First Look at Underground Transport Options

23/08/2023

Underground Transport – 1 - Specification

A.1 Transportation of Goods Underground

The majority of 'science' materials and equipment taken underground are transported using the man-shaft. The cage in this shaft comprises three levels, two of which are able to hold palletised loads up to 1,800 mm wide, 2,200 mm deep and 2,000 mm high. A drawing of the man-shaft cage is shown in Fig. 12. The weight limit for this cage is 6 tonnes. In addition, longer items of up to 6,000 mm in length can be transported on a trailer which is winched into the cage as shown in Fig. 13 by means of a central winch located in the top deck.

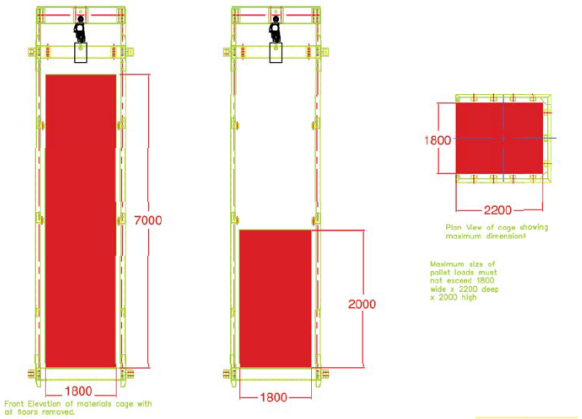


Figure 12: Schematic of the man-shaft cage.

For items too large to be transported in the man-shaft cage there remains the option for them to be 'slung' down the rock-shaft. This greatly increases the weight limit to 25 tonnes, but the maximum dimension which can be slung is limited to 1,880 mm wide, 2,500 mm deep and approximately 6,000 mm tall. There is also a requirement that the centre of mass of any items slung down the rock-shaft be directly below the hook from which they hang. A drawing of the rock-shaft dimensions is shown in Fig. 14.

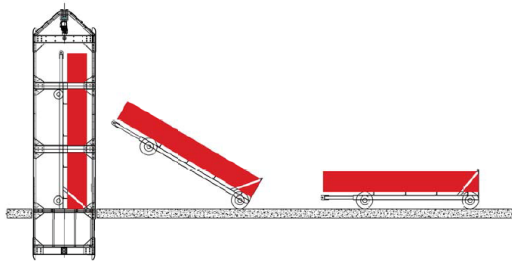


Figure 13: Schematic of the process for loading trailers into the man-shaft cage. The red object defines the maximum load dimension of 6,000 mm tall, 1,200 mm wide and 775 mm deep.

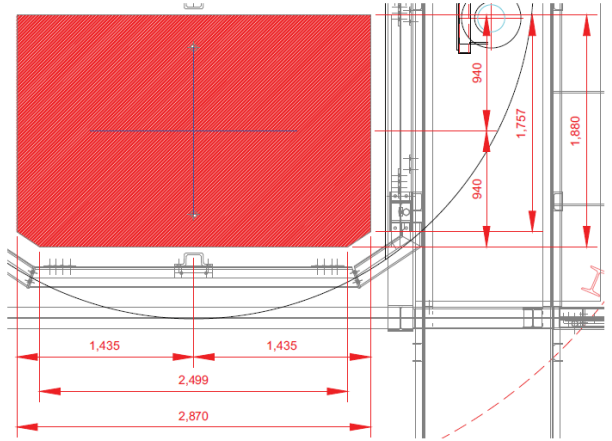


Figure 14: Schematic of the dimensions available for slinging items down the rock-shaft.

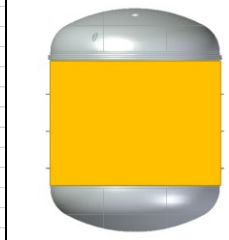
Slinging items down the rock-shaft is not straightforward and requires that ICL pause hoisting for an extended period. While this is not impossible, it would require coordination with ICL and would have to be reserved for a few key items which cannot be transported underground by any other means. It should also be noted that the rock-shaft is the return airway for air which passes round the mine. This means that is is substantially less clean and substantially warmer than the man-shaft. Mitigation against dust contamination needs to be considered for any items which must travel underground in this way.

Boulby Feasibility Study (Issue v1.0) Appendix B

Underground Transport – 2 - Summary

Method	Width Limit (mm)	Depth Limit (mm)	Height Limit (mm)	Weight Limit (Tonnes)	Notes
Man-Shaft Palletised Loads	1800	2200	2000	6	Cage compromises of three levels. Two levels in the cage can hold palletised loads. 6 tonnes is total cage limit.
Man-Shaft Winched Trailer	1200	775	6000	4.8	Trailer weight of 1.2 tonnes
Rock Shaft	1880	2500	~6000	25	Location of centre of mass needs to be below the hook. Use of the rock-shaft should be reserved for a few key items. Mitigation against dust contamination needs considered.

OCV Cylinder



1

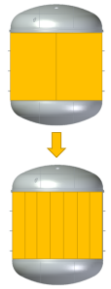
2

3

4

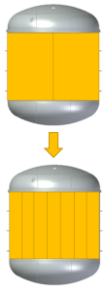
Man-Shaft Palletised Loads

	Min (mm)	Median (mm)	Max (mm)	Min (mm)	Median (mm)	Max (mm)	Min (mm)	Median (mm)	Max (mm)	Min (mm)	Median (mm)	Max (mm)
2	2012.00	2947.00	4024.00	1473.50	2012.00	4024.00	982.33	2012.00	4024.00	736.75	2012.00	4024.00
3	1012.00	2947.00	3484.89	1012.00	1473.50	3484.89	982.33	1012.00	3484.89	736.75	1012.00	3484.89
4	597.79	2845.40	2947.00	597.79	1473.50	2845.40	597.79	982.33	2845.40	597.79	736.75	2845.40
5	393.97	2365.25	2947.00	393.97	1473.50	2365.25	393.97	982.33	2365.25	393.97	736.75	2365.25
6	279.95	2012.00	2947.00	279.95	1473.50	2012.00	279.95	982.33	2012.00	279.95	736.75	2012.00
7	210.06	1745.95	2947.00	210.06	1473.50	1745.95	210.06	982.33	1745.95	210.06	736.75	1745.95
8	164.24	1539.92	2947.00	164.24	1473.50	1539.92	164.24	982.33	1539.92	164.24	736.75	1539.92
9	132.61	1376.29	2947.00	132.61	1376.29	1473.50	132.61	982.33	1376.29	132.61	736.75	1376.29
10	109.89	1243.48	2947.00	109.89	1243.48	1473.50	109.89	982.33	1243.48	109.89	736.75	1243.48
11	93.01	1133.69	2947.00	93.01	1133.69	1473.50	93.01	982.33	1133.69	93.01	736.75	1133.69
12	80.15	1041.49	2947.00	80.15	1041.49	1473.50	80.15	982.33	1041.49	80.15	736.75	1041.49
13	70.12	963.01	2947.00	70.12	963.01	1473.50	70.12	963.01	982.33	70.12	736.75	963.01
14	62.14	895.42	2947.00	62.14	895.42	1473.50	62.14	895.42	982.33	62.14	736.75	895.42
15	55.70	836.64	2947.00	55.70	836.64	1473.50	55.70	836.64	982.33	55.70	736.75	836.64
16	50.43	785.04	2947.00	50.43	785.04	1473.50	50.43	785.04	982.33	50.43	736.75	785.04



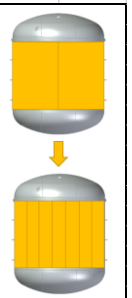
Man-Shaft Trailer

	Min (mm)	Median (mm)	Max (mm)	Min (mm)	Median (mm)	Max (mm)	Min (mm)	Median (mm)	Max (mm)	Min (mm)	Median (mm)	Max (mm)
2	2012.00	2947.00	4024.00	1473.50	2012.00	4024.00	982.33	2012.00	4024.00	736.75	2012.00	4024.00
3	1012.00	2947.00	3484.89	1012.00	1473.50	3484.89	982.33	1012.00	3484.89	736.75	1012.00	3484.89
4	597.79	2845.40	2947.00	597.79	1473.50	2845.40	597.79	982.33	2845.40	597.79	736.75	2845.40
5	393.97	2365.25	2947.00	393.97	1473.50	2365.25	393.97	982.33	2365.25	393.97	736.75	2365.25
6	279.95	2012.00	2947.00	279.95	1473.50	2012.00	279.95	982.33	2012.00	279.95	736.75	2012.00
7	210.06	1745.95	2947.00	210.06	1473.50	1745.95	210.06	982.33	1745.95	210.06	736.75	1745.95
8	164.24	1539.92	2947.00	164.24	1473.50	1539.92	164.24	982.33	1539.92	164.24	736.75	1539.92
9	132.61	1376.29	2947.00	132.61	1376.29	1473.50	132.61	982.33	1376.29	132.61	736.75	1376.29
10	109.89	1243.48	2947.00	109.89	1243.48	1473.50	109.89	982.33	1243.48	109.89	736.75	1243.48
11	93.01	1133.69	2947.00	93.01	1133.69	1473.50	93.01	982.33	1133.69	93.01	736.75	1133.69
12	80.15	1041.49	2947.00	80.15	1041.49	1473.50	80.15	982.33	1041.49	80.15	736.75	1041.49
13	70.12	963.01	2947.00	70.12	963.01	1473.50	70.12	963.01	982.33	70.12	736.75	963.01
14	62.14	895.42	2947.00	62.14	895.42	1473.50	62.14	895.42	982.33	62.14	736.75	895.42
15	55.70	836.64	2947.00	55.70	836.64	1473.50	55.70	836.64	982.33	55.70	736.75	836.64
16	50.43	785.04	2947.00	50.43	785.04	1473.50	50.43	785.04	982.33	50.43	736.75	785.04



Rock-Shaft

	Min (mm)	Median (mm)	Max (mm)	Min (mm)	Median (mm)	Max (mm)	Min (mm)	Median (mm)	Max (mm)	Min (mm)	Median (mm)	Max (mm)
2	2012.00	2947.00	4024.00	1473.50	2012.00	4024.00	982.33	2012.00	4024.00	736.75	2012.00	4024.00
3	1012.00	2947.00	3484.89	1012.00	1473.50	3484.89	982.33	1012.00	3484.89	736.75	1012.00	3484.89
4	597.79	2845.40	2947.00	597.79	1473.50	2845.40	597.79	982.33	2845.40	597.79	736.75	2845.40
5	393.97	2365.25	2947.00	393.97	1473.50	2365.25	393.97	982.33	2365.25	393.97	736.75	2365.25
6	279.95	2012.00	2947.00	279.95	1473.50	2012.00	279.95	982.33	2012.00	279.95	736.75	2012.00
7	210.06	1745.95	2947.00	210.06	1473.50	1745.95	210.06	982.33	1745.95	210.06	736.75	1745.95
8	164.24	1539.92	2947.00	164.24	1473.50	1539.92	164.24	982.33	1539.92	164.24	736.75	1539.92
9	132.61	1376.29	2947.00	132.61	1376.29	1473.50	132.61	982.33	1376.29	132.61	736.75	1376.29
10	109.89	1243.48	2947.00	109.89	1243.48	1473.50	109.89	982.33	1243.48	109.89	736.75	1243.48
11	93.01	1133.69	2947.00	93.01	1133.69	1473.50	93.01	982.33	1133.69	93.01	736.75	1133.69
12	80.15	1041.49	2947.00	80.15	1041.49	1473.50	80.15	982.33	1041.49	80.15	736.75	1041.49
13	70.12	963.01	2947.00	70.12	963.01	1473.50	70.12	963.01	982.33	70.12	736.75	963.01
14	62.14	895.42	2947.00	62.14	895.42	1473.50	62.14	895.42	982.33	62.14	736.75	895.42
15	55.70	836.64	2947.00	55.70	836.64	1473.50	55.70	836.64	982.33	55.70	736.75	836.64
16	50.43	785.04	2947.00	50.43	785.04	1473.50	50.43	785.04	982.33	50.43	736.75	785.04

