

Informal document GRSG-109-14  
(109<sup>th</sup> GRSG, 29 Sept.-2 October 2015  
agenda items 9 and 11)

# ISO TC22/SC41

## Specific aspects for gaseous fuels

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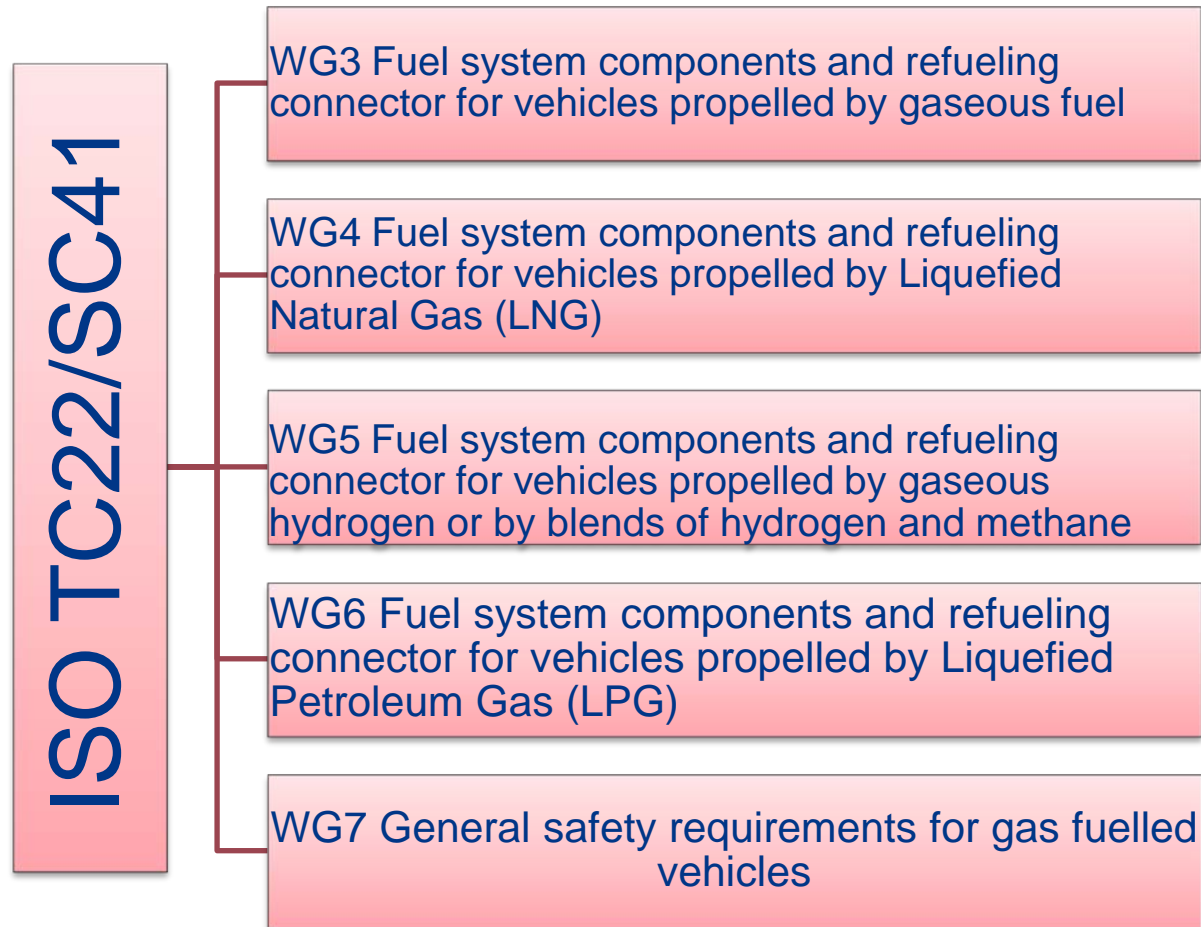


# Content of this presentation

- **Update on ISOTC22/SC41**
- **Introduction ISO standard in LNG**
- **Request for new topics in R67 and R110**

# Update on ISO TC22/SC41


## ■ Update on ISOTC22/SC41 (formally known as ISOTC22/SC25)





# WG3 Fuel system components and refueling connector for vehicles propelled by gaseous fuel

- **Revision/Update on ISO15500 parts.**
  - Adding non-metallic material test from ECE R110
  - Editorial
- **Revision of ISO14469 part 2 (new working item request part 1)**



# WG4 Fuel system components and refueling connector for vehicles propelled by Liquefied Natural Gas (LNG)

- **Published ISO12617:2015 LNG receptacle**
- **Published ISO12614:2014 Road vehicles -- Liquefied natural gas (LNG) fuel system components**
  - *Part 1: General requirements and definitions*
  - *Part 2: Performance and general test methods*
  - *Part 3: Check valve*
  - *Part 4: Manual valve*
  - *Part 5: Tank pressure gauge*
  - *Part 6: Overpressure regulator*
  - *Part 7: Pressure relief valve*
  - *Part 8: Excess flow valve*
  - *Part 9: Gas-tight housing and ventilation hose*
  - *Part 10: Rigid fuel line in stainless steel*
  - *Part 11: Fittings*
  - *Part 12: Rigid fuel line in copper and its alloys*
  - *Part 13: Pressure control regulator*
  - *Part 14: Differential pressure fuel content gauge*
  - *Part 15: Capacitance fuel content gauge*
  - *Part 16: Heat exchanger – vaporizer*
  - *Part 17: Natural gas detector*
  - *Part 18: Gas temperature sensor*



# WG5 Fuel system components and refueling connector for vehicles propelled by gaseous hydrogen or by blends of hydrogen and methane

- Working on ISO12619 Road vehicles — Compressed Gaseous Hydrogen (CGH<sub>2</sub>) and Hydrogen/ Methane blends fuel system components
- Published in 2014
  - ISO12619 Part 1 General requirements and definitions
  - ISO12619 Part 2 Performance and general test methods
  - ISO12619 Part 3 Pressure regulator
  - ISO16380 Road vehicles -- Blended fuels refueling connector
- Work in progress on the following:
  - ISO12619 Part 4: Check valve
  - ISO12619 Part 5: Manual cylinder valve



# WG6 Fuel system components and refueling connector for vehicles propelled by Liquefied Petroleum Gas (LPG)

- **ISO/WD 19825 “Road vehicles - Liquefied Petroleum Gas (LPG) refueling connector**
- **ISO/NWIP 20766: Road vehicles — Liquefied Petroleum Gas (LPG) fuel system components**
  - Part 1: General requirements and definitions – active
  - Part 2: Performance and general test methods – active
  - Part 3: Check valve – not yet started
  - Part 4: Manual valve – not yet started
  - Part 5: Manual tank valve – not yet started
  - Part 6: Automatic valve – not yet started
  - Part 7: Gas injector – not yet started
  - Part 8: Pressure indicator – not yet started
  - Part 9: Pressure regulator – not yet started
  - Part 10: Gas-flow adjuster – not yet started
  - Part 11: Gas/air mixer – not yet started
  - Part 12: Pressure relief valve (PRV) –not yet started
  - Part 13: Pressure relief device (PRD) – not yet started
  - Part 14: Excess flow valve – not yet started
  - Part 15: Gas-tight housing and ventilation hose – not yet started
  - Part 16: Rigid fuel line – not yet started
  - Part 17: Flexible fuel line – not yet started
  - Part 18: Filter – not yet started
  - Part 19: Fittings – not yet started



# WG7 General safety requirements for gas fuelled vehicles

- **ISO15501-2 Road vehicles -- Compressed natural gas (CNG) fuel systems -- Part 2: Test methods under revision**
- **ISO/AWI 19723-1 Road vehicles -- Liquefied natural gas (LNG) fuel systems -- Part 1: Safety requirements**
- **ISO/AWI 19723-2 Road vehicles -- Liquefied natural gas (LNG) fuel systems -- Part 2: Test methods**
- **New working item proposal for ISOxxxxx covering Compressed Gaseous Hydrogen (CGH<sub>2</sub>) and Hydrogen/Natural Gas blends as use for vehicle fuel.**
  - **Part 1: Safety requirements**
  - **Part 2: Test methods**



# LNG Task Force



## ■ Introduction ISO standard in LNG

- During the LNG Task force meetings was agreed to introduce the requirements from ISO12617:2015 LNG receptacle
- introduction using the example of the CNG nozzle (ISO14469)

