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2004 0031

3AL Testing, Corp.
8110 NW 66th Street Miami, Florida 33166 Tel (305) 499-9939 Fax (305) 499-9923

September 11, 2004

Mr. Robert A. McGuire
Associate Administrator for Hazardous Materials Safety
Attention: Exemptions, DHM-31
Research and Special Programs Administration
United States Department of Transportation
400 Seventh Street SW
Washington, DC 20590-0001

Dear Mr. Robert A. McGuire:

Enclosed is an application in duplicate submitted under the provision of 49CFR §107.105 to obtain an exemption from certain requirements of 49CFR §180.205, 180.209, 172.203 and §172.301. This exemption, when issued, would authorize the use of ultrasonic wall thickness measurements in lieu of the hydrostatic volumetric retest method to re-qualify DOT-3AL cylinders.

The suitability of ultrasonic thickness measurement methods for requalification has been made capable because of advancements in computerized sensing and recording instruments. As a result of this advanced technology, DOT has granted exemptions to FIBA, BOC Gases, Taylor Wharton, Scientific Cylinder, and CP Industries authorizing ultrasonic wall thickness measurements in lieu of hydrostatic retest for DOT-3AL aluminum cylinders.

This request applies to those cylinder specifications listed above.

Ultrasonic wall thickness measurements determine the actual wall thickness in small areas; whereas, the elastic expansion method of requalifying cylinders determines the average effective wall thickness. Because of local reinforcement it is impossible for hydrostatic testing to reveal isolated wall thinning. Therefore, the proposed method is more conservative and would reject cylinders with smaller thinned areas than would be accepted by the elastic expansion method.

The concept of reinforcement discussed on page 3 of our application under §107.105 (d) was used by the Compressed Gas Association to establish safe limits for cylinders that suffer corrosion.

This exemption, when issued, will be used only at requalification facilities operated, supervised, or licensed by 3AL Testing Corp.

Sincerely,

3AL Testing Corp.

Paul Graves

Paul Graves
Vice-President

Enclosures

Application for Exemption

In accordance with the provisions of 49CFR §107.105 of the Hazardous Materials Regulations of the U.S. Department of Transportation (DOT), 3AL Testing Corp. hereby applies for an exemption which would permit the use in transportation of DOT-3AL cylinders which were retested by a 100% ultrasonic wall thickness inspection in lieu of the internal visual and the hydrostatic retest required in 49CFR §180.205 (g). Set forth below is the information required under 49CFR §107.105:

(a) General

(a)(1) This application is submitted in duplicate.

(a)(2) The applicant is 3AL Testing Corp., 8110 NW 66th Street, Miami Florida 33166 (street and mailing address identical), 3AL representative: Paul Graves, Vice-President, 305-499-9939

(a)(3) The applicant is a resident of the United States.

(a)(4) The ultrasonic testing will take place at the following locations, being a part of 3AL Testing Corp. or administered by 3AL Testing Corp.:

Location 1

3AL Testing Corp.
8110 NW 66th Street
Miami, Florida 33166
(305) 499-9939

Other locations to be announced later

These facilities shall be administered by 3AL Testing and have identical capabilites

(b) Confidential treatment of information is not requested.

(c) Description of exemption proposal.

The following provides all information required by §107.105(c).

(c)(1) The applicant seeks relief from §180.205(f), (g); §180.209(a); §172.203(a); §172.301(c)

(c)(2) The proposed modes of transportation are: motor freight, cargo vessels, and cargo only aircraft.

(c)(3) The proposed exemption is to alter 180.205(f), and (g) and 180.209(a) to allow the use of ultrasonic wall thickness measurements in lieu of hydrostatic retest with visual I.D. inspection. The ultrasonic inspection system is detailed in Appendix I, the 3AL Procedure, dated 8/27/2004. The proposed exemption is to alter 172.203(a) and 172.301(c) in that each shipping paper or cylinder will not be required to be marked with the exemption number.

(c)(4) 3AL Testing Corp. requests that the exemption be of continuous duration and renewable per standard DOT procedures (§107.109).

(c)(5) Experimental data (see Appendix II) demonstrates the ability to determine the minimum wall thickness of a cylinder upon successive re-measurement.

(c)(6) 3AL Testing Corp. does not seek emergency processing per the provisions detailed in §107.117.

(c)(7) Liquefied or nonliquefied compressed gases, or mixtures of such compressed gases, classed as division 2.1 (flammable gas), division 2.2 (non-flammable gas), or division 2.3 (inhalation hazard) which are authorized in the Hazardous Materials Regulations for transportation in DOT-3AL cylinders.

(c)(8) The requested exemption will allow DOT-3AL cylinders to be retested by 3AL Testing Corp., or 3AL Testing Corp.'s licensee.

(c)(9) No alternative packages are requested.

(d) Justification of exemption proposal.

3AL Testing Corp. submits the following information to demonstrate that the exemption, if granted, will achieve a level of safety at least equal to that achieved by current regulations.

Current regulations permit the continuous use of DOT-3AL, DOT-3BN, DOT-3A, DOT-3AA, DOT-E9001, DOT-E9370, DOT-E9421, DOT-E9706, DOT-E9791, DOT-E9909, DOT-E10047, DOT-E10869 and DOT-E11692 cylinders at marked service pressure provided they pass the quinquennial hydrostatic test with only the permanent expansion limit of 10% applied. The hydrostatic test will only detect corrosion of large areas whereas the ultrasonic thickness measurements will detect all areas of 0.05 square inch or more which are less than the pre-set specified minimum allowable wall thickness, (§173.302a), thus, the exemption, if granted, would provide safety at least equal to existing regulations.

The following rationale was used to define and size general corrosion and isolated pitting used for calibration standards listed in 3AL Testing Corp. procedure 018. During development of CGA C-6 Standards for Visual Inspection of Steel Compressed Gas Cylinders in 1945, the CGA used current practice, experimental data and other codes to formulate defect rejection criteria. The size of an area of general corrosion that could safely be allowed was based on the ASME code. However, CGA's General Technical Committee and the membership also verified the validity of the code concept. The ASME Code, Section VIII, Unfired Pressure Vessels, 1952 states at UG-36 (Openings in Pressure Vessels) C(3)(b) "Single openings in vessels not subject to rapid fluctuations in pressure do not require reinforcement other than that inherent in the construction under the following conditions: (b) Threaded, studded, or expanded connections in which the hole is cut in the shell or head is not greater than 2 inch pipe size." (Underlining added for this rationale.) Reinforcement is inherent by virtue of the strength of the surrounding wall, and a blunt flaw is not a significant stress intensifier. Therefore, a 2 3/8 inch diameter hole could be cut into the sidewall of a pressure vessel without serving as the initiation point of a growing crack or significantly reduce the burst pressure of the vessel. Recent work done by Taylor Wharton has confirmed this position by bursting cylinders with large artificial pits machined into their sidewall with little to no degradation from virgin burst. The CGA selected this size as a practical, well-formulated and safe limit for area corrosion. The allowable depth of corrosion in that 2 3/8 inch diameter area was selected as a practical and prudent limit. This selection recognized that deep corrosion would not significantly reduce the burst safety factor, but good and reasonable operating maintenance practice should be allowed to prevent on-going localized corrosion. Despite this rationale we have elected to reduce the general corrosion area and isolated pit to the

sizes of 0.70 square inches and diameter 0.250 inches (0.125 inches for cylinder diameters less than 4 inches), respectively.

UT measurements are precise local measurements whereas E.E. determines average effective wall of the entire cylinder, the assurance that the wall remains in all areas greater that specified minimum will be more precise. This procedure will further guarantee that the exemption, if granted, will provide safety at least equal to existing regulations.

(d)(1) Limited shipping experience in the USA has been gained under DOT-E10922 which authorizes ultrasonic testing in lieu of hydrostatic test for DOT-3A and 3AA stated cylinders since 1993. Limited shipping experience in the USA has been gained under DOT-E12795 and DOT-E12966 which authorizes ultrasonic testing in lieu of hydrostatic test for DOT-3AL stated cylinders since 2001 and 2002, respectively. Reportedly, the experiences have been good.

Messer-Griesheim and Linde-AG have used ultrasonic inspection procedures for trailer tubes (17 inch nominal diameter) since the early 1980's. Reports indicate a good (accident free) safety record. Based on that and other experience the European Industrial Gas Association has published a technical treatise recognizing the alternation of ultrasonic testing in lieu of hydrostatic testing. The Compressed Gas Association has an on-going association with E.I.G.A. for exchange of technical matters and recognizes the validity of their treatise on Ultrasonic testing.

(d)(2) 3AL Testing Corp. believes that no increase in risk will result from the authorization of the requested exemption, if granted.

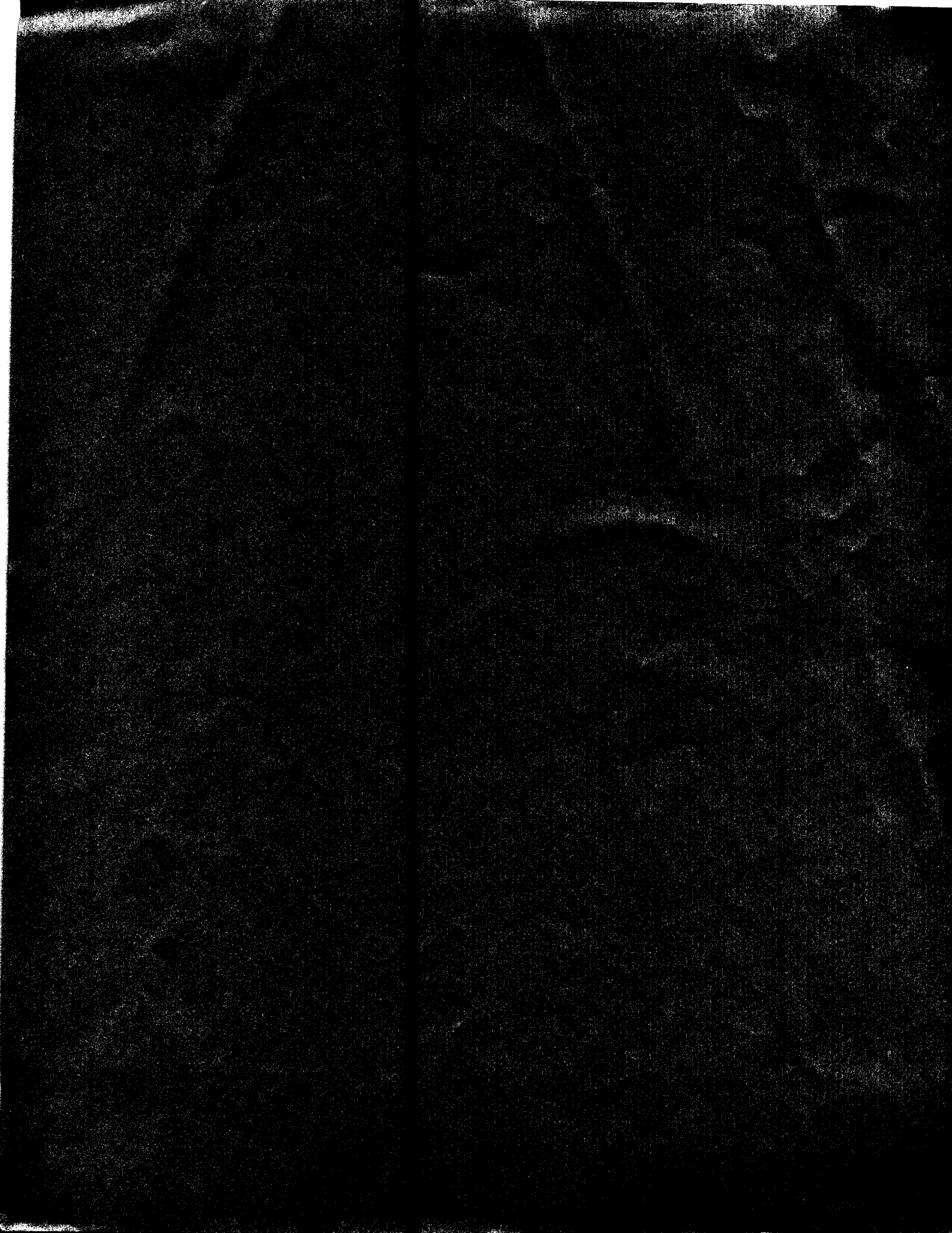
(d)(3) 3AL Testing Corp. submits the following procedures, data and test results in substantiation that the proposed alternative will achieve a level of safety at least equal to that required by the regulation from which exemption is sought.

Appendix I – 3AL Testing Corp. procedure

Appendix II – Data and analysis

Appendix III – 3AL Testing Corp., personnel qualification, dated 8/28/2004

Appendix IV – Draft exemption



Appendix I

3AL Testing Corp test procedures

3AL Testing Corp

List of 3AL Procedure Documents

Document	Name
System Operation	
3AL-scanner-001	Setting up a calibration job
3AL-scanner-002	Inputting calibration cylinder flaw information
3AL-scanner-003	Setting up a job
3AL-scanner-004	Operator procedures for scanning
3AL-scanner-005	Password procedures
3AL-scanner-006	Data analysis procedures
3AL-scanner-007	Report procedures
System Setup	
3AL-scanner-008	Setting static receiver gains
3AL-scanner-009	Setting system dynamic gains
3AL-scanner-010	Setting flaw gates
3AL-scanner-011	Data acquisition parameters procedure
3AL-scanner-012	Setting scanning parameters
Tutorials	
3AL-scanner-013	Data acquisition tutorial
3AL-scanner-014	Determining scanning parameters
3AL-scanner-015	Gain calculation tutorial
Data Sheets	
3AL-scanner-016	Cylinder data sheet
3AL-scanner-017	Job setup sheet
3AL-scanner-018	Calibration cylinder data sheet
3AL-scanner-019	Eddy current & enhanced visual inspection

Revision Number: 001
Revision Date: 08/27/04
Signature of Level III or Designee:
Date: 09/14/2004
Procedure Requirements: Level II or higher

Referenced Documents:
1. 3AL-scanner-002
2. 3AL-scanner-005
3. 3AL-scanner-008
4. 3AL-scanner-009
5. 3AL-scanner-011
6. 3AL-scanner-012
7. 3AL-scanner-017

Setting Up a Calibration Job

1. Turn on system
2. Double click on the **Flaw** icon
3. Input the cylinder and flaw information (***see 3AL-scanner-002***)
4. Double click on the **Scanner** icon
5. Log in as an **Administrator** (***see 3AL-scanner-005***)
6. Proceed to **Step 4** of ***3AL-scanner-008*** and perform static gain setting procedures
7. Proceed to **Step 9** of ***3AL-scanner-009*** and perform dynamic gain setting procedures
8. Click on **New** from the main menu
9. Review the data acquisition parameters used in **Steps 4** and **5** above. Make necessary changes to data acquisition parameters (see ***3AL-scanner-011***). Record these values into the ***Job Setup Sheet*** (***3AL-scanner-017***) for the calibration cylinder. Click on **OK**, the **Test Window** appears
10. Adjust **Scan Start** and **Stop** based on cylinder length to be scanned (see ***3AL-scanner-012***). Motor and scan settings (speed, acceleration, WPC, helix, sensor angle) cannot be changed from the settings used for the dynamic gain setting procedure. If changes are made to these parameters, **Steps 2** and **3** above must be repeated using the new settings. Record the settings into the ***Job Setup Sheet*** (***3AL-scanner-017***)
11. Do not adjust the flaw gates from the settings used in the determination of the dynamic gain settings (***3AL-scanner-009***)

12. Click on **OK** in Test Window. The **Calibration Job** has now been input and stored

Revision Number: 001
Revision Date: 08/27/04
Signature of Level III or Designee:
Date: 09-14-2004
Procedure Requirements: Level II or higher

Referenced Documents:
1. 3AL-scanner-011

Inputting Calibration Cylinder Flaw Information

1. Turn on system
2. Double click on the **Flaw** icon
3. Do not type in the file name. As the information is entered, the file name is created.
4. See ***Figure 1-3AL-scanner-002*** for the input fields
5. Click on **New**
6. Input the calibration cylinder **Type**
7. Input the calibration cylinder **Serial Number**
8. Input the calibration cylinder **OD**
9. Input the **Length** of the cylindrical section of the calibration cylinder
10. Input the operating **Pressure**
11. Input the **Subversion** number of the cylinder. This is used if multiple calibration cylinders exist for the same cylinder type
12. Input the **Minimum Wall Thickness**. See ***3AL-scanner-011***, **Step 10** for the calculation of this number
13. Input the number of flaws, **Flaw Number**, in the calibration cylinder
14. For each flaw:
15. Click on the down arrow to select the **Flaw**
16. Input the **Flaw Name** for the Flaw number
17. Input whether the defect is ID (**0**) or OD (**1**)

18. Input the **Size Along** the **Length** in inches

19. Input the **Circumferential Size** in inches

20. Input the **Position Along** the **Length** of the calibration cylinder. This is measured from the start position of the scan, and must be within +/- 0.5 inches of the actual location of the flaw

21. Click on **Apply**

22. Repeat **Steps 14-19** for each flaw number

23. Click on **OK**, all flaw information is now saved. The flaw information is used during the calibration scans to determine if all flaws were detected

24. Calibration cylinder information can be reviewed by clicking on the down arrow button on the **File Name** input field, and selecting a file name

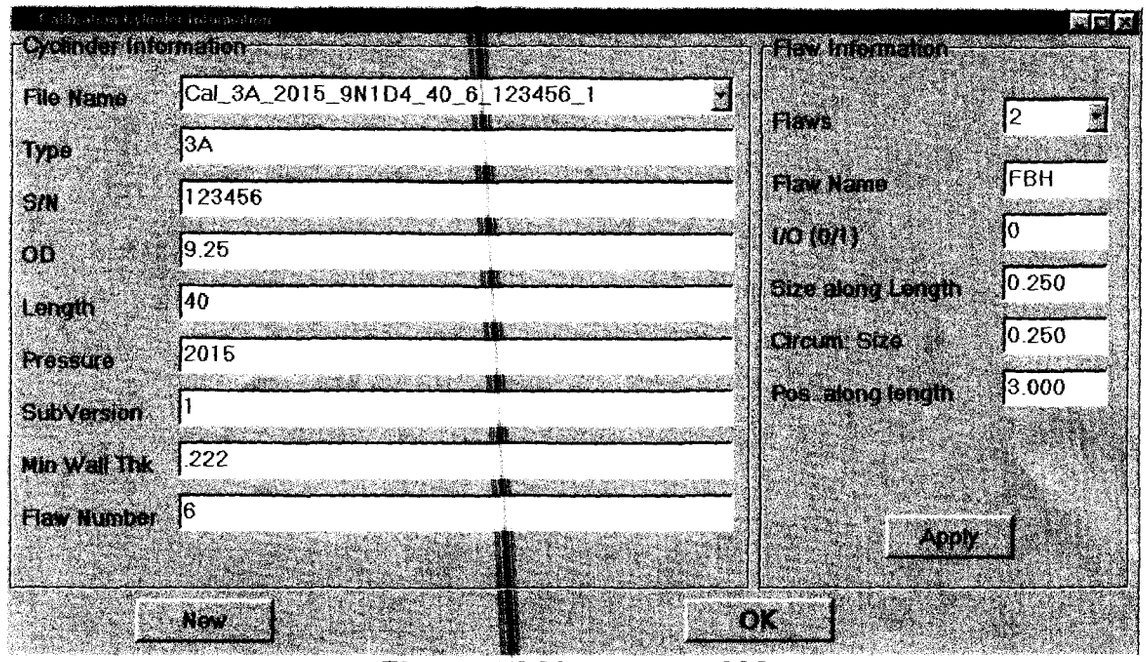


Figure 1-3AL-scanner-002

Revision Number: 001
Revision Date: 08/27/04
Signature of Level III or Designee:
Date: 09-14-2004
Procedure Requirements: Level II or higher

Referenced Documents:
1. 3AL-scanner-001
2. 3AL-scanner-005
3. 3AL-scanner-011
4. 3AL-scanner-012
5. 3AL-scanner-017

Setting Up a Job

1. Turn on system
2. Double click on the **Scanner** icon
3. Log in as an **Administrator** ***(see 3AL-scanner-005)***
4. Click on **New** from the main menu
5. Input the data acquisition parameters from the calibration cylinder that corresponds to the cylinder job (see ***3AL-scanner-011***). Record these values into the ***Job Setup Sheet*** (***3AL-scanner-017***). Click on **OK**, the **Test Window** appears
6. Adjust **Scan Start** and **Stop** based on cylinder length to be scanned (see ***3AL-scanner-012***). Motor and scan settings (speed, acceleration, WPC, helix, sensor angle) cannot be changed from the settings used for the dynamic gain setting procedure. If changes are made to these parameters, ***3AL-scanner-001*** must be repeated using the new settings. Record the settings into the ***Job Setup Sheet*** (***3AL-scanner-017***)
7. Set the flaw gates the same as for the calibration job
8. Click on **OK** in Test Window. The **Job** has now been input and stored

Revision Number: 001
Revision Date: 08/27/04
Signature of Level III or Designee: [signature]
Date: 09-14-2004
Procedure Requirements: Level I or higher

Referenced Documents:
1. 3AL-scanner-005
2. 3AL-scanner-006
3. 3AL-scanner-011

Operator Procedures for Scanning

1. Turn on system. Allow 10 minutes for system electronics to warm up
2. Log in as an **Operator** or **Administrator** (see ***3AL-scanner-005***)
3. Insert calibration cylinder for cylinder type to be scanned
4. Click on **New** from the main menu to perform system calibration
5. Select the **Calibration Job** matching the calibration cylinder. If a job is selected that is not a calibration job, the system will not allow the operator to proceed until the calibration scan is performed
6. Click on **OK** in the **Test Window**
7. Click on **Amp, TOF, Scan**. The system will scan the calibration cylinder and determine if all flaws have been detected
8. If all flaws in the calibration cylinder have been detected, the operator will be allowed to select scan jobs, and the user can proceed to scanning cylinders, **Step 10**
9. *If all the flaws were not detected, the system will not allow the operator to proceed further. The operator must inform the Level II or Level III personnel, and appropriate action will be taken*
10. Remove calibration cylinder and perform visual inspection of cylinder to be scanned. Note the cylinder serial number for input into the software and insert the cylinder
11. Click on **New** in the main menu
12. Select the appropriate **Job** for the cylinder type being examined and click on **OK**
13. Click on **OK** in the **Test Window**
14. Click on **Amp, TOF, Scan**

15. Adjust the receiver gain for the thickness scan

16. Input the cylinder serial number

17. The system will perform the **Thickness Scan**

18. Adjust the receiver gain for the flaw scans

19. The system performs the two **Circumferential Scans**. Circumferential scans are not required for DOT 3A and 3AA cylinders. The sensor offsets from the centerline a distance that creates the entry angle for the shear wave. The cylinder diameter used in the **Job** (***3AL-scanner-011, Step 7***) must have the same nominal diameter if the cylinder diameter is 6-inches or less. Cylinders greater than 6-inches in diameter must conform to the allowable size ranges shown in the following table.

Calibration Standard	Cylinder Size Ranges being retested by Ultrasonic Examination	
Outside Diameter (OD-inches)	Minimum OD-inches	Maximum OD-inches
7	6.30	10.50
7.50	6.75	11.25
9.00	8.10	13.50
9.25	8.33	13.88
10.00	9.00	15.00
12.00	10.80	18.00
14.00	12.60	21.00
14.25	12.83	21.38
18.00	16.20	27.00
22.00	19.80	33.00
24.00	21.60	36.00

20. After the two circumferential scans (if required), the user must orient the sensor to the proper angle for the **Axial Scans**. Rotate the search tube and sensor to the correct sensor position (towards the neck or towards the bottom of the cylinder) detent

21. Perform the data analysis (Level II or higher technician) according to ***3AL-scanner-006*** starting with **Step 3**, to determine if the cylinder has passed or failed the ultrasonic examination

22. If the cylinder passes the examination, quarantine the cylinder until the operator calibrates out

23. If the cylinder fails the examination, it is marked failed and quarantined to be X'd out after the operator calibrates out

24. At the end of a run of a given cylinder type, or after four (4) hours, or after 200 cylinders, or after loss of power or after changing equipment, the operator must perform a calibration check of the system. Follow **Steps 3-8** of this procedure.

25. If the system passes the calibration, stamp the quarantined cylinders according to the exemption

26. If the system does not pass the calibration, all cylinders tested from the last acceptable calibration will be re-inspected

3AL Testing Corp

Procedure Number: 3AL-scanner-005
Password Procedures

Revision Number: 001
Revision Date: 08/27/04
Signature of Level III or Designee:
Date: 09-14-2004
Procedure Requirements: Level I or higher

Referenced Documents:
1. None

Password Procedures

Operator

1. Turn on system
2. Start the software by double clicking on the **Scanner** icon
3. Type your password into the field
4. Click on **OK**
5. **Operators** are not allowed access to any of the UT system settings such as rotational speed, helix, gate settings, etc. Once a **Job** is created, no changes can be made by an **Operator**
6. The **New** button is active on the toolbar.

Administrator

7. Turn on system
8. Start the software by double clicking on the **Scanner** icon
9. Type your password into the field
10. Click on **OK**
11. The **New** button is active on the toolbar. The administrator has full access to the software so that he can perform Calibration setups and Job setups.
12. **To add a new Operator/Administrator:**
13. Log in as an **Administrator**
14. Click on **User** from main menu
15. Click on **Add User**

16. Type in **User Name**
17. Type in **User Password**
18. Type in **Level**
19. Check if user is Administrator
20. Click **OK**

Revision Number: 001
Revision Date: 08/27/04
Signature of Level III or Designee:
Date: 09-14-2004
Procedure Requirements: Level II or higher

Referenced Documents:
1. 3AL-scanner-005
2. 3AL-scanner-011
3. 3AL-scanner-018

Data Analysis Procedures

Live Analysis

1. If the software has not been started, start the software by double clicking on the **Scanner** icon. If the software is already running, and you are logged in as an **Administrator** go to **Step 3**

2. Log in as **Administrator** (see ***3AL-scanner-005***)

3. Click on the drop down arrow for the pass number. Select 1 for the thickness scan

4. The thickness **C-scan** plot will be displayed

5. Observe the thickness **C-scan** plot. Indications less than the inspection minimum wall thickness will be displayed as red areas on the plot. The inspection minimum wall thickness is determined by adding the design minimum wall thickness to the machine tolerance. (See ***3AL-scanner-011***)

6. If a minimum wall thickness indication is observed, investigate the indication as described below:

7. Click on the indication. The **A-scan** associated with the flaw will be displayed.

8. Observe the **A-scan** to determine if a **Lack-of-Back wall-Response (LBR)** has occurred. This is indicated by loss of back wall signal. A loss of back wall echo indicates internal surface roughness (pitting, corrosion). The area under question can be inspected with a thickness meter to determine if a thickness loss has occurred. If the thickness loss is verified, the cylinder will be failed

9. The Level II technician will determine if noise or wave propagation effects have affected the thickness calculation. If identifiable back wall echoes are present, the user can verify thickness measurements using cursors.

10. Highlight the **A-scan** window by clicking on it. Click on **Waveform** on the menu selection. Click on **Add Cursor** twice

11. Go to the **A-scan** window and place the mouse cursor (arrow) over the A-scan time/amplitude cursor (the arrow will turn to left-right arrows). Place the first cursor on a back wall echo, and place the second cursor on the adjacent back wall echo. Observe the time difference (Δt) to the left of the A-scan

12. Calculate the thickness using, **Thickness = (Time Difference * Propagation Velocity)/2**. If the thickness is greater than the inspection minimum wall thickness, the Level II will note this in the cylinder report and initial. Repeat for all indications.

13. If the minimum wall thickness indication is verified, and it meets the size criteria for the cylinder type, the Level II will fail the cylinder

14. Click on the drop down arrow for the pass number. Select 2 for the circumferential scan

15. Observe the flaw scan **C-scan** plot. Flaw indications greater than the flaw gate threshold setting will be displayed on the plot

16. If a flaw indication is observed, investigate the indication as described below:

17. Click on the indication. The **A-scan** associated with the flaw will be displayed.

18. Observe the **A-scan**. Determine if the indication is due to the front wall echo falling into the flaw gate or noise. If so, note on the cylinder report that the flaw indication is false and initial

19. If a large number of flaw indications are present due to the front wall falling into the flaw gate, the technician may adjust the **Reference Gate** threshold to ensure that the **Focus Gate** follows the front wall reference gate

20. If the flaw indication is verified, determine if the flaw indication meets the minimum size requirement of the calibration cylinder. These requirements are in the ***Calibration Cylinder Data Sheet (3AL-scanner-018)***

21. **Failed Cylinders** – DOT Specifications 3AL, 3AA, 3A, and 3BN, if flaw indications are found that meet the minimum flaw size requirements and are detected on opposing channels, mark the cylinder as failed and X out the DOT specification and pressure rating. For DOT Exemption cylinders manufactured under DOT-E9001, DOT-E9370, DOT-E9421, DOT-E9706, DOT-E9791, DOT-E9909, DOT-E10047, DOT-E10869, and DOT-E11692, if flaw indications are found that meet the minimum flaw size requirements and are detected on at least one channel, mark the cylinder as failed and X out the DOT specification and pressure rating.

22. **Passed Cylinders** - If no minimum flaw size indications are found, the cylinder will be quarantined until the user calibrates out

23. Repeat **Steps 14-22** for Scan 3 (circumferential flaw scan), Scan 4 (longitudinal flaw scan), Scan 5 (longitudinal flaw scan)

24. If the operator wishes to save the data for **Post Test** analysis, press the **Save** button on the main menu. The data will be saved in a subdirectory with the name of the cylinder serial number

Post Test Analysis

25. If the software has not been started, start the software by double clicking on the **Scanner** icon. If the software is already running, go to **Step 26**

26. Log in as **Administrator** (see ***3AL-scanner-005***)

27. Click on **Open** on the main menu

28. Locate the sub-directory with the serial number of the cylinder to be analyzed

29. Open the **Pass1.Wave** file. This is the thickness data

30. Click on the **TOF** button on the main menu

31. The thickness **C-scan** plot will be displayed

32. Observe the thickness **C-scan** plot. Indications less than the inspection minimum wall thickness will be displayed as red areas on the plot. The inspection minimum wall thickness is determined by multiplying the minimum design wall thickness by machine tolerance (see ***3AL-scanner-011***)

33. If a minimum wall thickness indication is observed, investigate the indication as described below:

34. Click on the indication. The **A-scan** associated with the flaw will be displayed.

35. Observe the **A-scan** to determine if a **Lack-of-Back wall-Response (LBR)** has occurred. This is indicated by loss of back wall signal. A loss of back wall echo indicates internal surface roughness (pitting, corrosion). The area under question can be inspected with a thickness meter to determine if a thickness loss has occurred. If the thickness loss if verified, the cylinder will be failed

36. The Level II technician will determine if noise or wave propagation effects have affected the thickness calculation. If identifiable back wall echoes are present, the user can verify thickness measurements using cursors.

37. Highlight the **A-scan** window by clicking on it. Click on **Waveform** on the menu selection. Click on **Add Cursor** twice

38. Go to the **A-scan** window and place the mouse cursor (arrow) over the A-scan time/amplitude cursor (the arrow will turn to left-right arrows). Place the first cursor on a back wall echo, and place the second cursor on the adjacent back wall echo. Observe the time difference (Δt) to the left of the A-scan

39. Calculate the thickness using, **Thickness = (Time Difference * Propagation Velocity)/2**. If the thickness is greater than the inspection minimum wall thickness, the Level II will note this in the cylinder report and initial. Repeat for all indications.

40. If the minimum wall thickness indication is verified, and it meets the size criteria, the Level II will fail the cylinder

41. Click on the **Open** button on the main menu

42. Open the **Pass2.Wave** file. This is the circumferential flaw scan data

43. Click on the **Amp** button on the main menu

44. Observe the flaw scan **C-scan** plot. Flaw indications greater than the flaw gate threshold setting will be displayed on the plot

45. If a flaw indication is observed, investigate the indication as described below:

46. Click on the indication. The **A-scan** associated with the flaw will be displayed.

47. Observe the **A-scan**. Determine if the indication is due to the front wall echo falling into the flaw gate or noise. If so, note on the cylinder report that the flaw indication is false and initial

48. If a large number of flaw indications are present due to the front wall falling into the flaw gate, the technician may adjust the reference gate threshold to ensure that the flaw gate follows the front wall reference gate

49. If the flaw indication is verified, determine if the flaw indication meets the minimum size requirement of the calibration cylinder. These requirements are in the ***Calibration Cylinder Data Sheet (3AL-scanner-018)***

50. **Failed Cylinders** - DOT Specifications 3AL, 3AA, 3A, and 3BN, if flaw indications are found that meet the minimum flaw size requirements and are detected on opposing channels, mark the cylinder as failed and X out the DOT specification and pressure rating. For DOT Exemption cylinders manufactured under DOT-E9001, DOT-E9370, DOT-E9421, DOT-E9706, DOT-E9791, DOT-E9909, DOT-E10047, DOT-E10869, and DOT-E11692, if flaw indications are found that meet the minimum flaw size requirements and are detected on at least one channel, mark the cylinder as failed and X out the DOT specification and pressure rating.

51. **Passed Cylinders** - If no minimum flaw size indications are found, the cylinder will be quarantined until the user calibrates out
52. Repeat **Steps 41-51** for Pass3 (circumferential flaw scan), Pass4 (longitudinal flaw scan), Pass5 (longitudinal flaw scan)

3AL Testing Corp

Procedure Number: 3AL-scanner-007
Report Requirements

Revision Number: 001
Revision Date: 08/27/04
Signature of Level III or Designee:
Date: 09-14-2004
Procedure Requirements: Level I or higher

Referenced Documents:
1. None

Report Requirements

Cylinder Reports

1. After each cylinder is scanned, a text file is created and named with the cylinder serial number

2. The report contains all operator and equipment information, as well as text output of all flaw indications

3. Once each week, copy all cylinder reports to a hard disk on another computer. A CD disk, floppy disk, or other recordable medium is acceptable, so long as all reports are backed up and saved independent of the cylinder scanners computer.

Revision Number: 001
Revision Date: 08/27/04
Signature of Level III or Designee:
Date: 09-14-2004
Procedure Requirements: Level II or higher

Referenced Documents:
1. 3AL-scanner-005
2. 3AL-scanner-011
3. 3AL-scanner-012
4. 3AL-scanner-014
5. 3AL-scanner-017

Setting Static Receiver Gains for Flaw and Thickness Measurements

Static Flaw Gain Settings

1. Turn on system. Allow 10 minutes for system electronics to warm up
2. Double click on the **Scanner** icon
3. Log in as an **Administrator** (see ***3AL-scanner-005***)
4. Insert calibration cylinder into tank
5. Click on **New** from the main menu
6. Input data acquisition parameters (go to ***3AL-scanner-011, Step 4***)
7. Input scanning parameters (go to ***3AL-scanner-012, Step 2***)
8. From the **Test Window**, click on **Continue** to display the A-scan
9. Press the **Start** button
10. Move the sensor to the correct focal point as stated by the manufacturers specification sheet, or using the effective beam width calculation, ***3AL-scanner-014*** using the **Y-axis** arrows. Maximize the reflected signal from the water/cylinder interface by adjusting the sensor position with the **X** and **Z-axis** arrows (***Figure 1-3AL-scanner-008***)
11. Press the **Upper** button (***Figure 1-3AL-scanner-008***) in the **Test Window**. This offsets the sensor into the correct position for the circumferential flaw scan
12. Move the sensor axially and rotate the cylinder until the maximum flaw response is obtained from the reflector
13. Rotate the search tube to maximize the flaw response from the flaw with the least response

14. Adjust the gain of the pulser/receiver until the amplitude of the signal is a minimum of 80% of full screen height (FSH). Add 1 dB of gain to the receiver to reach 88% FSH

15. Press the **Lower** (***Figure 1-3AL-scanner-008***) button in the **Test Window**. This offsets the sensor into the correct position for the circumferential flaw scan. Repeat **Steps 12-13**

16. If the amplitude difference between the upper and lower offsets for the flaw is greater than 3 dB, adjust the offset angle until the amplitude of the signals are within 2 dB for both the lower and upper offsets. Repeat **Steps 12-15**

17. Return the sensor to the mid-line of the cylinder.

18. Rotate the search tube and sensor to the axial flaw scan position, sensor positioned toward the base of the cylinder

19. Initially angling the transducer to approximately 19° +/- 4° to obtain a response from the artificial flaw.

20. Move the sensor axially using the **X-axis** arrows, and rotate the cylinder, using the **Rotate** arrows, to maximize the flaw response from the reflector with the least response

21. Rotate the search tube to maximize the flaw response, note angular position

22. Adjust the gain of the pulser/receiver until the amplitude of the signal is a minimum of 80% of full screen height (FSH). Add 1 dB of gain to the receiver to reach 88% FSH

23. Rotate the search tube and sensor to the axial flaw scan position, sensor positioned toward the dome/neck of the cylinder

24. Initially angling the transducer to approximately 19° +/- 4° to obtain a response from the artificial flaw.

25. Move the sensor axially using the **X-axis** arrows, and rotate the cylinder, using the **Rotate** arrows, to maximize the flaw response from the reflector with the least response

26. Rotate the search tube to maximize the flaw response, note angular position

27. If the amplitude difference between the neck and base positions for the flaw is greater than 3 dB, adjust the search tube angle until the amplitude of the signals are within 2 dB for both the lower and upper offsets. Repeat **Steps 19-26**

28. Note the static gain setting for the flaw scans for the calibration cylinder for use in the dynamic calibration (see ***3AL-scanner-009***)

Static Thickness Gain Settings

29. Move the sensor to approximately the center of the cylinder length using the **X-axis** arrows

30. Move the sensor to the correct focal point as stated by the manufacturers specification sheet, or using the effective beam width calculation, ***3AL-scanner-014*** using the **Y-axis** arrows

31. Maximize the longitudinal response using the **Z-axis** arrows

32. Set the receiver gain so that the second back wall echo amplitude is 80% full screen height

33. Rotate the cylinder while monitoring the **A-scan**. The average amplitude of the second back wall echo should be approximately 80% FSH. Observe the **A-scan** to determine if a **Lack-of-Back wall-Response (LBR)** or **Saturation** has occurred

34. Using the **Z-axis** adjust the longitudinal response so the average back wall echo can be observed without **Saturation** or **LBR,** increase or decrease gain so the average amplitude is 80%

35. Position the sensor over the minimum wall patch and read the thickness

36. Thickness reading must be within machine tolerance of the minimum wall patch thickness recorded in the ***Job Setup Sheet, 3AL-scanner-017***

37. If the thickness is incorrect, check the propagation velocity entered for the material and the gain settings for the thickness measurements

38. Note the gain settings for the thickness scans for the calibration cylinder for use in the dynamic calibration (see ***3AL-scanner-009***)

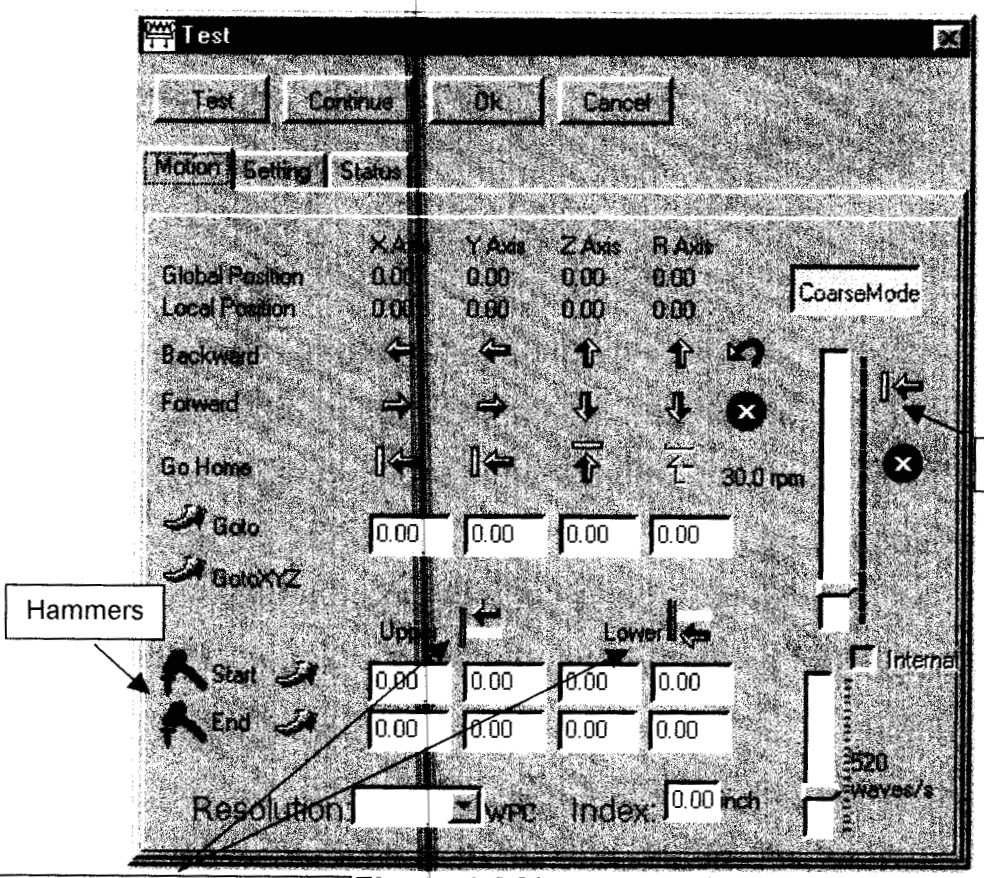


Figure 1-3AL-scanner-008

3AL Testing Corp

Procedure Number: 3AL-scanner-009
Setting System Dynamic Gains

Revision Number: 001
Revision Date: 08/27/04
Signature of Level III or Designee:
Date: 09-14-2004
Procedure Requirements: Level II or higher

Referenced Documents:
1. 3AL-scanner-005
2. 3AL-scanner-008
3. 3AL-scanner-010
4. 3AL-scanner-011
5. 3AL-scanner-012
6. 3AL-scanner-015
7. 3AL-scanner-017

Setting Dynamic System Gains

1. Turn on system. Allow 10 minutes for system electronics to warm up
2. Double click on the **Scanner** icon
3. Log in as an **Administrator** (see ***3AL-scanner-005***)
4. Insert calibration cylinder into tank
5. Click on **New** from the main menu
6. Input data acquisition parameters (see ***3AL-scanner-011***)
7. Input scanning parameters (see ***3AL-scanner-012***)
8. Determine system static gains (see ***3AL-scanner-008***)
9. Adjust the receiver gain to the static gain setting of the flaw which exhibited the least response, then add 3 dB of gain
10. Set flaw gates (see ***3AL-scanner-010, Step 8***)
11. Click on **OK** in Test Window
12. Click on **Scan** on Main toolbar
13. Follow the software directions for each scan (make sure to adjust the receiver gain to the flaw setting if different from thickness setting)
14. If all flaws are found, and after reviewing the **A-scan** data the signal amplitude from the least responsive reflector does not exceed 88% FSH for all scans, repeat the scans three (3) times. The minimum wall patch must be measured to within machine tolerance of the minimum wall patch thickness recorded in the ***Job Setup Sheet, 3AL-scanner-017***. The system must successfully detect and measure all flaws for each of the scans. If the flaws are successfully detected, record system gain settings for the calibration cylinder in the ***Job Setup Sheet, 3AL-scanner-017***,

and end the procedure. If the flaws are not detected, or the signal amplitudes exceed 88% continue to **Step 16**

15. If the signal amplitude from the least responsive reflector exceeds 88%, calculate the required reduction in system gain. Decrease the gain by this amount, to the nearest 1 dB (see ***Gain Calculation Tutorial, 3AL-scanner-015***), and rescan the cylinder, following **Steps 5-14**

16. If all flaws are not found, review flaw amplitudes by scrolling through the **A-scan** data. Calculate the amount of gain required to increase the signal amplitude to 88% FSH (see ***Gain Calculation Tutorial, 3AL-scanner-015***). Increase the receiver gain by this amount, to the closest 1 dB.

