Australian Government
Department of Industry, Science and Resources

National Measurement Institute

36 Bradfield Road, West Lindfield NSW 2070

Certificate of Approval

NMI 5/6B/204A

Issued by the Chief Metrologist under Regulation 60
of the
National Measurement Regulations 1999

This is to certify that an approval for use for trade has been granted in respect of the instruments herein described.

Liquid Controls Model M-40-1 Liquid-measuring System

submitted by Advanced Flow Solutions, Inc.
trading as Liquid Controls
9201 North I-35 Service Road
Oklahoma City OK 73131
USA

NOTE: This Certificate relates to the suitability of the pattern of the instrument for use for trade only in respect of its metrological characteristics. This Certificate does not constitute or imply any guarantee of compliance by the manufacturer or any other person with any requirements regarding safety.

This approval has been granted with reference to document NMI R 117-1, *Measuring Systems for Liquids Other than Water*, dated June 2011.

This approval is subject to review at the decision of the Chief Metrologist in accordance with the conditions specified in the document NMI P 106.

DOCUMENT HISTORY

Rev	Reason/Details	Date
0	Pattern & variants 1 to 3 approved – interim certificate issued	17/12/04
1	Pattern & variants 1 to 3 approved – certificate issued	30/03/05
2	Variant 4 approved – certificate issued	4/08/05
3	Pattern & variants 1 to 4 amended & reviewed – certificate issued	21/04/10
4	Variants 5 to 7 approved – certificate issued	13/08/10
6	Pattern & variants 1 to 7 reviewed & updated – certificate issued	29/01/15
7	Variant 8 approved – certificate issued	3/03/16

Document History (cont…)

Rev	Reason/Details	Date
8	Variant 9 & 10 approved – certificate issued	17/07/20
9	Pattern amended (submitted by) – Variant 9 cancelled – certificate issued	08/12/21
10	Variant 11 approved – certificate issued	05/03/25

CONDITIONS OF APPROVAL

General

Instruments purporting to comply with this approval shall be marked with pattern approval number 'NMI 5/6B/204A' and only by persons authorised by the submittor.

It is the submittor's responsibility to ensure that all instruments marked with this approval number are constructed as described in the documentation lodged with the National Measurement Institute (NMI) and with the relevant Certificate of Approval and Technical Schedule. Failure to comply with this Condition may attract penalties under Section 19B of the National Measurement Act and may result in cancellation or withdrawal of the approval, in accordance with document NMI P 106.

Auxiliary devices used with this instrument shall comply with the requirements of General Supplementary Certificate No S1/0B.

Signed by a person authorised by the Chief Metrologist to exercise their powers under Regulation 60 of the *National Measurement Regulations 1999*.

Darryl Hines
Manager
Policy and Regulatory Services

TECHNICAL SCHEDULE No 5/6B/204A

1. Description of Pattern approved on 17/12/04

A bulk-flowmetering system incorporating a Liquid Controls model M40 rotary motion positive displacement flowmeter (Table 1) for bulk metering of petroleum products other than LPG.

1.1 Field of Operation

The field of operation of the measuring system is determined by the following characteristics:

- Minimum measured quantity, V_{min} 200 L (#1)
- Maximum flow rate, Q_{max} 1700 L/min
- Minimum flow rate, Q_{min} 170 L/min
- Maximum pressure of the liquid, P_{max} 1034 kPa
- Minimum pressure of the liquid, P_{min} 140 kPa (#2)
- Dynamic viscosity at 20°C 0.4 to 20 mPa.s (#3)
- Liquid temperature range -10 to 50°C
- Ambient temperature range -25 to 55°C
- Accuracy class 0.5

(#1) The calculator/indicator indicates the volume at least in 1 L increments.

(#2) As specified for the gas elimination device for effective operation.

(#3) The flowmeter is adjusted to be correct for the liquid for which it is to be verified as marked on the data plate.

