DRAFT RECOMMENDATION

DR 3

(Inf.)

INFORMATION

New OIML Draft Recommendation

Compressed gaseous fuel measuring systems for vehicules

42nd CIML

ORGANISATION INTERNATIONALE DE MÉTROLOGIE LÉGALE

INTERNATIONAL ORGANIZATION OF LEGAL METROLOGY

DRAFT INTERNATIONAL RECOMMENDATION
Compressed gaseous fuel measuring systems for vehicles

The Draft Recommendation was submitted for direct CIML online approval as decided at the 41st CIML Meeting.

Votes and comments from CIML Members were closed on 15 July 2007. The original deadline was fixed on 2 July 2007 and the BIML decided to allow some extra weeks considering the number of votes received.

Thirty seven countries voted among which two countries abstained and four countries voted "No" on the Draft Recommendation.

Referring to the approval rules in case of a vote by correspondence, the Draft is not approved by correspondence since we received "No votes" and less than two-third of CIML Members voted.

Nevertheless, since the Draft is approved by a simple majority of all CIML Members, the online vote can be considered as a preliminary vote by correspondence and submitted for approval at the 42nd CIML Meeting in Shanghai. Please refer to 3.2 b) in OIML G 16 Guide on the categories of OIML Publications and their adoption procedures.

Voting results and comments received are summarized below.

The text of the Draft Recommendation has been kept identical to the one submitted for online approval. Changes accepted by the Secretariat further to the comments received will be implemented by the BIML before publishing the Recommendation.

Results of votes

ALBANIA	Yes
AUSTRALIA	Yes
BELARUS	Yes
BELGIUM	Yes
BRAZIL	Yes
CANADA	Yes
CYPRUS	Yes
CZECH REPUBLIC	Yes
DENMARK	Yes
FINLAND	Yes
FRANCE	Yes
GERMANY	Yes
HUNGARY	Yes
ISRAEL	Yes
KAZAKHSTAN	Yes
KOREA (R.)	Yes
MONACO	Yes
NORWAY	Yes
P.R. CHINA	Yes
POLAND	Yes
PORTUGAL	Yes
ROMANIA	Yes
RUSSIAN FEDERATION	Yes
SERBIA	Yes
SLOVAKIA	Yes
SLOVENIA	Yes
SWEDEN	Yes
SWITZERLAND	Yes
TURKEY	Yes
UNITED KINGDOM	Yes
VIET NAM	Yes
AUSTRIA	No
JAPAN	No
NETHERLANDS	No
UNITED STATES	No
CAMEROON	Abstained
SAUDI ARABIA	Abstained

Comments received from CIML Members
on the Draft Recommendation *Compressed gaseous fuel measuring systems for vehicles* submitted for online approval

Draft Recommendation	Country	Comments received	Secretariat's replies
General	Austria	The purpose of the instruments is to refuel motor vehicles in the same way as it is done by fuel dispensers of R117. So naturally, many points of this draft have the same object as in R117 (4.1.4 adjustment device, 4.1.5 correction device, 4.2 indicating device, 4.3 zero setting device, 4.4 price indicating device, 4.5 printing device, 4.6 memory device, 4.7 pre-setting device, 4.8 calculator, 5 technical requirements for electronic devices, 6 technical requirements for MS with self-service devices, 7.2 sealing devices and stamping plates, 8.1.1 – 8.1.4, 8.1.5 (with slight differences to R117), 8.1.6 – 8.1.9). For the ease of reading both documents the relevant points shall be strictly brought in line, perhaps giving a reference to R117-1; Eventual differences shall be indicated.	Agree to review consistency of both terminologies before publication and to align where appropriate Not accepted
General	Austria	The Annex B testing is too demanding and we fully support the comments of the Netherlands on the 3 CD (metrological aspects and economic aspects). Our experience with CNG fuel dispensers equipped with Coriolis meters (produced by 3 different manufacturers) was exclusively positive. We had relied on the type approval for the meter (based on tests only at constant flow rates) and tested the MS (deliveries including acceleration/deceleration at the start and checking phase as well as the low flow end when the receiver tank becomes filled up). Irregularities in the behavior of the meter due to the dynamic flow speed or to pressure peaks would have been revealed. The MS had performed well during the type	This comment and the proposed approach come late. The tests in annex B have been established in relation with experts of CNG measurements and have been considered necessary to ensure appropriate and reproducible testing conditions. In particular a rigorous approach leaded to consider that it was not possible to rely only on : - the experience got at constant flowrates with liquids because it does not reflect the dynamic measurements for this

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		approval, the initial verification and the subsequent verification without the necessity for adjustment of the meter factor.	application, - tests performed in limited situations in use, that would not ensure representativity of all situations and reproducibility of test conditions, These testing conditions were particularly reviewed during several meetings and the annex B reflects exactly the conclusion of the big majority of participants. Also do not forget that the draft is not limited to the Coriolis technology (decision of the SC).
General	Canada	Add a requirement for the performance of a "leak check" to be performed at the end of Test 3 and Test 6, after the dispenser stops registering mass flow, to check whether any gas is flowing in the hose as a result of a leaking flow-control valve. Such types of leaks are only detectable by means of listening and feeling (by wrapping your hand around the hose) the small vibrations occurring in the hose as a result of the mail flow control valve not closing. Note: Clause 2.5.5 states that "the system shall be designed to ensure that the measured quantity is delivered", and that requires a leak test to detect unregistered gas flow. Small leaks do occur and can sometimes be difficult to detect if the flow rate of the leak is very small. If the dispenser's main flow control valve continues to leak after it closes, and if the resultant leak rate is less than the programmed low-flow cut-off value, unregistered gas flow will occur. Some contractors may be reluctant to repair or replace a defective control valve which only has a small leak, especially if the leak is very small or intermittent, so the inclusion of a leak check requirement would enable inspectors to compel dispenser owners to take corrective action.	The Secretariat would not be against studying these proposals, but it seems impossible to introduce these fundamental changes or additions at the level of elaboration of the document. They need to be reviewed by experts. As this field of measurements is rather new and due to the necessity for several States to introduce an official regulation on these MIs very quick, the Secretariat proposes to accept the document without fundamental changes and to put the Recommendation in immediate process of revision.

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		- add a requirement for performing a "no load test", to detect whether the dispenser continues to register mass flow after the gas control flow valve has completely closed. Such problems are commonly observed and can occur if the zero setting is not adjusted properly. Note: This gas leak can be detected by listening for the audible noise of the gas passing through the flow control valve on the dispenser hose nozzle, or through the check valve on the test cylinder. - specify the minimum permissible value for the low-flow cut-off setting, to prevent the meter from inaccurately measuring mass flow at flow rates below the meter's rated operating range. Note: Typically the low-flow cut-off value recommended by the meter manufacturer is 0.5% of the maximum rated flow capacity of the meter. - for dual meter type dispensers (i.e. two hoses and two meters housed within the same dispenser enclosure), specify that at least one accuracy test must be conducted with both meters operating simultaneously, to detect whether the operation of one meter affects the operation of the other meter. Note: Excessive erratic errors have been observed by inspectors conducting a dispenser verification test on one side of a dual dispenser when the other side was being used to dispense gas into the vehicle of a paying customer. The manufacturer suspects the cause is mechanical vibration interference that is transmitted through piping interconnections, which in turn causes false signals to be received by the other coriolis meter. - add a clause to describe how the flow rate is to be measured, timed, and calculated, given that the flowrates will change with changes in the volume and pressure of the	

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		gas in the test cylinder.	
General	Germany	There raised up some more experience with the technology and the use of CNG dispensers in the recent time which have not been reflected in this document (of course due to the establishment of the main parts more than three or even four years ago). First we would ask for a revision concerning the unit of indication. Due the development of the gas market considering the calorific value of gases from different sources, it would be very helpful to take calorific value into consideration additionally and to allow also the use of kWh as well as kg. On the other hand we propose a revision and new discussion of the parts dealing with the requirements for pattern approval and initial verification. The reasons are: - Most of the test equipment currently available does not fulfill the requirements concerning uncertainty. - The test procedures are extremely extensive compared with the durability effects of the mainly used technology (coriolis meter).	The Secretariat basically agrees. See answer to Canada
General	Netherlands	The main reason for our "NO" vote is test B.2.1 (test at constant flow rate). In our opinion (supported by the test lab NMi Certin as well as by the industry), this mandatory test is not representative for the practical application of these instruments and therefore unnecessary and besides that, this test is in practice almost impossible: As far as we know, there is worldwide only one laboratory claiming it has a facility for this test. So this mandatory tests results in unnecessary extra costs for getting type approval. Therefore, in our opinion, this test must be replaced by a representative test at decreasing pressure and flow	The global testing procedure in annex B results of the conclusion of a big majority of participants in several meetings. In general it is not possible to make fundamental changes at this level of elaboration of the document, but on this particular aspect the following can be said. 1 The number of tests in normal operating conditions (with transient flowrates) is very limited and will not represent all situations of use, although they may be considered as representative of real situations.

