HydroBlast™ 7100MG EXM2 Water Cannon

Installation, Operating, & Maintenance Instructions

98613000 REV-Rel

1-574-295-8330
www.elkhartbrass.com

ELKHART BRASS
FIRE FIGHTING EQUIPMENT A SAFE FLEET BRAND

Table of Contents

List of Figures

List of Tables

FOREWORD

Note: This Manual, P/N 98613000, is to be used by qualified and trained personnel, knowledgeable of NFPA standards and any other applicable standards in effect.

This Manual is intended to provide guidance to qualified technical professionals for the installation, operation and maintenance of the HydroBlast™ Intelligent Mining washdown cannon system.

Only qualified persons experienced and trained in the installation of this type of equipment should install and configure the HydroBlast.They must be familiar and experienced with the wiring diagrams and components,electrical installation, and familiar not only with NEC, relevant NFPA and local codes but also trained and qualified by Elkhart Brass Manufacturing Company, Inc (a Safe Fleet Company). Elkhart Brass Manufacturing Company, Inc. is a manufacturer of the components that make up the HydroBlast washdown system, and may not have the opportunity to visit the sites where the product is installed or intended to be installed. It is the responsibility of the professional installer (described above) to properly install and configure the systems. Under no circumstances will Elkhart Brass Manufacturing Company, Inc. be liable for improper installation or configuration of the systems.

The technical data contained herein is provided for informational purposes only, and should not be used as a substitute for professional judgment. Although, Elkhart Brass Manufacturing Company, Inc. believes this information to be true and correct, it is published and presented without any guarantee or warranty whatsoever. Elkhart Brass Manufacturing Company, Inc. disclaims any liability for any use of the data other than as set out in this manual, foreword included.

Any questions concerning the information presented in this manual should be addressed to:

Elkhart Brass Manufacturing Company, Inc.
1302 West Beardsley Avenue
Elkhart, IN 46514, USA
Phone: 1-574-295-8330
www.elkhartbrass.com

TERMS AND ABBREVIATIONS

°C	°Celsius	**NEMA**	Nation Electrical Manufacturers Association
°F	°Fahrenheit	**NFPA**	National Fire Protection Association
A	Ampere	**V**	Volts
AC	Alternating Current	**VAC**	Volts AC
AWG	American Wire Gauge	**VDC**	Volts DC

cm	Centimeters
DC	Direct Current
ft	Feet
GPM	Gallons Per Minute
LPM	Liters Per Minute
m	Meters
mm	Millimeters
N	Newtons
LED	Light Emitting Diode
NEC	National Electric Code

PRODUCT SAFETY INFORMATION

- All personnel who may be expected to use this equipment must be thoroughly trained in its safe and proper use.
- Before flowing water from this device, check that all personnel are out of the stream path. Also, check to make sure stream direction will not cause avoidable property damage.
- Become thoroughly familiar with the hydraulic characteristics of this equipment, and the pumping system used to supply it. To produce effective streams, operating personnel must be properly trained.
- Whenever possible, this equipment should be operated from a remote location. Do not needlessly expose personnel to dangerous fire conditions.
- Open water valves supplying this equipment slowly so that piping fills slowly, thus preventing possible water hammer occurrence.
- After each use, and on a scheduled basis, inspect equipment per instructions in the Maintenance section.
- Any modifications to the electrical enclosures will destroy the NEMA 4 rating and void warranty coverage of the enclosure and all components within.

Important: Before installing and operating provided equipment, read this manual thoroughly. Proper installation is essential to safe operation.

SYSTEM INFORMATION:

Cannon Serial Number: _____

Cannon Accessories (Nozzle Gallonage and Type, Types of Transmitters, Water Valve, Etc.):

CHAPTER 1 - GENERAL INFORMATION

1-1 INTRODUCTION

This manual contains the operation, installation, maintenance, troubleshooting, and parts list information necessary to support the HydroBlast Automatic Remote Controllable Washdown Cannon System (hereinafter referred to as the "HydroBlast").

1-2 SYSTEM DESCRIPTION

The HydroBlast washdown system is an automatic remote controllable industrial washdown monitor (cannon) system which performs wash operations with high flow pressurized water based on customer defined pre-programmed wash sequence. For each wash application, the HydroBlast system can provide:

- Horizontal cannon travel
- Vertical cannon travel
- Diagonal cannon travel
- Variable cannon speed control

Figure 1-1 illustrates the HydroBlast washdown cannon system

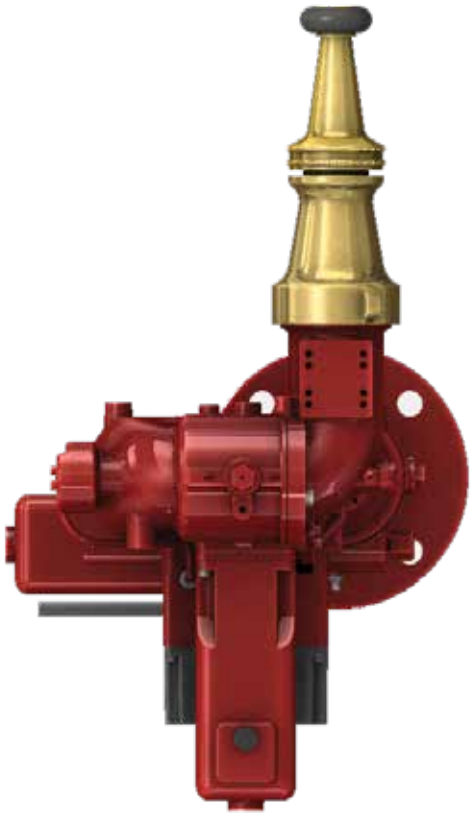

Figure 1-1. HydroBlast Washdown System

1-3 SYSTEM COMPONENTS

The main components of the HydroBlast washdown system are:

- Monitor (cannon)
- Monitor onboard CAN control module
- Nozzle
- CAN to Ethernet IP translator (gateway)

1-4 OPTIONAL COMPONENTS

- Remote control unit
- Local joystick control
- Monitor protective cage
- Gateway enclosure

1-5 CANNON

The HydroBlast cannon P/N 02007100MG is constructed of silicone bronze with industrial grade bearings and seals making it suitable for dusty and corrosive environment applications. It is specially designed for severe duty cycles. Unique waterway swivel joints utilize stainless steel thrust rods and needle roller thrust bearings for unprecedented durability in mining and construction applications. The monitor can be controlled by hardwired input devices via CAN bus. The monitor may be powered with 12-24 VDC.

