



SPECIAL PERMIT 2470 REVISION NO. 2

This Special Permit is issued pursuant to the terms of Section 71.6(a) of the "Canadian Transport Commission's Regulations for the Transportation of Dangerous Commodities by Rail" to authorize the shipment by railway in Canada of Flammable gas 2.1 and Non-flammable gas 2.2 in seamless aluminum cylinders with hoop reinforcement provided by Filament-Wound reinforced Plastic (FRP), under conditions prescribed herein, and does not relieve any shipper or carrier from compliance with any requirement of the said Regulations, except as specifically stated.

1. BASIS

Letters dated September 10, 1987 and February 18, 1988 from Alusuisse (Swiss Aluminum Ltd.), Buckhauserstrasse Postfach 390, CH-8048 Zurich.

2. COMMODITY CLASSIFICATION

Flammable gas 2.1 and non-flammable gas 2.2.

3. COMMODITY NAME

- a) Methane or natural gas.
- b) Hydrogen
- c) Helium

4. IDENTIFICATION NUMBER

- a) 1971
- b) 1049
- c) 1046

5. REGULATION AFFECTED

73.302.

6. AUTHORIZED SHIPPER

Alusuisse (Swiss Aluminum Ltd.), their agents, distributors and customers.

7. PACKAGING DESCRIPTION

- a) Non CTC specification hoop-wound filament reinforced seamless, aluminum lined cylinders made of definitely prescribed materials.

Design and construction must be in compliance with SPIFLEX and Swiss Aluminum's application dated November 18, 1985, Models ASHC 15-3000 and ASHC 20-3000 and additional design and performance data on file with the Director of Operation.

- b) In addition, the cylinders shall be in full compliance with DOT FRP-2, Standard dated January 15, 1982 (178.BB) except as follows:
- (i) 178.BB
Fiber reinforced thermoplastic profile (FRTP) hoop-wrapped composite (HW) cylinders made of definitely prescribed materials.
 - (ii) 178.BB -2 - Type, size and service pressure:
Type 3HW cylinder consisting of continuous fiber reinforced thermoplastic profiles wound in the circumferential direction only over a seamless aluminum liner made in compliance with modified 178.BB-6(a) not over 1500 pounds water capacity and service pressure at least 900 psi but not greater than 5000 psi.
 - (iii) 178.BB-3 - Inspection by whom and where:
Inspections and verifications must be performed by an Independent Inspection Agency approved in writing by the Railway Transport Committee.
 - (iv) 178.BB-4 - Duties of Inspector.
 - (a) to (f) ***
 - (g) Furnish complete inspector's report (178.BB-16) to cylinder maker, Canadian Transport Commission and upon request to the purchaser.
 - (v) 178.BB-5 - Authorized Material and Identification of Material:
 - (a) ***
 - (b) Filament material must be commercial Type E fiberglass Filament must be tested in accordance with "customer acceptance standards" from OWENS CORNING NR ERF 16/F (LD) (See chapter 3) and have a minimum strand strength of 200,000 psi
 - (c) Resin system must be Polyamide 12 type with at least 3% elongation at yield.

Profiles must be of rectangular section with maximum 1.2 inch width and 1/4 inch thickness.
 - (d) ***
 - (e) ***
 - (vi) 178.BB-6 - Manufacture
 - (a) Liner. Aluminum liner without overwrap must be suitable for a service pressure of at least 50 percent of the

service pressure marked on the composite cylinder, and must be in full compliance with CTC 3AL specification except as follows:

- (2) Type, size and service pressure
 - (a) Seamless, not over 1500 pounds capacity and at least 150 psi.

- (4) Duties of the Inspector
 - (a) to (d)(10) ***
 - (d)(11) and (d)(12) deleted

 - (e) ***

 - (f) ***

- (5) Authorized material and identification of material
 - (a) to (d) ***

 - (e) All starting stock must be 100 percent ultrasonically inspected. The equipment and continuous scanning procedure must be capable of detecting and rejecting internal defects such as cracks which have an ultrasonic response greater than that of a calibration block with a 5/64 inch diameter flat bottomed hole.

 - (f) ***

 - (g) ***

- (6) Manufacture
 - (a) Cylinder shells must be manufactured from seamless tubes produced by die and mandrel in a forward extrusion and have a cleanliness level adequate to ensure proper inspection.

Each end has a threaded opening conforming to the requirements of Section 8.

The end profile must be hemispherical, ellipsoidal or ogive like form.

 - (b) ***

 - (c) The thickness of the cylinder ends may not be less than the prescribed minimum wall thickness of the cylindrical shell.

 - (d) Deleted.

 - (e) ***

(f) ***

1. Three samples must be subjected to 100,000 pressure reversal cycles between zero and half the service pressure of the hoop-wrapped cylinder or 10,000 pressure reversal cycles between zero and half the test pressure of the hoop-wrapped cylinder, at a rate not in excess of 10 cycles per minute without failure.
2. Three samples must be pressurized to destruction and failure must not occur at less than 2.5 times half the service pressure of the hoop-wrapped cylinder. Each cylinder must remain in one piece. Failure must initiate in the cylinder sidewall in a longitudinal direction. Rate of pressurization must not exceed 200 psi per second.

