USERS MANUAL

Micro Cylinder Inspection System

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Contents

1 Introduction

1.1 Overview

The Nordco DSP500 Ultrasonic Cylinder Inspection System has been designed to conduct a 100% sidewall exam of a cylinder scanning for defects of a giving size and measuring wall thickness, with the ultrasonics immersion wheel technology. It is an original product of Nordco Rail Services and Inspection Technologies of Shelton, Connecticut. This document, both the printed hard-copy and the on-line help file, constitutes the main operator "Operation and Maintenance Manual" for the DSP500 system. On-line procedures are included in this document for both the operation and maintenance of the electronics subsystem.

The documentation in this help file describes the functionality of the DSP500 ultrasonic, nondestructive, in-line, full-body cylinder inspection system. Specifically discussed in the content are the inspection method (ultrasonic), assembly (transducer wheels), transducer control and related signal processing modules, testing process, control computers, flaw detection capabilities and exception reporting, and general system operation.

The equipment, electronics, and methods discussed herein are proprietary and are covered by the following Nordco U.S. and foreign patents and other patents pending:

4,004,455, 4,222,275, 4,229,978, 4,429,576, 4,487,071, 4,615,218, 4,763,526, 4,785,668, 4,872,130, 1,031,194 (Canada), 8,503,345.4(EPO)

The DSP500 system, including the transducer wheel assembly mounting mechanics, was designed and manufactured by Nordco Rail Services and Inspection Technologies (1 Waterview Drive, Suite 102A, Shelton, CT 06484).

Nordco Cyl-Sonic software versions will vary depending on time of purchase and whether customer subscribes to software updates after initial licensing period expires. The current manual is built on the latest version of Cyl-Sonic software, CylSonicBT v5.0.0.0. Nordco has provided custom software to customers in the past. This manual demonstrates use of Nordco's standard version of the software.

Nordco acknowledges the trademarks of other organizations for their products or services where mentioned in this documentation.

1.2 DSP System Architecture

1.2.1 Digital Signal Processing Considerations

The DSP system uses a state-of-the-art digital signal processing architecture combining FPGA (Field Programmable Gate Array) devices for implementing high-speed sequential signal processing tasks in real-time with a Digital Signal Processor (DSP) executing software algorithms processing less time critical operations. The initial high-speed sequential processing tasks implemented in the FPGA are the Haar Wavelet Transforms and Inverse Wavelet Transforms used in the ultrasonic signal de-noising process. The architecture

is also capable of implementing future signal correlation and discrimination techniques to support enhanced and/or new testing applications.

With the FPGA acting as a hardware accelerator, freeing up more time for the DSP to execute its targeted algorithms, an increased firing rate of the ultrasonic pulsers is achieved. The ability to fire the ultrasonic pulsers more rapidly translates into the ability to test faster and implement applications not possible with the previously restricted pulser firing rates.

In addition, the hybrid FPGA/DSP architecture enables the simultaneous processing of multiple ultrasonic test channels through a single set of processing hardware, thereby decreasing the system cost per channel. The goal of the hybrid FPGA/DSP development was to process four (4) ultrasonic test channels through a single FPGA/DSP combination within a 100 microsecond test frame.

The DSP provides an Ultrasonic Channel Density of four (4) channels per card. The system Pulser/Pre-Amp card and DSP card each support four (4) ultrasonic channels, so there is a one-to-one relationship between the Pulser/Pre-Amp and DSP cards. Therefore, a 32 Channel RIS System is made up of eight (8) Pulser/Pre-Amp and eight (8) DSP cards (4 X 8=32). The 48 Channel RIS System is configured from twelve (12) Pulser/Pre-Amp and twelve (12) DSP cards.

1.2.2 Digital Signal Processing (DSP) Card Design

The design goal for the DSP Card was to produce a Digital Signal Processing Card in the Compact PCI Express 6U form factor, capable of simultaneously processing four (4) 5 MHz ultrasonic test channels. Each ultrasonic test channel sampled at a minimum signal sampling rate of 20 MHz, producing a signed (2's complement) 12 Bit quantized value for each signal sample. All real-time signal processing functions complete their execution within a maximum ultrasonic test frame of 100 microseconds. In order to meet the real-time processing requirements, the card uses a state-of-the-art digital signal processing architecture combining FPGA (Field Programmable Gate Array) hardware processing with a 6-Core DSP (Digital Signal Processor). Each of the four (4) ultrasonic channels on the card has one DSP Core dedicated to processing the received ultrasonic RF signals. The remaining two (2) DSP Cores are used for inter-card communications and communicating to the application software. The DSP is also capable of producing synthesized ultrasonic test signals/frames used for manual and automatic system calibration functions. In each of the FPGA devices, a 32 bit custom RISC processor has been implemented to provide for configuration and control of system parameters.

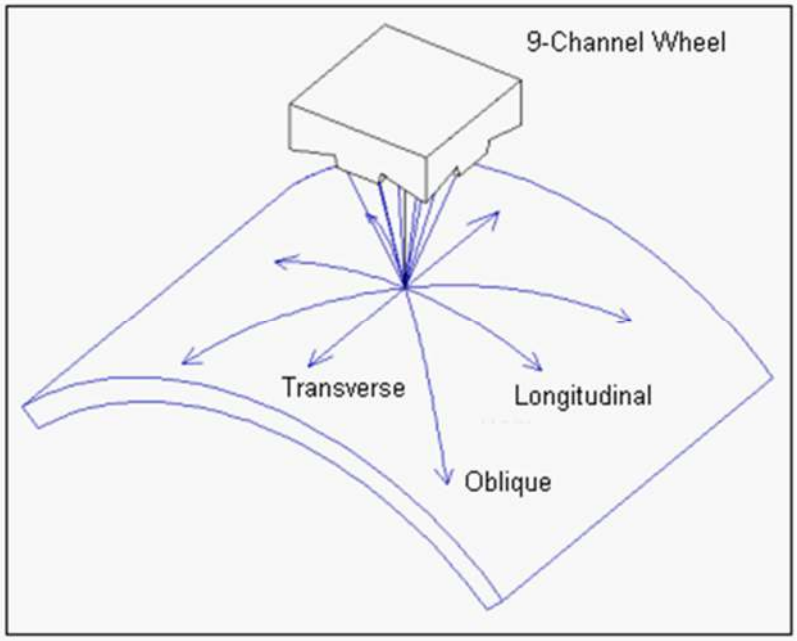
1.3 DSP500 System Specifications

The DSP500 ultrasonic gas cylinder inspection system is designed to meet or exceed the following capabilities.

1.3.1 Test Coverage

The transducer orientations are determined by the types of probes that are installed with the system. Some of the standard probe types are the 5-channel, 9-channel and 12-channel wheel probes. The five channel probe provides thickness and shear angle testing in the longitudinal and transverse directions. The nine channel probe provides thickness and shear angle testing in the longitudinal, transverse and oblique directions. The twelve channel probe provides thickness and shear angle testing in the longitudinal direction. In addition, custom probe assemblies are often designed to meet a customer's specific test requirements. The standard gas cylinder system configuration uses one 9-channel wheel probe that is designed to cover preset distance of the cylinder's surface on each revolution of the cylinder to meet scan plan requirements.

The system is capable of testing one hundred percent of the cylinder's sidewall depending on the mechanical and probe arrangements used. Note that the type of probe assembly utilized and the total number of probes determines the overall system throughput.



1.3.2 Testing Sensitivity

The DSP500 system provides for independent sensitivity levels to be set for each data channel using independent amplifier gains, gates, thresholds, and flaw alarm counters for each channel. The channel settings are typically selected to provide alarm conditions for known references such as a notch depth of 5-10% of minimum designed wall thickness (TminD) on a calibration standard as required by applicable regulatory body. The DSP500 system is capable of meeting or exceeding the requirements of most standard specifications from API, DIN, ASTM, etc.

1.3.3 Cylinder Inspection Speed

Normal system operation for all sensitivity settings is guaranteed for cylinder surface speeds of up to three hundred surface feet per minute (FPM) (1.5 meters per second) at test pulse densities of 1/16" (1.58 mm) resolution.

1.3.4 Completeness of Testing

The cylinder is tested for up to 100% of coverage of the sidewall of cylinder as determined by the mechanical system constraints and the probe designs used.

1.3.5 Channel Configuration

In the default system configuration the DSP500 In-line, full-body gas cylinder inspection system utilizes nine transducer data channels contained in a single wheel probe. There is one thickness measurement transducer, one clockwise-looking longitudinal defect detection channel, one counterclockwise-looking longitudinal

defect detection channel, one forward-looking transverse defect detection channel, one rearward-looking transverse defect detection channel, four oblique shear-angle defect detection channels oriented to look at 45 degree angles relative to the main cylinder axes.

The DSP500 system provides outputs that can be used to drive both an audible and a visual alarm represented in the Defect Map (C-scan) when defects are detected.

1.3.6 Operator-Assisted Automatic Calibration

Automatic calibration may be done for job definitions that may be stored in the DSP500 system at any time. The total number of jobs that may be stored is limited by the available the disk space on the system's hard disk. A typical job requires approximately 22-KBYTES of disk storage. The automatic calibration is achieved by having the previously set values for the amplifier gains, threshold settings, gates, etc. saved and restored to and from a serialized file on the main computer's hard disk. The initial definition of these values must be determined by an experienced UT operator who is authorized by the company's written practice to set up test methods. These initial calibrations are accomplished by having the operator change the existing values while monitoring the analog data and test results on an oscilloscope and the color graphics monitor, respectively. NOTE: adjustments to controls located on printed circuit boards are only necessary during periodic maintenance checks and should only be attempted by qualified personnel.

1.3.7 Test Map Reports

A test map report is provided for each cylinder after it has been tested with the DSP500 system. The test map with provide indication details as seen in the defect list as well as a copy of the thickness map and defect map.

1.3.8 Time Corrected Gain

A time corrected gain control feature (TCG) can be used in the amplifiers to offset the attenuation factor of the signals in the steel. This feature is sometimes referred to as "distance amplitude correction" (or DAC) and attempts to cause defects of the same size to appear with the same signal strength regardless of their depth in the steel.

1.3.9 System Setup

System setup for cylinder size changes shall typically be accomplished in less than five minutes by a Level II trained operator when using pre-calibrated job settings.

1.4 Micro Cylinder Inspection System at a glance

The Cyl-Sonic Micro performs ultrasound examinations (UE) of seamless metallic compressed gas cylinders with 2.26”-8” outside diameters and a length of 5.8”-30". The Cyl-Sonic Micro system's innovative probe head design quickly inspects and evaluates the integrity of the cylinder's sidewall and sidewall-to-base (SBT) region to ensure acceptability from the cylinder's exterior surface. The Micro is ideal for facilities specializing in small steel and aluminum gas-type cylinders containing welding, specialty, medical or electronic-type gases. Test operators do not need to submerge the cylinder or spend time removing the valve, filling, draining, drying, and replacing the valve in order to requalify it, therefore, increasing productivity and increasing daily throughput. This higher efficiency allows for a lower cost-per-cylinder test than hydrostatic testing. The system's foot print easily fit within most existing hydrostatic test areas. Site Prep & System Requirements

1.4.1 Electrical Requirements

110VAC 20A with neutral outlet

1.4.2 Pneumatic Requirements

The system requires 80 psi line supply pressure.

1.4.3 Water Requirements

The system requires a water supply nearby to fill the tank when it is emptied and cleaned.

The system requires a drain nearby to empty the tank periodically.

1.4.4 Cylinder Requirements

The cylinders that can be tested on this system can range from 3.2”-8” outside diameter and 4”-30" in length.

1.4.5 System Foot Print

Once System location and orientation has been determined adequate load and unload space can be assessed.

1102504 – ASSY, BENCHTOP FRAME

Length – 77in, Width – 130in, Height – 85in with Electrical Enclosure 32.5 x 32.5 x 71

2 Safety Advice

2.1 Safety Guidelines

Failure to adhere to Safety precautions could result in bodily injury and/or property damage.

A. It is necessary for all personnel and users to be aware of and familiar with the safety regulations included in this manual.
B. It is also necessary for all personnel and users to be aware of and familiar with the safety regulations of the equipment to which the Cyl-Sonic Micro System is linked to as well as those of any facility in which work is to be performed.
C. All persons working on the Cyl-Sonic Micro System must comply with any applicable safety regulations.

2.2 Scope of Documentation

A. The documentation included in this manual applies only to the portions of the Cyl-Sonic Micro System supplied by Nordco Rail Services.
B. Where possible we mention references to possible safety hazards posed by other systems, but it is not the purpose of this documentation to note all hazards associated with the environment in which work will take place.

2.3 Safety Devices Guidelines

A. Safety equipment must be in good, working condition.
B. Safety equipment must be properly installed and functioning before running the Cyl-Sonic Micro System.
C. Safety equipment must not be removed unless appropriate procedures to ensure a safe working environment are followed, the cylinder inspection system is turned off, appropriate signage is in place, and lockouts have been activated to ensure the Cyl-Sonic Micro System cannot be accidentally restarted.

2.3.1 List of Mechanical & Electrical Safety Devices

A. All enclosure covers.
B. Redundant bolting/fasteners.
C. Wire ways, tie-downs, and cable covers.
D. Electrical fuses.
E. Placards and signage indicating possible dangers or ongoing maintenance.

2.4 Safety Equipment Guidelines

A. Safety equipment must be clean and in good, working condition.
B. Safety equipment must be worn/used whenever maintenance is to be performed on the Cyl-Sonic Micro System.
C. Safety equipment must not be removed until all safety devices are properly installed and functioning.

2.4.1 List of Required Safety Equipment

A. Safety glasses must be worn at all times when performing maintenance tasks.
B. Ear protection must be worn as needed depending on the environment in which work is to be performed.

C. Proper foot protection (specifically rubber-capped, steel-toed boots.)
D. Proper-fitting protective garments are to be worn when performing maintenance activities.

3 Installation

3.1 Inspection

Inspect all equipment during arrival and after placement to insure there is no visual damage.

The following areas should be checked:

- Structural frame of equipment and accessories
- Cables and cables end connectors
- Electrical boxes and panel mounted connectors
- Air prep unit and pneumatic plumbing
- Water pan and water plumping
- Pneumatic cylinder fittings and cylinder mounted sensors

If any damage is found, Nordco's shipping department must be notified.
Photo documentation of the damage must be sent to Nordco immediately.

3.2 Power Connection

Plug power cord into a 110VAC 20A outlet.

3.3 System Connections

3.3.1 Main Machine Connections

Connect the junction box connection points to the appropriate main machine connection points as shown in system diagram E-DWG-0019.

3.3.2 Electrical Enclosure Connections

3.3.2.1 Rear Enclosure Section

Connect the following cables:

1. I/O & AC Power Cable (4 pin) from rear enclosure section to machine junction box.
2. Motor control cable (9 pin) from rear enclosure section to machine junction box.
3. I/O & DC Power Cable (10 pin) from rear enclosure section to machine junction box.
4. Encoder cable (19 pin) from rear enclosure section to machine junction box.