17. Rerun the scan, following **Steps 5-16**

18. The minimum wall patch must be measured to within machine tolerance of the minimum wall patch thickness recorded in the ***Job Setup Sheet, 3AL-scanner-017***

19. After all gains have been set and the thickness scan reads correctly, repeat the scans three (3) times. The system must successfully detect and measure all flaws for each of the scans. If the flaws are not detected, repeat **Steps 5-18**

20. Record the gain settings in the ***Job Setup Sheet, 3AL-scanner-017***

Revision Number: 001
Revision Date: 08/27/04
Signature of Level III or Designee:
Date: 09-14-2004
Procedure Requirements: Level II or higher

Referenced Documents:
1. 3AL-scanner-005
2. 3AL-scanner-011
3. 3AL-scanner-012

Setting Flaw Gates

1. Turn on system. Allow 10 minutes for system electronics to warm up
2. Double click on the **Scanner**
3. Log in as an **Administrator** (see ***3AL-scanner-005***)
4. Insert calibration cylinder into tank
5. Click on **New** from the main menu
6. Input data acquisition parameters (see ***3AL-scanner-011***)
7. Input scanning parameters (see ***3AL-scanner-012***)
8. Click on the **Analysis** button on the main menu
9. If gates are not present, click on **Add** gates until the **Number of Gates** equals 3.
10. Set the **Reference Gate** to **1**, the **Focus Gate** to **0**. The reference gate is set so that the front wall echo exceeds the reference gate threshold. The focus gate then follows the threshold crossing of the reference gate. The focus gate is used to detect flaw signals
11. The gates consist of two vertical bars which set the time width of the gate, and a horizontal bar which sets the voltage threshold of the gate
12. Set the start of the **Reference Gate** (gate 1) by placing the mouse cursor over the left vertical bar of the gate labeled **1**. The cursor will change from the single arrow to a left/right arrow. Hold the left mouse key down and move the left gate vertical to the far left side of the **A-scan** window
13. Set the end of the **Reference Gate** (gate 1) by placing the mouse cursor over the right vertical of the gate labeled **1**. The cursor will change from the single arrow to a left/right arrow. Hold the left mouse key down and move the right gate vertical to the far right side of the **A-scan** window

14. Set the threshold of the **Reference Gate** (gate 1) by placing the mouse cursor over the horizontal threshold line of the gate labeled **1**. The cursor will change from the single arrow to a left/right arrow. Hold the left mouse key down and move the threshold to 25% of full screen height (FSH)

15. To set the left vertical of the **Focus Gate** (gate 2), determine which flaw has the shortest TOF. This is depends on which node was used for calibration. If a full skip O.D. notch was used with the 1½ skip I.D. notch, the½ skip I.D. notch should be outside the gate.

16. Move the left vertical (see **Step 15** for adjustment) of the **Focus Gate** to include the notch with the shortest TOF used for calibration.

17. The left vertical of the **Focus Gate** (gate 2) should roughly be at two-thirds of the way from front wall echo and a third of the way from the flaw indication determined to have the shortest TOF used for calibration

18. Move the right vertical of the **Focus Gate** (gate 2) to include the notch with the longest time of flight

19. Set the threshold of the **Focus Gate** by placing the mouse cursor over the horizontal threshold line of the gate labeled 2. The cursor will change from the single arrow to a left/right arrow. Hold the left mouse key down and move the threshold to 80% of full screen height (FSH)

20. The echo from the notch should be within the **Focus Gate**. If not, adjust the left vertical of the gate until the echo is within the gate

21. The left vertical of the second **Focus Gate** (gate 3) should be set to include the second skip (if full skip OD notch was used) of the notch with the shortest time of flight.

22. Set the threshold of the second **Focus Gate** (gate 3) as described in step 19. The threshold shall be set approximately 10% below the peak amplitude of the second skip of the notch exhibiting the least response.

23. Move the right vertical of the second **Focus Gate** (gate 3) to include the second skip of the notch with the longest time of flight

24. The flaw gates are now set, ***Figure 1-3AL-scanner-010*** shows correctly set gates. Shown on the plots are cursors showing the peak of the front wall echo, and the placement of the **Focus Gate**

25. **The thickness analysis does not use gates**. The software automatically detects the peaks from the back wall echoes in the A-scan. Therefore there is no operator procedure for the setting of gates for the thickness scans

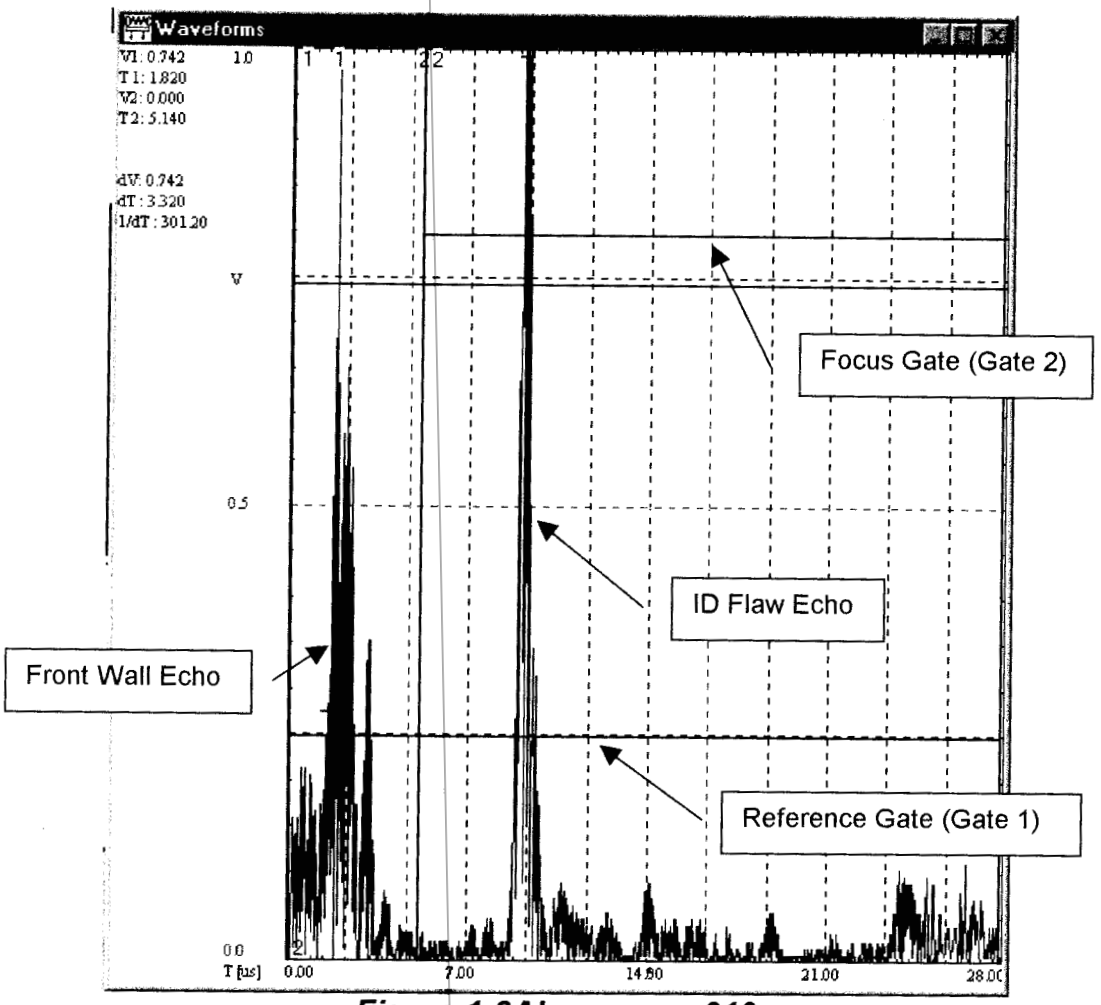


Figure 1-3AL-scanner-010

Revision Number: 001
Revision Date: 08/27/04
Signature of Level III or Designee:
Date: 09-14-2004
Procedure Requirements: Level II or higher

Referenced Documents:
1. 3AL-scanner-005
2. 3AL-scanner-012
3. 3AL-scanner-013
4. 3AL-scanner-016

Setting Data Acquisition and Scanning Parameters for a Job

1. Start the software by double-clicking on the **Scanner** icon

2. Log in as **Administrator** (see ***3AL-scanner-005***)

3. Click on the **New** button on the scanner toolbar

4. Input the job name with the following convention:

   Calibration Job:
   cal_TYPE_PRESSURE_OD_LENGTH_FLAW#_SERIAL#_Subversion#
   Scanning Job:
   TYPE_PRESSURE_OD_LENGTH

   TYPE – Cylinder type (e.g. 3AA)
   PRESSURE – Rated stamped operating pressure (e.g. 2015)
   OD – Nominal outside diameter (inches)
   LENGTH – Nominal cylinder length (inches)
   FLAW# - Number of flaws in calibration cylinder
   SERIAL# – Serial number of the calibration cylinder

   Example: cal_3A_2015_9N1D4_40_6_123456_1, is a calibration cylinder, type 3A, operating pressure of 2015 psi, outside diameter of 9.25 inches, a cylinder wall length of 40 inches, 6 machined flaws, serial number 123456 and has the subversion number 1

3. Select **Sampling Rate** (digital-to-analog (D/A) rate) according to sensor frequency (see ***Data Acquisition Tutorial, 3AL-scanner-013,*** for setting of D/A rate)

4. Input the **Number of Points** (sweep length) according to cylinder thickness, cylinder eccentricity and sensor frequency (see ***Data Acquisition Tutorial, 3AL-scanner-013,*** for setting of sweep length)

5. Do not set **Delay Points**

6. Unless otherwise specified, set the **Input Range** to +/- 1.1 V

7. Input the nominal cylinder diameter, **OD**, for the cylinder type (see ***Cylinder Data Sheet, 3AL-scanner-016***). This number is used for the calculation of the offset for the circumferential flaw scans. It must be accurate to within 10% of the cylinder diameter to be scanned

8. Input the nominal cylinder length, **Length**, for the cylinder type (see ***Cylinder Data Sheet, 3AL-scanner-016***)

9. Input the nominal wall thickness, **Thickness**, for the cylinder type (see ***Cylinder Data Sheet, 3AL-scanner-016***)

10. Input the minimum wall thickness to be used for the inspection, **Mini Thickness**, for the cylinder type (see ***Cylinder Data Sheet, 3AL-scanner-016***). The inspection minimum thickness is calculated using the equation below:

    Machine Tolerance + Minimum Design Wall Thickness

11. Input the propagation velocity, **Velocity**, for the cylinder material (see ***Cylinder Data Sheet, 3AL-scanner-016***)

12. Type the pulser/receiver settings into the test notes area in the following fashion:

    Pulser/Receiver Module Type and serial number – XXXX, YYYY
    Receiver Gain, Thickness – XX dB
    Receiver Gain, Flaw – XX dB
    Energy Setting – X
    Damping Setting – X
    HP Filter – XX
    LP Filter – XX
    PRF - EXT

13. Click on **OK**

14. The **Test Window** now appears

15. Either return to current procedure, or see ***3AL-scanner-012*** for the **Scanning Parameters** input

3AL Testing Corp

Procedure Number: 3AL-scanner-012
Setting Scanning Parameters

Revision Number: 001
Revision Date: 08/27/04
Signature of Level III or Designee:
Date: 09-14-2004
Procedure Requirements: Level II or higher

Referenced Documents:
1. 3AL-scanner-011
2. 3AL-scanner-014
3. 3AL-scanner-017

Setting Scanning Parameters

1. After entering the Data Acquisition Parameters, ***3AL-scanner-011***, and clicking **OK**, the **Test Window** appears.

2. Press the **Home All** Arrow, wait for all motors to home

3. Using the **X-axis** arrows, position the start position of the sensor

4. Using the **Z-axis** arrows, lower the sensor into the water and position the sensor near the centerline of the cylinder

5. Using the **Y-axis** arrows, move the sensor until the correct sensor focal length as stated by the manufacturers specification sheet, or using the effective beam width calculation, ***3AL-scanner-014*** is achieved

6. Click on the **Continue** button. Monitor A-scan

7. Click on the **Analysis** Button

8. Adjust the **Delay** button at the bottom of the analysis window until the first front wall echo is displayed. This is done by placing the mouse on the button, holding down the left mouse button, and then sliding the button to the left to decrease the delay, to the right to increase the delay

9. Press the **Hammer** button next to **Start**. This will automatically maximize the longitudinal wave signal for this sensor position. The x, y, z coordinates will be shown in the **Start** windows.

10. Adjust the **Delay** button to place the front wall echo on the second time scale gridline

11. Press the **Rotate** button and monitor the A-scan. If the front wall of the A-scan moves off the screen, increase the **Number of Points** (see ***3AL-scanner-011***) until the front wall echo stays on the screen. This is done by pressing **Continue** to stop the A-scan, and then pressing the **Cancel** button. Click on **New** from the main menu to access the data acquisition parameters, and type in the new **Number of Points**

12. Move the sensor using the X-axis arrows to the ending position of the scan. Press the **Hammer** button next to **End**. This will automatically maximize the longitudinal wave signal for this sensor position. The x, y, z coordinates will be shown in the **End** windows

13. Press the **Rotate** button and monitor the A-scan. If the front wall of the A-scan moves off the screen, increase the **Number of Points** (see ***3AL-scanner-011***) until the front wall echo stays on the screen. This is done by pressing **Continue** to stop the A-scan, and then pressing the **Cancel** button. Click on **New** from the main menu to access the data acquisition parameters, and type in the new **Number of Points**

14. The **Start** and **End** positions of the scan have now been set

15. Click on the menu arrow for the **WPC** input. Select the correct **WPC** (see ***3AL-scanner-014***)

16. Click on the **Index** box. Input the helix (see ***3AL-scanner-014***)

17. Click on the **Setting** tab. Ensure all motor settings are correct

18. Click on **Continue** to stop A-scan

19. Click on **OK**

20. From the main menu, select **Control**. Select **Change Incidence Angle** (see ***3AL-scanner-014*** for calculation of the angle) and input correct angle. Select **Factor**. Input correct factor from **Job Sheet**, ***3AL-scanner-017***.

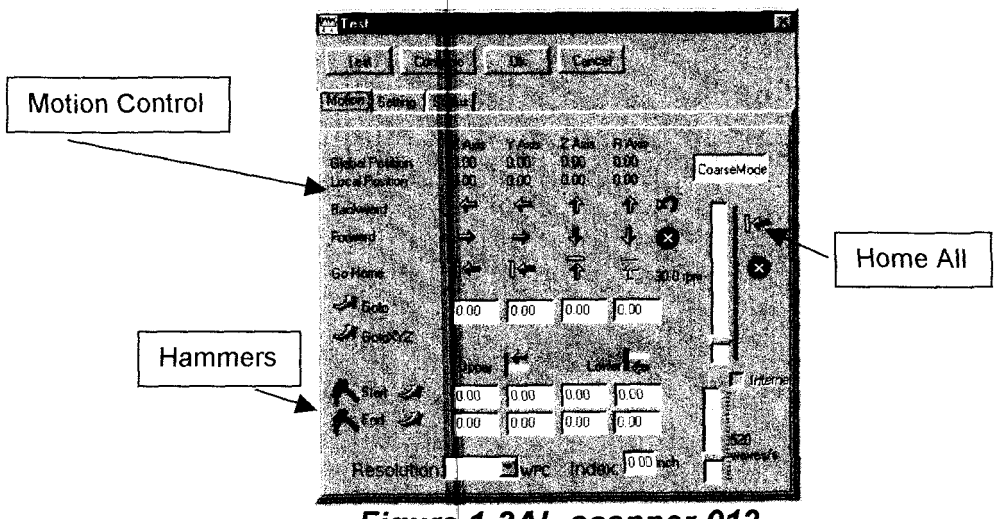


Figure 1-3AL-scanner-012

Revision Number: 001
Revision Date: 08/27/04
Signature of Level III or Designee:
Date: 09-14-2004
Procedure Requirements: Level II or higher

Referenced Documents:
1. None

Data Acquisition Tutorial

The cylinder scanner acquires data digitally. The setting of these parameters affects the data quality. This tutorial provides guidance on the setting of these parameters

A/D Sampling Rate

The heart of a digital system is the A/D conversion of the analog (voltage) signal to a digital representation. This is done using an A/D converter. The A/D converter samples the voltage signal at a constant rate, known as the ***sampling rate***. If this rate is too slow, the digital representation of the analog signal will not be true. If the rate is set too fast, un-needed data is acquired, which slows down the system scan. At a minimum, the sampling rate must be set to twice the sensor frequency. However, this sampling rate setting will not provide the time resolution required for accurate thickness measurements. For the purposes for cylinder scanning the sampling rate will be set at 10 times the sensor frequency, unless otherwise specified.

A/D Sampling Rate = 10 x (Sensor Frequency)

Example

For a 5 MHz transducer, the A/D sampling rate will be set to 50 MHz.

If a sensor is used that does not result in a sampling rate that is supported by the A/D converter, the next highest sampling rate will be used. For example, a 7.5 MHz transducer is selected, resulting a 75 MHz A/D sampling rate. The board supports 50 MHz and 100 MHz. The operator will select the 100 MHz sampling rate for the data acquisition.

Number of Points (Sweep Length)

In analog systems, the amount of time (or distance) displayed on the A-scan is known as the sweep length. In a digital system, this length of time (or distance) is controlled by the A/D sampling rate, and the ***number of points*** sampled. The first is set according to the resonant frequency of the sensor being used for the inspection; the second is controlled by several factors, including thickness of the specimen, sensor frequency and cylinder eccentricity. The formula below is used to determine the approximate number of points. This number can be adjusted to account for factors not anticipated here.

Number of Points = (1.5 * (2*Eccentricity/Velocity in Water)+8*(2*Wall Thickness/Wall Material Longitudinal Velocity))*A/D Sampling Rate

The 8 in the equation is used to ensure that enough points are used to include six back wall echoes in the data. The eccentricity portion of the calculations accounts for out-of-round cylinders.

Example – Steel Cylinder
Nominal Eccentricity: 0.25 inches
Velocity in Water: 58,000 inches/second
Nominal Wall Thickness: 0.3 inches
Wall Material Longitudinal Velocity: 232,000 inches/second
A/D Sampling Rate: 50 MHz (50,000,000 Hz)

Number of Points = (1.5*(2*0.25/58,000)+8*(2*0.3/232,000))*50,000,000
Number of Points = 1900 points

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Referenced Documents:
1. 3AL-scanner-008
2. 3AL-scanner-012
3. 3AL-scanner-013

Determining Scanning Parameters

The accuracy of an ultrasonic scan of a cylinder is determined by both the digital acquisition parameters (see ***Data Acquisition Tutorial, 3AL-scanner-013***) and by the Scanning Parameters. This document provides guidance on the determination of pulse density and helix based on the effective beam width of the transducer, flaw size and cylinder dimensions.

Cylinder scanner UT Pulse Operation

The cylinder scanner is a single sensor multiple pass ultrasonic scanning system. The user selects the number of ultrasonic pulses and helix (index) for each rotation of the cylinder. Because the diameter varies from cylinder-to-cylinder, the circumference of the cylinder varies. Thus, rather than specifying the number of pulses per inch, the user specifies the number of pulses per revolution. This number must be a multiple of 4000, since the encoder used on the rotary motor outputs 4000 pulses per revolution. The helix is input by the user, and can be any decimal number.

Effective Beam Width

The effective beam width is calculated by positioning the sensor on the flaw with the smallest reflection (least response). The gain is then adjusted until the signal amplitude is 80% of full screen height (FSH). The sensor is then moved off of the flaw until the signal amplitude drops by 50% (or 40% of FSH). The distance the sensor was moved is then noted. The sensor is then moved in the opposite direction until the signal again drops by 50% (or 40% of FSH). The distance between the two points is the effective beam width.

Example:

Flaw Type: FBH
Maximum Signal Amplitude Location: 21.35 inches
50% of Maximum Signal Amplitude Location (sensor moving to right): 21.42 inches
50% of Maximum Signal Amplitude Location (sensor moving to left): 21.27 inches
Effective Beam Width = 21.42 – 21.27 = 0.15 inches

Setting the WPC (Waveforms Per Circumference)

After the effective beam width is known, the number of Waveforms Per Circumference (WPC) can be calculated. This is done by calculating or measuring the circumference of the cylinder, then dividing the circumference by the effective beam width, and then multiplying by 1.1 to account for the 10% overlap of the beam width. The equation is given below.

WPC = (Circumference/Effective Beam Width)*1.1
Circumference = 3.14*Diameter

Example:
Cylinder Diameter = 9.25 inches
Effective Beam Width = 0.15 inches

WPC = ((3.14*9.25)/0.15)*1.1 = 213

Since the WPC must be a multiple of 4000, the user has a choice of either 200 or 250 waveforms per circumference. Since 200 does not meet the minimum requirement, the user would select 250 WPC's.

Setting the Helix
The helix must meet the 10% overlap requirement. Thus, the helix is calculated by multiplying the effective beam width by 0.9. The equation is:

Helix = 0.9*Effective Beam Width

Example:
Effective Beam Width = 0.15 inches

Helix = 0.9*0.15 = 0.135 inches

Calculating the Offset Angle
The offset angle is calculated either by using Snell's Law, or by measuring the offset during the static gain procedure and calculating the angle based on the offset.

Example: Snell's Law
By knowing the propagation velocities in the coupling and material mediums, the angle of incidence can be calculated using Snell's Law.

$$\frac{\sin\theta_1}{v_1} = \frac{\sin\theta_2}{v_2}$$

Calculate the offset angle for producing the 45 degree shear wave in an aluminum cylinder. Coupling medium is water.

Shear velocity in aluminum – 124,000 in/s
Velocity in water – 58,400 in/s
Angle in aluminum – 45 degrees

$$\frac{\sin\theta_1}{58{,}400} = \frac{\sin 45}{124{,}000}$$

$$\theta_1 = \sin^{-1}\left[\frac{58{,}400}{124{,}000}\sin 45\right]$$

$$\theta_1 = 19^0$$

This angle may be adjusted according to procedure ***3AL-scanner-.008***

Example: Calculation of Angle Based on Offset
Following the steps in ***3AL-scanner-008***, the user maximizes the return signal from the flaw by adjusting the sensor offset. The user can read the offset from the Test screen for the z-axis. By knowing the cylinder diameter, the angle can be calculated for **Step 20** in ***3AL-scanner-012*** using the equation below.

$$\theta_1 = \sin^{-1}\frac{offset}{radius}$$

Offset = 1.55 inches
Cylinder radius = 4.625 inches

$$\theta = \sin^{-1}\frac{1.55}{4.625}$$

$$\theta = 19.6^0$$

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Revision Date: 08/27/04
Signature of Level III or Designee:
Date: 09-14-2004
Procedure Requirements: Level II or higher

Referenced Documents:
1. None

Gain Calculation Tutorial

Gain settings are normally given in dB. The equation for the calculation of dB is:

$$dB = 20\log\frac{v}{v_{ref}}$$

Example – Gain Increase:
The peak amplitude of a signal is measured to be 0.4 volts. You would like to have the peak amplitude of the signal read 0.8 volts. How much should the signal be gained?

$dB = 20\log\frac{0.8}{0.4}$ = 6 dB (add 6 dB of gain)

Example – Gain Decrease:
The peak amplitude of a signal is measured to be 0.9 volts. You would like to have the peak amplitude of the signal read 0.6 volts. How much should the signal be gained?

$dB = 20\log\frac{0.6}{0.9}$ = -3.5 dB (remove 3.5 dB of gain)

Listed below are the gain multiples for various dB's.

1 dB – 1.12
2 dB – 1.26
3 dB – 1.41
6 dB – 1.99

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Signature of Level III or Designee:
Date: 09-14-2004
Procedure Requirements: Level II or higher

Referenced Documents:
1. None

Cylinder Data Sheet

This sheet provides general information about the cylinder type for input into the data acquisition parameters section of the software

Cylinder Type	Operating Pressure (psi)	OD (in)	Length (in)	Nominal Wall Thickness (in)	Minimum Design Wall Thickness (in)	Longitudinal Velocity (in/s)
3AA	2400	9.25	40	0.256	0.224	232,000
3BN	400	6.5	20	0.173	0.151	224,000
3A	2015	9.25	40	0.254	0.222	232,000
3AA	2015	9.25	40	0.201	0.176	232,000
3AA	2015	4.00	21	0.110	0.085	232,000
3AA	2265	9.00	40	0.270	0.210	232,000
3A	2015	9.12	44	0.237	0.200	232,000
3AA	2015	7.50	40	0.200	0.155	232,000
3BN	400	4.50	22	0.140	0.102	224,000
3BN	400	3.50	11.5	0.110	0.080	224,000
3AL	2015	8.00	42	0.385	0.356	250,000
3AL	2015	4.25	21	0.250	0.187	250,000
3AL	2015	4.25	9	0.250	0.187	250,000
3AA	2015	7.5	46.5	0.180	0.150	232,000
3A	2400	9.25	55.0	0.288	0.273	232,000
3AA	2265	9.00	48.0	0.250	0.210	232,000
3AA	1800	7.75	22.5	0.182	0.142	232,000
3AA	2015	6.73	23.0	0.178	0.138	232,000
3BN	400	4.5	22.0	0.137	0.097	224,000
3BN	400	3.5	11.5	0.120	0.080	224,000
3A	2015	6.3	26.0	0.196	0.156	232,000
3A	2015	9.00	51.0	0.274	0.234	232,000
3AA	2015	4.2	26.0	0.126	0.086	232,000
3AL	2015	8.0	48.0	0.396	0.356	250,000
3AL	2015	4.3	26.0	0.227	0.187	250,000
3AL	2216	9.8	51.0	0.892	0.492	250,000
3AL	2216	6.9	15.6	0.744	0.344	250,000
3AA	2015	5.23	14.0	0.507	0.107	232,000
3AL	1800	8.00	23.0	0.372	0.344	250,000

Aluminum Cyl Manufacturer Min Wall Data by Nom OD

Spec	Mfg.	Nom OD	OD	Part No.	Ser Prefix	Pressure	Mfg MW
3AL	Lux	3	3.20	C1.2,C1.5		1800	0.127
3AL	Cat	3	3.20	I6	EP	2216	0.153
3AL	Cat	3	3.20	M4,M6	BT,AD	2216	0.156
3AL	Lux	3	3.20	N004,N006,M004,M006		2216	0.158
3AL	Cat	3	3.20	S6	BV	3000	0.211
3AL	Cat	4	4.38	B2.5	BL	1800	0.172
3AL	Lux	4	4.40	N2.5		1800	0.174
3AL	Lux	4	4.38	C218,C25H		1800	0.177
3AL	Cat	4	4.38	ML6,ML7,M9,MD,ME	AI,AJ,LL,NN,MM	2015	0.192
3AL	Cat	4	4.38	ME	C	2015	0.220
3AL	Lux	4	4.40	N009		2015	0.194
3AL	Lux	4	4.40	ME24,M007,M009,MD15		2015	0.187
3AL	Lux	4	4.40	N007		2216	0.248
3AL	Cat	4	4.38	S13	AZ	3000	0.287
3AL	Cat	4	4.38	S17,S19,L13,L14	AY,EC,CB,ED,DC,DZ	3000	0.284
3AL	Cat	5	5.25	B5	BB	1800	0.206
3AL	Lux	5	5.25	C005		1800	0.208
3AL	Cat	5	5.25	I22	ER	2216	0.251
3AL	Lux	5	5.30	N022,M018,M022		2216	0.262
3AL	Cat	5	5.25	S21	DV	3000	0.341
3AL	Cat	5	5.25	S30,S40	BS,BI	3000	0.344
3AL	Cat	7	6.89	B15	ADN	1800	0.265
3AL	Cat	7	6.89	B10,B15,F10,F15	H,G,AV,AW	1800	0.270
3AL	Lux	7	6.89	NO10,N015	EL,EM	1800	0.270
3AL	Cat	7	6.89	C010,C015		1800	0.279
3AL	Cat	7	7.25	I33	EA	2216	0.333
3AL	Cat	7	7.25	I60	ES	2216	0.360
3AL	Cat	7	7.25	I90	ET	2216	0.347
3AL	Cat	7	7.25	M60,M90	BK,BR Pre 3/98	2216	0.347
3AL	Cat	7	7.25	M60,M90	BK,BR 3/98 and after	2216	0.360
3AL	Lux	7	6.90	N033		2216	0.344
3AL	Lux	7	7.20	N060,N088		2216	0.356
3AL	Lux	7	7.30	M060		2216	0.356
3AL	Cat	7	7.25	S53,S70,M74	DJ,DD,DO	3000	0.471
3AL	Cat	7	6.89	S45	EJ	3000	0.450
3AL	Cat	7	7.25	S53,S63,S67	AX,EF,BJ,AR	3000	0.471
3AL	Cat	7	7.25	S80	AS	3000	0.476
3AL	Cat	7	7.25	C60-C95	CE,T,EG,DY,EH,DW,EI,BA,CY,DI	3300	0.549
3AL	Cat	8	8.00	B20,B28,B35,F20,N020	F,BU,J,DX,EN	1800	0.320
3AL	Lux	8	8.00	C020,C035		1800	0.318
3AL	Lux	8	8.00	N150		2015	0.356
3AL	Cat	8	8.00	I122	EU	2216	0.381
3AL	Cat	8	8.00	M122,MM	AB	2216	0.386
3AL	Cat	8	8.00	M150	AP	2216	0.350
3AL	Lux	8	8.00	N122,MM		2216	0.391
3AL	Cat	8	8.00	C100	AA	3300	0.629
3AL	Lux	9	8.60	N155		1800	0.342
3AL	Lux	9	8.60	C050		1800	0.342
3AL	Lux	10	9.80	N265		2216	0.492

When UT requalifying cylinders produced by manufacturers not listed above the most conservative min wall for a given OD and service pressure is to be used.

8.0" 3AL 1800 0.318

9.8" 3AL 2216 0.492

3AL Testing, Corp.
8110 NW66th Street Miami, Florida 33166 Tel (305) 499-9939 Fax (305) 499-9923

Procedure number: 017
Job setup sheet
Cylinder Scanner Serial Number: 001

Calibration Cylinder File Job Name: Cal_3AL_2015_4N1D4_21_6_655247_L

Parameter	Setting
Sampling Rate	50 MHz
Number of Points	2048
Delay Points	6702
Input Range	+/- 1.10V
OD	4.250 inches
Length	21 inches
Thickness	0.250 inches
Minimum Thickness	0.187 inches
Velocity	250,000 inches/second
P/R Module	Panametrics, Model 5072PR
P/R Module S/N	99058606
Receiver Gain, Thickness	14 dB
Receiver Gain, Flaw	24 dB
Energy Setting	4
Damping Setting	1
HP Filter	1 MHz
LP Filter	10 MHz
Start (X, Y, Z)	31.00 5.63 14.23
End (X, Y, Z)	42.77 5.63 14.24
WPC	160
Index	0.200 inches
Transducer	Harisonic
Transducer Serial Number	3AL604
Transducer Frequency	2.25 MHz
Transducer Diameter	0.50 inches
Water Path	4.25 inches
Transducer Focal Length	3.5 inches
Offset Angle	16.80
Factor	1

Prepared by: Paul Graves
Date: August 26, 2004

3AL Testing Corp.
8110 NW66th Street Miami, Florida 33166 Tel (305) 499-9939 Fax (305) 499-9923

Procedure number: 017
Job setup sheet
Cylinder Scanner Serial Number: 001

Calibration Cylinder File Job Name: Cal_3AL_2216_3N1D4_9_6_BC56973_1

Parameter	Setting
Sampling Rate	50 MHz
Number of Points	2048
Delay Points	6152
Input Range	+/- 1.10V
OD	3.250 inches
Length	9 inches
Thickness	0.185 inches
Minimum Thickness	0.158 inches
Velocity	250,000 inches/second
P/R Module	Panametrics, Model 5072PR
P/R Module S/N	99058606
Receiver Gain, Thickness	16 dB
Receiver Gain, Flaw	30 dB
Energy Setting	4
Damping Setting	1
HP Filter	1 MHz
LP Filter	10 MHz
Start (X, Y, Z)	43.70 6.50 14.19
End (X, Y, Z)	52.25 6.50 14.25
WPC	100
Index	0.200 inches
Transducer	Harisonic
Transducer Serial Number	02A018
Transducer Frequency	3.50 MHz
Transducer Diameter	0.50 inches
Water Path	3.5 inches
Transducer Focal Length	3.5 inches
Offset Angle	16.80
Factor	1

Prepared by: Paul Graves
Date: August 26, 2004

3AL Testing Corp.
8110 NW66th Street Miami, Florida 33166 Tel (305) 499-9939 Fax (305) 499-9923

Procedure number: 017
Job setup sheet
Cylinder Scanner Serial Number: 001

Calibration Cylinder File Job Name: Cal_3AL_1800_8_30_6_U498759_0

Parameter	Setting
Sampling Rate	50 MHz
Number of Points	2048
Delay Points	6702
Input Range	+/- 1.10V
OD	8 inches
Length	18 inches
Thickness	0.330 inches
Minimum Thickness	0.318 inches
Velocity	250,000 inches/second
P/R Module	Panametrics, Model 5072PR
P/R Module S/N	99058606
Receiver Gain, Thickness	14 dB
Receiver Gain, Flaw	24 dB
Energy Setting	4
Damping Setting	1
HP Filter	1 MHz
LP Filter	10 MHz
Start (X, Y, Z)	31.00 5.63 14.23
End (X, Y, Z)	42.77 5.63 14.24
WPC	160
Index	0.200 inches
Transducer	Harisonic
Transducer Serial Number	C10691
Transducer Frequency	2.25 MHz
Transducer Diameter	0.750 inches
Water Path	5.25 inches
Transducer Focal Length	5.0 inches
Offset Angle	16.80
Factor	1

Prepared by: Paul Graves
Date: August 26, 2004

3AL Testing Corp.
8110 NW66th Street Miami, Florida 33166 Tel (305) 499-9939 Fax (305) 499-9923

Procedure number: 018
Calibration cylinders data sheets

Each calibration cylinder has a report associated with it which shows the exact locations where each flaw is located, which pass or passes the test must find it on, what size the flaw must measure in both axis directions, and the name of each flaw.

The following is a summary of the calibration cylinders (by serial number) included in procedure number 018:

- **655247 – aluminum**
- **BC56973 – aluminum**
- **U498759 – aluminum**

For each of the above calibration cylinders, a copy of the calibration report was printed out, stapled, and included in this manual. The Serial number for each report is located on the top center of the first page.

Prepared by: Paul Graves
Date: August 26, 2004

3AL Testing Corp.
8110 NW 66th Street Miami, Florida 33166 Tel (305) 499-9939 Fax (305) 499-9923

Statement of Calibration Cylinder Certification

DOT Specification: 3AL-2015-E

Serial Number: 655247

Date: September 1, 2004

This calibration cylinder has been certified to meet all standard reference requirements listed in 3AL Testing Corp's exemption application dated September 1, 2004. Please see attached drawing for flaw locations, and attached certification for flaw sizes.

Average minimum wall thickness for this cylinder was independently measured using a Stavely 133D thickness gauge (S/N 133D146G01805) and a SPECT-J7L 10MHz pitch-catch transducer (S/N 5329) and was found to be acceptable.

Robert A. Fick
3AL Testing Corp
ACCP level II

CURTIS INDUSTRIES, INC.

West Hills Industrial Park
Kittanning, PA 16201

Tel: (724) 545-8333
Fax: (724) 545-8334

REFERENCE STANDARD CERTIFICATION

Traceable to the National Institute of Standards and Technolo

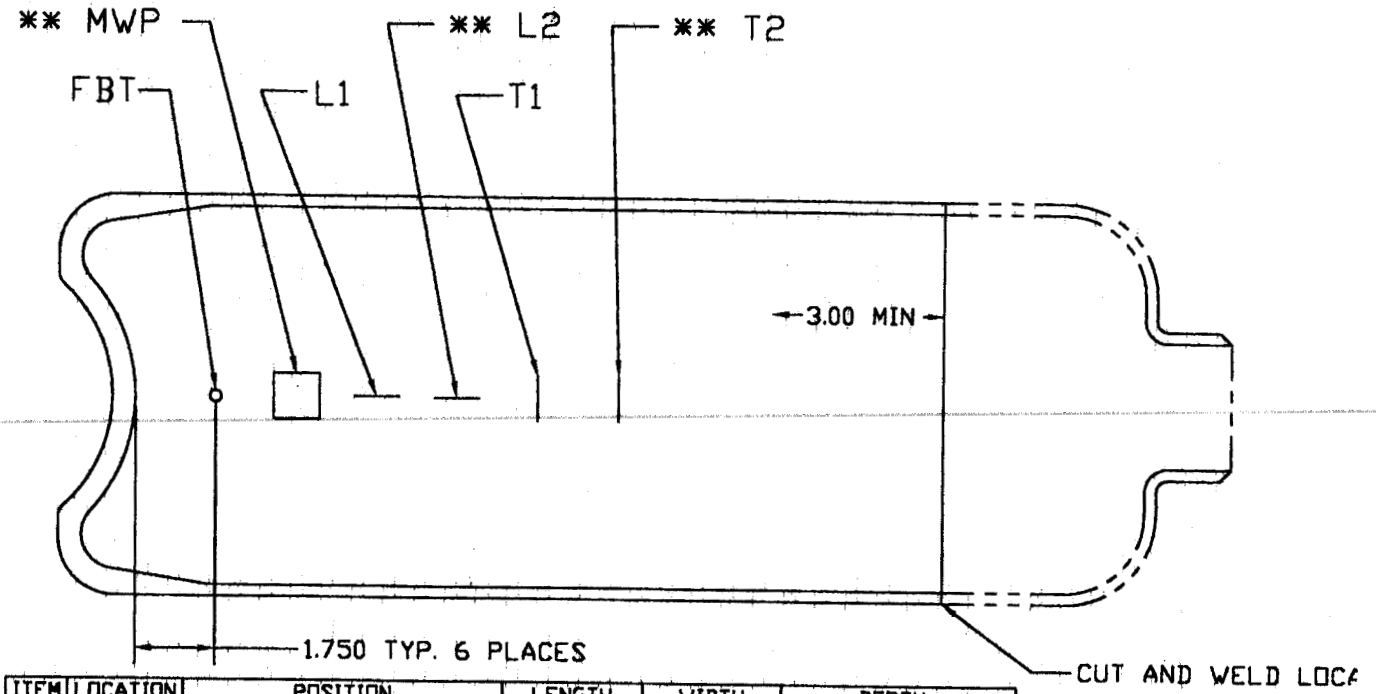
All artificial defects are measured by calibrated M&TE or measured by replica process on a Mitutoyo Model 176-942 Toolmakers Microscope Serial #030333 calibrated to Starrett Gage Block Serial #10989.2 to NCSL-Z540-1 traceable t NIST 821/261776-99

STANDARD	LOCATION	HOLE DIMENSIONS, IN.				NOTCH DIMENSIONS, IN					
UT Calibration		Diameter		Depth		Length		Width		Depth	
Cylinder		Nominal	Actual	Nominal	Actual	Nominal	Actual	Nominal	Actual	Nominal	Actu
S/N 655247											
3AL2015-E		±.010		+.0000							
				-.0005							
	FBH	.250	.2589	.0623	.0620						
	MWP									+.001/-.000	
	L1					.836	.8349	.836	.8359	.1870	.1873
	L2					1.000	.9974	.010 Max.	.0084	.0187	.0187
	T2					1.000	.9986	.010 Max.	.0088	.0187	.0187
	T1					1.000	.9994	.010 Max.	.0087	.0187	.0187
						1.000	1.0087	.010 Max.	.0084	.0187	.0186

Customer Digital Wave Corporation
Date December 27, 2001
Quality Control Manager Michael J. Johnson

Purchase Order Number 12062
Specification or Drawing Number 010087

MAKE FROM CYLINDER 655247
3AL2015-E Tmin= 0.187"



ITEM	LOCATION	POSITION	LENGTH	WIDTH	DEPTH
FBH	ID	FLAT BOTTOM HOLE	0.250±0.01"	DIAMETER	NOTE 1
MWP	ID	MINIMUM WALL PATCH	0.836	0.836	*0.187 +0.001 -0.000"
L1	ID	LONGITUDINAL NOTCH	1.00±0.01"	0.010 MAX	0.0187 +0.0/-0.0005
L2	OD	LONGITUDINAL NOTCH	1.00±0.01"	0.010 MAX	0.0187 +0.0/-0.0005
T1	ID	TRANSITION NOTCH	1.00±0.01"	0.010 MAX	0.0187 +0.0/-0.0005
T2	OD	TRANSITION NOTCH	1.00±0.01"	0.010 MAX	0.0187 +0.0/-0.0005

NOTES: 1) 1/3t min deep on ID 0.0623 +0.000/-0.0005

2) CENTERLINES WITHIN 1/16 INCH STRAIGHT POST WELDING
1/16" MAX DEVIATION TO STRING STRAIGHT FOR CYLINDER WALL.