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		(according to the situation in the field.). At the positive side: We can agree with the requirements. This means that if the draft would be split in 2 Parts like many nowadays OIML Recommendations (Part 1 requirements and Part 2 tests), we could easily vote YES for Part 1, but continue voting NO for part 2 as long as B.2.1 is maintained. To emphasize this, I can inform you that our country is currently preparing a Regulation for CNG dispensers and I expect that the requirements will be based on this draft OIML Recommendation. So you will understand that we would welcome a soon adoption of at least the requirements ("Part 1") as an OIML Recommendation!	The experts concluded that tests at constant (or almost constant) flowrates were necessary in order to demonstrate the basic metrological quality of the meter, because errors at different flowrates could be compensated in the course of a delivery. In conclusion of the two above considerations, this is to ensure that although we perform a very limited number of tests with transient flowrates at approval, the MS in use should be capable to face with satisfaction all practical situations. 2 See also answer to Austria on the technical aspects in particular 3 It has to be noticed that the required specific tests for the meter are not performed at constant flowrates but at flowrates in 5 ranges. This was decided because the experts have considered that it is relatively easy to design such testing conditions. Maybe there is only one test rig allowing tests at pure constant flowrates with gas in the world, but surely it does not allow concluding that only this test rig is appropriate. 4 There is nowadays a very limited number of manufacturers of these meters or measuring systems, and surely we do not need a lot of testing facilities. In any case the absence of testing facilities in a member State should not be a reason for

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			refusing the draft. 5 It is pointed out that the Netherlands had accepted the draft at the previous stage although nothing has been changed on these aspects. 6 Deleting aspects on the tests would not be fair because the way of testing is fundamental for these instruments. This would not ensure a real harmonization of practices and promotion of recognition of approvals.
General	USA	The main reason for the US "no" vote on this draft is that we strongly believe that this document should not have left the subcommittee level. We have read and re-read the current (1993) Directives for the Technical Work, Section 3.4.4. We agree that there is a clause that allows advancing a document from a CD to a DR before there 100% subcommittee consensus if "there is little or no prospect of obtaining wider acceptance of the CD by its further amendment." However, this clause is only allowed to be implemented AFTER the document has achieved approval by at least two-thirds of the subcommittee's P-members.	The situation was explained at the 41st CIML in Capetown. The Secretariat proceeded to a vote on the 3CD. Results of voting were presented at the CIML Meeting and the CIML concluded that it was necessary to implement provisions in order to finalize the work on this issue: there is a need for such a regulation in many Member States.
General	USA	In various sections of the document add spacing between the four numeral designations and beginning text in several clauses, for example, on page 16 revise clause "4.3.1.2Once the…completed." to read "4.3.1.2 Once the … completed." Legibility of the clause designation is lessened because numbers and text run together.	Thank you. All these details will be reviewed by the BIML before publication.
Title	Netherlands	Typing error : "Vehicules"	Thank you, accepted

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T.1.3.2 Note	USA	Does the Note mean that the document recognizes that the calculator may have two different functions (a metering and operational type) and the recommendation will specify if different requirements apply to the types of calculators when they are subjected to the same test or test conditions? Reader may arrive at multiple interpretations of the second sentence in the Note.	The necessity to introduce this double concept of calculators is due (in particular) to the fact that manufacturers of meters and MSs may be different companies. There is one calculator associated to the meter dealing with the Coriolis technology. This calculator sends the metrological information to another calculator dealing in particular with the price to pay. The Secretariat will see with the BIML how to clarify this, but suggestion would be welcome.
T.1.7, T.1.8	Netherlands	"Compressed gaseous fuel measuring systems for vehicles" (T.1.8) called hereafter "measuring systems" (T.1.7) Having these two overlapping definitions is somewhat confusing. So we suggest either deleting one of them or combining them.	The Secretariat does not consider this as critical. Moreover it makes the link with R117. Nevertheless the secretariat would not oppose if the BIML accepts to delete one definition leading to renumbering and that could result in possible mismatching in references in the document without particular care.
T.3	Canada	Add a definition for the term "scale interval", as this term is used extensively throughout the document.	Not accepted, it is defined in the VIM. See introduction of terminology
T.4.5	USA	Modify the text as follows: A set of specified values for influence factors that are fixed to ensure….measurements. Suggest editorial change to text for clarity.	Accepted
Scope	Canada	Amend the first sentence to clarify that this document specifies (recommends) requirements for pattern approval (or type approval) , initial verification, and subsequent reverification of compressed gaseous fuel measuring systems for vehicles.	Accepted
Scope	Netherlands	In our view, "road side motor vehicles" is a somewhat strange expression. May be this is meant to be: "roadside refueling stations for	Thank you: "roadside" was a mistake. Only "motor vehicles" will be used.

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		motor vehicles, ...” We have no information whether CNG is used at the moment, or in the near future, for small boats, aircraft, or trains. But this addition does no harm (if realistic).	It is better to keep it. This is homogeneous with R 117.
2.2.3	Netherlands	“*one shall verify*”: this is a test and not a “general requirement”. And who is “one” (manufacturer, owner, testing laboratory, inspection body, ...) We suggest to change this to a requirement by changing the text: *“.... these devices shall not affect ....”*	This is in line with R 117 and seems clear enough.
2.2.4	Netherlands	Delete “By definition”	Not accepted, this is to insist on the fact that this is a recall (see T.1.6)
2.3.2	Austria	Setting MMQ at such low values like 2 kg could cause difficulties for the MS, because by including start and stop phase in this small interval of 2 kg, the flow rate is changing permanently. 2 kg does not make sense because no consumer would claim for such a small amount.	This is consistent with 2 L for fuel dispensers in R 117.
2.3.2	Netherlands	What is in legislation the meaning of “Except in exceptional cases” ? We suggest deleting these words. And what to do in case the tank is almost full at the beginning of fuelling, so it is topped up before the “minimum measured quantity” is reached? We think, nothing more can be done than a warning that the error can be exceptional large.	This is the traditional wording in R 117. Checking of the final version of R 117- 1 will be done to ensure consistency between both documents.
2.3.2	USA	Explain if it is acceptable to use the measuring system for a delivery below the minimum measured quantity. What are the exceptional cases where the measuring system would be used to measure quantities less than the manufacturer's recommended minimum measured quantity?	This is the traditional wording in R 117. Checking of the final version of R 117- 1 will be done to ensure consistency between both documents.

