THERMO BLACK CLAWSON INC.
A Thermo Fibertek company

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Middletown, Ohio 45042-2117 USA
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LIQUID CYCLONE™/RUFFCLONE™

Installation, Operation, Maintenance, and Service Parts
MODELS: Manual Reject,Auto Reject and Continuous Reject
SIZES: 8,10,11,12,14,17,20, and 25
October 15, 1997

Deliver manuals to:

US Gypsum Company
6825 Evergreen Avenue
Jacksonville, FL 32208

Attention: Kevin Turk

Prepared for: US Gypsum Company

Mill: Jacksonville, FL

Customer order number: 22522619 Number of manuals: (4)

Shop order number	Serial number
4870391	97-LC17-1923
4872391	97-LC20-1924/1925
4870491	97-LC17-0471/0472/0473

Read this manual carefully to learn how to operate and service your equipment correctly; failure to do so could result in personal injury or equipment damage. Keep this manual readily accessible and legible to anyone doing maintenance on or operating this equipment.

Thank you for purchasing a Thermo Black Clawson product.

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Manual Overview

This manual is for general information and guidance. For specific information concerning parts or items, refer to the certified drawings of the equipment.

Your Thermo Black Clawson unit will provide many years of dependable service when installed, operated, and maintained according to our recommended procedures. The instructions in this manual are recommended procedures for installing, operating, and maintaining your unit. Correct installation of the unit is critical. Reasonable operation and maintenance will not compensate for poor installation.

All information, illustrations, and specifications in this manual are based on the latest information available at the time of publication.

Drawings in this manual are only sketches that exist for no other purpose other than to provide a visual reference for the text within this manual. The drawings in this manual are not to be used for construction purposes.

It is the responsibility of the purchaser of this equipment to make sure that operators, maintenance personnel, and anyone else involved with this equipment is aware of this manual, has easy access to this manual, and has read and understands the contents of this manual. It is also the purchaser's responsibility to keep this manual in legible condition.

WE RESERVE THE RIGHT TO MAKE CHANGES AT ANY TIME WITHOUT NOTICE.

Thermo Black Clawson Inc.

605 Clark Street, Middletown, OH 45042-0160 USA

Phone 1-513-424-7400

TOLL FREE 24-HOUR EMERGENCY SERVICE

1-800-448-5422

1.0 SAFETY

1.1 SAFETY INTRODUCTION

This manual is a guide for safe and trouble-free installation and operation of your Thermo Black Clawson equipment. Follow the recommendations in this manual to ensure the safety of your personnel along with the dependable operation of your Thermo Black Clawson equipment. Your particular situation may require additional procedures and safety measures.

You--the purchaser of this equipment--are responsible for ensuring that your personnel are trained in the safe operation and maintenance of this equipment. We recommend that your personnel obtain refresher sessions covering safety, operation, and maintenance procedures periodically throughout the life of your Thermo Black Clawson equipment. **Note**: Thermo Black Clawson offers qualified field service instructors to help train your operators and maintenance personnel.

FOLLOW THE SAFETY INFORMATION IN THIS MANUAL

RECOGNIZE SAFETY INFORMATION. The triangle to the left with the exclamation mark within it is the international safety alert symbol. When you see this symbol on your equipment or in this manual, be alert to the potential for personal injury. Follow recommended precautions and safe operating practices.

UNDERSTAND SIGNAL WORDS

DANGER

Danger indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury. *Danger* is to be limited to the most extreme situations.

WARNING

Warning indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION

Caution indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.

NOTE: Notes place special emphasis on information.

Safety Steps

- Carefully read all safety messages in this manual and on your machine safety signs.
- Do not operate equipment until it has been fully integrated into the system.
- Do not perform service or maintenance work on this equipment until unit is at zero mechanical state (ZMS).
- Keep safety signs in good condition, clean, and legible.
- Replace missing or damaged safety signs.
- Learn how to operate the machine and how to use controls properly.
- Do not let anyone operate the machine without instructions.
- Keep your machine in proper working condition.
- Do not modify the equipment without written authorization from Thermo Black Clawson. Unauthorized modifications may impair the function, shorten the machine life, and/or render built-in safety features useless.
- Inspect the unit before starting and make sure that the following conditions are met:

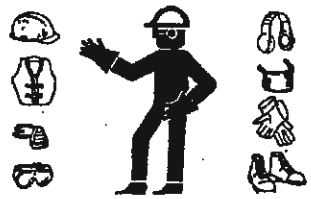
    - All guards and covers are in good condition and fastened in place.

    - No parts are loose, worn, damaged, or missing.

    - All personnel are clear of equipment.

Safe Maintenance Overview

- Keep equipment area clean and dry.
- Keep all equipment parts in good condition and properly installed.
- Understand service procedures before you do the work.
- Replace worn, broken, or missing parts.
- Do not operate damaged equipment--fix damage immediately.



- Wear close fitting clothing and safety equipment appropriate to the job.

- Consult applicable federal, state, and local codes for proper installation and guarding.

1.2 SAFETY GUIDELINES

Do not use or service this equipment until you read and understand the guidelines and instructions below and throughout this manual. If you have any questions, contact your supervisor.

Safety Guidelines

HAZARD	WHAT COULD HAPPEN	PREVENTION
Stock leaks from pipe connections, blind flanges, body joints, open access doors, etc. Water leaks from shower water, inlet dilution water, or other water sources.	**WARNING** Skin contact with stock might result in chemical or thermal skin reaction, such as skin irritation or scalding.	Follow shut down guidelines. Bring unit to ZMS. Tighten or replace loose, leaking connections.
Valves - air and electrically operated.	**WARNING** Amputation or severe injury to fingers, hands, or arms, could result.	Lock out valves and their energy sources and ensure that equipment is at zero mechanical state (ZMS). **NOTE: Controls may not be independent.** Extreme care must be used when isolating power sources. Be sure of what will shut down when energy sources are locked out. Make sure that other automatic equipment connected to source will also shut down. Do not insert fingers, hands, arms, head, or and other body parts into such devices.

HAZARD	WHAT COULD HAPPEN	PREVENTION
Exceeding design pressure of unit.	**WARNING** Seals, gaskets, or the vessel might fail and cause severe personal injury.	Know the correct design pressure of the equipment. Refer to the manual and the certified drawings. Adhere to proper operating procedures.
Discharged debris from trash chamber.	**WARNING** Cuts, abrasions, skin irritation, and scalding could occur.	Wear eye protection and protective clothing.

1.3 SAFETY PRACTICES

Post the laminated safety sign (provided by Thermo Black Clawson and pictured below) in plain view on or near the equipment at installation and keep it clean.

SAFETY INSTRUCTIONS

STOCK PREPARATION AND PULP MILL EQUIPMENT

Failure to follow these safety instructions may result in serious personal injury or death.

DO NOT PROCEED until you READ and UNDERSTAND these instructions.

1. READ and UNDERSTAND the machine's instruction/operation manual and ALL applicable OSHA regulations (29CFR1010.261).

2. FOLLOW the SHUT DOWN PROCEDURE in the manual.

3. The machine must be brought to a ZERO MECHANICAL STATE and LOCKED OUT with YOUR PADLOCK BEFORE any maintenance, inspection, cleaning, adjusting, or servicing is performed.

a) The MOTOR MAIN POWER DISCONNECT switch must be LOCKED OUT.

b) CHECK DISCONNECT. Try to start motor BEFORE proceeding further.

c) ALL SOURCES OF POWER AND FLOW OF MATERIAL must be SHUT OFF including BLEED OFF of pressure and LOCKING OUT ALL **pneumatic, hydraulic, electrical circuits, steam systems, chemical systems, gas systems, and flows of material stock.**

NOTE: See the glossary in the equipment manual to obtain the definition of zero mechanical state.

NEVER REMOVE another person's lockout (padlock) or tag.

DO NOT assume the machine is locked out. ALWAYS check yourself.

NOTE: If services are not independent of the main supply, DO NOT PROCEED--contact your supervisor.

d) Place or attach a "DANGER - PERSONNEL WORKING" sign near lockout.

e) BLOCK any rotating elements to prevent accidental rotation.

4. DO NOT ENTER vessel or unit unless you have at least ONE OTHER PERSON OUTSIDE the visceral unit at all times. Certain vessels require use or harness, gas masks, and other specialized safety equipment.

5. Upon completion, follow the START UP PROCEDURES in this manual.

6. NEVER START the machine UNLESS

a) All personnel are clear of the machine. b) All doors and hatches are closed.

c) All guards and covers are in place.

If you have any questions, contact your supervisor.

Middletown, Ohio 45042-2117 USA

THERMO BLACK CLAWSON INC.

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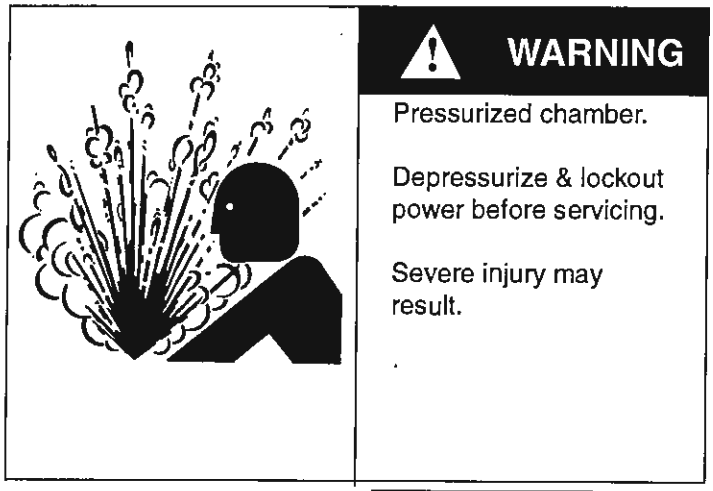
Toll Free 24 Emergency Service: 800-448-5422

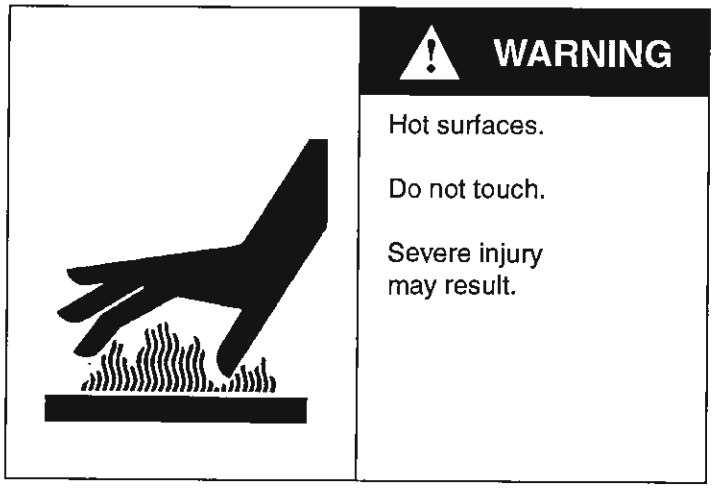
Laminated Safety Sign

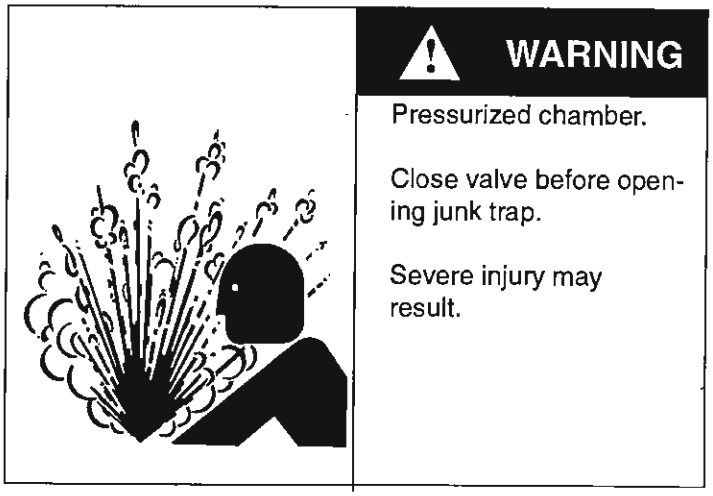
1.4 SAFETY SIGNS

These following signs are factory installed and should remain on the unit for the life of the machine and should be kept clean and legible. Do not remove the signs unless replacement signs are in hand and installed immediately after the old signs are removed.

