STRICTLY CONFIDENTIAL

PROJECT

Gas Lift

TITLE

Control Room Specification

ISSUE STATUS

ISSUE	AUTHOR	Date	Release Status	Change Request	AMENDMENTS
A	Philip Hockley	30/09/09	Superseded	N/A	Initial release
B	Peter Watson	01/06/10	Superseded	68	Amended to include software GUI operation and installation
C	David Reaves	19/07/10	In-Review	N/A	Implement comments from 18Jun10 & 07Jul10 meetings
C + 1	DM Reaves	02/8/2010	drafting	N/A	Implement comments on issue C

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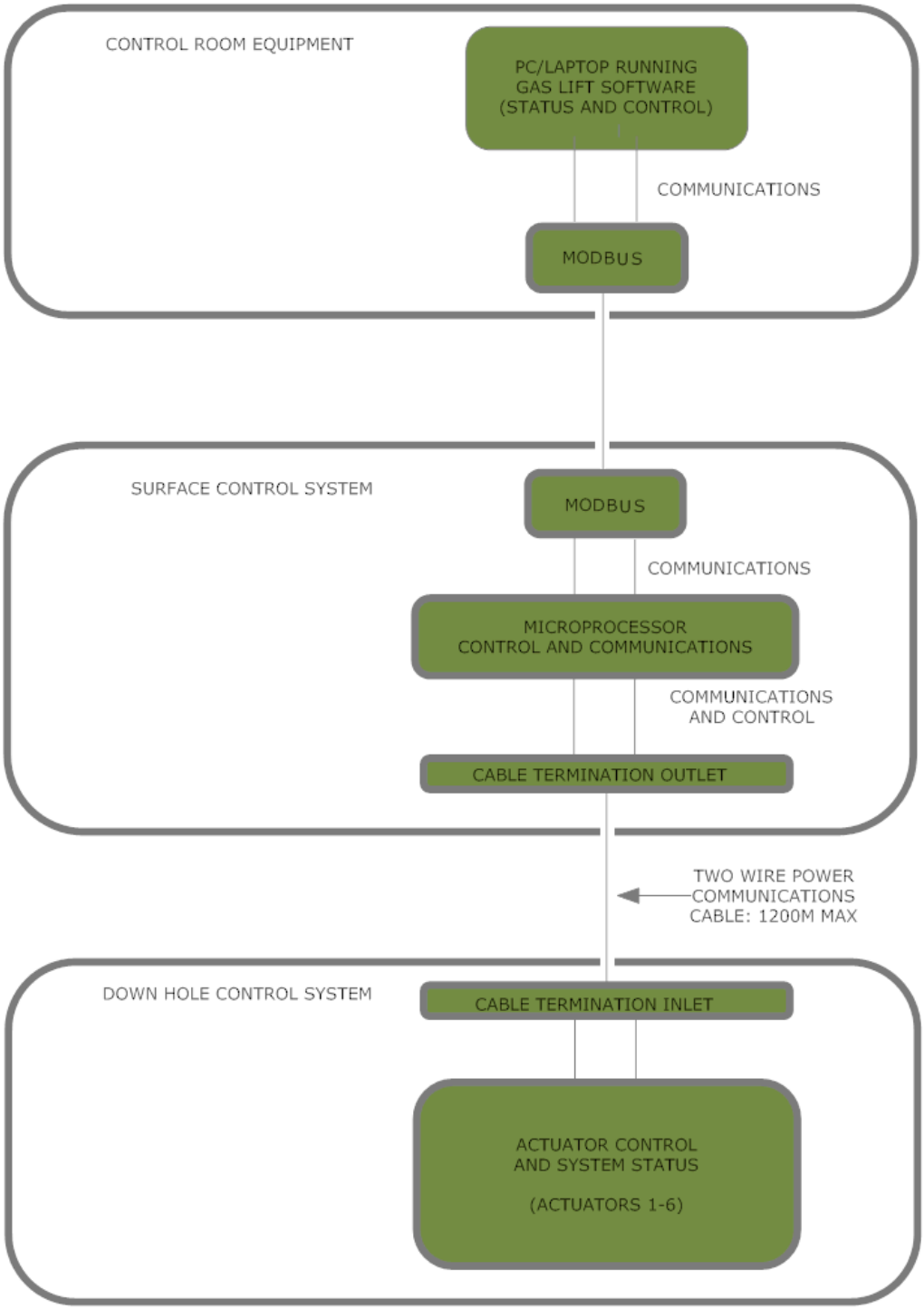
APPENDICES:

1. PURPOSE

The purpose of this document is to describe the equipment and software requirements for the control room area for the Artificial Gas lift system.

2. SYSTEM OVERVIEW

2.1. GENERAL SYSTEMS LAYOUT



2.2. CONTROL ROOM EQUIPMENT SPECIFICATION

The control room shall consist of the follow components

- Customer supplied PC or Laptop Running Camcon or third party Gas lift Software
- Suitable cable connection

2.3. PC/LAPTOP REQUIREMENTS

The PC or Laptop will run the Camcon Technology Gas lift Software, and be connected via the appropriate cable to the Surface Control System (SCS).

- Operating Systems: - Windows XP and Windows 7
- RAM: - To be advised by software implementer
- Hard Drive: - To be advised by software implementer
- Graphics - 1024 x 768 in 256 Colours (minimum)

The PC will be required to have both an RS232 port and an RS485 port, either internally or via external devices.

2.4. INTERFACES

2.4.1 MODBUS Control Interface

The RS485 interface is used to control and monitor the SCS and hence the Down-hole equipment. This interface uses the MODBUS protocol as specified by:

DL100001 (MODBUS protocol).

The Control Room PC is a MODBUS master. The system design allows for multiple MODBUS masters, multiple slaves and multiple interfaces (eg when using wireless links). A master may not see slave messages to or from another master.

It is assumed that the parameters for each MODBUS RS485 communications port (parity, stop bits etc) would be set up at the PC using standard Windows communications setup facilities. The system setup screen makes provision for there to be multiple MODBUS ports.

2.4.2 SBC Configuration Interface

The RS232 interface is used to configure the Single Board Computer (SBC) that is part of the SCS. The interface is specified by DL100002 (SBC Requirements) and is designed to be controlled by a standard terminal program (e.g. Hyper Terminal), hence no special

software is required at the PC for this interface. Note that the PC would need to be located such that the RS232 cable length limit (15m) is not exceeded whilst controlling the SBC configuration interface, but any suitable PC could be used for this purpose.

3. SOFTWARE COMPONENTS

The control software has two components. One component runs on the SBC within the SCS and is specified by DL100002 (SBC Requirements). The other is the subject of this document and runs on the customer's PC. Both documents need to be read in conjunction with DL100001 (MODBUS protocol specification).

This document specifies the control room system software (CRS) to be written for Camcon Technology Limited and is also intended to guide customers who wish to write their own software to control the SCS.

4. GAS LIFT SOFTWARE (CONTROL ROOM)

4.1. CONTROLS AND DISPLAY.

This software controls and displays the status of the Gas lift system.