High power, permanent magnet variable speed DC gear motors that drive the horizontal and vertical motions are NEMA 4 rated for use in harsh environments. The HydroBlast monitor has a flow efficient 2¼" vaned waterway to minimize turbulence and provide superior nozzle streams. The water supply connection in the monitor base is a 2½" female national pipe thread, and the discharge nozzle connection has a 2½" national hose male thread.

The HydroBlast monitors come with Absolute Position Feedback sensors. These sensors provide constant feedback to the onboard control module processor, even when the monitor is moved via manual override, to ensure accurate location of monitor position at all times.

Figure 1-2 shows the HydroBlast Cannon with onboard control Module

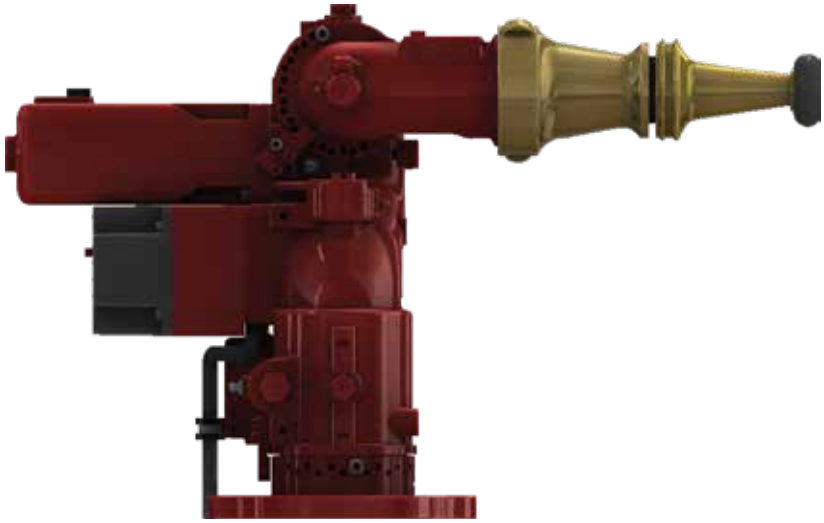

Figure 1-2. HydroBlast cannon with onboard control module

1-5 CAN CONTROL MODULE

The HydroBlast CAN Control Module (CCM) contains the system central processing units (CPU) and all of the primary circuits. The CCM is the heart of the HydroBlast system controlling the operations the HydroBlast Monitor. It receives data from remote control devices, processes the data based on pre-programmed instructions and transmit output command to the motors to drive the monitor with high degree of accuracy and precision.

The CCM also provides electrical power connection points for input power to the motors. Electronics in the CCM enclosure are fully potted with epoxy to prevent dust and water contact.

1-6 NOZZLE

The HydroBlast Washdown System has a wide range of nozzle options from electric to fixed deluge smoothbore nozzles to select for various applications. The HydroBlast washdown system nozzles provide constant flow for various flow rates. The stream pattern of electric nozzles is electronically actuated and controlled via the onboard CAN control module.

Figure 1-3 shows compatible nozzles of the HydroBlast washdown system

Figure 1-3. Smooth bore nozzle

1-7 CAN TO ETHERNET IP TRANSLATOR (GATEWAY)

The CAN to Ethernet IP gateway enables control of the HydroBlast system via Ethernet IP or ModbusTCP industrial automation protocol commands. The main function of the gateway is to translate ethernet IP commands into CAN protocol and vice versa. It enable remote control of the HydroBlast washdown system via remote control HMI or remote control panel. The gateway is compatible with ControlLogix, CompactLogix, SLC5/05, MicroLogix and other PLC controls, HMI and other devices supporting Ethernet/IP (CIP), ModbusTCP messaging and connections.

Figure 1-4 shows the HydroBlast CAN to Ethernet IP gateway

Figure 1-4. HydroBlast CAN to Ethernet IP gateway

1-8 MONITOR PROTECTIVE CAGE

The monitor protective cage is a rugged 316 stainless steel shield designed to provide protection of the monitor against damage from impact of fast-moving ore material in mining applications. The encapsulate the monitor and critical components such as motor, swivel and onboard control module.

Figure 1-5 shows the HydroBlast monitor protective cage

Figure 1-5. Protective Cage

CHAPTER 2 - INSTALLATION AND COMMISSIONING

2-1 INTRODUCTION

This chapter is intended for system installers. It provides information necessary to successfully prepare for and install the HydroBlast industrial washdown system.The system design is based on the requirements of Elkhart Brass Manufacturing Company Inc., codes and standards of National Fire Protection Association (NFPA). In all cases, the installation must meet the requirements of the local Authority Having Jurisdiction (AHJ). Refer also to the installer's wiring diagram, P/N 02007102MG, that is also packaged with the system.

2-2 PREPARE FOR INSTALLATION

Before beginning installation of the HydroBlast system, do the following:

1. Unpack the shipping carton

   Note: The use of two people to lift the monitor out of its carton is recommended

2. Gather all necessary materials and tools

2-2.1 STANDARD SYSTEM CONTENT

- Monitor with onboard control module, motor and harnesses
- Nozzle
- Gateway

2-2.2 ADDITIONAL ITEMS

The additional items below are available separately from the standard system

- Monitor protective cage
- Gateway enclosure
- Remote HMI control unit
- Local joystick control

2-2.3 MATERIALS/TOOLS REQUIRED

Recommended electrical requirements for the HydroBlast washdown system include

- Power and Ground wire gauge and length:

Distance Ft. (m)	Wire Gauge (AWG)
100 (30.5) < 150 (45.7)	8
50 (15.2) < 100 (30.5)	10
25 (7.62) < 50 (15.2)	14
< 25 (7.62)	16

- Power and Ground wire type: Cross Link or equivalent (Must meet or exceed NFPA 1901 Section 13)
- Maximum monitor amperage draw: 20 AMPS
- CAN wire gauge and length:
  - Main Line: 131 ft. (40 m) – 18-20 AWG (Must meet J1939 specification)
  - Branch (node) Line: 3 ft. (1 m) – 18-20 AWG (Must meet J1939 specification).
- CAN wire type and shielding: Twisted shielded pair - 105°C 150V (Belden 9841 series or equivalent)
- Shield Drain: Connect shield/drain to pin C of J1939 connector

2-3 INSTALLATION OVERVIEW

Step 1 – Mount monitor

Step 2 – Mount gateway

Step 3 – Wire system component

Step 4 – Configure system if required

Step 5 – Calibration

Step 6 – Set User Limits

2-4 INSTALLATION STEP 1: MOUNT MONITOR

- Before mounting the HydroBlast monitor, ensure that space allows for monitor to be rotated and calibrated. Disconnect all electrical connections.
- Bolt the monitor to water source pipe, terminated with DN80 flat face flange base. Use appropriate gasket for the application.
- Thread nozzle onto 2.5" NPT monitor outlet thread and tighten.