1.2 Components of the Flowmetering System (Figure 1)

(i) Tank

A supply tank, which may incorporate a detector for low liquid-level. The detector is used to prevent further deliveries when the low liquid-level is reached, and prevents air from entering the pipework.

(ii) Pump

A positive displacement, centrifugal or submersible turbine type pump may be used to provide flow through one or more flowmeters.

Systems fitted with a positive displacement pump shall include a gas elimination device capable of continuously separating any air/vapours entrained in the liquid upstream of the flowmeter.

A centrifugal type pump may only be installed below the liquid level of the supply tank and a submersible turbine type pump may be used either alone or supplying a centrifugal type pump positioned above or below the liquid level of the supply tank.

These systems shall include a gas elimination device capable of removing any pockets of air/vapours that may form in the pipework upstream of the flowmeter.

In any case, for all combination of usage, the pump(s) shall be of sufficient capacity to ensure that each flowmeter can operate over its approved flow rate range.

(iii) Non-return Valve

A non-return valve is fitted between the pump and the flowmeter to prevent reverse flow and keep the pipework full of liquid at all times.

(iv) Gas Elimination Device

The gas elimination device, comprising a Liquid Controls model F-30 strainer fitted with a model A8180 or 18184A air/vapour eliminator (or any other equivalent approved gas elimination device), fitted upstream of the flowmeter to prevent vapours entering the flowmeter.

For applications where the duration of the shut-down period does not cause thermal contraction of the liquid and formation of pockets of gas upstream of the flowmeter, the gas elimination device may be modified for use as a strainer only, provided the supply tank incorporates a detector for low liquid-level.

(v) Measurement Transducer

The measurement transducer is a Liquid Controls model M-40-1 rotary motion positive displacement flowmeter (Figure 2) with a mechanical output shaft connected via 90° bevel gear to a micrometer type calibration adjustment mechanism with a slotted shaft into which the drive shaft of the calculator/indicator fits.

The calibrator has a thimble which can be rotated in the direction marked for increasing or decreasing the rotation rate of the drive shaft of the calculator/indicator. The amount by which the volume, displayed by the calculator/indicator, is increased or decreased is determined with reference to the scale divisions on the calibrator, marked 1%, 0.1% and 0.02%.

The calibration adjustment is carried out using the liquid the flowmeter is intended to measure. Provision is made for inserting a thermometer and fitting a pressure gauge for measuring the liquid temperature and pressure at the flowmeter during calibration.

(vi) Calculator/Indicator

The calculator/indicator is an approved Veeder-Root mechanical register, as described in the documentation of approval S184B. The drive shaft of the calculator/indicator is designed to fit the slotted shaft of the flowmeter calibration mechanism.

To facilitate the deliveries, a pre-set mechanism may be fitted between the mechanical calculator/indicator and the flowmeter provided the pre-set device is marked ‘Pre-set Amount Not for Trade Use’ or similar wording. The pre-set device is mechanically linked to a Liquid Controls model V-7 flow control valve to automatically stop the delivery. Upon completion of delivery, the volume delivered is displayed by the calculator/indicator, which may differ from the pre-set amount.

The Veeder-Root mechanical register and the pre-set device may be replaced with any other compatible approved calculator/indicator and pre-set device.

(vii) Transfer Device

The transfer device is located downstream of the flowmeter and clearly defines the start and stop of the measured quantity. The transfer device may be in the form of a breakaway coupling, a nozzle or a positive shut-off component, such as a manually or automaticallyoperated flow control valve. Whatever the transfer device used, the pipework upstream of the transfer device shall be maintained full of liquid.

The system may have more than one transfer point, however the pipework design is such that once the measurement starts the flow continues through the intended transfer point until delivery is finalised; there is no possibility for diverting the measured quantity other than through the intended transfer point.

