

COMRADE Workshop 4- 5.12.2018

New "Linning" in Tanks on Ringhals AB



2018-11-23

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- From the beginning, the life time for rubber lining was decided to 30 years
- As early as the beginning of the 2000s was the rubber a drain tank for active water from different systems (Liquide waste processing system on R1 265 m²), in poor condition
- Vulcanization of natural rubber was not easy to implement because of high temperature was required for vulcanization (90°C)
- Instead of natural rubber, Ringhals chose butyl rubber for rubber lining (The product's commercial name is Chemoline 4CN).
- **CHEMOLINE 4 CN** is an already vulcanised black soft rubber lining based on Bromobutyl rubber (BIIR), which is equipped with an easy to bond, reactive bonding layer. **CHEMOLINE 4 CN** can be loaded directly without further vulcanisation.
- **CHEMOLINE 4 CN** is bonded on steel or concrete components by using the primer system **PRIMER PR 304** in combination with the adhesive system **CEMENT BC 3004** with 4% **HARDENER E 40**.
- Ringhals have very good experience after repair in 2010

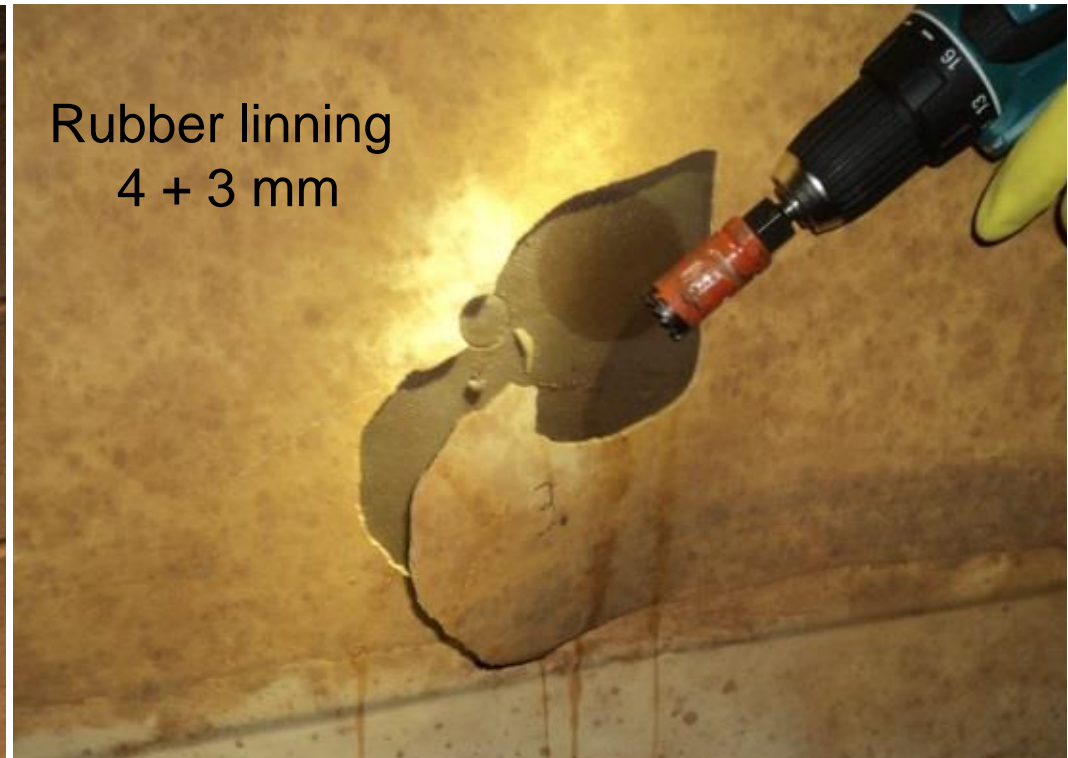
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- Unfortunately, this solution has not been easy to use with replacement of rubber lining in tanks with deionized or deionized and deaerated processwater.