3.3.2.2 Junction Box Wiring

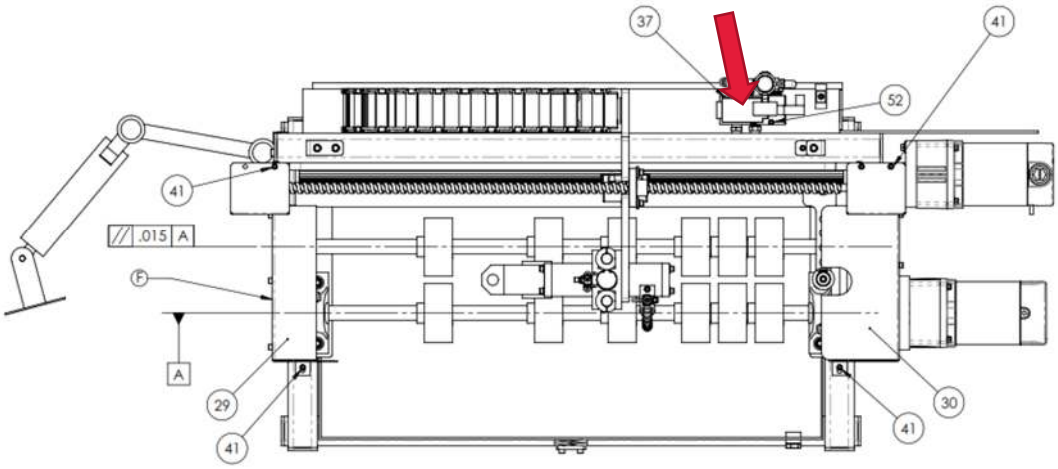
Connect the following cables:

1. I/O & AC Power Cable (4 pin) from rear enclosure section to machine junction box.
2. Motor control cable (9 pin) from rear enclosure section to machine junction box.
3. I/O & DC Power Cable (10 pin) from rear enclosure section to machine junction box.

4. Encoder cable (19 pin) from rear enclosure section to machine junction box.

3.4 Pneumatic Connection

Attach 80 psi dry shop air to 3/8 hose air input fitting located on the main machine. (Ref: 1102504)



3.5 Water Level

Fill water pan 1.5" below top of pan edge.

3.6 Internet Connection

For remote troubleshooting, software updates, and oversite compliance, system requires a LAN connection to computer with 6e/5e cable with internet access for remote control via team viewer software or other customer provided access. System speeds/bandwidth must support real time audio, video, and remote control from OEM as well as system data back up and file transfer for system and oversite specific functions.

4 Operation

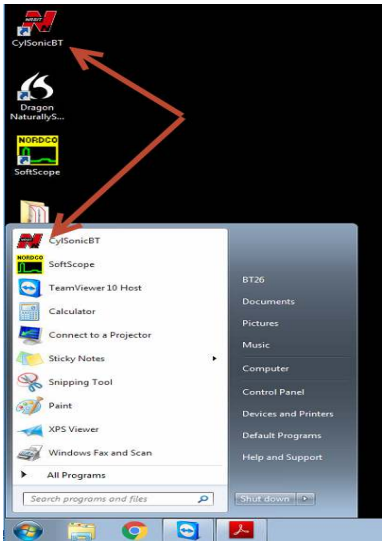
4.1 System Startup

1. Turn on the power switch for the DSP system located next to the router.

2. Turn on the computer by pressing the power button on the computer.
3. Verify that all E-Stops are not pressed by rotating them counterclockwise.
    a. One on the main frame on the left side.
    b. If E-Stop was depressed, press in the green reset button next to E-Stop.
4. Log into the computer with the password _____.

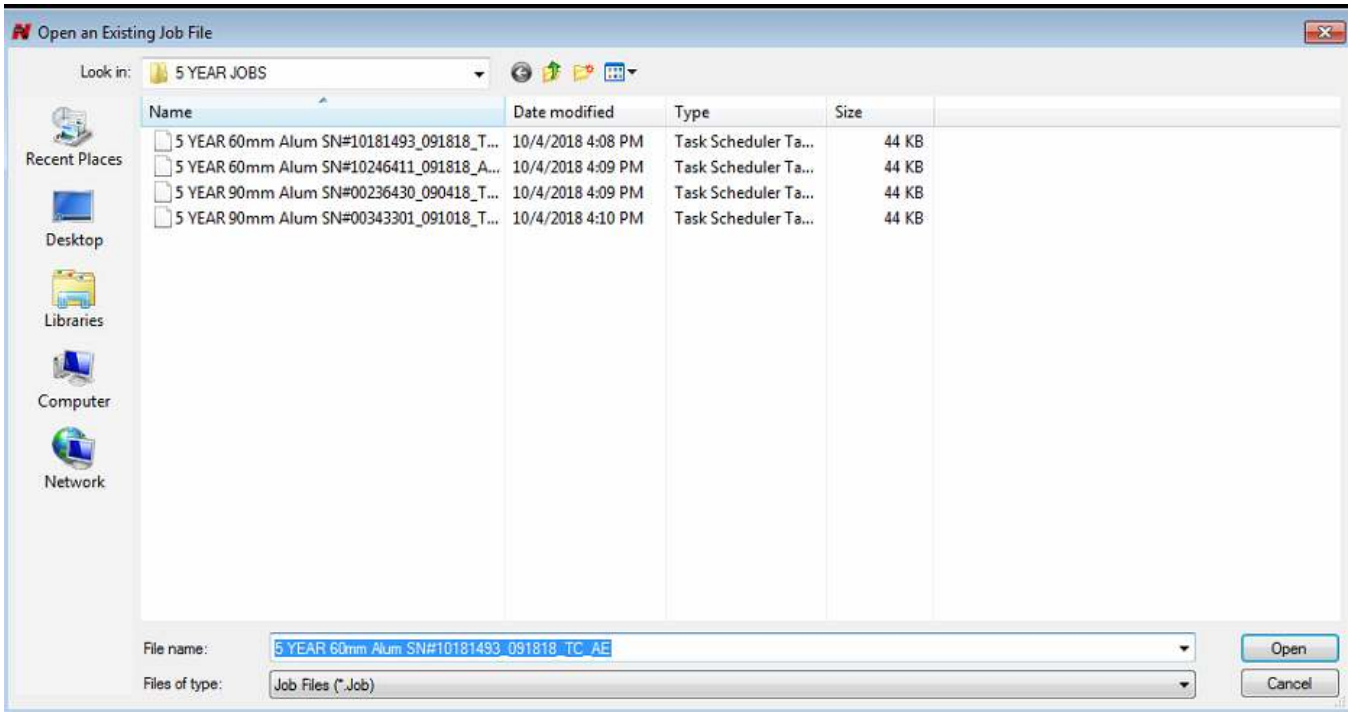
4.2 Starting up the DSP500 System

1. The DSP500 system is started by double-clicking the program's shortcut icon that is typically included on the desktop during the installation of the system software.



2. When the program is started the splash screen with the Nordco Logo and program name will appear for a few seconds or any key can be pressed to remove the screen.

3. Once the splash screen is closed, a File Open dialog box for job files will appear in the center of the display.
4. Select the appropriate job file for the cylinder standard and cylinder specification, service pressure and dimensions to be tested.



   a. Reference a copy of the system CylSonicPreTable for the selected cylinder specifications, pressure ratings and diameters allowed set up to be tested under that calibrations standard. The below are examples of Department of Transportation cylinder specifications.

5. CylSonicPreTable allows the system to store physical testing setting for a variety of cylinder specifications, service pressures, and dimensions.

ReferenceCo	AKA Part #-Spec-PSI-Dia-LG-Period	Diamet	Leng	CylinderSp	ServicePressu
CAL	Part # 1103299 CAL 3AL-2015-4.38-18.00	4.38	18	3AL	2015
DA	MD15-3AL-2015-4.38-16.2	4.38	16.2	3AL	2015
EA	ME24-3AL-2015-4.38-25.2	4.38	25.2	3AL	2015
ML4	ML4-3AL-2015-4.38-5.8	4.38	5.8	3AL	2015
M7	M7-3AL-2015-4.38-9.2	4.38	9.2	3AL	2015
ML6	ML6 -3AL-2015-4.38-7.9	4.38	7.9	3AL	2015
M9	M9-3AL-2015-4.38-10.6	4.38	10.6	3AL	2015

6. The company's written practice will designate the appropriate personnel to establish these settings, but they include starting and ending set down points, minimum wall thickness, helix, rotational speed etc.

Note: If the cancel button is clicked a default set of test parameters will be created using the file name "TheJob.Job". If the cancel button is clicked and the job is then saved to disk, all of the

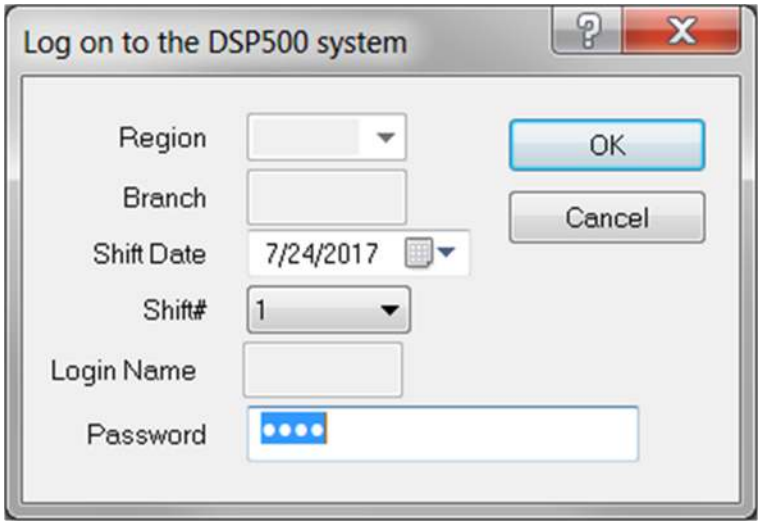
NOTE: Do not use the default filename "TheJob" as a working set of job parameters since they are easily overwritten with default values when starting up the system.

original parameters will then be lost! If a job filename is entered for a job that does not exist in the currently selected directory, the default set of test parameters will be used, and a new job file will be created. If an existing job filename is entered, the test parameters that were last saved using that job filename will be read in from the disk.

7. When a job file has been selected or created (either the OK or Cancel button has been clicked) the main application window will appear in its maximized state (e.g. it will take up the entire screen). At this point the system is still not ready to inspect cylinders. An operator must logon to the DSP500 system by entering a valid Access Code (e.g. password). When first starting up the system a dialog will appear to prompt the operator for his or her password. Once a valid password has been entered the operator will be able to operate those features of the system that his or her Access Level allows access to.

4.2.1 Log on to the DSP500 System

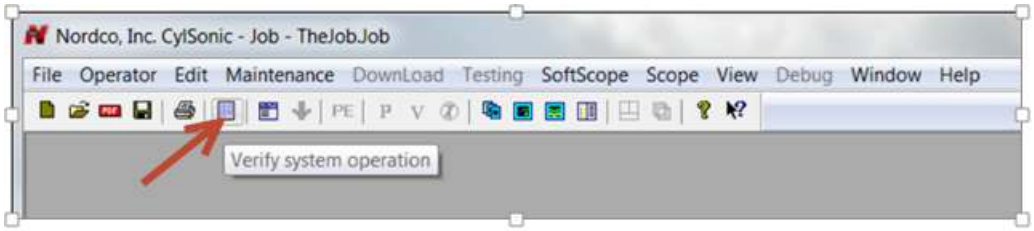
1. Enter Password – (Tab)
2. Enter Region – (00) (Set up at install by level 10 or higher)
3. Enter Branch Code (Set up at install by level 10 or higher)
4. Enter Shift- As required by test facility
5. Select “OK” Button



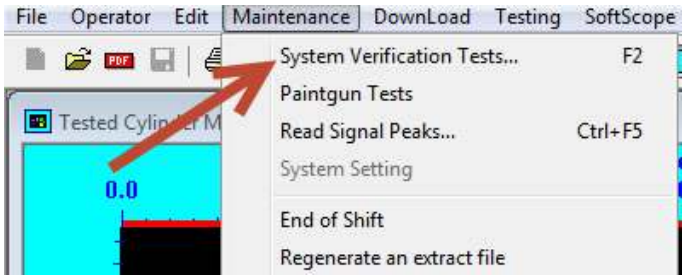
At this point the test parameters (gates, gains, etc.) have not been downloaded to the DSP500 system electronics and thus testing of cylinders is not allowed. EXTREMELY IMPORTANT: before downloading the test parameters, a parallel communications test must be run so the system knows which data channels are active, or "linked up". Only those data channels that pass the parallel communications test will be sent test parameters during a job download, and thus only those channels will be setup to inspect cylinders for defects.

4.2.2 Parallel Communications Test

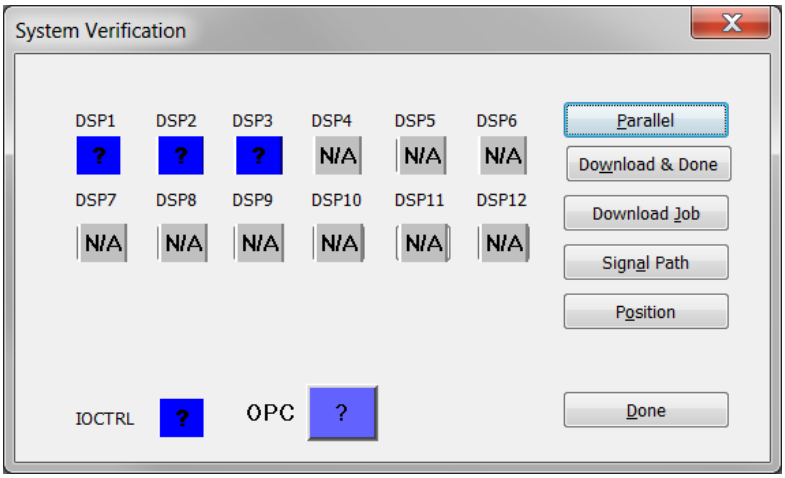
1. Select "Verify system operation" icon or press the F2 key or Maintenance Drop Down



or



2. Select "Parallel"
3. DSP1, DSP2, DSP3 – Should change from Blue to Green. *Note: If the built-in self-test fails, a problem with the hardware components should be suspected. Repeat step 2 a couple of times to confirm*
4. Select "Download & Done"



The DSP500 system will not allow the testing mode of operation to be entered unless:

1. A parallel communications test has been successfully passed,
2. A job parameter data file has been opened and the data downloaded to the DSP500 electronics.

