PIPE JOINING TECHNIQUES FOR THE ATLAS AND CMS TRACKER UPGRADES

Pipe joining, new options to be investigated

Swagelok VCR

- Swagelok VCR, combined with orbital welding has given by far the most reliable results
- Limitations:
- Smallest fitting is for 1/8” OD pipe
- Biggest fitting is for 1” OD pipe
- Orbital welding generally perfect for 1 mm wall, lowest limit around 0.5 mm but not easy.

Standard Flanges

- Interesting for diameters above max. VCR size
- Available in DIN, ANSI or B10 dimensions
- Applicable pressure ratings are:
  - PN160 - 160 bar
  - Class 900 – 2100 psi – 145 bar
  - Table T – 2800 psi – 190 bar
- Outside diameter of flanges 184 – 216 mm for DN50
- Space consumption generally too much for our installations

Flange dimensions

Flange Table

Nominal Size 50mm (2 in)

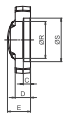
		Diameter of flange	Bolt circle number	Number of bolts	Diameter of bolts	Diameter of holes	Diameter of raised face	Height of raised face	Thickness of flange		
									Grey cast iron	Copper alloy	Cast and forged steel
BS 4504	PN 6	140	110	4	M12	14	90	3	10	-	-
	PN 10	165	125	4	M16	18	102	3	20	-	-
	PN 16	165	125	4	M16	18	102	3	20	11	20
	PN 25	165	125	4	M16	18	102	3	22	11	20
	PN 40	165	125	4	M16	18	102	3	-	13	20
	PN 64	180	135	4	M20	22	102	3		-	26
	PN 100	195	145	4	M24	26	102	3	-	-	30
	PN 160	195	145	4	M24	26	102	3	-	-	30
	PN 250	200	150	8	M24	26	102	3	-	-	38
ANSI	Class 125/150	152	121	4	16	19	92	2	16	13	(16
	Class 300	165	127	8	16	19	92	2	-	19	(22
	Class 600	165	127	8	16	19	92	6	-	-	2
	Class 900	216	165	8	22	25	92	6	-	-	38
	Class 1 500	216	165	8	22	25	92	6	-	-	38
BS 10	Table A	152	114	4	16	17	-	-	16	10	-
	Table D	152	114	4	16	17	-	-	17	10	14
	Table E	152	114	4	16	17	-	-	19	10	14
	Table F	165	127	4	16	17	-	-	19	11	16
	Table H	165	127	4	16	17	102	2	125	13	19
	Table J	165	127	4	19	22	102	2	-	25	25
	Table K	165	127	8	16	17	102	2	-	25	25
	Table R	165	127	8	18	17	102	2	-	-	25
	Table S	171	133	8	19	22	89	2	-	-	32
	Table T	184	146	8	19	22	102	2	-	-	35

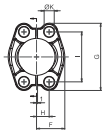
SAE Flanges

- Used for high pressure hydraulics 3000 & 6000 PSI series
- Normally sealed with O-ring, not suitable for CO2
- Copper gaskets from CF flanges can fit
- Gasket calculations show that the 6000 PSI series can operate with a MWP of >130 bar
- Several design options possible
- Parts are ordered, testing is foreseen

SAE Flanges

SAE Split Flange Halves
DB





Order Codes

★ Pair of SAE Split Flange Halves	DB-__
★ Including Metric bolts 8.8, spring rings, O-ring made of NBR (Buna-N®) (packed in kits)	DB-__-M-B#K
★ Including Metric bolts 10.9, spring rings, O-ring made of NBR (Buna-N®) (packed in kits)	DB-__-MH-B#K
★ Including UNC bolts (Gr10), spring rings, O-ring made of NBR (Buna-N®) (packed in kits)	DB-__-U-B#K

Material S355J0 / C45 or equivalent
Surface CrVI-free
Special Material Stainless Steel 1.4404 "-W5" on request

