Proposed §180.205(g):

I believe the proposed incorporation by reference of CGA C-1 into §180.205 would be a mistake and a step backwards in the regulations. The requirement to purchase C-1 would add yet another unnecessary financial burden to the retester with no benefit, except to CGA.

The preamble of this NPRM states:

"We agree the CGA publication more adequately reflects the equipment accuracy requirements for performing a pressure test on cylinders."

No, it doesn't. As a matter of fact, C-1 is missing the accuracy requirement for 1% accuracy of the expansion device that is currently a part of 180.205(g)(3)(ii). The incorporation of C-1 would detract from the current system accuracy requirements, not improve them. CGA C-1 provides no improvement over the current regulations. It would erroneously alter the current meaning of the regulations, and compliance with the altered meanings would add further undue financial burden with no benefit.

While CGA C-1 does contain some useful information, it is riddled with errors that will detract from the current level of safety and regulatory administration of cylinder requalification offered by the existing text of §180.205(g). While this list does not encompass all of the errors in C-1, I have listed below the errors that I feel would have a direct, adverse effect if C-1 is used to replace §180.205(g). [Commenter's note: I provide this proof reading service at no charge to CGA. However, I hope they will take to heart the seriousness of these errors, and the flagrant disregard for excellence that they represent.]

From CGA Pamphlet C-1 – 2004:

Section 3 Definitions

3.1 Accuracy

"Difference between the true value and the gauge indication expressed as a percentage of the gauge span"

This states that accuracy is "*expressed as a percentage of the gauge span"*. This is incorrect. Accuracy is expressed as a percentage of the reading. According to this definition, the 1% accuracy requirement of §180.205(g)(3) would allow a +/-100 psi deviation on a 10,000 psi gauge (1% of the gauge span). So, for testing at 3,000 psi, this definition would allow an error of up to 100 psi. This is obviously a mistake. The accuracy requirement of the regulations call for an accuracy of +/- 1% of the **prescribed test pressure** of any cylinder tested.

The text of C-1 has confused Accuracy with Accuracy Grade. It is the manufactured Accuracy Grade of the gauge that is expressed as a percentage of the gauge span (see current §180.205(g)(3)(i) for the 0.5% of full range accuracy grade requirement of the gauge.). These are two different terms with two different meanings. This erroneous definition would cause even more confusion in the industry.

3.11 Hydrostatic Test

"Cylinder qualification procedure consisting of application of internal pressure with measurement of cylinder expansion, generally performed with water, but other liquid or gas pressure may be used."

This states that the test may be performed with gas pressure. That would make it a pneumatic test, not hydrostatic. The definition of hydrostatic is *"of or relating to liquids at rest or the pressure they exert."* A test performed with gas would be a Pneumatic test.

This definition also says, *"…with measurement of cylinder expansion"*. That would be a Volumetric Expansion Test. This definition precludes a Proof Pressure test from being a Hydrostatic test. The Proof Pressure test does not measure expansion, but it is certainly a Hydrostatic test when performed using a liquid media for pressurization.

3.21 Volumetric expansion test

"Hydrostatic test with cylinder volumetric expansion determined by using a water jacket."

This states that expansion is determined by using a water jacket. This would preclude the Direct Expansion test.

3.?? Total Expansion (Missing definition)

Total Expansion is not defined. Elastic and Permanent expansion are defined, but not Total Expansion.

Section 5 Water Jacket Method

Page 4, Note 3:

"When test pressure cannot be achieved or maintained… the test may be repeated…"

This restriction of limiting a repeated test to the situation of a loss of pressure only was corrected in the 1996 edition of §173.34(e)(4)(v), where the wording was changed to say, *"In the case of a malfunction of the test equipment, the test may be repeated"*. The correct, current wording of §180.205(g)(5) allows for situations such as expansion system failure, or a loss of power to a computerized machine, or some other malfunction that may or may not be related to test pressure. Replacing the current text with C-1 would be taking a step backwards to a situation that was corrected over 10 years ago.

