	Calculated cost [MEur]	Project margin %	Project margin [MEur]	Technological margin %	Technological margin [MEur]
TOTAL	**1744**		**471**		**411**
1. Site preparation	**116**		**43**		**1**
1. 1. Land purchase	67	50%	33	0%	0
1. 2. Site infrastructure works	38	20%	8	0%	0
1. 3. Site facility construction	1	20%	0	0%	0
1. 4. Security installation construction	2	20%	0	0%	0
1. 5. Human resources	8	20%	2	10%	1
2. Repository construction	**998**		**290**		**277**
2. 1. Construction and outfitting shafts and ramp	173	30%	52	30%	52
2. 2. Construction and outfitting main gallery	21	30%	6	30%	6
2. 3. Construction and outfitting secondary galleries	129	30%	39	30%	39
2. 4. Construction and outfitting LILW and (TE)NORM disposal galleries	429	30%	129	30%	129
2. 5. Construction and outfitting non-heat-emitting HLW disposal galleries	43	30%	13	30%	13
2. 6. Construction and outfitting heat-emitting disposal galleries	96	30%	29	30%	29
2. 7. Construction and outfitting the pilot facility	4	30%	1	30%	1
2. 8. Ventilation system	6	30%	2	10%	1
2. 9. Site facility construction	17	20%	3	0%	0
2. 10. Maintenance	5	20%	1	10%	1
2. 11. Insurance	1	20%	0	0%	0
2. 12. Human resources	74	20%	15	10%	7
3. LILW and (TE)NORM waste disposal campaign	**423**		**85**		**86**
3. 1. Transport system	4	30%	1	10%	0
3. 2. Backfilling	11	20%	2	10%	1
3. 3, Sealing	95	20%	19	50%	48
3. 4, Site facility construction	64	20%	13	20%	13
3. 5, Maintenance	13	20%	3	10%	1
3. 6, Insurance	11	20%	2	0%	0
3. 7, Human resources	225	20%	45	10%	22
4. HLW disposal campaign	**76**		**15**		**21**
4. 1. Waste post-conditioning	11	20%	2	50%	5
4. 2. Backfilling	3	20%	1	10%	0
4. 3, Sealing	23	20%	5	50%	12
4. 4, Maintenance	5	20%	1	10%	0
4. 5, Insurance	2	20%	0	0%	0
4. 6, Human resources	33	20%	7	10%	3
5. Underground observation	**16**		**13**		**6**
5. 1, Maintenance	16	20%	3	10%	2
5. 2, Insurance	7	20%	1	0%	0
5. 3, Human resources	45	20%	9	10%	4
6. Repository closure	**116**		**25**		**21**
6. 1. Backfilling galleries and ramp	27	20%	5	10%	3
6. 2, Sealing galleries and ramp	17	20%	3	50%	9
6. 3, Sealing shafts	6	20%	1	50%	3
6. 4, Backfilling shafts	4	20%	1	10%	0
6. 5, Dismantling and decommissioning nuclear facilities	9	35%	3	10%	1
6. 6, Site dismantling and clearance	4	25%	1	5%	0
6. 7, Human resources	50	20%	10	10%	5

Totale kosten (in miljoen euro)

	Costs	Margins	Time (a)	Cost/a	Year
Kostenpost	**€ 2.626**	**34%**	**59**	**€ 45**	-
Voorbereiden locatie	€ 160	27%	**2**	€ 80	2
Bouw eindberging	€ 1.564	36%	**13**	€ 120	15
Plaatsen LMRA	€ 593	29%	**23**	€ 26	38
Plaatsen HRA	€ 112	32%	3	€ 37	41
Ondergrondse observatie	€ 35	55%	**10**	€ 4	51
Sluiting	€ 162	28%	**8**	€ 20	59

		planning [years]			quantity	unit	unit cost [Eur]	total cost [Eur]
		start	end	duration				
1.	**Site preparation**	**2115**	**2117**	**2**				**115,79**
1. 1.	**Land purchase**	**2115**	**2115**	**0**				**66,54**
1. 1. 1	nominal cost of land purchase				1.900.000	m²	35	66.500.000
1. 1. 2	notary fee				66.500.000	%	0,057%	37.905
1. 2.	**Site infrastructure works**	**2115**	**2117**	**2**				**38,43**
1. 2. 1	landscaping				445.500	m²	28	12.474.000
1. 2. 2	roads and parking lots				74.500	m²	207	15.421.500
1. 2. 3	green park area				200.000	m²	34	6.800.000
1. 2. 4	architect/engineer fee				34.695.500	%	4%	1.387.820
1. 2. 5	sewage system					ff	950.977	950.977
1. 2. 6	connection of site to utilities networks and sewage					ff	1.391.655	1.391.655
1. 3.	**Site facility construction**	**2115**	**2117**	**2**				**0,78**
1. 3. 1	utility buildings				2	unit	391.579	783.158
1. 4.	**Security installation construction**	**2115**	**2117**	**2**				**2,37**
1. 4. 1	security post construction				2	unit	61.758	123.516
1. 4. 2	security post furniture				2	unit	83.910	167.820
1. 4. 3	fence				6.600	m	90	594.000
1. 4. 4	perimeter gate				4	unit	10.069	40.276
1. 4. 5	monitoring system				2	unit	391.579	783.158
1. 4. 6	access control system				2	unit	167.820	335.640
1. 4. 7	automatic entrance detection system				1	unit	109.293	109.293
1. 4. 8	architect/engineer fee				2.153.703	%	10%	215.370
1. 5.	**Human resources**	**2115**	**2117**	**2**				**7,67**
1. 5. 1	Operator				2	year	1.805.364	3.610.728
1. 5. 2	COVRA				2	year	936.388	1.872.777
1. 5. 3	study cost for repository construction					ff	881.416	881.416
1. 5. 4	application and granting of the construction license					ff	1.308.800	1.308.800
2.	**Repository construction**	**2117**	**2130**	**13**				**997,57**
2. 1.	**Construction and outfitting shafts and ramp**	**2117**	**2124**	**7**				**173,44**
2. 1. 1	shaft construction				2	unit	44.981.233	89.962.466
2. 1. 2	shaft hoisting system				2	unit	4.564.692	9.129.384
2. 1. 3	ramp construction				1	unit	51.728.418	51.728.418
2. 1. 4	ramp hoisting system				1	unit	4.564.692,00	4.564.692
2. 1. 5	casting ramp floor				24.500	m³	400	9.800.000
2. 1. 6	architect/engineer fee				165.184.960	%	5%	8.259.248
2. 2.	**Construction and outfitting main gallery**	**2124**	**2125**	**1**				**21,39**
2. 2. 1	TBM				1	unit	4.934.976	4.934.976
2. 2. 2	assembly TBM				1	turn	592.951	592.951
2. 2. 3	dismantling TBM				1	turn	155.497	155.497
2. 2. 4	lining installation				1.000	m	12.441	12.441.000
2. 2. 5	casting floor				2.700	m³	400	1.080.000
2. 2. 6	outfitting (electricity, fire protection)				1.000	m	1.168	1.168.000
2. 2. 7	architect/engineer fee				20.372.424	%	5%	1.018.621
2. 3.	**Construction and outfitting secondary galleries**	**2125**	**2131**	**6**				**128,62**
2. 3. 1	TBM				2	unit	4.934.976	9.869.952
2. 3. 2	assembly TBM				10	turn	592.951	5.929.510
2. 3. 3	dismantling TBM				5	turn	155.497	777.485
2. 3. 4	lining installation				6.000	m	12.441	74.646.000
2. 3. 5	crossings				10	unit	1.778.887	17.788.870
2. 3. 6	casting floor				16.200	m³	400	6.480.000
2. 3. 7	outfitting (electricity, fire protection)				6.000	m	1.168	7.008.000
2. 3. 8	architect/engineer fee				122.499.817	%	5%	6.124.991
2. 4.	**Construction and outfitting LILW and (TE)NORM disposal galleries**	**2126**	**2136**	**10**				**429,09**
2. 4. 1	TBM				4	unit	4.934.976	19.739.904
2. 4. 2	assembly TBM				71	turn	592.951	42.099.521
2. 4. 3	dismantling TBM				71	turn	155.497	11.040.287
2. 4. 4	lining installation				14.200	m	12.441	176.662.200
2. 4. 5	end plug				2.237	m³	400	894.600
2. 4. 6	crossings				71	unit	1.778.887	126.300.977
2. 4. 7	casting floor				38.340	m³	400	15.336.000
2. 4. 8	outfitting (electricity, fire protection)				14.200	m	1.168	16.585.600
2. 4. 9	architect/engineer fee				408.659.089	%	5%	20.432.954
2. 5.	**Construction and outfitting non-heat-emitting HLW disposal galleries**	**2131**	**2137**	**6**				**42,86**
2. 5. 1	TBM				0	unit	3.046.281	0
2. 5. 2	assembly TBM				10	turn	244.690	2.446.900

2. 5. 3	dismantling TBM				10	turn	58.781	587.810
2. 5. 4	lining installation				2.000	m	9.152	18.304.000
2. 5. 5	end plug				114	m^3	400	45.600
2. 5. 6	crossings				10	unit	1.778.887	17.788.870
2. 5. 7	casting floor				1.200	m^3	400	480.000
2. 5. 8	outfitting (electricity, fire protection)				2.000	m	583	1.166.000
2. 5. 9	architect/engineer fee				40.819.180	%	5%	2.040.959
2. 6.	**Construction and outfitting heat-emitting disposal galleries**	**2125**	**2130**	**5**				**95,99**
2. 6. 1	TBM				2	unit	3.046.281	6.092.562
2. 6. 2	assembly TBM				33	turn	244.690	8.074.770
2. 6. 3	dismantling TBM				33	turn	58.781	1.939.773
2. 6. 4	lining installation				1.650	m	9.152	15.100.800
2. 6. 5	end plug				376	m^3	400	150.480
2. 6. 6	crossings				33	unit	1.778.887	58.703.271
2. 6. 7	casting floor				990	m^3	400	396.000
2. 6. 8	outfitting (electricity, fire protection)				1.650	m	583	961.950
2. 6. 9	architect/engineer fee				91.419.606	%	5%	4.570.980
2. 7.	**Construction and outfitting the pilot facility**	**2130**	**2130**	**0**				**3,61**
2. 7. 1	TBM (gallery diameter 3,7 m)				0	unit	4.934.976	0
2. 7. 2	assembly TBM (gallery diameter 3,7 m)				1	turn	592.951	592.951
2. 7. 3	dismantling TBM (gallery diameter 3,7 m)				1	turn	155.497	155.497
2. 7. 4	lining installation (gallery diameter 3,7 m)				100	m	12.441	1.244.100
2. 7. 5	end plug secondary gallery				32	m^3	400	12.920
2. 7. 6	casting floor secondary gallery				270	m^3	400	108.000
2. 7. 7	outfitting (electricity, fire protection) secondary gallery				100	m	1.168	116.800
2. 7. 8	TBM (gallery diameter 2,2 m)				0	unit	3.046.281	0
2. 7. 9	assembly TBM (gallery diameter 2,2 m)				2	turn	244.690	489.380
2. 7. 10	dismantling TBM (gallery diameter 2,2 m)				2	turn	58.781	117.562
2. 7. 11	lining installation (gallery diameter 2,2 m)				60	m	9.152	549.120
2. 7. 12	end plug disposal gallery				23	m^3	400	9.120
2. 7. 13	casting floor disposal gallery				36	m^3	400	14.400
2. 7. 14	outfitting (electricity, fire protection) disposal gallery				60	m	583	34.980
2. 7. 15	architect/engineer fee				3.395.450	%	5%	169.773
2. 8.	**Ventilation system**	**2117**	**2130**	**13**				**5,58**
2. 8. 1	fan main system				2	unit	30.706	61.412
2. 8. 2	fan auxiliary system				2	unit	15.605	31.210
2. 8. 3	main duct				13.100	m	201	2.633.100
2. 8. 4	10 m spiral duct connecting ducts of crossings galleries				116	unit	473	54.868
2. 8. 5	regulation gate at gallery crossing				116	unit	302	35.032
2. 8. 6	ducts in the disposal galleries				17.910	m	126	2.256.660
2. 8. 7	architect/engineer fee				5.072.282	%	10%	507.228
2. 9.	**Site facility construction**	**2117**	**2130**	**13**				**16,89**
2. 9. 1	visitor centre				1	unit	1.576.947	1.576.947
2. 9. 2	exhibition room furbishing				1	unit	573.435	573.435
2. 9. 3	administration building				1	unit	1.919.017	1.919.017
2. 9. 4	services building				1	unit	364.713	364.713
2. 9. 5	maintenance building				1	unit	490.033	490.033
2. 9. 6	ramp building				1	unit	6.102.529	6.102.529
2. 9. 7	backfill material processing building				1	unit	377.594	377.594
2. 9. 8	geotextile under rock dump				160.000	m^2	4	640.000
2. 9. 9	geotextile over rock dump				320.000	m^2	4	1.280.000
2. 9. 10	non-fertile soil cover on rock dump				250.000	m^3	3	750.000
2. 9. 11	fertile soil cover on rock dump				80.000	m^3	16	1.280.000
2. 9. 12	architect/engineer fee				15.354.268	%	10%	1.535.427
2. 10.	**Maintenance**	**2117**	**2130**	**13**				**5,04**
2. 10. 1	security buildings				13	year	4.800	62.696
2. 10. 2	utility buildings				13	year	10.000	130.616
2. 10. 3	administration building				11	year	46.750	517.132
2. 10. 4	services building				11	year	8.900	98.449
2. 10. 5	maintenance building				11	year	23.650	261.608
2. 10. 6	ramp building				6	year	63.000	381.884
2. 10. 7	shaft buildings				6	year	92.500	560.702
2. 10. 8	backfill material processing building				0	year	26.500	0
2. 10. 9	security installations				13	year	24.441	319.240
2. 10. 10	ramp hoisting system				6	year	22.000	133.356
2. 10. 11	shaft hoisting systems				6	year	44.000	266.712
2. 10. 12	visitor centre				11	year	129.100	1.428.058
2. 10. 13	green park area				13	year	67.600	882.967
2. 11.	**Insurance**	**2117**	**2130**	**13**				**0,58**
2. 11. 1	security posts				13	year	2.444	31.923
2. 11. 2	utility buildings				13	year	2.310	30.172
2. 11. 3	administration building				11	year	5.660	62.609
2. 11. 4	services building				11	year	1.076	11.902
2. 11. 5	maintenance building				11	year	1.445	15.984
2. 11. 6	ramp building				6	year	18.000	109.110

