

ATHENA INDUSTRIAL SERVICES

ECHO-3D OPERATOR MANUAL

ECHO-3D®

ASSET PROTECTION TECHNOLOGY



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Warranty

Athena Industrial Services Inc. (AIS) warrants the ECHO-3D® Sensor and Encoder Assembly to be free from defects related to materials and workmanship for a period of one (1) year from the date of shipment by AIS.

This warranty is limited to only ECHO-3D Sensor and Encoder Assemblies which have been operated in the manner described in this operation manual and has not been subjected to unwarranted mishandling, unauthorized repair, or modification.

AIS shall either repair or replace a defective sensor and encoder, at the option of AIS, during the warranty period.

AIS does not warrant the ECHO-3D Sensor and Encoder Assembly to be suitable for any intended use, or for any particular application or purpose.

AIS accepts no liability for consequential or incidental damages related to the use of the ECHO-3D Sensor and Encoder Assembly, including any damage to property or personal injury.

The Dell Latitude 12 Rugged Tablet shall be warrantied under the Dell warranty located in the tablets manual.

The customer shall advise AIS of any warranty claim in writing and will ship the ECHO-3D Sensor and Encoder Assembly, at its own expense, to the AIS facility for warranty repair or replacement. AIS shall ship back to the customer the repaired or replaced ECHO-3D Sensor and Encoder Assembly at no additional cost.

With respect to any other additional equipment not specified under this warranty, the customer shall be responsible for the cost of shipping any such additional equipment both to and from the AIS facility.

1. Introduction

This document has been written as a compliment to the ECHO-3D® Operator Training provided by Athena Industrial Services Inc. It is intended to help the operator of the ECHO-3D system and associated personnel perform the typical functions required for the detection, analysis, and reporting of surface breaking defects. This manual describes the operating techniques used when Sensors with firmware V1.12 or later are being used. This document does not cover Advanced or Distributor Mode operations which is only available to authorized personnel.

This current version of the ECHO-3D Sensor is a Beta version, known as Generation II (Gen II) and of limited production. The purpose of this is to expose the industry to the technology and concurrently solicit feedback and suggestions from the selected initial user base, resulting in further development leading to a Generation III sensor with expanded capability and broadened configurability.

Although the utmost effort has been undertaken to provide a clear, precise, and correct information, errors and omissions may have occurred. Feedback and suggestions are welcome and should be addressed to our general e-mail address info@athenaindustrial.com.

This manual does not include information regarding the operation of the Dell™ Latitude 12 Rugged Tablet nor the Microsoft® Windows® 10 Pro operating system. For information on operating the Tablet, please reference the latest version of Dell Latitude 12 Rugged Tablet-7202 User's Guide. This manual, and other additional accessories, are available from Athena Industrial Services or www.dell.com.

The manual has been divided into sections based on the software and operating techniques. Software sections follow the complete process from start to finish, and consequently, may seem to be very repetitive.

To aid in determining the source of text the following protocol is adhered to:

- Software titles and icon names are displayed in **Arial Black** font;
- Windows dropdown menu inputs are displayed in Arial font; and
- Keyboard inputs are displayed in Bookman Old Style font.

A Quick Start Guide is also included in the ECHO-3D kit and is a companion to this manual.

Terminology used within the manual is defined in Appendix A – Terminology.

For best results Athena recommends that only Athena trained personnel attempt to operate the ECHO-3D system to perform inspection processes.

2. Principles of Operation

ECHO-3D is an Electro-Magnetic Field (EMF) based technology that uses Electro-Magnetic Field Imaging (EMFI) to display surface breaking defects in a three-dimensional image. That is, akin to Magnetic Particle Inspection (MT), the ECHO-3D sensor creates a magnetic field. The EMF is created by an exciter coil and shaped by a focusing element which creates a hemi-elliptical toroidal field (greater than 30 mm) below the Sensor. The EMF shape is measured by two layers of eight equally-spaced specially-shaped antenna coils resulting in sixteen Transceiver Channels.

The EMF is effected by the following:

- Proximity to an electrically conductive material;
- The electric conductivity of the material;
- The magnetic permeability of the material; and
- The geometry of the material.

The ECHO-3D Sensor can cancel out these effects using Compensation before the scan is started. Two types of data are collected for each Transceiver Channel, being Amplitude and Phase. The ECHO-3D software triggers Shots to be taken at desired intervals and data is collected.

As the focused EMF from the Sensor passes over a surface breaking defect, such as a crack, stress corrosion cracking (SCC), or corrosion, the shape of the field is deformed. Unlike MT, the ECHO-3D Sensor measures the change in the shape of the field and converts this raw analog information to digital data for processing.

Unlike MT, the EMFI process works on any electric conducting material such as, but not limited to, 300 Series stainless steel, nickel alloys, superalloys, and aluminum; yet like MT, also works on ferromagnetic materials such as carbon steel. The ability to detect the change in the EMF is not greatly affected by lift-off (sensor distance from the sample surface) allowing the sensor to detect anomalies below cladding, paint, plastic or rubber linings, or insulation. Unlike MT, the sample is not left with a residual magnetic field and therefore does not require degaussing prior to return to service.

Like UT, the ECHO-3D can sense through a coating to detect a defect. Unlike UT, it does not require direct contact with the surface of the sample, nor does it require the use of a couplant.

Like PT, ECHO-3D detects surface breaking cracks. Unlike PT, the surface requires little preparation and results in a permanent electronic record of the data and report, leaving no residues to clean up.

The ECHO-3D system is designed to produce data samples known as Shots at regular intervals. Shots can be triggered by input received from the included Encoder or an ancillary X/Y-scanner. ECHO-3D software receives the digital data from the Sensor and processes it resulting in real-time B-Scan displaying defects depths.

When the Sensor is used to scan a region via multiple passes, either by hand or by mechanical encoded scanner, the software stitches the adjacent B-Scans and produces a C-Scan image in real-time. A combination of the B-Scan and C-Scan, which can be viewed and analyzed by ECHO-3D software, is utilized to determine the general positioning, orientation and severity of a defect including crack depths greater than 5 mm [$\frac{9}{16}$ "].

Protected Document Format (PDF) reports are generated with the ECHO-3D software and include details of: Inspection Company; Client details; Technician details; Sensor set-up; and Project details with defect locations, depths, and optional site photographs and screen shots.

3. ECHO-3D Components

ECHO-3D is available as a standard kit for pipeline inspection. The following describes the contents of the standard kit. Athena Industrial personnel can work with users to develop custom kit hardware and software for other applications.

3.1. ECHO-3D Kit

The ECHO-3D kit as supplied and shown below in Figure 1 contains the following equipment in a Model 1520 Pelican™ Protector™ Case:

- Model 1120 Pelican Small Case:
 - ECHO-3D Generation II Sensor
 - ECHO-X Detachable Single Axis Encoder with Interface Cable
 - USB to Sensor Interface Cable
- Sensor Shoe Kit:
 - ECHO-3D Sensor Centred Shoes (NPS 6, 8, 10, 12, 14, 16, 18, 20, 22, 24 and 30)

-
- ECHO-3D Sensor Offset Shoes (NPS 6, 8, 10, 12, 14, 16, 18, 20, 22, 24 and 30)
 - ECHO-3D Sensor Flat Shoe
 - ECHO-3D Sensor Jireh Lift-off Shoe
 - Sensor Wear Pads (Quantity 10)
 - Sensor Cleaning Brush
 - ECHO-3D Check Block
 - ECHO-3D Quick Start Guide
 - Dell Tablet Slipcase 14
 - Dell™ Latitude 12 Rugged Tablet with ECHO-3D Software
 - Dell Tablet 2-cell 26 W·h Lithium Ion Secondary Battery
 - Dell 45 W AC Charger
 - Dell Latitude 12 Rugged Tablet-7202 User's Guide



Figure 1 – ECHO-3D Kit

3.2. ECHO-3D Generation II Sensor

The Generation II (Gen II) Sensor is designed to accept input from a single axis (X) encoder assembly for manual operation and dual axis (X-Y) input for manual/automatic scanners. No operator serviceable components are found within the sensor housing.

3.2.1. Safety

The internal sensor temperature is monitored and will shut the sensor down if the internal temperature exceeds a set threshold of 85°C [185°F]. Sensor temperature is continuously monitored and displayed while the application is running.

During initial laboratory testing the Gen II Sensor has proven to be robust. Specific physical vibration and shock (drop) testing has not been performed.

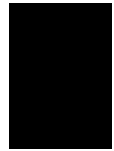
Job planning should consider all ambient conditions. Extremely high or low temperatures may affect the operations of both the Gen II Sensor and the Tablet. Touch screens often do not work well in very cold conditions.

Although the Tablets are light weight, a harness should be considered for extended use. All equipment should be tethered for any work involving heights or situations with workers underneath the work area.

3.2.2. Storage

The Gen II Sensor requires no special storage environment. As with any electronic instrument or device, care should be exercised not to expose the stored sensor in adverse conditions such as: high or low temperatures, wide temperature fluctuations, high humidity, direct exposure to rain or sun, and high levels of radiation. In general, the sensor should be stored in the same conditions as the tablet.

3.2.3. Disposal



In Accordance with European Community directive 2012/19/EU on Waste Electrical and Electronic Equipment (WEEE Directive), this symbol indicates that the product must not be disposed of as unsorted municipal waste, but should be collected separately.

Local regulations must be consulted to determine the correct method of disposal. Contact Athena Industrial Services for return and/or collection systems available in your jurisdiction.

3.2.4. Physical Attributes

The Gen II Sensor, shown below in Figure 2, has the following physical characteristics:

- Switches – Three switches: Compensation **C**; Mode **M**; and Record **R**
- Quick Disconnects – Two: USB cable (blue); encoder or scanner (red)
- Sensor Stabilizing Shoe – A shaped shoe designed to centre and stabilize the sensor on curved surfaces such as pipes and tubes or attachment to scanners
- Encoder – An encoder wheel assembly (ECHO-X) with integral signal cable
- USB Cable – Supplies power to the Sensor and data to the Windows based PC
- Replaceable Wear Pad – Opaque adhesive pad



Figure 2 - ECHO-3D Generation II Sensor

3.3. Dell Latitude 12 Rugged Tablet

The Dell Tablet, shown in Figure 3, is a ruggedized 300 mm [12"] nominal size PC based touch-screen table complete with preloaded ECHO-3D software. The Tablet meets or exceeds the following standards and codes:

- US Department of Defense MIL-STD-820G [31 October 2008], Environmental Engineering Considerations and Laboratory Tests
- ANSI/IEC 60529-2004, Degrees of Protection Provided by Enclosures (IP Code): IP-65
- ANSI/ISA-12.12.01-2013, Nonincendive Electrical Equipment for Use in Class I and II, Division 2 and Class III, Divisions 1 and 2 Hazardous (Classified) Locations
- US Department of Defense MIL-STD-461F [10 December 2007], Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment

The Tablet specifications are as follows:

- Processor Intel® Core™ M-5Y71¹ Processor with 4 MB cache
- 8 GB² 1,600 MHz LPDDR3 Memory
- 395 mm [11.6"] HD (1,366 x 768) WLED Outdoor-Readable Glove-Capable Touch Screen
- Windows® 10 Pro, 64-bit English
- Microsoft® Office® Trial Software
- 128 GB Mobility Solid State Drive
- Intel Dual Band Wireless-AC 7265 802.11ac Wi-Fi® + Bluetooth 4.0 LE
- Quick Reference Guide – English
- Dual 2-cell (26 W·h) Lithium Ion Hot Swappable Batteries
- 100-240 VAC 45 W Charger with 0.9 m [3 ft] North American Power Cord (optional cord configurations are available)
- Dell Slipcase 14 Carrying Case
- 2 MP HD Webcam / 8 MP Rear Camera with Flash and Dual Microphones
- 3 Year Limited Hardware Warranty: Mail-in; Customer supplies box, Dell pays shipping



Figure 3 - Dell Latitude 12 Rugged Tablet

¹ Some Tablets may be equipped with an Intel Core M-50Y10c processor

² Some Tablets may be equipped with 4 GB 1,600 MHz LPDDR3 memory

The Dell Latitude 12 Tablets are rated for non-operating temperatures from -20°C to 65°C [4°F to 149°F] and operating from 0°C to 50°C [32°F to 122°F]. Cold weather operations below 0°C may affect the operation of the touch screen.

4. System Specifications

4.1. ECHO-3D Gen II Sensor

- Overall Dimensions (W x H x D): 70 mm x 85 mm x 80 mm [2.75" x 3.35" x 3.38"]
- Weight without Encoder: 306 g [11 oz]
- Weight with Encoder: 343 g [12 oz]
- Operating Temperature: -20°C to 50°C [-4°F to 122°F]
- Storage Temperature: -20°C to 60°C [-4°F to 140°F]
- Scan Area: >30 mm [1.18"] diameter
- Frequencies: 100 Hz to 14 kHz
- Sample Rate: >500 samples/s
- Crack Detection: Surface breaking up to 15 mm [0.6"] per Probability of Defect Detection Chart
- Crack Depth Accuracy:
 - 0 to 4.0 mm ± 0.4 mm [0-0.16" ± 0.01 "]
 - 4.1 to 5.5 mm ± 0.5 mm [0.16-0.22" ± 0.02 "] or 10%, whichever is greater on cracks
 - 19 mm [0.75"] or longer
- Operating Humidity: Up to 95% RH
- Water Resistance: Splash Proof
- Sensor Diagnostics: Continuous
- Calibration: One-touch
- Lift-off Bias: Manual, geometry dependant

Coating Thickness (mm)	Probability of Defect Detection							
	Defect Depth [mm]							
	0.5	1.0	1.5	2.0	2.5	3.0	4.0	5.0
2	✓	✓	✓	✓	✓	✓	✓	✓
5	✗	✓	✓	✓	✓	✓	✓	✓
10	✗	✗	✓	✓	✓	✓	✓	✓
15	✗	✗	✗	✗	✗	✗	✓	✓

5. ECHO-3D Software

5.1. General Description

Athena has developed a separate Quick Start Guide which can be used as an aid for any of the processes described below. ECHO-3D software is designed for exclusive use with the ECHO-3D Gen II sensor. To facilitate job creation and supervisor review of work performed and project reporting, a limited subset of the software works in absence of the sensor.

The software is icon based to reduce operator training time and limit language issues and tablets have ECHO-3D pre-installed. Additional installations of ECHO-3D can be supplied to qualified personnel by contacting Athena Industrial Services Inc.


Icon definitions can be found in Appendix B – ECHO-3D Software Icon Definitions.

ECHO-3D software limits some standard Windows functionality and customization to reduce operator problems with the supplied touch-screen Windows OS Tablets. Many windows are resizable while others are not, but in most cases, can be minimized to view other active windows, then maximized to return to work. Background colours are not changeable until data has been collected and filed by the ECHO-3D system.

Users are granted the right to use the software, but the software remains the property of Athena Industrial Services Inc. For licensing details please refer to the ECHO-3D Software Licensing Agreement.

The following sections describe the process of setting up, conducting, and finalizing a job (Project).

ECHO-3D software has been extensively tested using Microsoft Windows 10 and 10 Pro and recommends this operating system for use with ECHO-3D. Some Windows applications, such as Windows Defender, have been known to interfere with ECHO-3D. If this occurs, it is recommended to disable the offending application until a remedy update can be installed. The Windows display Auto-Rotate function may also cause problems with software stability. It is recommended to disable the Auto-Rotate function before starting the ECHO-3D software.

The ECHO-3D software is designed to run in full screen mode and most windows only permit minimized (task bar) and full screen sizing. Attempting to adjust the window size will result in a jerking motion as the window tries to redraw to full screen as the operator attempts to resize it. Due to the difference in screen size and resolution, some icon buttons may not always appear on the screen. If this situation occurs, the hidden buttons may be accessed by selecting the  **More Icons** button.

ECHO-3D software only permits one incident of the application to run at any given time. Attempting to start a second instance will be ignored. If trying to start a session of ECHO-3D appears not to start the application, the user should check to make sure a previously running session has not been minimized to the Task Bar.

5.2. Operating ECHO-3D without Gen II Sensor

Initiating the ECHO-3D software without a Gen II Sensor connected to the Tablet/PC allows the user to access a limited number of functions. These functions are designed to correspond with the duties of the operator and management personnel for:

- Project creation and editing;
- Review of Project data and analysis; and
- Editing of generated reports.

It should be noted that raw data collected during scanning operations is recorded, securely filed, and not accessible to non-authorized personnel.

ECHO-3D Projects created by one user may be Exported and sent electronically to another user. The other user can then Import the Project. Data can be added at anytime, but previously collected data is secure and can't be deleted or altered.

The ECHO-3D software is designed to use Projects and Zones. These primary characteristics are intended to collect data from a single Sensor. Should it become necessary to swap Sensors during an inspection, a new Project should be created for data collection with the new Sensor.

5.2.1. Starting Software without Gen II Sensor



After installation of the ECHO-3D software, click on the start-up icon. Depending on your Operating System (OS) preferences this may require a double click. The following **Home Screen** window will appear.



During the start-up operation, the software attempts to connect to a sensor.



If a Sensor is not found the following window appears.



Selecting the **OK** button displays the following **Home Screen** window with limited buttons.



The window is divided into three zones: a left side status/button bar; a main screen area; and a right-hand status/button bar. Although the information and buttons displayed in the side bars varies depending on the main window, the status area at the bottom left hand corner always displays battery charge level and below that a display bar shows Sensor connection status (**Connected**, **Unlicensed**, or **Disconnected**). This general window architecture is consistent for all windows used by ECHO-3D.

The **Home Screen** window without sensor allows the user to perform three main functions and a variety of Project set-up functions from Tools:

- Work with Projects
- Open 3D (Scan) Viewer
- Generate a Report
- Tools
 - Technician Details
 - Inspection Company Details
 - Client Details
 - Encoder Details
 - Export Project
 - Import Project
 - Tool Status (Sensor Health)
 - Information / Help



Regardless of the current window, the **Home** button always appears in the top left hand corner. Selecting the **Home** button always returns the user to the **Home Screen** window.



Selecting the **OFF** button terminates the ECHO-3D software application but does not turn off the Tablet or PC.

5.2.2. Tools Window

The **Tools** window allows user to perform a variety of functions depending on whether a Sensor is connected or not. The **Tools** window is the only window with a traditional Menu Bar. Without a Sensor connected to the system the following messages will appear when selecting Menu Bar items:

File ⇒ Sensor ⇒ ECHO-3D Sensor Status, or File ⇒ Sensor ⇒ ECHO-3D Sensor Registration Info will display the following message.



Selecting the **OK** button closes the message.

Mode ⇒ Standard is the default operating mode for the software.

Mode ⇒ Advanced is an advanced operating mode for the software which allows an authorized user access to additional features. Selecting Advanced will prompt the user for a password before Advanced Mode can

be initiated. Advanced Mode operations are limited to Athena personnel and this manual does not cover these operations.

Mode ⇒ Distributor is an advanced operating mode for the software which allows an authorized user access to additional features. Selecting Distributor will prompt the user for a password before Distributor Mode can be initiated. Distributor Mode operations are limited to Athena authorized distributor personnel and this manual does not cover these operations.



Selecting the **TOOLS** button without a Sensor connected opens the following **Tools** window.



Selecting the **TOOL STATUS** button opens the following message.



Selecting the **OK** button closes the message.

5.3. First Time Start-up Requirements

ECHO-3D requires the following details to be created prior to setting up the first Project. These following procedures can be accomplished with or without a Gen II Sensor connected to the Tablet/PC.

5.3.1. Add Inspection Company Details

Before a Project can be created, the user must first input the Inspection Company Details. This is generally a one-time process. It can be initiated from the **TOOLS** button in the **Home Screen** window. Preloaded ECHO-3D software may have been installed with the correct Inspection Company information from the factory. If this information is missing or incorrect, follow the procedures described in the Section 5.4.1 Editing an Inspection Company.

5.3.2. Add Inspection Company Logo

The reports generated by ECHO-3D can display the Inspection Company's logo on the front page. The printed logo is small (80 x 80 pixels), and results in a logo approximately 27 mm x 27 mm [1.06" x 1.06"] on a standard ANSI A size [8½" x 11"] sheet. Image size in the original logo file should be considered. Too large or too small of a logo size could result in unsatisfactory scaling of the logo. If this information is

missing or incorrect, follow the procedures described in the Adding or Editing an Inspection Company Logo below.

5.4. Working with an Inspection Company

An Inspection Company is the organization providing the inspection service and is a required detail of a Project in the ECHO-3D software. The Inspection Company is saved as a detail stored in a Project and is a requirement for creating a Project.

The Inspection Company is added to the Project Details. See Section 5.8 Working with a Project for more information.

5.4.1. Adding an Inspection Company

An Inspection Company can be added or existing details edited. The following process starts from the **Home Screen** window. Care should be exercised when creating a new Inspection Company to ensure the Company Name is correct as this detail can't be edited once the Inspection Company has been saved.



Selecting the **TOOLS** button opens the **Project Set-up Tools** window.



Selecting the **COMPANY** button opens the **Inspection Company Details** window. If no Inspection Company Details exist, the window opens with the **New** radio button selected. Details can then be entered in each text box as desired. If one or more Inspection Companies exist, the window will open with the **Existing** radio button selected and the current active Inspection Company will be displayed.

A screenshot of the 'Inspection Company Details' window. At the top, it says 'Inspection Company Details' and 'Companies:'. Below this are two radio buttons: 'New' (selected) and 'Existing'. The form contains several text input fields: 'Name:', 'Street:', 'City:', 'Prov/State:', 'Postal/Zip:', 'Country:' (with a dropdown menu showing 'Canada'), 'Contact Name:', 'Phone #:', 'Fax #:', 'Contact Email:', and 'Website:'. There is also a 'Logo:' field with a small image icon. On the right side, there are three buttons: a red 'X' button, a 'Save' button, and a 'Cancel' button.

If required, after selecting the **New** radio button, each text box can now be completed. Moving the cursor from box to box is accomplished by Tab to advance, Shift+Tab to return, or by selecting in the box with

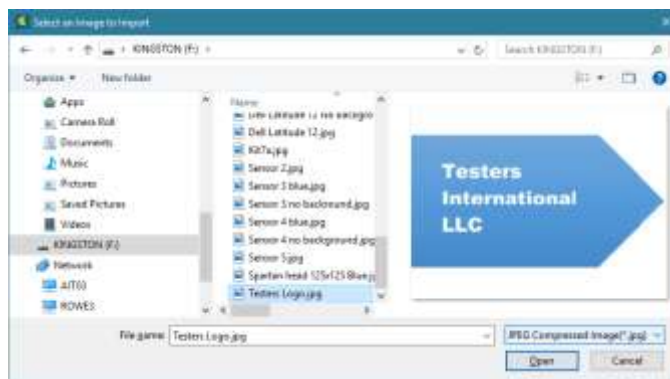
a pointing device (standard windows movements). Once all the Inspection Company Details have been correctly entered in the appropriate boxes the Inspection Company logo can then be added.

Text boxes can utilize any legal character with lengths as follows:

- a. Name: 150;
- b. Street: 50;
- c. City: 50;
- d. Prov/State: 50;
- e. Postal/Zip: 20;
- f. Country: pick from dropdown list;
- g. Contact Name: 30;
- h. Phone #: 30;
- i. Fax #: 30;
- j. Contact Email: 50; and
- k. Website: 100.



Selecting the **Browse for Logo** button opens the **Select an Image to Import** window. After browsing the Table and finding the logo, selecting the logo file adds the file name to the File name box. Only Joint Photographic Experts Group Compressed Image (.jpg), Portable Network Graphics (.png), or Graphic Interchange Format (.gif) logo files may be imported.



Open

Selecting the **Open** button closes the **Select an Image to Import** window and adds the logo to the **Inspection Company Details** window. A preview of the logo is displayed on the window.

Cancel

Selecting the **Cancel** button cancels the file selection and closes the message window.



Selecting the **SAVE** button saves the new details and closes the window. The last displayed Company when the window is closed, either by selecting the **CLOSE** or **SAVE** button, becomes the current active Inspection Company. ECHO-3D requires an active Inspection Company. Attempting to close the Inspection Company Details window without a Company displayed will result in the following error message.

Attempting to save Company Details without all the required text boxes being filled will result in a message prompting the user to complete the required field as shown below.

5.4.2. Editing an Inspection Company

Editing an existing Inspection Company is like adding an Inspection Company except that the Name field is not changed. Select the **Existing** radio button opens a dropdown box from which the desired Inspection Company can be selected. Once selected, the text boxes are populated. Edit any of the text boxes (other than Name which can't be edited) as required.



Select the **Update Company Details** button to save the changes to the existing company.



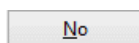
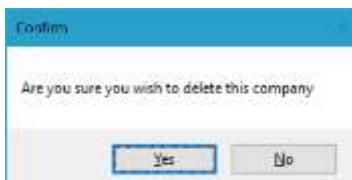
Selecting the **CLOSE** button will close the **Inspection Company Details** window without saving any changes. Changing an existing logo follows the same procedure as above.

5.4.3. Deleting an Inspection Company

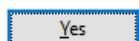
An Inspection Company and associated details can be deleted if they have not been used in a Project. Select the **Existing** radio button and from the dropdown box select the desired Inspection Company.



Selecting the **REMOVE** button prompts the user to verify the deletion.



Selecting the **No** button cancels the delete operation.

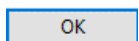
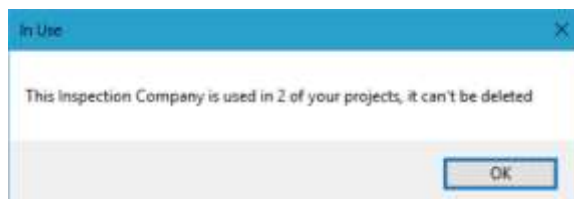


Selecting the **Yes** button deletes the selected Inspection Company and returns an empty Inspection Company Details window.



To close this window, select another existing Company from the dropdown list and select the **CLOSE** button.

If the Inspection Company has been used in a Project, the following message appears.



Selecting the **OK** button cancels the deletion process and closes the **In Use** message window.

5.5. Working with a Technician

A Technician is the person performing the inspection process, usually an employee of the Inspection Company. It is highly recommended that any inspector be trained by an Athena approved instructor and hold a current Certificate of Completion issued by Athena.

5.5.1. Adding a Technician

Adding a new Technician or editing an existing Technician must be completed prior to the creation or editing of a Project. Care should be exercised when creating a new Technician to ensure the correct Technician Name is entered as it can't be edited once saved. Adding a new Technician is accomplished by completing the following procedure, starting from the **Home Screen** window.



Selecting the **TOOLS** button opens the **Project Set-up Tools** window.



Selecting the **TECH** button opens the **Technician Details** window. Note that the **Technician Details** section of the window is inactive (shaded) until a Technician is selected from the **Select Technicians** list.



Selecting the **ADD** button activates the **SAVE New Record** button and makes the text boxes editable.



The technician's name and other details can then be entered in the appropriate text boxes. To add the technician's ECHO-3D certification, select the appropriate certification from the dropdown boxes.



Text boxes can contain any legal Windows character with lengths as follows:

- a. Name: 30;
- b. ID #: 20;
- c. Exp Date: 20;
- d. City: 20; and
- e. Prov/State: 20.




Once the Certification Level has been selected, selecting the **Save** button saves the new Technician details and closes the window.

Three Certification Levels are available and defined by Athena as follows:

1. Level I – Trainee or Inspector has completed ECHO-3D Level I training and can perform specific ECHO-3D operations and specific evaluations for acceptance or rejection determinations per written instructions and to record results. The Level I should receive the necessary instruction and supervision from a certified Level II or III individual.
2. Level II – Inspector qualified to interpret and evaluate results with respect to applicable codes, standards and specifications. The Level II should be thoroughly familiar with the scope and limitations of the methods for which he is qualified and should exercise assigned responsibility for on-the-job training and guidance of trainees and Level I personnel.
1. Level III – Inspector can develop, qualifying and approving procedures, establishing and approving techniques, interpreting codes, standards, specifications and procedures, as well as designating the methods, techniques and procedures to be used. The Level III is responsible for the ECHO-3D operations for which he is qualified and assigned and is capable of interpreting and evaluating results in terms of existing codes, standards and specifications. The Level III should have sufficient practical background in applicable materials, fabrication and product technology to establish techniques and to assist in establishing acceptance criteria when none are otherwise available. The Level III, in the methods in which he is certified, is capable of training and examining Level I and II personnel for certification in those methods.



Selecting the **CLOSE** button closes the **Technician Details** window without saving the data.

Closing the window by selecting the  in the right side of the Title Bar closes the window without saving the added data.

5.5.2. Editing a Technician

To edit an existing Technician's details, open the **Technician Details** window as described above. Select the Technician in the **Select Technician** box. The **Technician Detail** text boxes are then populated with the details. These details can be over-written and certification can be changed following the same procedures as described above.



Selecting the **SAVE Update Technician** button saves any changes made and closes the window.



Selecting the **CLOSE** button closes the **Technician Details** window without saving the changed data.

5.5.3. Deleting a Technician

To delete an existing Technician and all details, open the **Technician Details** window as described above. Select the Technician in the **Select Technician** box. The **Technician Detail** text boxes are then populated with the details.



Selecting the **REMOVE** button prompts the user to verify the deletion.



Selecting the **OK** button deletes the selected Technician and closes the window.



Selecting the **No** button cancels the delete operation.

If the selected Technician has been utilized in a Project, the following message will appear.



Selecting the **OK** button cancels the deletion and closes the window.

5.6. Working with a Client

A Client is the company or entity for which the inspection (customer) is being performed. This is usually the owner of the equipment being inspected, but may also be an intermediary company. A Client is a required detail of a Project.

5.6.1. Adding a Client

Adding a new Client or editing an existing Client can be done prior to, or during the creation or editing of, a Project. There are two methods to initiate the Add/Modify Client Details window described as follows:

1. Starting from the **Home Screen** window.



Selecting the **TOOLS** button opens the **Home Tools** window.



Selecting the **CLIENT** button opens the **Add/Modify Client Details** window, or

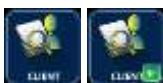
2. Starting from the **Home Screen** window.



Selecting the **PROJECT** button opens the **Project Details** window.



Selecting the **NEW** or **EXISTING** button opens the **Project Details** window.



Selecting the **CLIENT** button opens the **Client Select** window.





Selecting the **ADD** button opens the **Add/Modify Client Details** window.

This window opens with the **New** radio button selected where you can add customer details. Enter text in the appropriate text boxes.

Text boxes can contain any legal character with lengths as follows:

- a. Client Name: 100;
- b. Street: 50;
- c. City: 50;
- d. Prov/State: 50;
- e. Postal/Zip: 20;
- f. Country: pick from dropdown list;
- g. Contact Name: 30;
- h. Phone #: 30;
- i. Fax #: 30;
- j. Contact Email: 50; and
- k. Website; 100.



Selecting the **SAVE** button saves the new Client details and closes the window.



Selecting the **CLOSE** button closes the **Add/Modify Client Details** window without saving any new details.

5.6.2. Editing a Client

Editing an existing Client is accomplished by the selecting the **Existing** radio button from the **Add/Modify Client Details** window. Selecting the **Existing** radio button activates the dropdown box allowing selection of an existing customer for editing. Once selected the text boxes are populated and can be edited. It should be noted that Client Name cannot be edited.



Selecting the **SAVE Changes** button saves the edited details and closes the window.



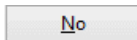
Selecting the **CLOSE** button closes the **Add/Modify Client Details** window without saving any new details.

5.6.3. Deleting a Client

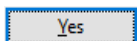
A Client can be from the **Add/Modify Client Details** window only if not used on a Project. Select the **Existing** radio button and the v to open the dropdown list. Select the Client to be deleted populating the text boxes.



Selecting the **REMOVE** button opens the **Verify Delete Client** window.

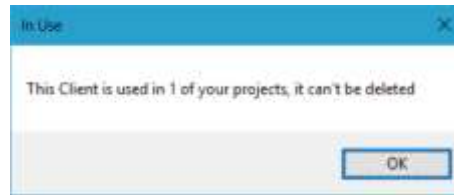


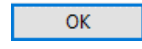
Selecting the **No** button cancels the delete operation.