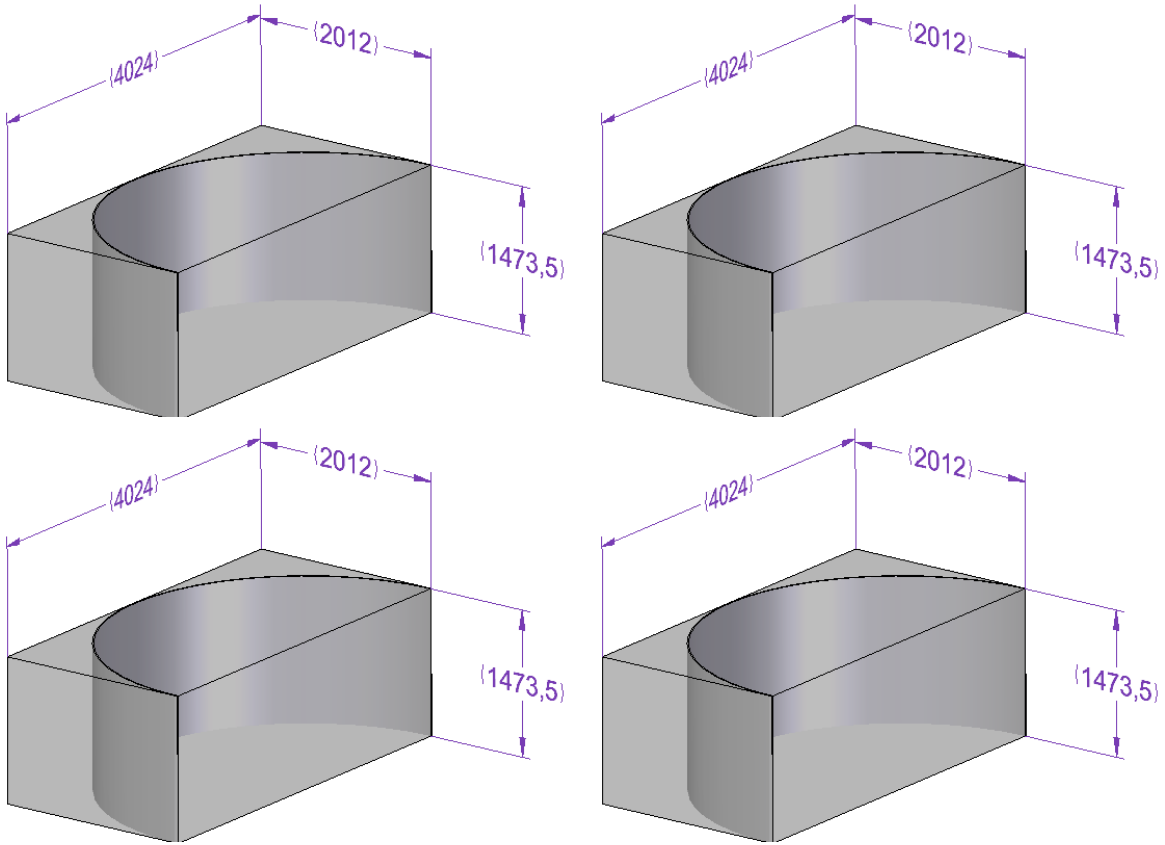


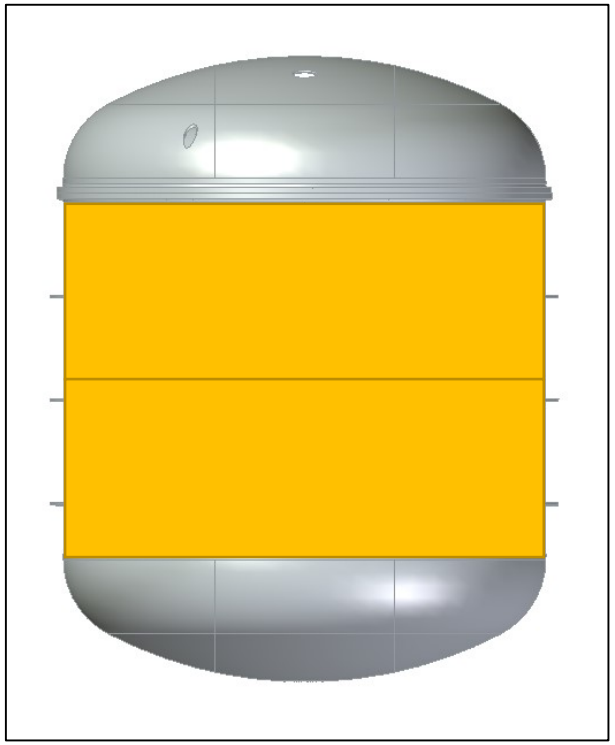
OCV Cylinder

Notes

- OCV cylinder longitudinally and circumferentially split (4 pieces total)
- The rock shaft would need to be used

Method	Width Limit (mm)	Depth Limit (mm)	Height Limit (mm)	Weight Limit (Tonnes)	Notes
Man-Shaft Palletised Loads	1800	2200	2000	6	Cage compromises of three levels. Two levels in the cage can hold palletised loads. 6 tonnes is total cage limit.
Man-Shaft Winched Trailer	1200	775	6000		Weight limit needs clarified
Rock Shaft	1800	2500	~6000	25	Location of centre of mass needs to be below the hook. Use of the rock-shaft should be reserved for a few key items. Mitigation against dust contamination needs considered.





OCV Flanges – Man Shaft

		Man-Shaft Palletised Loads		
		Min (mm)	Median (mm)	Max (mm)
Number of Segments	2	80.00	2069.00	4138.00
	3	80.00	1069.00	3583.61
	4	80.00	654.79	2926.01
	5	80.00	450.97	2432.26
	6	80.00	336.95	2069.00
	7	80.00	267.06	1795.41
	8	80.00	221.24	1583.54
	9	80.00	189.61	1415.28
	10	80.00	166.89	1278.71
	11	80.00	150.01	1165.81
	12	80.00	137.15	1070.99
	13	80.00	127.12	990.29
	14	80.00	119.14	920.79
	15	80.00	112.70	860.34
	16	80.00	107.43	807.28

		Man-Shaft Trailer		
		Min (mm)	Median (mm)	Max (mm)
Number of Segments	2	80.00	2069.00	4138.00
	3	80.00	1069.00	3583.61
	4	80.00	654.79	2926.01
	5	80.00	450.97	2432.26
	6	80.00	336.95	2069.00
	7	80.00	267.06	1795.41
	8	80.00	221.24	1583.54
	9	80.00	189.61	1415.28
	10	80.00	166.89	1278.71
	11	80.00	150.01	1165.81
	12	80.00	137.15	1070.99
	13	80.00	127.12	990.29
	14	80.00	119.14	920.79
	15	80.00	112.70	860.34
	16	80.00	107.43	807.28

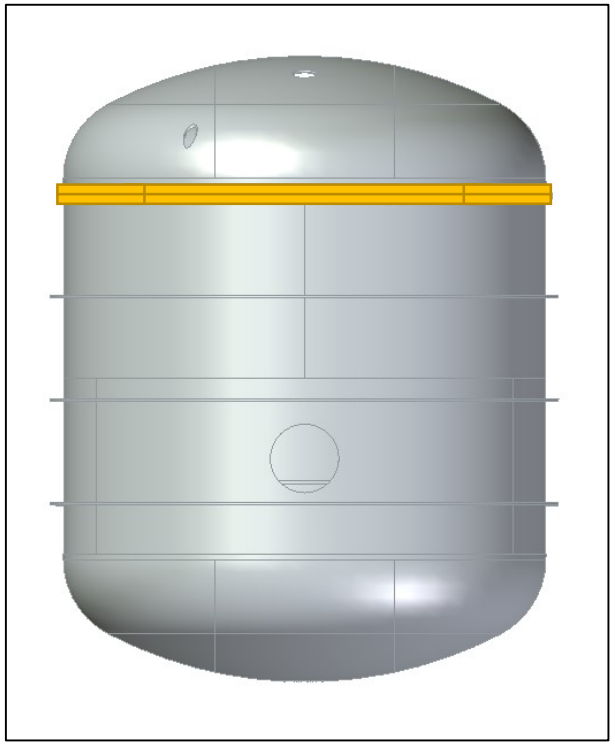
		Rock-Shaft		
		Min (mm)	Median (mm)	Max (mm)
Number of Segments	2	80.00	2069.00	4138.00
	3	80.00	1069.00	3583.61
	4	80.00	654.79	2926.01
	5	80.00	450.97	2432.26
	6	80.00	336.95	2069.00
	7	80.00	267.06	1795.41
	8	80.00	221.24	1583.54
	9	80.00	189.61	1415.28
	10	80.00	166.89	1278.71
	11	80.00	150.01	1165.81
	12	80.00	137.15	1070.99
	13	80.00	127.12	990.29
	14	80.00	119.14	920.79
	15	80.00	112.70	860.34
	16	80.00	107.43	807.28

OCV Flanges – Man Shaft

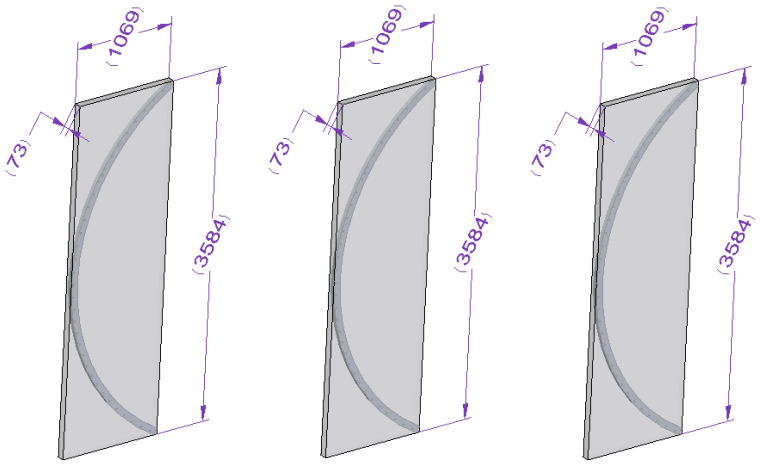
Notes

- OCV flange pair segmented into 3 pieces (6 segments total)
- The man-shaft trailer could be used
- All six segments could be transported in the same “load”
- Transport tooling would be required to support the flange segments

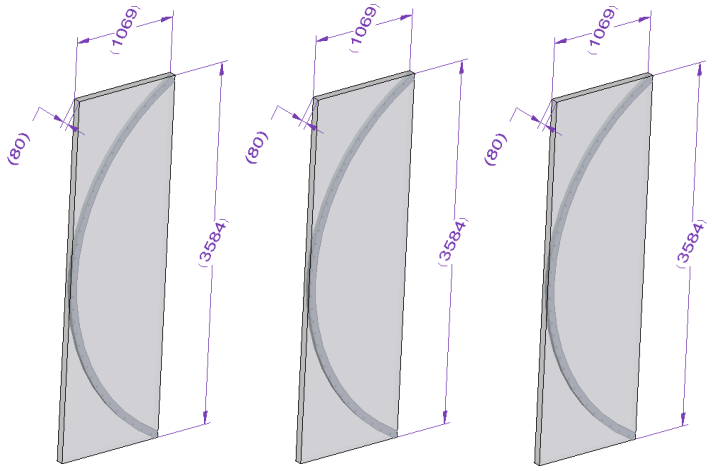
Method	Width Limit (mm)	Depth Limit (mm)	Height Limit (mm)	Weight Limit (Tonnes)	Notes
Man-Shaft Palletised Loads	1800	2200	2000	6	Cage compromises of three levels. Two levels in the cage can hold palletised loads. 6 tonnes is total cage limit.
Man-Shaft Winched Trailer	1200	775	6000		Weight limit needs clarified
Rock Shaft	1800	2500	~6000	25	Location of centre of mass needs to be below the hook. Use of the rock-shaft should be reserved for a few key items. Mitigation against dust contamination needs considered.