2. 11.	7	ramp hoisting system				6	year	13.464	81.614
2. 11.	8	shaft hoisting systems				6	year	26.928	163.228
2. 11.	9	backfill material processing building				0	year	1.114	0
2. 11.	10	visitor centre				11	year	6.390	70.684
2. 12.		**Human resources**	**2117**	**2130**	**13**				**74,46**
2. 12.	1	Operator				13	year	4.506.618	58.863.839
2. 12.	2	COVRA				13	year	939.963	12.277.456
2. 12.	3	study cost for partial repository closure					ff	440.708	440.708
2. 12.	4	application and granting of the operation license					ff	553.520	553.520
2. 12.	5	control of the construction license				13	year	178.204	2.327.637
3.		**LILW and (TE)NORM waste disposal campaign**	**2130**	**2153**	**23**				**422,88**
3. 1.		**Transport system**	**2130**	**2130**	**0**				**4,16**
3. 1.	1	standard locomotive with an integrated human control cabin				3	unit	695.496	2.086.488
3. 1.	2	waste transport cart				3	unit	606.075	1.818.225
3. 1.	3	relocatable turntable				3	unit	84.453	253.359
3. 2.		**Backfilling**	**2130**	**2153**	**23**				**10,77**
3. 2.	1	backfill material				24.508	m³	180	4.411.440
3. 2.	2	backfill operations				71	turn	89.504	6.354.784
3. 3.		**Sealing**	**2130**	**2153**	**23**				**95,01**
3. 3.	1	lining removal for seal installation				71	turn	390.000	27.690.000
3. 3.	2	seal bentonite				12.851	m³	5.000	64.255.000
3. 3.	3	concrete support for seal				7.668	m³	400	3.067.200
3. 4.		**Site facility construction**	**2148**	**2153**	**5**				**64,28**
3. 4.	1	post-conditioning facility				1	unit	49.227.068	49.227.068
3. 4.	2	pre-cast hall				1	unit	9.207.699	9.207.699
3. 4.	3	architect/engineer fee				58.434.767	%	10%	5.843.477
3. 5.		**Maintenance**	**2130**	**2153**	**23**				**12,95**
3. 5.	1	security buildings				23	year	4.800	110.400
3. 5.	2	utility buildings				23	year	10.000	230.000
3. 5.	3	administration building				23	year	46.750	1.075.250
3. 5.	4	services building				23	year	8.900	204.700
3. 5.	5	maintenance building				23	year	23.650	543.950
3. 5.	6	ramp building				23	year	63.000	1.449.000
3. 5.	7	shaft buildings				23	year	92.500	2.127.500
3. 5.	8	backfill material processing building				23	year	26.500	609.500
3. 5.	9	security installations				23	year	24.441	562.143
3. 5.	10	ramp hoisting system				23	year	22.000	506.000
3. 5.	11	shaft hoisting systems				23	year	44.000	1.012.000
3. 5.	12	visitor centre				23	year	129.100	2.969.300
3. 5.	13	green park area				23	year	67.600	1.554.800
3. 6.		**Insurance**	**2130**	**2153**	**23**				**11,01**
3. 6.	1	security posts				23	year	2.444	56.212
3. 6.	2	utility buildings				23	year	2.310	53.130
3. 6.	3	administration building				23	year	5.660	130.180
3. 6.	4	services building				23	year	1.076	24.748
3. 6.	5	maintenance building				23	year	1.445	33.235
3. 6.	6	ramp building				23	year	18.000	414.000
3. 6.	7	ramp hoisting system				23	year	13.464	309.672
3. 6.	8	shaft hoisting systems				23	year	26.928	619.344
3. 6.	9	backfill material processing building				23	year	1.114	25.622
3. 6.	10	visitor centre				23	year	6.390	146.970
3. 6.	11	Third-Party Liability				23	year	400.000	9.200.000
3. 7.		**Human resources**	**2130**	**2153**	**23**				**224,70**
3. 7.	1	Operator				23	year	8.407.035	193.361.805
3. 7.	2	COVRA				23	year	1.184.140	27.235.209
3. 7.	3	control of the operation license				23	year	178.204	4.098.692
4.		**HLW disposal campaign**	**2153**	**2156**	**3**				**75,74**
4. 1.		**Waste post-conditioning**	**2153**	**2156**	**3**				**10,63**
4. 1.	1	overpack				1.278	unit	5.206	6.653.268
4. 1.	2	filler				353	m³	110	38.830
4. 1.	3	concrete buffer				6.148	m³	400	2.459.200
4. 1.	4	envelope				198	ton	7.482	1.482.109
4. 2.		**Backfilling**	**2153**	**2156**	**3**				**2,52**
4. 2.	1	backfill material				5.333	m³	180	959.940
4. 2.	2	backfill operations (gallery length 45 m)				33	turn	20.138	664.554
4. 2.	3	backfill operations (gallery length 200 m)				10	turn	89.504	895.040
4. 3.		**Sealing**	**2153**	**2156**	**3**				**23,01**

4. 3. 1	lining removal for seal installation				43	turn	120.000	5.160.000
4. 3. 2	seal bentonite				3.440	m^3	5.000	17.200.000
4. 3. 3	concrete support for seal				1.634	m^3	400	653.600
4. 4.	**Maintenance**	**2153**	**2156**	**3**				**4,65**
4. 4. 1	security buildings				3	year	4.800	14.400
4. 4. 2	utility buildings				3	year	10.000	30.000
4. 4. 3	administration building				3	year	46.750	140.250
4. 4. 4	services building				3	year	8.900	26.700
4. 4. 5	maintenance building				3	year	23.650	70.950
4. 4. 6	ramp building				3	year	63.000	189.000
4. 4. 7	shaft buildings				3	year	92.500	277.500
4. 4. 8	backfill material processing building				3	year	26.500	79.500
4. 4. 9	security installations				3	year	24.441	73.323
4. 4. 10	ramp hoisting system				3	year	22.000	66.000
4. 4. 11	shaft hoisting systems				3	year	44.000	132.000
4. 4. 12	visitor centre				3	year	129.100	387.300
4. 4. 13	green park area				3	year	67.600	202.800
4. 4. 14	post-conditioning facility				3	year	880.000	2.640.000
4. 4. 15	pre-cast hall				3	year	106.990	320.970
4. 5.	**Insurance**	**2153**	**2156**	**3**				**1,95**
4. 5. 1	security posts				3	year	2.444	7.332
4. 5. 2	utility buildings				3	year	2.310	6.930
4. 5. 3	administration building				3	year	5.660	16.980
4. 5. 4	services building				3	year	1.076	3.228
4. 5. 5	maintenance building				3	year	1.445	4.335
4. 5. 6	ramp building				3	year	18.000	54.000
4. 5. 7	ramp hoisting system				3	year	13.464	40.392
4. 5. 8	shaft hoisting systems				3	year	26.928	80.784
4. 5. 9	backfill material processing building				3	year	1.114	3.342
4. 5. 10	visitor centre				3	year	6.390	19.170
4. 5. 11	post-conditioning facility				3	year	145.200	435.600
4. 5. 12	pre-cast hall				3	year	27.159	81.477
4. 5. 13	Third-Party Liability				3	year	400.000	1.200.000
4. 6.	**Human resources**	**2153**	**2156**	**3**				**32,97**
4. 6. 1	Operator				3	year	9.626.737	28.880.211
4. 6. 2	COVRA				3	year	1.184.140	3.552.419
4. 6. 3	control of the operation license				3	year	178.204	534.612
5.	**Underground observation**	**2156**	**2166**	**10**				**66,74**
5. 1.	**Maintenance**	**2156**	**2166**	**10**				**15,50**
5. 1. 1	security buildings				10	year	4.800	48.000
5. 1. 2	utility buildings				10	year	10.000	100.000
5. 1. 3	administration building				10	year	46.750	467.500
5. 1. 4	services building				10	year	8.900	89.000
5. 1. 5	maintenance building				10	year	23.650	236.500
5. 1. 6	ramp building				10	year	63.000	630.000
5. 1. 7	shaft buildings				10	year	92.500	925.000
5. 1. 8	backfill material processing building				10	year	26.500	265.000
5. 1. 9	security installations				10	year	24.441	244.410
5. 1. 10	ramp hoisting system				10	year	22.000	220.000
5. 1. 11	shaft hoisting systems				10	year	44.000	440.000
5. 1. 12	visitor centre				10	year	129.100	1.291.000
5. 1. 13	green park area				10	year	67.600	676.000
5. 1. 14	post-conditioning facility				10	year	880.000	8.800.000
5. 1. 15	pre-cast hall				10	year	106.990	1.069.900
5. 2.	**Insurance**	**2156**	**2166**	**10**				**6,51**
5. 2. 1	security posts				10	year	2.444	24.440
5. 2. 2	utility buildings				10	year	2.310	23.100
5. 2. 3	administration building				10	year	5.660	56.600
5. 2. 4	services building				10	year	1.076	10.760
5. 2. 5	maintenance building				10	year	1.445	14.450
5. 2. 6	ramp building				10	year	18.000	180.000
5. 2. 7	ramp hoisting system				10	year	13.464	134.640
5. 2. 8	shaft hoisting systems				10	year	26.928	269.280
5. 2. 9	backfill material processing building				10	year	1.114	11.140
5. 2. 10	visitor centre				10	year	6.390	63.900
5. 2. 11	post-conditioning facility				10	year	145.200	1.452.000
5. 2. 12	pre-cast hall				10	year	27.159	271.590
5. 2. 13	Third-Party Liability				10	year	400.000	4.000.000
5. 3.	**Human resources**	**2156**	**2166**	**10**				**44,73**
5. 3. 1	Operator				10	year	3.615.351	36.153.510
5. 3. 2	COVRA				10	year	623.717	6.237.165
5. 3. 3	study cost for repository closure					ff	440.708	440.708

5. 3. 4	application and granting of the dismantling and decommissioning license					ff	112.940	112.940
5. 3. 5	control of the operation license				10	year	178.204	1.782.040
6.	**Repository closure**	**2166**	**2174**	**8**				**116,32**
6. 1.	**Backfilling galleries and ramp**	**2166**	**2170**	**4**				**26,64**
6. 1. 1	backfill material				130.080	m^3	180	23.414.400
6. 1. 2	backfill operations				6	turn	537.023	3.222.137
6. 2.	**Sealing galleries and ramp**	**2170**	**2171**	**1**				**17,04**
6. 2, 1	gallery lining removal for seal installation				11	turn	390.000	4.290.000
6. 2. 2	ramp lining removal for seal installation				1	turn	735.000	735.000
6. 2. 3	seal bentonite (gallery seals)				1.991	m^3	5.000	9.955.000
6. 2. 4	seal bentonite (ramp seal)				302	m^3	5.000	1.510.000
6. 2. 5	concrete support (gallery seals)				1.188	m^3	400	475.200
6. 2. 6	concrete support (ramp seal)				196	m^3	400	78.400
6. 3.	**Sealing shafts**	**2170**	**2171**	**1**				**6,03**
6. 3. 1	dismantling hoisting system				2	unit	400.000	800.000
6. 3. 2	ad hoc rent of 2 temporary hoisting systems				1	years	1.000.000	1.000.000
6. 3. 3	dismantling and removal of the shaft interior				1.000	m	1.050	1.050.000
6. 3. 4	seal bentonite				604	m^3	5.000	3.020.000
6. 3. 5	concrete support for seal				392	m^3	400	156.800
6. 4.	**Backfilling shafts**	**2171**	**2172**	**1**				**3,53**
6. 4. 1	backfill material				19.635	m^3	180	3.534.300
6. 5.	**Dismantling and decommissioning nuclear facilities**	**2166**	**2168**	**2**				**8,86**
6. 5. 1	post-conditioning facility				8.859.540	unit	1	8.859.540
6. 6.	**Site dismantling and clearance**	**2172**	**2174**	**2**				**3,74**
6. 6. 1	security infrastructure				37.283	unit	1	37.283
6. 6. 2	utility buildings				176.184	unit	2	352.368
6. 6. 3	administration building				86.343	unit	1	86.343
6. 6. 4	services building				16.410	unit	1	16.410
6. 6. 5	maintenance building				22.048	unit	1	22.048
6. 6. 6	visitor centre				71.485	unit	1	71.485
6. 6. 7	backfill material processing building				16.989	unit	1	16.989
6. 6. 8	pre-cast hall				414.284	unit	1	414.284
6. 6. 9	air-lock ramp building				1.098.290	unit	1	1.098.290
6. 6. 10	levelling of soil and sowing of grass				11.000	m^2	5	55.000
6. 6. 11	clear road surface and parking lots				74.500	m^2	21	1.564.500
6. 7.	**Human resources**	**2166**	**2174**	**8**				**50,49**
6. 7. 1	Operator				8	year	5.974.773	47.798.184
6. 7. 2	COVRA				8	year	157.976	1.263.810
6. 7. 3	control of the dismantling and decommissioning license				8	year	178.204	1.425.632

ONDRAF/NIRAS

Planning input data

Start disposal campaign	2130	
Duration site preparation	2	years
Duration repository construction	13	years

Section	construction time (years)
Shaft and ramp construction	7
Ramp	7
Shaft 1	7
Shaft 2	7
Main + sec. gallery construction	1
Disposal galleries LILW/NORM	5
Disposal galleries HLW	5
Pilot facility	0 Included in HLW

Construction time	length (m)	turns (-)	excavation (days)	crossings (days)	total time (years)	TBM (-)
Main gallery	1000	0	50	0	0,1	2
Sec. galleries	6000	10	150	188	0,9	4
All galeries	7000	10	200	187,5	1	