4.3 Setting up an DSP500 Job

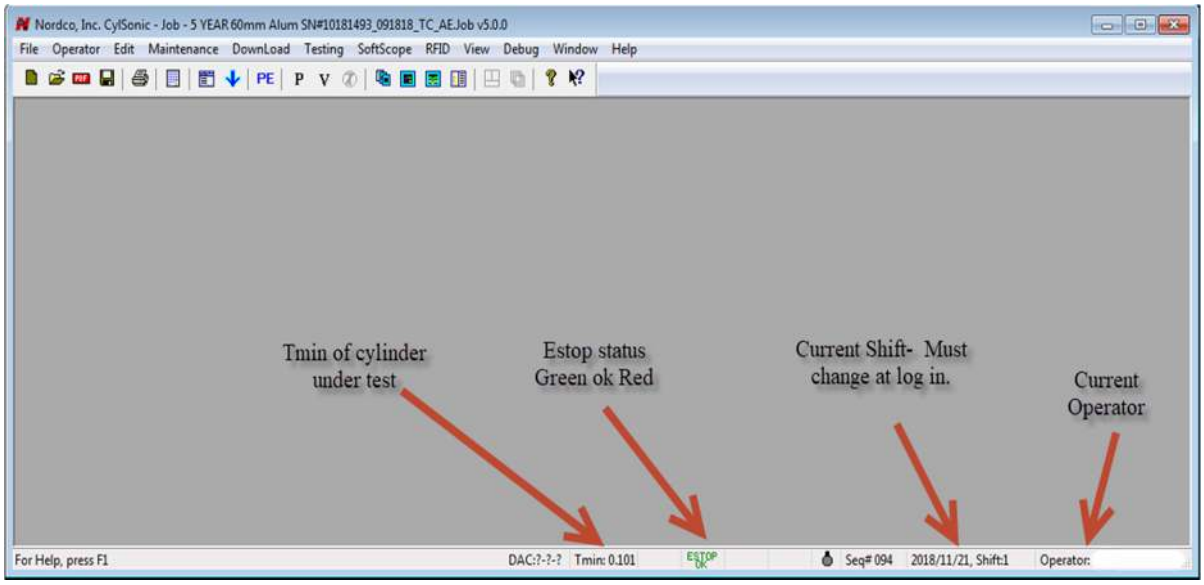
Correctly setting up a DSP500 Job for optimal inspection of cylinders requires a working knowledge of the DSP500 system menus and controls and a thorough understanding of ultrasonic principles is needed for setting the ultrasonic parameters. Once the job parameters have been set, however, an operator need only know the basics of running the DSP500 system in order to test cylinders. Once set up properly, inspection of cylinders for defects takes place in a semi-automatic fashion.

Customers can request Nordco to set up jobs as part of our Oversite services or request as part of the equipment purchase. For those providing their own oversite or Job set up, further training can be provided from Nordco with Advance Operator Training which covers calibration cylinder standards set up and job files.

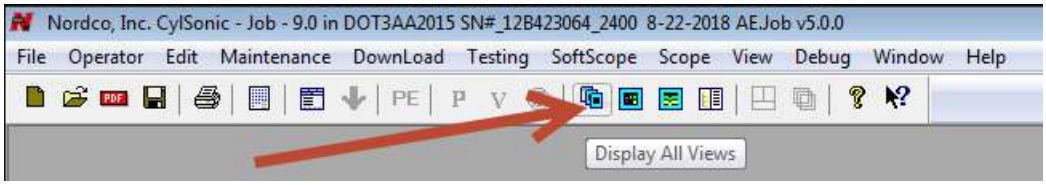
Once a job has been set up and the parameters are sent down to the electronics, the system can then be placed into a testing mode of operation using the Testing menu selection located on the mainframe window's menu bar. The typical scenario from this point is to first select the verification testing mode of operation and then run a calibration standard through the system in order to verify the job parameter settings. Adjustments to the job parameters are made as needed until the test results meet the specifications set by the user's standard operating procedures (SOP's). After the system setup has been verified, the production testing mode of operation can be selected.

4.3.1 Software Menu Display set up and Navigation

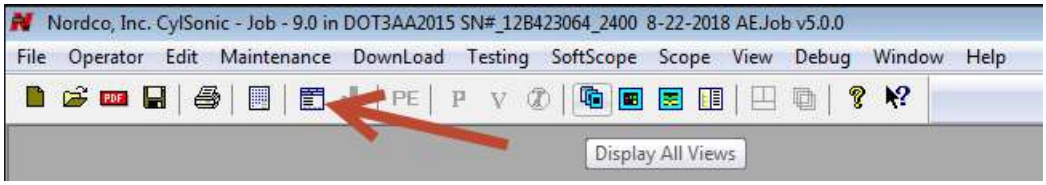
After System verification the following will display.



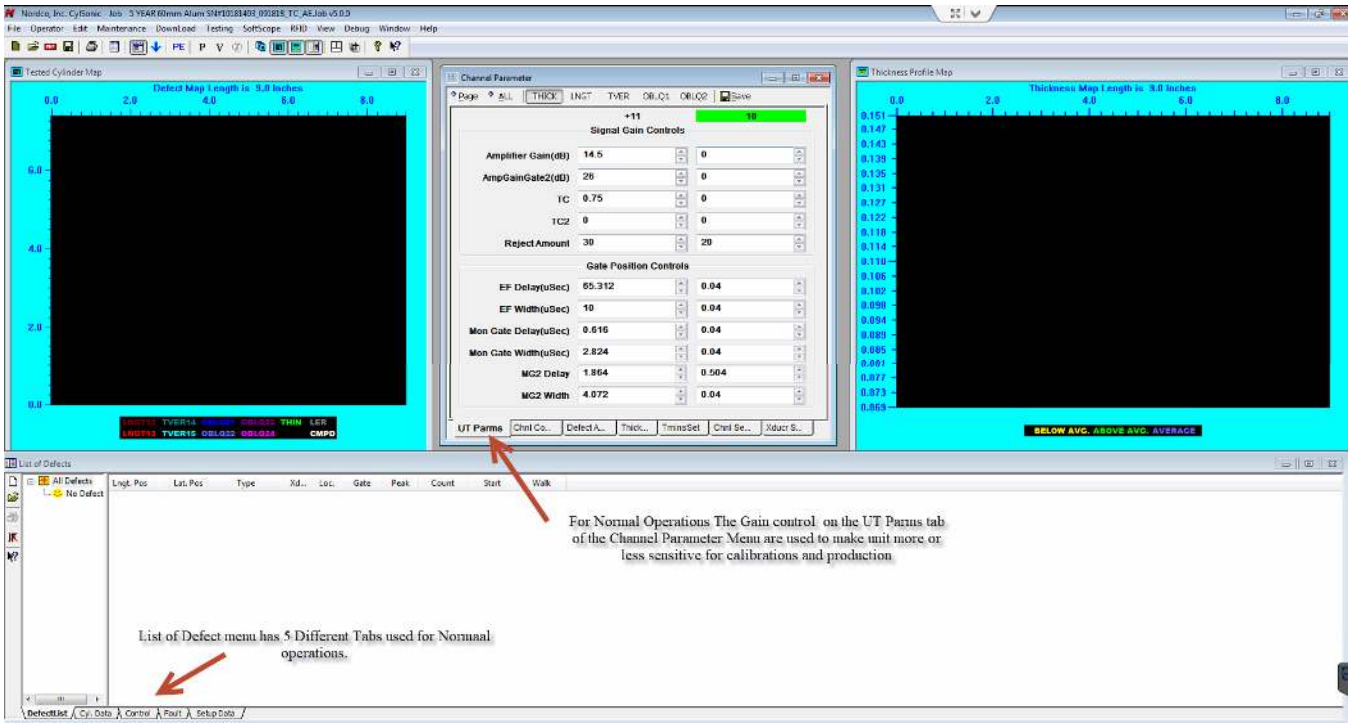
Open the C scan (Tested Cylinder Map) display, B scan (thickness map) display, and defect menu by clicking on the Display all Views icon.



Opening the channel parameter menu by clicking on the Channel Parameter icon.

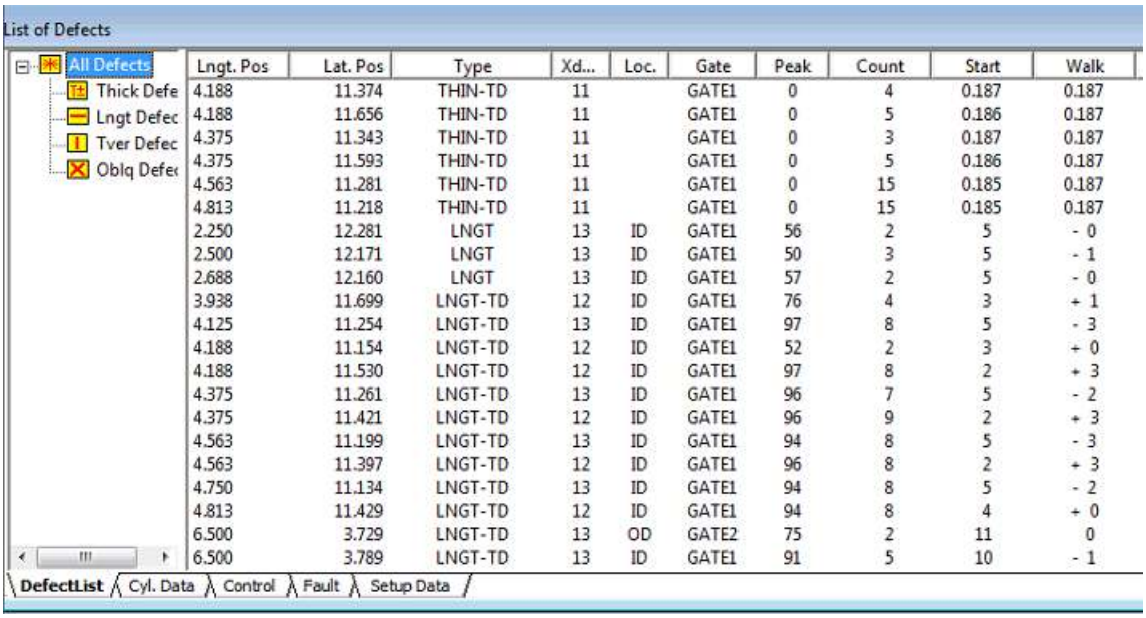


Arrange menu and display to suit by dragging them to desired location inside the screen.



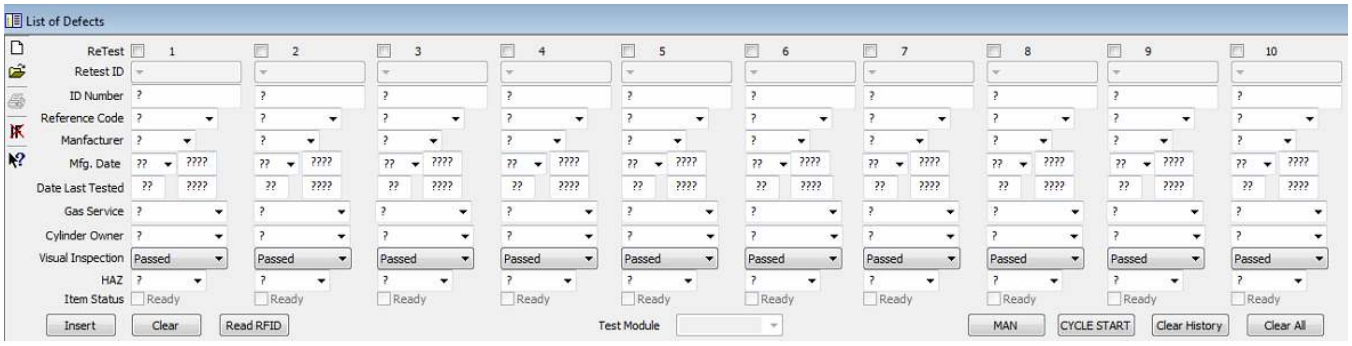
List of Defect Menu Tabs

Defect List Displays details of defects including position, type transducer, location, Gate, Peak (FSH), Alarm count, starting position in the gate and walk of defect through the gate.

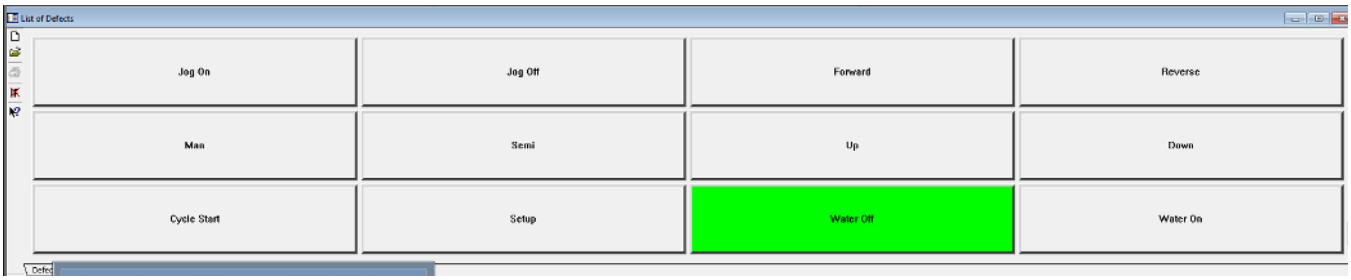


Lngt. Pos	Lat. Pos	Type	Xd...	Loc.	Gate	Peak	Count	Start	Walk
4.188	11.374	THIN-TD	11		GATE1	0	4	0.187	0.187
4.188	11.656	THIN-TD	11		GATE1	0	5	0.186	0.187
4.375	11.343	THIN-TD	11		GATE1	0	3	0.187	0.187
4.375	11.593	THIN-TD	11		GATE1	0	5	0.186	0.187
4.563	11.281	THIN-TD	11		GATE1	0	15	0.185	0.187
4.813	11.218	THIN-TD	11		GATE1	0	15	0.185	0.187
2.250	12.281	LNGT	13	ID	GATE1	56	2	5	- 0
2.500	12.171	LNGT	13	ID	GATE1	50	3	5	- 1
2.688	12.160	LNGT	13	ID	GATE1	57	2	5	- 0
3.938	11.699	LNGT-TD	12	ID	GATE1	76	4	3	+ 1
4.125	11.254	LNGT-TD	13	ID	GATE1	97	8	5	- 3
4.188	11.154	LNGT-TD	12	ID	GATE1	52	2	3	+ 0
4.188	11.530	LNGT-TD	12	ID	GATE1	97	8	2	+ 3
4.375	11.261	LNGT-TD	13	ID	GATE1	96	7	5	- 2
4.375	11.421	LNGT-TD	12	ID	GATE1	96	9	2	+ 3
4.563	11.199	LNGT-TD	13	ID	GATE1	94	8	5	- 3
4.563	11.397	LNGT-TD	12	ID	GATE1	96	8	2	+ 3
4.750	11.134	LNGT-TD	13	ID	GATE1	94	8	5	- 2
4.813	11.429	LNGT-TD	12	ID	GATE1	94	8	4	+ 0
6.500	3.729	LNGT-TD	13	OD	GATE2	75	2	11	0
6.500	3.789	LNGT-TD	13	ID	GATE1	91	5	10	- 1

Cylinder Data Tab is where you enter the required data for the cylinder to be tested.

