U.S. Department
of Transportation

**Pipeline and Hazardous
Materials Safety
Administration**

1200 New Jersey Avenue SE
Washington, DC 20590

NOV 25 2015

Mr. Attila Sonkoly
Hydro Test Operator
1217 W. Ball St.
Plant City, FL 33563

Ref. No.: 15-0055

Dear Mr. Sonkoly:

This is in response to your February 5, 2015 letter requesting clarification of the Hazardous Materials Regulations (HMR; 49 CFR Parts 171-180) applicable to the calibration and certification of gauges used for pressure testing cylinders. Your questions are paraphrased below:

Q1. You state that it is your understanding that a pressure-indicating device (PID) must have an accuracy grade of 0.5%, and that if your PID exhibited an accuracy grade of 0.6% you would not be able to use that measuring device for pressure testing. You ask for confirmation of your understanding.

A1. For the purposes of this answer, and all other answers in this letter, it is important to note that the term accuracy grade is not a term used in the HMR. Your understanding is correct. As required by § 180.205(g)(3)(i) the PID, itself, must be certified as having an accuracy of ±0.5%, or better, of its full range. If your PID exhibited an accuracy grade of 0.6% you would not be able to use that measuring device for pressure testing.

Q2. You give an example of a 0 to 11,000 PSI PID with 0.5% accuracy grade (the PID is +/- 55 psi accurate at any point). You request confirmation of your understanding that you could not test any cylinder under the test pressure of 5,500 psi.

A2. Your understanding is correct. Section 180.205(g)(3)(i) states that the PID, as part of the retest apparatus, is accurate within ±1.0% of the prescribed test pressure of any cylinder tested that day. For additional tests to be conducted that day, PID, as part of the retest apparatus, must be accurate within ±1.0% of each individual test pressure to be tested that day. However, if the PID, itself, is not in compliance with an accuracy of ±0.5%, or better, of its full range, retesting is not permitted on that day.

Q3. You present a scenario where you are testing cylinders with a test pressure range of 3,000 to 10,000 psi on a daily basis. You note that you understand you should have a 0 to 11,000 psi gauge to comply with the +/- 10% range rule and ask if a PID with a 0.5% accuracy grade is not adequate, but if a 0.25% accuracy grade would be appropriate.

A3. In the scenario you provide the PID with 0.5% accuracy would not be appropriate for testing all cylinders within the psi range you have provided. A PID with 0.25% accuracy would be compliant.

Q4. Using the same scenario as described in Q3 above (0.25% accuracy grade), you ask if you are unable to prove your PID is +/- 30 psi accurate that it would be a violation to test cylinders with the pressure of 3,000 psi or lower.

A4. It is unclear as to intent of your question. Other than verification each day before retesting, there is no requirement in the HMR to retest the PID during the day.

Q5. You state it is your understanding that an expansion-indicating device (EID) must have an accuracy of +/- 0.5% or better of its full range. You ask if this means the accuracy grade of the EID has to be at least 0.5%.

A5. As required by § 180.205(g)(3)(ii) the expansion-indicating device, as part of the retest apparatus, gives a stable reading of expansion and is accurate to ±1.0% of the total expansion of any cylinder tested or 0.1 cc, whichever is larger. The expansion-indicating device itself must have an accuracy of ±0.5%, or better, of its full scale.

Q6. You provide a scenario in which you are using a 0 to 1,000 g (1 g = 1 ml) digital scale as an EID with 0.5% accuracy grade (1000 x 0.5/100 = 5 g accurate). You ask if it would be a violation to test cylinders producing total expansion of less than 500 g.

A6. Each day before retesting, the retester shall confirm that the expansion-indicating device, as part of the retest apparatus, gives a stable reading of expansion and is accurate to ±1.0% of the total expansion of any cylinder to be tested that day or 0.1 cc, whichever is larger. In the scenario you describe, testing cylinders producing total expansion of less than 500 g would be a violation.

Q7. You present a scenario where the total expansion ranges from 6 ml to 510 ml and you are using a 0 to 1,000 g scale. You state it is your understanding that you would need a 0.01% accuracy grade and not a 0.5% accuracy grade.

A7. The expansion-indicating device, as part of the retest apparatus, must be is accurate to ±1.0% of the total expansion of any cylinder to be tested that day or 0.1 cc, whichever is larger.