1.3 Descriptive Markings and Notices

Each measuring system shall bear the following information, placed together either on the indicating device or on a data plate:

Pattern approval mark NMI	5/6B/204A
Manufacturer's identification mark or trade mark	…..
Meter model	…..
Serial number of the instrument	…..
Year of manufacture	…..
Maximum flow rate, Q_{max}	….. L/min
Minimum flow rate, Q_{min}	….. L/min
Maximum pressure of the liquid, P_{max}	….. kPa
Minimum pressure of the liquid, P_{min}	….. kPa
Type of the liquid for which the system is verified	..... (#1)
Environmental class	class C or I (#2)

(#1) This may be located separately, e.g. on a metal tag sealed to the instrument.

(#2) Class I applies to variations approved for use as mobile liquid-measuring systems.

The minimum measured quantity *(V_{min})* is clearly visible on the indicating device, e.g. 'Minimum Delivery 200 L'.

1.4 Verification Provision

Provision is made for the application of a verification mark.

1.5 Sealing Provision

Provision is made for sealing access to the calibration mechanism.

The calibration mechanism is located behind the counter bracket cover, which is held in place by drilled head screws to allow application of wire-and-lead type seal, or similar.

2. Description of Variant 1 approved on 17/12/04

Using certain other Liquid Controls flowmeters as listed in Table 1. Figure 3 shows a typical MS flowmeter.

TABLE 1

Flowmeter Model (#1)	Gas Eliminator Model (strainer with eliminator)	Maximum Flow (L/min)	Mininum Flow (L/min)	Minimum Delivery (L)
M-5	F-7 with A8180	227	22	20
M-7	F-7 with A8180	380	38	50
M-10	F-7 with A8180	570	57	100
M-15	F-15 with A8180	760	76	100
M-25	F-15 with A8180	1140	114	200
M-30	F-30 with A8180	1320	132	200
M-40	F-30 with A8180	1700	170	200
M-60	F-30 with A8180	2270	227	500
M-80	F-30 with A8180	3028	303	500
MS-7	FS-2” with A8930	380	38	50
MS-10	FS-2” with A8930	570	57	100
MS-15	FS-3” with A8930	760	76	100
MS-25	FS-3” with A8930	1140	114	200
MS-30	FS-3” or FS-4” with A8930	1320	132	200
MS-40	FS-4” with A8930	1700	170	200
MS-75	FS-4” or FS-6” with A8930	2650	265	500
MS-120 (150 mm)	FS-6” with A8930	3790	379	500
MS-120 (200 mm)	A8950	4540	454	500

(#1) Note that the flowmeter models listed above are basic model numbers only – the full model number may have additional alphanumeric characters, e.g. MSA-7-C-1, where:

‘M’ designates flowmeter.

‘S’ designates steel case, blank designates aluminium case.

‘A’ designates the working pressure; may be ‘AA’ (1896 kPa), ‘A’ (2413 kPa), ‘B’ (4964 kPa), ‘C’ (9928 kPa), or blank (1034 kPa or 1896 kPa for certain models).

‘7’ designates capacity, other capacities are listed in Table 1.

‘C’ designates flowmeter with counter, strainer and air eliminator, designation ‘K’ includes pre-set counter and pre-set valve.

‘1’ designates for use on refined petroleum products, or ‘2’ for use on aviation and jet fuel.

For minimum deliveries less than 200 L the calculator/indicator displays the volume at least in increments of 0.1 L. For minimum deliveries equal to or greater than 200 L the calculator/indicator displays the volume in 1 L increments.

For flowmeter sizes M5 to M25, the model A8180 gas elimination device may be replaced with the model A8197 device, which is similar to the A8180 except it incorporates a guide rod for the float.

The A8950 series air/vapour eliminator, available in 3”, 4”, 6” or 8” size, may replace the equivalent strainer and air/vapour eliminator combination listed in Table 1.

The F-7 and F-15 strainers are replaced with F-7 (Hi-Cap) and F-15 (Hi-Cap) strainers for flowmetering systems where the supply tank can run dry.