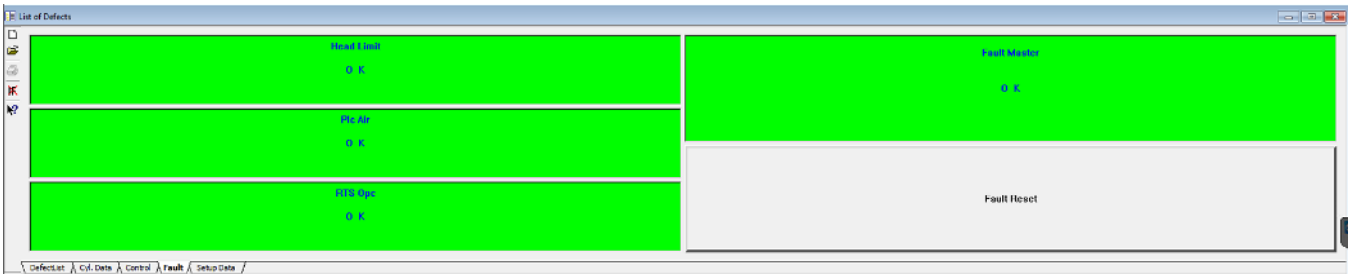


Control Tab controls the movement of the RSU, rollers, and water

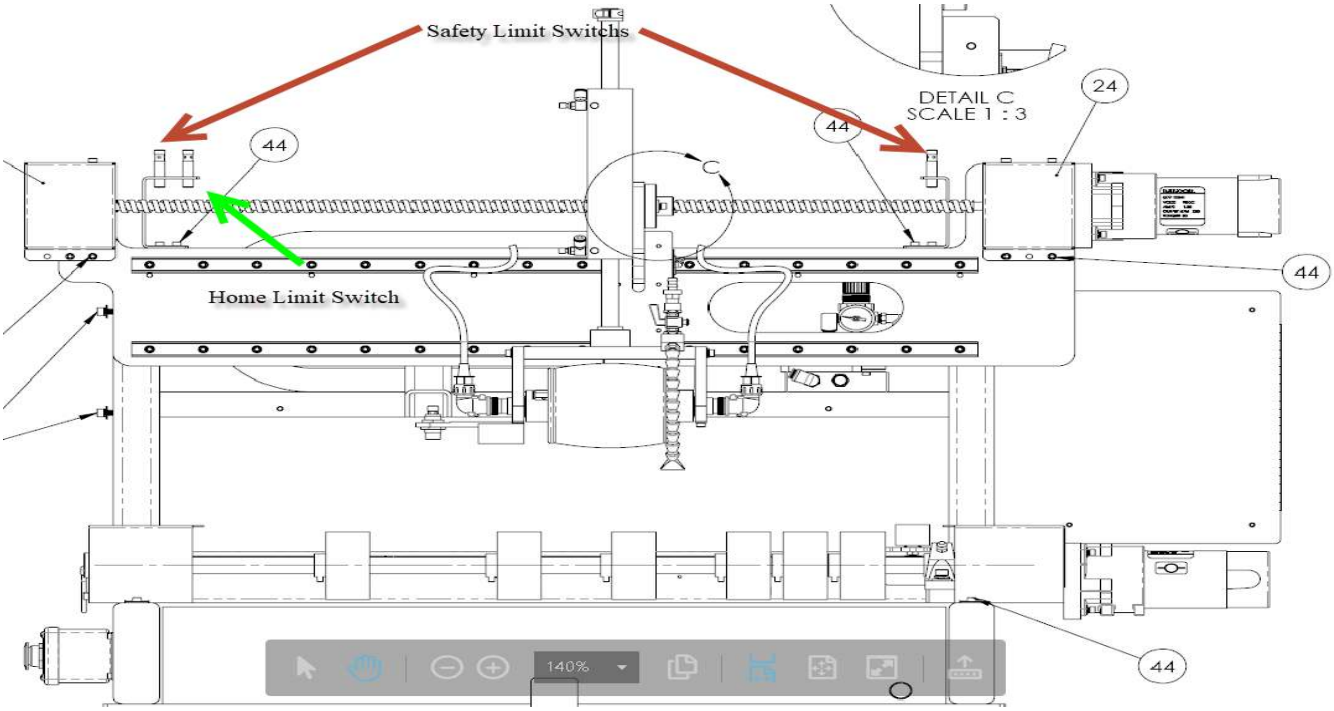


Add Note for Options: a) Length of Test Verification LTV. b) SoftHome

Fault Tab is where you reset a fault and display control alarms



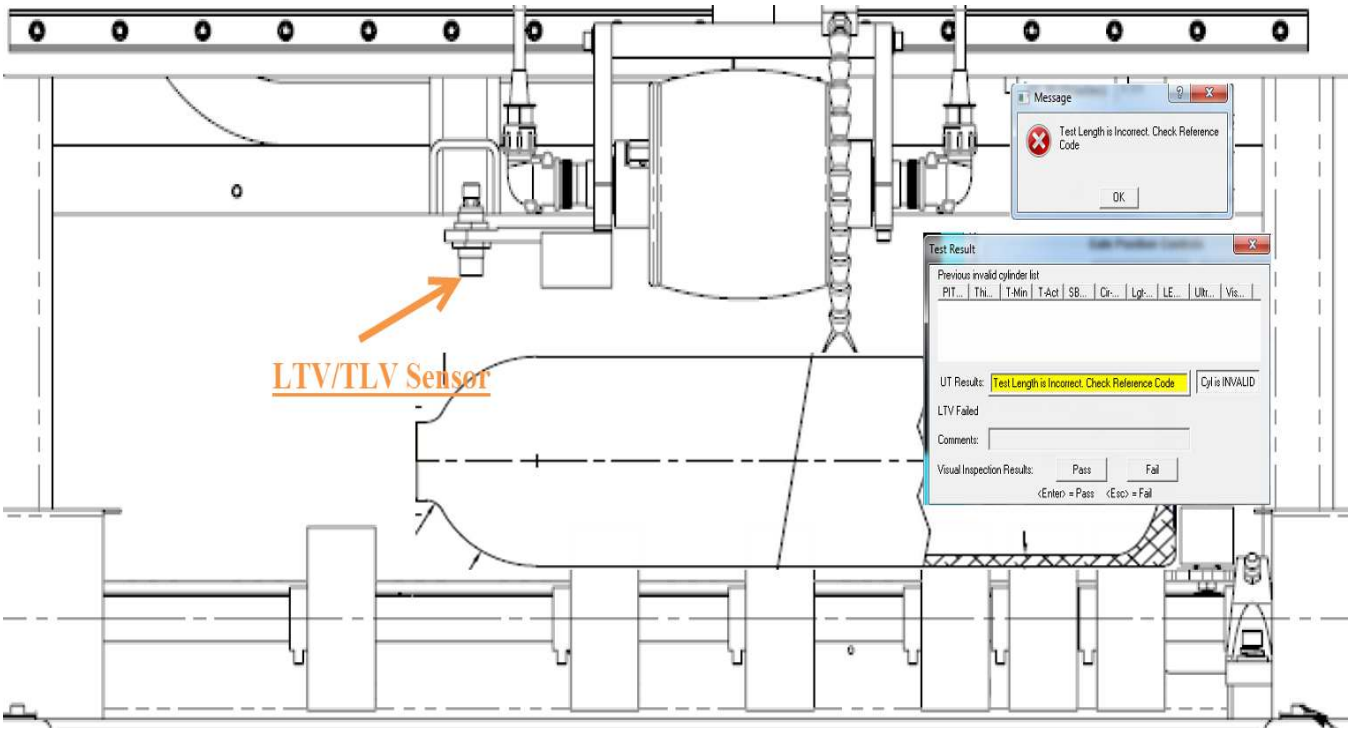
Head Fault would turn red if Safety Limit Switches were activated by the RSU traveling too far in either direction on the screw drive



Home Limit Switch marked in green is the starting and ending longitudinal position of the RSU Assembly unless Soft Home Feature (Optional) installed on unit.

Soft Home Feature (Optional):

Enables PLC software to return the test probe to the starting position of the first cylinder in the Cylinder Data when system switches automatically from Verification to Production modes and then to the starting position of the last cylinder tested in Production or Verification Modes, instead of returning to the machine's home position between each test. This will save significant cycle time before the start of next cylinder being tested.



Length Test Validation System (LTV/TLV) (Optional):

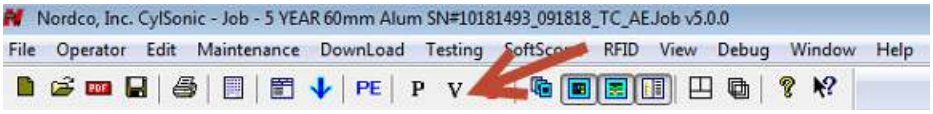
Proximity sensor (in orange above) that works in conjunction with CylSonic software to ensure 100% testing of the cylinder sidewall. If the operator enters an incorrect code and the device senses less than 100% testing of the cylinder sidewall, the software will abort the test and notify the operator to retest under the correct code.

Setup Data is the physical test setting of the cylinder under test. The data is loaded from the CylSonicPreTable.

Under typical operations only the production offset and end offset are controlled by operator to adjust starting and ending points of non-standard length cylinders

4.3.2 Verification

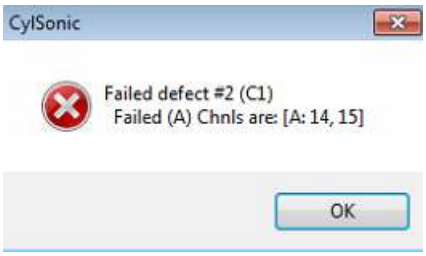
1. Place the calibration cylinder for the Job file selected onto the test table.
2. Select verification mode.



3. The following pop up window will verify

4. From Control Tab ensure system is in Semi mode.
    a. If it cannot be selected, ensure faults are clear, estop is showing green then select Man Mode then Setup to send RSU to Home.
    b. Once the unit verifies the RSU is at the home position, select Semi
5. Select Cycle Start from the Control Tab or the Cyl Data Tab

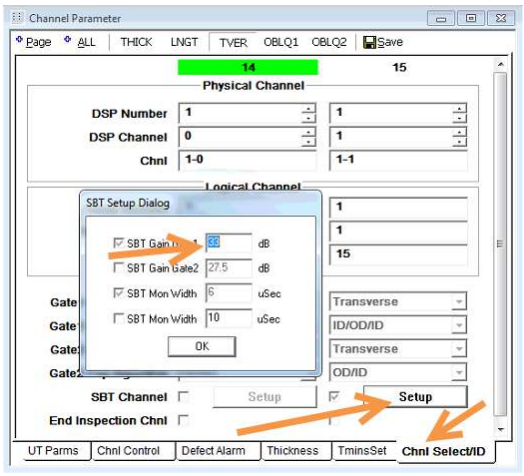
6. After the calibration has run, the system will provide a pop up for any required defect not found by the system.



7. You will also notice that the defect was not seen in the Cylinder Tested Map. For normal day to day operations, the gain will need to be adjusted to raise the sensitivity of the system to detect the flaw. Select the corresponding transducer set of the channel noted from the pop up to be adjusted:
    a. Parameter Menu ----> UT Parms Tab and raise the gain appropriately. Remember a 6db gain change results in a 50% FSH change from current.

b. For steel cylinders that require gain adjustments for the side to base transition area (SBT) flaw, gain control location is separated. To detect the circumferential flaw in the SBT, increased gain above regular side wall gain setting is required due to the thickening of cylinder wall for Channel 15.

Parameter Menu-→Channel Select/ID-→SBT Channel Setup-→SBT Gain Gate 1 or 2

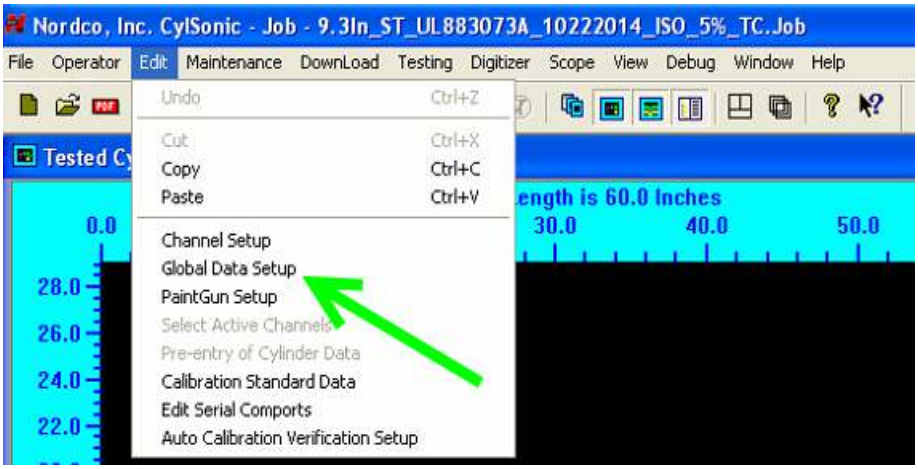


Optionally gain Control can be enabled for SBT length on other channels. Typically it is enabled for Thick Channel #11 Gate 1 or 2 to increase gain for thicker SBT regions in certain cylinders. This is to reduce loss of thickness readings or LER during testing.

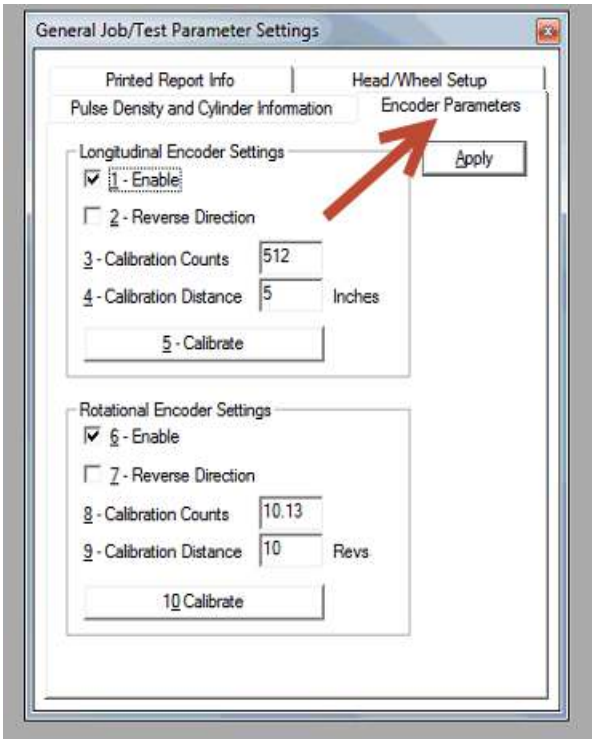
8. The Rotational (Circumferential) encoder may get out of calibration causing the series of defects in your calibration cylinder to appear to move up or down the Tested Cylinder Map(C-scan).

To correct the encoder:

a. Select Global Data Setup Menu from Edit Drop Down.