Q8. You ask several questions about verifying EID accuracy using Compressed Gas Association (CGA) Pamphlet C-1, Methods for Pressure Testing Compressed Gas Cylinders.

A8. CGA Pamphlet C-1 is not incorporated by reference and, therefore, is not a material made part of the regulations under the HMR and not enforceable.

I hope this information is helpful. If you have further questions, please do not hesitate to contact this office.

Sincerely,

Duane A. Pfund

Duane Pfund
International Standards Coordinator
Standards and Rulemaking Division

Webb
§180.205
Cylinders
15-0055

To: PHMSA Standards and Rulemaking Division

February 5, 2015

Formal Interpretation Letter Request

Attila Sonkoly Hydro Test Operator

4805 Heather Lyn Ct Apt H Tampa, FL 33617

Phone # : 813-515-9678

RE: Device accuracy while pressure testing compressed gas cylinders

Dear Sir,

Please assign this letter to an expert who has good knowledge of CFR 49 180.205 , who is expert on CGA C-1, and knows how accuracy grade works.

CFR 49.180.205.

(i) The pressure-indicating device, as part of the retest apparatus, is accurate within ±1.0% of the prescribed test pressure of any cylinder tested that day. The pressure indicating device, itself, must be certified as having an accuracy of ±0.5%, or better, of its full range, and must permit readings of pressure from 90%-110% of the minimum prescribed test pressure of the cylinder to be tested. The accuracy of the pressure indicating device within the test system can be demonstrated at any point within 500 psig of the actual test pressure for test pressures at or above 3000 psig, or 10% of the actual test pressure for test pressures below 3000 psig.

(ii) The expansion-indicating device, as part of the retest apparatus, gives a stable reading of expansion and is accurate to ±1.0% of the total expansion of any cylinder tested or 0.1 cc, whichever is larger. The expansion-indicating device itself must have an accuracy of ±0.5%, or better, of its full scale

I am an experienced hydro test operator. Recently while attending two online seminars and while talking to several instructors some of them said while checking the pressure indicating device (PID) against a master gauge the PID can be 1% off, others said it can be 0.5% percent off. When using digital scale as an expansion indicating device (EID) some of the instructors said it can be 1% off, others said it can be 0.5% off.

The worst thing I think all of them are wrong, and they do have a misconception on the concept of accuracy grade. Accuracy is of the utmost importance for hydro testers, misunderstanding the above paragraphs can lead to hard time while calibrating the system, it will result in incorrect and illegal testing if misinterpreted.

I occasionally help out training hydro test operators – I would like to ask for a letter I can show to them so they would get the correct concept on testing by CFR 49 accuracy standards.

Both the EID and the PID accuracy is described by accuracy grade what gives the maximum error that can occur at any point of the device. It is calculated by the largest acceptable error divided by the full range multiplied by 100%. It is an inherent quality of the device. (see quote from CGA C-1)

Example if I am using a 0 to 11,000 PSI PID with 0.5 % accuracy grade I can have at any point 11,000 x 0.5% = 55 PSI error the most. With other words my device is +/- 55PSI accurate. That is how all PIDs get certified and recertified when checking against a standard (master gauge or dead weight).

Question 1. (THE 0.5% RULE) "The pressure indicating device, itself, must be certified as having an accuracy of ±0.5%, or better, of its full range." To me it doesn't mean that the PID can be 0.5 percent off at all. It means to me that the **required accuracy grade I have to use for a PID is 0.5% or better**. If I look at the accuracy grade definition it is max error in percentage compared to the full range. So in technical terms CFR 49 tells me that the PID should have at least a 0.5% accuracy grade. If it was for example 0.6% accuracy grade I would not be able to use that measuring device for pressure testing.

I am attaching a CGA C-1 excerpt, a PHMSA interpretation letter and a Galiso Technical Bulleting to support my statement on this. Please let me know if my understanding it correct on this.