3. Description of Variant 2 — approved on 17/12/04 amended on 17/07/20

As a mobile liquid-measuring system as shown in Figure 4, which is similar to the pattern except:

- The outlet of the flowmeter is fitted with a K-series air-activated check valve designed to stop the flow of liquid when air is detected by the air elimination device.

  Alternatively, the gas elimination device incorporates a high capacity stainer, either amodel F-7 (Hi-cap) or a model F-15 (Hi-cap) suitable for the 50 mm (2”) flowmeters or the 75 mm (3”) flowmeters respectively.
- A spring-loaded check valve is fitted between the gas elimination device and the flowmeter.
- The transfer device may be in the form of a nozzle at the end of a hose reel, in which case an anti-drain valve is fitted, that retains a pressure not less than 55 kPa, so that the pipework is maintained full of liquid up to the transfer point.
- Instruments marked Environmental Class I as described in **1.3 Descriptive Markings and Notices**

4. Description of Variant 3 — approved on 17/12/04

A drum-filling liquid-measuring system (Figure 5) which is similar to the pattern except:

- The flowmeter is fitted with a pre-set device adjusted to deliver a verified/certified fixed quantity, which is equal to or greater than the minimum delivery specified for the flowmeter, and set to deliver at nominal flow rate. For systems with variable flow rate, the pre-set quantity is equal to or greater than twice the minimum delivery specified for the flowmeter.
- The pre-set device is mechanically linked to a control valve, either a V or VS series mechanically-activated piston valve, installed at the outlet of the flowmeter to automatically stop the delivery when the pre-set quantity is reached.
- The volume indicator is replaced with a fixed marking stating the batch quantity for which the flowmetering system is set, e.g. ‘PRE-SET FOR 200 L’.
- The outlet is either a drum-filling spear or a hose. If a spear is used, it is arranged to fully drain after each delivery so that the control valve is the transfer device. If a hose is used, it is fitted with a nozzle which has an anti-drain valve that retains a pressure not less than 55 kPa, so that the hose upstream of the nozzle is maintained full of liquid and the nozzle is the transfer device.

5. Description of Variant 4 — approved on 4/08/05

The pattern and variants approved for use with various grades of pure biodiesel and biodiesel/distillate blends (to Australian government standard).

6. Description of Variant 5 approved on 13/08/10

A bulk flowmetering system incorporating a Liquid Controls model M-7 positive displacement flowmeter approved for use with AdBlue fluid AUS32 (aqueous urea solution 32.5%) which is also known as Diesel Exhaust Fluid.

6.1 Field of Operation

The field of operation of the measuring system is determined by the following characteristics:

- Minimum measured quantity, V_{min} 50 L
- Maximum flow rate, Q_{max} 303 L/min
- Minimum flow rate, Q_{min} 76 L/min

Meters must be fitted with one of the Liquid Controls air/vapour eliminators listed below in Table 2. Guide rods are used for the float but no baffle is used.

TABLE 2

Eliminator model number	Material	Seals
A8985	Stainless steel	Kalrez or Viton
A8986	Stainless steel	Kalrez or Viton
A8987	Stainless steel	Kalrez or Viton

7. Description of Variant 6 approved on 13/08/10

A bulk flowmetering system incorporating any flowmeter of this approval for use with non-petroleum based liquids including cooking/edible oils, alcohols, or glycols.

Meters must be fitted with one of the Liquid Controls air/vapour eliminators listed below in Table 3. Guide rods and baffles may or may not be used.

TABLE 3

Eliminator model number	Material	Seals
A8191	Aluminum	Viton
A8192	Aluminum	Viton
A8217	Aluminum	Viton
A8223	Aluminum	Kalrez
A8224	Aluminum	Kalrez

8. Description of Variant 7 approved on 13/08/10

For use with any compatible (#) NMI-approved calculator/indicator and pulse generator.

(#) 'Compatible' is defined to mean that no additions/changes to hardware/software are required for satisfactory operation of the complete system.

