

Operation Manual

Disc Brake Control System

cLink®

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Responsibility for safety lies with the rig operator; always observe good operating practice.

About the Operating Manual

This Operating Manual has been written to provide a guide to the installation and operation of the Operator and Sand Drum control console.

It is important to acquire a good understanding of this system prior to attempting installation or operation of the system. Please study this manual carefully.

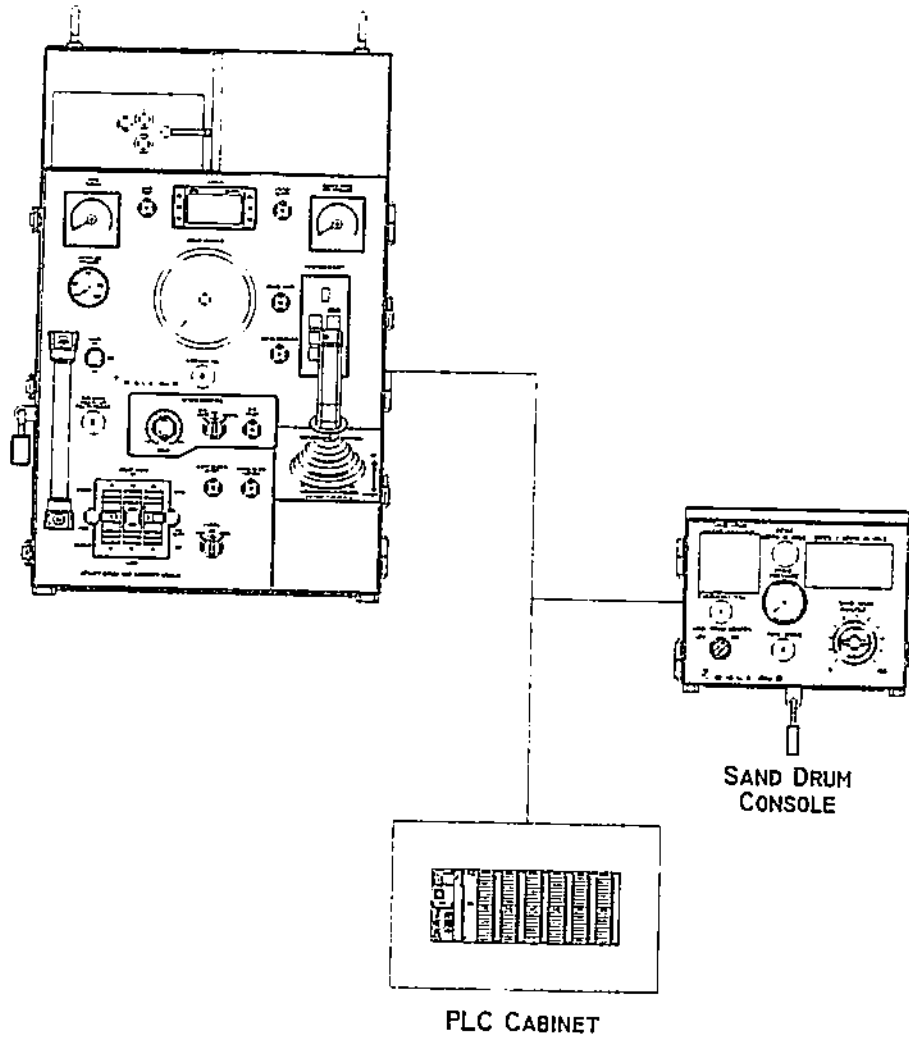
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1 SYSTEM OVERVIEW

1.1 Control System Topology



1.2 Basics

A principal overview of a Drawworks and Sand Drum Control system in an integrated operation of machinery and instrumentation is shown. We have basically three levels in the total picture of such a system:

1. Operator's Control Console for hoisting/lowering for Drawworks and Sand Drum and also monitoring various parameters by means of touch screen and analog gauges.
2. Machinery control PLC's and I/O equipment for interfacing, control, automation, and calculation.
3. Physical machinery and instrumentation.

1.3 Communication Network Links

The PLC has following communication links:

The PLC communicates through CP340 communication card with the BEKA Display, located on the Operator control console, using the BEKA ASCII serial protocol via RS232.

1.4 PLC and Software

Following PLC is used:

Siemens S7 – 315-2 DP

Programming language:

Step 7 version 5.2.1

The PLC is located in the PLC Cabinet.

The Main Console consists of the following components:

2.1.1 Alarm Silence/Accept Pushbutton

The Drawworks software is generating all critical alarms and displays them on the BEKA Display. When the Operator's Console receives an alarm, alarm text will be shown on BEKA display, along with sounding of the alarm horn. A flashing red light at the Operator console indicates an alarm exists. There is a momentary push button for alarm silence/accept. Typically the alarm message on the screen will be requesting the Accept button to be pressed to continue operation, which will silence the alarm horn. This pushbutton is also used to progress through various menus during system calibration.

2.1.2 Lamp Test Pushbutton

There is a momentary push button for lamp test. When pressed all the meters show full scale and the alarm lamp is operated by PLC.

2.1.3 Control – Main/Off/Sand Drum

This is a 3 Position maintained selector switch. In the **OFF** position, air is not supplied to either console and no PLC controlled operation is possible. In the **MAIN CONSOLE** position, air is supplied to the Main console and the Main console functions are activated. In the **SAND DRUM CONSOLE** Position, air is supplied to the Sand Drum console and the Sand Drum console functions are activated. This switch operates in conjunction with the Sand Drum ON/OFF control switch on the Sand Drum Console. Interlocks are programmed in the PLC such that control cannot be switched while a console is in operation. To switch operation to the Sand Drum Console From the Main Console, first place the **MAIN CONSOLE CONTROL** selector switch to the **SAND DRUM CONSOLE** position, then place the Sand Drum Console ON/OFF selector switch to the **ON** Position. With the Sand Drum ON/OFF selector switch in the **ON** position, moving the **MAIN CONSOLE CONTROL** selector switch has no effect.

2.1.4 Travel Block Override Pushbutton

When the travelling block hits the lower or upper travel limit, all the brakes are set. The travel block override momentary pushbutton allows the operator to override this interlock and lower/hoist the block beyond the lower and upper limit at a limited low speed.

2.1.5 Drawworks Joystick

This is a 4-axis movement joystick; it has a pushbutton on the top of the joystick and one on the front. It also includes a trigger button. Operation is allowed if the MAIN CONSOLE CONTROL switch is in the MAIN CONSOLE position. Operations of the forward/reverse functions are also overridden in the event of the SPEED CONTROL MODE SWITCH - OFF position. Micro-switches are mounted internally to the joystick for each axis.

