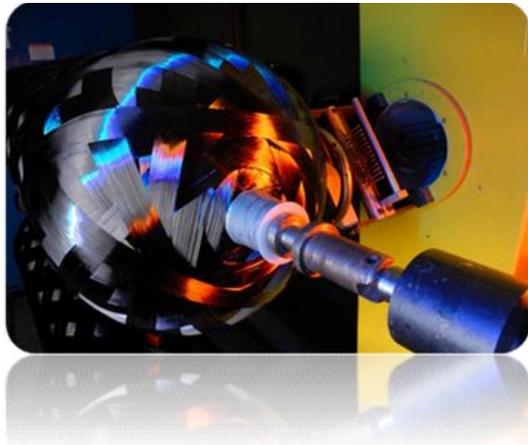


Containers and Modules for Industrial Gases and CNG



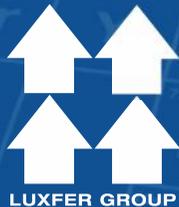
Dr. C. W. Rasche

A BRIEF OVERVIEW OF

Luxfer Group



A global
materials
technology
company



LUXFER GROUP

A BRIEF OVERVIEW OF

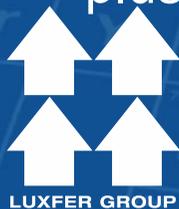
Luxfer Group

Environmental, Healthcare and Protection technologies.

Luxfer Group is the world leader in the manufacture of:

- magnesium alloys, magnesium powders and magnesium products;
- zirconium chemicals and oxides;
- superformed components in aluminium, magnesium and titanium;
- high pressure aluminium and carbon composite gas cylinders;

The Group is truly international employing approximately 1,630 people in over 25 countries. It operates 16 manufacturing plants in 6 countries, UK, USA, France, Czech Republic, Canada and China, plus joint ventures in Japan and India.





WHO WE ARE: OUR BRANDS



Magnesium Elektron

SERVICE & INNOVATION IN MAGNESIUM

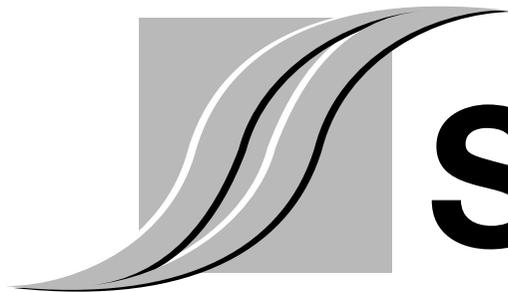


MEL *Chemicals*



Luxfer

Gas Cylinders



SUPERFORM



LUXFER GROUP

WHAT WE MAKE ON THE GAS CYLINDER SIDE



Aluminum **Al**

Luxfer **invented** the high-pressure, extruded **aluminum cylinder**, and we are the world's **largest** manufacturer of high-pressure aluminum cylinders.





WHAT WE MAKE ON THE GAS CYLINDER SIDE

Composites

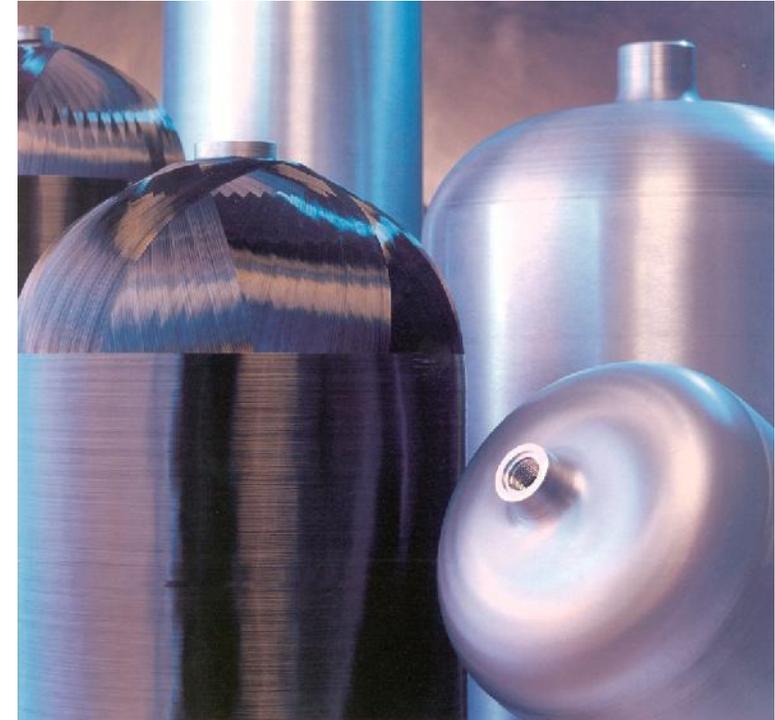
Luxfer is the world's **largest** Manufacturer of high-pressure **composite cylinders.**



Type III Cylinder Advantages



- Outstanding Product Quality
- Zero Faults in Service
- High Corrosion Resistance
- Superior Fast Fill Performance
- 15 Years OEM System Experience
- Certified to all relevant Standards
- Reduces Life Cycle Costs of Vehicles
- Lower Transportation Costs due to weight and Fill Performance
- OEM relationships Internationally



The Cylinder Performance



The Type III Cylinder is made from a seamless, thin-walled aluminum liner covered with a full carbon fibre overwrap.

Benefits of the Dynecell[®] cylinder include:

- Lightweight – up to 70 % lighter than steel
- High strength to weight ratio
- No Permeation and Leakage Potential
- High Corrosion Resistance
- True fast-fill capability; improved Fracture Mechanics



Dynetek is focused on addressing the growing demand for cylinders created by the rapidly expanding Natural Gas Vehicle (NGV) market.

Type I	Type II	Type III-Dynecell [®]	Type IV
<p>CNG-1 All Steel (1.2 to 1.5 kg/litre)*</p>	<p>CNG-2 Fiberglass Hoop Wrap Steel Liner (0.7 to 1.4 kg/litre)*</p>	<p>CNG-3 All Carbon Full Wrap Metallic Liner (0.3 to 0.4 kg/litre)*</p>	<p>CNG-4 Fiberglass/Carbon Full Wrap, Plastic Liner (0.35 to 0.5 kg/litre)*</p>

T3 Advantages vs other Cylinder Designs



vs Type I and II

- 50 - 68 % lighter
- extremely high corrosion resistance of the Al-Liner even with higher CO₂, H₂S and other aggressive components in Natural Gas
- No corrosion underneath the composite shell of an Aluminium lined Type III

vs Type IV

- No permeation and Leakage Potential
- No melting of the Al-Liner and uncontrolled blow off in a fire
- Extremely high thermal conductivity of the Aluminium provides higher filling efficiency in fast fill
- Lower Gas temperatures in a Type III after Fast Fill due to high Heat Flux
- High Vibration Resistance of the reinforced Cylinder Neck
- Higher Impact Resistance
- Improved Fracture Mechanics due to the Metal Liner which provides a better stress distribution in the Composite Shell
- No potential Electrostatic discharge of the Al-Liner

Life Cycle Costs/ Example for CNG



We can beat steel with higher Transport capacity and lower costs for the transported Kg CNG/ km and T4 with Fast Fill Performance !

Depending on Environmental Temperature, Compressor Design, Filling Speed Type III Container Solutions store more Gas than Type IV Cylinder Systems

Vs Type I Trailer Solutions we transport 80 % more Gas with a significant Lower Vehicle Weight !

