

DCS-XT-JR

**DIFFERENTIAL CONTROL SYSTEM
EXTENDED TECHNOLOGY**

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OPERATION MANUAL

ELECTRONIC DESIGN for INDUSTRY

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SPECIFICATIONS

System Enclosure Painted Steel (Weatherproof)
10"H X 10"W X 6"D
(Optional Rain Shield)

Weight Approx. 21 Lbs.

Control Input pressures Min. 0 PSI, Max. 1000 PSI
(Higher pressures optional)

Supply Input pressure Min. 5 PSI, Max. 50 PSI

Power Supply Rechargeable 6-volt Battery 10AH

Battery Life without Recharge 30 days

System Current Drain 15 MA Avg.

Solar Panel Charging Input Min. 8 volts, Max. 18 volts
Max. 0.5 Amp at full sunlight.

System Operating Temp. Range -22 deg. F to 185 deg. F
-30 deg. C to 85 deg. C

System Transducers Accuracy Linearity +/- 0.5% Full Scale
Repeatability +/- 0.1% Full Scale
Hysteresis +/- 0.4% Full Scale

GENERAL INFORMATION

THEORY OF OPERATION

The Differential Control System provides a manual and automatic control interface between the wellhead connections of an oil/gas well and the connecting valves and devices normally associated with a plunger lift production system.

The operating principal of the system is based on monitoring and control of the CASING PRESSURE, TUBING PRESSURE, and the DIFFERENTIAL PRESSURE between them.

The pressure differential between the casing and tubing string of the well is created by maintaining a static CASING PRESSURE and allowing a controlled amount of gas to be discharged from the tubing string. As this fluid saturated gas flows from the surrounding formation into the well bore and up the tubing string, the fluid and gas separates, causing a fluid column to start forming in the tubing and casing.

As this process continues, more and more fluid will enter the tubing, thus creating a hydrostatic pressure (fluid weight) which proportionately impedes the flow of gas in the tubing string. This causes a pressure drop above the rising fluid column, causing a difference between the CASING PRESSURE and TUBING PRESSURE, referred to as DIFFERENTIAL PRESSURE.

Every aspect of production relates to determining the proper differential and operating pressure that achieves the most efficient production.

Operating a well at maximum rock pressure allows very little fluid to migrate with the gas flowing into the well bore. As the bottom hole pressure is lowered, fluid saturation of the flowing gas will increase. As this process continues, a ratio will be reached that maximizes production. Beyond that point, fluid saturation will impede gas flow, eventually loading the surrounding formation and the well bore. Causing what is referred to as a LOAD CONDITION.

The goal is to achieve both an operating and a DIFFERENTIAL PRESSURE that provides a ratio that will maximize production.

After the operator has determined the proper operating pressures, the system will automatically maintain these pressures which controls the amount of fluid entering the well bore and the bottom hole pressure necessary to lift the fluid to the surface.

The system accomplishes this by opening and closing external motor valves (diaphragm operated valves) connected between the tubing string and the discharge line or lines. One motor valve is normally opened and closed for discharging of fluid referred to as a PLUNGER RUN. A second motor valve is opened and closed to control the discharge of gas referred to as GAS SALES and to maintain proper casing operating pressure.

When two motor valves are used with the system it may be necessary to place a choke or pinch valve down stream from the GAS DISCHARGE valve to provide a means to throttle the gas flow.

When a single discharge line is used, a special motor valve having two opening control inputs may be used. One of the inputs is controlled to open the valve completely for fluid discharge and the other input is controlled to throttle the opening for gas discharge. Such a valve is manufactured by Kimray, Inc., and identified as a 23 PVP Pneumatic Valve Positioner.

For low volume wells, two motor valves must be used; one for gas discharge and one for discharge of fluid directly into a tank.

NOTE: To enable gas to be discharged from the casing during the period the plunger is running to surface and returning to the bottom of the tubing, optional pneumatics can be added to the unit for controlling a motor valve connected to the casing.

This addition is recommended only for high volume wells having fast pressure recovery.

BASIC FUNCTION OF SYSTEM

The primary goal in producing a combination oil and gas well when using a plunger lift system is to release gas from the well at a controlled rate of volume and pressure and as fluid builds in the tubing string, systematically lift the fluid when a sufficient amount has accumulated.

The DCS-XT Control System provides the operator the necessary controls to do this without guesswork.

To simplify how this is accomplished, only five controls will be discussed: MINIMUM CASING PSI, MAXIMUM CASING PSI, LIFT PSI, MINIMUM DIFFERENTIAL PSI, and MAXIMUM DIFFERENTIAL PSI set controls. All controls and features of the control system are explained in detail under the heading of SYSTEM CONTROLS.

The MINIMUM CASING PSI and MAXIMUM CASING PSI controls provide the operator with the means to control the operating pressure of the well. The MINIMUM CASING PSI control sets the lower operating pressure limit and the MAXIMUM CASING PSI control sets the upper operating pressure limit of the well.

In operation, gas is released from the tubing until the CASING PRESSURE has bled down to the MINIMUM CASING PSI setting. When this point is reached, the well is SHUT-IN until the CASING PRESSURE rises to the MAXIMUM CASING PSI setting. When the MAXIMUM CASING PSI setting is reached, the system will again release gas from the well.

This process continues until a controlled amount of fluid accumulates in the tubing string. The amount of fluid allowed to accumulate in the tubing string is controlled by the MAXIMUM DIFFERENTIAL PSI and MINIMUM DIFFERENTIAL PSI settings. These controls prevent the well from loading or the plunger from running dry.

When sufficient fluid has accumulated in the tubing string causing the DIFFERENTIAL PRESSURE of the well to rise within the range of the MAXIMUM and MINIMUM setting of the differential controls, the system then automatically checks to determine if the CASING PSI is at or above the LIFT control set point. Should the CASING PSI be at or above this set point, the plunger will run and lift the fluid. Should the CASING PSI be below the LIFT control set point, the well is shut-in until the CASING PSI increases to the LIFT control set point, then the plunger will run.

To more fully understand the use and setting of these controls as well as all other controls and features of the system, the operator should review both the SYSTEM CONTROLS and CONTROL SETTINGS explanation.

FEATURES

The Differential Control System is reliable, easy to understand and operate, is solar powered and has many outstanding features including:

FOUR TIME PERIODS:

Open time - Fluid valve open.

Shut time - Gas valve and Fluid valve closed.

Purge time - Fluid valve open.

(time period after plunger arrival)

Recover time - Gas valve and Fluid valve closed.

(time period following OPEN TIME period if the plunger fails to reach the surface)

TWO CLOCK RATES:

Each time period may be timed in hours and minutes or minutes and seconds.

TWO OPERATIONAL MODES:

DCS MODE SELECT OPTION 1 OFF:

When the DIFFERENTIAL PRESSURE is at or above the MINIMUM DIFFERENTIAL PSI setting and the CASING PRESSURE is at or above the LIFT PSI setting the system will open the FLUID DISCHARGE valve starting the OPEN TIME period, upon arrival of the plunger, the system will close the FLUID DISCHARGE valve starting the SHUT TIME period. After the SHUT TIME period the system will restart with GAS SALES.

DCS MODE SELECT OPTION 1 ON:

When the DIFFERENTIAL PRESSURE is above the MAXIMUM DIFFERENTIAL PSI setting the system will start the SHUT TIME period, allowing the plunger to fall to the bottom of the tubing, then after the SHUT TIME period elapses and the CASING PRESSURE is at or above the LIFT PSI setting the system will open the FLUID DISCHARGE valve starting the OPEN TIME period, upon arrival of the plunger, the system will restart with GAS SALES.

TRACKING LOG:

The system logs every operational change, the reason why, and the pressures, date and time this change occurred. The log stores up to 220 entries.

STOP TIME AND RUN TIME:

The system may be set to stop or run on a daily, weekly, monthly, or yearly cycle.

RECORD KEEPING:

Total time GAS VALVE is open to sales line.
Total time FLUID VALVE is open to storage tank.
Total PLUNGER RUNS and PLUNGER FAILURES.
Total number of contact closures of devices connected to external inputs. (See EMERGENCY SHUT-IN page 15)

DISPLAY:

Time remaining in current time period.
Time period currently operating.
Load condition.
Input terminals that are closed by external inputs.
Battery power failure.
Electronic circuitry failures.
Operation stopped condition.