Upper Flange:



Lower Flange:

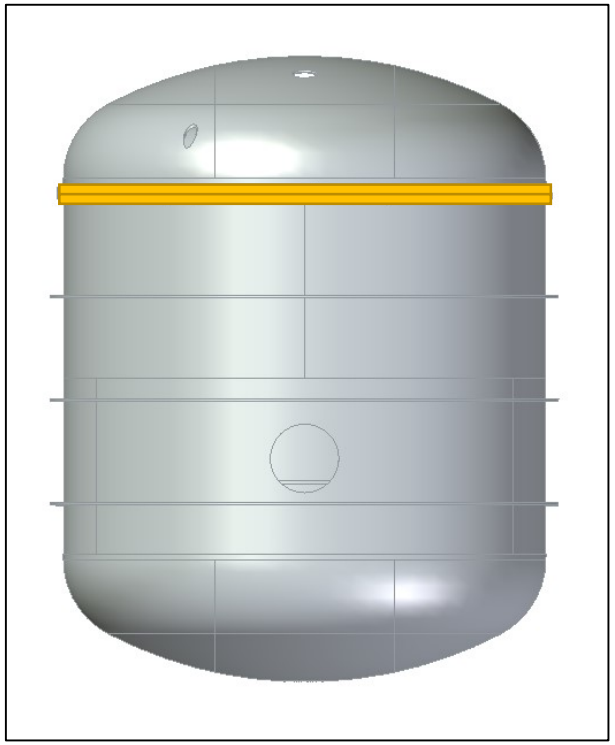


OCV Flanges – Rock Shaft Option

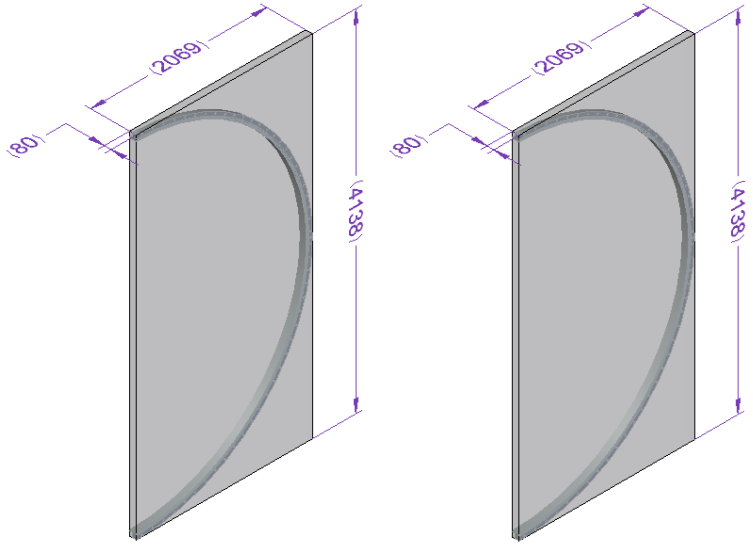
Notes

- OCV flange pair segmented into 2 pieces (4 segments total)
- The rock shaft would need to be used
- All segments could be transported in the same “load”
- Transport tooling must ensure that the centre of mass is directly below the rock shaft hook.

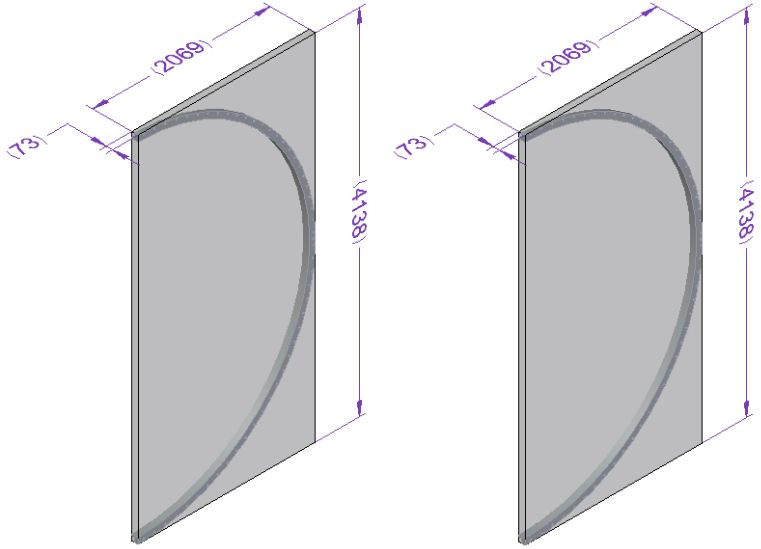
Method	Width Limit (mm)	Depth Limit (mm)	Height Limit (mm)	Weight Limit (Tonnes)	Notes
Man-Shaft Palletised Loads	1800	2200	2000	6	Cage compromises of three levels. Two levels in the cage can hold palletised loads. 6 tonnes is total cage limit.
Man-Shaft Winched Trailer	1200	775	6000		Weight limit needs clarified
Rock Shaft	1800	2500	~6000	25	Location of centre of mass needs to be below the hook. Use of the rock-shaft should be reserved for a few key items. Mitigation against dust contamination needs considered.



Upper Flange:

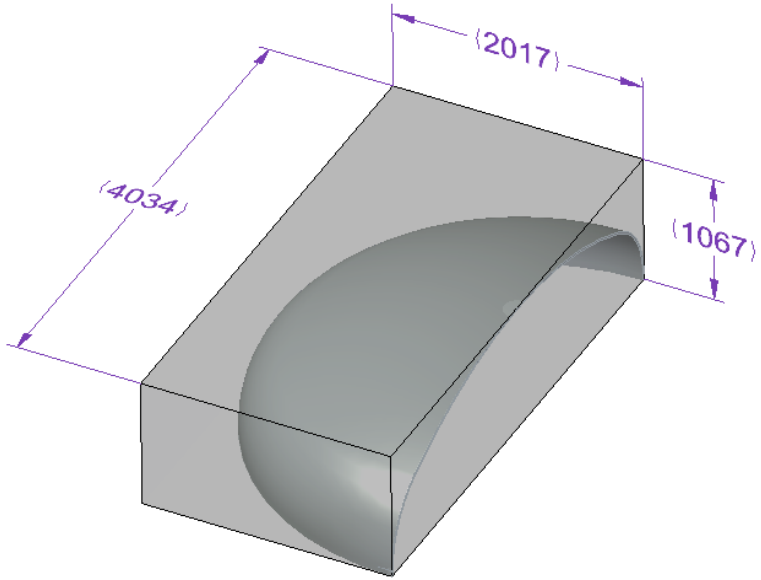


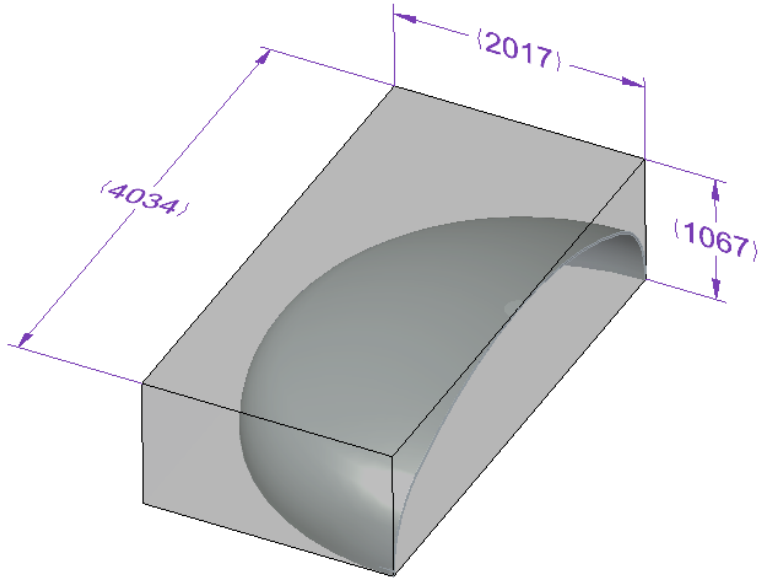
Lower Flange:

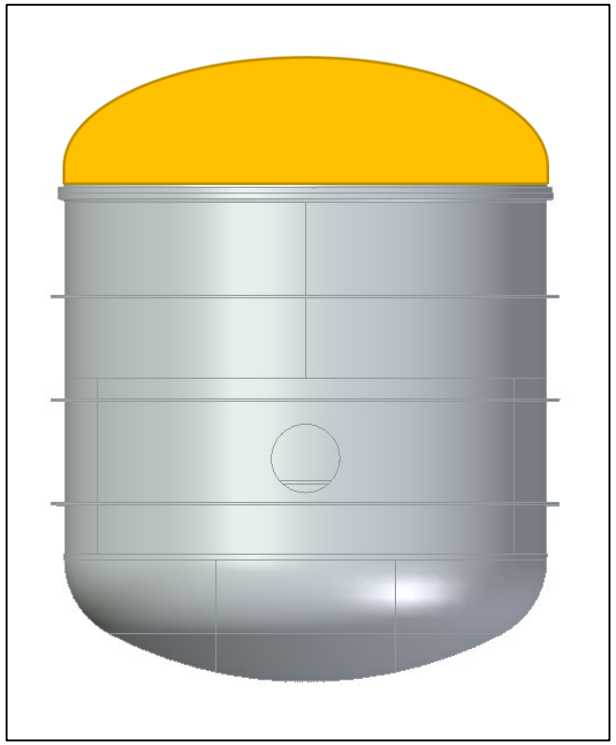


OCV Dished End

Method	Width Limit (mm)	Depth Limit (mm)	Height Limit (mm)	Weight Limit (Tonnes)	Notes
Man-Shaft Palletised Loads	1800	2200	2000	6	Cage compromises of three levels. Two levels in the cage can hold palletised loads. 6 tonnes is total cage limit.
Man-Shaft Winched Trailer	1200	775	6000		Weight limit needs clarified
Rock Shaft	1800	2500	~6000	25	Location of centre of mass needs to be below the hook. Use of the rock-shaft should be reserved for a few key items. Mitigation against dust contamination needs considered.

