LN_2-BOX FREEZER
MAINTENANCE AND SERVICE MANUAL

CES-BF-LIN-11x12x20-S

CES Project Number:

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MANUAL FOR LN_2-BOX FREEZER

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1. INTRODUCTION

1.1 Purpose

The purpose of this manual is to inform the operator, the technical personnel and the responsible persons on all important technical and safety information about the CES Box Freezer.

1.2 Scope

Chapter 1 provides the reader with general information about the objective and content of the manual, and gives a brief overview of the company history and the activities, the abbreviations used in the manual as well as the most important addresses for the customer.

Chapter 2 gives an overview of the most important technical data. The working principle of the CES Box Freezer has been explained as well.

Chapter 3 emphasises all important nitrogen safety information. The possible dangers, precaution measures and first aid principles are explained here.

Chapter 4 describes all aspects of the unloading, transport and movement of the CES Box Freezer.

Chapter 5 provides the operator with the procedures required for the initial start-up and tune-up of the CES Box Freezer.

Chapter 6 describes all aspects which are important for a safe, correct and economical operation of the freezer.

Chapter 7 provides the cleaning personnel with safety guidelines and instructions for the proper cleaning and drying of the freezer.

Chapter 8 provides the "Technical Service" with the schedules required for daily, monthly and yearly maintenance of the freezer.

Chapter 9 contains information for the detection and correction of possible faults.

Chapter 10 describes how to adjust the most important components and parameters of the CES Box Freezer.

Chapter 11 provides the "Technical Service" with information about corrective maintenance.

Chapter 12 lists for the most important spare parts the plan number, identification number and the recommended quantity.

Appendix A contains the technical drawings with corresponding part list of the freezer and the most important parts.

Appendix B contains a list of all electrical parts which have been built into the Box Freezer. Electrical and pneumatic schematics have been included as well.

Appendix C provides the test report of the Box Freezer. It contains the data of the identification plate, additional technical data, the results of the warm/cold test as well as the specifications of the most important components of the freezer.

Appendix D contains additional safety information about liquid nitrogen (LN_2).

1.3 Company History and Activities

CES is a young and dynamic company created in 1988, specialized in the manufacture of a very wide range of cryogenic chilling and freezing equipment. CES is a totally independent manufacturer.

CES continuously develops new chilling and freezing equipment to cope with the continually changing requirements of the industry all over the world.

CES freezers are mainly used in the food industry. Examples of other application areas are the biological and pharmaceutical industry as well as the branch of the metal, rubber and plastic recycling.

CES is specialised in the design, development, manufacture, installation and maintenance of special cryogenic equipment and systems for the food processing industry which meet all the customer's specific needs.

CES's reputation has been built on quality products and an excellent customer service throughout all phases of the contract.

1.4 Abbreviations

LN_2: Liquid Nitrogen.

1.5 Important Addresses

If the problems cannot be solved directly by the "Technical Service" or the specially trained personnel of the gas company, a request for intervention can be directed to the manufacturer (CES) of the freezer:

CES Inc.
11959 Tramway Drive
Cincinnati, Ohio 45241
USA

Phone: 513-761-4200 Fax: 513-761-7222

2. GENERAL INFORMATION

2.1 Identification, Warranty and Certification

PLEASE, ALWAYS SPECIFY THE PROJECT NUMBER IN ALL YOUR CORRESPONDENCE, REQUESTS FOR SPARE PARTS OR INFORMATION.

IN CASE OF MODIFICATIONS ON THE FREEZER WITHOUT THE PRIOR WRITTEN PERMISSION OF CES, ANY FORM OF WARRANTY OR CERTIFICATION EXPIRES.

The CES freezer, if properly installed, maintained and used according to its instruction, meets the fundamental safety and health requirements of the Machine Directive.

2.2 Test Report and additional Technical Data

The test report in Appendix C contains the data of the identification plate as well as the most important technical data of the freezer. An overview of the most important components and their characteristics can be found there too.

2.3 Important Parameter Settings and Boundary Conditions

For a safe and correct operation of the freezer a number of parameters and boundary conditions have to be always properly set. See Table 2.1 on "Important parameter settings and boundary conditions" as well as the test report in Appendix C.

IMPORTANT PARAMETER SETTINGS/BOUNDARY CONDITIONS	
REQUIRED LN_2-SUPPLY PRESSURE:	20 -> 40psi
TEMPERATURE PRODUCTION AREA:	32 -> 90°F
HUMIDITY PRODUCTION AREA:	MAX. 90%

Table 2.1: Important parameter settings and boundary conditions

2.4 Concept and Working Principle

The CES Box Freezer has been designed to freeze food products without any loss of quality during the freezing process. The extreme low temperatures required for this operation are obtained by spraying liquid nitrogen -384.8°F (-196°C) onto the product. This ensures the product is completely frozen and in thermal equilibrium when leaving the freezer. Cryogenic freezing methods allow for excellent product quality and considerably shorter dwell times as compared to conventional methods.

The product may be loaded manually on product trolleys supplied by the customer, which are then put into the freezer.

To freeze the product liquid nitrogen is used as a consumable. While the product is in the freezer, a controlled amount of nitrogen is sprayed onto the product. The heat emanating from the product vaporises the liquid nitrogen.

The cold nitrogen gas -320°F (-195.5°C) resulting in this way is made to pass in convective heat transfer relationship with the product towards the exhaust system of the freezer. Recirculation fans over the entire height of the freezer ensure an efficient heat exchange between the product and the cold nitrogen gas.

Thanks to the gas flow principle a maximal heat exchange with the incoming product is achieved. The product will be chilled and frozen at the surface almost instantaneously. Normally the surface of the product is colder than the core. This is particularly true after the food product has passed the spray system. After a short time, however, thermal equilibrium is attained.

A PU or vacuum insulated transfer line transports the liquid nitrogen from the storage tank towards the freezer. Once the liquid nitrogen has passed the LN_2 solenoid valve, it enters the spray header/rings. The spray bars have been provided with a number of nozzles along the entire height of the Box Freezer. The size and number of nozzles has been chosen to assure optimal performance.

Depending upon the type of product (size/shape/weight/water content), the entrance temperature and the desired production rate, the amount of liquid nitrogen to be injected and/or the dwell time of the product in the freezer have to be adjusted. The temperature regulator on the control panel automatically regulates the amount of liquid nitrogen required for the freezing operation and keeps the temperature at the inside of the freezer quite constant. The temperature in the freezer is measured with a temperature sensor.

The performance of the CES Box Freezer for a given product depends on a number of variables, such as:

- the product residence time in the Box Freezer;
- the set point temperature of the freezer;
- the nozzles used (size);
- the LN_2-supply pressure;
- the number of nozzles installed and spray headers/rings used.

2.5 Safety Information

CES URGES EVERY OPERATOR/TECHNICIAN/RESPONSIBLE PERSON TO BECOME THOROUGHLY FAMILIAR WITH ALL THE MECHANICAL AND ELECTRICAL OPERATING CHARACTERISTICS OF THE BOX FREEZER. START TO READ CHAPTER 3 ON "NITROGEN-SAFETY INFORMATION"!

SAFETY GUIDELINES AND WARNINGS HAVE BEEN PRINTED IN BOLD. CRUCIAL SAFETY INFORMATION CAN BE FOUND AMONG OTHERS IN SECTION 2.6 ("SAFETY SIGNALS"), CHAPTER 3 ("NITROGEN SAFETY INFORMATION"), CHAPTER 4 ("UNLOADING AND INSTALLATION OF FREEZER"), CHAPTER 6 ("FREEZER OPERATION") AND CHAPTER 7 ("FREEZER CLEANING AND DRYING").

2.6 Safety Signals

Red, Orange and Green Visual Signals

The colours of all visual signals (signal beacon and lamps on control panel) have been chosen with regard to the information to be imparted. Consult also section 6.3 on "Freezer Operation and Signals" for an overview of when which signal lamp will be activated.

Colour	COLOUR CODING OF MACHINE DIRECTIVE		
	Safety of Persons	**Condition of Equipment**	**State of Equipment**
Red	Danger	Emergency	No General Meaning
Yellow (Orange)	Caution	Abnormal	No General Meaning
Green	Safe	Normal	No General Meaning

2.6.1 Audible Signals

A horn provide an audible signal whenever an unsafe (red warning light) situation occurs. Consult also section 6.3 on "Freezer Operation and Signals" for an overview of when the horn will be activated.

3. NITROGEN SAFETY INFORMATION

3.1 What is Nitrogen?

Nitrogen is of essential importance for the survival of all living creatures. The atmosphere of the earth at sea level is composed of about 78% nitrogen, 21% oxygen and about 1% of other gases. Although, the human body needs the nitrogen in the air, a too high concentration may lead to very dangerous situations.

Cold nitrogen vapour is slightly heavier than air and therefore tends to settle near the floor. Without good ventilation and proper tuning/functioning of the exhaust system, nitrogen will build-up from the floor and displace the oxygen in the air. See also section 3.3 on "Possible Danger".