PERMANENT MEMORY:

All settings stored in the system are retained even in the event of a battery supply failure.

WATCH DOG:

The system contains a circuit referred to as a watch dog. This circuit monitors the microprocessor's activity and if this activity should cease the watch dog resets the microprocessor automatically, as if the operator had pressed the reset button located inside the unit, restoring the system to normal operation. An electrical disturbance (i.e. lightning, powerful radio transmitters, etc.) may cause the microprocessor to enter an unknown state from which it can not recover. The watch dog is designed to detect this condition, resetting the microprocessor, restoring normal operation, further increasing the reliability of the electronic system.

COMPONENT FAILURE:

The system is designed to continue to operate reliably, and warn the operator, if a failure is detected within the keyboard, external input, display, serial port, or memory circuits. This failure detection mechanism covers a major portion of circuitry yielding a highly reliable electronic system.

SERIAL COMMUNICATION:

The DCSXT-JR can communicate with a personal computer to generate reports or provide a means to monitor or change system settings. Communication is done via a hand held computer referred to as a DATA LOGGER.

PHYSICAL DESCRIPTIONS

CONTROL PANEL:

The control panel consists of: (23) function designated switch pads and (1) four-digit readout with dot indicators for identifying timing function status and auto or manual mode status of the controller. Abbreviated letter codes are also displayed on the readout for determining alarm and operating mode messages. The control panel is hinged for easy access to the power switch, reset button, battery and external input terminal strip, located behind the control panel.

EXTERNAL INPUTS:

(3) Inputs total. (1) PLUNGER SENSOR input; (1) EMERGENCY WELL SHUT-IN input; (1) BATTERY CHARGE input. The external connection wires exit the system through three bushed holes provided on the bottom side of the enclosure and are connected to the six (6) terminal connecting strips located behind the control panel at the lower right side on the main circuit board. Connections are made as shown on the inside of the enclosure door.

POWER SWITCH:

The power toggle switch is located inside the system at the upper right hand corner of the main circuit board and is labeled POWER.

POWER SWITCH:

The reset button is located inside the system at the upper center of the main circuit board and is labeled RESET. This switch causes a hardware reset to be issued to the microprocessor which causes the unit's software to start from an initialized state. This switch should not be confused with the restart switch located on the control panel which causes the DCS cycle to start over.

SERIAL PORT:

The system may be equipped with an RS232 serial port. This serial port allows connection to a hand-held computer (DATA LOGGER) which may also be supplied by EDI. All data may be read or set and all functions controlled from the DATA LOGGER. The serial port socket connection is located on the bottom side of the enclosure.

OPERATIONAL DESCRIPTION

SYSTEM CONTROLS

The following lists the controls and displays and describes their function:

LCD (LIQUID CRYSTAL DISPLAY):

The static well pressures, cycle counts, options, time periods, and all "PSI" setting values are displayed by pressing the corresponding button. The LCD also displays the operating mode of the system through the use of dot indicators and flashing messages.

DOT INDICATORS:

MANUAL OPERATION: (FLASHING DOT) LOWER CENTER

The dot located at the lower center of the LCD indicates that the system is in the MANUAL mode of operation. The MANUAL DOT flashes to attract the operator's attention.

OPEN TIME: (SOLID DOT) LOWER LEFT

The dot located at the lower left of the LCD indicates the system is in the OPEN TIME period and the FLUID DISCHARGE valve is open allowing the plunger to run. The OPEN DOT remains on solid to indicate the OPEN TIME period.

SHUT TIME: (SOLID DOT) LOWER RIGHT

The dot located at the lower right of LCD indicates the system is in the SHUT TIME period and the FLUID DISCHARGE and GAS DISCHARGE valves are closed allowing the plunger to free-fall to the bottom of the tubing. The SHUT DOT remains on solid to indicate the SHUT TIME period.

PURGE TIME: (FLASHING DOT) LOWER LEFT

The dot located at the lower left of the LCD indicates the system is in the PURGE TIME period and the plunger is at surface and the FLUID DISCHARGE valve is open allowing gas to purge the tank line. The PURGE DOT flashes to indicate the PURGE TIME period.

RECOVER TIME: (FLASHING DOT) LOWER RIGHT

The dot located at the lower right of LCD indicates the system is in the RECOVER TIME period and the FLUID DISCHARGE and GAS DISCHARGE valves are closed allowing the CASING PRESSURE and TUBING PRESSURE to rise causing the DIFFERENTIAL PRESSURE to decrease. The RECOVER DOT flashes to indicate the RECOVER TIME period.

TIME MODE: (FLASHING/SOLID DOTS) MIDDLE CENTER

When a time period is running the two vertical dots at the middle center of the "LCD" signify whether the time period value is counted once per second or once per minute. The TIME DOTS flash if the time period is set for hours and minutes. The TIME DOTS do not flash if the time period is set for minutes and seconds.

The TIME DOTS were chosen to work in this manner so the operator will always see something moving on the display. If timing is in hours and minutes the digits won't change but once per minute so the TIME DOTS flash once per second. If timing is in minutes and seconds the digits change once per second so the TIME DOTS don't flash.

MESSAGE INDICATORS:

The following messages appear on the display when the condition indicated by the message is active. These messages appear in sequence until all message conditions are displayed, then the time period count data and the dot indicators are displayed for 4 seconds, then the messages repeat. The dot indicators are only displayed for the 4 seconds the time period data is displayed and are extinguished during all message displays.

Whatever condition that causes display of a message termed a fatal error message shall cause the unit to immediately close both valves and start the "SHUT TIME" period if either valve was open. If neither valve was open no action is taken. In either case the valves won't open automatically until the fatal error is removed. The operator must eliminate the fatal error condition, if possible, and then reset the unit.

NOTE: To reset the unit the operator must press the RESET button located inside the unit. Or a reset command may be issued via the serial port.

[LoAd] - SHUT-IN:

A PLUNGER RUN has resulted in a PLUNGER FAILURE and the DIFFERENTIAL PRESSURE has remained above the MAXIMUM DIFFERENTIAL PSI setting throughout the SHUT TIME period, causing a LOAD CONDITION. The system can be manually cleared of a LOAD CONDITION by pressing the RESTART button.

The unit has a special sequence it follows whenever the well becomes loaded which may allow the unit to automatically recover from a LOAD CONDITION. The plunger did not reach the surface during a plunger run and the well has been SHUT-IN due to excessive fluid. This condition is recognized by the unit at the end of the second SHUT TIME period. The well will continue to be held SHUT-IN allowing the CASING PRESSURE and TUBING PRESSURE to rise causing the DIFFERENTIAL PRESSURE to decrease. When the TUBING PRESSURE has increased enough that the DIFFERENTIAL PRESSURE decreases to the MAXIMUM DIFFERENTIAL PSI setting or below. The LOAD CONDITION is cleared and the unit resumes normal operation.

The LOAD TIME count is the elapsed time since the well was SHUT-IN. This count appears as **[HH:MM]** and has a maximum range of **[99:59]** hours and minutes. At 100 hours after SHUT-IN the count rolls over to **[00:00]** and continues to count. This elapsed time count can be distinguished from one of the four time period counts because neither of the time period dot indicators light when this elapsed time count is displayed. Whenever one of the four time periods is displayed one of the two time period dot indicators is always on or flashing to indicate which time period is displayed.

[EgCY] - EMERGENCY SHUT-IN:

The external EMERGENCY WELL SHUT-IN input is making contact, both valves are closed, and normal operation of the unit is suspended.

The **[EgCY]** message indicates that an external device has closed a circuit connected to the EMERGENCY WELL SHUT-IN terminals. When the input is cleared, the unit will automatically return to normal operation.

If either valve is open when this input makes contact the SHUT TIME period is started, possibly aborting a PLUNGER RUN. This is done to ensure the plunger has sufficient time to reach the bottom of the tubing string before the unit may attempt another PLUNGER RUN even if the EMERGENCY WELL SHUT-IN input is cleared shortly after making contact.