Construction time	length (m)	turns (-)	excavation (days)	crossings (days)	total time (years)	TBM (-)	
disposal LILW/NORM	14200	71	355	1331	5	4	
disposal HLW	3710	45	185,5	1688	5	2	Including pilot

Secondary gallery	1	year
Disposal gallery 200m	0,1	year
Disposal gallery 50m	0,1	year

Disposal campaign 1 — 23 years

Waste	Number (-)	Disposal rate (-/day)	Disposal time (days)
200L	140000	50	2800
600L	0	0	0
1000L	12000	25	480
1500L	0	0	0
Konrad	9060	5	1812
			5092

161060

Disposal campaign 2 — 3 years

Waste	Number (-)	Disposal rate (-/day)	Disposal time (days)
Spent RR Fuel	75	2	38
CSD-V	478	2	239
CSD-C	625	2	313
ECN	100	2	50
			640

Supercontainers	-
CSD-V + CSD-C	478
SRRF+ECN	175
Totaal	1278

653

Duration underground observation phase	10	years
Duration repository closure	8	years

Section	closure time (years)
Backfilling galleries and ramp	4
Sealing galleries, ramp and shafts	1
Backfilling shafts	1
Dismantling and decommissioning post-conditioning facility	2
Site dismantling and clearance	2

Duration post-operational phase	100	years

Planning

	START	END	DURATION
	2115	2274	159
1 Site preparation	2115	2117	2
2 Repository construction	2117	2130	13
3 Disposal campaign 1	2130	2153	23
4 Disposal campaign 2	2153	2156	3
5 Underground observation phase	2156	2166	10
6 Repository closure	2166	2174	8
7 Post-operational phase	2174	2274	100

OPERATOR & COVRA

		reference		cost	index type	indexed cost
blood test administration personnel	[4]	p. 121	2008	228,51	w	255,76
blood test controlled zone	[4]	p. 121	2008	153,73	w	172,06

meal ticket	5
number of days in operation	226
average number of working days per employee	206
number of working hours per year	1650

salary code	salary [EUR/hour] 2012
100	178,55
101	94,38
102	64,72
103	54,73
104	49,37

salary code	salary [EUR/hour] 2012
200	315,29
201	163,94
202	118,53
203	100,57
204	90,50

Study cost repository construction

	salary code	salary [EUR/hour]	involvement [hours)	cost [EUR]
project manager	201	163,94	1400	229516
follow-up of the studies	201	163,94	700	114758
follow-up of the studies	202	118,53	1400	165942
license application documents	201	163,94	700	114758
license application documents	202	118,53	1400	165942
secretary	204	90,5	1000	90500
				881416

Study cost repository closure

	salary code	salary [EUR/hour]	involvement [hours]	cost [EUR]
project manager	201	163,94	700	114758
follow-up of the studies	201	163,94	350	57379
follow-up of the studies	202	118,53	700	82971
license application documents	201	163,94	350	57379
license application documents	202	118,53	700	82971
secretary	204	90,5	500	45250
				440708

REGULATOR

construction license

application (incl. environmental impact assessment)	301760	euro
granting	1007040	euro

operation license

application (incl. environmental impact assessment)	175880	euro
granting	377640	euro

dismantling and decommissioning license

application (incl. environmental impact assessment)	81470	euro
granting	31470	euro

license control

annual cost	178204	euro/year

Wage index

year	index
2001	7,4990
2002	7,8905
2003	8,1173
2004	8,3116
2005	8,5392
2006	8,7846
2007	8,9295
2008	9,1367
2009	9,5314
2010	9,6200
2011	9,7547

2012	10,0464
2013	10,3546
2014	10,4985

Construction industry price index

year	index
2001	540
2002	547
2003	560
2004	590
2005	612
2006	648
2007	665
2008	695
2009	670
2010	690
2011	705
2012	729
2013	739
2014	744

Heavy machinery and equipment price index

year	index
2005	94,1
2006	95,4
2007	97,3
2008	99,2
2009	101,1
2010	99,7
2011	101,2
2012	107,5
2013	108,8
2014	108,1

Function	salary [EUR/hour]	involvement [hours/year]	Phase 1 Site preparation	Phase 2 Repository construction	Phase 3 Disposal campaign LILW and (TE)NORM waste	Phase 4 Disposal campaign HLW waste	Phase 5 Underground observation phase	Phase 6 Repository closure	Phase 7 Post-operational phase
STRATEGIC MANAGEMENT									
General management			100%	100%	50%	50%	25%	25%	10%
chief executive officer	85,00	300	300	300	150	150	75	75	30
deputy director-general	85,00	100	100	100	50	50	25	25	10
secretary	35,00	100	100	100	50	50	25	25	10
Staff functions			100%	100%	50%	50%	25%	25%	10%
head of physical inspection	57,00	1200	1200	1200	600	600	300	300	120
internal service for prevention and protection at work	57,00	100	100	100	50	50	25	25	10
quality manager	57,00	100	100	100	50	50	25	25	10
safety strategy & environment protection	57,00	200	200	200	100	100	50	50	20
safety officer	57,00	100	100	100	50	50	25	25	10
secretary	29,00	400	400	400	200	200	100	100	40
GENERAL SERVICES									
Management			100%	100%	100%	100%	75%	75%	0%
director-coach for general services	85,00	100	100	100	100	100	75	75	0
General administration			0%	0%	100%	100%	50%	50%	0%
administrative assistant (human resource)	40,00	100	0	0	100	100	50	50	0
administrative assistant (logistics)	35,00	20	0	0	20	20	10	10	0
ICT technician	45,00	200	0	0	200	200	100	100	0
Legal advice			100%	100%	100%	100%	100%	100%	0%
legal advisor	140,00	200	200	200	200	200	200	200	0
Financial administration			100%	100%	100%	100%	100%	100%	0%
accountant	57,00	400	400	400	400	400	400	400	0
Purchasing & contracts			100%	100%	100%	100%	100%	100%	0%
purchaser	57,00	200	200	200	200	200	200	200	0
Communications			100%	100%	100%	100%	100%	100%	0%
communications expert	57,00	200	200	200	200	200	200	200	0
WASTE MANAGEMENT PLANNING									
Management			100%	100%	100%	100%	25%	25%	0%
director-coach for prescient waste management	85,00	300	300	300	300	300	75	75	0
secretary	35,00	100	100	100	100	100	25	25	0
Waste inventory			100%	100%	100%	100%	0%	0%	0%
radioactive waste treatment & conditioning expert	57,00	825	825	825	825	825	0	0	0
Cost evaluations			100%	100%	100%	100%	50%	50%	0%
cost engineer	57,00	600	600	600	600	600	300	300	0
Asset & Liability management (ALM)			100%	100%	100%	100%	50%	50%	0%
financial analyst	57,00	200	200	200	200	200	100	100	0
LONG-TERM WASTE MANAGEMENT									
Management			75%	75%	100%	100%	50%	0%	25%
director-coach for long term waste management	85,00	600	450	450	600	600	300	0	150
secretary	35,00	150	113	113	150	150	75	0	38
Acceptance criteria			50%	50%	100%	100%	0%	0%	0%
definition/revision of waste acceptance criteria	57,00	825	413	413	825	825	0	0	0
regularisations & derogations from acceptance criteria	57,00	200	100	100	200	200	0	0	0
Review Committee for Acceptance Criteria (meetings & secretariat)	57,00	200	100	100	200	200	0	0	0
Certifications			50%	50%	100%	100%	0%	0%	0%
certifications coordinator	57,00	200	100	100	200	200	0	0	0
certification of post-conditioning lines	45,00	400	200	200	400	400	0	0	0
certification of radiological characterization of waste for post-conditioning	45,00	400	200	200	400	400	0	0	0
certification of supercontainer prefabricated elements	45,00	400	200	200	400	400	0	0	0
secretary	29,00	400	200	200	400	400	0	0	0
RD&D geological disposal and licensing			100%	100%	100%	100%	100%	0%	50%
geotechnical engineer	57,00	1650	1650	1650	1650	1650	1650	0	825
nuclear physicist	57,00	1650	1650	1650	1650	1650	1650	0	825
geologist	57,00	1650	1650	1650	1650	1650	1650	0	825
chemist	57,00	1650	1650	1650	1650	1650	1650	0	825
secretary	29,00	1650	1650	1650	1650	1650	1650	0	825
CONTEMPORARY WASTE MANAGEMENT									
Management			0%	10%	100%	100%	0%	0%	0%

director-coach for contemporary waste management	85,00	300	0	30	300	300	0	0	0
secretary	35,00	100	0	10	100	100	0	0	0
Waste acceptance			10%	10%	100%	100%	0%	0%	0%
waste acceptance coordinator	57,00	400	40	40	400	400	0	0	0
inspection of radioactive waste for post-conditioning	45,00	1650	165	165	1650	1650	0	0	0
inspection of Monoliths or Supercontainers	45,00	1650	165	165	1650	1650	0	0	0
secretary	29,00	900	90	90	900	900	0	0	0
Installations management			0%	10%	100%	100%	0%	0%	0%
management of the post-conditioning installations	57,00	100	0	10	100	100	0	0	0
Installations dismantling			0%	10%	100%	100%	0%	0%	0%
dismantling of the post-conditioning installations	57,00	0	0	0	0	0	0	0	0

OPERATOR HUMAN RESOURCES							
Total salary cost	**[EUR]**	909.115	912.585	1.149.650	1.149.650	605.550	153.375	240.688
Various expenses (3% of the salary cost)	**[EUR]**	27.273	27.378	34.490	34.490	18.167	4.601	7.221
TOTAL COST		**936.388**	**939.963**	**1.184.140**	**1.184.140**	**623.717**	**157.976**	**247.908**

Function	Headcount	Salary [EUR/hour]	Site preparation	Repository construction	Disposal campaign LILW and (TE)NORM	Disposal campaign HLW waste	Underground observation phase	Repository closure	Post-operational phase	(ADM: administration; CZ: controlled zone)
General management			100%	100%	100%	100%	100%	100%	50%	
chief executive officer	1	85,00	1,0	1,0	1,0	1,0	1,0	1,0	0,5	ADM
secretary	1	35,00	1,0	1,0	1,0	1,0	1,0	1,0	0,5	ADM
Human resources			50%	100%	100%	100%	50%	100%	0%	
legal advisor	1	56,00	0,5	1,0	1,0	1,0	0,5	1,0	0,0	ADM
administrative assistant	2	30,00	1,0	2,0	2,0	2,0	1,0	2,0	0,0	ADM
Finance			100%	100%	100%	100%	50%	100%	0%	
financial controller	1	56,00	1,0	1,0	1,0	1,0	0,5	1,0	0,0	ADM
accountant	2	56,00	2,0	2,0	2,0	2,0	1,0	2,0	0,0	ADM
Contracts			100%	100%	100%	100%	50%	100%	0%	
contract specialist	1	140,00	1,0	1,0	1,0	1,0	0,5	1,0	0,0	ADM
administrative assistant	1	30,00	1,0	1,0	1,0	1,0	0,5	1,0	0,0	ADM
Archival			0%	100%	100%	100%	50%	100%	50%	
knowledge management officer	1	56,00	0,0	1,0	1,0	1,0	0,5	1,0	0,5	ADM
filing clerk	2	24,00	0,0	2,0	2,0	2,0	1,0	2,0	1,0	ADM
ICT			50%	100%	100%	100%	50%	100%	0%	
ICT coordinator	1	45,00	0,5	1,0	1,0	1,0	0,5	1,0	0,0	ADM
ICT assistant	1	30,00	0,5	1,0	1,0	1,0	0,5	1,0	0,0	ADM
Visitors Centre			0%	100%	100%	100%	100%	100%	100%	
supervisor	1	33,00	0,0	1,0	1,0	1,0	1,0	1,0	1,0	
receptionist	1	30,00	0,0	1,0	1,0	1,0	1,0	1,0	1,0	
touring guide	3	33,00	0,0	3,0	3,0	3,0	3,0	3,0	3,0	
Service management			0%	100%	100%	100%	50%	100%	0%	
service manager	1	56,00	0,0	1,0	1,0	1,0	0,5	1,0	0,0	
secretary	1	30,00	0,0	1,0	1,0	1,0	0,5	1,0	0,0	
General maintenance (non-industrial site infrastructure)			0%	100%	100%	100%	50%	100%	0%	
supervisor	1	45,00	0,0	1,0	1,0	1,0	0,5	1,0	0,0	
maintenance technician	4	36,00	0,0	4,0	4,0	4,0	2,0	4,0	0,0	
materials/stock manager	1	27,00	0,0	1,0	1,0	1,0	0,5	1,0	0,0	
Radiological laboratory			0%	0%	100%	100%	100%	100%	0%	
radiological laboratory technician	1	37,00	0,0	0,0	1,0	1,0	1,0	1,0	0,0	ADM+CZ
laboratory assistant	1	24,00	0,0	0,0	1,0	1,0	1,0	1,0	0,0	ADM+CZ
Land survey (surface + underground)			100%	100%	100%	100%	100%	100%	0%	
land surveyor	1	56,00	1,0	1,0	1,0	1,0	1,0	1,0	0,0	ADM+CZ
assistant land surveyor	1	56,00	1,0	1,0	1,0	1,0	1,0	1,0	0,0	ADM+CZ
Fire brigade			50%	100%	100%	100%	50%	50%	0%	
fire brigade captain	1	45,00	0,5	1,0	1,0	1,0	0,5	0,5	0,0	ADM+CZ
Site security management			50%	100%	100%	100%	100%	100%	100%	
security manager	1	45,00	0,5	1,0	1,0	1,0	1,0	1,0	1,0	
Permanent security outer perimeter			0%	100%	100%	100%	100%	100%	100%	
entry/exit control guard	4	30,00	0,0	4,0	4,0	4,0	4,0	4,0	4,0	
patrol guard	4	30,00	0,0	4,0	4,0	4,0	4,0	4,0	4,0	
Daytime reinforcement outer perimeter			100%	100%	100%	100%	100%	100%	100%	
entry/exit control guard	1,5	30,00	1,5	1,5	1,5	1,5	1,5	1,5	1,5	
patrol guard	1,5	30,00	1,5	1,5	1,5	1,5	1,5	1,5	1,5	
Permanent security inner perimeter			0%	100%	100%	100%	100%	100%	0%	
entry/exit control guard	4	30,00	0,0	4,0	4,0	4,0	4,0	4,0	0,0	
patrol guard	4	30,00	0,0	4,0	4,0	4,0	4,0	4,0	0,0	
Daytime reinforcement inner perimeter			0%	100%	100%	100%	100%	100%	0%	
entry/exit control guard	1,5	30,00	0,0	1,5	1,5	1,5	1,5	1,5	0,0	
General tasks			0%	50%	100%	100%	50%	100%	0%	
operational safety coordinator	1	45,00	0,0	0,5	1,0	1,0	0,5	1,0	0,0	ADM+CZ
nuclear safety coordinator	1	56,00	0,0	0,5	1,0	1,0	0,5	1,0	0,0	ADM
environmental protection coordinator	1	56,00	0,0	0,5	1,0	1,0	0,5	1,0	0,0	ADM
general QA coordinator	1	56,00	0,0	0,5	1,0	1,0	0,5	1,0	0,0	ADM
Emergency management			0%	0%	100%	100%	0%	0%	0%	
emergency manager	1	56,00	0,0	0,0	1,0	1,0	0,0	0,0	0,0	ADM
Site monitoring			0%	0%	100%	100%	50%	100%	50%	
site monitoring coordinator	1	56,00	0,0	0,0	1,0	1,0	0,5	1,0	0,5	ADM
Waste conformity			0%	0%	100%	100%	0%	0%	0%	
waste conformity manager	1	54,00	0,0	0,0	1,0	1,0	0,0	0,0	0,0	ADM+CZ
Follow-up team			100%	100%	100%	0%	0%	100%	0%	
construction engineer	1	56,00	1,0	1,0	1,0	0,0	0,0	1,0	0,0	ADM
geotechnical engineer	1	56,00	1,0	1,0	1,0	0,0	0,0	1,0	0,0	ADM
electro-mechanical engineer	1	56,00	1,0	1,0	1,0	0,0	0,0	1,0	0,0	ADM
nuclear engineer	1	56,00	1,0	1,0	1,0	0,0	0,0	1,0	0,0	ADM
Industrial operations management department			0%	0%	100%	100%	0%	0%	0%	
industrial operations manager	1	54,00	0,0	0,0	1,0	1,0	0,0	0,0	0,0	ADM+CZ
planning coordinator	1	54,00	0,0	0,0	1,0	1,0	0,0	0,0	0,0	ADM
secretary	1	29,00	0,0	0,0	1,0	1,0	0,0	0,0	0,0	ADM