3000 PSI Standard Pressure Series (according to ISO 6162-1)

PN (bar)[1] 8.8 Bolts	10.9 (MH) Bolts	Nominal Size DN	(in)	Order Codes	Dimensions (mm) ØR	ØS	C	D	E	F	G	H	I	Ø K[2]	for Bolts Metr.	UNC
350	350	13	1/2	**DB-301**	24,3	31	6,2	13	19	22,8	54	8,75	38,1	8,7	M8x25	5/16–18 UNC x 1-1/4
350	350	19	3/4	**DB-302**	32,2	38,9	6,2	14	22	25,9	65	11,15	47,6	10,5	M10x30	3/8–16 UNC x 1-1/4
250	315	25	1	**DB-303**	38,5	45,3	7,5	16	24	29,2	70	13,1	52,4	10,5	M10x30	3/8–16 UNC x 1-1/4
200	250	32	1-1/4	**DB-304-U**	43,7	51,6	7,5	14	24	36,3	79,5	15,1	58,7	12		7/16–14 UNC x 1-1/2
200	250	32	1-1/4	**DB-304-M12**	43,7	51,6	7,5	14	24	36,3	79,5	15,1	58,7	12,5	M12x35	
200	250	32	1-1/4	**DB-304-M**	43,7	51,6	7,5	14	24	36,3	79,5	15,1	58,7	10,5	M10x30	
200	200	38	1-1/2	**DB-305**	50,8	61,1	7,5	16	25	41,1	94	17,85	69,9	13,5	M12x35	1/2–13 UNC x 1-1/2
200	200	38	1-1/2	**DB-305-M14**	50,8	61,1	7,5	16	25	41,1	94	17,85	69,9	14,5	M14x35	
160	200	51	2	**DB-306**	62,8	72,3	9	16	26	48,2	102	21,45	77,8	13,5	M12x35	1/2–13 UNC x 1-1/2
160	200	51	2	**DB-306-M14**	62,8	72,3	9	16	26	48,2	102	21,45	77,8	14,5	M14x35	
100	160	64	2-1/2	**DB-307**	74,9	84,9	9	19	38	54,1	114,5	25,4	88,9	13,5	M12x40	1/2–13 UNC x 1-1/2
100	160	64	2-1/2	**DB-307-M14**	74,9	84,9	9	19	38	54,1	114,5	25,4	88,9	14,5	M14x40	
100	160	76	3	**DB-308**	90,9	102,4	9	22	41	65,3	135	30,95	106,4	17	M16x50	5/8–11 UNC x 2
35	35	89	3-1/2	**DB-309**	102,4	115,1	10,7	22	28	69,6	152	34,95	120,7	17	M16x50	5/8–11 UNC x 2
35	35	102	4	**DB-310**	115	127,8	10,7	25	35	75,9	162	38,9	130,2	17	M16x50	5/8–11 UNC x 2
35	35	127	5	**DB-311**	140,5	153,2	10,7	28	41	90,4	184	46,05	152,4	17	M16x55	5/8–11 UNC x 2

6000 PSI High Pressure Series (according to ISO 6162-2)

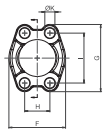
PN (bar)[1] 8.8 Bolts	10.9 (MH) Bolts	Nominal Size DN	(in)	Order Codes	Dimensions (mm) ØR	ØS	C	D	E	F	G	H	I	Ø K[2]	for Bolts Metr.	UNC
350	400	13	1/2	**DB-601**	24,6	32,5	7,2	16	22	23,6	56,5	9,10	40,5	8,7	M8x30	5/16–18 UNC x 1-1/4
350	400	19	3/4	**DB-602**	32,5	42,0	8,2	19	28	30,0	71,0	11,90	50,8	10,5	M10x35	3/8–16 UNC x 1-1/2
350	400	25	1	**DB-603-U**	38,8	48,4	9,0	24	33	34,8	81,0	13,90	57,2	11,9		7/16–14 UNC x 1-3/4
350	400	25	1	**DB-603-M**	38,8	48,4	9,0	24	33	34,8	81,0	13,90	57,2	13,0	M12x45	
350	400	32	1-1/4	**DB-604**	44,5	54,8	9,8	27	38	38,6	95,0	15,90	66,6	13,5	M12x45	1/2–13 UNC x 1-3/4
350	400	32	1-1/4	**DB-604-M14**	44,5	54,8	9,8	27	38	38,6	95,0	15,90	66,6	15,0	M14x45	
350	400	38	1-1/2	**DB-605**	51,6	64,3	12,0	30	43	47,5	113,0	18,25	79,3	17,0	M16x55	5/8–11 UNC x 2
350	400	51	2	**DB-606**	67,6	80,2	12,0	37	52	56,9	133,0	22,25	96,8	21,0	M20x70	3/4–10 UNC x 2-1/2

[1] The maximum working pressure applies only to the flange itself and depends on the bolts used (Grade 8.8 / 10.9). The actual maximum working pressure depends on the thickness and the quality of the tube used.
[2] Dimensions of screw holes in part different to the ISO to match both Metric and UNC screws.

