instructions.

Always keep the dry ice in the original container in which it was supplied. Store them in a well ventilated area.

If transporting dry ice containers in a vehicle they must be conveyed in a compartment separated from the drivers cab.

Never store dry ice in any gas tight container. Natural sublimation may cause the container to explode.

Do not allow dry ice to come into contact with skin. Frostbite may ensue with prolonged contact.

Wear insulated gloves when scooping dry ice for loading into the Blaster. Pay particular attention to cuffs.

Do not lean in to open storage containers.

Do not breath in when opening storage containers or internal retaining bags.

Ensure that dry ice cannot get trapped in folds in clothing if spilled.

Note: Placing dry ice in a commercial food deep freeze will not extend the shelf life. The freezer compressor will not operate as the dry ice temperature (-79.8 °C) will be below the thermostat set point. Consequently the freezer will act only as an insulated container, which will probably not be as well insulated as the container used to deliver the pellets.

A typical supplier dry ice safety sheet in English follows this section

"Drikold" - Solid Carbon Dioxide

QA & HES Department
MATERIAL SAFETY DATA SHEET

Document ID : **HGC-SDS-01002**
Revision date: **2001-05-24**
Revision: **01**
Valid for:
Valid to date: **2003-09-11**

Approved by: Maria Sanderson (2001-05-24)
Verified by: Trish Hallam (2001-01-16)
Prepared by: Maria Sanderson

External references:
Internal references:

Steering document level: 1.60

Approvers:	Maria Sanderson/Agri/Hydro	Approved by:	Maria Sanderson/Agri/Hydro on 2001-05-24
Verifiers:	Trish Hallam/Agri/Hydro	Verified by:	Trish Hallam/Agri/Hydro on 2001-01-16
Executive off.:	Maria Sanderson/Agri/Hydro	Valid for:	
Secretary:	Maria Sanderson/Agri/Hydro	Valid to:	2003-09-11

1. Company

Hydro Gas & Chemicals Limited
Immingham
North East Lincolnshire
DN40 2NS

Telephone: 01469 554700 Fax: 01469 554776

In emergency phone Hydro Agri (24 hrs) 01469 554750

2. Product

SOLID CARBON DIOXIDE

Tradename:
DRIKOLD

3. Composition

Chemical Name (IUPAC)
Carbon Dioxide, CO2

CAS No
124-38-9

Weight %
100

UN No. 1845

4. Hazards Identification

Human
Solid carbon dioxide is very cold and can cause frost bite if in contact with the skin. Solid carbon dioxide sublimes to a gas that in high concentrations is an asphyxiant, which acts by excluding O2 from the lungs.

Environment
Carbon dioxide is a natural component of air; it constitutes approximately 0.03% by volume of the earth's atmosphere.

5. First Aid Measures

General
Immediately remove the person from the source of exposure to fresh air; keep warm and at rest.
If unconscious, loosen tight clothing and place in a stable position, lying on one side.
If breathing has stopped, provide artificial respiration.
If breathing is difficult, provide oxygen if possible.
If the heart has stopped, provide cardiac compression.

Inhalation
See general, above

Skin
Do not rub frostbitten skin or break blisters.
Remove all clothing from around the affected area.
Immerse frostbitten toes, fingers, feet, hands or limbs in lukewarm water (about 40 deg C), NEVER HOT.
Do not use direct heat, hot water bottles, heat lamps, heating pads, etc. on the frostbitten area.
If possible, keep frost bitten fingers and toes separated with strips of gauze or clean cloth.
Seek medical assistance immediately if colour and feeling do not return to frostbitten areas within 20 minutes.

6. Fire Fighting Measures

Extinguishing Agents
None necessary; carbon dioxide is non flammable and is itself used as an extinguishing agent.

Hazards/Preventive Measures
Wear self-contained breathing apparatus in fires where large amounts of carbon dioxide are involved.

7. Accidental Release

Personal Precautions
Solid carbon dioxide is cold; wear protective clothing and footwear, eye/face protection and heavy gloves to avoid skin contact. If spillage occurs in an enclosed space with poor ventilation there is a danger of asphyxiation; wear self-contained breathing apparatus. The gas is heavier than air and will accumulate at floor level and in low-lying areas.

Environmental Precautions
None necessary.