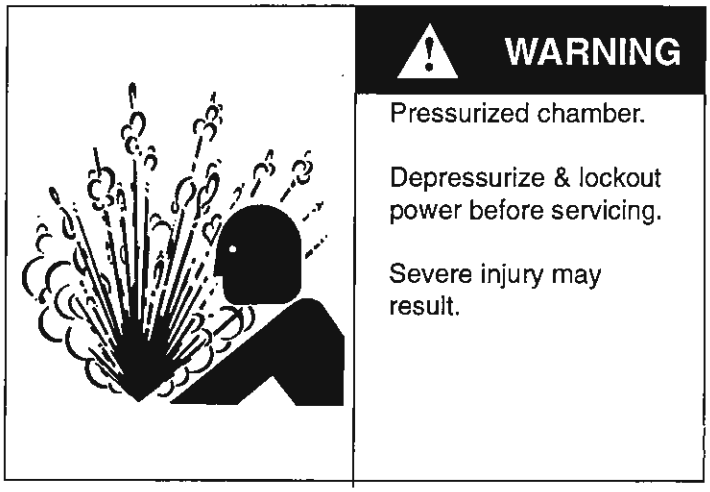


Safety Signs on the Manual Unit

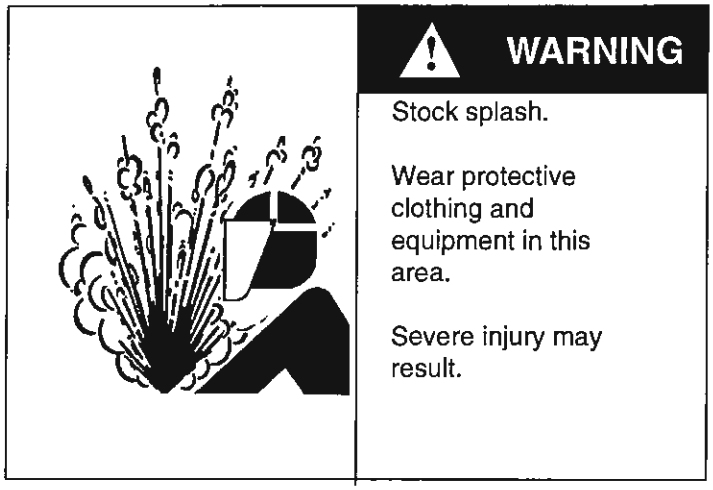


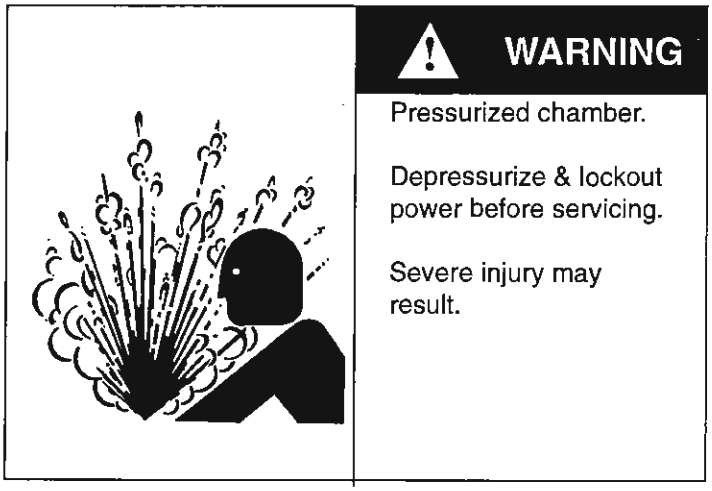


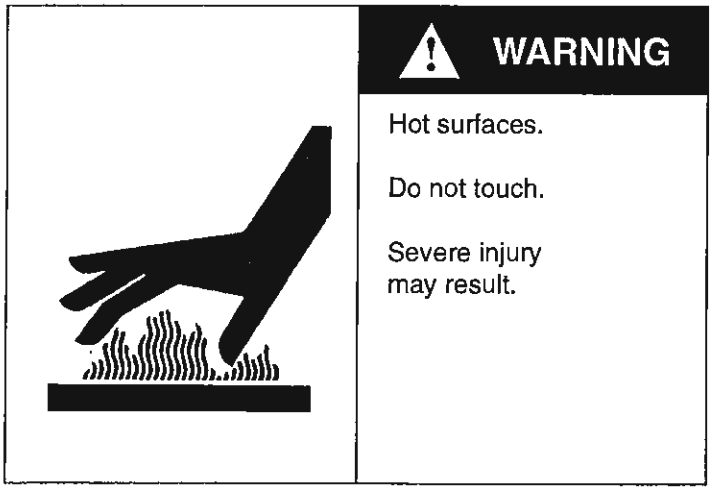
Safety Signs on the Automatic Unit



Safety Signs on the Continuous Rejects Unit







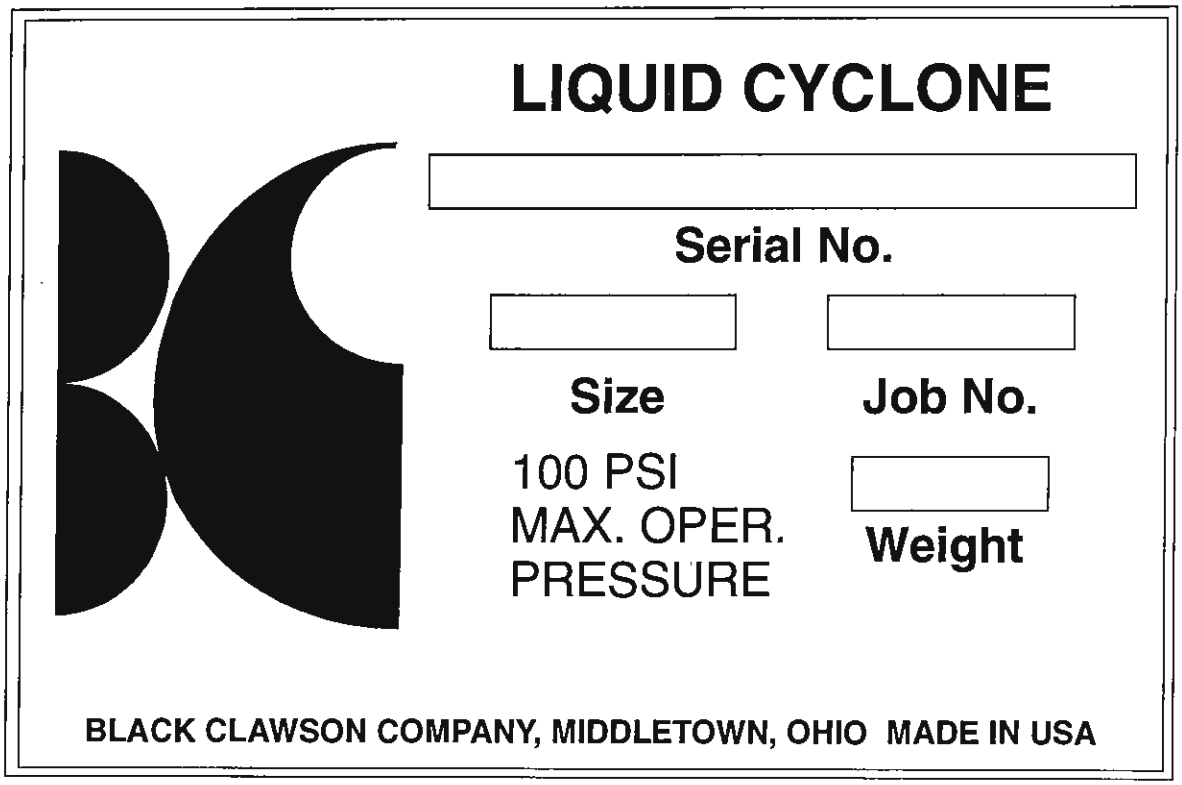
2.0 EQUIPMENT IDENTIFICATION

2.1 NAMEPLATE

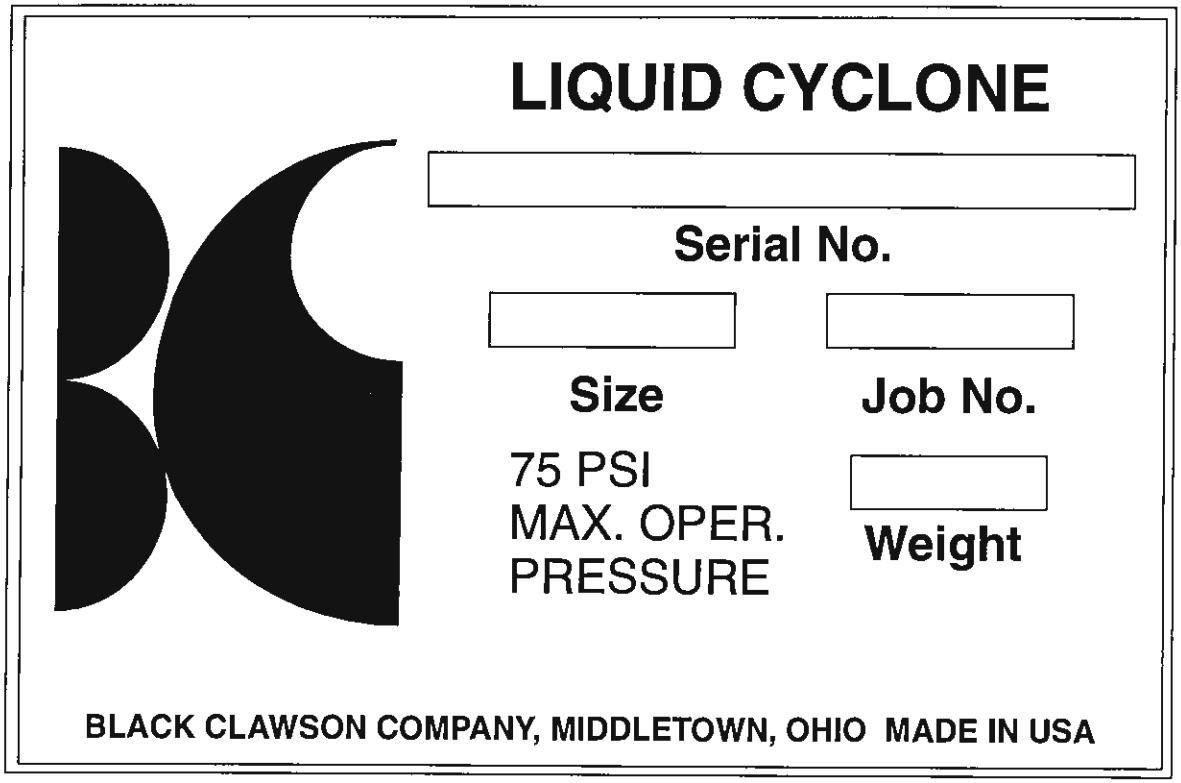
Product identification numbers include the serial number, job or shop order number, and model number. They are provided to help identify this unit if it needs service.

Thermo Black Clawson needs these numbers when you order parts.

Automatic Rejects and Continuous Rejects



Manual Rejects



3.0 GENERAL INFORMATION

3.1 EQUIPMENT DETAIL

Your Thermo Black·Clawson unit is designed to give trouble-free operation with minimum maintenance. However, certain precautions and procedures must be observed in handling, installing, and servicing the unit to obtain optimum performance.

The information in this manual should cover most situations. Should questions arise that are not covered in this manual, contact us for additional information:

Customer Service

Thermo Black Clawson Inc.