Bubbles in rubber lining

There were loose particles from the rubberized surface when the surface is sanded with grind paper



Poor adhesion

- The problem is the requirement for water chemistry and for rubber lining:

Ämne	Urlakningshastighet (mg/dm ² dygn)
Cl	mindre än 0,01
F	"- 0,01
SO ₄	"- 0,01
PO ₄	"- 0,01
SiO ₂	"- 0,001
Σ anjoner	"- 0,02
Fe	"- 0,0005
Cu	"- 0,0005
Pb	"- 0,0005
Zn	"- 0,005
Ca	"- 0,005
Al	"- 0,005
Mg	"- 0,005
Σ katjoner	"- 0,02
Suspenderat material inkl. kolloider	0,5

Värdena ovan gäller vid lakning i totalavsaltat vatten, 20°C och skakbord.

Content of:
Halogens ≤ 4ppm
Heavy metals ≤ 5ppm
In rubber lining

- Comprehensive leaching tests of **CHEMOLINE 4 CN** have been done without acceptable results according to Vattenfalls or Framatoms requirements
- Framatoms requirements are similar Vattenfalls but leaching is done at 60°C
- Another product **Kerabutyl V3** has also been tested
- Kerabutyl V3 is vulcanized two-ply soft rubber lining based on butyl rubber (IR)
- The KERABUTYL-V3-rubber lining system is composed of the single-component Keratex-Primer, a three-component adhesive BS or alternatively methylene chloride-free Kerabond adhesive and the KERABUTYL-V3-rubber sheet
- Even in this case comprehensive leaching tests of **Kerabutyl V3** have been done without acceptable results according to Vattenfalls or Framatoms requirements.
- In both cases the leaching content of sulfates, silicon, calcium, iron, zinc and lead was not acceptable even after many attempts to replace water

- The conclusion was that these products can not be used for exchange of rubber in tanks, except for minor repairs in tanks with ion exchange cleaner, because the water chemistry requirements could not be met.
- A new suggestion was to replace rubber with a ceramic epoxy painting **ARC SD4i** from Chesterton
- A study visit was made at the BWR reactor Brunswick there 2 Condensate storage tanks were renovated with Chesterton ARC SD4i 2007 respectively 2008. No problem with water chemistry or corrosion after
- **ARC SD4i** consists of:
 - **base material** - Selected blend of fine ceramic particles designed to achieve resistance to erosion and corrosion
 - **binder** - a two-component modified epoxy with an aliphatic amine hardener
- This time, leakage tests were acceptable in relation to set requirements

- Outage 2017 painting RWST R4
- Outage 2018 painting RWST R3
- The result shows that the water quality in the tanks has improved silicon and sulphates. Chlorides and fluorides and metals are just like before painting constant low while the concentration of organic acids appears to be higher than before repair during periods without cleaning via ion exchange (perhaps depending of residues after blasting. All lackable pollutants are kept at a low level and clearly within the requirements of chemical specifications using ion exchange treatment before and after outage.