9. Description of Variant 8 approved on 3/03/16

Consolidating float based gas elimination devices (which vary by non-metrological seal material characteristics and presence of guide road for the float as A81XX, A82XX, and A89XX series). Gas elimination models used with meters covered by this approval use the same float as stated for the pattern (Clause 1.2 (iv) Gas Elimination Device), and for Variant 1, Variant 5 and Variant 6.

Note: optical sensor-based gas elimination devices continue to be excluded.

10. Description of Variant 9 — approved on 17/07/20 cancelled on 08/12/21

Note: Variant 9 has been cancelled in respect of new instruments from the cancelled date. Approval for the flowmeters identified in this variant have been transferred to certificate NMI 5/6B/231.

Using certain other Liquid Controls series flowmeters as listed in Table 4.

Flowmeters marked with the Liquid Controls name and logo are shown in Figure 6. Flowmeters may also be known as Avery-Hardoll series flowmeters and markings include the Avery-Hardoll logo as shown in Figure 7.

TABLE 4

Flowmeter Model (#1)	**Flange size**	**Gas Eliminator Model (strainer with eliminator) (#2)**	**Maximum Flow (L/min)**	**Mininum Flow (L/min)**	**Minimum Delivery (L)**
BM250 (S)	DIN65	FS-3 with A89XX	1140	115	100
BM950 (S)	DIN80	FS-3 with A89XX	1500	115	200
BM450 (D)	DIN80	FS-3 with A89XX	2050	200	200
BM550 (D)	DIN100	FS-4 with A89XX	2280	220	500
BM350 (D)	DIN100	FS-4 with A89XX	2800	125	500
BM650 (T)	DIN100	FS-4 with A89XX	3000	300	500
BM850 (T)	DIN150	FS-6 with A89XX	4250	200	500
DM (S)	DIN100	FS-4 with A89XX	2500	200	200

(#1) S, D or T between brackets stands for respectively Single, Double or Triple Chamber configuration. P_{max} for the flowmeter models is 1034 kPa

(#2) For certain systems designed for fuelling of aircraft, Strainer and gas elimination devices may not be required.

11. Description of Variant 10 — approved on 17/07/20

The flowmeters described in the pattern and variant 1 with the full model number designation ‘A’ which is ‘AA’ or ‘Blank’, now having a maximum pressure of the liquid, P_{max} of 1965 kPa.

12. Description of Variant 11 — approved on 05/03/25

For use with lubricating oils having a dynamic viscosity in range 20 and 1250 mPa.s at 20°C. In these applications (Figure 1), the Liquid level control device and Flow Control valve at the Transfer point are mandatory, and Strainer/Gas Eliminator may not be required.