2-5 INSTALLATION STEP 2: MOUNT GATEWAY

- If Gateway enclosure will be use, follow the steps below to install the gateway enclosure
  - Mark and pre-drill holes for mounting bolts using enclosure dimension shown in figure 2-1 below. Two mounting holes (at top) and two mounting holes (at the bottom) are located in the enclosure rear that serve as template for surface mounting
  - Insert the upper two fasteners in the wall and screw them in place
  - Insert and tighten the two lower screws

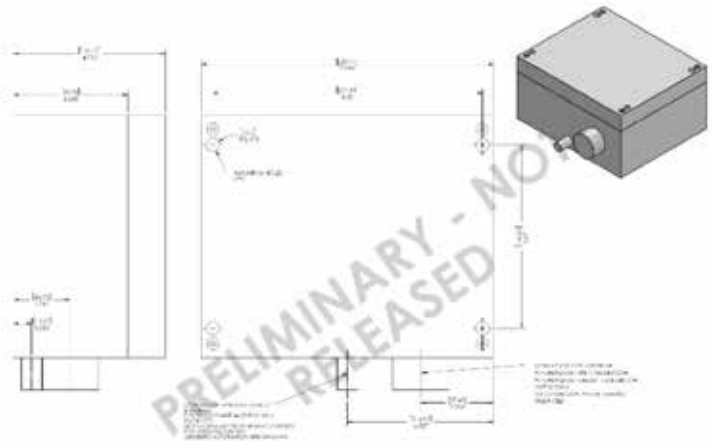

Figure 2-1 Gateway Enclosure Dimensions

- Mount gateway in either existing enclosure using available compatible mounting features or mount gateway in the gateway enclosure above

2-6 INSTALLATION STEP 3: WIRE SYSTEM COMPONENTS

- Connect onboard control module to gateway using harness
- Supply power to the monitor by connecting the red and black leads from the 6 pin connector to an appropriate power source. Install a 20 Amp fuse into the positive power lead for a 12V system (10 Amp for 24V system) to protect the monitor electrical components.
- Connect gateway to remote control unit. Figure 2-2 below provides an overview of the gateway enclosure connections

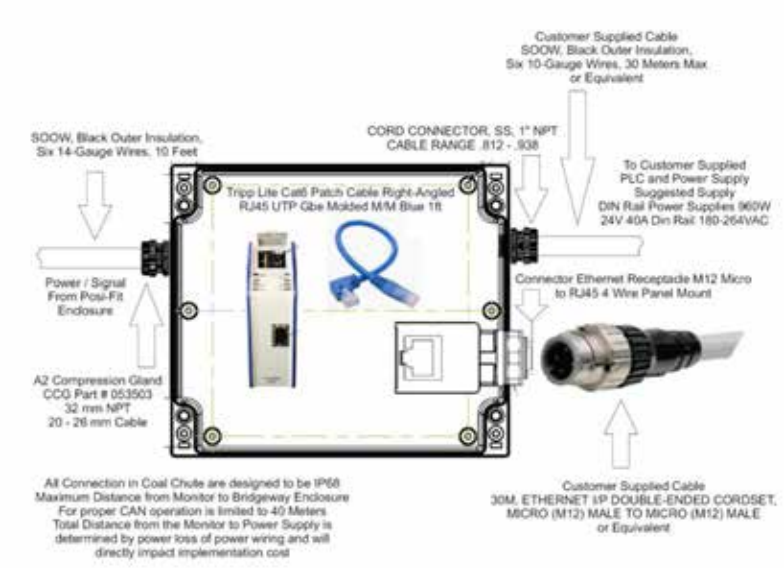

Figure 2-2. Gateway Enclosure Connections

2-7 INSTALLATION STEP 4: CONFIGURE SYSTEM IF REQUIRED

This chapter provides instructions on how to initialize an installed HydroBlast cannon and program all configurable options in the menu system to make the system ready for Normal Operation. The HydroBlast cannon is typically pre-calibrated from the factory, and will default the user programmable limits to the maximum safe operation of the cannon, only limited by mechanical limitations.

2-7.1 TRAVEL LIMITS

Setting limits for the HydroBlast system's horizontal and vertical rotation is a necessary step for the HydroBlast systems. The limits serve as a starting point for all other motion and commands. If not properly set, the system may not operate correctly. Travel limits can be used to aid in avoiding objects that may interfere with the motions of the monitor.

It is important to note that travel range cannot be increased further than that range which was set as system default during system configuration. If a larger travel range is desired, this must be changed by reconfiguring the system via the plant/remote control unit. See Operational and Programming Section for programming instructions.

2-10 COMMISSIONING

After mounting, wiring, configuring, and calibrating the HydroBlast system, check the installation of the entire system using the commissioning checklist in below.

COMMISSIONING CHECKLIST	
Company.	
Site.	
Order No.	
Date.	
Engineer.	
System Type.	
Installation Type.	

Serial Numbers		
Cannon:	**Gateway:**	**Reference:**

Pre Power-up Items	Check	
Has cannon been securely mounted?	YES	NO
Has nozzle been installed on cannon?	YES	NO
Has protective cage been, installed if required?	YES	NO
Has gateway been installed?	YES	NO
Has horizontal rotation been calibrated?	YES	NO
Has vertical rotation been calibrated?	YES	NO
Has horizontal hard stop limits been set?	YES	NO
Has vertical travel limits been set?	YES	NO
Has stow position been set?	YES	NO
Has programming stop limits been set?	YES	NO
Are LED indication lights on Cannon onboard control all green?	YES	NO
Is correct power cable being used?	YES	NO
Is the correct communication cable between gateway and plant/remote control in use?	YES	NO
Has communication been established between gateway and Cannon?	YES	NO
Has communication been established between gateway and plant/remote control?	YES	NO
Is plant/remote control able to manage functions of the cannon correctly?	YES	NO
Has system been configured for this particular wash application?	YES	NO

Unit Configuration.		
Is was time set correctly?	YES	NO
IS wash frequency set correctly?	YES	NO
Are hard stop limits set correctly?	YES	NO
Has valve been programmed to open and close correctly?	YES	NO
Has water supply line pressure been verified?	YES	NO
Notes:		

Witnessed by	**Please print name**	**Please sign here.**

CHAPTER 3 - OPERATION INSTRUCTIONS

3-1 INTRODUCTION

This chapter addresses operation of an individual HydroBlast cannon. Instructions on how to start up, configure and operate a HydroBlast cannon, including how to distinguish the different operating states and what the Status Indicating LEDs mean are presented in this chapter.