* REMAINING WALL THICKNESS

** ROTATE 180° FROM OTHER NOTCHES.

MED E 3AL2015 CALIBRATION STANDARD

010087

655247_cal std

Date: 8/26/2004 Time: 4:22:22 PM
Job No.:
Customer: 3AL
Cylinder S/N: 655247
Manufacture:
Manufacture Date:
Cylinder Min Wall: 0.187

Equipment
Model: DWC Reflex
Serial Number: 001

Transducer
Manufacturer: Harisonic
Serial Number: 3AL604
Diameter[Inch]: 0.500
EBW Size[Inch]: 0.220
Frequency[MHz]: 2.250
Water Path[Inch]: 4.250

Calibration Cylinder
Cal_Cylinder Type: 3AL
Diameter: 4.250
Cal-Cyl-S/N: 655247
Minimum Wall: 0.187
Pressure: 2015
Helix: 0.220
Cal-Cyl-Status: Passed
Cal-Cyl-Setupname: CAL_3AL_2015_4N1D4_21_6_655247_L
Cali-Operator: Paul Graves

Flaw Name	Size	123X Position	4X Position	5X Position	Found at:
MWP	0.500X0.500	2.500	0.000	0.000	1
FBH	0.120X0.120	0.000	0.250	1.300	45
L1	0.800X0.000	4.100	0.000	0.000	23
L2	0.800X0.000	5.700	0.000	0.000	23
T1	0.000X0.700	0.000	6.600	7.500	45
T2	0.000X0.700	0.000	8.800	9.800	45

Inspector
Name: Paul Graves
Certification: ASNT Level II

Inspection Procedure
Procedure Number:

Visual Inspection:
DOT Spec:

Examination Result
FAIL
On pass 1: Thin Wall
On pass 2 3 4 5 : Pit/Crack
See attached documentation for detailed flaw result

Comments:

Event	X	Y	Thk
256	0.220	5.341	0.183
257	0.220	5.257	0.186
262	0.220	4.840	0.181
266	0.220	4.506	0.178
166	0.220	12.851	0.000
322	0.440	13.185	0.186
323	0.440	13.101	0.183
326	0.440	12.851	0.183
327	0.440	12.768	0.186
328	0.440	12.684	0.186
329	0.440	12.601	0.186
330	0.440	12.517	0.186
1046	1.320	6.175	0.186
2083	2.860	13.101	0.178
2084	2.860	13.018	0.178
2085	2.860	12.935	0.186
2088	2.860	12.684	0.181
2089	2.860	12.601	0.178
2090	2.860	12.517	0.176
2242	3.080	13.185	0.183
2243	3.080	13.101	0.176
2244	3.080	13.018	0.181
2246	3.080	12.851	0.181
2247	3.080	12.768	0.183
2248	3.080	12.684	0.183
2250	3.080	12.517	0.178
2403	3.300	13.101	0.176
2404	3.300	13.018	0.178
2405	3.300	12.935	0.183
2406	3.300	12.851	0.181
2407	3.300	12.768	0.183
2408	3.300	12.684	0.178
2410	3.300	12.517	0.171
2563	3.520	13.101	0.173
2564	3.520	13.018	0.181
2565	3.520	12.935	0.183

Pass Number: 2

Event	X	Y	TOF	AMP
1022	1.320	8.178	19.360	0.249
1023	1.320	8.095	18.480	0.507
1024	1.320	8.011	17.460	0.309
	0.220	0.250		
2219	2.860	1.752	17.820	0.206
2220	2.860	1.669	17.020	0.490
2221	2.860	1.586	16.400	0.275
2379	3.080	1.752	17.860	0.189
2380	3.080	1.669	17.060	0.524
2381	3.080	1.586	16.420	0.292
2539	3.300	1.752	17.860	0.180
2540	3.300	1.669	17.060	0.447
2541	3.300	1.586	16.440	0.284
	0.660	0.250		
3099	4.180	8.428	25.140	0.189

3259	4.400	8.428	25.160	0.189
3419	4.620	8.428	25.140	0.206
	0.660	0.083		
2944	3.960	8.011	18.860	0.490
2945	3.960	7.928	17.840	0.593
2946	3.960	7.844	17.180	0.249
3103	4.180	8.095	19.680	0.180
3104	4.180	8.011	18.860	0.713
3105	4.180	7.928	17.860	0.825
3106	4.180	7.844	17.160	0.335
3107	4.180	7.761	16.160	0.172
3264	4.400	8.011	18.880	0.645
3265	4.400	7.928	17.860	0.791
3266	4.400	7.844	16.880	0.309
3267	4.400	7.761	13.880	0.155
3423	4.620	8.095	19.680	0.155
3424	4.620	8.011	18.880	0.619
3425	4.620	7.928	17.860	0.808
3426	4.620	7.844	16.880	0.327
3427	4.620	7.761	16.160	0.155
3584	4.840	8.011	18.880	0.395
3585	4.840	7.928	17.860	0.619
3586	4.840	7.844	16.880	0.284
	1.100	0.417		
4141	5.500	1.586	23.440	0.241
4142	5.500	1.502	22.580	0.292
4143	5.500	1.419	21.580	0.163
4300	5.720	1.669	23.960	0.241
4301	5.720	1.586	23.420	0.541
4302	5.720	1.502	22.620	0.782
4303	5.720	1.419	21.580	0.344
4304	5.720	1.335	15.480	0.292
4305	5.720	1.252	14.280	0.404
4306	5.720	1.168	14.080	0.662
4307	5.720	1.085	13.140	1.100
4460	5.940	1.669	23.980	0.215
4461	5.940	1.586	23.420	0.541
4462	5.940	1.502	22.580	0.696
4463	5.940	1.419	21.560	0.335
4464	5.940	1.335	15.500	0.309
4465	5.940	1.252	14.320	0.413
4466	5.940	1.168	14.100	0.662
4467	5.940	1.085	13.140	1.100
4620	6.160	1.669	24.000	0.215

Pass Number: 3

Event	X	Y	TOF	AMP
1058	1.320	5.174	7.920	0.739
	0.220	0.083		
2427	3.300	11.099	17.120	0.730
	0.220	0.083		
2101	2.860	11.599	7.120	0.688
2261	3.080	11.599	7.100	0.920
2262	3.080	11.516	7.940	0.816
2421	3.300	11.599	7.100	1.083
2422	3.300	11.516	7.740	0.988
2581	3.520	11.599	7.060	0.997
2582	3.520	11.516	7.900	0.963

	0.880	0.167		
3142	4.180	4.840	17.720	0.705
3302	4.400	4.840	17.700	0.679
	0.440	0.083		
2975	3.960	5.424	6.800	0.859
2976	3.960	5.341	7.580	1.100
2977	3.960	5.257	8.440	0.997
3135	4.180	5.424	6.800	1.048
3136	4.180	5.341	7.540	1.100
3137	4.180	5.257	8.360	1.100
3295	4.400	5.424	6.760	0.971
3296	4.400	5.341	7.500	1.100
3297	4.400	5.257	8.360	1.100
3455	4.620	5.424	6.740	0.945
3456	4.620	5.341	7.480	1.100
3457	4.620	5.257	8.300	1.100
3616	4.840	5.341	7.480	0.937
3617	4.840	5.257	8.320	0.722
	1.100	0.250		
4179	5.720	11.766	12.600	0.954
4180	5.720	11.683	13.420	0.756
4338	5.940	11.850	11.840	0.868
4339	5.940	11.766	12.620	1.100
4340	5.940	11.683	13.420	1.100
4498	6.160	11.850	11.860	0.842
4499	6.160	11.766	12.660	1.100
4500	6.160	11.683	13.460	1.100
4658	6.380	11.850	11.900	0.816
4659	6.380	11.766	12.680	1.100
4660	6.380	11.683	13.500	1.100
4818	6.600	11.850	11.920	0.928
4819	6.600	11.766	12.700	1.100
4820	6.600	11.683	13.540	1.074
	1.100	0.250		

Pass Number: 4

Event	X	Y	TOF	AMP
405	0.440	6.259	17.520	0.155
406	0.440	6.175	16.960	0.155
407	0.440	6.092	17.300	0.172
565	0.660	6.259	17.080	0.223
566	0.660	6.175	16.940	0.215
567	0.660	6.092	17.160	0.223
725	0.880	6.259	12.120	0.155
726	0.880	6.175	11.940	0.155
	0.660	0.250		
1601	2.200	13.268	16.080	0.155
1603	2.200	13.101	17.120	0.258
1604	2.200	13.018	17.080	0.241
1606	2.200	12.851	17.520	0.241
1607	2.200	12.768	15.980	0.266
1608	2.200	12.684	16.520	0.292
1609	2.200	12.601	15.820	0.284
1610	2.200	12.517	16.680	0.232
1761	2.420	13.268	13.840	0.249
1763	2.420	13.101	15.120	0.370
1764	2.420	13.018	14.700	0.309

1766	2.420	12.851	14.740	0.309
1767	2.420	12.768	13.600	0.309
1768	2.420	12.684	14.040	0.318
1769	2.420	12.601	13.280	0.335
1770	2.420	12.517	23.940	0.292
	0.440	0.834		
5359	7.260	6.759	18.880	0.232
5360	7.260	6.676	18.160	0.309
5361	7.260	6.592	18.820	0.352
5362	7.260	6.509	19.000	0.327
5363	7.260	6.426	19.180	0.284
5364	7.260	6.342	18.780	0.292
5365	7.260	6.259	18.760	0.292
5366	7.260	6.175	18.760	0.309
5367	7.260	6.092	19.020	0.309
5368	7.260	6.008	19.240	0.344
5369	7.260	5.925	18.380	0.387
5370	7.260	5.841	18.520	0.309
5371	7.260	5.758	18.460	0.206
5519	7.480	6.759	16.100	0.258
5520	7.480	6.676	16.440	0.361
5521	7.480	6.592	16.420	0.413
5522	7.480	6.509	17.420	0.361
5523	7.480	6.426	16.420	0.361
5524	7.480	6.342	16.420	0.352
5525	7.480	6.259	16.280	0.352
5526	7.480	6.175	16.280	0.395
5527	7.480	6.092	16.100	0.421
5528	7.480	6.008	16.460	0.413
5529	7.480	5.925	15.560	0.481
5530	7.480	5.841	16.160	0.378
5531	7.480	5.758	16.320	0.232
5679	7.700	6.759	11.680	0.163
5680	7.700	6.676	11.660	0.232
5681	7.700	6.592	11.500	0.292
5682	7.700	6.509	11.560	0.258
5683	7.700	6.426	12.340	0.223
5684	7.700	6.342	11.980	0.215
5685	7.700	6.259	11.600	0.206
5687	7.700	6.092	11.340	0.155
5689	7.700	5.925	11.400	0.258

Pass Number: 5

Event	X	Y	TOF	AMP
914	1.100	3.839	5.060	1.100
915	1.100	3.755	5.240	1.100
916	1.100	3.672	5.460	0.980
1075	1.320	3.755	7.720	0.730
	0.440	0.250		
2432	3.300	10.681	4.980	0.842
2433	3.300	10.598	5.000	1.074
2593	3.520	10.598	7.280	1.023
2594	3.520	10.515	7.460	0.963
2595	3.520	10.431	5.580	0.980
2596	3.520	10.348	5.820	0.928
2597	3.520	10.264	7.800	0.894
2440	3.300	10.014	5.320	0.000
2441	3.300	9.930	5.560	0.000
2442	3.300	9.847	4.980	0.000
2599	3.520	10.097	7.540	1.023

655247_cal std

2600	3.520	10.014	6.760	1.100
2601	3.520	9.930	6.960	0.988
	0.440	0.918		
2919	3.960	10.097	16.600	0.730
	0.220	0.083		
5709	7.700	4.256	6.280	0.877
5710	7.700	4.172	7.220	1.100
5711	7.700	4.089	7.260	1.100
5712	7.700	4.006	6.920	1.100
5713	7.700	3.922	7.120	1.100
5714	7.700	3.839	7.160	1.100
5715	7.700	3.755	7.240	1.100
5716	7.700	3.672	7.300	1.100
5717	7.700	3.588	7.160	1.100
5718	7.700	3.505	6.980	1.100
5719	7.700	3.421	6.840	1.100
5720	7.700	3.338	7.360	1.100
5721	7.700	3.254	7.420	1.100
5722	7.700	3.171	7.460	0.773
5871	7.920	4.089	9.300	0.713
5880	7.920	3.338	8.600	0.722
	0.440	1.168		
7233	9.900	10.598	12.620	0.902
7234	9.900	10.515	22.020	0.980
7235	9.900	10.431	11.300	0.911
7236	9.900	10.348	12.120	0.920
7237	9.900	10.264	12.160	0.945
7238	9.900	10.181	11.880	0.937
7239	9.900	10.097	12.120	0.902
7240	9.900	10.014	21.800	0.988
7241	9.900	9.930	11.560	0.834
	0.220	0.751		

3AL Testing Corp.
8110 NW 66th Street Miami, Florida 33166 Tel (305) 499-9939 Fax (305) 499-9923

Statement of Calibration Cylinder Certification

DOT Specification: 3AL-2216-M6

Serial Number: BC56973

Date: September 1, 2004

This calibration cylinder has been certified to meet all standard reference requirements listed in 3AL Testing Corp's exemption application dated September 1, 2004. Please see attached drawing for flaw locations, and attached certification for flaw sizes.

Average minimum wall thickness for this cylinder was independently measured using a Stavely 133D thickness gauge (S/N 133D146G01805) and a SPECT-J7L 10MHz pitch-catch transducer (S/N 5329) and was found to be acceptable.

Robert A. Fick
3AL Testing Corp
ACCP level II

CURTIS INDUSTRIES, INC.

Moon Hills Industrial Park
Moon Township, PA 15108

Tel: (724) 695-8300
Fax: (724) 695-8301

REFERENCE STANDARD CERTIFICATION

Traceable to the National Institute of Standards and Technology

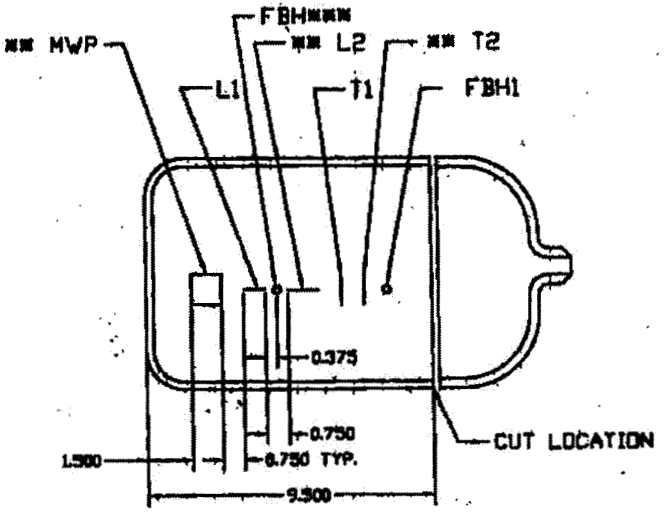
All geometrical features are measured by calibrated MPE or measured by replication process on a Nikon/Optiphot Model 170-542 Toolmakers Microscope Serial #1080333 calibrated to Starrett Gage Block Series #2100B-1 to MCSL-2540-1 traceable to NIST 821/261/76-99

STANDARD	LOCATION	HOLE DIMENSIONS, IN.				NOTCH DIMENSIONS, IN					
UT Calibration		Diameter		Depth		Length		Width		Depth	
		Nominal	Actual	Nominal	Actual	Nominal	Actual	Nominal	Actual	Nominal	Actual
Grinder											
S/N BC369Z3	#HR	.250	.2517	.0826	.0786						
"	MHP					.836	.8351	.436	.4354	.094	.0934
"	T1					1.00	1.0025	.010	.0092	.0158	.0156
"	T2					1.00	.9996	.010	.0092	.0158	.0154
"	T1					1.00	1.0022	.010	.0093	.0158	.0154
"	T2					1.00	.9999	.010	.0092	.0158	.0158
"	#HR2	.125	.1265	.0536	.0521						

Customer: Digital Wave Corporation
Date: March 4, 2002
Quality Control Manager:

Purchase Order Number: 12151
Specification or Drawing Number: 020050 Rev. A

UT CALIBRATION CYLINDER
DOT 3AL-2216; 3.2"OD - Tmin=0.158
FROM BC56973



ITEM	LOCATION	POSITION	LENGTH	WIDTH	DEPTH
FBH	ID	FLAT BOTTOM HOLE	0.1250±0.01"	DIAMETER	NOTE 1
MWP	ID	MINIMUM WALL PATCH	0.836	0.836	*0.158 +0.001 -0.000"
L1	ID	LONGITUDINAL NOTCH	1.00±0.01"	0.010 MAX	0.0158 +0.0/-0.0005
L2	OD	LONGITUDINAL NOTCH	1.00±0.01"	0.010 MAX	0.0158 +0.0/-0.0005
T1	ID	TRANSVERSE NOTCH	1.00±0.01"	0.010 MAX	0.0158 +0.0/-0.0005
T2	OD	TRANSVERSE NOTCH **	1.00±0.01"	0.010 MAX	0.0158 +0.0/-0.0005
FBH1	ID	FLAT BOTTOM HOLE	0.250±0.01"	DIAMETER	NOTE 1

NOTES: 1) 1/3t min deep on ID 0.0526 +0.000/-0.0005
2) CENTERLINES WITHIN 1/16 INCH STRAIGHT POST WELDING
1/16" MAX DEVIATION TO STRING STRAIGHT FOR CYLINDER WALL.
* REMAINING WALL THICKNESS
** ROTATE 180° FROM OTHER NOTCHES.
*** ROTATE 90° FROM OTHER NOTCHES.

HS-3.8" 3AL2216 CALIBRATION STANDARD
020050

BC56973_cal std

Date: 8/26/2004 Time: 8:03:07 AM
Job No.:
Customer:
Cylinder S/N: BC56973
Manufacture:
Manufacture Date:
Cylinder Min Wall: 0.158

Equipment
Model: DWC Reflex
Serial Number: 001

Transducer
Manufacturer: Harisonic
Serial Number: 02A018
Diameter[Inch]: 0.500
EBW Size[Inch]: 0.220
Frequency[MHz]: 3.500
Water Path[Inch]: 3.500

Calibration Cylinder
Cal_Cylinder Type: 3AL
Diameter: 3.250
Cal-Cyl-S/N: BC56973
Minimum Wall: 0.158
Pressure: 2216
Helix: 0.150
Cal-Cyl-Status: Passed
Cal-Cyl-Setupname: Cal_3AL_2216_3N1D4_9_6_BC56973_1
Cali-Operator: Paul Graves

Flaw Name	Size	123X Position	4X Position	5X Position	Found at:
MWP	0.700X0.700	0.210	0.000	0.000	1
L1	0.800X0.000	1.400	0.000	0.000	23
L2	0.800X0.000	3.100	0.000	0.000	23
FBH	0.120X0.120	0.000	2.300	2.800	45
T1	0.000X0.800	0.000	4.410	5.040	45
T2	0.000X0.800	0.000	4.800	5.600	45

Inspector
Name: Paul Graves
Certification: ASNT Level II

Inspection Procedure
Procedure Number:

Visual Inspection:
DOT Spec:

Examination Result
FAIL
On pass 1: Thin Wall
On pass 2 3 4 5 : Pit/Crack
See attached documentation for detailed flaw result

Comments:

Event	X	Y	Thk
76	0.000	2.450	0.153
171	0.210	2.961	0.156
172	0.210	2.859	0.156
176	0.210	2.450	0.151
177	0.210	2.348	0.156
271	0.420	2.961	0.153
273	0.420	2.757	0.153
276	0.420	2.450	0.148
277	0.420	2.348	0.156
371	0.630	2.961	0.156
373	0.630	2.757	0.156
376	0.630	2.450	0.153
3173	6.510	2.757	0.141
3174	6.510	2.655	0.143

Pass Number: 2

Event	X	Y	TOF	AMP
58	0.000	4.288	8.260	1.100
59	0.000	4.186	6.820	1.100
60	0.000	4.084	6.120	1.100
156	0.210	4.492	15.120	1.005
157	0.210	4.390	11.900	0.980
158	0.210	4.288	7.920	1.100
159	0.210	4.186	6.760	1.100
160	0.210	4.084	6.100	1.100
161	0.210	3.982	5.120	0.808
256	0.420	4.492	12.840	0.997
257	0.420	4.390	9.420	0.980
258	0.420	4.288	7.900	1.100
259	0.420	4.186	6.760	1.100
260	0.420	4.084	6.080	1.100
261	0.420	3.982	5.100	0.816
356	0.630	4.492	12.820	0.928
357	0.630	4.390	9.400	1.048
358	0.630	4.288	8.180	1.100
359	0.630	4.186	6.760	1.100
360	0.630	4.084	6.060	1.100
	0.840	0.613		
764	1.470	3.676	6.740	0.997
862	1.680	3.880	9.340	1.048
863	1.680	3.778	7.700	1.100
864	1.680	3.676	6.500	1.100
865	1.680	3.574	5.780	1.100
962	1.890	3.880	9.200	1.100
963	1.890	3.778	7.800	1.100
964	1.890	3.676	6.580	1.100
965	1.890	3.574	5.660	1.014
1062	2.100	3.880	9.300	1.040
1063	2.100	3.778	7.800	1.100
1064	2.100	3.676	6.640	1.100
1065	2.100	3.574	5.640	0.894
1162	2.310	3.880	9.140	0.825
1163	2.310	3.778	7.660	1.100
1164	2.310	3.676	6.540	1.100
1165	2.310	3.574	5.640	0.842
1264	2.520	3.676	6.700	1.074
	1.260	0.408		

1438	2.940	6.330	7.400	1.100
1439	2.940	6.228	6.420	0.859
	0.210	0.204		
1611	3.360	9.087	11.700	0.851
1711	3.570	9.087	10.440	1.100
1712	3.570	8.985	10.440	1.100
1811	3.780	9.087	10.420	1.100
1812	3.780	8.985	10.440	1.100
1911	3.990	9.087	10.420	1.100
1912	3.990	8.985	9.040	1.100
1913	3.990	8.883	7.780	0.859
2011	4.200	9.087	10.440	1.100
2012	4.200	8.985	8.980	1.100
2013	4.200	8.883	7.820	0.877
	1.050	0.306		
3162	6.510	3.880	7.480	1.100
3163	6.510	3.778	6.440	1.100
	0.210	0.204		

Pass Number: 3

Event	X	Y	TOF	AMP
78	0.000	2.246	6.420	0.859
178	0.210	2.246	6.420	0.963
278	0.420	2.246	6.440	0.851
	0.630	0.102		
86	0.000	1.429	5.100	1.100
87	0.000	1.327	5.940	1.100
88	0.000	1.225	6.860	1.100
89	0.000	1.123	7.640	1.100
90	0.000	1.021	9.120	0.885
91	0.000	0.919	14.920	1.100
186	0.210	1.429	5.120	1.100
187	0.210	1.327	5.940	1.100
188	0.210	1.225	6.880	1.100
189	0.210	1.123	7.640	1.100
190	0.210	1.021	9.140	1.057
191	0.210	0.919	14.660	1.100
286	0.420	1.429	5.140	1.100
287	0.420	1.327	5.960	1.100
288	0.420	1.225	6.900	1.100
289	0.420	1.123	7.640	1.100
290	0.420	1.021	9.140	1.100
291	0.420	0.919	14.660	1.100
386	0.630	1.429	5.160	1.100
387	0.630	1.327	5.960	1.100
388	0.630	1.225	6.920	1.100
389	0.630	1.123	7.680	1.100
390	0.630	1.021	9.180	0.834
391	0.630	0.919	14.840	1.091
	0.840	0.613		
782	1.470	1.838	5.740	0.937
783	1.470	1.736	6.600	1.100
882	1.680	1.838	5.700	1.100
883	1.680	1.736	6.340	1.100
884	1.680	1.634	7.620	1.100
886	1.680	1.429	14.760	1.100

887	1.680	1.327	15.420	0.954
982	1.890	1.838	5.720	1.100
983	1.890	1.736	6.360	1.100
984	1.890	1.634	7.620	1.100
986	1.890	1.429	14.640	1.066
987	1.890	1.327	15.560	0.928
1082	2.100	1.838	5.740	1.100
1083	2.100	1.736	6.360	1.100
1084	2.100	1.634	7.640	1.100
1086	2.100	1.429	14.680	0.859
1182	2.310	1.838	5.680	1.100
1183	2.310	1.736	6.320	1.100
1184	2.310	1.634	7.600	1.100
1283	2.520	1.736	6.840	1.100
	1.260	0.613		
1635	3.360	6.637	10.900	1.100
1636	3.360	6.535	12.340	0.808
1733	3.570	6.841	7.340	0.945
1734	3.570	6.739	10.520	1.100
1735	3.570	6.637	9.920	1.100
1736	3.570	6.535	12.160	1.100
1833	3.780	6.841	7.200	0.851
1834	3.780	6.739	10.340	1.100
1835	3.780	6.637	9.880	1.100
1836	3.780	6.535	12.160	1.091

Pass Number: 4

Event	X	Y	TOF	AMP
2166	4.410	3.471	7.180	1.057
2167	4.410	3.369	7.320	1.023
2168	4.410	3.267	7.500	1.100
2169	4.410	3.165	7.260	1.040
2170	4.410	3.063	7.040	1.066
2171	4.410	2.961	8.060	1.100
2172	4.410	2.859	7.080	1.066
2173	4.410	2.757	8.120	1.100
2174	4.410	2.655	7.180	1.100
2175	4.410	2.553	7.780	1.100
2176	4.410	2.450	7.500	0.902
2266	4.620	3.471	5.220	1.100
2267	4.620	3.369	5.300	1.100
2268	4.620	3.267	5.140	1.100
2269	4.620	3.165	5.660	1.100
2270	4.620	3.063	5.360	1.100
2271	4.620	2.961	5.860	1.100
2272	4.620	2.859	5.400	1.100
2273	4.620	2.757	5.420	1.100
2275	4.620	2.553	5.080	1.100
2276	4.620	2.450	5.180	1.100
	0.420	1.123		
2516	5.250	8.577	9.760	1.100
2517	5.250	8.474	9.320	1.100
2518	5.250	8.372	10.020	1.100
2519	5.250	8.270	9.860	1.100
2520	5.250	8.168	9.560	1.100
2521	5.250	8.066	9.780	1.100
2522	5.250	7.964	9.320	1.100
2523	5.250	7.862	9.660	1.100
2524	5.250	7.760	9.800	1.100
2525	5.250	7.658	9.620	1.100

2617	5.460	8.474	5.840	1.100
2618	5.460	8.372	5.560	1.100
2619	5.460	8.270	6.360	1.100
2620	5.460	8.168	6.800	1.100
2621	5.460	8.066	6.060	1.100
2622	5.460	7.964	5.600	1.100
2623	5.460	7.862	5.200	1.100
2624	5.460	7.760	5.240	1.100
2625	5.460	7.658	5.700	1.083
	0.420	1.021		
2869	5.880	3.165	6.540	1.083
2870	5.880	3.063	6.540	1.100
2871	5.880	2.961	6.640	1.100
2872	5.880	2.859	6.380	0.902
	0.210	0.408		
3710	7.770	9.189	13.480	0.859
	0.210	0.102		
3778	7.770	2.246	14.960	1.100
3779	7.770	2.144	14.480	1.100
3780	7.770	2.042	13.260	1.100
3781	7.770	1.940	13.820	1.100
3783	7.770	1.736	13.520	1.100
3784	7.770	1.634	13.280	1.100
	0.210	0.715		
3702	7.770	10.006	15.440	0.902
3703	7.770	9.904	15.540	0.834

Pass Number: 5

Event	X	Y	TOF	AMP
584	1.050	1.634	5.800	1.091
585	1.050	1.532	6.520	1.100
586	1.050	1.429	6.560	1.100
587	1.050	1.327	6.500	1.100
588	1.050	1.225	6.240	1.100
589	1.050	1.123	6.160	1.100
590	1.050	1.021	6.300	1.100
591	1.050	0.919	7.020	1.100
592	1.050	0.817	5.920	1.100
593	1.050	0.715	5.940	1.100
688	1.260	1.225	11.180	0.911
689	1.260	1.123	11.340	0.885
690	1.260	1.021	13.520	0.980
	0.420	1.021		
1563	3.150	3.778	5.160	0.945
1564	3.150	3.676	5.240	1.100
	0.210	0.204		
2583	5.250	1.736	5.360	1.074
2585	5.250	1.532	5.120	1.100
2586	5.250	1.429	5.180	1.100
2587	5.250	1.327	5.160	1.100
2588	5.250	1.225	5.840	1.100
2589	5.250	1.123	5.480	1.100
2590	5.250	1.021	5.560	1.100
2591	5.250	0.919	5.700	1.100
2592	5.250	0.817	6.020	1.100
2593	5.250	0.715	6.440	1.100

BC56973_cal std

2594	5.250	0.613	5.420	1.100
	0.210	1.225		
2934	6.090	6.739	5.680	0.971
2936	6.090	6.535	5.560	1.100
2937	6.090	6.432	5.100	1.100
2938	6.090	6.330	5.620	1.100
2939	6.090	6.228	5.400	1.100
2940	6.090	6.126	5.120	1.100
2941	6.090	6.024	5.440	1.100
2942	6.090	5.922	5.420	1.100
3034	6.300	6.739	9.360	1.100
3035	6.300	6.637	9.320	1.100
3036	6.300	6.535	10.160	1.100
3037	6.300	6.432	9.720	1.091
3038	6.300	6.330	9.280	1.100
3039	6.300	6.228	9.500	1.091
3040	6.300	6.126	9.280	1.091
3041	6.300	6.024	9.620	1.091
3042	6.300	5.922	10.140	1.100
3043	6.300	5.820	9.020	1.100
	0.420	1.021		
3386	6.930	1.429	6.460	1.057
3387	6.930	1.327	6.660	1.100
3388	6.930	1.225	6.400	1.100
	0.210	0.306		

3AL Testing Corp.
8110 NW 66th Street Miami, Florida 33166 Tel (305) 499-9939 Fax (305) 499-9923

Statement of Calibration Cylinder Certification

DOT Specification: 3AL-1800-20lbCO2

Serial Number: U498759

Date: September 1, 2004

This calibration cylinder has been certified to meet all standard reference requirements listed in 3AL Testing Corp's exemption application dated September 1, 2004. Please see attached drawing for flaw locations, and attached certification for flaw sizes.

Average minimum wall thickness for this cylinder was independently measured using a Stavely 133D thickness gauge (S/N 133D146G01805) and a SPECT-J7L 10MHz pitch-catch transducer (S/N 5329) and was found to be acceptable.

Robert A. Fick
3AL Testing Corp
ACCP level II

CURTIS INDUSTRIES, INC.

[illegible]
Tel: (724) [illegible]
Fax: (724) [illegible]

REFERENCE STANDARD CERTIFICATION

Traceable to the National Institute of Standards and Technology

All artificial defects are measured by calibrated M&TE or measured by replication process on a Mitutoyo Model 176-842 Toolmakers Microscope Serial #[illegible] calibrated to Starrett Gage Block Serial #10869.2 to NCSL-Z540-1 traceable to NIST 821/261776-99

STANDARD	LOCATION	HOLE DIMENSIONS, IN.				NOTCH DIMENSIONS, IN.					
[illegible]	AWT-548	Diameter		Depth		Length		Width		Depth	
		Nominal	Actual	Nominal	Actual	Nominal	Actual	Nominal	Actual	Nominal	Actual
[illegible]											
[illegible]											
8AL-1600	HOLE	.250	.2505	.1060	.1058						
	MSFP					.856	.850	.836	.8401	.318	.3182
	L1					1.00	1.0003	.010	.0070	.0318	.0318
	L2					1.00	1.0005	.010	.0071	.0318	.0318
	T1					1.00	.9998	.010	.0077	.0318	.0315
	T2					1.00	1.0005	.010	.0070	.0318	.0315

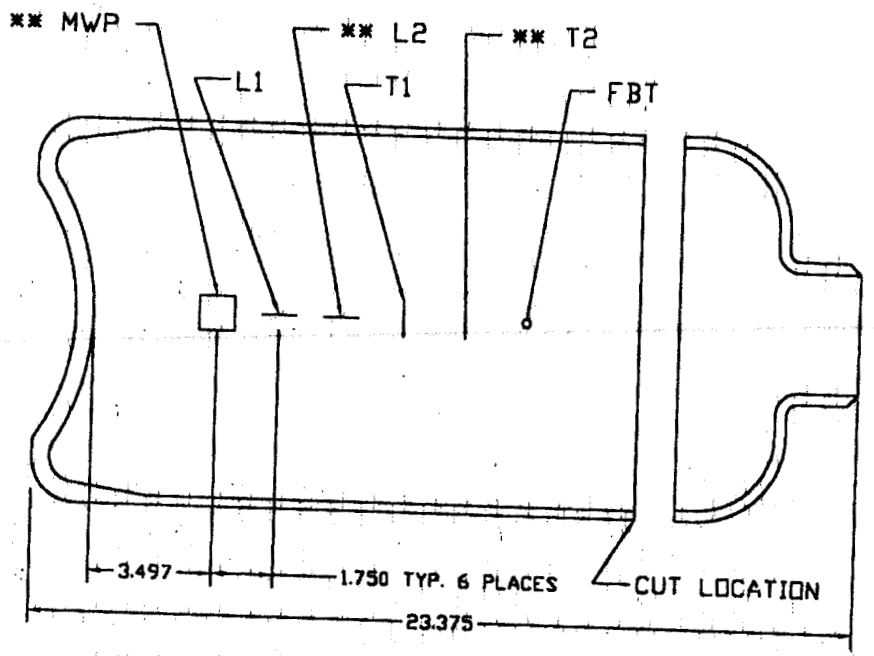
Customer: Digital Wave Corporation Purchase Order Number: 13151

Date: May 8, 2002 Specification or Drawing Number: 020830

Quality Control Manager: [illegible]

UT CALIBRATION CYLINDER
DOT 3AL-1800; 8.0"OD - Tmin=0.318
FROM U498759

Transducer C10691
.20
.18



ITEM	LOCATION	POSITION	LENGTH	WIDTH	DEPTH
FBH	ID	FLAT BOTTOM HOLE	0.250±0.01"	DIAMETER	NOTE 1
MWP	ID	MINIMUM WALL PATCH	0.836	0.836	*0.318 +0.001 -0.000"
L1	ID	LONGITUDINAL NOTCH	1.00±0.01"	0.010 MAX	0.0318 +0.0/-0.0005
L2	OD	LONGITUDINAL NOTCH	1.00±0.01"	0.010 MAX	0.0318+0.0/-0.0005
T1	ID	TRANSVERSE NOTCH	1.00±0.01"	0.010 MAX	0.0318 +0.0/-0.0005
T2	OD	TRANSVERSE NOTCH	1.00±0.01"	0.010 MAX	0.0318 +0.0/-0.0005

NOTES: 1) 1/3t min deep on ID 0.1060 +0.000/-0.0005
2) CENTERLINES WITHIN 1/16 INCH STRAIGHT POST WELDING
1/16" MAX DEVIATION TO STRING STRAIGHT FOR CYLINDER WALL.
* REMAINING WALL THICKNESS
** ROTATE 180° FROM OTHER NOTCHES.

N150-8" 3AL1800 CALIBRATION STANDARD
020030

U498759_cal std

Date: 8/26/2004 Time: 2:45:30 PM
Job No.:
Customer:
Cylinder S/N: U498759
Manufacture:
Manufacture Date:
Cylinder Min Wall: 0.318

Equipment
Model: DWC Reflex
Serial Number: 001

Transducer
Manufacturer: Harisonic
Serial Number: C10691
Diameter[Inch]: 0.750
EBW Size[Inch]: 0.250
Frequency[MHz]: 2.250
Water Path[Inch]: 5.000

Calibration Cylinder
Cal_Cylinder Type: 3AL
Diameter: 8.000
Cal-Cyl-S/N: U498759
Minimum Wall: 0.318
Pressure: 1800
Helix: 0.220
Cal-Cyl-Status: Passed
Cal-Cyl-Setupname: Cal_3AL_1800_8_30_6_U498759_0
Cali-Operator: Paul Graves

Flaw Name	Size	123X Position	4X Position	5X Position	Found at:
MWP	0.800X0.800	2.300	0.000	0.000	1
FBH	0.200X0.200	0.000	10.400	11.000	45
L1	0.800X0.000	4.200	0.000	0.000	23
L2	0.800X0.000	5.700	0.000	0.000	23
T1	0.000X0.800	0.000	7.000	7.300	45
T2	0.000X0.800	0.000	8.800	9.800	45

Inspector
Name: Paul Graves
Certification: ASNT Level II

Inspection Procedure
Procedure Number:

Visual Inspection:
DOT Spec:

Examination Result
FAIL
On pass 1: Thin Wall
On pass 2 3 4 5 : Pit/Crack
See attached documentation for detailed flaw result

Comments:

Event	X	Y	Thk
156	0.000	0.628	0.000
321	0.440	24.976	0.313
1617	2.200	22.462	0.313
1619	2.200	22.148	0.316
1775	2.420	22.777	0.298
1776	2.420	22.619	0.311
1777	2.420	22.462	0.313
1778	2.420	22.305	0.308
1779	2.420	22.148	0.313
1780	2.420	21.991	0.311
1935	2.640	22.777	0.313
1936	2.640	22.619	0.311
1937	2.640	22.462	0.313
1938	2.640	22.305	0.311
1939	2.640	22.148	0.313
1940	2.640	21.991	0.311
1941	2.640	21.834	0.308
2095	2.860	22.777	0.311
2096	2.860	22.619	0.311
2097	2.860	22.462	0.313
2098	2.860	22.305	0.313
2099	2.860	22.148	0.313
2100	2.860	21.991	0.311
2257	3.080	22.462	0.308
2260	3.080	21.991	0.313
8417	11.440	9.896	0.313

Pass Number: 2

Event	X	Y	TOF	AMP
1756	2.200	0.628	29.340	0.971
1757	2.200	0.471	27.500	1.100
1758	2.200	0.314	25.700	0.559
1916	2.420	0.628	29.520	1.100
1917	2.420	0.471	27.520	1.100
1918	2.420	0.314	26.060	0.627
2076	2.640	0.628	29.080	1.100
2077	2.640	0.471	27.080	1.100
2078	2.640	0.314	25.660	0.705
2236	2.860	0.628	29.460	0.842
2237	2.860	0.471	27.460	1.100
2238	2.860	0.314	25.640	0.670
	0.880	0.471		
1923	2.640	24.662	26.680	0.782
2083	2.860	24.662	26.300	0.816
	0.440	0.157		
2960	3.960	12.566	27.680	0.816
3119	4.180	12.723	35.660	0.679
3120	4.180	12.566	32.800	1.100
3121	4.180	12.409	25.820	0.756
3279	4.400	12.723	31.340	0.610
3280	4.400	12.566	28.640	1.100
3281	4.400	12.409	27.920	0.533
3439	4.620	12.723	28.100	0.602
3440	4.620	12.566	33.640	1.100

3441	4.620	12.409	32.340	0.670
3599	4.840	12.723	29.120	0.516
3600	4.840	12.566	27.120	1.100
3601	4.840	12.409	25.840	0.756
3760	5.060	12.566	32.780	0.937
	1.320	0.471		
4156	5.500	0.628	37.940	0.636
4157	5.500	0.471	35.940	1.100
4158	5.500	0.314	34.380	0.954
4316	5.720	0.628	33.860	0.842
4317	5.720	0.471	35.520	1.100
4318	5.720	0.314	34.020	1.100
4477	5.940	0.471	37.540	1.100
4636	6.160	0.628	38.300	0.765
4637	6.160	0.471	32.100	1.100
4638	6.160	0.314	34.400	0.937
4797	6.380	0.471	36.560	1.040
4798	6.380	0.314	34.220	0.705
	1.100	0.471		
8239	11.220	12.723	27.800	0.576
8398	11.440	12.881	24.480	0.559
8399	11.440	12.723	32.200	0.902
	0.440	0.314		

Pass Number: 3

Event	X	Y	TOF	AMP
1634	2.200	19.792	11.380	1.100
1635	2.200	19.635	13.400	1.074
1794	2.420	19.792	11.040	1.100
1795	2.420	19.635	12.480	1.100
1954	2.640	19.792	10.980	1.100
1955	2.640	19.635	12.440	1.100
2114	2.860	19.792	10.900	1.100
2115	2.860	19.635	12.360	1.100
2274	3.080	19.792	11.020	1.100
2275	3.080	19.635	14.520	1.100
	1.100	0.314		
2991	3.960	7.697	11.040	1.100
2992	3.960	7.540	13.940	1.100
3151	4.180	7.697	11.660	1.100
3152	4.180	7.540	12.060	1.100
3311	4.400	7.697	10.700	1.100
3312	4.400	7.540	12.120	1.100
3471	4.620	7.697	10.720	1.100
3472	4.620	7.540	16.800	1.100
3631	4.840	7.697	10.760	1.100
3632	4.840	7.540	12.180	1.100
	1.100	0.314		
4349	5.940	20.577	9.380	1.100
4350	5.940	20.420	10.080	1.100
	0.220	0.314		
4034	5.500	19.792	20.100	1.100
4193	5.720	19.949	21.980	1.100
4194	5.720	19.792	20.080	1.100
4195	5.720	19.635	21.820	1.091
4353	5.940	19.949	22.760	1.100

4354	5.940	19.792	23.700	1.100
4355	5.940	19.635	24.720	0.980
4513	6.160	19.949	19.880	1.100
4514	6.160	19.792	20.100	1.100
4515	6.160	19.635	21.640	1.066
4673	6.380	19.949	18.700	1.100
4674	6.380	19.792	20.060	1.100
4833	6.600	19.949	18.740	1.100
4834	6.600	19.792	20.160	1.100
	1.320	0.471		
8272	11.220	7.540	11.080	1.100
8273	11.220	7.383	12.520	1.100
	0.220	0.314		

Pass Number: 4

Event	X	Y	TOF	AMP
816	1.100	22.619	29.860	0.533
817	1.100	22.462	30.240	0.541
818	1.100	22.305	30.280	0.541
819	1.100	22.148	29.000	0.550
975	1.320	22.777	27.960	0.868
976	1.320	22.619	28.100	1.100
977	1.320	22.462	27.760	1.100
978	1.320	22.305	27.900	1.091
979	1.320	22.148	28.000	1.100
980	1.320	21.991	27.560	0.670
1134	1.540	22.934	25.960	0.653
1135	1.540	22.777	28.660	1.100
1136	1.540	22.619	26.360	1.100
1137	1.540	22.462	25.740	1.100
1138	1.540	22.305	28.820	1.100
1139	1.540	22.148	26.180	1.100
1140	1.540	21.991	26.140	0.670
1297	1.760	22.462	26.140	0.662
	0.880	1.100		
4737	6.380	9.896	40.020	0.550
	0.220	0.157		
5055	6.820	10.210	28.540	0.773
5056	6.820	10.053	27.720	0.877
5057	6.820	9.896	28.480	0.928
5058	6.820	9.739	28.320	0.885
5059	6.820	9.582	27.840	0.980
5060	6.820	9.425	27.820	0.765
5214	7.040	10.367	27.180	0.834
5215	7.040	10.210	27.280	1.100
5216	7.040	10.053	27.320	1.100
5217	7.040	9.896	27.360	1.100
5218	7.040	9.739	27.380	1.100
5219	7.040	9.582	27.080	1.100
5220	7.040	9.425	30.120	1.100
5376	7.260	10.053	23.960	0.636
5380	7.260	9.425	24.160	0.524
	0.660	1.100		
5936	8.140	22.619	37.840	0.524
6094	8.360	22.934	35.780	0.593
6095	8.360	22.777	35.600	1.057
6096	8.360	22.619	35.440	1.091

6097	8.360	22.462	36.340	0.971
6098	8.360	22.305	39.420	0.851
6099	8.360	22.148	36.460	0.988
6100	8.360	21.991	37.400	0.782
6254	8.580	22.934	37.440	0.748
6255	8.580	22.777	34.400	1.100
6256	8.580	22.619	34.060	1.100
6257	8.580	22.462	34.820	1.100
6258	8.580	22.305	34.480	0.808
6259	8.580	22.148	35.800	0.945
6260	8.580	21.991	33.420	0.627
	0.660	1.100		
7616	10.340	10.053	28.160	0.791
7617	10.340	9.896	26.920	0.799
7618	10.340	9.739	26.680	0.541
7776	10.560	10.053	25.460	0.713
7777	10.560	9.896	24.820	0.679
	0.440	0.471		

Pass Number: 5

Event	X	Y	TOF	AMP
2112	2.860	20.106	14.660	1.100
2113	2.860	19.949	9.180	1.100
2115	2.860	19.635	9.800	1.100
2116	2.860	19.478	11.440	1.100
2271	3.080	20.263	11.120	1.100
2272	3.080	20.106	11.000	1.100
2273	3.080	19.949	10.300	1.100
2274	3.080	19.792	10.920	1.100
2275	3.080	19.635	10.100	1.100
2276	3.080	19.478	11.760	1.100
2432	3.300	20.106	13.340	1.091
2433	3.300	19.949	17.380	1.057
	0.660	0.942		
5711	7.700	7.697	10.160	1.100
5712	7.700	7.540	12.440	1.100
5713	7.700	7.383	9.580	1.100
5714	7.700	7.226	10.940	1.100
5715	7.700	7.069	11.200	1.100
5716	7.700	6.912	11.700	1.100
5717	7.700	6.754	11.560	1.100
5871	7.920	7.697	12.740	1.100
5872	7.920	7.540	12.680	1.100
5873	7.920	7.383	11.900	1.100
5874	7.920	7.226	12.560	1.100
5875	7.920	7.069	12.040	1.100
5876	7.920	6.912	12.820	1.100
5877	7.920	6.754	12.140	1.100
	0.440	1.100		
7074	9.680	19.792	16.960	0.971
7075	9.680	19.635	16.820	1.005
7076	9.680	19.478	18.900	0.980
7233	9.900	19.949	18.920	1.100
7234	9.900	19.792	19.140	1.100
7235	9.900	19.635	18.740	1.100
7236	9.900	19.478	20.440	1.100
7393	10.120	19.949	20.520	1.100
7394	10.120	19.792	21.100	1.100
7395	10.120	19.635	21.080	1.100

U498759_cal std

	0.660	0.628		
8272	11.220	7.540	10.180	1.066
8273	11.220	7.383	9.400	1.100
8274	11.220	7.226	9.340	1.100
8432	11.440	7.540	10.720	1.100
8433	11.440	7.383	10.940	1.100
8434	11.440	7.226	10.900	1.100
	0.440	0.471		

Pusler/Receiver and #1 System Calibration Check

Date: June 14, 2004 **By: Faming Li**

Purpose:
1. Check pulser/receiver 99058606 (Panametrics 5072PR) 's consistancy and stability.
2. Check #1 machine system signal path and responsiveness to gain change.

Conclusion: The system signal path is good. The system has good signal responsiveness
The pulser/receiver has reasonable gain increase and gain range.
The scanner system is satisified to meet DOT requirements.