Selecting the **Yes** button deletes the selected Client and returns an empty Add/Modify Client Details window with the first Client in the dropdown list displayed in the Clients text box.

If the Client has been used in a Project, the following message appears.



 Selecting the **OK** button cancels the deletion process and closes the **In Use** window.

5.7. Working with an Encoder

An Encoder or Scanner is a required detail of a Project. In Scan Mode, ECHO-3D uses the signal from an encoder to trigger the acquisition of data in the form of a Shot. The Gen II Sensor requires a minimum of a single axis encoder (X-axis) which is utilized to trigger the data sampling Shots. ECHO-3D software is designed to support both single axis (X) encoders and dual axis (X-axis and Y-axis) scanners.

5.7.1. Adding an Encoder

New encoders or scanners can be installed by the user. It is recommended that Athena Industrial Services Inc. be contacted for assistance.

Three different types of encoders may be used by the manufacturers of scanners:

1. Single-ended incremental quadrature;
2. Differential; and
3. Absolute.

There are also three common encoding types, known as: X1, X2, and X4. When determining the encoder resolution (pulse/mm) care should be exercised and each new encoder pulse rate value should be tested for accuracy. As different scanner OEMs utilize encoders differently, commonly the published encoder resolution may need to be multiplied by a factor of 0.5 or 2 to get the correct scaling. Using an X-axis Scan Increment of 1.0 mm and scanning a known length is the simplest method for testing for the correct pulse rate. When the correct pulse rate is utilized, this method results in the scanned length in millimetres equalling the Shot count.

Currently ECHO-3D has one single-axis encoder (ECHO-X) and three two-axis scanners (*STIX* or MapSCANNER, *SKOOT* or MapROVER, and *NAVIC*) preloaded and selectable. Other encoders and scanners may be added and Athena personnel can assist in determining the correct settings. Default settings for supported scanners are provided in the following table.

ECHO-3D Encoder Default Settings		
Encoder/Scanner	X-Axis Pulse/mm	Y-Axis Pulse/mm
ECHO-X Single Axis Encoder	2.527	N/A
Jireh <i>STIX</i> or Olympus MapSCANNER	8.160	20.16
Jireh <i>SKOOT</i> or Olympus MapROVER	120.1	677.0
Jireh <i>NAVIC</i>	120.1	6.890

The above settings are the default. If extreme accuracy is required, these values may need to be corrected slightly to account for manufacturing tolerance in wheel diameters. For the ECHO-X Encoder, this can be accomplished by scanning a single Run over a known (measured) length and comparing the Run length to

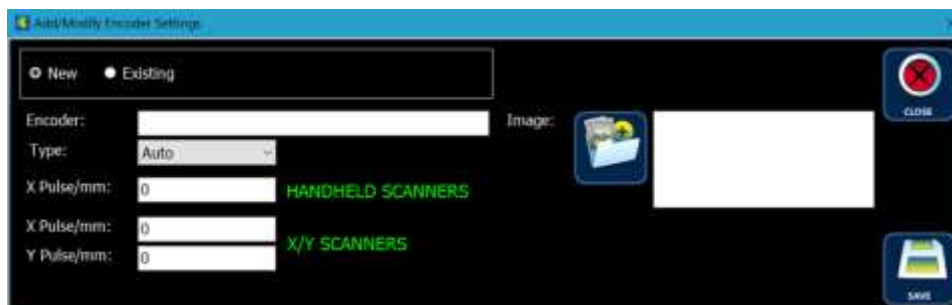
the Shot count. For the two-axis scanners, jogging the scanner in the X and Y-axes to known (measured) lengths and comparing those to the ECHO-3D Scan Mode X and Y-axes displays.



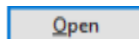
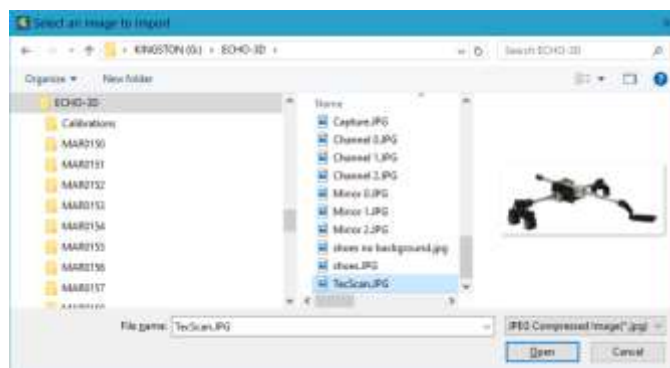
Starting from the **Home Screen** window, selecting the **TOOLS** button opens the **Home Tools** window.



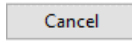
Selecting the **ENCODERS** button opens the **Add/Modify Encoder Settings** window. This window opens with the **New** radio button selected. Enter the appropriate information into the text boxes and select the Scanner Type from the dropdown list.

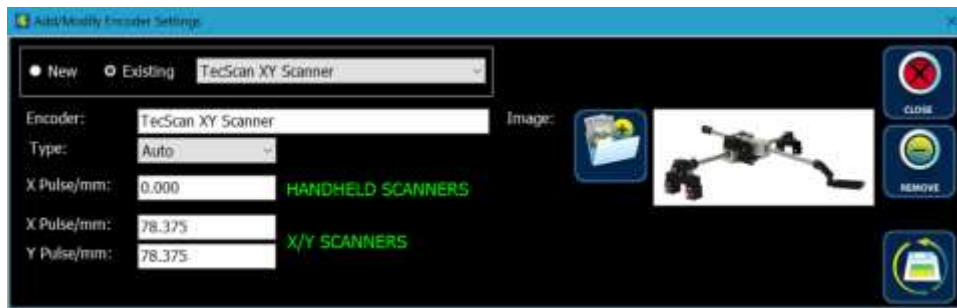


Selecting the **Browse for Logo** button opens the **Select an Image to Import** window. After browsing the Table and finding the logo, selecting the logo file adds the file name to the File name box. Only Joint Photographic Experts Group Compressed Image (.jpg), Portable Network Graphics (.png), or Graphic Interchange Format (.gif) logo files may be imported.



Selecting the **Open** button closes the **Select an Image to Import** window and adds the logo to the **Inspection Company Details** window. A preview of the logo is displayed on the window.

 Selecting the **Cancel** button cancels the file selection and closes the message window.



Selecting the **SAVE** button saves the new Scanner details and closes the window.



Selecting the **CLOSE** button closes the **Add/Modify Encoder Settings** window without saving any new details.

5.7.2. Editing an Encoder

Starting from the **Home Tools** window, the following describes the procedure for editing an Encoder or Scanner.



Selecting the **ENCODERS** button opens the **Add/Modify Encoder Settings** window. This window opens with the **New** radio button selected. Select the **Existing** radio button and select the ▼ to open the dropdown box. From the dropdown box, select the encoder or scanner to be edited or deleted.



To edit, make the desired changes in the text boxes and select the **Update details** button saving the changes and closing the window.



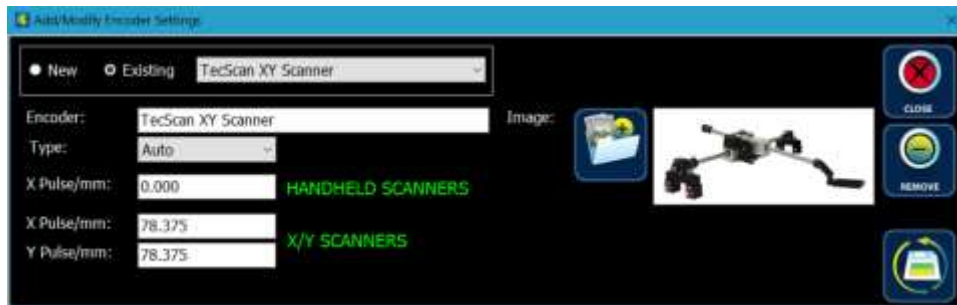
Selecting the **CLOSE** button closes the **Add/Modify Encoder Settings** window without saving any new details.

5.7.3. Deleting an Encoder

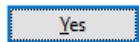
An Encoder or Scanner can be deleted from the **Encoder Manager** window. If an Encoder or Scanner has been used in a Project, it can't be deleted. Starting from the **Home Tools** window, the following describes the procedure for deleting an Encoder or Scanner.



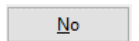
Selecting the **ENCODERS** button opens the **Add/Modify Encoder Settings** window. This window opens with the **New** radio button selected. Select the **Existing** radio button and select the **v** to open the dropdown box. From the dropdown box, select the encoder or scanner to be edited or deleted.



Selecting the **REMOVE** button opens the **Verify Delete Encoder Set** window.

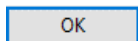


Selecting the **Yes** button deletes the selected encoder/scanner and closes the **Verify Delete Encoder Set** and **Encoder Manager** windows.



Selecting the **No** button cancels the operation and closes the window.

If the Encoder or Scanner is used in a Project the following message appears.



Selecting the **OK** button cancels the deletion process and closes the In Use window.

5.8. Working with a Project

Typically, a new inspection starts with the creation of a new Project. Projects can be subdivided into Zones which allows a Project to include the inspection of multiple areas. Projects are designed to be specific to an inspector, location, and Sensor. If any of these characteristics change once data has been collected for a Zone, a new Project should be created before more data is recorded.

5.8.1. Adding a Project



Selecting the **PROJECT** button opens the **Project Details** window. If no Projects yet exist, the window will appear as follows.



If the user has already created at least one Project, the window will appear as follows.



Selecting the **New Project** button opens the **Project Details** window.



Selecting the Back button returns the user to the **Project Details** window.



Selecting the **CLOSE** button before saving will delete any information added to the Project Details before closing the **Project Details** window.

Creating a New Project is a simple process of working through the **Active Project Details** buttons as follows.



Selecting the **Project NAME** button opens the **Project Name** window. Enter the Project Name in the text box. Select the Probe Type from the **Probe Type** dropdown box. Currently only one Probe Type is available, the ECHO3DGEN2 (ECHO-3D Generation II Sensor).

Although a Project Name may be up to 75 characters long, it is recommended that names be limited to less than 30 characters, permitting the complete Project Name to display in any dropdown boxes. ECHO-3D creates and writes files to a file folder utilizing the Project Name. Any character can be used in the Project Name except for the following:

- a. The following illegal Windows file path characters:
 - i. Less than (<);
 - ii. Greater than (>);
 - iii. Colon (:);
 - iv. Double quotation ("");
 - v. Forward slash (/);
 - vi. Backslash (\);
 - vii. Vertical bar or pipe (|);
 - viii. Question mark (?); and
 - ix. Asterisk (*).
- b. A period (.).



Selecting the **ACCEPT** button returns the user to the **Active Project Details** window.



Note that the **NAME** button now shows a checkmark indicating that this field has been filled in. Completing the remainder of the Project is a process of working through the two rows of buttons. When all buttons have checkmarks the Project details have been completed. When starting a new Project notice that **SCAN OPTIONS** already has a checkmark. These Project Details are default filled with commonly used values to speed up the creation process. Any of the Project details can be edited by re-selecting the button.



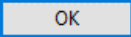
Selecting the **RENAME** button open the Rename window and allows the user to rename the Project. See Section 5.8.4 for details on renaming a Project.

Attempting to save the Project before all required information has been added will result in an error message. An example is seen below.



Project Names must be unique. If a Project previously exists with the same Project Name as the New Project being created the following message will appear after selecting the **SAVE** button.



 Selecting the **OK** button closes the message window and displays the **Project Details** window. The **NAME** button must then be selected and the Project Name edited before selecting the **ACCEPT** and **SAVE** buttons.



Selecting the **DETAILS** button opens the **Project Details** window. The Inspection Company must be selected from the **Company** dropdown menu. Detailed Project information can be entered in the **Project Details** text box. Selecting the **ACCEPT** button returns the user to the **Active Project Details** window. Project Details can include up to 520 characters. Any legal character can be used except for a carriage return [Enter]. Selecting Enter closes the **Project Details** window. Material Description is a text field used to describe the sample piece with a maximum of 100 characters. Any legal character can be used except for a carriage return [Enter]. Selecting Enter closes the **Project Details** window. The description should contain physical properties such as: material type and grade; heat treatment, tempering, or work-hardening; as well as geometric properties, such as: configuration (plate, pipe, bar, etc.); and nominal size and/or thickness.





Selecting the **CLIENT** button opens the **Select Client** window. Selecting the **v** opens the dropdown box. Select the Client from the list. If the Client does not yet exist, select the **ADD** button and create the new Client as described above in Section 5.6 Working with a Client.



Selecting the **ACCEPT** button saves the Client to the Project Details.



Selecting the **TECH** button opens the **Project Technicians** window. At least one Technician must be selected for a Project. The first Technician must be added to the Technician One box.



Selecting the left-hand **Add Technician One** button opens the **Technician Detail** window. To insert an existing Technician, select (highlight) the desired technician's name.





Selecting the **ACCEPT** button adds Technician One to the **Project Technician** window and displays the **ADD Technician Two** button. A second Technician can then be added to the Project using the same process as for Technician One.



To change the selected left-hand Technician, select the left-hand **Add Technician One** button again. Select (highlight) the new Technician and select the **ACCEPT** button.

Repeating this process for **Technician Two** (the right-hand button) inserts a second Technician to the Project if it is desired.



If a Technician Two needs to be removed from the Project, select the small **Clear this Technician** button to remove the second Technician.



Selecting the **ACCEPT** button returns the user to the **Active Project Details** window. Only two Technicians can be assigned to a Project.



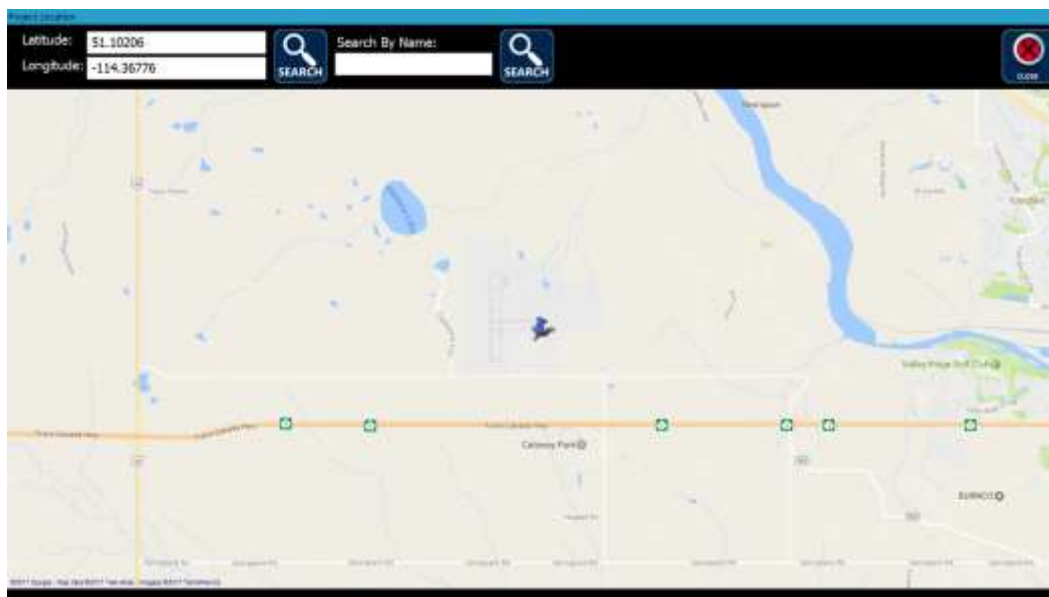
Selecting the **LOCATION** button opens the **Location Detail** window. The Project Location can then be entered in the text box and selecting the **ACCEPT** button returns the user to the **Active Project Details** window. The text box accepts locations with descriptions up to 100 characters. Any legal character can be used except for a carriage return [Enter]. Selecting Enter closes the **Location** window.



If available, the current geographic coordinates of the Tablet/PC are displayed below the Location text box as provided by the MS Windows Location Service. The longitude and latitude are displayed in the DD format (Decimal Degrees). If desired, these values can be entered as text into the Location text box for a permanent record of the geographic location.



Selecting the **MAP** button opens the **Project Location Map** window. This window utilizes Google Maps™ and can be used to search or verify location information.



If connected to the internet, the current Latitude and Longitude will be displayed and a map showing the current location will be displayed in the window.



A new location can be found by entering the latitude and longitude using: DMS – degrees, minutes, and seconds; DMM – degrees and decimal minutes; or DD – decimal degrees format in the text boxes. Selecting the **SEARCH** button next to the Latitude and Longitude text boxes will display the new location.



A new location can be found by entering a name in the Search By Name text box. Selecting the **SEARCH** button next to the Search By Name text box will display the new location.



Selecting the **CLOSE** button closes the **Project Location Map** window.



Selecting the **MATERIAL** button opens the **Material Description** window. The Project Material Type, Thickness, and Form can then be entered in the text box.



Material Type is selected from the dropdown box. Currently there are four basic Material Types:

1. Carbon Steel (based on UNS G41300);
2. Stainless Steel 316L (based on UNS S31603);
3. Aluminum 6061-T6 (based on UNS A96061); and
4. Nickel Clad Carbon Steel (Sample).

Nickel Clad Carbon Steel (Sample) is listed for reference only. This Material Type is based on a customer supplied sample of Nickel Explosive (EXW) Clad Carbon Steel plate and should be used with caution.

Other specific Material Types will be added as they become available. Material Type is used to calibrate the Sensor for the specific material being inspected. Using the wrong Material Type may result in erroneous readings.

Units has two options in the dropdown menu: **METRIC** and **IMPERIAL**. This selection determines the measurement system used for the Project.

Thickness is the actual measured thickness of a plate or wall thickness of a pipe sample, in millimetres or inches, depending on the **Units** selection.

Form is selected from a dropdown menu. **FLAT** is selected for plate and limits input to the Thickness text box. Selecting **PIPE** for pipe applications activates the **Outside Dia.** box. For Metric, the dropdown menu displays pipe in ISO DN sizes. For Imperial, the dropdown menu displays ASME/CSA NPS pipe sizes. Pipe sizes from NPS 4 [DN 100] up to NPS 36 [DN 900] are supported. See Appendix G for more information on pipe sizes and designations.



Selecting the **ACCEPT** button returns the user to the **Active Project Details** window.



Selecting the **ACCEPT** button returns the user to the **Active Project Details** window.



Selecting the **Y SCAN INDEX** button opens the **Y-Scan Index** window. This value is the Y-axis offset used for each scan when using a scanner. Selecting one of the 1, 2, 3, 4, or 5 number buttons sets the offset in millimetres (mm). For more information, see Section 10 Scanning Methods.



Selecting a Y-Scan Index highlights the selected index value.



Selecting the **ACCEPT** button returns the user to the **Active Project Details** window.



Selecting the **CHANNEL** button opens the **Lead Channel** window. Selection of the Lead Channel is a critical parameter of setting up a Project. Any of the four preselected Channels (0, 4, 8, and 12) may be selected. It should be noted that all sixteen channels collect data. Lead Channel is the channel that is at the largest X-axis position when initiating a Scan. The default and only setting for hand scanning with the ECHO-X Encoder is Lead Channel-0. When scanning with a dual-axis scanner, any of the four preselected Channels (0, 4, 8, and 12) in the dropdown box can be selected. For more information, see Section 7.3 Inspection Considerations and Techniques – Selecting Lead Channel.



Selecting a Lead Channel highlights the selected channel.



Selecting the **ACCEPT** button saves the Lead Channel setting and returns the user to the **Active Project Details** window.



Selecting **Scan Options** opens the **Scan Setup** window. Three X-axis **Scan Increments** are selectable from the dropdown menu: 0.5, 1.0, and 2.0 mm. This setting determines the distance between Shots. Selecting 0.5 mm/Shot increases data resolution but decreases maximum scan speed. Selecting 2.0 mm/Shot decreases resolution but increases maximum scan speed. The default is 1.0 mm/Shot and to-date this setting has provided sufficient resolution to perform acceptable data analysis. **Encoder Type** is selectable from the provided buttons and are divided into Manual and

Automatic (powered) types. Details of each encoder or scanner are determined from the list in the **Home Tools ENCODERS** window. Initially opening this window displays the following:



Supported encoders and scanners are as follows:

Manual	ECHO-X Jireh <i>STIX</i> Olympus MapSCANNER
Automated	Jireh <i>SKOOT</i> Olympus MapROVER Jireh <i>NAVIC</i>

The selected encoder or scanner is reaffirmed by the highlighted buttons and picture displayed to the left of the buttons.



Selecting the **ACCEPT** button returns the user to the **Active Project Details** window.



Selecting the **CLOSE** button before saving will delete any information added to the Project Details before closing the **Project Details** window.



Selecting the **SAVE** button saves the Project details, closes the window, and opens the New / Edit Defect Zone window. Note – a Project must have at least one Zone. See Section 5.9 for more details on creating a Zone.

The screenshot shows the 'New / Edit Defect Zone' window. It has a title bar with 'New / Edit Defect Zone' and three tabs: 'New Defect Zone' (red), 'Edit Defect Zone' (yellow), and 'Select Defect Zone' (green). The main area contains fields for 'Zone ID:' (highlighted in yellow), 'Technician Notes:', 'Lift-Off:' (set to 0.00), and 'Zone Location From Datum:'. Below this are 'Units:' (set to mm), 'X' Datum:' (0), and 'Y' Datum:' (0). A 'Measurement' section includes 'Distance From GW:' (Metric, 0 mm) and 'From TDC:' (Distance Metric, 0 mm). A 'CLOSE' button with a red X icon is in the top right corner.



Selecting the **CLOSE** button saves the Zone Details and closes the window. before saving will delete any information added to the Project Details before closing the **Project Details** window.

5.8.2. Editing a Project

Any existing Project can be edited using the **EXISTING** button and selecting the Project from the dropdown box. The following starts from the **Home Screen** window.



Selecting the **PROJECT** button opens the Project Options window.

The screenshot shows the 'Project Options' window. It has a title bar with 'Project Options' and an 'Options' button with a red X icon in the top right. The main area contains four buttons: 'NEW' (yellow circle), 'EXISTING' (blue square with a yellow arrow), 'COPY' (yellow folder), and 'COPY AS TEMPLATE' (blue folder with a yellow arrow).



Selecting the **EXISTING** button opens the **Active Project** window. Chose the Project that needs to be edited.

The screenshot shows the 'Active Project' window. It has a title bar with 'Active Project' and an 'Options' button with a red X icon in the top right. The main area contains a 'Project Selection' dropdown menu with 'Initial Setup Project' and 'Test' as options. There are 'BACK' and 'ACCEPT' buttons (green circles with white arrows) and a 'CANCEL' button (red circle with white X) in the bottom right corner.



Select the **ACCEPT** button to open the **Active Project: Initial Set-up Project** window.



Selecting the Back button returns the user to the **Project Details** window.

From the **Active Project: Initial Set-up Project** window, choose any parameter which requires editing and follow the same procedures described above for creating a new Project.



Selecting the **ZONES** button opens the **New / Edit Defect Zone** window. The window opens in the **New Defect Zone** tab.

Zones can be added or edited. See Section 5.9 for details on Zones.



Selecting the **REPORT** button opens the **Project Selection** window. Creating a Report at this point is a good practise and allows the operator to visually check all parameters of the Project for completeness and correctness. See Section 15. Generating a Report for more information.



Selecting the **SAVE** button saves the new Project details, closes the window, and displays the **Home Screen**.

5.8.3. Copying a Project

A new Project can be created from any existing Project using one of two methods:

1. The **Copy** function – This operation copies all the Project Details but no Zone Details nor collected data from the selected Project to a new Project.
2. The **Copy as Template** function – This operation copies all the Project and Zone Details, except collected data, from the selected Project to the new Project.

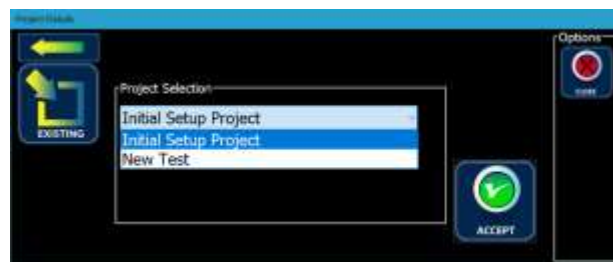
The following starts from the **Project Details** window.



5.8.3.1. Copy a Project Excluding Zones



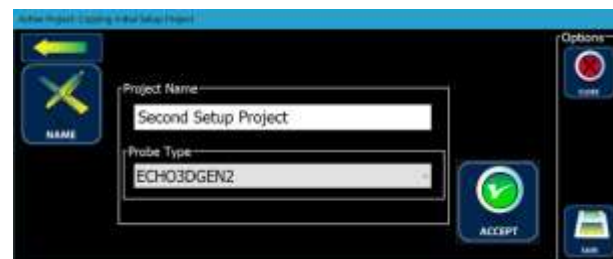
Selecting the **COPY** button opens the **Project Details: Project Selection** window. Choose the Project that will be used to create the new Project from the dropdown box.



Selecting the **ACCEPT** button opens the **Active Project: Copying** window.



Entering the new Project Name in the highlighted text box removes the highlighting.





Select the **ACCEPT** button to return to the **Active Project Details** window.



From this window choose any parameter which requires editing and follow the same procedures described above for creating a new Project.



Selecting the **SAVE** button saves the new Project Details and closes the **Active Project: Copy** window and opens the **New / Edit Defect Zone** window. The window opens in the **New Defect Zone** tab.

Zones can be added or edited. See Section 5.9 for details on Zones.



Selecting the **CLOSE** button before saving will delete any information added to the Project Details before closing the **Active Project: Copy** window.

5.8.3.2. Copy a Project Including Zones



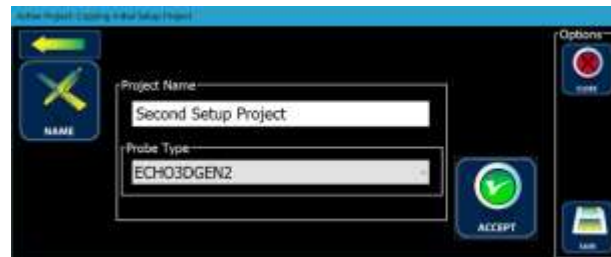
Selecting the **COPY AS TEMPLATE** button opens the **Project Details: Project Selection** window. Choose the Project that will be used to create the new Project from the dropdown box.



Selecting the **ACCEPT** button opens the **Active Project: Copying** window.



Entering the new Project Name in the highlighted text box removes the highlighting.



Select the **ACCEPT** button to return to the **Active Project Details** window.



From this window choose any parameter which requires editing and follow the same procedures described above for creating a new Project.



Selecting the **SAVE** button saves the new Project Details and closes the **Active Project: Copy** window and opens the **Home Screen**.



Selecting the **CLOSE** button before saving will delete any information added to the Project Details before closing the **Active Project: Copy** window.

5.8.4. Renaming a Project

The Project Name can be changed by the following procedure.



From the **Home Screen**, selecting the **PROJECT** button, then the **EXISTING** button opens the **Project Details** window. Select a Project to be renamed.



Select the **ACCEPT** button to display the **Active Project Details** window.



Selecting the **NAME** button opens the **Project Name** window.



Selecting the **RENAME** button opens the **Rename** window. Enter the new Project Name in the text box.





Selecting the **CLOSE** button cancels the Rename, closes the **Rename** window, and return the **Active Project:** window.



Selecting the **SAVE** button saves the new Project Name, closes the **Rename** window, and opens the **Project Name** window.



Selecting the **ACCEPT** button closes the **Project Name** window and returns the **Active Project** window.



Selecting the **SAVE** button closes the **Active Project** window and returns to the **Home Screen** displaying the new Project name as the Active Project.

5.8.5. Deleting a Project

Projects with or without collected data can be deleted if desired. There are two different methods which can be utilized for deleting a Project:

1. Complete Deletion; and
2. Deletion after Archiving.

5.8.5.1. Completely Deleting a Project

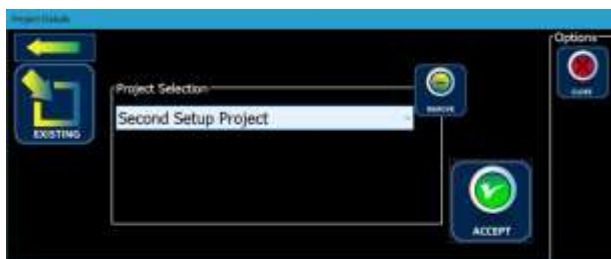
The following procedure should be followed when it is desirable Care should be exercised before deleting any Project, as once the Project is deleted, there is no way to “undelete” or recover the Project. A Project which is currently active can’t be deleted and attempting to delete an active Project will result in the **Delete Error** window below.



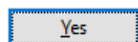
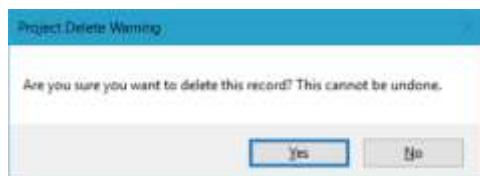
To delete a Project, first ensure that a different Project is designated as Active. The Active Project is displayed in the **Home Screen** window Title Bar.



From the **Home Screen**, selecting the **PROJECT** button, then the **EXISTING** button opens the **Project Details** window. Select the Project to be deleted (“Second Setup Project” in this example).

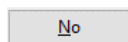


Selecting the **REMOVE** button display the following **Project Delete Warning** window.



Selecting the **Yes** button deletes the Project and displays the **Active Project Details** window.

Note: Selecting the **Yes** button permanently deletes that Project and all relevant files and this action **cannot** be undone or un-deleted.



Selecting the **No** button cancels the Delete and displays the **Project Details** window.



Selecting the **CLOSE** button closes the Project Details window and displays the **Home Screen** window.

5.8.5.2. Archiving and Deleting a Project

The Archive and Deletion feature permits the user to reduce the number of Projects which appear in the Project dropdown box and can be accessed through the ECHO-3D software. Once Archived the Project can be re-imported and accessed. The following starts from the **Tools Screen** window.




Selecting the **EXPORT** button opens the **Export Project & Data** window. Multiple Projects may be selected to Export from the list by selecting the appropriate checkboxes (placing a checkmark in

each box) to the left of the Project Name. Note that selecting any portion of the text line of the checkbox will place a checkmark in the box. Selecting a file tagged for Export will deselect that file.



 Selecting the **Select All** button selects all Projects.

 Selecting the **Deselect All** button deselects all selected Projects.

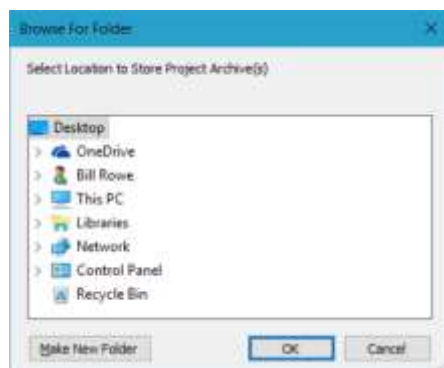
Selecting the **Delete Project After Export** checkbox deletes the selected Projects from the Projects dropdown list and removes it from the ECHO-3D environment.



Selecting the **CLOSE** button cancels the Export process and closes the window.

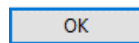


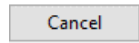
Selecting the **ACCEPT** button opens the **Browse For Folder** window.



Browse through the file directory and select the desired folder where the files will be exported to.

 Selecting the **Make New Folder** button permits the user to create a new folder if required using standard Windows protocol.

 Selecting the **OK** button performs the Export and deletion if selected. The Export function creates a single proprietary file for each Project with the “e3denc” extension.

 Selecting the **Cancel** button cancels the operation and closes the window.

The archived files can then be re-activated or re-installed in ECHO-3D using the Import function as described in Section 16.2 Importing a Project.

5.9. Working with a Zone

Zones are the sample areas to be scanned. They can be created, edited, and deleted as required, prior to, or during execution of a Project. Zones are linked to a Project and each Project must have at least one Zone. A Project must exist and be the active Project for an Zone to be added or any Zone edited.