Post-conditioning facility			0%	0%	0%	100%	0%	0%	0%	
shift supervisor	1	36,00	0,0	0,0	0,0	1,0	0,0	0,0	0,0	CZ
operator	14	30,00	0,0	0,0	0,0	14,0	0,0	0,0	0,0	CZ
radiological protection supervisor	2	38,00	0,0	0,0	0,0	2,0	0,0	0,0	0,0	CZ
QA supervisor	1	33,00	0,0	0,0	0,0	1,0	0,0	0,0	0,0	CZ
waste bookkeeper	1	33,00	0,0	0,0	0,0	1,0	0,0	0,0	0,0	CZ
administrative assistant	1	22,00	0,0	0,0	0,0	1,0	0,0	0,0	0,0	CZ
maintenance technician – foreman	1	36,00	0,0	0,0	0,0	1,0	0,0	0,0	0,0	CZ
maintenance technician	4	27,00	0,0	0,0	0,0	4,0	0,0	0,0	0,0	CZ
Precast hall for supercontainer concrete components			0%	0%	0%	100%	0%	0%	0%	
shift supervisor	1	36,00	0,0	0,0	0,0	1,0	0,0	0,0	0,0	
operator	4	30,00	0,0	0,0	0,0	4,0	0,0	0,0	0,0	
administrative assistant	1	22,00	0,0	0,0	0,0	1,0	0,0	0,0	0,0	
Underground operations support department			0%	100%	150%	150%	50%	50%	0%	
underground shift supervisor	1	45,00	0,0	1,0	1,5	1,5	0,5	0,5	0,0	CZ
underground radiological protection supervisor	1	38,00	0,0	1,0	1,5	1,5	0,5	0,5	0,0	CZ
maintenance technician – foreman	1	45,00	0,0	1,0	1,5	1,5	0,5	0,5	0,0	CZ
maintenance technician	3	36,00	0,0	3,0	4,5	4,5	1,5	1,5	0,0	CZ
Shaft and ramp operation and maintenance department			0%	0%	150%	150%	50%	100%	0%	
supervisor (mechanical)	1	45,00	0,0	0,0	1,5	1,5	0,5	1,0	0,0	CZ
supervisor (electrical)	1	45,00	0,0	0,0	1,5	1,5	0,5	1,0	0,0	CZ
maintenance electrician	5	36,00	0,0	0,0	7,5	7,5	2,5	5,0	0,0	CZ
maintenance mechanic	5	36,00	0,0	0,0	7,5	7,5	2,5	5,0	0,0	CZ
Mine rescue team			0%	0%	150%	150%	0%	50%	0%	
team captain	1	56,00	0,0	0,0	1,5	1,5	0,0	0,5	0,0	CZ
Waste disposal department			0%	0%	150%	150%	0%	0%	0%	
waste cart pilot	2	55,00	0,0	0,0	3,0	3,0	0,0	0,0	0,0	CZ
waste cart co-pilot	2	55,00	0,0	0,0	3,0	3,0	0,0	0,0	0,0	CZ
operator preparing the next disposal gallery section	2	55,00	0,0	0,0	3,0	3,0	0,0	0,0	0,0	CZ
Backfilling of disposal galleries			0%	0%	150%	150%	0%	0%	0%	
shift supervisor	1	36,00	0,0	0,0	1,5	1,5	0,0	0,0	0,0	CZ
radiological protection supervisor	1	38,00	0,0	0,0	1,5	1,5	0,0	0,0	0,0	CZ
operator	3	30,00	0,0	0,0	4,5	4,5	0,0	0,0	0,0	CZ
Sealing of disposal galleries			0%	0%	100%	100%	0%	0%	0%	
shift supervisor	1	36,00	0,0	0,0	1,0	1,0	0,0	0,0	0,0	CZ
operator	5	30,00	0,0	0,0	5,0	5,0	0,0	0,0	0,0	CZ
Backfilling and sealing of access galleries, shafts and ramp			0%	0%	0%	0%	0%	300%	0%	
shift supervisor	1	36,00	0,0	0,0	0,0	0,0	0,0	3,0	0,0	CZ
operator	2	30,00	0,0	0,0	0,0	0,0	0,0	6,0	0,0	CZ

OPERATOR HUMAN RESOURCES							
Total headcount	**[persons]**	20	65	120	147	55	88	20
Total salary cost	**[EUR/year]**	1.690.425	4.290.825	8.043.750	9.228.450	3.436.125	5.691.675	1.117.050
Various expenses (1% of the salary cost)	**[EUR/year]**	16.904	42.908	80.438	92.285	34.361	56.917	11.171
Overall personnel cost	**[EUR/year]**	1.707.329	4.333.733	8.124.188	9.320.735	3.470.486	5.748.592	1.128.221

BOARD OF DIRECTORS	**[EUR/year]**	25.000	25.000	25.000	25.000	25.000	25.000	25.000

EXTERNAL SERVICES							
People working in the administration zone	**[persons]**	17	25	34	30	16	29	3
People working in the controlled zone	**[persons]**	0	0	3	3	3	3	3
Medical services	**[EUR/year]**	0	0	20.812	25.458	9.714	15.306	0
Catering services	**[EUR/year]**	22.035	72.885	135.035	165.545	62.150	98.875	22.600
Office support	**[EUR/year]**	51.000	75.000	102.000	90.000	48.000	87.000	9.000

TOTAL COST	**[EUR/year]**	**1.805.364**	**4.506.618**	**8.407.035**	**9.626.737**	**3.615.351**	**5.974.773**	**1.184.821**

cost item in the OPERA cost calculation		reference			estimated cost item	cost [EUR]	index type	cost indexed to 2014 [EUR]	remarks or additional calculations
1.1.1.	nominal cost of land purchase	[4]	p. 94	2013	1 m² industry land (> 10 ha)	35	fixed	35	item 1.2.1 in the ONDRAF/NIRAS spreadsheet [4]
1.1.2.	notary fee	[4]	p. 94	2013	percentage of purchase cost	0,057%			in the ONDRAF/NIRAS cost evaluation a flat fee of 2.449,20 euro is assumed for the first 250.095 euro (item 1.2.4 in the ONDRAF/NIRAS spreadsheet) and a percentage on the amount above 250.095 euro (item 1.2.3 in the ONDRAF/NIRAS spreadsheet); here the percentage is applied on the whole amount and not only on the amount above 250.095 euro
1.2.1.	landscaping	[9]	p. 78	2007	landscaping 1 m²	25	c	28	
1.2.2.	roads and parking lots	[9]	p. 78	2007	1 m² road or parking	185	c	207	
1.2.3.	green park area	[9]	p. 78	2007	1 m² green park	30	c	34	
1.2.4.	architect/engineer fee site preparation works	[4]	p. 94	2013	percentage of construction cost	4%			item 1.4.6 in the ONDRAF/NIRAS spreadsheet
1.2.5.	sewage system	[9]	p. 78	2007	site sewage system	850.000	c	950.977	
1.2.6.	connection of site to utilities networks and sewage	[15]	p. 4	2008	connection to network 1500 m from site	1.300.000	c	1.391.655	
1.3.1.	utility building	[9]	p. 78	2007	100 m² utility building (including architect and engineering fee)	350.000	c	391.579	
1.4.1.	security post construction	[9]	p. 78	2007	construction of 48 m² security post	55.200	c	61.758	1150 euro/m² construction cost
1.4.2.	security post furniture	[9]	p. 78	2007	furniture 1 security post	75.000	c	83.910	
1.4.3.	fence	[9]	p. 78	2007	1 m fence	80	c	90	
1.4.4.	perimeter gate	[9]	p. 78	2007	construction of 1 perimeter gate	9.000	c	10.069	average between the two types of gates (the inner gate and personnel gate on the one hand and the nuclear and industrial transport gates on the other hand) which cost has been estimated at 8.000 euro and 10.000 euro respectively
1.4.5.	monitoring system	[9]	p. 78	2007	closed-circuit television system monitoring	350.000	c	391.579	
1.4.6.	access control system	[9]	p. 78	2007	access control system	150.000	c	167.820	
1.4.7.	automatic entrance detection system	[16]	p. 1	2010	detection system per perimeter length of 1400 m	101.360	c	109.293	the detection system considered in the memo is for a perimeter of 4x75 m and its cost was estimated at 21.720 euro; this cost was multiplied with 4,67 to estimate the cost for a 1400 m long perimeter
1.4.8.	architect/engineer fee	[9]	p. 78	2007	percentage of construction cost	10%			
2.1.1.	shaft construction	[9]	p. 92	2007	construction of a shaft (depth: 500 m, internal diameter: 5 m), including the construction of a breakout	40.205.000	c	44.981.233	an interpolation is made between the estimated costs for constructing (including breakout) the personnel shaft (internal diameter: 4 m; depth: 250 m) and the construction shaft (internal diameter: 6 m; depth: 250 m); the interpolated cost is doubled to come to an estimation for a shaft with a depth of 500 m
2.1.2.	shaft hoisting system	[9]	p. 92	2007	shaft hoisting system	4.080.000	c	4.564.692	an interpolation is made between the cost estimations for the hoisting system of the personnel shaft (internal diameter: 4 m; depth: 250 m) and the construction shaft (internal diameter: 6 m; depth: 250 m); the interpolated cost is doubled to come to an estimation for a shaft with a depth of 500 m
2.1.3.	ramp construction	[10]	p. 33	2012	construction of a ramp (depth: 500 m, internal diameter: 5 m)	50.685.506	c	51.728.418	an evaluation of the construction of a shaft and ramp in the ONDRAF/NIRAS disposal concept shows that constructing a ramp would cost 15% more than constructing a shaft
2.1.4.	ramp hoisting system	see cost item 2.1.2							
2.1.5.	casting ramp floor	[9]	p. 92	2007	casting 1 m³ concrete	400	fixed	400	
2.1.6.	architect/engineer fee	[4]	p. 94	2013	percentage of construction cost	5%			the ONDRAF/NIRAS cost evaluation assumed 5% or 10% architect/engineering fees on the repository construction depending on the repository part (items 2.1.4, 2.2.4, 2.4.4, 2.5.4, 2.7.6, 2.9.2 and 2.10.2 in the ONDRAF/NIRAS spreadsheet) ; the use of an overall fee of 5% here is justified by the study costs related to repository construction that were included in the human resources during the site preparation phase
2.2.1.	TBM	[9]	p. 92	2007	TBM (gallery diameter: 3.7 m)	4.441.935	m	4.934.976	intrapolation based on the cost estimations for disposal gallery (gallery diameter: 3 m) and access gallery (gallery diameter: 6 m): TBM cost proportional to the gallery diameter; the assembly and dismantling cost proportional to the square of the gallery diameter
2.2.2.	assembly TBM	[9]	p. 92	2007	assembly of a TBM (gallery diameter: 3.7 m)	533.711	m	592.951	
2.2.3.	dismantling TBM	[9]	p. 92	2007	dismantling of a TBM (gallery diameter: 3.7 m)	139.962	m	155.497	
2.2.4.	lining installation	[9]	p. 92	2007	installation of 1 m concrete wedge block lining (gallery diameter: 3.7 m)	11.120	c	12.441	interpolation between the cost estimations for the lining installation for disposal and access gallery; the cost is proportional to the lining volume
2.2.5.	casting floor	see cost item 2.1.5.							