3.2 Properties of Nitrogen

Nitrogen at atmospheric temperature and pressure is a colourless, odourless, tasteless and invisible gas and therefore is particularly dangerous for human beings. Cold nitrogen may be visible due to the condensation of the humidity in the air. Nitrogen has a boiling point of -196°C (-384.8°F) at atmospheric pressure. The most important properties have been summarised in Table 3.1.

Property	Characteristics
Molecular weight	28
Melting Point	-210 °C (-410°F)
Boiling Point	-196 °C (-384.8°F)
Critical Temperature	-147 °C (-296.6°F)
Relative Density, Gas	0.97 (air=1)
Relative Density, Liquid	0.8 (water=1)
Appearance, Liquid	colourless, transparent
Appearance, Gas	Colourless, odourless, tasteless, invisible.

Table 3.1: Physical and chemical properties of nitrogen

3.3 Possible Danger

Thoroughly inform all personnel about the potential hazards related to the use of liquid nitrogen in freezers!

3.3.1 Oxygen Deficiency due to Air Displacement

Assume nitrogen were allowed to flow continuously into a non-ventilated room. The nitrogen concentration will become so high all oxygen necessary for breathing will have disappeared. Personnel entering the room would become dizzy, unconscious and would quickly suffocate.

EXPOSURE TO AIR CONTAINING LESS THAN 12% OF OXYGEN WILL LEAD TO UNCONSCIOUSNESS WITHOUT ANY WARNING AND SO QUICKLY THAT THE INDIVIDUAL EVEN CANNOT HELP HIMSELF.

OXYGEN CONCENTRATIONS IN THE AMBIENT AIR (I.E. FREEZER AREA) SHOULD ALWAYS BE HIGHER THAN 19% (LEGAL LIMIT).

The user shall make sure that a safe working environment is guaranteed (see also section 3.4 on "Nitrogen Safety Guidelines") and that all personnel is informed about the potential hazards related to the use of nitrogen in freezers.

3.3.2 Cold Burns

The CES freezer has been specially designed to enclose and/or insulate cold surfaces. By accidental damage (e.g. supply line) liquid nitrogen may leak out of the freezer. Contact with liquid nitrogen or a jet of cold gas will lead to severe burns.

The surface of the product leaving the freezer is extremely cold. Only touch the product with sufficient protection (see also section 3.4 on "Nitrogen Safety Guidelines"). This also applies to the internal surfaces of the freezer when just opened.

DO NOT TOUCH LIQUID NITROGEN, COLD SURFACES (E.G. SUPPLY LINES) OR FROZEN PRODUCT WITH BARE HANDS! NEVER PLAY AROUND WITH LIQUID NITROGEN.

3.3.3 High Pressure Injury

Exposure to liquid nitrogen or gas jets may lead to severe injury (potential or kinetic energy).

PAY SPECIAL ATTENTION TO NITROGEN PIPING AS FOR THOSE FOR COMPRESSED AIR OR STEAM.

Always make sure not to keep liquid nitrogen trapped in a line. When warming up the nitrogen evaporates causing the pressure in the piping to increase strongly. Unless the gas (liquid) can bleed back into the nitrogen tank or out a safety relief valve, it may burst the line.

3.4 Nitrogen Safety Guidelines

Respect all nitrogen safety guidelines and thus assure the safety of all personnel (operation, cleaning, maintenance, etc.) of the freezer.

3.4.1 Oxygen Deficiency

Avoid too high nitrogen concentrations. Therefore take the following precaution measures (safety measures):

- Check continuously the oxygen concentration at the most critical locations. Position for this an O_2-meter near the entrance/exit of the freezer and at a height of 1m above the ground. See also section 3.6 on "Detection of Nitrogen".

- Ensure proper mechanical ventilation of the production area.

- For an optimal operation a small amount of nitrogen vapour should come out of the freezer. Keep this amount to the required minimum.

    - Check that the exhaust installation is on and functioning effectively during the start-up of and when operating with the freezer.

    - Verify that all liquid and vapour from the overpressure protections are piped out.

MAKE SURE VENTING IS TO AN OUT-DOOR LOCATION. PROPERLY SIZE DUCTING.

Avoid working near the floor when the freezer is working. Cold nitrogen will gradually build-up from the floor.

When entering an area of high nitrogen concentration is necessary:

- Always wear an oxygen mask with an independent source of supply.

- Provide emergency rescue personnel in stand-by.

3.4.2 Cold Burns

Always wear thick dry insulated gloves if contact with frozen surfaces or food is necessary.

Protect eyes, face and skin if contact with liquid nitrogen droplets or cold gas is possible.

3.4.3 High Pressure Jets

- Always provide pressure relief valves if nitrogen can accumulate in the lines.

- Only use piping and valves according to their destination.

- Always open valves slowly in case of a leak downstream.

- Know where the shut-off valves are if an emergency situation would occur.

3.5 First Aid

3.5.1 Inhalation

If the victim is unconscious:

- move the person immediately to a safe area;
- call for a doctor immediately;
- give artificial respiration if breathing stops (has stopped);
- keep the victim warm and quiet.

In case of cold sweat, rapid breathing or dizziness, leave the area with high nitrogen concentrations immediately.

Evacuate all personnel which may be exposed to enhanced nitrogen concentrations.

3.5.2 Eye/Skin Contact

Do not waste time and run immediately to a nearby shower or other water source to bath the injury. Preferably use water at body temperature. Turn on only a moderate water flow. **Never use a fire extinguisher as a water source.** Call immediately for medical assistance.

Contact with Eyes

Rinse the eyes thoroughly with water for at least 15 minutes.

Contact with Skin

Bath the injury in water for at least 15 minutes. **Do not rub the cold burn.** Use aseptic gauze. Treat as for normal burns.

3.6 Detection of Nitrogen

Under normal circumstances nitrogen is an odourless, tasteless and invisible gas. Only when large amounts of cold nitrogen gas get in contact with humid air nitrogen vapour may become visible as (water) vapour.

Too high concentrations of nitrogen may (if not too late!) be observed through lack of oxygen symptoms, i.e.:

- cold sweat;
- rapid breathing;

- loss of consciousness;
- dizziness.

Guarantee sufficient safety for the personnel and install an oxygen sensor on the wall (and at 1m from the ground) of the production area.

If for one or the other reason the nitrogen concentration should raise in the freezer area, the oxygen sensor will detect the decrease of oxygen in the ambient air. Give an alarm signal as soon as the limit of 19% is crossed.

3.7 Warning Signals

Post the following warning sign in all areas (particularly in the production area) where enhanced nitrogen concentration is possible:

CAUTION

Liquid nitrogen and/or nitrogen gas may come out of the equipment.

Always make sure the production area is properly vented.

Never touch liquid nitrogen -608°F(-320°C), cold surfaces or frozen products with bare hands (frost bite).

Do not render safety devices inoperative.

Figure 3.1: Nitrogen safety sign

4. UNLOADING AND INSTALLATION OF FREEZER

4.1 Introduction

This chapter provides the customer with instructions to ensure proper unloading and installation of the CES Box Freezer at the customer's premises.

THE CUSTOMER SHOULD MAKE HIMSELF FAMILIAR WITH THE VARIOUS UNLOADING AND INSTALLATION PROCEDURES TO PREVENT DAMAGE TO HIS FREEZER THROUGH IMPROPER HANDLING.

PRIOR TO UNLOADING, CHECK THE TRAJECTORY FROM THE UNLOADING TO THE INSTALLATION AREA FOR POSSIBLE HINDRANCES. CHECK THE AVAILABILITY OF SUPPLY CONNECTIONS AND OTHER INTERFACES.

4.2 Preparation for Reception and Unloading

4.2.1 Trajectory Requirements

Carefully investigate the trajectory to the installation area with respect to possible hindrances, and this prior to trailer unloading.

Pay attention to:

- the height and width of doorways on the path to the installation area;
- the height and width of the various corridors. Be sure to account for obstructions such as light armatures, ramps, overhangs, ducting, cupboards, shelves, etc.

Assure feasibility of freezer transportation by comparing measured values with overall freezer dimensions. Correct for the size of the transportation means used.

Determine the most suitable freezer orientation to pass through all "bottle necks" and to assure correct orientation at final in-plant location.

4.2.2 Preparation for Supply Connections

Allow for hook-up of the freezer by providing in advance the following in the production area:

- electrical conduit and connection points;

- LN_2-supply piping and corresponding connection;
- provisions for proper installation and connection of the exhaust installation;
- inclined floor with floor drains as required for the drainage of the cleaning water.

TO EASE PRODUCT HANDLING THE BOTTOM PLATE OF THE FREEZER HAS BEEN INSULATED ONLY TO A LIMITED EXTEND. PUT THE FREEZER ON AN INSULATED FLOOR PLATE TO AVOID ICE BUILD-UP UNDER THE FREEZER AND TO PREVENT THE FLOOR FROM FREEZING UP.

Take measures well prior to installation. Take into account the restrictions as provided in section 2.2 on "Test report and additional Technical Data" when designing and installing the connection points.