Once an Active Project with more than one Zone is selected the **SELECT ZONES** button displays in the Home Screen window.



Selecting the **SELECT ZONES** button opens the **Select Defect Zones** window. For more information see Section 5.9.3 Select an Active Zone.

5.9.1. Adding a Zone

The following procedure describes creating a Zone without a Gen II Sensor connected to the PC or Tablet. ECHO-3D must have an active Project selected before Zones can be accessed. The following procedure starts at the **Home Screen** window.



Selecting the **PROJECT** button opens the **Project Details** window.





Selecting the **EXISTING** button opens the **Active Project** window. Choose the Project for which the Zone needs to be created.



Selecting the **ACCEPT** button to opens the **Active Project** window. Edit any Project details which may require editing as previously discussed until all details are correct. The Active Project window appears as follows.



Selecting the **ZONES** button opens the **New / Edit Defect Zone** window. The window opens in the **New Defect Zone** tab.

New / Edit Defect Zone

New Defect Zone | Edit Defect Zone | Select Defect Zone

Zone ID: [Yellow Highlighted Field]

Technician Notes: [Text Field]

Lift-Off: [0.00]

Zone Location From Datum

Units: [mm] | "X" Datum: [0] | "Y" Datum: [0]

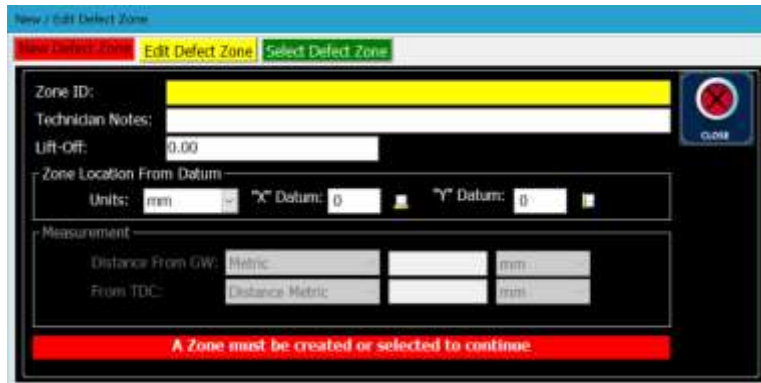
Measurement

Distance From GW: [Metric] [mm]

From TDC: [Distance Metric] [mm]

[CLOSE]

If no Zone exists, a Zone must be created before the window can be closed. Attempting to close this window without a Zone will result in the following error message.



The screenshot shows the 'New / Edit Detect Zone' window. At the top, there are three tabs: 'New Detect Zone' (highlighted in red), 'Edit Detect Zone' (highlighted in yellow), and 'Select Detect Zone' (highlighted in green). The window contains several input fields: 'Zone ID:' (a yellow text box), 'Technician Notes:' (a white text box), 'Lift-Off:' (a white text box with '0.00' entered), and 'Zone Location From Datum:' (a section with a 'Units:' dropdown set to 'mm', and 'X' Datum:' and 'Y' Datum:' text boxes, both with '0' entered). Below these is a 'Measurement' section with 'Distance From GW:' and 'From TDC:' labels, each followed by a 'Distance Metric' dropdown and a 'mm' unit box. A red banner at the bottom of the window displays the error message: 'A Zone must be created or selected to continue.' A 'CLOSE' button with a red 'X' icon is in the top right corner.

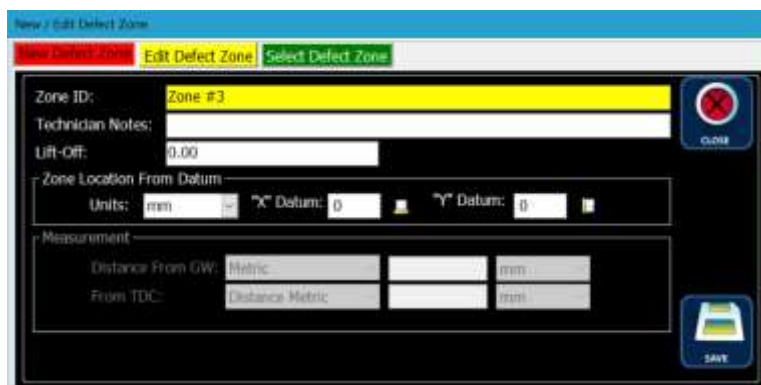
Enter the Zone ID, then any Technician Notes to a maximum of 50 characters. Technician Notes should at least establish the reference datum.

Lift-Off must be pre-measured using Lift-Off Mode as described in Section 5.11.3 and must be entered in millimetres (mm).

For non-piping applications, the **Zone Location From Datum** box establishes the position of the scan from the datum. The **Units** dropdown box permits the choice of millimetre (mm), centimetre (cm), or metre (m). Regardless of the selected value, the displayed units are always millimetres (mm). Values up to 10 characters can be entered into the **“X” Datum** and **“Y” Datum**. Conventional US (aka: Imperial) units are currently not supported for plate scanning.

For piping and pipeline applications, position of the Zone from the datum is established in the Measurement area. From Girth Weld offers 2 choices: Metric, and Imperial. From TDC offers 4 choices: O-Clock, Degrees, Distance Metric, and Distance Imperial.

After entering any text in a text box the **SAVE** button appears in the lower right corner. Enter all required values in the appropriate boxes.



This screenshot shows the same 'New / Edit Detect Zone' window, but now with data entered. The 'Zone ID:' field contains 'Zone #3'. The 'Lift-Off:' field still shows '0.00'. The 'Units:' dropdown is still 'mm', and the 'X' and 'Y' Datum fields still show '0'. In the 'Measurement' section, the 'Distance From GW:' dropdown is set to 'Metric' and the 'From TDC:' dropdown is also set to 'Distance Metric'. A 'SAVE' button with a floppy disk icon is now visible in the bottom right corner. The 'CLOSE' button remains in the top right corner.



Selecting the **SAVE** button saves the Zone details and closes the **New / Edit Detect Zone** window.

5.9.2. Editing a Zone

Several different modes can be initiated to edit a Zone. These being:

1. Edit existing text;
2. Clearing collected data;
3. Renaming;
4. Copying; and
5. Remove (delete).

5.9.2.1. Editing Zone Text

Editing an existing Zone can be accomplished by selecting the **Edit Defect Zone** tab in the **New / Edit Detect Zone** window. In the **Zone ID** box, click the **v** and select the Zone you want to edit. The other text boxes are populated. To edit, over-write the values in the desired text boxes.




The screenshot shows the 'New / Edit Detect Zone' window. The 'Edit Defect Zone' tab is active. The 'Zone ID' dropdown is set to 'Zone 1'. The 'Technician Notes' field is empty. The 'Lift-Off' field is set to '0.00'. The 'Zone Location From Datum' section shows 'Units: mm', 'X Datum: 0', and 'Y Datum: 0'. The 'Measurement' section has 'Distance From GW: Metric' and 'From TDC: Distance Metric'. On the right, there are buttons for 'CLOSE', 'RENAME', 'CLEAR ZONE', 'COPY', 'REMOVE', and 'SAVE'.



Selecting the **SAVE** button saves the Zone details and closes the **New / Edit Detect Zone** window.

5.9.2.2. Clearing Zone Data

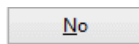
Data collected for a Zone may be deleted. This can be accomplished by selecting the **Edit Defect Zone** tab in the **New / Edit Detect Zone** window. In the **Zone ID** box, click the **v** and select the Zone you want to remove the data from.



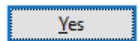
This screenshot is identical to the one above, showing the 'New / Edit Detect Zone' window with the 'Edit Defect Zone' tab selected. The 'Zone ID' is 'Zone 1', 'Lift-Off' is '0.00', and the 'Measurement' section shows 'Distance From GW: Metric' and 'From TDC: Distance Metric'.



Selecting the **CLEAR ZONE** button removes all collected data (Run information) whilst leaving the basic Zone information intact. The following message appears.



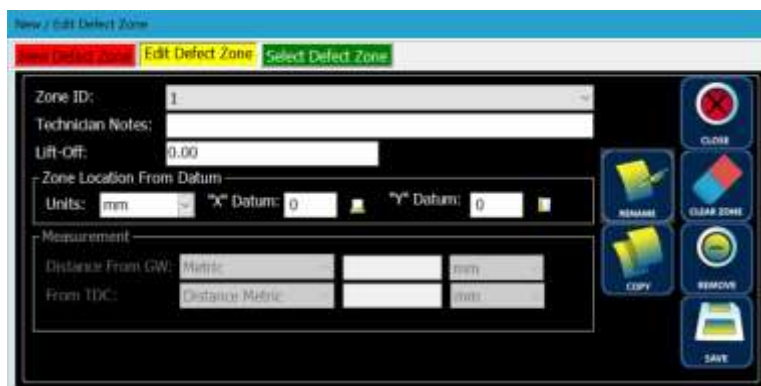
Selecting the **No** button cancels the delete action.



Selecting **Yes** button deletes the collected Run data.

5.9.2.3. Renaming a Zone

The name of a Zone can be changed by selecting the **Edit Defect Zone** tab in the **New / Edit Defect Zone** window. In the **Zone ID** box, click the **v** and select the Zone you want to rename. The other text boxes are populated.



Selecting the **RENAME** button open the **Rename** window. The new Zone name can be entered in the text box.



Selecting the **CLOSE** button cancels the Rename, closes the **Rename** window, and returns the **New / Edit Defect Zone** window.



Selecting the **SAVE** button saves the new Zone name, closes the **Rename** window, and returns the **New / Edit Defect Zone** window displaying the new Zone name.

The screenshot shows the 'New / Edit Defect Zone' window. It has a title bar and three tabs: 'New Defect Zone' (red), 'Edit Defect Zone' (yellow), and 'Select Defect Zone' (green). The 'Edit Defect Zone' tab is active. The form contains the following fields: 'Zone ID:' with a dropdown menu showing 'Zone 1'; 'Technician Notes:' with a text area; 'Lift-Off:' with a numeric input field showing '0.00'; 'Zone Location From Datum' section with 'Units:' set to 'mm', and 'X' Datum' and 'Y' Datum' each with a numeric input field showing '0'; a 'Measurement' section with 'Distance From GW:' and 'From TDC:' each having a 'Metric' label and two input fields; and a 'Distance Metric' label with two input fields. On the right side, there is a vertical stack of buttons: 'CLOSE' (red X), 'RENAME' (blue folder), 'COPY' (yellow folder), 'SAVE' (green folder), 'CLEAR ZONE' (red X), 'REMOVE' (green X), and 'SAVE' (green folder).

5.9.2.4. Copying a Zone

Zones may be copied to aid in creating multiple Zones with similar information.



Selecting the **COPY** button opens the **Rename** window. Enter the new Zone Name in the text box.

The screenshot shows the 'Rename' window. It has a title bar and a single text input field. Below the input field are two buttons: 'CLOSE' (red X) and 'SAVE' (green folder).



Selecting the **CLOSE** button cancels the Rename, closes the **Rename** window, and returns the **New / Edit Defect Zone** window.



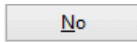
Selecting the **SAVE** button saves the new Zone name, closes the **Rename** window, and returns the **New / Edit Defect Zone** window displaying the new Zone name.

This is a duplicate of the screenshot above, showing the 'New / Edit Defect Zone' window with the 'Edit Defect Zone' tab active. It contains the same fields and buttons as described in the previous screenshot.

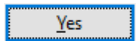
5.9.2.5. Deleting a Zone



Selecting the **REMOVE** button prompts the user to confirm the deletion.



Selecting the **No** button cancels the delete action.



Selecting **Yes** button deletes the selected Zone and confirms the deletion with the “**Zone Deleted Successfully. Select or Create a Zone.**” Message.



Selecting the **CLOSE** button closes the **New / Edit Defect Zone** window. Attempting to delete all Zones will display the following “**You must keep at least 1 Zone.**” error message. Attempting to delete the Active Zone will display the following “**You can not delete the active zone.**” error message. Attempting to Close the window without selecting a Zone will display the following “**A Zone must be created or selected to continue**” message.

5.9.3. Select an Active Zone

A Zone must be tagged as Active before any data can be collected and stored. To simply tag a Zone as Active, select the **Select Defect Zone** tab. This opens the **Select Defect Zone** window which displays any Zone created for the current Project.



Select (highlight) the desired Zone. A checkmark in the checkmark box confirms the selection.



Selecting the **SELECT** button tags that Zone as the Active and closes the **New / Edit Detect Zone** window.

Anytime the Project Details window is closed and the Project contains more than one Zone without an Active Zone, the **Select Defect Zone** window will display. Select (highlight) the desired Zone.



Selecting the **ACCEPT** button sets the highlighted Zone as the Active Zone and adds a checkmark to the checkmark box to confirm the selection.



Selecting the **CLOSE** button cancels the action and closes the window. It should be noted that at least one Zone must be Active.

5.10. Operating ECHO-3D with Gen II Sensor

All ECHO-3D software features functional without a Gen II Sensor connected to the Tablet or PC are also functional with the Sensor connected. Operating the software with a Sensor connected enables many additional features.

Although testing has shown the ECHO-3D Gen II Sensor and software to be functional on different Windows based Personal Computers (PC), operating with any PC other than the Athena provided Dell Latitude 12 Rugged Tablet operating on the Microsoft Windows 10 Pro occurs at the user's risk. Care should be exercised when connecting to a PC other than the Tablet. The Sensor power requirements

approach the maximum permitted for USB 2.0 port. If available, utilizing a USB 3.x port or a USB 2.0 with charging capability is preferred. Figure 4 below will help identifying USB port types.





Colour		Description
	Black or white	USB 1.x or USB 2.0
	Blue (Pantone 300C)	USB 3.0
	Teal blue	USB 3.1
	Yellow, orange or red	Ports only. High-current or sleep-and-charge

Figure 4 - USB Port Colour Codes

To connect the Gen II Sensor simply plug one end of the USB Interface Cable into the Sensor and the other to a Tablet or other Windows computer with a USB 2.0 compatible port. When connected, the Active Channel light will cycle through the four selectable Lead Channels and will stop at Channel-0, even without ECHO-3D software running. If the ECHO-3D software is running, the Active Channel light for the selected Lead Channel will be illuminated.

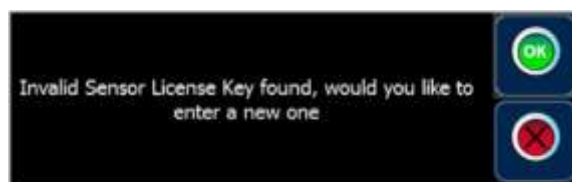
Operations of the ECHO-3D system should be suspended anytime noticeable damage occur to the Sensor, Encoder, or Interface Cable occurs or anytime the Sensor fails a Health Check. Should this occur contact our general e-mail address service@athenaindustrial.com or telephone our toll free, 24-hour help line at 1-866-787-9555.

5.10.1. Starting ECHO-3D with Gen II Sensor

Although connecting the Gen II Sensor to the Tablet with the software application operating is possible, it is best practise to always connect the Sensor to the Tablet or PC prior to starting up the ECHO-3D software. Upon connecting the Sensor to a live USB 2.0 port the Sensor will perform self-diagnostics and indicate proper functioning by cycling through the four possible Lead Channels, illuminating each Channel LED in the Sensor cover, one at a time until all four Channels have been illuminated. Afterwards, Lead Channel-0 remains illuminated until the USB power is terminated, or a different Lead Channel is selected.

5.10.1.1. Licensing

Sensors are protected from unauthorized use by a License Key. Anytime a Sensor is connected to a new Tablet or other Windows based computer it will be necessary to validate the Sensor License Key. Each Sensor has a unique License Key which is provided at time of delivery. The License Key for a Sensor only needs to be entered once for each Tablet or PC that the Sensor will be connected to, regardless of the number of computers used. If an issue with activating a Sensor persists, contact Athena Industrial Services for assistance. After starting ECHO-3D with the unlicensed Sensor connected the following message will appear.



Selecting the **CLOSE** button closes the message window and opens the Home Screen window in **Unlicensed** mode.



Selecting the **OK** button closes the message window and opens the **Sensor Registration Information** window.

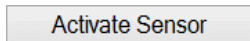
The 'Sensor Registration Information' window contains the following fields and controls:

Customer Name	Athena Industrial Services
Sensor Serial #	G2-S00007
Sales Order Number	LS-00011
Registration Date	2016/09/13 14:11:55

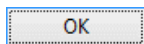
Sensor Activation

Sensor License	[Yellow Highlighted Box]	Activate Sensor
----------------	--------------------------	-----------------

Enter the Sensor License Key in the highlighted text box. Care should be exercised to ensure the Key is entered exactly as provided.



Selecting the **Activate Sensor** button displays the following message to confirm Sensor activation.



Selecting the **OK** button closes the **Complete** message window and the **Sensor Registration Information** window. Licensing is now complete and should not need to be relicensed again unless the License Key expires or the Sensor is connected to a new Windows computer.

5.11. Home Screen

The **Home Screen** window is similar in appearance to that without a Sensor connected except there is a second row of buttons. Unlike without a Sensor, and buttons are active when a Sensor is connected as appears as follows.



The window is divided into three zones: a left side status/button bar; a main screen area; and a right-hand status/button bar. Although the information and buttons displayed in the side bars varies depending on the main window, the status area the bottom left hand corner displays battery charge level and below a display bar showing Sensor connection status (**Connected** , **Unlicensed** , or **Disconnected**) . This is consistent for all windows used by ECHO-3D.



Regardless of the current window, the **Home** button always appears in the top left hand corner. Selecting the **Home** button always returns the user to the **Home Screen** window.

5.11.1. Radar Mode

Radar Mode is a live graphic interpretation of the measured EMF during sampling. Radar is a useful tool and can be used to: detect defect locations; determine defect orientation; or find a clean area of the sample for Compensating. It also helps the user to visualize how the EMF changes with differing sample characteristics.

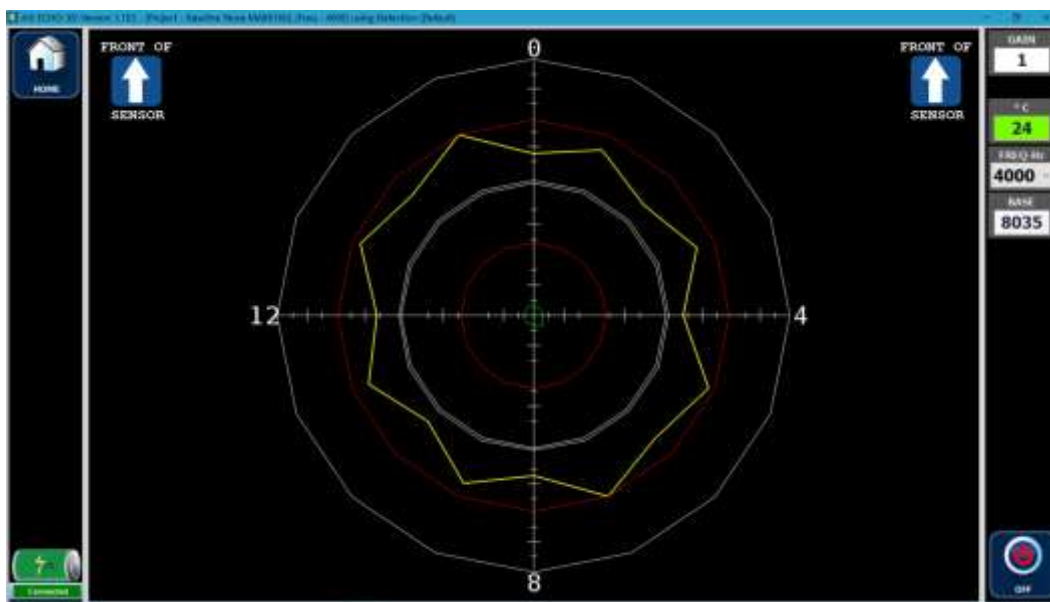


Figure 5 - Uncompensated Radar on Carbon Steel Plate

Radar is a circular or polar graph which displays both Amplitude and Phase values detected by all sixteen Transceiver Channels of the Sensor. The larger red circle represents the baseline for Amplitude and the smaller red circle represents the baseline for Phase. The white circles represent the full-scale maximum and minimum allowable values, with the minimum for Phase being the origin (0,0) or intersection of the two axes. The yellow “circle” is the measured differential value of the amplitude, and the green “circle” is the measured differential of the phase. Figure 5 above shows the Sensor response on a flat plate of carbon steel after having been Free-air Compensated.

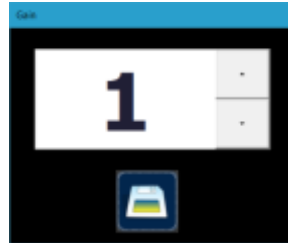
The ECHO-3D software triggers Shots to be taken at timed intervals so an encoder signal is not required for operation in this mode.



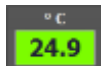
From the **Home Screen**, selecting the **RADAR** button initiates Radar Mode.



Selecting the **GAIN** button in the top right-hand corner opens the **Gain** window. Each selection of the ▲ button increases the Gain by 1. Each selection of the ▼ button decreases the Gain by 1. The Gain may also be entered directly into the text box by first highlighting the Gain value and entering a new value from the keyboard. Gain can be any integer value from 1 to 15, with the default Gain setting being 1.



Selecting the **Save** button saves the change to the new setting.



Displays the current Sensor Core Temperature in degrees Celsius (°C). Normal operating temperatures are displayed in green. If Sensor temperature is approaching the lower or upper limits the display will turn yellow as a precautionary measure. This occurs at below -15°C [5°F] or above 65°C [149°F]. Should the temperatures reach the lower operating limit of -20°C [-4°F] or the upper limit of 80°C [176°F], the display will turn red and the Sensor should be removed from service to prevent damage to the Sensor.



The **FREQuency-Hz** defaults to 4,000 Hz on initialization. The Frequency can be changed by selecting the ▼ to open the dropdown list. Frequencies of 600, 800, 1000, 2000, 4000, and 8000 Hz are available.



BASE displays the Base value. The initial Base number displayed is zero (0) as a reminder to the user to perform a Compensation. Selecting the **BASE** button or the Sensor **C** button performs a Compensation which is confirmed by a sound byte.

Figure 6 below shows the result from Compensating on the carbon steel plate and approaching a crack. Notice the change in the shape.

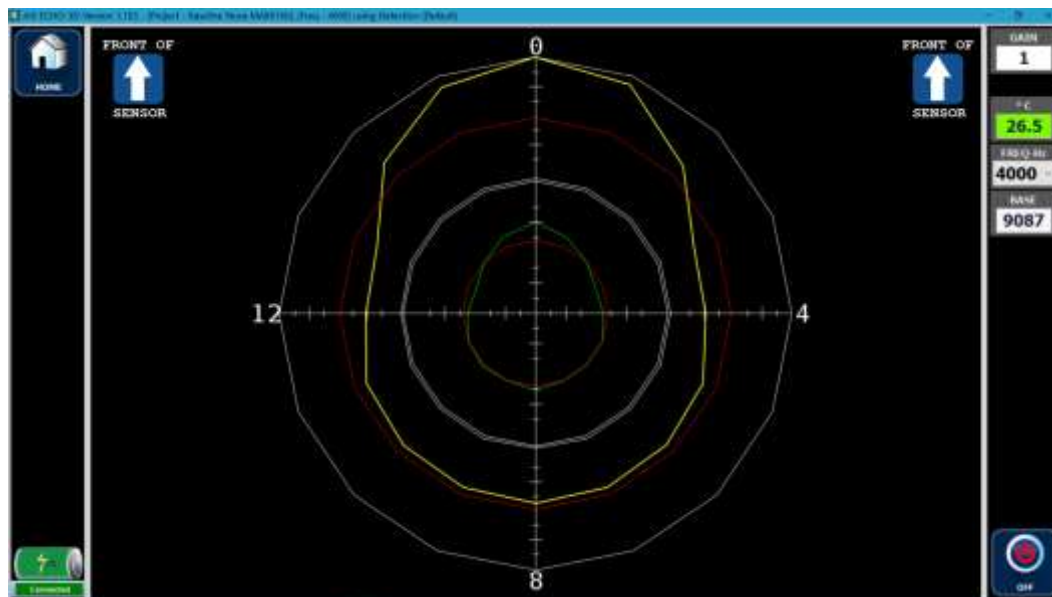


Figure 6 - Radar Approaching a Crack

As the Sensor passes over the crack or surface breaking anomaly the graph continuously changes shape as the differently positioned receivers pass over the defect.

5.11.2. Depth Mode

Depth Mode utilizes the Lead Channel to determine the depth in millimetres (mm) of a crack. Two distinct operational methodologies are available in Depth Mode: with and without an Active Project selected.

With no Active Project selected a default Depth Project is initiated. Upon start-up, the following parameters are preselected:

- Material Type = Carbon Steel
- Frequency = 4,000 Hz (as defined by the Material Type)
- Lead CH = 0
- Threshold = 0
- Lift-Off = 0

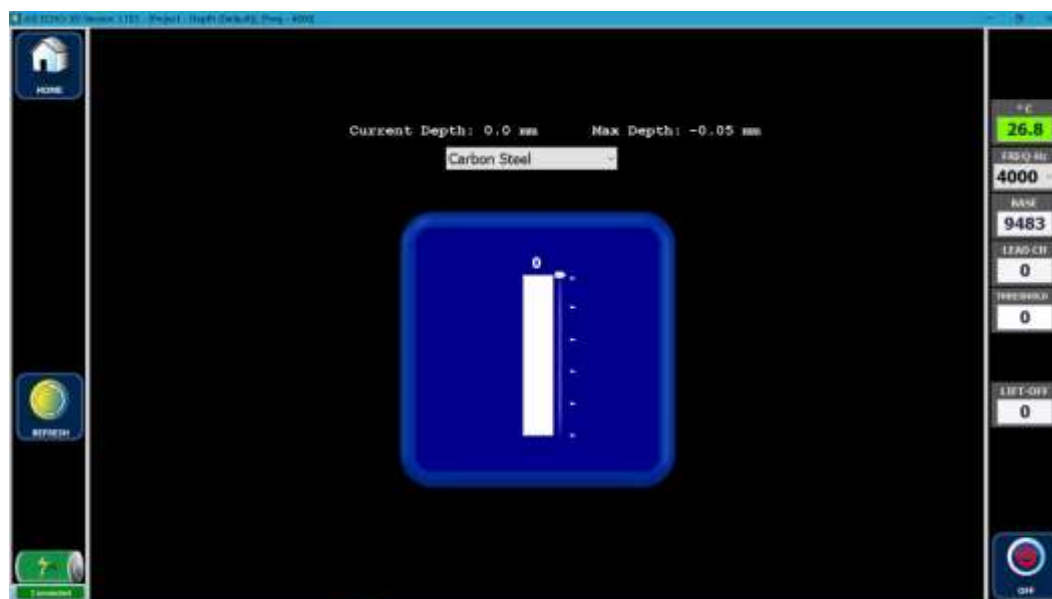
The ECHO-3D software triggers Shots to be taken at timed intervals and an encoder signal is not required for operation in this mode.

This mode is for preliminary examinations only and no data is recorded nor can screen shots be stored to a Project.

With an Active Project selected the above parameters are initially set to the values saved in the Active Project. With an Active Project, Zones can be selected, screen shots, and photos taken by the rear facing camera can be saved to the Active Project.



Selecting the **DEPTH** button opens the **Depth** window.



The Depth Gauge bar graph displays the Lead Channel and Current Depth detected and is an uncalibrated visual aid to help position the Sensor over the crack. Scanning over the same area several times improves the accuracy of the Depth measurement. The Current and Max Depth values are displayed in millimetres (mm) above the bar graph.

The correct Material Type must be selected from the dropdown box displayed immediately above the Depth Gauge. The displayed Material when the window originally opens is the Material selected for the Active Project. Any current Material Type can be selected from the dropdown menu by selecting the **v** button.



Selecting the **REFRESH** button clears the Max Depth value without Compensating the Sensor.



Displays the current Sensor Core Temperature in degrees Celsius (°C). Normal operating temperatures are displayed in green. If Sensor temperature is approaching the lower or upper limits the display will turn yellow as a precautionary measure. This occurs at below -15°C [5°F] or above 65°C [149°F]. Should the temperatures reach the lower operating limit of -20°C [-4°F] or the upper limit of 80°C [176°F], the display will turn red and the Sensor should be removed from service to prevent damage to the Sensor.



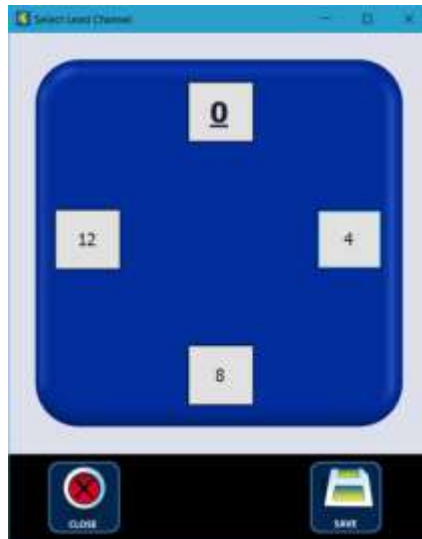
The **FREQuency-Hz** established from the Material Type is displayed in the right-hand tool bar.



BASE displays the Base value. Selecting the **BASE** button or the Sensor **C** button performs a Compensation, resets the **Max Depth** value, and is confirmed by a sound byte. The initial Base number displayed is acquired at the Sensor position when the Depth Mode window is opened.



LEAD CH displays the Lead Channel. Selecting the **LEAD CH** button opens the **Select Lead Channel** window.



Selecting the desired **Lead Channel** button shows the selected Channel as bolded and underlined text.



Selecting the **SAVE** button sets the Lead Channel to the selected channel and closes the **Select Lead Channel** window. The Lead Channel indicator (above the depth bar) changes to confirm the change in Lead Channel



Selecting the **CLOSE** button closes the **Select Lead Channel** window without changing the Lead Channel.



THRESHOLD controls the minimum depth to be displayed. It could also be described as a surface filter. That is, setting Threshold at 1.0, for example, will prevent any defect depth less than 1.0 mm from being displayed on the Depth Gauge or changing the Current Depth and Max Depth displayed. Selecting the **THRESHOLD** button opens the **Threshold** window. Each selection of the ▲ button increases the Threshold by 0.1. Each selection of the ▼ button decreases the Threshold by 0.1. Multiple integer values can be added or subtracted by selecting and holding appropriate ▲ or ▼ button. The Threshold may also be entered directly into the text box by first highlighting the Threshold value and entering a new value from the keyboard. Threshold can be any single decimal value from 0.0 to 9.0.



Keep in mind that the distance is in millimetres (mm) and any Threshold greater than 2.0 mm is not recommended.



LIFT-OFF displays the Sensor lift-off. Selecting the **LIFT-OFF** button opens the **Lift-Off** window. Each selection of the ▲ button increases the Lift-Off by 0.1. Each selection of the ▼ button decreases the Lift-Off by 0.1. Multiple integer values can be added or subtracted by selecting and holding appropriate ▲ or ▼ button. The Lift-Off may also be entered directly into the text box by first highlighting the Lift-Off value and entering a new value from the keyboard. Lift-Off can be any single decimal value from 0.0 to 30.0.



Keep in mind that this distance is in millimetres (mm) and any Lift-Off greater than 15 mm is not recommended.

5.11.3. Lift-Off Mode

The Gen II Sensor has the capability to accurately measure Lift-Off. Lift-Off measurement is independent of Frequency, but is dependent on: Base, Lead Channel, and Material Type. Care should be exercised to wait sufficiently for the Lift-Off value to stabilize before establishing the Lift-Off value. Lift-Off operates in two methodologies: with and without an Active Project selected.