The software shall display the following information in an easy to understand format for the Mandrel currently being controlled:

- Mandrel Name — Free text (up to 40 characters)
- Mandrel Slave Address — 1 to 247 (decimal)
- Mandrel Communication Status — Icons (see section 4.8)
- Orifice Diameters: — Free text (up to 6 characters)
- Actuator Status: — Open or Closed
- Annulus Pressure: — 0 - 700 Bar or 0 - 10,153 PSI (user choice)
- Production Pipe Pressure: — 0 - 700 Bar or 0 - 10,153 PSI (user choice)
- Production Pipe Temperature: — 0-125°C or 0 - 255°F (user choice)
- Actuator Health: — Open/Short Circuit, Actuator Stuck
- Capacitor Bank Health: — 0-100%

Details of user controls and displays are specified in DL100004 (Control room software graphical specification)

The following table shows the valid commands that can be sent on the MODBUS interface, all being a Fn5/Fn3 command pair except the last one which is a standalone Fn3 command:

Command	Action
Open Actuator 1	Opens Actuator one, updates Pressure/Temperature and actuator one health
Open Actuator 2	Opens Actuator two, updates Pressure/Temperature and actuator two health
Open Actuator 3	Opens Actuator three, updates Pressure/Temperature and actuator three health
Open Actuator 4	Opens Actuator four, updates Pressure/Temperature and actuator four health
Open Actuator 5	Opens Actuator five, updates Pressure/Temperature and actuator five health
Open Actuator 6	Opens Actuator six , updates Pressure/Temperature and actuator six health
Close Actuator 1	Closes Actuator one, updates Pressure/Temperature and actuator one health
Close Actuator 2	Closes Actuator two, updates Pressure/Temperature and actuator two health
Close Actuator 3	Closes Actuator three, updates Pressure/Temperature and actuator three health
Close Actuator 4	Closes Actuator four, updates Pressures/Temperature and actuator four health
Close Actuator 5	Closes Actuator five, updates Pressures/Temperature and actuator five health
Close Actuator 6	Closes Actuator six , updates Pressures/Temperature and actuator six health
Get Status	Updates Pressures/Temperature and data for a specific actuator
Get Data	Updates all status data to that currently held by the SCS (but not by the DHCS)

All commands update the status of the communications between the SCS and the DHCS for the selected mandrel.

4.2. SOFTWARE ENVIRONMENT & DEPLOYMENT

4.2.1 SOFTWARE ENVIRONMENT

The software shall be written in a C++ environment to run on both a windows XP and a windows 7 platform.

Where the word “parameter” is used, a mechanism shall be provided for the value to be changed within reasonable limits as defined at Appendix E, without rebuilding the software, eg via hyperterminal or a text-based parameter file. It is acceptable that a reboot would be required after any change.

4.2.2 SOFTWARE DEPLOYMENT.

The software shall be made available as a self extracting and installing application.

The un-extracted application prior to installation should be no greater than 50MB to enable swift download in areas of low speed connections.

4.3. INSTALLATION

4.3.1 LANGUAGE SUPPORT

The user interface shall be written in English but will wherever possible use Graphics/Icons to help users of any language to use it.

4.3.2 INSTALLATION STRUCTURE

4.3.2.1 The application shall have a default installation directory of:

c:\program files\Camcon_CRS.

At the point of install the customer can choose an alternative installation directory.

4.3.2.2 The installation directory shall have three sub folders which shall be :

- CRS – Contains all application files
- SETUP – Contains all configuration files (**Mandrel.Cfg & CRS.cfg**)
- LOGS – Contains the system log file (**camcom_syslog.txt**)

4.3.3 INSTALLATION APPLICATION

4.3.3.1 The installation application should be called CCS_Setup.exe with the desktop icon which is shown in .

Figure 1 - Start icon

4.3.3.2 The installation shall follow the procedure shown in Figure 2 after the installation icon is double clicked.

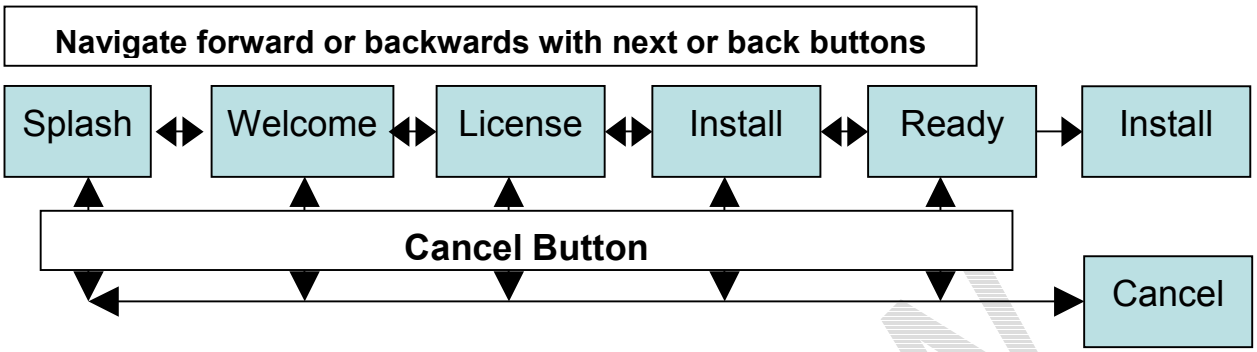


Figure 2 – Software installation Flow

4.3.3.3 Splash Screen

- The splash screen (see Figure 3) shall be displayed for a minimum of 5 seconds whilst the software loads.

Figure 3 - Splash screen (Help, "About" screen)

- During installation and until the application has completely loaded, the OK button shall be labelled "CANCEL" and if pressed will abort the installation and clean up to the pre-installation state. This splash screen is also used as the help about screen which will include the OK button.

- The Support Company information shall be hard coded as follows for the installation splash screen and shall also be used for the splash screen when loading installed software and for the software 'help about' screen if a system configuration file does not exist or does not contain full service agent contact data:-