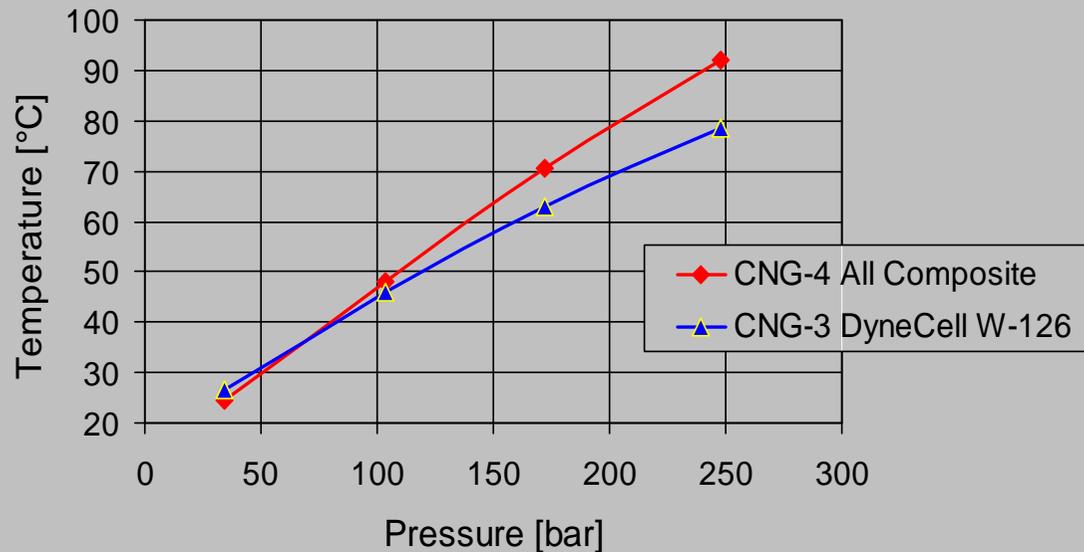
CNG Fast Fill (made on single cylinders)

SAE Report "CNG Fuel Cylinder Storage Efficiency and Economy in Fast Fill Operations" by D. Drew Diggins P.E, Pinnacle CNG Systems LLC, 1998



Dynetek™

Average Temperature Rise in Fast Fill Operation with CNG at 250 bar service pressure

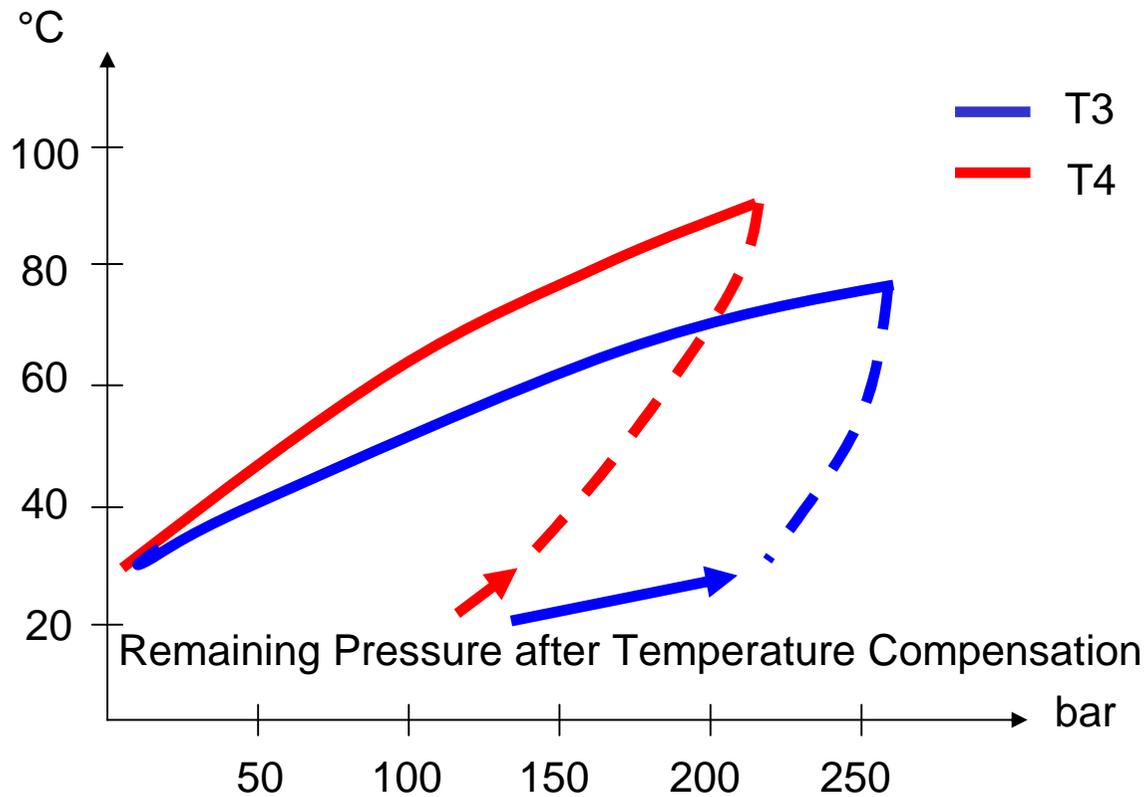


Cylinder Type	Change in Temperature [°C]	Fast Fill Duration [min]
Type 3 DyneCell W 126	52	4:33
Type 4	68	4:05
Difference	16	0:28

At the same filling pressures, the DyneCell cylinder has an increased storage capacity of approximately 10% more than an all-composite cylinder because the DyneCell cylinder has a greater temperature absorption.

Source: CNG Fuel Cylinder Storage Efficiency and Economy in Fast Fill Operations by D. Drew Diggins P.E, Pinnacle CNG Systems LLC, 1998

CNG Container Fast Fills measured in Asia/ Pacific; Type III vs Type IV



Cylinder Type	Change in Temperature [°C]	Fast Fill Duration [hours]
Type 3 DyneCell	30 to 74 @250 bar	4:10
Type 4	30 to 92 @ 210 bar	4:16
Difference	18	0:06

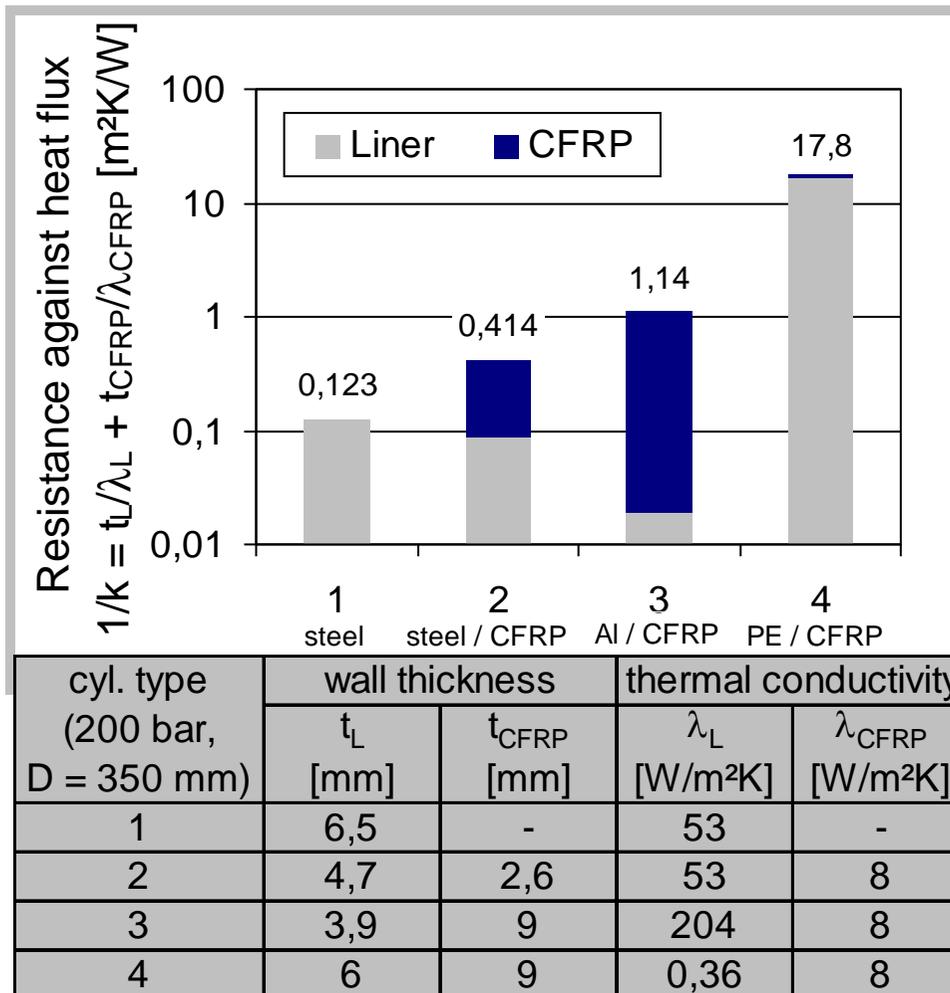
Container Fillings in Asia show that in a Type IV Container they have to stop the filling at 210 bar due to a too high Gas Temperature of 90°C. In a Type III Container our Clients can store around 40 - 50 % more Natural Gas.