3-2 CANNON COORDINATE SYSTEM

The HydroBlast cannon is designed to be easily used in washdown system, and the coordinate system is meant to be intuitive to the final user. The following diagrams demonstrate the horizontal and vertical coordinate system.

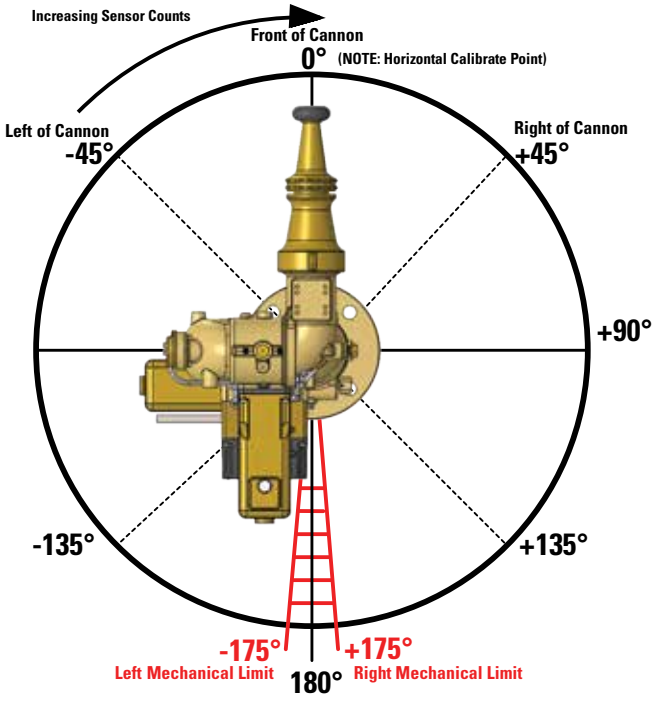

Figure 3-2.1 Cannon Horizontal Coordinate System

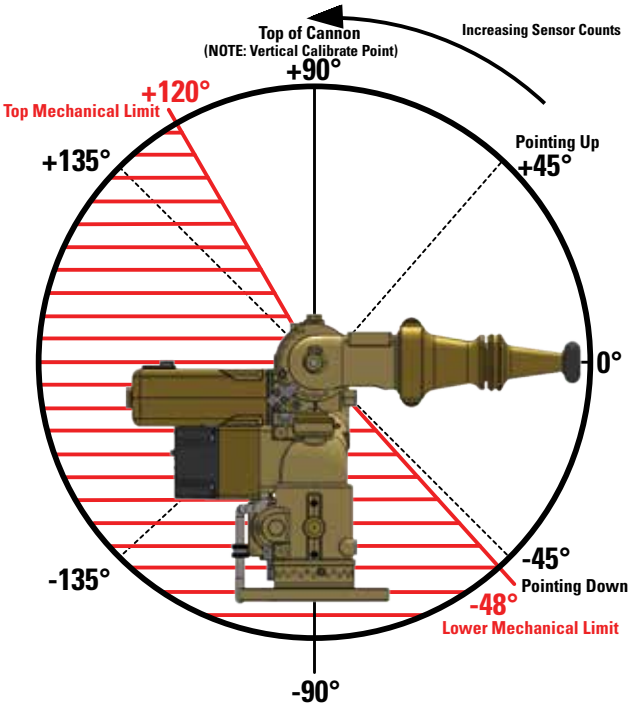

Figure 3-2.2 Cannon Vertical Coordinate System

The cannon position status is reported in tenths of a degree, so a cannon that is set with a horizontal position of 45 degrees to the right will read +450 on the horizontal position status, and 45 degrees to the left will read -450 on the horizontal position status. Please note that these mechanical limits are set for a cannon that does not have the optional protective covers installed, which would limit the vertical top mechanical limit to +90 degrees. While there are no mechanical hard stops on the horizontal axis that would not allow the cannon to go past the + / - 175 degrees limits, these limits are suggested to make sure that the main cannon harness does not wrap around the cannon multiple times causing failure.

3-3 OPERATING STATES

The HydroBlast system has multiple operating modes. There are modes related to calibration and setup of the cannon, and then the two normal operation modes. These modes are:

- Calibration Mode
- Jog Mode
- Goto Mode

3-3.1 CALIBRATION MODE

Calibration mode is used to calibrate the absolute position sensors and set the initial position of the cannon's horizontal and vertical locations. Typically, this process is done once at the factory and should normally not need to be repeated by the customer. In calibration mode, there are no user or mechanical limits on the cannon, and damage and or injury can occur if care is not taken. All position data returned to the controlling system in this mode is based on uncalibrated sensor readings and do not indicate the actual position of the monitor. As a safety precaution, Goto mode operations are disabled in calibration mode, since we do not know the monitors actual position in regards to the calibrate points.

To calibrate a cannon, you will need to use the Jog mode commands to place the cannon in the straight forward horizontal position **(Note: this position is marked by arrows on the fixed base and movable body of the cannon. Ensure that the cannon is installed with the base arrow pointing in the forward direction)**. You may move left and / or right using the Jog commands, and can go past the horizontal mechanical stops in this mode. Once the horizontal position is reached, you can use the vertical jog commands to place the vertical body is straight up and level. If this setting is not precisely set to the straight up position, then there is the possibility that when the cannon is commanded to go to the -45 degree mark, it will travel into the lower vertical mechanical stop at around the -48 degree mark. If this occurs, reset the monitor to its calibration points and recalibrate.

Calibration is initiated by executing a Calibration command from the PLC. In the event that there is a sensor replacement and the cannon will need to be recalibrated in the field, there is a Clear All Limits command, which will put it into calibration mode without any limits. Once calibrated, the position sensor will report cannon position based on the washdown coordinate system, and Goto commands are enabled.