Clean-Up Procedures
Solid carbon dioxide (DRIKOLD) will sublime (i.e. be transformed directly from the solid to the gaseous state) at room temperature. If spillage occurs indoors, provide adequate ventilation to minimise the danger of asphyxiation. No other special procedures are necessary.

8. Handling and Storage

Handling
Avoid skin contact.

Storage
Protect against direct sunlight and heat. Low temperatures can embrittle plastics, rubbers and some steels. Dry ice should not be stored in rooms or cellars without ventilation nor packed in gas tight atmospheres.

9. Exposure Control/Personal Protection

Engineering Measures
Provide adequate ventilation in areas where carbon dioxide is handled.

Control Parameters/Monitoring Procedures
Long term exposure limit (TWA 8 hours) 5000 ppm (=0.5%).

Personal Protection Equipment
Solid carbon dioxide is cold; wear protective clothing and footwear, eye/face protection and heavy gloves to avoid skin contact. Leakage of solid carbon dioxide to an enclosed space with poor ventilation may dilute the oxygen concentration of the air sufficiently to cause asphyxiation; wear self-contained breathing apparatus.

10. Physical and Chemical Properties

Appearance, Colour & Odour
Odourless solid, sublimes to gas

Melting Point/Range (0C)
Sublimes at –78.7 deg C (-56.6 deg C at 5.2 atm)

Specific Gravity (g/cm3)
1.56 (gas)

Relative Density (air=1)
1.52 (gas)

Water Solubility
0.88 CO2/litre H20 (200C, 1 atm)

Nominal Mass

Blocks:	25cm x 12.5 cm x 21 cm (10 kg)
Slices:	12.5cm x 21 cm x 2.5 cm (1 kg)
Pellets:	1cm dia x 2 cm long (10 kg bags)
Small Pellets:	0.3cm dia x 1cm long

11. Stability and Reactivity

General
Carbon dioxide gas is chemically inert under most conditions. The gas is soluble in water, however and forms a weak acid solution ("carbonic acid" H2CO3).

Conditions to Avoid
Cannot be used for extinguishing fires where metallic sodium, potassium or magnesium are involved.

12. Toxicological Information

Health Effects (General)
Solid carbon dioxide is very cold and can cause frostbite if in contact with the skin. Carbon dioxide gas in high concentrations is an asphyxiant, which acts by excluding O2 from the lungs.

Inhalation
Concentrations of 4-5% by volume may cause headache and dizziness. Concentrations of 6-8% may cause unconsciousness and paralysis of the respiratory system.

Skin
See above.

13. Ecological Information

Ecological Effects (General)
Carbon dioxide is a component of air; it constitutes approximately 0.03% by volume of the earth's atmosphere.

Mobility
Solid carbon dioxide will sublime at room temperature.

14. Disposal Considerations

General
With adequate ventilation and otherwise under conditions where the low temperature will not present a hazard or problem, the solid may be allowed to sublime. A cold "fog", heavier than air, will be formed.

