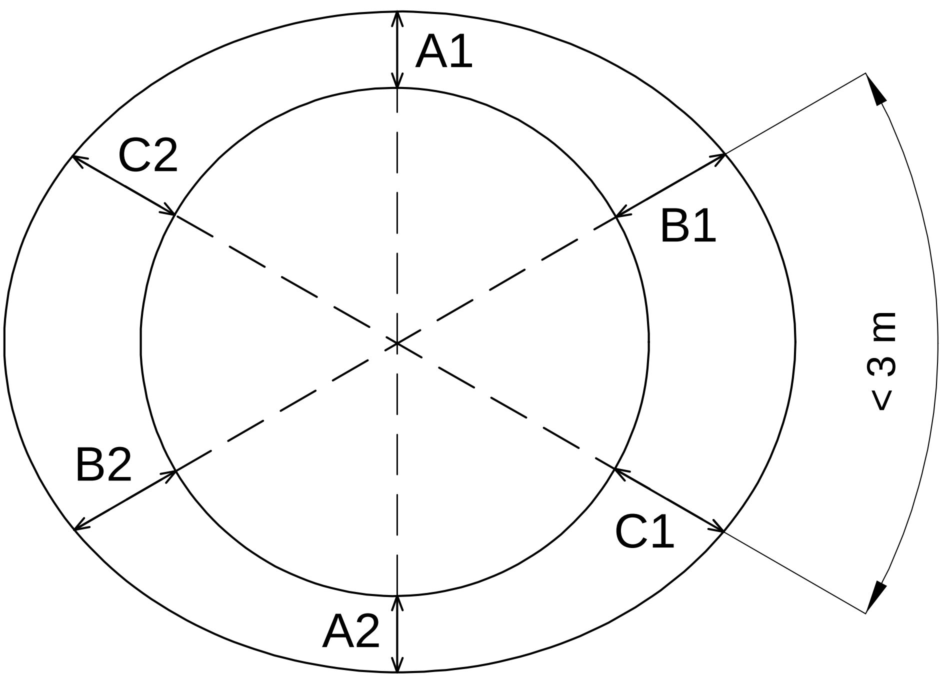
10 Risks of Tank Geometry and Rim Space Tolerances

Measurement of Tank Deformation

No tank construction code in the world, neither API 650, BS 2654, DIN 4119, EN 14015, nor any other tank code dealing with floating roof tanks can guarantee that a certain floating roof tank built in accordance with those standards, and a standard floating roof seal installed will fit together to seal the rim space at all floating conditions.
The reason for this unsatisfying situation **is that all existing tank codes bypass the realistic definitions of the floating roof system**.
The point were all tank codes are wrong is the fact that they all talk about **"the rim space"**, which means a rim space at any point of the tank circumference. And they talk of deformations of the tank shell and tolerances of the tank radius or tank diameter only.
These definitions do not give a complete base for the tolerances a floating roof seal has to deal with.
Of course not only the tank shell but also the floating roof has its deformations and deviations against the design geometry. In addition to this the roof can float into any direction. This means all tolerances of two diametrical points of the tank shell and the pontoon can add up at one side of the floating roof only.
The technically sound and successful evaluation of existing rim space dimensions to be used for the design of floating roof seals - according to our design criteria - is worked out as follows:

a) Add up the rim space measurements of **two diametrical rim spaces** (A1+A2, B1+B2, C1+C2, etc.) to find the max. total clearance between tank shell and floating roof at the tank circumference. The distance between two measuring points at the tank circumference should not be bigger than approx. 3 m.