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2.4.1	Netherlands	What is the "value" of the word "should"?	Compromise during discussions, some countries willing to display the price of the volume, which is not the recommended solution.
2.4.4	Netherlands	Suggestion to add: ".... the indications and prints provided ...."	A print is an indication. Not accepted
2.5	Canada	Add a system design requirement for reverse flow prevention, such as the installation of a non-return device or check valve located downstream of the transfer point, to prevent gas from flowing out of the vehicle's storage cylinder back through the dispenser in the event that the vessel to be refilled has a higher initial pressure than the dispenser delivery pressure.	This is effectively a necessary condition but we think it was already debated and considered to be a non necessary condition, because obvious or imposed by other regulations. In any case an MS not fitted with this device will fail to test 3 in B.2.2.1. Not necessary
2.5.4	Netherlands	Suggestion to complete the 1st and the 2nd paragraph with: ".... until a print has been made (if applicable) and the indicating device has been reset to zero."	To be considered in liaison with R 117-1
2.5.5	Canada	Add a mandatory requirement for performance of a "leak test" during pattern approval tests and verification tests, as the indication (display register) of the dispenser shall not register any flow.	See general comment
3.1	Japan	CNG dispensers installed in Japan are usually the systems on which we have already resolved many technical issues. Also, our affirmation on the aspect of accuracy is based on the technical background. In practice, it is very difficult that Japanese measuring systems conform to the contents of this recommendation. Therefore, We would like to request reconsideration for Japanese measuring systems with the following comments: 3.1 Maximum permissible errors and other metrological	

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		characteristics <u>1) When a complete measuring system satisfies the reference values, the reference values for meter alone shall be excluded.</u> As CNG is compressive gas, errors due to construction and dimensions of gas piping, etc. cannot be neglected. Those errors are added to those of meters alone. Therefore, for CNG dispensers, total filling accuracy of the measuring systems is important. In Japan, there are very few cases where meters are installed at filling stations on site and usually, manufacturers of dispensers assemble them as measuring systems at their plants and guarantee the total accuracy of the systems. These dispensers can be transported as complete systems assembled. Therefore, as long as measuring systems comply with the requirements of this recommendation, we think it also should be accepted that the compliance with "1% of the measured quantity for the meter alone" may be omitted. The reasons why total filling accuracy of measuring systems is important: are as follows: (1) Other than errors of meters alone, there exits some factors of errors due to constructions and dimensions of gas piping, etc., as follows: (a) Mass of residual gas in piping from a shutoff valve to a transfer point: For CNG dispensers, the mass of residual gas between a shutoff valve and a transfer point is a part of the previously measured quantity (quantity passed through a meter) and would not be measured at the	Not accepted It is a necessity to have the possibility to approve separately the meter. Moreover it is the philosophy of this Recommendation (and also in R 117) that all requirements applicable to a part of a MS apply even if a separate approval is not requested for the part. MPEs for the meter apply only at type approval in laboratory, not during tests on site of use. This is fully right and justifies the difference of concept between meter and MS.

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		subsequent delivery operation. As CNG is compressive fluid, the mass of the residual gas in the piping between a shutoff valve and a transfer point (filling nozzle) will vary depending on the pressure and the temperature at end of every delivery operation and consequently it becomes a factor of measuring errors. (b) Diffusion gas after completion of filling operation: The filling nozzle used for connection between a CNG dispenser and a fuel container on a vehicle cannot be removed under high pressure. Therefore, the pressure shall be decreased for removal of the filling coupler after completion of filling operation. These two matters become factors of measuring error because these gases are not supplied in the fuel container on a CNG vehicle in spite of having been measured through the CNG dispenser. From the above (a) and (b), the measuring accuracy of CNG dispensers cannot be determined by meters alone. We agree with the separate specifications for accuracy for meters alone and accuracy of measuring systems. We would like to confirm whether or not our understanding is correct, that assurance of accuracy of meters alone may be omitted when errors of measuring systems are within the specified value in this recommendation. <u>2) For MPE of measuring systems, 2 % is appropriate.</u> 1.5 % of MPE of measuring systems is decided to be impracticable. In 2.5.5 of this recommendation, "systematic correction or	As already mentioned a meter is never considered with piping (or piping likely to influence its accuracy), with it, it starts to become a MS.

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		repressurising before counting for the next delivery" is specified. When systematic correction is applied, correction error may be added. And, in the case of repressurising the hose, an error of pressure at pressurizing may be added. In Japan, many CNG stations may be installed in narrow sites in cities and there are suspension-hose type CNG dispensers that may require no islands. In these suspension-hose type dispensers, the hose and the piping are longer than those of general stand-alone type dispensers, and the quantity of residual gas between shutoff valves and transfer points may be increased. For this reason, 1.5 % of MPE for measuring systems is decided to be impracticable. At the same time, the worth of fuel for vehicles depends on the amount of heat of it. MPE of ± 0.5 % for gasoline is equivalent to MPE of ± 2 % for CNG. Therefore, for MPE for measuring systems, 2 % is decided to be appropriate. The justification for MPE of 2 % is as follows: (1) Only the mass of residual gas between a shutoff valve and a transfer point at every full filling corresponds to the error of maximum 1 % for filling of minimum measured quantity of 2 kg. The mass of residual gas between a shutoff valve and a transfer point (filling nozzle) will vary depending on the pressure and the temperature at the end of every delivery operation, because CNG is compressive gas. The mass of residual gas in gas piping measured at the previous delivery operation will be delivered into a fuel container without measuring at the beginning of the subsequent delivery. At the same time, the mass of gas remaining in the gas piping measured at the subsequent delivery will not be delivered to a CNG vehicle and	The Secretariat hopes the addition of the following in 3.1.1 could solve the concern of Japan. "The MPEs of 1,5 % of the measured quantity apply when the complete measuring system is fitted with an hose whose length is smaller than or equal to 3 m (this value might be modified within reasonable limits ; suggestions to be done). When the hose length is larger that this value the MPEs, positive or negative, are equal to 2 % of the measured quantity for the complete measuring system. The test report and the type approval certificate shall clearly indicate the maximum length allowed for the hose. Where in this Recommendation

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		remains in the gas piping at the completion of the subsequent delivery. For this reason, the difference between the pressure at termination of the previous delivery and the pressure at termination of the subsequent delivery will lead to a factor of error in measurement. An example is shown in Figure 1.1 (see below the table). Assuming that the volume of a gas piping is 1,000 cc (approximate 5 m from a shutoff valve to a transfer point), the mass of residual gas in the gas piping will be approximate 210 g, when the pressure at delivery completion is 20 MPa. When the pressure at completion of delivery is 19 MPa, the mass of residual gas in the gas piping will be approximate 200 g. That is, the difference between the two pressures at completion of delivery, 1 MPa leads to a difference of approximate 10 g in mass. This means that the subject vehicle at this time may receive 10 g more than the measured quantity, when the previous delivery terminated at 20 MPa and this time delivery terminates at 19 MPa. On the contrary, the vehicle may receive 10 g less than the measured quantity, when the previous delivery terminated at 19 MPa and this time delivery terminates at 20 MPa. This difference of 10 g corresponds to an error of 0.5 % at delivery of the minimum measured quantity of 2 kg. Some of the suspension-hose type CNG dispensers in Japan may have a volume of 2,000 cc gas piping (approximate 10 m between a shutoff valve and a transfer point). In these cases, pressure difference of 1 MPa at completion of delivery may generate approximate 20 g difference.	reference to MPEs applicable to the measuring system is made for aspects that are not linked to the hose length, the figure 1,5 applies."

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		This means that the subject vehicle at this time may receive 20 g more than the measured quantity when the previous delivery terminated at 20 MPa and this time delivery terminates at 19 MPa. On the contrary, the vehicle may receive 20 g less than the measured quantity, when the previous delivery terminated at 19 MPa and this time delivery terminates at 20 MPa. This difference 20 g corresponds to an error of 1 % at delivery of the minimum measured quantity of 2 kg. (2) Diffusion gas after completion of delivery corresponds to an error of 0.5 % at delivery of the minimum measured quantity of 2 kg. The filling couplers used for connection between the CNG dispenser and fuel containers on vehicles cannot be removed under high pressure. Therefore, to remove them after completion of delivery, they shall be depressurized. For this purpose, with operation of the 3-way valve after completion of delivery, CNG between the filling coupler and the 3-way valve shall be diffused. This diffused gas has been measured by the CNG dispenser, but does not been supplied in the fuel container on the CNG vehicle. When the volume between the filling coupler and the 3-way valve is assumed to be 50 cc, the mass of CNG at pressure of 20 MPa at completion of delivery will be about 10 g. This mass of 10 g corresponds to an error of 0.5 % at the minimum measured quantity of 2 kg. (3) In the case of delivery of, in particular, a specified quantity, systematic correction on measurement may be	