5.2.1.2 Expansion Indicating Device

"- in establishing resolution shall allow interpolation of measurements at the midpoint of the marked burette increments. "

This seems to be some sort of attempt to indicate that midpoint interpolation is permitted. This concept is clearly stated in the current §180.205(g)(2). However, in C-1 it is placed in the device requirements, and it says that the device shall allow interpolation. Interpolation of readings is not possible (or necessary) on the modern digital expansion indicating devices. This paragraph says "**shall** allow interpolation", and specifies a burette. A strict reading of this requirement would preclude the use of digital expansion devices.

5.2.1.2 Expansion Indicating Device (Missing Accuracy Requirement)

There is no +/-1% accuracy requirement for the expansion measurement system, as currently required in §180.205(g)(3)(ii). This is a significant omission, and would dramatically reduce the current level of safety offered by the existing regulations. Once again, this would be a step backwards from the current regulations, not an improvement.

5.2.2.2 Pressure Indicating Device

"The pressure indicating device (PID) shall be…

- readable to a resolution of +/-1.0% in the range of 90% to 110% of test pressure."

This is a mistake. It combines two parts of the current requirement into one erroneous statement. The current regulations call for 1% resolution of test pressure, and require that the device permits reading of pressures from 90% - 110% of test pressure:

§180.205(g)(2) The pressure indicating device of the testing apparatus must permit reading of pressures to within 1% of the minimum prescribed test pressure of each cylinder tested.

180.205(g)(3)(i) … must permit readings of pressure from 90% - 110% of the minimum prescribed test pressure.

The reason for requiring the gauge to permit readings from 90% – 110% of test pressure is so that; 1. The retester will know the point at or below where a 90% system check may be performed; and 2. So that, in the case of a malfunction of the test equipment, the test may be repeated at a pressure increased by 10% or 100 psi, not to exceed 110% of the minimum prescribed test pressure.

The 90% system check is not a test, and therefore should not be subject to the accuracy or resolution requirements. By adopting this standard, some currently authorized gauges will be required to be replaced. For example, a gauge with 20 psi increments could be read to 10 psi using midpoint interpolation. Therefore a test to 1,000 psi would currently be authorized since 10 psi is 1% of 1,000 psi. However, by incorporating C-1, the gauge could not be used for test pressures below 1,111 psi, because the gauge would have to be readable "TO A RESOLUTION OF +/- 1% in the range of 90% - 110% of test pressure". (1,000 psi is 90% of 1,111 psi.) This mistakenly altered version provides no improvement to the existing system requirements. It will only cause confusion, additional cost, and/or non-compliance.

5.2.2.2 Pressure Indicating Device

"It is recommended that PIDs be operated in the middle third of their full range."

This is an antiquated statement that would unduly restrict the useable range of the PID. Analog and digital gauge manufacturers no longer stipulate this limitation. There is no reason for this restriction to be imposed on this industry. In order to comply with this statement, a 15,000 psi gauge would be required in order to perform a test at 10,000 psi. The readability requirement has already been established at 90% to 110% of the minimum prescribed test pressure. This establishes the useable range – to perform a test at 10,000 psi, you need an 11,000 psi gauge. This recommendation would impose unnecessary burden on the industry with no benefit.

5.2.2.2 Pressure Indicating Device

"NOTE – The certificate of calibration should not be used to adjust actual PID values."

This statement is misleading, and would potentially render some systems out of calibration. Using the adjusted values of the certificate of calibration is sometimes critical in establishing 1% system accuracy of the test equipment as demonstrated by the calibrated cylinder. For example, if a gauge is off by -20 psi at 3,000 psi, as shown on the certificate of calibration of the gauge, and the retester pressurizes the calibrated cylinder to an indicated pressure of 3,000 psi on the gauge (without making the -20 psi

correction, as this statement dictates), he has actually pressurized the cylinder to 3,020 psi. This is almost at the limit of his 1% accuracy requirement (30 psi would be 1% of 3,000 psi). He may not be able to obtain a reading within 1% of the calibrated cylinder's expansion value at 3,000 psi. However, by using the adjusted value from his certificate of calibration for the gauge, he would pressurize to an indicated pressure of 2980 on the gauge, which would be a true pressure of 3,000 psi applied to the cylinder, and he may then be able to record expansion readings within the 1% requirement.