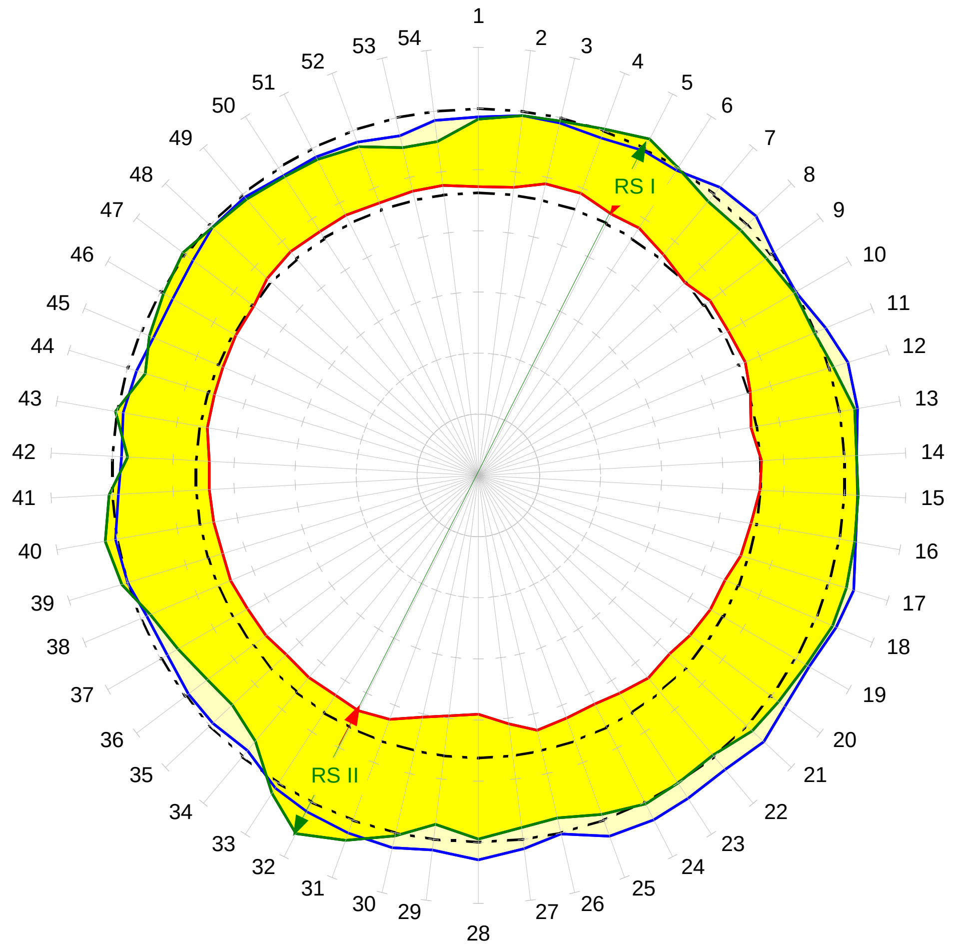
b) Repeat the above measurement procedure for different heights of flotation.



Typical Tank Deformation

Data taken from an existing tank
Design Tank Diameter: 62,000 m
Design Rim Space: 275 mm

- Tank Diameter at Bottom
- Tank Diameter at Top
- Pontoon Diameter
- Design Diameter



Rim Space Measurement with Floating Roof in Top Position

	RS_I		RS_{II}	$RS_I + RS_{II}$		RS_I		RS_{II}	$RS_I + RS_{II}$
1	220	28	409	629	15	323	42	268	591
2	235	29	357	592	16	344	43	305	649
3	211	30	398	609	17	363	44	236	599
4	223	31	421	644	18	382	45	262	644
5	**276**	**32**	**451**	**727**	19	364	46	274	638
6	235	33	382	617	20	362	47	290	652
7	228	34	272	500	21	369	48	245	614
8	250	35	240	490	22	330	49	224	554
9	230	36	240	470	23	351	50	213	564
10	251	37	263	514	24	366	51	205	571
11	246	38	284	530	25	335	52	196	531
12	284	39	345	629	26	294	53	146	440
13	344	40	360	704	27	341	54	144	485
14	312	41	328	640					