With no Active Project selected a default Lift-Off Project is initiated. Upon start-up, the following parameters are preselected:

- Material Type = Carbon Steel
- Lead CH = 0

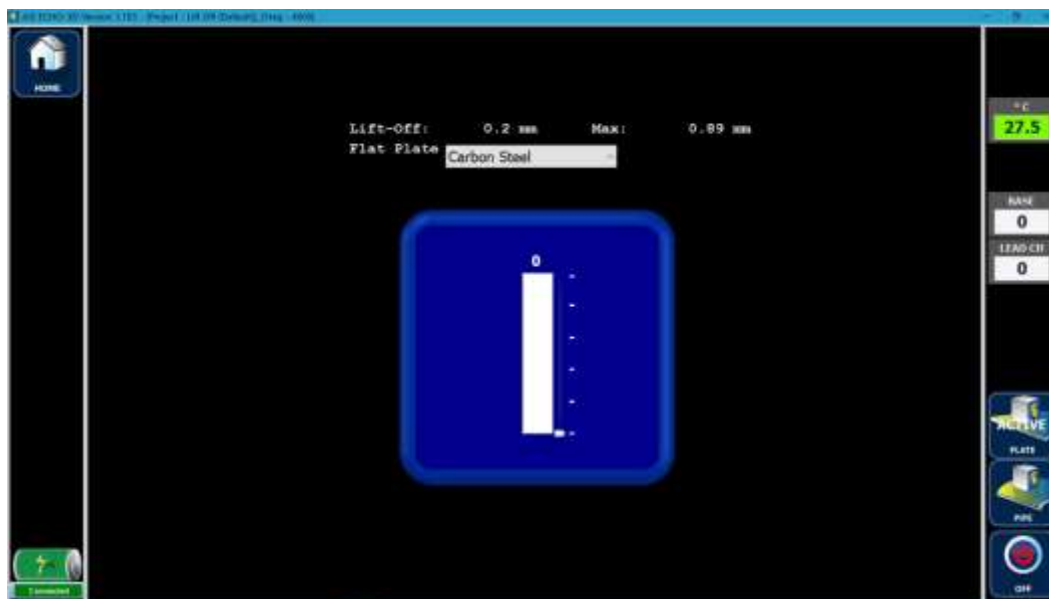
This mode is for preliminary examinations only and no data is recorded nor can screen shots be stored to a Project.

With an Active Project selected the above parameters are initially set to the values saved in the Active Project. With an Active Project, screen shots and photos taken by the rear facing camera can be saved to the Active Project.

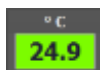
The accuracy of smaller lift-offs is effected by the grain structure of the base material. Initiating a Compensation when the Sensor is resting on the sample material (actual Lift-off is zero) nulls the material effects and zeroes the Lift-off scale. Accuracy in higher lift-off values is not effected by grain orientation.



Selecting the **LIFT-OFF** button opens the **Lift-Off** window. The bar graph provides a visual indication with full scale being 25.7 mm [1.012"] and the Lift-Off value is displayed immediately above the graph.



The correct Material Type must be selected from the dropdown box. The displayed Material when the window originally opens is the Material selected for the Active Project. Any current Material Type can be selected from the dropdown menu by selecting the ▼ button.



Displays the current Sensor Core Temperature in degrees Celsius (°C). Normal operating temperatures are displayed in green. If Sensor temperature is approaching the lower or upper limits the display will turn yellow as a precautionary measure. This occurs at below -15°C [5°F] or above 65°C [149°F]. Should the temperatures reach the lower operating limit of -20°C [-4°F] or the upper limit of 80°C [176°F], the display will turn red and the Sensor should be removed from service to prevent damage to the Sensor.



Base displays the Base value. Selecting the **Base** button or the Sensor **C** button performs a Compensation and zeroes the Lift-off scale which is confirmed by a sound byte. This function should only be used when the Sensor can be placed over a section of the sample that has had the coating or insulation removed in rests directly on the sample. If a bare sample is not available, do not Compensate as this will nullify the lift-off detected by the Sensor. Base is displayed a zero (0) when Lift-Off Mode is initiated as a reminder to perform a Compensation before proceeding with any defect depth measurement.



LEAD CH displays the Lead Channel. For **PLATE**, all sixteen channels are used to determine Lift-off and selecting the **LEAD CH** has no result. For **PIPE**, selecting the **LEAD CH** button opens

the **Select Lead Channel** window. Selecting the correct Lead Channel for pipe is important as lift-off corrections are made to account for the surface curvature of the pipe.



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Selecting the desired **Lead Channel** button shows the selected Channel as bolded and underlined text.



Selecting the **SAVE** button sets the Lead Channel to the selected channel and closes the **Select Lead Channel** window.



Selecting the **CLOSE** button closes the **Select Lead Channel** window without changing the Lead Channel.



Selecting the **PLATE** button activates Lift-Off in the Flat Plate Mode and is indicated with an **ACTIVE** label.



Selecting the **PIPE** button activates Lift-Off in the Pipe Mode and is indicated with an **ACTIVE** label. When active, collected data is automatically adjusted for the surface curvature of the pipe as determined by the Pipe Size selected in Project Details Material.

5.12. Scan Mode

Scan Mode is used for scanning operations. Since data will be recorded, an Active Project and a Active Zone must be selected prior to initiating Scan Mode. If Scan Mode is selected without an Active Project and a Current Zone, Depth Mode will be initiated.

In Scan Mode, the ECHO-3D software triggers Shots based on distance rather than time and an encoder signal, either from a single-axis encoder or dual-axis scanner, is required.

The following procedure starts from the **Home Screen window** and assumes the Project has already been created. See the Working with Project section for details on creating a new Project.



Selecting the **Create a New Project** button opens the **Project Details** window.



Selecting the **EXISTING** button opens the **Project Details** window.



Selecting the **v** opens a dropdown box from which the desired Project can be selected (highlighted).



Select the **ACCEPT** button to accept that Project as the Active Project. This opens the **Active Project** window.



Selecting the **ZONES** button opens the **New / Edit Defect Field** window. The window opens in the **New Defect Zone**. Select the **Select Defect Zone** tab and highlight the desired Zone.





Selecting the **SELECT** button tags that Zone as the Active Zone and closes the **New / Edit Detect Field** window.



Selecting the **CLOSE** button closes the **Add / Modify Client Details** window.

A Project always requires an Active Zone. Attempting to close the **Add / Modify Client Details** window without an Active Zone will result in the following message.



Selecting the **SCAN** button with an Active Project opens the **Scan** window. The Title Bar displays the Active Project, the Active Zone, and the Frequency. The widow varies depending on whether a single-axis encoder or dual-axis scanner is being used for the Scans.



See Section 12 Scanning View Modes for details on the **Scan** window.

6. ECHO-3D Hardware

The hardware of the ECHO-3D system is comprised of two basic components:

- The ECHO-3D Generation II (Gen II) Sensor
- The Dell Latitude 12 Rugged Tablet with ECHO-3D software

6.1. Generation II Sensor

Figure 7 shows the Gen II Sensor from the front or button side without a Shoe installed. The Sensor housing is fitted with two protrusions on each side used for retaining the Shoe when installed. In between

the protrusions are three lines imbedded into the case. The lines coincide with the centre of each signal receiver and mark the relative positions of each Lead Channel.



Figure 7 - Gen II Sensor Front Side



Figure 8 - Gen II Sensor Back Side

The three push-button momentary switches are colour coded and utilized as follows:

1. **C** Black “C” – Compensate
2. **M** White “M” – Mode Control
3. **R** Red “R” – Record

The back or connector side of the Sensor, shown in Figure 8, is fitted with two electrical multi-conductor quick-disconnect terminals for connection with the Tablet and the ECHO-X Encoder. Each connector is colour coded: the 6-pin Encoder connector is coded red; the 5-pin data connector is coded blue. The connectors are push-on and keyed so that the correct pins align when connected. The connectors are released by pulling back of the connector sleeve. The ECHO-X Encoder can be easily attached or removed from the Sensor. Additional interface cables to the Encoder connector are available for the Jireh *STIX*, *SKOOT*, and *NAVIC* scanners, and Olympus MapSCANNER and MapROVER scanners.

Each of the other two sides of the Sensor is fitted with a 12.8 mm [0.500"] diameter receptacle for yoke mounting of the Sensor to a scanner or other holding device.

No operator serviceable components are found within the sensor housing.

6.1.1. Compensate Switch

C The Gen II Sensor is designed to measure the changes in the electro-magnetic field generated by the Sensor. To simplify the collection of data used in the analysis of cracks, corrosion, and SCC, the Base effects of the material structure and geometric shape must be eliminated or reduced. This process is akin to pressing a “Tare” button on an electronic weight scale. Pressing the black Compensate button nulls out the effects of the parent material making it possible to easily identify field fluctuations caused by cracks, SCC, and other surface breaking anomalies. A sound byte confirms that Compensation has successfully occurred.

Compensating in a good or bad location effects the results of a scan. Ideally the operator should find a good sample of parent material void of any defects of reduction in thickness from erosion or corrosion. Compensation techniques are discussed in greater detail later in the Scanning Techniques section.



Selecting the **Base** button also performs a Compensation and is confirmed with a sound byte.

In Radar Mode, the effects of Compensation are quite noticeable. Figure 9 below shows the Radar screen after the Sensor is Compensated in free-air and then placed on a carbon steel plate. Figure 10 below shows the Radar screen after Compensation. Edge effect can also be eliminated with Compensation.

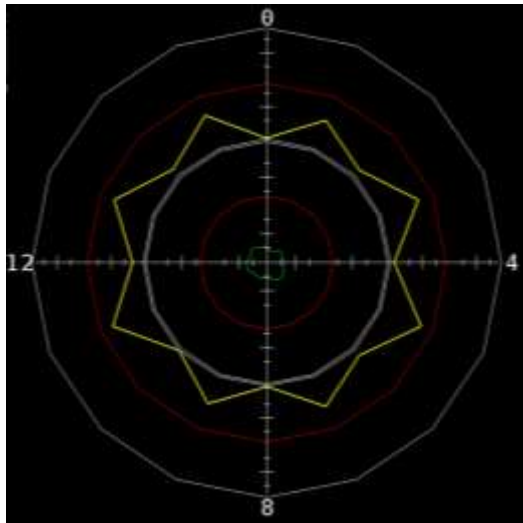


Figure 9 - Before Compensation

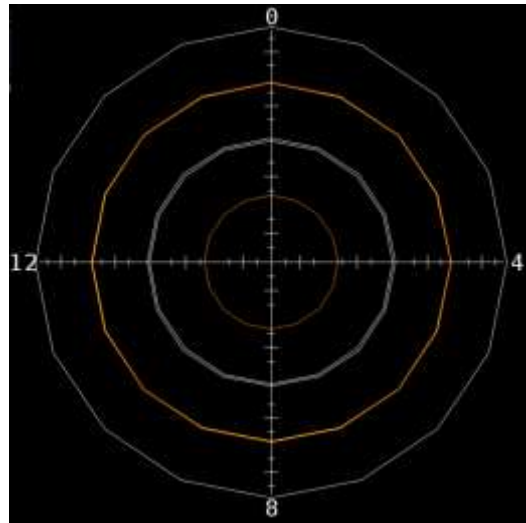


Figure 10 - After Compensation

6.1.2. Mode Switch

M The white Mode Switch currently is not fully utilized and is used only to abort Record On in Scan Mode when hand scanning with the ECHO-X Encoder. Aborting a Run using the Mode Switch should be performed with caution as no warning message is displayed prior to completing the abort.

6.1.3. Record Switch

R The red Record Switch is utilized only in 3D Viewer Mode and toggles the data Record function on and off. Audible feedback is provided as well as a change in colour of the **REC** button.



Red indicates data recording is not initiated. Selecting the **REC** button or pressing the Record **R** switch on the Sensor toggles the data recording on. Selecting the green **REC** button on the screen or pressing the Record **R** switch on the Sensor toggles the data recording off, changing the button colour to red.

6.2. Cables

The Gen II Sensor utilizes two interface cables. The actual cables required is dependent on the Encoder or Scanner chosen for the inspection process.

6.2.1. USB Cable

The USB Interface Cable provides power to the Gen II Sensor and transfers data from the sensor to the tablet. The sensor-end connector is a 5-pin Hirose Electric HR10A push-pull type and the tablet-end connector is a USB. The push-pull connector end is coded blue to match the receptacle on the sensor. The pin arrangement will not allow connection to the wrong receptacle.

Care should be exercised when coupling the connection. The connector is keyed and must be rotated until the key and keyway align. The connector should couple by applying only a slight inward force. Detaching the connector requires pulling back the locking collar and applying a slight outward force.

A special longer USB cable with length of 4.6 m [15 ft] is available for use with remote controlled scanners.

6.2.2. Encoder Cable

The Standard Encoder Cable is an integral part of the ECHO-X Encoder and provides the X-axis position input to the Gen II Sensor. The connector is a 6-pin Hirose Electric HR10A push-pull type. It is coded red to match the receptacle on the sensor.

Encoder Cables for the *STIX*, *SKOOT*, *NAVIC*, MapSCANNER, and MapROVER Scanners are designed to provide encoder signals to both the ECHO-3D Sensor and the Scanner Controller where necessary.

6.3. Sensor Shoe

The Sensor Shoe is a U-shaped device which installs onto the lower portion of the Sensor. It provides:

- The proper positioning of the Lead Channel and sensor stability on curved surfaces such as pipe or tube; and
- An interface to an X/Y-scanner

Shoes are available for all common pipe sizes from NPS 4 to 36 [DN 100 to 900]. Shoes can be mounted in any of four positions permitting the user to align different Transceiver Channels as the Lead Channel as necessary. Shoes are available with both centred (gold colour coded) and offset (blue colour coded) Lead Channels. Specialty Shoes can be provided on request for tubes, positioning close to welds, and other inspection demands. Figure 11 shows the standard Shoe Kit provided with each ECHO-3D system.

Each new ECHO-3D Kit contains ten different Shoes. Additional shoes are available on request. Users with access to a 3D printer may print their own additional shoes. Athena can provide sample 3D printer files or SolidWorks® 3D models from which printer files can be created.



Figure 11 – Standard Sensor Shoe Kit

Offset Shoes are primarily used for hand scanning and the bottom of each Offset Shoe side is protected by a polypropylene (PP) wear strip. Centred Shoes are primarily used for normal scanning operations in manual or automated scanners and each side is protected by tungsten carbide (WC) wear strips. Although these wear strips are quite durable, scanning performed in a powered scanner such as a *SKOOT* or *NAVIC* may result in increased wearing of the pads. PP Pads should be replaced before the Sensor wear pad comes in contact with the sample material. Failing to replace worn PP wear pads may result in Sensor damage. Tungsten carbide (WC) strips should not require replacement under typical operations.

7. Inspection Considerations and Techniques

Many different aspects of a new Project should be considered prior to conducting the inspection. Several of these considerations should be reviewed prior to the jobsite arrival to ensure the technician is ready to perform upon arrival.

7.1. Safety

All company, customer, site, and regulatory safety requirements should be considered and complied with for all jobsite work. The ECHO-3D Gen II Sensor and the provided Windows OS Tablet require no special considerations.

When using automated scanners, read, understand, and follow all operating procedures and safety precautions as provided in the scanner operating manual.

7.2. Sample Area Preparation

7.2.1. Environment

The inspection area should be suitably maintained for comfortable and safe conditions for the technician. Breathable air quality should be maintained and the area monitored for explosive potential. The sample area should be kept as dry as possible, and sheltered from direct rain or intense direct sunlight.

7.2.2. Accessibility

The area of interest must be exposed sufficiently to permit access by the sensor and its associated equipment. Whether hand scanning or machine scanning, a sufficient space must be available for the operator to perform the scanning operation and view the results on the Tablet as they are being generated.

7.2.3. Sample Surface Preparation

Surface preparation of the material to be inspected is not extensive. The sample area should be void of any loose debris and only a wipe-down is suggested to limit the contamination collection on the sensor and associated components. Removal of surface finishes such as paint or protective coatings is not usually necessary. Some rust-preventative coatings may contain zinc which can affect the EMF and these coatings may need to be removed to achieve best results. Other protective coverings such as wrapping may need to be removed if mechanical scanners are to be used.

Rough surfaces because of sandblasting or other surface preparation may result in excessive PP wear pad erosion on the Shoes. Special attention may need to be given to wear pad inspection and replacement. Athena recommends titanium soled Shoes for use with powered scanners such as Jireh *SKOOT* and *NAVIC*.

7.3. Selecting Lead Channel

The Gen II Sensor is equipped with 16 separate Transceiver Channels. These are equally positioned in a circular pattern near the base of the Sensor in a radial orientation. Only four Lead Channels are currently selectable, Channels 0, 4, 8, and 12. When sensing cracks in ferrous metals, the Channel perpendicular to the crack senses the greatest change in the EMF. The same is not true for other non-ferrous materials such as 300 Series stainless steels, where the Channel inline to the crack senses the greatest EMF variation.

The selected Lead Channel provides the data for display during the Scan acquisition. Although they are not initially displayed, all 16 channels are active during scanning operations, and can be displayed using the Analysis Tools after the Scan has been completed.

Typically, when hand scanning, the Sensor uses Ch-4 or Ch-12 whenever mapping longitudinal cracks typically found in weld seams and some SCC fields. Figure 12 shows the orientation of the 16 Transceiver Channels in respect to the Spartan Head logo on the top cover of the Gen II Sensor.

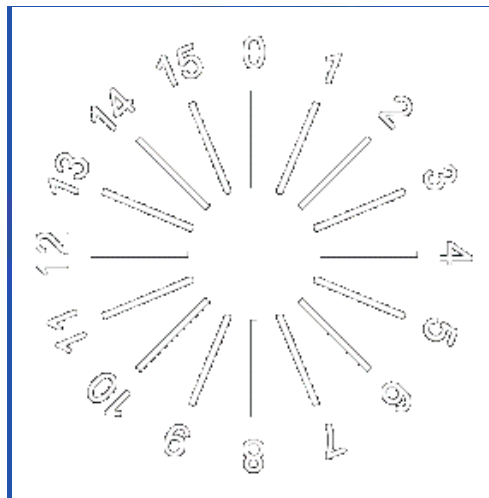


Figure 12 - Transceiver Channel Numbering

When scanning pipe with an automated scanner, Lead Channel-0 with a Centred Shoe is the preferred set-up. The chosen Lead Channel and should be installed in the scanner so that it is the leading channel on the first scanner pass. Lead Channel selection must be coordinated with Sensor Shoe selection and installation orientation. Both parameters must be properly selected before satisfactory results can be obtained.

7.4. Selecting Sensor Shoe

Sensor Shoe selection is dependant on the following variables:

- Geometry on the sample
- Location of the defect
- Type of defect
- Type of material
- Lead Channel selection
- Mapping method

Sensor Shoes are designed with witness marks to aid in determining the correct Shoe installation orientation for the selected Lead Channel. Witness marks are positioned to align with the centre of the Lead Channel and should be used to help position the Sensor close to a defect for Compensation. The witness marks can also be used to verify that the established Run length starts prior to, and ends past, the defect being mapped. Figure 13 below shows a typical Centred (blue) and Offset (gold) Shoes with their

witness marks. Offset (blue) Shoes are typically used with Depth Mode for hand detection of defects in ferrous metals. Centred (gold) Shoes are typically used in Scan Mode, on pipe, with a mechanical scanner.



Figure 13 – Typical Offset and Centred Shoes

Typically, Offset Shoes are used with hand scanning for initial defect detection. These Shoes utilize a polypropylene (PP) wear strip. Centred Shoes are more often used in scanners and utilize tungsten carbide (WC) strips.

7.4.1. Sample Geometry

The physical shape of the material to be sampled must be considered when considering which Shoe, if any, is appropriate to use. Materials which are flat or essentially flat do not necessarily require the use of a Shoe. Curved surfaces, such as pipe, need to use a specifically designed Shoe for the surface radius encountered. For pipe or tube, the Shoe keeps the Lead Channel perpendicular to the curved surface. Centred Shoes (gold) are designed to keep Ch-0 and Ch-8 as close to the sample surface as practicable. On pipe or tube, this arrangement would be utilized when detecting or mapping defects which occur circumferentially for carbon steels. Offset Shoes are designed to position either Ch-4 or Ch-12 (depending on Shoe orientation) closest to the sample surface and would typically be utilized for defecting longitudinal defects in carbon steel tube or pipe.

The above paragraph is written using the assumption that scanning will be performed using a single axis encoder, such as the ECHO-X Encoder, mounted to the backside on the Sensor. If the Sensor is to be mounted on a dual axis X/Y-scanner, the relationship between Lead Channel and Sensor Shoe becomes more complicated. This occurs because the Shoe can be mounted on the Sensor in four positions (sliding the Shoe on from any one of the four sides).

Other factors may need to be considered when selecting a Shoe. A common problem encountered is hand scanning of EFW pipe where the weld seam protrudes above the nominal pipe diameter. In this case a custom shoe is required – one that provides adequate Lift-Off so the Lead Channel clears the weld cap, yet allows for some radial movement around the pipe to permit several offset mapping Runs to be performed which will then result in the generation of a C-Scan map. In such conditions, Athena personnel can provide Shoes, Shoe printing files, or design guidance if the user prefers to design and print their own Shoes.

7.4.2. Defect Location

The location of a defect can influence the Shoe to be selected and how it is installed. Proximity of the defect to welds or fittings may necessitate choosing a specific Lead Channel, such as the closest Channel to the obstacle. The position of the obstacle may also prevent the use of an X/Y-scanner, requiring the

mapping to be performed by hand. If hand scanning is needed, Shoe and Lead Channel orientation needs to consider the use of a single axis encoder attached to the back of the Sensor.

7.4.3. Defect Type

Three different types of defects are currently detected by ECHO-3D: cracks, corrosion, and SCC. Research is currently being conducted to expand the detection capabilities of the system. These will be released when developed.

7.4.4. Material Type

The type of material must be considered as different materials affect the Sensor EMF differently. Most of research work to date has been performed on ferrous materials. Cracks in ferrous materials require selecting a Lead Channel oriented perpendicular to the crack direction. Non-ferrous materials, such as Austenitic (Series 300) stainless steels and Aluminum effect the EMF quite differently than ferrous materials and require the selection of a Lead Channel parallel to the crack, which is 90° offset from carbon steel.

Material Type defines Frequency at which the exciter coils operate and the default data filters used in Depth and Lift-Off Modes. Currently there are three basic Material Types:

1. Carbon Steel (UNS G41300);
2. Stainless Steel 316L (UNS S31603); and
3. Aluminum 6061-T6 (UNS A96061).

Other specific Material Types will be added as they become available. Material Type is used to calibrate the Sensor for the specific material being inspected. Using the wrong Material Type may result in erroneous readings. Research is ongoing to develop a materials library to help with Lead Channel selection for a wide array of materials and will be released later when available.

7.4.5. Lead Channel

The Lead Channel selected influences what Sensor Shoe should be selected and the orientation of the Shoe installation. See the previous Selecting Lead Channel section for details.

7.4.6. Mapping Method

The method of scanning impacts Lead Channel selection. Hand scanning with a single axis encoder attached to the Sensor limits the movement of the Sensor to one direction – forward with Ch-0 being the leading channel. Mapping using an X/Y-scanner may allow the Sensor to be oriented in multiple positions, depending on the scanner and Sensor mounting. This greatly increases the number of correct Lead Channel-Sensor Shoe arrangements that can be utilized to produce a satisfactory map.

Mapping with a scanner such as a *STIX*, *SKOOT*, or *NAVIC* present other challenges in fitting the Sensor to Probe Holders and moving parts. Each scanner has its own characteristics and Athena personnel can assist in helping users mount and integrate the ECHO-3D Sensor to a specific scanner.

7.5. Selecting Frequency

The ECHO-3D system can change the frequency of the excitation voltage to the coils that create the EMF. Changing the Frequency setting affects the characteristics of the EMF and how it reacts to different material, geometry, and anomalies. Frequency is preselected by the chosen Material Type and can only be changed in Radar Mode.

7.6. Selecting Lift-off

Several factors, such as coatings, cladding, or corrosion scabbing, can affect the ability of the user to locate the Sensor directly next to the sample. These cases introduce Lift-off which effects the accuracy of the Sensor measurements. That is, generally, the more the Lift-off, the greater the inaccuracy. Research and

Development (R&D) is currently being conducted to determine the data processing requirements to maintain accuracy with Lift-off to acceptable limits.

Pipe Shoe manufacturing tolerance and pipe OD tolerances (actual measured diameter and ovality) will result in varying Lift-offs for each inspection situation. The actual Lift-off for any particular set-up can be checked by initiating Lift-off Mode any reading the existing measured Lift-off without performing a Compensation.

8. Initial Defect Detection

The first stage of inspecting a sample is to determine the areas of interest. Several different technologies in addition to ECHO-3D are available to the industry. Many In-Line Inspection (ILI) techniques exist in “smart pig” technology. Once ILI has established general areas with defects and the pipe has been exposed, traditional MT and UT (manual or phased array) technologies are utilized to pinpoint the areas of greatest concern.

8.1. Radar

Radar Mode is a very useful tool for initial defect detection. Radar will show relative defect size and orientation when used in hand scanning. Radar can help identify the areas of interest for further investigation. Radar can also be used to help identify a defect free region of the sample where a good Compensation may be acquired. See Section 5.11.1 for more information on Radar Mode.

8.2. Depth

Once the area of interest has been established and general crack position and orientation has been established, the Depth Mode can be used to determine maximum defect depth. Shallow cracks and corrosion may then be eliminated from the area of interest if measured below the reporting minimum. Since Depth Mode only uses Channel-0 the user must be aware of the Sensor orientation relative to the crack. Keeping the Sensor as perpendicular as possible to the crack will produce the best results. Depth Mode also utilizes timed based Shots and an encoder is not required for this mode.

The accuracy of ECHO-3D depth measurement is unaffected by crack length for cracks greater than 30 mm [1.2”] and within published tolerance for cracks greater than 19 mm [0.8”]. Currently R&D is being conducted to determine the data processing required to produce satisfactory results for cracks shorter than 19 mm.

9. Sensor Calibration and Health

The ECHO-3D Generation II Sensor is subjected to a rigorous inspection, calibration, and validation process during its build. Sensor calibration should not be affected by normal day-to-day use and should not require re-calibration during its lifetime.

The Sensor continuously monitors a variety of electronic functions. Should any of these parameters fall outside of acceptable values, the Sensor Health window appears with an error message. Should such an event occur, the user should contact Athena to determine if the Sensor should remain in service or be returned to Athena for repair or replacement.

9.1. Sensor Health

The current health status of the Sensor can be checked at any time by the following two methods:

Connected Selecting the **Connected** button displays the Sensor Health window, or



From the **Home Screen**, select the **TOOLS** button, opening the **Tools** window.



Selecting the **TOOL STATUS** button opens the **Sensor Health** window.



Should a fault occur, the out of tolerance parameter will be in red text and an error message will appear in the Sensor Health Details text box.

9.2. Health Verification

The Check Block and associated process has been designed to confirm the accuracy and functionality of the Sensor is within specification. The procedure should be performed:

1. Prior to job commencement;
2. Prior to commencement of work each work day of a multi-day project;

-
3. At any time during the job that the sensor or its cables could have suffered damage (i.e.: dropping the sensor or significant stress to any interface cable.)
 4. At any time during its use that sensor behavior is not consistent or as expected; and
 5. At job completion.

At any time, should the Sensor fail any test required by this procedure, Athena Industrial Services Inc. shall be notified. A screen capture or copy of the Sensor Health information should be recorded and available for review by Athena personnel. Contact Athena Industrial Services Inc. at:

Via e-mail: info@athenaindustrial.com
Via telephone: Toll Free 1 (866) 787-9555 or
1 (403) 247-7666
Via facsimile: 1 (403) 236-8677

At no time should unauthorized personnel open the Sensor housing. No user serviceable parts are contained within. Upon receipt of notification of Sensor failure, Athena will contact the user with further instructions and make arrangements for a replacement Sensor if necessary.

9.2.1. Required Equipment

The following equipment is required to perform this procedure:

1. Multi-pin quick disconnect x USB 2.0 Gen II Sensor Interface Cable (with Code Blue connector);
2. ECHO-3D supplied Tablet or other Microsoft Windows based PC with compatible USB 2.0 port and ECHO-3D software;
3. ECHO-X Encoder; and
4. ECHO-3D Check Block.

9.2.2. Check Block Test Procedure

1. Using the sensor interface cable connect the sensor to the ECHO-3D Tablet or PC with the ECHO-3D application installed.
2. Start the ECHO-3D application. If required enter Gen II Sensor license code and activate.
3. From the Home Screen window, select the **TOOLS** button opening the Tools window.
4. Select the **TOOL STATUS** button.
5. The Sensor Health window appears. In the Sensor Health Details section verify "Sensor functioning within tolerances" is displayed.
6. Select the **Close** button to close the Sensor Health window.
7. From the Home Screen window, select the **LIFT-OFF** button. The Lift-Off Flat Plate button should appear **ACTIVE**. Ensure Material Type Carbon Steel is selected in the Material Type Text Box.
8. Place the sensor in the plastic cut-out on the Check Plate and Compensate by pressing the **C** button on the Sensor. A Lift-Off value of 0 (zero) ± 0.1 mm should be observed.
9. Place the sensor on the Check Plate Lexan surface beside the cut-out and wait for the displayed Lift-Off to stabilize. Verify a Lift-Off value as stamped on the end of the Check Plate ± 0.3 mm is displayed.

-
10. Select the **HOME** button, closing the Lift-Off window.
 11. Select the **PROJECT** button opening the Project Details window.
 12. Select the **DEPTH** button. Ensure Material Type Carbon Steel is selected in the Material Type Text Box and the Lead Channel is 0. Correct if necessary.
 13. Place the Sensor on the 'crack side' of the Check Plate so that the leading edge of the Sensor is in line with the machined 'crack'.
 14. Compensate for the material by pressing the Compensate **C** button on the Sensor.
 15. Pass the Sensor across the 'crack' and measure the depth. Several passes back and forth across the 'crack' may be required before the Max Depth stabilizes.
 16. Verify the Max Depth value reads the same as the engraved crack depth ± 0.2 mm.

10. Scanning Methods

10.1. Hand Scanning

Hand scanning is the simplest method of using the sensor requiring the operator to manipulate the sensor by freehand. This is usually accomplished with the aid of a paper or Mylar grid attached to the surface of the sample to be scanned. The grid is usually marked with lines along the X-axis sequentially offset by a common value in the Y-axis. The choice of Y-Offset is dependent on accuracy desired in the C-Scan and the size of the scan area. The smaller the offset, the more Runs are required to scan a specific area. This requires more time for scanning, but provides increased data which improves the C-Scan image. For smaller areas with multiple anomalies, a Y-Offset of 2 mm [0.08"] is suggested as a starting point. For larger areas with fewer anomalies, a Y-Offset of 5 mm [0.2"] is suggested. Experience using the ECHO-3D system will help in making this decision.

ECHO-3D software is configured to display the X-Y datum in top left-hand corner. Manual scans should be set-up to start in the top left-hand corner whenever possible.

The ECHO-X Encoder is provided to facilitate hand scanning. Attaching the Encoder to the Gen II Sensor is a matter of sliding the tension spring up under the mounting appendage from the bottom. Spread the "Y" portion of the Encoder arm and push up until the hubs snap into place in the mounting holes.

The signal cable must be connected to the sensor. The sensor-end connector is a 6-pin Hirose Electric HR10A push-pull type is a USB. The push-pull connector end is coded red to match the receptacle on the sensor. The pin arrangement will not allow connection to the wrong receptacle.

Care should be exercised when coupling the connection. The connector is keyed and must be rotated until the key and keyway align. The connector should couple by applying only a slight inward force. Detaching the connector requires pulling back the locking collar and applying a slight outward force.

The Encoder and Gen II Sensor are fitted with tiny magnets which allows the Encoder to be "parked" in an up position if desired. Figure 15 below shows a ECHO-X Encoder installed on a Gen II Sensor.