The front pushbutton and the trigger function are the PARKING BRAKE DEADMAN switch. One of these must be pushed for the release of the parking brake. Sufficient hydraulic pressure is also required for parking brake release.

Left or right movement from center will apply throttle to the engine. No brake release or clutch engage commands are applied.

Forward movement is for block hoisting operations. If the Parking Brake is allowed to release, then a small amount of forward movement will activate the forward micro-switch. Upon activation of this micro-switch, the clutch will be engaged. Further forward movement will proportionally release the service brake and increase the throttle. The brake pressure slope is increased from that of the curve in the event of reverse drum rotation in the Hoisting Mode.

Backwards movement (towards operator) of the joystick is for block lowering operations. If the Parking Brake is allowed to release, then a small amount of backwards movement will activate the Reverse micro-switch. Upon activation of this micro-switch, proportional service brake release is allowed. Note: Lowering speed may or may not be limited dependant upon the Calibration state, the position of the SPEED CONTROL MODE SWITCH, and the position of the SPEED CONTROL potentiometer.

2.1.6 Speed Control Mode Switch – WOB/CREEP -OFF-NORMAL

In the Off position of a 3-position maintained selector switch, lowering and hoisting operations are disabled. It controls the speed limit of the lowering operation. In the Normal position, speed is limited by the proportional SPEED CONTROL potentiometer position. In the WOB/Creep position, speed is limited to the creep speed, and Speed control is enabled (waiting on the WOB SET pushbutton to be pressed -).

2.1.7 Speed Control Potentiometer

This potentiometer provides a proportional 1-6 Ft/Sec speed limit to the lowering operation, with the SPEED CONTROL MODE SWITCH in the **NORMAL** Position. When in Milling Operation (SPEED CONTROL MODE SWITCH in the **CREEP/WOB** Position, after pressing WOB RESET Pushbutton) this potentiometer adjusts the amount of drum rotation allowed before setting the brake. In this operation when fully CCW, the brake sets after any monitored drum movement

2.1.8 WOB Reset Pushbutton

This momentary pushbutton starts the Milling Operation from the CREEP operation.

2.1.9 System Alarm Lamp

This RED LED cluster Lamp flashes whenever an alarm exists, such as "NOT CALIBRATED" or "FLOOR SAVER ACTIVATED".

2.1.10 System Alarm Horn (Rear Bumper)

This rear bumper horn is sounded whenever a new alarm is issued, and stays on until silenced.

2.1.11 Weight Indicator (Drawworks Hookload Meter)

This 6" Round 4-20mA meter displays the current Hookload.

2.1.12 Tong Torque Meter

This analog 96mm square 4-20mA meter displays the TONG TORQUE.

2.1.13 Service Brake Pressure Meter

This analog 96mm square 4-20mA meter displays the current value of service brake pressure.

2.1.14 BEKA Display

The BEKA Display is located on the Operator console. BEKA Display is communicating with PLC using the BEKA ASCII serial protocol via RS232. The BEKA display shows critical information such as block height, engine rpm and various alarms. It also allows the operator to calibrate block position and set lower and upper traveling limit.

2.1.15 System Air Pressure

This analog 63mm round dry gauge 0-200PSI meter monitors the rig air pressure.

2.1.16 Tongs On/Off

This valve in **On** position is used to turn on the rig hydraulic pump, which would power the hydraulic tongs motor to spin pipe in or break pipe out. This valve in **Off** position is used to turn off the rig hydraulic pump, which would stop hydraulic flow to the tong hydraulic motor.

2.1.17 Engine Start Pushbutton

A green momentary pushbutton sends a momentary dry open/close contact to the engine controller to crank the engine when transmission is in Neutral. This pushbutton is hardwired to the engine controller.

2.1.18 Engine Shutdown Pushbutton

A red momentary pushbutton sends a momentary dry open/close contact to the engine controller to shut off the engine as the fuel is shut off. This pushbutton is hardwired to the engine controller.

2.1.19 Transmission Shift

A transmission shift electrical control and gear indicator is provided at the control panel for control and monitoring of transmission gear. Transmission shifting of the Drawworks is fully independent from the PLC control system.

2.1.20 Emergency Kill Pneumatic Lever

Emergency kill activates an air solenoid, which cuts off the air and fuel thus shutting down the engine.

2.1.21 Manual Park Brake Pneumatic Lever

The Parking brake is a safety brake and a long-term brake. The Parking brake is hydraulically operated by an air valve operated by the Park Brake pneumatic switch. Pressure must be applied to release the spring applied Parking brake. The Park Brake Pneumatic switch must be pulled out to allow the brakes to release.

2.1.22 Utility Winch - Up/Down Valve

This valve in **Up** position used to winch in cable. This valve in **Down** position is used to winch cable out.

2.1.23 Mast – Retract/Extend Valve

The valve in **Extend** position moves the upper Mast section up out of the lower section from its road travel position to the well workover position. When the valve control handle is in **Retract** position the upper mast section back down into the inside of the lower section so the Mast may be lowered down onto the truck for road travel.

The air control valve is metering an air cylinder which is shifting a hydraulic valve section on the rig hydraulics to extend or retract the upper section of the Mast.

2.1.24 Air Slips – Open/Set Valve

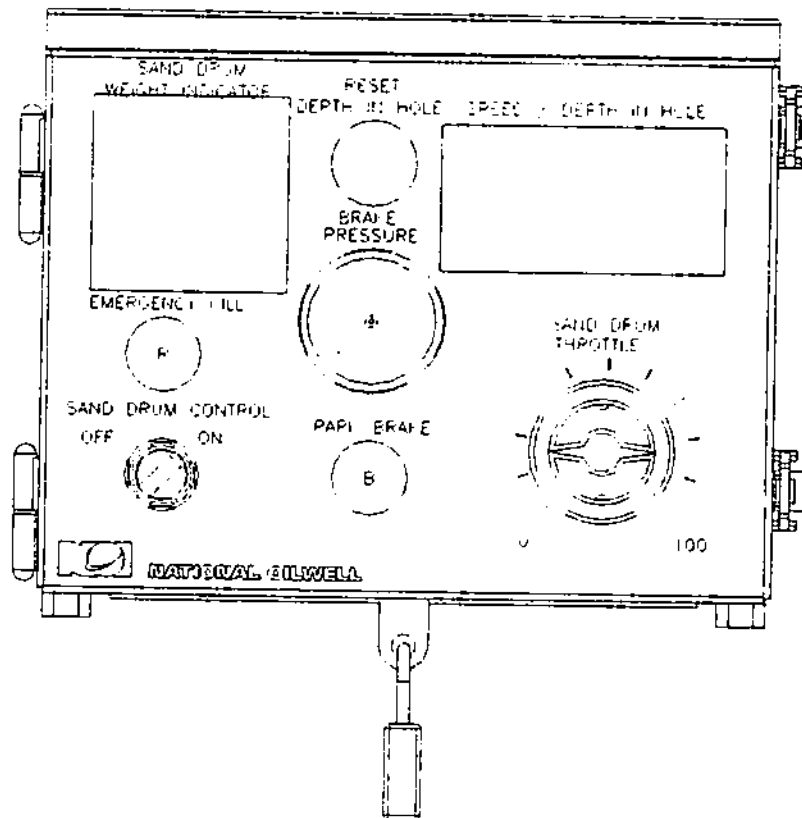
This valve in **Open** position is used to lift the slips out of the bowl to allow pipe to go into the well or be hoisted out of the well. This valve in **Set** position is used to put the slips into the bowl so as to hold the pipe from falling into the well.