Make sure the electrical conduit and LN_2-supply piping are sufficiently well protected against accidental damage. Make the LN_2-transfer line as short and direct as possible to minimise LN_2-consumption. Minimise the number of elbows.

All installations shall be performed by technical personnel. Conduit and wiring shall be installed by a certified electrician and in accordance to the local codes and regulations.

4.2.3 Space Requirements

Check the space available at the installation area against the relevant freezer dimensions.

- allow for sufficient space around the freezer for normal traffic;
- make sure the freezer is accessible in case of emergency;
- provide sufficient clearance for all pivoting parts (e.g. doors).

Peculiarities about overall freezer dimensions, infeed height, exit height, etc. can be found in Appendix C on "Test Report". Use these data to adjust the height of the freezer and/or processing line equipment.

4.2.4 Required Handling Equipment

Use forklifts or a crane with lifting chains of sufficient strength to lift and unload the freezer. Timber wood and straps are required if lifting is with a forklift.

On-site transportation towards and positioning in the production area can be achieved in a number of ways, depending on the equipment available. It is recommended that only pallet trucks, industrial rollers or forklift trucks will be used. Timber wood and straps are required if lifting is with a forklift.

Make sure suitable equipment is available to keep the parts in position during on-site transportation.

4.3 Inspection at Delivery

Visually inspect the freezer for dents, distortion, folding, etc. and other transport damage. Contact CES immediately if the freezer is found damaged.

Check the packaging list to make sure that all separately packed items (exhaust, spare parts, bolts, etc.) have been received. Contact CES immediately in case of incompleteness or damage.

4.4 Unloading of Freezer

Professional riggers are recommended for freezer unloading. Riggers generally have all the right equipment to unload the freezer and move it into the desired location in minimum time. The following instructions are provided in case professional riggers are not available, or if plant personnel is selected to do the job.

Freezers are shipped in trucks and held in place with timber blocks and/or straps. Use timber wood to prevent the freezer from accidental damage during unloading and on-site transportation.

For safety reasons the freezer should be unloaded preferably with a crane.

Unloading with Crane

Make sure that the total weight of the freezer does not exceed the maximum allowed load of the crane or lifting chains. Check the stability of the configuration during the lifting operation.

1. Remove the timber blocks and straps used to hold the freezer in position during the transport. Make sure the freezer doesn't slide off the trailer accidentally.

2. Attach the lifting chains only at the positions as indicated (see also technical drawing in Appendix A.2 on "Lifting Plan"). Do not lift the machine in any other way.

3. Lift the freezer and drive the truck from under the freezer. Put it on the ground for forklift transport or position it directly on industrial rollers.

Unloading with Forklift

Make sure that the total weight of the freezer does not exceed the maximum allowed load of the forklift. Check the stability of the configuration during the lifting operation.

1. Remove the timber blocks and straps used to hold the freezer in position during the transport. Make sure the freezer doesn't slide off the trailer accidentally.

2. Move the forks gently under the freezer. Make sure that the forks extend beyond the entire depth of the Box Freezer. If not the case, use then a crane or let professional riggers unload.

3. Use lifting straps to fix the freezer to the forklift. Take care the lifting straps do not snag directly on the sides, electrical conduits or electrical enclosure of the freezer. This can pinch or even crush the freezer causing severe damage.

4. Lift the freezer and drive the truck from under the freezer. Put it on the ground for forklift transport or position it directly on industrial rollers.

4.5 On-Site Transport and Positioning

To move the freezer from the unloading area to the installation area it may be lifted, transported horizontally and/or moved on inclines. Note the following:

4.5.1 Lifting of Freezer

The Box Freezer can be lifted either by means of a crane or forklifts. Lifting should be preferably with a crane.

Lifting with Crane

Make sure that the total weight of the freezer does not exceed the maximum allowed load of the crane or lifting chains.

Take care when positioning the lifting chains. See also technical drawings in Appendix A.2 on "Lifting Plan".

ONLY USE LIFTING CHAINS OF SUFFICIENT STRENGTH AND ONLY IN THOSE POSITIONS WHICH HAVE BEEN INDICATED. DO NOT LIFT THE FREEZER IN ANY OTHER WAY. MAKE SURE THEY DO NOT SNAG ON THE PANELS, MOTORS, ETC.

Lifting with Forklift

Lifting with forklifts is allowed to position the freezer on industrial rollers. Pay attention to the following:

LIFT THE BOX FREEZER WITH FORKLIFTS NEVER HIGHER THAN 500 MM.(19”) CHECK THE STABILITY BEFORE STARTING THE TRANSPORT.

Move the forks gently under the freezer. Make sure that the forks extend beyond the entire depth of the Box Freezer to avoid damaging the bottom. If the forks are not sufficiently long, then place timber wood on the forks.

MAKE SURE THAT THE WEIGHT OF THE BOX FREEZER DOES

NOT EXCEED THE MAXIMUM ALLOWED LOAD OF THE FORKLIFTS.

Lift the freezer gradually and check the balance before stating the transport. Make sure the fork tips are tilted up to prevent the freezer from sliding off.

WHEN DRIVING DOWN ON INCLINES IT MAY BE NECESSARY TO TILT THE FORKS FURTHER BACK TO PREVENT THE FREEZER FROM SLIDING OFF.

4.5.2 Horizontal Transport of Freezer

Once unloaded on the ground, lift the freezer again with a crane (and chains) and put it on industrial rollers. Always make sure that the weight of the freezer doesn't exceed the maximum allowed load of the crane or chains.

Push gently the load to the installation area by means of a forklift. Use timber wood to protect the freezer from damage.

If forklifts are used, carefully move the forks into position, secure the straps around the frame and then begin moving the freezer. Always make sure that the forks extend beyond the entire depth of the freezer to prevent ramming protruding hardware.

4.5.3 Positioning of Freezer

For small position changes a crane or a couple of forklifts should be used.

NEVER PUSH NOR PULL THE FREEZER WHEN POSITIONED DIRECTLY ON THE GROUND.

4.5.4 Moving the Freezer on Inclines

When transporting the freezer up a ramp or incline, forward movement is easier when pulling rather than pushing. Take care for unexpected movements.

4.6 Levelling

Correct levelling of the freezer is of great importance for a correct, economical and efficient operation of the installation. It:

- allows to drive the product trolleys easily into the freezer;
- avoids unnecessary mechanical strain in the freezer structure.

Levelling in cross direction

Level the freezer in the cross direction first. Place a level across the Box Freezer. Adjust the height with straps until the freezer stands completely horizontal in this direction.

Levelling in longitudinal direction

Level the freezer in the longitudinal direction subsequently. Place a level across the Box Freezer. Adjust the height with straps until the freezer stands completely horizontal in this direction.

4.7 Supply Connections

4.7.1 Electrical Connections

All electrical supply connections to the freezer shall be three phase, with neutral and protective conductor. The installation must be compliant with the applicable safety regulations.

THE MAIN ISOLATOR SWITCH CUTS ALL POWER TO THE FREEZER, INCLUSIVE THAT FOR THE CONTROL FUNCTIONS.

ALWAYS MAKE SURE THAT THE MAIN POWER TERMINALS ON THE FREEZER ARE COVERED COMPLETELY WITH A SHIELD. THEY REMAIN UNDER TENSION, EVEN IF THE MAIN ISOLATOR OF THE FREEZER HAS BEEN SWITCHED OFF.

Connect the freezer as follows:

1. Make sure the plant power (!!!) has been disconnected.

2. Install the main power cable through a hole (customer placed) in the electrical enclosure.

3. Connect the power cable, i.e. all three phases and the neutral conductor.

4. Make sure the freezer is ready for testing. Check if all shipping material and tools have been removed from the freezer.

5. Switch on the main power (main switch).

   The freezer has been factory tested. The rotating direction of all motors has been checked.

6. Start the recirculation fans of the Box Freezer for approximately 2 seconds. This should be sufficient to check if the recirculation fans are running in the right direction.

   If the recirculation fans rotate the other way around, stop the recirculation fans immediately. Disconnect the plant (!!!) power and switch the wires of the terminals L1 and L2.

Automatically all motors will rotate in the right direction.

7. Check the tightness of all electrical wiring connections inside the electrical enclosure.

4.7.2 Connection of LN_2-Supply

For operation, the freezer requires a source of liquid nitrogen from a storage tank. The LN_2-supply piping connects the storage tank with the LN_2-injection system of the freezer.

Safety Aspects

Contact the gas company for all piping towards the freezer and the safety related aspects.

The LN_2-injection system of the freezer has been provided, if necessary, with a pressure relief valve to prevent liquid nitrogen from being trapped in between closed valves which may burst the piping.

Take the following into account:

THE LN_2-SUPPLY CONNECTION SHOULD BE PROVIDED WITH A SAFETY VALVE AT VESSEL LOCATION TO PREVENT LIQUID NITROGEN FROM BEING TRAPPED BETWEEN THE SUPPLY VALVE AT THE TANK AND THE SHUT-OFF VALVE ON THE FREEZER.