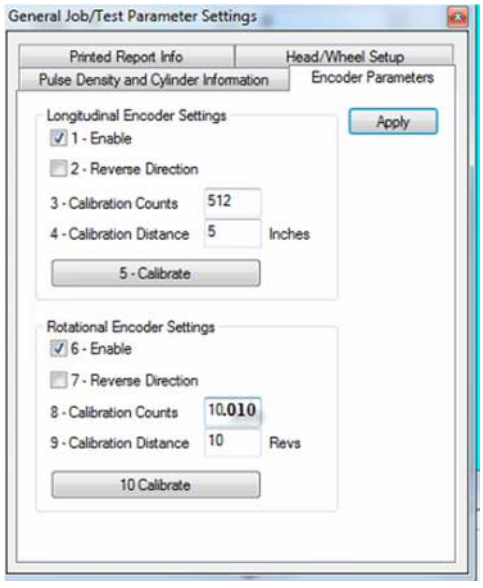


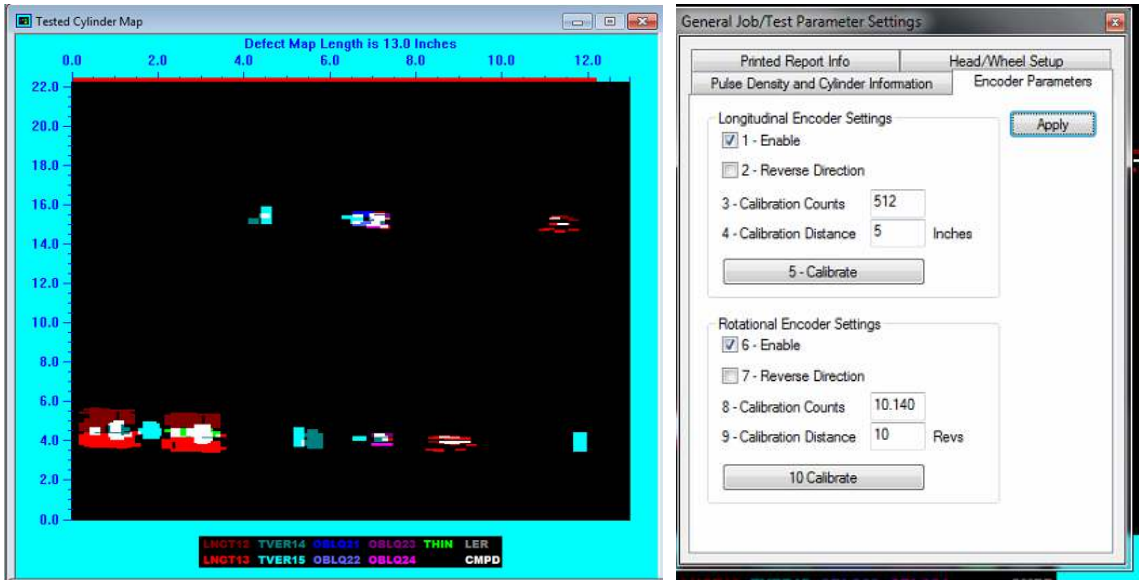
b. Select Encoder Parameters from the General Job /Test Parameter Setting Menu.



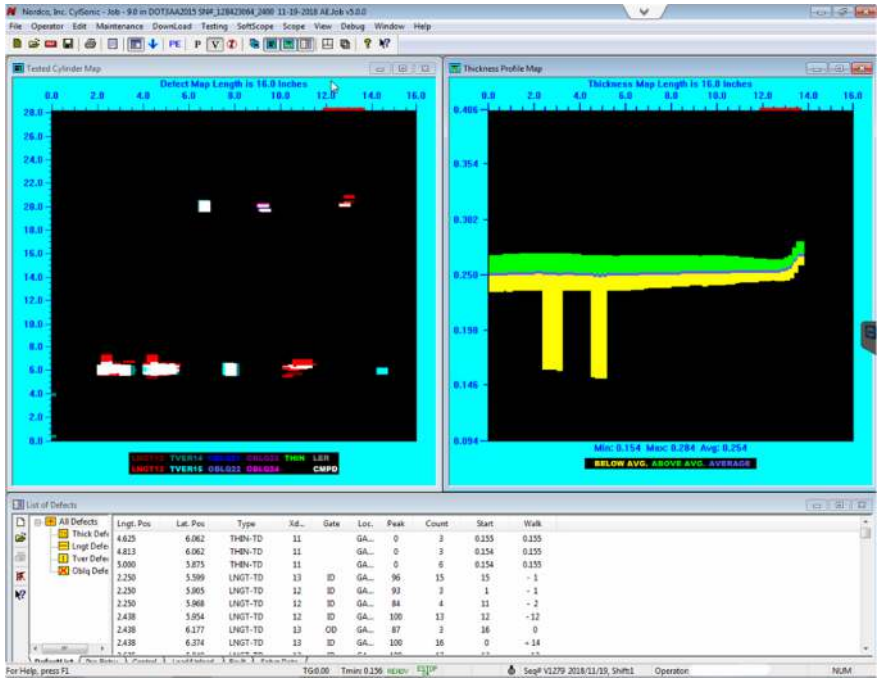
c. In the Rotational Encoder Setting 8- Calibration Counts adjust the number to straighten the flaws. If the line flaws are moving up on the Cylinder Tested Map as the head moves down the cylinder, you must increase the count. The opposite holds true if the line of flaws are moving down.

d. If it is a large movement, increase by a hundredth of an inch.e. If it is a small amount, use thousandths place to correct. See Example in Table below.

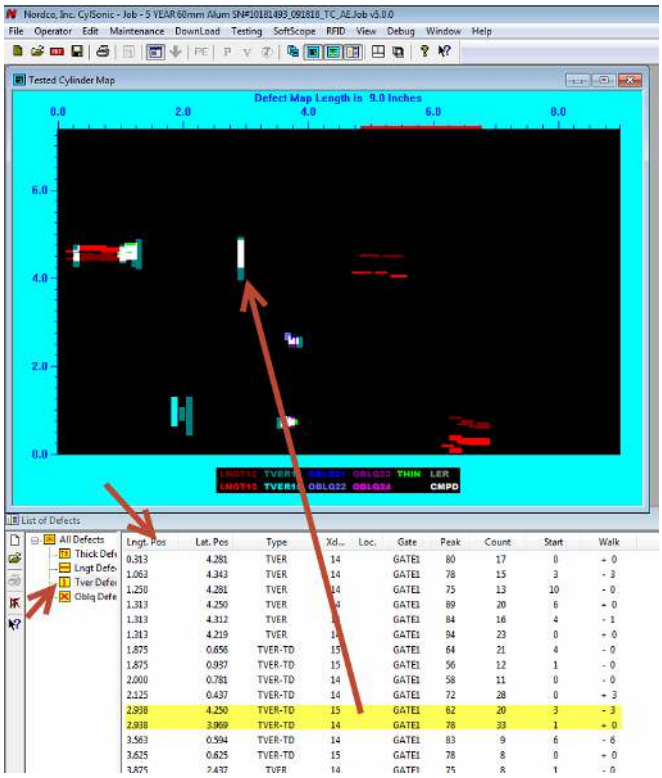




9. Rerun the calibration by selecting cycle start. A successful calibration will not provide any pop ups and all required defects will be displayed on Tested Cylinder Map visually and the details are shown in the List of Defects menu------→ Defect List tab. It is recommended that you verify the results against the calibration standard certificate for the calibration standard and job being used.



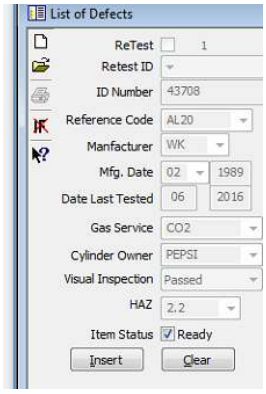
10. Defect List can be sorted to display all defects or defect by channel or type. For example to look at the second transverse defect, select Tver Defects in Defect List Tab then sort by Lngt Pos.



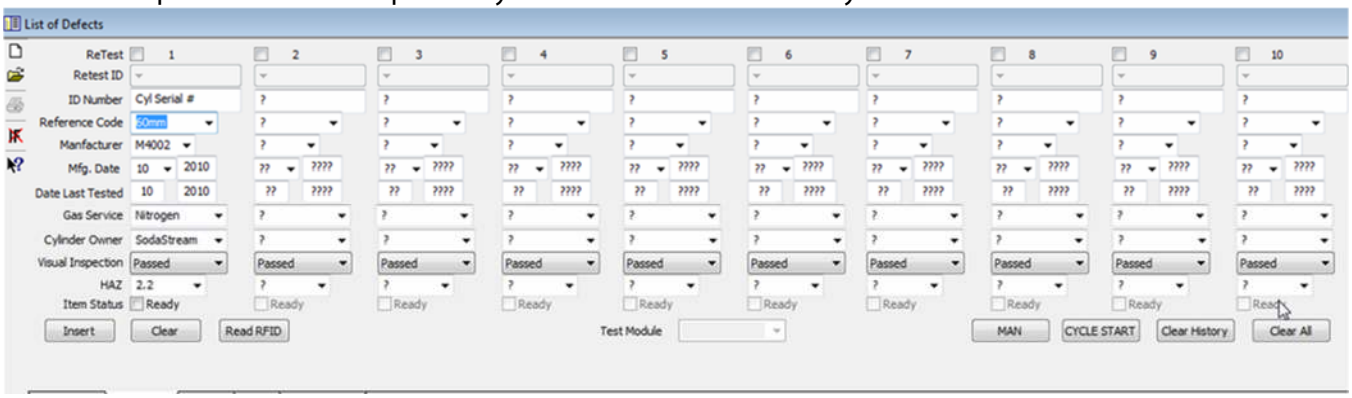
4.3.3 Production

1. Select Production Mode Icon from Menu.

Note: If the next cylinder to be tested in the Cyl Data Tab of the Defect List menu is ready, the system will automatically switch to Production mode after a successful Calibration. The below pop up message will confirm the switch.

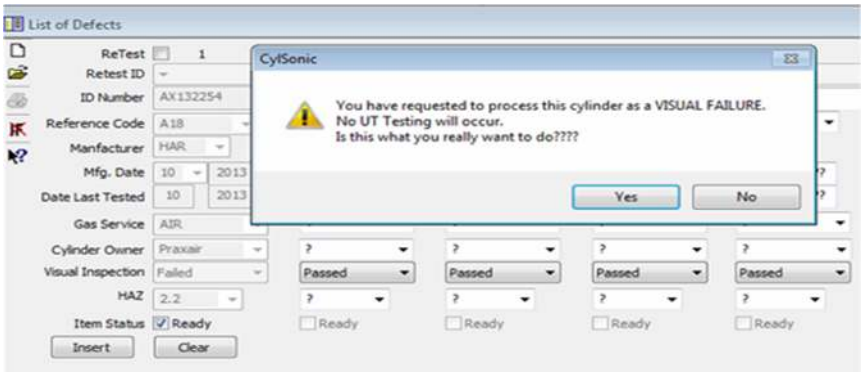


2. Enter Cylinder Data for cylinder to be test. Complete visual inspection in accordance with applicable standards. Operator can enter up to 10 cylinders to be tested in the Cyl Data Tab.



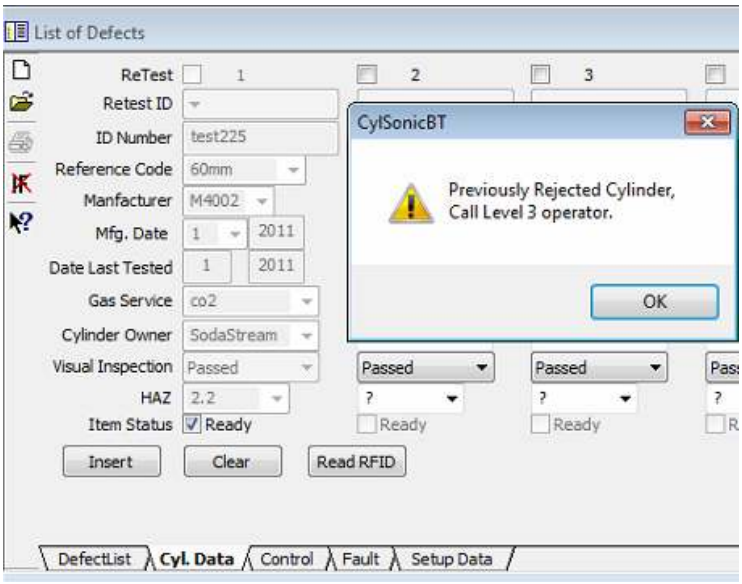
   a. Required fields are:
      i. ID # which is the serial # of the cylinder
      ii. Reference code corresponding to the cylinder specification, service pressure, dimensions of the cylinder to be tested. See CylSonicPreTable for reference.
      iii. Cylinder Manufacturer either the Name for order cylinders or the M # as assigned by the DOT
      iv. Cylinder Manufacturer Date
      v. Last Tested Date
      vi. Gas Service cylinder is currently in
      vii. Cylinder Owner

viii. Visual Inspection results-System will visually fail a cylinder if it is set to fail. It will not run a test but record the results in shift data.



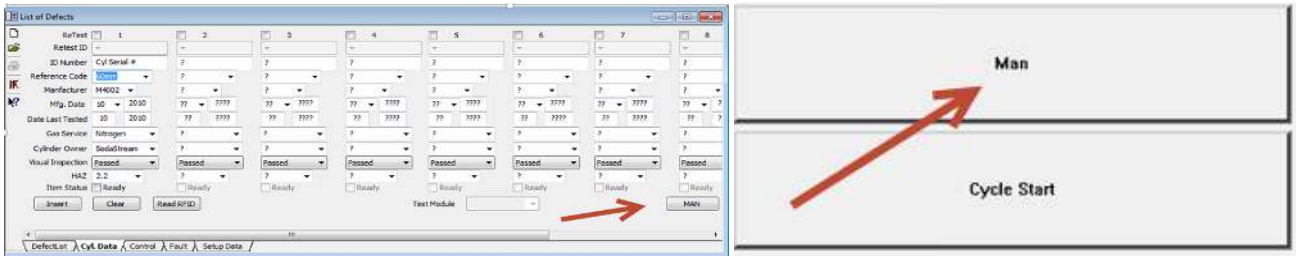
ix. Ready the cylinder for test by clicking on the Item Status.

b. If for any reason you try to rerun a cylinder that has previously been failed, you will get the following popup message.



3. Place the cylinder on the test table ensuring that the cylinder is touching the Stop Wheel. Then click Cycle Start from the Cyl Data or Control Tab start to test. Data Entry can continue while the cylinder is running.
4. **Note: If the test needs to be stopped in emergency the operator can:**
   a. Depress the Emergency stop switch mounted on the left side of the test frame.

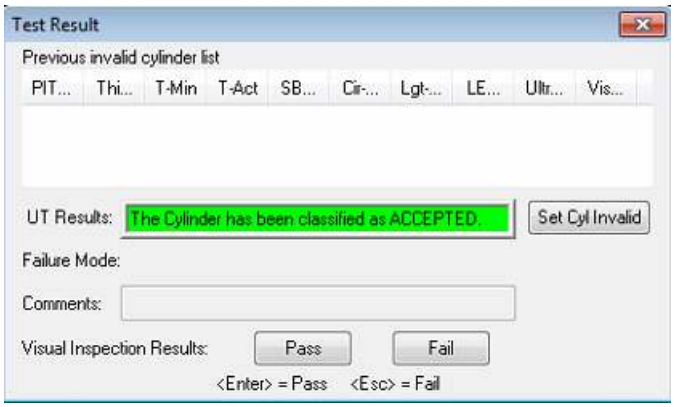
b. Click Manual on Man in either the Cyl Data or Control Tab for the List of Defect



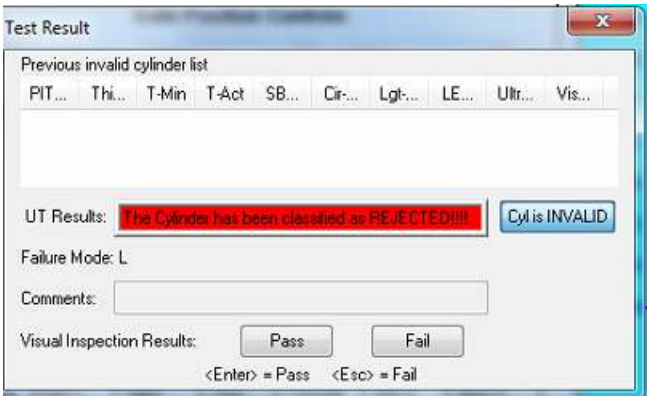
This will stop the water and rollers and lift the RSU straight Up. To reset if the emergency button has been pressed, turn emergency top button to the left and push the reset button which should turn green both on the button and on the lower screen of testing unit ESTOP ok. You will get a pop up stating that "Electronics have been reset".