  Camcon Ltd

  Unit 4A

  Button End Industrial Estate

Harston, Cambs

CB22 7GX

01223 873650

4.3.3.4 Welcome screen

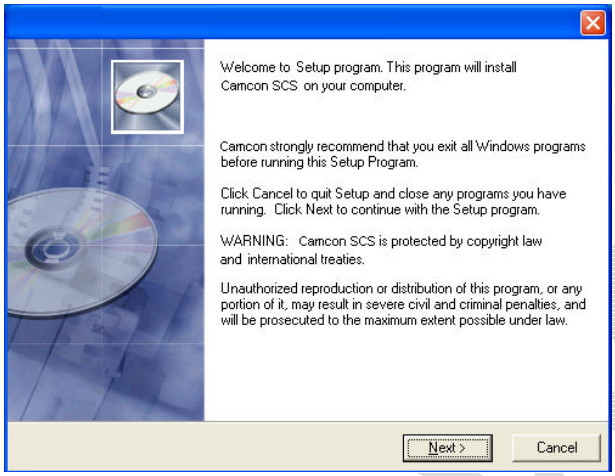


Figure 4 - Welcome screen

4.3.3.5 License screen

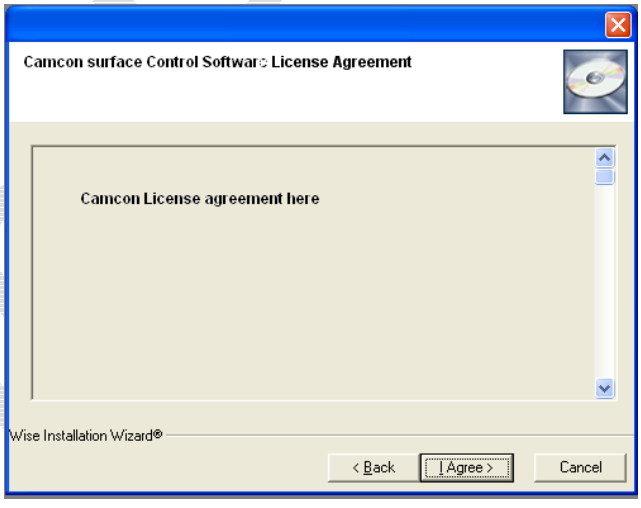


Figure 5 - License screen

4.3.3.6 Install folder screen

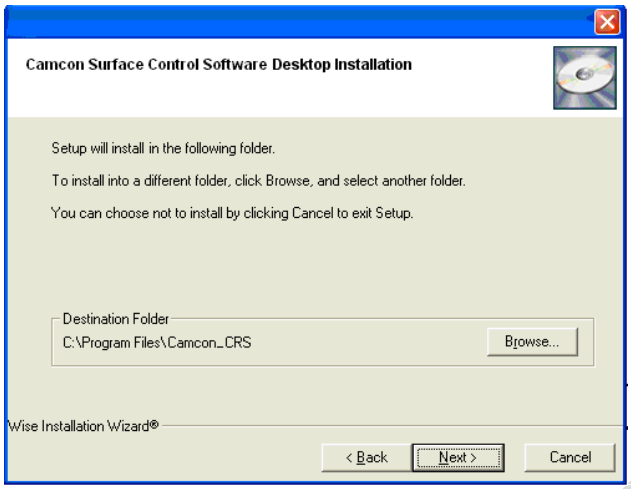


Figure 6 - Install directory screen

4.3.3.7 Ready to install screen

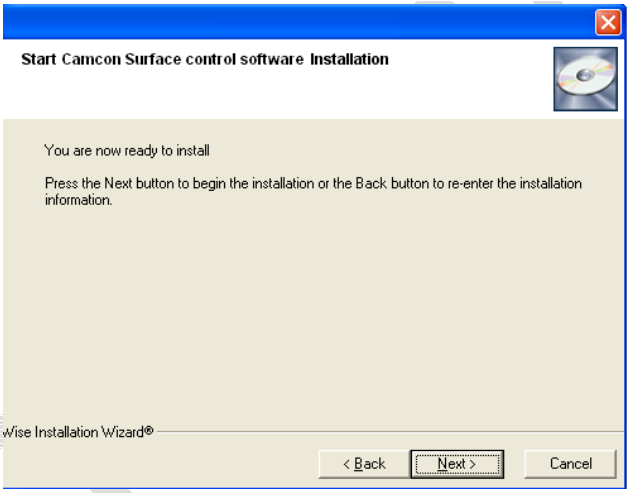


Figure 7- Ready to install

4.3.3.8 Installation complete screen

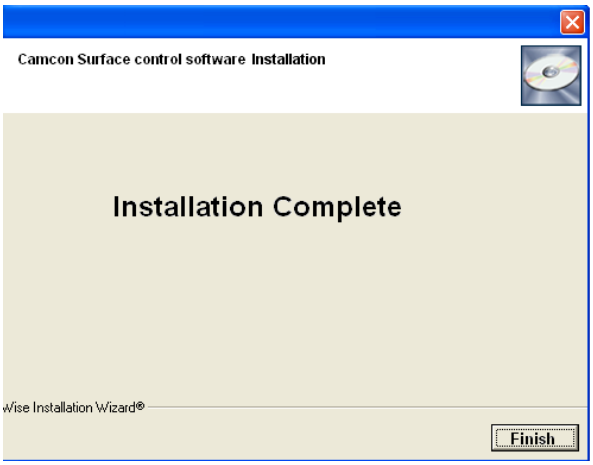


Figure 8 - Installation complete

4.3.3.9 Cancel screen

At any point through the installation process, prior to the installation complete screen, the customer can choose to cancel the installation. If the cancel button is chosen then the application shall show the Cancel screen as shown in Figure 9. On selecting the “Exit setup” option the installation shall be rolled back and the “installation cancelled” screen shall be displayed as shown in Figure 10.

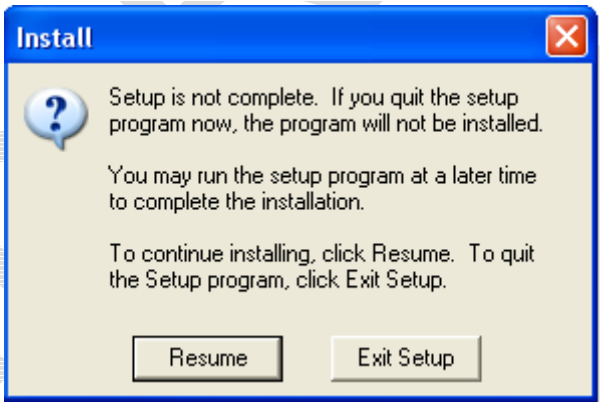


Figure 9 - Cancel screen

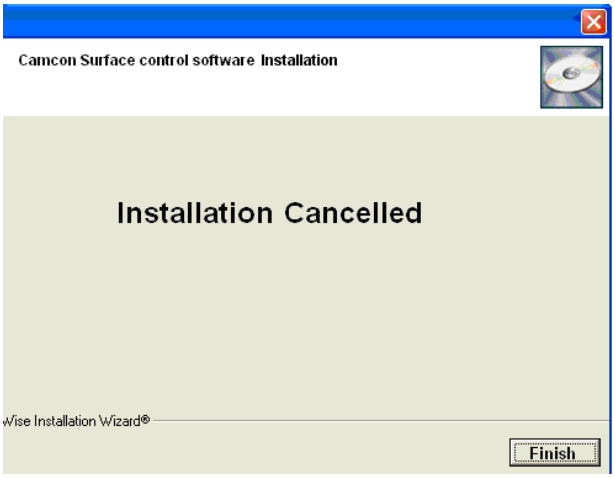


Figure 10 - Installation Cancelled

4.4. STARTING THE APPLICATION

Once the application is loaded it should start either from a desktop icon (see Figure 11) or from a Start Menu item pick (see Figure 12).

Figure 11 - Desktop icon

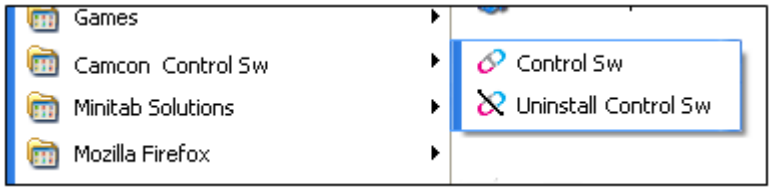


Figure 12 - Menu start selection

4.5. SYSTEM LOGGING

4.5.1 Log creation – On start up.

On startup of the application the system shall check for the presence of a system log **file camcom_syslog.txt** in the <install_directory\logs\>. If one is not present the system shall create one and time stamp the start time. If a file is present the time stamp shall be appended to the file. The message will take the form:-

<CURRENT DATE>, <CURRENT TIME>, Application Started

4.5.2 System Log messages

4.5.2.1 The system shall create a new log message on every action performed by the user or software, on every mandrel sensor event reported to the software and on any communications status change event. These actions and events shall be recorded in the logfile ~~as an action followed by the response to the action~~ as shown in the example of a user action below:-