DO NOT INSTALL ANY ADDITIONAL MANUAL SHUT-OFF VALVES BETWEEN THE VALVE AT THE STORAGE TANK AND THE CONNECTION TO THE FREEZER. ADDITIONAL VALVES WILL MAKE THE SAFETY SYSTEM INEFFECTIVE.

MAKE SURE ALL THE FREEZER ROOM VENTILATION SYSTEMS ARE PROPERLY WORKING.

Connection of LN_2-Supply

Insulate all LN_2-supply piping up to the connection at the freezer to ensure an efficient and economical operation.

When installing the LN_2-supply connection the following should be performed:

1. Blow out the LN_2-supply lines before final hook-up to the freezer.

2. Open the main valve at the storage tank slowly. Purge the LN_2-lines for approximately 30

seconds, then close the main valve.

4.7.3 Installation of Exhaust System

The exhaust system, if properly installed and tuned, will ensure an efficient removal of all superfluous nitrogen gas.

IT IS ESSENTIAL THAT THE ROOM IN WHICH THE FREEZER WILL BE INSTALLED SHALL BE LARGE ENOUGH AND HAVE SUFFICIENT AIR CHANGES, PREFERABLY WITH HIGH AND LOW LEVEL VENTILATION, TO PREVENT A BUILD-UP OF NITROGEN GAS IN CASE OF ACCIDENTAL SPILLAGE OR MALFUNCTIONING OF THE EQUIPMENT.

Installation

Note the following when installing the exhaust system:

- Design the exhaust ducting to facilitate cleaning and inspection. Use stainless steel.
- Make sure the supply of false air in the production area is adequate. This will allow for proper exhaust system performance and reduce negative pressure in the production area.
- Protect the exit of the exhaust system against bad weather conditions and/or birds. Mount for this purpose protective screens and/or grids.
- Try to keep the length of the exhaust ducting and the number of turns to an absolute minimum.
- Never install a flow regulation system directly in the main duct (ice build-up).

THE EXHAUST SYSTEM HAS TO BE SIZED FOR THE GOVERNING AMBIENT AND OPERATING CONDITIONS OF THE FREEZER.

5. INITIAL START-UP AND TUNE-UP OF FREEZER

The Box Freezer has been factory tested before delivery. All effort has been made to simulate the operating conditions when testing and calibrating the freezer. However, operating conditions may vary once the Box Freezer has been installed, therefore requiring fine-tuning of the equipment.

The guidelines presented here should help during initial start-up/tune-up of the freezer.

MAKE SURE ALL PERSONNEL IS FAMILIAR WITH THE NITROGEN-SAFETY GUIDELINES AS PROVIDED IN CHAPTER 3.

NITROGEN CONCENTRATIONS AT FLOOR LEVEL ARE CONSIDERABLY HIGHER THAN AT NORMAL WORKING LEVEL. AVOID PERSONNEL WORKING AT OR NEAR FLOOR LEVEL DURING FREEZER OPERATION.

CHECK-LIST FOR INITIAL START-UP/TUNE-UP OF BOX FREEZER

1. Verify that all packaging material and tools have been removed from the freezer (inside and outside).

2. Verify that all electrical, LN_2 and exhaust connections have been made according to the guidelines provided in section 4.7 on "Supply Connections".

3. Clean the Box Freezer thoroughly, prior to the initial start-up. See also section 7.3 on "Cleaning procedure".

   If additional drying is desired, consult then section 7.4 on "Drying of freezer".

4. Normally, the Box Freezer should shut down after cleaning and drying and in open position.

5. Switch on the main power with the main switch.

6. Perform a lamp test to verify they all light up. Press the button "LAMP TEST" on the control panel for this purpose. Also check the correct functioning of lights on the control panel when they are activated (option).

7. Check that all proximity switches (Box Freezer open/ closed) are properly working.

8. Make sure all parts, components and accessories are in position. Check in particular if the protection plates (recirculation fans) have been fixed and are in the right position.

9. Press the button "RESET" on the control panel to reset the Box Freezer. Verify that the light of the reset-button extinguishes. If not the case, check if emergency stops and/or proximity

switches have not been activated.

10. Close the door(s) of the freezer.

11. Set the temperature of the temperature controller to 32°F (manual operation). See also 6.3.3 on "Parameter Setting".

12. Check if the gauges of the LN_2-supply pressure (left) and the LN_2-injection pressure (right) indicate 0 bar (option).

13. Open the main shut-off valve of the LN_2-supply at the storage tank.

14. Verify that all manual shut-off valves of the LN_2-injection system have been opened completely.

15. Adjust the set point of the temperature controller to 20°F below the actual temperature in the freezer. See also 6.3.3 on "Parameter Setting".

    Check if the actual opening (on/off) of the solenoid valves corresponds to the programmed value.

16. Press the button "START FREEZING" at the control panel to start the freezer (the recirculation fans and the injection of liquid nitrogen). Check if the corresponding white light on the control panel is ON (option).

MAKE SURE THE EXHAUST (GAS REMOVAL) SYSTEM IS PROPERLY WORKING, PRIOR TO INITIAL COOL-DOWN.

The LN_2-solenoid valves have been interlocked electrically to prevent injection of liquid nitrogen if the recirculation fans are not working.

Visually check the end exhaust assemblies to ensure nothing is obstructing the nitrogen vapor removal.

If large amounts of nitrogen vapor are blown out of the freezer, press the buttons "STOP FREEZER" to stop the LN_2-supply immediately. Start the procedure from the very beginning or call for assistance.

17. At the end of the freezing cycle and when opening the door the exhaust fan (option) is running during an adjustable time. Check if the corresponding white light on the control panel is ON (option).

    Check if the exhaust flow is OK. Adjust the exhaust flow to mid-range. See also 6.3.3 on "Parameter Setting".

MAKE SURE THE EXHAUST (GAS REMOVAL) SYSTEM IS

PROPERLY WORKING.

Visually check the end exhaust assemblies to ensure nothing is obstructing the nitrogen vapor removal.

If large amounts of nitrogen vapor are blown out of the freezer, press the buttons "STOP FREEZER" to stop the LN_2-supply immediately. Start the procedure from the very beginning or call for assistance.

18. Verify on the corresponding gauges (option) that:

    a. the LN_2-supply pressure is in between 2 and 3 bars (option);
    b. the LN_2-injection pressure is indicated and lower than the LN_2-supply pressure.

19. Check the LN_2-solenoid valves (Magnatrol).

    a. Set the temperature controller set point to +100°F or the maximum value.
    b. Check that the solenoid valves (on/off) are fully closed. The LN_2-injection pressure on the gauge should be 0 bars.(option)
    c. Adjust the set point of the temperature controller to 20°F below the actual temperature in freezer. Check if the real opening of the solenoid valves (on/off) corresponds to the programmed value.

20. Lower the set point of the temperature controller by increments of 20°F until the final test temperature (-60°F) has been reached.

    Allow the temperature to stabilize for approximately 3 minutes between subsequent adjustments.

    Run the freezer at the test temperature (-60°F) for at least half an hour prior to the actual production run, to check for any leaks or other problems.

21. After half an hour of cold running at the final temperature (-60°F), check the following aspects:
    - check for any unusual noise;
    - make sure the freezer (recirculation fans, etc.) is running smoothly;
    - verify that all gauges are properly working (option);
    - check that there is no liquid nitrogen leaking out of the freezer;
    - check the LN_2-injection system and the supply lines for leaks;
    - check that all motors are running;
    - verify that all temperature sensors are properly working.

    Refer to chapter 9 on "Fault finding" to solve unexpected problems. Consult the control panel for more information with regard to the type of failure (system and control errors).

22. Shut down the Box Freezer as described in section 6.10 on "Freezer Shut-down".

6. FREEZER OPERATION

This chapter describes the most relevant aspects to be kept in mind for a safe, correct and economical operation of the freezer.

THE BOX FREEZER HAS BEEN DESIGNED TO OPERATE IN AS SAFE A MANNER AS POSSIBLE.

IT IS EMPHASIZED THAT THE ROOM IN WHICH THE FREEZER WILL BE INSTALLED SHALL BE LARGE ENOUGH AND HAVE SUFFICIENT AIR CHANGES, PREFERABLY WITH HIGH AND LOW LEVEL VENTILATION, TO PREVENT A BUILD-UP OF NITROGEN GAS IN CASE OF ACCIDENTAL SPILLAGE OR MALFUNCTIONING OF THE EQUIPMENT. AN O_2 SENSOR WITH ALARM FUNCTION IS STRONGLY RECOMMENDED.

THE FREEZER DESCRIBED IN THIS MANUAL CAN ONLY BE USED FOR FREEZING OF FOOD PRODUCTS AND HAS TO BE OPERATED ACCORDING TO THE INSTRUCTIONS AS PROVIDED IN THIS MANUAL.