605 Clark Street, Middletown, OH 45042-0160

Phone 1-513-424-7400

North America emergency 24-hour service: 1-800-448-5422

Global emergency 24-hour service: 1-513-391-0881

FAX: 1-513-424-1168

Serial Numbers

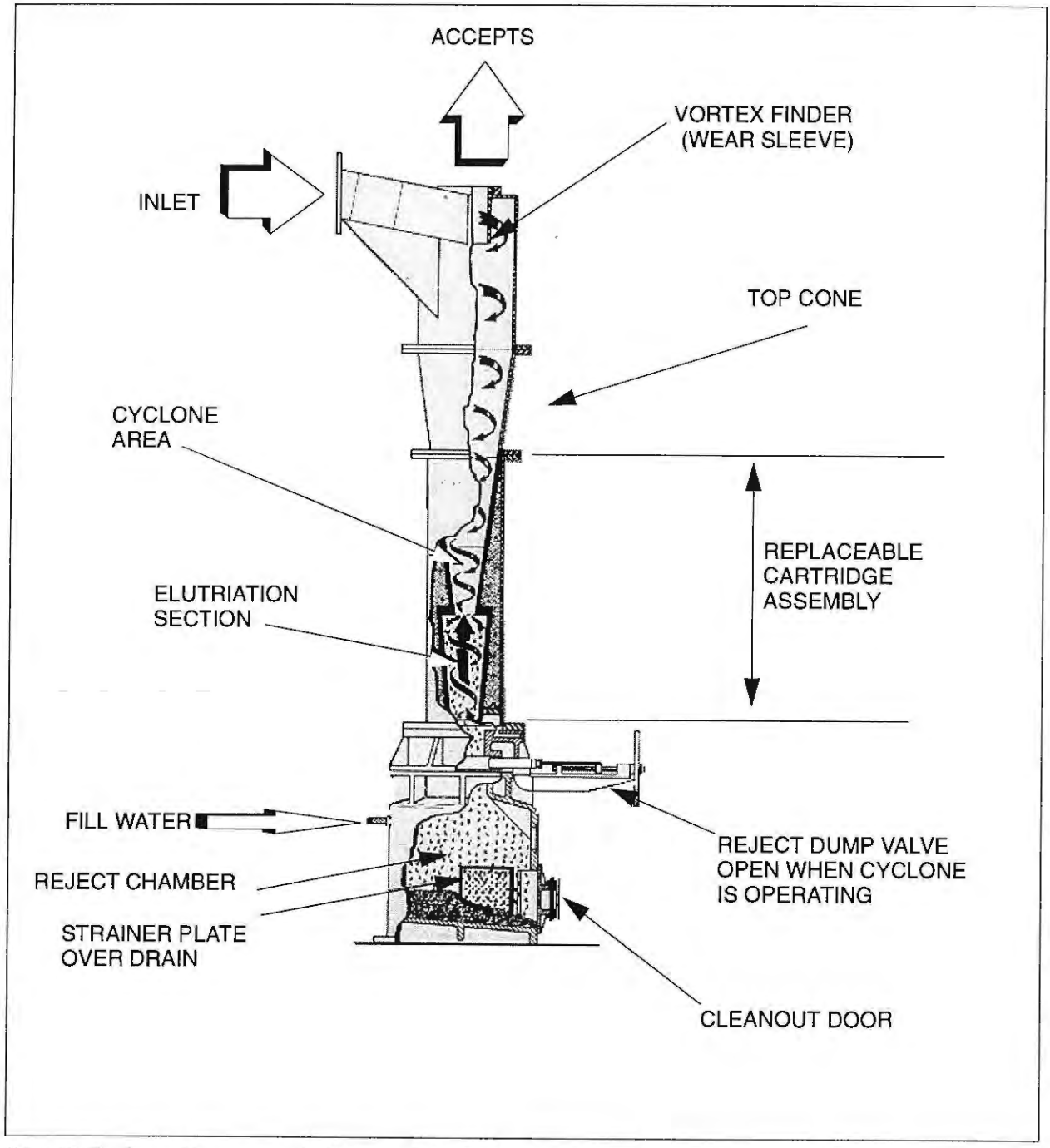
The serial number is on the nameplate and the certified drawings. When inquiring about service or maintenance problems, always provide the serial number, size, and type of unit.

Renewal Parts

Orders for renewal parts should state the serial number(s) and include the item number, description, and part number shown on the parts list of the certified drawings. **Part numbers are not specified in this manual.** Refer to your certified drawings for part numbers.

3.2 DESCRIPTION

The Liquid Cyclone consists of four major sections arranged vertically: inlet header, cone cartridge, transition flange, and the reject system.



Liquid Cyclone Components (Manual Rejects)

Inlet Header

The inlet header is located at the top of the unit and contains both the inlet and accept pipe con-

nections. Once installed, these connections and the header itself need not be disturbed. The tangential inlet initiates the rotational flow of the stock down the wall of the cleaner.

The inlet header and inlet housing are integral, manufactured in 304 stainless steel, 316 stainless steel or standard cast iron construction. The housing is machined at the top for the stainless steel accept overflow pipe.

Cone Cartridge

The cone cartridge contains both upper and lower cones of full length ceramic material, cement packed in a steel jacket, and flanged at each end.

The cylindrical inlet housing separates the heavy debris to the outside wall of the cleaner. The conical section further concentrates the debris by reversing a flow of fiber and water to the accept stream. At the elutriation section, fiber is further washed from the debris and undergoes final concentration prior to removal. This design results in high efficiency with virtually no fiber loss.

The reject zone decelerates the flow which allows the heavy material to drop and settle at the base of the cleaner. Also, it prevents heavies from rotating at high speed creating excessive wear.

There is very little fiber loss and it is extremely difficult to plug the unit.

Transition Flange

The transition flange provides means of attaching cartridge to reject chamber.

- Flange provided for valve mounting
- Two 3/4 inch elutriation water connections are provided.

Reject System - Manual Operation

The reject chamber is cast iron construction (stainless steel is optional) and flanged at the bottom for foundation bolts.

- A handwheel operated isolation valve is provided, along with an access door.
- Door opening is 10 inches high x 12 inches wide to permit shoveling out the reject material
- Floor is slanted toward door opening.
- A slide valve is furnished with each unit.
- The isolation slide valve is located between the elutriation chamber and the reject chamber to permit removal of rejects while operating.

Reject System - Automatic Operation

Where it is desired to continuously and automatically withdraw the rejects without the attention of an operator, an automatic purge and reject system is installed. An air operated valve is installed below the elutriation chamber followed by a cast chamber (square at the top/round at the bottom) which functions as a reject chamber. Another air operated valve is located at the bottom of this section to seal it during normal operation.

The sequence of operation is as follows:

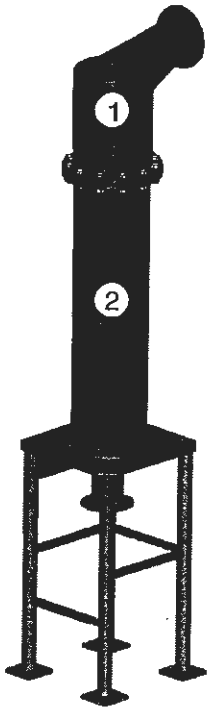
- With the bottom valve closed and the upper valve open, dirt collects in the reject chamber.
- After the time lapse (set by the operator), the upper valve closes and the bottom valve opens, dropping the rejects into a dump cart, or continuous conveyor for removal.
- The bottom valve will not open unless top valve is completely closed.

- While the bottom valve is open, a solenoid operated valve injects fresh water to fairly clean the reject chamber, and also to fill the reject chamber with water after the bottom valve closes.
- The top valve is then opened and reject removal resumes without surging the stock flow within the cyclone.
- The operation is completely automatic, and the frequency of the cycle is dependent upon the quantity and rate of collection of the recyclable material in the furnish.

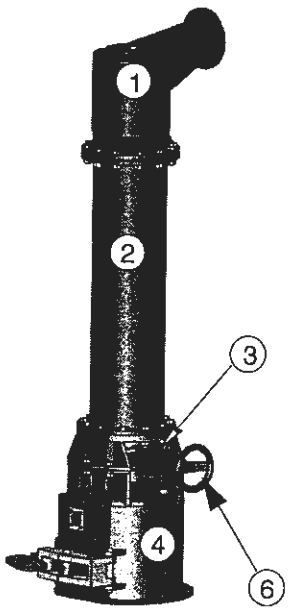
Applications

In addition to secondary fiber applications, Liquid Cyclones are suitable for the following applications:

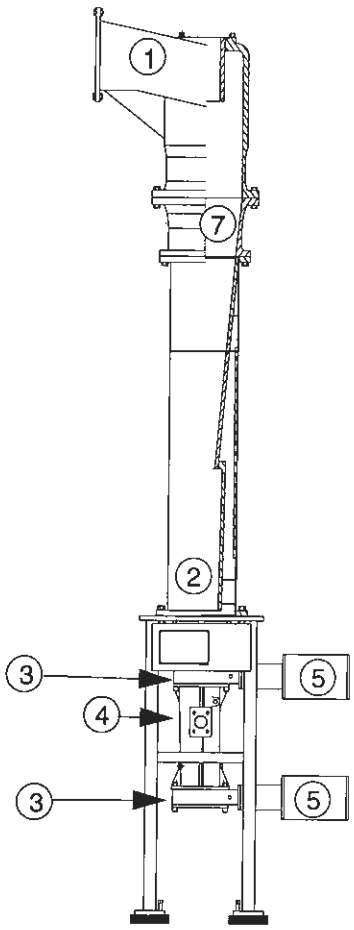
- Preceding refiners for plate protection
- After refiners for protection from broken plates
- Deflaker protection in broke system
- After the blow tank for rock and metal removal
- In groundwood system for grinder grit removal
- Ahead of primary coarse and fine screens for tramp metal and grit protection
- Removing sand from chip washer water
- White water cleaning
- On batch or continuous waste paper pulper discharge pumps



CONTINUOUS REJECTS



MANUAL REJECTS



AUTOMATIC REJECTS

1. INLET HEAD
2. CONE CARTRIDGE
3. VALVES
4. REJECT CHAMBER
5. CYLINDER
6. HANDWHEEL
7. TOP CONE (SIZES 17 AND ABOVE COME WITH TOP CONE)

NOTE: SIZES 17 AND ABOVE INCLUDE A TOP CONE. SIZES 14 AND BELOW DON'T INCLUDE A TOP CONE. THE ILLUSTRATIONS ABOVE SHOW THREE MODELS OF DIFFERENT SIZES. ALL MODELS, HOWEVER, COME IN ALL AVAILABLE SIZES.

Liquid Cyclone Models

Installed Liquid Cyclones

3.3 FEATURES

- Positive interlocking of reject valves eliminates possibility of large scale blow-through
- Valve open and closed position measured with sealed proximity switches
- Available in single or multiple designs
- Can be retrofitted to any Thermo Black Clawson Ruffclone or Liquid Cyclone or any manufacturer's centrifugal cleaner that use a collection-type reject system

3.4 ACCESSORY EQUIPMENT

Thermo Black Clawson offers complete system design or individual units to integrate into an existing system. Your local Thermo Black Clawson Sales Manager or our Systems Engineering Group is available to assist you with your specific application requirements.

This system is adaptable to Thermo Black Clawson Liquid Cyclone/Ruffclone or cleaners of other manufacturers that operate on an automatic periodic purge or a reject collection system.

Liquid Cyclone- Automatic Reject Control Panel

The Thermo Black Clawson Liquid Cyclone control panels are constructed with generic components available from local outlets. There are no proprietary circuit boards or components that will obsolete these panels. Parts can be furnished by Thermo Black Clawson or purchased from area distributorships.

There are three types of control panels offered:

- Single unit
- Multi Unit/Individual Operation
- Multi Unit/Sequential Operation

4.0 SHIPMENT CHECK

4.1 SHIPMENT/RECEIVING

Carrier

Thermo Black Clawson units and accessory equipment are shipped by truck.

Shipping Papers

One set of shipping papers is attached to the shipment in plain view to those unloading the unit. Another copy of the shipping papers was mailed to your receiving department.

WARNING

Verify weights shown on shipping papers with certified drawings and determine if your crane or hoist can lift the heaviest item safely.

Check-Off

During unloading, check-off parts from shipping papers. Report shortages to Thermo Black Clawson within 24 hours. File damage claim against transportation company within 24 hours.

Unloading Patterns

Trucks are generally unloaded from back to front. The crane operator must be sure of a clear lift or the piece being lifted may swing against other parts and cause damage.

Wooden Boxes (Crates)

Clamps, bolts, nuts, cap screws, eyebolts, and other small parts are shipped in one or more wooden boxes. **Do not store these boxes outdoors.**

Bracing Material

Leave wood blocks, steel strapping, and other bracing material in place until hoisting sling is in place and the piece is ready to be lifted.