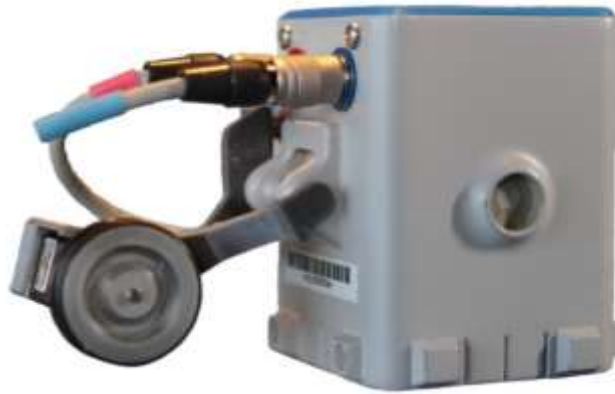


Figure 15 – ECHO-X Encoder Installed on Gen II Sensor

The selected Lead Channel will affect the positioning of the scan grid on the sample. Physical surface constraints such as pipe fittings, flanges, curved surfaces of elbows, or radial welds in the immediate proximity of the sample area may require the sampling to be conducted in a certain orientation. The ECHO-X Encoder only attaches to the Sensor on one side, behind Channel-8. When hand scanning, special attention must be applied to Lead Channel selection, Shoe selection, and Shoe installation orientation.

10.2. Mechanical Scanning

Currently only manual scanning with a Jireh *STIX* or Olympus MapSCANNER scanners are supported. Contact Athena Industries Inc. for integration with other types of non-powered scanners.



Figure 16 – Jireh STIX Manual Scanner

Figure 16 shows a typical *STIX* manually powered scanner suitable for use on materials ranging from flat to NPS 4 [DN 100]. A separate interface cable is required to utilize an existing *STIX* scanner with the Gen II Sensor. This cable provides the necessary signal input to operate the Sensor.

Scanning using a scanner differs from hand scanning in that the entire Scan is performed with a single recording session. Hand scanning using a single-axis encoder requires the user to start and stop Recording for each Run.

10.3. Powered Scanning

Athena has tested and supports powered scanning utilizing either the Jireh *SKOOT* or *NAVIC* and Olympus MapSCANNER and MapROVER scanners. Please contact Athena personnel for assistance with interfacing and operation of these scanners.



Figure 17 – Jireh NAVIC Steerable Automated Scanner

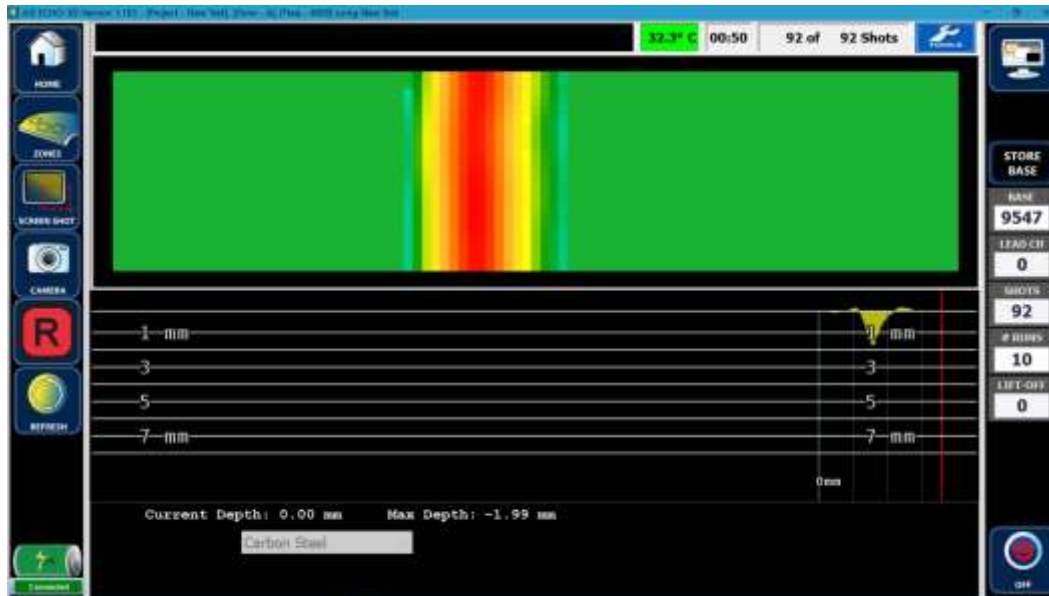
Figure 17 shows a Jireh NAVIC steerable automated scanner with raster arm. All personnel attempting to utilize an automated scanner must read, understand, and follow all recommended operating procedures prior to conducting any mapping operations.

11. Scanning Techniques

11.1. Manual Scanning

Manual scanning is a simple iterative process with each Run producing a B-Scan. Prior to commencing the scan, the user should Compensate the Sensor at the predetermined Compensate location. The Run is started by positioning the Sensor at the starting point of the Run. Depressing the Record Switch **R** on the Sensor or selecting the **REC** button on the Tablet starts the recording of data. An audible sound is emitted from the Tablet, the **REC** button changes to **R**, and the LED in the top of the Sensor flashes to confirm the Sensor is in Record Mode. Slide the Sensor along the grid line and stop at the desired point. Press the Record Switch or select the **REC** button to end the recording of the Run. An audible sound is emitted from the Tablet, the **REC** button changes to **R**, and the LED in the top of the Sensor stops flashing to confirm the Sensor had stopped recording. The **# of Runs** display increments by 1. As

additional Runs are made at the desired Y-offset a C-scan image of the scan area is created. Scanning can also be accomplished in a single Run which incorporates scanning in both directions on the X-axis.



The B-Scan is shown in the lower portion of the window and the C-Scan view is shown in the upper portion. Several functions are available from this window.

Manual scanning can also be accomplished utilizing a non-powered scanner such as a ECHO-3D Jireh STYX scanner. Unlike hand scanning, the Scan can be accomplished with a single Run by scanning back and forth in both X-axis directions while indexing the Y-axis before each pass in the X-axis.

11.2. Automated Scanning

Automated scanning requires the use of a self-powered scanner which can be controlled from a separate controller from the ECHO-3D system. Currently ECHO-3D does not directly support automated scanning, but has been tested, and can be operated in parallel with Jireh controllers for both the *SKOOT* and *NAVIC* scanners, and Olympus controller for MapROVER.

Scanning using a powered automated scanner such as a *SKOOT*, *NAVIC*, or MapROVER scanner is performed as a single Run. Scanning is performed in both directions on the X-axis. Scan speeds of 500 Shots/s can be achieved. At 1.0 mm/Shot this results in scanning speeds of 500 mm/s. Jireh scanners are designed to start the scan at the bottom left-hand corner and finish at the top right-hand corner. ECHO-3D software is designed to automatically accommodate this feature.

Note: Attempting to use multiple Runs (recording sessions) with an automatic scanner will result in no usable data being collected.

11.3. Mapping Gridlines

The X and Y-axis grid markings vary depending on the physical shape of the material being inspected. X-axis always starts on the left side of the scan and increases in value as the Sensor travels to the right. Y-axis values are labelled differently for plate and pipe:

- Plate – The Y-axis values for plate increase from top to bottom.
- Pipe – The Y-axis values for pipe increase using the Right-Hand Rule. The Right-Hand Rule is defined as: using your right hand, placing the thumb in the direction of fluid flow (pointing

downstream), the fingers then point in the direction of the increasing values. The result is, while facing in the downstream position, Y-axis increases in the clockwise direction.

Axes units of measurement are determined by Zone Details. See Section 5.9 Working with a Zone for details.

12. Scanning View Modes

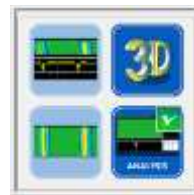
During or after scanning several different views of the map are available. Scanning always commences in the B/C-Scan View window. To change views during or after scanning, select the **Select View** at the top of the RH Tool Bar. It should be noted that only the B/C-Scan View is available until some data has been acquired and selecting the **Select View** button will respond with an audible tone indicating that no action will be taken.



Once data has been collected, selecting the **Select View** button opens the Analysis Window. The available Views are limited to 3D and Analysis when a Sensor is not connected. With a Sensor connected all four views are available: 3D, B/C-Scan, C-Scan, and Analysis.



Without Sensor



With Sensor

The current view is confirmed with a checkmark in the upper right hand corner of the button. Views can be changed by selecting the appropriate button. The standard B/C-Scan View and the C-Scan View are not available without a Sensor connected.

12.1. B/C-Scan Window

This is the default display when initiating a Scan. Two slightly different windows appear, determined by the type of encoder or scanner used for the Scan. This view is only available with a Sensor connected.



To return to the **B/C-Scan** view, select the **Scan View** button opens the **Scan View** window.



Without Sensor



With Sensor



Selecting the **B/C-Scan** button opens the **B/C-Scan** window. The ability to view the B/C-Scan window depends on several factors:

1. With a Sensor connected to the PC and no previously collected data for the Active Zone – the initial start-up window will appear;
2. With a Sensor connected to the PC and previously collected data for the Active Zone – the current data will appear;
3. Without a Sensor connected to the PC and no previously collected data for the Active Zone – The following message appears. Selecting the **OK** button returns the **Home Screen** window,



; and

4. Without a Sensor connected to the PC and previously collected data for the Active Zone – the current data will appear.

12.1.1.1. Single-Axis Encoder

The **B/C-Scan** window for the single-axis encoder, such as the ECHO-X Encoder, is shown below.



This window is divided into six sections.

1. The right-hand button bar displays Base, Lead Channel, Shots, the Number of Runs, and Lift-Off.
2. The left-hand button bar displays the Home, Zones, Screen Shot, Camera, Record, and Refresh buttons as well as the Battery Status, and Sensor Connect Status icons.
3. The top centre section displays Sensor Temperature, Encoder or Scanner information, and a **TOOLS** button.
4. The next centre section displays the ECHO-3D logo until data is collected. Once a Run has been completed, the C-Scan is written and displayed in place of the logo.
5. The next centre section displays the B-Scan live as the Run is being performed with the scale based on the Material Thickness defined in the Project Details.
6. The lower centre section displays the Current Depth at the Sensor position, the Maximum Depth encountered during the current Run, and the Material Type defined by the Project Details.

12.1.2. Two-Axis Scanner

The **Scan** window for the two-axis scanner, such as the Jireh *STIX*, *SKOOT*, or *NAVIC*, is shown below.



This window, like the single-axis encoder window, is divided into six sections. All displays and functions are the same with the exception that the X and Y coordinate positions are displayed in the Right-Hand Tool Bar. During scanning operations, a timer appears immediately left of the counter display and displays scan time.

12.1.2.1. Left-Hand Tool Bar



Selecting the **ZONES** button opens the **New / Edit Defect Zone** window allowing the user to add new, edit, delete, or make active Zones. The window opens in the **New Defect Zone** tab.



For information on working with Zones, see Section 5.9 Working with a Zone.



Selecting the **SCREEN SHOT** button creates a screen shot and opens the **Screenshot Notes** window. During a Screen Shot the background colour is temporarily changed to white to preserve printer ink when including the Screen Shot in the Report. Screen shot notes can be entered in the text

box. Although this text box has no limit to the number of characters, the notes should be limited to the initial display area for convenience.



Selecting the **SAVE** button saves the file, notes, and closes the window.





Selecting the **CLOSE** button cancels the screen shot and closes the window.



Selecting the **CAMERA** button starts the rear facing camera function. Photos can then be taken and files saved to the Tablet hard drive. See Section 14.2 Tablet Camera Operations for more information.



Red indicates data recording is not initiated. Selecting the **REC** button or pressing the Record  switch on the Sensor toggles the data recording on. Selecting the green **REC** button or pressing Record  switch on the Sensor toggles the data recording off. Selecting the REC button before performing a Compensation will result in a warning message



In Record Mode, the **Abort Run** button replaces the **REFRESH** button. Selecting the **Abort Run** button deletes the current Run.



Selecting the **REFRESH** button: clears the B-Scan area of the window; clears the Max Depth display (shown below the B-Scan area); and resets the Shot Counter without Compensating the Sensor.

12.1.2.2. Right-Hand Tool Bar

The RH Tool Bar varies depending on the type of encoder or scanner is being utilized.



Once data has been collected, selecting the **Select View** button opens the Analysis Window. The available Views are limited to 3D and Analysis when a Sensor is not connected. With a Sensor connected all four views are available: 3D, B/C-Scan, C-Scan, and Analysis.



Without Sensor

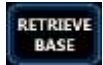


With Sensor

The current view is confirmed with a checkmark in the upper right hand corner of the button. Views can be changed by selecting the appropriate button. The standard B/C-Scan View and the C-Scan View are not available without a Sensor connected.




Selecting the **STORE BASE** button saves the current Base in memory for use in multiple Zones when it is desirable. The button text changes to green to indicate a Base is stored in memory. The stored Base remains with the Project. It can be rewritten, but not deleted.



Selecting the **RETRIEVE BASE** button rewrites the Base value with the stored value.



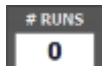
Base displays the Base value. Selecting the **Base** button or the Sensor  button performs a Compensation which is confirmed by a sound byte the button background momentarily displayed as green.



LEAD CH displays the Lead Channel.







Shots displays the number of record shot taken during the Run. This is useful to help ensure that the Runs are all the same length.



of Runs displays the number of complete B-Scans that have been completed.



Lift-Off displays the Sensor lift-off. Selecting the **Lift-Off** button opens the **Lift-Off** window. Each selection of the  button increases the Lift-Off by 0.1. Each selection of the  button decreases the Lift-Off by 0.1. Multiple integer values can be added or subtracted by selecting and holding appropriate  or  button. The Lift-Off may also be entered directly into the text box by first highlighting the Lift-Off value and entering a new value from the keyboard. Lift-Off can be any single decimal value from 0.0 to 30.0, with the default setting being 0.0.



Keep in mind that this distance is in millimetres (mm) and any Lift-Off greater than 15 mm is not recommended.

12.1.2.3. Encoder/Scanner Bar

This display varies slightly depending on the type or encoder or scanner being used. If a single-axis encoder such as an ECHO-X Encoder is utilized the display is as follows.



33.2° C

Displays the current Sensor Core Temperature in degrees Celsius (°C). Normal operating temperatures are displayed in green. If Sensor temperature is approaching the lower or upper limits the display will turn yellow as a precautionary measure. This occurs at below -15°C [5°F] or above 65°C [149°F]. Should the temperatures reach the lower operating limit of -20°C [-4°F] or the upper limit of 80°C [176°F], the display will turn red and the Sensor should be removed from service to prevent damage to the Sensor.

0 Shots

The top right-hand corner of the C-Scan window displays the Shot count. During the first Run the counter is grey coloured and records the number of Shots take.

367 of 367 Shots

After Run # 1, the counter displays the current Shots and the total Shots required for a complete Run. The counter displays originally with a grey background. When the Shot count is sufficient (± 5 Shots) for a complete Run, the background changes to green. The background changes to red if the Shot count is too large (greater than the Run Shots plus five).

If a two-axis scanner is utilized the display is as follows.



-13, 0 mm

The top right-hand corner of the C-Scan window displays the current X and Y position of Sensor.



Selecting the **TOOLS** button opens the **Scan Tools** window. The available buttons depend on whether data has or has not been collected.



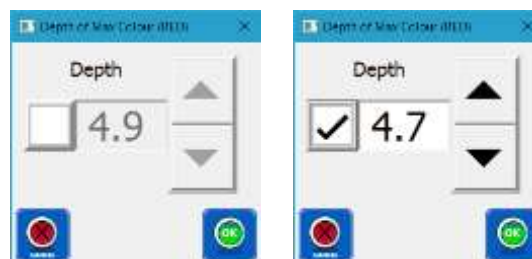
Without Data



With Data



Selecting the **DEPTH of Max Colour** button opens the Depth of Max Colour (Red) window. This controls the depth at which the colour red is displayed. The default value is determined by the maximum measured defect depth. Selecting the check-box places a checkmark in the check-box and activates the window. The depth at which red is displayed can then be reset with each selection of the ▲ button increases the Depth by 0.1. Each selection of the ▼ button decreases the Depth by 0.1. Multiple decimal values can be added or subtracted by selecting and holding appropriate ▲ or ▼ button. The Depth may also be entered directly into the text box by first highlighting the Depth value and entering a new value from the keyboard.





Selecting the **CANCEL** button closes the window without saving any changes.








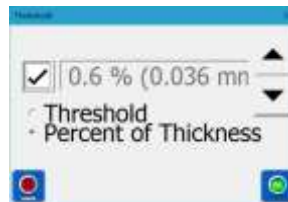
Selecting the **OK** button saves the new Depth of Max Colour setting and closes the window.




Selecting the **LOCKED Auto Scale Max** button toggles the depth scale to Unlocked and changes the button to **UNLOCKED**. When Unlocked, the depth scale varies with the depth of the deepest detected defect. Selecting the **UNLOCKED Auto Scale Max** button toggles the depth scale to Locked and changes the button to **LOCKED**. When Locked, the depth scale is set by the Material Thickness in Project Details.



Selecting the **DEPTH THRESHOLD** button opens the **Threshold** window. The default condition is activated, confirmed by the  in the upper right-hand corner of the button. Activating Threshold and setting the value above 0 sets the depth above which (shallower) data is not shown. This is useful to eliminate “noise” and minor surface defects that are not of interest. The Threshold can then be reset with each selection of the  button increasing the Threshold. Each selection of the  button decreases the Threshold. Multiple values can be added or subtracted by selecting and holding appropriate  or  button. The Threshold may also be entered directly into the text box by first highlighting the value and entering a new value from the keyboard.



 **Threshold** Selecting the **Threshold** radio button changes the value to depth in millimetres.

 **Percent of Thickness** Selecting the **Percent of Thickness** radio button changes the value to a percentage of the Material Thickness in Project Details.







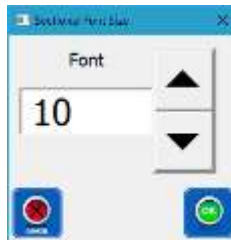
Selecting the **CANCEL** button closes the window without saving any changes.



Selecting the **OK** button saves the new Threshold setting and closes the window.



Selecting the **FONT** button opens the **Sectional Font Size** window. The Font Size displayed can then be reset with each selection of the  button increasing the font by 1. Each selection of the  button decreases the Font Size by 1. Multiple values can be added or subtracted by selecting and holding appropriate  or  button. The Font Size may also be entered directly into the text box by first highlighting the value and entering a new value from the keyboard.



Selecting the **CANCEL** button closes the window without saving any changes.



Selecting the **OK** button saves the new Font Size setting and closes the window.



Selecting the **B/G COLOUR** button opens the Background Colour window. Four background colours are selectable. The default background colour is black.

Note: Regardless of the chosen background colour, when printing a screen shot in a report, the background colour is automatically changed to white to preserve printer ink or toner.



Selecting the **CLOSE** button closes the window.



Selecting the **ZOOM** button opens the **Zoom** window. The area displayed can then be reset with each selection of the ▲ button increasing the Zoom factor by 10%. Each selection of the ▼ button decreases the Zoom factor by 10%. Multiple values can be added or subtracted by selecting and holding appropriate ▲ or ▼ button. The Zoom factor may also be entered directly into the text box by first highlighting the value and entering a new value from the keyboard. Increasing the Zoom factor above 100% activates the **ZOOMOUT** button. The scan area can also be zoomed by using a two-finger zoom swipe on touch screens.



Selecting the **ZOOMOUT** button returns the Zoom factor to 100% and deactivates the **ZOOMOUT** button.



Selecting the **CANCEL** button closes the window without saving any changes.



Selecting the **OK** button saves the new Zoom factor and closes the window.



Selecting the **FILTER** button opens the **Low Pass Filter** window. The user can select **None**, **Low**, **Medium**, and **High**. Increasing the Low Pass Filter decreases the “noise” and may make the defect easier to see. Selecting the different levels of Low Pass Filter changes the live view in the window allowing the user can to see the difference the Filter is making in the image. The Low level is selected by default.



Note: The Low Pass Filter retains the actual maximum depth value but may affect the visual depth of other features. Filtering is for display purposes only and all reported depths are not altered by the filters.



Selecting the **CANCEL** button closes the window without saving any changes.



Selecting the **OK** button saves the new Filter setting and closes the window.

12.2. C-Scan Window

The C-Scan window is a full screen view of the C-Scan shown in the regular Scan window and is available with any type of encoder or scanner once data has been collected.



Selecting the **Scan View** button opens the **Scan View** window.



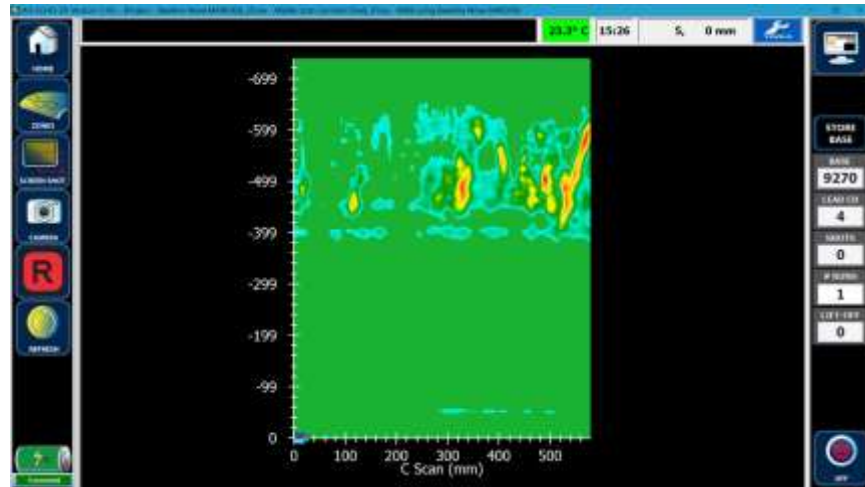
Without Sensor



With Sensor



Selecting the **C-Scan** button opens the full screen C-Scan window.



Selecting the **TOOLS** button opens the **Scan Tools** window.



All these buttons function the same as in **B/C-Scan** window above.

12.3. 3D Model Window

The 3D Model window displays a three-dimensional image created by ECHO-3D. The image displayed is dependent on whether Material Type is set for FLAT or PIPE. The PIPE setting displays as either a pipe of a flat sheet, and can be toggled back and forth.

The 3D view can be selected during data acquisition and draws the view in real time as the data is being collected. Bars on the left and right sides display various status details and buttons for performing various

functions. Buttons on the right-hand button bar allow the user to manipulate the 3D view of the scans, record screen shots. An encoder/scanner status display runs across the top of the main window immediately below the Window Title Bar.



Selecting the **Scan View** button opens the **Scan View** window.



Without Sensor

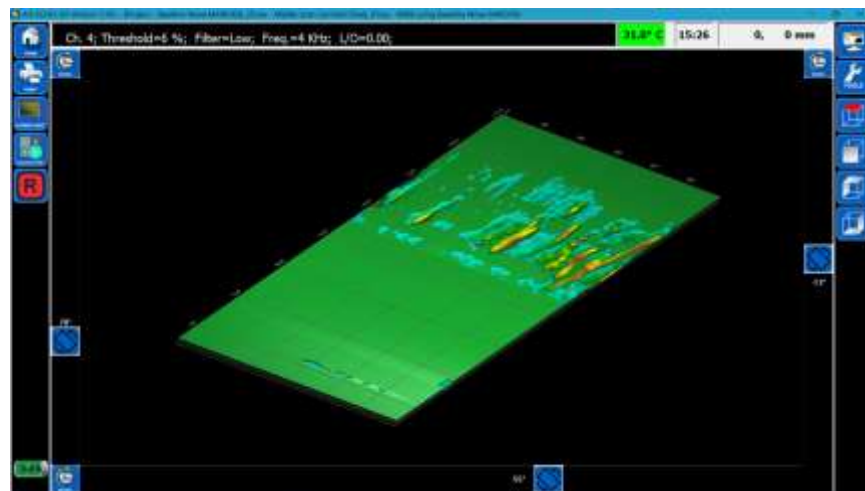


With Sensor

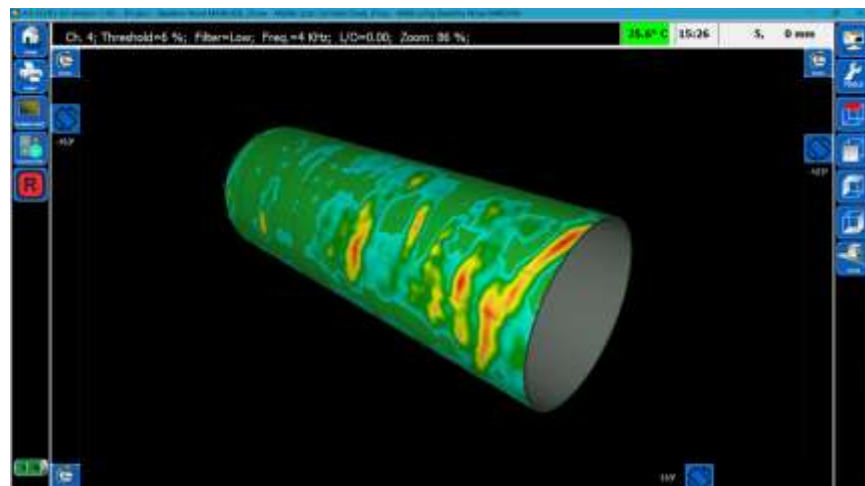


Selecting the **3D** button in the **Scan View** window opens the **3D View** window. The display varies depending on the Material Type setting of PIPE or FLAT.

FLAT Material will display the material as a flat plate as shown below.

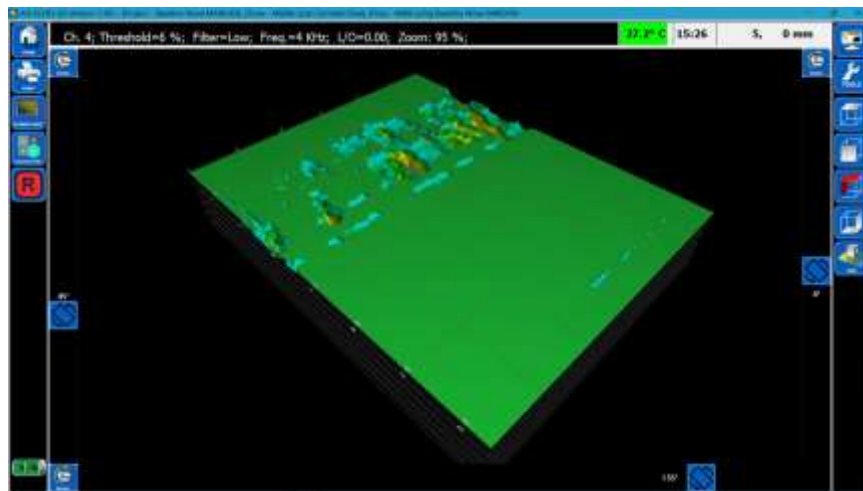


PIPE Material will display the material as a pipe as shown below.





Selecting the **PLATE** button changes the display to a flat image and changes the button to **PIPE**.



Selecting a **ROTATE** button starts a slower rotation of the display. Subsequent selection of the button changes the rotation to: slow, medium, fast, faster, then stopped. The top LH button rotates the image in the X-plane; the top RH button rotates the image in the Y-plane; the bottom LH button rotates the image in the Z-plane.

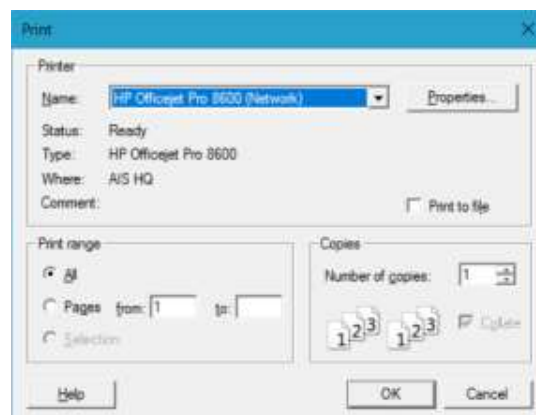


Images can be rotated to any position by selecting the appropriate **Rotate Slider** button and dragging it along the edge of the window.

The image can be panned within the window simply by selecting any point on the main window and dragging in the desired direction.



Selecting the **PRINT** button opens standard Windows **Print** window. Follow typical Windows commands and procedures to select a printer from the drop-down menu and the print the file. The print is automatically scaled to fit a single page and the background colour is momentarily changed to white to conserve printer ink or toner.





Selecting the **SCREEN SHOT** button opens the **Screenshot Notes** window. Information or comments regarding the screen shot can be entered in the text box. Background Colour is momentarily changed to white for the screen shot.



Selecting the **CANCEL** button closes the window without saving any changes.





Selecting the **OK** button saves the picture as a JPG file in the Project database.



Selecting the **Calculator** button opens the Windows Calculator for aiding in calculations.



Red indicates data recording is not initiated. Selecting the **REC** button or pressing the Record  switch on the Sensor toggles the data recording on and changes the **REC** button to green. Selecting the green **REC** button or pressing Record  switch on the Sensor toggles the data recording off and changes the button to red. In Record Mode, the **Abort Run** button becomes active.



Selecting the **TOOLS** button opens the Tools window allowing the user to apply different functions to the 3D view. Buttons with checkmarks indicate that these Tools are activated. Select outside the Tools window to close.



Selecting the **MAX COLOUR** button opens the depth of **Max Colour (RED)** window. The default setting Depth for the red colour is the maximum measured depth. Opening the window for the first time displays the setting (maximum measured depth). Notice that the digits and buttons are ghosted indicating they are not “live”.








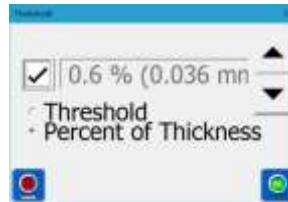
Selecting the check box changes the digits and button to active (black). The depth that the red colour starts can be increased by 0.5 mm by selecting the ▲ button and decreased by 0.1 mm by selecting the ▼ button. Multiple decimal values can be added or subtracted by selecting and holding appropriate ▲ or ▼ button, or, after highlighting the value, depth can be typed into the box.





Selecting the **LOCKED Auto Scale Max** button toggles the depth scale to Unlocked and changes the button to **UNLOCKED**. When Unlocked, the depth scale varies with the depth of the deepest detected defect. Selecting the **UNLOCKED Auto Scale Max** button toggles the depth scale to Locked and changes the button to **LOCKED**. When Locked, the depth scale is set by the Material Thickness in Project Details.



Selecting the **DEPTH THRESHOLD** button opens the **Threshold** window. The default condition is activated, confirmed by the  in the upper right hand corner of the button. Activating Threshold and setting the value above 0 sets the depth above which (shallower) data is not shown. This is useful to eliminate “noise” and minor surface defects that are not of interest. The Threshold can then be reset with each selection of the  button increasing the Threshold. Each selection of the  button decreases the Threshold. Multiple values can be added or subtracted by selecting and holding appropriate  or  button. The Threshold may also be entered directly into the text box by first highlighting the value and entering a new value from the keyboard.



 **Threshold** Selecting the **Threshold** radio button changes the value to depth in millimetres.

 **Percent of Thickness** Selecting the **Percent of Thickness** radio button changes the value to a percentage of the Material Thickness in Project Details.







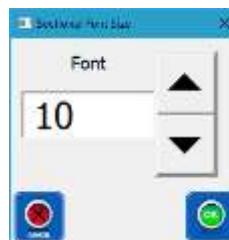
Selecting the **CANCEL** button closes the window without saving any changes.



Selecting the **OK** button saves the new Threshold setting and closes the window.



Selecting the **FONT** button opens the **Sectional Font Size** window. The Font Size displayed can then be reset with each selection of the  button increasing the font by 1. Each selection of the  button decreases the Font Size by 1. Multiple values can be added or subtracted by selecting and holding appropriate  or  button. The Font Size may also be entered directly into the text box by first highlighting the value and entering a new value from the keyboard.



Selecting the **CANCEL** button closes the window without saving any changes.

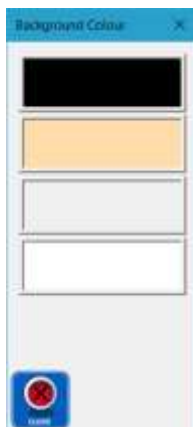


Selecting the **OK** button saves the new Font Size setting and closes the window.