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		a factor of an error under influence of gas temperature. At delivery of a specified quantity, the inner pressure of hoses will be optional before and after delivery to a vehicle. For this reason, systematic measuring correction is essential. As an example of systematic measuring correction, there is a method to estimate the mass of residual gas between a shutoff valve and a transfer point (filling coupler) from pressure and geometric volume. In this method, the mass of residual gas will be a factor of measuring error being affected by gas temperature. From above (1), assume that the mass of residual gas is about 210 g. When provided that temperature range is – 10 ˚C to + 50 ˚C and + 20 ˚C is a reference as specified 4.1.1 of this recommendation, the mass may vary + 21.5 g at – 10 ˚C and – 21.5 g at + 50 ˚C, respectively. These are within an error of ± 1.08 % against the minimum measured quantity of 2 kg. This error is an error when volume variation of ideal gas due to temperature is considered. However, there is variation of compressibility change (compression factor) due to pressure for actual gases to become a further error-contributing factor. In the case of suspension-hose type, the error may expand moreover due to increase of the mass of residual gas. (4) Repressurizing of hose corresponds to an error of 1% at delivery of minimum measured quantity of 2 kg. When hoses are repressurized, it is necessary to fully fill only the inside of hoses in a short time like a few seconds. In delivery of a small volume of only inside of	

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		hoses, it is difficult to pressurize to a given pressure precisely at every time. In the above (1), the difference of pressure at completion of delivery is assumed to be 1 MPa. In the case of repressurising hoses, it is supposed that there may be variations of about 2 MPa in pressure difference after repressurising. Therefore, approximate 20 g of difference may be generated. This difference of 20 g corresponds to an error of 1% at delivery of minimum measured quantity of 2 kg. (5) When the measuring error factors in above (1) to (4) are combined under each condition, the overall error may exceed 1.5 %. An example of calculation is shown as the following: □ In the cases of full delivery each time (volume of gas piping is 1,000 cc): Accuracy of meter alone: 1 % Influence of pressure difference at completion of delivery at every delivery: 0.5 % Influence of diffused gas after completion of delivery: 0.5 % (The diffused gas after completion of delivery is constant every time, it is always an error of 0.5 % at delivery of minimum measured quantity of 2 kg.) • Overall accuracy: $(1^2 + 0.5^2)^{1/2} + 0.5 = 1.62$ % □ In the case of full delivery each time (suspension-hose type and volume of gas piping is 2,000 cc):	

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		Accuracy of meter alone: 1 % Influence of pressure difference at completion of delivery at every delivery: 1% Influence of diffused gas after completion of delivery: 0.5 % (The diffused gas after completion of delivery is constant every time, it is always an error of 0.5 % at delivery of minimum measured quantity of 2 kg.) • Overall accuracy: $(1^2 + 1^2)^{1/2} + 0.5 = 1.91$ % □ In the case of systematic measuring correction (volume of gas piping is 1,000 cc): Accuracy of meter alone: 1 % Influence of measuring correction: 1.08 % Influence of diffused gas after completion of delivery: 0.5 % (The diffused gas after completion of delivery is constant every time, it is always an error of 0.5 % at delivery of minimum measured quantity of 2 kg.) • Overall accuracy: $(1^2 + 1.08^2)^{1/2} + 0.5 = 1.97$ % □ In the case of repressurising of hose (volume of gas piping is 1,000 cc): Accuracy of meter alone: 1% Influence of repressurising of hoses: 1% Influence of diffused gas after completion of	

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		delivery: 0.5% (The diffused gas after completion of delivery is constant every time, it is always an error of 0.5% at delivery of minimum measurable quantity of 2 kg) • Overall accuracy: $(1^2 + 1.^2)^{1/2} + 0.5 = 1.91$ % From above, MPE ± 1.5% cannot be satisfied in every condition. At the same time, the worth of vehicle fuel depends on the amount of heat of it. The amount of heat of CNG is almost proportional to the mass when CO_2 and N_2 do not exist. The error of the worth is determined only by the error of compressed gaseous fuel measuring systems for vehicles. And it is 2 %. MPE (maximum permissible error) for liquid fuel measuring systems for vehicles is 0.5 %. However, measurement is done for volume, and errors due to composition and temperature of liquid fuels may be added if the accuracy is assessed with the amount of their heat. For example, in the case of gasoline, variation of density due to temperature is approximately 1 % at 10 ˚C and the error of measuring systems may be 2 % considering variation of compositions. From the above, MPE of 2 % for compressed gaseous fuel measuring systems is an equivalent level to the MPE of 0.5 % for liquid fuels. Therefore, MPE of 2 % for measuring systems is appropriate.	

Draft Recommendation	Country	Comments received	Secretariat's replies
4.1.1	Canada	Canada recommends that the last sentence be amended to state that "The rated temperature range of the meter shall cover at least -30 °C to +40 °C, and unless otherwise specified is assumed to be -40 °C to +50 °C", since Measurement Canada's current specifications require testing at non-reference ambient temperatures of -30 °C and +40 °C, which reflects the actual range of climatic temperatures which NGV dispensers are subjected to in service in some parts of Canada.	We hope the following addition will fulfil the concern of Canada: "In any case the range shall suit the conditions of use." This will allow members to impose the suitable conditions of use.
4.1.5	Netherlands	"Meters may be fitted ..." but ".... non-corrected mass shall not be displayed" implies that a correction device is mandatory.	No, it can only be understood when a correction device is provided.
4.1.5 Note	Netherlands	Note: "National regulations **should .**..." What does this mean in practice?	It comes from R 117 and has never raised problems.
4.1.5	Netherlands	What to do with the statement *"The associated instruments ...with the **applicable International standards or Recommendations"***: Which ones?	It comes from R 117 and has never raised problems.
4.2.3	Netherlands	Is this minimum size of 10 mm also necessary for, for instance point of sale computer screens?	No, in the document, it is clear that "indicating device" refers to the main display of the meter or MS (see T.1.4).
4.2.3	USA	Should there be additional requirements for the visibility of indicated values under all environmental conditions? Figure height is specified; however, some intrinsically safe displays indications for mass, unit price, and total price to be paid are not visible in direct sunlight.	Why not, but this has never been considered even at the level of R 117, and could be the object of a further revision for both Recommendations.
4.5	Canada	Add a requirement for printing the date of sale, time of sale, and name and address of the supplier (contractor or sales agent). These items of information are currently required by Measurement Canada's existing type approval specification LMB-EG-08, in section 10-2.6.1.	This kind of provision is only made mandatory in the case of self-service devices as in R 117.

Draft Recommendation	Country	Comments received	Secretariat's replies
4.5.2	Netherlands	Considering the word "may", we suggest adding "*identification of the vehicle"*	Not necessary
4.5.4	Netherlands	Why not <u>always</u> print the quantity?	We understand the concern but it comes from R 117 and will be put in line with R 117-1.
4.6.2	Netherlands	What to do with "advisable" in legislation? We suggest changing the text: *"The storage capacity shall correspond to at least 3 month as expected in normal use"*. (or similar words).	Consistency with R 117-1 will be considered.
4.7.8	USA	The presetting device for a measuring system must deliver a minimum volume. A price presetting device could be programmed to stop at the lowest quantity amount that is calculated for a unit price.	Consistency with R 117-1 will be considered.
4.8.1	Austria	MPE of calculator is acc. to R117 one tenth of MPE (meter). No reason to step apart from this general principle.	Sorry but there is a good reason for this because this is only an apparent contradiction. The calculators for CNG and LOTW are the same but the MPEs in fluid measurements are larger for CNG. Imposing smaller MPEs for the calculator for CNG (by reference to MPEs to fluid performance which are larger) ensures in fact that the required performance are similar in both cases for the calculator.
5.1.1	Netherlands	*"... national requirements may foresee ...."* In OIML Recommendations, references to national requirements should be avoided as far as possible (see also the "Directives for the technical work")	This is relatively common practice in OIML Recommendations to give opportunity to member States to have specific provisions on some very specific points.
5.1.1	USA	Cite the intended meaning of the acronym "MI." Wide audience of users may be confused about infrequently used acronyms when they are not defined.	Agreed