2.1.25 Purge Panel

The pressurization is a method of reducing the internal area classification of an electrical enclosure located in a Division 2 area to a classification "non-hazardous", thus allowing ordinary industrial electrical equipment to be used in Class 1 Division 2 Hazardous area.

The purge allows air to enter the pressurized enclosure and raises the internal pressure above atmospheric pressure to prevent the ingress of the external flammable gas. If pressurization fails at any time an alarm will be given and action must be taken to restore pressure or switch off the power. Re-purging may be necessary after a pressurization failure.

2.2 Sand Drum Control



Sand Drum console consists of the following components: -

2.2.1 Sand Drum Control – Off/On

This is a 2-position maintained selector switch. In the ON position it allows throttle and clutch control via the SAND DRUM SPEED THROTTLE. This switch works in conjunction with the MAIN CONSOLE CONTROL switch position.

2.2.2 Sand Drum Speed Throttle

This potentiometer controls the speed of the sand drum. Initial movement engages the clutch via the included micro-switch. The off position is at engine idle and moving the handle forward will increase the engine speed. The handle remains where released to allow hands free constant engine speeds.

2.2.3 Sand Drum Weight Indicator Meter

This 4" Square 4-20mA meter displays the weight as determined by the SAND DRUM Load Cell (Mounted on the Block Sheave).

2.2.4 Sand Drum Line Speed/Depth Meter

This meter is a digital meter, which reads the current line speed and depth in hole.

2.2.5 Sand Drum Depth Reset Pushbutton

This momentary pushbutton zero's the SAND DRUM LINE DEPTH meter.

2.2.6 Emergency Kill

Emergency kill activates an air solenoid, which cuts off the air and fuel thus shutting down the engine.

2.2.7 Park Brake Pneumatic Switch

Pressure must be applied to release the spring applied Parking brake. The Parking brake is air operated. The Park Brake Pneumatic switch must be pulled out to allow the brakes to release.

2.2.8 Brake Pressure Gauge

This gauge displays the air pressure available to release the spring applied Parking Brake.

3 OPERATION PROCEDURES

3.1 Engine Start

- Press and hold the ENGINE START pushbutton, until engine starts.

3.2 Engine Shutdown

- Press and hold the ENGINE SHUTDOWN until engine stops. NOTE: The Normally Closed contact of ENGINE SHUTDOWN pushbutton must be in the circuit and operable for the engine to run.

3.3 Engine Shutdown Park Brake Interlock

- When Engine Speed is ≤ 500 RPM the PLC System engages the Park Brake.

3.4 Hoist Operation

To hoist the block:

- MAIN CONTROL SWITCH to MAIN CONSOLE position. This activates the air to the main console and enables the main console controls.
- Ensure engine is running and warmed up, and that the System Air Pressure is > 80 - 90 psi, and that the Service Brake Pressure is above 1500 psi.
- Move the MODE CONTROL SWITCH from the OFF position to either the CREEP or NORMAL position.
- Pull the panel mounted PARK BRAKE Release control.
- Ensure a Forward Gear is selected.
- Engage the Deadman Switch (Actuate and hold either the joystick trigger or front button on the joystick to release the parking brake.)
- Move the joystick forward. Once it moves beyond a certain small amount, the clutch will engage, the Service Brake Pressure will start to decline and the Engine will throttle up.

Block speed is dependant upon load, gear selected and joystick movement.

To stop hoisting, return joystick to center position and release the Deadman.

NOTE: It is desirable to return the joystick to center slowly in a slow controlled manner, or release the Deadman while in motion. Not doing so will quickly stop block movement, that may result in "bird nesting" of the line on the DW drum. Any time the DEADMAN is released or the joystick is centered, the clutch is disengaged and the parking brake is set.

If the system is calibrated, operation at or above the CROWN LIMIT requires the holding in of the TRAVEL OVERRIDE pushbutton.

3.5 Anti-Reverse Protection:

During hoisting operations there is a 2 level Anti-reverse protection scheme in place which will first increase the amount of service brake applied as a percentage of joystick movement, and then will apply the Parking brake in the event of approx ¼ drum rotation in reverse.

3.6 Lowering Operation

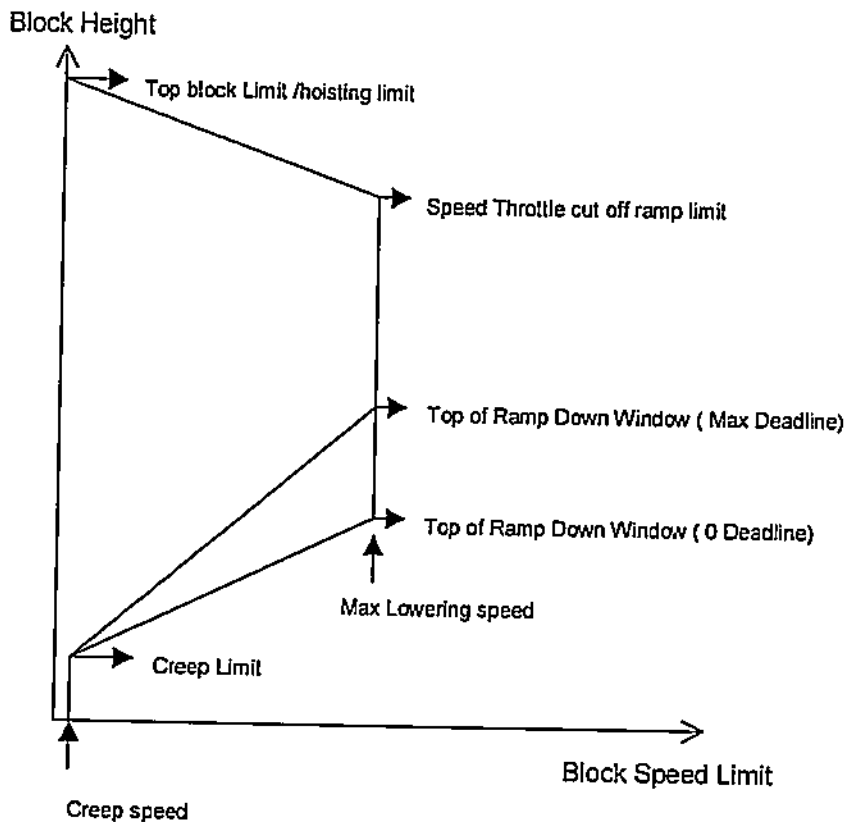
To lower the block:

- MAIN CONTROL SWITCH to MAIN CONSOLE position. This activates the air to the main console and enables the main console controls.
- Ensure engine is running and warmed up, and that the System Air Pressure is > 80-90 psi, and that the Service Brake Pressure is above 1500 psi.
- Choose the position of the MODE CONTROL SWITCH: NORMAL for 1-6 Ft/sec operation or WOB/CREEP for 1 in/sec operation. If in NORMAL, then choose the Speed Limit required for the operation on the SPEED CONTROL potentiometer.
- Pull the panel mounted PARK BRAKE Release control.
- Engage the Deadman Switch (Actuate and hold either the joystick trigger or front button on the joystick to release the parking brake.)
- Pull the Joystick towards the operator. The service brake will release proportionally to joystick position. Speed will increase until it meets the limit set in 3) above. Further backwards movement will not affect the speed. Moving the joystick forward from this point will slow the block.

If the system is calibrated, operation at or below the floor limit requires the holding in of the TRAVEL OVERRIDE pushbutton.

3.7 Speed Limiting During Lowering Operation

Lowering speed can be dynamically limited (changed at any time) in the NORMAL mode, by adjusting the SPEED CONTROL potentiometer.



3.8 Auto Speed Reduction Window

In NORMAL MODE, if the system has been Calibrated, then when the block reaches a certain height (about 10-15 ft above the FLOOR LIMIT), the SPEED LIMIT will decrease such that at about 1 FT above the FLOOR LIMIT it will be at CREEP speed. This provides a smooth stop at the bottom. In the event a smooth stop is not desirable, the top joystick button will override this Auto Speed Reduction function, allowing speed to reach the speed limit set by the SPEED CONTROL potentiometer.



WARNING!

The auto speed reduction feature is for crew safety and rig protection overriding it can be detrimental to personal injury, property damage or death.

3.9 Crown Limit

Dependant upon speed and load, the height at which the block will be stopped (by application of the service and parking brake) is at are somewhat below the set CROWN LIMIT. The Limit is set during the Calibration procedure. Travel above this point is permissible only with the application of the TRAVEL OVERRIDE button.

Note: Application of the CROWN LIMIT braking may cause an engine shutdown if the clutch does not disengage fast enough.

3.10 Floor Limit

The FLOOR LIMIT, set during calibration, is point below which operation is permissible only with the application of the TRAVEL OVERRIDE button.

3.11 Jaring Mode

HOLD

3.12 PLC Bypass Box

HOLD

3.13 Double Fast Line

HOLD



4 CALIBRATION & SETUP

The following Startup Menu Items are provided:

- Joystick Setup
- Line Setup
- Block Height Calibration

To perform these Calibration and setup operations, the BEKA Display needs to show the correct screen. If the BEKA Display is not cycling through the Startup Menu items then cycle power to the PLC system.

The purpose of the Joystick Setup is to allow simple setup of the joystick for proper rig operation. This operation is only expected to be performed in the event the joystick is ever replaced, and during commissioning.

The system needs to know the number of lines strung and how the fast line is connected. The Line Setup procedure allows this setup.

To use the Crown & Floor Saver, as well as the Auto Speed Reduction operation, a Calibration procedure is required to have been completed. Without this Calibration, the PLC cannot determine block height, therefore any operation dependant upon block height is disabled until this is procedure is performed.

Prerequisites for CALIBRATION: ABILITY TO MOVE BLOCK, Line Setup matching actual number of lines strung and actual connection of the dead line.

NOTE: ABILITY TO MOVE BLOCK = MAIN CONSOLE CONTROL SWITCH in the MAIN CONSOLE position, Engine running, Sufficient air pressure to engage clutch, Sufficient Hydraulic pressure to allow release of the parking brake, PARK BRAKE SET Hydraulic actuator pulled.