CNG Fast Fill/

Basis of Heat Flux in Different Cylinder Designs



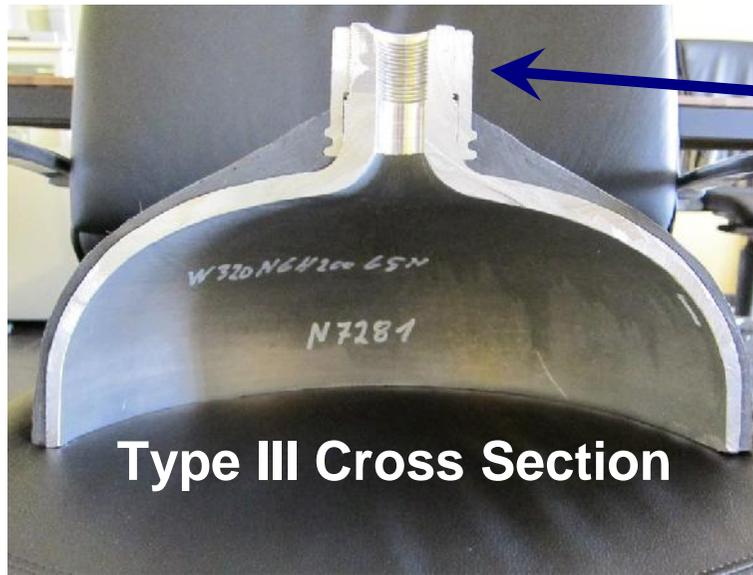
Why is the Gas Temperature in a Type IV higher than in a Type III after Fast Fill ?



The material selection of the DyneCell cylinder shows much lower resistance against heat flux during fast filling compared to the fully wrapped cylinders with polymer liner. The gas cools down during fast filling by heat transfer to the outside surface as well as by heat absorption in the aluminium wall.

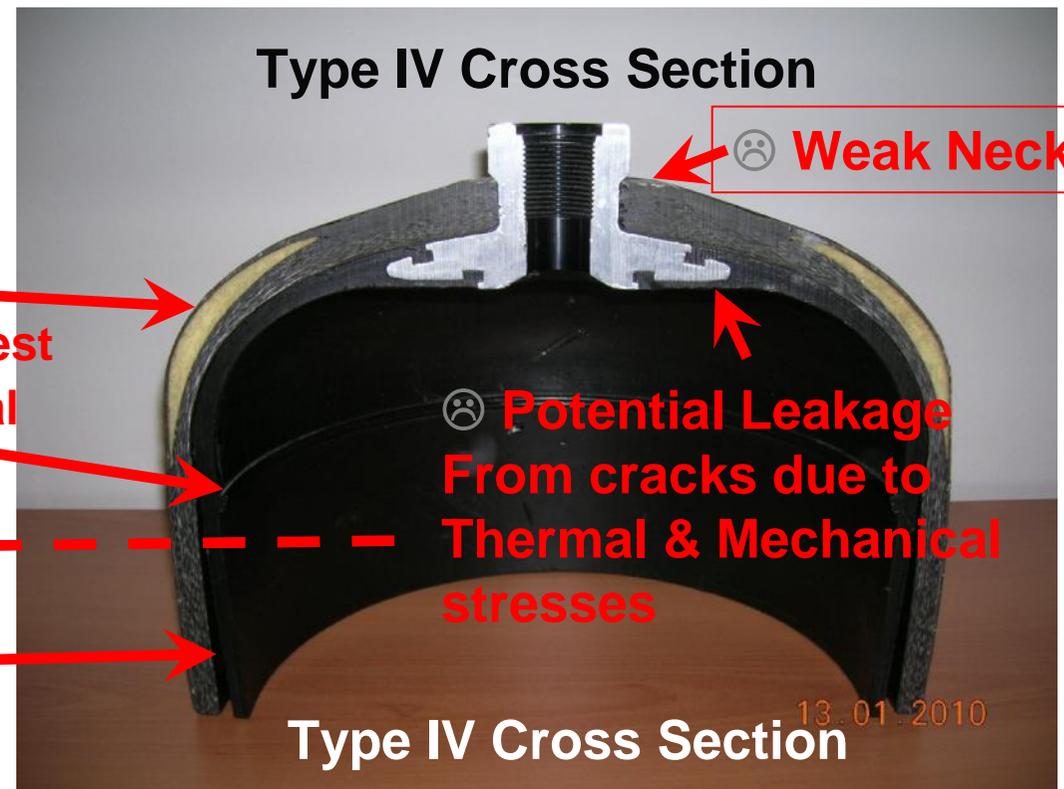
Source:
 Tabellenbuch Metall; Verlag Europa-Lehrmittel Haan; 40 (1997)
 Wärme- und Stoffübertragung by H. D. Baehr, K. Stephan; Springer Verlag Berlin; 3 (1998)
 Die Kunststoffe und ihre Eigenschaften by H. Domininghaus; VDI Verlag Düsseldorf; 4 (1992)

Dynetek Reinforced Neck checked in Vibration Testing and Vehicle Testing Grounds



Type III Cross Section

Dynetek's reinforced Neck
- Strong & Vibration Tested
- More than 8000 Buses with Neck Mounts in Operation



Type IV Cross Section

- ☹ Low Impact Resistance Without Foam doesn't pass Drop Test
- ☹ Weld in the Plastic Liner potential Failure Mode
- ☹ Constant Permeation of Gas
- ☹ No Bonding between Liner and Reinforcement will create Problems in Leakage Testing

☹ Weak Neck

☹ Potential Leakage From cracks due to Thermal & Mechanical stresses

Type IV Cross Section

13.01.2010

Type III Cylinder Advantages



Containers

- Cylinders mounted in a vertical Position
- Manifold on the Top; access with Cat Walk
- Optional Manual Shut Off Valves with or without TPRD and/ or Burst Disc
- Control Panel optional on the side or rear side
 - with 1 Pressure Gauge per Section (5000 I)
 - 1 Manual Shut Off per Section
 - 1 Main Shut Off
 - Easy drain with Bottom Plug
 - Optional:
 - 1 Pressure recorder with editable Software
 - Relief Device for the Manifold



Modules

- Cylinders mounted in a horizontal position
- Manifold on the front or rear side
- Easier, quicker and cheaper in Production



10ft, 20ft, 40 ft and special designed
Trailer editions



Virtual Pipeline for
Picking up Flare Gas
Using Stranded Gas
Providing instant Infrastructure



450 bar Storage Module

Largest Trailer in the World operated in Australia

10 ft. Module Variants



Dynetek®



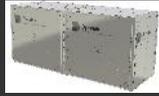
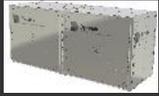
								
CNG Module derivatives	Custom (Horizontal)	Custom (Horizontal)	10' (Horizontal)	10' (Horizontal)	10' (Horizontal)	10' (Horizontal)		
Manufacturer	Dynetek	Dynetek	Dynetek	Dynetek	Dynetek	Dynetek		
Description	Type 3 CNG	Type 3 CNG	Type 3 CNG	Type 3 CNG	Type 3 H2	Type 3 H2		
Market								
Working Pressure	250 bar	250 bar	250 bar	250 bar	450 bar	450 bar		
Outside diameter	408 mm	408 mm	408 mm	408 mm	420 mm	420 mm		
Cylinder capacity	320 L	320 L	280 L	280 L	243 L	243 L		
Cyl. Weight	111 kg	111 kg	95 kg	95 kg	140 kg	140 kg		
Cylinder Life	40 years	40 years	40 years	40 years	30 years	30 years		
No of Cylinders	36	32	36	32	32	27		
Sections	3	3	3	2	2	2		
Total Cyl. Water volume	11520 L	10240 L	10080 L	8960 L	7776 L	6561 L		
Dimensions								
Overall length	3350 mm	3350 mm	2991 mm	2991 mm	2991 mm	2991 mm		
Overall width	2500 mm	2500 mm	2438 mm	2438 mm	2438 mm	2438 mm		
Overall height	2950 mm	2650 mm	2896 mm	2591 mm	2896 mm	2591 mm		
Weights								
Max. empty weight	6.8 t	6.2 t	5.6 t	5 t	7.3 t	6.3 t		
Total gas weight¹	2845 kg	2530 kg	2475 kg	2200 kg	230 kg	194 kg		
Total Container Weight, Full	9.7 t	8.8 t	8 t	7.2 t	7.5 t	6.5 t		