2.2.6.	outfitting (electricity, fire protection)	[9]	p. 92	2007	outfitting of 1 m concrete wedge block lining (gallery diameter: 3.7 m)	1.044	c	1.168	interpolation between the cost estimations for the equipment for disposal and access gallery; the cost is proportional to the lining volume
2.2.7.	architect/engineer fee	see cost item 2.1.6							
2.3.1.	TBM	see cost item 2.2.1							
2.3.2.	assembly TBM	see cost item 2.2.2							
2.3.3.	dismantling TBM	see cost item 2.2.3							
2.3.4.	lining installation	see cost item 2.2.4							
2.3.5.	gallery crossing construction	[9]	p. 92	2007	construction of a crossing between 2 galleries with an equal inner diameter of 3.7 m at a depth of 500 m	1.590.000	c	1.778.887	the construction cost is assumed to be similar to the construction of a crossing between galleries with inner diameters of 6.0 m and 3.0 m at a repository depth of 250 m
2.3.6.	casting floor	see cost item 2.1.5.							
2.3.7.	outfitting (electricity, fire protection)	see cost item 2.2.6							
2.3.8.	architect/engineer fee	see cost item 2.1.6							
2.4.1.	TBM	see cost item 2.2.1							
2.4.2.	assembly TBM	see cost item 2.2.2							
2.4.3.	dismantling TBM	see cost item 2.2.3							
2.4.4.	lining installation	see cost item 2.2.4							
2.4.5.	end plug	[9]	p. 92	2007	casting 1 m^3 concrete	400	fixed	400	
2.4.6.	crossings	see cost item 2.3.5.							
2.4.7.	casting floor	see cost item 2.1.5.							
2.4.8.	outfitting (electricity, fire protection)	see cost item 2.2.6							
2.4.9.	architect/engineer fee	see cost item 2.1.6							
2.5.1.	TBM	[9]	p. 92	2007	TBM (gallery diameter: 2.2 m)	2.741.935	m	3.046.281	extrapolation based on the cost estimations for disposal gallery (gallery diameter: 3 m) and access gallery (gallery diameter: 6 m): TBM cost proportional to the gallery diameter; the assembly and dismantling cost proportional to the square of the gallery diameter
2.5.2.	assembly TBM	[9]	p. 92	2007	assembly of a TBM (gallery diameter: 2.2 m)	220.244	m	244.690	
2.5.3.	dismantling TBM	[9]	p. 92	2007	dismantling of a TBM (gallery diameter: 2.2 m)	52.908	m	58.781	
2.5.4.	lining installation	[9]	p. 92	2007	installation of 1 m concrete wedge block lining (gallery diameter: 2.2 m)	8.180	c	9.152	extrapolation between the cost estimations for the lining installation for disposal and access gallery; the cost is proportional to the lining volume
2.5.5.	end plug	see cost item 2.4.5.							
2.5.6.	gallery crossing construction	[9]	p. 92	2007	construction of a crossing between 2 galleries with an inner diameter of 3.7 m and 2.2 m at a depth of 500 m	1.590.000	c	1.778.887	the construction cost is assumed to be similar to the construction of a crossing between galleries with inner diameters of 6.0 m and 3.0 m at a repository depth of 250 m
2.5.7.	casting floor	see cost item 2.1.5.							
2.5.8.	outfitting (electricity, fire protection)	[9]	p. 92	2007	outfitting of 1 m concrete wedge block lining (gallery diameter: 2.2 m)	521	c	583	extrapolation between the cost estimations for the equipment for disposal and access gallery; the cost is proportional to the lining volume
2.5.9.	architect/engineer fee	see cost item 2.1.6							
2.6.1.	TBM	see cost item 2.5.1							
2.6.2.	assembly TBM	see cost item 2.5.2							
2.6.3.	dismantling TBM	see cost item 2.5.3							
2.6.4.	lining installation	see cost item 2.5.4							
2.6.5.	end plug	see cost item 2.4.5.							
2.6.6.	crossings	see cost item 2.5.6							
2.6.7.	casting floor	see cost item 2.1.5.							
2.6.8.	outfitting (electricity, fire protection)	see cost item 2.5.8							
2.6.9.	architect/engineer fee	see cost item 2.1.6							
2.7.1.	TBM (gallery diameter 3,7 m)	see cost item 2.2.1							
2.7.2.	assembly TBM (gallery diameter 3,7 m)	see cost item 2.2.2							
2.7.3.	dismantling TBM (gallery diameter 3,7 m)	see cost item 2.2.3							
2.7.4.	lining installation (gallery diameter 3,7 m)	see cost item 2.2.4							
2.7.5.	end plug secondary gallery	see cost item 2.4.5.							
2.7.6.	casting floor secondary gallery	see cost item 2.1.5.							
2.7.7.	outfitting (electricity, fire protection) secondary gallery	see cost item 2.2.6							
2.7.8.	TBM (gallery diameter 2,2 m)	see cost item 2.5.1							
2.7.9.	assembly TBM (gallery diameter 2,2 m)	see cost item 2.5.2							
2.7.10.	dismantling TBM (gallery diameter 2,2 m)	see cost item 2.5.3							
2.7.11.	lining installation (gallery diameter 2,2 m)	see cost item 2.5.4							
2.7.12.	end plug disposal gallery	see cost item 2.4.5.							
2.7.13.	casting floor disposal gallery	see cost item 2.1.5.							

2.7.14.	outfitting (electricity, fire protection) disposal gallery	see cost item 2.5.8							
2.7.15.	architect/engineer fee	see cost item 2.1.6							
2.8.1.	fan main system	[11]	p. 59	2013	Korfmann fan (AL 14-900 (90 kW))	30.500	c	30.706	
2.8.2.	fan auxiliary system	[11]	p. 59	2013	Howden fan (Type VRE 0710/610 W 145/11)	15.500	c	15.605	
2.8.3.	main duct	[11]	p. 59	2013	1 m duct (diameter: 1000 mm)	200	c	201	
2.8.4.	10 m spiral duct connecting ducts of crossings galleries	[11]	p. 59	2013	10 m spiral duct (diameter 1000-400 mm)	470	c	473	
2.8.5.	regulation gate at gallery crossing	[11]	p. 60	2013		300	c	302	
2.8.6.	ducts in the disposal galleries	[11]	p. 59	2013	1 m duct (diameter: 400 mm)	125	c	126	
2.8.7.	architect/engineer fee	[4]	p. 95	2013	percentage of construction or installation cost	10%			items 2.12.1.2, 2.12.2.3 and 2.12.3.6 in the ONDRAF/NIRAS spreadsheet
2.9.1.	visitor centre	[17]	p. 4	2009	550 m² visitor centre	1.420.100	c	1.576.947	2840 euro/m² (architect and engineering fee included) = 2582 euro/m² (architect and engineering fee excluded)
2.9.2.	exhibition room furbishing	[17]	p. 4	2009	200 m² exhibition room	516.400	c	573.435	
2.9.3.	administration building	[7]	p. 76	2007	935 m² administration building	1.715.250	c	1.919.017	a smaller administration building is assumed in the OPERA cost evaluation (935 m² instead of 1266,5 m²) and the estimated cost is therefore reduced with 1150 EUR2007/m²
2.9.4.	services building	[7]	p. 77	2007	178 m² services building	325.987	c	364.713	
2.9.5.	maintenance building	[7]	p. 77	2007	473 m² maintenance building	438.000	c	490.033	
2.9.6.	ramp building	[7]	p. 92	2007	1260 m² ramp building	5.454.545	c	6.102.529	estimated cost (“air lock option”; ventilation not included) reduced with 10% as in architect/engineering fee of 10% was included in the estimation
2.9.7.	backfill material processing building	[7]	p. 92	2007	925 m² backfill material processing building	337.500	c	377.594	estimated cost reduced with 10% as in architect/engineering fee of 10% was included in the estimation
2.9.8.	geotextile under rock dump	[4]	p. 95	2013	1 m² geotextile	4	c	4	item 2.11.7 in the ONDRAF/NIRAS spreadsheet
2.9.9.	geotextile over rock dump	[4]	p. 95	2013	1 m² geotextile	4	c	4	item 2.11.8 in the ONDRAF/NIRAS spreadsheet
2.9.10.	non-fertile soil cover on rock dump	[4]	p. 95	2013	1 m³ non-fertile soil	3	fixed	3	items 2.11.1, 2.11.2 and 2.11.3 in the ONDRAF/NIRAS spreadsheet
2.9.11.	fertile soil cover on rock dump	[4]	p. 95	2013	1 m³ fertile soil	16	fixed	16	items 2.11.4, 2.11.5 and 2.11.6 in the ONDRAF/NIRAS spreadsheet
2.9.12.	architect/engineer fee	[4]	p. 95	2013	percentage of construction cost	10%			items 2.15.1.5, 2.15.2.4 and 2.15.3.3 in the ONDRAF/NIRAS spreadsheet
2.10.1.	security buildings	[4]	p. 79	2013	maintenance of 96 m² security building	4.800	fixed	4.800	
2.10.2.	utility buildings	[4]	p. 79	2013	maintenance of 200 m² utility buildings	10.000	fixed	10.000	
2.10.3.	administration building	[4]	p. 79	2013	maintenance of 935 m² administration building	46.750	fixed	46.750	
2.10.4.	services building	[4]	p. 79	2013	maintenance of 178 m² services building	8.900	fixed	8.900	
2.10.5.	maintenance building	[4]	p. 79	2013	maintenance of 473 m² maintenance building	23.650	fixed	23.650	the annual maintenance cost amounts 50 euro/m²
2.10.6.	ramp building	[4]	p. 79	2013	maintenance of 1260 m² ramp building	63.000	fixed	63.000	
2.10.7.	shaft buildings	[4]	p. 79	2013	maintenance of 1850 m² shaft buildings	92.500	fixed	92.500	
2.10.8.	backfill material processing building	[4]	p. 79	2013	maintenance of 530 m² backfill material processing building	26.500	fixed	26.500	
2.10.9.	security installations	[4]	p. 79	2013	maintenance cost for the security installations	24.441	fixed	24.441	it is assumed that the security installations are replaced every 30 years; therefore their annual maintenance is 3,3% of their installation cost (incl. 10% architect and engineering fee)
2.10.10.	ramp hoisting system	[4]	p. 79	2013	annual maintenance of the ramp hoisting system	22.000	fixed	22.000	the same cost as for the maintenance of the shaft hoisting system (cost item 2.9.11) is assumed; the ramp cable is 10 times longer, but the loads on the ramp cable are much smaller as well
2.10.11.	shaft hoisting systems	[4]	p. 79	2013	annual maintenance of 1 shaft hoisting system	22.000	fixed	22.000	twice (to take account of the larger depth of the shafts in the OPERA concept) the cost estimated by ONDRAF/NIRAS based on experience from the maintenance of the hoisting system of the 2nd shaft of HADES: (1) 10.000 euro cable needs to be replaced every 10 years and (2) the annual cost for safety checks by a control agency amounts 10.000 euro
2.10.12.	visitor centre	[4]	p. 79	2013	percentage of the exhibition roob furbishing	129.100	fixed	129.100	it is assumed that the exhibition room of the visitor centre will be refurbished every 4 years; therefore its annual maintenance is 25% of the cost for furbishing the exhibition room
2.10.13.	green park area	[4]	p. 79	2013	annual maintenance cost for 26 ha	67.600	fixed	67.600	cost estimated by ONDRAF/NIRAS based on following assumptions: (1) a gardener costs 25 euro/hour and can maintain 25 ha in 1 year (1.600 hours) and (2) replanting vegetation costs 50.000 euro/ha and this needs to be done gradually every 50 years
2.11.1.	security posts	[4]	p. 79	2013	insurance cost for the security posts	2.444	fixed	2.444	
2.11.2.	utility buildings	[4]	p. 79	2013	insurance cost for the utility buildings	2.310	fixed	2.310	
2.11.3.	administration building	[4]	p. 79	2013	insurance cost for the adminstration building	5.660	fixed	5.660	
2.11.4.	services building	[4]	p. 79	2013	insurance cost for the services building	1.076	fixed	1.076	
2.11.5.	maintenance building	[4]	p. 79	2013	insurance cost for the maintenance building	1.445	fixed	1.445	an approximative value of 0.33% of the construction or installation cost as assumed as insurance