<CURRENT DATE>, <CURRENT TIME>, <MANDREL> Open valve 1

<CURRENT DATE>,<CURRENT TIME>, <MANDREL> valve 1 open OK

4.5.2.2 If an action fails to be carried out successfully then the action and response shall be recorded together with the associated alarm message (see 4.5.2.7) ~~as appropriate from actuator health or communications status data status~~, as shown in the example below ~~where the second entry has word wrapped in the absence of any new line character within the entry~~:

<CURRENT DATE>,<CURRENT TIME>, <MANDREL>, Open valve 1

<CURRENT DATE>,<CURRENT TIME>, <MANDREL>, valve 1 failed to open

<CURRENT DATE>,<CURRENT TIME>, <MANDREL>, valve 1 possibly stuck closed, open circuit

4.5.2.3 Later implementation: Each status message received will be examined for any other data that has changed and each such change shall be recorded in the logfile as shown in the example below:

<CURRENT DATE>,<CURRENT TIME>, ~~System:~~ <MANDREL>, Temperature 110°C

4.5.2.4 Later implementation: A status message can be requested from the DHCS by pressing the option button 7 (communications health) and the data received shall be recorded in the logfile as shown in the example below:

<CURRENT DATE>,<CURRENT TIME>, ~~System: —~~<MANDREL>, Status: 100°C, 100Bar, 70Bar, 97%, CL1, OP2, FC3, OP4, FO5, CL6

The data comprises the four data readings and the state of the six actuators in the order displayed by the main application screen icons. Actuator states are displayed as “OP”

(open), “CL” (closed) , “FC” (faulty closed) or “FO” (faulty open), followed by the actuator number (1 to 6).

4.5.2.5 Later implementation: On detection of any fault whether indicated via the MODBUS or diagnosed locally, an e-mail shall be queued for sending at the first opportunity by the CRS to the diagnostic e-mail address, with the fault as subject and all system log data that has not been previously sent as the body or as an attachment. Further faults will not initiate an e-mail more often than every 30 minutes.

4.5.2.6 On Exit from the application the log file shall be updated with the following message:-

<CURRENT DATE>,<CURRENT TIME>, Application Exit

4.5.2.7 Every alarm message (see section 4.7.1) shall be recorded in the log file.

4.5.2.8 A list of types of log entry and their text strings is shown in Appendix A

4.6. SYSTEM CONFIGURATION

4.6.1 System startup.

On starting, the application will check for the existence of a CRS Configuration file, creating a default file if one does not already exist. If a file containing all Service Contact screen fields except TB4, TB5 and TB6 does not exist, the Service Contact Setup screen shall be displayed and all these fields must be completed and saved before the user can proceed to the Setup screen.

Otherwise, if on starting, the file does not contain Setup screen fields TB1, TB2, TB3 and PB1 to PB7 inclusive, the Setup screen shall be displayed and all these fields must be completed and saved before the user can proceed to the main screen.

In each case, the appropriate button(s) and screens in the application window menu (see section 4.7.6.3) will be greyed out and inactive.

If all the above constraints are satisfied, the main screen will be displayed at startup for the most recently selected mandrel.

4.6.2 System configuration data.

4.6.2.1 Service Contact Details Screen

See DL100004

4.6.2.2 Setup Screen

The data required for the setup screen:

Short name	Long name		Description
TB1	Text box 1	Customer entered mandrel name Max length: 40 characters	Free text
TB2	Text Box 2	Customer entered serial number. Max length: 8 Characters	Serial number entered from the mandrel paperwork supplied.
TB3	Text Box 3	Customer selected comms port from available ports	Computer communications port for this mandrel
TB4	Text Box 4	Customer selected child status from available options	Type of mandrel (normal, passive repeater, active repeater) - FUTURE
PB1	Pick box 1	Customer selected from the "Mandrel.cfg" configuration file or a customer entered value via a custom entry selection.	Orifice size for each gas actuator. Individually selected by the customer.
PB2	Pick box 2		
PB3	Pick box 3		
PB4	Pick box 4		
PB5	Pick box 5		
PB6	Pick box 6		
TB5	Text Box 5	Customer entered text. Max length: 1024 Characters	Description of the installation and any other data that the customer wishes to enter.

4.6.3 System Configuration file

The system shall store the information from the system setup screens in the following format. [Note: Software implementer may propose an alternative format if desired]

The first data line shall be a header line starting with 2 hash symbols (##)

Comments written prior to the hash symbols will be ignored.

This will then be followed by the company name and address information, including phone and email address, with each field having a single line. Where no entry has been made in a field an empty line shall be present. This information shall then be closed with a single hash symbol #.

The information regarding individual mandrel configuration shall then be as follows :-

Mandrel Name:- 'TB1'

Mandrel serial number:- 'TB2'

Comms port:- 'PB7' (probably the same for all mandrels of an SCS)

Slave address:- TB3

Child status:- TB4

Orifice sizes:- PB1,PB2,PB3,PB4,PB5,PB6

Installation Notes:- TB5

The end of each Mandrel definition shall be marked by a hash symbol.

If more than one mandrel is configured then all mandrels shall be listed in the format shown above and in the order applicable to user-selection.

The system configuration information shall be saved in a file called CRS_config.cfg.

When a change is made to a system configuration and the file is saved the original file shall become a backup (.bak), overwriting any previous backup.

A sample configuration file is shown in Appendix B

4.6.4 Status Synchronisation

On software startup and initial display of the main application screen, the CRS will send an Fn3 request status command to the SBC for each mandrel, repeated until status is received. As mandrels may be on different SCSs, the CRS will cycle around all mandrels, omitting each as status is received. This shall not prevent the user from selecting a different mandrel or initiating a command.

Note that this action will not provide up to date status on capacitor health nor on actuator faults. In local and remote control modes, the user can check actuators manually. In remote control mode, the user can also check capacitor health by pressing the Storage Bank Health button.

4.7. APPLICATION BEHAVIOUR

The wording of all ~~popups and~~ logging messages is to be agreed between the implementer and Camcon Technology Ltd.

4.7.1 System Alarm Processing

An alarm is a text string displayed in an alarm window that is separate to other windows. Alarm texts are specified at Appendix D.

On occurrence of a new alarm, the alarm window will be displayed in front of all others on the screen and will display the new alarm uppermost followed by any other extant alarms in descending order of occurrence. The user may bring any window to the foreground at any time by all normal means including clicking on a visible part of the other window, the use of ALT-TAB and the start bar tabs.

A single alarm window will contain all extant alarms, no matter to which mandrel they refer.

A new alarm will be highlighted until user-acknowledged or deleted by the system. A method will be provided for the user to re-highlight an alarm which has been acknowledged.

Alarm texts and associated variable fields within those texts are specified in Appendix D.

The user shall be able to select an alarm within the alarm window and delete it from the window by pressing the delete key and/or a “Delete” button within the window. Certain alarms are deleted by the system when the causal event is resolved.

On clearance of an alarm condition, the associated alarm will be deleted from the alarm window, subject to a minimum existence in the window of (parameter PC8) 2 seconds for an alarm deleted by the system. Clearance will not cause the display layer of the window with respect to other windows to change.

On recurrence of an extant alarm, the original alarm will be deleted and the alarm re-initiated as the most recent alarm.