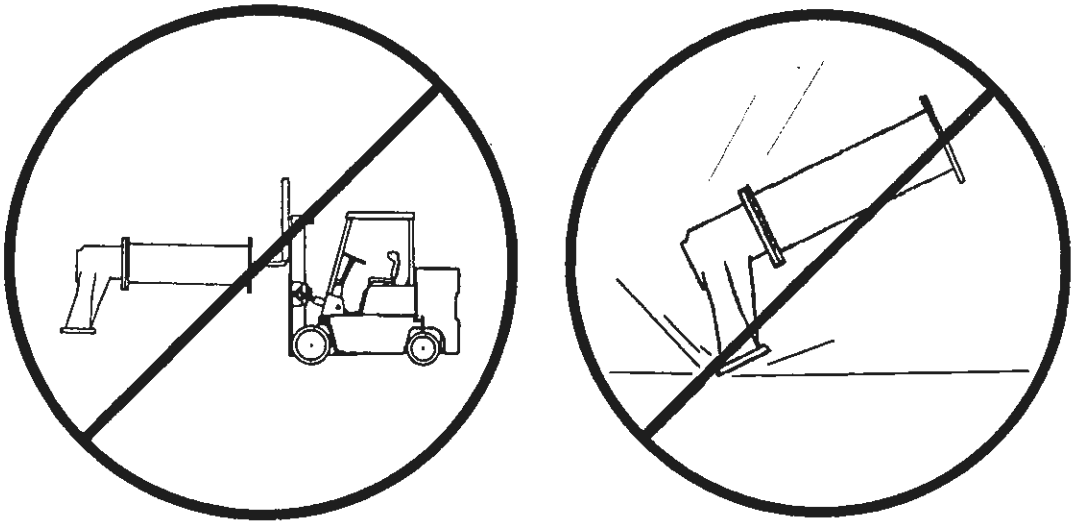
Typical Shipping

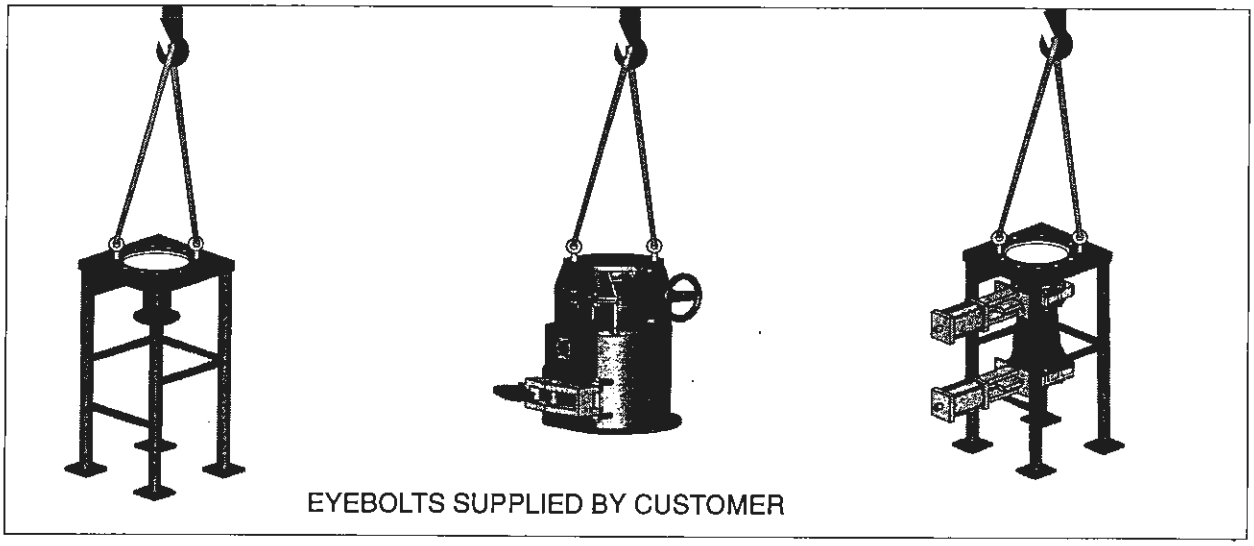
Liquid Cyclone/Ruffclone units are shipped on a platform skid. The overall height of a typical unit requires it to be laid down horizontally and banded to the skid. Units with a manual reject chamber are generally shipped completely assembled. Depending upon unit size and carrier shipping container requirements, the manual reject chamber may be shipped on a separate skid.

All units equipped with an automatic reject system are shipped with the reject base assembly disconnected and transported on a separate skid, regardless of the unit size. We recommend that the unit not be unpacked and set upright until you are ready to install the unit. Moving the unit in your mill should be done while the unit is still on the skid. Be sure to handle the unit with care to avoid damage. The cone cartridge is especially prone to damage when the unit is being removed from the skid and being set upright.

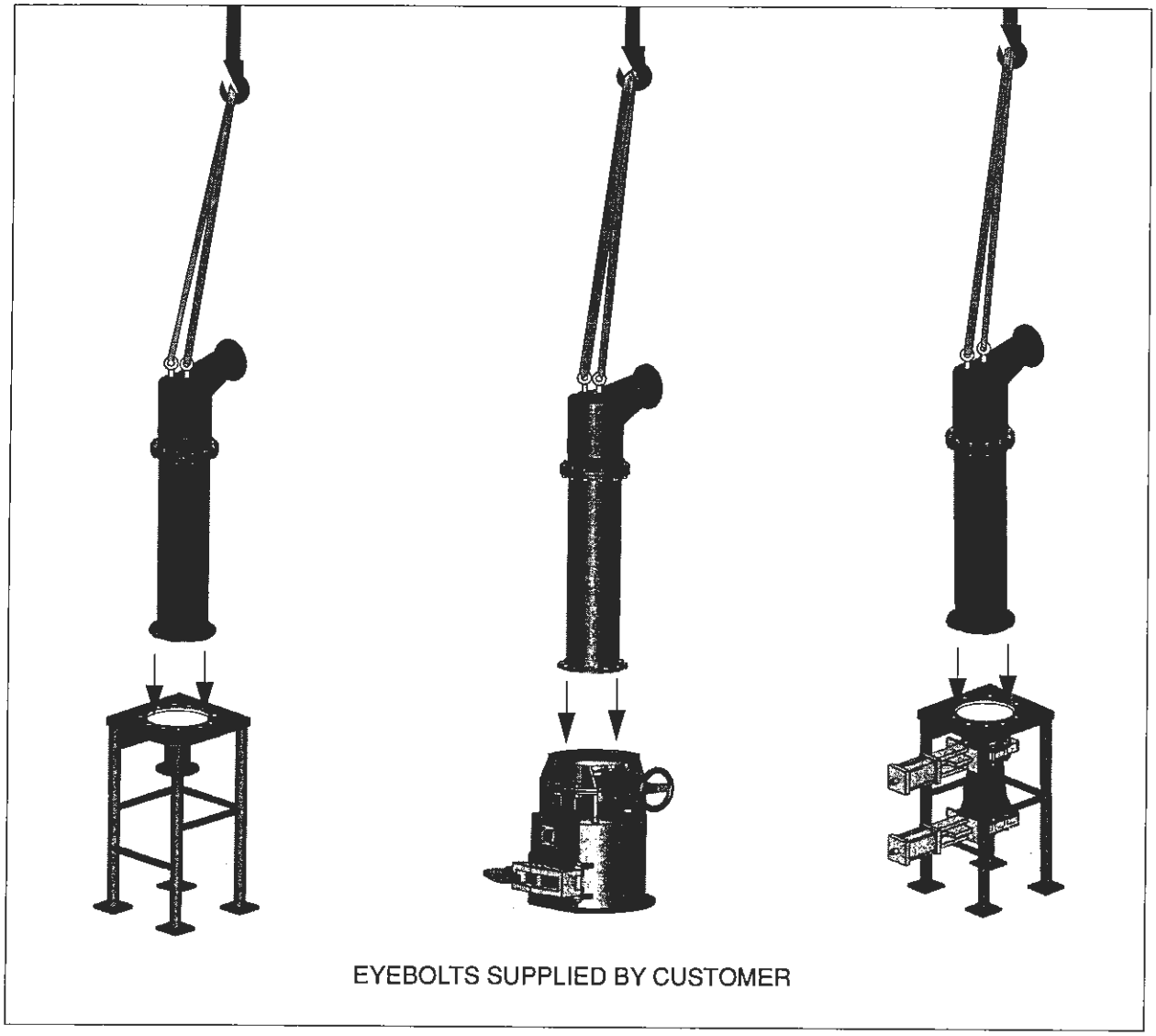
CAUTION

Do not lift the unit by inserting a fork or any lifting device into the center of the cone cartridge. The ceramic cartridge can also be damage by dropping the unit.





Recommended Method for Lifting Bottom Section



Recommended Method for Lifting Top Section

4.2 UNLOADING/HANDLING

Lifting, Unloading, and Moving Unit

- Check to be sure that eyebolts and hooks are attached securely and have appropriate lifting rating.
- Straighten the sling as the slack is removed. Test by allowing the weight of the piece to be supported by the crane while the piece is not more than one or two inches (25 to 51 mm) above the truck bed.
- Lift pieces carefully and smoothly. With cast parts, the flanges will break next to the cored holes if pieces are jerked suddenly by the crane.
- Use properly sized rigging.
- All lifting and rigging must comply with federal, state, and local safety codes.

WARNING

Never stand underneath equipment that is being lifted. To do so is to risk severe personal injury or death.

- While unit is on the skid, it can be moved with a fork truck.

- Use shipping weight as a guide to determine lifting requirements. Verify that lifting equipment has sufficient capacity.
- Do not lift unit by chaining or slinging around pipe connections or motor stand.
- Use a spreader bar to prevent damage to the unit when lifting.
- Pad any contact points between the tank and the chains or slings.

5.0 STORAGE

5.1 UNIT STORAGE

Take the following precautions to minimize potential damage to the unit if outside storage is planned:

- Cover equipment with waterproof covering.

- Do not allow water to accumulate in or on the unit, especially if the weather conditions approach freezing (32 degrees F [0 degrees Centigrade]) or below.

- Do not store items such as valves, cylinders, switches, etc. outside.

THERMO BLACK CLAWSON ASSUMES NO LIABILITY AS TO THE SPECIFIC STORAGE REQUIREMENTS FOR EQUIPMENT OR COMPONENTS.

6.0 INSTALLATION

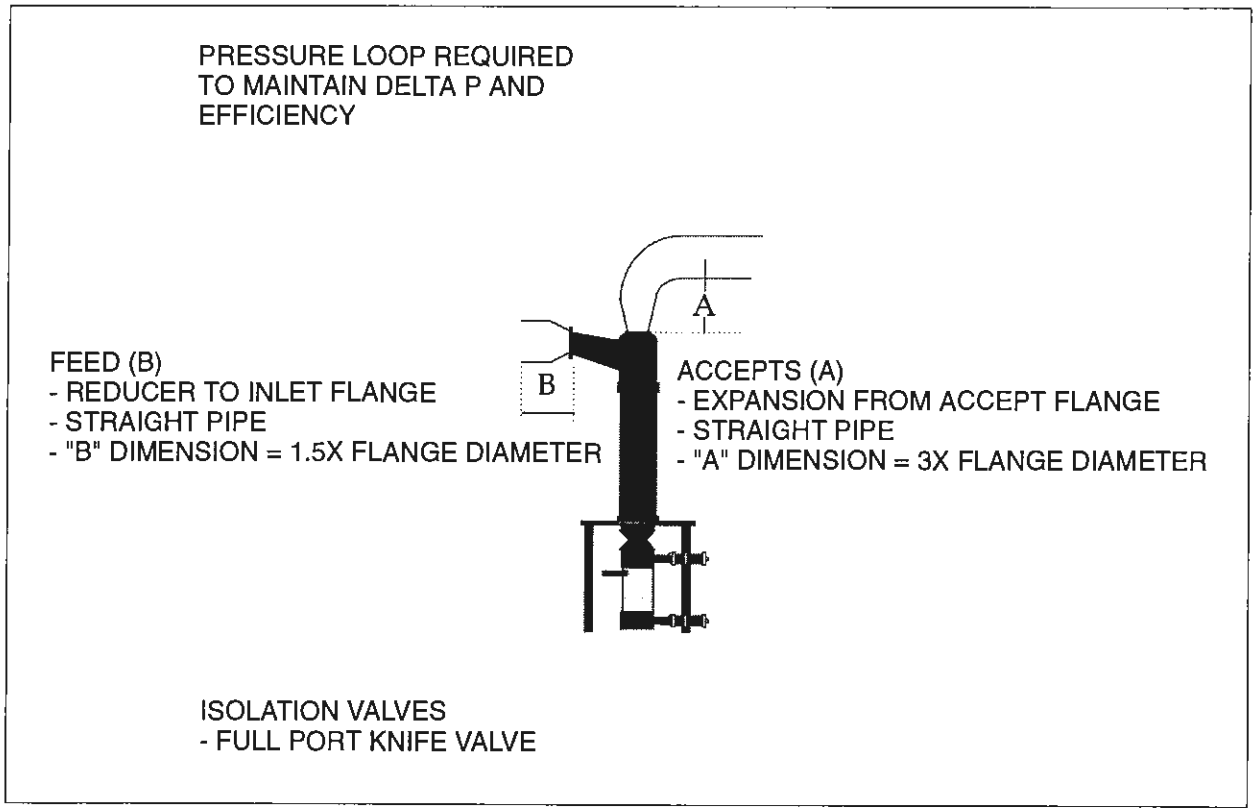
6.1 SAFETY PRECAUTIONS

Centrifugal cleaners have no internal moving parts and are designed to operate in a specific pressure range. Their overall geometry and materials of construction promote stock cleaning through centrifugal action. Continuous stock accepts flow through the cleaners. Rejects are discharged into a cylinder or other collector at the bottom of the units. This area should be guarded to protect against splash.

In some areas, where especially heavy contaminants are present, centrifugal cleaners are equipped with a reject chamber that has manual or automatic operated valves. A positive collection arrangement to discharge debris should be installed. Floor areas around centrifugal cleaners should be of non-skid construction.

Piping

Piping systems should permit cleaner bypass or shut off.



Proper Liquid Cyclone Piping

ATTENTION OPERATORS AND MAINTENANCE PERSONNEL! Read and make sure that you understand all of the safety information and correct procedures before using or servicing this equipment. This manual should be available to you at all times.

Do not modify the machine without authorization. Modifications could affect the function of

the machine, shorten machine life, or render built-in safety features useless.

Never start the machine unless the following conditions are met:

- All personnel are clear of the machine.
- All doors and/or hatches are closed.
- All guards and covers are in place.