[StoP] - OPERATION STOPPED:

This is a normal operation message. All controller functions stop, valves closed. To clear, set OPTION 4 to OFF, and check the REAL TIME STOP and RUN settings.

[PLuN] - EXTERNAL PLUNGER INPUT:

This is a normal operation message. The external plunger input is making contact. This message is seen any time the external plunger input is closed although, this input only effects system operation during the OPEN TIME period in either AUTO or MANUAL mode. It is ignored at all other times.

[diFF] [dLY] - GAS SALES:

This is a normal operation message. When OPTION 1 IS off (SHUT TIME AFTER PLUNGER RUN), a 10 minute time delay allows gas feed lines and separator to pressure up. This prevents false differential from triggering a plunger run. MINIMUM DIFFERENTIAL becomes active after 10 minutes. However, if the DIFFERENTIAL PRESSURE exceeds the MAXIMUM DIFFERENTIAL PSI setting, this delay time period is ignored and the system proceeds to the next step in sequence.

When OPTION 1 is ON (SHUT TIME BEFORE PLUNGER RUN) the DIFFERENTIAL DELAY TIME period is not used as the system must exceed the MAXIMUM DIFFERENTIAL PSI setting in order to run the plunger.

[dCS] - AUTOMATIC MODE:

This is a normal operation message. The system is in automatic, rather than the manual mode.

[HAnd] - SERIAL PORT:

This is a normal operation message. A hand held computer is currently connected to the serial port. While this message is displayed the controls are ineffective. All settings and information except the log will display but nothing may be altered. The manual valve controls also do not work.

[PASS] - CONTROL PANEL:

This is a normal operation message. The operator has entered a pass word containing at least one numeric digit via the serial communication port. While this message is displayed the controls are ineffective. All settings and information including the log will display but nothing may be altered. The manual valve controls also do not work.

[EECL] - CLEARING PERMANENT MEMORY:

This is a normal operation message. The unit is currently clearing the permanent memory. This message should appear only after setting option 6 on CLEAR PERMANENT MEMORY, when the OPTIONS button is released.

[LgCL] - CLEARING TRACKING LOG:

This is a normal operation message. The unit is currently clearing the TRACKING LOG. This message should appear whenever power is applied to the unit, or the permanent memory is cleared, or after setting OPTION 5 ON (CLEAR TRACKING LOG) when the OPTIONS button is released.

NOTE: If power is removed from the system and then restored quickly this message may not appear on power up. If this happens the TRACKING LOG may contain erroneous data. Either turn the power off for approximately 1 minute or clear the log via OPTION 5 (CLEAR TRACKING LOG).

[dEAd] - LOW BATTERY:

The 6 volt battery supply is low. This message differs from the others. If this message is flashed in sequence with the other messages, a SHUT TIME period has been started, and all normal functions have been disabled. The operator is not able to exit this mode until the battery supply is replenished and the unit is RESET.

When the battery supply has been restored, press the RESET button or turn the "POWER" switch on to restore normal operation. If the battery is still low the SHUT TIME period is started again repeating the power failure sequence. The unit cannot be made to operate if the battery is low.

If the SHUT TIME period elapses, and the LOW BATTERY condition remains, the microprocessor turns itself off to conserve what little power remains. At this point the unit becomes totally inoperative. The **[dEAd]** message remains on the display as long as there is enough voltage to power the display.

[EEFL] - HARDWARE FAILURE:

The permanent memory chip has failed. If this message persists. The unit may require return to E.D.I. for service.

[EYFL] - HARDWARE FAILURE:

The keyboard circuitry has failed. If this message persists. The unit may require return to E.D.I. for service.

[LgFL] - HARDWARE FAILURE:

One or more of the log data storage chips has failed. If this message persists. The unit may require return to E.D.I. for service.

[i2FL] - HARDWARE FAILURE:

The processor inter-circuit communication bus has failed. If this message persists. The unit may require return to E.D.I. for service.

[rSFL] - HARDWARE FAILURE:

The serial port circuitry has failed. The problem may be in the hand held computer (DATA LOGGER) or if this message persists after disconnection of the hand held computer. The unit may require return to E.D.I. for service.

[PLFL] - HARDWARE FAILURE:

The PLUNGER SENSOR input was closed immediately prior to opening either of the valves after a shut type time period (SHUT TIME, RECOVER TIME, or GAS SALES with GAS DISCHARGE valve closed) has elapsed, causing a PLUNGER ARRIVAL SWITCH error. The plunger may be stuck in the lubricator, or the plunger arrival switch may be defective or improperly wired. If this message persists after disconnection of the plunger arrival switch. The unit may require return to E.D.I. for service. The system can be manually cleared of a PLUNGER ARRIVAL SWITCH error by pressing the RESTART button.

RESTART (PUSH-BUTTON):

The button labeled CYCLE resets the system to the start point of a system cycle. In AUTO mode, this button closes both valves, cancels any time periods, clears the LOAD CONDITION and PLUNGER ARRIVAL SWITCH errors and starts the GAS SALES sequence of a cycle. In MANUAL mode this button closes both valves and cancels any time periods.

SET AND CLEAR (PUSH-BUTTONS):

These push-buttons are labeled UP AND DOWN. Depressing the UP button causes numeric value to increase. Depressing the DOWN button causes numeric values to decrease.

Depressing and holding either of these buttons will cause automatic stepping of value changes at a fast rate. When changing options or clearing counts, either the UP or DOWN button may be used.

Throughout this manual these push-buttons are referred to as the SET/CLEAR control. This control is used to alter all numeric values, change the on/off status of options and clear accumulated counts.

VALVE CONTROL (PUSH-BUTTONS):

These push-buttons are labeled MAN MODE and AUTO MODE.

When the MANUAL MODE has been activated, the DOT located in the lower center of the LCD will flash to alert the operator that the system is in the MANUAL MODE and all automatic functions have been stopped and the GAS VALVE and FLUID VALVE, OPEN and SHUT push-buttons are activated for manual valve control.

When the AUTOMATIC MODE has been activated, the system runs all cycle routines automatically, and the GAS VALVE and FLUID VALVE, OPEN and SHUT push-buttons are activated to set and read the REAL TIME functions of the system. These functions are labeled on the lower half of the push-buttons in black.

MANUAL VALVE/REAL TIME (PUSH-BUTTONS): (RED)

The following assumes the VALVE CONTROL (MANUAL MODE) has been activated:

OPEN GAS (PUSH-BUTTON):

When the OPEN GAS button is pressed, the GAS DISCHARGE valve is opened, assuming the GAS DISCHARGE valve was closed and no fatal errors preclude opening of the GAS DISCHARGE valve, no time period is started.

SHUT GAS (PUSH-BUTTON):

When the CLOSE GAS button is pressed, the GAS DISCHARGE valve will close if it was open. No time period is started.

OPEN FLUID (PUSH-BUTTON):

When the OPEN FLUID button is pressed, the FLUID DISCHARGE valve is opened and the OPEN TIME period starts, if the FLUID DISCHARGE valve was closed and no fatal errors preclude opening of the FLUID DISCHARGE valve.

SHUT FLUID (PUSH-BUTTON):

When the CLOSE FLUID button is pressed, the FLUID DISCHARGE valve is closed and the SHUT TIME period starts, if the FLUID DISCHARGE valve was open.

Once the FLUID DISCHARGE valve is opened manually and the operator neglects to close this valve. The unit closes the FLUID DISCHARGE valve automatically when the OPEN TIME period elapses or the plunger arrives at surface, even though the system was left in the MANUAL mode of operation.

The operator may activate the MANUAL mode and open the FLUID DISCHARGE valve, then return to AUTO mode. The system remains in the OPEN TIME period with the FLUID DISCHARGE valve open and resumes automatic operation as if the system had opened the FLUID DISCHARGE valve due to proper pressure conditions.