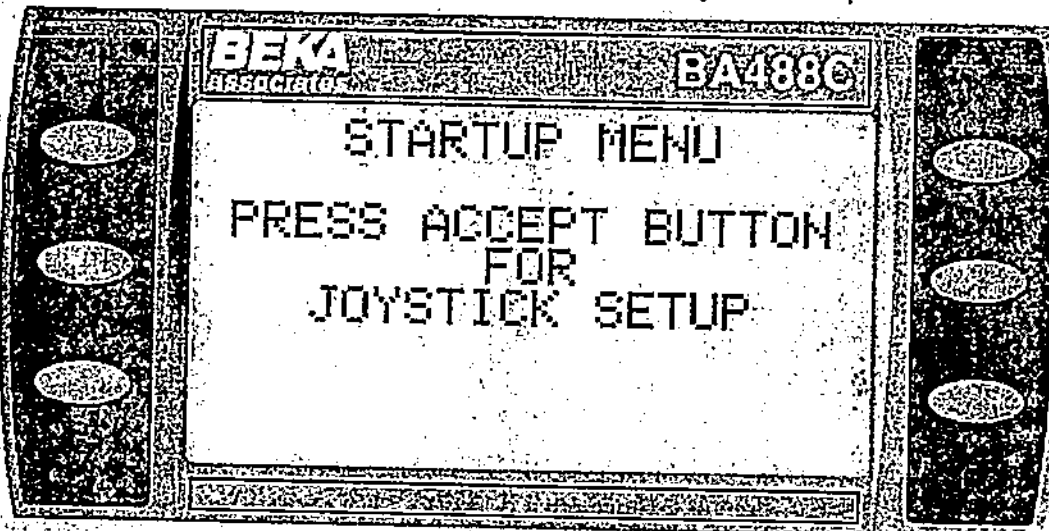
4.1 Joystick Setup



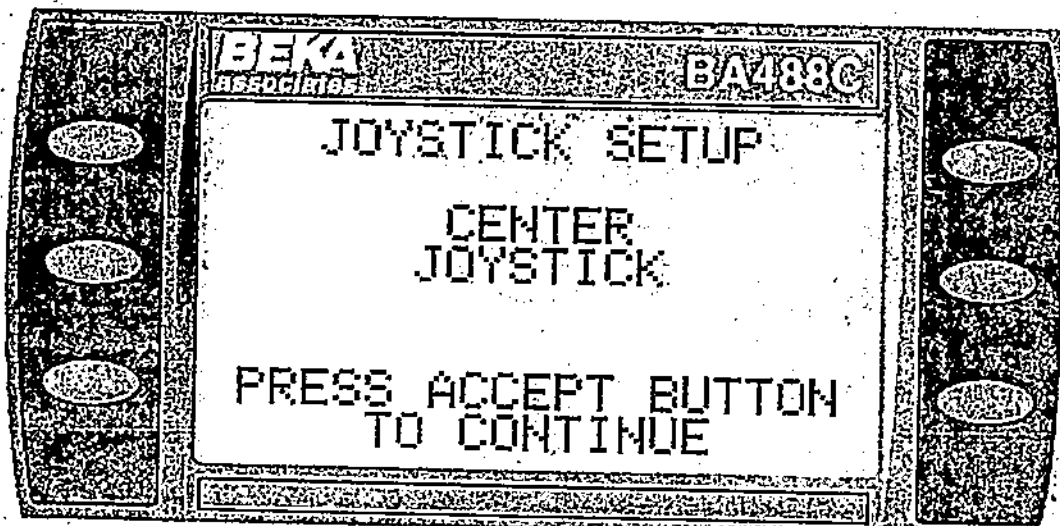
WARNING!

Ensure that the PARK BRAKE is applied, and the PARK BRAKE Pneumatic Switch is pushed in, and do not press the Joystick Trigger or Buttons during this operation. Not following this warning could be detrimental to personal, and/or cause injury, property damage or death.

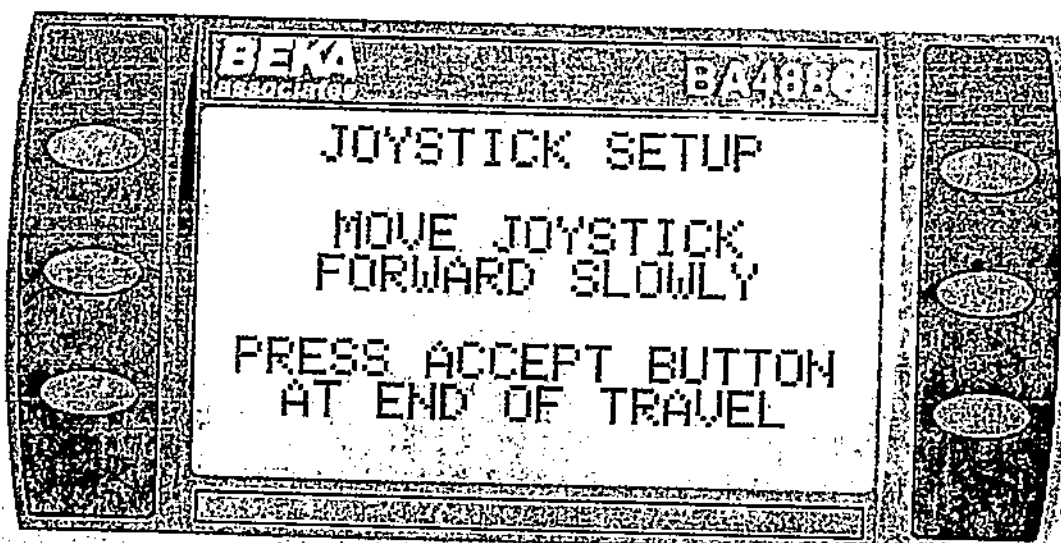
When the BEKA Display shows the Startup Menu Item: Joystick Setup



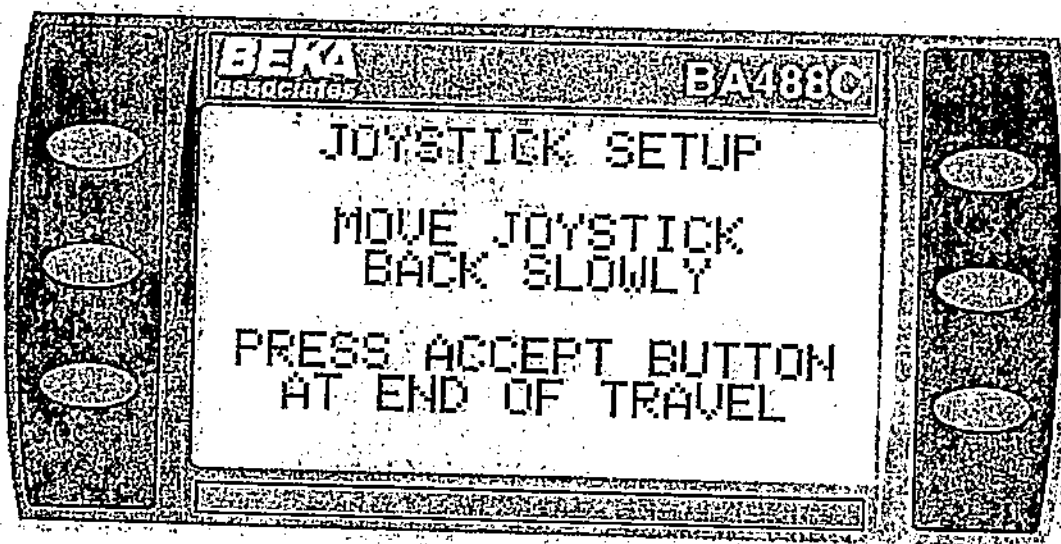
Press the green ACCEPT pushbutton on the MAIN CONSOLE. This will display the command to center the joystick.



Ensure that the joystick is centered and press the Green ACCEPT Pushbutton to continue. If the joystick is not centered, the same message will be redisplayed. If the Joystick is centered, then the following message will be displayed, requesting forward movement of the joystick.



Move the Joystick forward slowly. When the Joystick cannot be moved any further forward, press the Green ACCEPT pushbutton. Then the Center Joystick message will appear. Center joystick, and press green ACCEPT pushbutton. Then the move Joystick Backwards message will appear.