15. Transport Information

Proper Shipping Name
Carbon Dioxide, Solid

UN No.
1845

Class/Packing Group
not listed in Approved Carriage List

ADR/RID (road/rail)
Not subject to ADR

IMM/IMDG (sea)
Class 9
Page 9025

Emergency Procedures (IMDG)
EmS No. 8-08

Medical First Aid Guide (IMDG)
MFAG No. 615

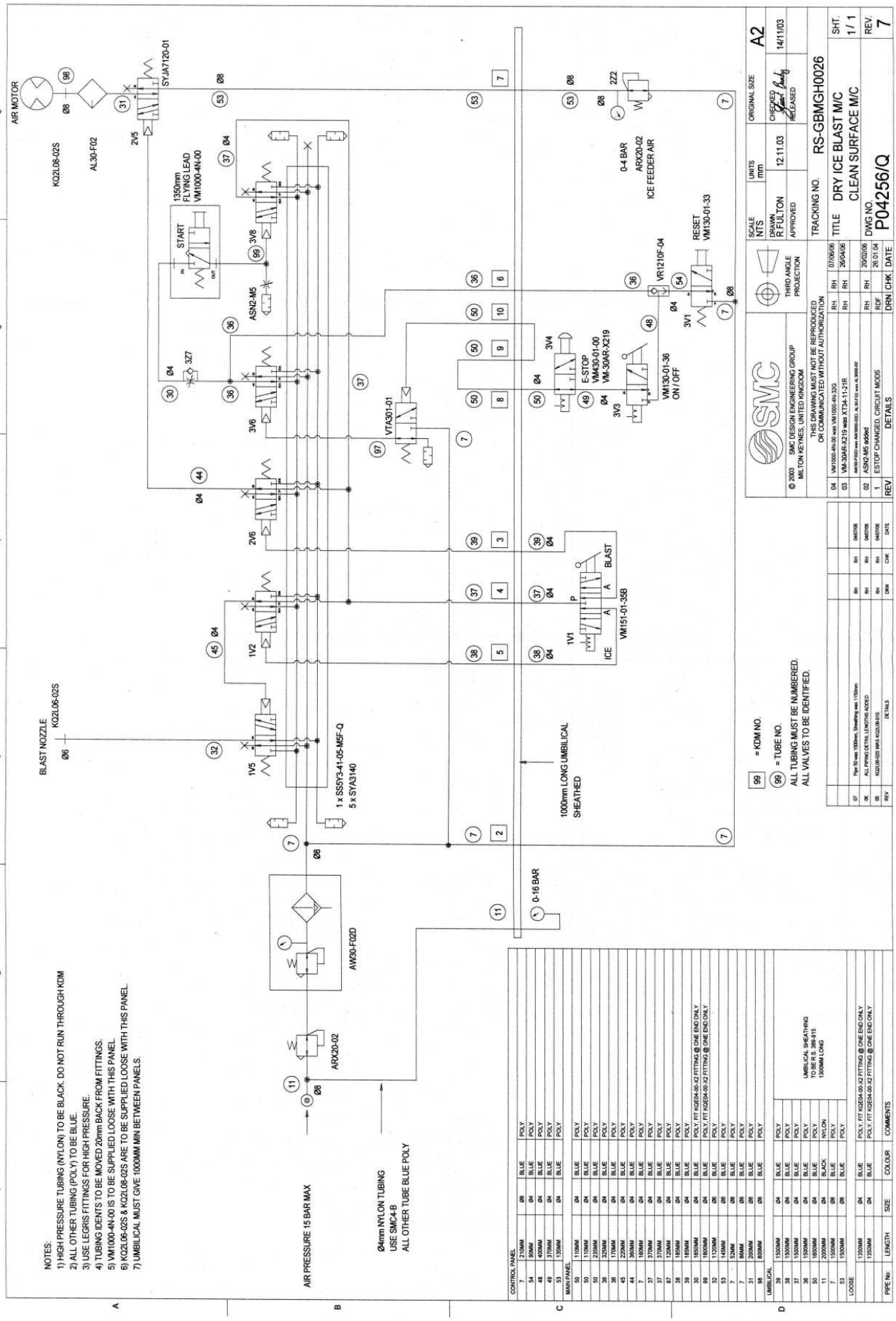
Packaging
Insulated boxes

16. Regulatory Information

General
Not regulated.