The operator may activate the MANUAL mode and open the "FLUID DISCHARGE" valve, then close the FLUID DISCHARGE valve which starts the SHUT TIME period, then return to "AUTO" mode. The system remains in the SHUT TIME period with both valves closed and resumes automatic operation as if the system had closed the FLUID DISCHARGE valve in response to the OPEN TIME period elapsing, as if the plunger failed to surface. The PLUNGER FAILURE count is not incremented, nor is a PLUNGER FAILURE recorded in the TRACKING LOG. However, now that the system is back in automatic operation, when the SHUT TIME period elapses, if the DIFFERENTIAL PRESSURE is above the MAXIMUM DIFFERENTIAL PSI setting, the LOAD CONDITION will be set.

MANUAL VALVE/REAL TIME (PUSH-BUTTONS): (BLACK)

The following discussion assumes the VALVE CONTROL (AUTOMATIC MODE) has been activated.

The STOP, RUN, CLOCK and LOG push-buttons cause their displays to operate in a circular manner. Once the last display in sequence has been displayed, another depression of the button causes the first display to appear again, repeating the sequence of displays indefinitely.

The display sequence does not automatically reset to the first display in sequence. This means, if the operator reads the first three of five displays at some time, then returns to the unit at any time in the future, the fourth display in sequence is displayed the next time the operator presses the button. Therefore, when first pressing one of these buttons upon arrival on site, what is displayed may not necessarily be the first display in sequence as described below.

CLOCK (PUSH-BUTTON):

The REAL TIME CLOCK is set or read via the CLOCK button when the system is in "AUTO" mode.

When the button is pressed the operator shall see one of 6 displays. The displays are described as follows:

[99:XX] Year of century.

[12:XX] Month of year.

[31:XX] Day of month.

[23:XX] Hour of day.

[59:XX] Minute of hour.

[07:XX] Day of week.

In all 6 displays the two digits left of the colon inform the operator what value is displayed. The "XX" right of the colon signifies the time value. While holding the button depressed, the operator may depress the SET and CLEAR (UP or DOWN) button to change the two digit value represented by the "XX" characters right of the colon. The value may be set between "00" or possibly "01" and the upper limit shown by the two digits left of the colon. When either limit is reached, the displayed value will roll over to the other limit. When the clock button is released, the value is saved and the next value is readied for display to read or set.

SETTING REAL TIME:

The REAL TIME CLOCK displays 24 hours a day (International Time), which runs from 00:00 hours (12:00 AM Midnight) to 23.59 hours (11:59 PM). Therefore, 12:00 PM (or Noon) would be 12:00 hours, 1:00 PM would be 13:00 hours, etc. Please note that SUNDAY is considered the first day of the week, Monday, day 2, etc.

The REAL TIME CLOCK is not set at the factory. The system is shipped with the Power off. Any time power is removed from the system the REAL TIME is lost. Upon

resumption of power the REAL TIME data is undefined and may include values outside the normal range. **Any time power is restored to the system, the REAL TIME CLOCK must be set by the operator.**

NOTE: If the operator clears the permanent memory or performs a hardware reset via the reset button located inside the unit, REAL TIME data is not affected. Although, the amount of time elapsed in the last minute is lost. Therefore, the REAL TIME CLOCK may end up 1 minute behind after the system is reset.

Example: (Setting real time clock)

If this time string were set into REAL TIME, the unit would indicate a real time of Monday, November 23rd, 1992 at 08:59 AM.

[99:92] Year of century
[12:11] Month of year
[31:23] Day of month
[23:08] Hour of day
[59:59] Minute of hour
[07:02] Day of week

NOTE: The REAL TIME CLOCK must be set before using the Stop, Run and Log features of the system.

STOP AND RUN (PUSH-BUTTONS):

The system may be set to stop or run on a daily, weekly, monthly or yearly cycle. The STOP TIME and RUN TIME displays are identical. While depressing either the STOP or RUN button, the operator shall see one of 5 displays. The displays are described as follows:

[12:XX] Month of year
[31:XX] Day of month
[23:XX] Hour of day
[59:XX] Minute of hour
[07:XX] Day of week

In all 5 displays the two digits left of the colon inform the operator what value is displayed. The "XX" right of the colon signifies the time value. While depressing either the STOP button or the RUN button, the operator may depress the SET and CLEAR (UP or DOWN) button to change the two digit value represented by the "XX" characters right of the colon. The value may be set between "00" and the upper limit shown by the two digits left of the colon. When either limit is reached, the displayed value will roll over to the other limit.

NOTE: To disable the STOP and RUN times when they are not used, the operator must set "00" in each of the 5 time displays in both the STOP and RUN controls.

SETTING STOP TIME AND RUN TIME:

The "XX" values (time) that can be set in the STOP and RUN TIME are the same as those of the REAL TIME CLOCK.

The 24 hours in a day are counted in International Time, which runs from 00:00 hours (12:00 AM midnight) to 23:59 hours (11:59 PM). Therefore, 1:00 AM would be 01:00 hours, 12:00 PM (noon) would be 12:00 hours, 1:00 PM would be 13:00 hours, etc.

The first day of the week is SUNDAY, followed by Monday (the second day), continuing through SATURDAY (the seventh day).

IMPORTANT: The 00:00 (or 12:00 AM Midnight) setting cannot be used as a DAILY time cycle setting. This is because the minute of the hour "00" setting and all other time settings being "00", indicate to the system that no action should be taken. This is true for either stop or run control. A setting of 1 minute before midnight (23:59) or 1 minute after midnight (00:01) or any DAILY time cycle setting other than midnight (00:00) can be set to stop, run or by setting both controls, will cycle the system ON and OFF.

When a cycle or time period is set for more than a DAILY period, then the above does not apply and a time setting of midnight (00:00) may be used.

The following chart shows the displays that are set for **yearly, monthly, weekly,** and **daily** STOP and RUN cycles of the system:

CYCLE:	YEARLY	MONTHLY	WEEKLY	DAILY
SET RANGE:	01-12	01-31	01-07	00-23
DISPLAY MO. OF YR.	12:XX	12:00	12:00	12:00
DISPLAY DAY OF MO.	31:XX	31:XX	31:00	31:00
DISPLAY DAY OF WK.	07:00	07:00	07:0X	07:00
DISPLAY HR. OF DAY	23:XX	23:XX	23:XX	23:XX
DISPLAY MIN.OF HR.	59:XX	59:XX	59:XX	59:XX

EXAMPLE: YEARLY CYCLE

	STOP (MARCH 15, AT 11:30 PM)	RUN (SEPT. 21, AT 6:00 AM)
MO. OF YR.	12:03	12:09
DAY OF MO.	31:15	31:21
DAY OF WK.	07:00	07:00
HR. OF DAY	23:23	23:06
MIN.OF HR.	59:30	59:00

EXAMPLE: MONTHLY CYCLE

	STOP (10TH AT 12:00 AM)	RUN (25TH AT 12:30 PM)
MO. OF YR.	12:00	12:00

DAY OF MO.	31:10	31:25
DAY OF WK.	07:00	07:00
HR. OF DAY	23:00	23:12
MIN.OF HR.	59:00	59:30

EXAMPLE: WEEKLY CYCLE

STOP (FRIDAY AT 5:30 PM) RUN (MONDAY AT 8:15 AM)

MO. OF YR.	12:00	12:00
DAY OF MO.	31:00	31:00
DAY OF WK.	07:05	07:02
HR. OF DAY	23:17	23:08
MIN.OF HR.	59:30	59:15

EXAMPLE: DAILY CYCLE

STOP (6:45 PM) RUN (7:10 AM)

MO. OF YR.	12:00	12:00
DAY OF MO.	31:00	31:00
DAY OF WK.	07:00	07:00
HR. OF DAY	23:18	23:07
MIN.OF HR.	59:45	59:10

NOTE: The operator may override a STOP or RUN time period by changing the status of Option 4. This option can be accessed by pressing the CYCLE INFORMATION option SET/READ button. To change the Option 4 to ON activates the system STOP mode. Setting Option 4 to OFF activates the system RUN mode.

LOG (PUSH-BUTTON):

The TRACKING LOG is read via the LOG button with the system operating in the AUTO mode. The LOG records all manual or automatic changes or events occurring during operation of the system, and the time the change occurred.

The LOG has capacity for 220 entries. After 220 records, the LOG starts over at 0000 and clears all previous LOG records automatically. The operator may scan through the entries and select any LOG record by holding the LOG button depressed and pressing the SET CLEAR (UP or DOWN) button.