6.1 General Guidelines

Ensure the safety of operating personnel and avoid damage to your freezing equipment by considering the following guidelines:

1. Always check the exhaust system for proper functioning before starting the injection of liquid nitrogen.

2. Avoid stopping the recirculation fans during the freezing cycle. The installation will freeze up.

3. Always make sure the protection plates (recirculation fans) are in the right position before starting the freezer.

4. Never reach inside the freezer when it is running. Severe body injury can result.

5. Operating the freezer below -150°F will adversely affect the freezer performance, the efficiency as well as the operational life time.

6. Lower the set point temperature never by more than 20°F. Allow the freezer temperature to stabilize for at least 3 minutes (idle running) before making further adjustments.

7. Lower the set point temperature only in small steps during production. Wait long enough

before further adjusting the set point.

8. Never leave the freezer unattended when it is running.

9. Never wear loose clothing (e.g. open work coats, loose strings, scarf's, etc.) in the neighborhood of moving mechanical parts (e.g. recirculation fans, etc.). This can result in severe body injury.

10. Never get in touch with liquid nitrogen or frozen product with bare hands. Both are extremely cold and can cause cold burns.

11. Never touch internal freezer components with bare hands while cold. The skin may freeze up and result in cold burn.

CONSULT CHAPTER 3 ON "NITROGEN SAFETY INFORMATION".

NITROGEN CONCENTRATIONS AT FLOOR LEVEL ARE CONSIDERABLY HIGHER THAN THOSE AT NORMAL WORKING LEVEL. AVOID PERSONNEL WORKING AT OR NEAR FLOOR LEVEL AT ANY TIME DURING FREEZER OPERATION.

6.2 Daily Inspection List

At the beginning of each working day the operator of the freezer should run through the following to make sure the freezer is ready for full production.

The few minutes required to run through this list may prevent unscheduled shut-downs or damage if the freezer due to lack of attention.

Consider this list as a guide. The operating conditions may vary making more frequent and more complete inspection necessary.

INSPECTION LIST PRIOR TO COOL DOWN

1. Perform a lamp test to check if all lamps of the control panel (option) and the light beacon are working correctly. Check also the horn.

2. Verify that the door of the freezer is closed.

3. Check if the cryogenic seals of the freezer are still in good condition.

4. Check the exhaust system for proper functioning and ventilation (option).

5. Verify that all recirculation fans are running smoothly.

6. Check proper functioning of all temperature sensors (temperature regulation, minimum temperature, product temperature (option), exhaust temperature (option)).

7. Verify that all subsystems are in position. Check in particular the protection plates (recirculation fans).

INSPECTION LIST AFTER COOL DOWN

8. Cool down the freezer. Verify that the automatic operating system is holding the set point value.

9. Verify smooth operation of the drive systems. Check in particular the recirculation fans.

10. Inspect all gauges: LN_2-supply pressure and LN_2-injection pressure (option).

11. Check the complete freezer system (seals, LN_2-injection system, etc.) for leaks. Verify that no liquid nitrogen is coming out of the freezer.

12. Check if the product is emerging properly from the freezer.

13. Check the freezer for damage or any abnormalities.

6.3 Freezer Operation and Signals

6.3.1 Safety Functions

The table below provides a functional overview of the visual and auditive safety signals as incorporated in the system. See also section 6.10 on "Operator Trouble Shooting Guide" for more information and corrective actions to be taken.

OVERVIEW SAFETY FUNCTIONS		
Problem	**Horn**	**Lamps on Control Panel**
Emergency stop activated	On.	-
O_2-alarm (option)	On.	-
Opening door during freezing cycle	On.	-
Door not closed when starting	On.	-
Failure fans	On.	- Fault Fans: red.
Minimum temperature	On.	- Min. Temp.: red.
Wire rupture temperature sensor minimum temperature	On.	- Min. Temp.: red.
Wire rupture temperature sensor set point	On.	-
Cycle running	-	-
End cycle	On.	- End of cycle : blue
Normal operation.	-	- Activated systems: white/green.

The white lamps (push buttons) on the control panel are burning if the corresponding freezer sub-

systems are properly working. Red lamps indicate a failure or abnormal situation occurred. See also table "Overview of Safety Functions" and section 6.3.2 on "Function Buttons and Control Lamps" for the specific meaning of the various control lamps (option).
Whenever an emergency stop has been activated, the illuminated button "RESET" has to be pushed to continue with normal operation. Check if the corresponding control light extinguishes.

6.3.2 Function Buttons and Control Lamps

See electrical schematic in appendix B.1 on "Electrical Schematic" for an overview of the control panel of the Box Freezer.

EXHAUST FAN (OPTION)

Push Buttons to Start and Stop the Exhaust Fan

Start Exhaust: Push button to start the exhaust fan.
Stop Exhaust: Push button to stop the exhaust fan.

Indicator Lights of Exhaust Fan

(Exhaust working): Indicates that the exhaust fan is running (white control light);
Fault Exhaust: Indicates that the motor of the exhaust fan has been overloaded (red alarm light).

FREEZER (RECIRCULATION FANS AND LN_2-INJECTION SYSTEM)

Push Buttons to Start and Stop the Freezing (Recirculation Fans and LN_2-Injection)

Start Freezing: Push button to start the freezer (recirculation fans and LN_2-injection).
Stop Freezing: Push button to stop the freezer (recirculation fans and LN_2-injection).

Indicator Lights of Freezing

(Freezing working): Indicates that the freezing cycle has been stated (white control light).

Indicator Lights of Recirculation Fans

Fault Fans: Indicates that the recirculation fans have been overloaded (red alarm light).

Indicator Light for Minimum Temperature

Min. Temp.: Red alarm light, lighting up if the temperature of the temperature sensor for minimum temperature drops below the set point value.

LAMP TEST

Push Button for Lamp Test

Lamp Test: Push button to check if all lamps (not functions!) on the control panel are properly working.

RESET

Push Button for Reset

Reset: Push button to be used for general start-up or when an emergency stop has been activated.

TEMPERATURE CONTROLLER

Display of Temperature Controller

Temp. Controller: Read-out indicating the set point temperature and actual temperature in the freezer.

Control Lamps

The white (green) lamps on the control panel light up if the corresponding components of the freezer are functioning correctly (option). See also section 6.3.1 on "Safety Functions" for the meaning of the red control lamps (option).

6.3.3 Parameter Setting

Adjustment of Exhaust Flow (Option)

Adjustment of the exhaust flow rate is possible by varying the time the exhaust fan will be activated. Further adjustment of the exhaust flow rate can be obtained by regulating the position of the manual handle (option) of the exhaust system.

Adjustment of Residence Time

Adjustment of the product residence time is possible by varying the setting of the timer on the control panel.

Adjustment of Temperature

Modify the set point temperature of the freezer as follows:

Modify the temperature setpoint by simply pressing the up and down arrow buttons to arrive at the desired temperature setting.

Note: For safety reasons the temperature range has been limited at the lower end.

Adjustment of Pulse-Pause-Setting

Modify the pulse-pause-setting of the freezer as follows:

1. Turn the main switch into the "on" position.
2. Press and hold the up and down buttons simultaneously.
3. Press the advance button to move through the parameter prompts until you reach parameter "Ftb2". This parameter controls the duration of one on/off cycle.
4. Press and hold the up and down buttons to change the parameter value.
5. Press the advance button to move through the parameter prompts until you reach parameter "Ftb2". This parameter controls the percentage of the "on" portion of the cycle.
6. Press the infinity button to go back to the main menu.

6.4 Normal Freezer Start-Up

The manual valve of the LN_2-supply at the storage tank will be normally closed at the end of each working day.

CHECK-LIST FOR MANUAL START-UP

1. Open the manual shut-off valve (main valve) of the LN_2-supply at the storage tank.
2. Check if there is still enough liquid nitrogen in the storage tank and if the pressure is adequate (pressure 2-3 bars).
3. Make sure that the Box Freezer is free of tools or any other objects.
4. Check if the freezer is completely clean and dry prior to cool down. If not the case, consult chapter 7 on "Freezer Cleaning and Drying".

ONLY START FREEZING IF THE FREEZER IS COMPLETELY DRY AND CLEAN! OTHERWISE YOUR FREEZER WILL BE PERMANENTLY DAMAGED.

5. Turn the main power switch at the side of the electrical enclosure into the "ON" position.

6. Make sure all parts, components and accessories are in position. Check in particular if the protection plates (recirculation fans) are in the right position.

7. Press the button "RESET" on the control panel to reset the Box Freezer. Verify that the light of the reset-button extinguishes. If not the case, check if emergency stops and/or proximity switches have not been activated.

8. Put the product into the freezer and close the door(s) of the freezer.

9. Set the set point of the temperature controller to 20°F under the real temperature in the freezer (manual operation). See also 6.3.3 on "Parameter Setting".

10. Set the residence time of the product in the freezer to the desired value (manual operation). See also 6.3.3 on "Parameter Setting".

11. Press the button "START FREEZING" at the control panel to start the freezer (the recirculation fans and the injection of liquid nitrogen). This starts the freezer cool-down process. Check if the corresponding white light on the control panel is ON (option).