20 ft. Module Variants



Dynetek®



								
CNG Module derivatives	Custom (Horizontal)	Custom (Horizontal)	20' (Horizontal)	20' (Horizontal)	20' (Horizontal)	20' (Horizontal)	20 ft (Vertical)	20 ft (Vertical)
Manufacturer	Dynetek	Dynetek	Dynetek	Dynetek	Dynetek	Dynetek	Dynetek	Dynetek
Description	Type 3 CNG	Type 3 CNG	Type 3 CNG	Type 3 CNG	Type 3 H2	Type 3 H2	Type 3 CNG	Type 3 H2
Market							EU (1)	EU (1)
Working Pressure	250 bar	250 bar	250 bar	250 bar	450 bar	450 bar	250 bar	450 bar
Outside diameter	408 mm	408 mm	408 mm	408 mm	420 mm	420 mm	408 mm	420 mm
Cylinder capacity	320 L	320 L	280 L	280 L	243 L	243 L	234 L	243 L
Cyl. Weight	111 kg	111 kg	95 kg	95 kg	140 kg	140 kg	84 kg	140 kg
Cylinder Life	40 years	40 years	40 years	40 years	30 years	30 years	40 years	30 years
No of Cylinders	72	64	72	64	64	54	76	68
Sections	5	5	5	4	4	4	4	4
Total Cyl. Water volume	23040 L	20480 L	20160 L	17920 L	15552 L	13122 L	17784 L	16524 L
Dimensions								
Overall length	6776 mm	6776 mm	6058 mm	6058 mm	6058 mm	6058 mm	6058 mm	6058 mm
Overall width	2500 mm	2500 mm	2438 mm	2438 mm	2438 mm	2438 mm	2438 mm	2438 mm
Overall height	2950 mm	2650 mm	2896 mm	2591 mm	2896 mm	2591 mm	2591 mm	2896 mm
Weights								
Max. empty weight	14 t	12.5 t	11.3 t	10.1 t	14.6 t	12.6 t	9 t	16 t
Total gas weight¹	5690 kg	5060 kg	4950 kg	4400 kg	460 kg	388 kg	4445 kg	489,6 kg
Total Container Weight, Full,	19.7 t	17.6 t	15.3 t	14.6 t	15.1 t	13 t	13.4 t	16.5 t

40 ft. Module Variants



Dynetek®



									
CNG Module derivatives			40' (Horizontal)	40' (Horizontal)	40' (Horizontal)	40' (Horizontal)	40' (Horizontal)	40 ft (Vertical)	
Manufacturer			Dynetek	Dynetek	Dynetek	Dynetek	Dynetek	Dynetek	Dynetek
Description			Type 3 CNG	Type 3 CNG	Type 3 H2	Type 3 H2	Type 3 CNG	Type 3 CNG	Type 3 H2
Market							EU (0)		
Working Pressure			250 bar	250 bar	450 bar	450 bar	250 bar	250 bar	450 bar
Outside diameter			408 mm	408 mm	420 mm	420 mm	408 mm	408 mm	420 mm
Cylinder capacity			280 L	280 L	243 L	243 L	234 L	234 L	243 L
Cyl. Weight			95 kg	95 kg	140 kg	140 kg	84 kg	84 kg	140 kg
Cylinder Life			40 years	40 years	30 years	30 years	40 years	40 years	30 years
No of Cylinders			2x72	2x64	2x64	2x54	152	152	136
Sections			9	8	7	6	8	8	7
Total Cyl. Water volume			40320 L	35840 L	31104 L	26244 L	35568 L	35568 L	33048 L
Dimensions									
Overall length			12192 mm	12192 mm	12192 mm	12192 mm	12192 mm	12192 mm	12192 mm
Overall width			2438 mm	2438 mm	2438 mm	2438 mm	2438 mm	2438 mm	2438 mm
Overall height			2896 mm	2591 mm	2896 mm	2591 mm	2591 mm	2591 mm	2896 mm
Weights									
Max. empty weight			22.6 t	20.2 t	29.2 t	25.2 t	17.5 t	17.5 t	26 t
Total gas weight¹			9900 kg	8800 kg	920 kg	776 kg	8890 kg/ 6890 kg	8890 kg/ 6890 kg	979,2 kg
Total Container Weight, Full,			30.6 t	29.2 t	30.2 t	26 t	26.4 t 24.4 t	26.4 t 24.4 t	27 t

450 Bar Options for Helium, Hydrogen and other Gases



Dynetek Europe GmbH



Composite Tube Cylinders Type VxxxT500U5D

Specification

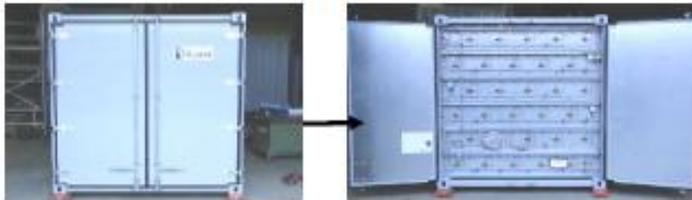
Cylinder Type:	Type 3 (Al-Liner, CF in EP)
Gas:	see table
Service Pressure:	see table
Max. Pressure at 65°C:	590 bar
Temperature Range:	-40 °C to +65 °C
Port Thread:	1 1/8-12 UNF-2B (D5 Port) with internal bore seal
Mounting	vertical or horizontal belly or neck mounting
Approval	according to ADR/TPED (π-mark) in progress

Performance

Test Pressure:	750 bar (10,088 psi)
Burst Pressure:	> 1500 bar (21,750 psi)
Service Life:	30 Years



Neck mounting example



Model*	Volume [L]	Diameter [mm]	Length [mm]	Mass [kg]	Gas type with Working Pressure at 15 °C and Gas Mass [kg] / Volume in Standard Cubic Metres [Sm ³]								
					Hydrogen 500 bar	Helium 500 bar	Nitrogen 462 bar	Air 444 bar	Neon 497 bar	Argon 447	Methane 412 bar	Krypton 392 bar	Carbon monoxide 459 bar
V081	81	419	1021	67	2.57 / 30.5	5.47 / 32.8	33.1 / 28.3	35.3 / 29.3	27.0 / 32.1	54.9 / 32.9	21.2 / 31.6	122 / 34.8	33.2 / 28.4
V151	151	419	1708	102	4.78 / 56.8	10.2 / 61.1	61.7 / 52.7	66.2 / 55.0	50.4 / 59.8	102 / 62.4	39.5 / 58.9	227 / 64.8	61.9 / 52.9
V188	188	419	2086	122	5.96 / 70.9	12.7 / 76.0	78.9 / 65.7	82.4 / 68.4	62.7 / 77.4	128 / 76.4	49.2 / 73.4	283 / 80.8	77.0 / 65.8
V243	243	419	2834	152	7.70 / 91.6	16.4 / 98.2	99.3 / 84.9	107 / 88.4	81.0 / 96.2	165 / 98.7	63.5 / 94.7	365 / 104	99.8 / 85.1
V293	293	419	3130	179	9.28 / 110	19.8 / 118	120 / 102	128 / 107	97.7 / 116	199 / 119	76.6 / 114	440 / 126	120 / 103

*These cylinder sizes are typical examples. Intermediate sizes are available and will be included in the type approval.
Copyright © 2012 Dynetek

20" Container 250 bar CNG View from the Rear, Top and Control Panel



Dynetek[®]



Integrity • Customer Focus • Teamwork • Can-do Attitude

10ft and 20 ft Modules for 250 bar CNG



Dynetek[®]



10ft Module

Weight Module : 4t

Weight CNG : 2506 kg @ 250 bar
(density 0,84 kg/m³)

Dimensions

Length: 2991mm

Width: 2438mm

Height: 2591mm

20ft Module

Weight Module : 8t

Weight CNG : 5012 kg @ 250 bar
(density 0,84 kg/m³)