Each LOG record consists of 5 displays. Each display is accessed by pressing the LOG button once and holding for each display. The 5 displays are described as follows:

1. [0XXX] LOG RECORD ENTRY NUMBER (0000 thru 0220) (**NOTE 1**)
2. [CCDD] EVENT CODE (CC) AND DAY OF MONTH OCCURRED (DD)(**NOTE 2**)
3. [HH:MM] HOUR AND MINUTE OF DAY EVENT OCCURRED
4. [X.XXX] CASING PRESSURE OR OLD SET POINT (**NOTE 3**)
5. [XXX.X] TUBING PRESSURE OR NEW SET POINT (**NOTE 4**)

NOTE 1: LOG entry [0000] is not used for coding of an event. Instead, the event code (CC) in the second display indicates the month of the year the LOG was started.

NOTE 2: The event codes (CC) and their description are listed under the heading CODE DESCRIPTION on the following pages.

NOTE 3: When an operating set point change is made by an operator, the OLD set point is displayed in the fourth display instead of the casing pressure. In either case, the dot on the left side of the display indicates the fourth display.

NOTE 4: When an operating set point change is made by an operator, the new set point is displayed in the fifth display instead of the casing pressure. In either case, the dot on the right side of the display indicates the fifth display.

NOTE 5: When the set point data in the fourth and fifth displays is a change in one of the timing periods, it is necessary to determine if the timing is in hours and minutes or minutes and seconds. This is accomplished by CODING the second most significant digit in the MINUTE and SECONDS timing mode. Normally, the seconds would read **0X** through **5X**; however, to IDENTIFY the timing in MINUTES and SECONDS, they are changed to read **8X** through **DX** as follows:

EXAMPLE:

CODE:	CHANGE	SECONDS
85 SEC	8 TO 0 =	05 SEC
90 SEC	9 TO 1 =	10 SEC
A6 SEC	A TO 2 =	26 SEC
B0 SEC	B TO 3 =	30 SEC
C5 SEC	C TO 4 =	45 SEC
D9 SEC	D TO 5 =	59 SEC

CODE DESCRIPTIONS

The tracking log codes (**CC**) are as follows:

DCS PROCESS CODES:

- 61 - OPEN GAS VALVE (AUTOMATIC).
- 62 - RESTART DCS CYCLE (AUTOMATIC).
- 63 - CLOSE GAS VALVE (AUTOMATIC).
- 64 - START PURGE TIME - NO VALVE ACTION.
- 65 - START RECOVER TIME - NO VALVE ACTION.
- 66 - RUN TIME EQUALS REAL TIME.
- 67 - STOP TIME EQUALS REAL TIME.
- 68 - START SHUT TIME - CLOSE BOTH VALVES.
- 6E - START OPEN TIME - OPEN FLUID VALVE.
- 6F - PLUNGER ARRIVAL.

MANUAL CONTROL CODES (LOCAL):

- 98 - RESTART IN MANUAL MODE.
- 99 - RESTART IN AUTO MODE.
- A0 - MANUAL MODE SET.
- A1 - AUTO MODE SET.
- AA - GAS VALVE CLOSED - MANUAL.
- Ab - GAS VALVE OPENED - MANUAL.
- AC - FLUID VALVE OPENED - MANUAL.
- Ad - FLUID VALVE CLOSED - MANUAL.

MANUAL CONTROL CODES (REMOTE):

- C8 - RESTART IN MANUAL MODE.
- C9 - RESTART IN AUTO MODE.
- d0 - MANUAL MODE SET.
- d1 - AUTO MODE SET.
- dA - GAS VALVE CLOSED - MANUAL.
- db - GAS VALVE OPENED - MANUAL.
- dC - FLUID VALVE OPENED - MANUAL.
- dd - FLUID VALVE CLOSED - MANUAL.

SET POINT CHANGE CODES (LOCAL)

80 - RECOVER TIME SET.
81 - PURGE TIME SET.
82 - OPEN TIME SET.
83 - SHUT TIME SET.
84 - MINIMUM CASING PSI SET.
85 - MAXIMUM CASING PSI SET.
86 - MINIMUM DIFFERENTIAL PSI SET.
87 - MAXIMUM DIFFERENTIAL PSI SET.
88 - LIFT PSI SET.
8E - RUN TIME SET.
8F - STOP TIME SET.
93 - REAL TIME CLOCK SET.

SET POINT CHANGE CODES (REMOTE):

b0 - RECOVER TIME SET.
b1 - PURGE TIME SET.
b2 - OPEN TIME SET.
b3 - SHUT TIME SET.
b4 - MINIMUM CASING PSI SET.
b5 - MAXIMUM CASING PSI SET.
b6 - MINIMUM DIFFERENTIAL PSI SET.
b7 - MAXIMUM DIFFERENTIAL PSI SET.
b8 - LIFT PSI SET.
bE - RUN TIME SET.
bF - STOP TIME SET.
C0 - PASSWORD SET.
C3 - REAL TIME CLOCK SET.

COUNT CLEAR CODES: (LOCAL)

89 - PLUNGER ARRIVAL COUNT.
8A - PLUNGER FAILURE COUNT.
8b - EMERGENCY WELL SHUT-IN COUNT.
8C - GAS VALVE OPEN ELAPSED TIME.
8d - FLUID VALVE OPEN ELAPSED TIME.

COUNT CLEAR CODES (REMOTE):

b9 - PLUNGER ARRIVAL COUNT.
bA - PLUNGER FAILURE COUNT.
bb - EMERGENT WELL SHUT-IN COUNT.
bC - GAS VALVE OPEN ELAPSED TIME.
bd - FLUID VALVE OPEN ELAPSED TIME.

OPTION CHANGE CODES: (LOCAL):

94 - OP1 OFF - SHUT TIME AFTER PLUNGER RUN.
95 - OP2 OFF - TANK PURGE STOP AT MINIMUM CASING.
96 - OP3 OFF - GAS SALES AT MINIMUM CASING.
97 - OP4 OFF - NORMAL OPERATION.
9A - OP1 ON - SHUT TIME BEFORE PLUNGER RUN.
9b - OP2 ON - TANK PURGE IGNORES MINIMUM CASING.
9C - OP3 ON - GAS SALES AT MAXIMUM CASING.
9d - OP4 ON - STOP SYSTEM OPERATION.
9E - OP5 ON - CLEAR TRACKING LOG.
9F - OP6 ON - CLEAR PERMANENT MEMORY.

OPTION CHANGE CODES (REMOTE):

C4 - OP1OFF - SHUT TIME AFTER PLUNGER RUN.
C5 - OP2 OFF - TANK PURGE STOP AT MINIMUM CASING.
C6 - OP3 OFF - GAS SALES AT MINIMUM CASING.
C7 - OP4 OFF - NORMAL OPERATION.
CA - OP1 ON - SHUT TIME BEFORE PLUNGER.
Cb - OP2 ON - TANK PURGE IGNORES MINIMUM CASING.
CC - OP3 ON - GAS SALES AT MAXIMUM CASING.
Cd - OP4 ON - STOP SYSTEM OPERATION.
CE - OP5 ON - CLEAR TRACKING LOG.
CF - OP6 ON - CLEAR PERMANENT MEMORY.

GENERAL ERROR CODES:

E0 - PROCESS ERROR - PLUNGER FAILURE.
E1 - FATAL ERROR - RS232 SERIAL PORT.
E3 - FATAL ERROR - KEYBOARD PORT.
E5 - FATAL ERROR - PROCESSOR INTER-CIRCUIT BUS.
E6 - FATAL ERROR - LOW BATTERY.
E7 - FATAL ERROR -TRACKING LOG MEMORY.
Eb - FATAL ERROR - LCD DISPLAY.
EC - FATAL ERROR - PERMANENT MEMORY.
Ed - FATAL ERROR - PLUNGER ARRIVAL SWITCH.
EE - PROCESS ERROR - LOAD CONDITION.
EF - PROCESS ERROR - EMERGENCY WELL SHUT-IN.

SYSTEM EVENT CODES:

F0 - RS232 PORT OFF.

F1 - RS232 PORT ON.