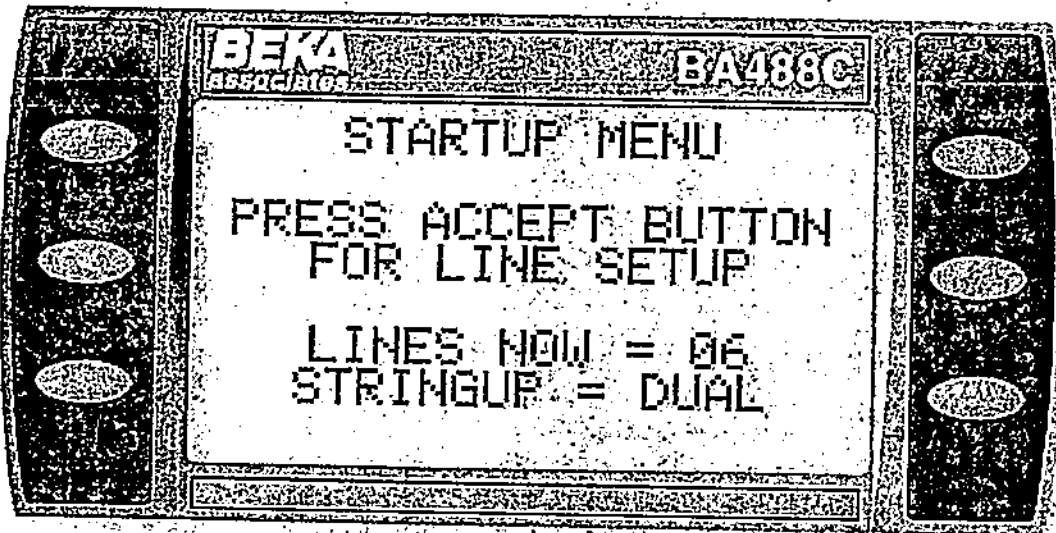
Move the Joystick towards the operator (away from the console) and press the green ACCEPT pushbutton when the joystick can not be moved any further. . Then the Center Joystick message will appear. Center joystick, and press green ACCEPT pushbutton. The Joystick is now setup, and the Startup menu will begin cycling again.

4.2 Line Setup

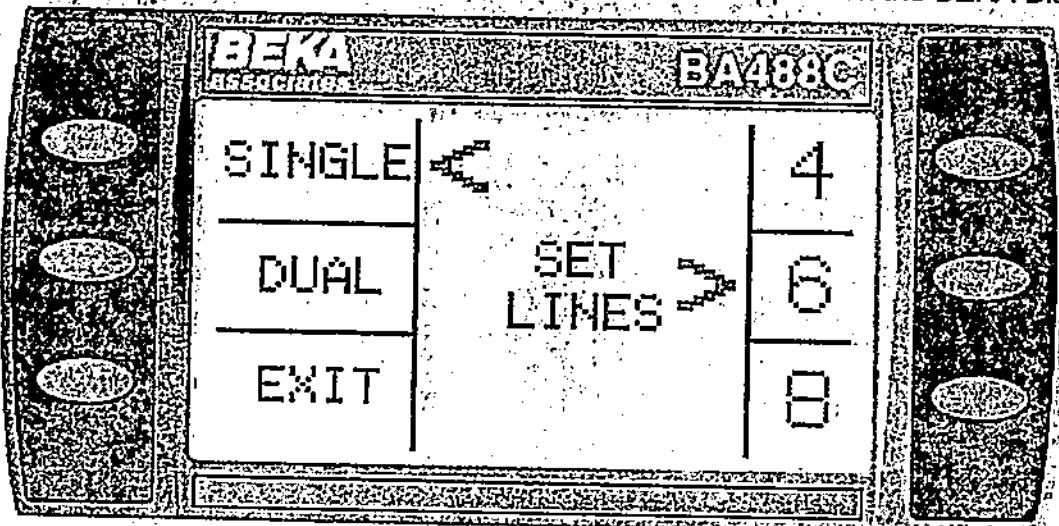


WARNING!

To prevent misapplication, Lines Strung setup through BEKA Display should be selected considering actual number of lines strung. Improper application can be detrimental to causing failure and possible personal injury, property damage or death.
When the display shows the Startup Menu: Line Setup screen:



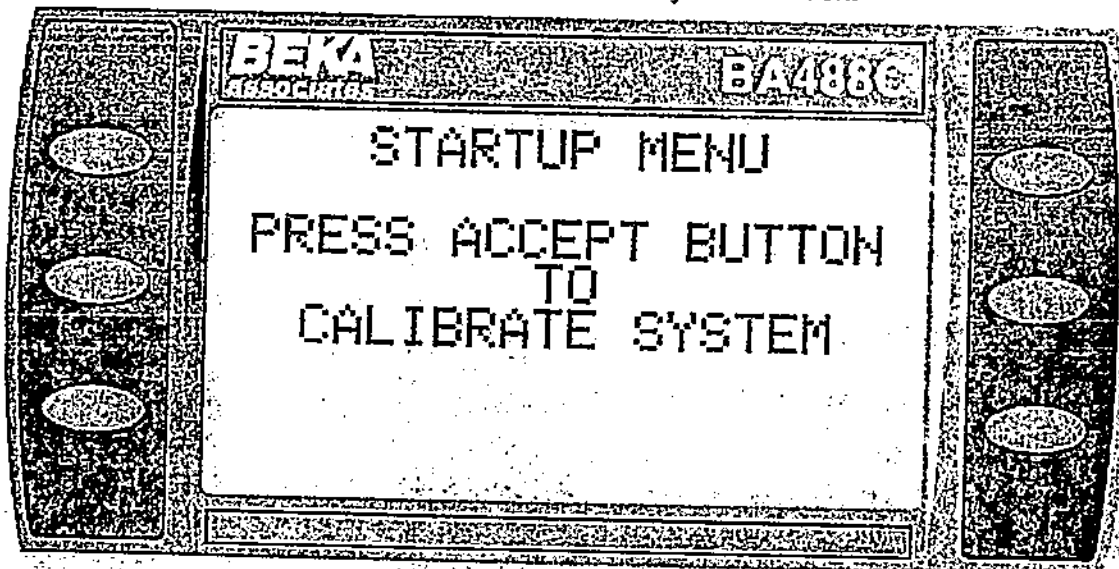
Press the Green ACCEPT Pushbutton on the console, if the Line setup does not match actual conditions. This will cause display the Line Setup Screen to appear on the BEKA Display:



Push the appropriate button on the BEKA Display to match actual conditions. Then Press the EXIT button on the BEKA Display to return to the Startup Menu.