Dimensions

Length: 2991mm

Width: 2438mm

Height: 2591mm



20" Container 250 bar CNG (Version India) Characteristics



Container: 20" Type "1A"
Container length: 20 ft / 6,058 mm
Container height: 8 ft / 2,438 mm
Container width: 8 ft / 2,438 mm



Cylinders Dynetek code: "Q140"
No. of Cylinders per Trailer: 104
Volume: 140 L
Filling pressure: 250 bar
Test pressure: 375 bar
Dimensions OD, Length: 332 mm nom.; 2182 mm nom.
Unladen weight: 51.5 kg
Convex- Neck thread: Double neck – 1.125-12 UNF with O-ring Neck

Volume in l and m³: 14560 l / 4385 m³

CNG in kg with a density of 0,83 kg/m³: 3640 kg

20" Container 250 bar CNG - Roll on version Characteristics



60 cylinders x 275 liters

Methane

		Container ISO 20'	
Capacity	Liters	16500	
		3,3673	3,1398
	M3	4900	5255
		Density of Kg/m3	
		0,679	0,785
	Kg	3327	4125
Cylinders	Kg	5700	5700
Valves, PRD's, Tubing and filling panel	Kg	300	300
Frame	Kg	900	900
Container 20'	Kg	2400	2400
Trailer	Kg		
Sub Total Container empty	Sub Kg	9300	9300
Total Trailer empty	Kg	12627	13425
Length	mm	6200	
Width	mm	2550	
Height	mm	2950	
Minimum Filling time with 1,2 or 4 NGV2 nozzle or special DN 25 connectors	mn	50	
Temperature inside cylinders, 15°C outside	°C	<60	
Efficiency	%	98	
Capacity after filling at 250 bar	Kg	3261	4043
	m3	4802	5150

Sources : 0.679, Gaz Encyclopedia of Air Liquide, volume of gaseous phase, Methane - 0.785, Ecofisk Gaz Density

20" Container 250 bar CNG - Roll on version Characteristics



70 cylinders x 275 liters

Methane

		Container ISO 20'	
Capacity	Liters	19250	
		3,3673	3,1398
	M3	5717	6131
		Density of Kg/m3	
		0,679	0,785
	Kg	3882	4813
Cylinders	Kg	6650	6650
Valves, PRD's, Tubing and filling panel	Kg	350	350
Frame	Kg	1050	1050
Container 20'	Kg	2600	2600
Trailer	Kg		
Sub Total Container empty	Sub Total Trailer empty	Kg	10650
Total Trailer empty			
Total	Kg	14532	15463
Length	mm	6200	
Width	mm	2550	
Height	mm	3380	
Minimum Filling time with 1,2 or 4 NGV2 nozzle or special DN 25 connectors	mn	50	
Temperature inside cylinders, 15°C outside	°C	<60	
Efficiency	%	98	
Capacity after filling at 250 bar	Kg	3804	4717
	m3	5602	6008

Sources : 0.679, Gaz Encyclopedia of Air Liquide, volume of gaseous phase, Methane - 0.785, Ecofisk Gaz Density

20" Container 250 bar CNG Characteristics



Container: 20" Type "1AA"
Container length: 20 ft / 6,058 mm
Container height: 8 ft 6 in / 2,591 mm
Container width: 8 ft / 2,438 mm

Cylinders Dynetek code: "W234"
No. of Cylinders per Trailer: 76
Volume: 234 L
Filling pressure: 250 bar
Test pressure: 375 bar
Dimensions OD, Length: 408 mm nom.; 2346 mm nom.
Unloaden weight: 84 kg
Convex- Neck thread: Double neck – 1.125-12 UNF with O-ring Neck



Volume in l and m³: 17784 l / 5356 m³
CNG in kg with a density of 0,83 kg/m³: 4445 kg
= 217.805 MJ or = 60.007 kWh or = 206 MBtu

40" Container 250 bar CNG Characteristics



Container: 40" Type "1CC"
Container length: 40 ft / 12,192 mm
Container height: 8 ft 6 in / 2,591 mm
Container width: 8 ft / 2,438 mm

Cylinders Dynetek code: "W234"
No. of Cylinders per Trailer: 152
Volume: 234 L
Filling pressure: 250 bar
Test pressure: 375 bar
Dimensions OD, Length: 408 mm nom.; 2346 mm nom.
Unladen weight: 84 kg
Convex- Neck thread: Double neck – 1.125-12 UNF with O-ring Neck

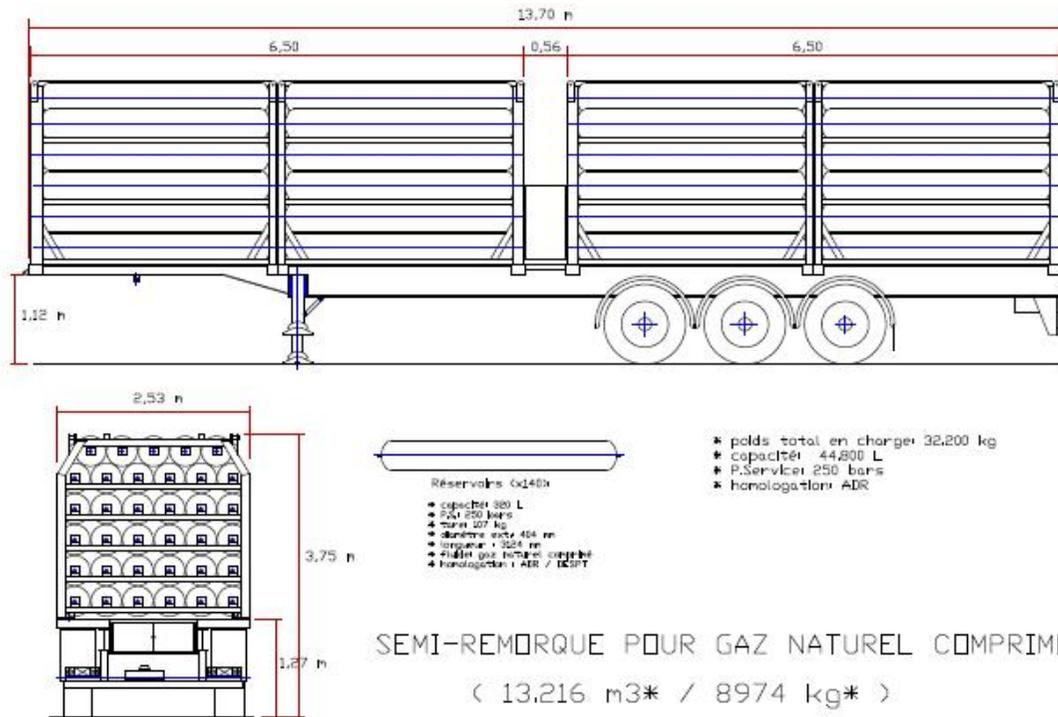


Volume in l and m³: 35568L/ 10712 m³

CNG in kg with a density of 0,83 kg/m³: 8890 kg

= 435.610 MJ or = 120.014 kWh or = 412 MBtu

45" Trailer 250 bar CNG Characteristics



		Methane	
		Trailer 45'	
Capacity	Liters	44800	
		3,3673	3,1398
	M3	13304	14268
		Density of Kg/m3	
		0,679	0,785
	Kg	9034	11201
Cylinders	Kg	14420	14420
Valves, PRD's, Tubing and filling panel	Kg	700	700
Frame	Kg	1900	1900
Container 20'	Kg		
Trailer	Kg	4000	4000
Sub Total Container empty	Kg	21020	21020
Sub Total Trailer empty	Kg	21020	21020
Total	Kg	30054	32221
Length	mm	13700	
Width	mm	2500	
Height	mm	3750	
Minimum Filling time with 1,2 or 4 NGV2 nozzle or special DN 25 connectors	mn	70	
Temperature inside cylinders, 15°C outside	°C	<60	
Efficiency	%	98	
Capacity after filling at 250 bar	Kg	8853	10977
	m3	13038	13983

Sources : 0.679, Gaz Encyclopedia of Air Liquide, volume of gaseous phase, Methane - 0.785, Ecofisk Gaz Density

Mobile Fuelling Systems



“World’s largest completely autarkic mobile CNG filling station“



„Our mobile natural gas filling station has everything on board. From the storage element with 72 Dynetek carbon cylinders to the high-performance compressor and the natural gas turbo engine, right through to the dispenser – everything functions without any additional energy supply or equipment.