Selecting the **B/G COLOUR** button opens the Background Colour window. Four background colours are selectable. The default background colour is black.

Note: Regardless of the chosen background colour, when printing a screen shot in a report, the background colour is automatically changed to white to preserve printer ink or toner.



Selecting the **CLOSE** button closes the window.



Selecting the **ZOOM** button opens the **Zoom** window. The area displayed can then be reset with each selection of the ▲ button increasing the Zoom factor by 10%. Each selection of the ▼ button decreases the Zoom factor by 10%. Multiple values can be added or subtracted by selecting and holding appropriate ▲ or ▼ button. The Zoom factor may also be entered directly into the text box by first highlighting the value and entering a new value from the keyboard. Increasing the Zoom factor above 100% activates the **ZOOMOUT** button. The scan area can also be zoomed by using a two-finger zoom swipe on touch screens.



Selecting the **ZOOMOUT** button returns the Zoom factor to 100% and deactivates the **ZOOMOUT** button.



Selecting the **CANCEL** button closes the window without saving any changes.



Selecting the **OK** button saves the new Zoom factor and closes the window.



Selecting the **FILTER** button opens the **Low Pass Filter** window. The user can select **None**, **Low**, **Medium**, and **High**. Increasing the Low Pass Filter decreases the “noise” and may make the defect easier to see. Selecting the different levels of Low Pass Filter changes the live view in the window allowing the user can to see the difference the Filter is making in the image. The Low level is selected by default.



Note: The Low Pass Filter retains the actual maximum depth value but may affect the visual depth of other features. Filtering is for display purposes only and all reported depths are not altered by the filters.



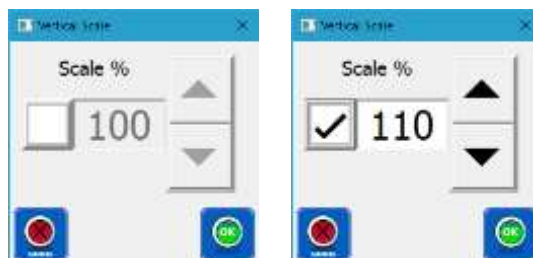
Selecting the **CANCEL** button closes the window without saving any changes.



Selecting the **OK** button saves the new Filter setting and closes the window.



Selecting the **VERT SCALE** button opens the Vertical Scale window. This window adjusts the vertical scale used to display the 3D image and functions similarly to the Threshold window above except it increments in steps of 5%.



Selecting the **CANCEL** button closes the window without saving any changes.



Selecting the **OK** button saves the new Vertical Scale setting and closes the window.



Selecting the **GRID** button toggles the 3D gridlines on and off.



Selecting the **TOP** button resets the 3D image to top (plan) view. When selected, the displayed surface is shown in red on the button.



Selecting the **FRONT** button resets the 3D image to the front view. When selected, the displayed surface is shown in red on the button.



Selecting the **Top/Left** button resets the 3D image to the top left-hand view. When selected, the displayed surface is shown in red on the button. This is often considered the standard orthographic view.



Selecting the **Bottom/Right** button resets the 3D image to the bottom right-hand view. When selected, the displayed surface is shown in red on the button. This is often considered the “up-side-down” view of the standard orthographic view.



Selecting the **PIPE** or **PLATE** button toggles the view from Pipe to Plate as described above.

12.4. Analysis View Window

The Analysis View window is used to identify, label, and characterize or analyze defects found within the C-Scan. The main window is divided into four zones: the upper left area displays the Analysis Plan View, a top view of the scanned area; the lower left area displays the X-Plane Section View; the upper right area displays the Y-Plane Section View; and the lower right area displays the cursor position and a Defect List which identifies each defect and provides additional information. When opening the window for the first time in a Zone, the cursor or Bullseye is automatically positioned at the deepest defect. Selecting and dragging the Bullseye to any position on the plan view will result in showing the appropriate section views for that position.

Any analytical work performed in this window is saved. If the window is closed and later re-opened, the last work performed will be displayed.



Selecting the **Select View** button opens the Scan View Window.



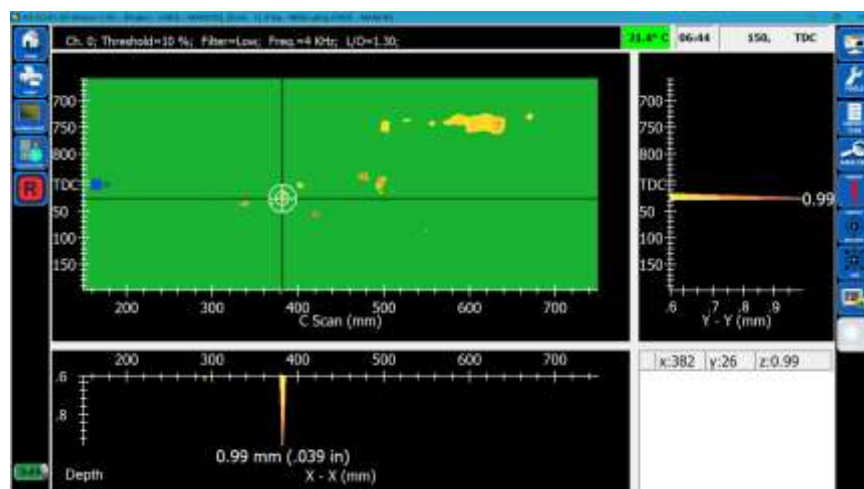
Without Sensor



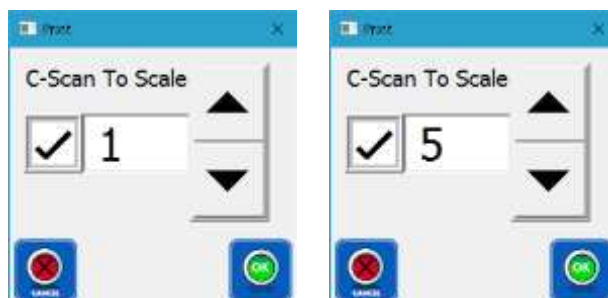
With Sensor



Selecting the **ANALYSIS** button opens the **Analysis Section View** window.



Selecting the **PRINT** button opens the **Print to Scale** window. Leaving the checkbox blank will automatically scale the print to single page showing and three views. Selecting the checkbox places a checkmark in the box activates the scaling. Each selection of the ▲ button increases the Scaling by 1. Each selection of the ▼ button decreases the Scaling by 1. Multiple integer values can be added or subtracted by selecting and holding appropriate ▲ or ▼ button. The scaling may also be entered directly into the text box by first highlighting the Scaling value and entering a new value from the keyboard.



When the checkbox is filled with a checkmark, the resulting print includes only the Plan View. If the scaling results in the print consisting of multiple paper sheets, the document will automatically paginate allowing the user to piece the map into a single sheet for review. Scaling the Plan View to full scale permits the plotting of the map and the direct comparison with the test sample.

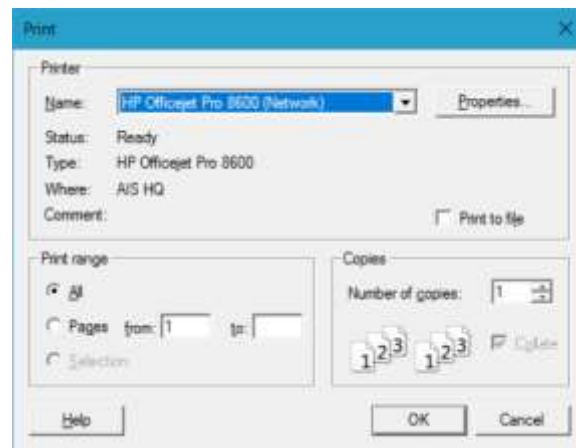


Selecting the **CANCEL** button closes the window without saving any changes.



Selecting the **OK** button saves the new Scale Setting, closes the window, and opens the Print window. A printer can be selected from the drop-down menu and the file printed. The resulting print

displays is can be used to print out a full-sized plot if a plotter is available. The plot can then be laid on the sample to compare the map to the actual test sample.



Selecting the **SCREEN SHOT** button opens the **Screenshot Notes** window. Information or comments regarding the screen shot can be entered in the text box. Background Colour is momentarily changed to white for the screen shot.



Selecting the **CANCEL** button closes the window without saving any changes.





Selecting the **OK** button saves the picture as a JPG file in the Project database.



Selecting the **Calculator** button opens the Windows Calculator for aiding in calculations.



Red indicates data recording is not initiated. Selecting the **REC** button or pressing the Record  switch on the Sensor toggles the data recording on, changing the **REC** button to green. Selecting the green **REC** button or pressing Record  switch on the Sensor toggles the data recording off, changing the **REC** button to red. In Record Mode, the **Abort Run** button is activated.



Selecting the **TOOLS** button opens the Tools window allowing the user to apply different functions to the 3D view. Buttons with checkmarks indicate that these Tools are activated. Select outside the Tools window to close.



Selecting the **MAX COLOUR** button opens the depth of **Max Colour (RED)** window. The default setting Depth for the red colour is the maximum measured depth. Opening the window for the

first time displays the setting (maximum measured depth). Notice that the digits and buttons are ghosted indicating they are not “live”.




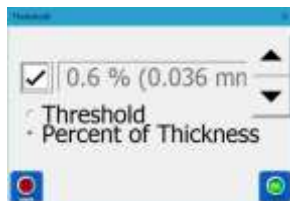
Selecting the check box changes the digits and button to active (black). The depth that the red colour starts can be increased by 0.5 mm by selecting the ▲ button and decreased by 0.1 mm by selecting the ▼ button. Multiple decimal values can be added or subtracted by selecting and holding appropriate ▲ or ▼ button, or, after highlighting the value, depth can be typed into the box.




Selecting the **LOCKED Auto Scale Max** button toggles the depth scale to Unlocked and changes the button to **UNLOCKED**. When Unlocked, the depth scale varies with the depth of the deepest detected defect. Selecting the **UNLOCKED Auto Scale Max** button toggles the depth scale to Locked and changes the button to **LOCKED**. When Locked, the depth scale is set by the Material Thickness in Project Details.



Selecting the **DEPTH THRESHOLD** button opens the **Threshold** window. The default condition is activated, confirmed by the  in the upper right-hand corner of the button. Activating Threshold and setting the value above 0 sets the depth above which (shallower) data is not shown. This is useful to eliminate “noise” and minor surface defects that are not of interest. The Threshold can then be reset with each selection of the ▲ button increasing the Threshold. Each selection of the ▼ button decreases the Threshold. Multiple values can be added or subtracted by selecting and holding appropriate ▲ or ▼ button. The Threshold may also be entered directly into the text box by first highlighting the value and entering a new value from the keyboard.



 **Threshold** Selecting the **Threshold** radio button changes the value to depth in millimetres.

• **Percent of Thickness** Selecting the **Percent of Thickness** radio button changes the value to a percentage of the Material Thickness in Project Details.



Selecting the **CANCEL** button closes the window without saving any changes.



Selecting the **OK** button saves the new Threshold setting and closes the window.



Selecting the **FONT** button opens the **Font Size** window. The Font Size displayed can then be reset with each selection of the ▲ button increasing the font by 1. Each selection of the ▼ button decreases the Font Size by 1. Multiple values can be added or subtracted by selecting and holding appropriate ▲ or ▼ button. The Font Size may also be entered directly into the text box by first highlighting the value and entering a new value from the keyboard.



Selecting the **CANCEL** button closes the window without saving any changes.



Selecting the **OK** button saves the new Font Size setting and closes the window.



Selecting the **B/G COLOUR** button opens the Background Colour window. Four background colours are selectable. The default background colour is black.

Note: Regardless of the chosen background colour, when printing a screen shot in a report, the background colour is automatically changed to white to preserve printer ink or toner.





Selecting the **CLOSE** button closes the window.



Selecting the **ZOOM** button opens the **Zoom** window. The area displayed can then be reset with each selection of the ▲ button increasing the Zoom factor by 10%. Each selection of the ▼ button decreases the Zoom factor by 10%. Multiple values can be added or subtracted by selecting and holding appropriate ▲ or ▼ button. The Zoom factor may also be entered directly into the text box by first highlighting the value and entering a new value from the keyboard. Increasing the Zoom factor above 100% activates the **ZOOMOUT** button. The scan area can also be zoomed by using a two-finger zoom swipe on touch screens.



Selecting the **ZOOMOUT** button returns the Zoom factor to 100% and deactivates the **ZOOMOUT** button.



Selecting the **CANCEL** button closes the window without saving any changes.



Selecting the **OK** button saves the new Zoom factor and closes the window.



Selecting the **FILTER** button opens the **Low Pass Filter** window. The user can select **None**, **Low**, **Medium**, and **High**. Increasing the Low Pass Filter decreases the “noise” and may make the defect easier to see. Selecting the different levels of Low Pass Filter changes the live view in the window allowing the user can to see the difference the Filter is making in the image. The Low level is selected by default.



Note: The Low Pass Filter retains the actual maximum depth value but may affect the visual depth of other features. Filtering is for display purposes only and all reported depths are not altered by the filters.



Selecting the **CANCEL** button closes the window without saving any changes.



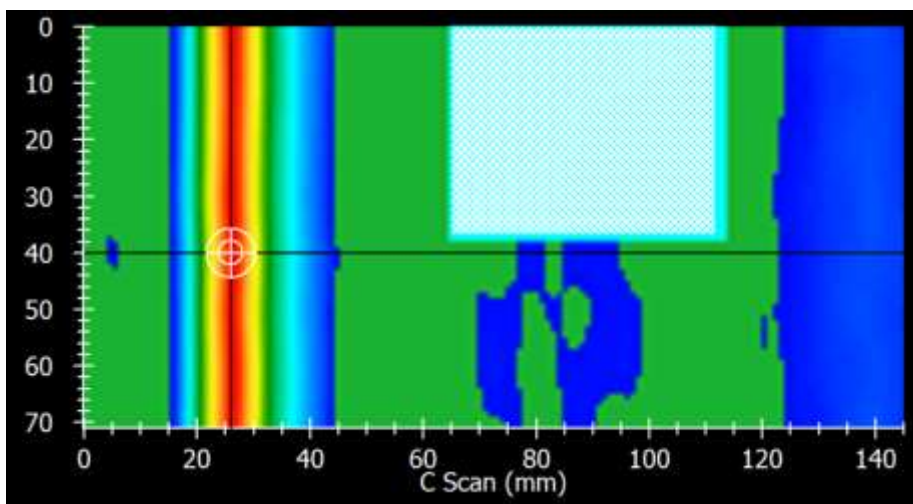
Selecting the **OK** button saves the new Filter setting and closes the window.



Selecting the **CROP** button opens the **Crop – Add Rectangular Regions** window. This is a cropping tool which can be used to delete undesired areas from the scan map.



After opening the **Crop – Add Rectangle Regions** window, rectangular areas of the scan can be selected for cropping by selecting the first corner, and dragging the cursor to the opposite corner.



Selecting the **CANCEL** button closes the window without saving any changes.



Selecting the **REMOVE** button removes the highlighted area.



Selecting the **OK** button saves the cropping and closes the window.



Selecting the **1:1** button toggles Full Width on and changes the button to the **Full Width** button. In Full Width mode, the length of the Scan is scaled to utilize the entire width of the window. Selecting the **Full Width** button toggles back to 1:1 mode and changes the button to the **1:1** button. In this view, both the width (Y-axis) and length (X-axis) are the same scale.



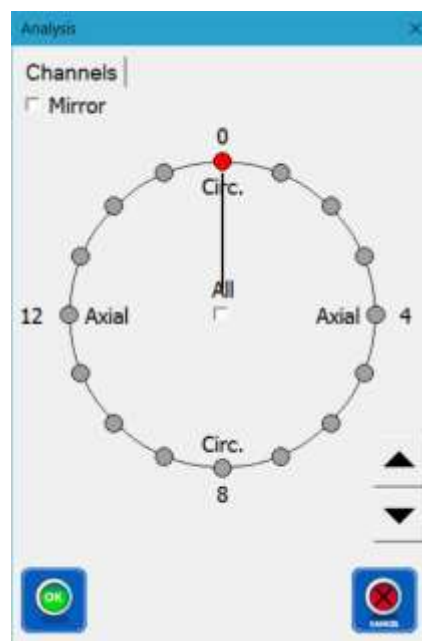
Selecting the **DEFECT TYPE** button open the **Defect Type** window. The default selection is NONE which utilizes only the Lead Channel.



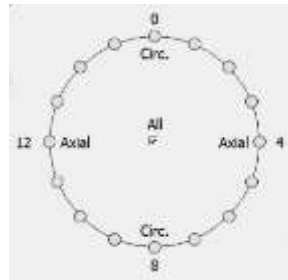
Selecting the **NONE** button utilizes only the Lead Channel for display and analysis.



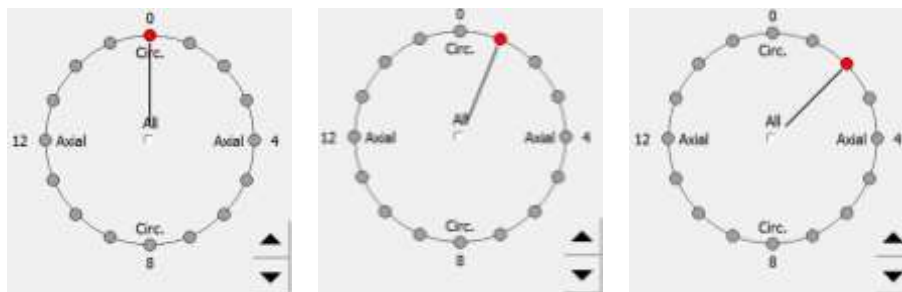
Selecting the **CRACK** button opens the **Analysis** window.



Selecting **All** places a checkmark in the check-box and displays the greatest data value of all 16 Channels. Corrections are made for the different positioning of each Channel within the Sensor and during the scanning process.

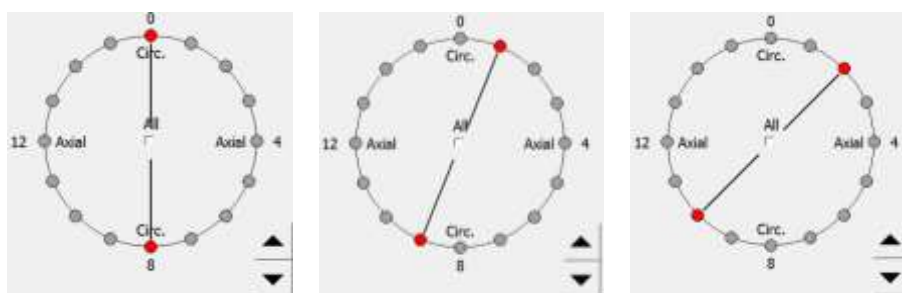


Unselecting **All** removes the checkmark in the check-box and displays the data value of the Channel which is pointed and highlighted. Any Channel can be directly chosen by selecting the desired Channel or by using the ▲ or ▼ spin buttons. Below illustrates three consecutive selections of the spin button.



Crack data is directional and depending on the material being inspected the Channels are more sensitive to cracks either perpendicular (ferrous materials) or linear (non-ferrous materials) to the Channel's major axis. By "scrolling" through the different Channels and monitoring the display, defects otherwise undetected, may indeed be seen.

☒ **Mirror** Selecting **Mirror** places a checkmark in the check-box and displays the greatest data value of the display opposing Channels. As above, any Channel can be directly chosen by selecting the desired Channel or by using the ▲ or ▼ spin buttons. Below illustrates two consecutive selections of the spin button.



Selecting the **CANCEL** button closes the window without saving any changes.



Selecting the **OK** button saves latest settings and closes the window.



Selecting the **CORROSION** button opens the **Corrosion Type** window.



Selecting the **GENERAL CORROSION** button instigates a wide area lift-off based analysis method suitable for use with corrosion that is the same size or larger than the footprint of the Sensor. No user input is required for this type of defect.



Selecting the **LOCALIZED CORROSION** button opens the Localized Corrosion Selection window.



Selecting the **LOCALIZED WITHOUT** Cracks button instigates a small area lift-off based analysis method for use with corrosion that is smaller than the footprint of the Sensor. No user input is required for this type of defect.



Selecting the **LOCALIZED AXIAL** Cracks button instigates a small area analysis method for use with corrosion that is smaller than the footprint of the Sensor and has axial cracks. No user input is required for this type of defect.



Selecting the **LOCALIZED CIRC**umferential Cracks button instigates a small area analysis method for use with corrosion that is smaller than the footprint of the Sensor and has circumferential cracks. No user input is required for this type of defect.

13. Analysis

Several different analysis methods are available depending on the type of defect. Defects should first be marked, after which they may be analyzed using a variety of tools available to the user. The Analysis functions described in this section are only applied to:

- the visible C-Scan View. Caution should be exercised if any view other than 100% Zoom (full scan) is utilized; and
- Defects that are deeper than the current Threshold setting.

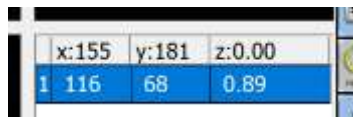
Many of the different processes discussed in this section are compatible. Multiple processes can often be combined to produce a unique analysis.

13.1. Defect Marking

The Analysis View is utilized marking Defects and performing Defect analysis. Several features available in the Analysis View are convenient for use in these tasks. The Analysis View window initially displays the deepest defect by placing the cursor at that defect.

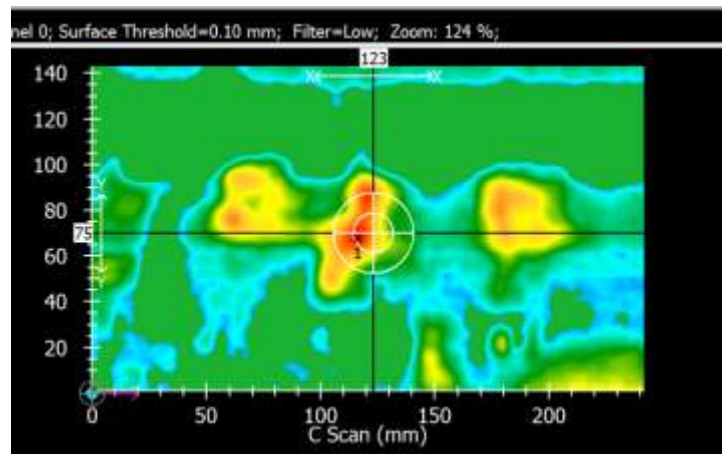
Although Zooming can be accomplished using the **TOOLS** ⇒ **ZOOM** buttons, zooming can also be accomplished within the Plan View area using standard Windows operations (Mouse Wheel or two-finger drag for touch screens). It should be noted that the processes described below only apply to the C-Scan image displayed. If the image is zoomed in and defects are no longer displayed, these defects will not be included in any of the following actions.

Whether extended or contracted, the current cursor position is displayed in the header of the Defect List.



	x:155	y:181	z:0.00
1	116	68	0.89

The Cursor position is also displayed on the crosshairs in the Plan View while dragging the cursor to a new position.

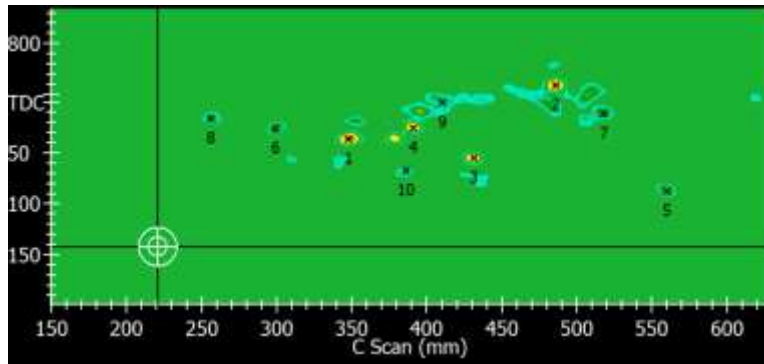


Once zoomed above 100% the Plan View can be panned using standard Windows actions (with mouse hold down the LH button and drag, touch and drag with a touch screen).

Whenever the Sensor is installed on a powered scanner such as a *SKOOT* or *NAVIC* the position of the Lead Channel is indicated by an arrow as shown below.



The following is an example of Defect Marking, regardless whether of the creation method.



13.1.1.1. Manual Defect Marking

Each Defect can be tagged and labelled manually using the Bullseye Cursor on the C-Scan area of the Analysis View. The Bullseye Cursor appears at the crosshairs intersection. The Bullseye is comprised of two circles centred about the intersection of the crosshairs, and inner and an outer. The Bullseye can be dragged and dropped at any location on the Analysis Plan View.



Selecting the **SIZE** button opens the **Bullseye Style and Size** window. The Bullseye cursor is a resizable circular area marked around the intersection of the crosshairs and determines the defect pick area if no defect is yet marked within the Bullseye. If a defect is already marked, then the area become an exclusion zone for the next deepest pick. The Bullseye can be dragged and dropped anywhere within the Analysis Plan View.



Selecting the **Dynamic** radio button maintains the Bullseye at fixed size as is appears on the screen. That is, as the user scales the scan view in or out, the Bullseye is automatically rescaled to remain the same size in the window. The actual viewed size of the Bullseye can be changed by using the ▲ or ▼ buttons, each selection incrementing the size in steps of 10% between 10% and 500%. Any size

can also be typed directly into the text box by selecting the box, highlighting the current text, typing the new desired size, and selecting the **OK** button.



Fixed Selecting the **Fixed** radio button maintains the Bullseye at the size displayed in the text box. That is, as the user scales the scan view in or out, the Bullseye become larger or smaller, remaining at the designated size. The actual viewed size of the Bullseye can be changed by using the ▲ or ▼ buttons, each selection incrementing the size in steps of 5 mm between 5 and 100 mm [0.20" steps between 0.20" and 4.00" for traditional units. Any size can also be typed directly into the text box by selecting the box, highlighting the current text, typing the new desired size.



mm **Inch** Selecting mm or Inch radio buttons determines which measurement system is used to determine the cursor size.



Selecting the **OK** button saves the new Bullseye setting and closes the window.



Selecting the **CANCEL** button closes the window without saving any changes.



Selecting the **ANALYSIS** button opens the following window.



No Defects Marked

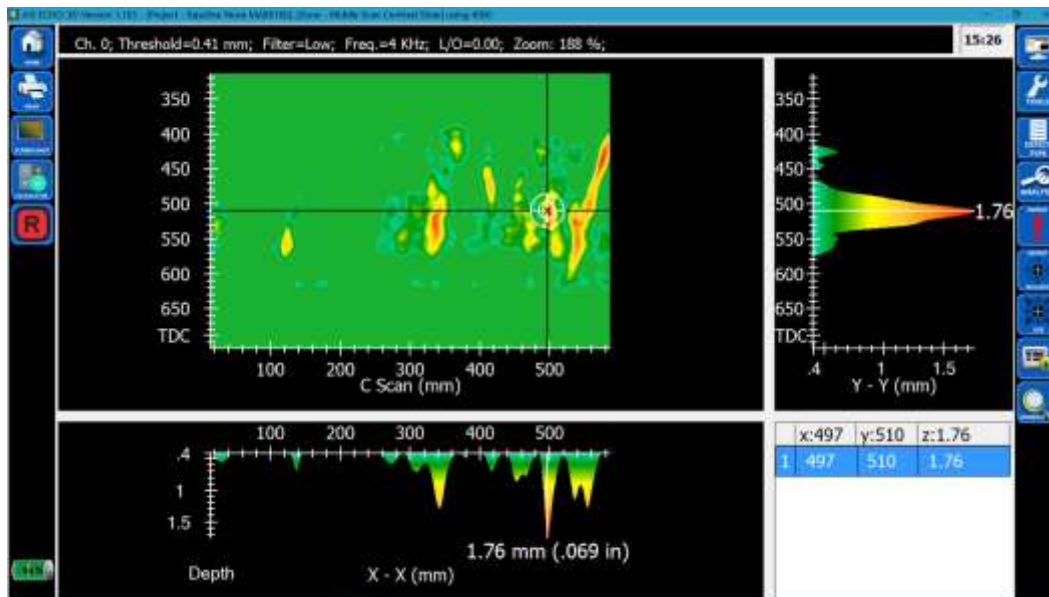


With Defects Marked

The buttons displayed in the window change depending on whether any Defects have been marked yet. Once at least one Defect has been marked, the **REMOVE** and **REMOVE ALL** buttons appear.



Selecting the **MARK DEEPEST** button finds the deepest point of a Defect within the Bullseye, Marks the location with an **x**, and labels the Defect. Information on the position and depth of the Defect are displayed in the bottom right hand zone of the main window in the Defect List. Any number of Defects can be labelled in this manner with the Defect Number increasing by one each time.



Multiple Defects can be marked by simply moving the Bullseye Cursor around the C-Scan View and repeating the marking procedure. However, a tool is available to semi-automate the process. This ensures that Defects are marked in order of deepest to shallowest.



Selecting the **MARK DEFECT** button tags a Defect label at the centre of the Bullseye. This can be used to label other features in the scan that the user may wish to label. See Section 13.1.2 below.

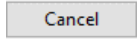
Note: The Bullseye Cursor can be moved to any existing marked Defect by selecting (highlighting) the desired Defect in the Defect List.



Selecting the **REMOVE** button with the Bullseye Cursor over a Defect Mark opens the following warning.



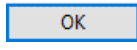
Selecting the **OK** button removes the Defect Labels and rennumbers the remaining Defects if needed.

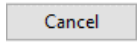
 Selecting the **Cancel** button cancels the operation and closes the window.



Selecting the **REMOVE ALL** button opens the following warning.



 Selecting the **OK** button removes all the Defect Marks and Labels.

 Selecting the **Cancel** button cancels the operation and closes the window.

13.1.2. Automated Defect Marking

ECHO-3D can Mark multiple Defects at once using an automated process. If all Defects are to be Marked, ensure that the C-Scan image is zoomed to full extent (100%).



Selecting the **ANALYSIS** button opens the following window.



No Defects Marked

With Defects Marked

The buttons displayed in the window change depending on whether any Defects have been marked yet. Once at least one Defect has been marked, the **REMOVE** and **REMOVE ALL** buttons appear.



Selecting the **MARK DEFECTS** button opens the **Mark Defects** window.

Add - The number of Defect Marks to be created can then be reset with each selection of the Add ▲ button increasing the number by 1. Each selection of the ▼ button decreases the number by 1. Multiple values can be added or subtracted by selecting and holding appropriate ▲ or ▼ button. The Add number may also be entered directly into the text box by first highlighting the value and entering a new value from the keyboard.

Exclusion - The Exclusion length is the minimum distance from one Marked Defect to the next. The Exclusion displayed can then be reset with each selection of the Exclusion ▲ button increasing the distance by 1 mm. Each selection of the ▼ button decreases the distance by 1 mm. Multiple values can be added or subtracted by selecting and holding appropriate ▲ or ▼ button. The Exclusion length may

also be entered directly into the text box by first highlighting the value and entering a new value from the keyboard.



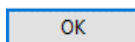
Selecting the **CLOSE** button cancels the **Mark Defects** and closes the window.



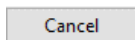
Selecting the **ADD** button marks that number of Defects Marks from deepest to shallowest. Each subsequent button selection will add the same number of Defect Marks.



Selecting the **REMOVE** button opens the following warning.



Selecting the **OK** button removes the Defect Labels and rennumbers the remaining Defects if needed.



Selecting the **Cancel** button cancels the operation and closes the window.

13.2. Exclusion Zones

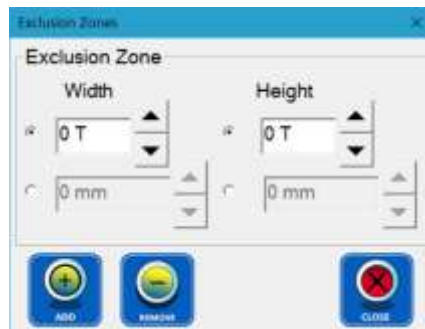
Exclusion Zones are used in the analysis of corrosion type defects.