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Inside area about
500 m²

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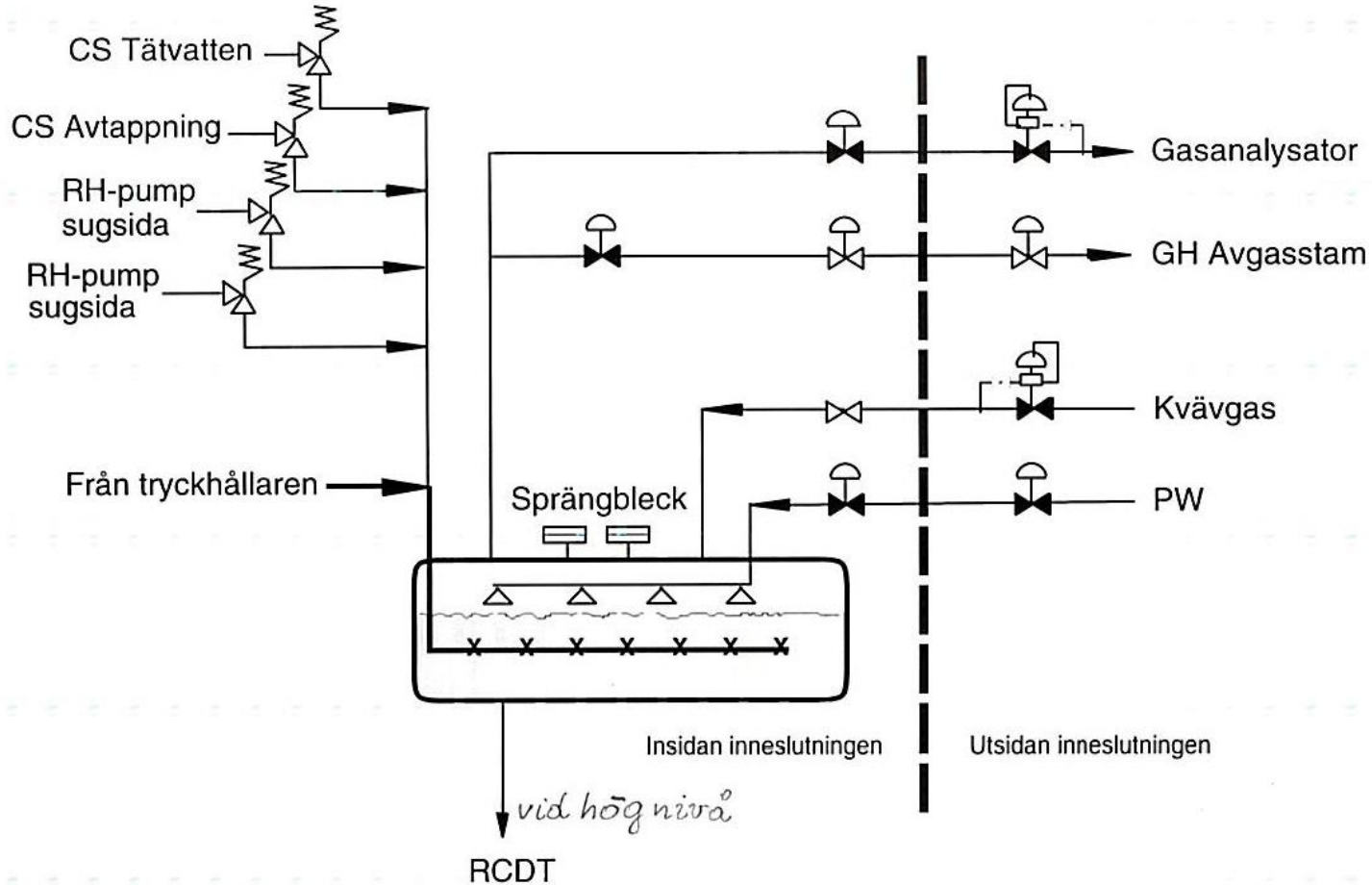
Ringhals AB – Environmental Qualification of Isolation Valves on PWR



2018-11-29

- During the work on environmental qualification, a number of residual points have been identified.
- For some isolation valves, of the type membrane valves, the question about membrane in the valves could be considered fulfilling its function according to environmental qualification requirements
- The reason is they contain polymeric materials that can be sensitive to gamma radiation and temperature in a long-term (6 month) accident scenario.
- *Each line that is connected to a closed system inside the containment is provided with at least one containment isolation valve located outside the containment. For lines normally in operation, it is an automatic valve or is capable of remote manual operation. For lines normally shut, it is a locked closed valve.*
- On Ringhals is two valves on each line, one inside of containment and one outside of containment.