4.3 Block Height Calibration

.When the display shows the Startup Menu: Calibrate System screen:



This will show the Go to Floor Message:

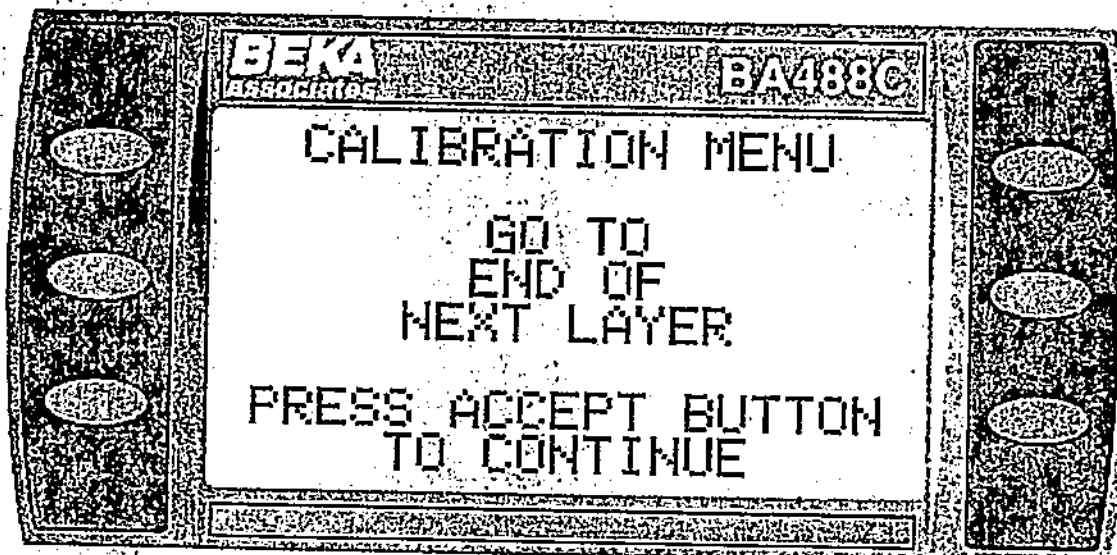


Bring the block to the position required for the FLOOR LIMIT. The FLOOR LIMIT is the point below which the Parking Brake is set unless disabled by the TRAVEL BLOCK OVERRIDE pushbutton. With the block at this position, press the green ACCEPT pushbutton.

Go to End of first Layer message will be displayed:

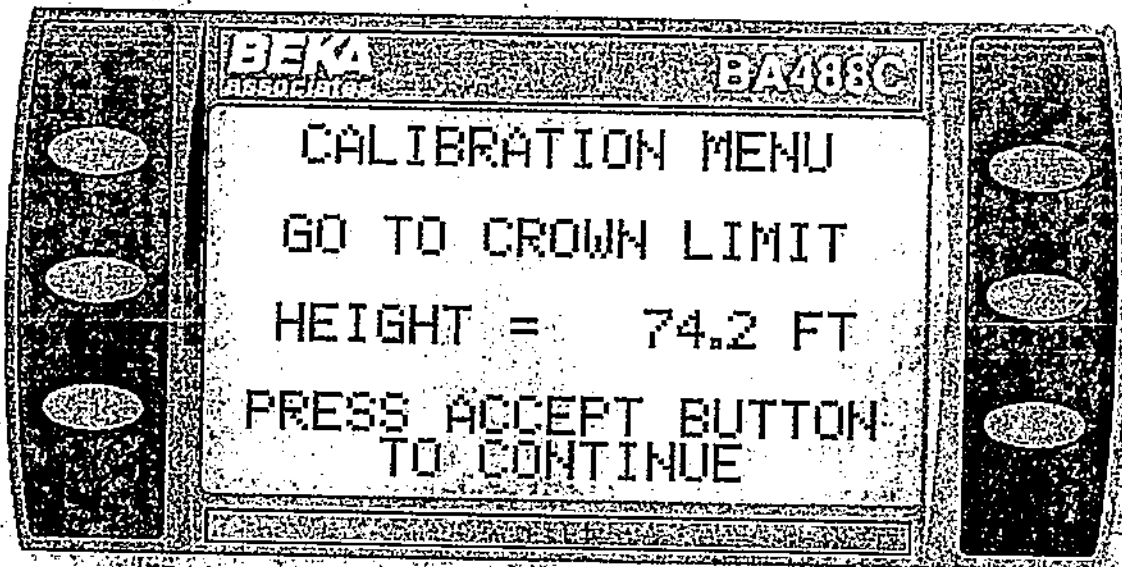


Now raise the block such that the line is at the transition between the layer it was on at the FLOOR LIMIT and the next layer. Press the green ACCEPT pushbutton. This will display the Go to End of Next Layer message:



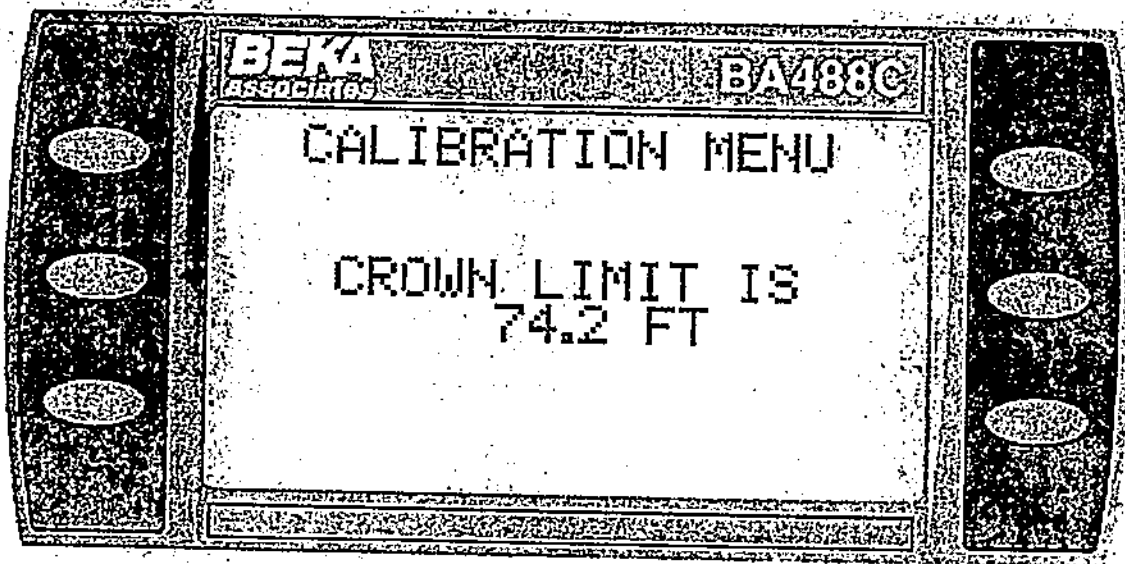
Now raise the block such that the line is at the next layer transition point. Press the green ACCEPT pushbutton

After this transition is set, the PLC is now able to calculate block height correctly. The current block height, as calculated, is now displayed.