5.2.2.4 Associated plumbing

"Additional pressure supply system components, such as surge chambers…"

This sentence seems to condone the use of a surge chamber, while not giving direction as to the proper configuration requirements.

If the pump speed is not properly adjusted, it may be difficult to test small cylinders since just a couple of strokes of the pump will cause the pressure to go over test pressure. So, some retesters have installed surge chambers (typically a large high pressure cylinder) that are pressurized simultaneously with a small cylinder to reduce the surges of the pump, and make it easier to control the pressurization of the cylinder being tested.

The problem arises when the pump is stopped. If there is not an isolation valve between the surge chamber and the pressurization circuit, then the cylinder being tested may have a leak that is being compensated for by the surge chamber. For example, small medical oxygen M6 or M9 cylinders have test pressures of 3,775 psi and 3,360 psi, with Total Expansions between 6.0cc – 9.0cc. One of these small cylinders could lose 35 to 40 psi (1% of test pressure) before the expansion dropped 0.1cc. Without the surge chamber, the test would be aborted due to a loss of pressure. However, if there is no isolation valve between the surge chamber and the pressure circuit (the isolation valve should be closed after test pressure is reached), then the "surge chamber" becomes a pressure reservoir that will make up the pressure in the case of a leak, and cause an invalid test to go unnoticed.

5.3.1 Design for a calibrated cylinder

"The preferred design for a calibrated cylinder is one that has known expansion values at the exact pressures at which cylinders are to be tested."

This is not correct, and will impose unnecessary changes to current calibrated cylinder designs. The current regulations specifically state:

180.205(g)(3)(i) 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.

This text was adopted in the 1996 edition of 173.34(e) in order to preclude the very concept that C-1 puts forth. It is not feasible or beneficial to try to design calibrated cylinders with each and every exact test pressure. The current text of the CFR was adopted in 1996 in order to allow calibrated cylinders to have pressure points at even 1,000 psi incremental marks. This created a more useable and producible standard that would correspond with the corrected pressure values of the PID's certificate of calibration. Once again, adopting this standard would be a step backwards into errors that were corrected over 10 years ago.

5.4 Test system accuracy verification

This section details the alternate method of demonstrating calibration from the current regulations as being the preferred method (i.e. bringing the total expansion to a known value on the calibration certificate of the calibrated cylinder and then verifying that the resulting pressure is within +/-1%), then adds a note to say that the verification may also be accomplished by bringing the pressure to a known value, then verifying that the resulting expansion is within +/-1%.

There is no reason for this more awkward method to be the preferred method. When performing the hydrostatic test, retesters pressurize cylinders to known test pressures, not to expansion values. Telling them to do it backwards only causes confusion. While both methods should yield the same results, there is no reason to tell the retester to perform his calibration in a procedure that is backwards from the way he tests cylinders.

Section 6 Direct Expansion Method

6.6 Test system trouble shooting

"… If the decrease [in pressure] *is accompanied by a fall in the burette level, leakage of the pressure system valves or associated plumbing is indicated."*

This is incorrect and misleading, and indicates a lack of understanding of the Direct Expansion test system. This trouble shooting text was simply copied from the Water Jacket trouble shooting section, and does not apply to the Direct Expansion system.

In the Direct Expansion test, the expansion water is used to pressurize the cylinder. The pressurization pump draws water from the expansion measuring system, and pumps it into the cylinder. Once test pressure is achieved, the pump is stopped and/or the pressurization valve is closed, thus isolating the expansion from the pressure until the end of the hold time when the pressure release valve is opened, allowing the water to flow

back into the expansion measuring device. If there is a leak in the pressure system valves or associated plumbing in a Direct Expansion system, the pressure will fall, but the expansion will remain constant.

Figures

Figure 7 on page 16 is not correct. This table shows the compressibility factors for water at various pressures and temperatures. These values were apparently extrapolated from a single data point, and do not match actual values. A calibrated cylinder that was calibrated in a Water Jacket will not match its certified values in a Direct Expansion system if these erroneous compressibility factors are used. The calculated Direct Expansion results coincide with actual expansion values at approximately 2,500 psi, indicating this was possibly the point used for the extrapolation of data. From 2,000 psi to about 3,500 psi, this error is within 1%. However, above or below this range, the error induced by this incorrect table goes beyond the 1% accuracy requirement. At 500 psi, there is a +10.2% error, and at 4,000 psi there is an -1.3% error.