The user shall be able to scroll the alarm window if its contents exceed the window size. This action will be overwritten by any new alarm subject to (parameter PC6) a 20 seconds delay after the most recent user scroll action.

All texts including field texts shall be in the form of a separate ASCII text file that can be edited and/or replaced. Any changes to the file shall be incorporated into the software when it is next run.

4.7.2 Background Tasks

At all times whilst the software is running and setup is complete such that the main screen is not inhibited from display, the software shall perform background tasks independently of which screen is currently being displayed.

~~4.7.2.1 Periodic Status Synchronisation with the SCS~~

~~For each mandrel whilst in remote control mode, the CRS shall send a Fn5 Get Status command (parameter PC1) 5 minutes after the most recent Fn5 command addressed to the mandrel. This command shall be delayed if necessary to give priority to any user command and shall be followed after (parameter PC1) 2 seconds by a Fn3 command~~ [Note: moved to the SBC]

4.7.2.2 Periodic Status Update from the DHCS

For each mandrel, the CRS shall send a Fn3 command (parameter PC2) 1 second after the most recent Fn3 command addressed to the mandrel unless a Fn3 response is expected resulting from a previous Fn5 command. Periodic commands will re-start with the Fn3 command that follows the Fn5 command as the first of the new series.

4.7.2.3 Status Message Processing

Fn3 status response messages shall be used to update data displayed for the currently displayed mandrel and to update data held by the CRS for other mandrels such that it is immediately available when the user switches to another mandrel for display.

An actuator icon will be displayed as open or closed, as indicated by the status message except:

a) for a status response to a command for an actuator to change, if a fault is indicated for that actuator and communications are OK, the fault (open) or fault (closed) icon will be displayed to reflect the reported position and the appropriate alarm (A22 to A27) will be displayed.

~~b) for a status response to a command for an actuator to change, if no fault is indicated for that actuator and communications are OK but the actuator position has not changed, the fault (open) or fault (closed) icon will be displayed to reflect the reported position. However, this situation should not occur.~~

c) for a status response to a command for an actuator to change, if communications are not OK, the fault (unknown position) icon will be displayed for that actuator.

d) for a status response to a command for an actuator to change, if an additional actuator moves as well as the commanded one, this is likely to be due to a short circuit to actuator casing and alarm A1 will be displayed to suggest this possibility).

e) for any status message that indicates a fault for any actuator other than one commanded to change, the fault (open) or fault (closed) icon will be displayed to

reflect the reported position. This situation should only occur on initialisation and on restoration after loss of communications.

Later implementation: Any pressure value that has changed by more than (parameter PC3) 10% shall lead to the appropriate alarm (A2 or A3). Any temperature value that has changed by more than (parameter PC4) 10% shall lead to the appropriate alarm (A4 or A5). So that slow changes are detected as well as a step change, the comparison shall be against all values received up to and including the most recent one that was received more than one hour previously.

Later implementation: Whenever the temperature increases to a value greater than 125°C (or the Fahrenheit equivalent), alarm A6 shall be displayed and re-established as the most recent alarm after any other alarm occurs.

Later implementation: Alarm A7 shall be displayed if status messages indicate that the SCS has remained in local mode for a period of 30 minutes. It shall be deleted if the mode changes to 'remote' or shall be re-established as the most recent alarm at 30 minute intervals whilst the mode remains 'local'.

Later implementation: The appropriate alarm (A8 or A9) shall be displayed on any unexpected change of actuator position whilst in remote mode.

The communications health button will display the system healthy icon on receipt of a status message that indicates good communications for the mandrel. See section 4.8 for communications error condition processing.

Status Message processing shall be maintained and alarms displayed even if for a different mandrel to that selected.

4.7.2.4 Health Check Monitoring

Later implementation: For each mandrel, alarm A10 will be displayed if every non-faulty actuator has not been toggled within the previous 8 days. It shall be deleted if the user presses the associated actuator button or shall be re-established as the most recent alarm each day until resolved.

Later implementation: For each mandrel, alarm A11 will be displayed if a capacitor health check has not been performed within the previous 8 days. It shall be deleted if the user presses the capacitor health button or shall be re-established each day until resolved.

4.7.3 Main application screen

4.7.3.1 Graphical user interface

The main screen graphical user interface and its related buttons and icons are described in DL100004 (Control room software graphical specification). The following behavioural requirements supplement those described in DL100004.

4.7.3.2 Screen behaviour (entry)

The main application screen shall not be selectable for display unless the system has a valid configuration file including data for at least one mandrel, see section 4.6. On entry to the screen, the selected mandrel shall be that most recently selected on this or the Setup screen, otherwise mandrel number 1, and the application shall update all graphics accordingly. On initial entry to the screen, the mandrel shall be that selected at the previous program exit or the first mandrel in sequence if none had ever been selected.

4.7.3.3 Screen Behaviour (alternative display units)

Later implementation (initial design to default to centigrade and Bar): Temperature and pressure can be displayed in alternative units as described in DL100004. The appropriate conversions will be applied to the text for display, ignoring any correction for depth below sea level.

4.7.3.4 Screen Behaviour (Communications health button 7)

Later implementation: Operation of the communications health button whilst it indicates system healthy and the SCS is in remote control mode, causes the CRS to send a Fn5/Fn3 command pair to interrogate the DHCS status and deletes any alarm A18, A19 or A20.

In local mode and for the other button state, this action leads to the appropriate alarm (A18 to A20) to indicate that the data may be stale and the reason (ie because of local mode / lost DHCS communications / lost MODBUS communications).

4.7.3.5 Screen Behaviour (Capacitor Health Check button 14)

Later implementation: Operation of the Capacitor Health Check button whilst the communications system is healthy and the SCS is in remote control mode, causes the CRS to commence the capacitor health check specified in DL100005 and deletes any

existing alarm A11, A12, A13 or A14. Otherwise, the appropriate alarm (A12 to A14) will be displayed and no further action will be taken.

The CRS will first re-check each non-fault valve via a Fn3 command to confirm that communications are still healthy and that the valve is still non-faulty, and then initiate the process by sending a Fn5 command to set the valve to its current position. If the response to the associated Fn3 command indicates a potentially bad measurement by means of the out-of-range value 0xFF for capacitor health, the CRS will send Fn3 commands at (parameter PC5) a period of 3 seconds until a valid capacitor health value or a fault status is received. The CRS will repeat the whole process for each non-faulty actuator, displaying alarm A15 until complete or the process is aborted.

A second press of the Capacitor Health Check button will abort the process and display alarm A11 if the conditions of section 4.7.2.4 are met.

Any communications failure or change to local control mode during the process will abort the process and display the appropriate alarm (A12 to A14).

4.7.3.6 Screen behaviour (diagnostics logging window)

The diagnostics logging window displays data as it is added to the CRS log, scrolling up when full such that the most recent data line is at the bottom of the displayed data. The user may scroll to previous data from the CRS log. The addition of new data by the CRS will cause the most recent data to be re-instated to display after (parameter PC6) a period of 20 seconds since any user scroll action.

The displayed data replicates that in the log except that (later implementation) to save space the date is suppressed from each data line. The top line displayed is always the date applicable to the second line. Any date change within the displayed data is shown by another date line.

Later implementation: The user may add free-text notes to the log. Clicking on the window will place the cursor at the end of the most recent data line, or if notes have been commenced but not entered, at the closest point within the notes to the cursor. Typing the first character will scroll up one line to accumulate the note on the bottom line.