APPENDIX C

PNEUMATIC CIRCUIT DIAGRAM & PARTS LIST


NOTES:
1) HIGH PRESSURE TUBING (NYLON) TO BE BLACK. DO NOT RUN THROUGH KDM
2) ALL OTHER TUBING (POLY) TO BE BLUE.
3) USE LEGRIS FITTINGS FOR HIGH PRESSURE.
4) TUBING IDENTS TO BE MOVED 20mm BACK FROM FITTINGS.
5) VM1000-4N-00 IS TO BE SUPPLIED LOOSE WITH THIS PANEL.
6) KQ2L06-02S & KQ2L08-02S ARE TO BE SUPPLIED LOOSE WITH THIS PANEL.
7) UMBILICAL MUST GIVE 1000MM MIN BETWEEN PANELS.
AIR MOTOR
KQ2L08-02S
AL30-F02
SYJA7120-01
2V5
1350mm FLYING LEAD VM1000-4N-00
START
3V8
ASN2-M5
3V6
2V6
1V2
1V5
VTA301-01
E-STOP VM430-01-00 VM-30AR-X219
3V4
3V3
VM130-01-36 ON / OFF
VR1210F-04
3V1
RESET VM130-01-33
0-4 BAR ARX20-02 ICE FEEDER AIR
BLAST NOZZLE
KQ2L06-02S
1 x SS5Y3-41-05-M5F-Q
5 x SYA3140
1000mm LONG UMBILICAL SHEATHED
VM151-01-35B
ICE
BLAST
0-16 BAR
AW30-F02D
ARX20-02
AIR PRESSURE 15 BAR MAX
Ø4mm NYLON TUBING USE SMC A-B ALL OTHER TUBE BLUE POLY
= KDM NO.
= TUBE NO.
ALL TUBING MUST BE NUMBERED.
ALL VALVES TO BE IDENTIFIED.
SMC
SCALE NTS
UNITS mm
ORIGINAL SIZE A2
DRAWN R.FULTON 12.11.03
CHECKED
APPROVED
RELEASED
THIRD ANGLE PROJECTION
© 2003 SMC DESIGN ENGINEERING GROUP MILTON KEYNES, UNITED KINGDOM
THIS DRAWING MUST NOT BE REPRODUCED OR COMMUNICATED WITHOUT AUTHORIZATION
TRACKING NO. RS-GBMGH0026
TITLE DRY ICE BLAST M/C
CLEAN SURFACE M/C
DWG NO. P04256/Q
SHT. 1/ 1
REV. 7
04 VM1000-4N-00 was VM1000-4N-32G RH RH 07/06/06
03 VM-30AR-X219 was XT34-11-21R RH RH 26/04/06
07 Pipe 30 was 1500mm, Sheathing was 1150mm RH RH 04/07/06
06 ALL PIPING DETAIL LENGTHS ADDED RH RH 04/07/06
05 KQ2L06-02S WAS KQ2L06-01S RH RH 04/07/06
02 ASN2-M5 added RH RH 20/02/06
1 ESTOP CHANGED, CIRCUIT MODS RDF 26.01.04
REV DETAILS DRN CHK DATE
CONTROL PANEL
MAIN PANEL
UMBILICAL
LOOSE
PIPE No. LENGTH SIZE COLOUR COMMENTS
UMBILICAL SHEATHING TO BE R.S. 389-915 1300MM LONG

APPENDIX D

COMPRESSED AIR REQUIREMENTS FOR STANDARD BLAST NOZZLES

Compressed air requirements for TV range of blast nozzles

1. Low Pressure Nozzle Operation from Shop Compressed Air Network or alternative Systems:

LP Nozzle (TV250/LP/00 or /90)

DESIGN RATING	**2.4** m3/min at	**5.5** bar	**85**	ft3/min at	**80** psi
	2.6 m3/min at	**6.0** bar	**92**	ft3/min at	**87** psi
	3.0 m3/min at	**7.0** bar	**106**	ft3/min at	**101** psi
	3.3 m3/min at	**8.0** bar	**116**	ft3/min at	**116** psi
	3.7 m3/min at	**9.0** bar	**130**	ft3/min at	**130** psi
	4.1 m3/min at	**10.0** bar	**145**	ft3/min at	**145** psi

When using a shop air system based on a 7 bar compressor, the maximum available pressure should be made available.

2. High Pressure Operation from Mobile Diesel Driven Compressor or alternative Systems

HP Nozzle (TV750/HP/00 or /90)

DESIGN RATING	**7.5** m3/min at	**9.5** bar	**265**	ft3/min at	**140** psi
	10.0 m3/min at	**12** bar	**355**	ft3/min at	**175** psi

When selecting a high pressure compressor always allow for piping and aftercooler/dryer losses of up to 2 bar.

To ensure maximum cleaning efficiency and trouble free operation all compressed air should be dried using refrigerant or desiccant drying systems.

When compressors cannot be located with drying systems they must at least be fitted with an aftercooler and a coalescent filter pack to remove water droplets down to micron level.

Note: The Blast Nozzles behave as a simple orifice and the compressed air consumption will follow a set curve governed by the laws of fluid flow. Increasing the compressed air supply pressure will require the Blast Nozzle to pass a greater volume of air to sustain that pressure. If the compressor system cannot make the increased volume available then the system will stabilise at a lower pressure that matches the available volume.

In shop networks the diameter and length of the piping may severely restrict the flow of air to the take off point resulting in poor cleaning performance. Long distance ring main piping should be at least 2" dia with minimum 1" dia piping down to the take off point, which should be fitted with a 1" full bore ball valve and not restrictive quick fit connectors.

APPENDIX E

OPERATOR GUIDELINES

(Relevant laminated versions supplied loose under blaster lid)

SYSTEM 2000 DRY ICE BLASTER

Short Operating Guidelines using Low Pressure Nozzles TV250/00 and TV250/90 & 45

Please note, the Setting up, Operating & Maintenance Instruction Manual supplied with the Blaster must be studied in detail and fully understood before using this equipment and these guidelines.