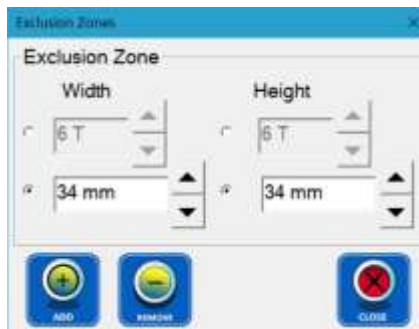
Selecting the **ADD EXCLUSION ZONES** button open the **Exclusion Zones** window.

Width - The exclusion width is selectable between multiples of pipe wall thickness or millimetres. It can then be reset with each selection of the ▲ button increasing the number by 1. Each selection of the ▼ button decreases the number by 1. Multiple values can be added or subtracted by selecting and holding appropriate ▲ or ▼ button. The number may also be entered directly into the text box by first highlighting the value and entering a new value from the keyboard.

Height - The exclusion height is selectable and adjustable as described above for Width.

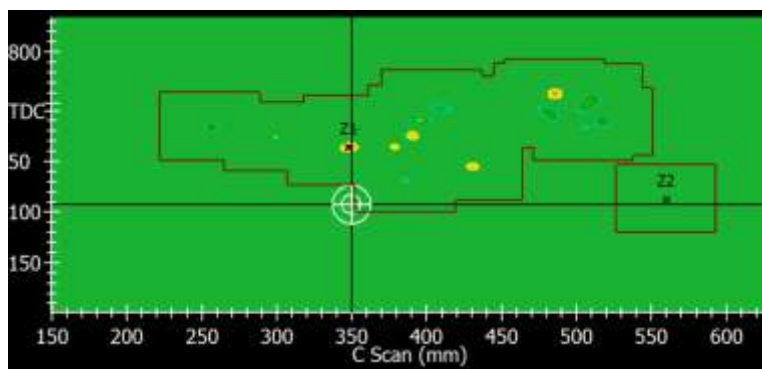


Using Wall Thickness



Using Millimetres

The following is an example of applied Exclusion Zones.



13.3. Sectional Grid

Sectional Grid is utilized to mark a gridwork on the scan area. This is often required to compare ECHO-3D results with other manual inspection methods such as UT and MT, or as a customer requirement.



Selecting the **ANALYSIS** button opens the following window.



No Defects Marked

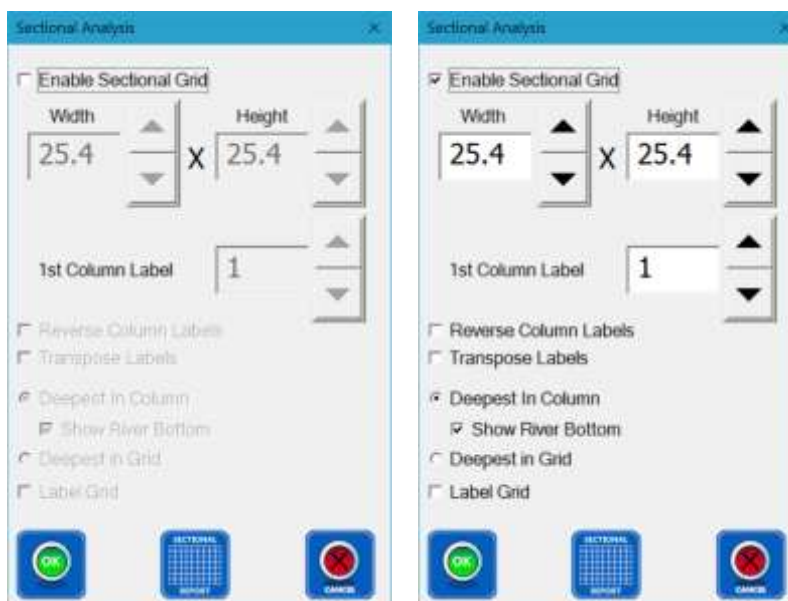


With Defects Marked

The buttons displayed in the window change depending on whether any Defects have been marked yet. Once at least one Defect has been marked, the **REMOVE** and **REMOVE ALL** buttons appear.



Selecting the **SECTIONAL REPORT** button opens the **Sectional Analysis** window.



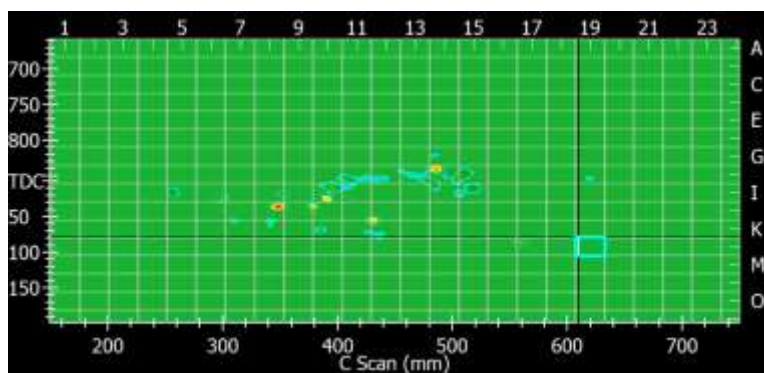
☒ Enable Sectional Grid

Selecting the Enable Section Grid check-box activates the Grid. The default grid size is 25.4 mm [1"] x 25.4 mm [1"]. Deepest in Column and Show River Bottom are selected by default. See Section 13.5 for more information on River Bottom.

Width - The grid width can be reset with each selection of the ▲ button increasing the number by 1. Each selection of the ▼ button decreases the number by 1. Multiple values can be added or subtracted by selecting and holding appropriate ▲ or ▼ button. The number may also be entered directly into the text box by first highlighting the value and entering a new value from the keyboard.

Height - The grid height is selectable and adjustable as described above for Width.

The standard configuration is to have columns numbered from left to right starting at 1 and rows labelled by letters starting at "A" as shown below.

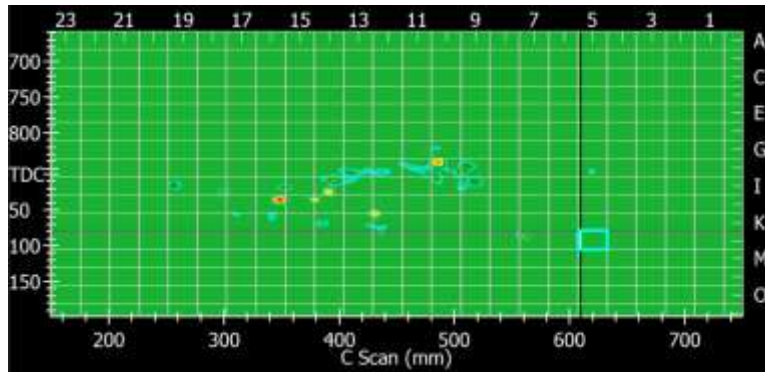


☒ Reverse Column Labels

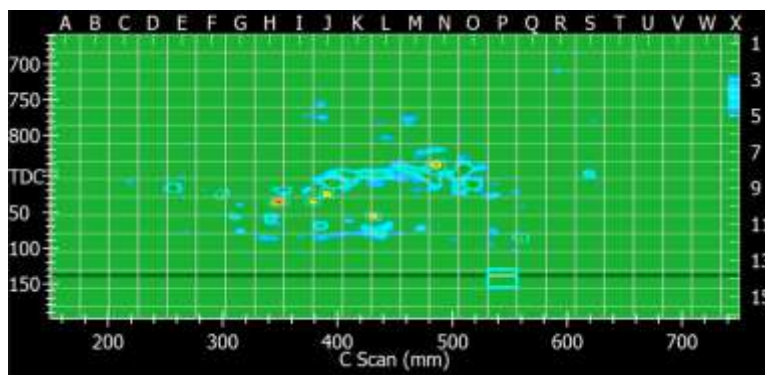
Selecting Reverse Column Labels changes the columns to be numbered right to left. This requires that the 1st Column Label be increased as necessary.

1st Column Label - The column label is reset with each selection of the ▲ button increasing the number by 1. Each selection of the ▼ button decreases the number by 1. Multiple values can be added

or subtracted by selecting and holding appropriate ▲ or ▼ button. The number may also be entered directly into the text box by first highlighting the value and entering a new value from the keyboard.



☒ **Transpose Labels** Selecting Transpose Labels converts the columns to letter labels and the rows to numbers.



Note: Both Reverse Column Labels and Transpose Labels can be selected. An example has not been shown.

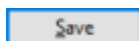
☒ **Deepest In Column** Selecting Deepest In Column finds the deepest defect within the column.

☒ **Deepest in Grid** Selecting Deepest in Grid finds the deepest defect within grid cell.

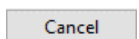
☒ **Label Grid** Selecting Label Grid displays the above selected deepest value.



Selecting the **SECTIONAL REPORT** button creates a Microsoft Excel spreadsheet file and opens the **Save As** window. The spreadsheet is used to export the grid information. A file name must be entered in the File Name box and a file location must be selected using standard Windows methods.



Selecting the **Save** button saves the file in the selected location.



Selecting the **Cancel** button cancels the operation and closes the window.



Selecting the **OK** button saves the new settings and closes the window.



Selecting the **CANCEL** button closes the window without saving any changes.

13.4. Defect Labelling and Editing

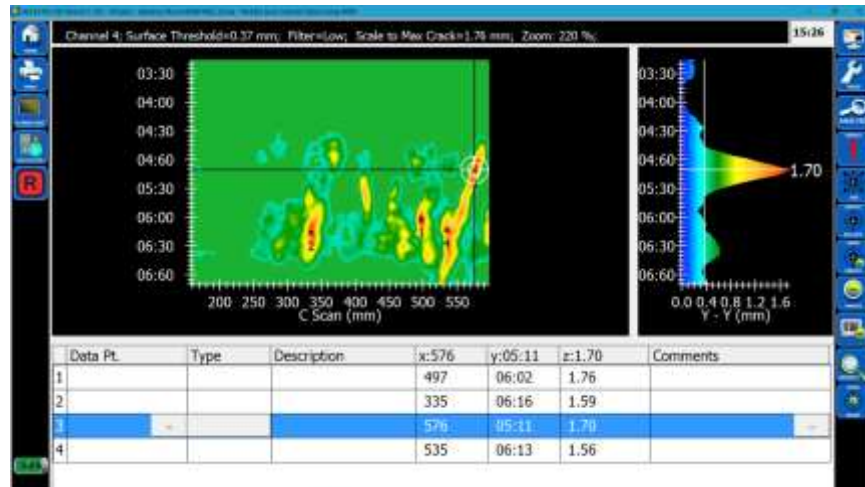
Once a Defect has been marked it can be further labelled. The following starts from the Analysis View window.



If needed, select the **More** button to display additional buttons hidden on smaller PC or Tablet displays.



Selecting the **Expand List** button resizes the Defect list hiding the X-X Section view.



Additional labelling and analysis can be performed by selecting the desired defect (highlighting the defect line).

Data Pt.	Type	Description	x:576	y:05:11	z:1.70	Comments
1			497	06:02	1.76	
2			335	06:16	1.59	
3			576	05:11	1.70	
4			535	06:13	1.56	



Selecting the **More** button in **Data Pt.** opens the **Data Pt.** window. Text can be entered in the box. Any labelled defect in the list can be selected for adding or editing the Data Point Label.

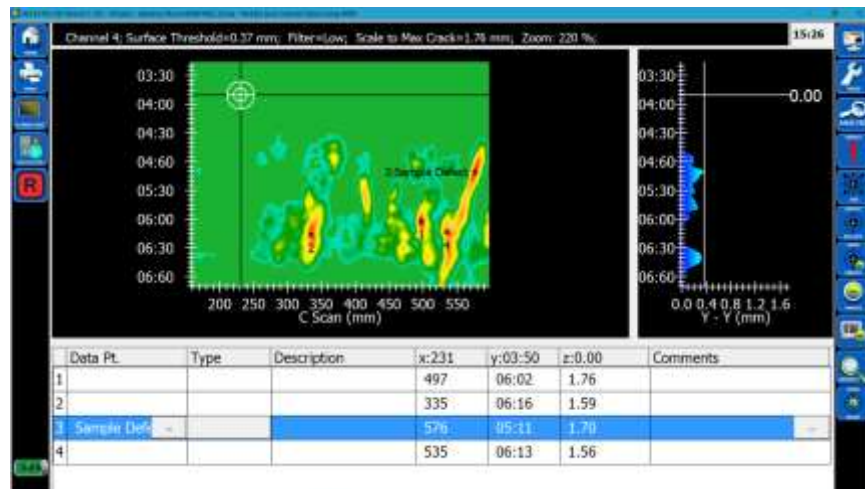
The screenshot shows a window titled "Data Pt." with a text input field labeled "Sample Defect". Below the input field are two buttons: a red "CANCEL" button and a green "OK" button.



Selecting the **CANCEL** button closes the window without saving any changes.



Selecting the **OK** button saves the entered text in the Data Pt. box of that Defect. Any labelled Defect in the list can be selected for adding or editing.



Selecting the **More** button in **Comments** opens the **Defect Comments** window. Text can be entered in the box. Any labelled defect in the list can be selected for adding or editing the Defect Comments.

Defect Comments

Sample defect comment

OK



Selecting the **CANCEL** button closes the window without saving any changes.



Selecting the **OK** button saves the entered text in the Comments box of that Defect. Any labelled Defect in the list can be selected for adding or editing Length and Comments.

Data Pt.	Type	Description	x:231	y:03:50	z:0.00	Comments
1			497	06:02	1.76	
2			335	06:16	1.59	
3	Sample Defect		576	05:11	1.70	Sample defect comment
4			535	06:13	1.56	



Selecting the **Contract List** button reduces the Defect List back to the original size hiding the Comments area and redisplaying the X-X Section view.




Selecting the **100 ZOOMOUT** button returns the scaling back to 100%.

13.4.1. Defect Type


 Selecting the box under the **Type** heading opens the **Defect Type Selection** window.



13.4.1.1. Crack

 Selecting the **CRACK** button places “Crack” in the **Type** field and opens the **Crack Length Calculator** window.



 Starting at the top for vertical cracks or the left for horizontal cracks, place the Bullseye at the start of the crack and select the **CRACK START** button. The starting position of the crack is input into the text box right of the button and marked on the plan view by **Cs**. Selecting the check-marked **CRACK START** button deselects the marked crack starting point. A new starting point can then be selected by dragging the Bullseye to a new location and reselecting the **CRACK START** button again.

 Dragging the Bullseye and selecting the **MOVE DEFECT LOCATION** button resets the defect mark location to the centre of the Bullseye.



 Selecting the **RESTORE ORIGINAL LOCATION** button changes it back to the **SET DEFECT LOCATION** button, removes the checkmark, and resets the mark and label to the original location.



Place the Bullseye at the end of the crack and select the **CRACK END** button. The ending position of the crack is input into the text box right of the button, marked on the plan view with **Ce**, and the Crack Length is automatically calculated.



Selecting the check-marked **CRACK END** button deselects the marked crack end-point. A new end-point can then be selected by dragging the Bullseye to a new location and reselecting the **CRACK END** button again.

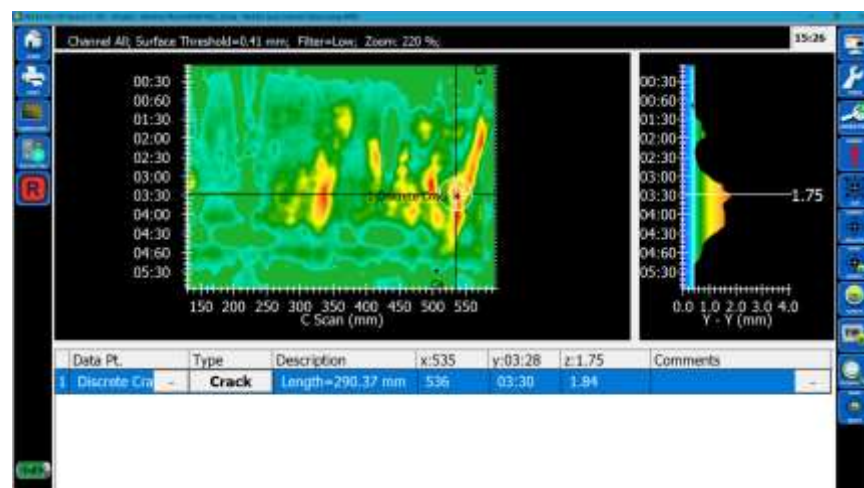
Crack Length is automatically recalculated anytime the Crack Start (**Cs**) or Crack End (**Ce**) positions are changed.



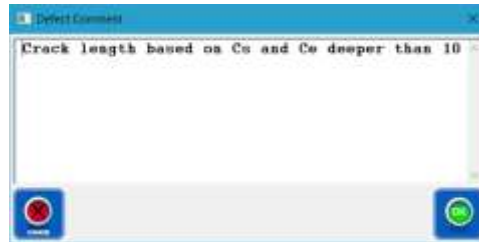
Selecting the **CANCEL** button closes the window without saving any changes.



Selecting the **OK** button closes the Crack Analysis window.



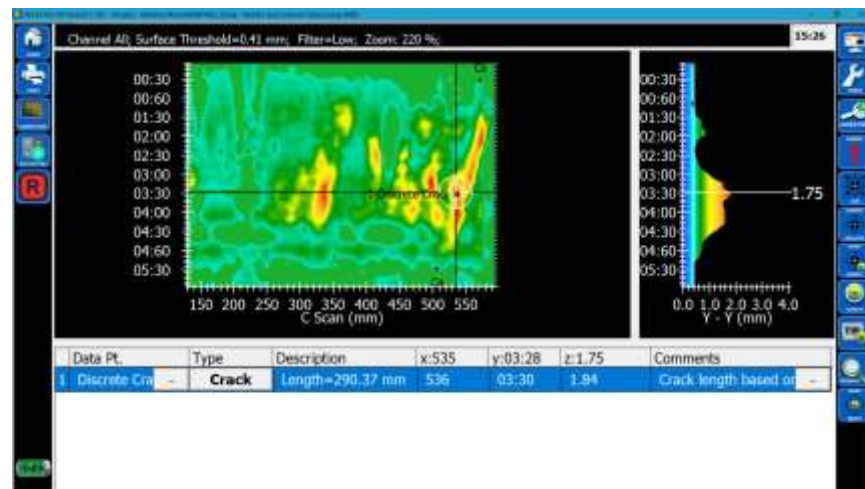
... Selecting the **More** button in **Comments** opens the **Defect Comments** window. A comment can then be entered in the text box. Entered Comment appear as Tech Notes in the Report.



Selecting the **CANCEL** button closes the window without saving any changes.



Selecting the **OK** button saves the Defect Comment and closes the window.



13.4.1.2. Corrosion and SCC

Corrosion or SCC can be analyzed starting at the Analysis View with expanded defect details window. Corrosion with tightly positioned pitting is best analyzed using the Corrosion (from the drop-down box below) technique.

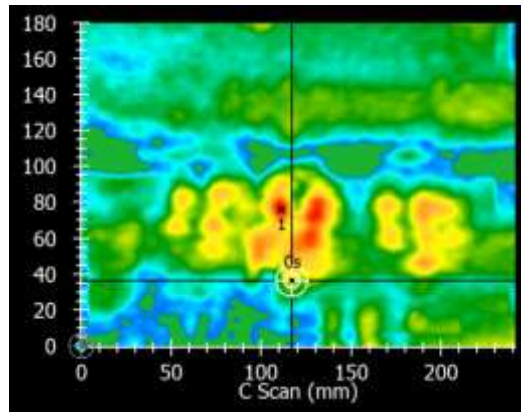


Selecting the **Corrosion** or **SCC** button opens places Corrosion of SCC in the Type column and the **Corrosion Calculator** window.



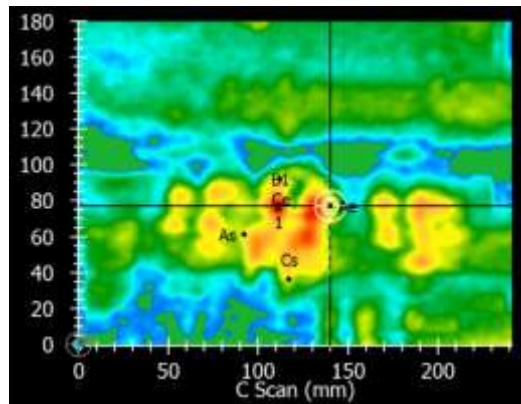
Cs

Position the cursor at the circumferential start (Y-axis) of the corrosion area and select the **Cs** (Circumferential start) button. The defect area is **Cs** labelled and a checkmark confirms the event.



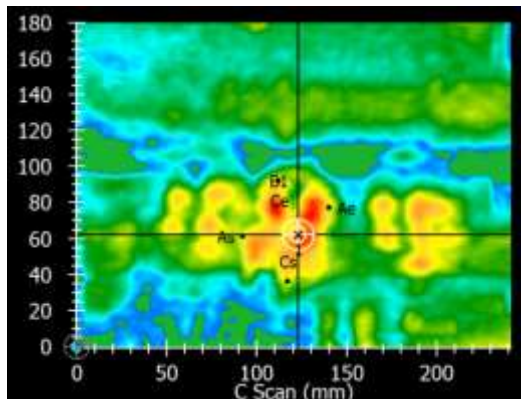
Ce **As** **Ae**

Following the same procedure, work through the three other boundary coordinates: **Ce** – Circumferential end; **As** – Axial start; and **Ae** – Axial end.



MOVE DEFECT LOCATION

Moving the cursor to a new location and selecting the **MOVE DEFECT LOCATION** button moves the defect marker to the new location and changes the button to **RESTORE ORIGINAL LOCATION**.





Selecting the **RESTORE ORIGINAL LOCATION** button move the defect marker back to the original placement and returns the button to **MOVE DEFECT LOCATION**.



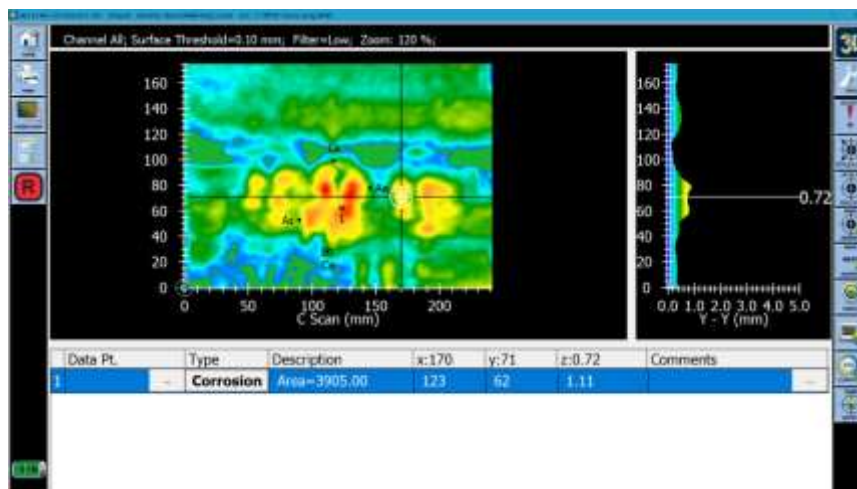
The **Sketch All** button can be used to determine the corrosion boundary instead defining four points. Selecting the **Sketch All** button automatically defines **Cs**, **Ce**, **As**, and **Ae** from the outline drawn on the display.



Selecting the **CANCEL** button closes the window without saving any changes.



Selecting the **OK** button saves latest settings and closes the window. “Corrosion” is placed in the Type column and the calculated area is displayed in the Description column.



14. Screen Shots and Pictures

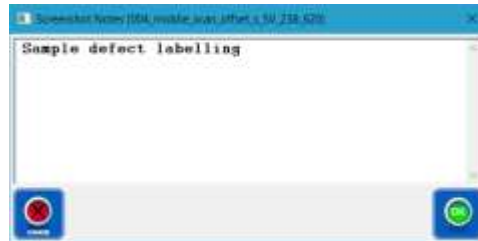
ECHO-3D allows the user to take Pictures or Screen Shots at any time during the running of a Project. Pictures are taken by the rear side Tablet camera permitting the user to take pictures of jobsite, inspection set-up, defect location, and any other topic of interest. Previously taken pictures can also be imported.

14.1. Screen Shots

Screen Shots can be taken anytime the **SCREEN SHOT** button is displayed. When taking a Screen Shot of a 3D image or Section view, the background colour automatically changes to white regardless of the selected background colour. After the Screen Shot has been taken the background colour reverts back to the original background colour.



Selecting the **SCREEN SHOT** button opens the **Screen Capture Notes** window. The Screen Shot filename is written by ECHO-3D and is displayed in the Title Bar (i.e.: 004_middle_scan_offset_s_SV_238_620.jpg in the example below).



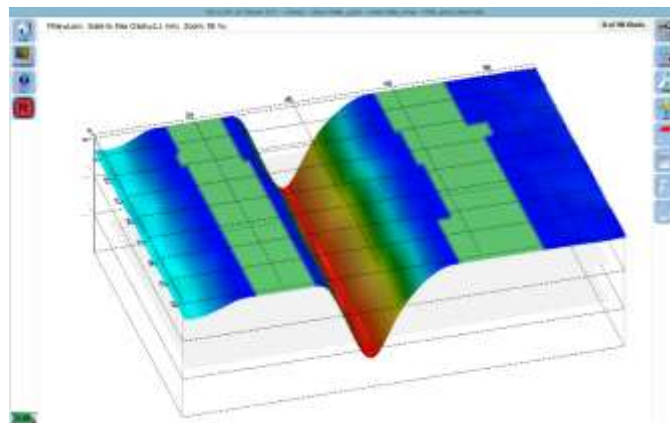
A description of the Screen Shot can be entered in the window and



Selecting the **CANCEL** button closes the window without saving any changes.



Selecting the **OK** button saves the Screen Shot to the file folder for the active Project and closes the window.



14.2. Tablet Camera Operation

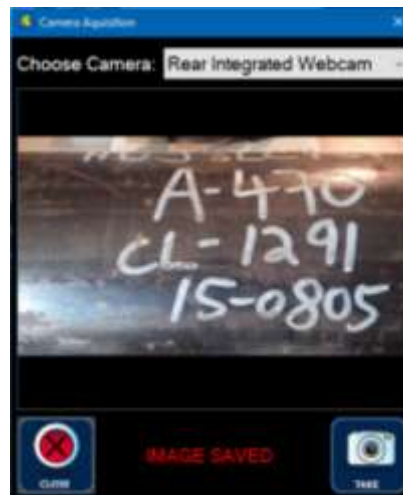
Pictures can be taken anytime the **CAMERA** button is displayed.



Selecting the **CAMERA** button opens the Camera Acquisition window permitting operation of the Tablet front or rear facing camera.



Selecting the **TAKE Photo** button saves the photo image in the Project folder and displays the file name in the **Stored Images** box.



15. Generating a Report

ECHO-3D directly generates a report based on the information saved in the Project. ECHO-3D combines the saved details, pictures, and screen shots into a single report. The report results in a Protected Document Format (PDF) file which can then be printed or transmitted electronically.

There are two methods for starting the Report generating process:

1. Starting from the Home Screen window; or
2. Starting from the Active Project window

Starting from the **Home Screen** window.



Selecting the **REPORT** button opens the **Project Selection** window.



Select (highlight) the desired Project. A checkmark is added to the checkmark box to confirm the selection.



Selecting the **CLOSE** button closes the window without saving any changes.



Selecting the **SELECT** button closes the **Project Selection** window and opens the **Generate Report for Project** window.



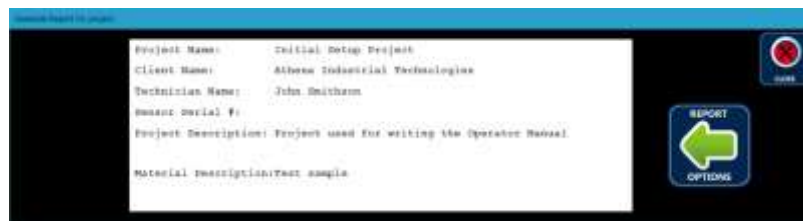
Starting from the **Active Project** window.



Selecting the **REPORT** button opens the **Generate Report for Project** window.



Selecting the **Details** button opens the **Generate Report for Project: Details** window allowing the user to review the Project Details prior to generating the Report. If any Detail requires editing this window must be closed and the appropriate Detail edited as discussed previously.



Selecting the **BACK** button returns the user to the **Generate Report for Project** window.



Selecting the **ZONES** button displays the Report Zones. The **Existing Zones** box displays all Zones attached to the Project and are default selected (check-box filled with checkmark) to be included in the Report. De-selecting the check-box (removing the checkmark) eliminates that Zone from the Report but does not delete the Zone nor any data associated with the Zone. The order which the Zones appear in the Report is the order in which they are listed. The order can be adjusted by dragging and dropping

the selecting (highlighting) the Zone, or by selecting the Up or Down arrow to move the selected Zone. The other fields associated with the selected (highlighted) Zone can be edited.



 Selecting the **Select All** button selects all the Zones.

 Selecting the Deselect All button deselects all the Zones.



Selecting the **BACK** button saves the edited Zone details and returns the user to the **Generate Report for Project** window.



Selecting the **IMAGES** button displays the **Stored Images Details** window. The **Stored Images** box displays all Images attached to the Project and are default selected (check-box filled with checkmark) to be included in the Report. Deselecting the check-box (removing the checkmark) eliminates that Image from the Report but does not delete the Image file. The order which the Images appear can be adjusted by selecting (highlighting) the file name, then dragging and dropping, or selecting the Up or Down arrow to move the selected Image. Existing images on file in the Tablet/PC can be imported into the Project files without effecting the original image file.



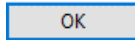
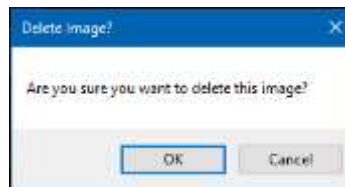
Selecting (highlighting) an Image file name displays an **Image Preview** and **Image Notes**, and activates the **REMOVE** and **SAVE** buttons. The **Notes** text box can be edited at this time.



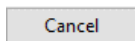
Selecting the **SAVE** button saves the edited Notes, de-selects (un-highlights) the file name and deactivates the **REMOVE** and **SAVE** buttons.



Selecting the **REMOVE** button deletes the highlighted Image file, displaying the following message.



Selecting the **OK** button completed the deletion and closes the message window.



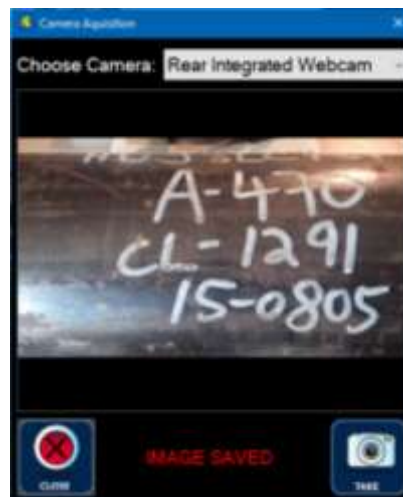
Selecting the **Cancel** button cancels the file deletion and closes the message window.



Selecting the **CANCEL** button cancels any Notes editing and returns the **Stored Images Details** window.



Selecting the **TAKE Photo** button opens the **Camera Acquisition** window displaying a preview of the photo image. Either the front or rear Tablet cameras can be selected from the drop-down list.



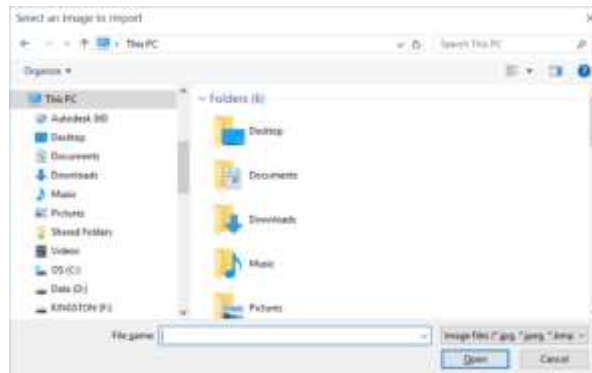
Selecting the **CLOSE** button closes the **Camera Acquisition** window.