Any further system logging prior to the use of the return key will be displayed prior to the user entry line(s) by scrolling previous data upwards. Whilst any user-text exists, the current time and the text “Note: “ shall precede the user text. Text will line-wrap but use of the return key will complete that entry. Entry of null text will cause the window to discard the time and “Note: “ text.

Note: an acceptable alternative is to use a separate window for text entry, displayed as a popup by clicking on the diagnostics logging window.

All alarms will also be displayed in the diagnostics logging window but with seconds of time rounded (or truncated) to an integer and without duplicating the event in the log.

4.7.3.7 Button behaviour

Further actions associated with each button are described in DL100004 (Control room software graphical specification).

Later implementation: Pressing any button that requires a response from the DHCS whilst the SCS is in local mode will lead to alarm A7 and send a Fn3 command to the SBC to obtain the most recent data held by the SBC, but will cause no further action. [Wingpath: you suggested displaying remote/local status continually instead. Was this for initial implementation or a suggested change for final functionality?]

Later implementation: Pressing any button that requires a response from the DHCS whilst the SCS is in remote control mode will display a wait indication to the user until the associated Fn3 response is received, eg an hour–glass instead of the pointer. See also section 4.8.6 [Wingpath: you suggested greying out controls instead of an hour-glass. Was this for initial implementation or a suggested change for final functionality?]

The processing specified by sections 4.7.2.3 and 4.8 will occur as appropriate.

On pressing a valve button that is displaying the fault icon, a command will be sent to the actuator to the same position as that commanded or reported, whichever is the most recent event. If a non-fault status response is received, the appropriate normal icon will be displayed but alarm A16 will be displayed, explaining that the fault condition may not have been resolved and should be checked by attempting to change the actuator position twice. Otherwise, the normal error response to a valve button press will occur.

If the user presses a valve button, any associated Alarm A16 will be deleted in addition to the normal action for the button.

4.7.4 Setup screen (Service agent contact details)

4.7.4.1 Graphical user interface

The Service agent contact details screen graphical user interface and its related buttons and icons are described in DL100004 (Control room software graphical specification). The following behavioural requirements supplement those described in DL100004.

4.7.4.2 Screen behaviour (entry)

On first entry to the screen the system will check for a valid configuration file and if present will populate the display with all available field data. Fields for which no data exists should be displayed blank.

4.7.4.3 Screen behaviour (exit)

If the system configuration file does not contain all service contact fields except TB4, TB5 and TB6, the user cannot proceed to any other screen. The appropriate button(s) and screens in the application window menu (see section 4.8.4) will be greyed out and inactive.

If the system configuration file does not contain setup screen fields TB1, TB2, TB3 and PB1 to PB7 inclusive, the user cannot proceed to the main screen. The main screen button and screen in the application window menu (see section 4.8.4) will be greyed out and inactive.

On selection of the setup or main screen whilst there are unsaved changes on the service contact screen, the system shall prompt with a separate Yes/No dialog box “Do you wish to save your changes for this screen?”. Choosing “Yes” shall save the changes in the system configuration file and then display the setup screen. Choosing “No” shall close the dialog and the user will be able to continue working.

4.7.5 Setup screen (System setup screen)

4.7.5.1 Graphical user interface

The System setup screen graphical user interface and its related buttons and icons are described in DL100004 (Control room software graphical specification). The following behavioural requirements supplement those described in DL100004.

4.7.5.2 Screen behaviour (entry)

On first entry to the screen the system will populate all available field data for the most recent mandrel selected on this or the Main screen, otherwise mandrel number 1.

Later implementation: A Fn43 Read Device Identification command will be addressed to the mandrel and the data response will be displayed at the top of the Notes area of the Setup screen, preceding any existing notes. On selecting a different mandrel, the command will be addressed to the new mandrel and the data on the screen will be updated accordingly although if the mandrel is connected to the same SCS, the vendor name data will be the same.

4.7.5.3 Screen Behaviour (add mandrel)

A new mandrel will be added to the order stored in the configuration file in a position immediately following the currently displayed mandrel.

4.7.5.4 Screen Behaviour (child mandrel)

The following two paragraphs describe future functionality with the intent that the initial implementation architecture is such as to support their future implementation. The initial software requirement is for standalone mandrels only.

The child mandrel function allows a mandrel to be situated more than 1200m from the SCS by fitting one or more intermediate mandrels that act as repeaters for the communications link. The following selections exist:

- *"Standalone mandrel" - the default that is implemented.*
- *"Bottom mandrel of set" - the deepest in the well, supported by shallower repeaters*
- *"Repeater for next, active" - this mandrel is a repeater for the next one in sequence, and it has active actuators.*
- *"Repeater for next, hidden" - this mandrel is a repeater for the next one in sequence but it is hidden in the main screen because its actuators remain closed and are not controllable.*

A set of linked mandrels in a single hole can comprise up to 3 mandrels. The last in sequence of a set is intended to be at the deepest level in the pipe and to be active. Any of the others in the set may be active or hidden in any order.

Note that there can be up to three standalone mandrels in a pipe but in this case the deepest cannot be more than 1200m from the SCS and they have individual links to the SCS instead of being daisy–chained on to a single link when using repeaters.

4.7.5.5 Screen Behaviour (comms port)

Comms Port is intended to link the MODBUS port to the software and to specify the interface speed and any other necessary parameters if these are not configured by standard comms setup software. [Note: software implementer to advise and this screen function to be removed or extended as appropriate]

4.7.5.6 Screen Behaviour (valve orifice sizes)

The list of values for actuator orifice size are obtained from the mandrel configuration file which is provided at the time of sale. A facility shall be provided to enable the user to select from these values or to enter custom values.

4.7.5.7 Screen behaviour (exit)

If the system configuration file does not contain setup screen fields TB1, TB2, TB3 and PB1 to PB7 inclusive, the user cannot proceed to the main screen. The main screen button and screen in the application window menu (see section 4.8.4) will be greyed out and inactive.

On selection of the service contact or main screen whilst there are unsaved changes on the service contact screen, the system shall prompt with a separate Yes/No dialog box "Do you wish to save your changes for this screen?". Choosing "Yes" shall save the changes in the system configuration file and then display the selected screen. Choosing "No" shall close the dialog and the user shall be able to continue working.

4.7.5.8 Saving behaviour

Saving shall save the current data to the configuration file and log this data.

4.7.6 Application Menu Options

Later implementation: Normal Microsoft Office keyboard short cuts will be available where appropriate (eg cut/copy/paste/exit etc)

4.7.6.1 File Menu Options.

4.7.6.1.1 Save Log option

The "save log" option is available on any screen and allows the user to save the standard system log file to any location. When selected the system shall present a dialog box allowing the user to set the location where the file should be saved and also allow the user the change the file name.

4.7.6.1.2 Properties option

Later implementation: As Microsoft Office standard

4.7.6.1.3 Close & Exit options

The close and exit options allow users to exit the application at any time except when another dialog window is already open. When the user selects this option whilst

displaying a setup screen with unsaved changes, the system shall prompt with a separate Yes/No/Cancel dialog box “Do you wish to save your changes for this screen before closing?”. Choosing “Yes” shall save the changes and then close the application. Choosing “No” shall close the application. Choosing “Cancel” shall close the dialog and the user shall be able to continue working.