1. **Air Supply:** Ensure the compressed air supply to the Blaster can provide at least 2.4 m^3/min (85 cfm) of clean DRY air at a minimum pressure of 5.5 bar g. If the pressure drops below 5.5 bar when operating, the Blaster cleaning efficiency will be reduced.

2. **Function Checks:** With the hopper lid open, but with no dry ice loaded:
   - Open the manual compressed air supply valve located on the side of the blaster.
   - Switch the FUNCTION CONTROL to ICE ONLY position.
   - Turn the KEY LOCK to the ON position.
   - Release the EMERGENGY STOP button.
   - Press the RESET button.
   - Press NOZZLE TRIGGER and check that the auger turns and the hammer operates.

3. **Set Up:** Still without dry ice in the hopper
   - Ensure all personnel in vicinity are wearing ear and eye protection. See instructions packed with ear protectors.
   - Switch the FUNCTION CONTROL to RUN position.
   - Point Blast Nozzle to a safe area and press NOZZLE TRIGGER (TAKE CARE: Blast Air will be discharged from Nozzle). NEVER POINT THE NOZZLE AT ANY PERSON.
   - Set the dry ice feed rate to 0.8 bar whilst Blast Air is discharging.
   - If wet blast the inside of the hopper with dry compressed air.

4. **Testing:** Load only one scoop of dry ice and make a test blast. Increase or decrease the dry ice feed rate within the range 0.8 to 1.2 bar to obtain the best result. Always use the lowest possible setting.

5. **Blasting:** Blast at 90 degrees to the surface being cleaned at a minimum stand-off of between 30 and 50 mm. For less aggressive cleaning use up to 150 mm stand-off.

6. **Loading Dry Ice:** Load only enough dry ice for the job in hand. A full hopper will last up to 40 min. When the job is finished clean up the work area or the Blaster itself to empty the hopper.

5. **Handling Dry Ice:** Leaving dry ice in the hopper or an open storage container will allow time for condensation from the air to settle on the dry ice pellets and freeze the surface into a crust. In wet or humid conditions this takes only a few minutes, so ensure that the container and hopper lids remain closed.

6. **Freezing Up:** Freezing up can occur after a stoppage in 2 ways:

   1. The auger turns, but dry ice does not flow.
   2. The auger does not turn.

   In case 1, remove the frozen dry ice crust from inside the open end of the auger tube and re-start blasting.
   In case 2, clear the auger tube as above and re-start blasting, whilst at the same time increasing the dry ice feed rate. As soon as the hammer knock is heard, turn the dry ice feed rate back. In extreme cases break up the crust on the dry ice in the hopper using a wooden or plastic stick.

9. **Blocking:** Dry ice can also stop flowing to the nozzle if the nozzle freezes or the supply hose is twisted or squashed. This stops dry ice being sucked out of the auger tube and gives the false impression that the blockage is in the auger tube. The blockage is quickly released by placing the open end of the blast nozzle tight[1] against a flat surface and pressing the blast trigger. This purges dry ice out of the open end of the auger tube. It is important the area behind the auger tube is clear before taking this action.

   [1]**CAUTION:** If the older type blast hose is being used (Blue Silicone Ice Hose) the blast nozzle must be placed no closer than 1mm to the flat surface. The pressure rating for the silicone ice hose is much less than the latest ice hose and could blow off the end of the fitting if the nozzle is fully dammed.

   Note: Blocking is caused by WET compressed air.

SYSTEM 2000 DRY ICE BLASTER

Short Operating Guidelines using Medium Pressure Nozzle TV500/00 and TV500/90

Please note, the Setting up, Operating & Maintenance Instruction Manual supplied with the Blaster must be studied in detail and fully understood before using this equipment and these guidelines.

1. **Air Supply:** Ensure the compressed air supply to the Blaster can provide at least 5.0 m^3/min (175 cfm) of clean DRY air at a minimum pressure of 7.5 bar g. If the pressure drops below 7.5 bar when operating, the Blaster cleaning efficiency will be reduced.