Then you must send the head home by clicking Man on Control Tab if not already done, then Setup. Once the RSU is set back up on the Home Switch, Select Semi to start testing again. Depending on the stopping method used, you may need to open Job file again and repeate system verification. If gain parameters are the same or known, testing can continue. If changed and unknown, Operators must retest all cylinder processed since the last sucessful calibration out.

5. At the end scan, the Test Results pop up window will display the disposition of the cylinder.
   a. If passed, no relevant defects were found in accordance with the job parameters and the UT Results will be in green. To accept the operator must confirm the Visual Inspections Results by clicking PASS or Enter. The cylinder must then be placed into quarantine awaiting successful calibration out prior to release to production.



b. If for any reason the operator must retest the cylinder, they can set the cylinder invalid up to 3 times prior to required final disposition (Pass or Fail) by clicking on Set Cyl Invalid. An example for using this feature when test results pass: the operator realized that he placed the wrong production cylinder on the test table, requiring it to be rerun with the correct serial # or the production start or end of test did not ensure 100 % scanning of the sidewall.

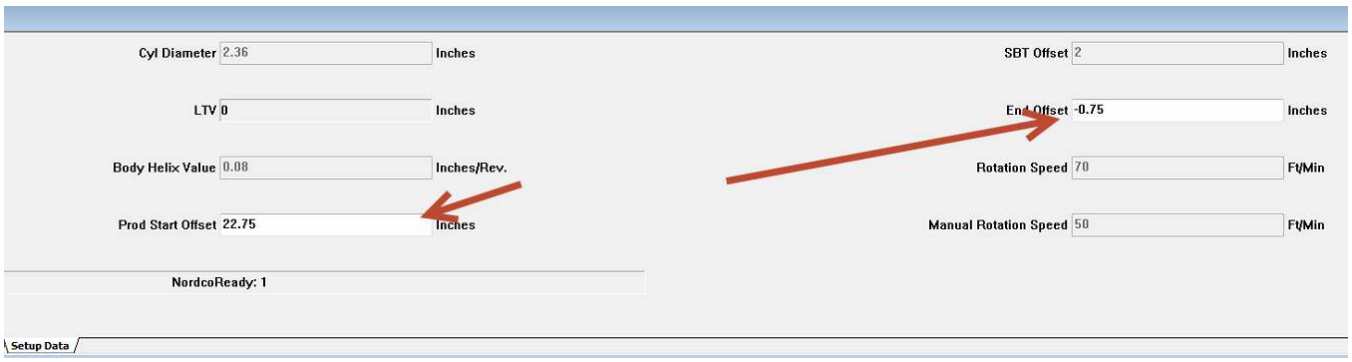


c. If failed meaning a relevant defect was found in accordance with the job parameters and the UT results will be red and the Failure Mode will be indicated showing which flaws were found. For details you can view in the Defect List tab in the List of Defects menu.

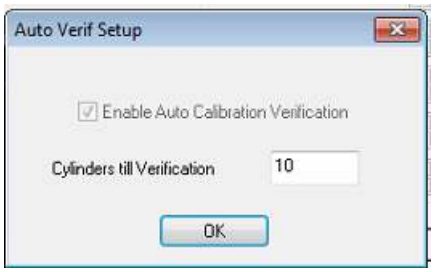
d. An operator can set the test result to invalid by clicking Set Cyl Invalid in order to attempt to lower the sensitivity of the tested while still passing calibration or address a false indication such as water or debris inside cylinder. The cylinder should be marked with relevant defect(s) and place into quarantine to be rerun later in the shift. Operator is still required to confirm Visual Inspection Results by clicking on Pass or hitting the enter key.

6. Remove the cylinder and continue testing.

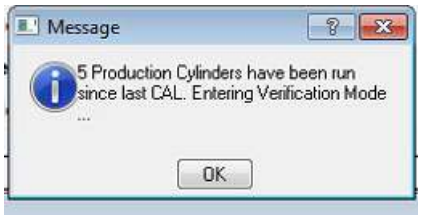
Not all cylinders with the same reference code are exactly alike so even though the operator selects the correct reference code he many need to start production sooner or run the test longer to ensure the scan plan is met. This method can be used also if the cylinder has the same specification and service pressure, and diameter but is just longer. Once the cylinder in question is placed onto the test table and the cylinder is ready in slot #1 of the Cyl Data Tab, the operator can adjust test length by selecting the Setup Data Tab and adjusting the Prod Start (inches from home RSU Travels Prior to set down) or End Offset (inches up from Stop the cylinder stops test). This should be done only by an experienced and certified operator.



Typically the calibration cylinder will need to be verified after the number of tests as set up in the unit software. This number is usually set at 10 on a bench top unit.



In this example the number above is set a 5. After the 5 cylinders in production are run, the system will notify via Pop up, that a verification is required and switch to Verification mode after clicking on OK.

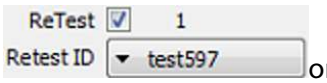


At the end of shift regardless of the number of cylinder test or prior to testing another cylinder specification that requires another job and calibration cylinder, the operator should run verification by selecting verification mode.

1. Place calibration cylinder onto test table
2. If calibration passes, the operator shall release cylinder from quarantine awaiting successful calibration out to be marked in accordance with national authority regulations and continue with the process or end shift.
3. Systems with later versions for CylSonic software may allow retry of a failed calibration as stipulated by oversight. System will not allow changes to any system parameters. If this function is available and enabled by responsible Level III overseeing the company's testing and a calibration passes as specified is achieved, production will be valid.

4. If calibration does not pass, the system will mark all cylinders tested since the last successful calibration as invalid and they will need to be retest. This also includes any cylinders that were invalidated after a relevant indication was noted by the system.

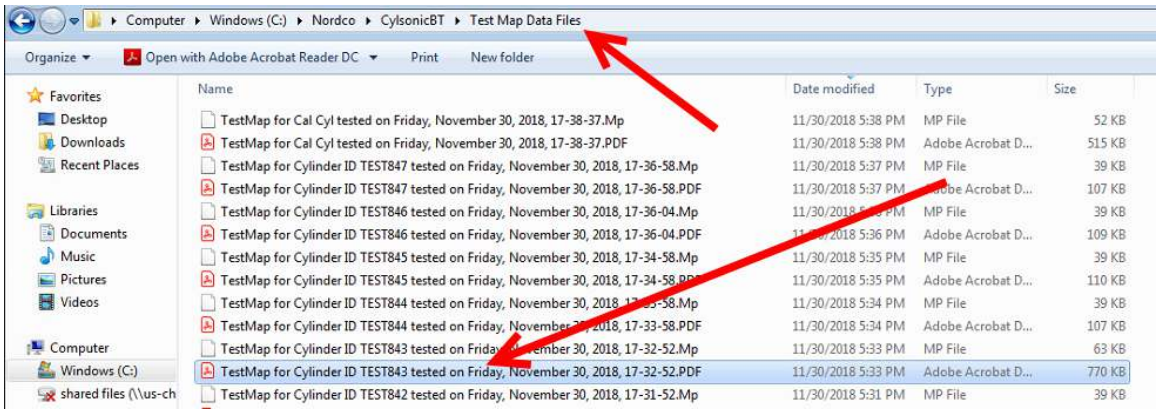
   Since the cylinder information has already been entered into the system, the operator can pull up the cylinder data by selecting the serial number from the drop down by checking ReTest



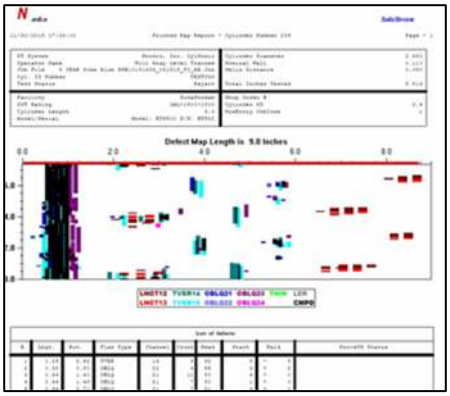
on the Cyl. Data Tab. The system will not count invalids produced by missing calibration against the allowable quantity of 3 invalid test per cylinder. Ensure calibration is achieved and reviewed (See 4.4.2) prior to retesting.

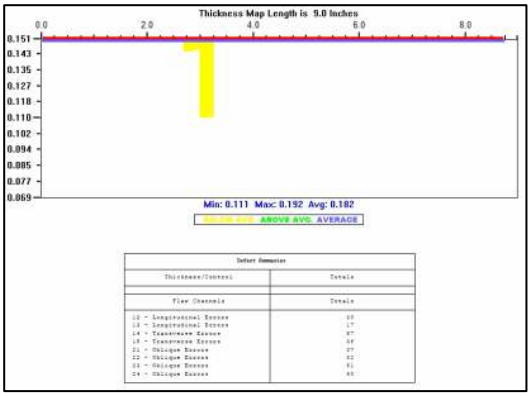
4.3.3.1 Processing Invalids:

1. Cylinders that have been set invalid in the system due to relevant indications, must be retested.
2. Cylinder Condition: Depending on the indication and cylinder condition, the operator must take appropriate action to address the physical condition of the cylinder that may cause a false indication such as label, paint, water in the cylinder etc. If by taking the appropriate action, the cause of the invalid is not seen in the retesting of the cylinder and all other conditions are the same, we know the indication was false. Such actions include but are not limited to:
    a. Blasting to remove paint and rust
    b. Removing labels
    c. Internal washing of cylinders
    d. Internal blasting
3. Sensitivity of UE System: Depending on the indication and the cylinder condition, the operator may need to adjust the sensitivity of the unit set up at calibrations. Many times during normal operations, the unit is running by default at a higher sensitivity that needed. If during normal operations, the invalids are manageable, then running higher sensitivity ensure calibrations pass consistently. During invalid processing the operator should a) identify which set of transducers triggered the relevant indication. This can be done by pulling up the PDF version (.mp files are meant to be opened in the software) of the cylinder test map from the following menu path: C:\Nordco\CylsonicBT\Test Map Data Files

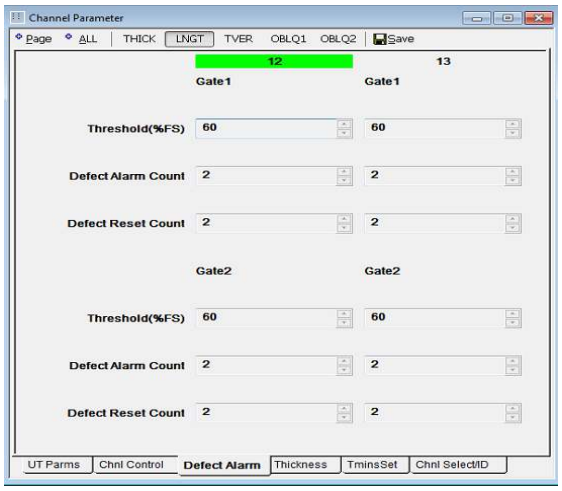


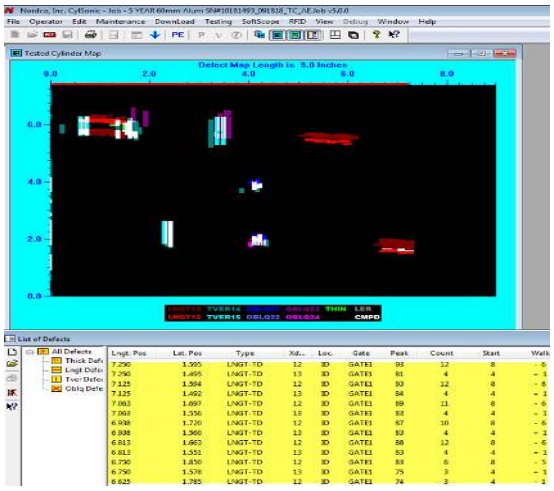
4. The cylinder should be marked with the indication type (thickness, Pit, etc.) from the previous test(s) but operator can find details in the test by selecting cylinder serial number in the test map folder and opening it. In this case, Test843 was the calibration cylinder. The Test Map will have the Cylinder Test Map, Cylinder Thickness, the list of relevant defects found and a Defect Summary.



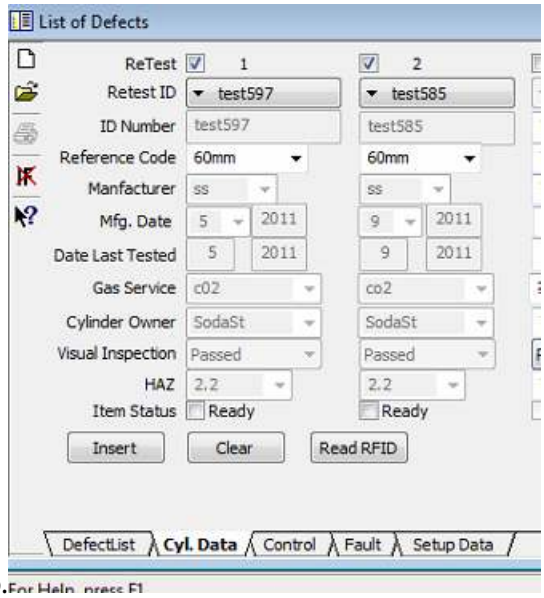


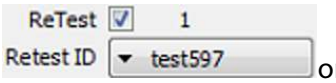
5. Recalibrate the unit and review the FSH and the Counts for the transducer(s) of the relevant indication. In this example we will look at Longitudinal channels 12/13 indication vs their Alarm Threshold and Counts as set on the Defect Alarm Tab of Channel Parameters Menu. The Threshold is 60 % Full Screen and alarm count 2. Actual reading from calibration are upper 80's to lower 90's with counts of up to 12. You can see that most of the higher FS and Alarm counts are on channel 12. In this case rerun the calibration with a 3db lower gain on both 12/13 and continue to lower until Alarm counts are 3-4 and FS is 65-75 db.





6. Longitudinal Threshold as set on Defect Alarm Tab of Channel Parameters Menu is a Threshold of 60 % Full Screen and alarm count 2. Actual reading from calibration is upper 80's to lower 90's with counts of up to 12. You can see that most of the higher FS and Alarm counts are on channel 12. In this case it is recommended to rerun the calibration with a 3db lower gain on both 12/13 and continue to lower until Alarm counts are 3-4 and FS is 65-75 db.
7. After lowering the gain and successful calibration rerun the invalid cylinder. Since the cylinder information has already been entered into the system, the operator can pull up the cylinder data by selecting the serial number from the drop down by checking ReTest





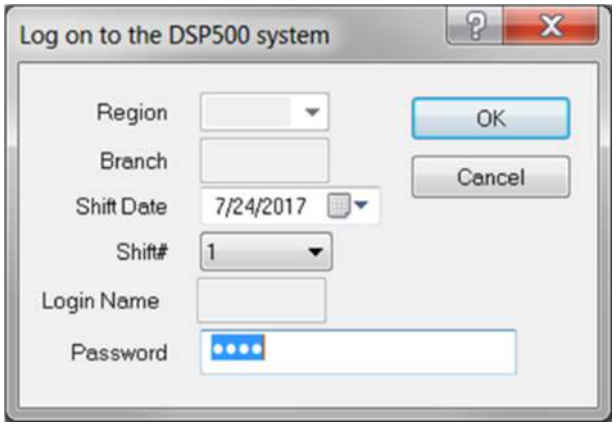
on the Cyl. Data Tab.