Simply independent!“ (Schandl/ Germany)

MEGC (Multi-Element Gas Container) Structural Analysis according to ADR



Every system design is submitted to FEA analysis to ensure system strength.

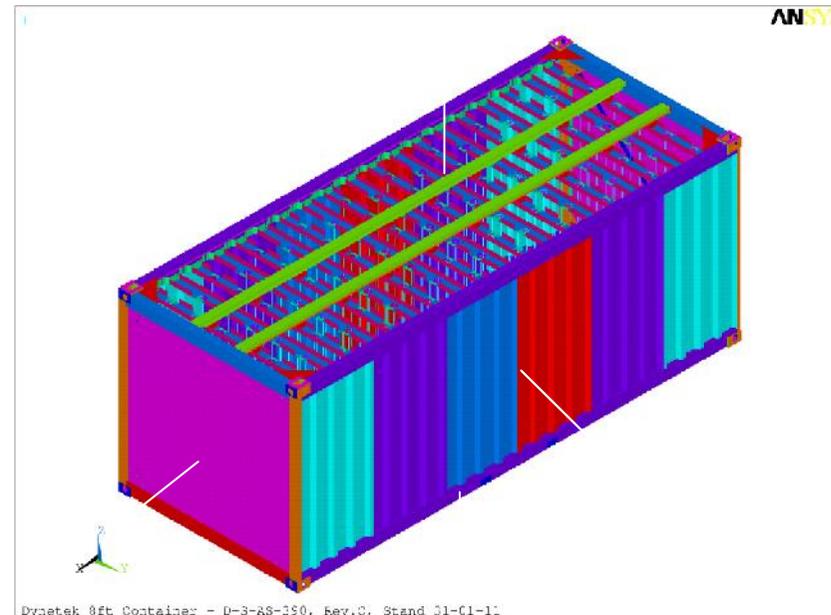
ADR, Chapter 6.8.2.1.2:

Direction of travel: 2g

Transverse: 1g

Vertically up: 1g

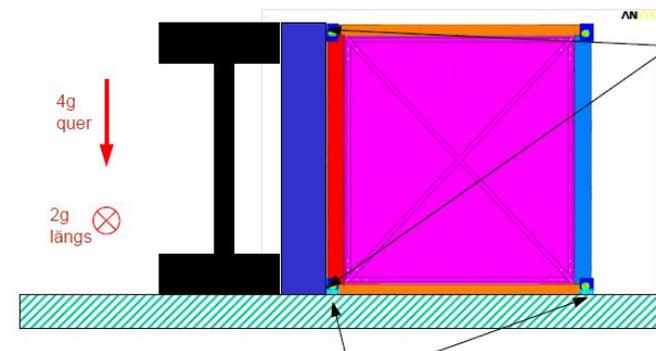
Vertically down: 2g



Additional Dynetek requirements:

“Tilt” =

Direction of travel: 4g + Transverse: 2g



MEGC (Multi-Element Gas Container) Structural Analysis according to ADR



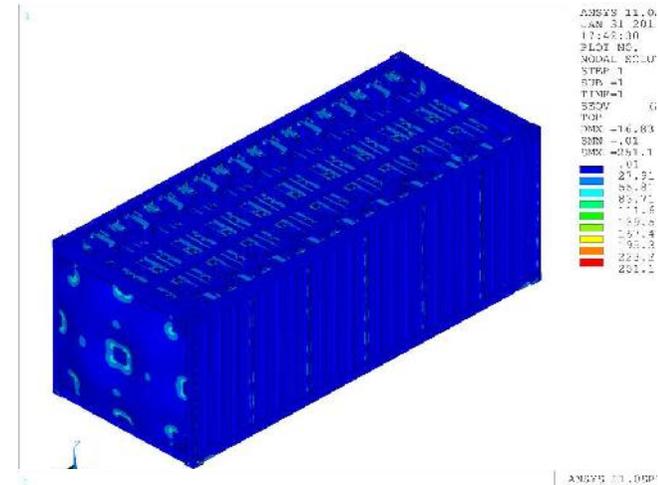
Dynetek[®]

Examples of FEA results

Direction of travel: 2g

Results:

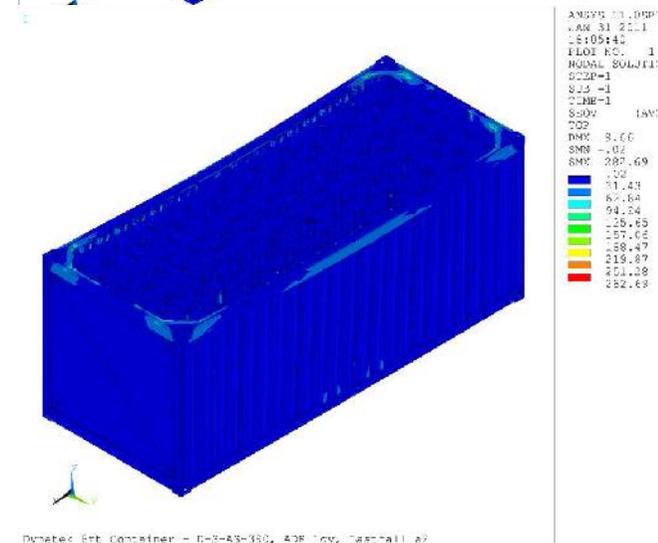
The maximum comparative stress amounts to 251 MPa.



Transverse: 1g

Results:

The maximum comparative stress amounts to 283 MPa.



Luxfer/ Dynetek is the only company which provide a dynamic calculation !

MEGC (Multi-Element Gas Container) Structural Analysis according to ADR



Examples of FEA results

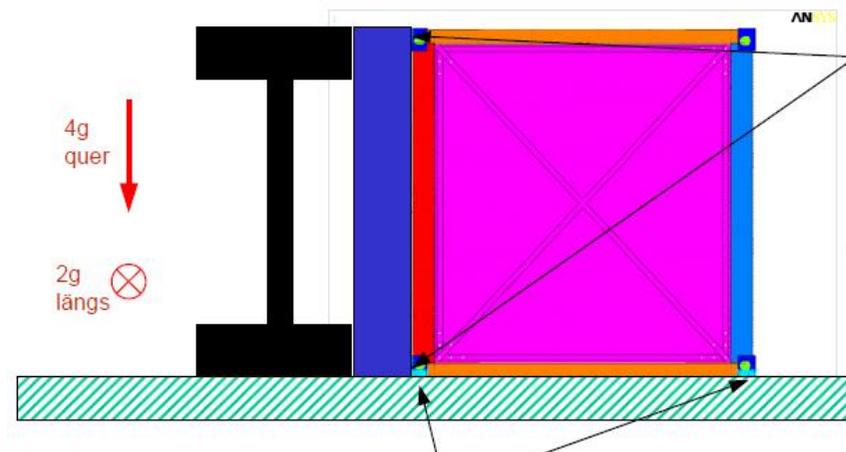
Additional Dynetek requirements:

“Tilt” =

Direction of travel: 4g + Transverse: 2g

Results:

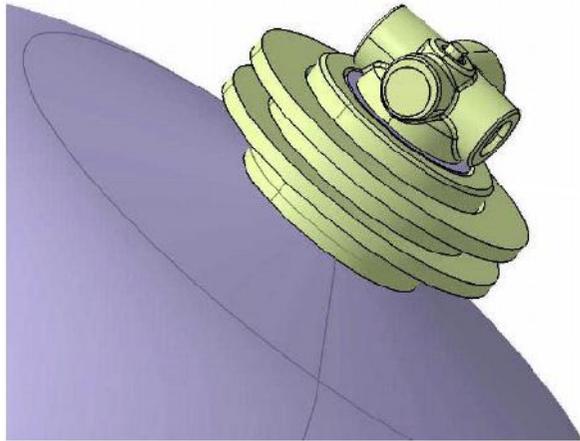
- no parts incl. cylinders will be detached from the container
- deformation will take place but the structure will remain complete
- the cylinders cannot slide out of the losse bearing