MAKE SURE THE EXHAUST (GAS REMOVAL) SYSTEM IS PROPERLY WORKING, PRIOR TO INITIAL COOL-DOWN.

THE LN_2-SOLENOID VALVES HAVE BEEN INTERLOCKED ELECTRICALLY WITH THE RECIRCULATION FANS TO PREVENT INJECTION OF LIQUID NITROGEN IN CASE THE RECIRCULATION FANS ARE NOT WORKING.

Visually check the end exhaust assemblies to ensure nothing is obstructing the nitrogen vapor removal.

If large amounts of nitrogen vapor are blown out of the freezer, then press the buttons "STOP FREEZER" to stop the LN_2-supply immediately. Call for assistance.

12. Lower the set point of the temperature by increments of 20 °F until the desired temperature is reached. Wait at least 3 minutes after the set point temperature has been reached before setting the next value.

Allow the temperature of the freezer to stabilize at the desired final temperature for several minutes before starting the freezing of the product. Cooling down the freezer normally takes only 10 to 15 minutes.

Avoid long periods of idle running (LN_2-consumption). If the delays occur after the freezer is already at desired final temperature, raise the set point temperature by 20°F. Lower the temperature to the desired set point in time. Allow the product to enter the freezer after the freezer is at the desired temperature for at least 5 minutes (freezer sufficiently cold). See also section 6.9 on "Idle Running" in case of longer interruptions.

13. At the end of the freezing cycle (and when opening the door) the exhaust fan (option) is running during an adjustable time. Check if the corresponding white light on the control panel is ON (option).

    Check if the exhaust flow is OK (option). Adjust the time if required. See also 6.3.3 on "Parameter Setting".

    MAKE SURE THE EXHAUST (GAS REMOVAL) SYSTEM IS PROPERLY WORKING.

14. Check the temperature and condition of the food coming out of the freezer. Make one or more of the following adjustments if required:

    - residence time;
    - set point temperature;
    - production rate.

Use the check-list of section 6.9 on "Freezer Shut-down" to switch off the freezer.

6.5 Optimum Production Rate (LN_2-Consumption)

The Box Freezer can be operated efficiently over a wide range of production rates.

Optimum operation, i.e. the lowest LN_2-consumption per pound of food, is normally obtained for the highest possible (product exit temperature satisfactory!) exit gas temperature. This point should be determined experimentally.

- If the temperature of the exhausted nitrogen is too high, the Box Freezer will process fewer kg of food per hour. The LN_2-consumption per kg of food will increase as losses in the system (fixed) become predominant.

- If the exhaust gas temperature is too low, the nitrogen will be exhausted before all of its useful refrigeration has been absorbed. The amount of refrigeration obtained from each kg of liquid nitrogen will decrease, causing the LN_2-consumption per kg of food to increase.

The point of optimum LN_2-consumption for a given production rate should be determined experimentally, taking into account the considerations given above.

6.6 Product Temperature Adjustments

THE PRODUCT COMING OUT OF THE FREEZER FIRST MAY NOT BE REPRESENTATIVE FOR THE STEADY STATE OPERATION. WAIT SEVERAL MINUTES BEFORE ADJUSTING THE SET POINT

TEMPERATURE.

The temperature of the product exiting the freezer can be adjusted in several ways, e.g. by:

1. Increasing or decreasing the time of the freezing cycle so that the product residence time in the freezer changes.

2. Increasing or decreasing the set point of the temperature controller so that the amount of liquid nitrogen being injected into the freezer changes.

Arrive at the right product discharge temperature by:

a. setting the time of the freezing cycle to the maximum value i.e. maximum residence time of the product in the freezer.

b. setting the temperature of the freezer as warm as possible to minimize the LN_2-consumption.

Check the product temperature when leaving the Box Freezer and make sure the desired temperature has been achieved.

OPERATING THE BOX FREEZER BELOW -150 °F WILL ADVERSELY AFFECT THE FREEZER PERFORMANCE AND THE EFFICIENCY, AS WELL AS THE EQUIPMENT OPERATIONAL LIFETIME.

If the product exiting the freezer is too cold, gradually raise the set point of the temperature controller in steps of 2°F at a time. Monitor the product discharge temperature. Wait sufficiently long in between subsequent adjustments of the set point. Make further adjustments if required.

If the product exiting the freezer is too warm, reverse the procedure, i.e. gradually drop the set point of the temperature controller. Wait sufficiently long before making further adjustments. Check if the desired production rate can still be maintained.

6.7 Optimal Gas Flow

At the end of the freezing cycle (and when opening the door) cold gas will be removed from the freezer during an adjustable time (option). If properly adjusted, only a small amount of nitrogen gas should arrive in the production area.

Adjustment of Nitrogen Gas Flow

A correct adjustment of the desired exhaust flow rate (option) occurs during the initial start-up and tuning of the freezer. If the product size, production rate or environmental conditions change significantly, it may be necessary to re-adjust the flow rate.

Vary the flow rate of the exhaust system (option) to achieve this slight spillage of nitrogen gas coming out of the freezer. Restrict the amount to the required minimum.

6.8 Idle Running

Avoid long periods (e.g. 10 minutes) of idle running in order to reduce LN_2-consumption.

KEEP THE RECIRCULATION FANS RUNNING DURING IDLE OPERATION OR BREAKS TO PREVENT THEM FROM FREEZING-UP AND DAMAGING THE FREEZER.

If delays in operation occur after the freezer is already at the desired temperature, raise the set point by 20°F. Lower the temperature to the desired set point in time. Allow the product to enter the freezer only, after the freezer is at the desired temperature for at least 5 minutes (freezer sufficiently cold).

If the period of idle running exceeds 30 minutes, set the set point another 20°F warmer. Never idle the freezer above -20°F. For operation, readjust the temperature by increments of 20°F.

6.9 Freezer Shutdown

CHECK-LIST FOR FREEZER SHUT-DOWN

1. Wait unit the freezing cycle ends, the "END CYCLE" lamp is on and the buzzer gives a signal. At the end of the freezing cycle the fans and the LIN-injection are stopped automatically.

2. Open the door(s) and remove all products out of the Box Freezer. When opening the door the exhaust fan (option) will be running during an adjustable time.

3. At the end of all production, close the manual shut-off valve (main valve) of the LN_2-supply at the storage tank. Press the button "START FREEZING" to start the LN_2-supply. Wait until the main duct is pressureless.

4. Press the button "STOP FREEZING" to stop the freezer (LN_2-supply and recirculation fans).

5. Wait until the temperature controller displays a positive temperature (>32°F). If not, irreparable damage may occur in case of early re-start.

6. Check one more time if all systems of the freezer have been shut down.

7. Open the door(s) of the Box Freezer. When opening the door the exhaust fan (option) will be running during an adjustable time.

8. Switch off the main power disconnect.

9. Make sure the freezer can be restarted for subsequent cleaning and drying.

6.10 Operator Trouble Shooting Guide

During the operational lifetime of the freezer unexpected problems may be encountered. This trouble shooting guide helps the operator finding the cause of the problem and allows him to take the appropriate actions. If the operator cannot solve the problems directly using the table below, the "Technical Service" should be notified.

PROBLEM	CAUSE	CORRECTION
No power at control panel or components.	Main isolator not switched on.	Turn main isolator into "ON" position.
Light of "RESET" button doesn't extinguish.	Emergency stop activated.	Pull plunger and push "RESET" button.
	"RESET" Button not pushed.	Push "RESET" button.
Indicator light not burning.	Function not activated.	Activate function if desired.
Product exits freezer too warm at start-up of production.	Freezer not sufficiently cooled down.	Idle freezer at lower temperature.
	Steady state not reached.	Wait sufficiently long before correcting.
Product exits freezer too warm.	Set point temperature too high.	Lower gradually set point temperature.
	Product residence time too short.	Raise product residence time.
	LN_2-injection pressure too low.	Verify if all valves are open.
	No LN_2-injection.	See section 4-7.
Product exits freezer too cold.	Set point temperature too low.	Raise gradually set point temperature.
	Product residence time too long.	Lower product residence time.
No response to set point temperature adjustment.	Temperature controller defective.	Switch to manual operation.
Exhaust fan (option) not running.	Freezing cycle not completed.	Wait until freezing cycle has been completed.
	Door not opened.	Open door.
Excessive amount of N_2-vapor coming out of freezer.	Exhaust system not started.	Start the freezer again.
Recirculation fans not running.	Recirculation fans not started.	Start freezer.

PROBLEM	CAUSE	CORRECTION
	Exhaust system (option) not started.	Start exhaust system.
	Emergency stop pushed.	Pull plunger and push "RESET" button.
	Door not closed. Proximity switch not activated.	Open door and close again.
No LN_2-injection.	Freezer not started.	Start freezer.
	Storage tank is empty.	Re-order.
	Main shut-off valve at storage tank closed.	Open main shut-off valve.
	Temperature controller not switched to manual or automatic.	Activate correct mode.
	Set point is warmer than ambient temperature in freezer.	Lower set point temperature to desired value.
	Emergency stop pushed.	Pull plunger and push "RESET" button.
	Exhaust fan (option) not started.	Start exhaust fan.
	Door not closed. Proximity switch not activated.	Open door and close again.
	Proximity switch "door open" activated.	Open door.
	Various drive units (recirculation fans) not started.	Make sure all drive units have been started and are properly working.
Liquid nitrogen coming out of freezer.	Set point temperature too low.	Raise gradually set point temperature.
	Set point adjusted by a too large increment.	Never reduce set point temperature by increments of more than 20°C.