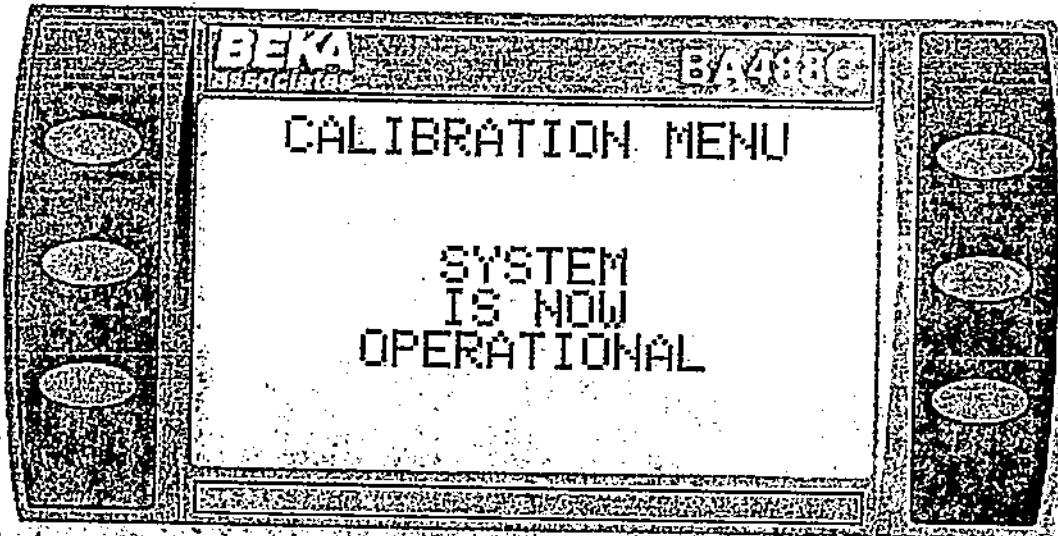


Now raise the block to the CROWN LIMIT height. This will be the height at which the Parking brake should automatically set if the block is raised any further. Press the green ACCEPT pushbutton.

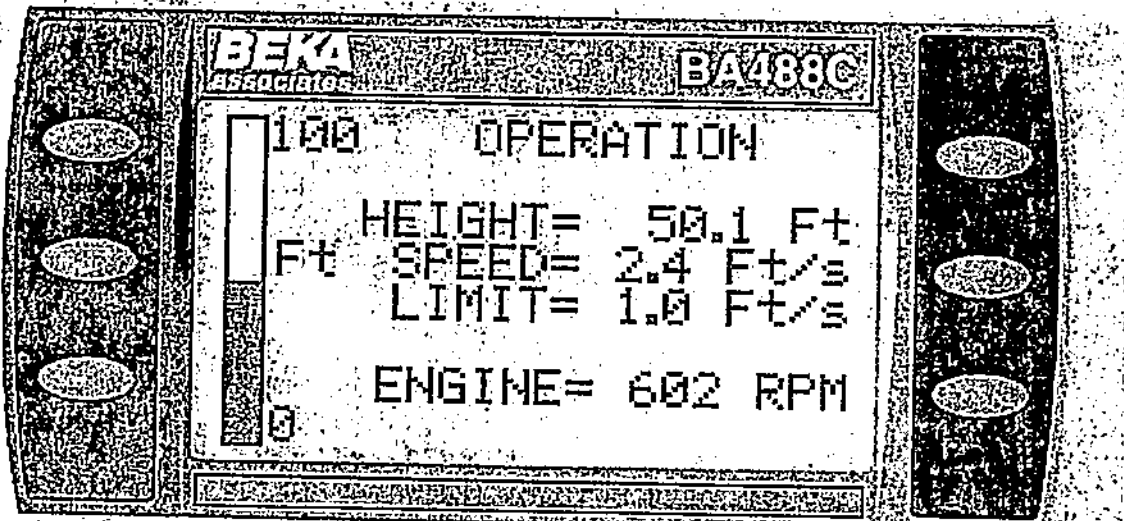
At this point, the Calibration procedure is complete and the screen will display:



The system will wait 2 seconds, and then inform the operator the system is now operational.



Then wait 2 more seconds and display the standard operational screen:



5 MILLING OPERATION

Milling operation is implemented as a typical Weight on Bit (WOB) control system. WOB is controlled by releasing the service brake to allow the drum to rotate a small amount (adjustable via SPEED CONTROL potentiometer) whenever the monitored WOB is less than what it is whenever the WOB SET pushbutton is pressed. Once movement of drum meets the expected Feed rotation the service brake is increased to stop block movement. During operation, the SPEED CONTROL potentiometer may be moved to increase or decrease the FEED rotation, which will similarly increase/decrease the amount of weight that will be added to the bit during a release operation.

1. MAIN CONTROL SWITCH to MAIN CONSOLE position. This activates the air to the main console and enables the main console controls.
2. Ensure engine is running and warmed up, and that the System Air Pressure is > 80-90 psi, and that the Service Brake Pressure is above 1500 psi.
3. Place the MODE CONTROL SWITCH to WOB/CREEP.
4. Place the SPEED CONTROL potentiometer based upon requested weight change during a release. If unsure, then place the potentiometer in the middle or the leftmost rotation. Full rotation to the left is the smallest amount of drum movement allowed.
4. Pull the panel mounted PARK BRAKE Release control.
5. Engage the Deadman Switch (Actuate and hold either the joystick trigger or front button on the joystick to release the parking brake.)
6. Pull the Joystick towards the operator. The service brake will release proportionally to joystick position. Once movement is achieved the block will move at approx 1"/sec.
7. When the bit reaches the WOB required, press the WOB SET pushbutton. This will activate the WOB control. The service brake pressure will increase and then initiate a single WOB release cycle.
8. Release the Joystick. The system will constantly monitor the WOB and will automatically initiate release cycles as necessary.



WARNING!

To prevent misapplication, Driller's console should not be left unattended. Improper application can be detrimental to causing failure and possible personal injury, property damage or death.

9. Any further movement of the Joystick (or triggering of the Deadman) will cancel the WOB operation and return full control to the joystick.



6 MAINTENANCE

6.1 Purge Panel

- Check the source of purge medium is uncontaminated
- Check air filter is clean and working correctly.
- Check the working pressure is correct.
- Check the spark arrestor is not choked
- Corrosion inspection

6.2 System Air Pressure Gauge

- Check for broken windows
- Check for case damage – dents and/or cracks
- Discoloration of gauge fill that impedes readability
- Any sign of service media leakage through the gauge including its connection

6.3 Load Cell

- Check it is secure and has not slipped or slackened off from the calibration nut.
- Confirm circuit calibration with use of a 4-20mA simulator representing the sensor inputs and check zero to full scale on each display is within calibration.

7 TROUBLESHOOTING

Q. On power up the PLC CPU stoplight is on?

A. Open right hand flap on CPU and set switch to Run mode.

Q. The potentiometer signal is unstable?

A. Ensure that the links are fitted to power supply.