Question 2. (THE 1% RULE) Most commonly misunderstood point between hydro test operators: "The pressure-indicating device, as part of the retest apparatus, is accurate within ±1.0% of the prescribed test pressure of any cylinder tested that day." **To me this doesn't mean at all that the PID can be 1% off at any point when comparing it to a master guge. To me that seems impossible, as only the entirety of the system as a whole can be 1% off based on CFR 49. To me what it means that if I am using a 0 to 11,000 PSI PID with 0.5 percent accuracy grade (the PID is +/- 55PSI accurate at any point) I cannot test any cylinder under the test pressure of 5,500 PSI.** For example if I tested a cylinder with this PID at 3360 test pressure it could have a 55 PSI error and that would be larger than 1% of the test pressure of the cylinder what I am testing. If I have a 0.5% accuracy grade PID I can use it to hydro test cylinders but not every single one of them, sometimes if the test pressure is too small compared to the entire test range a better accuracy grade is required based on the one percent rule.

Question 3. (PID applicability for high pressure cylinder testing facilities) **If I am testing from 3,000 to 10,000 PSI test pressure range on a daily basis, I should have a 0 to 11,000 PSI gauge to comply with the +/- 10% range rule. In this case 0.5% accuracy grade is not adequate, but a 0.25% accuracy grade 11,000PSI x 0.25% = 27.5 PSI would be perfect, as 27.5 PSI is less than 1 percent of the 3,000 PSI test pressure.**

Question 4. (PID verification) If I want to verify if the before mentioned device (0 to 11,000 PSI range PID with 0.25% accuracy grade) is precise and meets the accuracy requirement set by CFR 49 (this might happen as part of my troubleshooting during calibration or because I am following CGA C-1 appendix B and I am recertifying the gauge after every sixth month using certified master gauges) when I put my pressure device against a master gauge and if it gives larger than 30 PSI error at any point, with other words **if I am unable to prove it is +/- 30 PSI accurate (for example it gives a 50 PSI error t 6,000 PSI or gives 70 PSI error at 10,000 PSI) it would be illegal to test cylinders with the pressure of 3,000 PSI** or lower. The PID needs to get repaired or and recalibrated as it is not meant to have errors of that magnitude.

See attached references which support my understanding.

Expansion Indicating Device (EID)

My understanding is similar as on PID, I will describe it shortly

Question 5. (EID 0.5% rule) : The expansion-indicating device itself must have an accuracy of ±0.5%, or better, of its full scale, **to me this means that the accuracy grade of the EID has to be at least 0.5%.**

Question 6. (EID 1% rule) If I am using a 0 to 1,000g (1gramm = 1 ml) digital scale as an EID with 0.5% accuracy grade it is 1000 x 0.5/100 = 5g accurate. It would be illegal to use to test cylinders producing total expansion of less than 500g .

Question 7 (EID accuracy application to high pressure test facilities) If my total expansion ranges from 6 ml to 510 ml, and if I am using a 0 to 1,000 g scale I need that to be at least +/- 0.1 g accurate what is 0.1 / 1,000 x 100% = 0.01 % accuracy grade. So given my scale range I would need a 0.01% accuracy grade and not a 0.5% accuracy grade.

Question 8. Verifying EID. If I have to use a 0 to 1,000 g scale 0.01% accuracy grade scale and I want to verify its accuracy either for trouble shooting reason or because I wanted to do a periodical EID verification as by CGA C-1 appendix B when placing different weights on the scale I should not have anywhere more than 0.1 g error if I am testing cylinders producing total expansion 10g or lower on a daily basis.

Please let me know if my understanding is correct.

Sincerely ,

Attila Sonkoly ,

813-515-9678 (mostly available during weekdays after 3pm)

Galiso Technical Bulletin

GALISO HOME
Volumetric Hydrostatic Testing
VHT - Chinese Version
WEMS - Weight Expansion Measurement
Backup Data to USB Drive
Calibrated Cylinder
Cylinder Calibration
CGA Pamphlets
Composite Cylinder
Cut Off Key
Cylinder Results Import
Cylinder Testing
DOT Requirements
Gauge Accuracy
More

Technical Bulletin

ject: GAUGE REQUIREMENTS

duction

act from 49CFR 173.34.e.(4) (iii) A)

"The pressure-indicating device, as part of the retest apparatus, is accurate to within + or - 1% of the prescribed test pressure of any cylinder tested that day. The pressure-indicating device, itself, must be certified as having an accuracy of + or - 0.5%, or better, of it's full range and must permit readings of pressure from 90% to 110% of the minimum prescribed test pressure of the cylinder to be tested. The accuracy of the pressure indicating device within the test system can be demonstrated at any point within 500 psi of the actual test pressure for test pressures at or above 3000 psi, or 10% of the actual test pressure for test pressures below 3000 psi.."