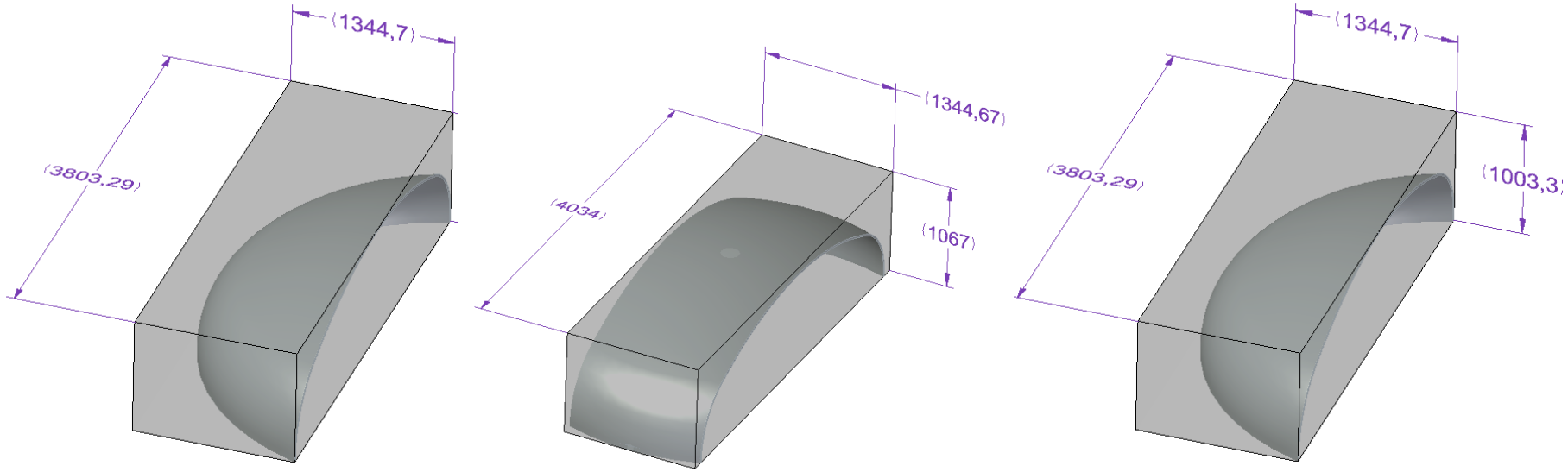


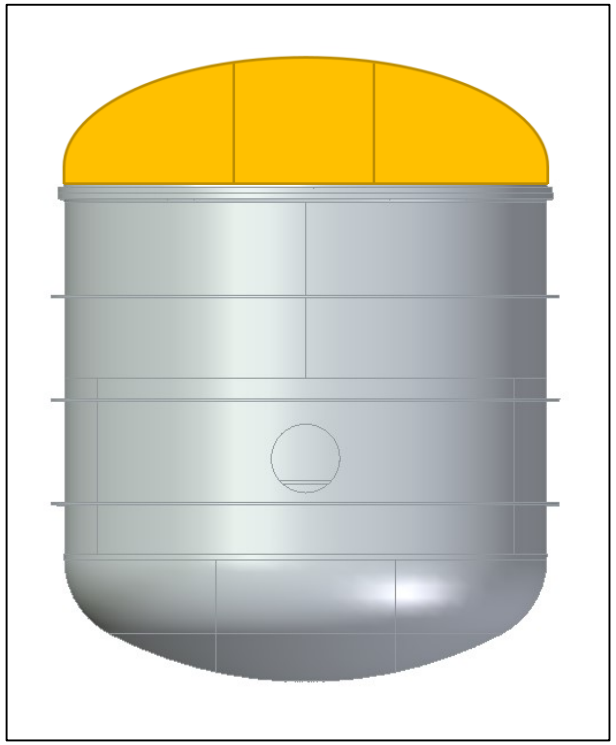




OCV Dished End

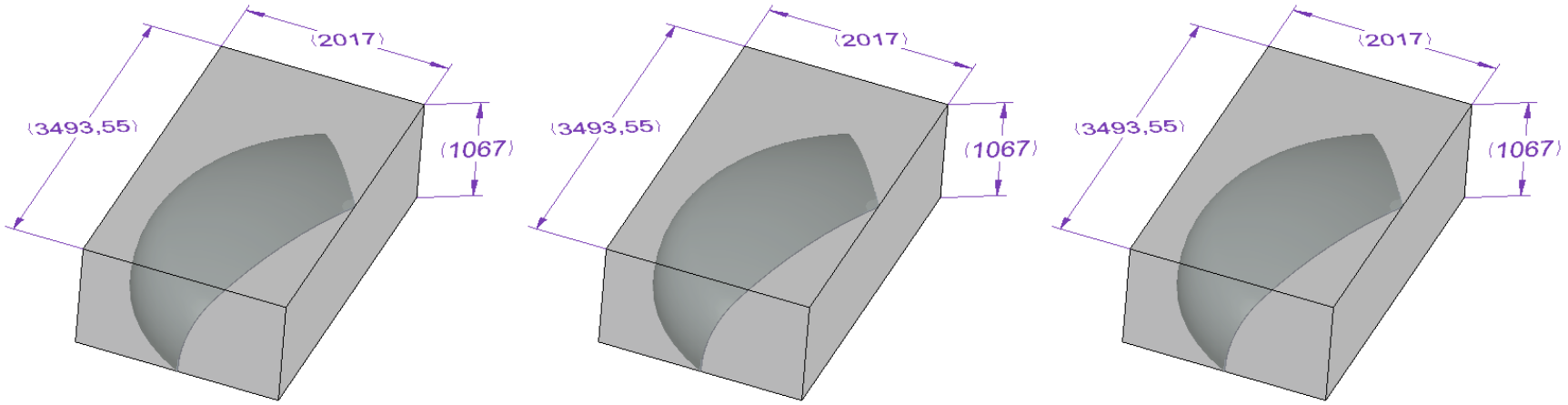
Method	Width Limit (mm)	Depth Limit (mm)	Height Limit (mm)	Weight Limit (Tonnes)	Notes
Man-Shaft Palletised Loads	1800	2200	2000	6	Cage compromises of three levels. Two levels in the cage can hold palletised loads. 6 tonnes is total cage limit.
Man-Shaft Winched Trailer	1200	775	6000		Weight limit needs clarified
Rock Shaft	1800	2500	~6000	25	Location of centre of mass needs to be below the hook. Use of the rock-shaft should be reserved for a few key items. Mitigation against dust contamination needs considered.

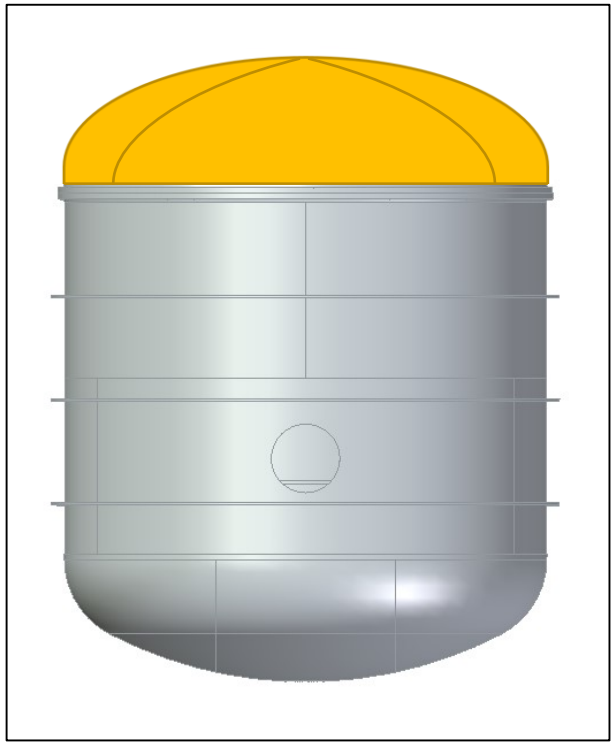




OCV Dished End

Method	Width Limit (mm)	Depth Limit (mm)	Height Limit (mm)	Weight Limit (Tonnes)	Notes
Man-Shaft Palletised Loads	1800	2200	2000	6	Cage compromises of three levels. Two levels in the cage can hold palletised loads. 6 tonnes is total cage limit.
Man-Shaft Winched Trailer	1200	775	6000		Weight limit needs clarified
Rock Shaft	1800	2500	~6000	25	Location of centre of mass needs to be below the hook. Use of the rock-shaft should be reserved for a few key items. Mitigation against dust contamination needs considered.





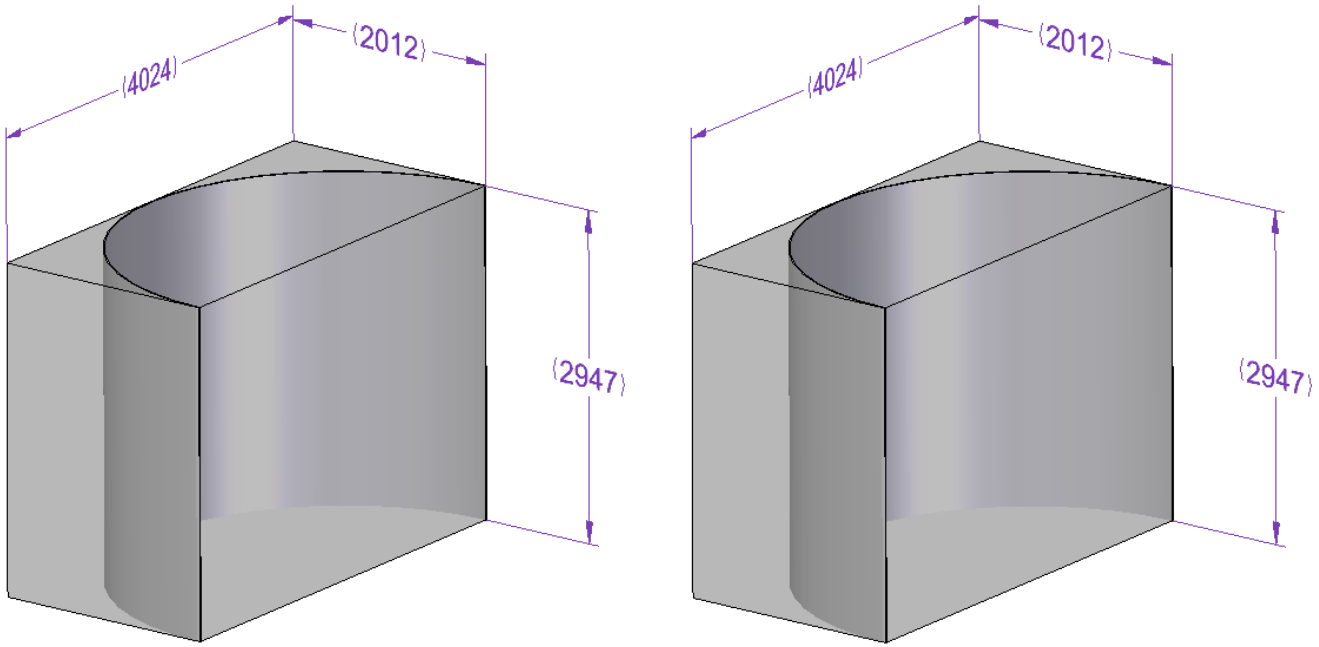
Additional Slides – CAD Checks

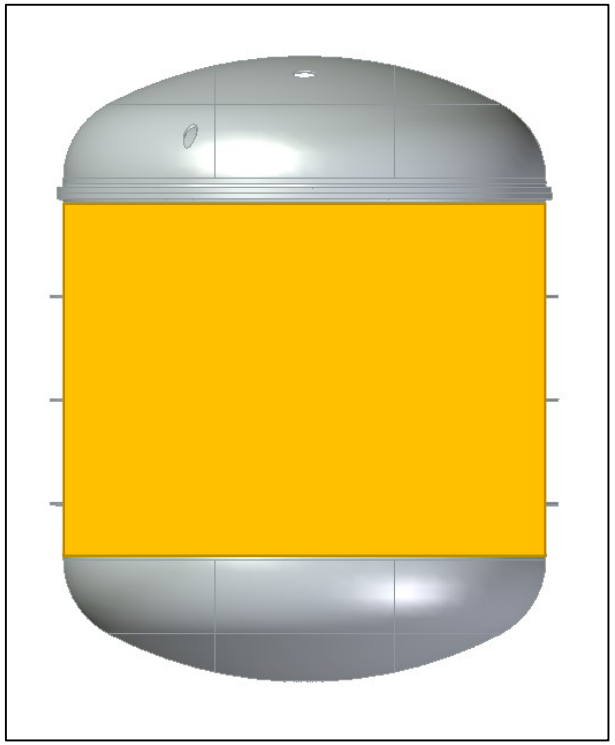
OCV Cylinder

Notes

- OCV cylinder longitudinally split into 2 pieces
- Neither the man-shaft or rock-shaft options are suitable

Method	Width Limit (mm)	Depth Limit (mm)	Height Limit (mm)	Weight Limit (Tonnes)	Notes
Man-Shaft Palletised Loads	1800	2200	2000	6	Cage compromises of three levels. Two levels in the cage can hold palletised loads. 6 tonnes is total cage limit.
Man-Shaft Winched Trailer	1200	775	6000		Weight limit needs clarified
Rock Shaft	1800	2500	~6000	25	Location of centre of mass needs to be below the hook. Use of the rock-shaft should be reserved for a few key items. Mitigation against dust contamination needs considered.