Draft Recommendation	Country	Comments received	Secretariat's replies
5.1.1 Note	USA	The manufacturer may not be able to ensure the measuring system's owner/operator uses the system within the rated operating conditions. Please clarify the intent of the Note, it appears to place a great responsibility on the manufacturer that may not be under their control.	This will be considered in relation with R 117-1 because it seems that a similar provision will be introduced in it.
5.1.4	Netherlands	(And probably also in other clauses) replace *"pattern"* by *"type"* (see VIML).	"Pattern" seems also allowed. The BIML will decide.
5.3.2, 5.3.4, 4.3.5	Austria	R117-1 requires checking the correct functioning of the checking facilities only at the stage of the type approval. No reason to step apart from this general principle.	R 117 requires that verifications shall be possible at verification. This has been deleted in R 117-1, but the SC in charge of CNG decided to keep some provision on this. The Secretariat has introduced in the last draft a provision which can easily fulfil the 2 approaches, because with modern technologies conformity to type ensures systematically the good operation of CF.
5.3.4.3	USA	Recommend editing text "The second possibility is ~~on the one hand~~ to …and ~~on~~ the other ~~hand~~ to check the display." to read "The second possibility is the option to …and the other alternative is to check the display." Suggest editorial change to text for clarity.	No this is a misunderstanding: both shall be checked in this case. Maybe the text could be improved with: " The second possibility is to check both: a) Automatically the electronic circuits used for the indicating device except the driving circuits of the display itself, and b) To check the display.
5.3.5	Netherlands	Add a check that the printer is connected.	No because this checking is necessary only when the printing device is mandatory (see introduction of 5.3.5) and the presence of "at least" allows omitting this particular case".

Draft Recommendation	Country	Comments received	Secretariat's replies
6.1.7, 6.3.1.3	USA	Explain what is a "registered" customer. Is the measuring system required to operate differently because the transactions takes place with a "registered" customer?	It comes from R 117 and will be aligned on R 117-1.
6.3.1.3	Netherlands	Add: *"... is **only** used by registered customers ...."*	Agree in principle but should be considered with R 117-1.
6.3.1.3	USA	A nonresettable totalizer should be a required part of the measuring system. Totalizers should be required and have specific functions as well as be accessible for use in determining throughput and to discern which meter they are associated with.	It comes from R 117 and will be aligned on R 117-1.
7.1.1 g)	Austria	The terms "sequential control device" and "maximum allowed speed for the sequential control device" shall be explained!	Sequential control device is defined in T.4.9 and together with T.4.8 (Banks) it was supposed to be clear. Nevertheless agree to clarify: "… speed of switching between banks for the sequential control device…"
7.1.1, 7.1.2	Netherlands	Is *"dial"* here the right word? (According to 4.2.1, the display **shall** be digital).	Thank you. This is a bad copy of R 117. "Front face of the indicating device" or something similar will be used.
7.1.1	Netherlands	We suggest to add the year of manufacture. Concerning the possibility of separately tested modules (see 8.1.1) make "type approval sign" in plural (if applicable)l: a) *Type approval sign**(s)***	Will be aligned on R 117-1 It would not be appropriate as this refer to "**Each** measuring system, component or sub-system…"
7.1.1 e)	Netherlands	We suggest to mention these first.	Will be aligned on R 117-1
7.1.1 f) and g)	Netherlands	Are f) and g) really necessary?	Yes.
7.2.1	Canada	Specify or list which dispenser components or adjustment mechanisms require sealing provisions or protection by physical sealing, such as the delivery flow rate adjustment element, the zero-adjust mechanism, and the zero cut-off setting.	General conditions on sealing specified in 7.2 are considered sufficient.

Draft Recommendation	Country	Comments received	Secretariat's replies
7.2.2.1.5	Netherlands	What is, in legislation, the meaning of: *"..., it is strongly encouraged that ...."* ?	Agree it is not optimal but this is the compromised result of discussions. R 117-1 will be considered.
7.2.2.1.5	USA	The date/time the parameter was changed should be tracked and recorded automatically rather than manually entered. Manual entries are subject to human error or can be fraudulent. Technology has the capability to provide unlimited communications to access system parameters that adjust or reconfigure electronic features. Sales to the public or between private businesses should have safeguards. If technology can make a more sophisticated device that is easier to use it should also provide a higher level of security that provides more information than a broken seal. A broken seal can be the result of a harsh environment or a curious customer. An audit trail method of electronic security on the means to access metrological parameters should be readily available for viewing in an understandable format or in the case of a large number of interventions a printable record. A large number of records should be retained because it is difficult to detect a problem such as improper repair work and unscrupulous practices when authorities are off duty if there is only limited data. The record of this access should not be erasable and retained if there is a power loss. See the U.S. requirements for electronic security listed below.	Thank you but at this stage all what we can do is to align on R 117-1 if appropriate.
8	Netherlands	Last sentence: What is the meaning (in legislation) of: *"... will be subject of specific* ***International Recommendations"***: ? Which Recommendations/drafts/projects?	Agree to change " International Recommendations" into " International Documents"
8.1.1	Netherlands	In this case, we will also need requirements,or at least (distribution of) MPEs - for the meter and the transducer.	Not in practice because we pass from the transducer to the meter adding a calculator with an indicating device which generate

Draft Recommendation	Country	Comments received	Secretariat's replies
			very small errors. In practice all experts understand that MPEs for the transducer and the meter are the same.
8.1.4.3	Netherlands	Suggested addition: *"... this body allows **in writing** the ...."*	Accepted
8.1.5.1	Netherlands	In our opinion, the sentence "*In any case MPEs are those applicable to the meter."* is superfluous.	It seems useful because it is indicated that tests for the meter may be performed on the whole MS.
8.1.7.1	Netherlands	Is *" ... has already been approved ...."* in practice always possible?	No problem
8.2.1, last paragraph	Austria	The verification of the presence and correct operation of the checking facilities shall be done at the stage of the type approval (as in R117-1), not at verification.	Thank you to point out this inconsistency. Will be replaced with: "Initial verification of electronic systems shall include a procedure for verifying the presence and correct operation of checking facilities when this conformity is not ensured by the conformity to type"
8.3	Austria	Subsequent verification and its requirements shall be the responsibility of the national authorities.	This is true: this is explicitly indicated in B.5 and what is in 8.3 does not contradict this. A reference will be made to B.5 in 8.3. Also a reference will be made to B.4 in 8.2.
Annex A	Austria	Shall be completely brought in line with the relevant requirements of R117-1 Annex A.10 and A.11 (adding A.4.1.4 of this draft for testing of battery driven devices)	Agree that the best application of D 11 should be taken as the reference for both documents and to add this test if relevant what is not obvious because we deal with fixed MS not MS on trucks.
Annex A.2	Netherlands	Why B and C ? The alphabet starts with A and B ???	To be consistent with R 117
Annex A.3	Netherlands	Please reconsider the lay out: *1) For parts ....* en *2) Substitute .....*	These are two foot page notes. Will be modified before publishing.
Annex A.4 1)	Netherlands	We suggest replacing in the 1st line *"..... should ....."* by *"..... are likely to ....."*	Accepted