definition of accuracy grade

Accuracy

- For a test pressure of 10,000 psi, the gauge must read to 110% of this, i.e. 11,000 psi.
- If the gauge has an accuracy of 0.5% of full-scale, the gauge is only accurate to 55 psi. This means at any given reading, the gauge might be up to 55 psi in error.
- Since that gauge must be accurate to 1% of the prescribed test pressure, at pressures below 5,500 psi, the gauge general inaccuracy of 55 psi exceeds this 1% figure. The gauge is therefore not suitable for use below 5,500 psi

10% rule

" must permit readings of pressure from 90-110%."

The chart below lists some popular gauge ranges and is based on the DOT prescribed accuracy of 1/2 %. **N.B. Galiso master gauges are 1/4 % accurate - exceeding DOT minima.**

Gauge max value psi	Max test pressure psi	Accuracy of gauge %	Gauge possible error /psi	Minimum test pressure psi
11,000	10,000	0.5%	55	5,500
7,500	6,818	0.5%	37.5	3,750
6,000	5,455	0.5%	30	3,000
3,000	2,727	0.5%	15	1,500

min accuracy grade 0.5%

1% rule

" is accurate +/- 1% of the prescribed test pressure of any cylinder tested that day."

Use of calibration cylinder

The calibration cylinder must be used to verify equipment at 500 psi intervals above 3000 psi and within 10% of test pressure below 3000 psi.

See relevant 49 CFR and CGA pamphlets. These items are not intended as a replacement for DOT specific training. Information is given for guidance only and as a quick reference. The appropriate DOT regulations must be referred to for further clarification.

Home

Galiso, Inc.® 1-800-854-3789/+970-249-0233

GALISO® INCORPORATED

PRESSURE GAUGE

Calibration Certificate

PART NUMBER 36-11-2500 SERIAL NUMBER E051085

PRESSURE RANGE 0-11,000 P.S.I. ACCURACY .025% FULL SCALE ±2750 P.S.I.

DATE OF CALIBRATION: 12-23-13 CALIBRATED BY: M Scott Cott EMP. #: 109

CALIBRATION

INCREASING PRESSURE		
Applied Press.	Indicated Press.	Difference
0	0	0
1000	990	-10
2000	2000	0
3000	2990	-10
4000	3990	-10
5000	5000	0
6000	6000	0
7000	7000	0
8000	8000	0
9000	9010	+10
10,000	10,010	+10

Received in Calibration:

YES ☐ NO ☒

NEW ☐ RECAL ☒ REPAIR ☐

GALISO

DATE PUT INTO SERVICE DEC 26 2013

QUALITY ASSURANCE

Calibrated in UPRIGHT Position

Temperature 66 °F

Calibration Control: Heise Model PM Digital Pressure Indicator S/N: 42180, 42179
Last Calibration: 8/20/13 Next Calibration Due: 8/20/14
Pressure Module Serial Numbers: 0-2500: #42180, 0-10,000 #42179
"This instrument has been calibrated with measurement standards whose accuracy is traceable to National Institute of Standards and Technology.(N.I.S.T.)"

GALISO INCORPORATED
22 PONDEROSA COURT (81401)
P.O. BOX 1468
MONTROSE, CO 81402
(970) 249-0233 (800) 854-3789

GALISO® INCORPORATED

PRESSURE GAUGE

Calibration Certificate

PART NUMBER 36-11-2500 SERIAL NUMBER E0510 85

PRESSURE RANGE 0-11,000 P.S.I. ACCURACY 0.25% FULL SCALE ± 27.50 P.S.I.