2.11.6.	ramp building	[4]	p. 79	2013	insurance cost for the ramp building	18.000	fixed	18.000	an approximative value of 0,33% of the construction or installation cost as assumed as insurance cost based on experience with the BELGOPROCESS surface installations
2.11.7.	ramp hoisting system	[4]	p. 79	2013	insurance cost for the ramp hoisting system	13.464	fixed	13.464	
2.11.8.	shaft hoisting systems	[4]	p. 79	2013	insurance cost for the shaft hoisting system	26.928	fixed	26.928	
2.11.9.	backfill material processing building	[4]	p. 79	2013	insurance cost for the backfill material processing building	1.114	fixed	1.114	
2.11.10.	visitor centre	[4]	p. 79	2013	insurance cost for the visitor centre	6.390	fixed	6.390	
3.1.1.	standard locomotive with an integrated human control cabin	[12]	p. 55	2013	standard locomotive with an integrated human control cabin	700.000	m	695.496	
3.1.2.	waste transport cart	[12]	p. 55	2013	waste transport cart including coupling system	610.000	m	606.075	
3.1.3.	relocatable turntable	[12]	p. 57	2013	relocatable turntable	85.000	m	84.453	
3.2.1.	backfill material	[18a]	p. 139	2014	1 m^3 cellular concrete (foam concrete)	180	fixed	180	average between 127 euro/m^3 and 232 euro/m^3
3.2.2.	backfill operations	[9]	p. 92	2007	equipment to backfill 200 m gallery	80.000	c	89.504	20% of the estimated cost to backfill 1000 m disposal gallery
3.3.1.	lining removal for seal installation	[9]	p. 91	2007	removal of 10 m lining (inner diameter: 3.7 m)	390.000	fixed	390.000	the cost for filling the volume when increasing the gallery with 35% with bentonite was assumed to be representative for the cost for removing the gallery lining
3.3.2.	seal bentonite	[9]	p. 92	2007	1 m^3 bentonite	5.000	fixed	5.000	
3.3.3.	concrete support for seal	see cost item 2.1.5.							
3.4.1.	post-conditioning facility	[9]	p. 92	2007	post-conditioning facility for vitrified high-level waste	44.000.000	c	49.227.068	estimated cost reduced with 50% as 10% architect/engineering fee and 40% uncertainty margin were included in the estimation
3.4.2.	pre-cast hall	[9]	p. 92	2007	pre-cast hall for supercontainer concrete components	8.230.000	c	9.207.699	estimated cost reduced with 10% as an architect/engineering fee was included in the estimation
3.4.3.	architect/engineer fee				percentage of the construction cost	10%			the estimated costs for the post-conditioning facility and pre-cast hall were reduced with 10% as the estimations included the architect/engineering fee (see cost items 3.3.1 and 3.3.2 in the ONDRAF/NIRAS spreadsheet [4])
3.5.1.	security buildings	see cost item 2.10.1.							
3.5.2.	utility buildings	see cost item 2.10.2.							
3.5.3.	administration building	see cost item 2.10.3.							
3.5.4.	services building	see cost item 2.10.4.							
3.5.5.	maintenance building	see cost item 2.10.5.							
3.5.6.	ramp building	see cost item 2.10.6.							
3.5.7.	shaft buildings	see cost item 2.10.7.							
3.5.8.	backfill material processing building	see cost item 2.10.8.							
3.5.9.	security installations	see cost item 2.10.9.							
3.5.10.	ramp hoisting system	see cost item 2.10.10.							
3.5.11.	shaft hoisting systems	see cost item 2.10.11.							
3.5.12.	visitor centre	see cost item 2.10.12.							
3.5.13.	green park area	see cost item 2.10.13.							
3.6.1.	security posts	see cost item 2.11.1.							
3.6.2.	utility buildings	see cost item 2.11.2.							
3.6.3.	administration building	see cost item 2.11.3.							
3.6.4.	services building	see cost item 2.11.4.							
3.6.5.	maintenance building	see cost item 2.11.5.							
3.6.6.	ramp building	see cost item 2.11.6.							
3.6.7.	ramp hoisting system	see cost item 2.11.7.							
3.6.8.	shaft hoisting systems	see cost item 2.11.8.							
3.6.9.	backfill material processing building	see cost item 2.11.9.							
3.6.10.	visitor centre	see cost item 2.11.10.							
3.6.11.	Third-Party Liability	[4]	p. 79	2013	annual 3rd party liability in the field of nuclear energy	400.000	fixed	400.000	
4.1.1.	overpack	[14]	p. 11	2006	1 carbon steel overpack for 2 CSD-V canisters	4.503	w	5.206	
4.1.2.	filler	[4]	p. 79	2013	1 m^3 mortar	110	fixed	110	
4.1.3.	concrete buffer	[4]	p. 79	2013	1 m^3 concrete for supercontainer buffer	400	fixed	400	
4.1.4.	envelope	[4]	p. 79	2013	1 ton stainless steel	7.482	fixed	7.482	
4.2.1.	backfill material	see cost item 3.2.1.							
4.2.2.	backfill operations	[7]	p. 92	2007	equipment to backfill 45 m gallery	18.000	c	20.138	4,5% of the estimated cost to backfill 1000 m disposal gallery
4.2.3.	backfill operations	see cost item 3.1.2.							
4.3.1.	lining removal for seal installation	[9]	p. 91	2007	removal of 10 m lining (inner diameter: 2.2 m)	120.000	fixed	120.000	the cost for filling the volume when increasing the gallery with 35% with bentonite was assumed to be representative for the cost for removing the gallery lining

4.3.2.	seal bentonite	see cost item 3.2.2.							
4.3.3.	concrete support for seal	see cost item 2.1.5.							
4.4.1.	security buildings	see cost item 2.10.1.							
4.4.2.	utility buildings	see cost item 2.10.2.							
4.4.3.	administration building	see cost item 2.10.3.							
4.4.4.	services building	see cost item 2.10.4.							
4.4.5.	maintenance building	see cost item 2.10.5.							
4.4.6.	ramp building	see cost item 2.10.6.							
4.4.7.	shaft buildings	see cost item 2.10.7.							
4.4.8.	backfill material processing building	see cost item 2.10.8.							
4.4.9.	security installations	see cost item 2.10.9.							
4.4.10.	ramp hoisting system	see cost item 2.10.10.							
4.4.11.	shaft hoisting systems	see cost item 2.10.11.							
4.4.12.	visitor centre	see cost item 2.10.12.							
4.4.13.	green park area	see cost item 2.10.13.							
4.4.14.	post-conditioning facility	[4]	p. 79	2013	maintenance of the post-conditioning facility	880.000	fixed	880.000	it is assumed that the maintenance cost of the post-conditioning facility is 3% of its construction cost; this is reduced with 30% (to 2%) as maintenance costs are already partly included in the human resource costs for general maintenance
4.4.15.	pre-cast hall	[4]	p. 79	2013	maintenance of the pre-cast hall facility	106.990	fixed	106.990	it is assumed that the maintenance cost of the pre-cast hall is 2% of its construction cost; this is reduced with 30% (to 1,3%) as maintenance costs are already partly included in the human resource costs for general maintenance
4.5.1.	security posts	see cost item 2.11.1.							
4.5.2.	utility buildings	see cost item 2.11.2.							
4.5.3.	administration building	see cost item 2.11.3.							
4.5.4.	services building	see cost item 2.11.4.							
4.5.5.	maintenance building	see cost item 2.11.5.							
4.5.6.	ramp building	see cost item 2.11.6.							
4.5.7.	ramp hoisting system	see cost item 2.11.7.							
4.5.8.	shaft hoisting systems	see cost item 2.11.8.							
4.5.9.	backfill material processing building	see cost item 2.11.9.							
4.5.10.	visitor centre	see cost item 2.11.10.							
4.5.11.	post-conditioning facility	[4]	p. 79	2013	insurance cost for the post-conditioning facility	145.200	fixed	145.200	approximative value for the insurance of the BELGOPROCESS surface installations
4.5.12.	pre-cast hall	[4]	p. 79	2013	insurance cost for the pre-cast hall	27.159	fixed	27.159	approximative value for the insurance of the BELGOPROCESS surface installations
4.5.13.	Third-Party Liability	see cost item 3.6.11.							
5.1.1.	security buildings	see cost item 2.10.1.							
5.1.2.	utility buildings	see cost item 2.10.2.							
5.1.3.	administration building	see cost item 2.10.3.							
5.1.4.	services building	see cost item 2.10.4.							
5.1.5.	maintenance building	see cost item 2.10.5.							
5.1.6.	ramp building	see cost item 2.10.6.							
5.1.7.	shaft buildings	see cost item 2.10.7.							
5.1.8.	backfill material processing building	see cost item 2.10.8.							
5.1.9.	security installations	see cost item 2.10.9.							
5.1.10.	ramp hoisting system	see cost item 2.10.10.							
5.1.11.	shaft hoisting systems	see cost item 2.10.11.							
5.1.12.	visitor centre	see cost item 2.10.12.							
5.1.13.	green park area	see cost item 2.10.13.							
5.1.14.	post-conditioning facility	see cost item 4.3.14.							
5.1.15.	pre-cast hall	see cost item 4.3.15.							
5.2.1.	security posts	see cost item 2.11.1.							
5.2.2.	utility buildings	see cost item 2.11.2.							
5.2.3.	administration building	see cost item 2.11.3.							
5.2.4.	services building	see cost item 2.11.4.							
5.2.5.	maintenance building	see cost item 2.11.5.							
5.2.6.	ramp building	see cost item 2.11.6.							
5.2.7.	ramp hoisting system	see cost item 2.11.7.							
5.2.8.	shaft hoisting systems	see cost item 2.11.8.							

5.2.9.	backfill material processing building	see cost item 2.11.9.							
5.2.10.	visitor centre	see cost item 2.11.10.							
5.2.11.	post-conditioning facility	see cost item 4.4.11.							
5.2.12.	pre-cast hall	see cost item 4.4.12.							
5.2.13.	Third-Party Liability	see cost item 3.5.11.							
6.1.1.	backfill material	see cost item 3.2.1.							
6.1.2.	backfill operations	[7]	p. 92	2007	equipment to backfill 1.000 m gallery section	440.000	c	537.023	120% of the estimated cost to backfill 1000 m disposal gallery
6.2.1.	gallery lining removal for seal installation	see cost item 3.3.1.							
6.2.2.	ramp lining removal for seal installation	[7]	p. 92	2007	removal of 10 m lining (inner diameter: 3,7 m)	735.000	fixed	735.000	the cost for filling the volume when increasing the gallery with 35% with bentonite was assumed to be representative for the cost for removing the gallery lining
6.2.3.	seal bentonite (gallery seals)	see cost item 3.3.2.							
6.2.4.	seal bentonite (ramp seal)	see cost item 3.3.2.							
6.2.5.	concrete support (gallery seals)	see cost item 2.1.5.							
6.2.6.	concrete support (ramp seal)	see cost item 2.1.5.							
6.3.1.	dismantling hoisting system	[4]	p. 99	2013	cost for dismantling the shaft hoisting system	400.000	fixed	400.000	the cost for dismantling the shaft hoisting system in the ONDRAF/NIRAS concept was estimated at 200.000 euro (items 7.2.1, 12.3.1 and 12.5.1 in the ONDRAF/NIRAS spreadsheet [4]; based on the cost for removing the hoisting system in the Konrad 2 shaft); as the OPERA shafts are twice as deep, this cost is doubled
6.3.2.	ad hoc rent of 2 temporary hoisting systems	[4]	p. 103	2013	annual rent for 1 temporary hoisting system	1.000.000	fixed	1.000.000	the rental cost for 1 temporary shaft hoisting system was estimated at 500.000 euro/year by ONDRAF/NIRAS for a 250 m deep shaft; as the OPERA shafts are twice as deep, this cost is doubled
6.3.3.	dismantling and removal of the shaft interior	[4]	p. 99	2013	removal of shaft interior equipment over 1 m	1050	fixed	1.050	items 7.2.2, 12.3.2 and 12.5.2 in the ONDRAF/NIRAS spreadsheet [4]; based on the cost for removing the Konrad 2 shaft interior equipment (total cost for removing the shaft interior equipment was 1.050.000 euro; shaft depth is 1000 m) (done in 2007-2009)
6.3.4.	seal bentonite	see cost item 3.3.2.							
6.3.5.	concrete support for seal	see cost item 2.1.5.							
6.4.1.	backfill material	see cost item 3.2.1.							
6.5.1.	decommissioning and dismantling post-conditioning facility	[4]	p. 102	2013		8.800.000	c	8.859.540	ONDRAF/NIRAS experience (cf. IPM from cAt project)
6.6.1.	security posts	[4]	p. 79	2013		37.032	c	37.283	ONDRAF/NIRAS experience (cf. IPM from cAt project)
6.6.2.	utility buildings	[4]	p. 79	2013		175.000	c	176.184	ONDRAF/NIRAS experience (cf. IPM from cAt project)
6.6.3.	administration building	[4]	p. 79	2013		85.763	c	86.343	ONDRAF/NIRAS experience (cf. IPM from cAt project)
6.6.4.	services building	[4]	p. 79	2013		16.299	c	16.410	ONDRAF/NIRAS experience (cf. IPM from cAt project)
6.6.5.	maintenance building	[4]	p. 79	2013		21.900	c	22.048	ONDRAF/NIRAS experience (cf. IPM from cAt project)
6.6.6.	visitor centre	[4]	p. 79	2013		71.005	c	71.485	ONDRAF/NIRAS experience (cf. IPM from cAt project)
6.6.7.	backfill material processing building	[4]	p. 79	2013		16.875	c	16.989	ONDRAF/NIRAS experience (cf. IPM from cAt project)
6.6.8.	dismantling pre-cast hall	[4]	p. 79	2013		411.500	c	414.284	ONDRAF/NIRAS experience (cf. IPM from cAt project)
6.6.9.	air-lock ramp building	[4]	p. 79	2013		1.090.909	c	1.098.290	ONDRAF/NIRAS experience (cf. IPM from cAt project)
6.6.10.	levelling of soil and sowing of grass	[4]	p. 79	2013	levelling 1 m^2 soil and sowing grass	5	c	5	ONDRAF/NIRAS experience (cf. IPM from cAt project)
6.6.11.	clear road surface and parking lots	[4]	p. 79	2013	break up 1 m^2 road and sowing grass	21	c	21	ONDRAF/NIRAS experience (cf. IPM from cAt project)