See "Operation" section for complete start-up procedure.

Do not exceed the maximum design pressure. Maximum design pressure of this unit is stated on the certified drawings.

Bring machine to ZMS before servicing. Unit must be at zero mechanical state (ZMS) before any service work is done. All energy sources and stock supply must be shut-off and locked out with your padlock before and during installation, maintenance, inspection, cleaning, or adjusting this unit.

WARNING

Never remove another person's lock-out (padlock) or tag.

Check disconnect. Try to start motor before servicing unit.

Bleed off pressure and lock out all pneumatic, hydraulic and steam systems, electrical circuits, chemical and gas systems, water, and stock flow.

Do not proceed if services are not independent of the main supply. Contact your supervisor.

Follow installation and maintenance procedures in this manual along with your company's safety guidelines.

Use valves designed for lock-out and tagging. All valves used on this equipment should be designed to be locked out and tagged. Never operate unit without guards in place.

Tighten sheave bushings to manufacturer's specification.

Check torque prior to start up. Tack welding of bolt heads is an accepted industry practice.

CAUTION

Over tightening fasteners can result in failure of bolts and other attachments.

6.2 PRE-INSTALLATION

Complete pre-installation before you receive the unit. Use this section as a checklist.

Documents

- **Certified Drawings** - prepared by Thermo Black Clawson upon receipt of your purchase order and your returned approval drawings.
- **Owner's Manual** - sent with certified drawings.
- **Shipping List** - we send one copy with the shipment and one to the mill the day of shipment.

Foundation

Refer to the certified drawings for foundation information.

Equipment Placement

Certified drawings show space requirements for equipment operation and the anchor bolt plan. Consider equipment clearances in your layouts and maintenance and installation requirements.

When equipment has to be lowered through an opening in the floor above, be sure that it is in correct foundation position before the unit is erected.

NOTE: Check the certified drawings to determine if any unusual clearance problems will arise while moving the unit through the mill.

Lifting Equipment

We have attempted to ensure that the unit weights (not including crating weight) are on the certified drawings for each piece of equipment. If the weight is not on the certified drawings, contact Thermo Black Clawson. Verify that the hoist or crane at the mill has adequate load capacity to lift the unit safely. If not, lease lifting equipment or contract for the services of a rigger.

Electrical Requirements

Be sure that power cables and controls are properly sized, and can be routed to the unit with a minimum of bends and turns. Verify that the available electricity is correct for the equipment.

Piping

Check certified drawings for pipe sizes. Be sure that correct sizes of pipe, fittings, and adapters will be available when the piping is installed. All piping must be well supported. Expansion loops or joints should be installed in the connecting pipes to allow for linear expansion. Piping must not be connected to the unit until the grout has hardened and the foundation bolts have been tightened.

Leveling Instrument

Use a four foot level on the side of the cone cartridge.

6.3 INSTALLATION

Thermo Black Clawson assumes no responsibility for the site preparation and/or construction required for the installation of this equipment. An adequate foundation, determined from the machine weight and floor loading conditions, must be provided.

The general guidelines suggested in this manual are for those individuals involved in installing the unit. It is the responsibility of the customer's erection crew or agents to maintain *As Built* specifications during the installation of the unit. If you have any problems or questions concerning the installation of this equipment, please contact the Thermo Black Clawson Field Service Department.

Customer Supply

The customer is to furnish all foundations, anchor bolts, steel shims, packing, piping, etc. Refer to quotations and certified drawings for a complete listing of parts and hardware furnished by Thermo Black Clawson.

Foundation Surfaces

Clean all loose concrete chips and dust from foundation.

Anchor Bolt Pockets

Remove all debris and dust from anchor bolt pockets before installing sleeves.

Shim Packs

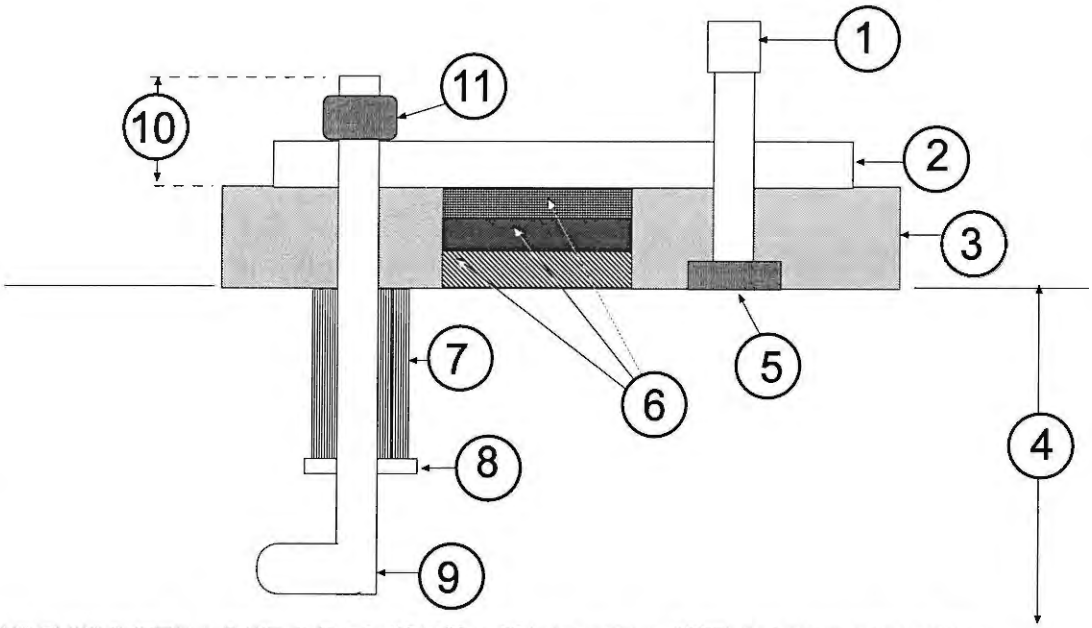
Steel shims will be required to level the unit before it is grouted in place. Mill supply must include 3 inch x 3 inch (76 mm x 76 mm) shims.

Anchor Bolts

Bolts must project at least ¼ inch (6.35 mm) through the nut when the unit is bolted down. Allow for grout and thickness of soleplate/footpads and nut when determining bolt length. See "Recommended Anchor Bolt Method" on page 34. The certified drawings call out the anchor bolt sizes, typical spacing, and layout. We recommend that anchor bolts be encased in sleeves to make allowance for minor deviations in mounting hole location.

Grout

All grout design and placement of grout is the responsibility of the customer. Deviations from standard grouting practice could result in structural failure. Piping must not be connected to the unit until the grout has thoroughly hardened and the foundation bolts have been tightened. All couplings should be final aligned after the piping is completed.



1. LEVELING SCREW; 2. BASE PLATE; 3. GROUT; 4. FOUNDATION; 5. STEEL BLOCK; 6. SHIM PACK; 7. SLEEVE; 8. WASHER; 9. ANCHOR BOLT; 10. DISTANCE PROVIDED IN CERTIFIED DRAWINGS; 11. NUT

Recommended Anchor Bolt Method

Leveling the Unit

Install the unit on the foundation by lowering it over the anchor bolts. Level the unit and place steel shims next to each anchor bolt and underneath unsupported lengths of the unit base. Level the unit by checking the vertical alignment. Plumb the unit to within .25 of an inch per four feet. Use care not to distort the alignment of the unit when shimming. The leveling screws are intended only for leveling and should carry no weight of the unit when the anchor bolts are tight. It is a good practice to remove the leveling screws at the completion of the installation.

It is important not to twist or bow the base, since this will misalign the shaft as well as change the running clearance of the rotor. The base should be checked for level on the slide surfaces on the

motor end of the unit. The top flange is not acceptable for leveling.

Snug the nuts on the anchor bolts to hold the unit while the grout is poured and sets. Firmly tighten the nuts on the anchor bolts after the grout has set.

Check the center and feed end base pads to assure that they are all resting on the shim blocks before the anchor bolts are tightened. Use caution to not have a *soft foot* which would pull a base pad down as the anchor bolt is tightened.

6.4 EQUIPMENT SET-UP

Water to Elutriation and Reject Chamber Flush Lines

- 5 to 10 psi above stock feed pressure with a flow rate of 20 to 50 gpm
- Lines should be fitted with check valves close to the entry point and throttling valves
- Quick opening ball valves are recommended for this application

The bottom of the Lohse valves are square in shape. If a transition is attached to the bottom of the lower valve to direct the "Rejects," be careful not to block the opening. Any blockage will allow the contaminants to collect - resulting in the valve jamming.

Do not make the connecting flange round. It will create a pocket for debris to build-up and jam the valve.

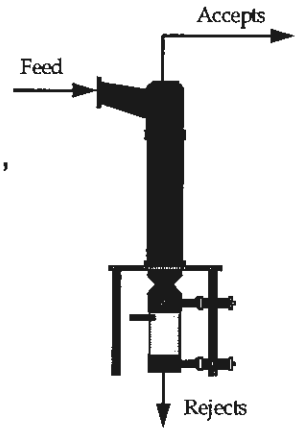
Pneumatics - Automatic Reject System

Three solenoid valves are supplied for each cleaner. These valves are stacked and assembled together for easy mounting as one unit. Each valve has speed control adjustments to allow tuning of the cylinder stroke to prevent slamming. The air supply to these valves is to be plumbed by the customer through the filter/regulator unit supplied by Thermo Black Clawson. We supply this unit with an isolation valve that can be pad locked in the closed position so as to bring the air system to a zero state.

Refer to the Certified Piping Drawing for plumbing the cylinders and flush valve.

RUFFCLONE - HIGH DENSITY CLEANING

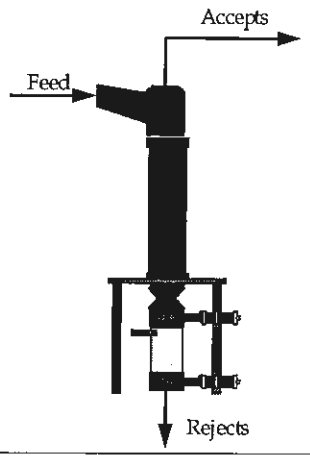
- prior to coarse screening system
- for the removal of stones, box staples, bullets, and other gross debris
- 8" to 25" diameter
- 300 to 3,300 GPM
- 5 to 20 Delta P
- timed purge cycle - intermittent rejects
- feed consistency range - 5% maximum



Ruffclone

LIQUID CYCLONE - MEDIUM DENSITY CLEANING

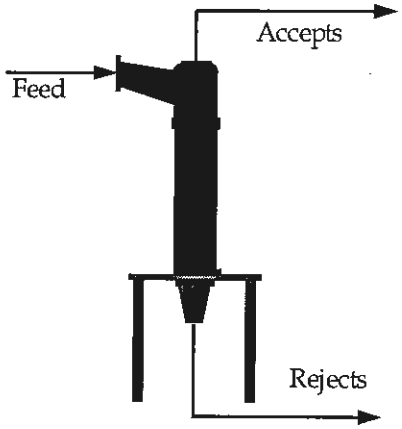
- prior to fine screens
- for the removal of sand, aluminum foil, paper staples and other gross debris
- 8" to 25" diameter
- 340 to 4,400 GPM
- 20 to 35 Delta P
- timed purge cycle - intermittent rejects
- feed consistency - 2.5% maximum



Liquid Cyclone

LIQUID CYCLONE CONTINUOUS REJECTS

- used in primary medium density cleaning position
- secondary stage auto rejects
- 10" to 25" diameter
- 520 to 4,000 GPM
- 20 to 30 Delta P
- continuous rejects - no valves
- feed consistency range - 2.5% maximum



Liquid Cyclone Continuous Rejects

Service Connections

Follow each manufacturer's recommended installation instructions.
The following items require your attention:

- Proximity Switches - Electrical connection
- Solenoid Valve - Air/Control connection
- Lohse Valves - Air/Control connection

Check your certified drawings to determine hook-up locations on the unit and service connection sizes.

7.0 OPERATION

7.1 PRE-CHECKOUT

Many programmable solid state systems have the capability of simulating operation in a mode known as *Test Mode* or *Dry Run Mode*. These modes allow a user to check a program and correct obvious programming errors with outputs disabled. Unexpected machine motion and possible damage to equipment is avoided. These modes can also be used to verify proper system operation after a repair.

Many programmable systems provide for *Force On* and *Force Off* of inputs and outputs. These functions can reduce troubleshooting and maintenance time by enabling personnel to bypass certain operations without physically operating switches on a machine.

WARNING

When using *Force* functions avoid exposing personnel to hazardous machine motions or process operations which might cause personal injury or death.

Mechanical start-up involves the following steps, which must be carried out in sequence:

- Inspect the installation before the power is connected.
- Disconnect motors and other devices that cause machine motion.
- Test inputs.
- Test outputs.
- Enter and verify your program.
- Test the system with motors and other motion-causing devices reconnected.
- Go through a *dry run* of the application.