SAE Flange Clamp
BM

Order Codes

★ SAE Flange Clamp	BM-__
★ Including Metric bolts 8.8, spring rings, O-ring made of NBR (Buna-N®) (packed in kits)	BM-__-M-B#K
★ Including Metric bolts 10.9, spring rings, O-ring made of NBR (Buna-N®) (packed in kits)	BM-__-MH-B#K
★ Including UNC bolts (Gr10), spring rings, O-ring made of NBR (Buna-N®) (packed in kits)	BM-__-U-B#K



Material S355J0 / C45 or equivalent
Surface CrVI-free
Special Material Stainless Steel 1.4404 "-W5" on request

3000 PSI Standard Pressure Series (according to ISO 6162-1)

PN (bar)[1] 8.8 Bolts	10.9 (MH) Bolts	Nominal Size DN	(in)	Order Codes	Dimensions (mm) ØR	ØS	C	D	E	F	G	H	I	Ø K[2]	for Bolts Metr.	UNC
350	350	13	1/2	**BM-301**	24,3	31	6,2	13	19	46	54	17,5	38,1	8,7	M8x25	5/16–18 UNC x 1-1/4
350	350	19	3/4	**BM-302**	32,2	38,9	6,2	14	22	52	65	22,3	47,6	10,5	M10x30	3/8–16 UNC x 1-1/4
250	315	25	1	**BM-303**	38,5	45,3	7,5	16	24	59	70	26,2	52,4	10,5	M10x30	3/8–16 UNC x 1-1/4
200	250	32	1-1/4	**BM-304-U**	43,7	51,6	7,5	14	24	73	79,5	30,2	58,7	12		7/16–14 UNC x 1-1/2
200	250	32	1-1/4	**BM-304-M12**	43,7	51,6	7,5	14	24	73	79,5	30,2	58,7	12,5	M12x35	
200	250	32	1-1/4	**BM-304-M**	43,7	51,6	7,5	14	24	73	79,5	30,2	58,7	10,5	M10x30	
200	200	38	1-1/2	**BM-305**	50,8	61,1	7,5	16	25	83	94	35,7	69,9	13,5	M12x35	1/2–13 UNC x 1-1/2
200	200	38	1-1/2	**BM-305-M14**	50,8	61,1	7,5	16	25	83	94	35,7	69,9	14,5	M14x35	
160	200	51	2	**BM-306**	62,8	72,3	9	16	26	97	102	42,9	77,8	13,5	M12x35	1/2–13 UNC x 1-1/2
160	200	51	2	**BM-306-M14**	62,8	72,3	9	16	26	97	102	42,9	77,8	14,5	M14x35	
100	160	64	2-1/2	**BM-307**	74,9	84,9	9	19	38	109	114,5	50,8	88,9	13,5	M12x40	1/2–13 UNC x 1-1/2
100	160	64	2-1/2	**BM-307-M14**	74,9	84,9	9	19	38	109	114,5	50,8	88,9	14,5	M14x40	
100	160	76	3	**BM-308**	90,9	102,4	9	22	41	131	135	61,9	106,4	17	M16x50	5/8–11 UNC x 2
35	35	89	3-1/2	**BM-309**	102,4	115,1	10,7	22	28	140	152	69,9	120,7	17	M16x50	5/8–11 UNC x 2
35	35	102	4	**BM-310**	115,0	127,8	10,7	25	35	152	162	77,8	130,2	17	M16x50	5/8–11 UNC x 2
35	35	127	5	**BM-311**	140,5	153,2	10,7	28	41	181	184	92,1	152,4	17	M16x55	5/8–11 UNC x 2