Selecting the **TAKE Photo** button saves the photo image in the Project folder and displays the file name in the **Stored Images** box when it is displayed.

[Click Here To Import Images](#)

Selecting the **Click Here To Import Images** button opens the **Select an Image to Import** window.



Browse to find the file to be imported and select (highlight) the file. Note that only Joint Photographic Experts Group (jpg and .jpeg) and Device Independent Bitmap (.bmp) files can be imported.

[Cancel](#)

Selecting the **Cancel** button cancels the file import and closes the Select an Image to Import window.

[Open](#)

Selecting the **Open** button displays a preview of the image. Image Notes can be added in the Notes text box.



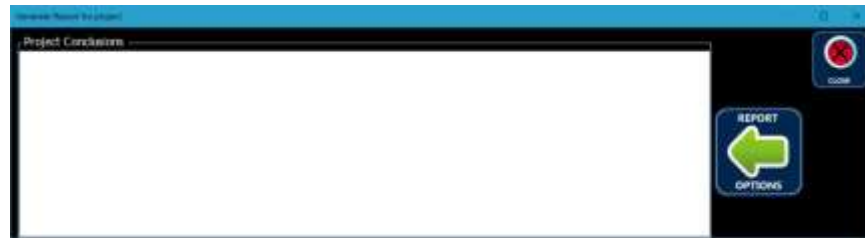
Selecting the **SAVE** button saves file and any added Notes and returns the **Stored Images Details** window.



Selecting the **BACK** button saves the edited Notes details and returns the user to the **Generate Report for Project** window.



Selecting the **CONCLUSIONS** buttons displays the Report Conclusions. Conclusions can be added, but most likely this field will be left empty until the inspection work has been performed.



Selecting the **CLOSE** button closes the window without saving any entered text.



Selecting the **BACK** button saves the edited Notes details and returns the user to the **Generate Report for Project** window.



Selecting the **REPORT** button generates the report and displays the PDF Report file.

Initial Setup Project_Report_R1.pdf - Adobe Acrobat Reader DC

File Edit View Window Help

Home Tools Initial Setup Project... * Sign In

1 (1 of 3) 68.5%

		Project ID: Initial Setup Project			
		Page: 1 of 3			
		Date: 12-Jul-16			
		SW Ver: 1103095			
	Company:	Testers International LLC	Contact:	Joe Doe	
	Address:	1001 100 Ave	Email:	joe.doe@testers.com	
		Anytown, Alberta	Website:	www.testers.com	
		Canada A1B 2C3	Phone #:	(403) 555-9999 Fax #: (403) 555-8888	
Client:	Athena Industrial Technologies	Contact:	Doug		
Address:	554 Hurricane Dr	Email:	doug.se@athenaindustrial.com		
	Calgary, AB	Website:	www.athenaindustrial.com		
	Canada T3Z3S8	Phone #:	(403) 247-7666 Fax #: (403) 247-7437		
PROJECT DETAILS					
Project Description:		Project used for writing the Operator Manual			
# of Zones:	2	Material Description:	Test sample		
Sensor Serial #:		Mat Thickness:	8 mm		
Frequency:	4000 Hz	Location:	AIS Headquarters		
DEFECT ZONE SUMMARY					
Zone ID:	Zone 1	# of Runs:	0	Tech Notes:	
Base:	Not Taken	X Datum:	mm	Y Datum:	mm
		Y Scan Offset:	10 mm	Max Length:	0 mm
Zone Location Details:		From GW:	mm	From TDC:	N/A
				Pipe Diameter:	0.0 mm
Zone ID:	Zone 2	# of Runs:	7	Tech Notes:	
Base:	R050	X Datum:	mm	Y Datum:	mm
		Y Scan Offset:	10 mm	Max Length:	144 mm
Zone Location Details:		From GW:	mm	From TDC:	N/A
				Pipe Diameter:	0.0 mm
EXAMINATION DETAILS AND RESULTS					
Client:	Athena Industrial Technologies	Project:	Initial Setup Project		
Conclusion					

The Report can then be filed as desired using the PDF viewer software.

Note: A copy of the Report is automatically filed in the C:\ProgramData\AIS-ECHOField\raw files/<Project Name> folder. This folder may be hidden and can be seen by selecting “Hidden items” in the Windows Explorer View menu.

16. Exporting and Importing Projects

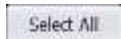
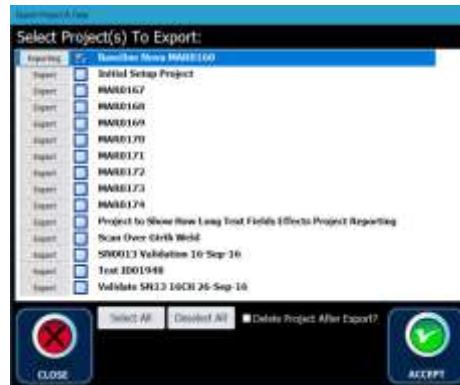
ECHO-3D allows the user to Export and Import Projects from one PC or Tablet to another. The export function bundles all of the files included in the Project. The Export function provides a method of archiving old Projects allowing the user to limit the number of Projects which appears in the dropdown lists.

16.1. Exporting a Project

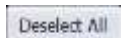
The following starts from the **Tools Screen** window.



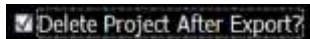
Selecting the **EXPORT** button opens the **Export Project & Data** window. Multiple Projects may be selected to Export from the list by selecting the appropriate checkboxes (placing a checkmark in each box) to the left of the Project Name and changing the label to **Exporting**.



Selecting the **Select All** button selects all Projects.



Selecting the **Deselect All** button deselects all selected Projects.



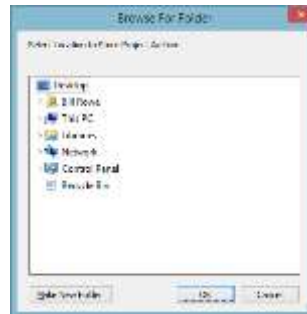
Selecting the **Delete Project After Export** checkbox deletes the selected Projects from the Projects dropdown list. It should be noted that Projects Exported to the same Tablet/PC and filed in a separate folder (such as an archive folder) are not deleted from that folder.



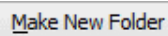
Selecting the **CLOSE** button cancels the Export process and closes the window.



Selecting the **ACCEPT** button opens the **Browse For Folder** window.



Browse through the file directory and select the desired folder where the files will be exported to.



Selecting the **Make New Folder** button permits the user to create a new folder if required using standard Windows protocol.



Selecting the **OK** button performs the Export. The Export function creates a single proprietary file with the “e3denc” extension.



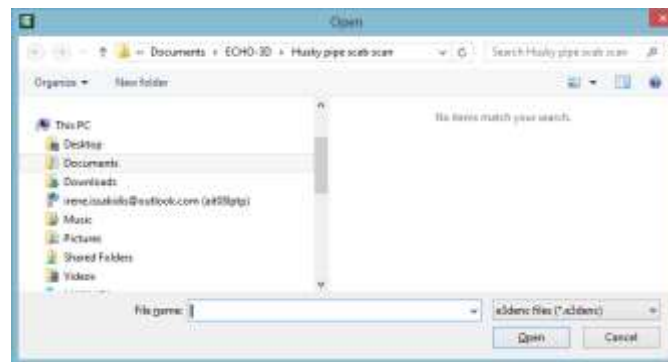
Selecting the **Cancel** button cancels the operation and closes the window.

16.2. Importing a Project

Projects previously Exported to other storage devices may be Imported for viewing, editing and use in ECHO-3D. The following starts from the **Tools Screen** window.



Selecting the **IMPORT** button opens the **Open** window.



Browse to find the desired E3DENC file and select highlighting the file and adding the file name to the **File name** box. Multiple files can be selected for Import using standard Windows methods.



Selecting the **Open** button creates a Project folder under My Documents\ECHO-3D for each selected file being Imported, converts the single E3DENC file back to the all of the original files for the Project (akin to UnZipping), and writes those files to the folder. The following message is displayed.

Cancel

Selecting the **Cancel** button cancels the operation and closes the window.



OK

Selecting the **OK** button closes the message window.

17. Help Files

The ECHO-3D Software includes an extensive collection of Help Files. The Help Files utilize the user's Default Internet Browser and scripting. This may result in a message similar to below. Blocked content will need to be allowed before the Help Files will load into the Browser.



Note: Problems have occurred if the Help Files not opening using Microsoft Edge. If problems are encountered, try changing the default internet browser to Internet Explorer or Google Chrome.



Selecting the **Help / Info** button opens the ECHO-3D Help window.



The left side of the window displays a navigation window. Selecting the subject opens that subject page or shows the next level of pages.

Close the Browser to close the Help Files.

18. Maintenance

18.1. Gen II Sensor

The ECHO-3D Gen II Sensor has no internal moving or serviceable parts and does not require any ongoing maintenance other than cleaning. The Sensor should be cleaned on a regular basis using a cleaning solution such as Spray Nine® or SuperClean®. The use of petroleum based solvents should be avoided and could cause damage to the Sensor.

The Sensor base is fitted with a replaceable Lexan Wear Pad and may be damaged during operations if the surface being inspected is exceptionally rough or abrasive. The Wear Pad is attached to the Sensor by PSA (Pressure Sensitive Adhesive). Replacing the Pad requires removal of the old Pad. This can be accomplished by using a knife blade to carefully peel back a corner of the Pad. Once enough of the Pad is exposed, grab the corner and remove the Pad by firmly pulling it off. If the Sensor base is soiled or retains excessive adhesive, it should be cleaned with cleaning solution prior to the installation of the new Pad. Peel back the protective cover on the new Wear Pad. Carefully place the Pad on the bottom of the Sensor and apply an even pressure over the entire Pad to set the PSA.

Using the Sensor in a powered scanner on pipe has shown that excessive wear of the Wear Pad may occur. Inspection of the Wear Pad prior to, and after, each scan is important to ensure that permanent damage to the Sensor does not occur.

18.2. ECHO-X Encoder

The ECHO-X Encoder wheel will pick up debris from the sample surface during scanning operations. Using the supplied brush, remove any excess dirt or debris which may prevent the wheel from following the sample surface. If required a cleaning solution, as described previously, can be used.

Should a wheel O-ring become damaged they can be easily replaced by simply prying off the old O-ring and installing the new one. O-rings supplied with the kit are of Nitrile (NBR) 90 Durometer and should be sufficiently resistant to chemical attack from contaminants found on sample surfaces.

18.3. Sensor Shoes

Standard Sensor Shoes are fitted with Teflon (TFE) wear strips. Operation in powered scanners on pipe may result in excessive wear and should be checked prior to and after each scan. Excessively worn strips will expose the Sensor Wear Pad to the pipe and possibly result in excessive wear and possibly inaccurate data collection. Excessively worn strips will allow the Sensor to wobble slightly when installed on a pipe. Shoes fitted with titanium wear strips are available for use with powered scanners.

19. Revisions and Updates

Athena continues to conduct research and testing to further develop the ECHO-3D system and the Generation II Sensor. Sensor firmware updates, when required to add increased functionality, will be initiated directly to the Sensor by Athena Industrial Services via the Internet.

20. Bug, Issue, and Recommendation Reporting

ECHO-3D is currently a Beta version only. This Beta version has been distributed to selected inspection companies with the intension of soliciting recommendations from industry experts so that the development of the commercial version (Generation III) results in a system that meets industry requirements and expectations. Feedback and suggestions are welcome and should be addressed to our general e-mail address info@athenaindustrial.com.

21. Troubleshooting

All Tablets supplied with ECHO-3D are equipped with the latest version of TeamViewer software permitting Athena personnel to access the Tablets and share screens for help with troubleshooting problems.

For troubleshooting problems with the Dell Tablet please refer to the Dell 12 Rugged Tablet-7202 User's Guide.

Appendix A – Terminology and Definitions

ATEX	European Union (EU) directives describing what equipment and work environment is allowed in an environment with an explosive atmosphere.
Base	An average dimensionless value of twenty sample Shots from Lead Channel acquired during Compensation.
Bottom Right View	An orthographic projection of a three-dimensional image as viewed looking at the bottom right corner with the datum in the top left corner of the image. This is an “up-side-down” view of the standard orthographic view.
B-Scan	A two-dimensional, cross-sectional view produced by a single pass of a test sensor over a length of the target sample. Originated in medicine.
Button	An area of the active window designated with a button or icon that, when selected, performs a task such as opening a window.
Compensation	The process the Gen II Sensor uses to neutralize the effects of material properties and sample geometry. This is akin to pressing a Tare button on a weight scale.
Channel	See Transceiver Channel
Client	The Inspection Company’s customer. Typically, the company paying for the service.
C-Scan	A top down view of the scanned area created by “stitching” together a series of B-Scans.
Depth Gauge	Measures defect depth from the chosen Lead Channel in real time. During Depth Gauge use no data recording occurs.
DN	ISO dimensionless designator for pipe size commonly used in areas using the metric measurement system.
EFW	Electric Fusion Welded, also known as Fusin Welded (FW) is a method of seam welding pipe used by the A. O. Smith Company to manufacture welded pipe from 1930 to the 1960s.
EMF	Electro-Magnetic Field is a physical field produced by electrically charged objects.
EMFI	Electro-Magnetic Field Imaging, the basic principle utilized in the ECHO-3D system whereby changes in the EMF are recorded and processed to create a three-dimensional image.
ERW	Electric Resistance Welding is a process that produces a weld at the faying surfaces of two similar metals
Exclusion Zone	The area of a circle surrounding a defect, defined by the Exclusion radius, which is mutually free from any other defects or neighbouring Exclusion Zone of another defect.
Free-air Position	Any positioning of the Gen II Sensor which results in a measured Lift-Off of the maximum 25.7 mm [1.0”]. Flipped on its back in “dead bug” position with the base exposed to air is an example.

Lead Channel	The channel designated to provide defect depth measurement during Crack Detection or mapping data during scanning operations resulting in B-Scan and C-Scan images.
Lift-Off	The distance between the Sensor and the sample material. Lift-Off can be achieved by: the use of a Shoe; an X/Y-scanner that supports the Sensor; or by a coating applied to the surface of the material to be inspected.
MT	Magnetic Particle Inspection – An inspection technique utilizing an electro-magnetic field to align ferromagnetic particles visually exposing a defect or defect.
NPS	ASTM/ASME dimensionless designator for pipe size derived from Nominal Pipe Size more commonly used in North America in lieu of Inch Nominal Size.
Project	A term used to describe the activities of a job. A Project is limited to a single physical location or jobsite but can contain more the Zone.
Radar	A graphic visualization in Plan View (above the sensor looking down) of the raw signals received by the sensor. This mode observes the shift in the electro-magnetic field and is used as a training tool only.
SCC	Stress Corrosion Cracking is the cracking induced from the combined influence of tensile stress and a corrosive environment.
Section View	A combination of B-Scan and C-Scan views with the ability to note defect locations within the scanned area with cross-section views in both X and Y directions.
Select/Selecting	The same function as a left-hand mouse button “click” on a PC.
Sensor Shoe	An accessory designed to properly position the Gen II Sensor in the correct orientation to the sample. Shoes are specifically designed: for use with different Lead Channels; or to prevent rocking on specified pipe ODs. Sensor Shoes attach onto sensor via shoe guides.
Thumbnail	A C-Scan preview of scanned area in 3D Mode.
Top Left View	An orthographic projection of a three-dimensional image as viewed looking at the top left corner with the datum in the top left corner of the image. This is typically used as a standard orthographic view.
Transceiver Channel	One of 16 receiver coils. Channels are divided into two eight-coil equally-spaced groups forming a circle. The two circles of coils are positioned parallel, at different heights, and rotated 22.5° from the other.
Y-Offset	The distance between scan runs in the Y-axis.
Zone	A Technician defined scan area of a test specimen. There can be multiple Zones within a Project.

Appendix B – ECHO-3D Software Icon Definitions



Starts ECHO-3D Software



Opens the 3D viewer



Sets 3D to Top View



Sets 3D to Top/Left View



Opens the Help Files



Contracts the Defect List view



Updates details



Opens Additional Buttons window



Initiates the C-Scan View window



Removes Technician Two from Project



Aborts current Run



Accepts the current process



Initiates adding a Technician to Project



Marks SCC Right Edge



Initiates the Analysis window



Marks SCC Left Edge



Goes back to Previous Screen



Opens View Select window



Sets 3D to Front View



Sets 3 to Bottom/Right View



Expands the Defect List view



Initiates Browse for Logo



Saves the current setting



Initiates the Scan View window



Cancels the action



Rotates 3D Image



Opens the Scan View window



Permits adding a new set of details



opens Add Exclusion Zones





































Initiates Analysis View window





































































Same as a keyboard Carriage Return



Open the Background Colour window

	Open Windows Calculator window		Switches to Tablet Camera Mode
	Cancels the operation		Marks SCC Bottom Edge
	Initiates Lead Channel of Project		Opens/Confirms Lead Channel set
	Opens the Client Details window		Opens/Confirms Client saved to Project
	Removes any data from a Zone		Closes the current window
	Opens Company Details window		Opens Report Conclusions window
	Copies an existing Project without Zones		Copies an existing Project with Zones
	Opens the Corrosion window		Initiates Crack Analysis Tool
	Marks Crack End point (Ce)		Marks Crack Start point (Cs)
	Opens the Crop Tool window		Marks corrosion Circumferential Start
	Marks SCC Circumferential Start		Finds deepest defect
	Finds Deepest Defect within the Bullseye		Opens the Defect Type window
	Initiates Depth Mode		Opens Depth of Max Colour window
	Opens a Details window		Opens/Confirms Details added to Project
	Starts Defect Detect Mode		Opens Encoder Manager window
	Opens the Project Selection box		Initiates the Exporting of a Project
	Opens the 3D Filter window		Opens the Font Size window

	Open Frequency window		Initiates/confirms Frequency for Project
	Resizes Map to use full screen width		Toggles the 3D Grid on
	Returns user to Home Screen window		Opens the Images window in Report
	Initiate the Importing of a Project		Initiates Lift-Off Mode
	Opens/Confirms Lift-Off set for Project		Starts Localized Corrosion without Cracks
	Starts Localized Corrosion with Axial Cracks		Starts Localized Corrosion with Circ Cracks
	Initiates adding Location to Project		Opens/Confirms Location added to Project
	Displays depth set to Material Thickness		Labels Deepest Defect in Bullseye
	Open the Mark Defects window		Labels Defect at Bullseye centre
	Initiates Mark Defects window		Opens the Mapping Function
	Initiates adding a Material to Project		Opens/Confirms Material added to Project
	Displays more buttons		Moves Defect to a new location
	Opens the Project Name window		Opens/Confirms Project Name filed
	Initiates creating a new Project		Utilizes the Lead Channel only
	Shuts down ECHO-3D		Closes the Information window
	Closes the Crack or SCC window		Scales both X and Y same
	Initiates Pipe Mode		Initiates Plate Mode

	Initiates a Print window		Opens the Project Details window
	Record Mode is on		Record Mode is off
	Initiates Radar Mode		Clears the value or screen
	Removes the selected item		Removes all labelled Defects
	Renames a Project		Generates a Report
	Returns to Report Options window		Moves Defect Marker to original location
	Overwrites Base with stored value		Toggles 3D to Pan Mode
	Saves the current details		Update Technician saves the changes
	Initiates Scan Mode		Opens Scan Option window
	Initiates SCC Analysis Tool		Saves a Screen Shot File
	Initiates Section Report window		Sets Selected Zone
	Opens the Select Defect Zone window		Opens Bullseye Style and Size window
	Stores the current Base		Opens Sectional Grid window
	Takes a picture		Opens Technician Details window
	Opens/Confirms Tech added to Project		Opens/Confirms Mat Thickness for Project
	Opens the Set Depth Threshold window		Opens Toe Crack Analysis window
	Opens the Home Tools window		Displays the Sensor Health dialogue



Displays depth scale unlocked



Initiates selecting Y-Offset for Project



Initiates working with Zones



Resets Zoom to 100%



Opens Vertical Scale window



Opens/Confirms Y-Offset for Project set



Opens the Zoom window

Appendix C – ECHO-3D Parts Lists

Part Number	Description
11-02-010	ECHO-3D Calibration Check Block
11-02-014	ECHO-3D Generation II Sensor
11-02-015	ECHO-3D Pelican 1520 Field Kit Case with Foam Insert
11-02-016	ECHO-X Single Axis Encoder Assembly
11-02-018	ECHO-3D Pelican® 1120 Sensor Travel Case with Foam Insert
11-02-022	Shoe Wear Strip Kit PP
11-02-024	Encoder Wheel O-ring Kit (FKM)
11-02-025	Sensor Wear Pad Kit
11-03-017	Sensor Cleaning Brush
11-03-056	ECHO-3D Pelican® 1050 Ancillaries Case
11-03-091	Cap Screw Hex Socket Head M6X1.00 x 20 mm
11-04-005	Sensor USB Interface Cable, 1.8 m [6 ft]
11-04-011	Sensor USB Interface Cable, 4.6 m [15 ft]
11-05-007	ECHO-3D Operator Manual Binder
11-05-008	ECHO-3D Quick Start Guide

Appendix D – Sensor Shoe Parts Lists

Part Number	Description
11-03-044	Sensor Shoe Jireh Fixed Lift-Off (Black)
11-03-123	Sensor Shoe Flat (Gold) WC Wear Strip
11-03-043	Sensor Shoe NPS 6 [DN 150] (6 $\frac{5}{8}$ " OD) Offset (Blue) PP Wear Strip
11-03-107	Sensor Shoe NPS 6 [DN 150] (6 $\frac{5}{8}$ " OD) Centred (Gold) WC Wear Strip
11-03-020	Sensor Shoe NPS 8 [DN 200] (8 $\frac{5}{8}$ " OD) Offset (Blue) PP Wear Strip
11-03-108	Sensor Shoe NPS 8 [DN 200] (8 $\frac{5}{8}$ " OD) Centred (Gold) WC Wear Strip
11-03-030	Sensor Shoe NPS 10 [DN 250] (10 $\frac{3}{4}$ " OD) Offset (Blue) PP Wear Strip
11-03-109	Sensor Shoe NPS 10 [DN 250] (10 $\frac{3}{4}$ " OD) Centred (Gold) WC Wear Strip
11-03-021	Sensor Shoe NPS 12 [DN 300] (12 $\frac{3}{4}$ " OD) Offset (Blue) PP Wear Strip
11-03-110	Sensor Shoe NPS 12 [DN 300] (12 $\frac{3}{4}$ " OD) Centred (Gold) WC Wear Strip
11-03-061	Sensor Shoe NPS 14 [DN 350] (14" OD) Offset (Blue) PP Wear Strip
11-03-111	Sensor Shoe NPS 14 [DN 350] (14" OD) Centred (Gold) WC Wear Strip
11-03-022	Sensor Shoe NPS 16 [DN 400] (16" OD) Offset (Blue) PP Wear Strip
11-03-112	Sensor Shoe NPS 16 [DN 400] (16" OD) Centred (Gold) WC Wear Strip
11-03-084	Sensor Shoe NPS 18 [DN 450] (18" OD) Offset (Blue) PP Wear Strip
11-03-113	Sensor Shoe NPS 18 [DN 450] (18" OD) Centred (Gold) WC Wear Strip
11-03-041	Sensor Shoe NPS 20 [DN 500] (20" OD) Offset (Blue) PP Wear Strip
11-03-114	Sensor Shoe NPS 20 [DN 500] (20" OD) Centred (Gold) WC Wear Strip
11-03-032	Sensor Shoe NPS 22 [DN 550] (22" OD) Offset (Blue) PP Wear Strip
11-03-115	Sensor Shoe NPS 22 [DN 550] (22" OD) Centred (Gold) WC Wear Strip
11-03-023	Sensor Shoe NPS 24 [DN 600] (24" OD) Offset (Blue) PP Wear Strip
11-03-116	Sensor Shoe NPS 24 [DN 600] (24" OD) Centred (Gold) WC Wear Strip
11-03-085	Sensor Shoe NPS 26 [DN 650] (26" OD) Offset (Blue) PP Wear Strip
11-03-117	Sensor Shoe NPS 26 [DN 650] (26" OD) Centred (Gold) WC Wear Strip
11-03-086	Sensor Shoe NPS 28 [DN 650] (28" OD) Offset (Blue) PP Wear Strip
11-03-118	Sensor Shoe NPS 28 [DN 700] (28" OD) Centred (Gold) WC Wear Strip
11-03-024	Sensor Shoe NPS 30 [DN 750] (30" OD) Offset (Blue) PP Wear Strip
11-03-119	Sensor Shoe NPS 30 [DN 750] (30" OD) Centred (Gold) WC Wear Strip
11-03-087	Sensor Shoe NPS 32 [DN 800] (32" OD) Offset (Blue) PP Wear Strip
11-03-120	Sensor Shoe NPS 32 [DN 800] (32" OD) Centred (Gold) WC Wear Strip
11-03-088	Sensor Shoe NPS 34 [DN 850] (34" OD) Offset (Blue) PP Wear Strip
11-03-121	Sensor Shoe NPS 34 [DN 850] (34" OD) Centred (Gold) WC Wear Strip
11-03-089	Sensor Shoe NPS 36 [DN 900] (36" OD) Offset (Blue) PP Wear Strip
11-03-122	Sensor Shoe NPS 36 [DN 900] (36" OD) Centred (Gold) WC Wear Strip

Appendix E – Scanner Parts List

Part Number	Description
AAS061	Installation/Removal Mat
CWG002-0300	Raster Arm Kit, 300 mm [12"]
CXA008	Handheld Controller, <i>NAVIC</i> or <i>SKOOT</i>
CWG002-0600	Raster Arm Kit, 600 mm [23.6"]
CWG002-0900	Raster Arm Kit, 900 mm [35.4"]
CWG002-1160	Raster Arm Kit, 1160 mm [45.7"]
CWS023	Raster Arm Female Pivot Nose (replaces CWS007)
CXG002-AK-07.5	<i>NAVIC</i> Scanner with AK Option for ECHO-3D Gen II Sensor
DNS006	Manipulation Handle
DSG002-05-N-H	<i>SKOOT</i> ECHO-3D Scanner with: HD Probe Holder, 5 m Umbilical and J300 Cable, North American Power Supply, and Type H Case
DSG002-05-E-H	<i>SKOOT</i> ECHO-3D Scanner with: HD Probe Holder, 5 m Umbilical and J300 Cable, European Power Supply, and Type H Case
DSG001-AK-01.2-X	<i>STIX</i> Scanner with AK Option for ECHO-3D Gen II Sensor
EA154	Probe Holder Arm Adjustment Knob
EA243	Lifting Sling, <i>SKOOT</i>
EA414	Hex Drive, 3 mm Ball Point
EA470	Wrench, $\frac{3}{8}$ ", Boxed End
EA480	Flat Driver, 3 mm Blade
MD074-020	Arm Clamp Screw
PH0011-01	Probe Holder Pivot Button, 8 mm
PH0165	Probe Holder Arm
PHS043-W-01	Heavy Duty Vertical Probe Holder for ECHO-3D Gen II Sensor
PHS047	Heavy Duty Probe Holder Large Yoke
PHS049	Heavy Duty Vertical Probe Holder Subassembly
UMA016-AK-05	J200 Encoder Interface Cable, <i>NAVIC</i> , 5 m [16.4 ft]
UMA016-AK-07.5	J200 Encoder Interface Cable, <i>NAVIC</i> , 7.5 m [25 ft]
UMA017-06	Controller Cable, 6 m [19.7 ft]
UMA022-05	Umbilical, <i>STIX</i> , 5 m [16.4 ft]
UMA022-07.5	Umbilical, <i>STIX</i> , 7.5 m [25 ft]
UMA025-AK-05	J300 Encoder Interface Cable, <i>SKOOT</i> , 5 m [16.4 ft]
UMA025-AK-07.5	J300 Encoder Interface Cable, <i>SKOOT</i> , 7.5 m [25 ft]
UMA026-AK-01.2	J100 Encoder Interface Cable, <i>STIX</i> , 1.2 m [3.9 ft]
UMA026-AK-05	J100 Encoder Interface Cable, <i>STIX</i> , 5 m [16.4 ft]
UMA026-AK-07.5	J100 Encoder Interface Cable, <i>STIX</i> , 7.5 m [25 ft]

Appendix F – Dell Latitude 12 Rugged Tablet Parts List

Part Number	Description
210-AFVQ	Dell Latitude 12 Rugged Tablet with ECHO-3D Software
	Dell Latitude 12 Rugged Tablet-7202 User's Guide
340-APSJ	Dell Quick Reference Guide - English
451-BBOQ	Dell Tablet 2-cell (26 W·h) Lithium Ion Spare Battery
492-BBHO	Dell 45 W AC Charger with 0.9 m Power Cord
469-4546	Dell 90 W Auto/Air Charger with Power Cord
537-BBBD	Dell 0.9 m 3-prong US Power Cord
331-3761	Dell KM632 Wireless Keyboard and Mouse Combo
580-ADYL	Dell Keyboard Cover with Kickstand
560-BBBE	Dell Extended I/O Module (2 USB, Ethernet)
452-BBXJ	Dell Desktop Dock
460-BBED	Dell Tablet Slipcase 14
642-BBBC	Dell Active Pen
409-BBFV	Dell Passive Pen (Replacement for original)
395-BBBD	Dell Nylon Handle
395-BBBF	Dell Cross Strap
460-BBTP	Dell Chest Harness
395-BBBE	Dell Shoulder Strap
452-BBXR	Dell Kickstand
460-BBMO	Dell Professional Topload Carrying Case - 14"
429-AAUX	Dell External USB Slim DVD/RW Optical Drive

Appendix G – Standard ASME Pipe Sizes

The following is a partial list of standard pipe sizes per ASME B36.10M-2015 Welded and Seamless Wrought Steel Pipe, CSA Z245.1 Steel Pipe, and ISO 6708 Pipework Components – Definition and selection of DN (nominal size).

Imperial or Customary Units			Metric Units		
Nominal Size	OD [inch]	Circumference [in]	Nominal Size	OD [mm]	Circumference [mm]
NPS 4	4.500	14.14	DN 100	114.3	359.1
NPS 5	5.563	15.71	DN 125	141.3	399.0
NPS 6	6.625	20.81	DN 150	168.3	528.7
NPS 8	8.625	27.10	DN 200	219.1	688.2
NPS 10	10.75	33.77	DN 250	273.0	857.8
NPS 12	12.75	40.06	DN 300	323.8	1,017
NPS 14	14.00	43.98	DN 350	355.6	1,117
NPS 16	16.00	50.27	DN 400	406.4	1,277
NPS 18	18.00	56.55	DN 450	457	1,436
NPS 20	20.00	62.83	DN 500	508	1,596
NPS 22	22.00	69.12	DN 550	559	1,756
NPS 24	24.00	75.40	DN 600	610	1,915
NPS 26	26.00	81.68	DN 650	660	2,075
NPS 28	28.00	87.68	DN 700	711	2,234
NPS 30	30.00	94.25	DN 750	762	2,394
NPS 32	32.00	100.5	DN 800	813	2,553
NPS 34	34.00	106.8	DN 850	864	2,713
NPS 36	36.00	113.1	DN 900	914	2,873
NPS 38	38.00	119.4	DN 950	965	3,032
NPS 40	40.00	125.7	DN 1000	1,016	3,192
NPS 42	42.00	131.9	DN 1050	1,067	3,351
NPS 44	44.00	138.2	DN 1100	1,118	3,511
NPS 46	46.00	144.5	DN 1150	1,168	3,630
NPS 48	48.00	150.8	DN 1200	1,219	3,830
NPS 52	52.00	163.4	DN 1300	1,321	4,149
NPS 56	56.00	175.9	DN 1400	1,422	4,469
NPS 60	60.00	188.5	DN 1500	1,524	4,788
NPS 64	64.00	201.1	DN 1600	1,626	5,107
NPS 68	68.00	213.6	DN 1700	1,727	5,426
NPS 72	72.00	226.2	DN 1800	1,829	5,745
NPS 76	76.00	238.8	DN 1900	1,930	6,224
NPS 80	80.00	251.3	DN 2000	2,032	6,384

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