Draft Recommendation	Country	Comments received	Secretariat's replies
Annex A.4.1 3)	Netherlands	We suggest adding: 3) Test methods for Coriolis meters	Accepted
Annex A.4.1 and following clauses	Netherlands	Add new Annex E "Bibliography" with at least the complete titles and versions (year of publication) of the standards referred to. In a few cases plural (severities) is used in cases where there is only one prescribed severity.	The Secretariat prefers not to introduce a bibliography which should contain not only references to classical standards used by OIML but also references to publication on CNG measurement, what is not available to-day.
Annex A.4 Annex A.4.3.a Annex A.4.3.b	Netherlands	We are doubtful about the necessity of prescribing both the humidity tests; Draft R 117-1 (2007) only prescribes the cyclic (condensing) tests.	Agree to delete this test if not in R 117-1
Annex A.4 Annex A.4.5.a Annex A.4.5.b	Netherlands	As in both cases 10 V/m (level 3) is prescribed, there is no need to mention mobile phones separately and the tables A.4.5.a and A.4.5.b can be easily combined.	Will be considered in conjunction with R 117-1
Annex A.4.6 Table	USA	Cite the intended meaning of the acronym "EM" Wide audience of users may be confused about infrequently used acronyms when they are not defined.	Will be considered in conjunction with R 117-1
Annex A.4.7	Netherlands	*Severity level* [(1)] but there is no note or footer (1)	Thank you. Deleted
Annex A.4.8	Netherlands	Title "... control lines" in text "I/O and communication ports" Although this is in compliance with the text of the present OIML D 11, I suggest to harmonize this terminology.	Will be considered in conjunction with R 117-1
Annex A.4 Annex A.4.9 Annex A.4.12 Annex A.4.13	Netherlands	We are in doubt whether these instruments will in practice ever be supplied from DC mains networks. But, on the other hand, it does no harm when there are requirements for this case.	Yes, it does no harm.
Annex A.4.12	Netherlands	Suggest adding: *"Repetition rate 5 kHz."*	Accepted
Annex A.4 Annex A.4.11	Netherlands	There is a contradiction: 1st sentence below the table in A.4 says that the severity levels are corresponding to industrial environments. But the note in A.4.11 refers to both IEC 61000-6-1 (residential etc) and IEC 61000-6-2 (industrial). And the severity level in A.4.11 corresponds to IEC 61000-	Thank you; this shall be checked, in particular in conjunction with R 117-1.

Draft Recommendation	Country	Comments received	Secretariat's replies
		6-1 (residential etc.). See 4.2 in IEC 61000-6-1 and 4.2 in IEC 61000-6-2. Furthermore, in the IEC standards and in D 11 the interruption is down to 0 %, not ">95%". We have no objection against the choice of the severity level, but we suggest reconsidering the text.	
Annex A.4 Annex A.4.14	Netherlands	We can hardly imagine that these instruments will ever be powered by a disposable internal battery. Please note that in D 11 the situation of a "back up battery", continuously/frequently recharged from the mains supply, is regarded as "powered from the mains supply. And therefore, 14.1 of D 11 refers to *"Low voltage of internal battery (not connected to the mains power)"*.	For this reason it is insisted in the title with "if relevant". As already said, it does no harm.
Annex B.2.1	USA	Cite the intended meaning of the acronym "FR" as follows:"B.2.1. Tests at constant flowrate (FR)" Wide audience of users may be confused about infrequently used acronyms when they are not defined.	Accepted
Annex B.2.2	Japan	1) When it is once demonstrated that changeover of bank would not affect on measuring accuracy and there is no changes in delivery control method, we propose to adopt an idea that bank changeover tests may be omitted. 2) For CNG filling stations of one bank type or 2-bank type, it should be accepted to carry out 2-bank tests. When dispensers control flow volume and bank changeover, there would be no effect on the measuring accuracy due to bank changeover. In Japan, as the most of systems have adopted the control methods that flow volume is controlled by flow control valves in dispensers and bank changeover of storage gas tanks is carried out by dispensers, no variation of flow volume that may effect the measuring accuracy is generated at changing over of bank. When it is once verified that changeover of bank would not effect on measuring accuracy at pattern approval test, it should be accepted that	The Secretariat hopes that the following will solve the concern of Japan. It will be added that "the proposed procedure may be adapted by National Authorities, in particular for tests on site of use and/or taking into consideration the specific design of filling stations."

Draft Recommendation	Country	Comments received	Secretariat's replies
		tests under bank changeover could be omitted at tests after type approval, initial verification and subsequent verification. Moreover, most of the CNG dispensers used in Japan are for small flow volume of 30 kg/min or less. And many CNG stations have been installed in narrow spaces in cities and most of them have only one bank or two banks. Therefore, tests for two banks are decided to be appropriate in Japan. We agree that results of tests for three banks can be applied to any number of banks. However, as one bank test is approved in this recommendation (B.2.3), it should be approved that two-bank test may apply to CNG stations of one bank type and two banks type. Figure 2.1 (see below the table) shows how the flow volume would change at changeover of bank in the typical dispensers in Japan. In the case of filling into 500 L containers, as the filling proceeds, internal pressure of the fuel containers will increase to reduce the flow volume gradually. Even when the banks are changed over, flow volume does not change significantly within the operation range. Figure 2.2 (see below the table) shows the data at test filling of a container with 31 L to 500 L of volume. The horizontal axis is for average mass flow and the longitudinal axis is for accuracy. For containers with not less than 200 L of volume, the bank is once changed over during filling, and for containers with not more than 150 L, the bank is not changed over. These results show that there is no substantive difference in accuracy of containers with 31 L to 500 L of volume. Therefore, effect on accuracy by bank changeover can be neglected.	
Annex B.2.5	Japan	We agree with performance of endurance test at pattern approval tests. However, we do not agree with the test	Taking into account the advice of experts, it was the decision of the SC to impose an

Draft Recommendation	Country	Comments received	Secretariat's replies
		method at present because it is full of question marks. We request response for the following questions: Questions: (1) What is the purpose of that "the endurance test shall involve at least 5 000 deliveries performed in less than six months" in this recommendation? This time, this number of deliveries has been reduced from 10 000 to 5 000. Please clarify the grounds for it? (2) It is stated that "It is advisable to perform the endurance test on site in real conditions of use". However, isn't it inconsistent with the proper measuring transaction required in this recommendation to transact measurement with dispensers which have not yet passed a pattern approval test? If the dispensers fail a pattern approval test, how should the deliveries already performed be handled? As mentioned above, this endurance test cannot be considered to be practicable under present situations. As for an endurance test, the purpose of the test shall be clarified in this recommendation and the method should be left at the discretion of each country.	endurance test involving 10 000 measurements in the conditions described in the draft. Nevertheless in response with the previous Japanese comments, the Secretariat has reduced the number to 5 000. No alternative test procedure has been proposed. In order to ensure reproducibility of tests results and recognition of approvals, this test may not be left to National Authorities. Some Members have the possibility to authorize instruments subject to type approval to be put in provisional use for some specific tests (after demonstration of a minimum of good performance in laboratory).
Annex B.3.2	Austria	Unnecessary to test the MS at the stage of type approval for extreme settings of adjustment parameters, because these parameters will be fixed prior to the initial verification, and then the MS will be verified with these parameters thus revealing detrimental effects.	Not agreed. Nothing ensures that the most severe conditions will be possible the day of verification. The logic of the draft it to test in the most severe conditions at type approval, note these conditions in the type approval certificate as far as relevant, and then check that the conditions in use will suit this information.
Annex B.3.4	USA	Suggest rework of paragraph three to clarify the intent. In particular the use of the word "respects" and the phrase "when accepted using this substitute procedure." Recommend editing the third paragraph to clarify the	Accepted. The text could be: "Provisions in this paragraph shall be implemented so that it can be assumed that the measuring systems in use respect

Draft Recommendation	Country	Comments received	Secretariat's replies
		conditions and/or required performance of the meter when it is designed to deliver various products.	maximum permissible errors with the intended gas or all the gases. The shifted and/or reduced maximum permissible errors are established taking into consideration the reproducibility of the type of meter or measuring system."
Annex B 4.1	USA	Provide some guidance for this theoretically procedure. Provide guidance at this point.	The Secretariat does not see the need for the time being.
Annex B.4.1.1	Canada	Where they are listed in this clause, test 3 and test 6 should be made mandatory and not optional, in order to assess the relative contribution to the overall error of a transaction of mass registrations that occur during the low-flow portion of a fueling transaction or fill. This matter is important, as the third bullet in Annex B states that one of the major factors affecting the system's accuracy is the relative contribution of the low flow rate portions to the total gas quantity delivered. Furthermore, it is stated in clause B.1.2 of Annex B that "in each flow test ... the actual test reservoir volume(s) used shall ensure that, within the last 20 seconds of filling, the test flowrate drops to 120% of the specified minimum flowrate or less of the meter or of the measuring system."	The Secretariat prefers to keep the flexibility allowing each Member to decide.
Annex C.6	Canada	In the second formula for "T", a multiplication symbol ("x") needs to be inserted between the multiplicands of 1.5 and 10-3.	Agree, thank you
Annex D.4.1	USA	Provide some guidance for this theoretically procedure.	Annex D is supposed to provide enough guidance at this stage. If necessary, additional guidance could be developed in the course of a revision.
Annex D.4.6	USA	Suggest editorial change in paragraph two to read as follows: "If it is not possible….to cold cool the temperature…manufacturer."	Agree, thank you

Additional comments from the USA:

Minimum Requirement for Audit Trails for Measuring Devices

Philosophy for Sealing Typical Features to be Sealed

Principles for Determining Features to be Sealed

The need to seal some features depends upon:

- the ease with which the feature or the selection of the feature can be used to facilitate fraud; and
- the likelihood that the use of the feature will result in fraud not being detected.