## ■ Reason for introduction:

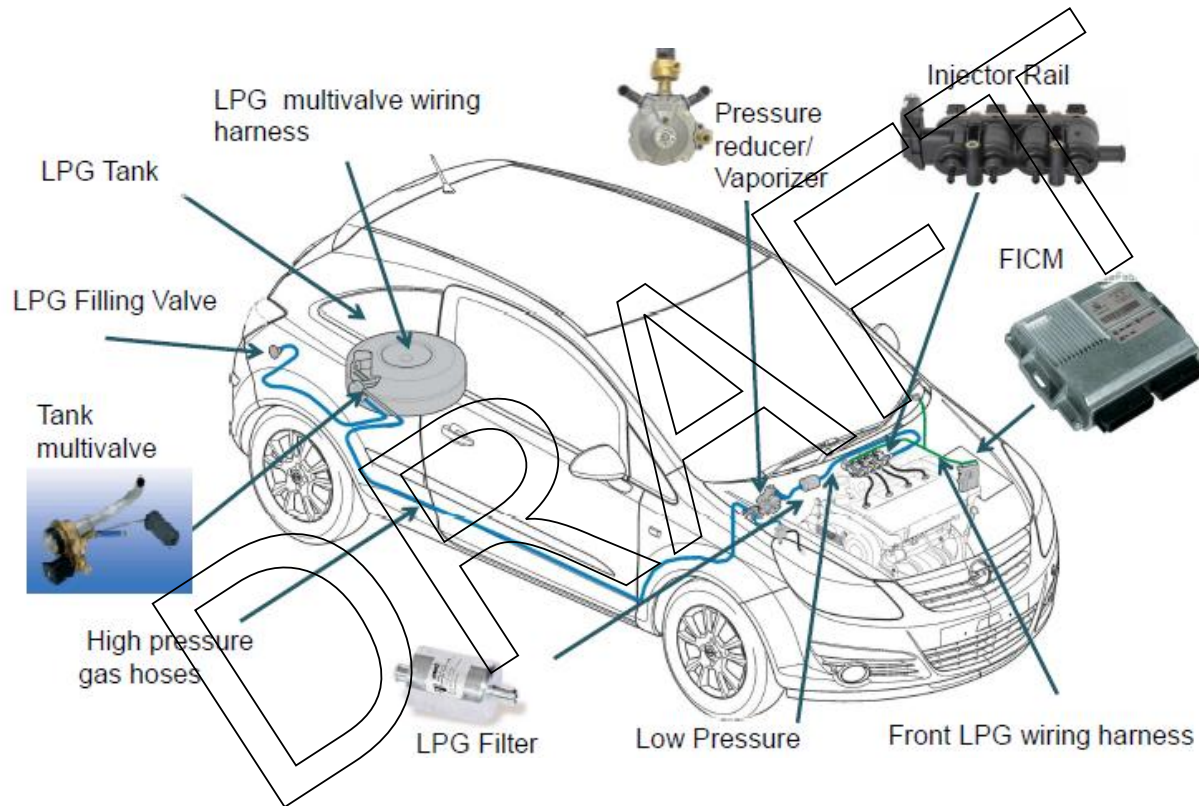
- Uniform Profile of the receptacle
- Requirements in line with what is currently in ECE R110 for the CNG receptacle.

# Request for new topics in R67



- **Request from OEM to update the R67 requirements on the fuel line and welding requirement. (see next sheets for explanation)**

# PROPOSAL: APPROVAL OF USING AUTOMOTIVE STEEL TUBING BRAKE SYSTEM LINES AS RIGID LIQUEFIED PETROLEUM GASES LINES



# Proposed amendment to ECE REGULATION No. 67

## APPROVAL OF USING AUTOMOTIVE STEEL TUBING BRAKE SYSTEM LINES AS RIGID LIQUEFIED PETROLEUM GASES LINES

### Proposal:

#### Part II , para 17.8.1

17.8. Gas connections between the components of the LPG-system

17.8.1. Soldered or welded joints and bite-type compression joints are not permitted. Soldering or welding can be permitted for connecting the individual parts of detachable couplings to the gas tube or component.

## Justification for the proposal

Double Wall steel tubing used for brake lines are feasible for much more than 67 bar. Overall, Parameters are set very high due to Safety and Quality issues that valued by GMW14658.

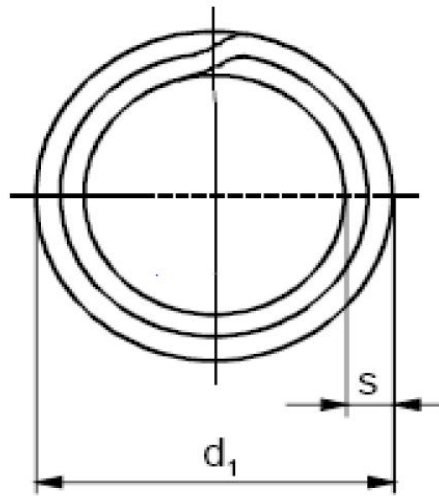
From our point of view it makes sense to qualify more parts for the LPG usage regarding the Class 1. We all would gain more products on market which are feasible for us.

Double Wall Tubes are already known in brake and fuel tubing applications and allows the whole variety of end forms and coupling techniques. Due to their usage they have to withstand high pressure and a high resistance for pressure pulses. From our experience the LPG pressure pulses are very much less strength than in brake lines.

Hence the amendment is proposed for more clarity and flexibility in the regulation for suppliers and customers and would help the commercialization process of LPG lines.



# Brake lines – Form & Size



## Minimum Requirements:

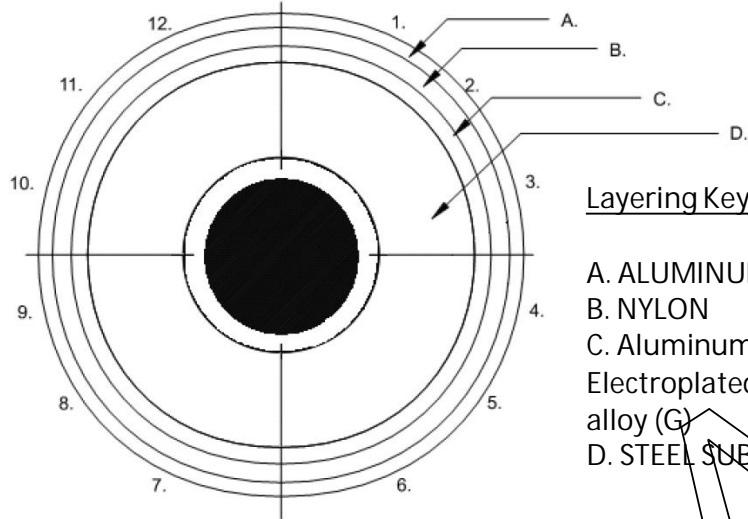
Rm	300 MPa
0.2% Yield Strength $R_{p0.2}$	200 MPa
Fracture Elongation $A_{10}$	14%

Figure 1: Dimensions for Diameter and Wall Thickness

$d_1$ <sup>Note 1</sup> in mm	$s$ <sup>Note 1</sup> in mm	Weight <sup>Note 2</sup> in kg/1000 m $\pm 2$ kg	Burst Pressure in MPa	Permissible Operating Pressure in MPa	Smallest Bending Radius $r$ <sup>Note 3</sup> In mm		
					Cylinder Roller	Profile Roller <sup>Note 4</sup> Without Internal Punch	With Internal Punch
6	0.7	89	80	32	25	12	-
6.35	0.7	93	73	30	28	13	-
7	0.7	107	66	27	35	16	13
8	0.7	125	57	23	46	19	14
	1.0	174	84	34			
9	0.7	144	50	21	59	23	15