DATE OF CALIBRATION: 12-18-12 CALIBRATED BY: M. Scott Baff EMP. #: 109

CALIBRATION

INCREASING PRESSURE		
Applied Press.	Indicated Press.	Difference
0	0	0
1000	990	-10
2000	2000	0
3000	3000	0
4000	3990	-10
5000	5000	0
6000	6000	0
7000	7000	0
8000	8000	0
9000	9010	+10
10000	10,010	+10

Received in Calibration:

YES ☐ NO ☒

NEW ☐ RECAL ☒ REPAIR ☐

GALISO

DATE PUT INTO SERVICE DEC 18 2012

QUALITY ASSURANCE

Calibrated in UPRIGHT Position

Temperature 66 °F

Calibration Control: Heise Model DXD Digital Pressure Indicator S/N: 7297
Last Calibration: 8/02/12Next Calibration Due: 8/2/13
Pressure Module Serial Numbers: 0-10,000 S/N 7297
"This instrument has been calibrated with measurement standards whose accuracy is traceable to National Institute of Standards and Technology (N.I.S.T.)"

GALISO INCORPORATED
22 PONDEROSA COURT (81401)
P.O. BOX 1468
MONTROSE, CO 81402
(970) 249-0233 (800) 854-3789

1 Introduction

Pressure testing of compressed gas cylinders is required for many newly manufactured cylinders and also is an accepted test method for the requalification of cylinders. The referenced edition of the applicable documents, as specified by the U.S. Department of Transportation (DOT) in Title 49 of the U.S. *Code of Federal Regulations* (49 CFR), in Canada by Transport Canada (TC) in CSA B339, *Cylinders, Spheres, and Tubes for the Transportation of Dangerous Goods*, as referenced by the *Transportation of Dangerous Goods Regulations*, or the authority having jurisdiction, shall be available at each facility conducting pressure testing/requalification [1, 2, 3].

For the testing/requalification of cylinders manufactured under an exemption/special permit or permit, a current copy of that exemption or permit shall also be available. (See Appendix A for addresses of agencies that produce these documents).

2 Scope

This standard contains operating and equipment requirements necessary to properly perform pressure testing of compressed gas cylinders.

3 Definitions

For the purpose of this standard, the following definitions apply.

3.1 Accuracy
Degree of conformity of a measured or calculated quantity to its actual (true) value.

3.2 Accuracy grade
Inherent quality of the device.

NOTE—Accuracy grade expresses the maximum error allowed for the device at any reading and is expressed as a percentage of the full scale of the device.

3.3 Actual test pressure
True, recorded pressure applied to a cylinder during a test.

3.4 Bar
Metric measurement used for marking service pressure (1 bar = 14.5 psi).

3.5 Calibration
Process of adjusting a device to match a known standard so that it indicates to within specified accuracy limits.

NOTE—See Appendix B for information on calibration devices.

3.6 Calibration verification
Checking of an individual device or test apparatus by comparison with a given standard to determine the indication error at specified points of the scale.

3.7 Calibrated cylinder
Cylinder that has certified calibration points of pressure with corresponding expansion values.

NOTE—It is a secondary, derived standard used for the verification and demonstration of test system accuracy and integrity.

3.8 Condemn
Determination that a cylinder is unserviceable for continued transportation of dangerous goods and that the cylinder may not be restored by repair, rebuild, requalification, or other procedures.

5.3.2.2 Pressure indicating device

The pressure indicating device (PID) shall be a pressure gauge or other suitable device such as a pressure transducer and digital readout that:

- shall be manufactured and certified to an accuracy grade of ±0.5% or better;
- shall permit reading of pressures to within 1% of the test pressure of each cylinder tested. For analog PIDs, interpolation to one half of the marked increment is permitted;
- shall permit readings of pressures from 90% to 110% of the test pressure of any cylinder tested;
- shall be accurate to ±1% of test pressures; and
- shall be recalibrated periodically in accordance with Appendix B.

For example, using a 10 000 psi pressure gauge with an accuracy grade of ±0.5%, the reading is accurate to ±50 psi (0.5% x 10 000 psi) at any point on the pressure gauge. For a test pressure range of 3000 psi to 5000 psi, at 3000 psi the gauge accuracy may deviate by only ±30 psi (1% of 3000 psi) while for 5000 psi the gauge may deviate by as much as ±50 psi.

NOTE—The gauge in this example satisfies the accuracy grade requirement but could not be used for test pressures less than 5000 psi since the gauge is only accurate to ±50 psi. An accuracy of ±30 psi is required for the minimum test pressure at 3000 psi. A gauge with a smaller range (e.g., 5000 psi) or a better accuracy (e.g., ±0.25%) is needed.