The purpose of these procedures is to isolate such problems as wiring mistakes, equipment malfunction, and programming errors in a systematic, controlled manner. Go through these procedures very carefully. Following a given set of steps will help avoid possible personal injury and equipment damage.

WARNING

During all phases of motion check-out, station a person ready to operate the power switch if necessary.

Inspect and make sure of the following before starting the unit:

- All guards and covers are in good condition and fastened in place.
- No parts are loose, worn, damaged, or missing.
- All personnel are clear of the equipment.

7.2 CONTROL GUIDELINES

Safety considerations are an important element of proper troubleshooting procedures. Actively thinking about safety of yourself and others, as well as the condition of your equipment is of primary importance. Several safety areas are discussed below.

Power Supply

Before working on a power supply, always remove the AC power source at the main disconnect switch. When using more than one power supply, be sure to disconnect all of them.

Main Power Disconnect

The main power disconnect switch should be located where operators and maintenance personnel have quick and easy access to it. Ideally, the disconnect switch is mounted on the outside of the enclosure so that it can be accessed without opening the enclosure. In addition to disconnecting electrical power, de-energize all other sources of power (pneumatic and hydraulic) before working on a panel controlled machine or process.

Activating Devices When Troubleshooting

When troubleshooting, never reach into the machine to actuate a device. Unexpected machine motion could occur.

Operation Safety Precaution

When troubleshooting any control panel problem, have all personnel remain clear of the machine. The problem could be intermittent, and sudden unexpected motion could occur. Have someone ready to operate an emergency stop switch in case it becomes necessary to shut off power to the machine.

Program Alteration

There are several causes of alteration to the user program, including extreme environmental conditions, electromagnetic interference (EMI), improper grounding, improper wiring connections and unauthorized tampering. If you suspect the memory has been altered, check the program against an approved version such as on the EEPROM memory module.

Hardwired Circuitry

WARNING

Circuits that are installed on the machine for safety reasons, including overtravel limit switches, stop push buttons, and interlocks, should always be hardwired in series so that when any one device opens, the master control relay is de-energized, thereby removing power to the machine. Never alter these circuits to defeat their function. Serious injury or machine damage could occur.

Safety Recommendation for Maintenance Personnel

All maintenance work should be done by qualified personnel familiar with construction, operation, and hazards involved with the equipment.

Follow the appropriate work practices of the National Fire Protection Association (NFPA) for Electrical Standards for Industrial Machinery.

Make-Do testing devices such as incandescent lamps have low impedance. The low impedance of these devices can effectively change a voltage level from logic *1* condition to a logic *0* condition when attempting to make a measurement. Unexpected machine motion can result if an output to a controlled device is energized as a result. Neon lamps do not respond to voltages typically used in logic circuits (e.g. 32 VDC or less). Use of a neon lamp tester could lead to false conclusions about the voltage present in a circuit.

High input impedance meters are required to obtain accurate voltage measurements in high impedance circuits. Unless otherwise specified by the manufacturer, a meter with an input impedance of ten (10) megohms or greater is recommended for making voltage measurements. The meter must also have sufficient sensitivity to measure logic level voltages; some meters do not respond to low voltages.

Control Panels

The control panels are designed using all NEMA (National Electrical Manufacturer's) and/or UL (Underwriter's Laboratory) approved components suited for the environment in which it is being placed. Every effort is made to adhere to the NEC (National Electrical Code), OSHA (Occupational Safety and Health Act), ANSI (American National Standards Institute), and mill standards as they apply to your application.

The power feed should include an equipment grounding conductor to bond the enclosure to building earth ground.

DANGER

Touching exposed live electrical wires will cause serious personal injury or death.

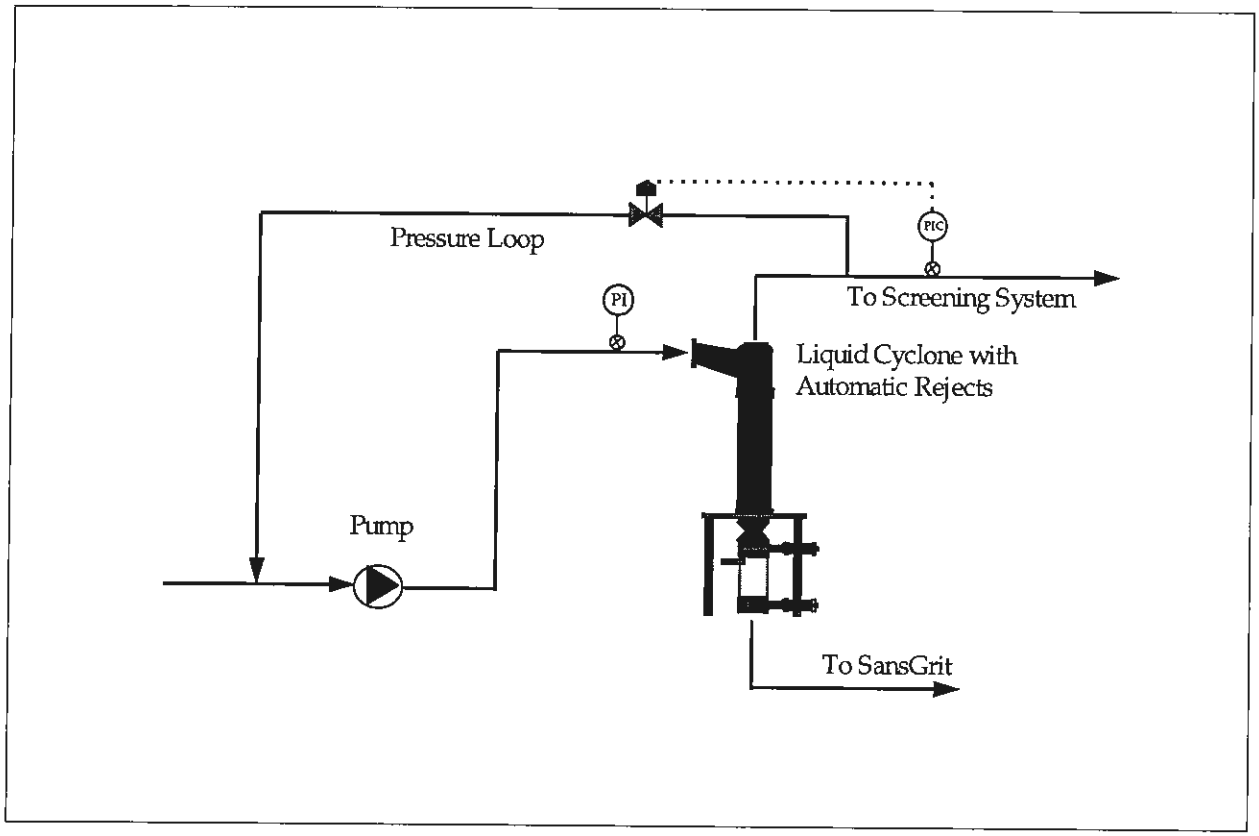
- Power feed should have a disconnect or breaker capable of being locked in the open position.
- Wire field devices per certified drawings furnished with the control panel.
- Route field wiring to separate the AC from the DC and/or low level signals.
- All the electronic instruments were factory programmed to a fail safe state (if a component failure occurs). The panels include a power push button that, when pushed, will power down the main panel.

Ruffclones generally operate in the 5 to 20 PSI (35 to 105kPa) pressure drop range and remove nuts, bolts, staples, rocks, paper clips, and other large and heavy objects at consistencies up to 5%. Liquid Cyclones generally operate in the 20 to 35 PSI (105 to 238 kPa) pressure drop range, and remove metal clips, glass, sand, metal foil, and other small heavy debris and abrasives from the

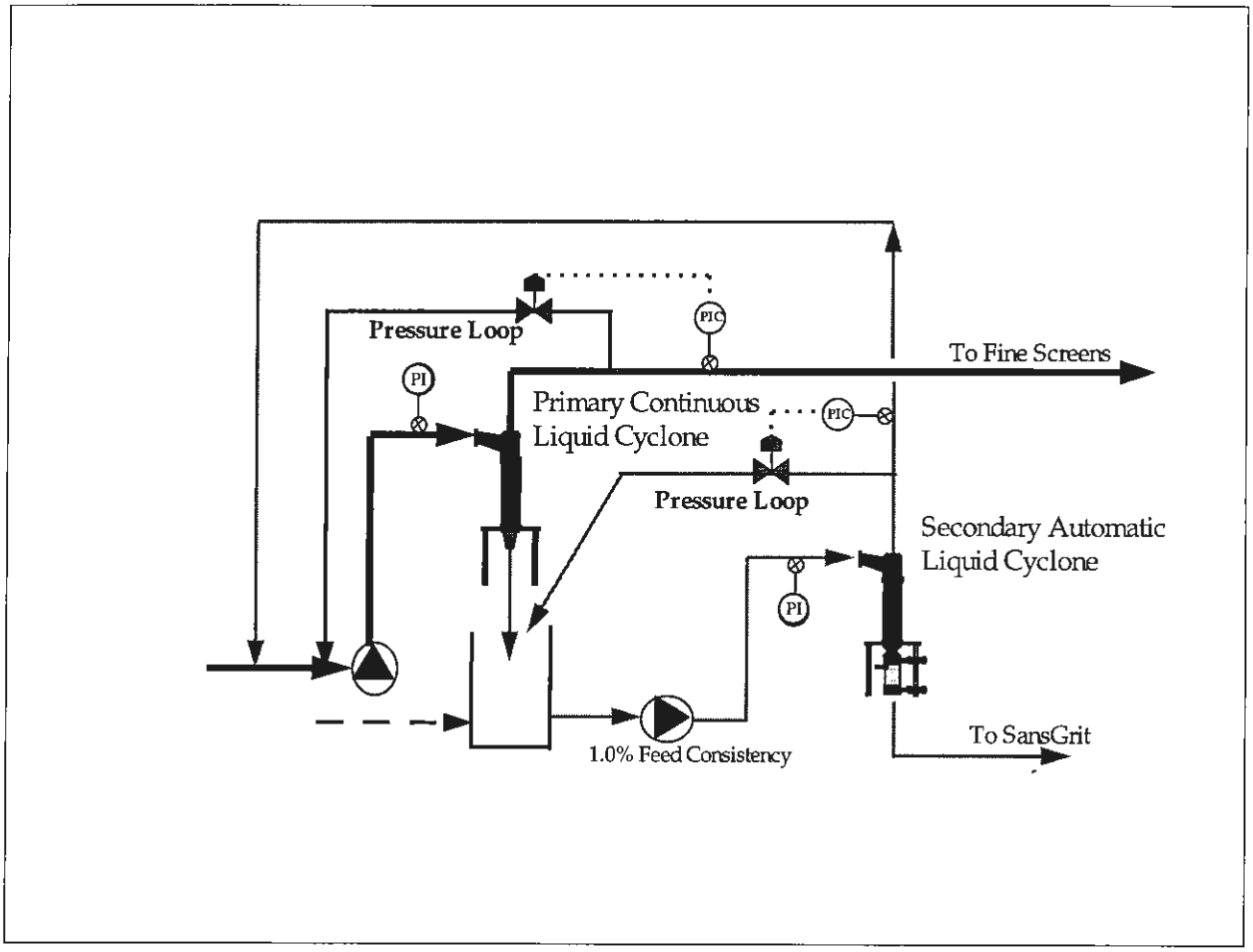
water and stock at up to approximately 2.5% consistency.