3-3.1.1 USER LIMITS

Once the monitor has been calibrated, limits are automatically populated for both the hard (or mechanical) and user limits. The default hard limits are set to + / - 175 degrees in the horizontal axis and +90 / -45 degrees in the vertical axis. User limits are defaulted to + / - 90 degrees horizontal and +90 / -45 degrees vertical. If needed, these limits can be modified one of two ways:

1. The PLC may issue a command that directly programs the limits to an absolute position without needing to move the cannon there first. For example, to set the right horizontal user limit to +175 degrees, you would issue this command with 1750 in the absolute position field.
2. The other way of setting limits is to move the monitor to the position where you want to set the limit and execute a set limit command with the current position as the desired limit. Once all limits have been programmed, you are ready to use the cannon to do either Jog or Goto commands.

3-3.2 JOG MODE

In Jog Mode, you can control the direction and speed of both the horizontal and vertical axis at the same time. When issued, the Left, Right, Up and Down bits of the command buffer control which axis is going to move. You can set both a horizontal and vertical Jog bit at the same time to do diagonal moves. Jog mode is best used when manual control is needed to operate the monitor, for example using a joystick that is connected to the PLC. Any previous Jog command will be canceled by entering a new command, either Goto or Jog. This means that if you command the monitor to move right at 15.0 degrees per second, and you want to slow down the move, you would just issue a new Jog command with the updated speed, and the previous move would be automatically canceled and the new move programmed. Since we do not stop the motors in between moves, you can use a proportional joystick to operate the cannon seamlessly in Jog mode. A Jog command will execute until the following happens:

1. A Jog Stop command is issued (This is a Jog command with none of the jog bits set to a one)
2. A User or Hard limit is reached.
3. Another command is issued to override the previous command

There is a command status buffer that indicates the status of the last executed command. If the Command in Process bit is still set, the last command is still in effect, and commanded axis is still moving at the last commanded speed. If the Command Complete has occurred, it means that one of the previous three conditions has occurred. If the reason that the Jog command ended was due to hitting a limit, a Command Error bit is also set. All status bits are cleared upon executing a new command.

3-3.3 GOTO MODE

In Goto Mode, you can program a move from the current location to a programmed point in the horizontal / vertical axis. For example, if cannon was at the home location, 0 horizontal and 0 vertical, and needs to be moved diagonally up and to the right by 45 degrees each, Goto command would have to be executed with 450 programmed into the vertical desired position and 450 programmed into the horizontal desired position. The Goto speed would then have to be programmed to tell the cannon how fast to make the move. The actual distance from these two points would be around 63 degrees total, so if we program up 210 (21.0 degrees per second) into the Goto speed register, the move would take around 3 seconds to complete. To program up a series of moves, you would issue your first Goto command and wait for the command complete bit to be set, at which point you would execute your next move. Goto commands can also be overridden by a new command.

3-4 CANNON ETHERNET INTERFACE (GATEWAY)

The HydroBlast cannon is typically controlled by a PLC which is programmed by writing registers through the PLC Ethernet interface, which are translated by the gateway to CAN commands to the cannon. These commands are designed to allow easy programming of moves, along with current status of the cannons operation. This following section will explain the register interface and give specific technical details for operating the cannon from an Allen Bradley ControlLogix PLC. Other PLC controllers may require different gateway commands to operate the monitor.

3-4.1 MOVEMENT COMMANDS

The most basic command that can be sent to the cannon is a Movement Command. This command is sent by filling a buffer with values which specify the movement which is to be triggered, and then send the command to the cannon. The structure of the PLC buffer for the movement command is shown here below. This buffer is designed to be sent to the gateway, where it will be converted into an 8 byte CAN message and sent to the cannon. Note that PLC Big Endian 16 bit integers are translated to CAN Little Endian 8 bits registers, so that when the data is sent, the first 8 bit field sent will be the 8 bit Jog Command Field.

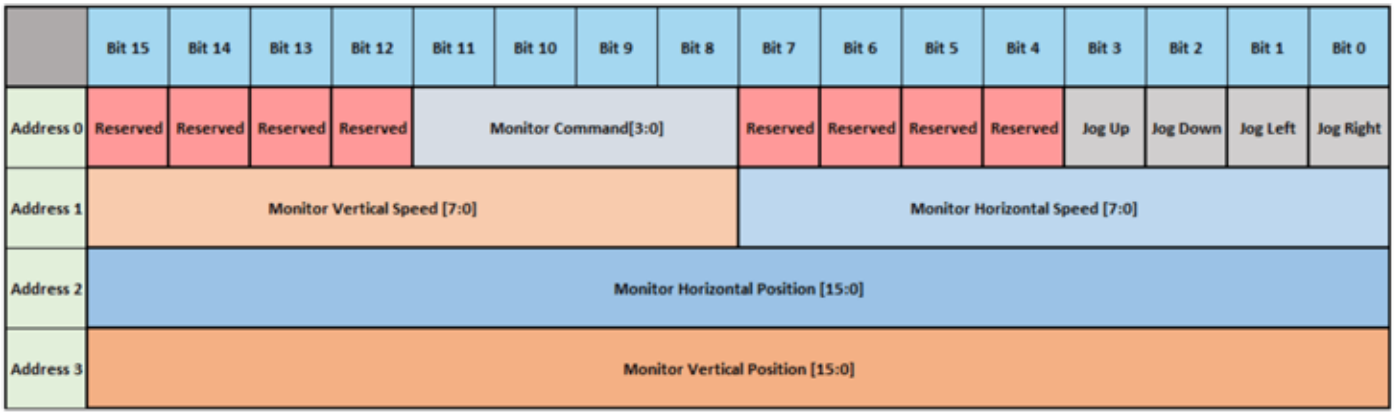

Figure 3-4.1 PLC view of command buffer in 16 bits words

Currently, there are only two valid entries into the Cannon Command Field, Either:

0x0	Jog Mode
0x1	Goto Mode

3-4.1.1 Jog Commands

To execute a Jog command, you would enter 0x0 into the Cannon Command Field, and set the appropriate movement bits in the Jog Commands Field. For example, if you want to move right, set the Jog Right bit to 1. Since the Jog right is a horizontal move, you would also have to put the speed at which you want to move. This value is in tenths of a degree per second, so a value of 100 decimal would move the cannon at 10 degrees per second. To actually send the command, you will set up a CIP generic command with the following parameter as a rung in your PLC program, so that when you execute the command the CAN message is immediately sent.