8. If it passes, release cylinder after successful calibrations. If not, continue to lower sensitivity or address physical condition on cylinder in order to pass.

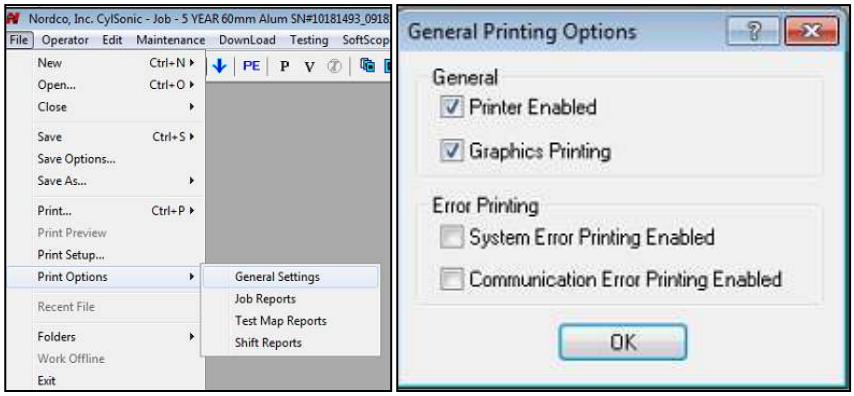
4.3.4 Shift Report Printing.

After the completion of testing for that day/shift and depending on the procedure followed for record keeping, the operator should print, review then sign a shift report. Level of Certification to sign off on test results depends on the standard implemented and the national authority but typically a Level II UE operator is required. Best operating practice suggest you have one over one signatures from a supervisor or another Level II operator and the shift report is formatted like this.

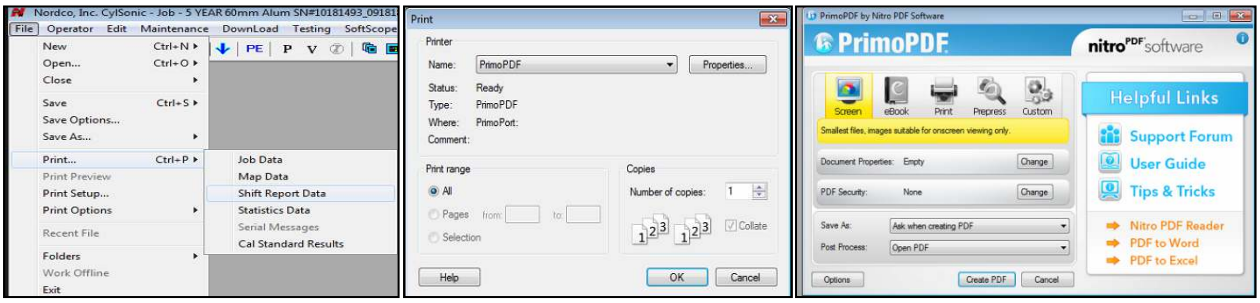
A shift report is created for the date and the shift entered at login to the unit.



1. From the file menu select Printer Options→ General Setting→Enable printing.



2. Nordco installed PrimoPDF (prior to Win 10 print to pdf function) for customers who would like to print shift reports to a PDF document and retain electronically but can also print directly to printer. From File menu select Print→Shift Report Data→Printer ID or PDF



3. Review shift report for accuracy, sign and file according to requirements of national authority and implemented standards.

Nordco

SodaStream

2018/12/03 11:25:13

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CYLINDER TESTING RECORD

Facility: SodaStream REGION: BF BRANCH: 01
TEST OPERATOR: Will Gray Level Trainee
DATE OF TEST: 2018/11/30

Disposition Codes: P=Passed,F=Failed,C=Cal.,I=Invalid
Failure Mode Codes: P=Pit,C=Circ,L=Long,T=Thin,S=SBT,Z=LER

Time Tested	Op. Name	Cylinder Number	Cylinder OD	Cylinder Length	Svc Gas	Cylinder Mfg.	Cylinder Date	Type/ Rating	Owner	Disp U/V	Failure Mode	TMin	TAct
13:43	Will Gray Level Traine	10181493	2.4	9.0			/	3AL-1800-1800		C/P			
13:44	Will Gray Level Traine	test701	2.4	9.0	c02	ss	1/2011	3AL-1800-1800	SodaSt	P/P			
13:45	Will Gray Level Traine	TEST702	2.4	9.0	c02	M4002	1/2012	3AL-1800-1800	SodaSt	P/P			
13:46	Will Gray Level Traine	TEST703	2.4	9.0	c02	ss	1/2013	3AL-1800-1800	SodaSt	P/P			
13:47	Will Gray Level Traine	TEST705	2.4	9.0	c02	ss	1/2014	3AL-1800-1800	SodaSt	F/P	T	0.106	0.101
13:49	Will Gray Level Traine	TEST706	2.4	9.0	c02	ss	1/2015	3AL-1800-1800	SodaSt	F/P	P,C,L		
13:53	Will Gray Level Traine	TEST707	2.4	9.0	c02	ss	1/2016	3AL-1800-1800	SodaSt	I/F	Z		
13:56	Will Gray Level Traine	TEST708	2.4	9.0	c02	ss	1/2017	3AL-1800-1800	SodaSt	P/P			
13:58	Will Gray Level Traine	TEST709	2.4	9.0	c02	ss	1/2010	3AL-1800-1800	SodaSt	P/P			
13:59	Will Gray Level Traine	TEST710	2.4	9.0	c02	ss	1/2009	3AL-1800-1800	SodaSt	P/P			
14:00	Will Gray Level Traine	TEST711	2.4	9.0	c02	ss	3/2009	3AL-1800-1800	SodaSt	P/P			
14:03	Will Gray Level Traine	10181493	2.4	9.0			/	3AL-1800-1800		C/P			
14:05	Will Gray Level Traine	TEST712	2.4	9.0	c02	ss	3/2010	3AL-1800-1800	SodaSt	P/P			
14:06	Will Gray Level Traine	TEST713	2.4	9.0	c02	ss	3/2011	3AL-1800-1800	SodaSt	P/P			
14:07	Will Gray Level Traine	TEST714	2.4	9.0	c02	ss	10/2011	3AL-1800-1800	SodaSt	P/P			
14:09	Will Gray Level Traine	TEST715	2.4	9.0	c02	ss	1/2014	3AL-1800-1800	SodaSt	P/P			
14:12	Will Gray Level Traine	TEST716	2.4	9.0	c02	ss	1/2011	3AL-1800-1800	SodaSt	I/P			
14:14	Will Gray Level Traine	TEST717	2.4	9.0	c02	ss	1/2011	3AL-1800-1800	SodaSt	P/P			
14:16	Will Gray Level Traine	TEST718	2.4	9.0	c02	ss	11/2011	3AL-1800-1800	SodaSt	P/P			
14:19	Will Gray Level Traine	TEST719	2.4	9.0	c02	ss	5/2011	3AL-1800-1800	SodaSt	P/P			
14:20	Will Gray Level Traine	TEST716	2.4	9.0	c02	ss	1/2011	3AL-1800-1800	SodaSt	P/P			
14:25	Will Gray Level Traine	TEST719	2.4	9.0	c02	ss	1/2012	3AL-1800-1800	SodaSt	P/P			
14:26	Will Gray Level Traine	10181493	2.4	9.0			/	3AL-1800-1800		C/P			
14:28	Will Gray Level Traine	TEST720	2.4	9.0	c02	ss	1/2012	3AL-1800-1800	SodaSt	P/P			
14:30	Will Gray Level Traine	TEST721	2.4	9.0	c02	ss	2/2010	3AL-1800-1800	SodaSt	P/P			
14:32	Will Gray Level Traine	tEST722	2.4	9.0	c02	ss	12/2011	3AL-1800-1800	SodaSt	P/P			

Nordco, Inc. CylSonic Ultrasonic Cylinder Inspection System Model: RTS500 S/N: BTU32

Transducer	Frequency	Size	Manufacturer	Transducer	Frequency	Size	Manufacturer
Thickness	5.0 Mhz	1/2 in dia	Nordco, Inc.	Transversal	3.5 Mhz	5/8 in dia	Nordco, Inc.
Longitudinal	3.5 Mhz	5/8 in dia	Nordco, Inc.	Oblique	2.25 Mhz	5/8 in dia	Nordco, Inc.

OPERATOR SIGNATURE: _____ CERT LEVEL: _____ DATED: _____

I hereby certify that all the above tests were made under my supervisor and in accordance with DOT/TC regulations.

SUPERVISOR SIGNATURE: _____ CERT LEVEL: _____ DATED: _____

4. Prior to login out for next shift or shutting down for the day, disable printer by deselecting print enabled from the Print Options→General Setting.

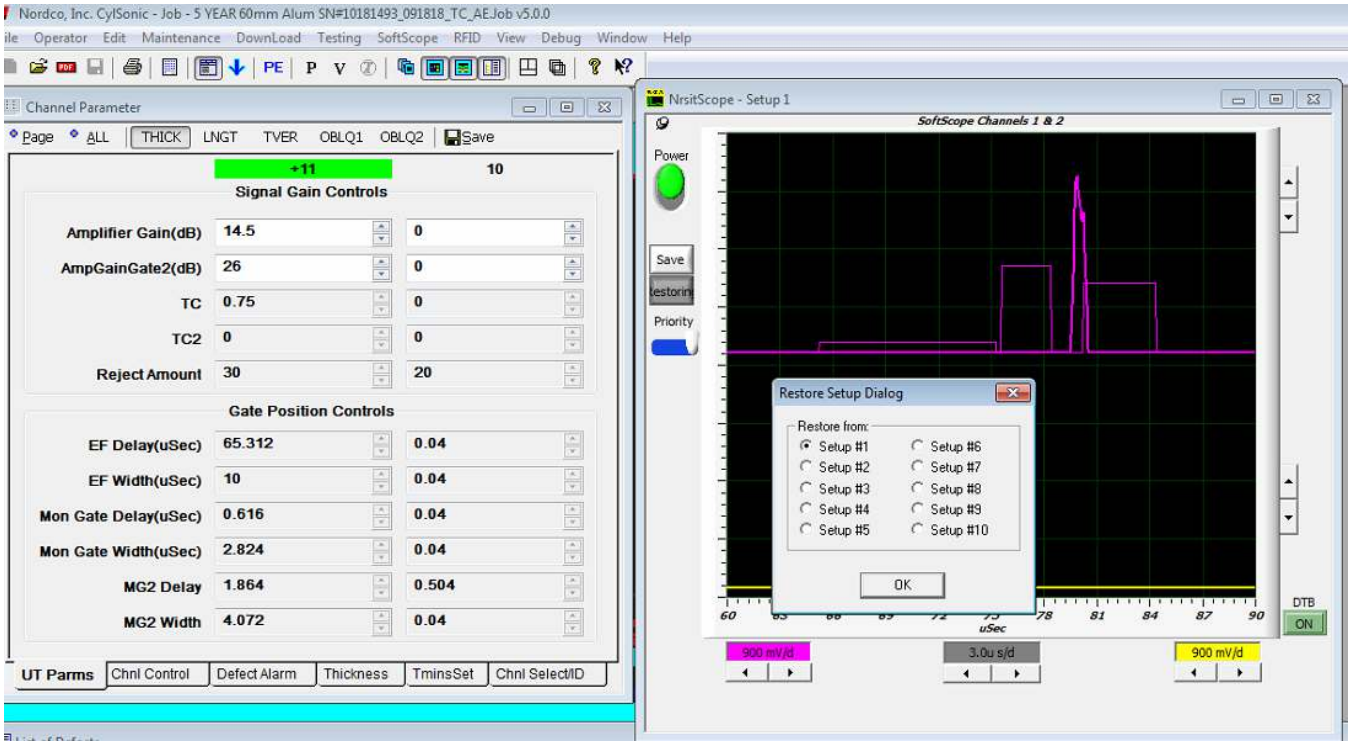
Warning: If not disabled, each test map will print automatically after running a production or verification on the unit.

4.4 Probe Wheel Zeroing Procedure

This probe wheel zeroing procedure only applies to systems that use the Nordco wheel probe(s) as the sensor housing. Self-aligning shoes, etc. do not require zeroing.

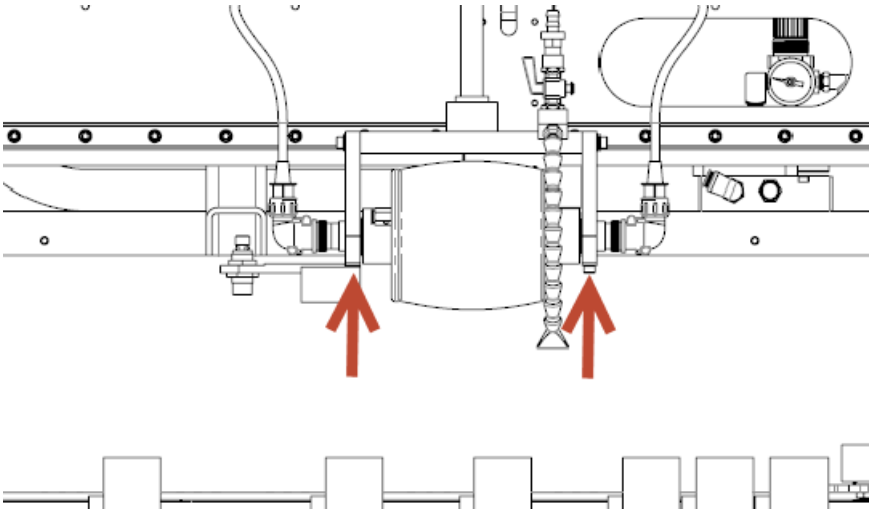
IMPORTANT: Verify that all mechanical adjustments on the test head are properly set. Perform the following steps to zero the wheel:

1. Start Up and Login as normal. Open A scan by selecting SoftScope→ Open→ Toggle Power to On. Select Thick Transducer in Channel Parameter to display a scan for transducer 11. Typically Thickness Channel SoftScope display settings can be Restored from Setup#1.
    a. Note: To display gates and threshold in softscope, you may need to click on another channel and back onto Thick Channel Parameter to bring up proper channel view on softscope.
    b. You can pin the softscope menu to stay open by selecting the push pin symbol on top right of NRISTSCOPE menu

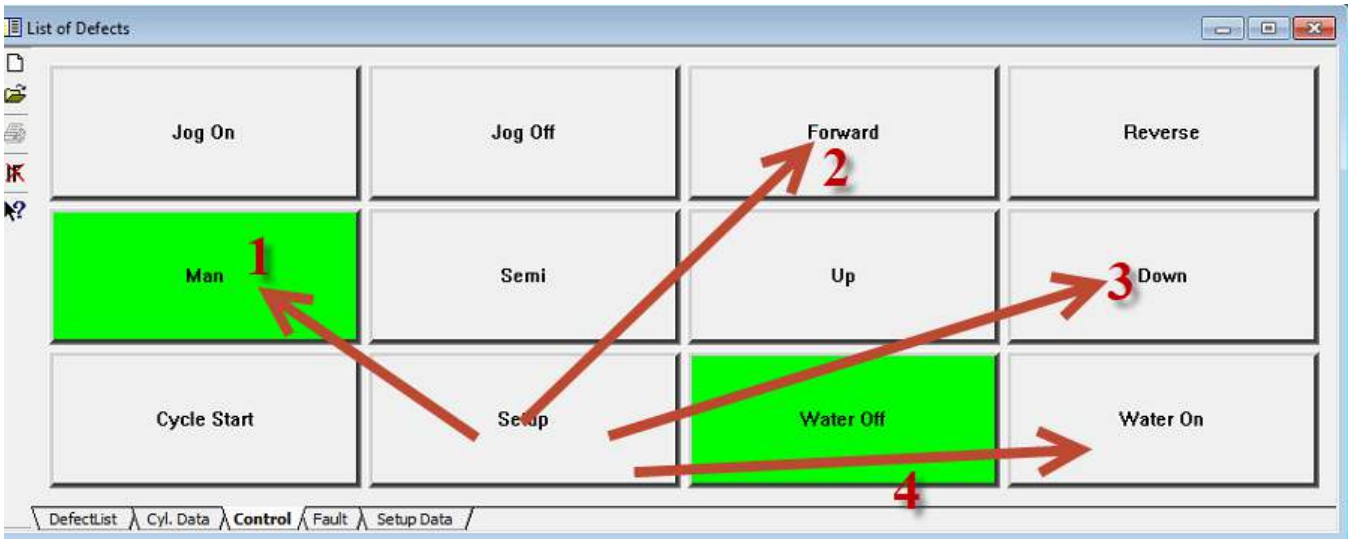


2. Loosen the wheel probe bracket just enough so that the wheel can be turned freely yet is still secure and has a resistance.