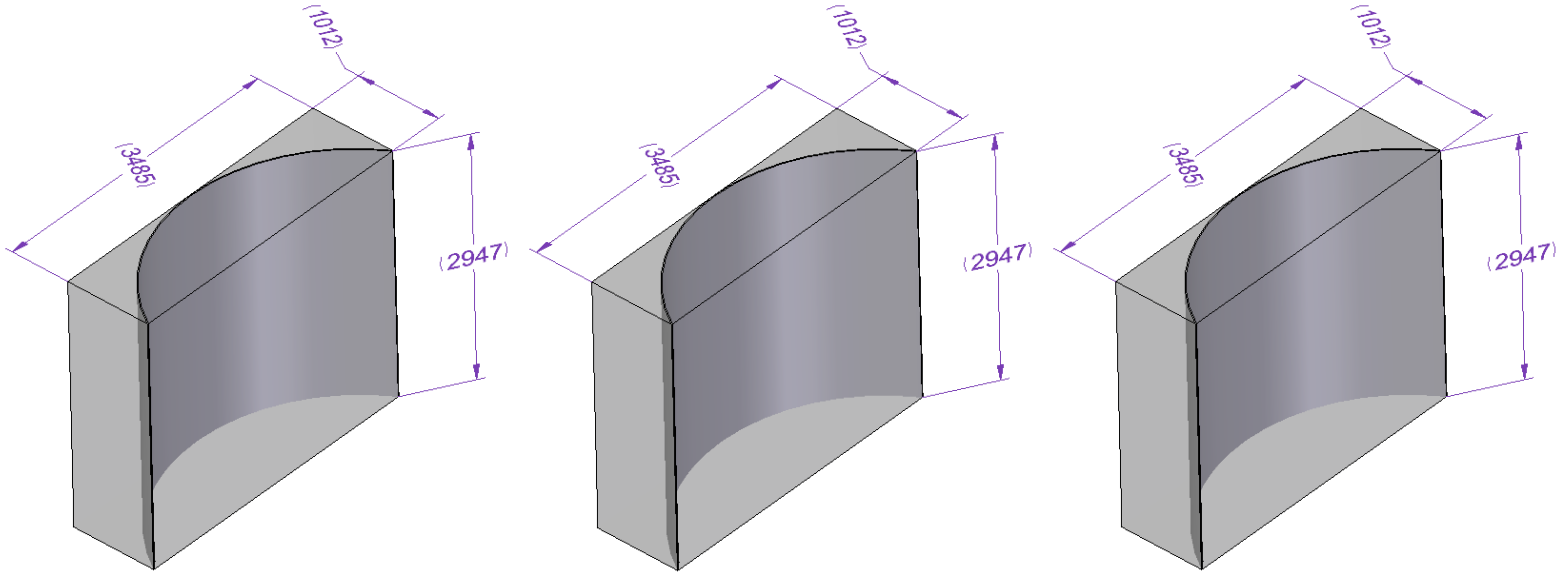


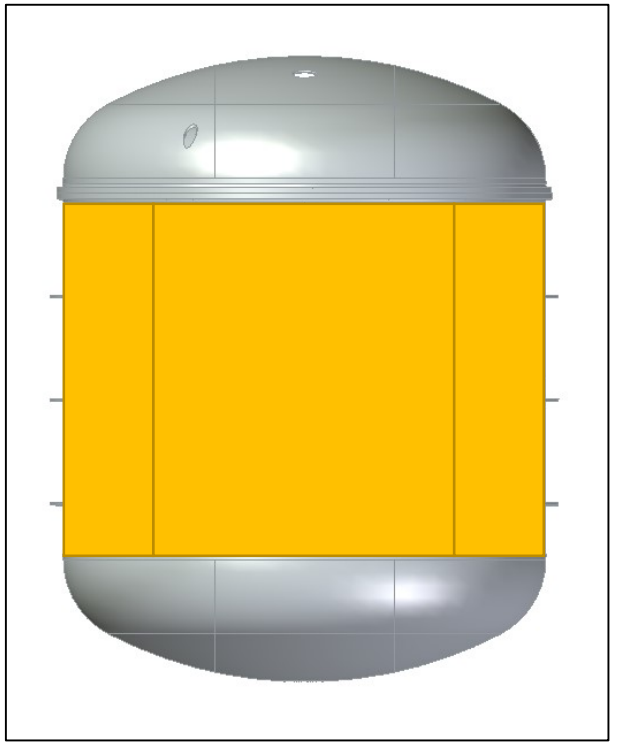
OCV Cylinder

Notes

- OCV cylinder longitudinally split into 3 pieces
- Neither the man-shaft or rock-shaft options are suitable

Method	Width Limit (mm)	Depth Limit (mm)	Height Limit (mm)	Weight Limit (Tonnes)	Notes
Man-Shaft Palletised Loads	1800	2200	2000	6	Cage compromises of three levels. Two levels in the cage can hold palletised loads. 6 tonnes is total cage limit.
Man-Shaft Winched Trailer	1200	775	6000		Weight limit needs clarified
Rock Shaft	1800	2500	~6000	25	Location of centre of mass needs to be below the hook. Use of the rock-shaft should be reserved for a few key items. Mitigation against dust contamination needs considered.



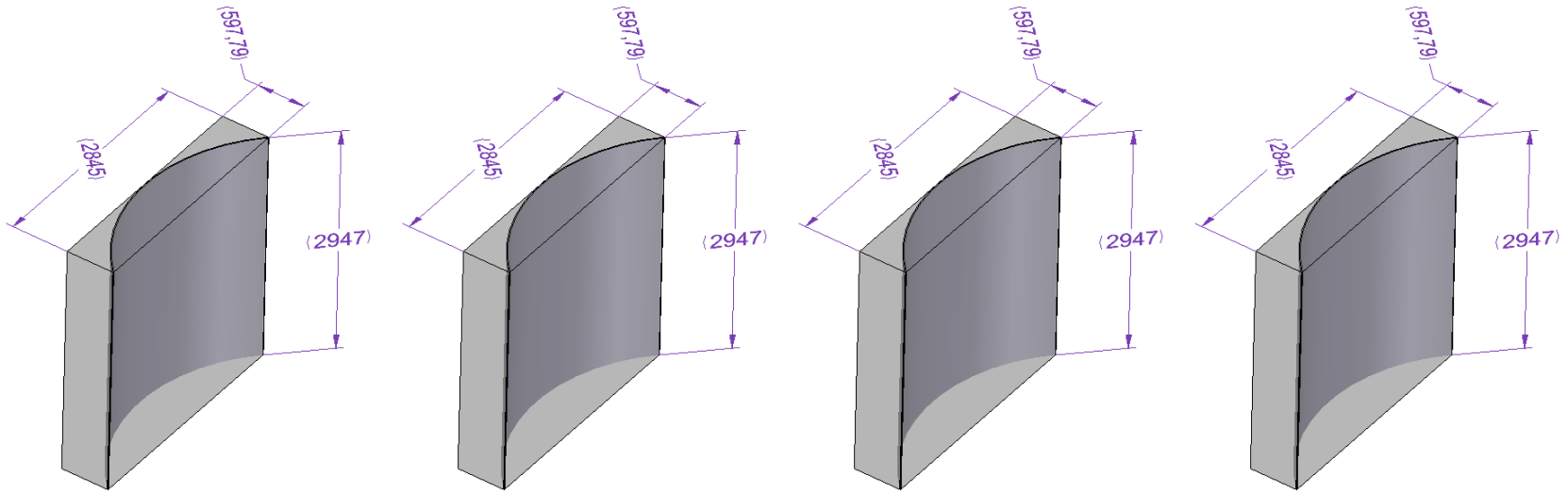


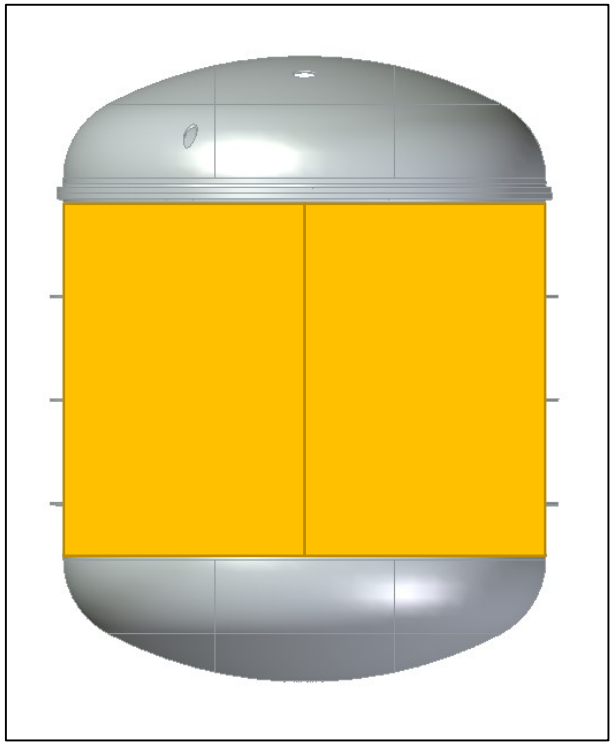
OCV Cylinder

Notes

- OCV cylinder longitudinally split into 4 pieces
- Neither the man-shaft or rock-shaft options are suitable

Method	Width Limit (mm)	Depth Limit (mm)	Height Limit (mm)	Weight Limit (Tonnes)	Notes
Man-Shaft Palletised Loads	1800	2200	2000	6	Cage compromises of three levels. Two levels in the cage can hold palletised loads. 6 tonnes is total cage limit.
Man-Shaft Winched Trailer	1200	775	6000		Weight limit needs clarified
Rock Shaft	1800	2500	~6000	25	Location of centre of mass needs to be below the hook. Use of the rock-shaft should be reserved for a few key items. Mitigation against dust contamination needs considered.