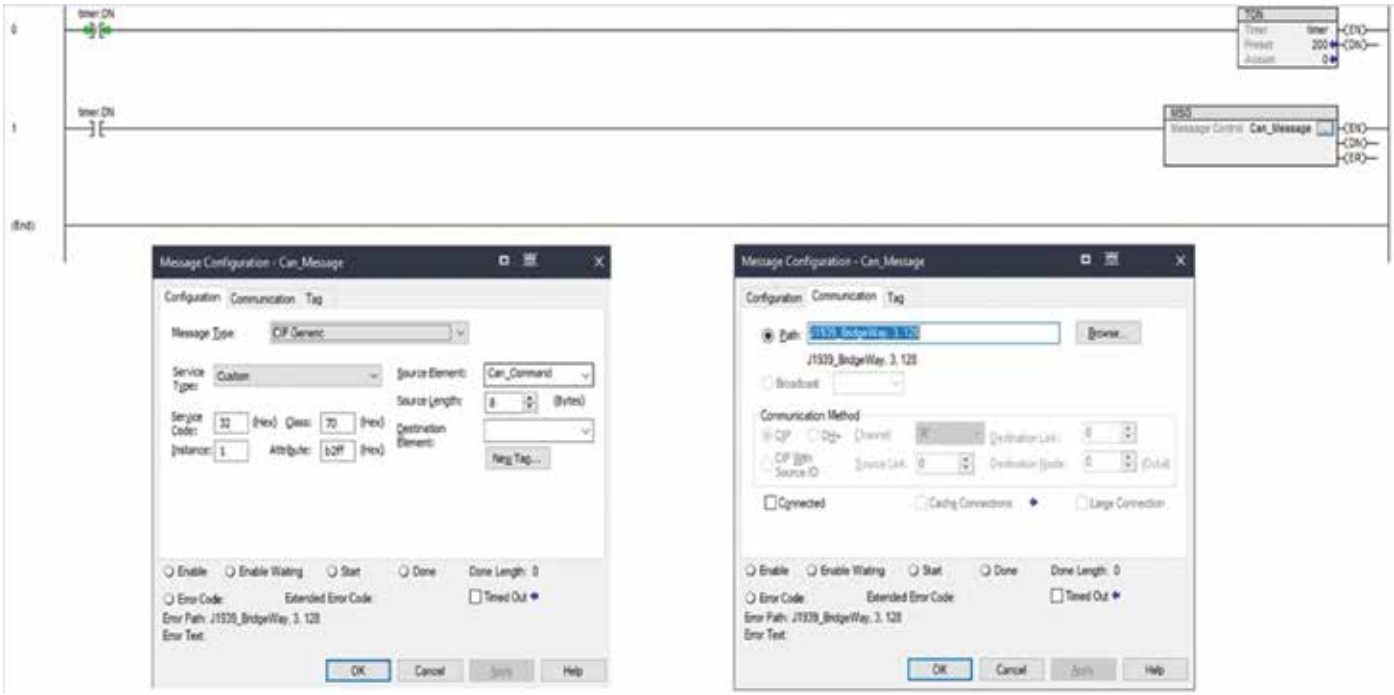

Figure 3-4.1.2 PLC Setup for Movement Command

The above PLC rung will send a periodic message every 200 ms to the cannon. In this configuration, whenever you set a jog bit to true, then the cannon will start to move at the programmed speed. If you modify the horizontal speed field, then the move will change speed dynamically. This mode is useful if you are using a joystick with proportional control. When the joystick is in the center position, the Jog bits will be cleared and no movement will happen. As the joystick proportional control magnitude is increased, the updated speeds will cause the cannon to move faster.

As an alternative, you can send the command once as a one shot, and the cannon will move until you send another command with all of the Jog bits cleared, another Jog or Goto command, or a programmable limit is reached. To determine the current status of the cannon move operation, you will need to look at the PLC Status Registers shown below. Note that the first 8 address of the gateway Input Table are reserved for internal operation and are not used, so the cannon status begins at address 0x08 of the input table.

	Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Address 0x08	Reserved For Future Use (Always Read as Zero)												Command Mode Status	Command Error	Command In Process	Command Completed
Address 0x09	Calibrate Cannon	Cannon Error	Cannon Warning	Obstacle Detected	Up Move in Progress	Down Move in Progress	Left Move in Progress	Right Move in Progress	At Top Hard Limit	At Bottom Hard Limit	At Left Hard Limit	At Right Hard Limit	At Top User Limit	At Bottom User Limit	At Left User Limit	At Right User Limit
Address 0x0A	Current Horizontal Position [15:0] (Signed Integer - In Tenths of a Degree)															
Address 0x0B	Current Vertical Position [15:0] (Signed Integer - In Tenths of a Degree)															
Address 0x0C	Reserved For Future Use (Always Read as Zero)								Current Horizontal Speed [7:0] (in Tenths of a Degree / Second)							
Address 0x0D	Reserved For Future Use (Always Read as Zero)								Current Vertical Speed [7:0] (In Tenths of a Degree / Second)							
Address 0x0E	Reserved For Future Use (Always Read as Zero)								Current Horizontal Current [7:0] (In Tenths of an Ampere)							
Address 0x0F	Reserved For Future Use (Always Read as Zero)								Current Vertical Current [7:0] (In Tenths of an Ampere)							
Address 0x10	Reserved For Future Use (Always Read as Zero)												Number of Error / Warning Messages [3:0]			
Address 0x11	Reserved For Future Use (Always Read as Zero)								Cannon Temperature [7:0] (in Degrees Celsius)							
Address 0x12	Cannon Voltage[15:0] (In Tenths of a Volt)															
Address 0x13	Current Horizontal Torque [7:0] (in Newton Meters)															
Address 0x14	Current Vertical Torque [7:0] (in Newton Meters)															
Address 0x15	Current Error / Warning Number [3:0]				Error / Warning Indentifier [11:0]											

Figure 3-4.1.3 PLC Status Registers

When a Jog or Goto command is sent to the cannon, the Command in Process bit will be set in the status buffer. The command is then evaluated by the cannon controller module, and in the case that the move is valid based on cannon status, programmed to begin. When the cannon is actively moving in either the horizontal or vertical axis, the Command in Process bit will be set. In the case where the command would result in no movement, for example setting all the Jog bits to zero, the Command in Process will be cleared and the Command Complete bit will be set. If the Jog command is terminated due to either hitting a user or hard stop, the command will also assert the Command Error bit when it completes. If this happens, you can view the limit bits to determine why the error occurred. Note that programming a command that is not valid will also cause the Command Error to occur.