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Figur 1.8 Avblåsningstanken med anslutningar

hand valve

pneumatic

own media controlled

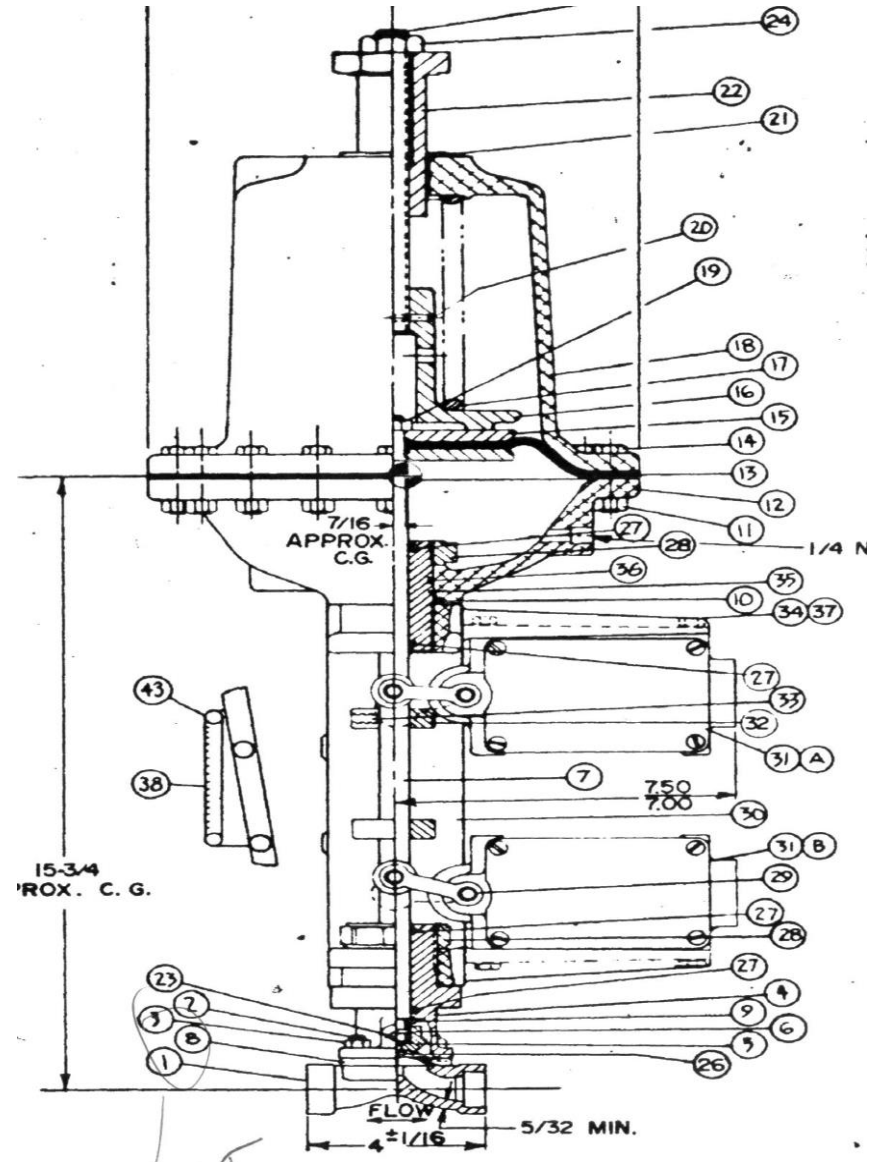
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System-position	Typ/Ritning/ Fabrikat	Slaglängd (nominell)	Cykler/år (uppskattat)	Membran (diaphragm)	Mtrl- nummer (RAB/ Leverantör)	UH instruktion/ UH intervall
30/40 313- 8093A	SD-C-102864 Grinell (AOV) 3/4" DA92R	9,5 mm	40	E.P.T (EPDM)	8432791/ 2471-10M	1745017/3.0 12 år
30/40 342- 7105	SD-C-102857 Grinell (AOV) 3/8"	9,5 mm	20	E.P.T (EPDM)	8432791/ 2471-10M	1745017/3.0 12 år
30/40 342-7109	SD-C-102863 Grinell (AOV) 3/4" DA62R	9,5 mm	20	E.P.T (EPDM)	8432791/ 2471-10M	1745017/3.0 12 år
30/40 342- LCV1003	SD-C-100598 Grinell (AOV) 3"DA92R	41 mm	50	E.P.T (EPDM)	8432452/ 1277	1745020/3.0 12 år
30/40 345-2254	NC 0091 Siers (AOV) 3"DA72RF	32 mm	20-30	Natural rubber (NR)	8844870/ NC-0091-7	2177512/3.0 12 år
30/40 735-4104	NC 0090 Siers (manual) 4"X72DP	-	1-20	Natural rubber (NR)	8844912/ NC-0090-7	2163207/4.0 12 år
30/40-735 4109	NC 0088 Siers (manual) 2"X72DP	-	1-20	Natural rubber (NR)	8844979 /NC-0083-7	1919983/4.0 12 år