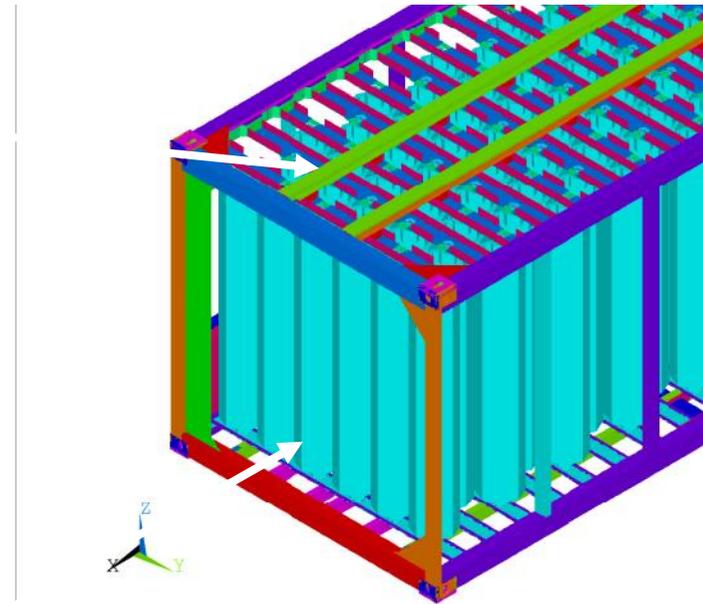
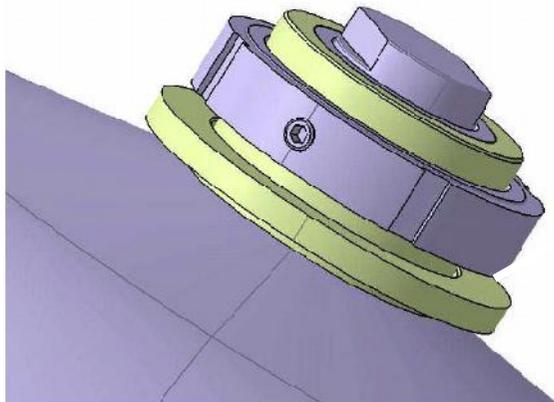
Neck mounting Type 3 and 4



SLIDING BEARING



FIXED BEARING



Dynetek 8ft Container - D-S-AS-390, Rev.C, Stand 31-01-390

The cylinders move freely in vertical direction (sliding bearing).

Cylinder Certificates



Dynetek[®]

TUV NORD

ZERTIFIKAT CERTIFICATE

(Konformitätsbescheinigung) / (of conformity)
EG-Baumusterprüfung
EC type-examination

nach Richtlinie 1999/36/EG / according to directive 1999/36/EC

Zertifikat-Nr. / Certificate No.: 07 202 1410 Z 0547/0/D/0059

Name und Anschrift des Herstellers
Name and address of bearer/ manufacturer:
Dynetek Europe GmbH
Breitscheider Weg 117b
40885 Ratingen

Hiermit wird bescheinigt, dass das unten genannte EG-Baumuster die Anforderungen der Richtlinie 1999/36/EG erfüllt. We hereby certify that the type examination mentioned below fulfils the requirements of directive 1999/36/EC.

Geprüft nach Richtlinie 1999/36/EG
Tested according to 1999/36/EC

Prüfbericht-Nr. / Test report No.:

Beschreibung des Baumusters:
Description of type:

Auslegungsstandard / Design Standard:

Fertigungsstätte/Place of manufacture:

Gültig bis/ valid until:
Essen, 16.12.2010

EG-Baumusterprüfung (Modul B)
EC type-examination (module B)

1410 P 0547/0/0059

Vollumwickelte Großflaschen aus Verbundwerkstoffen mit nahtlosem Aluminium-Liner / fully wrapped composite tubes with seamless aluminium liner
Durchmesser / diameter: 405 mm
Länge / length: 1622 - 3128 mm
Inhalt / volume: 151 - 320 Liter / litre
Prüfdruck / test pressure: 375 bar
Lebensdauer / service life: 40 Jahre / Years
Zeichnungs-Nr. / drawing no.: WxxxT250U5N(5V)

ATR D 3/10 (DIN EN 12245:2009)

Dynetek Europe GmbH
Breitscheider Weg 117b, 40885 Ratingen

15.12.2020

Zertifizierungsstelle für Druckgeräte
der TÜV NORD Systems
GmbH & Co. KG

Matthaei, Dipl. Ing.

Benannte Stelle/ Notified Body, 0045

Mitglied der
Member of



CONFEDERATION EUROPEENNE D'ORGANISMES DE CONTRÔLE

TÜV NORD Systems
GmbH & Co. KG
Große Bahnstr. 31
D-22525 Hamburg, Germany

Tel. +49-(0) 201/825 2680
Fax +49-(0) 201/825 2661
e-mail hweinberger@tuev-nord.de

Modul B W Typ 151 Da 320 Liner Rev 0

TUV NORD

ZERTIFIKAT CERTIFICATE

Bauartzulassung / type approval
nach EN ISO 11439:2000 / according to EN ISO 11439:2000

Zertifikat-Nr. / Certificate No.: 07 202 1410 Z 0568/8/D/0059

Name und Anschrift des Herstellers
Name and address of manufacturer:
Dynetek Europe GmbH
Breitscheider Weg 117b
D-40885 Ratingen

Hiermit wird bescheinigt, dass das unten genannte Baumuster die Anforderungen der EN ISO 11439:2000 erfüllt. We hereby certify that the type mentioned below fulfils the requirements of EN ISO 11439:2000.

Geprüft nach EN ISO 11439:2000
Tested according to EN ISO 11439:2000

Beschreibung des Baumusters:
Description of type:

Zeichnung Nr. / drawing no.:

Betriebsdruck: / working pressure:

Inhalt / capacity:

Gastemperatur: / gas temperature:

Gas / gas:

Gültig bis/ valid until:

Essen, 04.11.2008

Bauartzulassung
type approval

Gasflaschen zur Mitführung von verdichtetem Erdgas als Treibstoff für Kraftfahrzeuge - CNG-3 Verbund-Gasflaschen, Liner voll verstärkt mit harzprägnierter Endlosfaser / High pressure gas cylinders for the on-board storage of natural gas as a fuel for automotive vehicles - CNG-3 Metal liner reinforced with resin impregnated continuous filament (fully wrapped)

D-WxxxC200G5 (G5N), D-WxxxC200G8 (G8N)

200 bar @ 15°C

61, 76, 126, 150, 205, 212, 251, 292, 320 L

siehe Zeichnung / see drawing no. D-VxxxC200G5, G5N, G8, G8N -02

-40 °C bis / to 65 °C

Erdgas (CNG), für die Gasqualität gelten die Anforderungen der EN ISO 11439, Nr. 4.5 und die Festlegungen in den Herstellerunterlagen / For the gas quality see EN ISO 11439, clause 4.5 and the manufacturers description

03.11.2018

TÜV CERT-Zertifizierungsstelle
für Druckgeräte
der TÜV NORD Systems
GmbH & Co. KG

Matthaei, Dipl. Ing.

Benannte Stelle/ Notified Body, 0045

Mitglied der
Member of



CONFEDERATION EUROPEENNE D'ORGANISMES DE CONTRÔLE

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GmbH & Co. KG
Langemarckstraße 20
D-45141 Essen, Germany

Tel. +49-(0) 201/825-2680
Fax +49-(0) 201/825-2661
e-mail hweinberger@tuev-nord.de

Bauartzulassung W-Typen.doc

Bulk Transport of Hydrogen



Shaker test



10' Module for 450 bar H₂	
Service Pressure:	450 bar
Water Capacity:	30 x 243 L = 7290 L
Stored H ₂ mass:	213 kg
Container Weight:	6561 kg (full)

Manufactured for the German Army

EU Law ADR = Accord Dangereux Routier

(European regulations concerning the international transport of dangerous goods by road).