TEST PROCEDURE

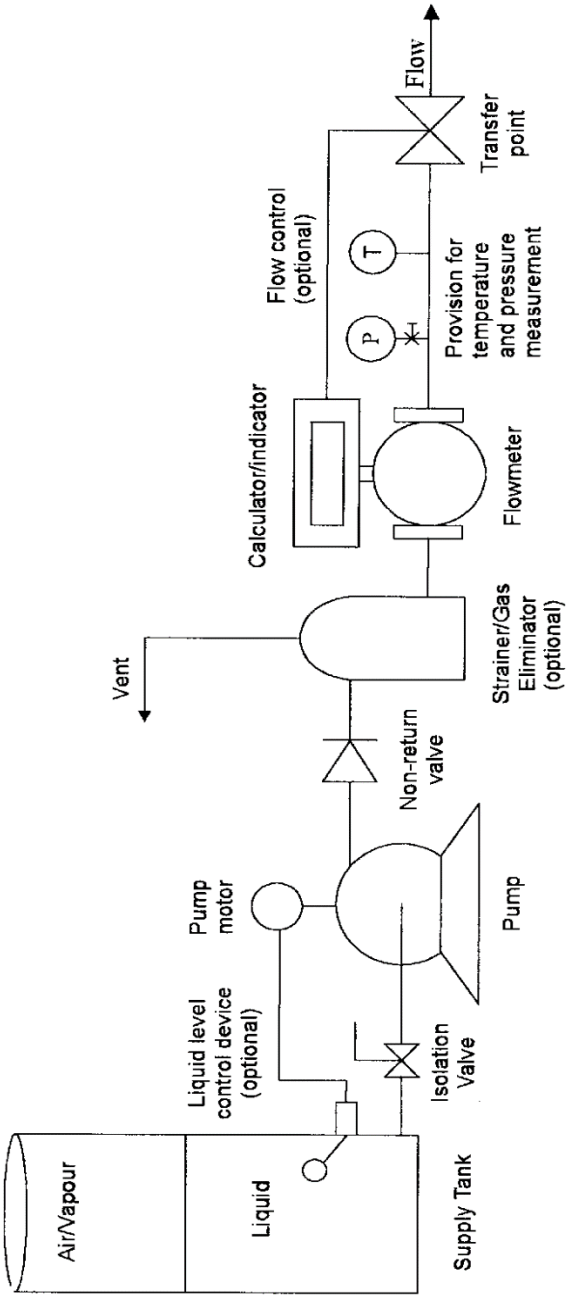
Instruments shall be tested in accordance with any relevant tests specified in the National Instrument Test Procedures.

The instrument shall not be adjusted to anything other than as close as practical to zero error, even when these values are within the maximum permissible errors.

Maximum Permissible Errors

The maximum permissible errors are specified in Schedule 1 of the *National Trade Measurement Regulations 2009*.

FIGURE 5/6B/204A – 1



Liquid Controls Model Liquid-measuring System (The Pattern)