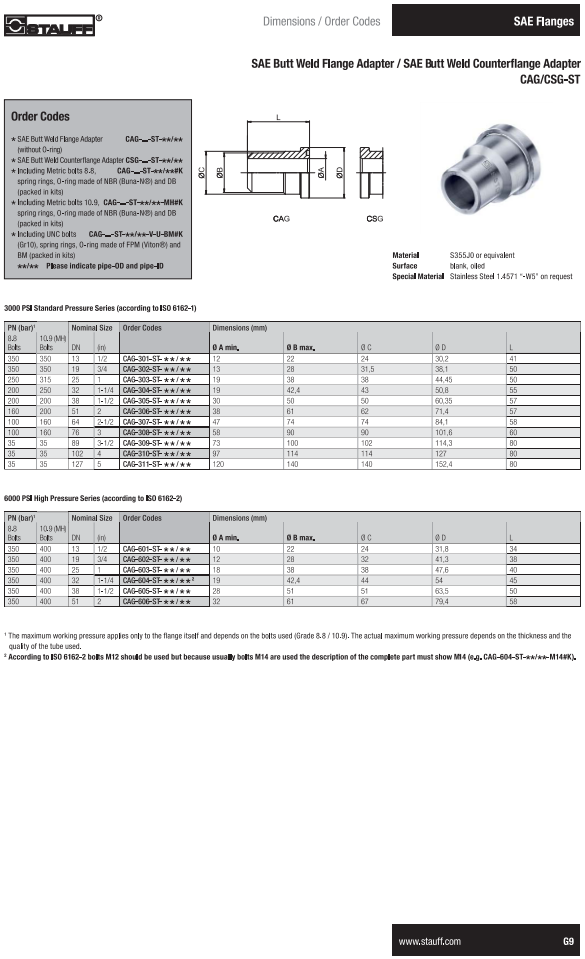
6000 PSI High Pressure Series (according to ISO 6162-2)

PN (bar)[1] 8.8 Bolts	10.9 (MH) Bolts	Nominal Size DN	(in)	Order Codes	Dimensions (mm) ØR	ØS	C	D	E	F	G	H	I	Ø K[2]	for Bolts Metr.	UNC
350	400	13	1/2	**BM-601**	24,6	32,5	7,2	16	22	48	56,5	18,2	40,5	8,7	M 8x30	5/16–18 UNC x 1-1/4
350	400	19	3/4	**BM-602**	32,5	42	8,2	19	28	60	71	23,8	50,8	10,5	M 10x35	3/8–16 UNC x 1-1/2
350	400	25	1	**BM-603-U**	38,8	48,4	9	24	33	70	81	27,8	57,2	12		7/16–14 UNC x 1-3/4
350	400	25	1	**BM-603-M**	38,8	48,4	9	24	33	70	81	27,8	57,2	13	M 12x45	
350	400	32	1-1/4	**BM-604**	44,5	54,8	9,8	27	38	78	95	31,8	66,6	13,5	M 12x45	1/2–13 UNC x 1-3/4
350	400	32	1-1/4	**BM-604-M14**	44,5	54,8	9,8	27	38	78	95	31,8	66,6	15	M 14x45	
350	400	38	1-1/2	**BM-605**	51,6	64,3	12	30	43	95	113	36,5	79,3	17	M 16x55	5/8–11 UNC x 2
350	400	51	2	**BM-606**	67,6	80,2	12	37	52	114	133	44,5	96,8	21	M 20x70	3/4–10 UNC x 2-1/2

[1] The maximum working pressure applies only to the flange itself and depends on the bolts used (Grade 8.8 / 10.9). The actual maximum working pressure depends on the thickness and the quality of the tube used.
[2] Dimensions of screw holes in part different to the ISO to match both Metric and UNC screws.

G Flanges

SAE Flanges, adapter



STAUFF®

Dimensions / Order Codes — **SAE Flanges**

SAE Butt Weld Flange Adapter / SAE Butt Weld Counterflange Adapter
CAG/CSG-ST

Order Codes

- ★ SAE Butt Weld Flange Adapter (without O-ring) **CAG-...-ST-★★/★★**
- ★ SAE Butt Weld Counterflange Adapter **CSG-...-ST-★★/★★**
- ★ Including Metric bolts 8.8, spring rings, O-ring made of NBR (Buna-N®) and DB (packed in kits) **CAG-...-ST-★★/★★HK**
- ★ Including Metric bolts 10.9, spring rings, O-ring made of NBR (Buna-N®) and DB (packed in kits) **CAG-...-ST-★★/★★-MHHK**
- ★ Including UNC bolts (Gr10), spring rings, O-ring made of FPM (Viton®) and BM (packed in kits) **CAG-...-ST-★★/★★-V-U-BMHK**

★★/★★ **Please indicate pipe-OD and pipe-ID**

Material S355J0 or equivalent
Surface blank, oiled
Special Material Stainless Steel 1.4571 "-W5" on request