NOTE: Be careful not to loosen the wheel axle from the wheel flange. Align the transducer by eye as close to vertical to the shell's surface as possible.

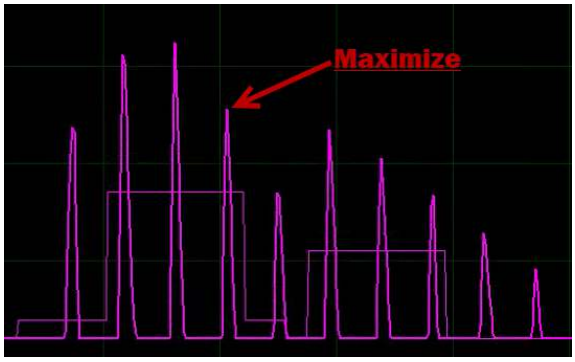


3. With the calibration cylinder on the test table, place the RSU onto the spot on the smallest diameter calibration cylinder for that unit. In the Control Tab of the List of Defect Menu, move the RSU but selecting MAN, then move the RSU forward and placing it Down, then Water On. Make sure the wheel is not on a flaw to peak the back wall thickness signal and that it has ample couplant beneath it. This can be done by Clicking on 1-Man in the Control Tab, clicking 2-forward until the RSU is over the spot to peak, then clicking 3-down and 4-water on.



4. Using Channel Parameters, Turn down Gain for Gate 1 on thickness channel 11 to 50-80% FSH so that you can see the peak maximize in the zero position (software does not display peaks over 100% even though it may actually be higher). Using a wrench, rotate the wheel back and forth to find the maximum back-wall signal, and leave it positioned at the maximum.

NOTES:
*1) **DO NOT** grip cable connector to rotate axle.*
*2) **DO NOT** rotate axle beyond the range which the cable connector will allow.*



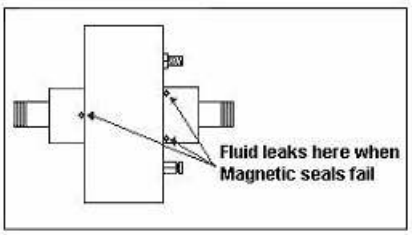
5. Prior to raising the RSU, tighten the wheel brackets, making sure that the amplitude of the back wall signals does not decrease. If it decreases, go back to step 4, re-loosening wheel brackets only if necessary. After Securing, return the RSU to home be selecting Setup in Control Tab.

4.5 Preventive Maintenance

The DSP500 system requires little in the way of maintenance for the electronics system. Maintenance procedures associated with the mechanical components are listed as following.

4.5.1 Daily Inspection

1. Check motor couplings
2. Check encoder couplings
3. Ensure that the air gauge on the main LP regulator is pressurized to 80 psi.
4. Check the air gauge on regulator to ensure it reads 9 psi + 1 psi during operation.
5. Ensure that RSU is properly pressurized to 3.75 psi with no bubbles visible or damage to membrane.
6. Ensure magnetic seals are not failing by inspecting weep holes to make sure they are free of probe fluid.



7. Ensure water is clean and free of debris and couplant is flowing properly.

4.5.2 Monthly Inspection

1. Grease "zerk" fittings located at the following areas:
    a. Cylinder driven rotation shaft, 2 each
    b. Cylinder idler rotation shaft, 2 each
    c. Carriage horizontal track (on carriage), 2 each
    d. Carriage screw, 2 each
2. Ensure the helix drive shaft is lightly spotted with WD40 or light tool oil.
3. Check the water couplant drain for any suspected stoppage.
4. Recommended to drain and replace couplant water. This may need to be done more frequently if environmental conditions are less clean or with high throughput of cylinders tested.
5. Check calibration cylinders for moisture.
6. Check Probe Membrane for cracking, wear, and distention (recommended replacement 3-6 months depending on use and conditions).

4.5.3 Annual Inspection

Nordco recommends an annual full system functionality check (aka Annual Calibration). This check includes a number of system tests and calibrations including Gain Control Accuracy.

Nordco recommends that data required by national authority is backed up to a separate storage location.

4.5.4 Three (3) Year Inspection

1) Nordco recommends evaluation of test table pillow block bearings, shafts and wheels.
2) Nordco recommends RSU maintenance performed:
    1. By transducer replacement
    2. By verification of transducer performance
    3. By RSU exchange program

4.5.5 Roller Bed Alignment

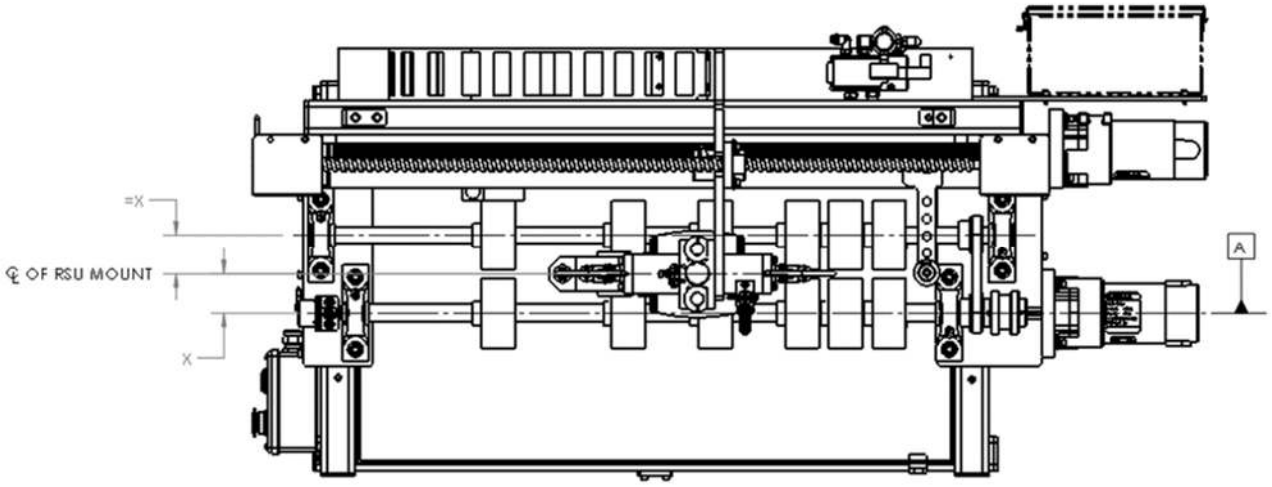
The roller bed must be aligned to the RSU any time the rollers, roller shafts or bearings are replaced.

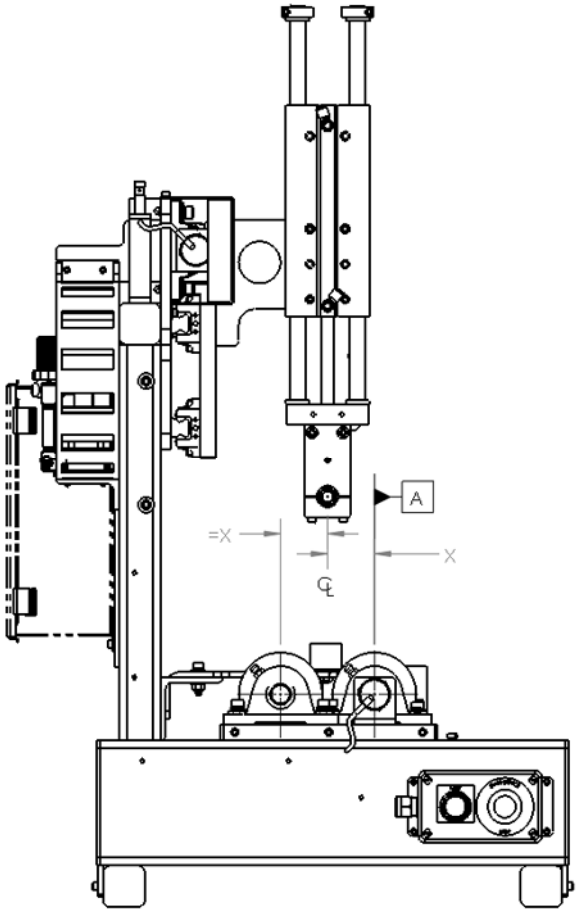
The procedure below should be used for alignment.

1. Install drive belt on drive shaft.
2. Install drive shaft with and align with motor with motor coupling. (*Leave pillow block fasteners loose*)
3. Move the RSU head to the motor end of the roller bed.
4. Using a plumb line hanging from the RSU mounting hole find the dimension "x" from the drive shaft area closes to the motor to the center of the RSU mount.
5. Move the RSU head to the encoder end of the roller bed.
6. Using a plumb line hanging from the RSU mounting hole set the dimension "x" from the drive shaft area closes to the encoder to the center of the RSU mount.
7. Tighten drive shaft bearing pillow block screws and double check all dimensions.
8. Mount drive belt on idler shaft pulley.
9. Install idler shaft and align parallel with drive shaft. (Leave pillow block fasters loose)
10. With the RSU head at the encoder end of the roller bed.

11. Using a plumb line hanging from the RSU mounting hole set the dimension “x” from the idler shaft area closes to the encoder to the center of the RSU mount.
12. Move the RSU head to the motor end of the roller bed.
13. Using a plumb line hanging from the RSU mounting hole set the dimension “x” from the idler shaft area closes to the motor to the center of the RSU mount.

14. Tighten idler bearing pillow block screws and double check all dimensions.





4.6 Testing DSP500 System Hardware Components

Testing the hardware components of the DSP500 system is mainly a matter of running the system verification tests that are designed to automatically detect and locate the majority of system hardware failures. If the built-in self-test fails, a problem with the hardware components should be suspected.

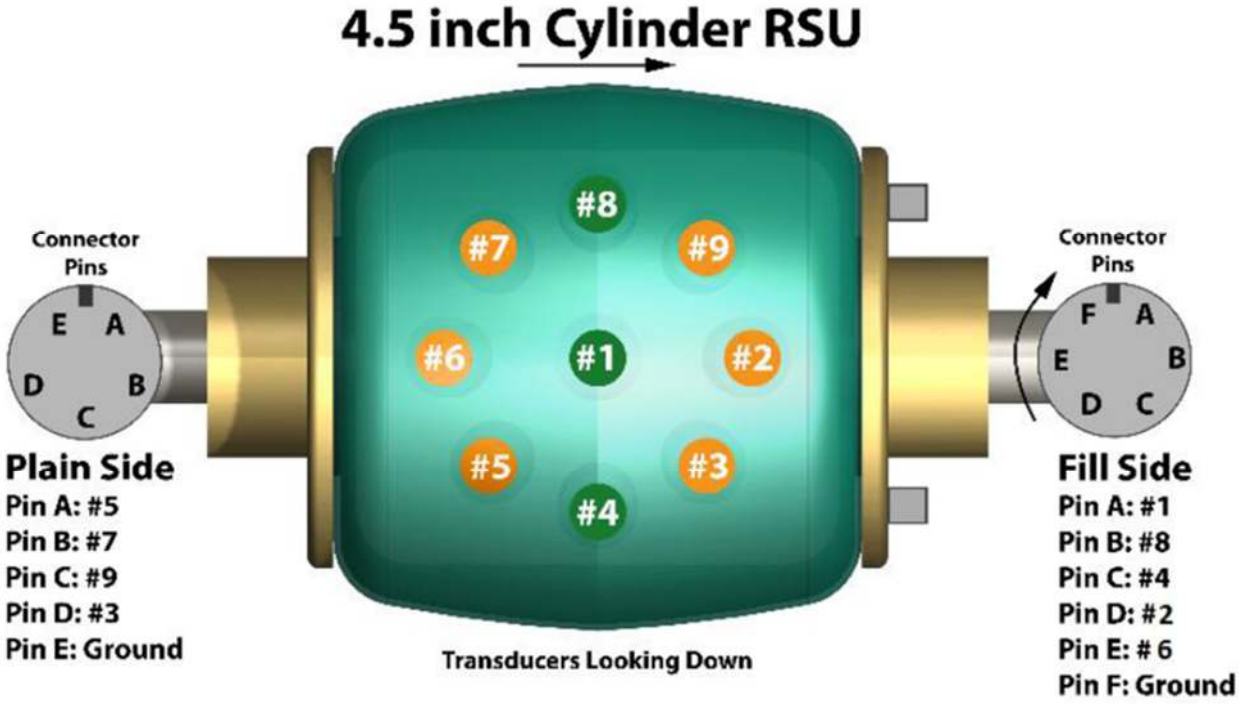
5 Customer Service & Spare Parts

All available parts can be found in the Cyl-Sonic Micro Parts Book PB-0003

1000259 - ASSY, RSU 4.5IN, CYL MICRO, 9CH

The Micro 9 channel wheel is equipped with the following transducers:

#1	Thickness	5 MHz-S
#8, #4	Longitudinal	5 MHz-L
#2, #6	Transversal	3.5 MHz
#5, #7, #9, #3	Oblique	3.5 MHz



ITEM NO.	PART NO.	DESCRIPTION	QTY.
1	4003001	MEMBRANE, BT WHEEL, TH-309	1
2	1000961	FLUID, WHEEL, CLEAR, 1 GL	1
3	8001570	O-RING, # 338 BUNA N, SMALL	2
4	1103640	SCREW, 100 PACK, CSCS 6-32 X 0.5IN, BRASS	1

6 Technical Data

More in-depth information can be found in the software on line help.

7 Appendices

7.1 Mechanical Drawings

1102504 ASSY, CYLSONIC MICRO FRAME

7.2 Electrical Drawings

E-DWG-0018 ELECTRICAL SCHEMATICS, CYLSONIC MICRO
E-DWG-0019 SYSTEM DIAGRAM, CYLSONIC MICRO

7.3 References

Verification and Gain Adjustment Manual