1. Tool: Tektronix TDS1012 100MhzBW/1Gs/s
2. Condition: Power up pulse/receiver and machine for 30 minutes.
Position transducer to the direction in which the front wall echo reaches its highest.
Use the oscilloscope to measure the PK-PK value.
3.Connect Wiring: Connect TDS1012 to Pulser/Receiver's output

4. Check Receiver: Set: PRF = ext HPF = 1MHz
Energy = 1 LPF = Full BW
Damping = 4 Mode = 1 (T/R)

Gain	Reading(v)	dB	Gain	Reading(v)	dB
0	0.54	2.254086	20	2.1	0.482674
5	0.7	0.939931	21	2.22	0.60448
6	0.78	0.434385	22	2.38	0.700855
7	0.82	0.808573	23	2.58	0.710767
8	0.9	0.739671	24	2.8	1.105382
9	0.98	0.347482	25	3.18	0.73298
10	1.02	0.334114	26	3.46	0.440506
11	1.06	0.63198	27	3.64	0.281729
12	1.14	0.869314	28	3.76	0.406168
13	1.26	0.534685	29	3.94	0.087737
14	1.34	0.744961	30	3.98	0.425864
15	1.46	0.463357	31	4.18	1.590549
16	1.54	0.858564	32	5.02	0.569221
17	1.7	0.592449	33	5.36	0.03235
18	1.82	0.731876	34	5.38	0.096332
19	1.98	0.511082	35	5.44	

Range: 20.0641

5. Pulser

5.1 Keep everything same as in 4. set Gain = 0.0 Damping = 4

Energy	Reading	Energy	Reading
1	0.54	3	0.78
2	0.64	4	0.96

5.2 Keep everything same as in 4. set Gain = 0.0 Energy = 2

Damping	Reading	Damping	Reading
1	2.38	5	1.02
2	2	6	0.9
3	1.5	7	0.78
4	1.3	8	0.74

6. Motion Movement Check: 2" movement is verified
7. Thickness measurement: Thickness measurement is checked

3AL Testing Corp
PROCEDURE FOR CALIBRATED GAIN ACCURACY

Amplitude Control Linearity – verifies the accuracy as exhibited by a constant relationship between amplitudes, by adding +6 dB the amplitude should result in a 200% increase and -6 dB would be 50% decrease in amplitude.

Step 1 Position the transducer to peak up on a notch or flat bottom hole on one of the calibration cylinders. Adjust the delay to place one echo at horizontal midscreen. Use this notch or flat bottom hole for the remainder of the steps.

Step 2 Adjust the system gain (dB) to 40 and output attenuation to 0. Rotate the cylinder to producer an echo to approximately 80% full screen height.

NOTE: For accuracy in determining the echo amplitude % screen height, place gate 2 just at the peak of the echo. In the gates menu press update display to get the % threshold full screen height. This will be done for each of the steps below.

Step 3 In the gain settings, increase the attenuation output by 6 to decrease the amplitude as shown below in row 1. Place gate 2 just at the echo peak and record the % screen height from the gates menu page. Record the % screen height in row 1.

Step 4 Without any adjustment to the gain rotate the cylinder to produce an 80% full screen height. In the gain settings adjust the attenuation output by 12 to decrease the amplitude. Record the % screen height in row 2

Step 5 With the same gain settings, rotate the cylinder to produce an echo to approximately 40% screen height. Decrease the attenuation output by 6 to increase the amplitude.. Record the % screen height in row 3.

.Step 6 Rotate the cylinder to produce a 20% full screen height, use the gate threshold for accuracy. In the gain settings decrease the attenuation output by 12 to increase the amplitude. Record the % full screen height in row 4.

Indications Set at % Full Screen	dB Control Change	Recorded Echo	Indication Limits % of Full Screen
80%	-6 dB	40%	32 to 48 %
80%	-12 dB	20%	16 to 24 %
40%	+6 dB	80%	64 to 96 %
20%	+12 dB	80%	64 to 96 %

The recorded echo must fall within the Indication Limits % of full Screen height for the ultrasonic cylinder scanning system to pass. The ultrasonic cylinder scanning system must be checked at 6 month intervals.

Should the recorded echo fail to fall within the Indication Limits % of full Screen height for the ultrasonic cylinder scanning system to pass. The ultrasonic cylinder scanning systems' pulser/receiver must be sent to the manufacturer or accredited calibration laboratory to repair or tune the pulser/receiver. A certificate of calibration from the manufacturer or accredited calibration laboratory will be kept on file verifying the pulser/receiver Amplitude Control Linearity limits achieved.

Ultrasonic cylinder scanning Immersion System # 001
Date of Calibration AUGUST 30, 2004
Disposition PASS
Inspectors Name PAUL GRAVES

3AL Testing Corp.
8110 NW66th Street Miami, Florida 33166 Tel (305) 499-9939 Fax (305) 499-9923

Procedure number: 019
Eddy Current Evaluation and Enhanced Visual Inspection Procedure

1. SCOPE

1.1 This procedure covers the requirements for both *eddy current* and *enhanced visual examination* nondestructive methods for detecting cracks and other discontinuities in the cylinder threads and valve neck area on DOT Specification 3AL cylinders manufactured from aluminum alloy 6351-T6.

1.2 This document is specific to the eddy current evaluation (EE) and enhanced visual examination (VE) which is a required supplementary examination to the Ultrasonic Examination (UE). The procedure meets the (EE, VE) inspection requirements of 3AL Testing Corp's application for exemption, dated September 1, 2004.

2. DESCRIPTION AND PURPOSE

2.1 Cylinders made of aluminum alloy 6351-T6 are known to be susceptible to sustained load cracking (SLC) in the neck and threaded area of a cylinder. The purpose of both internal visual and eddy current examination tests is to detect possible cracks or discontinuities open to the surface. The eddy current technique has been a proven method for detecting cracks in the threads by comparing manufactured notches in a standard of similar material type, size, and configuration. In principle, small circular funnel-shaped *eddy current fields* are introduced into the threaded portion of the cylinder specimen by the use of a threaded probe housing a sensor. These bands of circular current fields are sensitive to alterations and interruptions caused by discontinuities such as cracks and other surface irregularities. Any disruption of the field can easily be distinguishable on the eddy current instrument display. Visual examination is done with the use of a high-intensity light and mirror. Enhanced visual evaluation is applied as additional inspection when it is necessary to further determine the detection and size of such cracks. Each technique has its own range of usefulness to gather quantitative and qualitative information. No one technique should be used alone to obtain the information for reliable and accurate results of relevant indications.

3. REFERENCES

Visual Plus "Owner's Guide"; directions for setup and cylinder inspection

Visual Plus "Technical Update"; informative technical information in the evaluation process

Visual Plus "Inspection Guide"; A poster illustrating photographs of defects and their waveforms

Luxfer Scuba Cylinder Visual Inspection Guide

Visual Eddy "Eddy Current Inspection Unit"; directions for setup and cylinder inspection

U.S. Department of Transportation Advisory: Aluminum Cylinders Made of Aluminum Alloy 6351-T6

4. EQUIPMENT

4.1 The eddy current instrument used for the inspection of cylinders is the Visual Plus or the Visual Eddy.

4.2 Visual inspection equipment will consist of a mirror and light source. The mirror must be 1/4 to 5/8 inch diameter in size and have 2x minimum magnification. It must fit inside the neck of the cylinder. Any light source of high intensity such that it is capable of aiding in the detection of cracks shall be used. The T.I.P. (thread inspection pipe) tool used by 3AL is considered an acceptable visual tool. A small dental mirror and flashlight is acceptable provided it meets the requirements.

5. REFERENCE STANDARDS

5.1 Aluminum-threaded, test-ring standards will be used as calibration tools to establish proper operating settings of the equipment. These standards are manufactured with a single notch to simulate a crack common to DOT-3AL 6351-T6 cylinders.

5.2 DOT-3AL ring standards used with the visual plus or visual eddy instrument for the testing of cylinders shall be those supplied by the manufacturer. The two standards supplied by the Visual Plus manufacturer are serial #2 (3/4" ID) and serial #3 (1.125" ID). The two standards supplied by the Visual Eddy manufacturer are serial #2006 (3/4" ID) and serial #3008 (1.125" ID).

5.2.1 The ring standard used in the calibration setup shall be of the same ID as that of the cylinder to be tested.

5.2.2 Calibration standard identified as serial #2 (3/4" ID) and calibration standard identified as serial #2006 shall be used for the following cylinder types (Please note this list is not intended to be all inclusive.):

TYPE	PART NUMBER	DATE
Medical C	M9	01-88
Medical D	MD	12-87
Medical E	ME	12-87
All Walter Kidde	----	-------
Cliff Impact	----	07-90

Tests shall be done on cylinders manufactured before the given dates.

5.2.3 Calibration standard identified as serial #3 (1.125" ID) and calibration standard identified as serial #3008 shall be used for the following cylinder types (Please note this list is not intended to be all inclusive.):

TYPE	PART NUMBER	DATE
CO2 20 pound	C20	04-88
CO2 35 pound	C35	04-88
CO2 50 pound	C50	02-88
Industrial 150	N150	05-88
All Walter Kidde	-----	-----
Cliff Impact	-----	07-90

Tests shall be done on cylinders manufactured before the given dates.

NOTE: A list of "Potentially Affected Cylinders" that may require testing can be found in the U.S. Department of Transportation publication "Advisory: Aluminum Cylinders Made of Aluminum Alloy 6351-T6." This publication can be found at the end of this procedure.

6. VISUAL PLUS AND VISUAL EDDY CALIBRATION SETUP

6.1 The Owner's guide specific to each manufacturer of eddy current instrument shall be used for the calibration setup. First-time users should review the material contained in the guide and experiment

6.2 If the sensitivity of the probe does not create a spike approximately *half the total size of the screen* (the trace line is considered bottom of screen), then cylinder testing must cease. The threshold (dotted line) is about ¼ screen height. Further testing cannot be done until the calibration sensitivity is corrected and the requirements of calibration setup are acceptable.

6.3 Any sensitivity adjustments needed for an acceptable calibration must be done following the instructions found in the Visual Plus or Visual Eddy Owner's Guide.

6.4 Calibration setup of the instrument must be done before any cylinder testing commences and the spike created is approximately *half the total size of the screen.*

6.5 A verification of calibration setup on the standard shall be done after completion of all cylinder testing.

6.5.1 If, after cylinder testing, the calibration has notably changed from the previous calibration check, all cylinders tested between the calibration checks shall be re-inspected.

6.6 A new calibration setup must be done every time the unit is turned on, a change of user or probe, or the unit is moved from one area to another.

6.7 A verification check of calibration shall be done at a minimum every *half hour* of continuous use.

7. EDDY CURRENT CYLINDER INSPECTION

7.1 Cylinder neck threads are to be examined when the valve is removed from the cylinder.

7.2 The inspection process duplicates the instructions found in the owner's guide but does not contain illustrations which are found in the guide. First-time users should review the material and illustrations contained in the guide and use it as a reference to become even more familiar with the instrument.

Step 1 – Clean the cylinder neck threads before screwing in the eddy current probe.

Step 2 – Screw the probe into the threads of the cylinder approximately four rotations until probe is below the top thread of cylinder.

Step 3 – Press **MENU** to display the menu and select **ALARM** option. Put the arrow to activate the audio alarm to **ALARM ON**.

Step 4 – Continue to screw the probe into the cylinder. If the trace line (continuous ine moving across screen) drops to the very bottom of the screen, press the **RESET** button.

Step 5 – The threshold light will stay red and a constant audio signal will be heard once the probe is completely screwed into the cylinder and the sensor is no longer in contact with metal. The trace line will also be visible at the very top of the screen which indicates that the sensor is now below the bottom thread. This procedure is to ensure that all of the threads will be inspected when the probe is withdrawn from the cylinder.

Step 6 – The cylinder inspection starts at the bottom of the threads and is performed while the probe is exiting the cylinder.

Step 7 – Begin the inspection by rotating the probe counterclockwise until the probe is completely withdrawn from the cylinder.

Step 8 – While testing, the trace line may vary from cylinder to cylinder. If the trace line drops to the very bottom of the screen, press **RESET** to return the trace to a readable position.

7.3 In the evaluation of a flaw or any spike indication, the trace line must be midway between the bottom of the screen and the threshold. If the spike breaks the threshold and activates the audio signal, determine if it exceeds the established criteria.

8. ENHANCED VISUAL CYLINDER INSPECTION

8.1 A thorough visual inspection of the cylinder threads and neck area shall be done when the valve is removed from the cylinder.

8.2 Visual inspection shall be done after the eddy current inspection and is the governing examination method. If, during the visual examination, a rejectable defect is found that will condemn the cylinder during the visual examination, no further eddy current testing or ultrasonic examination needs to be done.

8.3 For internal visual inspection of the threads and neck of the cylinder, a light source such as a flashlight and a ½" dental mirror with 2X magnification shall be used. 3AL Testing recommends the T.I.P. visual tool as the preferred method.

8.3.1 Most cracks begin at the bottom of the threads and propagate upwards. Look for very small, tight, linear indications. A crack may appear as jagged or straight and could be shiny or dark in appearance.

8.4 Visual inspection shall be done after eddy current inspection. Visual inspection shall be used to evaluate the cylinder thread area where the eddy current spike has exceeded the threshold limits. Visual inspection shall also be conducted to evaluate the neck surface area beneath the first thread for cracks that cannot be detected by eddy current.

8.5 Visual inspection shall be used to make a positive identification, locate, characterize and size any flaw.

9. VISUAL PLUS AND VISUAL EDDY EVALUATION AND INTERPRETATION

9.1 The Visual Plus inspection guide poster and the Visual Eddy owner's manual should be referenced as a resource for waveform evaluation and interpretation for the various discontinuities that may be encountered.

- **Cracks** will be displayed as sharp, straight, up and down indications.
- **Corrosion** will be displayed by a noisy or erratic trace line. Decreasing frequency 5 points to decrease sensitivity may be necessary to complete the inspection. In this case, any ¼ screen height spike will be considered the threshold for a crack.
- **Folds** will have a rounded indication that may sometimes be interrupted by the top of the instrument's screen.
- **Valleys** will have a generously rounded indication that may sometimes be interrupted by the top of the instrument's screen.

10. ACCEPT/REJECT CRITERIA

10.1 All imperfections that produce a signal amplitude of ¼ screen height on the Visual Plus or Visual Eddy shall be investigated to the extent that the technician can determine the shape, identity and location. All such imperfections shall be evaluated in terms of the acceptance standards.

10.1.1 The following relevant indications found through enhanced visual or by the eddy current method are unacceptable and cause for the cylinder to be condemned.

- **Neck Cracks** – Imperfections interpreted to be cracks are unacceptable regardless of length. Cylinders with neck cracks must be condemned.
- **Folds** – Any fold that interrupts one complete threads or more.
- **Valleys** – Any valley that interrupts seven full threads for tapered threads and six full threads for straight threads.
- **Threads** – Cylinders containing less than seven continuous full threads for tapered threads or six continuous full threads for straight threads. A thread shall be considered full if its root and crest display no significant visual difference to that of the uppermost cylinder. Threads that do not meet this criterion are considered to be incomplete or partial threads.

10.2 Tool stop marks are linear indications that need to be distinguished from a crack. Tool stop marks are considered acceptable.

10.3 Cylinders shall be rejected if the required number of effective threads is materially reduced so that a gas-tight seal cannot be obtained by reasonable valving methods. Thread defects include threads that are galled, worn, corroded, broken, cracked, nicked, and "double-threaded" (from forcing an incorrect valve into the threads).

10.4 Each acceptable cylinder shall be stamped with the letters "EE" after the letters "UE" in characters not less than ¼ high for cylinders with a diameter equal to or greater than 4" and 1/8" high for a cylinder with a diameter less than 4".

10.5 Rejected cylinders shall have a series of Xs stamped over the DOT specification number and marked service pressure. Steel stamping "CONDEMNED" on the shoulder or neck is also acceptable.

11. EXAMINATION RECORDS

11.1 A report form for eddy current and visual inspection shall be filled out for each cylinder tested to identify it as acceptable or rejectable. Reports are to remain file at the testing facility. Cylinders, which are acceptable and proceed to Ultrasonic

11.2 Examination (UE) are considered to have meet this requirement by the generation of an ultrasonic examination report. Since no rejectable cylinder is allowed to proceed to UE, all rejectable cylinders must have a report filled out, either by paper copy or electronic.

11.3 For any rejected cylinders by eddy current or visual test method, the type, location and dimension of the flaw should be included in the report.

The following shall be included on the inspection report:

(a) eddy current model number and serial number
(b) serial number of the standard/probe combination used.
(c) Cylinder serial number and type
(d) Examination date
(e) Accept / reject results

12. VALVING AND DEVALVING

12.1 When valving, caution should be exercised that the thread configuration is noted straight versus tapered. In some cases, if a valve with tapered threads (3/4" NGT) will fit into a cylinder with straight threads (3/4" NGS), damage to the cylinder or valve may result. A thread gauge can be used to verify size and type of threads. Therefore, if in doubt, a thread gauge must be used.

12.2 Valves should be torqued into the cylinders with the minimum amount of force required for the valve and cylinder to seal. In no case shall the torque exceed the following:

Straight threads	¾-14 NGS (NPSM)	100 lbf-ft
Straight threads	0.750-16 UNF	60 lbf-ft
Straight threads	0.875-14 UNF 20 lbs CO2	80 lbf-ft
Straight threads	1.125-12 UNF	100 lbf-ft
Tapered threads	½ NGT	50 lbf-ft
Tapered threads	¾ NGT	100 lbf-ft
Tapered threads	1 NGT	125 lbf-ft

12.3 O-ring Gland. Many aluminum cylinders have an O-ring gland and straight threads. Both the O-ring and the lubricant, if used, should be compatible with the lading. Where the cylinder is part of a certified assembly, like in the self-contained breathing apparatus (SCBA) unit used by fire fighters and emergency response people, the only O-ring used may be the O-ring type originally certified with the assembly. In the case of cylinders used in SCBA service, any replacement O-ring must be obtained from the SCBA unit manufacturer. O-rings should be clean and smooth. Replace damaged O-rings.

Table - Affected Cylinders Manufactured by Luxfer USA

DOT	Service and Type Cylinder		Part No.	Date Mfd. Before
Spec. 3AL	Carbon Dioxide	1.2 and 1.5 lb.	C1.2, C1.5	01-89
		2.18 lb.	C2-18	11-88
		10 lb.	C10	08-88
		5 lb.	C5	06-88
		15 lb.	C15	11-87
		20 and 35 lb.	C20, C35	04-88
		50 lb.	C50	02-88
	SCBA	7, 8 and 13 cu. ft.	L7, L8, L13	09-87
		13.3 cu. ft.	L13-30	05-88
		15 cu. ft.	L15	01-89
		26 cu. ft.	L26	02-88
		45 cu. ft.	L45	11-87
	SCUBA	30 and 63 cu. ft.	S30, S63	05-88
		40 cu. ft.	S40	06-88
		50 and 92 cu. ft.	S50, S92	04-88
		72 and 100 cu. ft.	S72, S100	08-87
		80 cu. ft.	S80	01-88
		80.8 cu. ft.	S80.8	05-87
	Medical Oxygen	C	M9	01-88
		D and E	MD, ME	12-87
	Industrial	22 and 150 cu. ft.	N22, N150	05-88
		33 cu. ft.	N33	11-88
		60 and 122 cu. ft.	N60, N122	12-87
		88 cu. ft.	N88	12-88
DOT-E 7235 (Note 3)	Service Pressures 2016 and 3000 psig			08-89
	Service Pressure 4500 psig (cylinders must be fitted with a neckring)			

Enhanced Visual and Eddy Current Testing

of Aluminum 6351-T6 cylinders

All employees of 3AL Testing Corp. are required to comply with the enhanced visual and eddy current policies, standards and procedures for the inspection of Aluminum cylinders made of 6351-T6. By signing this form the inspector acknowledges he has been trained in the use of the visual inspection tools and the Eddy current Visual Plus or Visual Eddy instrument to carry out a thorough and professional inspection. The inspector has also read and understands the contents of the following documents for performing the inspection and for evaluating discontinuities;

It is recognized that some of the following documents are used as reference material only, but offer knowledge that can be helpful in a thorough inspection.

_____ 3AL Testing Corp Eddy Current Evaluation and Enhanced Visual procedure Number 019

_____ Visual Eddy "Owners Guide"

_____ Visual Plus "Owners Guide"

_____ Visual Plus "Technical Update"

_____ Visual Plus "Inspection Guide" poster

_____ Luxfer Scuba Cylinder Visual Inspection Guide

Name _____ Date 08-31-2004

Name Paul Brass Date 8-30-2004

Name _____ Date _____

CERTIFICATE OF CALIBRATION

VISUAL EDDY TEST UNIT SN 224632

CALIBRATED 8/1/04

by John J. Flaherty Flare Technology Inc.

for 3 AL TESTING, MIAMI, FL

COMMENTS

APPROVED

CERTIFICATE STATEMENT FOR REFRENCE RING

DATE: September 1, 2004

Company: 3AL Testing Corp.
Location: 8110 NW 66th Street Miami, Florida 33166
Reference: Exemption application dated September 1, 2004
Subject: Eddy Current Visual Eddy Ring Standards #1006, #2006, and #3008

This certificate statement is in reference to 3AL Testing Corp's exemption application, Appendix IV (Draft Exemption), section 7 (d)(2) pertaining to Eddy Current Reference Rings. All three reference rings identified as serial numbers 1006, 2006 and 3008 have been verified and accepted for use with the Visual Eddy instrument serial number 224362.

The rings were tested for sensitivity for locating cracks by the 3AL Testing Corp quality control department and found to be acceptable for use in the testing of 6351-T6 cylinders as required with the exemption. Please see the attached drawings for flaw locations and flaw sizes.

Robert Fick
Quality Control manager, ASNT Level II
3AL Testing Corp.

CGA C-6.1—2002

STANDARDS FOR VISUAL INSPECTION OF HIGH PRESSURE ALUMINUM COMPRESSED GAS CYLINDERS

FOURTH EDITION

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Docket 00-04
Cylinder Specifications Committee

NOTE—Technical changes from the previous edition are underlined.

NOTE—Appendices A, B, and C (Informative) are for information only.

FOURTH EDITION: 2002
THIRD EDITION: 1995
SECOND EDITION: 1984
FIRST EDITION: 1980

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Printed in U.S.A.

Contents **Page**

Table

Figures

Appendices

1 Introduction

The U.S. Department of Transportation (DOT) and Transport Canada (TC) require that cylinders used for the transportation of compressed gases be requalified periodically by visual inspection followed by hydrostatic testing if they are to remain in service (CGA C-1, *Methods for Hydrostatic Testing of Compressed Gas Cylinders*) [1].[1] However, a cylinder that was charged or filled before the requalification became due may remain in service until it has been emptied. U.S. regulations in Title 49 of the *Code of Federal Regulation* (49 CFR) Part 173.34, and equivalent Canadian regulations in CAN/CSA B339 Section 24 identify the inspection and hydrostatic testing requirements for most cylinders [2, 3]. Cylinders fabricated in accordance with DOT, TC, or the former Canadian Transport Commission (CTC) permits or exemptions shall be requalified as specified in the exemption or permit. These documents may be obtained from DOT, TC, or the manufacturer.

The approval of the DOT-3AL specification in 49 CFR 178.46 (effective date of change July 2, 1982) consolidated the majority of the exemptions and special permits for aluminum cylinders into one manufacturing regulation [2]. The Canadian Specification TC-3ALM also consolidates specification CTC-3AL and permits for aluminum cylinders into their regulations [3, 4].

In the United States, DOT exemptions E 6498, E 7042, E 8107, E 8364, and E 8422 were previously issued that identified the manufacturing, usage, and inspection requirements of these cylinders. These exemptions have been superseded by DOT specification 3AL, and copies of the exemptions are no longer required. Cylinders marked with S.P. preceding the previously noted exemption numbers, designating special permits, are also covered by the DOT specification 3AL. Some cylinders with the previously noted markings may be preceded by CTC indicating compliance with the CTC requirements, for example, CTC/DOT E 6498-1800. Exemption and special permit cylinders shall be remarked at the time of the first hydrostatic testing occurring since July 2, 1982. Requirements for remarking can be found in 49 CFR 173.23(c), which states that after July 2, 1982 a seamless aluminum cylinder manufactured in conformance with and for use under DOT exemption E 6498, E 7042, E 8107, E 8364, or E 8422 may be continued in use if marked before or at the time of the next retest with the specification identification 3AL immediately above the exemption number, or if the DOT mark (i.e., DOT 3AL 1800) is added in proximity to the exemption marking [2]. See Figures 1 and 2 for examples of exemption marked cylinders.

Experience in the inspection of cylinders is an important factor in determining the acceptability of a given cylinder for continued service. Users lacking this experience or having questionable cylinders should consult the manufacturer or other knowledgeable sources.

2 Scope

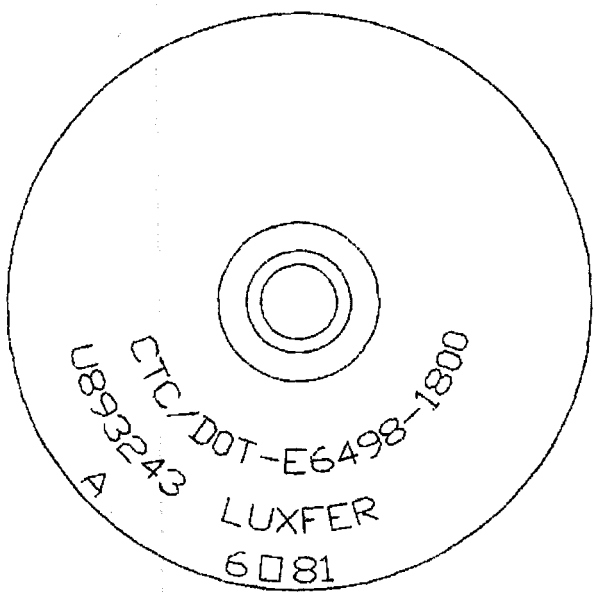
This publication has been prepared as a guide for the visual inspection of aluminum compressed gas cylinders with service pressures of 1800 psig (12 410 kPa) or greater.[2] It is general in nature and does not cover all circumstances for each individual cylinder type or lading.

Additional publications prepared by the Compressed Gas Association, Inc. that may be helpful include:

- CGA C-1, *Methods for Hydrostatic Testing of Compressed Gas Cylinders* [1];
- CGA C-6, *Standards for Visual Inspection of Steel Compressed Gas Cylinders* [6];
- CGA C-6.2, *Guidelines for Visual Inspection and Requalification of Composite High Pressure Cylinders* [7]; and
- CGA C-6.3, *Guidelines for Visual Inspection and Requalification of Low Pressure Aluminum Compressed Gas Cylinders* [8].

[1] References are shown by bracketed numbers and are listed in order of appearance in the reference section.

[2] kPa shall indicate gauge pressure unless otherwise noted as (kPa, abs) for absolute pressure or (kPa, differential) for differential pressure. All kPa values are rounded off per CGA P-11, *Metric Practice Guide for the Compressed Gas Industry* [5].



Note—It is recommended that existing exemption markings remain intact.

Figure 1—Exemption marked cylinder

Figure 2—DOT-3AL marked exemption cylinder

3 Definitions

3.1 Bow
Cylinder manufactured with a curve in it shaped like a banana.

3.2 Bulge
Visible swelling of the container.

3.3 Condemned
No longer fit for service. The cylinder is required to be removed from service.

3.4 Corrosion
Loss of metal thickness by some corrosive media and is usually apparent from a general loss of wall thickness or pitting. Corrosion of aluminum will appear as a roughened and discolored area with a white deposit sometimes associated with the corrosion.

3.4.1 General corrosion
Somewhat uniform loss of metal in a relatively large area. General corrosion may be difficult to see unless it is very pronounced.

3.4.2 Line corrosion
Series of pits closely spaced as to appear to be in a line. This condition is considered more serious than isolated pitting.

3.4.3 Pitting corrosion
The most common form of attack on aluminum. The pits can be small and localized or larger and scattered. Small, isolated pits have very little effect on the strength of the cylinder, but the degree of pitting and concentration of the pits will determine if the cylinder can be continued in service. See Figure 3.

3.5 Crack
Split or rift in the metal.

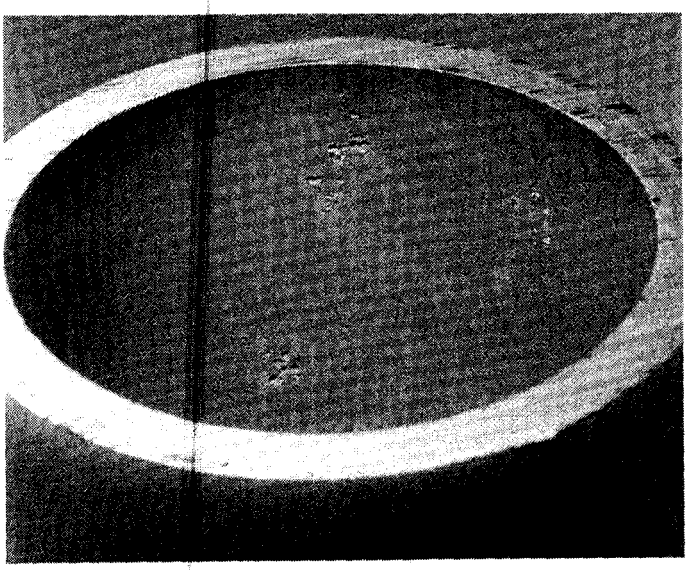


Figure 3—Cylinder with pitting corrosion

3.6 Cuts, digs, and gouges

Defects that are indicated by removed or upset metal. They are associated with some loss of wall thickness and are usually caused by a sharp object. See Figure 4.

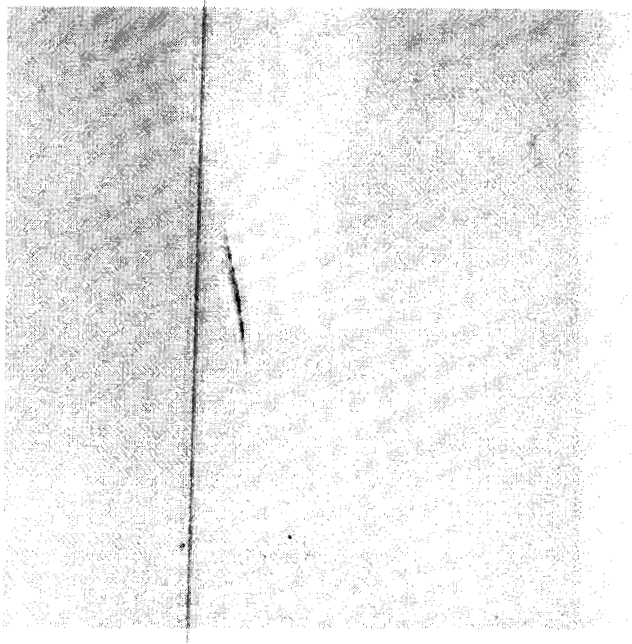


Figure 4—Gouged cylinder

3.7 Dent

Deformations of the cylinder caused by a blunt object so that the metal is relocated and the wall thickness is not reduced. See Figure 5.

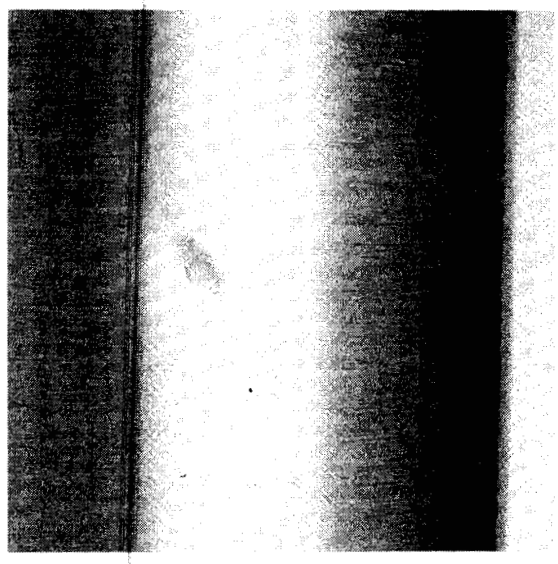


Figure 5—Dented cylinder

3.8 Exemption and special permit cylinders

Both DOT and TC have provisions in their regulations for introduction of new cylinder designs, materials, and fabrication techniques. Aluminum cylinders, before implementation of CTC/DOT specification 3AL and TC specification 3ALM, have been manufactured under special permits and/or exemptions E 6498, E 7042, E 8107, E 8364, E 8422, or CTC SP 890 or SP 922. Permit or exemption numbers are stamped on the shoulder of the cylinder. These cylinders may be continued in use in Canada. In the United States, these cylinders with the exception of CTC SP 922 may be continued in use but shall be remarked in compliance with 49 CFR 173.23 at the time of the first retest following July 2, 1982 [1]. Care should be exercised that other exemption number cylinders should not be remarked.

3.9 Fold

Sharp visual groove along the length of the cylinder usually in the crown area. See Figure 6.

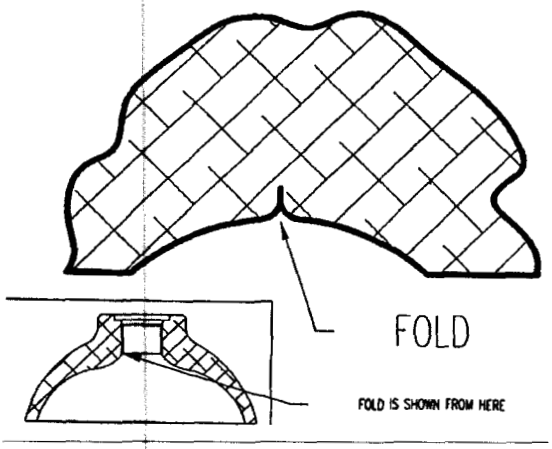


Figure 6—Fold

3.10 High pressure

For the purpose of this publication, 1800 psig (12 410 kPa) or greater. Since there has been little or no experience with aluminum cylinders in the pressure range from 900 psig to 1800 psig (6210 kPa to 12 410 kPa), this publication is directed at cylinders with a service pressure of 1800 psig (12 410 kPa) or greater. CGA C-6.3 is available for cylinders with lower service pressure [8].

3.11 High pressure aluminum cylinders

Aluminum cylinders manufactured in accordance with DOT-3AL, CTC-3AL, and TC-3ALM specifications. See Figure 7.

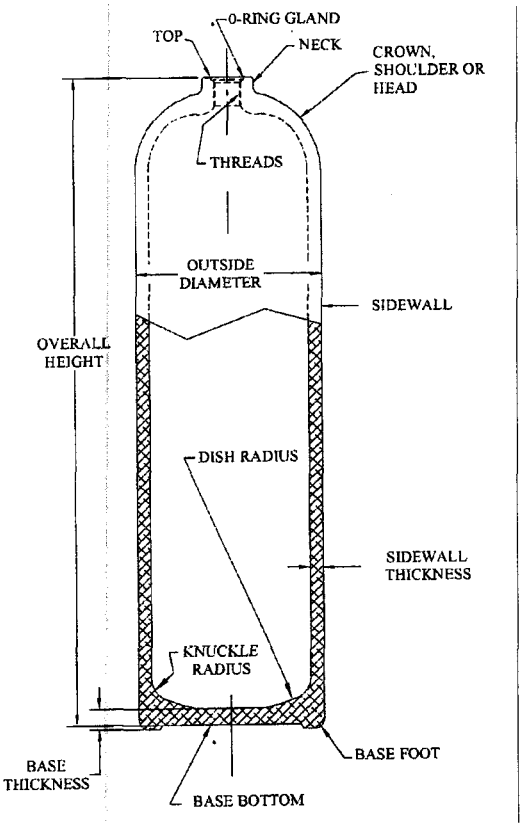


Figure 7—Typical cylinder features

3.12 Minimum design wall thickness

Minimum wall thickness as established by the cylinder manufacturer. Consult the manufacturer for specific minimum design wall thickness.

3.13 Valley

Shallow and smooth elongated depression usually found in the crown area. Compare this to "fold." See Figure 8.

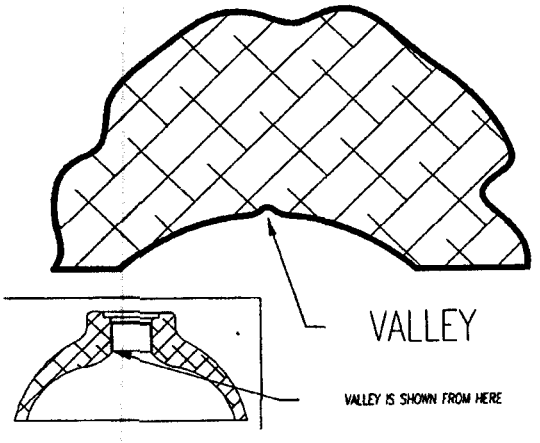


Figure 8—Valley

4 Preparation for inspection and hydrostatic testing

4.1 *Inspection equipment*

4.1.1 Depth gauges, scales, and straightedges

Exterior corrosion, denting, bulging, gouges, or digs are normally measured by simple direct measurement with depth gauges or scales, and straightedges. In brief, a rigid straightedge of sufficient length is placed over the defect, and a scale is used to measure the distance from the bottom of the straightedge to the bottom of the defect. Also available are commercial depth gauges that are especially suitable for measuring the depth of small cuts or pits. It is important when measuring such defects to use a scale that spans the entire affected area. When measuring cuts, the upset metal should be removed or compensated for so that only actual depth of metal removed from the cylinder wall is measured.

4.1.2 Inspection light

One of the most useful tools for the internal inspection of cylinders is a high intensity light probe. See Figure 9.

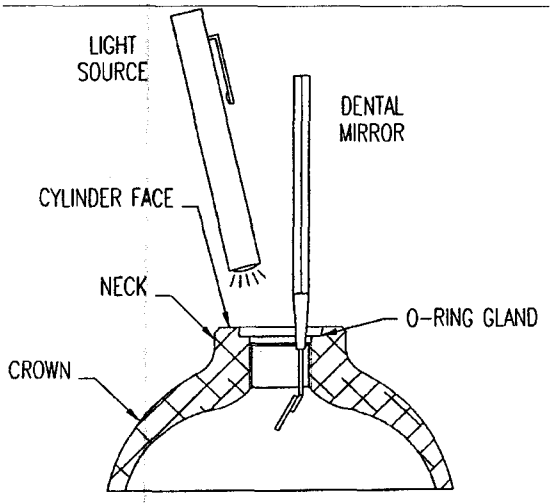


Figure 9—Light and mirror used to inspect threads and crown

4.1.3 Inspection mirror

A 1/2-in (13-mm) diameter 2X dental mirror is commonly used to aid a visual inspection of internal neck and crown surfaces. See Figure 9.

4.1.4 Penetrant inspection

Dye penetrant materials are available that show surface faults not readily visible to the unaided eye.

4.1.5 Other devices

There are other inspection methods available such as ultrasonic and eddy current. These can be used to detect subsurface faults, neck defects, and to measure thickness. See Appendix A.

4.2 Venting

***CAUTION**: Venting unknown gases from cylinders by improper methods may result in injury or death.*

If there is any question about the safe venting of a cylinder, the cylinder owner should be contacted to make safe disposition of the cylinder and contents.

4.3 Aluminum cylinder identification

Aluminum cylinders can be identified by DOT, TC, or CTC markings found on the shoulder of the cylinder. Some of the exemption and special permit numbers of high pressure aluminum cylinders are listed in 3.8. Additional information may be obtained from the DOT, TC, or the cylinder manufacturer.

4.4 Cleaning

Judgment is required to determine the extent of cleaning required and whether removal of paint is necessary. Remove all attachments that may conceal corrosion or other defects before inspection. If internal/external cleaning is performed in conjunction with periodic hydrostatic retest, cleaning should be accomplished before hydrostatic testing.

4.4.1 External cleaning

Paint stripping should be performed only with products recommended for aluminum. *Do not use* solutions of strong alkali (caustic), acid, or heat sources such as furnaces or blow torches.

Note: Abrasive shot blasting or cleaning methods that remove or may remove cylinder material are not recommended to be used. Recommendations from manufacturers or equipment suppliers should be followed. Threads should be protected and all abrasive materials removed from the cylinder.

4.4.2 Internal cleaning

Tumble cleaning, if required, should be with a watery slurry of aluminum oxide pellets, ceramic chips, or other inert media. After tumbling, a thorough flushing is required to remove loose particles and cleaning media, followed by thorough drying. *Do not use* solutions of strong alkali (caustic) or acid for internal cleaning. See note in 4.4.1.

4.4.3 Other

Other cleaning methods (e.g., media blasting, vapor honing, etc.) may be used for cleaning. Methods, procedures, or chemical cleaning that removes or might remove cylinder material shall comply with the requirements in 5.3.3. Recommendations from cylinder manufacturers should be followed. Threads shall be protected during cleaning processes. The cleaned cylinder shall be free of all media, by-products, and materials (see 4.4.2).

5 Inspection criteria for aluminum high pressure cylinders

5.1 Markings

Specification-required cylinder markings shall be legible and complete.

5.1.1 Stampings prohibited

The plus (+) stamp mark is *not allowed* on aluminum cylinders. The plus stamp signifies the qualification of a steel cylinder for filling to a settled pressure 10% in excess of the stamped service pressure. With aluminum cylinders, the full settled pressure shall not exceed the service pressure limit stamped on the cylinder.

5.1.2 Retest dates

The regulations of 49 CFR 173.34(e)(7) require that the retester's identifying numbers be stamped between the month and year of retest [1]. The current practice is to place retest marks near the original hydrostatic test date. Canadian *Transportation of Dangerous Goods Regulations* also require the retesters registered symbol be stamped on the cylinder as prescribed in CAN/CSA B-339 Section 24.6.3 [3].

5.2 Corrosion limits

It is not practical to identify corrosion limits for all types, designs, and sizes of cylinders and include them in a standard. The following general descriptions will provide guidelines for the acceptability of aluminum cylinders

for service. The allowable corrosion depths specified are for high pressure cylinders with a wall thickness of 3/16 in (0.187 in; 4.762 mm) or greater.

5.2.1 General corrosion limits

If the wall thickness is unknown, the allowable corrosion depth is 1/32 in (0.031 in; 0.787 mm). If the wall thickness is known, the maximum allowable corrosion depth is 15% of the minimum design wall thickness. The area of corrosion shall not extend over 25% of the external or internal surface area.

5.2.2 Isolated pit limits

If the wall thickness is unknown, the allowable depth of pitting is 1/16 in (0.062 in; 1.575 mm). If the wall thickness is known, the allowable depth of pitting is 30% of the minimum design wall thickness. As an example, for a known wall thickness of 0.345 in (8.763 mm) the allowable pit depth is 0.345 in x .30 = 0.103 in (2.616 mm). The pitting shown in Figure 3 measured 0.086 in (2.184 mm). This is more than the allowable pit depth for a cylinder with an unknown design wall thickness, but is less than the allowable pit depth for a cylinder with a known design wall thickness of 0.345 in (8.763 mm).

5.2.3 Line corrosion

If the wall thickness is unknown, the allowable line corrosion depth is 1/32 in (0.031 in; 0.787 mm). If the wall thickness is known, the allowable line corrosion depth is 15% of the minimum design wall thickness. The length of the line corrosion shall be less than 6 in (152 mm).

5.3 Cuts, digs, and gouges

5.3.1 Measurement

Cuts, digs, and gouges may be measured with suitable depth gauges or with a pipe pit gauge. Any upset metal shall be smoothed to allow true measurements without causing further damage to the cylinder.

5.3.2 Limits

If the wall thickness is unknown, the allowable cut, dig, or gouge is 1/32 in (0.031 in; 0.787 mm). If the wall thickness is known, the allowable cut, dig, or gouge is 15% of the minimum design wall thickness. The length of the cut, dig, or gouge shall be less than 6 in (152 mm). Condemn any cylinder with a cut, dig, or gouge 6 inches (152 mm) or more in length. For example, for a gouged cylinder of known design wall thickness of 0.380 in (9.652 mm), the allowable gouge depth is 0.380 in x .15 = 0.057 in (1.448 mm). The gouge in the cylinder in Figure 4 measured 0.060 in (1.524 mm). This is more than the allowable gouge depth (0.031 in; 0.787 mm) for a cylinder with an unknown design wall thickness, and also more than the allowable gouge depth (0.057 in; 1.448 mm) for a cylinder with a known design wall thickness of 0.380 in (9.652 mm).