3000 PSI Standard Pressure Series (according to ISO 6162-1)

PN (bar)[1] 8.8 Bolts	10.9 (MH) Bolts	Nominal Size DN	(in)	Order Codes	Dimensions (mm) Ø A min.	Ø B max.	Ø C	Ø D	L
350	350	13	1/2	CAG-301-ST-★★/★★	12	22	24	30,2	41
350	350	19	3/4	CAG-302-ST-★★/★★	13	28	31,5	38,1	50
250	315	25	1	CAG-303-ST-★★/★★	19	38	38	44,45	50
200	250	32	1-1/4	CAG-304-ST-★★/★★	19	42,4	43	50,8	55
200	200	38	1-1/2	CAG-305-ST-★★/★★	30	50	50	60,35	57
160	200	51	2	CAG-306-ST-★★/★★	38	61	62	71,4	57
100	160	64	2-1/2	CAG-307-ST-★★/★★	47	74	74	84,1	58
100	160	76	3	CAG-308-ST-★★/★★	58	90	90	101,6	60
35	35	89	3-1/2	CAG-309-ST-★★/★★	73	100	102	114,3	80
35	35	102	4	CAG-310-ST-★★/★★	97	114	114	127	80
35	35	127	5	CAG-311-ST-★★/★★	120	140	140	152,4	80

6000 PSI High Pressure Series (according to ISO 6162-2)

PN (bar)[1] 8.8 Bolts	10.9 (MH) Bolts	Nominal Size DN	(in)	Order Codes	Dimensions (mm) Ø A min.	Ø B max.	Ø C	Ø D	L
350	400	13	1/2	CAG-601-ST-★★/★★	10	22	24	31,8	34
350	400	19	3/4	CAG-602-ST-★★/★★	12	28	32	41,3	38
350	400	25	1	CAG-603-ST-★★/★★	18	38	38	47,6	40
350	400	32	1-1/4	CAG-604-ST-★★/★★[2]	19	42,4	44	54	45
350	400	38	1-1/2	CAG-605-ST-★★/★★	28	51	51	63,5	50
350	400	51	2	CAG-606-ST-★★/★★	32	61	67	79,4	58

[1] The maximum working pressure applies only to the flange itself and depends on the bolts used (Grade 8.8 / 10.9). The actual maximum working pressure depends on the thickness and the quality of the tube used.
[2] According to ISO 6162-2 bolts M12 should be used but because usually bolts M14 are used the description of the complete part must show M14 (e.g. CAG-604-ST-★★/★★-M14HK).

G Flanges

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Compact Flanges

Vector SPO Compact Flange

HOME > HIGH INTEGRITY CONNECTORS > HIGH INTEGRITY COMPACT FLANGES > VECTOR SPO COMPACT FLANGE

Save weight, space, time and money !

The Vector SPO Compact Flange has been used across the globe since 1989, offshore, onshore and subsea, offering significant weight and space savings over conventional flanges, leak-free joint integrity and therefore is the most effective environmentally friendly piping joint available today.Its double sealing action prevents hydrocarbon releases, addressing health and safety issues and concerns.

Typically weighing between 70 - 82% less than a conventional flange, the Vector SPO Compact Flange is designed using state-of-the-art finite element analysis and is in full accordance with ASME VIII, Div 2 provisions and with ANSI/ASME B31.3.

Compact Flanges

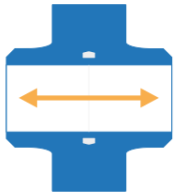
Benefits

Size & Weight

The Vector SPO Compact flange is an up to 60% smaller and 80% lighter proven alternative to conventional ASME flanges.

Static connection

No relative flange movement of SPO components even under extreme loads.The only flange that meets the strict design requirements in DNV-OS-F201 and ISO 13628-7.



Fully flush bore

The faces have full contact at the internal bore. There is no discontinuity which can disturb the flow.