3-4.1.2 Goto Commands

	Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Address 0	Reserved	Reserved	Reserved	Reserved	Monitor Command[3:0]				Reserved	Reserved	Reserved	Reserved	Jog Up	Jog Down	Jog Left	Jog Right
Address 1	Monitor Vertical Speed [7:0]								Monitor Horizontal Speed [7:0]							
Address 2	Monitor Horizontal Position [15:0]															
Address 3	Monitor Vertical Position [15:0]															

Figure 3-4.1.2 PLC Status Registers

Goto commands are executed by setting of the command buffer with the appropriate values and sending the command using a one shot instruction. The first setting is to set the Cannon Command field to 0x1 to place the cannon in Goto mode. The move will begin from the current position and complete with the cannon at the location specified in the Monitor Horizontal and Vertical Position fields. The speed at which you complete this move is programmed into the Monitor Vertical Speed Field, and the Monitor Horizontal Speed field is ignored. If the move is a diagonal move, the appropriate distance and speed is calculated to make the horizontal and vertical portions of the moves to complete at the same time. Hitting a user or hard limit will stop the movement for that axis, but the other axis will try to complete the programmed move. If you want to program up a series of consecutive moves, you would program the first move and wait for the Command Complete bit to be set. This would be the trigger to start the next move in the sequence.

3-4.1 LIMIT COMMANDS

The other command that can be sent to the cannon is a Limit Command. This command is also sent by filling a buffer with values which specify which operation is to be executed, and then send the command to the cannon. The structure of the PLC buffer for the Limit Commands is as follows.

	Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 1	Bit 2	Bit 0
0x00	Limit Command								Reserved for Future Use - Write to Zero							
0x01	Reserved for Future Use - Write to Zero															
0x02	Vertical Absolute Postion to Set [15:0]															
0x03	Horizontal Absolute Postion to Set [15:0]															

Figure 3-4.1.1 PLC Limit Command Buffer

Limit Command Field is filled with the value that corresponds to the limit or operation that is to be executed, along with the Vertical or Horizontal Absolute Position to be Set Field if needed, and then issue the appropriate CIP command from the PLC. CIP Setup is similar to the Move Command, except that the attribute field is set to 0xc0ff and the source element field points to the above Limit Command Buffer. The following is a list of commands that can be executed.

Limit Command	Operational Description	Vertical Absolute Position Field	Horizontal Absolute Position Field
0x09	Set Vertical Bottom User Limit to Current Position	Not Used	Not Used
0x29	Set Vertical Top User Limit to Current Position	Not Used	Not Used
0x0d	Set Horizontal Left User Limit to Current Position	Not Used	Not Used
0x2d	Set Horizontal Right User Limit to Current Position	Not Used	Not Used
0x0b	Set Vertical Bottom User Limit to Absolute Position	Limit Position to Set in Tenths of a Degree	Not Used
0x2b	Set Vertical Top User Limit to Absolute Position	Limit Position to Set in Tenths of a Degree	Not Used
0x0f	Set Horizontal Left User Limit to Absolute Position	Not Used	Limit Position to Set in Tenths of a Degree
0x2f	Set Horizontal Right User Limit to Absolute Position	Not Used	Limit Position to Set in Tenths of a Degree
0x41	Calibrate Cannon	Not Used	Not Used
0x80	Clear All Limits (Calibration Mode)	0xffff	0xffff

Figure 3-4.1.2 Limit Commands

3-5.1 TORQUE LIMIT COMMANDS

Torque Limit Commands are used to set operational safety limits and calibration commands to the cannon. There are separate torque limits for the horizontal, vertical up and vertical down movements, along with limits for vertical and horizontal detection of movement stoppage. The structure of the PLC buffer for the Torque Limit Commands is as follows.

	Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0x00	Torque Limit Command															
0x01	Integer Value[15:0]															
0x02	Floating Point Value [31:16]															
0x03	Floating Point Value [15:0]															

Figure 3-5.1.1 PLC Torque Limit Command Buffer

Torque Limit Command Field is filled with the value that corresponds to the operation that is to be executed, along with either the 16 bit integer value or the 32 bits IEEE 754 floating point value, and then issue the appropriate CIP command from the PLC. CIP Setup is similar to the Move Command, except that the attribute field is set to 0xb3ff and the source element field points to the above Torque Limit Command Buffer. The following is a list of Torque Limit Commands that can be executed.

Torque Limit Command	Operational Description	Integer Value Field	Floating Point Value Field
0x01	Set Vertical Up Minimum Torque (Slow Speed Base)	Not Used	Vertical Up Minimum Torque Value
0x02	Set Vertical Up Torque Slope (Slow to Fast Speed Mulitplier)	Not Used	Vertical Up Torque Slope
0x03	Set Vertical Down Minimum Torque (Slow Speed Base)	Not Used	Vertical Down Minimum Torque Value
0x04	Set Vertical Up Torque Slope (Slow to Fast Speed Mulitplier)	Not Used	Vertical Down Torque Slope
0x05	Set Horizontal Minimum Torque (Slow Speed Base)	Not Used	Horizontal Minimum Torque Value
0x06	Set Horizontal Torque Slope (Slow to Fast Speed Mulitplier)	Not Used	Horizontal Torque Slope
0x07	Vertical Non Movement Minimum Speed	Minimum Average Vertical Movement Speed	Not Used
0x08	Horizontal Non Movement Minimum Speed	Minimum Average Horizontal Movement Speed	Not Used
0x09	Vertical Movement Speed Margin	Vertical Speed Margin	Not Used
0x0a	Horizontal Movement Speed Margin	Horizontal Speed Margin	Not Used
0x0b	Minimum Vertical PWM for Lowest Speed Operation	Minimum Vertical PWM	Not Used
0x0c	Minimum Horizontal PWM for Lowest Speed Operation	Minimum Horizontal PWM	Not Used
0x0d	Vertical PWM Slope	Not Used	Vertical PWM Slope
0x0e	Horizontal PWM Slope	Not Used	Horizontal PWM Slope

Figure 3-5.1.2 Torque Limit Commands

The values of these non-volatile registers should be set at the factory to allow proper operation of the cannon with sufficient operating margin, but protect both the cannon and external equipment from damage from collision. If the configuration of the cannon is changed, such as inverted operation, or if the standard nozzle is replaced with a different weight nozzle, then these parameters may need to be changed for correct operation.

The speed calibration is present in case the cannon is operated at alternate voltage, or the speed profile has changed due to operational wear. Incorrect changes to these registers could result in equipment malfunction and / or damage.