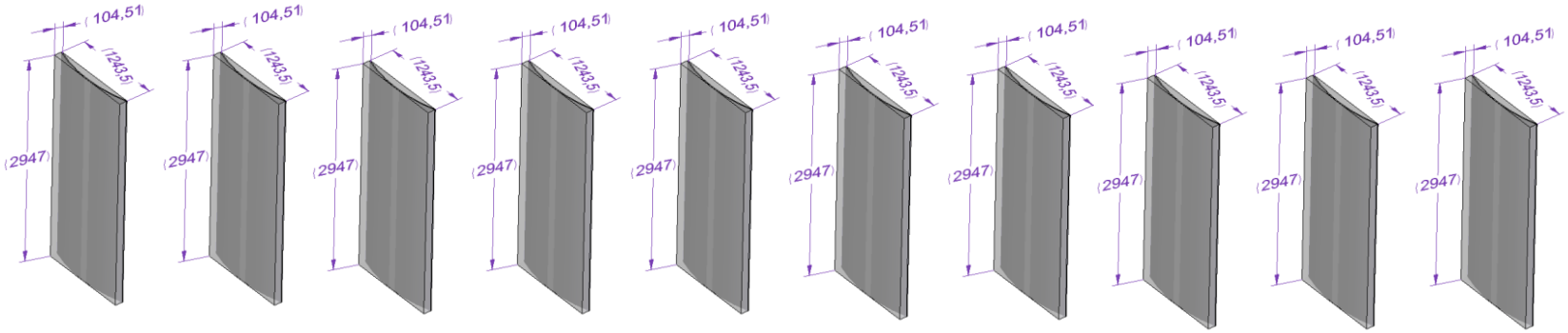


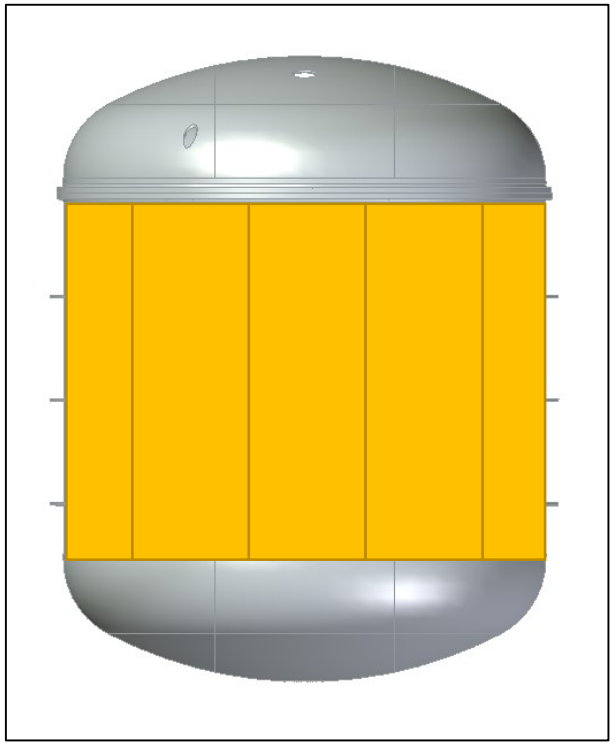
OCV Cylinder

Notes

- OCV cylinder longitudinally split into 10 pieces
- The rock-shaft would need to be used

Method	Width Limit (mm)	Depth Limit (mm)	Height Limit (mm)	Weight Limit (Tonnes)	Notes
Man-Shaft Palletised Loads	1800	2200	2000	6	Cage compromises of three levels. Two levels in the cage can hold palletised loads. 6 tonnes is total cage limit.
Man-Shaft Winched Trailer	1200	775	6000		Weight limit needs clarified
Rock Shaft	1800	2500	~6000	25	Location of centre of mass needs to be below the hook. Use of the rock-shaft should be reserved for a few key items. Mitigation against dust contamination needs considered.

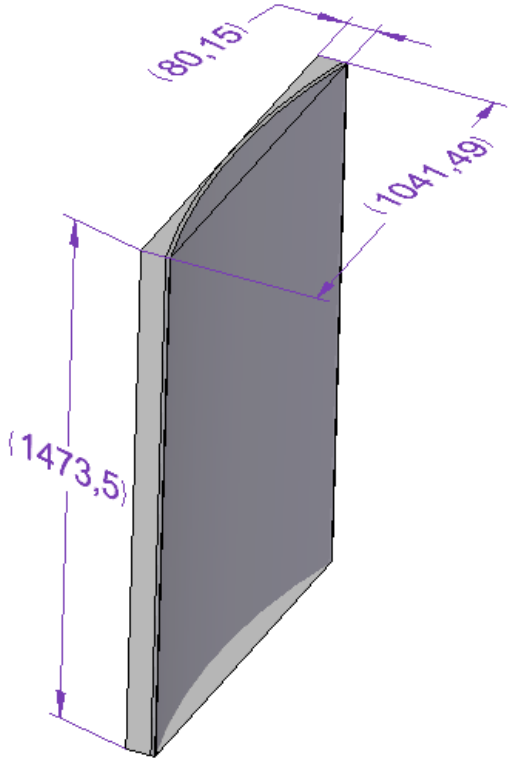




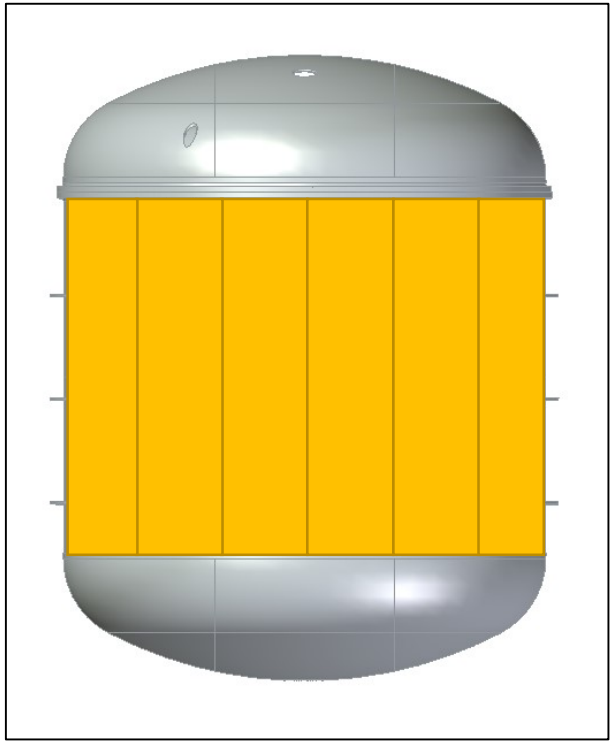
OCV Cylinder

Notes

- OCV cylinder longitudinally split into 12 pieces
- The man-shaft winched trailer can be used



Method	Width Limit (mm)	Depth Limit (mm)	Height Limit (mm)	Weight Limit (Tonnes)	Notes
Man-Shaft Palletised Loads	1800	2200	2000	6	Cage compromises of three levels. Two levels in the cage can hold palletised loads. 6 tonnes is total cage limit.
Man-Shaft Winched Trailer	1200	775	6000		Weight limit needs clarified
Rock Shaft	1800	2500	~6000	25	Location of centre of mass needs to be below the hook. Use of the rock-shaft should be reserved for a few key items. Mitigation against dust contamination needs considered.

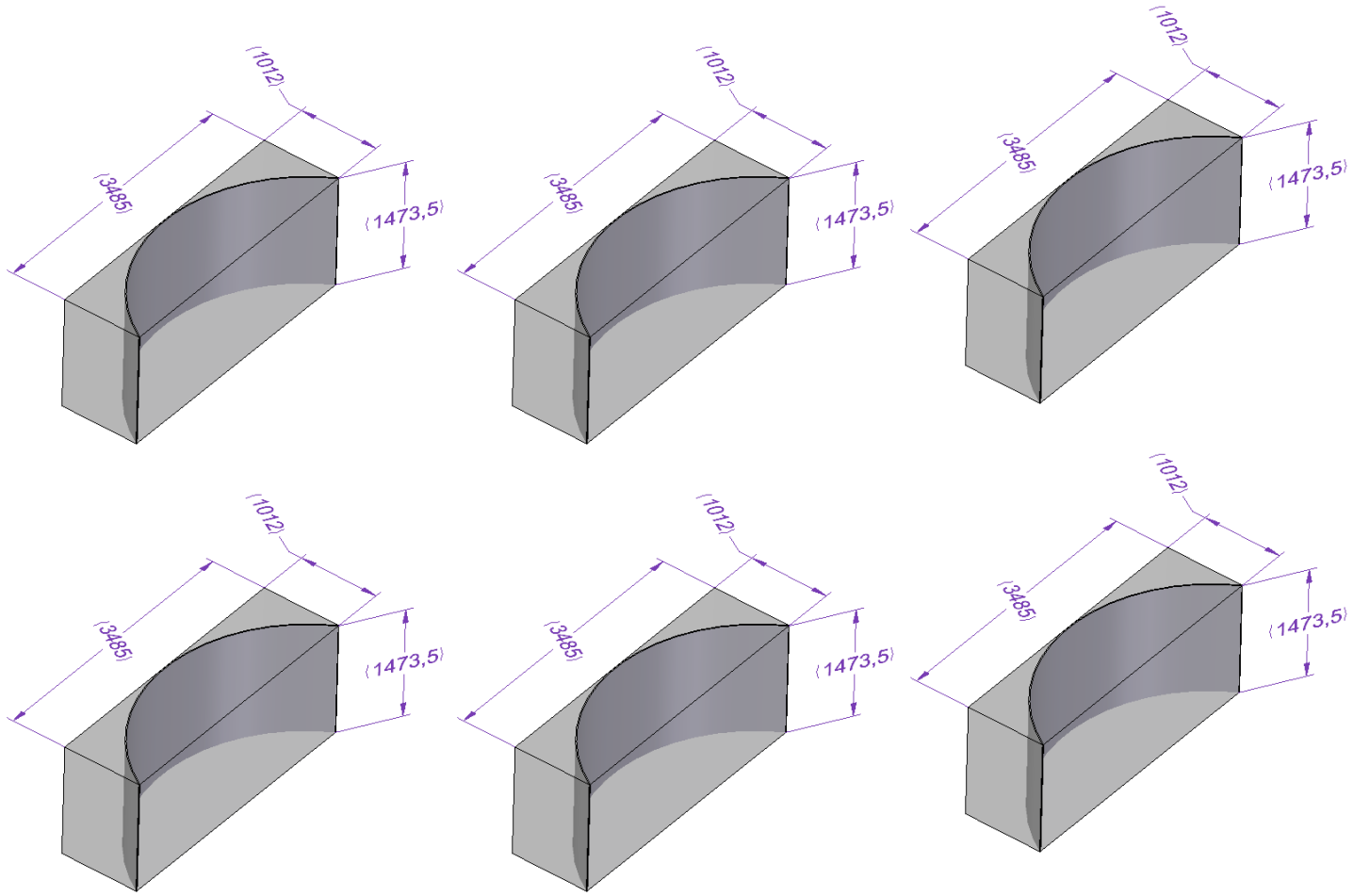


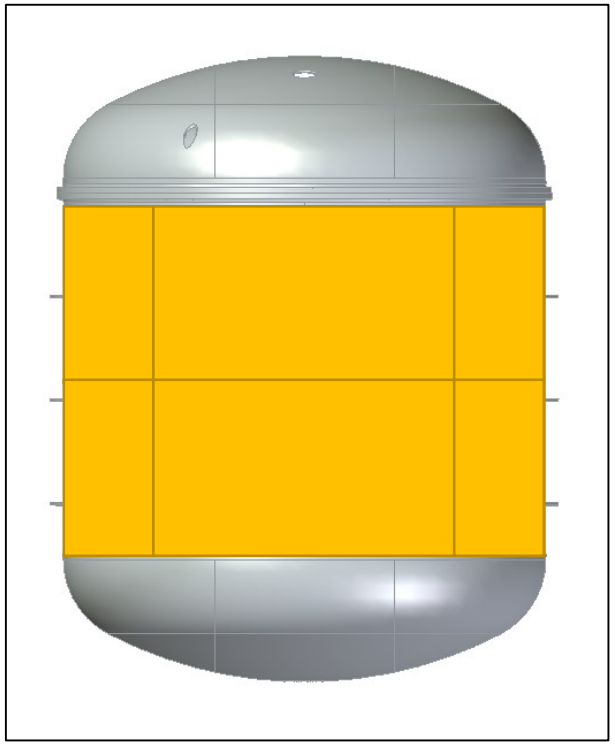
OCV Cylinder

Notes

- OCV cylinder longitudinally and circumferentially split (6 pieces total)
- The rock shaft would need to be used

Method	Width Limit (mm)	Depth Limit (mm)	Height Limit (mm)	Weight Limit (Tonnes)	Notes
Man-Shaft Palletised Loads	1800	2200	2000	6	Cage compromises of three levels. Two levels in the cage can hold palletised loads. 6 tonnes is total cage limit.
Man-Shaft Winched Trailer	1200	775	6000		Weight limit needs clarified
Rock Shaft	1800	2500	~6000	25	Location of centre of mass needs to be below the hook. Use of the rock-shaft should be reserved for a few key items. Mitigation against dust contamination needs considered.