**ECE R67-01:  
max. 6,7 MPa**

# Brake Tube Coatings Over-View



## Layering Key (example)

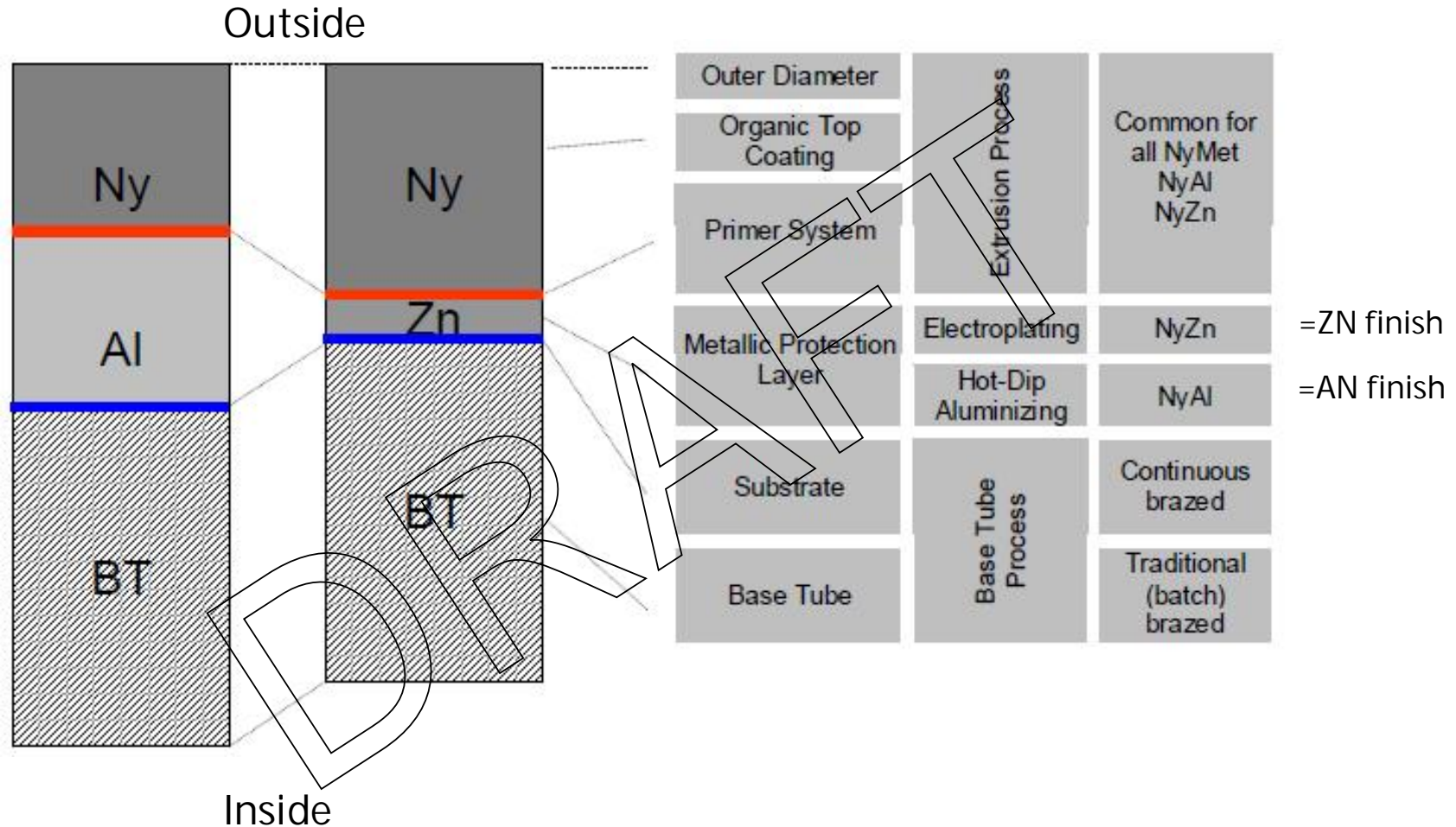
- A. ALUMINUM FOIL (when used)
- B. NYLON
- C. Aluminum Rich Epoxy Paint (E), Electroplated Zinc (Z) or Zinc-aluminum-alloy (G)
- D. STEEL SUBSTRATE



Name	Metallic Protection Layer (C.)	Organic top coating (B.)	Remarks
NyGal	Galfan	Extruded Nylon PA12, PA612 (PA11)	Impl. in the USA since 1998 No introduction in europe planned
NyAl	Aluminum		European Standard
NyZn	Zinc		European Standard



# Process Mapping-Brake lines



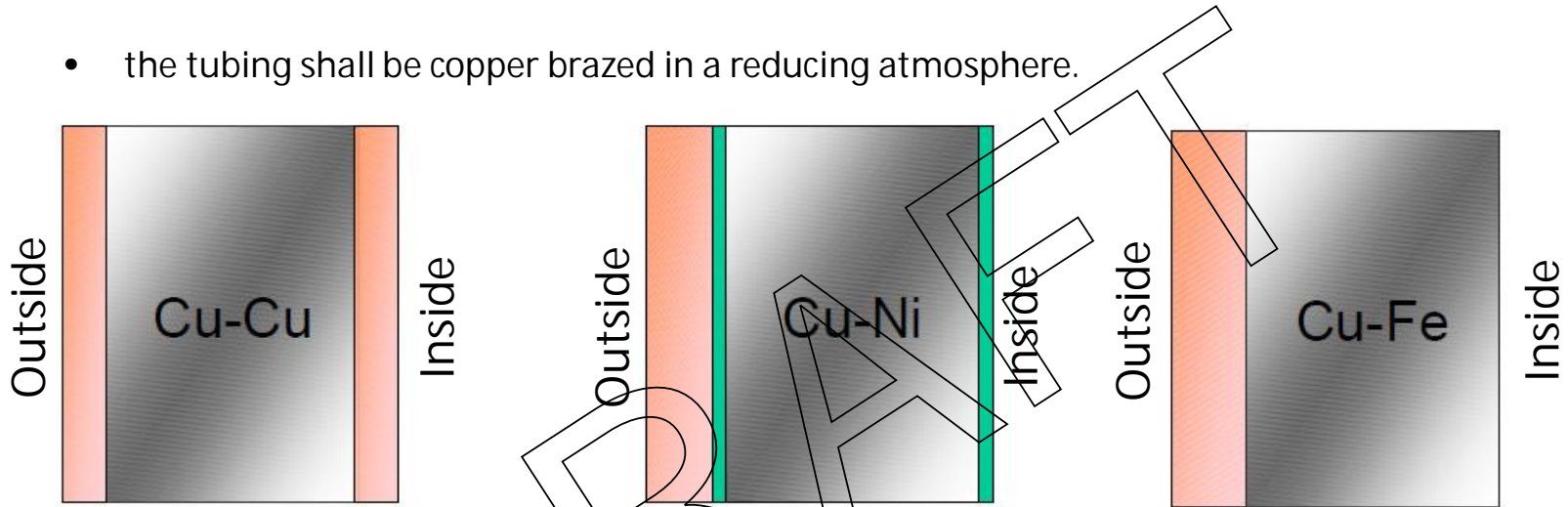
Source: TI automotive





# Manufacturing Process (1) -DW Strip constructs

- Strip (Copper plated steel preferred) is wound in longitudinal direction by rolling-drawing process to a double wall tubing, so that the appropriate processed longitudinal edges of the strip are overlapping.
- the tubing shall be copper brazed in a reducing atmosphere.

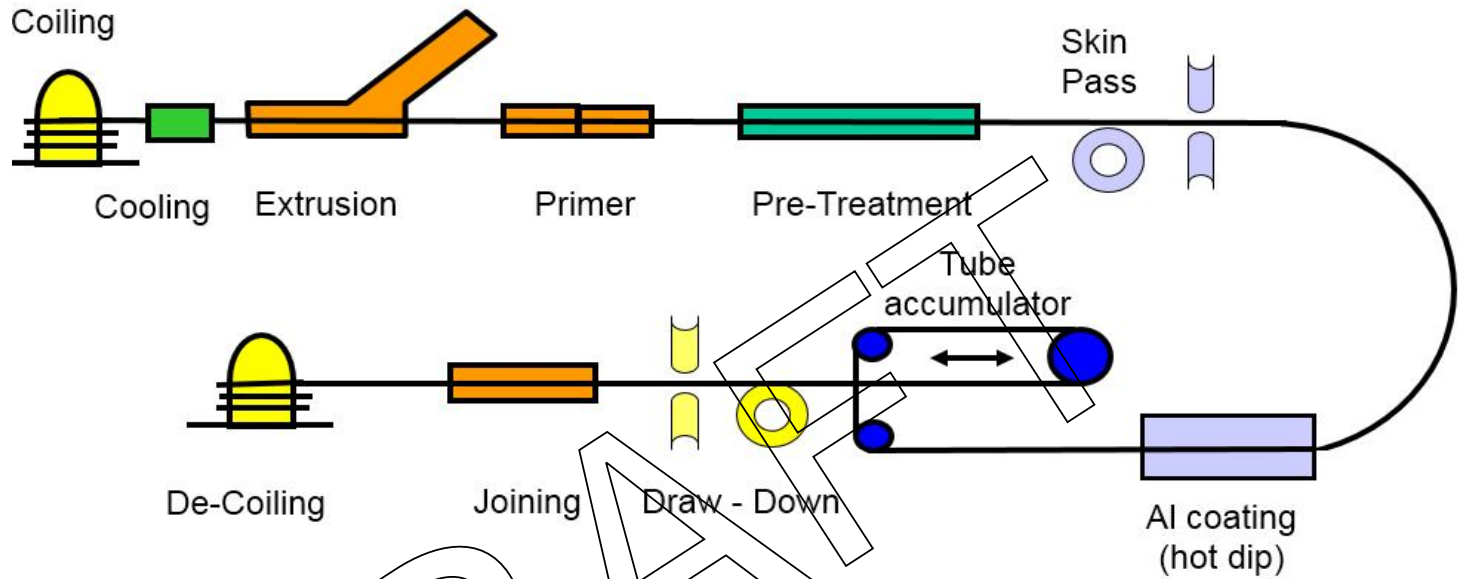


Strip		Base Tube Construct	Steel Thickness:	Substrate	
				Ni	Cu
Ni-Fe	Nickel - Steel	SW Double Wall	0.700	0.50µm	
Fe-Fe	Steel - Steel				
<b>Cu-Fe</b>	<b>Copper - Steel</b>	<b>DW Double Wall</b>	<b>0.345</b>		<b>4.50µm</b>
<b>Cu-Ni</b>	<b>Copper - Nickel</b>			<b>0.50µm</b>	<b>3.00µm</b>
<b>Cu-Cu</b>	<b>Copper - Copper</b>			<b>3.00µm</b>	<b>3.00µm</b>