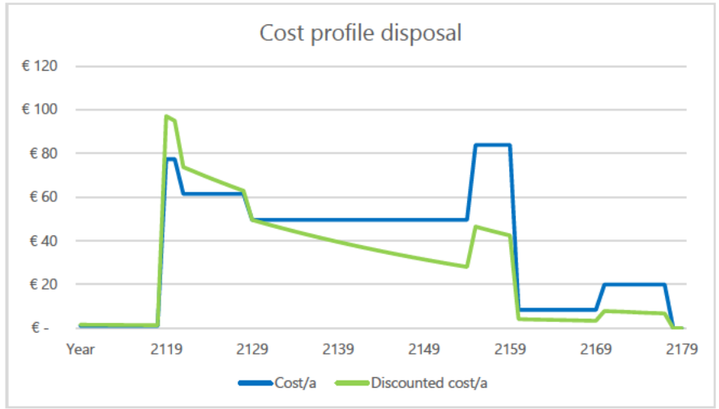
	Calculated cost [MEur]	Project margin %	Project margin [MEur]	Technological marg n %	Technological marg n [MEur]
TOTAL	**1798**		**471**		**412**
1. Site preparation	**116**		**43**		**1**
1. 1. Land purchase	67	50%	33	0%	0
1. 2. Site infrastructure works	38	20%	8	0%	0
1. 3. Site facility construction	1	20%	0	0%	0
1. 4. Security installation construction	2	20%	0	0%	0
1. 5. Human resources	8	20%	2	10%	1
2. Repository construction	**998**		**290**		**277**
2. 1. Construction and outfitting shafts and ramp	173	0%	52	30%	52
2. 2. Construction and outfitting main gallery	21	0%	6	30%	6
2. 3. Construction and outfitting secondary galleries	129	0%	39	30%	39
2. 4. Construction and outfitting LILW and (TE)NORM disposal galleries	429	0%	129	30%	129
2. 5. Construction and outfitting non-heat-emitting HLW disposal galleries	43	0%	13	30%	13
2. 6. Construction and outfitting heat-emitting disposal galleries	96	0%	29	30%	29
2. 7. Construction and outfitting the pilot facility	4	0%	1	30%	1
2. 8. Ventilation system	6	0%	2	10%	1
2. 9. Site facility construction	17	20%	3	0%	0
2. 10. Maintenance	5	20%	1	10%	1
2. 11. Insurance	1	20%	0	0%	0
2. 12. Human resources	74	20%	15	10%	7
3. LILW and (TE)NORM waste disposal campaign	**423**		**85**		**86**
3. 1. Transport system	4	0%	1	10%	0
3. 2. Backfilling	11	20%	2	10%	1
3. 3 Sealing	95	20%	19	50%	48
3. 4 Site facility construction	64	20%	13	20%	13
3. 5 Maintenance	13	20%	3	10%	1
3. 6 Insurance	11	20%	2	0%	0
3. 7 Human resources	225	20%	45	10%	22
4. HLW disposal campaign	**76**		**15**		**21**
4. 1. Waste post-conditioning	12	20%	2	50%	6
4. 2. Backfilling	2	20%	0	10%	0
4. 3 Sealing	23	20%	5	50%	12
4. 4 Maintenance	5	20%	1	10%	0
4. 5 Insurance	2	20%	0	0%	0
4. 6 Human resources	33	20%	7	10%	3
5. Underground observation	**67**		**13**		**6**
5. 1 Maintenance	16	20%	3	10%	2
5. 2 Insurance	7	20%	1	0%	0
5. 3 Human resources	45	20%	9	10%	4
6. Repository closure	**118**		**25**		**21**
6. 1. Backfilling galleries and ramp	29	20%	6	10%	3
6. 2 Sealing galleries and ramp	17	20%	3	50%	9
6. 3 Sealing shafts	6	20%	1	50%	3
6. 4 Backfilling shafts	4	20%	1	10%	0
6. 5 Dismantling and decommissioning nuclear facilities	9	35%	3	10%	1
6. 6 Site dismantling and clearance	4	25%	1	5%	0
6. 7 Human resources	50	20%	10	10%	5

Min	Range	Max
€ 1.369	€ 2.053	€ 2.738
	License application process	€ 14
	Design and construct	€ 1.447
	Waste emplacement	€ 497
	Observation	€ 37
	closure	€ 58
		€ 2.053

sequentially	modular		
€ 2.598	€ 2.598	Construction	Emplacement
€ 155	€ 155		
€ 1.516	€ 492		
€ 575	€ 1.289	55%	45%
€ 109	€ 420	74%	26%
€ 83	€ 83		
€ 159	€ 159		

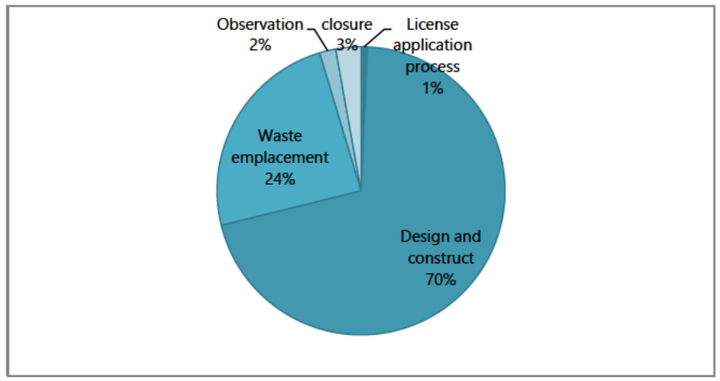
Discounrate:
2,30%

Year	Year	Cost/a	Discounted cost/a
2010	-20	€ 1	€ 1,6
2111	-19	€ 1	€ 1,5
2112	-18	€ 1	€ 1,5
2113	-17	€ 1	€ 1,5
2114	-16	€ 1	€ 1,4
2115	-15	€ 1	€ 1,4
2116	-14	€ 1	€ 1,4
2117	-13	€ 1	€ 1,3
2118	-12	€ 1	€ 1,3
2119	-11	€ 1	€ 1,3
2120	-10	€ 77	€ 97,1
2121	-9	€ 77	€ 95,0
2122	-8	€ 61	€ 73,7
2123	-7	€ 61	€ 72,1
2124	-6	€ 61	€ 70,5
2125	-5	€ 61	€ 68,9
2126	-4	€ 61	€ 67,3
2127	-3	€ 61	€ 65,8
2128	-2	€ 61	€ 64,3
2129	-1	€ 61	€ 62,9
2130	0	€ 50	€ 49,6
2131	1	€ 50	€ 48,5
2132	2	€ 50	€ 47,4
2133	3	€ 50	€ 46,3
2134	4	€ 50	€ 45,3
2135	5	€ 50	€ 44,2
2136	6	€ 50	€ 43,2
2137	7	€ 50	€ 42,3
2138	8	€ 50	€ 41,3
2139	9	€ 50	€ 40,4
2140	10	€ 50	€ 39,5
2141	11	€ 50	€ 38,6
2142	12	€ 50	€ 37,7
2143	13	€ 50	€ 36,9
2144	14	€ 50	€ 36,1
2145	15	€ 50	€ 35,2
2146	16	€ 50	€ 34,5
2147	17	€ 50	€ 33,7
2148	18	€ 50	€ 32,9
2149	19	€ 50	€ 32,2
2150	20	€ 50	€ 31,5
2151	21	€ 50	€ 30,7
2152	22	€ 50	€ 30,1
2153	23	€ 50	€ 29,4
2154	24	€ 50	€ 28,7
2155	25	€ 50	€ 28,1
2156	26	€ 84	€ 46,5
2157	27	€ 84	€ 45,4
2158	28	€ 84	€ 44,4



	Costs	Margins	Time (a)	Cost/a	Year
Kostenpost	**€ 2.598**	**33%**	59	€ 44	-
Voorbereiden locatie	€ 155	27%	2	€ 77	2
Voorbereiden eindberging	€ 492	36%	8	€ 61	15
Bouw en Plaatsen LMRA	€ 1.289	29%	26	€ 50	38
Bouw en Plaatsen HRA	€ 420	32%	**5**	€ 84	41
Ondergrondse observatie	€ 83	22%	**10**	€ 8	51
Sluiting	€ 159	28%	8	€ 20	59

€ 2.608
€ 10



2159	29	€	84	€	43,4
2160	30	€	84	€	42,4
2161	31	€	8	€	4,1
2162	32	€	8	€	4,0
2163	33	€	8	€	3,9
2164	34	€	8	€	3,9
2165	35	€	8	€	3,8
2166	36	€	8	€	3,7
2167	37	€	8	€	3,6
2168	38	€	8	€	3,5
2169	39	€	8	€	3,4
2170	40	€	8	€	3,4
2171	41	€	20	€	7,8
2172	42	€	20	€	7,7
2173	43	€	20	€	7,5
2174	44	€	20	€	7,3
2175	45	€	20	€	7,2
2176	46	€	20	€	7,0
2177	47	€	20	€	6,8
2178	48	€	20	€	6,7
2179	49	€	-	€	-
2180	50	€	-	€	-
		€	**2.608**	**€**	**2.053**

Function	salary [EUR/hour]	involvement [hours/year]	Phase 1 Site preparation	Phase 2 Repository construction	Phase 3 Disposal campaign LILW and (TE)NORM waste	Phase 4 Disposal campaign HLW waste	Phase 5 Underground observation phase	Phase 6 Repository closure	Phase 7 Post-operational phase
STRATEGIC MANAGEMENT									
General management			100%	100%	50%	50%	25%	25%	10%
chief executive officer	85,00	300	300	300	150	150	75	75	30
deputy director-general	85,00	100	100	100	50	50	25	25	10
secretary	35,00	100	100	100	50	50	25	25	10
Staff functions			100%	100%	50%	50%	25%	25%	10%
head of physical inspection	57,00	1200	1200	1200	600	600	300	300	120
internal service for prevention and protection at work	57,00	100	100	100	50	50	25	25	10
quality manager	57,00	100	100	100	50	50	25	25	10
safety strategy & environment protection	57,00	200	200	200	100	100	50	50	20
safety officer	57,00	100	100	100	50	50	25	25	10
secretary	29,00	400	400	400	200	200	100	100	40
GENERAL SERVICES									
Management			100%	100%	100%	100%	75%	75%	0%
director-coach for general services	85,00	100	100	100	100	100	75	75	0
General administration			0%	0%	100%	100%	50%	50%	0%
administrative assistant (human resource)	40,00	100	0	0	100	100	50	50	0
administrative assistant (logistics)	35,00	20	0	0	20	20	10	10	0
ICT technician	45,00	200	0	0	200	200	100	100	0
Legal advice			100%	100%	100%	100%	100%	100%	0%
legal advisor	140,00	200	200	200	200	200	200	200	0
Financial administration			100%	100%	100%	100%	100%	100%	0%
accountant	57,00	400	400	400	400	400	400	400	0
Purchasing & contracts			100%	100%	100%	100%	100%	100%	0%
purchaser	57,00	200	200	200	200	200	200	200	0
Communications			100%	100%	100%	100%	100%	100%	0%
communications expert	57,00	200	200	200	200	200	200	200	0
WASTE MANAGEMENT PLANNING									
Management			100%	100%	100%	100%	25%	25%	0%
director-coach for prescient waste management	85,00	300	300	300	300	300	75	75	0
secretary	35,00	100	100	100	100	100	25	25	0
Waste inventory			100%	100%	100%	100%	0%	0%	0%
radioactive waste treatment & conditioning expert	57,00	825	825	825	825	825	0	0	0
Cost evaluations			100%	100%	100%	100%	50%	50%	0%
cost engineer	57,00	600	600	600	600	600	300	300	0
Asset & Liability management (ALM)			100%	100%	100%	100%	50%	50%	0%
financial analyst	57,00	200	200	200	200	200	100	100	0
LONG-TERM WASTE MANAGEMENT									
Management			75%	75%	100%	100%	50%	0%	25%
director-coach for long term waste management	85,00	600	450	450	600	600	300	0	150
secretary	35,00	150	113	113	150	150	75	0	38
Acceptance criteria			50%	50%	100%	100%	0%	0%	0%
definition/revision of waste acceptance criteria	57,00	825	413	413	825	825	0	0	0
regularisations & derogations from acceptance criteria	57,00	200	100	100	200	200	0	0	0
Review Committee for Acceptance Criteria (meetings & secretariat)	57,00	200	100	100	200	200	0	0	0
Certifications			50%	50%	100%	100%	0%	0%	0%
certifications coordinator	57,00	200	100	100	200	200	0	0	0
certification of post-conditioning lines	45,00	400	200	200	400	400	0	0	0
certification of radiological characterization of waste for post-conditioning	45,00	400	200	200	400	400	0	0	0
certification of supercontainer prefabricated elements	45,00	400	200	200	400	400	0	0	0
secretary	29,00	400	200	200	400	400	0	0	0
RD&D geological disposal and licensing			100%	100%	100%	100%	100%	0%	50%
geotechnical engineer	57,00	1650	1650	1650	1650	1650	1650	0	825
nuclear physicist	57,00	1650	1650	1650	1650	1650	1650	0	825
geologist	57,00	1650	1650	1650	1650	1650	1650	0	825
chemist	57,00	1650	1650	1650	1650	1650	1650	0	825
secretary	29,00	1650	1650	1650	1650	1650	1650	0	825
CONTEMPORARY WASTE MANAGEMENT									
Management			0%	10%	100%	100%	0%	0%	0%

director-coach for contemporary waste management	85,00	300	0	30	300	300	0	0	0
secretary	35,00	100	0	10	100	100	0	0	0
Waste acceptance			10%	10%	100%	100%	0%	0%	0%
waste acceptance coordinator	57,00	400	40	40	400	400	0	0	0
inspection of radioactive waste for post-conditioning	45,00	1650	165	165	1650	1650	0	0	0
inspection of Monoliths or Supercontainers	45,00	1650	165	165	1650	1650	0	0	0
secretary	29,00	900	90	90	900	900	0	0	0
Installations management			0%	10%	100%	100%	0%	0%	0%
management of the post-conditioning installations	57,00	100	0	10	100	100	0	0	0
Installations dismantling			0%	10%	100%	100%	0%	0%	0%
dismantling of the post-conditioning installations	57,00	0	0	0	0	0	0	0	0

OPERATOR HUMAN RESOURCES							
Total salary cost	**[EUR]**	909.115	912.585	1.149.650	1.149.650	605.550	153.375	240.688
Various expenses (3% of the salary cost)	**[EUR]**	27.273	27.378	34.490	34.490	18.167	4.601	7.221
TOTAL COST		**936.388**	**939.963**	**1.184.140**	**1.184.140**	**623.717**	**157.976**	**247.908**