7. FREEZER CLEANING AND DRYING

7.1 Safety Warnings

When cleaning and drying the Box Freezer at least the following safety precaution measures should be considered to prevent personal injury or damage.

- Close and secure all electrical enclosures and conduit covers on the freezer and in the cleaning area to prevent personal injury due to electrical shock. This helps to avoid contact between water and conductors.
- Protect the electrical components from water and moisture damage.
- Wear gloves and safety glasses to avoid personal injury from high pressure hot water or steam jets.
- Remove or secure loose fitting clothing to prevent them from being caught in moving freezer components during cleaning.

Carefully read chapter 3 on "Nitrogen Safety Information" to assure a safe operating environment for all personnel.

7.2 Equipment and Products Required

Allow for proper cleaning of the Box Freezer and provide the following equipment and cleaning products:

- steam hose for high pressure cleaning;
- air hose for high pressure cleaning;
- stainless steel approved detergents.

7.3 Cleaning Procedure

Under normal circumstances the Box Freezer should be shut down completely with the door in open position. Apply the shut-down procedure as described in section 6.9 on "Freezer Shut-down" if not the case.

Wait at least 30 minutes after the freezer has been shut down to start the cleaning procedure.

CHECK-LIST FOR CLEANING

1. Check if the manual shut-off valve at the LN_2-storage tank has been closed.

2. Check that the Box Freezer (recirculation fans, exhaust fan (option), etc.) has been shut down. Refer to the shut-down procedure as described in section 6.9 on "Freezer Shut-down" if not the case.

3. Make sure that the electrical enclosures (and conduits) on the freezer and in the production area are properly closed and secured. Use plastic bags to protect the electrical enclosures

from water.

4. Remove residue product from all accessible parts of the freezer. Take care: The product can be extremely cold.

5. Clean the interior of the Box Freezer. For maximum effectiveness, a high pressure hot water system is recommended.

   The use of a high pressure hot water system removes all residue ice, assures a high efficiency of the freezer and is compliant with the governing hygiene standards.

   Avoid direct spray on the electrical enclosure and the injection system inside the freezer.

   IT IS FORBIDDEN TO HOSE DOWN THE ELECTRICAL ENCLOSURE OR DRIVE UNIT OF THE BOX FREEZER. A HIGH PRESSURE WATER JET MAY CAUSE SUBSTANTIAL DAMAGE TO THESE COMPONENTS.

   After the inside of the freezer has been thoroughly cleaned, cleanse the entrance and exit ducts. Also clean the outside of the freezer.

6. Close the door(s) of the Box Freezer.

7. Start cleaning of previously hidden surfaces (see also point 7).

8. Remove the plastic bags from the electrical enclosures after cleaning and rinsing has been finalized.

9. Open the door(s) of the Box Freezer.

10. Shut down the freezer completely.

11. Check if the main power switch on the electrical enclosure has been switched into the "OFF" position.

7.4 Drying Procedure

ALL PARTS OF THE BOX FREEZER SHALL BE COMPLETELY DRY BEFORE START-UP TO PREVENT ICE BUILD-UP IN CRITICAL PARTS.

Drying of the freezer is necessary if the start-up occurs within 12 hours.

CHECK-LIST FOR DRYING

1. Check if the main power switch on the electrical enclosure has been switched into the "OFF" position.

2. Dry the complete freezer with compressed air if required. Pay special attention to the moving parts of the Box Freezer.

3. Check one more time if the freezer is ready for the next operating shift.

The following procedure should be applied if no compressed air is available in the production area:

a. Switch on the main power switch on the electrical enclosure.

b. Close the door(s) of the freezer.

c. Start the Box Freezer.

   MAKE SURE THE MANUAL SHUT-OFF VALVE (MAIN VALVE) OF THE LN_2-SUPPLY AT THE STORAGE TANK IS CLOSED SO NO NITROGEN IS BEING INJECTED INTO THE BOX FREEZER.

d. Run the installation for 15 minutes or until the freezer is completely dry.

e. The flow of unsaturated air through the Box Freezer will facilitate drying. Normally, drying for 15 minutes should be sufficient.

f. Shut down the Box Freezer completely. See also section 6.9 on "Freezer Shut-down". Switch off the main power switch ("OFF" position).

g. Check one more time if the freezer is ready for the next operating shift.

8. MAINTENANCE SCHEDULES

This chapter provides the "Technical Service" with relevant information for the daily, monthly and yearly check. These schedules inform the user with respect to what has to be checked and when. Consult the appendices and other chapters for more specific information.

8.1 Daily Inspection List

At the beginning of each working day the operator of the freezer should run through the following to make sure the freezer is ready for full production. The few minutes required to run through this list may prevent unscheduled shut-downs or damage if the freezer due to inattention. Consider this list as a guide. The operating conditions may vary making more frequent and more complete inspection necessary.

CHECK-LIST FOR DAILY INSPECTION

See section 6.2 on "Daily inspection list" for an overview of the items which have to be checked daily by the operator.

8.2 Monthly Maintenance Schedules

Start every monthly scheduled maintenance with the check-list for the daily inspection as described in the previous section.

CHECK-LIST FOR MONTHLY MAINTENANCE

1. Thoroughly clean the complete freezer. See chapter 7 on "Freezer Cleaning and Drying". Pay special attention that the electrical enclosure and the most critical components (motors, etc.) are properly covered and protected.

2. Inspect all flexible conduits and fittings.

3. Check the entire electrical system and make sure that:
   - all emergency stops are still properly working;
   - all temperature sensors are fully operational;
   - the door seals of the electrical enclosure are in good condition;
   - all conduit covers are properly closed and locked;
   - all proximity switches are working correctly.

4. Check the LN_2-system (piping and sub-systems) for leakage.

5. Tighten all loose nuts and bolts of the freezer.

6. Clean the LN_2-filter every 6 months. Be very careful. First eliminate all nitrogen pressure before demounting the LN_2-filter.

8.3 Yearly Maintenance Schedules

Use the following maintenance schedule at least once every year, combined with the daily inspection list and the monthly maintenance schedule.

CHECK-LIST FOR YEARLY MAINTENANCE

1. Check if the proximity switches are still at the right distance. Reposition them if necessary. Remove food remnants and metallic waste.

2. Tighten all loose bolts and nuts of the freezer. Pay special attention to the bolts and nuts of the protection grids of the recirculation fans.

3. Tighten all loose bolts and nuts of freezer. Pay special attention to the bolts and nuts of the belt suspension system.

4. Verify if the freezer is still in horizontal position. Adjust if necessary

5. Check if all electrical cord-grips are still properly tightened.

6. Go through the initial start-up and tune-up procedure as described in chapter 5 of this manual on "Initial Start-up and Tune-up of Freezer".

7. Replace the seals of the freezer if necessary.

8. Check if the blades of the recirculation fans and the exhaust fan (option) are still in good condition.

9. Check if the O_2 measuring and alarm system is still OK for the coming period (1 year).

10. Check all motors and of the freezer every 5000 production hours.

9. FAULT FINDING

This chapter helps the "Technical Service" finding the system errors and taking the appropriate actions. Additional information on the various components can be found in the appendices. Use also Chapter 11 on "Corrective Maintenance of Freezer Subsystems".

Fault finding should be carried out by specifically trained personnel.

9.1 Electrical Power Supply

The CES Box Freezer has been designed to be connected to a 3-phase network, 60 Hz with neutral. Use the electrical scheme in Appendix B.1 on "Electrical Schematic" for more information with respect to the voltage required and other specifications.

The supply voltage of the Box Freezer always has to lie in between +10 % and -5 % around the nominal value. In case of any operating problems, first check the voltage at the main isolation switch on the electrical enclosure.

Check the control circuit fuse and the pilot light bulbs if the light of the "RESET"-button and the components on the control panel are not reacting when turning on the main isolation switch.

9.2 LN_2-Supply

Check if the amount of liquid nitrogen in the storage tank is adequate for the intended operating period. Do this before attempting to operate the Box Freezer.

If the food product exiting the freezer is not completely frozen, check then if the LN_2-solenoid valves are open (gauge (option)). Are the LN_2-solenoid valves fully open, check then if the pressure in the storage tank is sufficiently high. When the pressure in the storage tank is lower than the minimum required pressure (2 bars), insufficient quantity of liquid nitrogen will flow to the freezer through the supply piping. Fill-up. The normal operating pressure is 2.5 bars.