5.3.3 Wall loss

Most surface (internal or external) treatment processes have the potential to remove material from the sidewall of the cylinder. Therefore, it is essential that these processes are performed before final requalification test. The wall thickness shall be determined after any metal removal process, regardless of the quantity of material loss that has occurred. Any reconditioning process used to clean, alter, or improve the finish of a cylinder after it has entered the market shall not reduce the wall thickness below 85% of the minimum design wall thickness in any isolated locations as described in 5.2 through 5.2.3 and 5.3.2. Cylinders with greater wall loss than this shall be condemned.

If the cylindrical portion is to be reconditioned beyond isolated locations described in 5.2 through 5.2.3 and 5.3.2, then the cylinder wall thickness may not be reduced below the minimum design wall thickness. Cylinders with greater wall loss than this shall be condemned. The criteria for isolated defects subsequent to such reconditioning remain applicable.

Processes that can produce loss of wall include:

- cleaning internal or external surfaces (see 4.4);

- cutting, grinding, trimming, or shaving metal from the internal or external surfaces; and
- application of chemicals that dissolve or react with aluminum.

5.4 Dents

In general, dents that do not reduce the wall thickness can be tolerated. However, current practice is to accept dents up to 1/16 in (0.062 in; 1.575 mm) in depth when the major diameter of the dent is 2 in (50.8 mm) or greater. See Figure 5. Cylinders with one or more dents that are smaller than 2 in (50.8 mm) in diameter shall be condemned.

5.5 Leaks and holes

5.5.1 Detection

Leaks and holes may be found or suspected in a cylinder by different means. A close visual inspection on the exterior and interior surfaces is strongly recommended. Use of a dye or penetrant can be helpful (see 4.1.4). A cylinder that is leaking or that may have a hole may rupture if it is pressurized, so checking for leaks with a soap solution or immersion in water is not recommended. Holes may be concealed with construction material and then painted, or attempts at plugging holes may be seen. If the cylinder owner has identified a time when the cylinder lost pressure for unknown reasons, he may suspect a leak or hole.

NOTE—Hydrostatic testing may identify a cylinder with a leak. Do not pressurize a cylinder that is suspected of having a leak or hole outside a test jacket capable of safely containing or relieving the pressure released from a catastrophic failure.

5.6 Bulges

Cylinders are manufactured with a reasonably symmetrical shape. Those with definite visible bulges shall be condemned.

5.6.1 Limits

Cylinders with leaks through the metal shall be condemned. Cylinders found with holes (plugged or not plugged) shall be condemned. Repair of aluminum cylinders with leaks or holes is not allowed.

5.7 Fire and thermal damage

5.7.1 Fire damage

Aluminum cylinders subjected to the action of fire (e.g., in a fire) shall be condemned. Reconditioning of aluminum cylinders subjected to a fire is not allowed.

5.7.2 Thermal damage

Aluminum cylinders can be permanently damaged by exposure to elevated temperatures. Cylinders heated to metal temperatures in excess of 350 °F (177 °C) shall be condemned. See Appendix C. If there is a doubt about the temperature a cylinder may have reached, the cylinder shall successfully pass the hydrostatic retest (see 5.7.4).

Processes that can produce metal temperatures in excess of 350 °F (177 °C) include:

- paint baking, curing, or drying;
- oven drying;
- vinyl coating;
- heat stripping of paint; and
- application of heat to assist the mixing of gases in cylinders containing gas mixtures.

Follow cylinder manufacturer's recommendations regarding the painting or refurbishing of cylinders.

5.7.3 Arc burns

Cylinders with arc burns shall be condemned.

5.7.4 Inspection for fire and thermal damage

Direct and indirect evidence of a cylinder being subjected to the action of fire or evidence of exposure to elevated temperatures includes:

- charring or blistering of the paint or other protective coating;
- melting, cratering, or scarfing of the metal;
- adding of welding metal, weld marks, and arc burns;
- distorting (e.g., bulging) of the cylinder;
- melting, scorching, or deformation of valve handwheel or valve protector;
- charring, blistering, distortion, or discoloration of labels or attachments;
- activating a pressure release device (e.g., a ruptured burst disk or melted fuse plug(s)); and
- increases in total or permanent expansion from hydrostatic testing.

CAUTION: *Do not conceal fire or thermal damage by painting or other means.*

5.8 Neck defects

Cylinder necks shall be examined for cracks, folds, and other flaws.

5.8.1 Neck cracks

All aluminum cylinders shall be internally inspected for cracks in the neck region. The inspection shall be visual but may be confirmed using an electronic nondestructive testing device. See Appendix A. Cylinders with cracks shall be condemned. Repair of neck cracks is not allowed. See Figure 10.

A neck with a tool stop mark is to be distinguished from a neck crack. Cylinders with a tool stop mark are acceptable for use. See Figure 11.

Aluminum cylinders manufactured from 6351 alloy may exhibit sustained load cracking (SLC) growing over several years of use. Such cylinders should be given diligent and proper inspections at the time of requalification. See Appendix B.

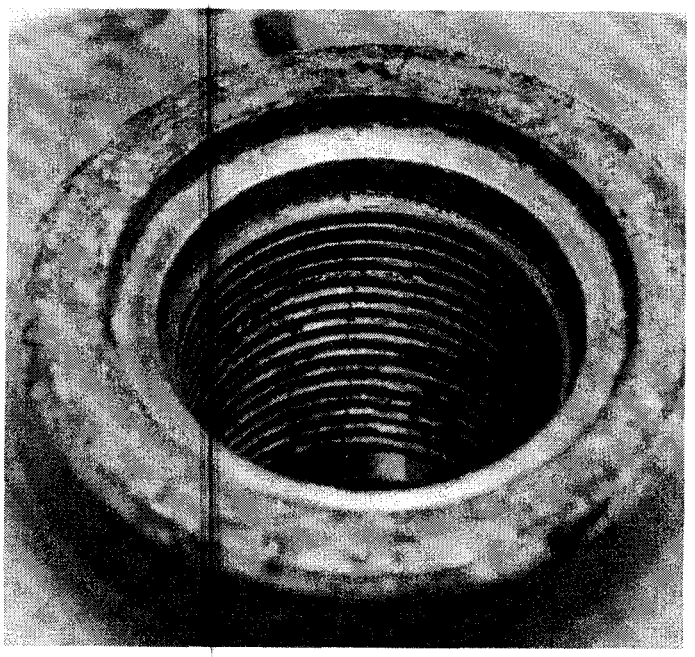


Figure 10—Neck crack

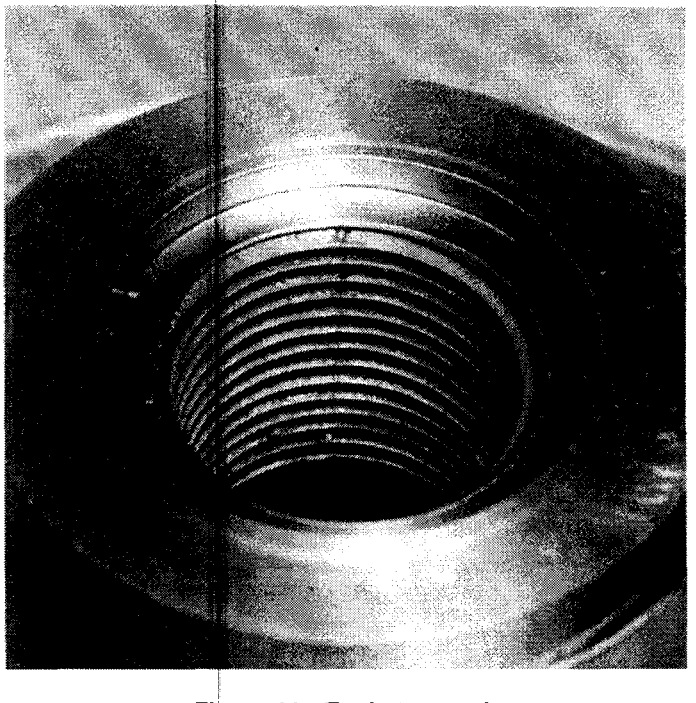


Figure 11—Tool stop mark

5.8.2 Folds

Folds found in the crown region that extend into the base of the neck may appear to be a crack by the internal visual inspection of the neck. Condemn all cylinders with folds that enter into more than one continuous full neck thread. See Figure 6.

5.8.3 Valleys

Cylinders with one or more valleys are acceptable for use provided the valley(s) does not enter into the minimum number of required threads (see 5.9). See Figure 8.

5.9 Threads and valving

Cylinder neck threads should be examined whenever the valve is removed from the cylinder. Cylinders have a specified number of full threads of proper form as required in applicable thread standards. Cylinders shall be rejected if the required numbers of effective threads are materially reduced so that a gas-tight seal cannot be obtained by reasonable valving methods. Thread defects include threads that are galled, worn, corroded, broken, cracked, nicked, and "double threaded" (from forcing an incorrect valve into the threads).

5.9.1 O-ring gland

Many aluminum cylinders have an O-ring gland and straight threads. Both the O-ring and lubricant, if used, should be compatible with the lading. Where the cylinder is part of a certified assembly, like in the self-contained breathing apparatus (SCBA) unit used by fire fighters and emergency response people, the only O-ring used may be the O-ring type originally certified with the assembly. In the case of cylinders used in SCBA service, any replacement O-ring shall be obtained from the SCBA unit manufacturer. O-rings should be clean and smooth. Replace damaged O-rings.

5.9.2 Valving/devalving

When valving, note the thread configuration, straight versus tapered. In some cases a valve with tapered threads (3/4-in NGT) will fit into a cylinder with straight threads (3/4-in NGS) and damage to the cylinder or valve may result. A thread gauge can be used to verify size and type of threads.

5.9.3 Torque values

Automatic valving machines can overtorque valves if not properly set. Valves should be torqued into cylinders with the minimum amount of force required for the valve and cylinder to seal. Maximum torque values are shown in Table 1.

Table 1—Maximum recommended torque values for aluminum cylinder valve threads

Threads	Thread size	Maximum torque
Straight threads	3/4-14 NGS (NPSM)	100 lbf-ft (136 N•m)
	.750-16 UNF	60 lbf-ft (81 N•m)
	.875-14 UNF	80 lbf-ft (108 N•m)
	1.125-12 UNF	100 lbf-ft (136 N•m)
Tapered threads	1/2 NGT	50 lbf-ft (68 N•m)
	3/4 NGT	100 lbf-ft (136 N•m)
	1 NGT	125 lbf-ft (169 N•m)

5.9.4 Gas service

DOT specifies the use of specific thread types for certain gas service. Refer to 49 CFR 173.302(a)(4) and (a)(5) [2]. Refer to CSA B340 for equivalent Canadian requirements [4].

5.10 Bow

A cylinder with bow is an acceptable condition.

6 Condemning a cylinder

When visual inspection detects a defect requiring that the cylinder be condemned (see Section 5), the cylinder shall be removed from service. In addition, the cylinder shall have a series of Xs stamped through the specification number and marked service pressure or the word CONDEMNED stamped on the shoulder, top head, or neck using a steel stamp. Alternately the cylinder may be rendered unable to contain gas under pressure with permission of the cylinder owner. When a cylinder has been condemned, the cylinder owner shall be notified in writing that the cylinder is condemned and may not be filled with hazardous material for transportation in commerce where use of a specification packaging is required.

7 References

Unless otherwise stated, the latest edition shall apply.

[1] CGA C-1, *Methods for Hydrostatic Testing of Compressed Gas Cylinders*, Compressed Gas Association, Inc., 4221 Walney Rd., 5th floor, Chantilly, VA 20151.

[2] *Code of Federal Regulations,* Title 49 CFR Parts 100-180 (Transportation), U.S. Department of Transportation. Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

[3] CAN/CSA B339, *Cylinders, Spheres and Tubes for the Transportation of Dangerous Goods*, CSA International, Standards Division, 178 Rexdale Blvd., Toronto, ON, Canada M9W 1R3.

[4] CSA B340, *Selection and Use of Cylinders, Spheres, Tubes and Other Containers for the Transportation of Dangerous Goods, Class 2*, CSA International, Standards Division, 178 Rexdale Blvd., Toronto, ON, Canada M9W 1R3.

[5] CGA P-11, *Metric Practice Guide for the Compressed Gas Industry,* Compressed Gas Association, Inc., 4221 Walney Rd., 5th floor, Chantilly, VA 20151.

[6] CGA C-6, *Standards for Visual Inspection of Steel Compressed Gas Cylinders,* Compressed Gas Association, Inc., 4221 Walney Rd., 5th floor, Chantilly, VA 20151.

[7] CGA C-6.2, *Guidelines for Visual Inspection and Requalification of Fiber Reinforced High Pressure Cylinders,* Compressed Gas Association, Inc., 4221 Walney Rd., 5th floor, Chantilly, VA 20151.

[8] CGA C-6.3, *Guidelines for Visual Inspection and Requalification of Low Pressure Aluminum Compressed Gas Cylinders*, Compressed Gas Association, Inc., 4221 Walney Rd., 5th floor, Chantilly, VA 20151.

[9] CGA TB-19, *Uses Of Eddy Current On Refillable High Pressure Vessels To Detect Imperfections,* Compressed Gas Association, Inc., 4221 Walney Rd., 5th floor, Chantilly, VA 20151.

Appendix A—Eddy current devices (Informative)

Besides visual inspections (for material loss and defects), there are non destructive testing techniques that are less likely to miss defects than the human eye.

Some of these testing techniques use eddy current. Eddy current devices are especially suitable to detect neck defects (see 5.8). For more information regarding eddy current and its application to cylinder inspection, see CGA TB-19, *Uses of Eddy Current on Refillable High Pressure Vessels to Detect Imperfections* [9].

There are commercially available testing units that easily identify neck cracks and thread defects in cylinders. Contact the cylinder manufacturer for testing recommendations.

Appendix B—Sustained load cracking (SLC) (Informative)

This appendix provides additional information regarding SLC in aluminum cylinders.

As the name implies, the SLC process (in a cylinder) is where cracking occurs in the metal when the cylinder is pressurized (filled). Cracking begins and grows in the head region of a pressurized cylinder. The process requires stress and certain components in the metal alloy, but SLC does not always occur.

Over the years, all-metal aluminum gas cylinders and some composite cylinders with aluminum liners have been manufactured from different aluminum alloys. Some of those alloys were found to exhibit a characteristic later named SLC. The commonly used (in the United States) aluminum alloy that may exhibit SLC, is identified by the Aluminum Association alloy number 6351. It is referred to as the 6351 alloy, and cylinders manufactured using this alloy are generally referred to as 6351 alloy cylinders or 6351 cylinders.

Today, the most commonly used aluminum alloy in North America manufactured to DOT specification 3AL and specification TC-3ALM uses the Aluminum Association alloy number of "6061." What is known so far is that straight threaded, high pressure aluminum cylinders manufactured from 6061 alloy do not develop SLC.

Is the aluminum cylinder made from 6351 alloy?

Cliff Impact, a division of Parker Hannifin, manufactured cylinders from 6351 alloy before July 1990.

Justice Cylinders produced all-aluminum cylinders manufactured from 6351. They primarily manufactured medical cylinders during the two-year period 1984 and 1985.

Luxfer USA, now known as Luxfer Gas Cylinders, produced 6351 alloy cylinders in the United States to DOT and CTC specifications before June 1988. Cylinders from Luxfer USA with a first hydrostatic test date of May 1988 or earlier are manufactured from 6351 aluminum alloy. Some cylinders before May 1988 were manufactured from the 6061 aluminum alloy. If the cylinder being tested is dated between December 1987 and June 1988 contact Luxfer Gas Cylinders to find out what aluminum alloy was used.

The Walter Kidde 6351 alloy cylinder was no longer produced after 1990. Cylinders from Walter Kidde with a first hydrostatic test date of December 1989 or earlier are manufactured from 6351 aluminum alloy.

Aluminum alloy cylinders manufactured by Catalina Cylinders and Cliff Division of Catalina Cylinders have never been manufactured with 6351 aluminum alloy.

The composite cylinders that were manufactured using 6351 alloy (as liners) are near or have passed their life limit of 15 years. Composite cylinders manufactured using 6351 alloy because of their age are no longer eligible for another requalification.

More about SLC

Not all 6351 cylinders will exhibit SLC. Some 6351 cylinders have been in service for 30 years without showing signs of SLC. Some will never exhibit cracking from SLC. In addition, low pressure cylinders are less likely to develop SLC.

SLC has been closely studied since before 1980. One or more cracks may develop in a cylinder. The conditions needed to crack the metal are that the metal is under a sustained load or in the case of gas cylinders the metal is under pressure. A full or nearly full high pressure 6351 aluminum alloy cylinder may crack slowly in the head and neck region.

Evidence and actual experience has shown that SLC takes many years to develop into a large crack or leaking cylinder. If an attempt is made to fill a leaking cylinder, a rupture can occur, which might lead to injury, death, or property damage. The 3-year periodic requalification for composites and the 5-year periodic requalification for all-metal 6351 aluminum alloy cylinders provides ample opportunity to discover neck cracks before they lead to leaks. Some cylinder manufacturers, regulatory authorities, or industries may recommend a different frequency

of visual inspection. For example, the SCUBA industry recommends an annual visual inspection of all SCUBA cylinders regardless of make, model, or material. Recommendations are not required to be performed.

What is most important is that the visual inspection be performed accurately and with diligence. More frequent poor quality inspections will not discover cylinder imperfections. Diligent, properly performed inspections at the current required frequency do find cylinder defects before they may lead to catastrophic failure.

As stipulated in this publication any aluminum cylinder with a crack(s) shall be condemned. Likewise, any cylinder that is leaking shall be condemned.

Appendix C—Heat exposure and condemning aluminum cylinders (Informative)

As a general rule, aluminum cylinders that have reached temperatures in excess of 350 °F (177 °C) shall be condemned as described in this publication. This is because the strength properties of the aluminum metal material degrade when material temperatures exceed 350 °F (177 °C). The longer the material remains at this or higher temperatures the greater degradation of the metal. The higher the temperature the cylinder material reaches, the faster and greater the degradation. It is a combination of temperature and time that is critical to the effect heat has on aluminum (or any metallic) cylinder.

However, this heating concern is not to be confused with *heat exposure*. Elevated heat exposure is a different condition than obvious heat or fire damage. The difference is whether the cylinder material actually reaches elevated temperature even though the environment may be over 350 °F (177 °C). Elevated heat exposure may or may not result in permanent heat damage to the cylinder depending on whether or not the metal material temperature has exceeded 350 °F (177 °C).

Damaging elevated heat exposure occurs when the cylinder has been subjected to a temperature in the environment that causes the cylinder material to attain temperatures in excess of 350 °F (177 °C). When the cylinder material exceeds 350 °F (177 °C), then the cylinder is damaged and needs to be condemned.

A cylinder is not intended for normal use in any environment that would heat the material to temperatures in excess of 350 °F (177 °C). The temporary, short-term exposures to temperatures in excess of 350 °F (177 °C) such as in a firefighting environment do not cause the cylinder material to exceed 350 °F (177 °C), and thus is not cause for cylinder condemnation. For example, a cylinder used within SCBA on a person's back) might be exposed to elevated temperatures well over 350 °F (177 °C) but the material of the cylinder did not reach such a temperature and remains safe to fill and use. Such exposures were short and the metal did not get hot.

Prolonged unprotected heat exposure to an environment just over 350 °F (177 °C), or a short heat exposure to an environment of much greater temperatures (over 600 °F [316 °C]) is cause for condemning a cylinder.

If there is any doubt whether a cylinder has been damaged from heat exposure, the hydrostatic test properly and diligently performed will determine if the cylinder is fit for service. Any suspect cylinder unable to pass the hydrostatic retest shall be condemned. Any suspect cylinder that passes the hydrostatic retest may be returned to service if all other requalification criteria are satisfied.

Appendix II

Data and Analysis

DATA REVIEW

3AL Testing Corp examined 52 aluminum cylinders to document the effectiveness of the ultrasonic equipment. In addition to the 52 cylinders, data is included on the calibration cylinders used. The report generated for each cylinder is included. Color print out graphs of flaw locations are provided for cylinders where flaws were detected. The chart below summarizes the results of the data. To demonstrate repeatability, calibration standard serial number 655247 was tested 10 times as a production cylinder and all ten times produced each of the flaws in the calibration standard. In the interest of saving paper, only one of the ten calibration test reports was printed out as E655247.

Cylinder serial number AD97758 exhibited wall thickness readings of 0.153" in the red area on the color graph. The wall thickness directly opposite this reading was measured to 0.196". Based on these readings, our assumption is that this cylinder was manufactured with an eccentric base. The cylinder was cut open at the base allowing a clear view of the eccentricity. Calipers were used to verify the UE equipment measurements. A color snapshot of a cylinder with base eccentricity has been included with this cylinder. The color graph is very indicative of a cylinder, which has passed the cylinder manufacturers' current quality control process. This eccentricity defect most likely would only be discovered under the most severe circumstances.

Cylinder serial number BC273171 did not have any indications. The color graphs accompanying this cylinder show what the color graphs look like for every cylinder, which was tested and passed. For this reason, only this color graph for passed cylinders was printed.

Cylinder serial numbers BC56973 and 655247 are the two calibration standards used in the compiling of this data. All five color graphs are provided to show the artificial defects in each of the five scans.

Cylinder serial number D56126 failed the eddy current examination for cracked threads. Three consecutive threads from the crown up towards the opening have cracks, which were detected with the visual eddy equipment and with the naked eye, using mirrors and a flashlight. Due to failing the EE test, this cylinder has no UE report.

Cylinder serial number E11670 failed the eddy current examination for cracked threads. Only one thread at the opening of the cylinder was not cracked. At least five separate cracks, with one passing through all but one thread were detected with the visual eddy equipment and the naked eye. No mirrors or flashlight were needed. Due to failing the EE test, this cylinder has no UE report.

Serial number	MFG	MFG Date	6061	6351	Disposition
AD137619	M4002	03/99	X		PASS
AD173962	M4002	03/99	X		PASS
AD97758	M4002	06/97	X		UE FAIL-WALL THINNING
BC273171	M4141	10/98	X		PASS
BC335949	M4141	03/99	X		PASS
BC337460	M4141	03/99	X		PASS
BC344850	M4141	07/99	X		PASS
BC345736	M4141	07/99	X		PASS
BC719933	M4141	03/99	X		PASS
FH1546	M4002	08/98	X		PASS
ML2020	M4002	07/99	X		PASS
D56126	M4141	07/83		X	EE FAIL-NECK CRACKED
E115969	M4141	01/85		X	PASS
E11670	M4141	10/82		X	EE FAIL-NECK CRACKED
E142802	M4141	09/85		X	PASS
E14759	M4141	09/93	X		PASS
E178919	M4141	07/86		X	PASS
E198873	M4141	12/86		X	PASS
E205513	M4141	08/95	X		PASS
E222142	M4141	05/87		X	PASS
E227076	M4141	06/87		X	PASS
E249366	M4141	11/87		X	PASS
E265537	M4141	04/88	X		PASS
E36611	M4141	01/94	X		PASS
E404411	M4141	02/90	X		PASS
E51373	M4141	04/94	X		PASS
E643088	M4141	03/92	X		PASS
E647791	M4141	11/97	X		PASS
E655247-CAL STD	M4141		X		UE FAIL-ALL FLAWS FOUND
E668029	M4141	06/92	X		PASS
E671160	M4141	06/92	X		PASS
E690417	M4141	07/92	X		PASS
E697936	M4141	03/98	X		PASS
E849044	M4141	11/98	X		PASS
E91005	M4141	07/93	X		PASS
BV3286	M4141	07/99	X		PASS
BV36094	M4141	07/99	X		PASS
BV36108	M4141	07/99	X		PASS
BV5032	M4141	05/99	X		PASS
F079493	M4141	07/89	X		PASS
F091035	M4141	01/91	X		PASS
F10591	M4141	07/93	X		PASS
F121087	M4141	11/98	X		PASS
F123435	M4141	02/99	X		PASS
MM129553	M4002	06/95	X		PASS
R82219	M4002	01/99	X		PASS
R82472	M4002	01/99	X		PASS
R82815	M4002	01/99	X		PASS
T11149	M4002	06/99	X		PASS
T11177	M4002	06/99	X		PASS
T18880	M4002	07/99	X		PASS
T21211	M4002	07/99	X		PASS

Date: 7/30/2004 Time: 4:27:27 PM
Job No.:
Customer:
Cylinder S/N: AD137619
Manufacture: M4002
Manufacture Date: 09/98
Cylinder Min Wall: 0.156

Equipment
Model: DWC Reflex
Serial Number: 001

Transducer
Manufacturer: Harisonic
Serial Number: 02A018
Diameter[Inch]: 0.500
EBW Size[Inch]: 0.180
Frequency[MHz]: 3.500
Water Path[Inch]: 3.750

Calibration Cylinder
Cal_Cylinder Type: 3AL
Diameter: 3.250
Cal-Cyl-S/N: BC56973
Minimum Wall: 0.158
Pressure: 2216
Helix: 0.150
Cal-Cyl-Status: Passed

Inspector
Name: Paul Graves
Certification: ASNT Level II

Inspection Procedure
Procedure Number: SCC-12795

Visual Inspection: PASS
DOT Spec: 3AL-2216

Examination Result
PASS

See attached documentation for detailed flaw result

Comments:

AD137619 Pass 1_Thk.Txt
Event X Y Thk

Pass Number: 2
Event X Y TOF AMP

Pass Number: 5
Event X Y TOF AMP

Date: 7/30/2004 Time: 4:35:17 PM
Job No.:
Customer:
Cylinder S/N: AD173962
Manufacture: M4002
Manufacture Date: 03/99
Cylinder Min Wall: 0.156

Equipment
Model: DWC Reflex
Serial Number: 001

Transducer
Manufacturer: Harisonic
Serial Number: 02A018
Diameter[Inch]: 0.500
EBW Size[Inch]: 0.180
Frequency[MHz]: 3.500
Water Path[Inch]: 3.750

Calibration Cylinder
Cal_Cylinder Type: 3AL
Diameter: 3.250
Cal-Cyl-S/N: BC56973
Minimum Wall: 0.158
Pressure: 2216
Helix: 0.150
Cal-Cyl-Status: Passed

Inspector
Name: Paul Graves
Certification: ASNT Level II

Inspection Procedure
Procedure Number: SCC-12795

Visual Inspection: PASS
DOT Spec: 3AL-2216

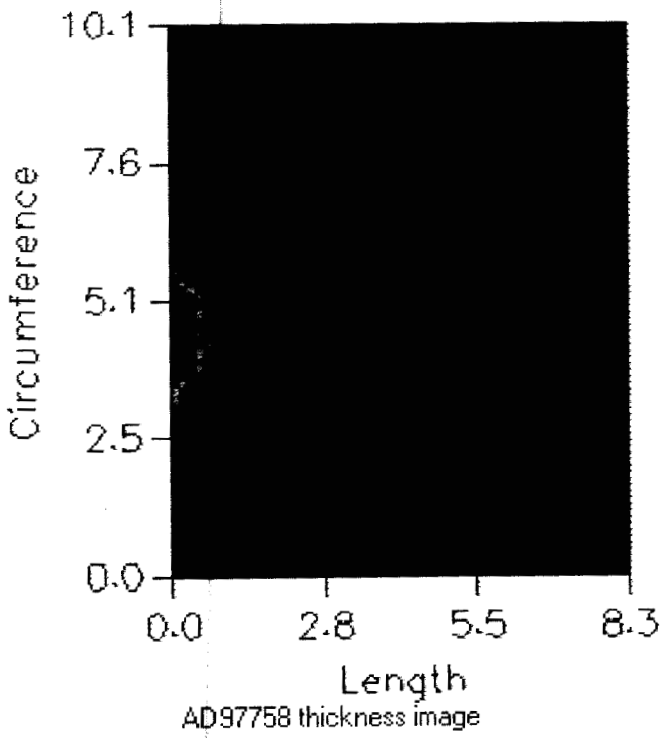
Examination Result
PASS

Comments:

AD173962 Pass 1_Thk.Txt
Event X Y Thk

Pass Number: 2
Event X Y TOF AMP

Pass Number: 5
Event X Y TOF AMP



AD97758 thickness image

Date: 8/9/2004 Time: 2:07:23 PM
Job No.:
Customer:
Cylinder S/N: AD97758
Manufacture: M4002
Manufacture Date: 06/97
Cylinder Min Wall: 0.156

Equipment
Model: DWC Reflex
Serial Number: 001

Transducer
Manufacturer: Harisonic
Serial Number: 02A018
Diameter[Inch]: 0.500
EBW Size[Inch]: 0.180
Frequency[MHz]: 3.500
Water Path[Inch]: 3.750

Calibration Cylinder
Cal_Cylinder Type: 3AL
Diameter: 3.250
Cal-Cyl-S/N: BC56973
Minimum Wall: 0.158
Pressure: 2216
Helix: 0.150
Cal-Cyl-Status: Passed

Inspector
Name: Paul Graves
Certification: ASNT Level II

Inspection Procedure
Procedure Number: SCC-12795

Visual Inspection: PASS
DOT Spec: 3AL-2216

Examination Result
FAIL
On pass 1: Thin Wall
See attached documentation for detailed flaw result

Comments:

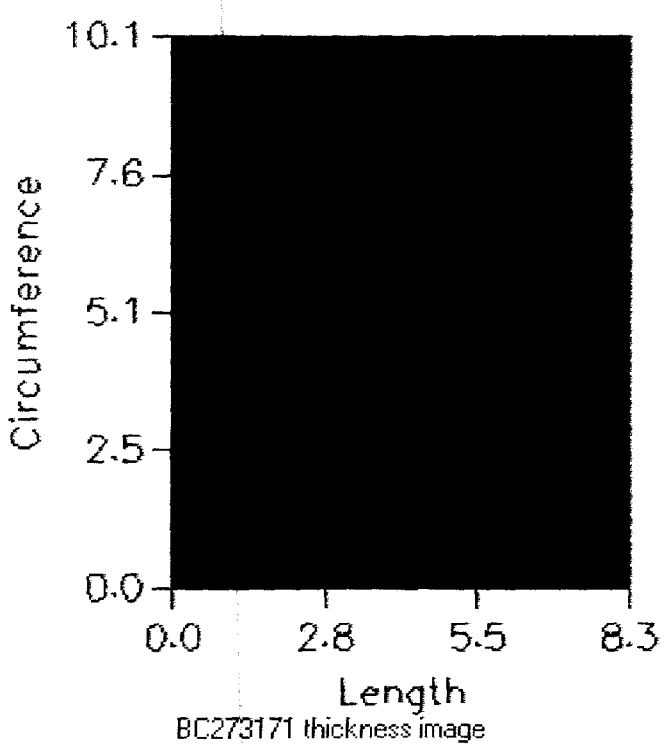
AD97758 Pass 1_Thk.Txt

Event	X	Y	Thk
45	0.000	5.616	0.156
46	0.000	5.513	0.153
47	0.000	5.411	0.151
48	0.000	5.309	0.153
49	0.000	5.207	0.153
50	0.000	5.105	0.151
51	0.000	5.003	0.153

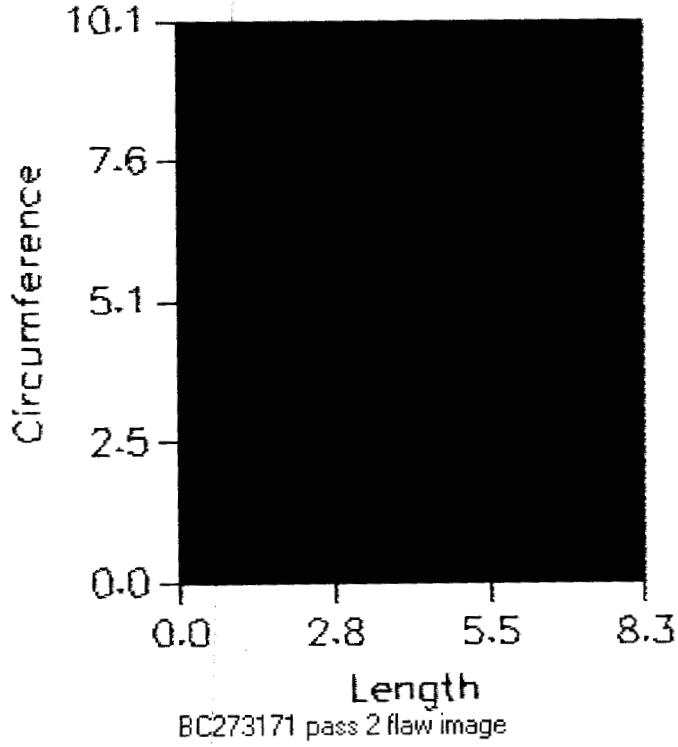
52	0.000	4.901	0.151
53	0.000	4.799	0.151
54	0.000	4.697	0.151
55	0.000	4.595	0.151
56	0.000	4.492	0.151
57	0.000	4.390	0.151
58	0.000	4.288	0.151
59	0.000	4.186	0.151
60	0.000	4.084	0.151
61	0.000	3.982	0.148
62	0.000	3.880	0.151
63	0.000	3.778	0.151
64	0.000	3.676	0.151
65	0.000	3.574	0.151
66	0.000	3.471	0.153
67	0.000	3.369	0.153
68	0.000	3.267	0.156
69	0.000	3.165	0.156
146	0.150	5.513	0.156
147	0.150	5.411	0.153
148	0.150	5.309	0.156
149	0.150	5.207	0.153
150	0.150	5.105	0.156
151	0.150	5.003	0.153
152	0.150	4.901	0.153
153	0.150	4.799	0.153
154	0.150	4.697	0.153
155	0.150	4.595	0.153
156	0.150	4.492	0.153
157	0.150	4.390	0.153
158	0.150	4.288	0.153
159	0.150	4.186	0.153
160	0.150	4.084	0.153
161	0.150	3.982	0.153
162	0.150	3.880	0.151
163	0.150	3.778	0.156
164	0.150	3.676	0.153
165	0.150	3.574	0.156
166	0.150	3.471	0.156
168	0.150	3.267	0.156
248	0.300	5.309	0.156
249	0.300	5.207	0.153
250	0.300	5.105	0.153
251	0.300	5.003	0.153
252	0.300	4.901	0.153
253	0.300	4.799	0.153
254	0.300	4.697	0.153
255	0.300	4.595	0.153
256	0.300	4.492	0.156
257	0.300	4.390	0.153
258	0.300	4.288	0.153
259	0.300	4.186	0.153
260	0.300	4.084	0.153
261	0.300	3.982	0.153
262	0.300	3.880	0.153
263	0.300	3.778	0.153

Pass Number: 5

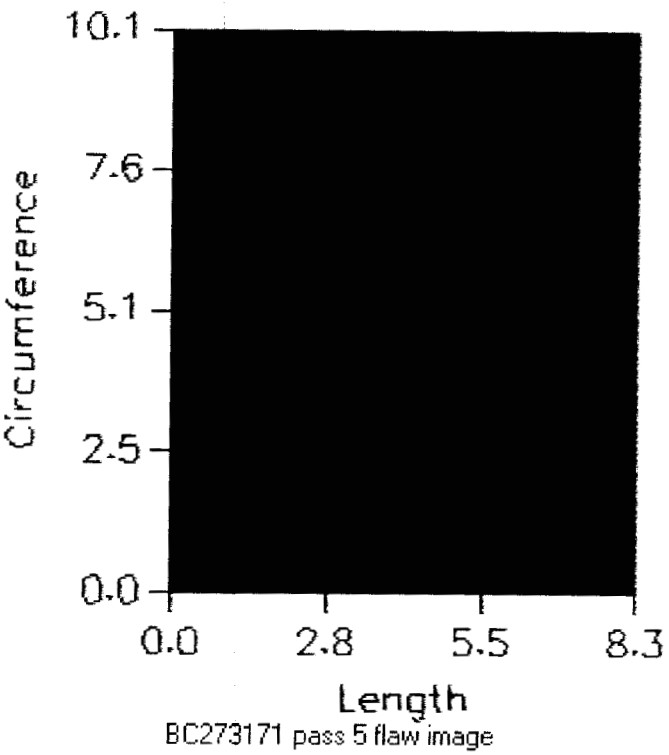
Event	X	Y	TOF	AMP



BC273171 thickness image



BC273171 pass 2 flaw image



BC273171 pass 5 flaw image

Date: 7/30/2004 Time: 4:11:35 PM
Job No.:
Customer:
Cylinder S/N: BC273171
Manufacture: M4141
Manufacture Date: 10/98
Cylinder Min Wall: 0.158

Equipment
Model: DWC Reflex
Serial Number: 001

Transducer
Manufacturer: Harisonic
Serial Number: 02A018
Diameter[Inch]: 0.500
EBW Size[Inch]: 0.180
Frequency[MHz]: 3.500
Water Path[Inch]: 3.750

Calibration Cylinder
Cal_Cylinder Type: 3AL
Diameter: 3.250
Cal-Cyl-S/N: BC56973
Minimum Wall: 0.158
Pressure: 2216
Helix: 0.150
Cal-Cyl-Status: Passed

Inspector
Name: Paul Graves
Certification: ASNT Level II

Inspection Procedure
Procedure Number: SCC-12795

Visual Inspection: PASS
DOT Spec: 3AL-2216

Examination Result
PASS

Comments:

BC273171 Pass 1_Thk.Txt
Event X Y Thk

Pass Number: 2
Event X Y TOF AMP

Pass Number: 5
Event X Y TOF AMP

Date: 7/30/2004 Time: 4:05:12 PM
Job No.:
Customer:
Cylinder S/N: BC335949
Manufacture: M4141
Manufacture Date: 03/99
Cylinder Min Wall: 0.158

Equipment
Model: DWC Reflex
Serial Number: 001

Transducer
Manufacturer: Harisonic
Serial Number: 02A018
Diameter[Inch]: 0.500
EBW Size[Inch]: 0.180
Frequency[MHz]: 3.500
Water Path[Inch]: 3.750

Calibration Cylinder
Cal_Cylinder Type: 3AL
Diameter: 3.250
Cal-Cyl-S/N: BC56973
Minimum Wall: 0.158
Pressure: 2216
Helix: 0.150
Cal-Cyl-Status: Passed

Inspector
Name: Paul Graves
Certification: ASNT Level II

Inspection Procedure
Procedure Number: SCC-12795

Visual Inspection: PASS
DOT Spec: 3AL-2216

Examination Result
PASS

Comments:

BC335949 Pass 1_Thk.Txt
Event X Y Thk

Pass Number: 2
Event X Y TOF AMP

Pass Number: 5
Event X Y TOF AMP

Date: 7/30/2004 Time: 4:08:33 PM
Job No.:
Customer:
Cylinder S/N: BC337460
Manufacture: M4141
Manufacture Date: 03/99
Cylinder Min Wall: 0.158

Equipment
Model: DWC Reflex
Serial Number: 001

Transducer
Manufacturer: Harisonic
Serial Number: 02A018
Diameter[Inch]: 0.500
EBW Size[Inch]: 0.180
Frequency[MHz]: 3.500
Water Path[Inch]: 3.750

Calibration Cylinder
Cal_Cylinder Type: 3AL
Diameter: 3.250
Cal-Cyl-S/N: BC56973
Minimum Wall: 0.158
Pressure: 2216
Helix: 0.150
Cal-Cyl-Status: Passed

Inspector
Name: Paul Graves
Certification: ASNT Level II

Inspection Procedure
Procedure Number: SCC-12795

Visual Inspection: PASS
DOT Spec: 3AL-2216

Examination Result
PASS

Comments:

BC337460 Pass 1_Thk.Txt
Event X Y Thk

Pass Number: 2
Event X Y TOF AMP

Pass Number: 5
Event X Y TOF AMP

Date: 7/30/2004 Time: 4:15:01 PM
Job No.:
Customer:
Cylinder S/N: BC344850
Manufacture: M4141
Manufacture Date: 07/99
Cylinder Min Wall: 0.158

Equipment
Model: DWC Reflex
Serial Number: 001

Transducer
Manufacturer: Harisonic
Serial Number: 02A018
Diameter[Inch]: 0.500
EBW Size[Inch]: 0.180
Frequency[MHz]: 3.500
Water Path[Inch]: 3.750

Calibration Cylinder
Cal_Cylinder Type: 3AL
Diameter: 3.250
Cal-Cyl-S/N: BC56973
Minimum Wall: 0.158
Pressure: 2216
Helix: 0.150
Cal-Cyl-Status: Passed

Inspector
Name: Paul Graves
Certification: ASNT Level II

Inspection Procedure
Procedure Number: SCC-12795

Visual Inspection: PASS
DOT Spec: 3AL-2216

Examination Result
PASS

Comments:

BC344850 Pass 1_Thk.Txt
Event X Y Thk

Pass Number: 2
Event X Y TOF AMP

Pass Number: 5
Event X Y TOF AMP

Date: 7/30/2004 Time: 4:20:18 PM
Job No.:
Customer:
Cylinder S/N: BC345736
Manufacture: M4141
Manufacture Date: 07/99
Cylinder Min Wall: 0.158

Equipment
Model: DWC Reflex
Serial Number: 001

Transducer
Manufacturer: Harisonic
Serial Number: 02A018
Diameter[Inch]: 0.500
EBW Size[Inch]: 0.180
Frequency[MHz]: 3.500
Water Path[Inch]: 3.750

Calibration Cylinder
Cal_Cylinder Type: 3AL
Diameter: 3.250
Cal-Cyl-S/N: BC56973
Minimum Wall: 0.158
Pressure: 2216
Helix: 0.150
Cal-Cyl-Status: Passed

Inspector
Name: Paul Graves
Certification: ASNT Level II

Inspection Procedure
Procedure Number: SCC-12795

Visual Inspection: PASS
DOT Spec: 3AL-2216

Examination Result
PASS

Comments:

BC345736 Pass 1_Thk.Txt
Event X Y Thk

Pass Number: 2
Event X Y TOF AMP

Pass Number: 5
Event X Y TOF AMP

Date: 7/30/2004 Time: 3:51:52 PM
Job No.:
Customer:
Cylinder S/N: BC719933
Manufacture: M4141
Manufacture Date: 03/99
Cylinder Min Wall: 0.158

Equipment
Model: DWC Reflex
Serial Number: 001

Transducer
Manufacturer: Harisonic
Serial Number: 02A018
Diameter[Inch]: 0.500
EBW Size[Inch]: 0.180
Frequency[MHz]: 3.500
Water Path[Inch]: 3.750

Calibration Cylinder
Cal_Cylinder Type: 3AL
Diameter: 3.250
Cal-Cyl-S/N: BC56973
Minimum Wall: 0.158
Pressure: 2216
Helix: 0.150
Cal-Cyl-Status: Passed

Inspector
Name: Paul Graves
Certification: ASNT Level II

Inspection Procedure
Procedure Number: SCC-12795

Visual Inspection: PASS
DOT Spec: 3AL-2216

Examination Result
PASS

Comments:

BC719933 Pass 1_Thk.Txt
Event X Y Thk

Pass Number: 2
Event X Y TOF AMP

Pass Number: 5
Event X Y TOF AMP

Date: 8/5/2004 Time: 8:27:47 AM
Job No.:
Customer:
Cylinder S/N: FH1546
Manufacture: M4002
Manufacture Date: 08/98
Cylinder Min Wall: 0.156

Equipment
Model: DWC Reflex
Serial Number: 001

Transducer
Manufacturer: Harisonic
Serial Number: 02A018
Diameter[Inch]: 0.500
EBW Size[Inch]: 0.180
Frequency[MHz]: 3.500
Water Path[Inch]: 3.750

Calibration Cylinder
Cal_Cylinder Type: 3AL
Diameter: 3.250
Cal-Cyl-S/N: BC56973
Minimum Wall: 0.158
Pressure: 2216
Helix: 0.150
Cal-Cyl-Status: Passed

Inspector
Name: Robert Fick
Certification: ASNT Level II

Inspection Procedure
Procedure Number: SCC-12795

Visual Inspection: PASS
DOT Spec: 3AL-2216

Examination Result
PASS

Comments:

FH1546 Pass 1_Thk.Txt
Event X Y Thk

Pass Number: 2
Event X Y TOF AMP

Pass Number: 5
Event X Y TOF AMP

Date: 7/30/2004 Time: 4:24:01 PM
Job No.:
Customer:
Cylinder S/N: ML2020
Manufacture: M4002
Manufacture Date: 07/99
Cylinder Min Wall: 0.156