2. **Function Checks:** With the hopper lid open, but with no dry ice loaded:
   - Open the manual compressed air supply valve located on the side of the blaster.
   - Switch the FUNCTION CONTROL to ICE ONLY position.
   - Turn the KEY LOCK to the ON position.
   - Release the EMERGENGY STOP button.
   - Press the RESET button.
   - Press NOZZLE TRIGGER and check that the auger turns and the hammer operates.

3. **Set Up:** Still without dry ice in the hopper
   - Ensure all personnel in vicinity are wearing ear and eye protection. See instructions packed with ear protectors.
   - Switch the FUNCTION CONTROL to RUN position.
   - Point Blast Nozzle to a safe area and press NOZZLE TRIGGER (TAKE CARE: Blast Air will be discharged from Nozzle). NEVER POINT THE NOZZLE AT ANY PERSON.
   - Set the dry ice feed rate to 1.0 bar whilst Blast Air is discharging.
   - If wet or dirty blast clean the inside of the hopper with compressed air.

4. **Testing:** Load only one scoop of dry ice and make a test blast Increase or decrease the dry ice feed rate within the range 0.8 to 1.4 bar to obtain the best result. Always use the lowest possible setting.

5. **Blasting:** Blast at 90 degrees to the surface being cleaned at a minimum stand-off of between 60 and 80 mm. For less aggressive cleaning use up to 300 mm stand-off.

6. **Loading Dry Ice:** Load only enough dry ice for the job in hand. A full hopper will last up to 20 min. When the job is finished clean up the work area or the Blaster itself to empty the hopper.

7. **Handling Dry Ice:** Leaving dry ice in the hopper or an open storage container will allow time for condensation from the air to settle on the dry ice pellets and freeze the surface into a crust. In wet or humid conditions this takes only a few minutes, so ensure that the container and hopper lids remain closed.

8. **Freezing Up:** Freezing up can occur after a stoppage in 2 ways:

   1. The auger turns, but dry ice does not flow.
   2. The auger does not turn.

   In case 1, remove the frozen dry ice crust from inside the open end of the auger tube and re-start blasting.
   In case 2, clear the auger tube as above and re-start blasting, whilst at the same time increasing the dry ice feed rate. As soon as a hammer knock is heard, turn the dry ice feed rate back. In extreme cases break up the crust on the dry ice in the hopper using a wooden or plastic stick.

9. **Blocking:** Dry ice can also stop flowing to the nozzle if the nozzle freezes or the supply hose is twisted or squashed. This stops the dry ice being sucked out of the auger tube and gives the false impression that the blockage is in the auger tube. The blockage is quickly released by placing the open end of the blast nozzle tight[1] against a flat surface and pressing the blast trigger. This purges the dry ice out of the open end of the auger tube. It is important the area behind the auger tube is clear before taking this action.

   [1]**CAUTION:** If the older type blast hose is being used (Blue Silicone Ice Hose) the blast nozzle must be placed no closer than 1mm to the flat surface. The pressure rating for the silicone ice hose is much less than the latest ice hose and could blow off the end of the fitting if the nozzle is fully dammed.

   Note: Blocking is caused by WET compressed air.

SYSTEM 2000 DRY ICE BLASTER

Short Operating Guidelines using High Pressure Nozzle TV750/HP/00 and TV750/HP/90

Please note, the Setting up, Operating & Maintenance Instruction Manual supplied with the Blaster must be studied in detail and fully understood before using this equipment and these guidelines.

1. **Air Supply:** Ensure the compressed air supply to the Blaster can provide at least 7.5 m^3/min (265 cfm) of clean DRY air at a minimum pressure of 9.5 bar g. If the pressure drops below 9.5 bar when operating, the Blaster cleaning efficiency will be reduced.

2. **Function Checks:** With the hopper lid open, but with no dry ice loaded:

Open the manual compressed air supply valve located on the side of the blaster.

- Switch the FUNCTION CONTROL to ICE ONLY position.
- Turn the KEY LOCK to the ON position.
- Release the EMERGENGY STOP button.
- Press the RESET button.
- Press NOZZLE TRIGGER and check that the auger turns and the hammer operates.

4. **Set Up:** Still without dry ice in the hopper

- Ensure all personnel in vicinity are wearing ear and eye protection. See instructions packed with ear protectors.
- Switch the FUNCTION CONTROL to RUN position.
- Point Blast Nozzle to a safe area and press NOZZLE TRIGGER (TAKE CARE: Blast Air will be discharged from Nozzle). NEVER POINT THE NOZZLE AT ANY PERSON.
- Set the dry ice feed rate to 1.2 bar whilst Blast Air is discharging.
- If wet blast the inside of the hopper with dry compressed air.