Suitable for HPHT applications

Suitable for high pressure (available up to 20,000psi) or extreme temperature requirements

Compact Flanges

- Described in the NORSOK standard
- Are used in oil and gas industry
- Important size reduction
- Could be interesting for larger diameters
- Needs further investigation

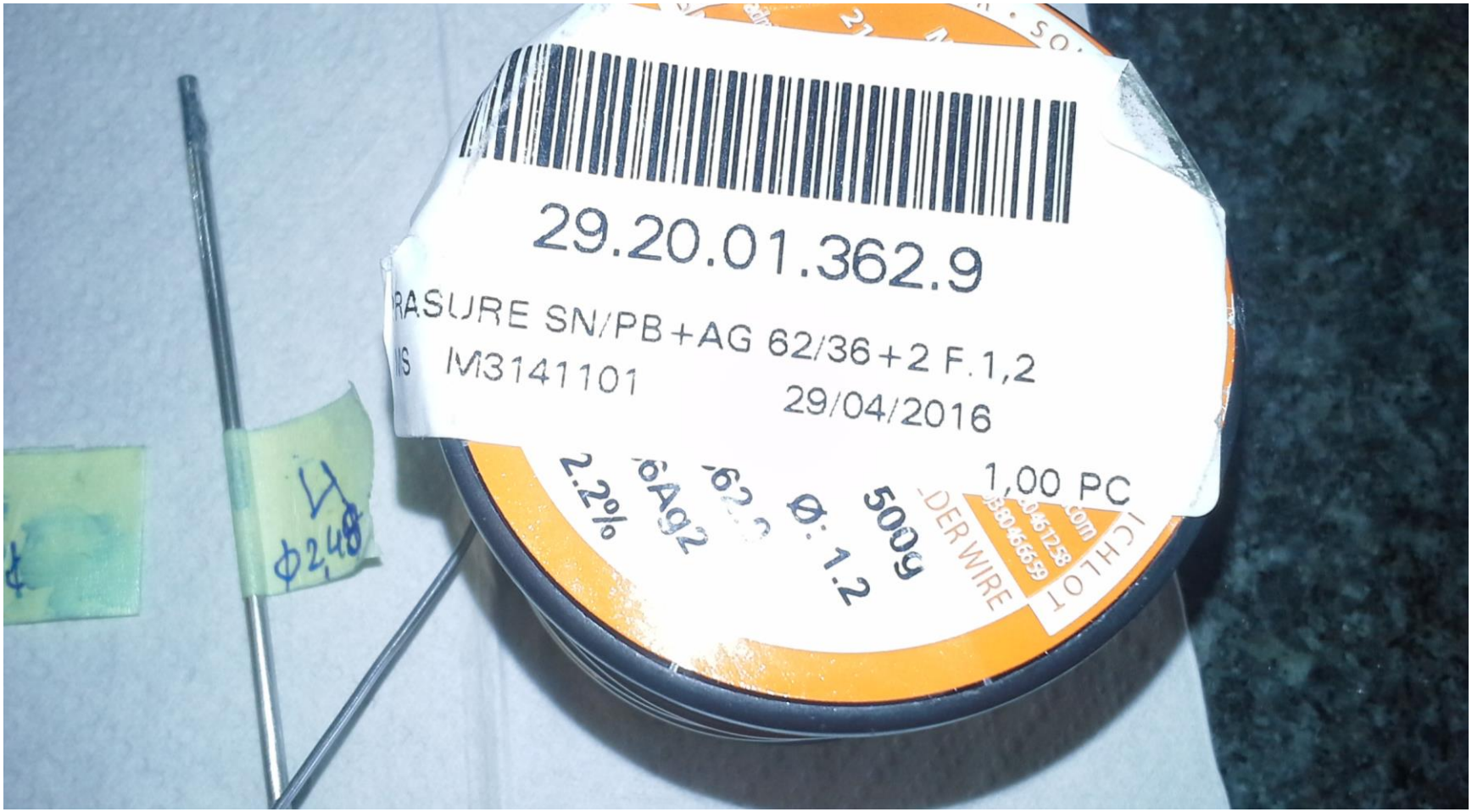
Soft soldered joints, why

- Brazing is not easy and cannot be used during detector installation
- Same applies to laser welding
- Soft soldering widely used during TOB construction, was very easy and proved to be fully reliable.
- TOB used only copper-nickel tube and brass connector pieces