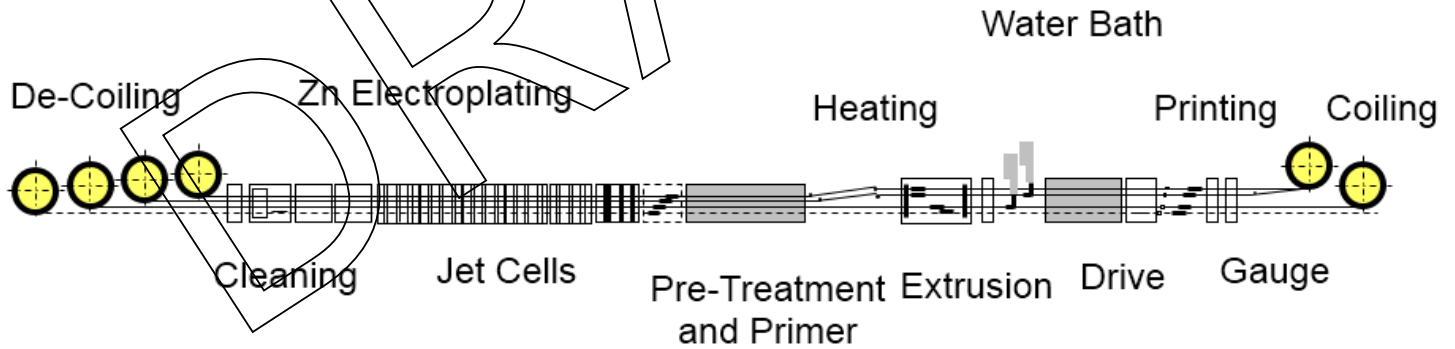
Source: TI automotive

# Manufacturing Process (2)

NyAl



NyZn



Source: TI automotive



GME Engineering



# Quality (GMW 14658) – GM internal requirement

*Automotive steel tubing shall ...*

- be commercially round, smooth and free from rust and defects.
- not exceed outside diameter tolerance
- not interfere with flare forming operation or with the accomplishment of leak-tight coupling joints
- when specific lengths are specified, reasonably straight, and ends shall be free from burrs

*, and...*

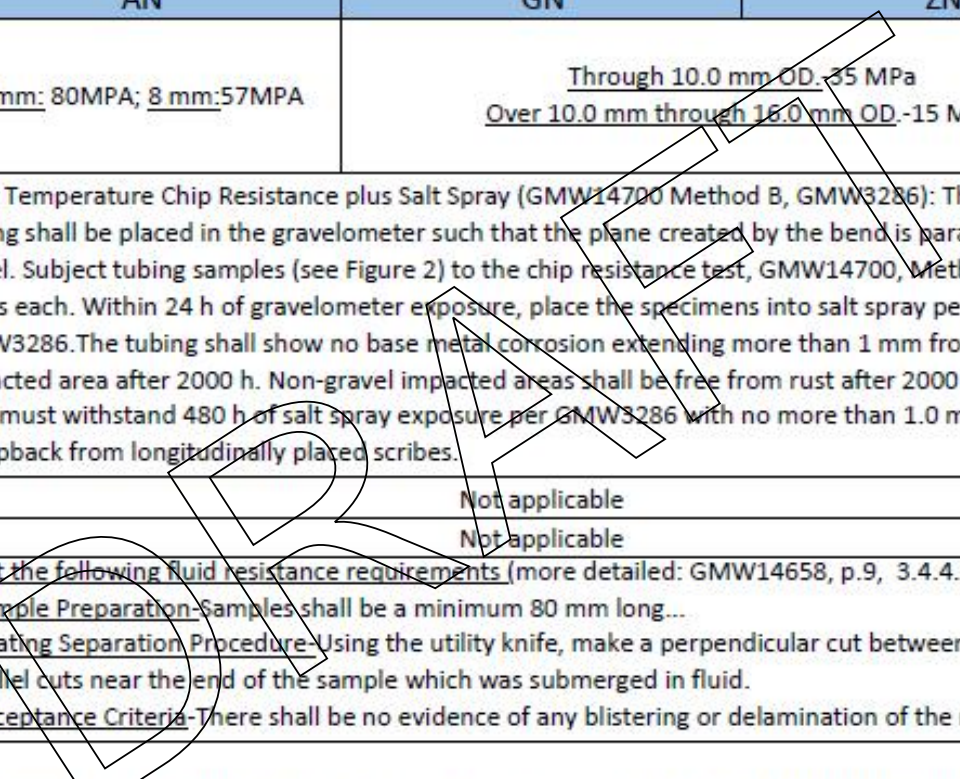
- withstand internal cleanliness conforming to a maximum of 0.20 g per square meter of internal surface, determined by a test.



# Detail of GMW 14658 - Summary of Requirements (1)

*As you can see, the GMW requirements are much higher than the ECE R67-01!*

Requirements	AN	GN	ZN
Burst Pressure	<u>6mm</u> : 80MPa; <u>8 mm</u> :57MPa	Through 10.0 mm OD -35 MPa Over 10.0 mm through 16.0 mm OD -15 Mpa	
Salt Spray	Low Temperature Chip Resistance plus Salt Spray (GMW14700 Method B, GMW3286): The formed tubing shall be placed in the gravelometer such that the plane created by the bend is parallel to the panel. Subject tubing samples (see Figure 2) to the chip resistance test, GMW14700, Method B, five times each. Within 24 h of gravelometer exposure, place the specimens into salt spray per GMW3286. The tubing shall show no base metal corrosion extending more than 1 mm from gravel impacted area after 2000 h. Non-gravel impacted areas shall be free from rust after 2000 h. AY & AN (AY) must withstand 480 h of salt spray exposure per GMW3286 with no more than 1.0 mm of creepback from longitudinally placed scribes.		
Humidity	Not applicable		
Solvent Rub	Not applicable		
Fluid Resistance	meet the following fluid resistance requirements (more detailed: GMW14658, p.9, 3.4.4.2): <ul style="list-style-type: none"> <li>• <u>Sample Preparation</u>-Samples shall be a minimum 80 mm long...</li> <li>• <u>Coating Separation Procedure</u>-Using the utility knife, make a perpendicular cut between the two parallel cuts near the end of the sample which was submerged in fluid.</li> <li>• <u>Acceptance Criteria</u>-There shall be no evidence of any blistering or delamination of the nylon prior to</li> </ul>		
Cleanliness	Wash internally a minimum of 12 m (or several pieces totaling 12 m) of tubing by pouring 100 mL of a 50/50 mixture of hexane and acetone through the tube. Evaporate the solvent in a steam or hot water bath, and dry at 110 °C (230 °F) until the vapors are completely removed. Upon evaporation of the solvent, the remaining residue shall not exceed 0.20 g/m2.		





# Detail of GMW 14658 - Summary of Requirements (2)

As you can see, the GMW requirements are much higher than the ECE R67-01!

Requirements	AN	GN	ZN
Abrasion resistances	Not applicable		
Temperature Resistances	temperature resistance requirements: a. 3 h ± 5 minimum at ± 120 °C ± 3 °C, followed by, b. 1 h ± 5 minimum at +23 °C ± 5 °C, followed by, c. 3 h ± 5 minimum at -30 °C ± 3 °C, followed by, d. 17 h ± 15 minimum at ± 23 °C ± 5 °C. After 5 cycles a section of the tube of 250 mm in length shall be bent through		
Heat Age	a. 120 ± 2 h at +80 ± 3 °C After the test a section of the tube of 250 mm in length shall be bent through 180° over a mandrel with a diameter of 30 mm at +23 ± 5 °C. The plastic coating shall show no flaking or cracks.		
Zinc Chloride resistance	Not applicable		
Cyclic Corrosion	<p>Knife Cut plus Cyclical Corrosion : Using straight tubing with standard fittings, scribe parallel lines, 4 cm long and 2.4 ± 0.1 mm apart, near the center. Within 24 h of scribing, perform cyclical corrosion per GMW14124, Cycle J, 10 cycles (20 weeks). After cycling, the (GN) and (ZN) tubing shall exceed a pressure test of 14 MPa for tubing through 10.0 mm OD or 7 MPa for tubing over 10 mm OD and the (AN) and (AY) tubing shall exceed the burst requirements of Table 2 and Table 4. In order for this test to be valid, there cannot be corrosion from inside out that causes a failure in the pressure test. Therefore, it is recommended that the tube fittings be fastened into a solid block of aluminum, to keep the system closed during exposure.</p> <p>Furthermore, sealing the fittings with a wax is acceptable to keep these parts functional for the pressure test. Results shall be reported with the submission for engineering approval.</p>		



# Request for new topics in R110



- Request from OEM to update the ECE R110 with the following changes on couplings of hoses.