Equipment
Model: DWC Reflex
Serial Number: 001

Transducer
Manufacturer: Harisonic
Serial Number: 02A018
Diameter[Inch]: 0.500
EBW Size[Inch]: 0.180
Frequency[MHz]: 3.500
Water Path[Inch]: 3.750

Calibration Cylinder
Cal_Cylinder Type: 3AL
Diameter: 3.250
Cal-Cyl-S/N: BC56973
Minimum Wall: 0.158
Pressure: 2216
Helix: 0.150
Cal-Cyl-Status: Passed

Inspector
Name: Paul Graves
Certification: ASNT Level II

Inspection Procedure
Procedure Number: SCC-12795

Visual Inspection: PASS
DOT Spec: 3AL-2216

Examination Result
PASS

Comments:

ML2020 Pass 1_Thk.Txt
Event X Y Thk

Pass Number: 2
Event X Y TOF AMP

Pass Number: 5
Event X Y TOF AMP

Date: 8/3/2004 Time: 2:51:16 PM
Job No.:
Customer:
Cylinder S/N: E115969
Manufacture: M4141
Manufacture Date: 01/85
Cylinder Min Wall: 0.187

Equipment
Model: DWC Reflex
Serial Number: 001

Transducer
Manufacturer: Harisonic
Serial Number: 3AL604
Diameter[Inch]: 0.500
EBW Size[Inch]: 0.220
Frequency[MHz]: 2.250
Water Path[Inch]: 4.250

Calibration Cylinder
Cal_Cylinder Type: 3AL
Diameter: 4.250
Cal-Cyl-S/N: 655247
Minimum Wall: 0.187
Pressure: 2015
Helix: 0.200
Cal-Cyl-Status: Passed

Inspector
Name: Paul Graves
Certification: ASNT Level II

Inspection Procedure
Procedure Number: SCC-12966

Visual Inspection: PASS
DOT Spec: 3AL-2015

Examination Result
PASS

Comments:

E115969 Pass 1_Thk.Txt
Event X Y Thk

Pass Number: 2
Event X Y TOF AMP

Pass Number: 5
Event X Y TOF AMP

Date: 8/4/2004 Time: 6:36:15 AM
Job No.:
Customer:
Cylinder S/N: E142802
Manufacture: M4141
Manufacture Date: 09/85
Cylinder Min Wall: 0.187

Equipment
Model: DWC Reflex
Serial Number: 001

Transducer
Manufacturer: Harisonic
Serial Number: 3AL604
Diameter[Inch]: 0.500
EBW Size[Inch]: 0.220
Frequency[MHz]: 2.250
Water Path[Inch]: 4.250

Calibration Cylinder
Cal_Cylinder Type: 3AL
Diameter: 4.250
Cal-Cyl-S/N: 655247
Minimum Wall: 0.187
Pressure: 2015
Helix: 0.200
Cal-Cyl-Status: Passed

Inspector
Name: Paul Graves
Certification: ASNT Level II

Inspection Procedure
Procedure Number: SCC-12966

Visual Inspection: PASS
DOT Spec: 3AL-2015

Examination Result
PASS

Comments:

E142802 Pass 1_Thk.Txt
Event X Y Thk

Pass Number: 2
Event X Y TOF AMP

Pass Number: 5
Event X Y TOF AMP

Date: 8/3/2004 Time: 2:09:32 PM
Job No.:
Customer:
Cylinder S/N: E14759
Manufacture: M4141
Manufacture Date: 09/93
Cylinder Min Wall: 0.187

Equipment
Model: DWC Reflex
Serial Number: 001

Transducer
Manufacturer: Harisonic
Serial Number: 3AL604
Diameter[Inch]: 0.500
EBW Size[Inch]: 0.220
Frequency[MHz]: 2.250
Water Path[Inch]: 4.250

Calibration Cylinder
Cal_Cylinder Type: 3AL
Diameter: 4.250
Cal-Cyl-S/N: 655247
Minimum Wall: 0.187
Pressure: 2015
Helix: 0.200
Cal-Cyl-Status: Passed

Inspector
Name: Paul Graves
Certification: ASNT Level II

Inspection Procedure
Procedure Number: SCC-12966

Visual Inspection: PASS
DOT Spec: 3AL-2015

Examination Result
PASS

Comments:

E14759 Pass 1_Thk.Txt
Event X Y Thk

Pass Number: 2
Event X Y TOF AMP

Pass Number: 5
Event X Y TOF AMP

Date: 8/4/2004 Time: 5:54:06 AM
Job No.:
Customer:
Cylinder S/N: E178919
Manufacture: M4141
Manufacture Date: 07/86
Cylinder Min Wall: 0.187

Equipment
Model: DWC Reflex
Serial Number: 001

Transducer
Manufacturer: Harisonic
Serial Number: 3AL604
Diameter[Inch]: 0.500
EBW Size[Inch]: 0.220
Frequency[MHz]: 2.250
Water Path[Inch]: 4.250

Calibration Cylinder
Cal_Cylinder Type: 3AL
Diameter: 4.250
Cal-Cyl-S/N: 655247
Minimum Wall: 0.187
Pressure: 2015
Helix: 0.200
Cal-Cyl-Status: Passed

Inspector
Name: Paul Graves
Certification: ASNT Level II

Inspection Procedure
Procedure Number: SCC-12966

Visual Inspection: PASS
DOT Spec: 3AL-2015

Examination Result
PASS

Comments:

E178919 Pass 1_Thk.Txt
Event X Y Thk

Pass Number: 2
Event X Y TOF AMP

Pass Number: 5
Event X Y TOF AMP

Date: 8/3/2004 Time: 2:36:00 PM
Job No.:
Customer:
Cylinder S/N: E198873
Manufacture: M4141
Manufacture Date: 12/86
Cylinder Min Wall: 0.187

Equipment
Model: DWC Reflex
Serial Number: 001

Transducer
Manufacturer: Harisonic
Serial Number: 3AL604
Diameter[Inch]: 0.500
EBW Size[Inch]: 0.220
Frequency[MHz]: 2.250
Water Path[Inch]: 4.250

Calibration Cylinder
Cal_Cylinder Type: 3AL
Diameter: 4.250
Cal-Cyl-S/N: 655247
Minimum Wall: 0.187
Pressure: 2015
Helix: 0.200
Cal-Cyl-Status: Passed

Inspector
Name: Paul Graves
Certification: ASNT Level II

Inspection Procedure
Procedure Number: SCC-12966

Visual Inspection: PASS
DOT Spec: 3AL-2015

Examination Result
PASS

Comments:

E198873 Pass 1_Thk.Txt
Event X Y Thk

Pass Number: 2
Event X Y TOF AMP

Pass Number: 5
Event X Y TOF AMP

Date: 8/3/2004 Time: 10:54:13 AM
Job No.:
Customer:
Cylinder S/N: E205513
Manufacture: M4141
Manufacture Date: 08/95
Cylinder Min Wall: 0.187

Equipment
Model: DWC Reflex
Serial Number: 001

Transducer
Manufacturer: Harisonic
Serial Number: 3AL604
Diameter[Inch]: 0.500
EBW Size[Inch]: 0.220
Frequency[MHz]: 2.250
Water Path[Inch]: 4.250

Calibration Cylinder
Cal_Cylinder Type: 3AL
Diameter: 4.250
Cal-Cyl-S/N: 655247
Minimum Wall: 0.187
Pressure: 2015
Helix: 0.200
Cal-Cyl-Status: Passed

Inspector
Name: Paul Graves
Certification: ASNT Level II

Inspection Procedure
Procedure Number: SCC-12795

Visual Inspection: PASS
DOT Spec: 3AL-2015

Examination Result
PASS

Comments:

E205513 Pass 1_Thk.Txt
Event X Y Thk

Pass Number: 2
Event X Y TOF AMP

Pass Number: 5
Event X Y TOF AMP

Date: 8/3/2004 Time: 2:14:20 PM
Job No.:
Customer:
Cylinder S/N: E222142
Manufacture: M4141
Manufacture Date: 05/87
Cylinder Min Wall: 0.187

Equipment
Model: DWC Reflex
Serial Number: 001

Transducer
Manufacturer: Harisonic
Serial Number: 3AL604
Diameter[Inch]: 0.500
EBW Size[Inch]: 0.220
Frequency[MHz]: 2.250
Water Path[Inch]: 4.250

Calibration Cylinder
Cal_Cylinder Type: 3AL
Diameter: 4.250
Cal-Cyl-S/N: 655247
Minimum Wall: 0.187
Pressure: 2015
Helix: 0.200
Cal-Cyl-Status: Passed

Inspector
Name: Paul Graves
Certification: ASNT Level II

Inspection Procedure
Procedure Number: SCC-12966

Visual Inspection: PASS
DOT Spec: 3AL-2015

Examination Result
PASS

Comments:

ONE- NON RELEVANT INDICATION (P.G)

E222142 Pass 1_Thk.Txt
Event X Y Thk

Pass Number: 2
Event X Y TOF AMP ← OD SCRATCH

7717 10.560 10.264 13.260 0.808
0.220 0.083

Pass Number: 5

Event	X	Y	TOF	AMP

Date: 8/3/2004 Time: 12:22:14 PM
Job No.:
Customer:
Cylinder S/N: E227076
Manufacture: M4141
Manufacture Date: 06/87
Cylinder Min Wall: 0.187

Equipment
Model: DWC Reflex
Serial Number: 001

Transducer
Manufacturer: Harisonic
Serial Number: 3AL604
Diameter[Inch]: 0.500
EBW Size[Inch]: 0.220
Frequency[MHz]: 2.250
Water Path[Inch]: 4.250

Calibration Cylinder
Cal_Cylinder Type: 3AL
Diameter: 4.250
Cal-Cyl-S/N: 655247
Minimum Wall: 0.187
Pressure: 2015
Helix: 0.200
Cal-Cyl-Status: Passed

Inspector
Name: Paul Graves
Certification: ASNT Level II

Inspection Procedure
Procedure Number: SCC-12966

Visual Inspection: PASS
DOT Spec: 3AL-2015

Examination Result
PASS

Comments:

E227076 Pass 1_Thk.Txt
Event X Y Thk

Pass Number: 2
Event X Y TOF AMP

Pass Number: 5
Event X Y TOF AMP

Date: 8/3/2004 Time: 12:34:52 PM
Job No.:
Customer:
Cylinder S/N: E249366
Manufacture: M4141
Manufacture Date: 11/87
Cylinder Min Wall: 0.187

Equipment
Model: DWC Reflex
Serial Number: 001

Transducer
Manufacturer: Harisonic
Serial Number: 3AL604
Diameter[Inch]: 0.500
EBW Size[Inch]: 0.220
Frequency[MHz]: 2.250
Water Path[Inch]: 4.250

Calibration Cylinder
Cal_Cylinder Type: 3AL
Diameter: 4.250
Cal-Cyl-S/N: 655247
Minimum Wall: 0.187
Pressure: 2015
Helix: 0.200
Cal-Cyl-Status: Passed

Inspector
Name: Paul Graves
Certification: ASNT Level II

Inspection Procedure
Procedure Number: SCC-12966

Visual Inspection: PASS
DOT Spec: 3AL-2015

Examination Result
PASS

Comments:

E249366 Pass 1_Thk.Txt
Event X Y Thk

Pass Number: 2
Event X Y TOF AMP

Pass Number: 5
Event X Y TOF AMP

Date: 8/3/2004 Time: 9:00:03 AM
Job No.:
Customer:
Cylinder S/N: E265537
Manufacture: M4141
Manufacture Date: 04/88
Cylinder Min Wall: 0.187

Equipment
Model: DWC Reflex
Serial Number: 001

Transducer
Manufacturer: Harisonic
Serial Number: 3AL604
Diameter[Inch]: 0.500
EBW Size[Inch]: 0.220
Frequency[MHz]: 2.250
Water Path[Inch]: 4.250

Calibration Cylinder
Cal_Cylinder Type: 3AL
Diameter: 4.250
Cal-Cyl-S/N: 655247
Minimum Wall: 0.187
Pressure: 2015
Helix: 0.200
Cal-Cyl-Status: Passed

Inspector
Name: Paul Graves
Certification: ASNT Level II

Inspection Procedure
Procedure Number: SCC-12795

Visual Inspection: PASS
DOT Spec: 3AL-2015

Examination Result
PASS

Comments:

E265537 Pass 1_Thk.Txt
Event X Y Thk

Pass Number: 2
Event X Y TOF AMP

Pass Number: 5
Event X Y TOF AMP

Date: 8/3/2004 Time: 1:50:09 PM
Job No.:
Customer:
Cylinder S/N: E36611
Manufacture: M4141
Manufacture Date: 01/94
Cylinder Min Wall: 0.187

Equipment
Model: DWC Reflex
Serial Number: 001

Transducer
Manufacturer: Harisonic
Serial Number: 3AL604
Diameter[Inch]: 0.500
EBW Size[Inch]: 0.220
Frequency[MHz]: 2.250
Water Path[Inch]: 4.250

Calibration Cylinder
Cal_Cylinder Type: 3AL
Diameter: 4.250
Cal-Cyl-S/N: 655247
Minimum Wall: 0.187
Pressure: 2015
Helix: 0.200
Cal-Cyl-Status: Passed

Inspector
Name: Paul Graves
Certification: ASNT Level II

Inspection Procedure
Procedure Number: SCC-12795

Visual Inspection: PASS
DOT Spec: 3AL-2015

Examination Result
PASS

Comments:

E36611 Pass 1_Thk.Txt
Event X Y Thk

Pass Number: 2
Event X Y TOF AMP

Pass Number: 5
Event X Y TOF AMP

Date: 8/3/2004 Time: 2:37:43 PM
Job No.:
Customer:
Cylinder S/N: E404411
Manufacture: M4141
Manufacture Date: 02/90
Cylinder Min Wall: 0.187

Equipment
Model: DWC Reflex
Serial Number: 001

Transducer
Manufacturer: *Harisonic*
Serial Number: 3AL604
Diameter[Inch]: 0.500
EBW Size[Inch]: 0.220
Frequency[MHz]: 2.250
Water Path[Inch]: 4.250

Calibration Cylinder
Cal_Cylinder Type: 3AL
Diameter: 4.250
Cal-Cyl-S/N: 655247
Minimum Wall: 0.187
Pressure: 2015
Helix: 0.200
Cal-Cyl-Status: Passed

Inspector
Name: Paul Graves
Certification: ASNT Level II

Inspection Procedure
Procedure Number: SCC-12795

Visual Inspection: PASS
DOT Spec: 3AL-2015

Examination Result
PASS

Comments:

E404411 Pass 1_Thk.Txt
Event X Y Thk

Pass Number: 2
Event X Y TOF AMP

Pass Number: 5
Event X Y TOF AMP

Date: 8/3/2004 Time: 5:10:23 PM
Job No.:
Customer:
Cylinder S/N: E51373
Manufacture: M4141
Manufacture Date: 04/94
Cylinder Min Wall: 0.187

Equipment
Model: DWC Reflex
Serial Number: 001

Transducer
Manufacturer: Harisonic
Serial Number: 3AL604
Diameter[Inch]: 0.500
EBW Size[Inch]: 0.220
Frequency[MHz]: 2.250
Water Path[Inch]: 4.250

Calibration Cylinder
Cal_Cylinder Type: 3AL
Diameter: 4.250
Cal-Cyl-S/N: 655247
Minimum Wall: 0.187
Pressure: 2015
Helix: 0.200
Cal-Cyl-Status: Passed

Inspector
Name: Paul Graves
Certification: ASNT Level II

Inspection Procedure
Procedure Number: SCC-12795

Visual Inspection: PASS
DOT Spec: 3AL-2015

Examination Result
PASS

Comments:

E51373 Pass 1_Thk.Txt
Event X Y Thk

Pass Number: 2
Event X Y TOF AMP

Pass Number: 5
Event X Y TOF AMP

Date: 8/3/2004 Time: 1:48:24 PM
Job No.:
Customer:
Cylinder S/N: E643088
Manufacture: M4141
Manufacture Date: 03/92
Cylinder Min Wall: 0.187

Equipment
Model: DWC Reflex
Serial Number: 001

Transducer
Manufacturer: Harisonic
Serial Number: 3AL604
Diameter[Inch]: 0.500
EBW Size[Inch]: 0.220
Frequency[MHz]: 2.250
Water Path[Inch]: 4.250

Calibration Cylinder
Cal_Cylinder Type: 3AL
Diameter: 4.250
Cal-Cyl-S/N: 655247
Minimum Wall: 0.187
Pressure: 2015
Helix: 0.200
Cal-Cyl-Status: Passed

Inspector
Name: Paul Graves
Certification: ASNT Level II

Inspection Procedure
Procedure Number: SCC-12795

Visual Inspection: PASS
DOT Spec: 3AL-2015

Examination Result
PASS

Comments:

E643088 Pass 1_Thk.Txt
Event X Y Thk

Pass Number: 2
Event X Y TOF AMP

Pass Number: 5
Event X Y TOF AMP

Date: 8/3/2004 Time: 7:52:28 AM
Job No.:
Customer:
Cylinder S/N: E647791
Manufacture: M4141
Manufacture Date: 11/97
Cylinder Min Wall: 0.187

Equipment
Model: DWC Reflex
Serial Number: 001

Transducer
Manufacturer: Harisonic
Serial Number: 3AL604
Diameter[Inch]: 0.500
EBW Size[Inch]: 0.220
Frequency[MHz]: 2.250
Water Path[Inch]: 4.250

Calibration Cylinder
Cal_Cylinder Type: 3AL
Diameter: 4.250
Cal-Cyl-S/N: 655247
Minimum Wall: 0.187
Pressure: 2015
Helix: 0.200
Cal-Cyl-Status: Passed

Inspector
Name: Paul Graves
Certification: ASNT Level II

Inspection Procedure
Procedure Number: SCC-12795

Visual Inspection: PASS
DOT Spec: 3AL-2015

Examination Result
PASS

Comments:

E647791 Pass 1_Thk.Txt
Event X Y Thk

Pass Number: 2
Event X Y TOF AMP

Pass Number: 5
Event X Y TOF AMP

Date: 7/30/2004 Time: 6:08:39 PM
Job No.:
Customer:
Cylinder S/N: E655247
Manufacture: M4141
Manufacture Date:
Cylinder Min Wall: 0.187

Equipment
Model: DWC Reflex
Serial Number: 001

Transducer
Manufacturer: Harisonic
Serial Number: 3AL604
Diameter[Inch]: 0.500
EBW Size[Inch]: 0.220
Frequency[MHz]: 2.250
Water Path[Inch]: 4.250

Calibration Cylinder
Cal_Cylinder Type: 3AL
Diameter: 4.250
Cal-Cyl-S/N: 655247
Minimum Wall: 0.187
Pressure: 2015
Helix: 0.200
Cal-Cyl-Status: Passed

Inspector
Name: Paul Graves
Certification: ASNT Level II

Inspection Procedure
Procedure Number: SCC-12795/12966

Visual Inspection: PASS
DOT Spec: 3AL-2015

Examination Result
FAIL
On pass 1: Thin Wall
On pass 2 3 4 5 : Pit/Crack
See attached documentation for detailed flaw result

Comments:

E655247 Pass 1_Thk.Txt

Event	X	Y	Thk
16	0.000	12.017	0.186
41	0.000	9.930	0.186
47	0.000	9.430	0.186

53	0.000	8.929	0.186	
58	0.000	8.512	0.186	
127	0.000	2.754	0.186	
130	0.000	2.503	0.183	
131	0.000	2.420	0.183	
142	0.000	1.502	0.186	
1871	2.420	4.089	0.168	
1872	2.420	4.006	0.173	
1874	2.420	3.839	0.183	
1875	2.420	3.755	0.173	
1876	2.420	3.672	0.178	
1877	2.420	3.588	0.181	
1878	2.420	3.505	0.173	
2031	2.640	4.089	0.186	
2032	2.640	4.006	0.181	
2034	2.640	3.839	0.178	
2035	2.640	3.755	0.186	
2037	2.640	3.588	0.186	
2038	2.640	3.505	0.176	
2039	2.640	3.421	0.181	
2191	2.860	4.089	0.176	
2192	2.860	4.006	0.173	
2193	2.860	3.922	0.176	
2194	2.860	3.839	0.176	
2195	2.860	3.755	0.173	
2196	2.860	3.672	0.176	
2197	2.860	3.588	0.178	
2198	2.860	3.505	0.173	
2199	2.860	3.421	0.168	

Pass Number: 2

Event	X	Y	TOF	AMP
134	0.000	2.170	30.200	1.100
	0.220	0.083		
2442	3.300	9.847	32.000	1.100
	0.220	0.083		
2639	3.520	6.759	32.080	1.100
	0.220	0.083		
2749	3.740	10.932	8.880	0.808
2750	3.740	10.848	8.080	1.100
2751	3.740	10.765	7.280	1.100
2910	3.960	10.848	8.920	0.920
2911	3.960	10.765	8.000	1.100
2912	3.960	10.681	7.240	1.100
3071	4.180	10.765	8.920	0.851
3072	4.180	10.681	8.100	1.100
3073	4.180	10.598	7.320	1.100
3074	4.180	10.515	6.580	0.773
3232	4.400	10.681	8.120	1.100
3233	4.400	10.598	7.280	1.100
	0.880	0.501		
2905	3.960	11.266	18.420	0.885

3066	4.180	11.182	18.520	0.791
3226	4.400	11.182	18.460	0.773
	0.660	0.167		
3949	5.280	4.256	13.080	1.100
3950	5.280	4.172	12.220	0.773
4108	5.500	4.339	13.900	0.834
4109	5.500	4.256	12.700	1.100
4110	5.500	4.172	12.300	1.100
4269	5.720	4.256	12.760	1.100
4270	5.720	4.172	12.260	1.100
4429	5.940	4.256	12.680	1.100
4430	5.940	4.172	11.920	1.031
4589	6.160	4.256	13.100	1.100
4590	6.160	4.172	12.320	0.980
	1.100	0.250		
9627	13.200	11.099	26.500	1.100
	0.220	0.083		
11077	15.180	10.264	20.340	1.100
	0.220	0.083		
11473	15.620	3.922	28.380	1.100
	0.220	0.083		
15032	20.460	0.668	29.840	1.100
	0.220	0.083		

Pass Number: 3

Event	X	Y	TOF	AMP
690	0.880	9.179	8.100	1.066
691	0.880	9.096	9.240	0.834
	0.220	0.167		
1895	2.420	2.086	7.980	0.851
2054	2.640	2.170	7.160	0.782
2055	2.640	2.086	8.060	0.877
2214	2.860	2.170	7.140	1.100
2215	2.860	2.086	7.960	1.100
	0.660	0.167		
2775	3.740	8.762	17.960	0.808
2935	3.960	8.762	17.920	0.773
3095	4.180	8.762	18.000	0.765
	0.660	0.083		
2609	3.520	9.263	7.700	0.782
2768	3.740	9.346	6.840	0.894
2769	3.740	9.263	7.560	1.100
2770	3.740	9.179	8.380	1.100
2928	3.960	9.346	6.760	0.808
2929	3.960	9.263	7.580	1.100
2930	3.960	9.179	8.440	1.100
3088	4.180	9.346	6.840	0.859
3089	4.180	9.263	7.580	1.100
3090	4.180	9.179	8.400	1.100
3248	4.400	9.346	6.800	0.756
3249	4.400	9.263	7.520	1.100

3250	4.400	9.179	8.300	1.100
	1.100	0.250		
3884	5.280	9.680	25.980	1.100
	0.220	0.083		
4299	5.720	1.752	22.980	0.773
4459	5.940	1.752	23.060	0.808
	0.440	0.083		
3973	5.280	2.253	12.720	1.100
3974	5.280	2.170	13.600	1.100
4132	5.500	2.337	11.980	0.937
4133	5.500	2.253	12.400	1.100
4134	5.500	2.170	13.540	1.100
4292	5.720	2.337	11.920	0.791
4293	5.720	2.253	12.720	1.100
4294	5.720	2.170	13.600	1.100
4452	5.940	2.337	11.960	0.937
4453	5.940	2.253	12.460	1.100
4454	5.940	2.170	13.620	1.100
4613	6.160	2.253	12.780	1.005
4614	6.160	2.170	13.580	0.825
	1.100	0.250		

Pass Number: 4

Event	X	Y	TOF	AMP
353	0.440	10.598	6.680	0.756
354	0.440	10.515	7.360	0.799
	0.220	0.167		
1549	1.980	4.256	6.300	1.100
1551	1.980	4.089	6.080	0.971
1552	1.980	4.006	6.000	0.988
1554	1.980	3.839	5.940	0.988
1555	1.980	3.755	5.920	1.074
	0.220	0.584		
1558	1.980	3.505	6.180	0.911
	0.220	0.083		
1846	2.420	6.175	26.440	1.100
	0.220	0.083		
3560	4.840	10.014	25.560	1.100
	0.220	0.083		
4219	5.720	8.428	25.120	1.100
	0.220	0.083		
4351	5.940	10.765	23.740	1.100
	0.220	0.083		
5308	7.260	11.015	7.260	1.100
5309	7.260	10.932	7.580	1.100
5310	7.260	10.848	7.740	1.100
5311	7.260	10.765	7.580	1.100
5312	7.260	10.681	7.580	1.100
5313	7.260	10.598	7.200	1.100

5314	7.260	10.515	7.180	1.100
5315	7.260	10.431	7.880	1.100
5316	7.260	10.348	7.100	1.100
5317	7.260	10.264	7.540	1.100
5318	7.260	10.181	7.120	1.100
5319	7.260	10.097	6.880	1.100
5320	7.260	10.014	6.900	0.834
	0.220	1.085		
5537	7.480	5.257	26.120	1.100
	0.220	0.083		
6351	8.580	4.089	12.120	0.859
6352	8.580	4.006	11.960	0.825
6353	8.580	3.922	13.060	0.773
6354	8.580	3.839	11.760	0.859
6355	8.580	3.755	12.900	0.885
6356	8.580	3.672	12.600	0.877
6357	8.580	3.588	11.960	0.894
6358	8.580	3.505	12.260	0.920
6359	8.580	3.421	12.100	0.782
6511	8.800	4.089	10.260	0.799
	0.440	0.751		
7251	9.900	9.096	27.280	1.100
	0.220	0.083		
9040	12.320	6.676	24.880	0.894
9041	12.320	6.592	24.860	0.963
9042	12.320	6.509	24.820	0.765
9199	12.540	6.759	23.100	0.791

Pass Number: 5

Event	X	Y	TOF	AMP
261	0.220	4.923	34.660	1.100
	0.220	0.083		
854	1.100	8.846	31.580	1.100
1016	1.320	8.679	6.240	0.765
1017	1.320	8.595	6.600	1.014
1018	1.320	8.512	6.780	1.100
1019	1.320	8.428	6.740	1.100
1020	1.320	8.345	6.240	1.066
	0.440	0.584		
2534	3.300	2.170	5.900	0.911
2535	3.300	2.086	6.100	1.100
2536	3.300	2.003	6.220	1.100
2537	3.300	1.919	6.000	1.100
2538	3.300	1.836	6.040	1.100
2540	3.300	1.669	5.880	0.971
2542	3.300	1.502	6.140	1.100
2543	3.300	1.419	6.080	1.100
	0.220	0.834		
5651	7.700	9.096	6.100	0.868
5652	7.700	9.012	6.980	1.100
5653	7.700	8.929	5.920	1.100
5654	7.700	8.846	6.620	1.100
5655	7.700	8.762	6.580	1.100

5656	7.700	8.679	6.100	1.100
5657	7.700	8.595	6.560	1.100
5658	7.700	8.512	6.280	1.100
5659	7.700	8.428	7.080	1.100
5660	7.700	8.345	6.760	1.100
5661	7.700	8.261	6.220	1.100
5662	7.700	8.178	6.420	1.100
5663	7.700	8.095	6.300	1.100
5664	7.700	8.011	6.220	0.756
5813	7.920	8.929	8.420	1.100
5814	7.920	8.846	8.640	1.100
5815	7.920	8.762	8.680	1.100
5816	7.920	8.679	9.020	1.100
5817	7.920	8.595	8.780	1.100
5818	7.920	8.512	8.560	1.100
5819	7.920	8.428	8.520	1.100
5820	7.920	8.345	8.620	1.100
5821	7.920	8.261	8.820	1.100
5822	7.920	8.178	8.520	1.100
5823	7.920	8.095	7.880	1.100
5824	7.920	8.011	8.460	1.005
	0.440	1.168		
7177	9.680	1.919	10.700	0.808
7178	9.680	1.836	10.420	1.100
7179	9.680	1.752	11.300	1.100
7180	9.680	1.669	11.100	1.023
7181	9.680	1.586	11.060	1.100
7182	9.680	1.502	11.640	1.100
7183	9.680	1.419	12.140	1.100
7185	9.680	1.252	11.560	1.100
7186	9.680	1.168	11.600	1.023
	0.220	0.834		
8634	11.660		0.501 30.520	1.100
	0.220	0.083		

Date: 8/4/2004 Time: 5:49:09 AM
Job No.:
Customer:
Cylinder S/N: E668029
Manufacture: M4141
Manufacture Date: 06/92
Cylinder Min Wall: 0.187

Equipment
Model: DWC Reflex
Serial Number: 001

Transducer
Manufacturer: Harisonic
Serial Number: 3AL604
Diameter[Inch]: 0.500
EBW Size[Inch]: 0.220
Frequency[MHz]: 2.250
Water Path[Inch]: 4.250

Calibration Cylinder
Cal_Cylinder Type: 3AL
Diameter: 4.250
Cal-Cyl-S/N: 655247
Minimum Wall: 0.187
Pressure: 2015
Helix: 0.200
Cal-Cyl-Status: Passed

Inspector
Name: Paul Graves
Certification: ASNT Level II

Inspection Procedure
Procedure Number: SCC-12795

Visual Inspection: PASS
DOT Spec: 3AL-2015

Examination Result
PASS

Comments:

E668029 Pass 1_Thk.Txt
Event X Y Thk

Pass Number: 2
Event X Y TOF AMP

Pass Number: 5
Event X Y TOF AMP

Date: 8/3/2004 Time: 12:53:55 PM
Job No.:
Customer:
Cylinder S/N: E671160
Manufacture: M4141
Manufacture Date: 06/92
Cylinder Min Wall: 0.187

Equipment
Model: DWC Reflex
Serial Number: 001

Transducer
Manufacturer: Harisonic
Serial Number: 3AL604
Diameter[Inch]: 0.500
EBW Size[Inch]: 0.220
Frequency[MHz]: 2.250
Water Path[Inch]: 4.250

Calibration Cylinder
Cal_Cylinder Type: 3AL
Diameter: 4.250
Cal-Cyl-S/N: 655247
Minimum Wall: 0.187
Pressure: 2015
Helix: 0.200
Cal-Cyl-Status: Passed

Inspector
Name: Paul Graves
Certification: ASNT Level II

Inspection Procedure
Procedure Number: SCC-12795

Visual Inspection: PASS
DOT Spec: 3AL-2015

Examination Result
PASS

Comments:

E671160 Pass 1_Thk.Txt
Event X Y Thk

Pass Number: 2
Event X Y TOF AMP

Pass Number: 5
Event X Y TOF AMP

Date: 8/3/2004 Time: 2:29:41 PM
Job No.:
Customer:
Cylinder S/N: E690417
Manufacture: M4141
Manufacture Date: 07/92
Cylinder Min Wall: 0.187

Equipment
Model: DWC Reflex
Serial Number: 001

Transducer
Manufacturer: Harisonic
Serial Number: 3AL604
Diameter[Inch]: 0.500
EBW Size[Inch]: 0.220
Frequency[MHz]: 2.250
Water Path[Inch]: 4.250

Calibration Cylinder
Cal_Cylinder Type: 3AL
Diameter: 4.250
Cal-Cyl-S/N: 655247
Minimum Wall: 0.187
Pressure: 2015
Helix: 0.200
Cal-Cyl-Status: Passed

Inspector
Name: Paul Graves
Certification: ASNT Level II

Inspection Procedure
Procedure Number: SCC-12795

Visual Inspection: PASS
DOT Spec: 3AL-2015

Examination Result
PASS

Comments:

E690417 Pass 1_Thk.Txt
Event X Y Thk

Pass Number: 2
Event X Y TOF AMP

Pass Number: 5
Event X Y TOF AMP

Date: 8/3/2004 Time: 2:34:14 PM
Job No.:
Customer:
Cylinder S/N: E697936
Manufacture: M4141
Manufacture Date: 03/98
Cylinder Min Wall: 0.187

Equipment
Model: DWC Reflex
Serial Number: 001

Transducer
Manufacturer: Harisonic
Serial Number: 3AL604
Diameter[Inch]: 0.500
EBW Size[Inch]: 0.220
Frequency[MHz]: 2.250
Water Path[Inch]: 4.250

Calibration Cylinder
Cal_Cylinder Type: 3AL
Diameter: 4.250
Cal-Cyl-S/N: 655247
Minimum Wall: 0.187
Pressure: 2015
Helix: 0.200
Cal-Cyl-Status: Passed

Inspector
Name: Paul Graves
Certification: ASNT Level II

Inspection Procedure
Procedure Number: SCC-12795

Visual Inspection: PASS
DOT Spec: 3AL-2015

Examination Result
PASS

Comments:

E697936 Pass 1_Thk.Txt
Event X Y Thk

Pass Number: 2
Event X Y TOF AMP

Pass Number: 5
Event X Y TOF AMP

Date: 8/3/2004 Time: 10:52:15 AM
Job No.:
Customer:
Cylinder S/N: E849044
Manufacture: M4141
Manufacture Date: 11/98
Cylinder Min Wall: 0.187

Equipment
Model: DWC Reflex
Serial Number: 001

Transducer
Manufacturer: Harisonic
Serial Number: 3AL604
Diameter[Inch]: 0.500
EBW Size[Inch]: 0.220
Frequency[MHz]: 2.250
Water Path[Inch]: 4.250

Calibration Cylinder
Cal_Cylinder Type: 3AL
Diameter: 4.250
Cal-Cyl-S/N: 655247
Minimum Wall: 0.187
Pressure: 2015
Helix: 0.200
Cal-Cyl-Status: Passed

Inspector
Name: Paul Graves
Certification: ASNT Level II

Inspection Procedure
Procedure Number: SCC-12795

Visual Inspection: PASS
DOT Spec: 3AL-2015

Examination Result
PASS

Comments:

E849044 Pass 1_Thk.Txt
Event X Y Thk

Pass Number: 2
Event X Y TOF AMP

Pass Number: 5
Event X Y TOF AMP

Date: 8/3/2004 Time: 2:02:42 PM
Job No.:
Customer:
Cylinder S/N: E91005
Manufacture: M4141
Manufacture Date: 07/93
Cylinder Min Wall: 0.187

Equipment
Model: DWC Reflex
Serial Number: 001

Transducer
Manufacturer: Harisonic
Serial Number: 3AL604
Diameter[Inch]: 0.500
EBW Size[Inch]: 0.220
Frequency[MHz]: 2.250
Water Path[Inch]: 4.250

Calibration Cylinder
Cal_Cylinder Type: 3AL
Diameter: 4.250
Cal-Cyl-S/N: 655247
Minimum Wall: 0.187
Pressure: 2015
Helix: 0.200
Cal-Cyl-Status: Passed

Inspector
Name: Paul Graves
Certification: ASNT Level II

Inspection Procedure
Procedure Number: SCC-12795
Visual Inspection: PASS
DOT Spec: 3AL-2015

Examination Result
PASS

Comments:

E91005 Pass 1_Thk.Txt
Event X Y Thk

Pass Number: 2
Event X Y TOF AMP

Pass Number: 5
Event X Y TOF AMP

Date: 7/31/2004 Time: 11:29:56 AM
Job No.:
Customer:
Cylinder S/N: BV3286
Manufacture: M4141
Manufacture Date: 07/99
Cylinder Min Wall: 0.187

Equipment
Model: DWC Reflex
Serial Number: 001

Transducer
Manufacturer: Harisonic
Serial Number: 3AL604
Diameter[Inch]: 0.500
EBW Size[Inch]: 0.220
Frequency[MHz]: 2.250
Water Path[Inch]: 4.250

Calibration Cylinder
Cal_Cylinder Type: 3AL
Diameter: 4.250
Cal-Cyl-S/N: 655247
Minimum Wall: 0.187
Pressure: 2015
Helix: 0.200
Cal-Cyl-Status: Passed

Inspector
Name: Paul Graves
Certification: ASNT Level II

Inspection Procedure
Procedure Number: SCC-12795

Visual Inspection: PASS
DOT Spec: 3AL-2015

Examination Result
PASS

See attached documentation for detailed flaw result

Comments:

BV3286 Pass 1_Thk.Txt
Event X Y Thk

Pass Number: 2
Event X Y TOF AMP

Pass Number: 5
Event X Y TOF AMP

Date: 7/30/2004 Time: 5:40:36 PM
Job No.:
Customer:
Cylinder S/N: BV36094
Manufacture: M4141
Manufacture Date: 07/99
Cylinder Min Wall: 0.187

Equipment
Model: DWC Reflex
Serial Number: 001

Transducer
Manufacturer: Harisonic
Serial Number: 3AL604
Diameter[Inch]: 0.500
EBW Size[Inch]: 0.220
Frequency[MHz]: 2.250
Water Path[Inch]: 4.250

Calibration Cylinder
Cal_Cylinder Type: 3AL
Diameter: 4.250
Cal-Cyl-S/N: 655247
Minimum Wall: 0.187
Pressure: 2015
Helix: 0.200
Cal-Cyl-Status: Passed

Inspector
Name: Paul Graves
Certification: ASNT Level II

Inspection Procedure
Procedure Number: SCC-12795

Visual Inspection: PASS
DOT Spec: 3AL-2015

Examination Result
PASS

See attached documentation for detailed flaw result

Comments:

BV36094 Pass 1_Thk.Txt
Event X Y Thk

Pass Number: 2
Event X Y TOF AMP

Pass Number: 5
Event X Y TOF AMP

Date: 7/30/2004 Time: 5:38:03 PM
Job No.:
Customer:
Cylinder S/N: BV36108
Manufacture: M4141
Manufacture Date: 07/99
Cylinder Min Wall: 0.187

Equipment
Model: DWC Reflex
Serial Number: 001

Transducer
Manufacturer: Harisonic
Serial Number: 3AL604
Diameter[Inch]: 0.500
EBW Size[Inch]: 0.220
Frequency[MHz]: 2.250
Water Path[Inch]: 4.250

Calibration Cylinder
Cal_Cylinder Type: 3AL
Diameter: 4.250
Cal-Cyl-S/N: 655247
Minimum Wall: 0.187
Pressure: 2015
Helix: 0.200
Cal-Cyl-Status: Passed

Inspector
Name: Paul Graves
Certification: ASNT Level II

Inspection Procedure
Procedure Number: SCC-12795

Visual Inspection: PASS
DOT Spec: 3AL-2015

Examination Result
PASS

See attached documentation for detailed flaw result

Comments:

BV36108 Pass 1_Thk.Txt
Event X Y Thk

Pass Number: 2
Event X Y TOF AMP

Pass Number: 5
Event X Y TOF AMP

Date: 7/31/2004 Time: 11:27:31 AM
Job No.:
Customer:
Cylinder S/N: BV5032
Manufacture: M4141
Manufacture Date: 05/99
Cylinder Min Wall: 0.187

Equipment
Model: DWC Reflex
Serial Number: 001

Transducer
Manufacturer: Harisonic
Serial Number: 3AL604
Diameter[Inch]: 0.500
EBW Size[Inch]: 0.220
Frequency[MHz]: 2.250
Water Path[Inch]: 4.250

Calibration Cylinder
Cal_Cylinder Type: 3AL
Diameter: 4.250
Cal-Cyl-S/N: 655247
Minimum Wall: 0.187
Pressure: 2015
Helix: 0.200
Cal-Cyl-Status: Passed

Inspector
Name: Paul Graves
Certification: ASNT Level II

Inspection Procedure
Procedure Number: SCC-12795

Visual Inspection: PASS
DOT Spec: 3AL-2015

Examination Result
PASS

Comments:

BV5032 Pass 1_Thk.Txt
Event X Y Thk

Pass Number: 2
Event X Y TOF AMP

Pass Number: 5
Event X Y TOF AMP

Date: 7/31/2004 Time: 11:12:29 AM
Job No.:
Customer:
Cylinder S/N: F079493
Manufacture: M4141
Manufacture Date: 07/89
Cylinder Min Wall: 0.187

Equipment
Model: DWC Reflex
Serial Number: 001

Transducer
Manufacturer: Harisonic
Serial Number: 3AL604
Diameter[Inch]: 0.500
EBW Size[Inch]: 0.220
Frequency[MHz]: 2.250
Water Path[Inch]: 4.250

Calibration Cylinder
Cal_Cylinder Type: 3AL
Diameter: 4.250
Cal-Cyl-S/N: 655247
Minimum Wall: 0.187
Pressure: 2015
Helix: 0.200
Cal-Cyl-Status: Passed

Inspector
Name: Paul Graves
Certification: ASNT Level II

Inspection Procedure
Procedure Number: SCC-12795

Visual Inspection: PASS
DOT Spec: 3AL-2015

Examination Result
PASS

Comments:

F079493 Pass 1_Thk.Txt
Event X Y Thk

Pass Number: 2
Event X Y TOF AMP

Pass Number: 5
Event X Y TOF AMP

Date: 7/30/2004 Time: 5:29:36 PM
Job No.:
Customer:
Cylinder S/N: F091035
Manufacture: M4141
Manufacture Date: 01/91
Cylinder Min Wall: 0.187

Equipment
Model: DWC Reflex
Serial Number: 001

Transducer
Manufacturer: Harisonic
Serial Number: 3AL604
Diameter[Inch]: 0.500
EBW Size[Inch]: 0.220
Frequency[MHz]: 2.250
Water Path[Inch]: 4.250

Calibration Cylinder
Cal_Cylinder Type: 3AL
Diameter: 4.250
Cal-Cyl-S/N: 655247
Minimum Wall: 0.187
Pressure: 2015
Helix: 0.200
Cal-Cyl-Status: Passed

Inspector
Name: Paul Graves
Certification: ASNT Level II

Inspection Procedure
Procedure Number: SCC-12795

Visual Inspection: PASS
DOT Spec: 3AL-2015

Examination Result
PASS

Comments:

F091035 Pass 1_Thk.Txt
Event X Y Thk

Pass Number: 2
Event X Y TOF AMP

Pass Number: 5
Event X Y TOF AMP

Date: 7/31/2004 Time: 11:06:47 AM
Job No.:
Customer:
Cylinder S/N: F10591
Manufacture: M4141
Manufacture Date: 07/93
Cylinder Min Wall: 0.187

Equipment
Model: DWC Reflex
Serial Number: 001

Transducer
Manufacturer: Harisonic
Serial Number: 3AL604
Diameter[Inch]: 0.500
EBW Size[Inch]: 0.220
Frequency[MHz]: 2.250
Water Path[Inch]: 4.250

Calibration Cylinder
Cal_Cylinder Type: 3AL
Diameter: 4.250
Cal-Cyl-S/N: 655247
Minimum Wall: 0.187
Pressure: 2015
Helix: 0.200
Cal-Cyl-Status: Passed

Inspector
Name: Paul Graves
Certification: ASNT Level II

Inspection Procedure
Procedure Number: SCC-12795

Visual Inspection: PASS
DOT Spec: 3AL-2015

Examination Result
PASS

Comments:

F10591 Pass 1_Thk.Txt
Event X Y Thk

Pass Number: 2
Event X Y TOF AMP

Pass Number: 5
Event X Y TOF AMP

Date: 8/4/2004 Time: 1:23:56 PM
Job No.:
Customer:
Cylinder S/N: F121087
Manufacture: M4141
Manufacture Date: 11/98
Cylinder Min Wall: 0.187

Equipment
Model: DWC Reflex
Serial Number: 001

Transducer
Manufacturer: Harisonic
Serial Number: 3AL604
Diameter[Inch]: 0.500
EBW Size[Inch]: 0.220
Frequency[MHz]: 2.250
Water Path[Inch]: 4.250