Otherwise, the system shall prompt with a separate Yes/No dialog box “Do you really wish to exit?”. Choosing “Yes” shall close the application. Choosing “No” shall close the dialog and the user shall be able to continue working.

4.7.6.2 Edit Menu Options

4.7.6.2.1 Undo/Repeat Options

Later implementation: As Microsoft Office standard multi-level but only for text input fields and not beyond a save action or a screen type change.

4.7.6.2.2 Cut/Copy/Paste/Clear/Select_All Options

Later implementation: As Microsoft Office standard including interaction with other applications but only for text input fields.

4.7.6.3 Window Menu Option

4.7.6.3.1 Main screen option

Selecting the “main screen” option shall allow you to navigate to the Main screen from the current screen. The rules for exiting from the current screen shall be enforced when performing this function.

4.7.6.3.2 System setup option

Selecting the “System setup” option shall allow you to navigate to the System setup screen from the current screen. The rules for exiting from the current screen shall be enforced when performing this function.

4.7.6.3.3 Service agent contact option

Selecting the “Service agent contact” option shall allow you to navigate to the Service agent contact screen from the current screen. The rules for exiting from the current screen shall be enforced when performing this function.

4.7.6.4 Help menu Option

4.7.6.4.1 “Help” option

Later implementation: The “Help” menu option shall link to a Camcon Technology web page TBD using the system default internet brower.

4.7.6.4.2 “About” option

The “About Menu” shall display the Splash screen shown in Figure 3 except that if a system configuration file exists and contains full service agent contact data, that data shall be displayed instead of the Camcon data.

4.8. ERROR REPORTING

~~4.8.1 SCS / DHCS Communication Errors~~

~~In addition to sending commands and the display of status, any communication errors between the SCS and DHCS will also need to be displayed. The table below gives the possible communication errors.~~

~~Error Code~~	~~Meaning~~	~~Icon~~
~~None~~	~~DHCS is communicating~~	
~~ERR1~~	~~No communication to DHCS~~	

~~**Figure 13 - Communication error codes**~~

~~Note: this status reflects the validity of the display to the user of mandrel parameters reported from the hole and as such will indicate ERR1 when the fault is between the SBC and the SCS or between the CRS and the SBC. The CRS Diagnostics Logging Screen will provide extended data where available, including whether the detected fault is of the MODBUS or of the SBC/SCS/DHCS communications.~~

Wingpath: deleted because the GUI spec DL100004 adequately specifies the two icons which we assume are implemented for the initial software delivery?

4.8.2 No Response to a User-initiated MODBUS Fn5

If no response has been received to a user-initiated MODBUS Fn5 (Write Single Coil) command within (parameter PC7) 1 second, this shall be logged (later implementation) as a failure to acknowledge a Fn5 command, but (implement now) a Read Holding Registers command will be sent in the normal way after (parameter PC1) 2 seconds and any response will update the status display and raise any alarm as normal. If no response to the latter command is received within (parameter PC7) 1 second (later implementation), this shall be logged as a failure to respond to a Fn3 command and alarm A17 shall be raised, inviting the user to try again. The alarm will be deleted if the user re-initiates the command and re-established if the condition persists.

~~Similar processing will apply to a user-initiated standalone Fn3 command (if such a command is used).~~

4.8.3 DHCS Communications Error Response to a User-initiated Command

Later implementation: If whilst the conditions for any of alarms A13, A17 or A19 exist (whether or not deleted by the user), any user-initiated command for the subject mandrel results in an Fn3 status response that indicates a DHCS communication error, alarm A26 shall be displayed. Avoidance of further actions by the user will cause the mandrel capacitor to lose all power such that the mandrel processor will be reset. ~~Upon expiry, a Fn5 Get Status command shall be sent, followed after a 2 second interval by a Fn3 command. If the response indicates no error, the pop up will be cleared, otherwise the Fn5 / Fn3 pair will be repeated and the popup cleared on no error. If the error persists, the popup will be replaced by one indicating that the mandrel has a persistent fault. The PC display will show the current status and the user is responsible for repeating the command if desired.~~

~~A pop up can be cancelled by the user who may then action another command. If a command is requested for the same mandrel whilst its communication error persists, it will be processed as normal including the processing applicable if a recent Fn5 command has not completed its associated Fn3 command.~~

~~If more than one mandrel is active, the pop-up message shall include "Press CANCEL to work on another mandrel"~~

4.8.4 Periodic MODBUS Fn5

If no response has been received to a software-initiated periodic MODBUS Fn5 (Write Single Coil) command within (parameter PC7) 1 second, this shall be logged (later implementation), but (implement now) a Fn3 (Read Holding Registers) command will be sent in the normal way after (parameter PC1) 2 seconds and any response will update the status display.

If no response to the Fn3 command is received within (parameter PC7) 1 second, this shall be logged (implement later) and the Fn5 / Fn3 commands shall be repeated. On no response to this second Fn3 command, the appropriate alarm (A19 to A20) shall be displayed indicating that MODBUS communications ~~to the subject mandrel~~ have been lost and (implement now at the first 'no response') the communications icon for that mandrel shall be set to "no communication".

If a response to a Fn5 / Fn3 command pair indicates DHCS communications failure, the Fn5 / Fn3 commands shall be repeated (implement later). If the Fn3 response still indicates failure, the appropriate alarm (A19 to A20) shall be displayed indicating that mandrel communications have been lost and (implement now at the first 'no response') the communications icon for that mandrel shall be set to "no communication".

4.8.5 Periodic MODBUS Fn3

Later implementation: If a software-initiated periodic Fn3 command has been sent (whether standalone or following a periodic Fn5 command) and no response has been received within the Fn3 (parameter PC7) 1 second above, this shall be logged. As the frequency of these commands is high, subsequent sequential multiple failures shall be logged once against the time of the most recent unsuccessful message as an aggregate failure with a count of failed attempts. The diagnostics logging screen shall display this message once with time and count updated at each failure, hence the log will contain the first and last occasion and the count. Implement now at the first 'no response': The communications icon for the mandrel shall be set to "no communication".

Note that no alarm will be displayed because a periodic standalone Fn3 command is most unlikely to lead to a status display update except in local mode.

4.8.6 Later implementation: SCS / DHCS Interface Constraints

The software will control the data flow over the MODBUS to ensure that SCS/DHCS interface constraints are met, displaying an error message if a user action would breach these constraints.

Any user action that would otherwise cause a command to be sent after a Fn5 but before a response or timeout to the associated Fn3 command shall cause alarm A21 to be displayed and no further action to be taken. Any user action will delete this alarm unless the condition persists.

Any user action that would otherwise cause a command to be sent before a response or timeout to a Fn3 command that is not associated with a Fn5 shall cause alarm A21 to be displayed and no further action to be taken. Any user action will delete this alarm unless the condition persists. ~~If an error condition is being processed, the popup shall indicate the issue and that the user-action will be aborted. Otherwise, the popup shall indicate "please wait" and the user-action will follow as soon as permitted. Note that there is no cancel available for the popup so any further user action will be ignored whilst the popup is displayed, preventing more than a single command from being queued. The popup shall be displayed for at least parameter 2 seconds to avoid confusing the user with a very brief appearance.~~

Appendix A. – Diagnostic Window and System Log Texts.

All message texts shall be in the form of a separate ASCII text file that can be edited and/or replaced. It shall be possible to embed variable fields (eg <n>) at any position within the text. Any changes to the file shall be incorporated into the software when it is next run.