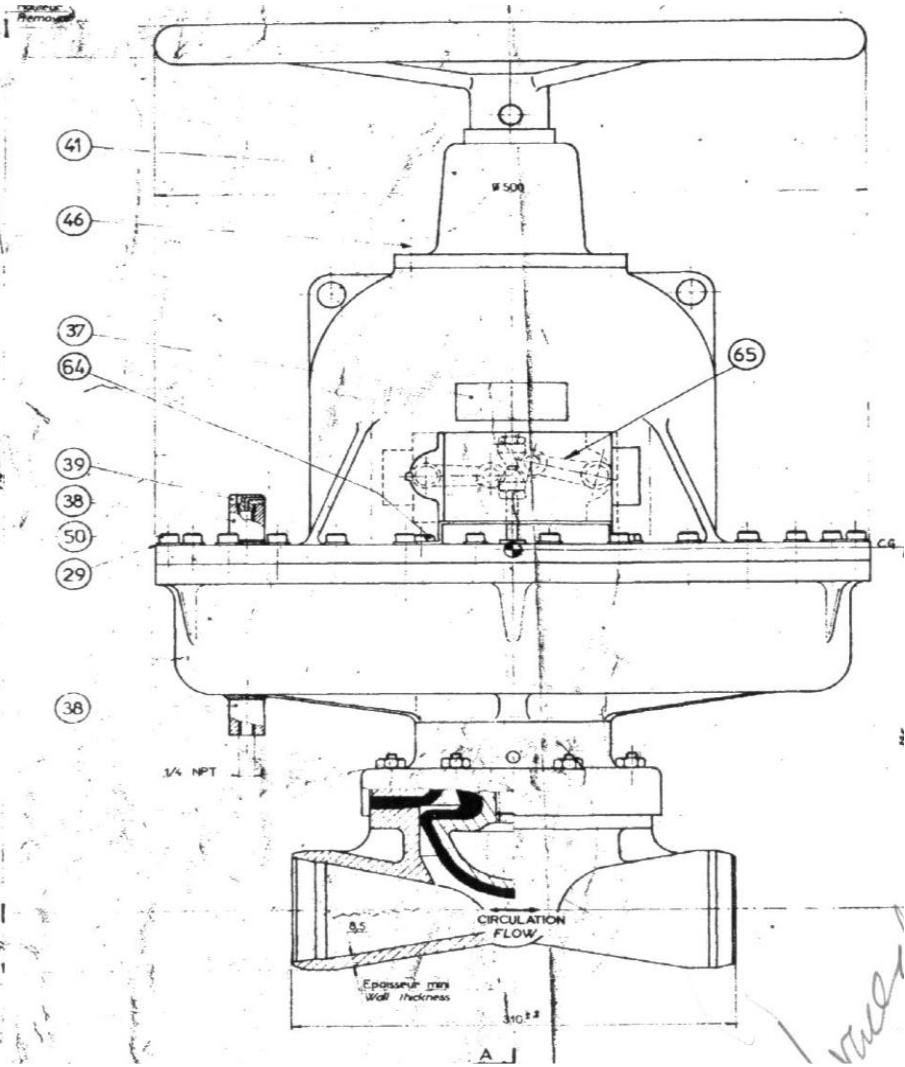
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Pneumatic valve, F.C, closes with spring force when the air is released.
membrane "E.P.T" = EPDM