Calibration Cylinder
Cal_Cylinder Type: 3AL
Diameter: 4.250
Cal-Cyl-S/N: 655247
Minimum Wall: 0.187
Pressure: 2015
Helix: 0.200
Cal-Cyl-Status: Passed

Inspector
Name: Paul Graves
Certification: ASNT Level II

Inspection Procedure
Procedure Number: SCC-12795

Visual Inspection: PASS
DOT Spec: 3AL-2015

Examination Result
PASS

Comments:

F121087 Pass 1_Thk.Txt
Event X Y Thk

Pass Number: 2
Event X Y TOF AMP

Pass Number: 5
Event X Y TOF AMP

Date: 7/31/2004 Time: 11:09:35 AM
Job No.:
Customer:
Cylinder S/N: F123435
Manufacture: M4141
Manufacture Date: 02/99
Cylinder Min Wall: 0.187

Equipment
Model: DWC Reflex
Serial Number: 001

Transducer
Manufacturer: Harisonic
Serial Number: 3AL604
Diameter[Inch]: 0.500
EBW Size[Inch]: 0.220
Frequency[MHz]: 2.250
Water Path[Inch]: 4.250

Calibration Cylinder
Cal_Cylinder Type: 3AL
Diameter: 4.250
Cal-Cyl-S/N: 655247
Minimum Wall: 0.187
Pressure: 2015
Helix: 0.200
Cal-Cyl-Status: Passed

Inspector
Name: Paul Graves
Certification: ASNT Level II

Inspection Procedure
Procedure Number: SCC-12795

Visual Inspection: PASS
DOT Spec: 3AL-2015

Examination Result
PASS

Comments:

F123435 Pass 1_Thk.Txt
Event X Y Thk

Pass Number: 2
Event X Y TOF AMP

Pass Number: 5
Event X Y TOF AMP

Date: 7/31/2004 Time: 10:54:05 AM
Job No.:
Customer:
Cylinder S/N: MM129553
Manufacture: M4002
Manufacture Date: 06/95
Cylinder Min Wall: 0.187

Equipment
Model: DWC Reflex
Serial Number: 001

Transducer
Manufacturer: Harisonic
Serial Number: 3AL604
Diameter[Inch]: 0.500
EBW Size[Inch]: 0.220
Frequency[MHz]: 2.250
Water Path[Inch]: 4.250

Calibration Cylinder
Cal_Cylinder Type: 3AL
Diameter: 4.250
Cal-Cyl-S/N: 655247
Minimum Wall: 0.187
Pressure: 2015
Helix: 0.200
Cal-Cyl-Status: Passed

Inspector
Name: Paul Graves
Certification: ASNT Level II

Inspection Procedure
Procedure Number: SCC-12795

Visual Inspection: PASS
DOT Spec: 3AL-2015

Examination Result
PASS

Comments:

MM129553 Pass 1_Thk.Txt
Event X Y Thk

Pass Number: 2
Event X Y TOF AMP

Pass Number: 5
Event X Y TOF AMP

Date: 7/31/2004 Time: 11:19:32 AM
Job No.:
Customer:
Cylinder S/N: R82219
Manufacture: M4002
Manufacture Date: 01/99
Cylinder Min Wall: 0.187

Equipment
Model: DWC Reflex
Serial Number: 001

Transducer
Manufacturer: Harisonic
Serial Number: 3AL604
Diameter[Inch]: 0.500
EBW Size[Inch]: 0.220
Frequency[MHz]: 2.250
Water Path[Inch]: 4.250

Calibration Cylinder
Cal_Cylinder Type: 3AL
Diameter: 4.250
Cal-Cyl-S/N: 655247
Minimum Wall: 0.187
Pressure: 2015
Helix: 0.200
Cal-Cyl-Status: Passed

Inspector
Name: Paul Graves
Certification: ASNT Level II

Inspection Procedure
Procedure Number: SCC-12795

Visual Inspection: PASS
DOT Spec: 3AL-2015

Examination Result
PASS

Comments:

R82219 Pass 1_Thk.Txt
Event X Y Thk

Pass Number: 2
Event X Y TOF AMP

Pass Number: 5
Event X Y TOF AMP

Date: 7/30/2004 Time: 6:02:00 PM
Job No.:
Customer:
Cylinder S/N: R82472
Manufacture: M4002
Manufacture Date: 01/99
Cylinder Min Wall: 0.187

Equipment
Model: DWC Reflex
Serial Number: 001

Transducer
Manufacturer: Harisonic
Serial Number: 3AL604
Diameter[Inch]: 0.500
EBW Size[Inch]: 0.220
Frequency[MHz]: 2.250
Water Path[Inch]: 4.250

Calibration Cylinder
Cal_Cylinder Type: 3AL
Diameter: 4.250
Cal-Cyl-S/N: 655247
Minimum Wall: 0.187
Pressure: 2015
Helix: 0.200
Cal-Cyl-Status: Passed

Inspector
Name: Paul Graves
Certification: ASNT Level II

Inspection Procedure
Procedure Number: SCC-12795

Visual Inspection: PASS
DOT Spec: 3AL-2015

Examination Result
PASS

Comments:

R82472 Pass 1_Thk.Txt
Event X Y Thk

Pass Number: 2
Event X Y TOF AMP

Pass Number: 5
Event X Y TOF AMP

Date: 7/31/2004 Time: 11:15:52 AM
Job No.:
Customer:
Cylinder S/N: R82815
Manufacture: M4002
Manufacture Date: 01/99
Cylinder Min Wall: 0.187

Equipment
Model: DWC Reflex
Serial Number: 001

Transducer
Manufacturer: Harisonic
Serial Number: 3AL604
Diameter[Inch]: 0.500
EBW Size[Inch]: 0.220
Frequency[MHz]: 2.250
Water Path[Inch]: 4.250

Calibration Cylinder
Cal_Cylinder Type: 3AL
Diameter: 4.250
Cal-Cyl-S/N: 655247
Minimum Wall: 0.187
Pressure: 2015
Helix: 0.200
Cal-Cyl-Status: Passed

Inspector
Name: Paul Graves
Certification: ASNT Level II

Inspection Procedure
Procedure Number: SCC-12795

Visual Inspection: PASS
DOT Spec: 3AL-2015

Examination Result
PASS

Comments:

R82815 Pass 1_Thk.Txt
Event X Y Thk

Pass Number: 2
Event X Y TOF AMP

Pass Number: 5
Event X Y TOF AMP

Date: 7/30/2004 Time: 5:27:08 PM
Job No.:
Customer:
Cylinder S/N: T11149
Manufacture: M4002
Manufacture Date: 06/99
Cylinder Min Wall: 0.187

Equipment
Model: DWC Reflex
Serial Number: 001

Transducer
Manufacturer: Harisonic
Serial Number: 3AL604
Diameter[Inch]: 0.500
EBW Size[Inch]: 0.220
Frequency[MHz]: 2.250
Water Path[Inch]: 4.250

Calibration Cylinder
Cal_Cylinder Type: 3AL
Diameter: 4.250
Cal-Cyl-S/N: 655247
Minimum Wall: 0.187
Pressure: 2015
Helix: 0.200
Cal-Cyl-Status: Passed

Inspector
Name: Paul Graves
Certification: ASNT Level II

Inspection Procedure
Procedure Number: SCC-12795

Visual Inspection: PASS
DOT Spec: 3AL-2015

Examination Result
PASS

Comments:

T11149 Pass 1_Thk.Txt
Event X Y Thk

Pass Number: 2
Event X Y TOF AMP

Pass Number: 5
Event X Y TOF AMP

Date: 7/31/2004 Time: 11:25:06 AM
Job No.:
Customer:
Cylinder S/N: T11177
Manufacture: M4002
Manufacture Date: 06/99
Cylinder Min Wall: 0.187

Equipment
Model: DWC Reflex
Serial Number: 001

Transducer
Manufacturer: Harisonic
Serial Number: 3AL604
Diameter[Inch]: 0.500
EBW Size[Inch]: 0.220
Frequency[MHz]: 2.250
Water Path[Inch]: 4.250

Calibration Cylinder
Cal_Cylinder Type: 3AL
Diameter: 4.250
Cal-Cyl-S/N: 655247
Minimum Wall: 0.187
Pressure: 2015
Helix: 0.200
Cal-Cyl-Status: Passed

Inspector
Name: Paul Graves
Certification: ASNT Level II

Inspection Procedure
Procedure Number: SCC-12795

Visual Inspection: PASS
DOT Spec: 3AL-2015

Examination Result
PASS

Comments:

T11177 Pass 1_Thk.Txt
Event X Y Thk

Pass Number: 2
Event X Y TOF AMP

Pass Number: 5
Event X Y TOF AMP

Date: 7/31/2004 Time: 10:57:10 AM
Job No.:
Customer:
Cylinder S/N: T18880
Manufacture: M4002
Manufacture Date: 07/99
Cylinder Min Wall: 0.187

Equipment
Model: DWC Reflex
Serial Number: 001

Transducer
Manufacturer: Harisonic
Serial Number: 3AL604
Diameter[Inch]: 0.500
EBW Size[Inch]: 0.220
Frequency[MHz]: 2.250
Water Path[Inch]: 4.250

Calibration Cylinder
Cal_Cylinder Type: 3AL
Diameter: 4.250
Cal-Cyl-S/N: 655247
Minimum Wall: 0.187
Pressure: 2015
Helix: 0.200
Cal-Cyl-Status: Passed

Inspector
Name: Paul Graves
Certification: ASNT Level II

Inspection Procedure
Procedure Number: SCC-12795

Visual Inspection: PASS
DOT Spec: 3AL-2015

Examination Result
PASS

Comments:

T18880 Pass 1_Thk.Txt
Event X Y Thk

Pass Number: 2
Event X Y TOF AMP

Pass Number: 5
Event X Y TOF AMP

Date: 7/30/2004 Time: 5:48:03 PM
Job No.:
Customer:
Cylinder S/N: T21211
Manufacture: M4002
Manufacture Date: 07/99
Cylinder Min Wall: 0.187

Equipment
Model: DWC Reflex
Serial Number: 001

Transducer
Manufacturer: Harisonic
Serial Number: 3AL604
Diameter[Inch]: 0.500
EBW Size[Inch]: 0.220
Frequency[MHz]: 2.250
Water Path[Inch]: 4.250

Calibration Cylinder
Cal_Cylinder Type: 3AL
Diameter: 4.250
Cal-Cyl-S/N: 655247
Minimum Wall: 0.187
Pressure: 2015
Helix: 0.200
Cal-Cyl-Status: Passed

Inspector
Name: Paul Graves
Certification: ASNT Level II

Inspection Procedure
Procedure Number: SCC-12795

Visual Inspection: PASS
DOT Spec: 3AL-2015

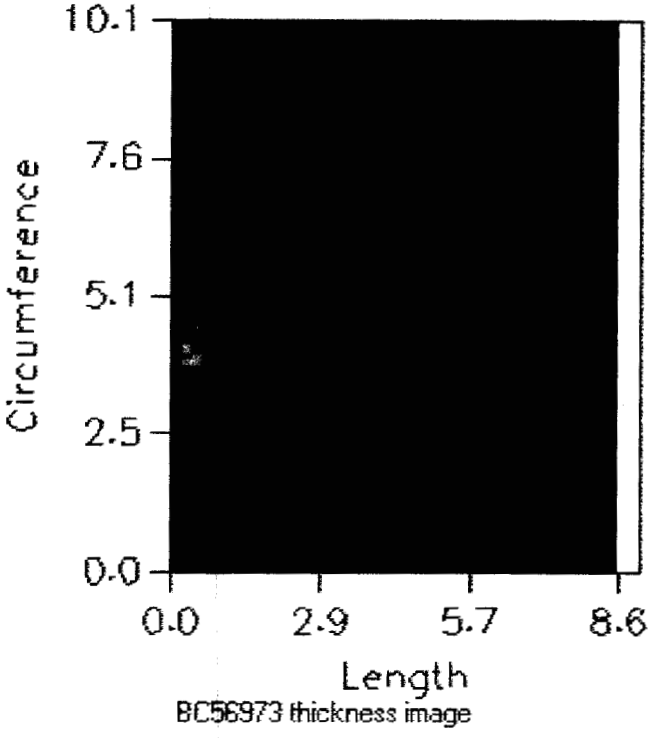
Examination Result
PASS

Comments:

T21211 Pass 1_Thk.Txt
Event X Y Thk

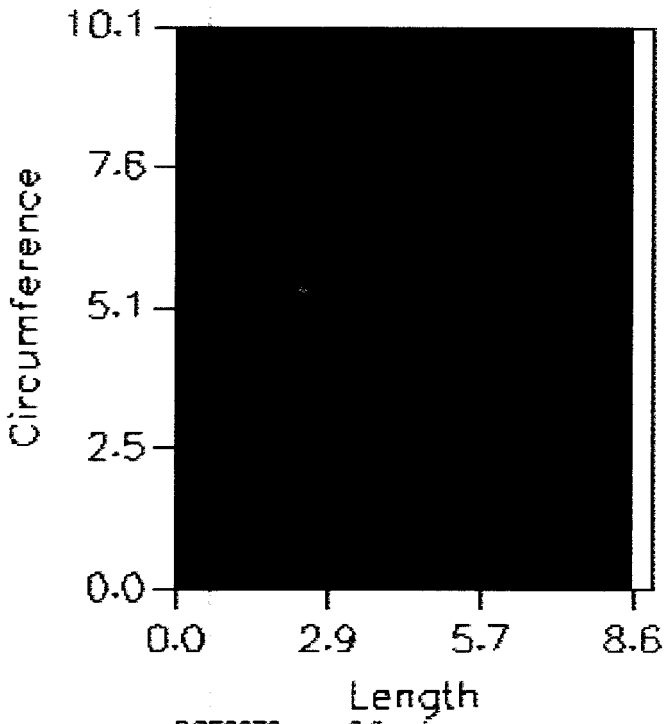
Pass Number: 2
Event X Y TOF AMP

Pass Number: 5
Event X Y TOF AMP

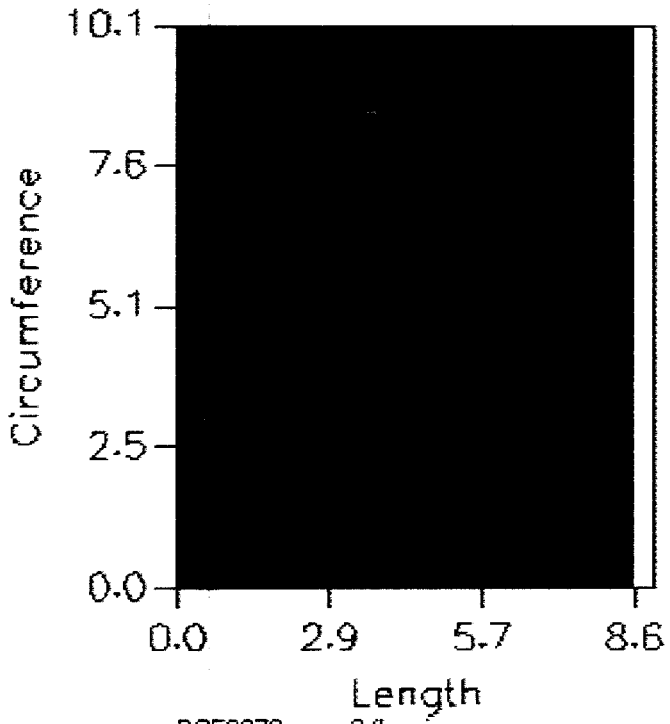


BC56973 thickness image

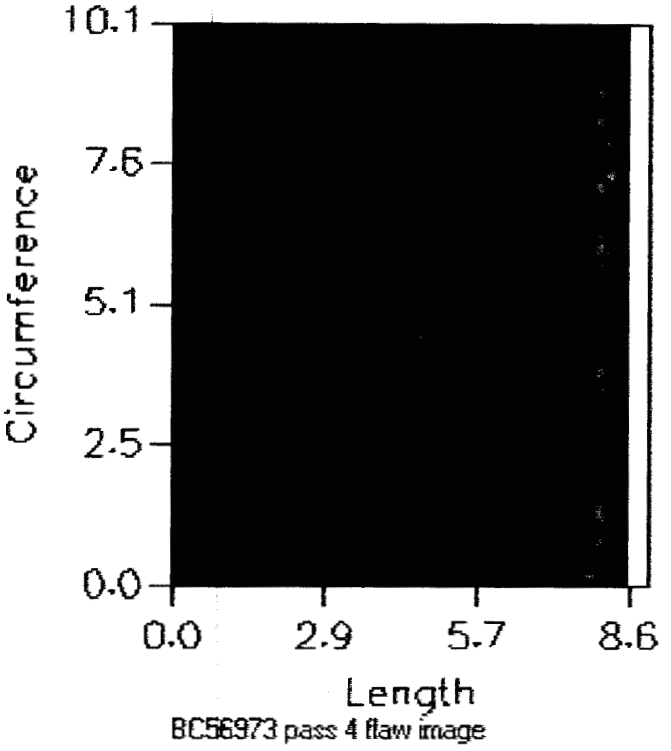
CALIBRATION STANDARD



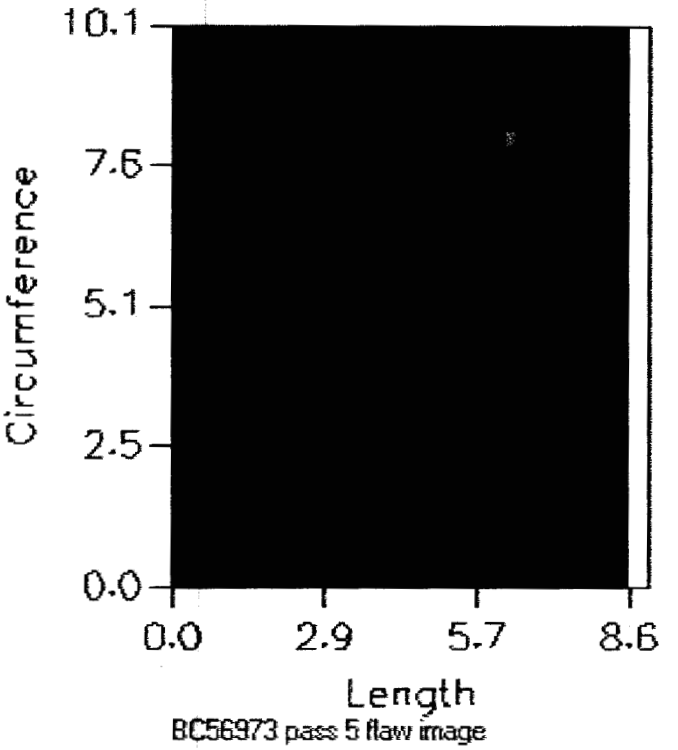
BC56973 pass 2 flaw image



BC56973 pass 3 flaw image



BC56973 pass 4 flaw image



BC56973 pass 5 flaw image

Date: 7/30/2004 Time: 4:52:16 PM
Job No.:
Customer:
Cylinder S/N: BC56973
Manufacture: M4141
Manufacture Date: 03/97
Cylinder Min Wall: 0.158

Equipment
Model: DWC Reflex
Serial Number: 001

Transducer
Manufacturer: Harisonic
Serial Number: 02A018
Diameter[Inch]: 0.500
EBW Size[Inch]: 0.180
Frequency[MHz]: 3.500
Water Path[Inch]: 3.750

Calibration Cylinder
Cal_Cylinder Type: 3AL
Diameter: 3.250
Cal-Cyl-S/N: BC56973
Minimum Wall: 0.158
Pressure: 2216
Helix: 0.150
Cal-Cyl-Status: Passed
Cal-Cyl-Setupname: Cal_3AL_2216_3N1D4_9_6_BC56973_1
Cali-Operator: Paul Graves

Flaw Name	Size	123X Position	4X Position	5X Position	Found at:
MWP	0.700X0.700	0.210	0.000	0.000	1
L1	0.800X0.000	1.400	0.000	0.000	23
L2	0.800X0.000	3.100	0.000	0.000	23
FBH	0.120X0.120	0.000	2.300	2.800	45
T1	0.000X0.800	0.000	4.410	5.040	45
T2	0.000X0.800	0.000	4.800	5.600	45

Inspector
Name: Paul Graves
Certification: ASNT Level II

Inspection Procedure
Procedure Number: SCC-12795

Visual Inspection: PASS
DOT Spec: 3AL-2216

Examination Result
FAIL
On pass 1: Thin Wall
On pass 2 3 4 5 : Pit/Crack
See attached documentation for detailed flaw result

Comments:

BC56973 Pass 1_Thk.Txt

Event	X	Y	Thk
255	0.420	4.595	0.156
257	0.420	4.390	0.153
258	0.420	4.288	0.151
259	0.420	4.186	0.153
260	0.420	4.084	0.153
261	0.420	3.982	0.156
262	0.420	3.880	0.156
263	0.420	3.778	0.153
356	0.630	4.492	0.156
357	0.630	4.390	0.156
358	0.630	4.288	0.153
359	0.630	4.186	0.153
360	0.630	4.084	0.153
361	0.630	3.982	0.156
363	0.630	3.778	0.156
4008	8.400	9.393	0.153
4073	8.400	2.757	0.156
4170	8.610	3.063	0.148

Pass Number: 2

Event	X	Y	TOF	AMP
42	0.000	5.922	7.480	1.091
43	0.000	5.820	6.580	1.100
142	0.210	5.922	7.740	1.091
143	0.210	5.820	6.580	1.100
242	0.420	5.922	7.580	1.100
243	0.420	5.820	6.680	1.100
342	0.630	5.922	7.700	1.100
343	0.630	5.820	6.660	1.100
344	0.630	5.718	5.620	0.868
	0.840	0.306		
847	1.680	5.411	7.700	1.100
848	1.680	5.309	6.420	1.100
947	1.890	5.411	7.420	1.100
948	1.890	5.309	6.420	1.100
1047	2.100	5.411	7.660	1.100
1048	2.100	5.309	6.400	1.100
1147	2.310	5.411	7.680	1.100
1148	2.310	5.309	6.420	1.100
1247	2.520	5.411	7.200	0.937
	1.050	0.204		
1422	2.940	7.964	7.080	1.100
	0.210	0.102		
1695	3.360	0.511	11.120	1.091
1795	3.570	0.511	11.360	1.100
1895	3.780	0.511	11.180	1.091
1995	3.990	0.511	11.420	1.100
	0.840	0.102		
3145	6.510	5.616	8.000	0.988
3146	6.510	5.513	7.000	1.100
3147	6.510	5.411	6.100	1.031

	0.210	0.306		
4167	8.610	3.369	7.420	1.100
4168	8.610	3.267	6.580	1.100
4167	8.610	3.369	7.420	1.100
4168	8.610	3.267	6.580	1.100
	0.210	0.204		

Pass Number: 3

Event	X	Y	TOF	AMP
69	0.000	3.165	5.980	1.100
70	0.000	3.063	7.040	1.100
169	0.210	3.165	6.040	1.100
170	0.210	3.063	7.100	1.100
269	0.420	3.165	6.160	1.100
270	0.420	3.063	7.120	1.100
369	0.630	3.165	6.160	1.100
370	0.630	3.063	7.080	1.100
371	0.630	2.961	8.180	1.031
	0.840	0.306		
765	1.470	3.574	6.800	1.100
865	1.680	3.574	6.620	1.100
965	1.890	3.574	6.660	1.100
966	1.890	3.471	7.960	0.816
1065	2.100	3.574	6.640	1.100
1165	2.310	3.574	6.640	1.100
1166	2.310	3.471	7.980	0.894
	1.050	0.204		
1441	2.940	6.024	6.940	1.100
	0.210	0.102		
1617	3.360	8.474	11.160	0.911
1717	3.570	8.474	11.400	1.100
1718	3.570	8.372	12.520	0.834
1816	3.780	8.577	10.480	0.937
1817	3.780	8.474	11.080	1.100
1916	3.990	8.577	10.380	0.920
1917	3.990	8.474	10.940	1.100
1918	3.990	8.372	12.320	0.842
2016	4.200	8.577	10.460	0.980
2017	4.200	8.474	10.900	1.100
2018	4.200	8.372	12.280	0.928
	1.050	0.306		
3167	6.510	3.369	7.320	1.100
	0.210	0.102		

Pass Number: 4

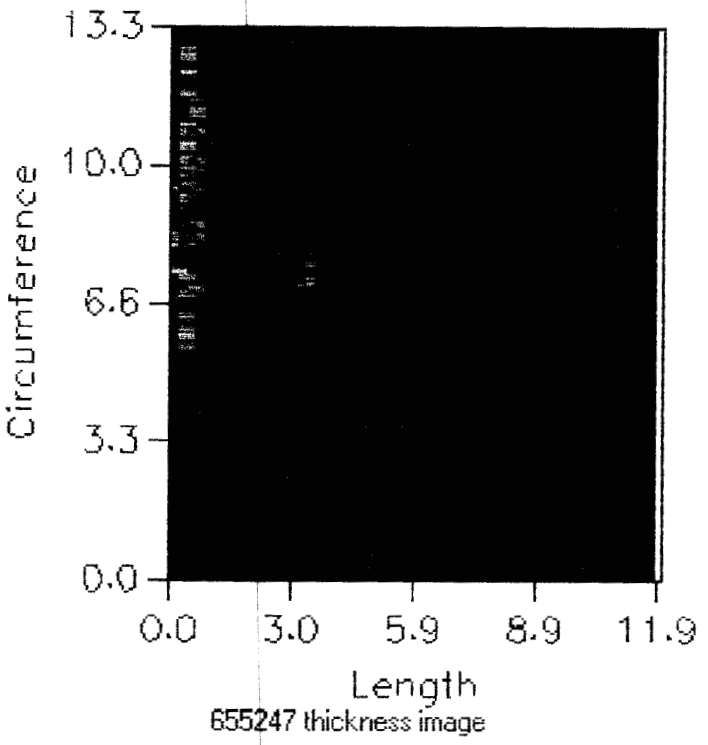
Event	X	Y	TOF	AMP
360	0.630	4.084	5.100	0.937
361	0.630	3.982	5.080	0.816
363	0.630	3.778	5.660	0.842
	0.210	0.408		
1234	2.520	6.739	6.960	0.816

1335	2.730	6.637	5.420	1.066
	0.420	0.204		
2256	4.620	4.492	7.020	1.100
2257	4.620	4.390	7.380	1.100
2258	4.620	4.288	7.540	1.100
2259	4.620	4.186	7.280	1.100
2260	4.620	4.084	6.480	1.100
2261	4.620	3.982	6.700	0.902
2262	4.620	3.880	7.660	0.868
2263	4.620	3.778	7.280	0.877
2264	4.620	3.676	6.920	0.885
2265	4.620	3.574	6.780	0.997
2266	4.620	3.471	6.620	0.928
2357	4.830	4.390	5.280	1.100
2358	4.830	4.288	5.340	1.100
2359	4.830	4.186	5.140	0.894
2362	4.830	3.880	5.460	1.100
2363	4.830	3.778	5.240	1.100
2366	4.830	3.471	5.060	1.014
	0.420	1.123		
2607	5.460	9.495	9.640	1.100
2608	5.460	9.393	9.900	1.100
2609	5.460	9.291	10.080	1.100
2610	5.460	9.189	10.060	1.100
2611	5.460	9.087	9.840	1.100
2612	5.460	8.985	9.140	1.100
2613	5.460	8.883	9.820	1.100
2614	5.460	8.781	10.120	1.100
2615	5.460	8.679	9.520	1.100
2707	5.670	9.495	5.840	1.100
2708	5.670	9.393	5.680	1.100
2709	5.670	9.291	6.520	1.100
2710	5.670	9.189	5.860	1.100
2711	5.670	9.087	6.080	1.100
2712	5.670	8.985	5.640	1.100
2713	5.670	8.883	5.220	1.100
2714	5.670	8.781	5.260	1.100
2715	5.670	8.679	5.600	1.100
	0.420	0.919		
2960	6.090	4.084	6.840	0.816
2961	6.090	3.982	6.300	1.031
2962	6.090	3.880	6.060	1.100
2963	6.090	3.778	5.540	1.100
2964	6.090	3.676	6.500	1.100
2965	6.090	3.574	6.440	0.894
	0.210	0.613		
3796	7.770	0.408	14.600	0.902
3798	7.770	0.204	15.180	0.937
3799	7.770	0.102	15.460	1.100
3899	7.980	0.102	12.260	1.100
	0.420	0.408		
3872	7.980	2.859	14.680	1.091

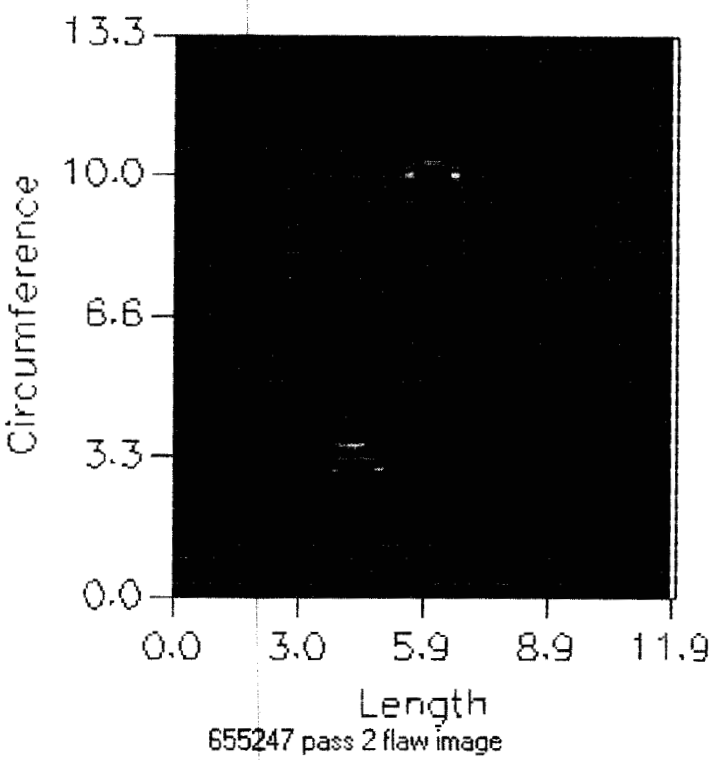
Pass Number: 5

Event	X	Y	TOF	AMP

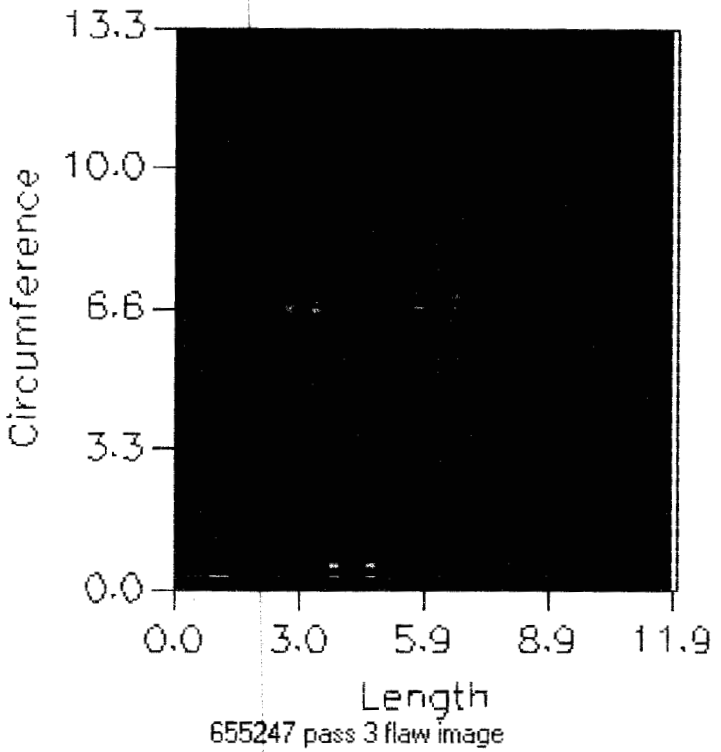
466	0.840	3.471	5.160	1.040
	0.210	0.102		
469	0.840	3.165	5.060	1.100
	0.210	0.102		
473	0.840	2.757	5.100	0.971
474	0.840	2.655	5.060	1.091
	0.210	0.204		
1547	3.150	5.411	5.480	0.928
	0.210	0.102		
2567	5.250	3.369	5.160	0.859
2568	5.250	3.267	5.380	1.100
2569	5.250	3.165	5.360	1.014
2570	5.250	3.063	5.800	1.031
2571	5.250	2.961	5.860	1.048
2572	5.250	2.859	5.760	0.911
2573	5.250	2.757	5.840	0.911
2574	5.250	2.655	5.080	1.100
2575	5.250	2.553	5.740	1.083
2576	5.250	2.450	5.760	1.040
2577	5.250	2.348	5.480	1.100
	0.210	1.123		
2925	6.090	7.658	5.240	0.834
3017	6.300	8.474	5.440	1.100
3018	6.300	8.372	8.840	1.014
3019	6.300	8.270	9.120	1.031
3020	6.300	8.168	9.120	1.048
3021	6.300	8.066	8.440	0.911
3022	6.300	7.964	9.180	0.911
3023	6.300	7.862	9.240	0.911
3024	6.300	7.760	9.180	0.885
3025	6.300	7.658	9.280	1.023
3026	6.300	7.556	9.480	1.091
3118	6.510	8.372	10.220	0.988
3119	6.510	8.270	10.860	0.971
3120	6.510	8.168	10.380	0.868
3121	6.510	8.066	11.600	0.825
3122	6.510	7.964	10.640	0.859
3123	6.510	7.862	10.720	0.808
3125	6.510	7.658	11.140	0.868
3126	6.510	7.556	11.700	0.928
	0.630	1.021		



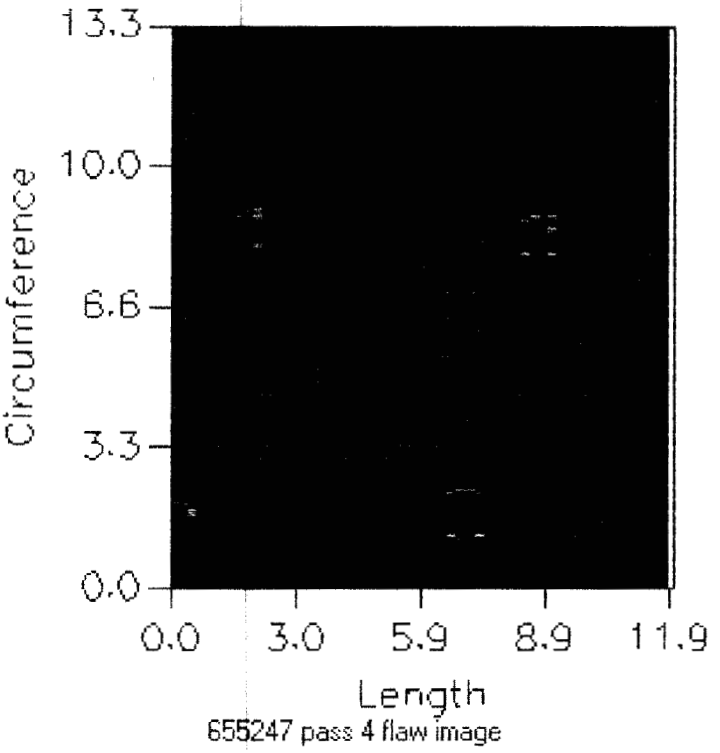
CALIBRATION STANDARD



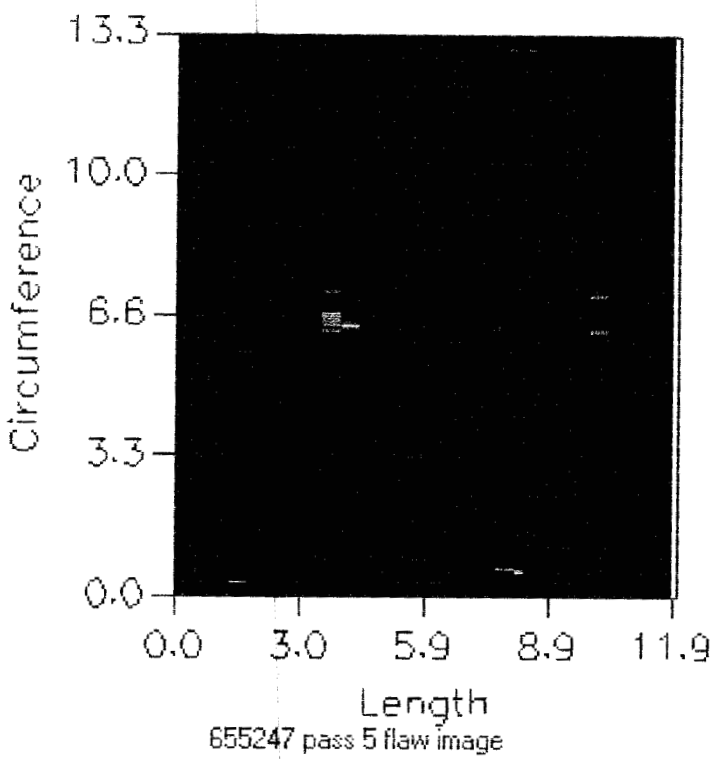
655247 pass 2 flaw image



655247 pass 3 flaw image



655247 pass 4 flaw image



655247 pass 5 flaw image

Date: 7/30/2004 Time: 5:17:59 PM
Job No.:
Customer:
Cylinder S/N: 655247
Manufacture:
Manufacture Date:
Cylinder Min Wall: 0.187

Equipment
Model: DWC Reflex
Serial Number: 001

Transducer
Manufacturer: Harisonic
Serial Number: 3AL604
Diameter[Inch]: 0.500
EBW Size[Inch]: 0.220
Frequency[MHz]: 2.250
Water Path[Inch]: 4.250

Calibration Cylinder
Cal_Cylinder Type: 3AL
Diameter: 4.250
Cal-Cyl-S/N: 655247
Minimum Wall: 0.187
Pressure: 2015
Helix: 0.200
Cal-Cyl-Status: Passed
Cal-Cyl-Setupname: CAL_3AL_2015_4N1D4_21_6_655247_L
Cali-Operator: Paul Graves

Flaw Name	Size	123X Position	4X Position	5X Position	Found at:
MWP	0.500X0.500	2.500	0.000	0.000	1
FBH	0.120X0.120	0.000	0.250	1.300	45
L1	0.800X0.000	4.100	0.000	0.000	23
L2	0.800X0.000	5.700	0.000	0.000	23
T1	0.000X0.700	0.000	6.600	7.500	45
T2	0.000X0.700	0.000	8.800	9.800	45

Inspector
Name: Paul Graves
Certification: ASNT Level II

Inspection Procedure
Procedure Number: SCC-12795/12966

Visual Inspection:
DOT Spec:

Examination Result
FAIL
On pass 1: Thin Wall
On pass 2 3 4 5 : Pit/Crack
See attached documentation for detailed flaw result

Comments:

655247 Pass 1_Thk.Txt

Event	X	Y	Thk
208	0.220	9.346	0.183
363	0.440	9.763	0.183
365	0.440	9.597	0.183
366	0.440	9.513	0.183
368	0.440	9.346	0.183
369	0.440	9.263	0.183
216	0.220	8.679	0.183
217	0.220	8.595	0.183
218	0.220	8.512	0.185
219	0.220	8.428	0.185
220	0.220	8.345	0.185
222	0.220	8.178	0.185
224	0.220	8.011	0.185
371	0.440	9.096	0.186
374	0.440	8.846	0.186
375	0.440	8.762	0.183
379	0.440	8.428	0.183
380	0.440	8.345	0.186
381	0.440	8.261	0.178
382	0.440	8.178	0.186
383	0.440	8.095	0.186
224	0.220	8.011	0.186
506	0.660	11.182	0.186
511	0.660	10.765	0.183
520	0.660	10.014	0.186
523	0.660	9.763	0.186
524	0.660	9.680	0.186
525	0.660	9.597	0.178
529	0.660	9.263	0.186
530	0.660	9.179	0.186
531	0.660	9.096	0.186
532	0.660	9.012	0.186
533	0.660	8.929	0.186
534	0.660	8.846	0.186
535	0.660	8.762	0.186
538	0.660	8.512	0.186
542	0.660	8.178	0.186
231	0.220	7.427	0.181
393	0.440	7.260	0.181
398	0.440	6.843	0.183
402	0.440	6.509	0.183
403	0.440	6.426	0.183
405	0.440	6.259	0.183
408	0.440	6.008	0.183
410	0.440	5.841	0.186
413	0.440	5.591	0.186
557	0.660	6.926	0.186

Pass Number: 2

Event	X	Y	TOF	AMP
2998	3.960	3.505	25.020	0.155
3157	4.180	3.588	25.720	0.172
3158	4.180	3.505	24.980	0.198

3317	4.400	3.588	25.820	0.163
3318	4.400	3.505	25.060	0.206
3477	4.620	3.588	25.700	0.155
3478	4.620	3.505	25.000	0.198
	0.880	0.167		
3002	3.960	3.171	19.500	0.206
3003	3.960	3.088	18.520	0.705
3004	3.960	3.004	17.540	0.524
3005	3.960	2.921	16.980	0.249
3161	4.180	3.254	19.840	0.155
3162	4.180	3.171	19.540	0.249
3163	4.180	3.088	18.460	0.851
3164	4.180	3.004	17.460	0.524
3165	4.180	2.921	16.680	0.258
3322	4.400	3.171	19.540	0.241
3323	4.400	3.088	18.540	0.773
3324	4.400	3.004	17.580	0.593
3325	4.400	2.921	16.720	0.258
3481	4.620	3.254	19.840	0.155
3482	4.620	3.171	19.520	0.206
3483	4.620	3.088	18.440	0.782
3484	4.620	3.004	17.460	0.559
3485	4.620	2.921	16.700	0.292
3643	4.840	3.088	18.540	0.378
3644	4.840	3.004	17.580	0.352
3645	4.840	2.921	16.740	0.163
	1.100	0.417		
4199	5.720	10.097	23.820	0.180
4200	5.720	10.014	22.980	0.395
4201	5.720	9.930	22.120	0.318
4202	5.720	9.847	18.860	0.241
4203	5.720	9.763	15.300	0.163
4358	5.940	10.181	24.460	0.249
4359	5.940	10.097	23.700	0.344
4360	5.940	10.014	22.940	0.713
4361	5.940	9.930	22.200	0.593
4362	5.940	9.847	15.840	0.370
4363	5.940	9.763	15.360	0.284
4518	6.160	10.181	24.480	0.223
4519	6.160	10.097	23.800	0.292
4520	6.160	10.014	23.040	0.619
4521	6.160	9.930	22.200	0.516
4522	6.160	9.847	15.760	0.378
4523	6.160	9.763	18.060	0.223
4678	6.380	10.181	24.480	0.266
4679	6.380	10.097	23.720	0.318
4680	6.380	10.014	23.160	0.679
4681	6.380	9.930	22.200	0.516
4682	6.380	9.847	15.860	0.370
4683	6.380	9.763	18.180	0.249
4839	6.600	10.097	23.820	0.206
4840	6.600	10.014	23.060	0.438
4841	6.600	9.930	22.220	0.413
4842	6.600	9.847	15.760	0.275
4843	6.600	9.763	15.280	0.180
	1.100	0.501		

Pass Number: 3

Event	X	Y	TOF	AMP
957	1.100	0.250	7.860	0.980
958	1.100	0.167	8.980	0.773
	0.220	0.167		
2161	2.860	6.592	7.700	0.825
2320	3.080	6.676	6.920	0.808
2321	3.080	6.592	7.800	0.902
2480	3.300	6.676	6.800	1.005
2481	3.300	6.592	7.660	1.100
	0.660	0.167		
3034	3.960	0.501	6.620	0.911
3035	3.960	0.417	7.380	1.100
3036	3.960	0.334	8.260	1.100
3194	4.180	0.501	6.700	1.057
3195	4.180	0.417	7.440	1.100
3196	4.180	0.334	8.200	1.100
3354	4.400	0.501	6.580	0.902
3355	4.400	0.417	7.360	1.100
3356	4.400	0.334	8.260	1.100
3514	4.620	0.501	6.660	0.894
3515	4.620	0.417	7.400	1.100
3516	4.620	0.334	8.160	1.100
	0.880	0.250		
3041	4.180	13.268	17.820	0.834
3201	4.400	13.268	17.900	0.859
3361	4.620	13.268	17.780	0.799
3521	4.840	13.268	17.800	0.739
	0.880	0.083		
4237	5.720	6.926	11.760	0.816
4238	5.720	6.843	12.560	1.100
4239	5.720	6.759	13.380	1.100
4398	5.940	6.843	11.660	0.868
4399	5.940	6.759	12.100	1.100
4400	5.940	6.676	13.300	1.100
4558	6.160	6.843	11.780	0.945
4559	6.160	6.759	12.600	1.100
4560	6.160	6.676	13.400	1.100
4718	6.380	6.843	11.700	0.894
4719	6.380	6.759	12.480	1.100
4720	6.380	6.676	13.380	1.100
4878	6.600	6.843	11.760	0.688
4879	6.600	6.759	12.620	1.100
4880	6.600	6.676	13.440	0.894
	1.100	0.334		

Pass Number: 4

Event	X	Y	TOF	AMP
139	0.000	1.752	17.980	0.172
297	0.220	1.919	17.160	0.180
298	0.220	1.836	17.380	0.206
299	0.220	1.752	17.480	0.232
459	0.440	1.752	15.360	0.155
	0.660	0.250		

1336	1.760	8.679	16.900	0.206
1337	1.760	8.595	17.580	0.206
1338	1.760	8.512	17.700	0.180
1339	1.760	8.428	17.680	0.206
1340	1.760	8.345	16.520	0.223
1341	1.760	8.261	17.540	0.223
1342	1.760	8.178	24.720	0.198
1343	1.760	8.095	16.700	0.163
1494	1.980	8.846	23.580	0.292
1496	1.980	8.679	14.940	0.309
1497	1.980	8.595	23.300	0.292
1498	1.980	8.512	13.960	0.292
1499	1.980	8.428	14.760	0.301
1500	1.980	8.345	23.020	0.309
1501	1.980	8.261	22.920	0.318
1502	1.980	8.178	22.840	0.292
1503	1.980	8.095	15.480	0.241
	0.440	0.834		
5094	6.820	2.170	18.860	0.215
5095	6.820	2.086	19.120	0.258
5096	6.820	2.003	20.060	0.275
5097	6.820	1.919	19.560	0.241
5098	6.820	1.836	19.220	0.223
5099	6.820	1.752	19.500	0.232
5100	6.820	1.669	19.160	0.241
5101	6.820	1.586	19.780	0.232
5102	6.820	1.502	19.580	0.249
5103	6.820	1.419	19.480	0.301
5104	6.820	1.335	19.780	0.292
5105	6.820	1.252	19.740	0.206
5253	7.040	2.253	17.180	0.232
5254	7.040	2.170	17.040	0.378
5255	7.040	2.086	17.620	0.507
5256	7.040	2.003	17.660	0.464
5257	7.040	1.919	17.480	0.430
5258	7.040	1.836	17.500	0.438
5259	7.040	1.752	17.320	0.413
5260	7.040	1.669	17.400	0.430
5261	7.040	1.586	16.760	0.473
5262	7.040	1.502	16.700	0.481
5263	7.040	1.419	16.660	0.567
5264	7.040	1.335	17.460	0.541
5265	7.040	1.252	17.440	0.378
5266	7.040	1.168	16.860	0.232
5414	7.260	2.170	12.820	0.206
5415	7.260	2.086	12.780	0.284
5416	7.260	2.003	12.520	0.275
5417	7.260	1.919	12.440	0.241
5418	7.260	1.836	12.420	0.241
5419	7.260	1.752	12.280	0.232
5420	7.260	1.669	12.060	0.249
5421	7.260	1.586	11.920	0.275
5422	7.260	1.502	11.820	0.292
5423	7.260	1.419	12.480	0.292
5424	7.260	1.335	12.440	0.284

Pass Number: 5

Event	X	Y	TOF	AMP
1277	1.540	0.250	6.100	0.945

1278	1.540	0.167	5.480	1.100
1279	1.540	0.083	6.620	1.100
1280	1.540	0.000	6.580	1.100
	0.220	0.334		
2795	3.740	7.093	5.220	0.791
2796	3.740	7.010	5.000	1.057
2797	3.740	6.926	5.880	1.100
2798	3.740	6.843	5.660	1.100
2799	3.740	6.759	5.820	1.100
2800	3.740	6.676	5.820	1.100
2802	3.740	6.509	5.620	1.100
2804	3.740	6.342	5.980	1.100
2805	3.740	6.259	6.000	1.100
	0.220	0.918		
3124	4.180	6.342	15.120	0.842
	0.220	0.083		
5913	7.920	0.584	5.540	0.834
5914	7.920	0.501	5.860	1.100
5915	7.920	0.417	5.320	1.100
5916	7.920	0.334	6.000	1.100
5917	7.920	0.250	6.100	1.100
5918	7.920	0.167	5.900	1.100
5919	7.920	0.083	5.740	1.100
5920	7.920	0.000	6.220	1.100
6074	8.140	0.501	7.700	1.100
6075	8.140	0.417	7.920	1.100
6076	8.140	0.334	7.940	1.100
6077	8.140	0.250	8.800	1.100
6078	8.140	0.167	7.880	1.100
6079	8.140	0.083	8.140	1.100
6080	8.140	0.000	8.360	1.100
	0.440	0.668		
5921	8.140	13.268	6.260	1.100
5922	8.140	13.185	6.220	1.100
5923	8.140	13.101	6.200	1.100
5924	8.140	13.018	5.980	1.100
5925	8.140	12.935	6.100	1.100
6081	8.360	13.268	8.180	1.100
6082	8.360	13.185	8.020	1.100
6083	8.360	13.101	8.260	1.100
6084	8.360	13.018	7.720	1.100
6085	8.360	12.935	7.600	1.100
	0.440	0.417		

7436	10.120	7.010	10.280	0.859
7437	10.120	6.926	10.340	1.100
7438	10.120	6.843	11.100	1.100
7439	10.120	6.759	10.960	1.100
7440	10.120	6.676	10.980	1.100
7441	10.120	6.592	10.440	1.100
7442	10.120	6.509	10.440	1.100
7443	10.120	6.426	10.840	1.100
7444	10.120	6.342	10.860	1.100
7445	10.120	6.259	9.620	1.100
	0.220	0.834		

Appendix III

Personnel Qualification

August 28, 2004
Revision 0

3AL Testing Corp.