5.3.2.3 Pressure recording device

The use of a pressure recording device is not required. However, if used, the device should be compatible with the maximum system pressure capability. The pressure recording device shall be adjustable so that correlation with the PID can be achieved.

5.3.2.4 Associated plumbing

All pressure valves, fittings, and connecting tubing shall be of a size and material appropriate for the pressures and the stresses of the test and be adequately sized and installed in a manner to prevent leakage, air entrapment, or exposure to external damage. Additional pressure supply system components such as surge chambers, reservoirs, pulsation dampeners, accumulators, etc., shall be selected with consideration to pressure cycling capabilities and maximum test pressures. All pressure supply system components shall be properly selected, installed, and maintained to ensure leak-free performance.

CAUTION: *In the design and construction of the pressure system, consideration shall be given to the potential hazards associated with the containment of liquids under high pressure. The use of additional safety equipment such as relief devices, blast shields, test cages, etc., is advisable to prevent possible injury to testing personnel and equipment.*

5.3.3 Timing device

During testing, a timing device that is capable of accurately measuring the minimum test duration shall be used.

5.4 Calibrated cylinder

A calibrated cylinder is required when performing the verification procedure for test methods where volumetric expansion determinations are required. The calibrated cylinder is a derived secondary standard used to demonstrate test apparatus integrity and to confirm PID and EID accuracy.

A calibrated cylinder is a cylinder that has been specially prepared so that it no longer experiences permanent expansion at the pressures for which it has been calibrated. The expansion readings of the cylinder shall be repeatable and linear. A certification for the cylinder noting the actual pressure and expansion values for each pressure calibration level shall be available. The original signed certification of calibration should be maintained in a safe place and a copy shall be posted on or near the hydrostatic test console.

Example 2: 92 – 2.3 = 89.7

Cylinder expansions are measured with an EID such as a burette where the volume of water is measured in cubic centimeters or measured with a weighing scale where the weight of water in grams is converted to cubic centimeters. For the purpose of this standard, 1 g is equivalent to 1 cc. All expansion values are expressed in cc.

See Appendix D for sample test record forms.

5.3 Test system components

5.3.1 Expansion system

5.3.1.1 Water jacket

The water jacket shall be of sufficient size to allow a cylinder to expand freely in all directions. The water jacket and/or sealing head shall be designed to prevent leakage or air entrapment.

5.3.1.2 Expansion indicating device

The EID shall be a burette, scale, or other suitable device that:

- shall permit reading of the cylinder expansion to within 1% of the total expansion of each cylinder tested, or 0.1 cc, whichever is larger. Example: For total expansion readings of less than 10 cc, a reading to 0.1 cc is acceptable. Interpolation to one half of the marked increment is permitted. The device shall give a stable reading;
- shall be accurate to within ±1% of the total expansion of any cylinder tested, or 0.1 cc, whichever is larger
- shall be designed to take into account the barometric effect of differing water levels (see Figure 5);
- shall be certified as having an accuracy grade of ±0.5% or better. Example: A burette with a full scale of 150 cc and an accuracy grade of 0.5% would be accurate to a reading of 0.75 cc. Therefore, this burette shall not be used for total expansions less than 75 cc in order to maintain a ±1% accuracy of the total expansion (see Figure 6); and
- scale-based devices shall be verified periodically in accordance with Appendix B.

For all readings, the adjustable panel shall be moved so that the meniscus of the water column in the graduated burette is at the same level as the reference point indicator of the test panel.

The bottom of the water meniscus is used for all readings as shown in Figure 5.

5.3.1.2.1 Burette systems

For burette systems, all measurements shall be taken at the same reference level and from the bottom of the meniscus (see Figure 5).

The reference point indicator should be positioned so that measurements can be taken conveniently at eye level. The burette assembly shall be moveable so that the water level in the burette is at the same height when reading zero, total expansion, and permanent expansion. This water level should be above the highest point of water in the water jacket and its connecting piping.

5.3.1.2.2 Nonburette type systems

For nonburette type systems, the EID shall be such that any change in water level does not affect the required accuracy. The EID shall be verified periodically in accordance with Appendix B.

Nonburette type systems shall be designed to accommodate changes in water level without causing errors in the expansion readings.

Pictures of typical nonburette and micro processor-based systems are found in Figures 7 and 8.