Definition of Rim Space Tolerances

By working out the above data for a certain tank you get the successful design base for the floating roof seal.
Hence the correct definition of tolerances of a floating roof system would read as follows:

$$\boxed{D_{Tank} - D_{Roof} = A1 + A2 = 2\ RS_n + t_D}$$

RS_n = nominal Rim Space or design Rim Space

A1 = measured rim space at a certain point at tank circumference

A2 = measured rim space at a point diametrical to A1

t_D = total tolerance or diametrical tolerance of a floating roof system

It would be very much advisable for the owner of a tank farm to ask a tank builder to specify and guarantee his value of t_D for the total clearance between tank shell and floating roof before an order for a new tank construction is placed.

And of curse it is necessary to inform the seal supplier about this value of t_D the tank builder is able to guarantee.
A workable value for t_D will be:

$$t_D = \frac{D_{Tank}}{1000}$$

Especially for individual and spring forced primary or secondary seals or compression plate seals, the knowledge of the possible max. rim space is an absolute must.
Typical shoe type seals with pantograph system or similar do not encounter the same risks of damage as individual spring forced seals. But the risk of the pantograph type system is that the seal may not span over extreme rim spaces, with limited sealing efficiency, when the effective value of t_D is unknown.

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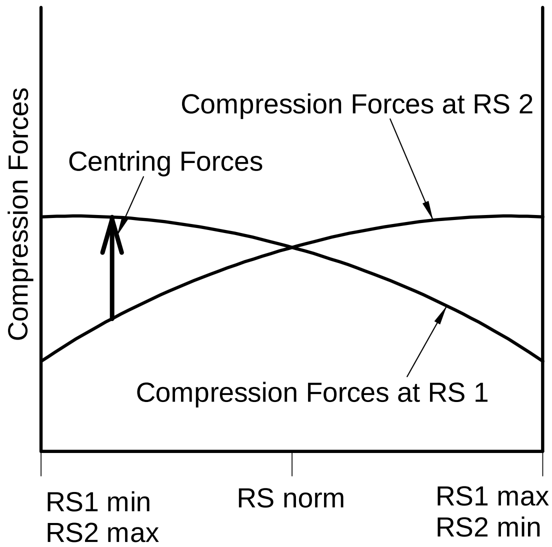
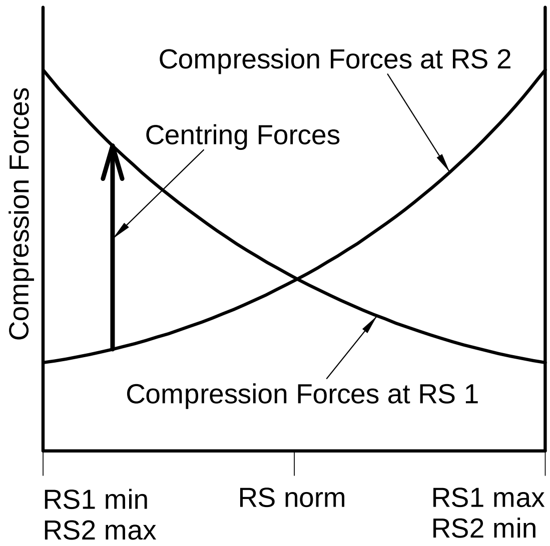
11 Centring of Floating Roof

Proper sealing of a floating roof rim space as well as the general life expectance of a sealing system are based on adequate and sufficient centring of the floating roof.
Foam filled primary seals and spring loaded seals can offer sufficient centring forces. Liquid filled seals provide little centring forces and require perfect tank roundness.
The centring characteristic and the specific centring forces of a certain sealing system can be described by comparing the compression forces existing at two diametrical points of the floating roof, as shown in the following diagram. Sealing systems with good centring characteristic show progressive increase of sealing forces when the rim space is reduced.
IMHOF supplies primary and secondary systems with progressive spring force characteristics, resulting in centred floating roofs.

Diagram of Centring Forces



System with poor centring



System with good centring