WRITTEN PRACTICE FOR THE QUALIFICATION AND CERTIFICATION OF NDT PERSONNEL

PREPARED BY:_____ Date:_____

Kevin Harkreader ASNT Level III 50275

STATEMENT

This written practice is a qualification and certification standard used by 3AL Testing Corp meeting the guidelines and recommendations of document SNT-TC-1A standard for qualification and certification of nondestructive testing personnel. It is intended to meet the two mandatory requirements of that document. The first being a written practice for qualifying and certifying personnel for nondestructive testing using the ultrasonic immersion system in the testing of compressed gas cylinders and second, modifying the suggestions of SNT-TC-1A to make the qualification and certification requirements appropriate for the company's needs. 3AL Testing Corp understands it is responsible for assuring that the qualification requirements are satisfactory for the NDT work that the employee will perform. It is our intention that individuals working on obtaining certification will work with and not just under the supervision of a qualified person to gather the necessary understanding for the ultrasonic NDT process. 3AL Testing Corp's Level III will exercise judgment to ensure each technician / operator is competent in performing nondestructive testing and operating the ultrasonic immersion system.

1. SCOPE

1.1 This written practice establishes the minimum requirements for the *control and administration* of training, examination, and certification of personnel conducting the ultrasonic discipline for testing compressed gas cylinders using the ultrasonic immersion method.

1.2 This written practice establishes the minimum requirements for education, training, experience, examination, and certification for personnel responsible for conducting ultrasonic testing while in the employment of 3AL Testing Corp and for any personnel employed by a licensee of the ultrasonic cylinder scanning immersion system.

3. DEFINITIONS

CERTIFICATION: Written testimony that the employee has met the applicable requirements of this standard.

EXPERIENCE: Actual performance or observation conducted during work activities in the ultrasonic NDT method under the direction of qualified supervision but not including time spent in organized training programs.

QUALIFICATION: Is the combination of demonstrated skill and knowledge with documented training and experience required for personnel to properly perform to a specified NDT Level.

OUTSIDE AGENCY: A Company or individual who provides NDT Level III services to the licensee of an ultrasonic cylinder scanning immersion system.

SHALL: A verb used to express the minimum requirements of this written practice.

TRAINING: The organized program developed to impart the knowledge and skills necessary for qualification.

WRITTEN PRACTICE: A written description of the requirements and actions that apply specifically to personnel involved in NDT.

GENERAL EXAMINATION: A documented written examination addressing the basic principles and theories of the ultrasonic NDT method.

SPECIFIC EXAMINATION: A documented written examination to determine an individual's understanding of applying ultrasonic's to testing cylinders, equipment calibration and immersion system setup parameters, types of flaws, and the accept reject criteria for cylinders.

PRACTICAL EXAMINATION: A documented oral, hands-on practical examination used to demonstrate the individuals ability to operate the immersion system, data evaluations and interpretations.

4. REFERENCES

ASNT Recommended Practice No. SNT-TC-1A, "Personnel Qualification and Certification in Nondestructive Testing," 1988 edition.

"Guide to Personnel Qualification and Certification," by George Wheeler.

SNT-TC-1A Method Supplements for Ultrasonic's.

SNT-TC-1A Questions and Answers: Inquiries to and Response from ASNT, SNT-TC-1A Interpretation Panel, current edition.

5. LEVELS OF QUALIFICATION

5.1 There are three basic levels of qualification used by NDT personnel at 3AL Testing Corp. Since the skills and responsibilities are specifically directed towards inspecting cylinders, it is therefore considered a unique and specialized discipline and falls under its own umbrella of specialized training. Employees certified under 3AL Testing Corp's written practice will be certified as a Level I or Level II "Special". The word "Special" is used to indicate the Level II has been properly trained and qualified specifically for the inspection of cylinders using the immersion method. It also means his duties, as a Level I or II is limited to the inspection of cylinders only. An individual in the process of becoming qualified and/or certified to NDT Level I is considered a trainee. A trainee shall not conduct tests or interpret, evaluate, or report test results independent of a certified 3AL Testing Corp Level II or Level III.

5.2 NDT Level I

1. An NDT Level I individual shall be qualified to properly perform specific calibrations, ultrasonic immersion test of cylinders and specific evaluations for acceptance or rejection determinations according to written instructions.
2. Record test results but has no authority to sign reports for the purpose of signifying satisfactory completion.
3. Receive instruction or supervision from a company certified Level II or Level III.

5.3 NDT Level II "Special"

1. Individuals shall be familiar with the scope and limitations of Ultrasonic's.
2. Ability to set up and calibrate ultrasonic immersion equipment.
3. Interpret and evaluate results of ultrasonic findings with respect to the applicable standards.
4. Train and guide Level I and trainee personnel.

5.4 NDT Level III.

1. An NDT Level III individual shall be capable of establishing techniques and procedures; interpreting codes, standards, specifications, and procedures; and designating the particular NDT methods, techniques, and procedures to be used.

2. The NDT Level III shall be responsible for the NDT operations for which qualified and assigned and shall be capable of interpreting and evaluating results in terms of existing codes, standards, and specifications.
3. The NDT Level III shall 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 NDT Level III shall have general familiarity with other NDT methods, as demonstrated by the ASNT Level III Basic Examination or other means.
4. The NDT Level III, in the methods in which certified, shall be capable of training and examining NDT Level I and II and Company Level III personnel for certification in those methods.

6. EDUCATION AND TRAINING REQUIREMENTS FOR LEVEL I & II

6.1 Personnel being considered for *initial* certification shall complete sufficient training to become thoroughly familiar with the principles and practices of the ultrasonic.

6.2 The training program should include or follow the training as outlined in SNT-TC-1A the"Recommended Training Course". A reputable outside agency or organization which offers this service as a structured classroom course for level I and II ultrasonic's and can provide documentation of classroom hours and certificate of completion will be accepted as meeting these requirements.

6.3 For both Levels I and Level II, in lieu of outside structured training, an in house, on the job (OTJ) training will be acceptable for meeting the training requirements. In house training must be from a certified Level II or Level III. Training shall consist of practical hands on of the ultrasonic system supplemented with review of ultrasonic book material that covers principals and theory directly related to the ultrasonic cylinder scanning immersion system.

6.4 Technicians with two years of schooling in an accredited NDT program and carry an associate's degree *for NDT* will have been considered properly trained for the methodology.

6.5 Any outside training shall be conducted by a Level III or by an outside agency or accredited school for NDT.

6.6 Documented training time exhibited in **Table 6.1** in the ultrasonic method shall be considered as satisfying the education training requirements of this written practice.

6.7 Technicians with previous Level II status in Ultrasonic's with a former employer, who has documentation as to the training, companies he worked for, the jobs performed, his job title, grades or certification status to prove, may be considered properly trained for the methodology.

6.8 Training on the ultrasonic cylinder scanning immersion system in accordance to **Table 6.1** will be required to obtain the Level I or Level II status. This training will also qualify towards any experience requirements listed in Table 7.1. Training may include classroom, practical calibration set-ups, learning software parameters, and scanning of cylinders under the direction and supervision of a company Level II or Level III.

Table 6.1
Ultrasonic Training Hours with No Previous Documented Training

	Ultrasonic Level I	Ultrasonic Level II
HS graduate or equivalent	**40 Hours divided by theory / principles and the cylinder scanning immersion system**	**40 Hours theory / principles 16 hours cylinder scanning immersion system**

A person may be qualified directly to NDT Level II with no time as a certified Level I, providing the required training consists of the sum of the hours required for NDT Level I and NDT Level II.

7. EXPERIENCE REQUIREMENTS FOR LEVEL I, II and III

7.1 To be considered for certification as a Level I, a new hire with no previous experience may obtain a Level I immediately provided he has completed training on the ultrasonic cylinder scanning system and has passed the general, specific and practical examinations.

7.2 Technicians with previous Level II status in Ultrasonic's with a former employer who has documentation as to the companies he worked for, the jobs performed, his job title, grades or certification status to prove, will be able to use this experience in satisfying 3AL Testing Corp's certification requirements. Minimum experience is exhibited in **Table 7.1**.

7.3 To be considered for certification as a Level II, a candidate shall meet the minimum experience qualification time on the ultrasonic cylinder scanning immersion system as exhibited in **Table 7.1**. Documented experience previously gained in ultrasonic inspection activities equivalent to those of Level I, II, and /or III may be considered in satisfying the qualification requirements of 3AL Testing Corp's written practice

7.4 Time experience needed to certify as a Level I or II will be at the discretion of 3AL Testing Corp's Level III, or any designated company Level II. Table 7.1 will be used as a base line for experience time required, however, this time can vary at the discretion of the Level III in accordance to each individual's ability.

7.5 For Level II status accumulated training time and experience time can be combined to meet the minimum 1 week requirement. Latitude is given for experience qualification time since the abilities of each technician differ and will be a determining factor for receiving Certification for Level I and II status. For reliable NDT inspection, the final responsibility for justifying ones certification will be determined by 3AL Testing Corp's Level III.

Table 7.1
Experience Requirements

	As an Ultrasonic Level I	As an Ultrasonic Level II
New hire with no previous NDT field experience.	**Once training has been done and test taken, 2 months or 200 documented learning hours of actual testing of cylinders on the ultrasonic cylinder scanning immersion system under supervision before advancing.**	**Up to 2 weeks of documented time on the ultrasonic cylinder scanning immersion system reviewing accept rejection criteria. Minimum of 1 week.**
New hire with previous Level II status and with 6 months of ultrasonic experience from former employer		**Up to 2 weeks of documented time on the ultrasonic cylinder scanning immersion system evaluating cylinders. Minimum of 1 week.**
New hire with 2 years of NDT training from an accredited school and no previous experience		**Up to 2 weeks of documented time on the ultrasonic cylinder scanning immersion system evaluating cylinders. Minimum of 1 week.**

* This time given above can vary at the discretion of the Level III in accordance to each individual's ability

7.6 All new employees or employees of a licensee shall perform training work with supervision from an experienced technician who is a Level II or Level III employed by 3AL Testing Corp or by a designated outside source. The technician shall be able to perform the method or technique to the satisfaction of the supervisor prior to any certification. Procedures and test techniques that individuals will encounter in cylinder testing, and the applicable instructions, specifications, or codes used by the industry shall be part of each candidate's informal on-the-job training.

8. EXAMINATIONS

8.1 The grading and administration of the examinations specified in Section 8.2 through 8.8 shall be the responsibility of the designated 3AL Testing Corp Level III certified in ultrasonic's, he/she shall approve the use of Level I and II questions, the practical test samples, and the performance checks. However, the administration and grading of examinations may be delegated to a representative of the NDT Level III. Those designated at this time are quality control personnel including Robert Fick.

8.2 General Examination for NDT Levels I and II

8.2.1 Each Level I and II candidate shall be given a general, objective type, multiple choice written examination addressing the basic ultrasonic principles of for which certification is sought. This examination will either be administered as part of the organized training program or given

separately when experienced personnel are being examined for rectification or for initial certification when coming from a former employer and complying with this written practice.

8.2.2 In preparing the examinations, a Level III employed by 3AL Testing Corp shall select or devise appropriate questions for ultrasonic's.

8.2.3 Candidate personnel shall have access to questions only at the time of the examination. This examination shall be closed-book; however, necessary data, such as graphs, tables, specifications, procedures, and codes may be provided.

8.2.4 **Table 8.1** summarizes the minimum number of general examination questions.

Table 8.1

	General Examination		Specific Examination	
Level	I	II	I	II
Ultrasonic Questions	40	40	20	40

8.3 Specific Examination NDT Levels I and II

8.3.1 Each Level I and II candidate shall be given a specific, objective type, multiple choice written examination addressing the equipment, operating procedures, and test techniques that the personnel may encounter in their specific job assignments. This shall address the common specifications, codes, procedures and acceptance criteria used.

8.3.2 In preparing the examinations, a Level III employed by 3AL Testing Corp shall select or devise appropriate questions.

8.3.3 Candidate personnel shall have access to questions only at the time of the examination. This examination shall be closed-book; however, necessary data, such as graphs, tables specifications, procedures, and codes may be provided.

8.3.4 Table 8.1 summarizes the minimum number of specific examination questions.

8.4 Practical Examination (for Level I and II examination)

8.4.1 The Level I and II candidate shall be given a practical "hands-on" examination that demonstrate familiarity with and ability to setup, perform specific calibrations and operate all necessary equipment to the proper procedures in accordance to examiners instructions.

8.5 Grading

8.5.1 The grading of examinations may be delegated to a representative of the NDT Level III.

8.5.2 A composite grade shall be determined by simple averaging of the general, specific, and practical examination results.

8.6.3 Examinations administered for qualification shall result in a composite grade of at least 80 percent, with no individual examination having a grade less than 70 percent.

8.9 Reexamination

8.9.1 Those failing to attain the required grades shall wait at least thirty (30) days or receive suitable additional training as determined by the NDT Level III or quality department before reexamination. With additional training an earlier re-examination may be given.

9. CERTIFICATION

9.1 Certification of all levels of NDT personnel is the responsibility of 3AL Testing Corp.

9.2 3AL Testing Corp's Level III shall certify Level I and II individuals, upon their completion of the training, experience and examinations required by this written practice.

9.3 Personnel certifications and copies of this written practice shall be maintained on file by 3AL Testing Corp.

9.4 The qualification records of the certified individuals shall be maintained by 3AL Testing Corp and shall include the following: See Sample Form ***Employee Profile and NDT Certification of Qualification.***

- Name of certified individual.
- Level of certification and NDT method.
- Educational background and experience of certified individuals.
- Statement indicating satisfactory completion of training in accordance with this written practice.
- Results of the vision examinations for the current certification period.
- Current examination copies or evidence of successful completion of examinations.
- Other suitable evidence of satisfactory qualifications when such qualifications are used in lieu of examinations.
- Composite grade(s) or suitable evidence of grades.
- Dates of certification and/or recertification and the dates and assignments to NDT.
- Signature of employer's designated representative.

10. RECERTIFICATION

10.1 All Level II NDT personnel shall be recertified every 3 years based upon evidence of continuing satisfactory performance as judged and documented by a Level III for the applicable method. Where a weakness is identified by the NDT Level III or quality department in the technical performance of an individual, supplemental training, and specific examinations may be used, at the discretion of the NDT Level III or quality department, to upgrade the individual prior to completion of recertification.

11. TERMINATION OF CERTIFICATION

11.1 The certification of all NDT personnel shall terminate upon a period of one (1) year during

which no NDT-related work is performed in the method certified.

11.2 All NDT certification of personnel leaving the employment of 3AL Testing Corp are revoked at the time of the employee's separation.

11.3 NDT personnel may be reexamined any time at the discretion of the employer or the Level III and have there certifications extended or revoke.

12. PREVIOUS CERTIFICATIONS

12.1 3AL Testing Corp has the option of accepting previous qualifications and certifications for contract employment and or limited level II status or recertifying that individual for the method. This decision will be based off the individual's previous experience with the methods and the difficulty and technical aspect of the work involved.

12.2 To grandfather an individual's previous qualification and certifications the individual must have documents indicating past experience, qualifications and certifications.

13. DOCUMENTATION

13.1 The NDT Level III or designated Level II in the quality department is responsible for the gathering and organization of all documentation relating to the overall NDT program at 3AL Testing Corp. Included in the documentation to be maintained as part of the objective evidence for the NDT program at 3AL Testing Corp are the following;

(1) This written practice
(2) Documentation of each test, employee profile listing related training and experience
(3) Documentation for current NDT status

In following the requirements of this document, the designated 3AL Testing Corp Level III is

Name: Kevin Harkreader ASNT Level III 50275 Date: August 28, 2004

Those individuals who are qualified and designated under the Level III to perform such functions as related to this written practice are as follows such as training and testing on the ultrasonic cylinder scanning immersion system ;

Name	Level	Name	Level
Robert Fick	II		

Sample EMPLOYEE PROFILE AND NDT CERTIFICATION OF QUALIFICATION FOR ULTRASONIC IMMERSION TESTING

Employee Name: _____
Date Employed: _____

ORGANIZED CLASSROOM TRAINING
Trained by Company: _____ Amount of Training Time: _____HRS
School: _____ Graduation Date: _____

OR

IN HOUSE ON THE JOB TRAINING
Trained by: _____ Amount of Training Time: _____HRS

Does training qualify and meet 3AL Testing Corp written practice: YES NO

EXPERIENCE (ON THE JOB EXPERIENCE / TRAINING)
Previous Ultrasonic Level I II Experience:
Experience with what Company: _____
Experience with what Company: _____
Experience with what Company: _____

Experience Time Total: _____ Level Certified too: _____

Does previous experience qualify and meet 3AL Testing Corp written practice: YES NO

3AL Testing Corp ULTRASONIC CYLINDER SCANNING IMMERSION LEVEL II EXPERIENCE
Trained by: _____ Experience Total Time: _____
Dates from: _____ too: _____

Does his/her time spent on the ultrasonic cylinder scanning system meet 3AL Testing Corp written practice: YES NO

WRITTEN EXAMINATION GRADES
Location: _____

General _____ Administered by _____ Date _____
Practical _____ Administered by _____ Date _____
Specific _____ Administered by _____ Date _____

Composite (average) Grade: _____ =General + Practical + Specific / 3

Date Certified as Level II: _____ Expiration Date _____

_____ certifies the above named individual has satisfactorily met the qualifications required of this written practice in accordance with SNT-TC-1A.

3AL Testing Corp.
8110 N.W. 66th Street Miami, Florida 33166 Phone: (305) 499-9939 Fax: (305) 499-9923

August 27, 2004

RE: Personnel file-practical test of Paul Graves

This letter is to acknowledge that on August 27, 2004 Paul Graves was administered a practical test on Ultrasonic inspection of cylinders on the cylinder scanner, serial number 1. His successful completion of the practical test hereby qualifies him as a UT level II with 3AL Testing Corp following the written practice (Personnel Qualification) dated August 27, 2004. Documentation of 80 hours total classroom training is attached. All previous experience and documentation is retained in the employee personnel file.

Robert A. Fick certificate# KM-2033
President

THE AMERICAN SOCIETY FOR NONDESTRUCTIVE TESTING

Cleveland Section

December 4, 1997

Dear Paul;

Congratulations!!!

You are hereby notified that you have successfully completed the course offered by ASNT Cleveland Section fall 1997 session.

Course: Ultrasonic Inspection I
Contact hours: 40

The content of this course was based on the recommended guidelines of SNT-TC-1A 1996 Edition .

Please keep a copy of this letter and enclosed certificate for your personal records.

Yours Truly,

Dale

Dale T. Murphy
Educational Chairman 1997 -1998

American Society for
Nondestructive Testing

CLV-UT-(F)-97-007

This is to certify that

Paul Graves

has successfully completed the educational curriculum, has maintained the required attendance and has demonstrated proficiency by satisfactory completion of an examination on the subject of

Ultrasonic Inspection I

Presented by the Cleveland ASNT Section

On this 4th day of December 19 97

INSTRUCTOR

SECTION CHAIR

EDUCATIONAL CHAIR

THE AMERICAN SOCIETY FOR NONDESTRUCTIVE TESTING

Cleveland Section

May 20, 1998

Dear Paul,

Congratulations!!!

You are hereby notified that you have successfully completed the course offered by ASNT Cleveland Section spring 1998 session.

Course: Ultrasonic Inspection Level II
Contact hours: 40

The content of this course was based on the recommended guidelines of SNT-TC-1A 1996 Edition .

Please keep a copy of this letter and enclosed certificate for your personal records.

Yours Truly,

Dale

Dale T. Murphy
Educational Chairman 1997 - 1998

American Society for Nondestructive Testing

CLV-UT-(S)-98-006

This is to certify that

Paul Graves

has successfully completed the educational curriculum, has maintained the required attendance and has demonstrated proficiency by satisfactory completion of an examination on the subject of

Ultrasonic Inspection II

Presented by the Cleveland ASNT Section

On this 20th day of May 19 98

Ronald M Graves
INSTRUCTOR

Claire P Klausnic
SECTION CHAIR

Joseph T Murphy
EDUCATIONAL CHAIR

Appendix IV

Draft Exemption

Draft Exemption
DOT-EXXXXX
(First Revision)

Expiration Date: _____

(For Renewal, See 49 CFR §107.109)

1. Grantee: 3AL Testing Corp.
Miami, Florida

2. Purpose and Limitation:

a. This exemption authorizes the use of certain DOT specification 3AL cylinders used for the transportation in commerce of the compressed gases described in paragraph 6 below, when retested by a 100% ultrasonic examination in lieu of the internal visual and the hydrostatic retest required in 49 CFR §180.205. In addition to the 100% ultrasonic examination, cylinders manufactured from 6351 alloy material are checked with an eddy current device for sustained load cracking (SLC) in the threads. This exemption provides no relief from the Hazardous Materials Regulations (HMR) other than as specifically stated herein.

b. The safety analysis performed in development of this exemption only considered the hazards and risks associated with transportation in commerce.

c. Party status will not be granted to this exemption.

3. Regulatory system affected: 49 CFR parts 106, 107 and 171-180.

4. Regulations from which exempted: 49 CFR §172.203(a) and 172.301(c) in that each shipping paper or cylinder is not required to

be marked with the exemption number; §180.205(f) introductory text, 180.205(g), 180.209(a), in that the ultrasonic examination (UE) is performed in lieu of the specified internal visual examination and hydrostatic pressure test on DOT-3AL cylinders made of 6061 aluminum alloy. 49 CFR §172.203(a) and 172.301(c) in that each shipping paper or cylinder is not required to be marked with the exemption number; § 180.205(f) introductory text, 180.205(g), 180.209(a), in that the ultrasonic examination (UE) and eddy current examination (EE) is performed in lieu of the specified internal visual examination and hydrostatic pressure test on DOT-3AL cylinders made of 6351-T6 alloy.
NOTE: This does not relieve the holder of this exemption form securing an approval for retesting cylinders from the Associate Administrator for Hazardous Materials Safety.

5. Basis: This exemption is based on 3AL Testing Corp.'s application dated September 1, 2004, submitted in accordance with 49 CFR §107.109.

6. Hazardous Materials (49 CFR §172.101):

Hazardous Materials Description/Proper shipping name	**Hazard Class**	**Identificaion Number**	**Packing Group**
Liquefied or non-liquefied compressed gases, or mixtures of such compressed gases, classed as division 2.1 (flammable gas), division 2.2 (nonflammable gas), division 2.3 (inhalation hazard), which are authorized in the hazardous materials regulations for transportation in DOT-3AL cylinders.	2.1, 2.2, or 2.3 as appropriate	As listed in 49 CFR part 172.101 for specific compressed gas or gas mixture.	N/A

7. Safety Control Measures:

a. Packaging: Packaging prescribed is a DOT specification 3AL cylinder that is subjected to periodic retesting, reinspection and marking prescribed in 49 CFR 180.205 and

180.209(a), except that the cylinder's sidewall is examined by an ultrasonic method in lieu of the hydrostatic pressure test and internal visual inspection. Each cylinder manufactured from aluminum alloy 6351-T6 must have the neck examined by eddy current and enhanced visual inspection, in addition to the ultrasonic examination. Each cylinder must be subjected to an external visual examination and retested and marked in accordance with the procedure described herein and 3AL Testing Corp. September 1, 2004 application for exemption on file with the Office of Hazardous Materials Exemptions and Approvals (OHMEA). A cylinder that has been exposed to fire or to excessive heat may not be retested under the terms of this exemption.

b. Ultrasonic Equipment: The ultrasonic equipment performance must conform to the 3AL Testing Corp. application on file with OHMEA and as prescribed in this exemption. The UE equipment incorporates a single channel immersion system arranged to perform straight and angle beam examinations. The ultrasonic pulses must enter into the cylinder wall in both circumferential and longitudinal directions and normal to the cylinder wall to ensure 100 percent coverage of the cylinder wall. All defects (such as isolated pits, line corrosion, sidewall defects (e.g. cracks, folds) and area corrosion must be detected. The transducer or cylinder must be arranged so that the ultrasonic beams enter into the cylinder wall and measure thickness and detect the sidewall flaws. The immersion UE system must have a high speed board to digitize and capture each A-scan during examination of the cylinder. Gain control accuracy must be checked every six months with equipment that is calibrated in accordance with industry standards for checking gain linearity accuracy, as published in ASTM-E317. Search units of 2.25 to 15 MHz. nominal frequency and ¼" to a 1" diameter must be used during ultrasonic examination. A manual contact shear or longitudinal search unit may be used for confirmation and sizing of an indicated defect. If manual UE is used, it must be performed by a level II or III inspector and in accordance with American Society of Testing Materials (ASTM) practice E213.

c. Eddy Current Equipment: Equipment, such as Visual Plus or Visual Eddy, must be capable of detecting the notches on the standard reference ring.

d. Standard references (reference cylinder):

1. UE reference cylinder: A cylinder must be used as a standard reference and must have similar acoustic properties, surface finish, metallurgical condition as the cylinder being examined. The standard reference, (reference cylinder) must have a known minimum design wall thickness (t_m) which is less than or equal to the cylinder under test. The standard reference cylinder for cylinders less than or equal to 6-inches in diameter must have the same nominal diameter as the cylinder being tested. Cylinders greater than 6-inches in diameter must conform to the allowable size ranges shown in the following table:

STANDARD REFERENCE	Cylinder size ranges is being retested by UE	
Outside Diameter (OD inches)	Minimum OD inches	Maximum OD inches
7.00	6.30	10.50
7.50	6.75	11.25
9.00	8.10	13.50
9.25	8.33	13.88
10.00	9.00	15.00
12.00	10.80	18.00

Prior to placing the simulated defects such as minimum wall thickness, the average minimum wall thickness for the standard reference must be determine by means of an independent method.

The standard reference shall contain six artificial reflectors to simulate the following defects, a wall thickness patch (area corrosion), an ID longitudinal notch, an OD longitudinal notch, an ID circumferential notch, an OD circumferential notch, and a flat bottom hole (isolated pit).

ID Flat bottom hole: The flat bottom hole will be 0.250 inches diameter (0.125 inches for cylinders with a diameter less than 4 inches), by 33% of the minimum design wall thickness in depth. The flat bottom hole will simulate an isolated pit.

ID and OD Circumferential notches: The notches will be 1.00 inch in length, and 10% depth of the minimum design wall thickness. The width of the notch must be less than or equal to 0.010 inch.

ID and OD Longitudinal notches: The notches will be 1.00 inch in length, and 10% depth of the minimum design wall thickness. The width of the notch must be less than or equal to 0.010 inch.

Wall thickness patch: The artificial defect for area corrosion will be 0.70 square inch (in^2) and the remaining wall thickness must be at least the design minimum wall for a cylinder being tested.

Each serialized calibration standard at each site where testing is performed must have a certification signed by a certified Level III. This certification must include a reference drawing showing the dimensions and locations of each simulated defect and be available for review upon request.

2. Eddy Current Reference Ring: The reference ring must be produced to represent one or more DOT 3AL cylinders. The reference ring must include artificial notches that simulate neck cracking (SLC).

The size of artificial notch (depth and length) must be obtained from the EE equipment manufacturer. A certification statement signed by a Level III must be available for all EE reference rings at each site where retesting is performed. The certification statement must include a standard reference drawing for each reference ring. The standard reference drawing must include the depth of each notch, diameter and type of DOT 3AL cylinder that the reference ring is used for.

e. Calibration of equipment:

Ultrasonic Examination (UE) System Standardization: The equipment calibration and set up for testing shall be such that a reject signal is produced and recorded when the indicated thickness at any location is less than the minimum design wall thickness for the cylinder under test or less than the minimum remaining wall thickness specified for corrosion pits, lines or areas. The equipment may not allow testing of cylinders unless the system has been properly calibrated.

Eddy Current Examination (EE) Equipment Standardization: The EE equipment must be standardized for each type of DOT 3AL cylinder, using the standard reference ring that includes simulated neck crack notch. The EE system is considered standardized when the probe is threaded into the mid-length of standardization ring and the sensitivity adjusted to produce a spike that crossed the gate (1/2 screen high) as it passes over the simulated neck crack notch. The details of the equipment standardization for each type of DOT 3AL cylinder must be obtained from the manufacturer's instruction manual included as part of this standardization procedure.

f. Test Procedures: A written test procedure for performing UE, EE and enhanced visual inspection of cylinder neck under the terms of this exemption must be at each facility performing retests under this exemption. At a minimum, this test procedure must include:

1. A description of the test set-up; test parameters; transducer model number, frequency, and size; transducer assembly used; system standardization procedures and threshold gain used during the test; and other pertinent information.
2. Requirements for the equipment standardization to be performed at the end of the test interval (cal-out), after 200 cylinders or four hours, which ever occurs first. This cal-out can be considered the cal-in for the next interval during continuous operation. Cylinders examined during the interval between cal-in and cal-out must be quarantined until an acceptable cal-out has been performed. An acceptable cal-out occurs when the calibration cylinder is examined and all required features are revealed without changing examination settings. If an acceptable cal-out does not occur, if any equipment that affects the UE results are replaced or altered (such as a search unit or coaxial cable etc.) or when a loss of power occurs, all cylinders examined since the last successful calibration must be re-examined. Additionally, standardization of test equipment shall be performed at the beginning of each work shift, when the cylinder under test has dimensions that exceed the allowable ranges of the reference cylinder, when there is a change of operator(s), if any equipment that effects the UE results are replaced or altered (such as a search unit or coaxial cable etc.) or when a loss of power occurs, and at the end of each work shift.

The test procedure must be made available to a DOT official when requested. Any change to the written procedure must be submitted to OHMEA as soon as practical.

The equipment may not allow testing of a cylinder unless the system has been properly standardized (calibrated).

The rotational speed of a reference cylinder must be such that all simulated defects are adequately detected, measured and recorded.

The rotational speed of the cylinder under UE must not exceed the rotational speed used during the standardization.

The area of ultrasonic examination (UE) coverage must be 100% of the cylindrical section. The coverage must extend three inches into the sidewall-to-base transition taper. The area of eddy current and enhanced visual examination coverage must be 100% of the threaded neck of the cylinder.

The external surface of the cylinder to be examined must be free of loose material such as scale and dirt.

g. Assessment of results: A cylinder is not authorized for reuse if it exhibits conditions that exceed the acceptance criteria detailed in Appendix I.

h. Ultrasonic Cylinder test procedure: The equipment must be recalibrated after each 4 hours of operation, or when 200 cylinders have been examined.

i. Personnel qualification: The personnel responsible for performing cylinder retesting pursuant to this exemption shall be trained and certified as a level II Ultrasonic test operator per the ASNT recommended practice SNT-TC-1A. Such personnel will be 3AL Testing employees or 3AL Testing licensees with verified certifications.

j. Test Procedure: The retest procedure and acceptance criteria must conform to the following: 1) A written document describing the test set up and test parameters; transducer type frequency and size, transducer assembly, couplant used, and system sensitivity standard used in the test; and other pertinent information shall be on file at the test site, and must be made available to a DOT official when

requested. 2) Cylinders that exhibit less than acceptable wall thicknesses must be rejected.

k. Rejected cylinders: When a cylinder is rejected, the retester must stamp a series of X's over the DOT specification number and marked service pressure, or stamp CONDEMNED on the shoulder, top head, or neck using a steel stamp, and must notify the cylinder owner, in writing, that the cylinder is condemned and may not be filled with hazardous material for transportation in commerce.

    1. Alternatively, at the direction of the cylinder owner, the retester may render the cylinder incapable of holding pressure.

    2. If a condemned cylinder contains hazardous materials and the testing facility does not have the capability of safely removing the hazardous material, the retester must stamp the cylinder "CONDEMNED" and affix conspicuous labels on the cylinder(s) stating: "UE REJECTED DOT-EXXXXX. RETURNING TO ORIGIN FOR PROPER DISPOSITION". The retester may only offer the condemned cylinders for transportation by a motor vehicle operated by a private or common carrier to a facility, identified to, and acknowledged in writing with OHMEA, that is capable of safely removing the hazardous material. A current copy of this exemption must accompany each shipment of condemned cylinders transported for the disposal of hazardous material.

l. Marking: Each cylinder passing retest under the provisions of this exemption must be marked as prescribed in 49 CFR §180.213. In addition, each 6061 alloy cylinder must be marked UE, in characters not less than ¼" high for a cylinder with a diameter equal to or greater than 4 inches and 1/8" for a cylinder with a diameter less than 4 inches. Each 6351-T6 alloy cylinder must be marked UEEE, in characters not less than ¼" high for a cylinder with a diameter equal to or

greater than 4 inches and 1/8" for a cylinder with a diameter less than 4 inches The marking must be at a location close to the retester's marking.

m. Report: A report must be generated for each cylinder that is examined. The UE, EE (6351-T6 alloy only), and visual examination report must include the following:

1. UE equipment, model and serial number
2. UE transducer size, frequency, and manufacturer
3. Specification of each standard reference used to perform UE and EE (6351-T6 alloy only). UE and EE (6351-T6 alloy only) standard reference must be identified by serial number or other stamped identification marking.
4. Cylinder serial number and type
5. UE technicians name and certification level
6. Examination date
7. Location and type of each defect on the cylinder sidewall and in the threaded neck (e.g. longitudinal line corrosion 5 inches from base)
8. Dimensions (area, depth, and remaining wall thickness, crack length and depth) and brief description of each defect.
9. Acceptance / rejection results
10. The report must be on file at the test site and made available to a DOT official when requested.

n. Operational Controls:

1. No person may perform inspection and testing of cylinders subject to this exemption unless:

   (i) that person is an employee or agent of 3AL Testing Corp. and has a current copy of this exemption at the location of such inspection and testing, and

   (ii) complies with all the terms and conditions of this exemption

a. The marking of the retester's symbol on the cylinders certifies compliance with all of the terms and conditions of this Exemption.

b. Each facility approved by OHMEA to test cylinders under the terms of this exemption must have a resident operator with at least a Level II certification in UT.

8. Special Provisions:

a. During the initial use of the exemption, the total number of cylinders retested under this exemption must be reported to OHMEA on an annual basis. The reports must be summarized to two tables which include a list of all the passed and failed cylinders under this exemption. One copy of the summarized reports must be submitted on CD or diskette in a word processing format compatible with Word Perfect, Microsoft Word, or Microsoft Excel.

1. The table for the passed cylinders must include:
   i. UE date
   ii. Cylinder type (e.g. DOT 3AL 2216)
   iii. Cylinder serial number
   iv. The standard reference number used to standardize the UE equipment

2. The table for the failed cylinders must include:
   i. UE date
   ii. Cylinder type (e.g. DOT 3AL 2216)
   iii. Cylinder serial number
   iv. The standard reference number used to standardize the UE equipment
   v. Types of defects (area corrosion, isolated pit, longitudinal line corrosion, circumferential line corrosion or other type such as dent, etc.)
   vi. Location of the defect (e.g. longitudinal line corrosion 5 inches from base)
   vii. Dimensions (e.g. for area corrosion, larger than 0.70 in^2 or for an isolated pit deeper than $1/3t_m$

viii. Alloy type (e.g. 6061 alloy, 6351-T6 alloy)

3. 3AL Testing Corp must submit to DOT an evaluation of the effectiveness of the ultrasonic and eddy current examination program authorized by this exemption as part of any request to renew the exemption submitted in accordance with §107.109.

b. Offerors may use the cylinders specified and tested in accordance with the provisions of this exemption for the transportation in commerce of those hazardous materials specified herein, provided no modifications or changes are made to the cylinders, and all the terms of this exemption are complied with.

c. Shippers using the packaging covered by this exemption must comply with the provisions of this exemption, and all other applicable requirements contained in 49 CFR parts 100-180.

d. Transportation of Division 2.1 (flammable gases) and Division 2.3 (gases which are poisonous by inhalation) are not authorized aboard cargo vessel or aircraft unless specifically authorized in the Hazardous Materials Table (§172.101).

e. Transportation of oxygen is only authorized by aircraft when in accordance with §172.102(c)(2) Special Provision A52 and §175.85(h) and (i).

9. Modes of transportation authorized:

Motor vehicle, rail freight, cargo vessel, passenger-carrying aircraft, and cargo aircraft only as currently authorized by the regulations for the hazardous materials being transported.

10. Modal Requirements: See paragraphs 8.d. and 8.e. for restrictions.

11. Compliance: Failure by a person to comply with any of the following may result in suspension or revocation of this exemption and penalties prescribed by Federal hazardous materials transportation law, 49 U.S.C. Section 1501 et, seq.;

- All terms and conditions prescribed in this exemption and the Hazardous Materials regulations, 49 CFR, parts 171-180, unless expressly exempted by this exemption.
- Registration required by 49 CFR §107.601 et, seq. when applicable.
- Persons operating under the terms of this exemption must comply with the security plan requirement in Subpart I of Part 172 of the HMR, when applicable.

Each "hazmat employee", as defined in §171.8, who performs a function subject to this exemption must receive training on the requirements and conditions of this exemption in addition to the training required by §172.700 through 172.704.

No person may use or apply this exemption, including display of its number, when the exemption has expired or is otherwise no longer in effect.

12. Reporting Requirements: The carrier is required to report any incident involving loss of packaging contents or packaging failure to the Associate Administrator for Hazardous Materials Safety (AAHMS) as soon as practicable. (49 CFR 171.15 and 171.16 apply to any activity undertaken under the authority of this exemption.) In addition, the holder(s) of this exemption must also inform the AAHMS, in writing, as soon as practicable of any incidents involving the package and shipments made under this exemption.

Issued in Washington, D.C.:

Robert A. McGuire
Associate Administrator for
Hazardous Materials Safety

Date

Address all inquiries to: Associate Administrator for Hazardous Materials Safety, Research and Special Programs Administration, Department of Transportation, Washington, D.C. 20590. Attention: DHM-31.

Copies of this exemption may be obtained by accessing the Hazardous Materials Safety Homepage at http://hazmat..dot.gov/exemptions Photo reproductions and legible reproductions of this exemption are permitted. Any alteration of this exemption is prohibited.