Cleaning Efficiency

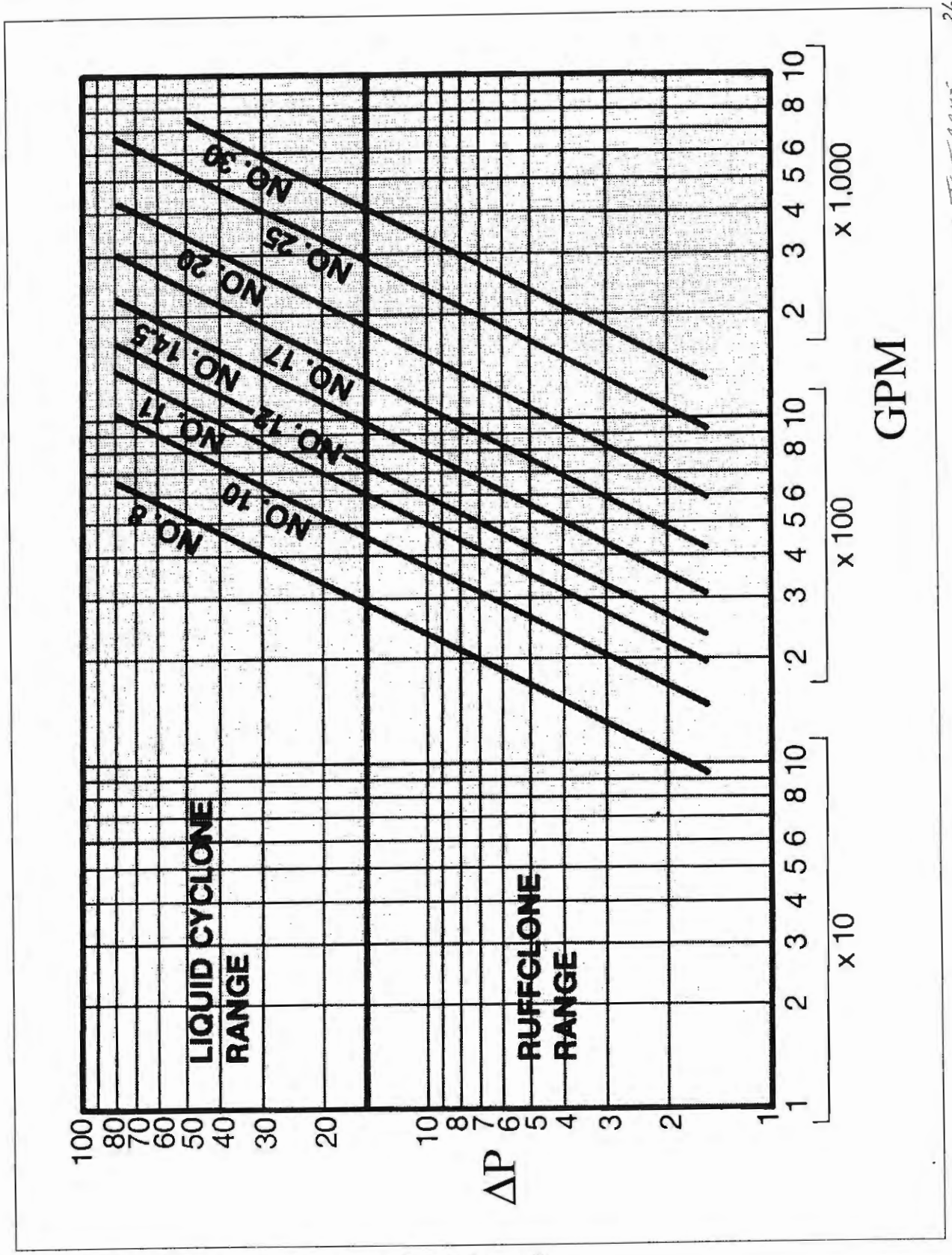
Both Liquid Cyclones and Ruffclones clean more efficiently at lower consistencies and higher pressure drop ranges. If constant outlet pressure is desired (for direct feed into a pressure screen, refiner, etc.), size the feed pump for your maximum flow volume plus 10 to 20 percent for recirculation. Elutriation water (20 to 50 GPM) is added to wash the fiber from the rejects. Elutriation water pressure should be 5 PSI (35 kPa) higher than feed pressure.



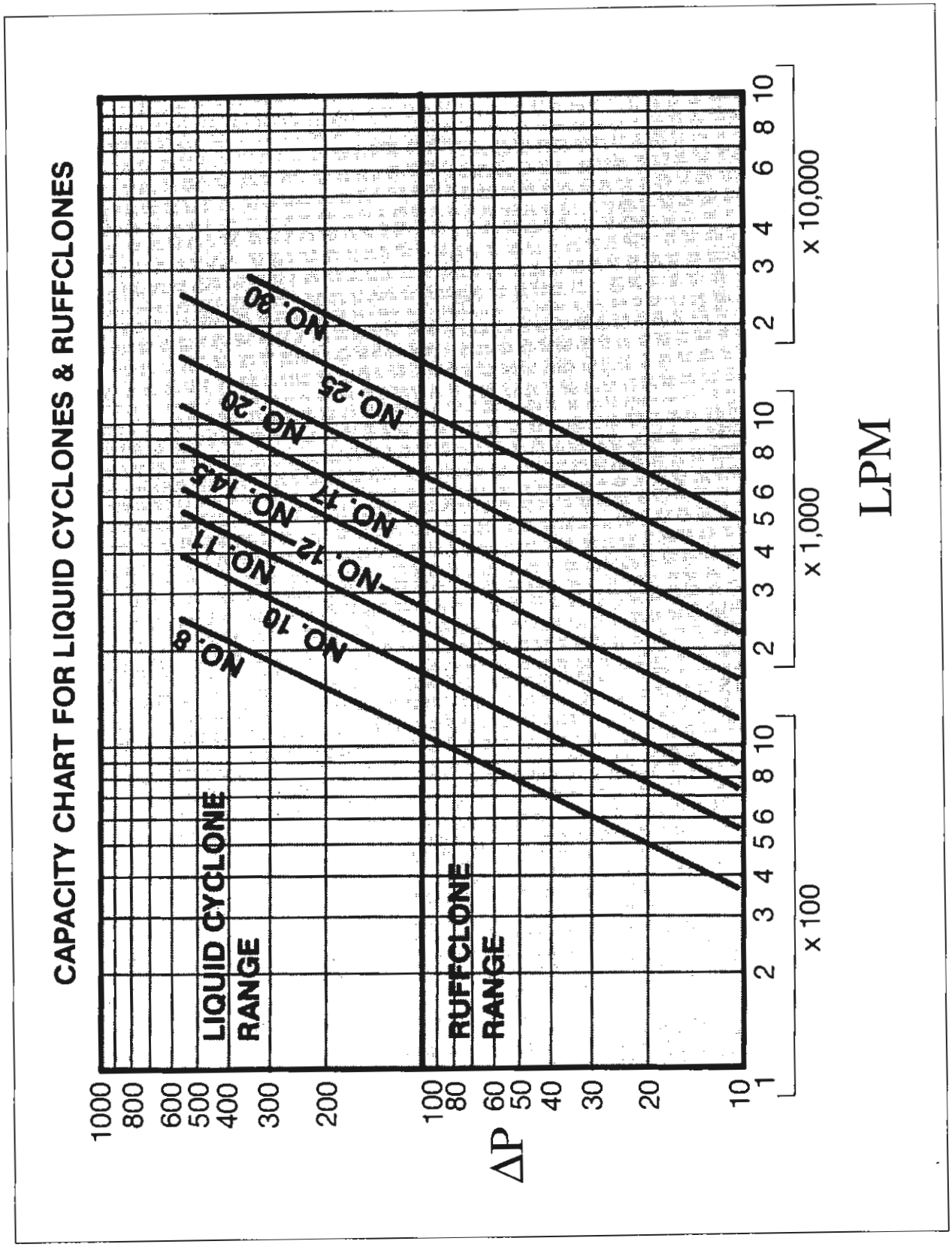
Automatic Reject Liquid Cyclone System



Continuous Reject Liquid Cyclone System



Capacity Chart for Liquid Cyclones and Ruffclones #1



Capacity Chart for Liquid Cyclones and Ruffclones #2

Education and Knowledge Lead to Safety

Planning for an effective solid state circuit requires enough knowledge to make basic decisions that will render the system safe as well as effective. Everyone who works with a solid state control should be educated in its capabilities and limitations. This includes in-plant installers, operators, service personnel, and system designers.

7.3 OPERATION

Elutriation Water

This is white water going into the bottom end of the cone cartridge and should have a pressure of 5 to 10 psi above the stock inlet pressure with a flow rate of 20 to 50 gpm. A check valve, close to the entry point, will aid in keeping stock out of the water line, in the event of pressure loss. The elutriation water serves to slow the high rotation of material inside of the cone cartridge, which promotes the descent of heavy material and flushes fiber back up to the accept port. Wear in the top valve is also reduced by the slower rotation. To confirm that there is flow in the elutriation lines, they may be checked for temperature, providing there is a difference between the stock and white water temperature. Another check point would be the window in the reject chamber. A slight rotation of stock may be seen along with a low fiber content. Insufficient elutriation water results in a higher rate of rotation and higher fiber content in the reject chamber.

Manual Reject System

The manual reject box would be used in a system that would produce reject material in quantities that would require the box to be cleaned out once or twice a shift. A hand wheel operated valve is provided to isolate the cone cartridge and line stock pressure, from the reject chamber.

Reject Box Cleanout Procedure

- Close the reject chamber isolation valve.

WARNING

Close the reject chamber isolation valve. Be sure valve is closed before proceeding. Serious personnel injury can occur when opening the clean out door if valve is not properly closed. Contaminant build up in the valve area may be so severe that the unit may need to be isolated and bypassed to remove the blockage from the valve.

- Open the bleed off valve on the top of the chamber to relieve any pressure.
- Open the drain valve on the bottom of the chamber.
- Open the cleanout door and remove the reject material.
- Clean off the face of the door and the chamber to obtain a good seal.
- Close door and secure.
- Close the drain valve.
- Open the white water fill valve, until water comes out of the bleed off valve.
- Close the bleed off valve.
- Open the reject chamber isolation valve.

The Liquid Cyclone is now back on line.

Automatic Reject System

The automatic reject system consists of two air-operated, slide, gate valves and a reject chamber. The valves are positioned on the top and bottom of the reject chamber with the top valve normally open and the bottom closed. The reject cycle has the top valve closing and the bottom valve opening, with a white water flush line being opened to flush out the reject chamber. Proper controls are provided that assure that both valves do not open at the same time.

WARNING

Do not operate unit on line with valves cycling out of sequence.

NOTE: Normally, proximity switches have been found to e the most successful as opposed to mechanical type switches. As the bottom valve opens, a white water flush valve Is opened, which will clean out the chamber.

Valve Failure /Plugging

WARNING

Do not reach into the cleaner if a reject port becomes plugged. Use a mechanical assist to clear the obstruction.

In the event that the valves fail to operate, the cone cartridge chamber will fill up with reject material and cause severe wear. This condition must soon be corrected and periodic checks need to be made to insure that a plugged condition does not exist. In the event of this happening, the plug must be removed. Too many people find it easier to try to punch it out with a steel rod, up through the reject chamber. This may or may not be successful and is very dangerous to the ceramic liners, which are easily broken. Also, do not hammer on the out side of the cone cartridge, as this may fracture the ceramic liner. It would be best to support the inlet chamber, remove the bolts from the top and bottom ends of the cone cartridge and swing it out for cleaning. When the chamber is replaced, note that the rubber gasket at each end may need to be replaced.

Normal Start Up

Don't start the machine until the following conditions are met:

- All personnel are clear of the machine.
- All doors and/or hatches are closed.
- All guards and covers are in place.

When the preceding conditions are met, begin the start-up procedure as follows:

- Start feed pump.
- Open accept valve.
- Adjust valves for pressure.

Single Unit

This control panel uses a collect-dump timer system to sequence through a cycle of rejects.

- When the collection time has expired, the top valve closes and activates its closed limit switch which allows the bottom valve to open. When this valve opens, a limit switch is activated, the flush water valve is opened and the dump timer started.
- When the dump timer expires, the bottom valve closes but the flush water valve remains open to fill the reject chamber. The top valve will reopen only after the bottom valve's limit switch is actuated. The flush water valve closes upon expiration of the interval timer.
- The cycle is now complete and will automatically repeat upon expiration of the collection timer.

Multi Unit/Individual Operation

This control panel is used when a mill has two or more cleaners in a series loop at different points in the process. The panel can be installed at a central location allowing minimal conduit runs from the multiple cleaners. The panel contains individual controls for each cleaner. The operating sequence of each cleaner is identical to the sequence described for the single unit panel. The panel hardware is usually changed from discrete timers to a programmable controller for control of three or more cleaners, but each cleaner would still have its own selector switches, pilot lights and timer settings.

Multi Unit/Sequential Operation

This control panel is used when a mill has two or more cleaners piped in parallel somewhere in the process. The operating sequence is as follows:

- Operator pushes the cycle start push button to initiate cleaner sequence. This begins the collection period.
- Upon the expiration of the fill timer, No. 1 cleaner's top valve closes starting its dump cycle.
- When the top valve closes, the sensor actuates and the bottom valve will open and the flush-water solenoid energizes introducing washout water.
- Upon expiration of the dump timer, the bottom valve closes but the flush water solenoid remains energized to put some fill water into the dump chamber. This solenoid de-energizes upon the expiration of the fill-flush timer.
- When the bottom valve closed sensor actuates, the No. 1 cleaner dump complete signal is set initializing No.2 cleaner's cycle just described and upon receiving its dump complete signal,

will initiate the next cleaner if required.

- After the last cleaner's complete signal is set, the collection period starts over and the sequence repeats.

NOTE: Each cleaner has a by-pass switch when turned to the position will cause its valves to remain closed. Its cycle will time as normal and when its dump complete signal is set the following cleaner will cycle.

NOTE: During a cycle, the operator has the ability at any time in the sequence to manually dump any cleaner by pushing its manual reject button.