A too high pressure in the storage tank (above 3 bars) can cause erratic freezing. The LN_2-solenoid valves will be almost always closed and the gauge of the supply pressure will fluctuate significantly. Reduce the pressure in the storage tank to below 3 bars by venting nitrogen gas.

Occasionally, the injection openings (spray nozzles) may become blocked due to dirt in the liquid nitrogen. To compensate for this loss, the LN_2-control system will cause a higher than normal injection pressure, to maintain the temperature. In case of severe blockage the temperature in the freezer will still rise, and the product will no longer be sufficiently frozen. Clean the spray bars and clear the blockage of the spray nozzles as described in section 12.10 on "Cleaning of LN_2-Injection System".

9.3 Drive

The recirculation fans of the Box Freezer are driven by a 3 phase (240VAC) induction motors. If the recirculation fan motors fail to operate:

- first check if the emergency stops have not been activated. Reset if necessary.
- secondly check if the main fuses of the recirculation fan motors are intact.

See also section 9.4 on "Fault finding guide".

9.4 Fault Finding Guide

During the operational lifetime of the freezer unexpected problems may be encountered. The following table helps the "Technical Service" analysing and solving the problems. The trouble shooting guide for the operator (section 6.10) has been reproduced entirely and completed further. Also use the other chapters of this manual and the technical documentation in the appendices. Contact CES if necessary.

PROBLEM	CAUSE	CORRECTION
No power at control panel or components.	Main isolator not switched on.	Turn main isolator into "ON" position.
	Main fuses failed.	Identify cause. Replace if required.
	Power supply of plant failed.	Check power supply to machine.
Light of "RESET" button doesn't extinguish.	Emergency stop activated.	Pull plunger and push "RESET" button.
	"RESET" Button not pushed.	Push "RESET" button.
Indicator light not burning.	Function not activated.	Activate function if desired.
	Indicator light defective.	Replace indicator light.
Product exits freezer too warm at start-up of production.	Freezer not sufficiently cooled down.	Idle freezer at lower temperature.
	Steady state not reached.	Wait sufficiently long before correcting.
Product exits freezer too warm.	Set point temperature too high.	Lower gradually set point temperature.
	Product residence time too short.	Raise the product residence time.
	LN_2-injection pressure too low.	Verify if all valves are open.
	No LN_2-injection.	See elsewhere.

PROBLEM	CAUSE	CORRECTION
Product exits freezer too cold.	Set point temperature too low.	Raise gradually set point temperature.
	Product residence time too long.	Lower the product residence time.
No response to set point temperature adjustment.	Temperature sensor defective.	Replace temperature sensor.
	Temperature controller defective.	Switch to manual operation.
Exhaust fan (option) not running.	Freezing cycle not completed.	Wait until freezing cycle has been completed.
	Door not opened.	Open door.
	Time interval "exhaust fan activated" elapsed.	Set time interval differently or start again.
	Fuse of motor failed.	Reset fuse. Push "RESET" button. Replace if necessary.
	Current monitoring system activated. Exhaust motor drawing too much or too little current.	Check any fouling of exhaust blades. Check motor and fuse. Replace if necessary.
Excessive amount of N_2-vapor coming out of freezer.	Exhaust system not started.	Start the freezer again.
	Time interval "exhaust fan activated" not properly adjusted.	Set time interval correctly.
	Exhaust system obstructed.	Identify cause. Remove obstruction.
	Exhaust system failed.	Check exhaust system (motor, blades, shaft, etc.). Replace if necessary.
Recirculation fans not running.	Recirculation fans not started.	Start freezer.
	Exhaust system (option) not started.	Start exhaust system.
	Emergency stop pushed.	Pull plunger and push "RESET" button.
	Door not closed. Proximity switch not activated.	Open door and close again.
		Replace proximity switch.
	Fouling of fan.	Identify cause and solve.

PROBLEM	CAUSE	CORRECTION
	Thermo-magnetic or automatic fuse of motor tripped out.	Check thermo-magnetic or automatic fuse. Reset. Measure current to motor in case of repeated trip-out.
No LN_2-injection.	Freezer not started.	Start freezer.
	Storage tank is empty.	Fill-up storage tank.
	Main shut-off valve at storage tank closed.	Open main shut-off valve.
	Temperature controller not switched to manual or automatic.	Activate correct mode.
	Set point temperature is warmer than temperature in freezer.	Lower set point to desired temperature.
	Emergency stop pushed.	Pull plunger and push "RESET" button.
	Exhaust fan (option) not started.	Start exhaust fan.
	Door not closed. Proximity switch not activated.	Open door and close again.
		Replace proximity switch.
	Proximity switch "door open" activated.	Open door.
		Replace proximity switch.
	Various drive units (recirculation fans) not started.	Make sure all drive units have been started and are properly working.
	Solenoid valve (safety) activated.	Identify cause and rectify.
	System "Liquid on floor" activated.	Identify cause and rectify.
	Nozzles of spray header blocked.	Remove spray header and nozzles and clean.
	"Controller" for minimum temperature (i.e. liquid on floor) not operating.	Check temperature sensor "minimum temperature". Replace if required.
		Check temperature "controller" "minimum temperature". Replace if required.

PROBLEM	CAUSE	CORRECTION
Liquid nitrogen coming out of freezer.	Set point temperature too low.	Raise gradually set point temperature.
	Set point adjusted by a too large increment.	Never reduce set point temperature by increments of more than 20°C.
	Temperature control system defective.	Check temperature sensor. Replace if necessary.
		Check temperature controller. Replace if necessary.
	Temperature sensor minimum temperature not positioned correctly.	Contact manufacturer of freezer.
	"Controller" for minimum temperature (i.e. liquid on floor) not operating.	Check temperature sensor "minimum temperature". Replace if required.
		Check temperature "controller" "minimum temperature". Replace if required.
	LN_2-supply pressure too high.	Vent storage tank or call for assistance.

10. ADJUSTMENT OF FREEZER SUBSYSTEMS

This chapter provides the "Technical Service" with the information required to set or adjust the various subsystems of the freezer. Contact the manufacturer (CES) in case of problems.

10.1 Adjustment of Temperature Sensor "Liquid on Floor"

As soon as liquid nitrogen appears at the bottom of the freezer, the nitrogen supply should be blocked completely. For this reason a boundary temperature sensor for minimum temperature has been mounted just under the spray headers. To ensure a safe operation of the freezer the controller of the temperature sensor for minimum temperature should be set at a value within the range -250°F to -300°F.

Normally the set point has been set and sealed by the manufacturer. Make sure the set point always is within the range -250°F to -300°F.

11. CORRECTIVE MAINTENANCE OF FREEZER SUBSYSTEMS

Chapter 11 provides the "Technical Service" with relevant information for corrective maintenance of the various subsystems of the freezer.

MAKE SURE THE MAIN POWER SUPPLY HAS BEEN DISCONNECTED BEFORE STARTING ANY CORRECTIVE MAINTENANCE.

11.1 Replacement of Exhaust Fan/Motor (Option)

Contact the manufacturer of the freezer (CES).

11.2 Replacement of Recirculation Fan/Motor

1. Open the door of the Box Freezer.
2. Disconnect the main power (main switch).
3. Unscrew the bolt of the shaft.
4. Remove the recirculation fan.
5. Remove the protection plate of the recirculation fan motors.
6. Disconnect the electrical wiring of the motor (only to remove the motor).
7. Unscrew the fixation bolts and remove the motor (only to remove the motor).

Apply the identical procedure but in opposite order to install the recirculation fan/motor (again).

11.3 Replacement of Seals

1. Open the door of the Box Freezer.
2. Disconnect the main power (main switch).
3. Unscrew the small nuts (#10).
4. Remove the metallic strip and seal.

Apply the identical procedure but in opposite order to install the new seal.

11.4 Replacement of LN_2-Solenoid Valve

Contact the manufacturer of the freezer (CES).

11.5 Replacement of Solenoid Valve (Safety)

Contact the manufacturer of the freezer (CES).

11.6 Replacement of Temperature Sensor

1. Disconnect the main power (main switch).
2. Disconnect the electrical wiring in the electrical enclosure.
3. Loosen the screw of the stainless steel tube.
4. Remove the temperature sensor.

Apply the identical procedure but in opposite order to install the new temperature sensor.

11.7 Replacement of LN_2-Filter (option)

1. Close the main valve of the LN_2-supply at the storage tank.
2. Activate the LN_2-injection to eliminate all nitrogen which has accumulated in the supply piping. Check that this step has been performed correctly.
3. Remove the filter carefully and replace.

11.8 Replacement of Emergency Stop

1. Disconnect the main power (main switch).
2. Remove the socket with the wiring.
3. Unscrew the ring.
4. Remove the emergency stop.

Apply the identical procedure but in opposite order to install the new emergency stop.

11.9 Replacement of Proximity Switch

Contact the vendor of the freezer (CES).

11.10 Cleaning of LN_2-Spray Header

1. Unscrew the entire spray header and remove it from the freezer.
2. Unscrew the nozzles (option).
3. Thoroughly clean all parts with compressed air.
4. Mount again in opposite order.