EPT



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NR

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Environmental qualification shall be made as follows:

- accelerated thermal aging for scheduled operating time
- accelerated irradiation aging for scheduled operating time and accident scenario time
- thermal aging for accident scenario time

The evaluation will be based on

- tensile testing and extension before break
- hardness testing
- visual inspection

The main criterion is: tensile strength must not be significantly worse than 50% of the tensile strength in comparison to an unused membrane

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Prov	Id	Beskrivning	Antal	Simulerad miljö		Behandlingsmiljö (enl Arrhenius)		Värmeåldring start	Värmeåldring klar	Strålning		
				År	Temp	Tid [timmar]	Temp			Stråldos [kGy]	Strålrat [Gy/h]	Tid [dagar]
Siers	1	Referens	2									
	2	EP154, 6 års drift	2	6	55	3450	90	2018-10-08 10:15	2018-12-20 16:30	264	500	22
	3	Realistisk, Endast radiologisk	2							240	500	20
	4	Realistisk full haveridos	2	6	40	1827	80	2018-10-05 13:30	2018-12-20 16:30	240	500	20
	5	Realistisk, halv haveridos	2	6	40	1827	80	2018-10-05 13:30	2018-12-20 16:30	120	500	10
Grinell	1	Referens	2									
	2	EP154, 12 års drift	2	12	55	1323	115	2018-10-05 12:20	2018-11-29 15:20	264	500	22
	3	Realistisk, Endast radiologisk	2							240	500	20
	4	Realistisk, 6 år drift	2	6	40	1827	80	2018-10-05 13:30	2018-12-20 16:30	120	500	10
	5	Realistisk, 12 års drift	2	12	40	1770	90	2018-10-08 10:15	2018-12-21 04:15	240	500	20
KSB/Sisto	1	Referens	2									
	2	Realistisk, 6 år drift	2	6	40	1827	80	2018-10-05 13:30	2018-12-20 16:30	120	500	10
	3	Realistisk, 12 års drift	2	12	40	1770	90	2018-10-08 10:15	2018-12-21 04:15	240	500	20
	4	EP154, motsv 12 år	2	12	55	1323	115	2018-10-05 12:20	2018-11-29 15:20	264	500	22
	5	EP154, motsv 12 år endast termiskt	1	12	55	1323	115	2018-10-05 12:20	2018-11-29 15:20			
Siers ut anläggninge	1	Endast dragprov	1									

EP 154 (conservative interpretation of environmental conditions in case of accident)

- 150 °C, 0–10 minutes
- 140 °C, 10 minutes – 3 hours
- 101 °C, 3 hours – 30 hours
- 67 °C, 30 hours – 30 days
- 36 °C after 30 days (27 °C in sea) – months
- Gamma radiation absorbed dose in air, incl. spray , 6 months: 264 kGy

Realistic with accident

- 140 °C, 0 – 30 min
- 130 °C, 30 min – 3 hours
- 100 °C, 3 hours – 10 hours
- 80 °C, 10 hours – 22 hours
- 67 °C, 22 hours – 400 hours (16 days)
- 40 °C, 400 hours – 720 hours (30 days)
- 36 °C, 30 days – 6 months
- Gamma radiation absorbed dose in air, incl. spray , 6 months: 240 kGy