Normal Shut Down

- Shut off the pump.
- Turn off elutriation water.
- Stop reject valve timer.

Emergency Shut Down

Shut off the pump.

8.0 MAINTENANCE

8.1 ROUTINE MAINTENANCE

Perform a general inspection of the equipment at least every three months or every 1,000 hours of running time. Locating and eliminating minor problems will extend the service life of the unit.

Periodic Inspection

Perform a general inspection and tightening of the machine twice a year. Locating and eliminating minor problems will assure long and dependable service. In many instances, periodic inspections will eliminate costly shut-downs and delays.

WARNING

Follow your prescribed safety procedures and those listed in this manual to prevent accidental starting while inspecting or servicing the unit.

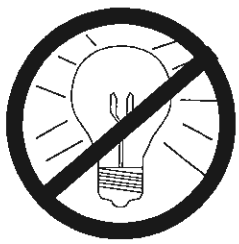
To prepare for a maintenance check, shut down the unit according to "Normal Shut Down" on page 49 and bring it to a zero mechanical state (ZMS) and lock out all sources of energy. Bringing the unit to a zero mechanical state includes but may not be limited to the following:

- Close off and divert stock lines
- Manually operate dump valves and block them open
- In situations where automatic timed dump valves are used, the system is to be blocked, locked out, and posted at the main control panel.

Use mechanical assists in cleaning. A wash down of internal parts and surfaces may be required. Take special care in handling these units--blemishes or distortions will adversely affect their ability to separate contaminants.

WARNING

Do not operate an incandescent light bulb as a load to a proximity sensor. The in-rush current will cause an overload condition.

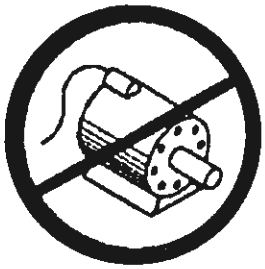


WARNING

Do not operate a proximity sensor from a wall outlet without a load. This is considered ad dead short and can cause catastrophic damage to a nonshort-circuit protected sensors.

WARNING

Do not directly operate a motor with a proximity sensor. The in-rush current can cause an overload condition. Always use a motor starter, relay, or other appropriate device.



Components Requiring Routine Maintenance

COMPONENT	SERVICE	FREQUENCY
valves	lubricated	daily
	monitored to ensure that they are operating	daily
proximity switches	check tightness of mounting bolts and for their proper operation	daily
inlet header	check for wear	twice a year
cone cartridge	inspect for damage and check for wear of the cone cartridge	twice a year
reject chamber	check for wear	twice a year
elutriation and reject chamber flush lines	check for flow.	Check daily.

8.2 TROUBLESHOOTING

Troubleshooting Guide

CONDITION	CHECK FOR
excessive fiber loss	elutriation water flow and pressure
rapid wear of top valve	elutriation water flow and pressure
low delta-P	flow rate lower than design plugged cone cartridge worn feed pump
valves not operating	air pressure setting debris in valve slide ways Lubrication point(s) on valve
rapid wear of reject chamber	flush line pressure may be excessive
small amount of reject material while running dirty furnish	valve not operating
	elutriation water flow and pressure.

9.0 SERVICE PARTS

9.1 RECOMMENDED PARTS

We recommend that you keep the following parts on hand for repairs and routine maintenance. This list does not include specific part numbers for your unit. You should refer to your certified drawings for individual part numbers or, if you would like a list of part numbers for your unit, contact:

Thermo Black Clawson Inc.

605 Clark Street, Middletown, OH 45042-0160

Phone 1-513-424-7400

North America emergency 24-hour service: 1-800-448-5422

Global emergency 24-hour service: 1-513-391-0881

Customer Service Department

Fax: 1-513-422-1168

E-Mail: CUSTSERV@BLACKCLAWSON.COM

IMPORTANT: When ordering spare parts or requesting a parts list, refer to the certified drawings and give the item number, drawing number, and part description, along with the product numbers. (Product identification numbers include the serial number, shop order number and model number.) Generally, allow eight to twelve weeks for delivery.

Do not modify the equipment without written authorization from Thermo Black Clawson. Unauthorized modification may impair the function, shorten the machine life, and/or render built-in safety features useless.

Recommended Spare Parts - Manual Rejects

Description	Quantity
Sight window	one per unit
Cone cartridge	one per unit
Wear sleeve	one per unit

Recommended Spare Parts - Automatic Rejects

Description	Quantity
Valves (less cylinder)	two per unit
Repair kit (valves)	two per unit
Repair kit (cylinder)	two per unit
Cone cartridge	one per unit

Description	Quantity
Wear sleeve	one per unit
Solenoid	one per unit
Proximity switch	one per unit

Recommended Spare Parts - Continuous Rejects

Description	Quantity
Cone cartridge	one per unit
Wear sleeve	one per unit

10.0 CUSTOMER INPUT

10.1 QUALITY ASSURANCE THROUGH CUSTOMER INPUT

As a Thermo Black Clawson customer, you can help us toward our goal of providing high quality manuals that meet or exceed our customers' expectations. We would like to hear from you if you have suggestions or comments that would help us toward this effort. From procedures to safety issues and other areas, your input and concerns are important to us. Perhaps we haven't described something as much as you think we should have. Maybe you have a technique that you'd like to share with us. If you have input that would help us improve our manuals, write or fax your comments to us:

Thermo Black Clawson Inc.
Technical Writing
605 Clark Street
Middletown, OH 45042 USA
Fax: 1-513-424-1168

11.0 GLOSSARY

Term	Synonym/s Definition/Function
absolute viscosity	Absolute viscosity is the kinematic viscosity corrected to overcome the variations caused by the differences in specific gravity. The centipoise is one hundredth of a poise and is the unit of absolute viscosity most commonly used. The relation between absolute and kinematic viscosity is as follows: $\frac{\text{Centipoises}}{\text{Specific Gravity}} = \text{Centistokes; or Centipoises} = \text{Centistokes} \times \text{Specific Gravity}$
API gravity	An arbitrary scale (chosen by the American Petroleum Institute) in which the specific gravity of pure water is taken as 10. Liquids lighter than water have values greater than 10; liquids heavier than water have values less than 10. $\text{Degrees A.P.I.} = \frac{141.5}{\text{S.G. 60/60F}} - 131.5$ S.G. = specific gravity F = degrees Fahrenheit
cp	Centipoise One centipoise is 0.01 poise which is the absolute unit of viscosity. The centipoise is derived from the kinematic unit of viscosity, the centistoke, by multiplying it by the specific gravity of the fluid. By definition, the viscosity of water at 20 degrees Centigrade is one centipoise. centipoise = centistoke x specific gravity
CFM	cubic feet per minute
cSt	Centistokes The unit of kinematic viscosity is the centistoke. Kinematic Viscosity in centistokes = Ct C = viscometer constant t = observed flow time in seconds

Term	Synonym/s Definition/Function
cavitation	The formation and collapse of vapor bubbles in a liquid.
DCS	distributed control system
D.O.D.	diameter of discharge
D.O.S.	diameter of suction
EMI	electromagnetic interference
friction head	h_f The head required to overcome the resistance to flow in the pipe and fittings. It is dependent upon the size and type of pipe, flow rate, and nature of the liquid.
GPM	gallons per minute
H	*see* total head
h_d	*see* total dynamic suction discharge head
h_f	*see* friction head
HIC	hand indicator controller
HP	horse power
h_s	*see* total dynamic suction lift and total dynamic suction head
h_v	*see* velocity head
head	The pressure at any point in a liquid can be thought of as being caused by a vertical column of the liquid which, due to its weight, exerts a pressure equal to the pressure at the point in question. The height of this column is called the static head and is expressed in terms of feet of liquid. The static head corresponding to any specific pressure is dependent upon the weight of the liquid accord to the following formula: $\text{Head in feet} = \frac{\text{Pressure in PSI x 2.31}}{\text{Specific Gravity}}$
junk trap	junk chamber, junk box, trashwell
kPa	kilopascal

Term	Synonym/s Definition/Function
kW	kilowatt
kinematic viscosity	The property measured when a fixed amount of oil flows through a capillary tube under the force of gravity. The unit of kinematic viscosity is the stoke or centistoke. An intermediate measurement in seconds can be converted to centistoke with the use of the viscometer (or viscosimeter) constant. Kinematic Viscosity, cs=Ct where C=Viscometer Constant t=Observed flow time in seconds
LPM	Liters per minutes
NPSH	net positive suction head The total suction head in feet absolute, determined at the suction nozzle and corrected to datum, less the vapor pressure of the liquid in feet absolute. It is an analysis of energy conditions on the suction side of a pump to determine if the liquid will vaporize at the lowest pressure point in the pump.
NPSHA	net positive suction head available NPSHA is a function of the system in which the pump operates. It is the excess pressure of the liquid in feet absolute over its vapor pressure as it arrives at the pump suction.
NPSHR	net positive suction head required NPSHR is a function of the pump design. As the liquid passes from the pump suction to the eye of the impeller, the velocity increases and the pressure decreases. There are also pressure losses due to shock and turbulence as the liquid strikes the impeller. The centrifugal force of the impeller vanes further increases the velocity and decreases the pressure of the liquid. The NPSHR is the positive head in feet absolute required at the pump suction to overcome these pressure drops in the pump and maintain the liquid above its vapor pressure. The NPSHR varies with speed and capacity within any particular pump.
OCC	old corrugated container
OD T/D	oven dried tons per day
PSI	pounds per square inch
PSIG	pounds per square inch gage In this manual, PSI and PSIG have the same meaning.

Term	Synonym/s Definition/Function
pressure head	Pressure head must be considered when a pumping system either begins or terminates in a tank which is under some pressure other than atmospheric. The pressure in such a tank must first be converted to feet of liquid. A vacuum in the suction tank or a positive pressure in the discharge tank must be added to the system head, whereas a positive pressure in the suction tank or vacuum in the discharge tank would be subtracted. The following formula converts inches of mercury vacuum into feet of liquid: (Vacuum is abbreviated to Vac.) $\text{Vac., ft. of liq.} = \frac{\text{Vac., in. of Hg x 1.13}}{\text{Specific Gravity}}$
static discharge head	The vertical distance in feet between the pump centerline and the point of free discharge of the surface of the liquid in the discharge tank.
static head	*see* head
static suction head	The vertical distance in feet from the centerline of the pump to the free level of the liquid being pumped.
static suction lift	The vertical distance in feet from the centerline of the pump to the free level of the liquid to be pumped.
suction head	Exists when the source of supply is above the centerline of the pump.
suction lift	Exists when the source of supply is below the centerline of the pump
T/D	tons per day
TDH	total dynamic head The total dynamic discharge head minus the total dynamic suction head or plus the total dynamic suction lift. $TDH=h_d + h_s$ (with a suction lift) $TDH=h_d - h_s$ (with a suction head)
T.I.R.	total indicated runout (on a dial indicator)
total dynamic head	(see TDH)

Term	Synonym/s Definition/Function
total dynamic discharge head	h_d The static discharge head plus the velocity head at the pump discharge flange plus the total friction head in the discharge line. The total dynamic discharge head, as determined on pump test, is the reading of a gage at the discharge flange, converted to feet of liquid and corrected to the pump centerline, plus the velocity head at the point of gage attachment.
total dynamic suction head	h_s The static suction head plus the velocity head at the pump suction flange minus the total friction head in the suction line. The total dynamic suction head, as determined on pump test, is the reading of the gage on the suction flange, converted to feet of liquid and corrected to the pump centerline, plus the velocity head at the point of gage attachment.
viscosity	Viscosity is a measure of flowability at definite temperatures. Change in viscosity indicates contamination or oxidation instability.
viscosity index	The viscosity index is an empirical number indicating the rate of change in viscosity of an oil within a given temperature range. A low viscosity index signifies a relatively large change in viscosity with temperature, while a high viscosity shows a relatively small change in viscosity with temperature.
ZMS	zero mechanical state - (1) Every power source that can produce a machine member movement has been locked off; (2) Pressurized fluid (air, oil, or other) power lockoffs (shut-off valves), if used, will block pressure from the power source and will reduce pressure on the machine side port of that valve by venting to atmosphere or draining to tank; (3) All accumulators and air surge tanks are reduced to atmospheric pressure or treated as power sources to be locked off, as stated in paragraph 1 and 2; (4) The mechanical potential energy of all portions of the machine is at its lowest practical value--so that opening of pipe(s), tubing, hose(s), or actuation of any valve(s) will not produce a movement that could cause injury; (5) Pressurized fluid (air, oil, or other) trapped in the machines lines, cylinders, or other components is not capable of producing a machine motion upon actuation of any valve(s); (6) The kinetic energy of the machine members is at its lowest practical value; (7) Loose or freely movable machine members are secured against accidental movement; (8) A workpiece or material supported, retained, or controlled by the machine shall be considered as part of the machine if the workpiece or material can move or can cause machine movement.