F6 - TRACKING LOG CLEARED (OVERFLOW).

F7 - TRACKING LOG CLEARED (LOCAL).

F8 - TRACKING LOG CLEARED (REMOTE).

F9 - PERMANENT MEMORY CLEARED.

FA - SYSTEM RESET.

Fb - REMOTE SYSTEM RESET.

CYCLE INFORMATION (PUSH-BUTTONS):

These push-buttons are labeled OPTION SET/READ and DATA READ/CLEAR.

OPTIONS (PUSH-BUTTON):

The OPTION push-button is used to display or set a total of six (6) options. The option NUMBER will display and then the status ON or OFF will display. Each time the OPTION button is depressed, the option displayed will advance one count.

The ON/OFF status of an OPTION can be changed by depressing either the UP or DOWN button of the SET and CLEAR control while reading an option display. Upon release of the OPTION button, then pressing again, the OPTION status of Option 1 through 4 is re-displayed. As long as the operator changes the status of a display to ON or OFF, the option display does not advance when the OPTION button is released.

CAUTION !!! OPTIONS 5 AND 6 DO NOT HAVE THIS FEATURE.

The following lists the options and their function:

- OP 1 OFF: SHUT time starts after plunger run.
 ON: SHUT time starts before plunger run.

- OP 2 OFF: Stop PURGE time and shut valve at MIN. CASING.
 ON: Shut valve at end of PURGE time.

- OP 3 OFF: Open gas valve above MIN. CASING after SHUT time.
 ON: Open gas valve at MAX. CASING after SHUT time.

- OP 4 OFF: All functions of the controller are operational.
 ON: All functions stop and the display flashes STOP.

- OP 5 OFF: Normal operation.
 ON: Clears tracking LOG entries. Display reads donE.

- OP 6 OFF: Normal operation.
 ON: Clears all set information in the controller. Display reads donE.

OPTION 1 - SHUT TIME SELECT

OPTION 1 allows the operator to have a choice of when SHUT TIME occurs in a cycle. SHUT TIME provides time for the plunger to fall to the bottom of the tubing string and the well to build pressure.

OPTION 1 - OFF:

When OPTION 1 is set to OFF, the SHUT TIME occurs AFTER a plunger run. This order of sequence is normally used when operating low to medium producing wells when production parameters are critical and a well defined gas production chart is important.

The SHUT TIME occurring at this point in the cycle allows the casing pressure of the well to rebuild and stabilize before gas discharge begins in a new cycle. Normally the gas discharge is restricted on the surface with a choke or pinch valve which controls the rate the casing pressure is fed down. This lengthens the time of gas discharge during each cycle providing a more readable gas chart, controls fluid entry, and also prevents the plunger from floating up the tubing string.

In this mode the unit attempts to lift a fluid load whenever the CASING PRESSURE is at or above the LIFT PSI, and the DIFFERENTIAL PRESSURE is at or above the MINIMUM DIFFERENTIAL PSI setting, and the DIFFERENTIAL DELAY TIME period has elapsed. The DIFFERENTIAL PRESSURE may be above or below the MAXIMUM DIFFERENTIAL PSI setting.

PLUNGER RUN CYCLE SEQUENCE (A)

When the above criteria are met the FLUID DISCHARGE valve is opened and the GAS DISCHARGE valve is closed (if it was open) and the OPEN TIME period is started.

PLUNGER ARRIVAL CYCLE SEQUENCE (B)

If the plunger arrival switch closes the PLUNGER SENSOR input circuit signaling arrival of the plunger at surface before the OPEN TIME period elapses, a PLUNGER ARRIVAL is recorded in the log. The PLUNGER ARRIVAL count is incremented, the remainder of the OPEN TIME period is canceled and the PURGE TIME period is started.

PURGE TIME CYCLE SEQUENCE (C)

The PURGE TIME period may be set to zero, causing the PURGE TIME period to end immediately. The PURGE TIME period may be set to allow gas stored behind the plunger to force the fluid remaining in the tank discharge line into the storage tank, clearing the discharge line of fluid.

SHUT TIME CYCLE SEQUENCE (D)

When the PURGE TIME period elapses, the SHUT TIME period starts and both valves are closed for the remainder of the SHUT TIME period. During this time, the plunger falls back to the bottom of the tubing in preparation to start the cycle over again.

PLUNGER RUN CYCLE SEQUENCE (A1)

When the SHUT TIME period elapses, if the pressures are correct for another PLUNGER RUN, the unit immediately opens the FLUID DISCHARGE valve and starts the OPEN TIME period. The GAS DISCHARGE period is skipped as it was not needed due to already having a sufficient amount of DIFFERENTIAL PRESSURE and LIFT PRESSURE for a PLUNGER RUN.

If the plunger arrives at surface as in CYCLE SEQUENCE (B), then the above cycling is repeated. If the plunger does not arrive at surface as in CYCLE SEQUENCE (B), then the following will occur:

PLUNGER FAILURE

If the plunger does not surface before the OPEN TIME period elapses, a PLUNGER FAILURE is recorded in the log and the PLUNGER FAILURE count is incremented and the SHUT TIME period is started. The PURGE TIME period is ignored. When the SHUT TIME period elapses, if the DIFFERENTIAL PRESSURE is not above the MAXIMUM DIFFERENTIAL PSI setting, the unit continues operation normally as explained above. The result of this type of failure is the recording of the PLUNGER FAILURE. Since the well recovered with the DIFFERENTIAL PRESSURE at or below the MAXIMUM DIFFERENTIAL PSI setting before the SHUT TIME period elapsed, no further special action need be taken by the unit.

When the SHUT TIME period elapses, if the DIFFERENTIAL PRESSURE is above the MAXIMUM DIFFERENTIAL PSI setting, the LOAD CONDITION is set and the RECOVER TIME period is started. The RECOVER TIME period may be set to zero, causing the RECOVER TIME period to end immediately.

RECOVER TIME (SET TO ZERO)

If the RECOVER TIME period **is set to zero**, the LOAD CONDITION is terminated when the DIFFERENTIAL PRESSURE decreases to become equal to the MAXIMUM DIFFERENTIAL PSI setting, or the RESTART button is pressed, at which time normal operation continues. Both valves remain closed throughout the period of the LOAD CONDITION.

RECOVER TIME (NOT SET TO ZERO)

If the RECOVER TIME period **is not set to zero**, the LOAD CONDITION is terminated when the DIFFERENTIAL PRESSURE decreases to become equal to the MAXIMUM DIFFERENTIAL PSI setting, or when the RECOVER TIME period elapses regardless of the DIFFERENTIAL PRESSURE, or when the RESTART button is pressed, at which time normal operation continues. Both valves remain closed throughout the period of the LOAD CONDITION.

OPTION 1 - ON:

When OPTION 1 is set to ON, the SHUT-TIME occurs BEFORE a plunger run. This order of sequence is normally used when operating a HIGH VOLUME well.

The gas flow rate from this type of well is sometimes enough to cause the plunger to float up the tubing string during the gas producing period of a cycle.

The SHUT-TIME occurring AFTER gas discharge and BEFORE a plunger run provides the time necessary for the plunger to fall to the bottom of the tubing string and also allows the casing pressure to build. In this mode, the unit attempts to lift a fluid load whenever the CASING PRESSURE is at or above the LIFT PSI, and the DIFFERENTIAL PRESSURE is ABOVE the MINIMUM DIFFERENTIAL PSI setting.

PLUNGER RUN CYCLE SEQUENCE (A)

When the above criteria are met, the SHUT TIME period is started and both valves are closed. When the SHUT TIME period elapses (if the DIFFERENTIAL PRESSURE has not fallen below the MINIMUM DIFFERENTIAL PSI setting and the CASING PRESSURE remains at or above the LIFT PSI setting) the FLUID DISCHARGE valve is opened and the OPEN TIME period is started.

When the SHUT TIME period elapses, if the CASING PRESSURE is below the LIFT PSI setting, the well remains SHUT-IN until LIFT PRESSURE is obtained, then a PLUNGER RUN is started.

If the DIFFERENTIAL PRESSURE has fallen BELOW the MINIMUM DIFFERENTIAL PSI setting, the PLUNGER RUN is skipped and the GAS DISCHARGE VALVE is opened, starting a new cycle.