## **Proposal for amendments to Regulation No. 110 (Specific components for CNG)**

The aim of this proposal is to allow Class 0 hoses with couplings using sealing technologies other than with 45° cone.

### **I. Proposal**

*Annex 4B, Paragraph 1.6.2.2., amend to read:*

"1.6.2.2        ~~The sealing cone of swivel nut type shall be of the type with a half vertical angle of 45°.~~ **The interface type for the hose coupling shall be chosen as to comply with the tests described in Paragraph 1.7, as well as tests mentioned in Annexes 5A and 5B.**

**In case of an interface type using a soft seal body (e.g. O ring), the type of material chosen shall be tested in accordance with Annexes 5D, 5F and 5G."**

### **II. Justification**

1. Avoid design restrictive requirements, and have performance oriented regulation.
  2. State of the art: other technologies than metal/metal with 45° cone can provide an adequate level of safety and durability. R110 should allow these technologies, as long as the hose assembly can withstand the impulse test of § 1.7 and tests of Annexes 5A (overpressure test) and 5B (external leakage test).
  3. When using soft seal body (e.g. O ring), the compatibility of the material with use conditions has to be demonstrated. This is done by testing according to Annexes 5D (CNG/LNG compatibility test), Annex 5F (resistance to dry heat) and Annex 5G (ozone ageing).
-

# 2 Sealing concepts for rigid and flexible fluid systems



**O-Ring Face Seal**

**Vs.**

**45 degree conical face**

ENGINEERING YOUR SUCCESS.

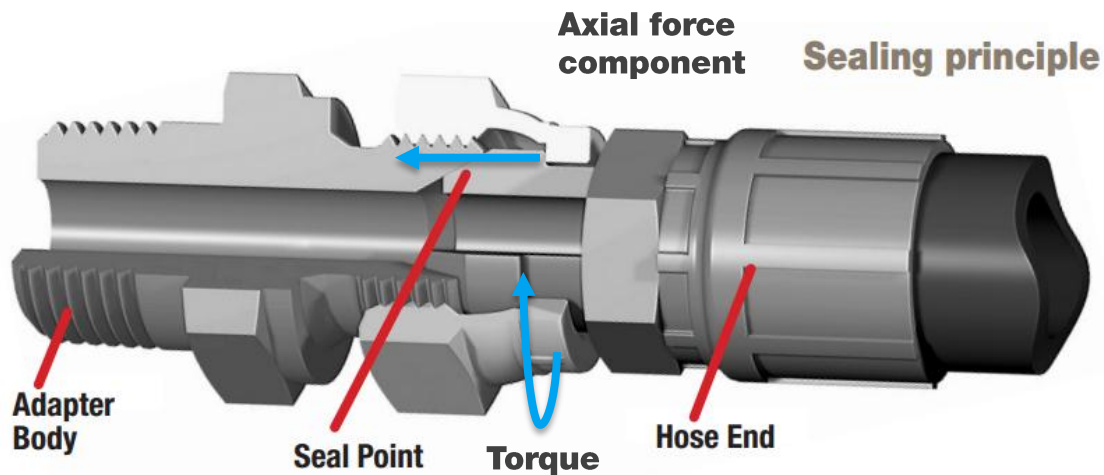


# Metal-to-metal sealing cone

- **For reference:**
  - **Common Metal-to-metal flared fitting standards**
    - ISO 8434-1
    - ISO 8434-2
    - DIN 2353
    - DIN 3861
    - SAE J512
    - SAE J513
    - SAE J514
    - SAE J1949
    - NFPA 54/ANSI. Z223.1

# Metal-to-metal sealing cone

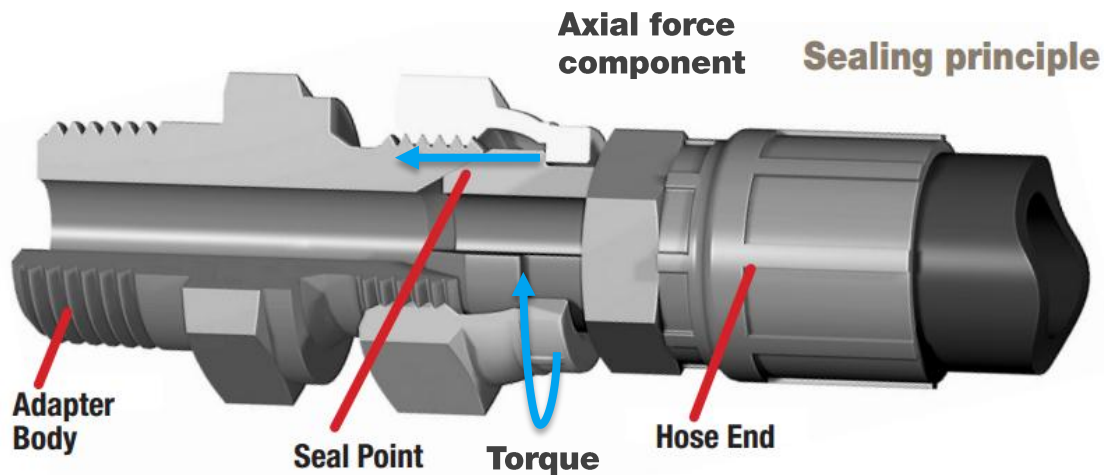
- **Metal-to-metal sealing conical face principle of function:**



- **Nut torque converted into effective stress**
  - **Simplified: Rotational stress + axial stress**

# Metal-to-metal sealing cone

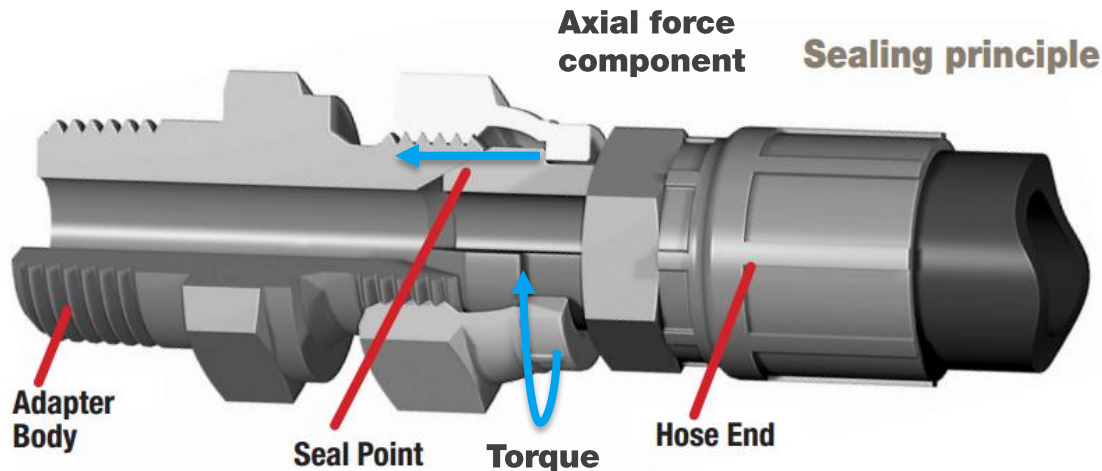
- **Metal-to-metal sealing cone principle of function:**



- Axial stress component acting on thread area exerts axial force on hose/pipe end core
- Axial force applies contact traction on conical face surfaces

# Metal-to-metal sealing cone

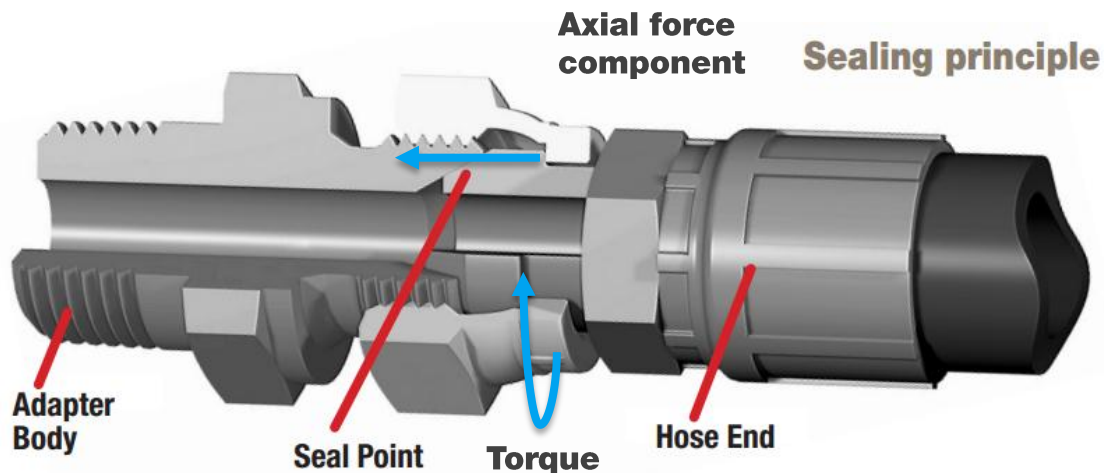
- **Metal-to-metal sealing cone principle of function:**