Summary of proposal to reference CGA C-1:

It is because of these significant errors that CGA C-1 should not be incorporated by reference into the CFR. Replacing the current text of 49 CFR 180.205(g) with CGA C-1 will have an adverse effect on the existing system requirements, not the improvement stated in the proposal.

I can find nothing to indicate that C-1 “more adequately reflects the equipment accuracy requirements for performing a pressure test on cylinders”. On the contrary, C-1 is missing part of the requirement. It contains altered and mistaken interpretations of the current regulations, erroneous statements, and archaic notions that should have been removed long ago. Other than some 30 year old drawings of a burette (which is rarely produced anymore), and a poorly drawn schematic of a test apparatus, C-1 offers nothing to improve the current system requirements.

If PHMSA truly believes there is some benefit in referencing C-1, I would suggest that it is referenced as an informational document only in §171.7(b), and not incorporated by reference. However, I would strongly suggest that PHMSA require the errors listed above to be corrected before this document is even referenced as informational in §171.7(b).

Suggestion 180.205(g):

As previously submitted by this commenter to PHMSA in July of 2006, the following, simple corrections to §180.205(g) would correct some out of context requirements found in the current text.

This suggestion is to move the Pressure and Expansion device requirements up into the proper sections, out of the verification sections (See underlined additions and crossed-out deletions below).

180.205(g)
(2)(i) The pressure indicating device of the testing apparatus must permit reading of pressures to within 1% of the minimum prescribed test pressure of each cylinder tested, except that for an analog device, interpolation to 1⁄2 of the marked gauge divisions is acceptable. 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.
(ii) The expansion-indicating device of the testing apparatus must also permit incremental reading of the cylinder expansion to 1% of the total expansion of each cylinder tested or 0.1 cc, whichever is larger. Midpoint visual interpolation is permitted. The expansion-indicating device itself must have an accuracy of ±0.5%, or better, of its full scale.

(3) Each day before retesting, the retester shall confirm, by using a calibrated cylinder or other method authorized in writing by the Associate Administrator, that:
(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.~~

Proposed §180.205(g)(2):

"Each day before testing, the requalifier shall confirm the accuracy of the expansion indicating device and the pressure-indicating device by using a calibrated cylinder or other method authorized in writing by the Associate Administrator."

I suggest adding text to include the use of a reference gauge for the Proof Pressure Test. This is currently a gray area, and many facilities performing the Proof Pressure Test fail to realize that these requirements pertain to the Proof Pressure Test as well as the Volumetric Expansion Test.

I suggest the following:

"… by using a calibrated cylinder <u>for the Volumetric Expansion Test, or a reference gauge for the Proof Pressure Test,</u> or other method authorized in writing by the Associate Administrator."

Proposed §180.205(g)(2):

"In the event the calibrated cylinder's expansion values have changed from the certified certificate expansion values, the calibrated cylinder may be recalibrated using a dead weight test device traceable to the National Institute of Standards and Testing (NIST) measurement standards or using another calibrated cylinder."

I suggest removing the words, *"using a dead weight test device traceable to the National Institute of Standards and Testing (NIST) measurement standards or using another calibrated cylinder."* There is no such requirement for the initial calibration of the calibrated cylinder. Furthermore, a dead weight test device is rarely (if ever) used in the actual calibration of the cylinder. Instead, a dead weight tester or electronic pressure indicating device of appropriate accuracy is used to calibrate the system on which the calibration of the cylinder will be performed. This text would preclude the use of an electronic pressure indicating device, and require a dead weight tester to be physically attached to the test apparatus for the calibration of the cylinder. Additionally, the words, "… *or using another calibrated cylinder"* could be used to imply that the retester could simply use another calibrated cylinder to verify his equipment, then attempt to recalibrate his own calibrated cylinder.