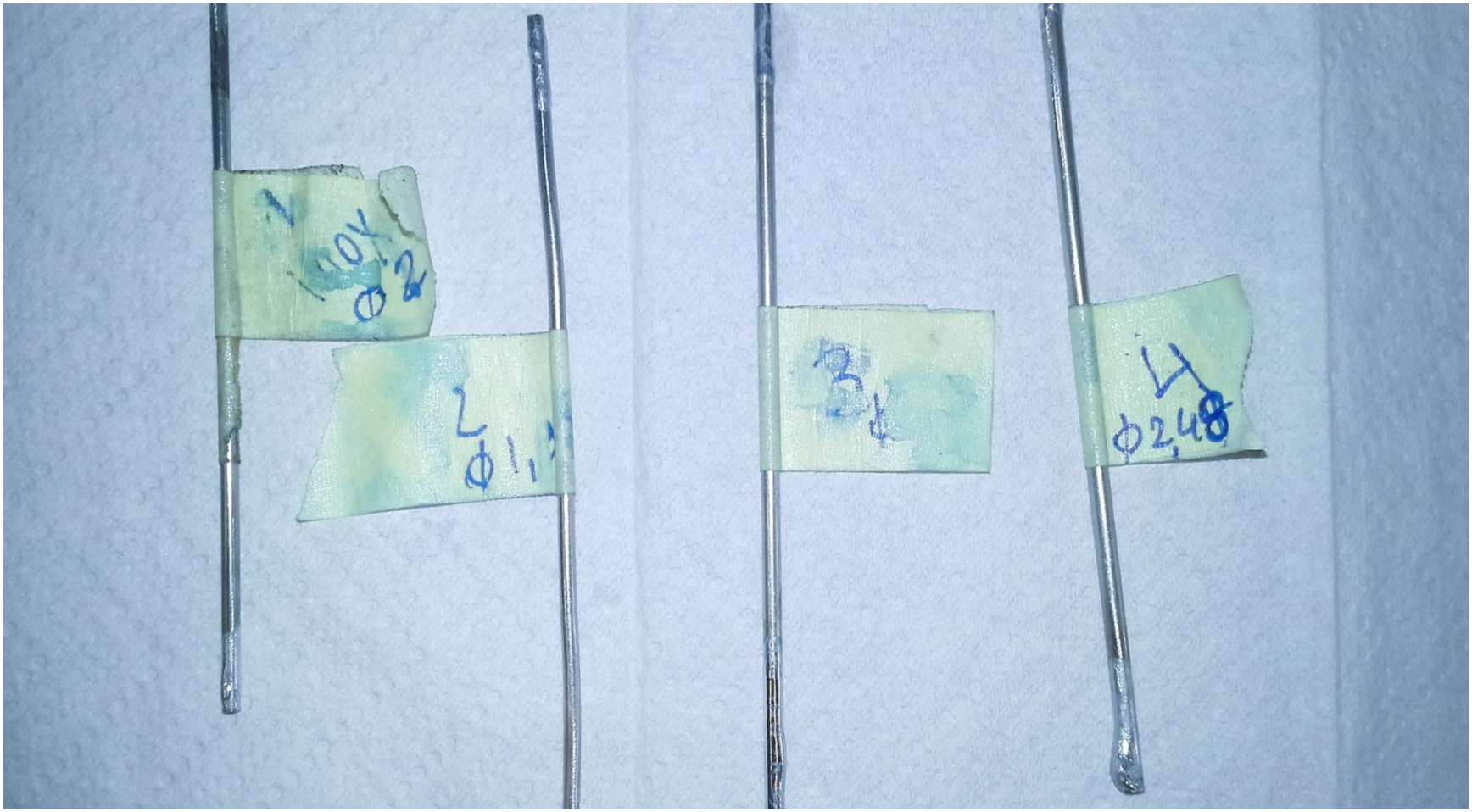
Soft soldered joints

- VCR connectors only in stainless steel
- Stainless steel tubing might be advantageous in CO2 systems (higher pressures than TOB)
- Soft soldering on SST is not easy but possible
- Strength of solder joint can be easily achieved for small tubes, 2-3 mm diameter
- Creep strength might be an issue but seems feasible (further investigation needed)
- A first batch of samples was produced and tested

Soft soldered joints



Soft soldered joints



Soft soldered joints

Soft soldered joints

- Parts were first “plated” with solder, then assembled without flux
- This method mimics installation where cleaning afterwards is not possible
- “Plating” is not yet a clean and practical operation, further development needed
- Best traction test showed 2000 N
  - Comparable to shear strength of some solders
  - Compared to shear force of 30 N @ 100 bar

Conclusions

- Several open issues in CO2 pipe connections
- SAE flanges can cover the range of DN25 to DN50
- Compact flanges available up to very large diameters
- Investigations have started, more is needed
- Looking for people with experience in soft soldering of stainless steel