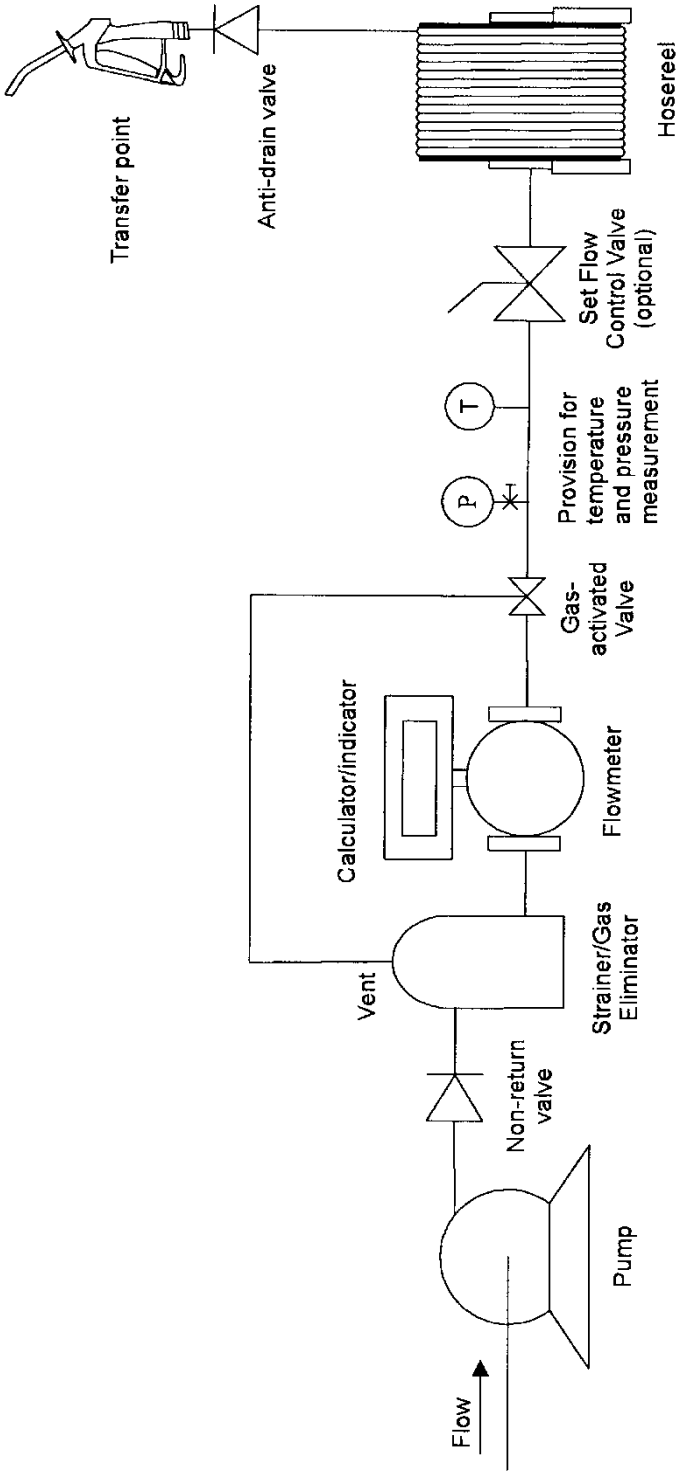
FIGURE 5/6B/204A – 2

Liquid Controls Model M40 Flowmeter (The Pattern)

FIGURE 5/6B/204A – 3

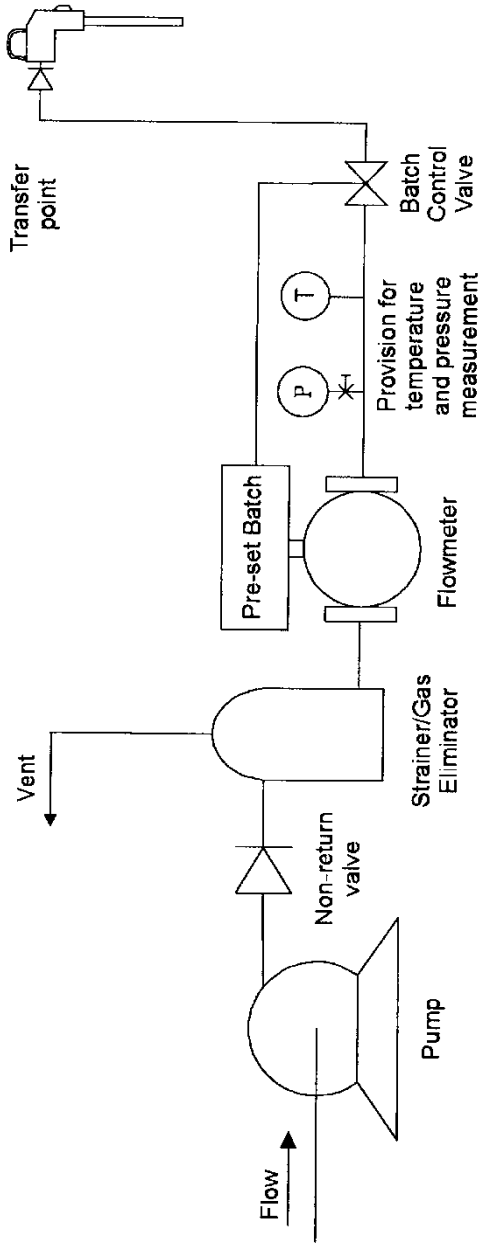
Liquid Controls Model MS Flowmeter

FIGURE 5/6B/204A – 4



Liquid Controls Model Mobile Liquid-measuring System (Variant 2)