Small Modules for CNG, Hydrogen, Helium etc. Transport



- Can be towed with a standard pick-up truck
- Self-contained system with aluminum covers.
- Include necessary hoses, fittings, etc.
- US DOT & Transport Canada approved cylinders and system configuration. DOT E-13173

TRAILER VOLUMES:	Hydrogen			CNG		
Model #	kg	Nm3	SCF	kg	Nm3	SCF
MRFS-17	73	855	30177	840	1238	43704
MRFS-10	43	503	17751	494	728	25708
MRFS-8	34	402	14201	395	582	20566

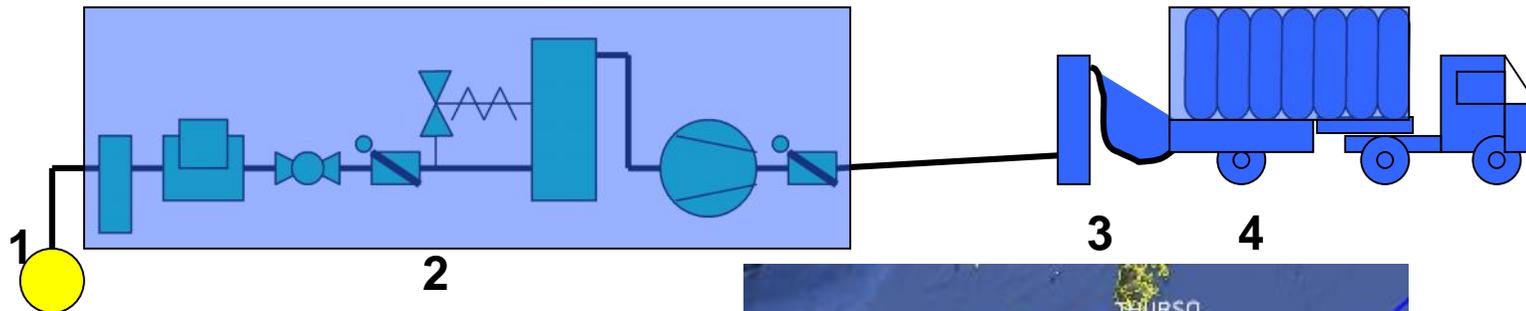


- Length : 169"
- Height: 72" (MRFS-8 model)
- 10 cyl. Trailer Empty Weight : 4750 lbs (2160 kg)
- 10 cyl. Module Length : 120" Height : 50"
- 10 cyl. Module Empty Weight : 3,250 lbs (1,450 kg)

“Virtual Pipeline”



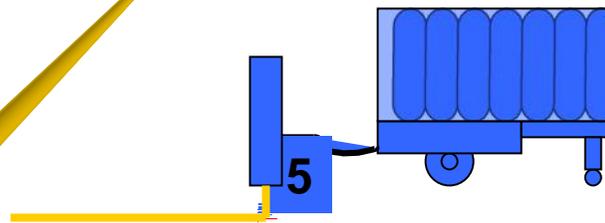
Mother Station



- 1 Gas grid (7 bar)
- 2 Compressor station
- 3 Dispenser
- 4 Gas Bulk Trailer
- 5 Pressure reduction
- 6 Customer supply



Grid

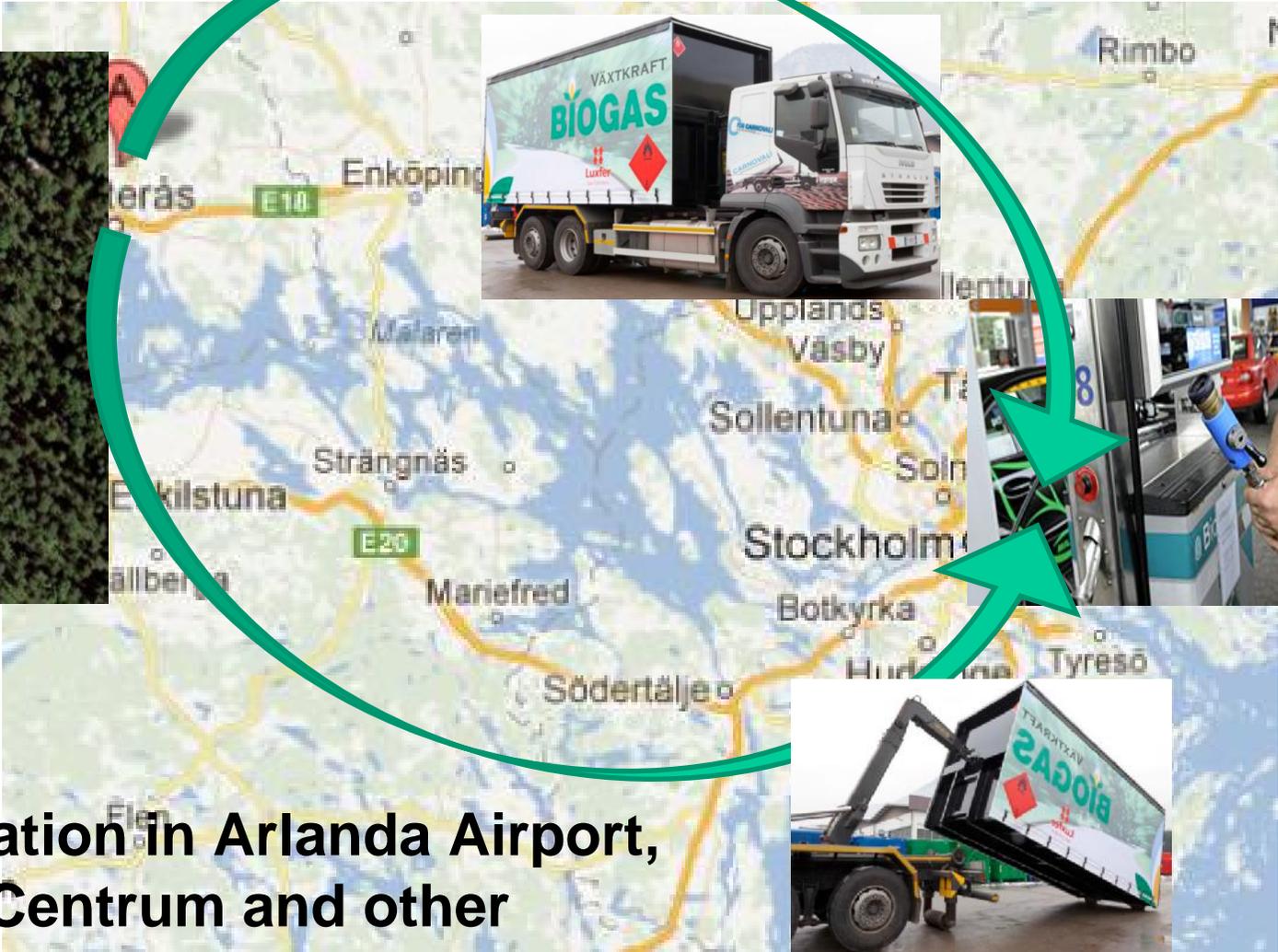


“Virtual Pipeline for BioGas in Sweden”



Dynetek[®]

BioGas Plant

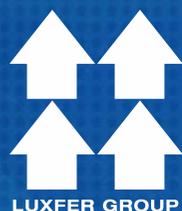


**Taxi Gas Station in Arlanda Airport,
Stockholm Centrum and other
GasStaion for Taxis**



**Do You Have
Any Questions?**

**We would be happy to
help.**



Income Statement

AGM London 31st of May 2012

	12 Months to		Variance
	Dec-11	Dec-10	
	£m	£m	£m
Revenue			
Gas Cylinders	138.8	129.3	9.5
Elektron	135.3	130.1	5.2
Rare Earth Zr Surcharge	43.4	2.1	41.3
Eliminations	(0.2)	(0.3)	0.1
Group Revenue	317.3	261.2	56.1
Gross Profit	74.7	63.3	11.4
<i>Gross Profit Percentage</i>	<i>23.5%</i>	<i>24.2%</i>	
Trading Profit			
Gas Cylinders	7.4	7.9	(0.5)
Elektron	33.5	21.8	11.7
Group Trading Profit	40.9	29.7	11.2
<i>ROS %</i>	<i>12.9%</i>	<i>11.4%</i>	
Other income / (expense)	0.2	(0.5)	0.7
Operating Profit	41.1	29.2	11.9
Group Adjusted EBITDA *	49.9	38.7	11.2
<i>EBITDA Margin %</i>	<i>15.7%</i>	<i>14.8%</i>	

* Trading Profit plus depreciation and amortisation