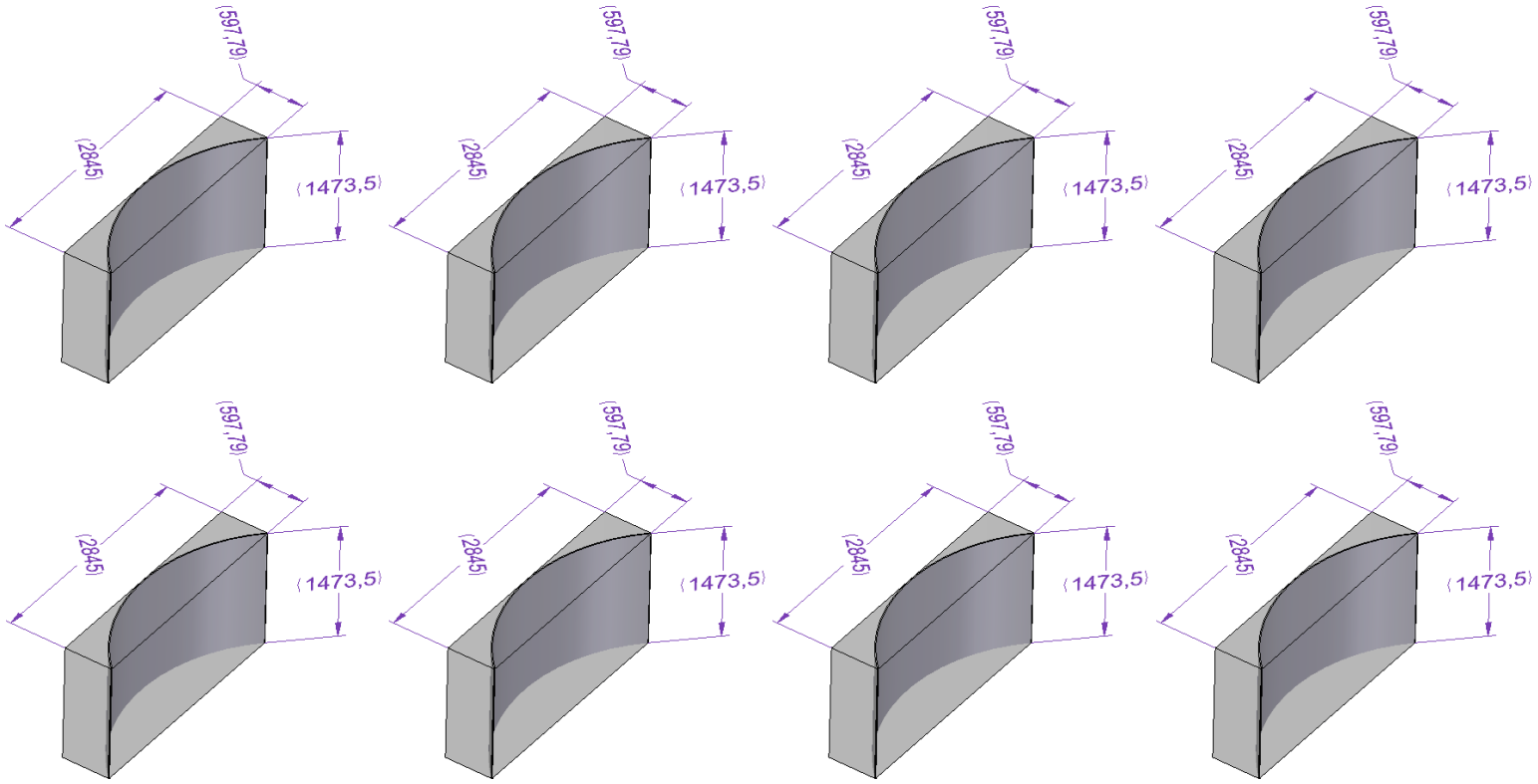


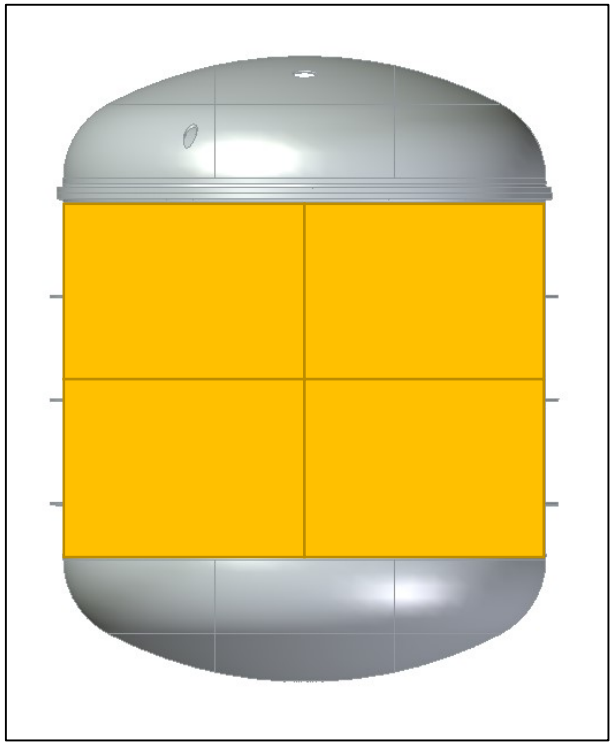
OCV Cylinder

Notes

- OCV cylinder longitudinally and circumferentially split (8 pieces total)
- The rock shaft would need to be used

Method	Width Limit (mm)	Depth Limit (mm)	Height Limit (mm)	Weight Limit (Tonnes)	Notes
Man-Shaft Palletised Loads	1800	2200	2000	6	Cage compromises of three levels. Two levels in the cage can hold palletised loads. 6 tonnes is total cage limit.
Man-Shaft Winched Trailer	1200	775	6000		Weight limit needs clarified
Rock Shaft	1800	2500	~6000	25	Location of centre of mass needs to be below the hook. Use of the rock-shaft should be reserved for a few key items. Mitigation against dust contamination needs considered.



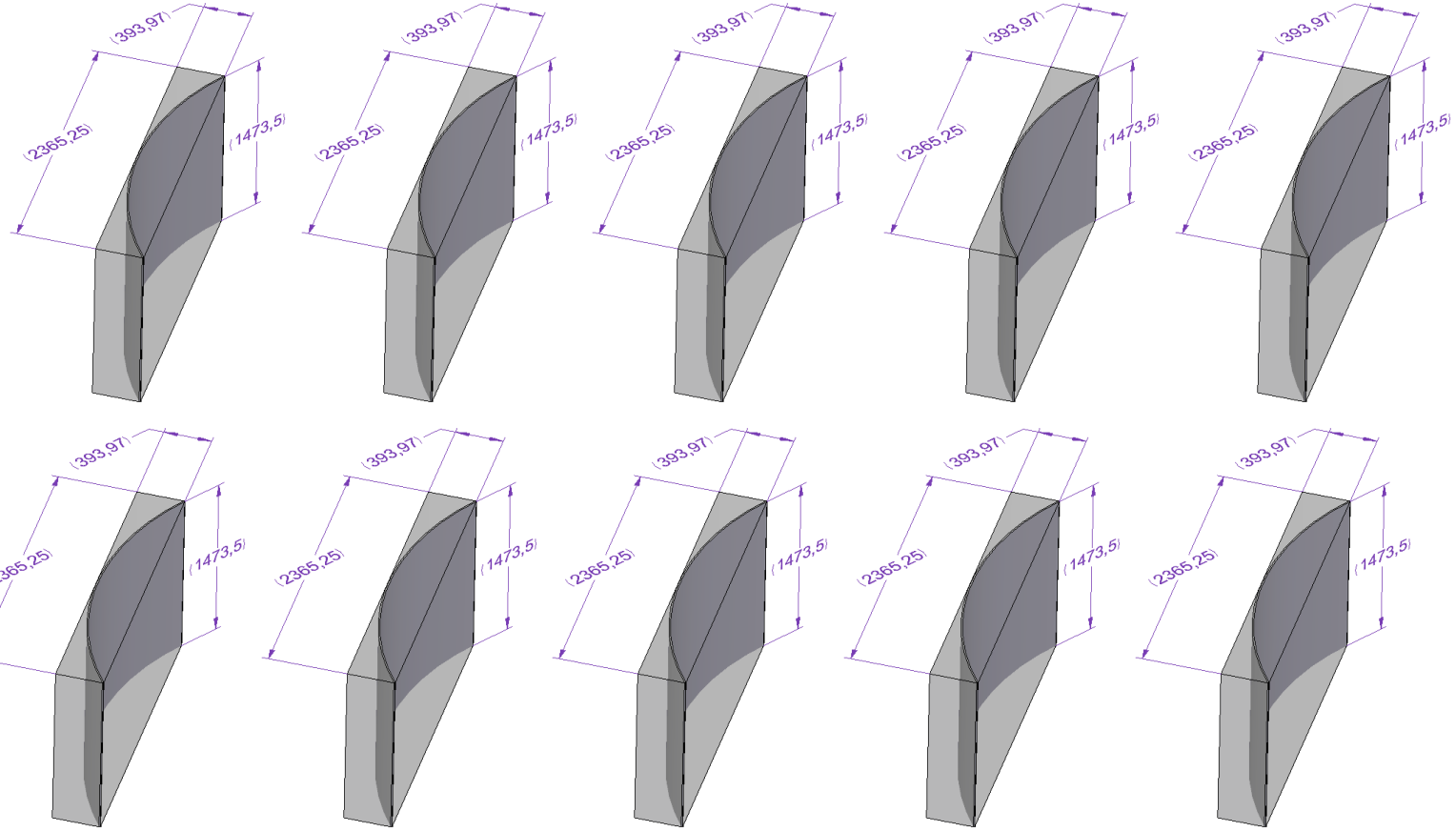


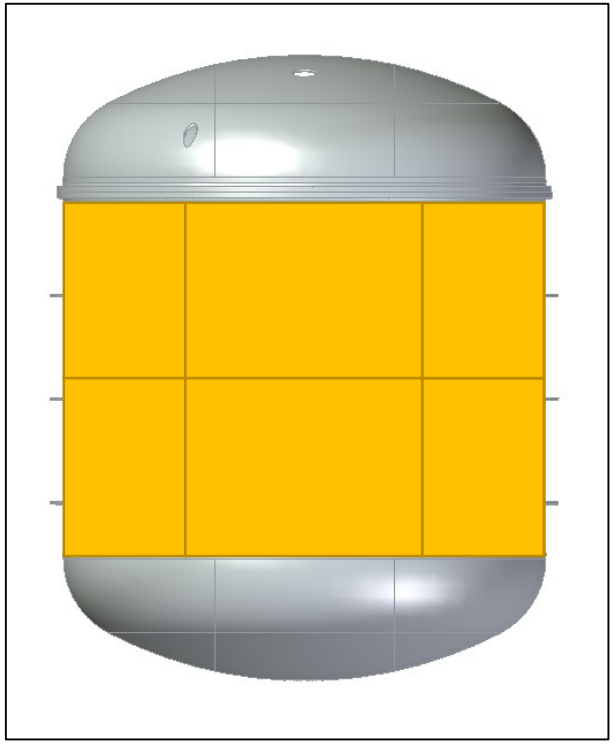
OCV Cylinder

Notes

- OCV cylinder longitudinally and circumferentially split (8 pieces total)
- The rock shaft would need to be used