4. **Testing:** Load only one scoop of dry ice and make a test blast Increase or decrease the dry ice feed rate within the range 0.8 to 1.4 bar to obtain the best result. Always use the lowest possible setting.

5. **Blasting:** Blast at 90 degrees to the surface being cleaned at a minimum stand-off of between 60 and 80 mm. For less aggressive cleaning use up to 300 mm stand-off.

6. **Loading Dry Ice:** Load only enough dry ice for the job in hand. A full hopper will last up to 20 min. When the job is finished clean up the work area or the Blaster itself to empty the hopper.

7. **Handling Dry Ice:** Leaving dry ice in the hopper or an open storage container will allow time for condensation from the air to settle on the dry ice pellets and freeze the surface into a crust. In wet or humid conditions this takes only a few minutes, so ensure that the container and hopper lids remain closed.

8. **Freezing Up:** Freezing up can occur after a stoppage in 2 ways:

   1. The auger turns, but dry ice does not flow.
   2. The auger does not turn.

   In case 1, remove the frozen dry ice crust from inside the open end of the auger tube and re-start blasting.
   In case 2, clear the auger tube as above and re-start blasting, whilst at the same time increasing the dry ice feed rate. As soon as a hammer knock is heard, turn the dry ice feed rate back. In extreme cases break up the crust on the dry ice in the hopper using a wooden or plastic stick.

9. **Blocking:** Dry ice can also stop flowing to the nozzle if the nozzle freezes or the supply hose is twisted or squashed. This stops the dry ice being sucked out of the auger tube and gives the false impression that the blockage is in the auger tube. The blockage is quickly released by placing the open end of the blast nozzle tight[1] against a flat surface and pressing the blast trigger. This purges the dry ice out of the open end of the auger tube. It is important the area behind the auger tube is clear before taking this action.

   [1]**CAUTION:** If the older type blast hose is being used (Blue Silicone Ice Hose) the blast nozzle must be placed no closer than 1mm to the flat surface. The pressure rating for the silicone ice hose is much less than the latest ice hose and could blow off the end of the fitting if the nozzle is fully dammed.

   Note: Blocking is caused by WET compressed air.

APPENDIX F

GUIDELINES FOR HEARING PROTECTION

(Relevant laminated versions supplied loose under blaster lid)

Guidelines for Hearing Protection whilst using Low and High Pressure Blast Nozzles

Please note that the Setting up, Operating & Maintenance Instruction Manual supplied with the Blaster must be studied in detail and fully understood before using this equipment and these guidelines.

Each Blaster is supplied with a set of high attenuation earmuffs, type LM77, and several soft disposable Max earplugs.

To ensure that operators and all persons in the neighbourhood of the blaster are properly protected against the blast noise it is essential that both the soft earplugs and the ear muffs are worn. The soft earplugs should be inserted as shown on the packaging before putting on the earmuffs.

The combination LM77 muff and Max plugs have been certified to provide the attenuation figures given below which, subject to blaster background noise levels, should be sufficient to protect operators from blast noise. The use of other combinations with lesser attenuation values or the use of uncertified protection equipment is not recommended.

Hz	63	125	250	500	1K	2K	4K	8K	SUM
Blaster base level as measured *	85	80	82	91	101	112	120	122	124.3
Assumed protection Value**	28.5	28.3	32.3	41	42.6	36.3	49.2	40.3	
Final level	**56.5**	**51.7**	**49.7**	**50**	**58.4**	**75.7**	**70.8**	**81.7**	**82.5**

* Base level is the measured spectrum for a System 2000 Blaster with TV750/HP/00 Nozzle operating at 9 bar in a sound-insulated enclosure at 1 metre from nozzle exit.

** Assumed Protection Value is the Mean Attenuation, after deduction of Standard Deviation, provided in INSPEC Laboratories Ltd Report HP/94/29 on the attenuation achieved with LM77 muffs and Max plugs supplied by Howard Leight (Europe) Limited.

All figures are in dB except for summations which are in dB(A)

IMPORTANT NOTE:

Failure to comply with these guidelines may result in operators being exposed to higher than acceptable noise levels.

Users must by law ensure that all personnel able to hear the blast noise are adequately protected.