Features or functions which are routinely used by the operator as part of device operation, such as setting the unit prices on gasoline dispensers and maintaining unit prices in price look-up codes stored in memory, are not sealable parameters and shall not be sealed.

If a parameter (or set of parameters) selection would result in performance that would be obviously in error, such as the selection of parameters for different countries, then it is not necessary to seal the selection of these features.

If individual device characteristics are selectable from a "menu" or a series of programming steps, then access to the "programming mode" must be sealable.

Note: *If an audit trail is the only means of security, then the audit trail shall update only after at least one sealable parameter has been changed; simply accessing the sealable parameters via a menu shall not update the audit trail.*

If a device must undergo a physical act, such as cutting a wire and physically repairing the cut to reactivate the parameter, then this physical repair process would be considered an acceptable way to select parameters without requiring a physical seal or an audit trail.

Requirements for Metrological Audit Trails

Definitions

The following definitions apply to the discussion of metrological audit trails. Those definitions, which were added to NIST Handbook 44 as a result of NCWM action in July 1993, are indicated by *italicized* type.

Adjustment mode. An operational mode of a device which enables the user to adjust sealable parameters, including changes to configuration parameters.

Adjustment. A change in the value of any of a device's sealable calibration parameters or sealable configuration parameters.

Audit trail. *An electronic count and/or information record of the changes to the values of the calibration or configuration parameters of a device.* (The term addresses all forms of audit trail described in this paper.)

Calibration parameter. *Any adjustable parameter that can affect measurement or performance accuracy and, due to its nature, needs to be updated on an ongoing basis to maintain device accuracy, (e.g., span adjustments, linearization factors, and coarse zero adjustments).*

Configuration parameter. *Any adjustable or selectable parameter for a device feature that can affect the accuracy of a transaction or can significantly increase the potential for fraudulent use of the device and, due to its nature, needs to be updated only during device installation or upon replacement of a component, (e.g., division value (increment), sensor range, and units of measurement).*

Enabling/inhibiting sealable hardware. Physically sealable hardware, such as a two-position switch, located on a remotely configurable device, that enables and inhibits the capability to receive adjustment values or changes to sealable configuration parameters from a remote device.

Event. An action in which one or more changes are made to configuration parameters or adjustments are made to one value (or values for a set of values) for a calibration parameter (e.g., adjustments for a set of calibration factors to linearize device output), while in the adjustment mode. If no adjustment is made, then there is no event. In the case of a centralized audit trail, the same values for the same parameter sent to multiple devices shall be considered to be the same event. **In the case of a centralized event logger, the event logger must identify both the device and the parameter that was changed.**

Event counter. *A nonresettable counter that increments once each time the mode that permits changes to sealable parameters is entered and one or more changes are made to sealable calibration or configuration parameters of a device.*

Note: *An event counter shall have a capacity of at least 1000 values [e.g., 000 to 999].*

Event logger. *A form of audit trail containing a series of records where each record contains the number from the event counter corresponding to the change to a sealable parameter, the identification of the parameter that was changed, the time and date when the parameter was changed, and the new value of the parameter.*

Physical Seal. A physical means, such as lead and wire, used to seal a device to detect access to those adjustable features that are required to be sealed.

Remote configuration capability. *The ability to adjust a weighing or measuring device or change its sealable parameters from or through some other device that is not itself necessary to the operation of the weighing or measuring device or is not a permanent part of that device.*

Remote device. A device that (1) is not required for the measurement operation of the primary device or computing the transaction information in one or more of the available operating modes for commercial measurements or (2) is not a permanent part of the primary device. A remote device has the ability to adjust another device or change its sealable configurable parameters.

Remotely configurable device. Any weighing or measuring device with remote configuration capability that permits sealable configuration or calibration parameter values to be deleted, appended to, modified, or substituted in whole or in part by downloading over any type of communications link from another device, such as a geographically local or remote console or computer, whether or not the secondary apparatus is part of the network connecting the devices.

Seal. As a verb, to seal a device is to make a device secure so that access to adjustments and other sealable parameters will be detectable.

Sealable parameters. Calibration and configuration parameters that are required to be sealed.

Unrestricted access to sealable parameters. Unrestricted access means that a physical security seal is not present, so that access to the sealable parameters is available from a remote device at any time at the request of an authorized operator subject to the operating status of the receiving device.

Categories of Device: Three Forms of Audit Trail

Three forms of the audit trail have been established; the form of audit trail acceptable for a device depends on the capability to adjust the device or change sealable parameters. The form that applies to a particular device depends upon the availability of remote configuration capability and, if so, whether or not there is virtually unrestricted access to the configuration or calibration parameters of the device. Three categories of device are listed below with the category designation numbered to correspond to the capability and ease of changing sealable parameters from a remote device.

Category 1. A device that does not have remote configuration capability.

These devices may be sealed with either a physical security seal or an audit trail. If an audit trail is used, then the minimum form of audit trail must be provided (see next page).

Category 2. If a device has remote configuration capability, but the activation of the remote configuration capability is through physical hardware (such as a switch) that can be sealed with a physical seal, then the device may be sealed using a physical seal **or** the minimum form of the audit trail.

Because the event logger (see category 3 below) requires significant memory and many device manufacturers want to provide remote configuration capability for at least some of the sealable parameters, a "hybrid" form of audit trail was established. Restricted access to the hardware inhibiting and activating the remote configuration capability eliminates the need for the event logger as the form of audit trail for this category of device.

The second category of device specifies that, when the device is in the remote configuration mode, there must be a clear and continuous indication to that effect. The objective is that the device shall not be (erroneously) sealed with the remote communication capability operational. The clear and continuous indication is intended to reduce this possibility. A "clear and continuous indication" that the device is in the remote configuration mode must be of such a nature that it discourages the use of the device for normal transactions when in this mode. This may be a partial obscuring of the numbers, an alternating display message, or some other obvious indication. The lighting of an annunciator is not sufficient. If values can be printed when in the configuration mode, the system shall record a message to indicate that the system is in the configuration mode.

Category 3. A device that allows virtually unrestricted access to configuration parameters or calibration parameters, or has remote configuration or calibration capability, must have an **event logger** as its minimum form of the audit trail.

An **event logger** contains detailed information on the parameters that have been changed and documents the new parameter values. An event logger requires a significant amount of memory; however, it is anticipated that any device to which unrestricted access is given, will be part of sophisticated measurement process that will have considerable memory available. A centralized audit trail may be used, but additional criteria apply.

NIST Handbook 44 Mass Flow Meters Code available at www.nist.gov/owm then go to Quick List and click on Handbook 44

S.3.5. Provision for Sealing. - Adequate provision shall be made for an approved means of security (e.g., data change audit trail) or physically applying security seals in such a manner that no adjustment or interchange may be made of:

(a) any measuring or indicating element,

(b) any adjustable element for controlling delivery rate when such rate tends to affect the accuracy of deliveries,

(c) the zero adjustment mechanism, and

(d) any metrological parameter that will affect the metrological integrity of the device or system.

When applicable, the adjusting mechanism shall be readily accessible for purposes of affixing a security seal.