- **Contact traction causes stress & strain in core**
- **Axial stress to maximum shear stress ratio is depending on core geometry and tribology parameters of the contact.**
- **When nut torque is sufficient, elastic deformation and microplasticization of sealing cone surface occurs, establishing a seal.**

# Metal-to-metal sealing cone

- **Metal-to-metal sealing cone principle of function:**



- **Contact area constitutes a gradual pressure drop as a seal**
- **Flare angle is a trade off between surface contact area, torque range needed and the corresponding material properties needed.**

# Metal-to-metal sealing cone

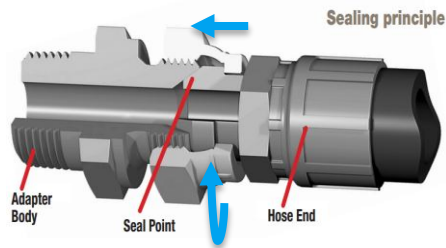
- **Metal-to-metal sealing cone principle of function:**



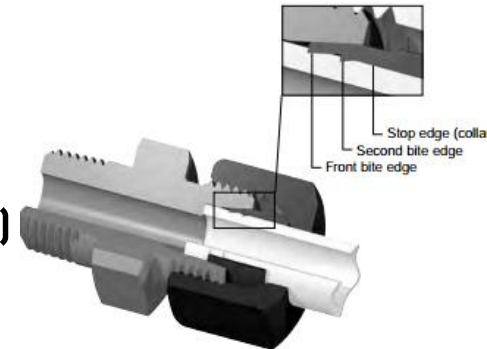
- **Clarification: the “flare angle” or cone angle referred to is generally one of the two depicted above in the example, as displayed on a male adapter part of a coupling.**
- **For some standards the angle is defined as the full angle between faces ( $\alpha$ ), for others as the half angle ( $\beta$ ) (example: JIC 37° versus SAE/ISO 60°).**

# Metal-to-metal sealing cone

- **Metal-to-metal sealing cone principle of function:**

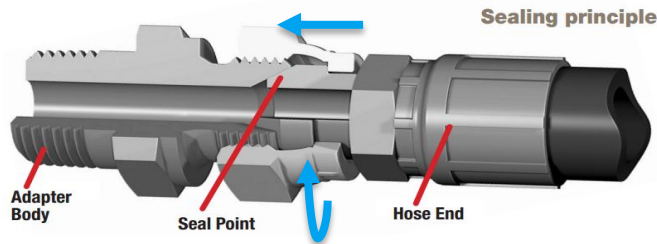


- **Principal methods of achieving the conical face:**
- **Bite-ring type flare on straight tube**
- **Machined solid flares (hose end fittings and port adapters)**
- **Flared tubes and support sleeve**



# Metal-to-metal sealing cone

- **Metal-to-metal sealing cone principle of function:**



- **Sealing cone surface at an angle offers:**
  - **No need for welded pipe joints**
  - **Low tolerance sensitivity for surface roughness if the materials shear- and compression modulus is sufficient.**
  - **Some tolerance to radial movement and vibration**
  - **No need for an elastomer to achieve the seal**
    - **Low cost of manufacturing and assembly**
    - **wide temperature operating range span**
    - **Long shelf life**



# Metal-to-metal sealing cone

- **Metal-to-metal sealing cone principle of function:**
  - **However:**
    - **Hard to control the seal functionality! Why?**
    - **Consider serial assembly environment:**
    - **Principal ways of controlling if a seal is achieved is by:**
      - **Measuring torque – varies with fitting size**
      - **Measuring nut displacement**
      - **Wrench against resistance - very unreliable**
    - **The actual amount of the nut torque that is converted into stress varies greatly with a number of parameters:**
      - **Temperature**
      - **Surface treatment and surface roughness**
      - **Material**
      - **Lubricant, threads... etc. etc.**
      - **Also, torque wrenches are inherently inaccurate ( $\pm \sim 10\%$ )**

# Metal-to-metal sealing cone

- **Metal-to-metal sealing cone principle of function:**
  - The amount of torque on the nut varies with the assembly process!!
  - If a flare fitting is **overtorqued**, the cone will collapse locally, radially towards the centerline of the tube. This means that the corresponding contact area is not under elastic deformation and will no longer provide the required pressure drop to contain the fluid. Depending on the match of components, the tip of the cone can also be pushed into the receiving ends sealing seat, causing damage to the cone tip.
  - If a flare fitting is **undertorqued**, the entire conical face will be under insufficient elastic deformation to provide the required pressure drop to contain the fluid.
  - Typically, the angular displacement of the nut needed to achieve the required preload of the nut is  $\sim 30^\circ$  from when the surfaces are in first contact (“finger tight”). The allowed deviation from this also depends on the above parameters.

# Metal-to-metal sealing cone

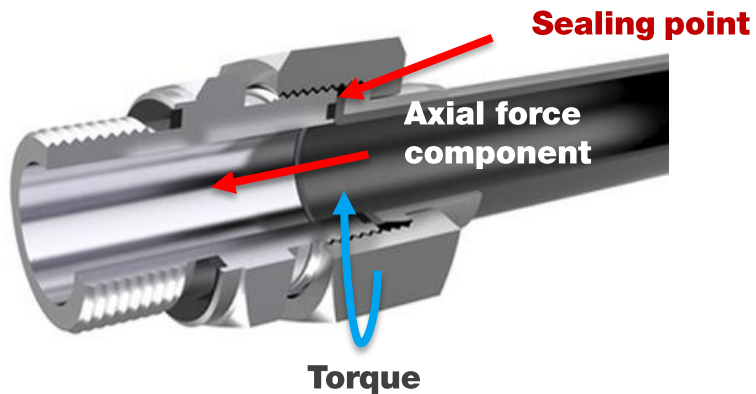
- **Metal-to-metal sealing cone principle of function:**
  - So,
  - The total torque on the nut varies
  - The amount of **that** torque, that goes into **creating stress** in the cone varies ( the needed torque to create the seal ).
  - Is torque wrench a reliable method?
  
  - It is hard to know how much **deviation of angular displacement** that is allowed from the ideal angle (what is the ideal angle?).
  - Even with a zero deviation how much useful torque is converted into stress?
  - How many degrees does “finger tight” vary from case to case?
  - Is ocular estimation of angular displacement a reliable method?

# Metal-to-metal sealing cone

- **Other considerations:**
- **Does the induced stress in a joint hold under operating conditions?**
  - Thermal expansion of the nut and/ or core ( the core is in contact with the fluid).
  - Thermal expansion of the nut can release the traction on the threads.
  - Thermal expansion of the core can induce additional stress risking to exceed plasticization limit of the material.
  - The maximally occurring stress on the cone also depends on the maximally occurring pressure in the system!
  - The maximally allowed shear stress in the cone gets lower with added vibrational cycles.
  - Re-use of a connection can potentially reduce the seal functionality.
  - Re-tightening can be needed after some time of use.
- **NOTE!** There are conical seal versions that include an elastomer seal for the above mentioned reasons. Example Parker E02 ( follows ISO 8434, DIN 2353, DIN3861).