FIGURE 5/6B/204A – 5



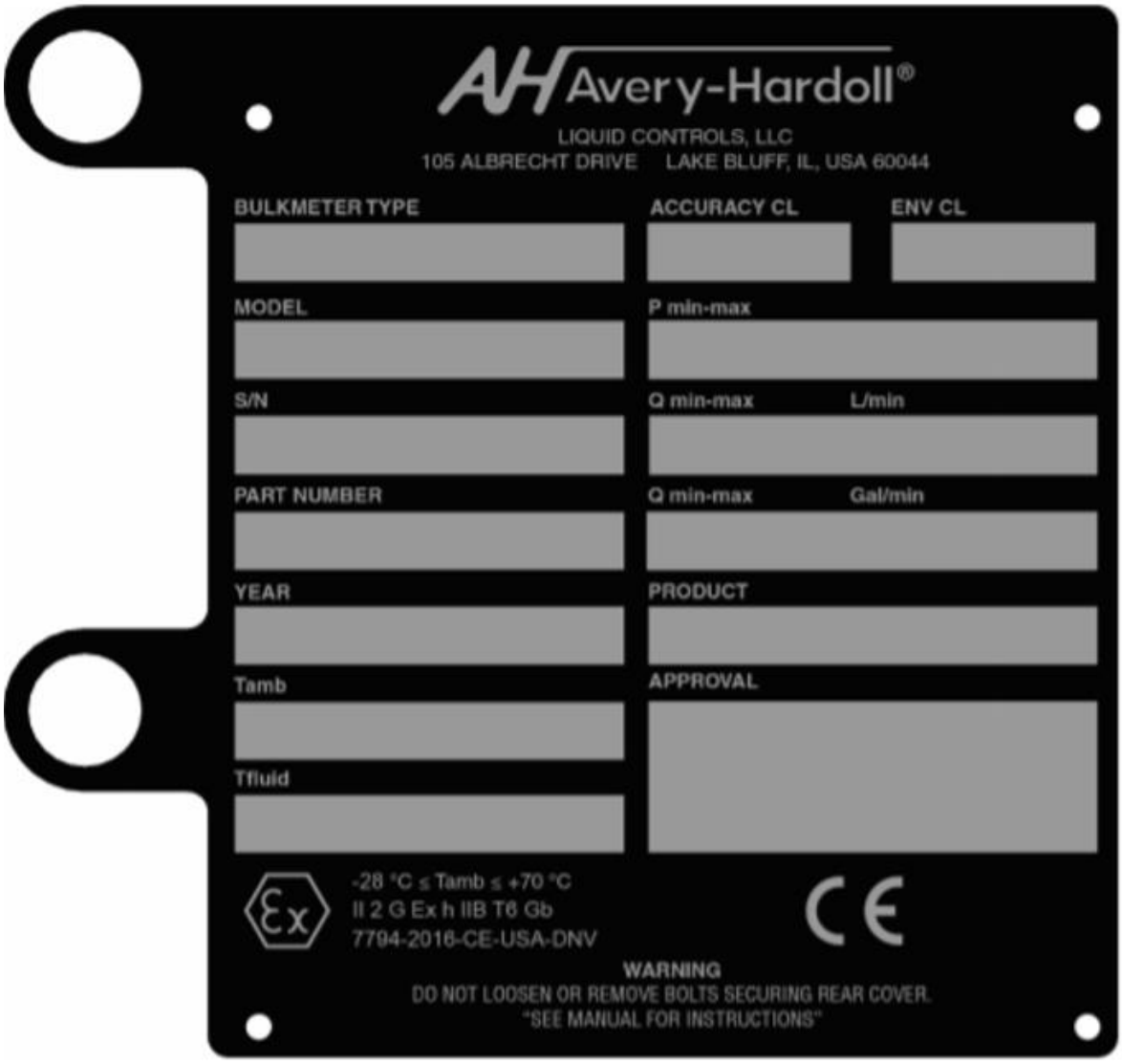
Liquid Controls Model Drum-filling Liquid-measuring System (Variant 3)

FIGURE 5/6B/204A – 6

a) Liquid Controls Model BM250 Flowmeter (Variant 9)

b) Liquid Controls Model DM Flowmeter (Variant 9)

FIGURE 5/6B/204A – 7



Avery-Hardoll series flowmeter markings (Variant 9)

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