PLUNGER ARRIVAL CYCLE SEQUENCE (B)

If the plunger arrival switch closes the PLUNGER SENSOR input circuit signaling arrival of the plunger at surface before the OPEN TIME period elapses, the PLUNGER ARRIVAL is recorded in the log and the PLUNGER ARRIVAL count is incremented. The remainder of the OPEN TIME period is canceled and the PURGE TIME period is started.

PURGE TIME CYCLE SEQUENCE (C)

The PURGE TIME period may be set to zero, causing the PURGE TIME period to end immediately. The PURGE TIME period may be set to allow gas stored behind the plunger to force the fluid remaining in the tank discharge line into the storage tank, clearing the discharge line of fluid.

PLUNGER RUN CYCLE SEQUENCE (A1)

When the PURGE TIME period elapses, (and the pressures are correct for another PLUNGER RUN), the unit starts the SHUT TIME period in preparation for another PLUNGER RUN. The GAS SALES period is skipped as it was not needed due to already having a sufficient amount of DIFFERENTIAL PRESSURE and LIFT PRESSURE for a PLUNGER RUN.

If the plunger arrives at surface as in CYCLE SEQUENCE (B), then the above cycling is repeated. If the plunger does not arrive at surface as in CYCLE SEQUENCE (B), then the follow will occur:

PLUNGER FAILURE:

If the plunger does not surface before the OPEN TIME period elapses, a PLUNGER FAILURE is recorded in the log and the PLUNGER FAILURE count is incremented, and an additional SHUT TIME period is started. The PURGE TIME period is ignored. When this additional SHUT TIME period elapses, if the DIFFERENTIAL PRESSURE is not above the MAXIMUM DIFFERENTIAL PSI setting, the unit continues operation normally with GAS SALES. The result of this type of failure is the recording of the PLUNGER FAILURE. Since the well recovered with the DIFFERENTIAL PRESSURE not above the MAXIMUM DIFFERENTIAL PSI setting before the additional SHUT TIME period elapsed, no further special action need be taken by the system.

When this additional SHUT TIME period elapses, if the DIFFERENTIAL PRESSURE is above the MAXIMUM DIFFERENTIAL PSI setting, the LOAD CONDITION is set and the RECOVER TIME period is started. The RECOVER TIME period may be set to zero, causing the RECOVER TIME period to end immediately.

RECOVER TIME SET TO ZERO

If the RECOVER TIME period is set to zero, the LOAD CONDITION is terminated only when the DIFFERENTIAL PRESSURE decreases to become equal to the MAXIMUM DIFFERENTIAL PSI setting, or when the RECOVER TIME period elapses regardless of the DIFFERENTIAL PRESSURE, or the RESTART button is pressed, at which time normal operation continues. Both valves remain closed throughout the period of the LOAD CONDITION.

RECOVER TIME (NOT SET TO ZERO)

If the RECOVER TIME period is not set to zero, the LOAD CONDITION is terminated when the DIFFERENTIAL PRESSURE decreases to become equal to the MAXIMUM DIFFERENTIAL PSI setting, or when the RECOVER TIME period elapses regardless of the DIFFERENTIAL PRESSURE, or the RESTART button is pressed, at which time normal operation continues. Both valves remain closed throughout the period of the LOAD CONDITION.

OPTION 2 - PURGE TIME:

OPTION 2 - OFF:

The PURGE TIME period is canceled if the CASING PRESSURE falls below the MINIMUM CASING PSI setting.

OPTION 2 - ON:

The PURGE TIME period runs to completion regardless of the CASING PRESSURE.

OPTION 3 - GAS DISCHARGE VALVE:

OPTION 3 - OFF:

The system will automatically OPEN the GAS DISCHARGE valve after a SHUT TIME period if the CASING PRESSURE is at or above the MINIMUM CASING setting and the well DIFFERENTIAL PRESSURE is below the MINIMUM DIFFERENTIAL setting.

OPTION 3 - ON:

The system will automatically OPEN the GAS DISCHARGE valve after a SHUT TIME period if the CASING PRESSURE is at or above the MAXIMUM CASING setting and the well DIFFERENTIAL PRESSURE is below the MINIMUM DIFFERENTIAL setting.

OPTION 4 - SYSTEM OPERATION:

OPTION 4 - OFF:

The system is fully operational.

OPTION 4 - ON:

When OPTION 4 is set to ON, either manually or automatically by the STOP and RUN clock, all functions of the system are stopped and the GAS DISCHARGE valve and FLUID DISCHARGE valves are closed.

The system will remain in this state until OPTION 4 is set to the OFFstate, either manually by the operator or automatically by the STOP and RUN clock.

OPTION 5 - CLEAR TRACKING LOG:

OPTION 5 - OFF:

This is the normal operation setting.

OPTION 5 - ON:

When OPTION 5 is set to ON, the TRACKING LOG is immediately cleared and the display will read [donE].

OPTION 6 - CLEAR PERMANENT MEMORY:

OPTION 6 - OFF:

This is the normal operation setting.

OPTION 6 - ON:

When OPTION 6 is set to ON, all SET information and DATA stored in the SYSTEM MEMORY is CLEARED, with the exception of the REAL TIME CLOCK settings, which are not affected. The display will read [donE], then [EECL], THEN [LgCL].

NOTE:

Before CLEARING the system memory, the SYSTEM should be set in the MANUAL MODE. This action will close either valve that might be open and allow the operator to make new SETTINGS without the system automatically interfering.

When the system memory is cleared, the PLUNGER TRAVEL OPEN and SHUT timing is AUTOMATICALLY set to ONE (1) MINUTE OPEN and ONE (1) MINUTE SHUT. These settings are unavoidable due to not being able to set the OPEN and SHUT time periods to "0". This condition will cause the FLUID DISCHARGE valve to cycle OPEN and SHUT on one (1) minute intervals.

DATA (PUSH-BUTTON):

This button allows the operator to display or clear cycle related count data. Upon depression of this button, the first count in sequence is displayed. Upon release of this button, the next count in sequence is readied for display.

This button causes its displays to operate in a circular manner. Once the last display in sequence has been displayed, another depression of the button causes the first display to appear again, repeating the sequence of displays indefinitely. The display remains where left after the last use of this button.

When data is displayed, a one or two word message is followed by the numerical count. The individual displays cycle through the word message(s), then the count data at the rate of one display per second. In the following description, the characters shown are what the operator will see displayed in the LCD.

The order in which data is displayed is as follows:

DISPLAYS	1ST	2ND	3RD	4TH
PLUNGER ARRIVAL COUNT	PLun	####		
PLUNGER FAILURE COUNT	FAiL	####		
EMERGENCY SHUT-IN COUNT	EgCY	####		
GAS VALVE OPEN TIME	ELAP	gAS	HHHH	MM:SS
FLUID VALVE OPEN TIME	ELAP	oiL	HHHH	MM:SS
BATTERY VOLTAGE LEVEL	batt	0#.##		

Note 1: To clear accumulated data, press and hold the DATA READ/CLEAR button and press the UP or DOWN button. The data status will change to zeros.

Note 2: A battery voltage of 5.50 or less could cause operation failure.

STATIC WELL PRESSURES (PUSH-BUTTONS):

The CASING PRESSURE, TUBING PRESSURE, and DIFFERENTIAL PRESSURE of the well, are displayed on the LCD when the associated button is pressed.

CYCLE OPERATING SET POINTS (PUSH-BUTTONS):

MAXIMUM CASING PSI (PUSH-BUTTON):

This control establishes the maximum limit of the CASING PRESSURE range during GAS DISCHARGE. When this pressure settings is reached, the GAS DISCHARGE valve is opened until the CASING PRESSURE falls to the MINIMUM CASING PSI setting or the DIFFERENTIAL PRESSURE builds to the MAXIMUM DIFFERENTIAL PSI setting, then the GAS DISCHARGE valve is closed. The above cycling continues until LIFT PRESSURE, and the prescribed amount of DIFFERENTIAL PRESSURE is obtained, at which time a PLUNGER RUN is started.