Unless PHMSA determines to actually define a calibrated cylinder and the proper procedures involved in its production, this introduction of a requirement for the recalibration is inappropriate.

Proposed §180.205(g)(3):

The wording of the existing §180.205(g)(4) and proposed §180.205(g)(3) causes confusion:

"The requalifier must demonstrate calibration in conformance with this paragraph (g) to an authorized inspector on any day that the requalifier retests cylinders."

The words *"must demonstrate"* imply that on any day the retester is going to test, he will have to go find an authorized inspector and demonstrate his calibration in conformance with paragraph (g).

I suggest the following:

"The requalifier must be able to demonstrate calibration in conformance with this paragraph (g) to an authorized inspector on any day that the requalifier retests cylinders, upon request of the inspector."

Proposed §180.205(g)(4):

I agree with the proposed §180.205(g)(4), however I would suggest one correction and two additional points:

Correction:

"When a test pressure cannot be achieved or maintained due to a malfunction of the test equipment, the pressure test may be repeated only at a pressure increased by 10% or 100 psig, whichever is the lower value."

Remove the words *"When a test pressure cannot be achieved or maintained due to a malfunction of the test equipment,…"* and return to the current text of 180.205(g)(5):

"In the case of a malfunction of the test equipment, the test may be repeated at a pressure increased by 10% or 100 psig, whichever is less."

The restriction of limiting a repeated test to the situation of a loss of pressure only was corrected in the 1996 edition of §173.34(e)(4)(v), where the wording was changed to say, *"In the case of a malfunction of the test equipment, the test may be repeated"*. The correct, current wording of §180.205(g)(5) allows for situations such as expansion system failure, or a loss of power to a computerized machine, or some other malfunction that may or may not be related to test pressure. This change is unwarranted, and would be taking a step backwards to a situation that was corrected over 10 years ago.

Additions:

1. Add a limit of no more than 3 repeated tests permitted. In the proposed version, the test of a cylinder with a test pressure of 7,500 psi could be repeated seven times. This is unnecessary, and would indicate some continuing system malfunction or operator error. In the case of an aborted test, the test operator should correct the problem, and then perform a system check at or below 90% of minimum prescribed test pressure. The test operator should not attempt the repeated test at a higher pressure until he is able to

complete a successful system check at or below 90% of test pressure. By following this procedure, it should not be necessary to perform more than 3 repeated tests. Some small cylinders and some composite cylinders can be very difficult to test, and may require more than one repeated test. However, repeating the test on a cylinder more than 3 times indicates an on-going problem that has not been resolved.

2. Reduce the allowable permanent expansion of a repeated test to 5%. In an experiment, we repeated the test on two cylinders that had failed and were condemned due to excessive permanent expansion (greater than 10%). On repeat tests at +100 psi, these cylinders (one 3HT, one 3A) had permanent expansions of 9.6% and 9.0%, respectively. Had this been an actual requalification scenario, the retester might have passed these cylinders, since they did not exceed 10% permanent expansion. Once a cylinder has been pressurized to the minimum prescribed test pressure, any settling due to deformation of the cylindrical shape has been stretched out, and subsequent repeated tests of the cylinder should show little to no permanent expansion if the applied pressure has not reached the yield point of the cylinder. A reduced limit of 5% allowable permanent expansion for any repeated test would improve safety by eliminating the possibility of a bad cylinder passing requalification on a repeated test, while not adversely affecting the repeat test of a safe cylinder in good condition.

Omission:

Omitted: *§180.205(g)(5) "A system check may be performed at or below 90%"*.

Although C-1 says "any internal pressure applied to a cylinder before the test pressure shall not exceed 90% of the minimum prescribed test pressure", it is a note (page 4, note #2), and worded as a precautionary limit rather than regulatory permission, and therefore does not carry the same meaning. The use of a system check at 90% is critical for many composite, galvanized, and small cylinders. Some manufacturers have this 90% system check written into their technical bulletins as the proper test procedure. The specific, stated permission for performing a system check at or below 90% of minimum prescribed test pressure should not be omitted from the regulations.

Respectfully submitted,

Darrell K. Garton
CTC Certified Training Co.
info@ctcseminars.com
www.ctcseminars.com