*[Audit trails shall use the format set forth in Table S.3.5.]**
*[*Nonretroactive as of January 1, 1995]*
(Amended 1992, 1995, and 2006)

Table S.3.5. Categories of Device and Methods of Sealing	
Category of Device	***Method of Sealing***
Category 1: No remote configuration capability.	*Seal by physical seal or two event counters: one for calibration parameters and one for configuration parameters.*
Category 2: Remote configuration capability, but access is controlled by physical hardware. *The device shall clearly indicate that it is in the remote configuration mode and record such message if capable of printing in this mode or shall not operate while in this mode.*	*[The hardware enabling access for remote communication must be on-site. The hardware must be sealed using a physical seal or an event counter for calibration parameters and an event counter for configuration parameters. The event counters may be located either at the individual measuring device or at the system controller; however, an adequate number of counters must be provided to monitor the calibration and configuration parameters of the individual devices at a location. If the counters are located in the system controller rather than at the individual device, means must be provided to generate a hard copy of the information through an on-site device.]** *[*Nonretroactive as of January 1, 1996]*

Category 3: Remote configuration capability access may be unlimited or controlled through a software switch (e.g., password). *[Nonretroactive as of January 1, 1995]* *The device shall clearly indicate that it is in the remote configuration mode and record such message if capable of printing in this mode or shall not operate while in this mode.* *[Nonretroactive as of January 1, 2001]*	*An event logger is required in the device; it must include an event counter (000 to 999), the parameter ID, the date and time of the change, and the new value of the parameter. A printed copy of the information must be available through the device or through another on-site device. The event logger shall have a capacity to retain records equal to ten times the number of sealable parameters in the device, but not more than 1000 records are required. (**Note:** Does not require 1000 changes to be stored for each parameter.)*

[Nonretroactive as of January 1, 1995]
(Table Added 1995) (Amended 1995, 1998, 1999, and 2006)

Minimum Form of the Audit Trail

The minimum form of the audit trail shall consist of two event counters: one for *configuration* parameters and one for the *adjustment* (calibration) parameters (000 to 999 for each counter).

The maximum number of values or parameters that must be retained in event logger memory is 1000. (This limit may not apply to centralized event loggers. See the section titled "Centralized Event Loggers" for details.)

The octane blend settings for a retail motor-fuel dispenser are considered to be configuration parameters.

Event Loggers: Acceptable Form of Audit Trail for Category 3 Devices

1. The event logger is the minimum form of audit trail for Category 3 devices (those that have unrestricted remote access to the configuration or calibration parameters.) The event logger shall contain the following information:

Event counter	Date and time	Parameter ID	New value

2. This information shall be automatically entered into the event logger by the device. In the case of centralized event loggers, the parameter identification shall include the device identification to which the event applies. Additional relevant information is permitted, (e.g., the identification of the person who made the adjustment or the old value of the parameter that was changed).

3. The date and time shall be presented in understandable format. The date shall include month, day, and year. The time shall include the hour and minutes.

4. A hard-copy print-out of the contents of the event logger shall be available upon demand from the device or an associated device on the site of the device installation. The display or printing of the event logger contents shall exclude other information, such as transaction data, operator inventory records, or shift totals.

5. An event logger shall have a capacity of at least 10 times the number of sealable parameters; however, it is not required to retain more than 1000 events for all parameters combined. This limit applies to devices for which the event logger is dedicated to a single device. (See the section titled "Centralized Event Loggers.")

Centralized Event Logger

Remote configuration will be used most frequently when several devices interface with a host computer or other host device. A centralized event logger may be used when several "satellite" devices interface with a host device. The following criteria must be satisfied if a centralized event logger is to be used:

1. If electronic parameters monitored by the event logger are changed at the device, rather than through the device containing the centralized audit trail. The changes shall be transferred to and maintained in the centralized audit trail. It shall not be possible to circumvent the unit containing the audit trail. For example, if the audit trail unit is disconnected or inhibited, the attached network devices shall be inoperable and impossible to adjust electronically when in the network configuration. Mechanical adjustments are not expected to be monitored by the event logger since there will probably not be an electrical connection from the mechanical adjustment to the event logger. Sealable mechanical adjustments must be secured by a physical security seal.

2. If the same values for change to a parameter (e.g., the division value for the device) are sent from the host device to several satellite devices, this shall be represented as one event in the logger. If changes are made to individual devices rather than to all attached devices, the event logger shall identify both the parameter and the device that was changed. Identification may be by individual devices, groups of devices, or designated as all devices.

3. If a device can be installed in a stand-alone operation, it must have the minimum form of audit trail when installed in the stand-alone mode.

4. A system shall be capable of providing, upon demand, a hard copy of the event logger information.

The printer requirement is a user requirement, not a device specification.

5. If a centralized audit trail is used for a large number of devices on a network, the logger capacity of 1000 events may not be sufficient.

General Requirements for Metrological Audit Trails

When an audit trail is the form of security, minimum forms of audit trail are specified for different categories of devices. The following general requirements for metrological audit trails must be satisfied as part of all three minimum forms of audit trail.

1. The adjustment mode shall address only sealable parameters in order to avoid entering the adjustment mode to access non-sealable parameters that must be routinely changed as part of the normal use of the device. Because the audit trail requirements are intended to satisfy the weights and measures requirements of the U.S. and Canada, any parameters required to be sealed in one country, but not the other, may be included in the adjustment mode and still comply with this requirement. Manufacturers should consult with the weights and measures authority to discuss those parameters that may be questionable as to whether or not the parameter must be sealed. Manufacturers may choose to incorporate the capability to set a software "switch" that determines whether or not a parameter is sealable. If this is done, then the software switches (that determine whether or not a parameter is sealable) shall be sealable.

2. A "clear and continuous indication" that the device is in the remote configuration mode must be of such a nature that it discourages the use of the device for normal transactions when in this mode. This may be a partial obscuring of the numbers, an alternating display message, or some other obvious indication. The lighting of an annunciator is not sufficient. If values can be printed when in the configuration mode, the system shall record a message to indicate that the system in the configuration mode.

3. An event counter shall have a capacity of at least 1000 values (e.g., 000 to 999).

   a. The event counter for calibration parameters shall increment only when a change is made to at least one sealable calibration parameter during an event (during the time when in the adjustment mode); the counter shall increment only once regardless of the number of changes made while in the adjustment mode. When the calibration mode is entered, but no changes are made, this does not constitute an event and the counter must not increment.

   b. The event counter for configuration parameters shall increment only when a change is made to at least one sealable configuration parameter during an event (during the time when in the configuration mode). The counter shall increment only once regardless of the number of changes made while in the configuration mode. When the configuration mode is entered, but no changes are made, this does not constitute an event and the counter must not increment.

   c. In the case of the event logger, the event counter will increment once for each change to a sealable parameter since each new value must be retained in the event logger.

Note: *The criteria in items 3(a) and 3(b) specify the minimum requirements for event counters. A device may have a separate event counter for each sealable parameter; in this case, the corresponding event counter must increment once each time its sealable parameter is changed.*

4. When the storage memory of the event logger has been filled to capacity, any new event shall cause the oldest event to be deleted. The event counter used in the event logger shall continue to increment to its capacity, although the event logger may retain fewer records than the count capacity of the event counter. The event counter provides the necessary information to indicate the number of records that have been overwritten in the event logger as new information overwrites the old records.

5. The audit trail data shall be:

   a. stored in non-volatile memory and shall be retained for at least 30 days if power is removed from the device; and

   b. protected from unauthorized erasure, substitution, or modification.

6. Access to the audit trail information for the purpose of viewing or printing the contents must be "convenient" for the enforcement official.

   a. Accessing the audit trail information for review shall be separate from the calibration mode so there is no possibility for the weights and measures official to change or corrupt the device configuration or the contents of the audit trail.

   b. Accessing the audit trail information shall not affect the normal operation of a device before or after accessing the information.

   c. A key (for a panel lock) may be required to gain access to the means to view the contents of the audit trail. Access may be through the supervisor's mode of operation of the device.

   d. Accessing the audit trail information shall not require the removal of any additional parts other than normal requirements to inspect the integrity of a physical seal.

7. The displayed or printed form of the audit trail information shall be readily interpretable by the inspector.

8. The information from an event logger shall be displayed or printed in order from the most recent event to the oldest event. If a device is not capable of displaying all the information for a single event on one line or at one time, the information shall be displayed in blocks of information which are readily understandable.