Method	Width Limit (mm)	Depth Limit (mm)	Height Limit (mm)	Weight Limit (Tonnes)	Notes
Man-Shaft Palletised Loads	1800	2200	2000	6	Cage compromises of three levels. Two levels in the cage can hold palletised loads. 6 tonnes is total cage limit.
Man-Shaft Winched Trailer	1200	775	6000		Weight limit needs clarified
Rock Shaft	1800	2500	~6000	25	Location of centre of mass needs to be below the hook. Use of the rock-shaft should be reserved for a few key items. Mitigation against dust contamination needs considered.

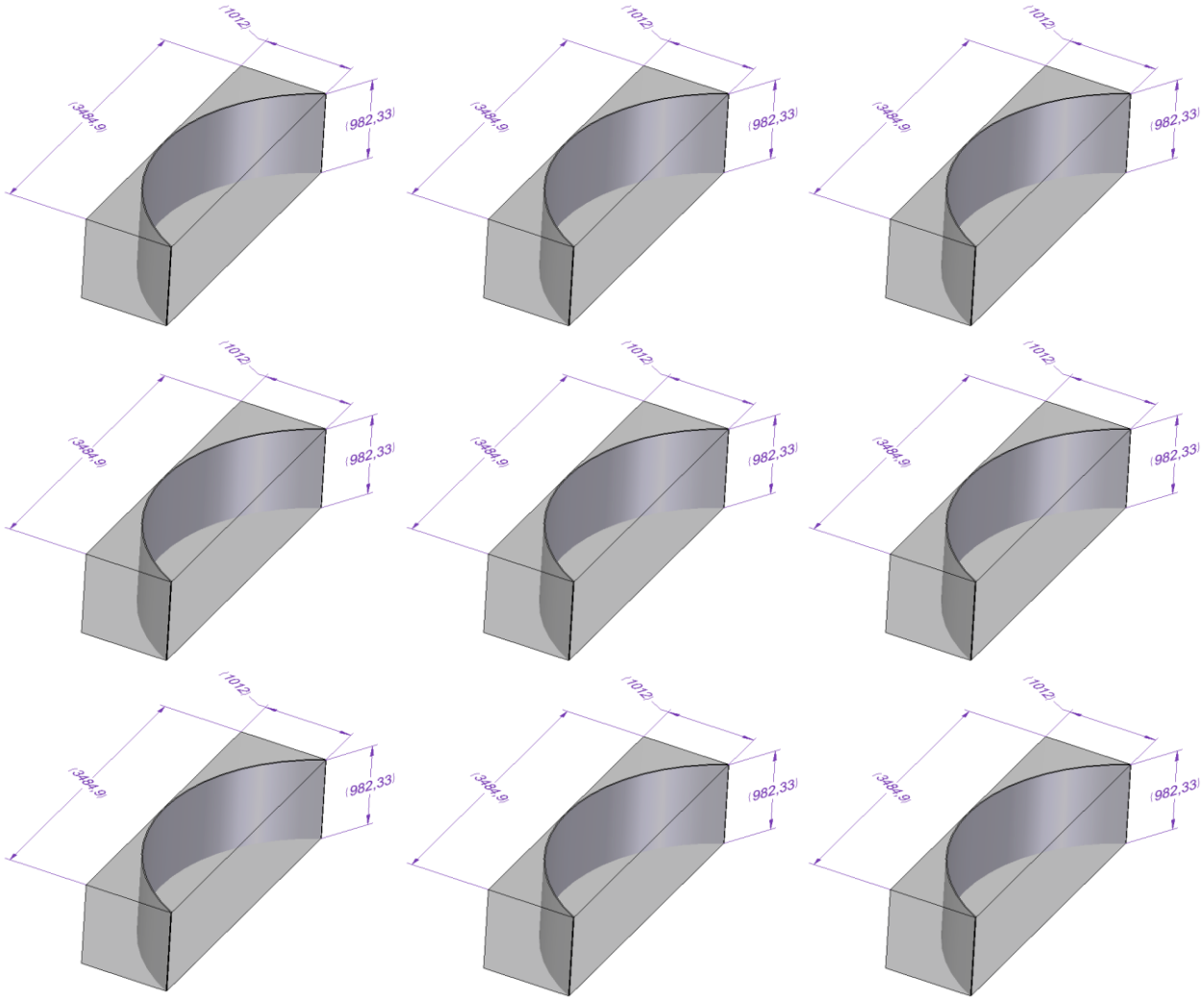




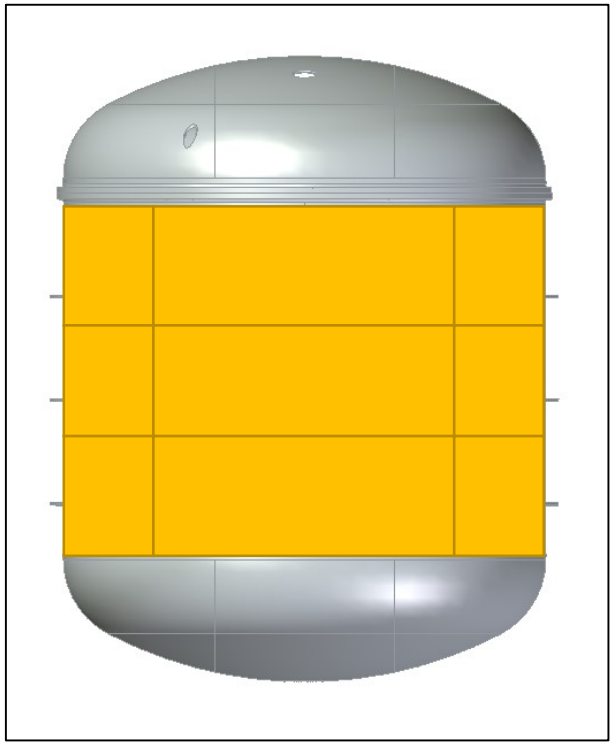
OCV Cylinder

Notes

- OCV cylinder longitudinally and circumferentially split (9 pieces total)
- The rock shaft would need to be used



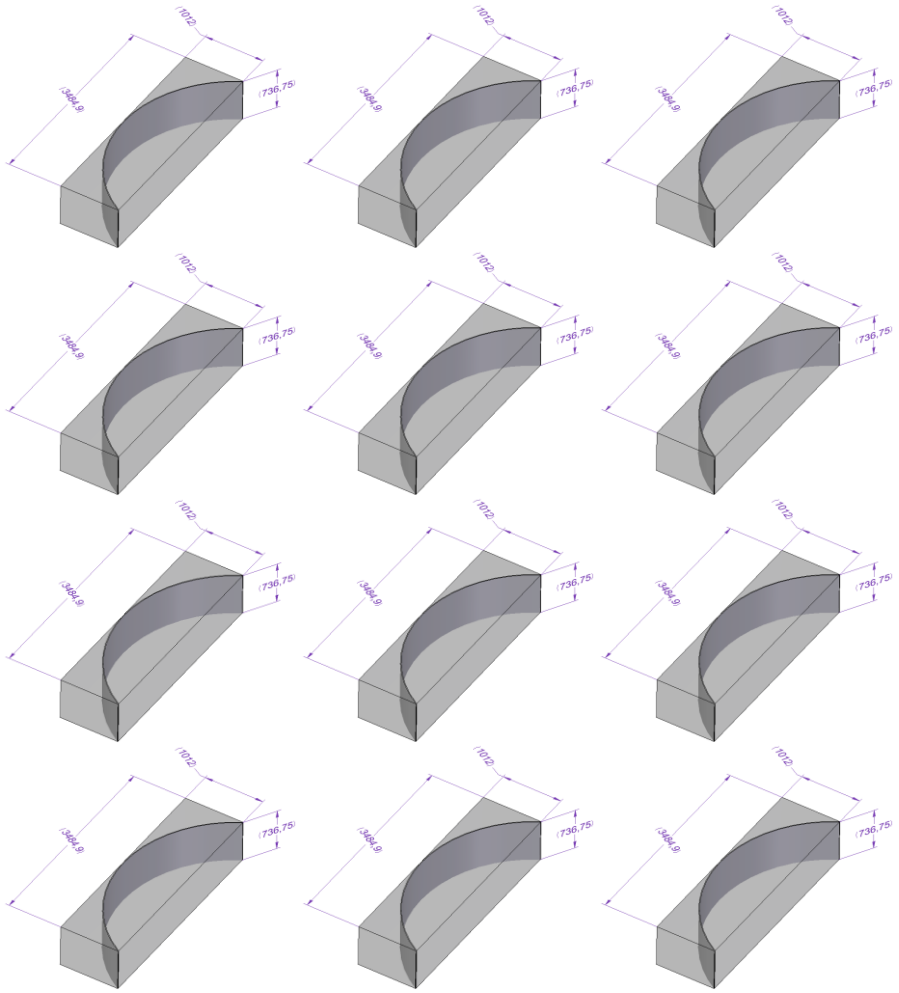
Method	Width Limit (mm)	Depth Limit (mm)	Height Limit (mm)	Weight Limit (Tonnes)	Notes
Man-Shaft Palletised Loads	1800	2200	2000	6	Cage compromises of three levels. Two levels in the cage can hold palletised loads. 6 tonnes is total cage limit.
Man-Shaft Winched Trailer	1200	775	6000		Weight limit needs clarified
Rock Shaft	1800	2500	~6000	25	Location of centre of mass needs to be below the hook. Use of the rock-shaft should be reserved for a few key items. Mitigation against dust contamination needs considered.



OCV Cylinder

Notes

- OCV cylinder longitudinally and circumferentially split (12 pieces total)
- The rock shaft would need to be used



Method	Width Limit (mm)	Depth Limit (mm)	Height Limit (mm)	Weight Limit (Tonnes)	Notes
Man-Shaft Palletised Loads	1800	2200	2000	6	Cage compromises of three levels. Two levels in the cage can hold palletised loads. 6 tonnes is total cage limit.
Man-Shaft Winched Trailer	1200	775	6000		Weight limit needs clarified
Rock Shaft	1800	2500	~6000	25	Location of centre of mass needs to be below the hook. Use of the rock-shaft should be reserved for a few key items. Mitigation against dust contamination needs considered.