Each message shall be both displayed in the diagnostic window and recorded in the system log.

The log file format shall be plain ASCII text.

Every log message shall commence with two fields (date and time) in the following format:

dd/mmm/yyyy, hh:mm:ss.sss, where time is to the nearest millisecond.

Every diagnostics window message shall commence with two fields (date and time) in the following format:

dd/mmm/yyyy, hh:mm:ss, where time is rounded (or truncated) to the nearest second.

In the remaining text, specified below, 'mandrel' is the mandrel name defined during setup

User messages:

<Mandrel> Open valve <n> *where <n> = 1 -6*

<Mandrel> Close valve <n> *where <n> = 1 -6*

<Mandrel> Test valve <n> *where <n> = 1 -6. This is used when a faulty actuator icon button is pressed*

<Mandrel> Test communication health

<Mandrel> Test capacitor health

System messages:

Application started

Application exit

<Mandrel> valve <n> open OK *where <n> = 1 -6*

<Mandrel> valve <n> closed OK *where <n> = 1 -6*

<Mandrel> valve <n> failed to open *where <n> = 1 -6*

<Mandrel> valve <n> failed to close *where <n> = 1 -6*

<Mandrel> valve <n> position unknown *where <n> = 1 -6*

<Mandrel> temperature <Temp> *where <Temp> = temperature in the units chosen by the user and including °C or °F as appropriate.*

<Mandrel> annulus pressure <Pressure> *where <Pressure> = pressure in the units chosen by the user and including 'bar' or 'psi' as appropriate.*

<Mandrel> pipe pressure <Pressure> *where <Pressure> = pressure in the units chosen by the user and including bar' or 'psi' as appropriate.*

<Mandrel> status: <status_text> *where <status_text> is per spec para 4.5.2.4*

Script messages:

Future enhancement.

Alarm messages:

Each alarm, whether or not acknowledged and/or cancelled in the Alarm Window.

Configuration save message (section 4.7.5.7 refers):

This message reflects any change to the system configuration file.

Configuration Change: <Mandrel_Name>, <Serial Number>, <Slave_Address>, <Actuator 1 orifice>, <Actuator 2 orifice>, <Actuator 3 orifice>, <Actuator 4 orifice>, <Actuator 5 orifice>, <Actuator 6 orifice>, <PC Comms port>

Appendix B. – Sample configuration (CRS_config.cfg) file

The following file describes a setup of 2 Mandrels supported by oil installations.

##

Oil installation engineering

Unit7

Any street

Oil town

UK

ZZ7 8ZA

01234 456789

info@Oil-installations.com

logging@ Oil-installations.com

#

Description:- Well 7 600m mandrel

Serial number:- 08051001

Comms port:- 9

Orfice sizes:- 3,3,3,4,3,3

Installation Notes:- Mandrel at 576m in well 7 has 1 unloading actuator (actuator 4). Gives maximum production rate at 12 Bar differential pressure

#

Description:- Well 7 1200m mandrel

Serial number:- 08051002

Comms port:- 6

Orfice sizes:- 3,3,3,3,3,3

Installation Notes:- Mandrel at 1156m in well 7 with balanced actuators. Gives maximum production rate at 26 Bar differential pressure.

#

Appendix C. – Sample Mandrel.cfg

Camcon Mandrel config file (Actuator sizes)

##

1.0

2.0

3.0

4.0

5.0

6.0

#

Appendix D. – System Alarm Texts

The alarm references ("An") in the following table correspond to the equivalent references within the main body of this document. Within the text, <Fn> is a reference to a field that varies according to circumstances and is defined in the second table below. The message text shall be scripted as shown (or with other characters as escape characters) such that the variable fields can be embedded anywhere within the fixed text if it is modified or translated into other languages.

Alarm	Text
A1	<F1>, <F2>, valve <F3> changed as well as commanded valve <F4>. Possible mandrel fault.
A2	<F1>, <F2>, annulus pressure changed significantly
A3	<F1>, <F2>, pipe pressure changed significantly
A4	<F1>, <F2>, electronics temperature changed significantly
A5	<F1>, <F2>, pipe temperature changed significantly
A6	<F1>, <F2>, CRITICAL TEMPERATURE - rose above <F5> at <F6>
A7	<F1>, <F2>, in local mode since <F6>
A8	<F1>, <F2>, valve <F7> opened unexpectedly
A9	<F1>, <F2>, valve <F7> closed unexpectedly
A10	<F1>, <F2>, valve <F7> not tested for <F8> days
A11	<F1>, <F2>, capacitor health not checked for <F8> days
A12	<F1>, <F2>, cannot measure capacitor health (mandrel is in local mode)
A13	<F1>, <F2>, cannot measure capacitor health (mandrel communications lost)
A14	<F1>, <F2>, cannot measure capacitor health (MODBUS communications lost)
A15	<F1>, <F2>, capacitor health measurement may take longer than usual. To abort, click the capacitor health button again.
A16	<F1>, <F2>, change valve <F4> once more to confirm fault resolved. Alternate fault and healthy indications imply a stuck valve.
A17	<F1>, <F2>, communications failure: state of valve <F7> unknown. Try again.
A18	<F1>, <F2>, status last updated <F9> (mandrel is in local mode)
A19	<F1>, <F2>, status last updated <F9> (mandrel communications lost)

Alarm	Text
A20	<F1>, <F2>, status last updated <F9> (MODBUS communications lost)
A21	<F1>, <F2>, Previous action aborted. Please repeat.
A22	<F1>, <F2>, valve <F7> possibly stuck open. Try again
A23	<F1>, <F2>, valve <F7> possibly stuck open, open circuit coil
A24	<F1>, <F2>, valve <F7> possibly stuck open, short circuit coil
A25	<F1>, <F2>, valve <F7> possibly stuck closed. Try again
A26	<F1>, <F2>, valve <F7> possibly stuck closed, open circuit coil
A27	<F1>, <F2>, valve <F7> possibly stuck closed, short circuit coil

Field	Field description
F1	Date/time of alarm initiation as “ddmmmyyyy, hh:mm:ss”
F2	Subject mandrel name
F3	1st additional actuator number
F4	Commanded actuator number
F5	“125°C” or “257°F” depending on user selection for units of temperature
F6	Date/time of first initiation of this series of alarms as “ddmmmyyyy hh:mm:ss”
F7	Actuator number (1 to 6)
F8	Number of whole days since the last check
F9	Date/time of last status update as “ddmmmyyyy hh:mm:ss”

Appendix E. – System Parameters

Parameter	Default	Description	Range & Step
PC1	2 seconds	Fn3 message delay after an Fn5 message	0.1 – 25.5 in tenths
PC2	1 second	Time between periodic Fn3 messages	0.1 – 25.5 in tenths
PC3	10%	Change in pressure causing an alarm	1 to 255 %
PC4	10%	Change in temperature causing an alarm	1 to 255 %
PC5	3 seconds	Period between Fn3 messages following failure to obtain a valid capacitor health measurement	0.1 – 25.5 in tenths
PC6	20 seconds	Delay to any diagnostic or alarm window update after a user scroll action	1 to 255 in seconds
PC7	1 second	Fn3 or Fn5 response delay before logging a timeout error	0.1 – 25.5 in tenths
PC8	2 seconds	Minimum time to display a self-clearing popup screen or alarm message	1 to 255 in seconds