# O-ring Face Seal (ORFS)

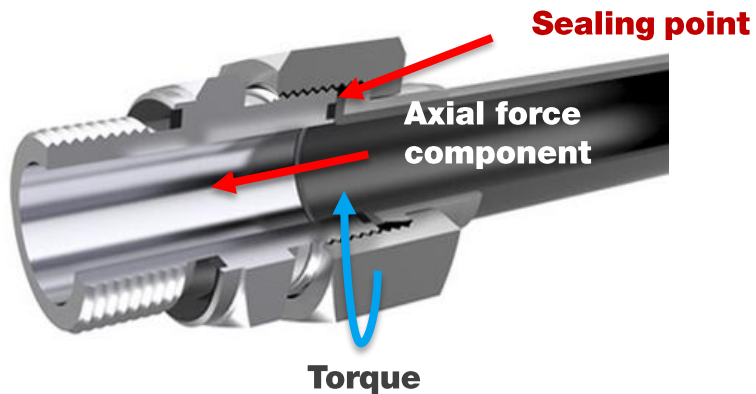
- ORFS principal of function



- Nut torque converted into effective stress
  - Simplified: Rotational stress + axial stress

# O-ring Face Seal (ORFS)

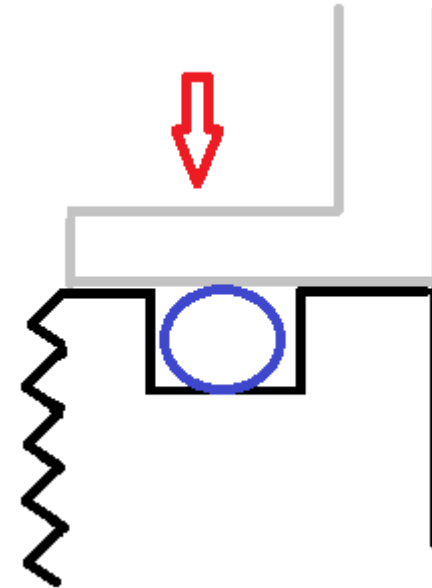
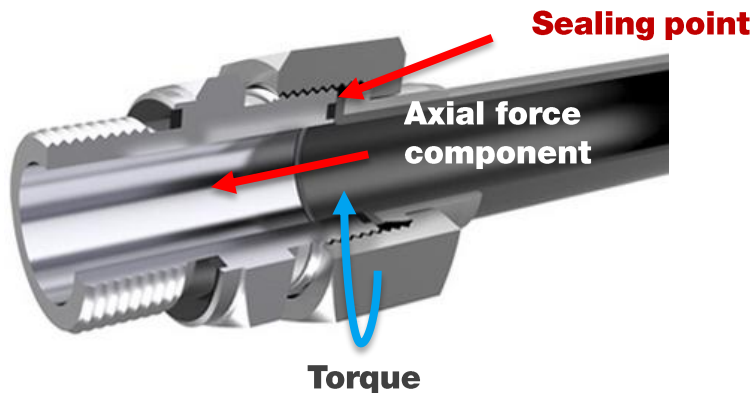
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# O-ring Face Seal (ORFS)

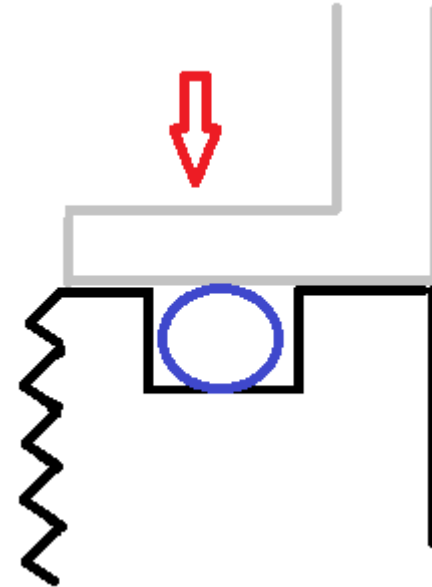
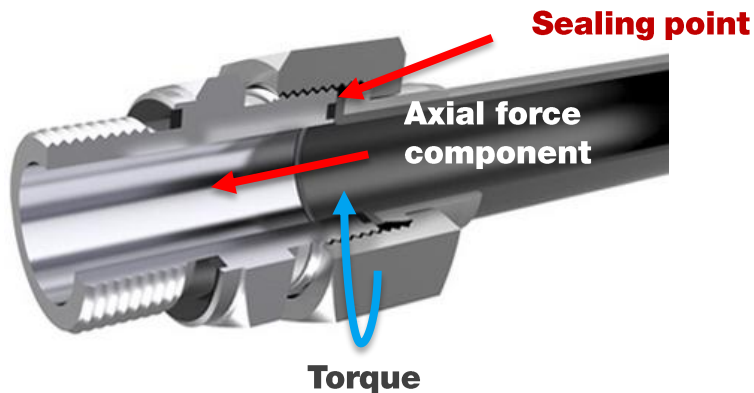
- ORFS principal of function



- Axial stress component acting on thread area exerts axial force on hose/pipe end flare
- Axial force applies contact surface traction on O-ring face surface

# O-ring Face Seal (ORFS)

- ORFS principal of function

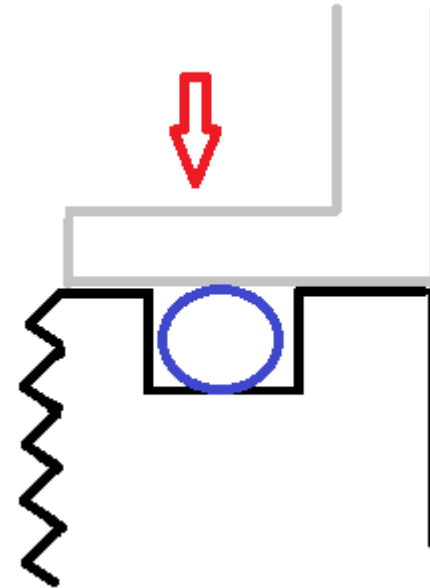
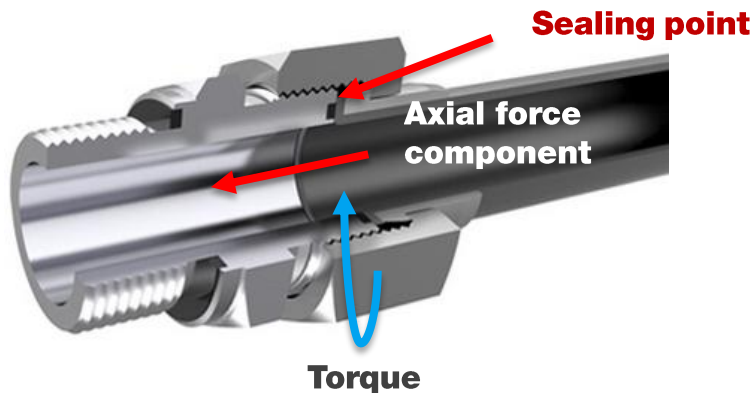


- Principal methods of achieving the flat face (tube end):
- Machined solid flat face (hose end fittings and port adapters)
- Cold formed tubes plus support sleeve



# O-ring Face Seal (ORFS)

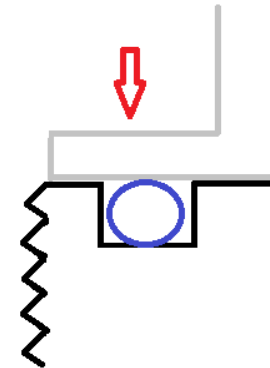
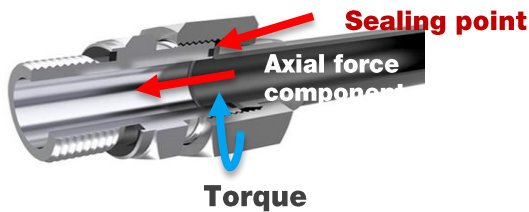
- ORFS principal of function



- When a threshold amount of torque is applied, there is contact between the faces, the o-ring is in hydrostatic stress mode, establishing a seal.
- Additional torque effectively only loads the threads and locks the nut further, without affecting the level of hydrostatic stress (pressure) on the seal body.

# O-ring Face Seal (ORFS)

- ORFS principal of function

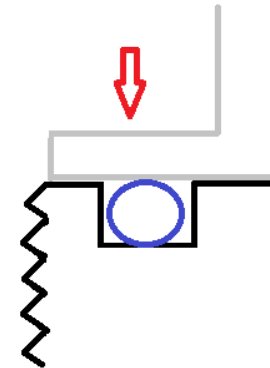
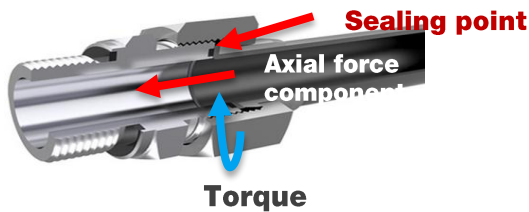


- O-Ring Face Seal offers:

- No need for welded pipe joints
- Very good tolerance to radial movement and vibration
- Due to compressive stress state and close to plane stress condition in the tube flat face, the maximal occurring shear stress is low.
- This means it is very hard to overtorque an ORFS fitting! If extreme amounts of torque is applied the threads will come off before anything else breaks.
- Use enough torque and/or pull to stop -> functional seal!