(7) Wall thickness

(a) The wall thickness is to be calculated for hoop-wrapped cylinder according to DOT FRP-2 (178.BB-7) and must be such that the wall stress when calculated with the formula in subparagraph (7)(b) at half the test pressure of the hoop-wrapped cylinder will not exceed 80 percent of the minimum yield strength nor exceed 67 percent of the minimum ultimate tensile strength as verified by physical tests in paragraph 13.

(b) ***

(c) ***

(8) Openings

(a) to (e)(2) ***

(e)(3) Other straight threads are authorized as prescribed in DOT FRP-2 (178.BB-8(d)).

(10) Pressure relief devices. Deleted

(11) Hydrostatic test.

Hydrostatic test prior to supplying the filament wrap is not authorized.

(12) Flattening test.

(a) The flattening test must be performed on one cylinder taken at random out of each lot of 200 or less by placing the cylinder or a tube of sufficient length between wedge shaped knife edges having a 60° included angle, and rounded in accordance with the following table. The longitudinal axis of the cylinder must be at an angle 90° to the knife edge during the test.

(b) ***

(c) ***

(15) Marking

No marking is to be applied to the cylinder except as specifically authorized in DOT FRP-2 (178.BB-15).

(16) Inspector's report.

Delete record of Hydrostatic tests on cylinders.

(b) Composite cylinder

The composite cylinder must be fabricated from an aluminum liner circumferentially wrapped over the entire cylindrical portion with filament reinforced thermoplastic profiles under controlled tension to develop the designed liner prestress.

Winding being made with surface and edge heat melting of the profiles at the contact point in order to obtain a continuity in the whole wrapping.

No defect is acceptable that is likely to weaken the finished cylinder appreciably.

(c) ***

(d) Lot size

(1) ***

(2) Composite cylinder only. A "lot" means a group of cylinders successively produced from qualified liners, having the same size and configuration, the same specified materials of construction, the same process of manufacture to the same cylinder specification and hooped with the same type of fiber reinforced thermoplastic profile, under the same number of layers and with the same pattern of tensions.

(3) ***

(e) Design qualification tests: ***

(vii) 178.BB-7 Wall thickness

(a) Minimum thickness of the liner must be at least equal to the minimum design thickness (178.BB-18(h)) and be such

that after hooping, the compressive stress in the sidewall of the liner at zero pressure will not exceed 95% of the minimum yield strength of the aluminum as determined in 178.BB-6(a) or 95% of the minimum design yield strength shown in 178.BB-18(h).

The maximum tensile stress of the liner at operating pressure must not exceed 60% of the yield strength.

(b) ***

(c) The end designs must incorporate added materials to assure the stresses in these areas not supported by the hoop wrap are less than the stresses allowed in the cylindrical portion.

(d) Stresses shall be computed from formulas given in technical document on file with the Director of Operation.

(viii) 178.BB-9 Thermal Treatment. Deleted

(ix) 178.BB-11 Nondestructive test

(1) By water-jacket or direct expansion method, in accordance with pamphlet C1 of CGA, operated to obtain evaluation of total and permanent expansion to accuracy of 1%.

(2) ***

(3) Pressure must be maintained for 30 seconds and sufficiently longer to ensure complete expansion. Any internal pressure applied after hooping and previous to the official test must not exceed 90% of the test pressure.

(4) Each cylinder must be tested to at least 5/3 time service pressure.

(x) 178.BB-15 Marking.

(a) Each cylinder must be permanently marked (other than stamping in the composite wrap) on the side near the end of the cylinder containing the valve outlet.

(b) Required markings are as follows:

(1) CTC SP 2470 - YYYY (where Y = service pressure in psig).

- (2) A serial number and an identifying symbol (letters); location of number to be just below or immediately following the CTC mark; location of symbol to be just below or immediately following the number. The symbol and numbers must be those of the maker.
- (3) The Inspector's official mark must be placed near the serial number.
- (4) Date of test (month and year)

- (c) ***
- (d) ***
- (e) ***

(xi) 178.BB-16 Inspector's report.

- (a) Required to be clear, legible and in accordance with the following form:

REPORT OF MANUFACTURE OF FIBER
 REINFORCED THERMOPLASTIC PROFILE (FRTP) 3HW HOOP WRAPPED COMPOSITE (HW)
 ALUMINIUM-LINED COMPRESSED GAS CYLILNDERS

(Place).....
 (Date).....
 (Special Permit Number).....

Manufactured for.....
 Location at.....
 Consigned to.....
 Location at.....
 Quantity.....size.....inches outside diameter by.....inches long.

Marks placed on.....of the cylinder are:
 CTC-SP.....
 Serial numbers..... toinclusive.....
 Identifying Symbol (registered).....
 Inspector's Mark.....
 Test date.....
 Other marks (if any).....