3-6.1 SPEED CALIBRATION

Typically, the speed is controlled in a closed loop with the motor PWM being automatically adjusted as needed. This feature will need to be temporarily turned off so that we can set the motors to move at a constant speed based on the Minimum Vertical or Horizontal PWM value, and adjust the PWM value to meet the required speed. Currently, the minimum supported speed of the cannon is 0.5 degrees / sec. We will use the Jog Commands with proper limits set to operate the monitor and monitor the speed. Starting from 0, increment the PWM value and execute a Jog move. If the monitor does not move, increase the value until movement starts. Keep repeating until the desired speed of 0.5 degrees / second is meet.

Now, repeat these same jog commands but with the maximum speed (15 degrees/second) programmed into the Jog commands. Slowly increase the PWM slope from 0 in small increments such as .01 until the programmed maximum speed is reached. Typical values for a cannon at 24 volts with a standard nozzle would be a PWM minimum of around 12 and a PWM slope of around 0.325. Re-enable speed control when complete.

3-7.1 TORQUE CALIBRATION

Torque Calibration will determine the maximum torque that is required to detect an obstacle or hard stop for the cannon. The minimum torque value is the amount of torque that is required to stop a move in progress at the lowest programmed speed. This value is set such that a known amount of torque is needed to stop the move in progress. This is measured by placing a force gauge attached to an anchor point, and starting a Jog move with the minimum speed of 0.5 degrees / second. Start from 0 and command a Jog move. If no movement stops the value is set too low, so increase by small values such as .01 and repeat the Jog move until movement starts without tripping the Torque Limit. Continue increasing until the force gauge reads the desired minimum torque. This should be enough torque to allow movement under maximum flow, but allow the movement to be stopped with a moderate amount of additional force.

Repeat the above steps with the cannon set for maximum speed and increase the slope slowly until the high speed operation is also stopped at the additional desired torque.

3-8.1 CANNON INDICATORS

LED indications on onboard controller for Normal and Off-Normal Mode operating states are listed in Table 3-1 below.

Table 3-8.1. Normal and Off-Normal Mode Operating States

LED Indication/State	Interpretation
Power LED ON	Cannon is powered
Horizontal LED ON	Cannon received command from remote control or joystick control to move left or right
Vertical LED ON	Cannon received command from remote control or joystick control to move up or down
Status LED ON	Green indicates Normal Mode Operation, Yellow is warn state, Red is cannon error, Magenta indicates Calibration Mode.

CHAPTER 4 - MAINTENANCE INSTRUCTIONS

4-1 INTRODUCTION

The HydroBlast System must be inspected, tested and maintained in accordance with the inspection, testing and maintenance schedule mandated by the Authority Having Jurisdiction.

Follow the required inspection, testing, and maintenance procedures for the associated plant/ remote control unit as directed by the manufacturer and by the standards and codes that apply to those systems.

4-2 PREVENTIVE MAINTENANCE

The complete monitor and control system should be inspected during each scheduled inspection. Careful inspection for damage to the monitor and nozzle is especially important after use of the HydroBlast system in wash operations.

- Operate all possible functions to ensure that each works normally
- Flow water to check the nozzle pattern
  - If the pattern is disrupted, clear the debris
  - If the obstruction still remains, remove the nozzle and check for debris lodged between the nozzle stem and body
- During nozzle flow test, inspect monitor swivel joints for leaks
- Inspect all exposed wiring for signs of damage
- If protective cage is used, use the appropriate tool to clean the cage of dust build up

Note: Although grease fittings are provided for the up-down and left-right gear cases, routine greasing should not be necessary. If the monitor is exposed to high level of radiant heat for a prolonged period, it may be possible for the factory grease to thin and run out of the gear cases. In such an event, fresh grease should be applied. It is recommended that Mobilith AW2 grease be used to lubricate the monitor gearing.

Caution: DO NOT use high pressure spray to clean the HydroBlast System.

Using high pressure spray can damage seals and lead to serious damage of electrical components.

4-3 UNDERSTANDING SYSTEM LEDs

4-3.1 MONITOR ONBOARD CONTROLLER LEDs

- When the monitor is first powered up all LEDs turn on for approximately 1 second, then only the Power LED remains illuminated
- When the monitor control box receives a right or left command, the horizontal LED illuminates.
- When the monitor control box receives an up or down command, the vertical LED illuminates.

4-4 TROUBLESHOOTING

Table 4-1 below provides list of potential faults and suggested procedure to return the HydroBlast system to proper operating condition

Table 4-1. General System Faults

Fault	Probable Cause	Corrective Action

5-1 PARTS LIST

Table 5-1 below provides descriptions and part numbers available for the HydroBlast wash system

Part Number	Description
00007100MG	HydroBlast Wash System including brass monitor with DN80 flange, onboard control, brass nozzle and gateway
	Brass HydroBlast brass monitor with DN80 flange
	Brass Smoothbore Nozzle for HydroBlast wash system
	Gateway for HydroBlast wash system
	HydroBlast motors, 12-24VDC
	HydroBlast wash monitor protective cage
	HydroBlast local joystick control

CHAPTER 5

APPENDICES

5-1 SYSTEM SPECIFICATIONS

5-1.1 MONITOR SPECIFICATIONS

- Max Flow Rating 700 GPM (2650 LPM)
- Max Operating Pressure 500 PSI Continuous Duty (17.2 Bar)
- Inlet Size 2.5" Inlet ID
- Outlet Size 2.5" NHT, 2.5" BSPP
- Travel Vertical: -45° to +90°
- Horizontal: L175° to R175°
- Motors Voltage: 24VDC
- Run current: 5A
- Stall current: 10A
- Current trip point: 8A
- Material Silicon Bronze
- Flange *DN80 Table E per AS2129 (*2.5" inlet ID)
- Seals Industrial grade bearing seals
- Weight 63 LBS

Operating temperature range -40°F to +185°F (-40°C to +85°C)

- Environmental Rating NEMA 4, IP68

5-1.2 NOZZLE SPECIFICATIONS

- Inlet Size 1.5" Inlet / ½" Outlet (Smooth Bore)

5-1.3 ONBOARD CONTROLLER SPECIFICATIONS

- Input power 18 to 28 Volts DC
- Electrical Load 500 mA

5-1.4 GATEWAY SPECIFICATIONS

- Input power 24 Volts DC
- Electrical Load 50 mA

5-5 NOTES

Elkhart Brass Manufacturing Co., Inc.

1302 W. Beardsley Avenue Elkhart, IN 46514

Tel. (574) 295-8330

Toll Free (800) 346-0250

Fax (574) 293-9914

www.elkhartbrass.com

Email: eb.info@safefleet.net

98613000 REV-Rel
11-19