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- ORFS principal of function

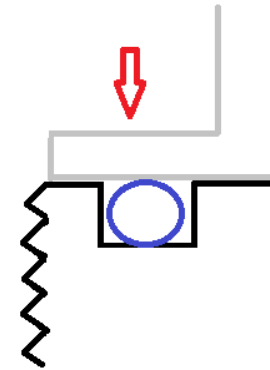
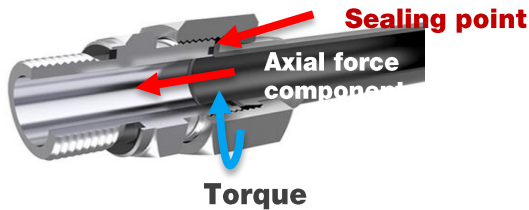


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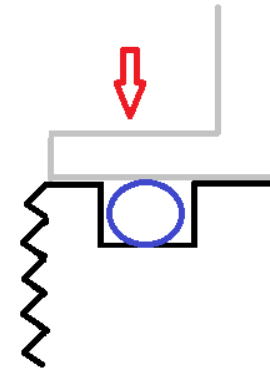
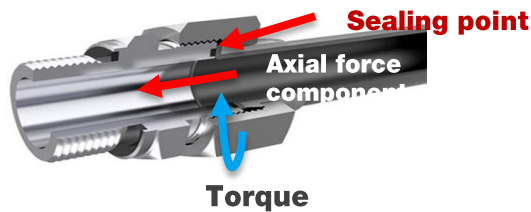


- However:

- Important to use ORFS with CORG (Captive O-ring Groove) in order to avoid loosening or damaging of the O-rings during assembly. (this is not included in the standard)!
- Elastomer needed to achieve the seal
  - Operating temperature span depends on elastomer, as well as media compatability

# O-ring Face Seal (ORFS)

- ORFS principal of function

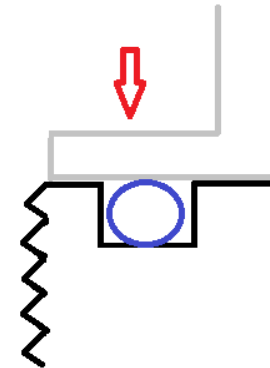
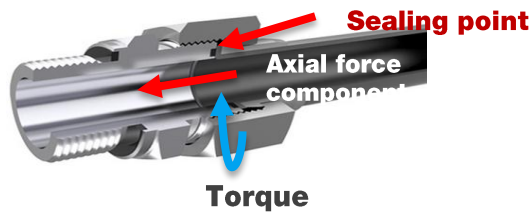


- However:

- Not suitable for use in cryogenic conditions, due to elastomer behavior under extremely low temperatures.
- For systems with extreme pressure transients, it is important to use an elastomer that is able to withstand explosive decompression.

# O-ring Face Seal (ORFS)

- ORFS principal of function



- However:

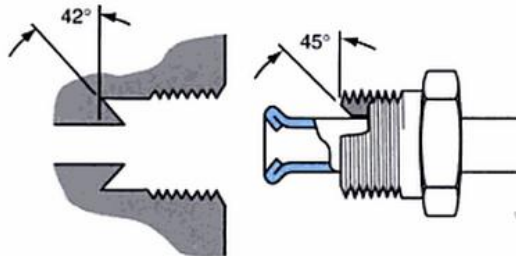
- Parker ORFS fittings can be ordered with a proprietary FKM compound (VG109) that is tested both for CNG use, Biodiesel and that has a proven field performance in high pressure transient systems and a temperature range of -45 to + 200 degrees.

# O-ring Face Seal (ORFS)

- **Other considerations:**
- **Does the induced stress in a joint hold under operating conditions?**
  - Thermal expansion of the nut and/ or core ( the core is in contact with the fluid).
  - Thermal expansion of the nut can release the traction on the threads, but if the nut is sufficiently loaded this will not be a problem.
  - Thermal expansion of the core cannot induce enough stress risking to exceed plasticization limit of the material.
  - The maximally occurring stress on the threads also depends on the maximally occurring pressure in the system.
  - The maximally allowed shear stress in the fitting or hose coupling gets lower with added vibrational cycles, however the total effective stress in the material is significantly lower than in a flare fitting.
  - Re-use of a connection does not potentially reduce the seal functionality, as long as the O-ring is not damaged.
  - Re-tightening is generally not needed if enough torque is applied at first fit.

## Relation to ECE R110

- ECE R110 states that a 45 degree flare has to be used.
  - There are 2 common areas of use for 45 degree flare fittings SAE J512/513:
    - Automotive air/oil brake systems
      - Usually require a double flare:



A1 3/8 x 24 UNF  
common American  
nut with 45 degree  
double flare on  
3/16"/4.75MM dia.  
tube



M5 10 x 1.0mm  
common Asian nut  
with 45 degree double  
flare on  
3/16"/4.75MM dia.  
tube

- Normally used with spherical tube ends or corresponding male conical surfaces.



## Relation to ECE R110

- **Refrigeration/gas systems ( Typically low-medium pressure brass fittings), SAE J513**
- **The standard for these 2 fittings and the corresponding standards for piping and complete fuel lines allow for different pressure classes.**
- **However, there is no industry practice to manufacture these fittings for high pressures, as they are generally produced for low pressure systems for specific markets.**
- **The industry practice for high pressure lines (up to ~300 bar working pressure) on mobile equipment tend to be 37 and 24 degrees as well as ORFS instead. For high pressure fuel lines 60 degree flare and spherical tube end is widely used.**

## Relation to ECE R110

- So, there are a number of different standards (different angles) which employ the same basic principle, demonstrably capable of handling much higher pressures than most 45 degree fittings are designed for.
- Metal-to-metal seal type of fitting systems **for flexible fuel lines** are limited to only 45 degree flares under ECE R110, but there is no major difference in the principle of function between different metal-to-metal fittings with different angles. Also, 45 degree fittings with double flare dictates softer and thinner tubing to be able to cold form the double flare.
- Exception: 60 degree high pressure fuel lines, where the spherical tube end forms a circular “line” seal surface to the cone, and where the hardness of the tube is required to be less than that of the fitting.

## Relation to ECE R110

- **CNG system designs are changing to require higher pressures**
- **Metal-to-metal seal fittings share a number of drawbacks that ORFS fittings do not.**
- **There are possibilities to overcome the limitation on ORFS fittings, provided that the right elastomer is used, and the O-ring is protected from loss or damage (CORG).**

## Relation to ECE R110

- Flexible fuel lines usually incorporate a hose fitting that is a machined or cold formed solid, which follows a tube fitting standard.
- There is no widespread industry practice in manufacturing high pressure 45 degree flare metal-to-metal hose fittings. Also, the standards usually only describes rigid tubing requirements.
- ORFS fittings are allowed under ECE R110 **for rigid fuel lines**, and **have a proven track record for high pressure gas systems**, but is disqualified from use in flexible fuel lines.

## Suggested conclusions

- **There is no apparent reason to specifically require 45 degree flare or cone for a flexible fuel line coupling, as long as the functional criteria of the sealing point are met.**
- **The 45 degree angle requirement disqualifies a number of capable fitting types that are currently available, while it dictates a type of fitting that is not currently and generally available for high pressure systems.**

## Suggested conclusions

- **There is no limitation on the fitting type or technology used for rigid fuel components. This is ambiguous since:**
  - **The coupling type only constitutes the manner in which the seal is accomplished between fuel lines.**
  - **If the flexible fuel line meets the requirements for mobile use (e.g. pressure, flexibility, temperature, swivel function etc), there is no apparent reason for excluding a sealing point method. Furthermore, more common high pressure fitting types which are usually used with hoses have been verified for use with both flexible lines ( i.e. fleximpulse tests), as well as tubes.**

- **We would like to ask:**
  - **In the light of the discussion above, for a vehicle level approval, would it be possible to judge the total functionality of a fuel line or fitting type, regardless of the current 45 degree criterium?**
  - **Are there any inarticulate reasons as to why 45 degrees is specified as a flare angle, and thereby why metal-to-metal sealing is required under ECE R110 for flexible fuel lines, not explicitly listed in the document?**

# Errors in current regulation 110



- **Part 7.1 ....of paragraphs 8.12 to 8.21. of .....**
  - Of paragraphs 8.12 to 8.22. of.....
- **Part 8.1.1. electromagnetic compatibility (EMC) requirements according to Regulation No. 10, 03 series of amendments, or equivalent.**
  - Current version of ECE R10 is **revision 5**
- **Annex 4A: double definition for class 1:**
  - 4.2.2. The pressure relief valve and pressure relief device of **Class 1** shall be so designed as to be leak-proof at a pressure of 1.5 times the working pressure (MPa) with the outlet closed off (see Annex 5B).
  - 4.2.3. The pressure relief valve of **Class 1** and Class 2 shall be so designed as to be leak-proof at twice the working pressure with the outlets closed off.



# Errors in current regulation 110

- 18.6.1.2. The automatic valve shall be operated such that the fuel supply is cut off when the engine is switched off, irrespective of the position of the ignition switch, and shall remain closed while the engine is not running. A delay of **2** seconds is permitted for diagnostic.
- Annex 4H
- 2.2. The switching off delay of the automatic valve after stalling of the engine may not be more than **5** seconds.

Thank you for your attention!



Questions?



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