MINIMUM CASING PSI (PUSH-BUTTON):

This control establishes the minimum limit of the CASING PRESSURE range, which is the lowest CASING PRESSURE desired during GAS DISCHARGE. When this pressure setting is reached, the GAS DISCHARGE valve is closed until the CASING PRESSURE builds to the MAXIMUM CASING PSI setting, then the GAS DISCHARGE valve is reopened.

LIFT PSI (PUSH-BUTTON):

This control sets the amount of CASING PRESSURE required to lift the maximum amount of fluid as determined by the MAXIMUM DIFFERENTIAL PSI setting.

MAXIMUM DIFFERENTIAL PSI (PUSH-BUTTON):

This control establishes the maximum limit of the DIFFERENTIAL PRESSURE range in accordance with fluid volume and pressure characteristics of the well. The MAXIMUM DIFFERENTIAL PSI control is set in accordance with the LIFT PRESSURE that has been chosen by the operator.

When the DIFFERENTIAL PRESSURE reaches the MAXIMUM DIFFERENTIAL PSI setting, the GAS DISCHARGE valve is closed. If the CASING PRESSURE is at or above the LIFT PSI setting, a PLUNGER RUN starts immediately, even if the DIFFERENTIAL DELAY TIME period has not yet elapsed.

If the CASING PRESSURE is below the LIFT PSI setting, the well is SHUT-IN until the CASING PRESSURE reaches the LIFT PSI setting, then the system starts a PLUNGER RUN. Should the DIFFERENTIAL PRESSURE drop below the MINIMUM DIFFERENTIAL PSI setting, the GAS DISCHARGE valve is opened.

MINIMUM DIFFERENTIAL PSI (PUSH-BUTTON:

This control establishes the minimum limit of the DIFFERENTIAL PRESSURE range in accordance with depth and pressure characteristics of the well. This control should be set to ensure, that when the plunger surfaces, there will be sufficient fluid above the plunger to cushion its arrival at the surface.

The system automatically overrides this control by going into a DIFFERENTIAL DELAY TIME period for ten (10) minutes when the GAS DISCHARGE valve is opened following a SHUT-TIME period. This function prevents the system from acting on a false DIFFERENTIAL created by the gas flow surge into the gas separator and discharge line.

The display will repeatedly flash [diFF], then [dLY] during the ten(10) minute delay.

Should the DIFFERENTIAL PRESSURE reach the MAXIMUM DIFFERENTIAL PSI setting, the GAS DISCHARGE valve is closed. If the CASING PRESSURE is at or above the LIFT PSI setting, a PLUNGER RUN starts immediately, even if the DIFFERENTIAL DELAY TIME period has not yet elapsed.

If OPTION 1 is OFF, SHUT-TIME AFTER PLUNGER RUN, and the CASING PRESSURE is already at or above the LIFT PSI setting. A PLUNGER RUN starts when the DIFFERENTIAL PRESSURE equals or exceeds the MINIMUM DIFFERENTIAL PSI setting and the DIFFERENTIAL DELAY TIME has elapsed.

If OPTION 1 is ON, SHUT-TIME BEFORE PLUNGER RUN and the CASING PRESSURE is already at or above the LIFT PSI setting, a PLUNGER RUN shall not start until the DIFFERENTIAL PRESSURE exceeds the MAXIMUM DIFFERENTIAL PSI setting.

If the DIFFERENTIAL PRESSURE is above the MAXIMUM DIFFERENTIAL PSI setting and the CASING PRESSURE is below the LIFT PSI SETTING, the system will SHUT-IN the well until the CASING PRESSURE reaches the LIFT PSI setting, then start a PLUNGER RUN.

Should the DIFFERENTIAL PRESSURE fall below the MINIMUM DIFFERENTIAL PSI setting during the time required for the CASING PRESSURE to reach the LIFT PSI setting, the system will open the GAS DISCHARGE valve allowing gas to flow until the DIFFERENTIAL PRESSURE increases to the MAXIMUM DIFFERENTIAL PSI setting. The system will then shut-in the well to obtain LIFT PRESSURE.

PLUNGER TRAVEL TIME (PUSH-BUTTONS):

HRS. & MIN./MIN. & SEC. (PUSH-BUTTONS):

The HRS. & MIN. and MIN. & SEC. Push-buttons select the TIMING MODE for the OPEN/PURGE and SHUT/RECOVERY timing periods. A TIMING MODE is selected by pressing and releasing one of the TIMING MODE push-buttons prior to setting a TIME PERIOD.

OPEN/PURGE-SHUT/RECOVERY (PUSH-BUTTONS):

The OPEN/PURGE and SHUT/RECOVERY push-buttons are used to READ and or SET the TIMING PERIOD functions of the system. Upon the first depression of either of these buttons, a one word message identifying the TIME PERIOD followed by TIMING DATA is displayed and repeated as long as the button is held depressed. Upon release of the button and pressing again, the next TIME PERIOD will be identified on the display followed by TIMING DATA.

The FOUR TIMING PERIODS can be set in ANY ORDER of HOURS and MINUTES or MINUTES and SECONDS by first selecting the TIME MODE, then selecting the TIME PERIOD and while HOLDING THE TIME PERIOD DEPRESSED, depress the SET and CLEAR, UP or DOWN PUSH-BUTTON.

The time periods can be set from ONE (1) SECOND to 99 HOURS and 59 MINUTES.

NOTE: When a NEW TIME is SET in a TIME PERIOD that is COUNTING DOWN, the NEW TIME does not become effective until the CURRENT TIME PERIOD has counted down to "0" or the operator manually TERMINATES the TIME PERIOD.

When a TIME PERIOD is displayed, the CENTER PAIR OF DOTS on the LCD display signify the timing mode of the TIME PERIOD being counted. When the dots FLASH ON and OFF, the TIME PERIOD is set for HOURS and MINUTES. When the dots are on SOLID, the TIME PERIOD is set for MINUTES and SECONDS.

The dot on the lower left of the display signifies that the OPEN TIME is being displayed when the dot is on SOLID. When the dot is FLASHING, the PURGE TIME is being displayed.

The dot on the lower right of the display signifies that the SHUT TIME is being displayed when the dot is on SOLID. When the dot is FLASHING, the RECOVERY TIME is being displayed.

CONTROL SETTINGS

The following calculations are provided for use as a guide only for individuals who are not familiar with the operation of the DCS-XT CONTROLLER.

To maximize production, it may be necessary to vary the suggested settings by a considerable amount. However, changes should be made in steps every 24 to 48 hours. This will allow the operator to analyze the well's reaction to the changes made.

1. Obtain the ROCK PRESSURE value by shutting the well in for a 24 hour period if the ROCK PRESSURE is not known.
2. Obtain nominal back pressure of gas discharge line (LINE PRESSURE).
3. Set MAXIMUM CASING PSI at $.75 \times \text{ROCK PRESSURE}$.
4. Set MINIMUM CASING PSI at $.50 \times \text{ROCK PRESSURE}$.
5. Set LIFT PSI at $.75 \times (\text{ROCK PRESSURE})$.
6. Set MAXIMUM DIFFERENTIAL PSI at $.33 \times \text{LIFT PSI} \text{ minus } \text{LINE PRESSURE}$.

NOTE: Do not subtract LINE PRESSURE if discharging fluid directly into a holding tank.

7. Set MINIMUM DIFFERENTIAL PSI at $.5x \text{ MAXIMUM DIFFERENTIAL PSI SETTING}$.

NOTE: Maintain a minimum of 10 PSI between the MAX. DIFF. and the MIN. DIFF. settings.

8. Set PLUNGER TRAVEL TIME as follows:
 - A. OPEN TIME period for 5 minutes per 1000' of well depth.
 - B. SHUT TIME period for 5 minutes per 1000' of well depth.

NOTE: Proper time settings may vary considerably due to fluid volume and gas pressure.

9. Set the choke or pinch valve in the gas discharge line to feed the casing PSI down at a rate of 1 lb. of casing PSI every two (2) minutes. This is only a starting point. The rate may vary due to gas volume and fluid entry.

NOTE: Wells having low gas volume and pressure usually require a choke or pinch valve installed between the gas discharge valve of the system and the gas separator to hold back pressure on the well.