Each composite cylinder was made by circumferentially overwrapping a seamless aluminum liner with fiber reinforced thermoplastic profile (FRTP). Composite overwrap was made by winding..... continuous FRTP over this liner in the circumferential direction only, at controlled temperature and tension. The liners are in compliance with 178.BB-6(a) of this Special Permit for unwrapped cylinders having a service pressure of.....psig. Compliance

of the liners with 178.BB-6(a) was verified by performance of the prescribed tests or by obtaining the report of the inspector performing the prescribed tests.

Filament and resin were certified by the manufacturers, identified by package number. FRTP was verified as to tensile strength and tensile young modulus.

Hooping and hydrostatic test, as prescribed, were made in the presence of the inspector. All cylinders accepted are in compliance with requirements. Tensile stress on the aluminum liner is calculated to be.....psi at service pressure. Filament stress is calculated to be.....psi at service pressure.

I hereby certify that all of these cylinders proved satisfactory in every way and comply with the requirement of CTC SP 2470; except as follows:

Exceptions taken to any reporting or testing requirement of this section are:

.....
.....
.....
.....

(Signed).....
Inspector

(xii) 178.BB-18 Design qualification tests

(a) General - Except as authorized in 178.BB-10(a), qualification tests as prescribed in this paragraph shall have been performed on representative cylinders of each specific design prior to the initial shipment. All cylinders used for design qualification tests must be fabricated on the same equipment and subjected to the same processes as is used to produce cylinders intended for charging and shipment. All tests must be witnessed by an independent inspector. Test reports must be kept on file by the cylinder maker and made available to the independent inspector and the Director of Operation upon request.

(b) Deleted.

(c) test requirements:

cylinders representative of each design change must be subjected to tests as prescribed by the Director of Operation.

(d) Pressure cycling tests. ***

(1) *** After successfully passing this test the cycling test from 0 to service pressure must be pursued to destruction and the number of cycles recorded.

(2) ***

(3) ***

(e) ***

(f) ***

(g) ***

(h) qualification test results:

a report of all tests describing test set up, procedure and results must be submitted by authorized BUREAU VERITAS to the Director of Operation. This report must include at least the following basic information on each cylinder tested:

BASIC CYLINDER DESIGN INFORMATION
Dimensional, material and pressure data

Cylinder designation:

(AluSuisse-Spiflex hooped Cylinder)

(Date)

(Special Permit Number)

Service pressure.....	psig
Test pressure.....	psig
Minimum prescribed burst pressure.....	psig
Volume.....	cc.ft
Inside diameter.....	inch
Outside diameter of cylinder.....	inch
Liner material.....	
Filament material.....	
Resin material.....	
Total weight of cylinder.....	pounds
Weight of liner.....	pounds
Weight of composite material.....	pounds
Minimum side wall thickness of liner (Qual. test cyl.).....	inch
Minimum design wall thickness of liner.....	inch
Yield strength of liner (Qual. test cylinder).....	psi
Minimum design yield strength of liner.....	psi
Nominal thickness of FRTP overwrap.....	inch

Minimum strength of FRTP..... psi
 Minimum elongation of resin at yield..... psi

DESIGN STRESSES AND LOAD DISTRIBUTION

Pressure	STRESS				LOAD	
	Direction		Distribution (PSI)		Distribution (%)	
	Long	Circ.	Liner	Overwrap	Liner	Overwrap
ZERO	x	-				
	-	x				
SERVICE	x	-				
	-	x				
TEST	x	-				
	-	x				
*Minimum burst	x	-				
	-	x				

* based on 178.BB-7

8. SPECIAL REQUIREMENTS


- (a) Cylinder service life is not to exceed 15 years.
- (b) Every cylinder must be reinspected and hydrostatically retested every three years in accordance with Section 73.34(e) of the CTC Regulations prescribed for CTC 3HT cylinders, except that permanent volumetric expansion must not exceed 5 percent of total volumetric expansion at test pressure. Retest dates must be stamped into the metal of the cylinder shoulder near the original test date.
- (c) A cylinder which has been subjected to the action of fire shall not be returned to service.
- (d) The Director of Operation shall be advised of any change in design of the cylinders.
- (e) Prior to first shipment Bureau Veritas shall witness all prototype testing and submit a satisfactory report to this office.
- (g) All cylinders under this Special Permit shall be manufactured at the facilities and using the equipment inspected by the Director of Operation.

9. REPORTING REQUIREMENTS

The Director of Operation shall be advised of any incident involving loss of contents and shall be provided with a summary of experience before the expiration date of this Special Permit.

10. EXPIRY DATE

April 14, 1989.


Director of Operation
Rail Safety Branch

Issued at Hull, Quebec
this 14th day of April 1988

Address all inquiries to:

Director of Operation, Rail Safety Branch
National Transportation Agency
25 Eddy Street, 14th Floor
Hull, Quebec
K1A 0N9