Berekening indexatie eindberging 2014-2017

De uitgavan voor de eindberging bestaan globaal uit loonkosten en overig, derhalve gekozen voor indexatie van PPI (industrie) en cao lonen (energie)

		basis 2010
PPI	jan-14	113,1
	jan-15	102,2
	jan-16	98,4
	jan-17	107,8

percentage loonkosten 21%

average	weighed
95,31%	75,30%

		basis 2010
cao lonen energie	jan-14	105,0
	jan-15	106,0
	jan-16	107,1
	jan-17	108,1

average	weighed
102,95%	21,62%

Totale index **96,92%**

		Calculated cost [MEur]	Project margin %	Project margin [MEur]	Technological margin %	Technological margin [MEur]
TOTAL		**1742**		**457**		**399**
1.	**Site preparation**	**112**		**42**		**1**
1. 1.	Land purchase	64	50%	32	0%	0
1. 2.	Site infrastructure works	37	20%	7	0%	0
1. 3.	Site facility construction	1	20%	0	0%	0
1. 4.	Security installation construction	2	20%	0	0%	0
1. 5.	Human resources	7	20%	1	10%	1
2.	**Repository construction**	**967**		**281**		**268**
2. 1.	Construction and outfitting shafts and ramp	168	30%	50	30%	50
2. 2.	Construction and outfitting main gallery	21	30%	6	30%	6
2. 3.	Construction and outfitting secondary galleries	125	30%	37	30%	37
2. 4.	Construction and outfitting LILW and (TE)NORM disposal galleries	416	30%	125	30%	125
2. 5.	Construction and outfitting non-heat-emitting HLW disposal galleries	42	30%	12	30%	12
2. 6.	Construction and outfitting heat-emitting disposal galleries	93	30%	28	30%	28
		0		0		0
		0		0		0
2. 7.	Construction and outfitting the pilot facility	4	30%	1	30%	1
2. 8.	Ventilation system	5	30%	2	10%	1
2. 9.	Site facility construction	16	20%	3	0%	0
2. 10.	Maintenance	5	20%	1	10%	0
2. 11.	Insurance	1	20%	0	0%	0
2. 12.	Human resources	72	20%	14	10%	7
3.	**LILW and (TE)NORM waste disposal campaign**	**410**		**82**		**83**
3. 1.	Transport system	4	30%	1	10%	0
3. 2.	Backfilling	10	20%	2	10%	1
3. 3.	Sealing	92	20%	18	50%	46
3. 4.	Site facility construction	62	20%	12	20%	12
3. 5.	Maintenance	13	20%	3	10%	1
3. 6.	Insurance	11	20%	2	0%	0
3. 7.	Human resources	218	20%	44	10%	22
4.	**HLW disposal campaign**	**74**		**15**		**21**
4. 1.	Waste post-conditioning	11	20%	2	50%	6
4. 2.	Backfilling	2	20%	0	10%	0
4. 3.	Sealing	22	20%	4	50%	11
4. 4.	Maintenance	5	20%	1	10%	0
4. 5.	Insurance	2	20%	0	0%	0
4. 6.	Human resources	32	20%	6	10%	3
5.	**Underground observation**	**65**		**13**		**6**
5. 1.	Maintenance	15	20%	3	10%	2
5. 2.	Insurance	6	20%	1	0%	0
5. 3.	Human resources	43	20%	9	10%	4
6.	**Repository closure**	**115**		**24**		**20**
6. 1.	Backfilling galleries and ramp	28	20%	6	10%	3
6. 2.	Sealing galleries and ramp	17	20%	3	50%	8
6. 3.	Sealing shafts	6	20%	1	50%	3
6. 4.	Backfilling shafts	3	20%	1	10%	0
6. 5.	Dismantling and decommissioning nuclear facilities	9	35%	3	10%	1
6. 6.	Site dismantling and clearance	4	25%	1	5%	0
6. 7.	Human resources	49	20%	10	10%	5

Totale kosten (in miljoen euro)

	Costs	Margins	Time (a)	Cost/a	Year
Kostenpost	**€ 2.598**	**33%**	**59**	**€ 44**	-
Voorbereiden locatie	€ 155	27%	**2**	€ 77	2
Bouw eindberging	€ 1.516	36%	**13**	€ 117	15
Plaatsen LMRA	€ 575	29%	**23**	€ 25	38
Plaatsen HRA	€ 109	32%	3	€ 36	41
Ondergrondse observatie	€ 83	22%	**10**	€ 8	51
Sluiting	€ 159	28%	**8**	€ 20	59

		planning [years]			quantity	unit	unit cost [Eur]	total cost [Eur]
		start	end	duration				
1.	**Site preparation**	**2115**	**2117**	**2**				**115,79**
1. 1.	**Land purchase**	**2115**	**2115**	**0**				**66,54**
1. 1. 1	nominal cost of land purchase				1.900.000	m²	35	66.500.000
1. 1. 2	notary fee				66.500.000	%	0,057%	37.905
1. 2.	**Site infrastructure works**	**2115**	**2117**	**2**				**38,43**
1. 2. 1	landscaping				445.500	m²	28	12.474.000
1. 2. 2	roads and parking lots				74.500	m²	207	15.421.500
1. 2. 3	green park area				200.000	m²	34	6.800.000
1. 2. 4	architect/engineer fee				34.695.500	%	4%	1.387.820
1. 2. 5	sewage system					ff	950.977	950.977
1. 2. 6	connection of site to utilities networks and sewage					ff	1.391.655	1.391.655
1. 3.	**Site facility construction**	**2115**	**2117**	**2**				**0,78**
1. 3. 1	utility buildings				2	unit	391.579	783.158
1. 4.	**Security installation construction**	**2115**	**2117**	**2**				**2,37**
1. 4. 1	security post construction				2	unit	61.758	123.516
1. 4. 2	security post furniture				2	unit	83.910	167.820
1. 4. 3	fence				6.600	m	90	594.000
1. 4. 4	perimeter gate				4	unit	10.069	40.276
1. 4. 5	monitoring system				2	unit	391.579	783.158
1. 4. 6	access control system				2	unit	167.820	335.640
1. 4. 7	automatic entrance detection system				1	unit	109.293	109.293
1. 4. 8	architect/engineer fee				2.153.703	%	10%	215.370
1. 5.	**Human resources**	**2115**	**2117**	**2**				**7,67**
1. 5. 1	Operator				2	year	1.805.364	3.610.728
1. 5. 2	COVRA				2	year	936.388	1.872.777
1. 5. 3	study cost for repository construction					ff	881.416	881.416
1. 5. 4	application and granting of the construction license					ff	1.308.800	1.308.800
2.	**Repository construction**	**2117**	**2130**	**13**				**997,57**
2. 1.	**Construction and outfitting shafts and ramp**	**2117**	**2124**	**7**				**173,44**
2. 1. 1	shaft construction				2	unit	44.981.233	89.962.466
2. 1. 2	shaft hoisting system				2	unit	4.564.692	9.129.384
2. 1. 3	ramp construction				1	unit	51.728.418	51.728.418
2. 1. 4	ramp hoisting system				1	unit	4.564.692,00	4.564.692
2. 1. 5	casting ramp floor				24.500	m³	400	9.800.000
2. 1. 6	architect/engineer fee				165.184.960	%	5%	8.259.248
2. 2.	**Construction and outfitting main gallery**	**2124**	**2125**	**1**				**21,39**
2. 2. 1	TBM				1	unit	4.934.976	4.934.976
2. 2. 2	assembly TBM				1	turn	592.951	592.951
2. 2. 3	dismantling TBM				1	turn	155.497	155.497
2. 2. 4	lining installation				1.000	m	12.441	12.441.000
2. 2. 5	casting floor				2.700	m³	400	1.080.000
2. 2. 6	outfitting (electricity, fire protection)				1.000	m	1.168	1.168.000
2. 2. 7	architect/engineer fee				20.372.424	%	5%	1.018.621
2. 3.	**Construction and outfitting secondary galleries**	**2125**	**2131**	**6**				**128,62**
2. 3. 1	TBM				2	unit	4.934.976	9.869.952
2. 3. 2	assembly TBM				10	turn	592.951	5.929.510
2. 3. 3	dismantling TBM				5	turn	155.497	777.485
2. 3. 4	lining installation				6.000	m	12.441	74.646.000
2. 3. 5	crossings				10	unit	1.778.887	17.788.870
2. 3. 6	casting floor				16.200	m³	400	6.480.000
2. 3. 7	outfitting (electricity, fire protection)				6.000	m	1.168	7.008.000
2. 3. 8	architect/engineer fee				122.499.817	%	5%	6.124.991
2. 4.	**Construction and outfitting LILW and (TE)NORM disposal galleries**	**2126**	**2136**	**10**				**429,09**
2. 4. 1	TBM				4	unit	4.934.976	19.739.904
2. 4. 2	assembly TBM				71	turn	592.951	42.099.521
2. 4. 3	dismantling TBM				71	turn	155.497	11.040.287
2. 4. 4	lining installation				14.200	m	12.441	176.662.200
2. 4. 5	end plug				2.237	m³	400	894.600
2. 4. 6	crossings				71	unit	1.778.887	126.300.977
2. 4. 7	casting floor				38.340	m³	400	15.336.000
2. 4. 8	outfitting (electricity, fire protection)				14.200	m	1.168	16.585.600
2. 4. 9	architect/engineer fee				408.659.089	%	5%	20.432.954
2. 5.	**Construction and outfitting non-heat-emitting HLW disposal galleries**	**2131**	**2137**	**6**				**42,86**
2. 5. 1	TBM				0	unit	3.046.281	0
2. 5. 2	assembly TBM				10	turn	244.690	2.446.900

2. 5. 3	dismantling TBM				10	turn	58.781	587.810
2. 5. 4	lining installation				2.000	m	9.152	18.304.000
2. 5. 5	end plug				114	m^3	400	45.600
2. 5. 6	crossings				10	unit	1.778.887	17.788.870
2. 5. 7	casting floor				1.200	m^3	400	480.000
2. 5. 8	outfitting (electricity, fire protection)				2.000	m	583	1.166.000
2. 5. 9	architect/engineer fee				40.819.180	%	5%	2.040.959
2. 6.	**Construction and outfitting heat-emitting disposal galleries**	**2125**	**2130**	**5**				**95,99**
2. 6. 1	TBM				2	unit	3.046.281	6.092.562
2. 6. 2	assembly TBM				33	turn	244.690	8.074.770
2. 6. 3	dismantling TBM				33	turn	58.781	1.939.773
2. 6. 4	lining installation				1.650	m	9.152	15.100.800
2. 6. 5	end plug				376	m^3	400	150.480
2. 6. 6	crossings				33	unit	1.778.887	58.703.271
2. 6. 7	casting floor				990	m^3	400	396.000
2. 6. 8	outfitting (electricity, fire protection)				1.650	m	583	961.950
2. 6. 9	architect/engineer fee				91.419.606	%	5%	4.570.980
2. 7.	**Construction and outfitting the pilot facility**	**2130**	**2130**	**0**				**3,61**
2. 7. 1	TBM (gallery diameter 3,7 m)				0	unit	4.934.976	0
2. 7. 2	assembly TBM (gallery diameter 3,7 m)				1	turn	592.951	592.951
2. 7. 3	dismantling TBM (gallery diameter 3,7 m)				1	turn	155.497	155.497
2. 7. 4	lining installation (gallery diameter 3,7 m)				100	m	12.441	1.244.100
2. 7. 5	end plug secondary gallery				32	m^3	400	12.920
2. 7. 6	casting floor secondary gallery				270	m^3	400	108.000
2. 7. 7	outfitting (electricity, fire protection) secondary gallery				100	m	1.168	116.800
2. 7. 8	TBM (gallery diameter 2,2 m)				0	unit	3.046.281	0
2. 7. 9	assembly TBM (gallery diameter 2,2 m)				2	turn	244.690	489.380
2. 7. 10	dismantling TBM (gallery diameter 2,2 m)				2	turn	58.781	117.562
2. 7. 11	lining installation (gallery diameter 2,2 m)				60	m	9.152	549.120
2. 7. 12	end plug disposal gallery				23	m^3	400	9.120
2. 7. 13	casting floor disposal gallery				36	m^3	400	14.400
2. 7. 14	outfitting (electricity, fire protection) disposal gallery				60	m	583	34.980
2. 7. 15	architect/engineer fee				3.395.450	%	5%	169.773
2. 8.	**Ventilation system**	**2117**	**2130**	**13**				**5,58**
2. 8. 1	fan main system				2	unit	30.706	61.412
2. 8. 2	fan auxiliary system				2	unit	15.605	31.210
2. 8. 3	main duct				13.100	m	201	2.633.100
2. 8. 4	10 m spiral duct connecting ducts of crossings galleries				116	unit	473	54.868
2. 8. 5	regulation gate at gallery crossing				116	unit	302	35.032
2. 8. 6	ducts in the disposal galleries				17.910	m	126	2.256.660
2. 8. 7	architect/engineer fee				5.072.282	%	10%	507.228
2. 9.	**Site facility construction**	**2117**	**2130**	**13**				**16,89**
2. 9. 1	visitor centre				1	unit	1.576.947	1.576.947
2. 9. 2	exhibition room furbishing				1	unit	573.435	573.435
2. 9. 3	administration building				1	unit	1.919.017	1.919.017
2. 9. 4	services building				1	unit	364.713	364.713
2. 9. 5	maintenance building				1	unit	490.033	490.033
2. 9. 6	ramp building				1	unit	6.102.529	6.102.529
2. 9. 7	backfill material processing building				1	unit	377.594	377.594
2. 9. 8	geotextile under rock dump				160.000	m^2	4	640.000
2. 9. 9	geotextile over rock dump				320.000	m^2	4	1.280.000
2. 9. 10	non-fertile soil cover on rock dump				250.000	m^3	3	750.000
2. 9. 11	fertile soil cover on rock dump				80.000	m^3	16	1.280.000
2. 9. 12	architect/engineer fee				15.354.268	%	10%	1.535.427
2. 10.	**Maintenance**	**2117**	**2130**	**13**				**5,04**
2. 10. 1	security buildings				13	year	4.800	62.696
2. 10. 2	utility buildings				13	year	10.000	130.616
2. 10. 3	administration building				11	year	46.750	517.132
2. 10. 4	services building				11	year	8.900	98.449
2. 10. 5	maintenance building				11	year	23.650	261.608
2. 10. 6	ramp building				6	year	63.000	381.884
2. 10. 7	shaft buildings				6	year	92.500	560.702
2. 10. 8	backfill material processing building				0	year	26.500	0
2. 10. 9	security installations				13	year	24.441	319.240
2. 10. 10	ramp hoisting system				6	year	22.000	133.356
2. 10. 11	shaft hoisting systems				6	year	44.000	266.712
2. 10. 12	visitor centre				11	year	129.100	1.428.058
2. 10. 13	green park area				13	year	67.600	882.967
2. 11.	**Insurance**	**2117**	**2130**	**13**				**0,58**
2. 11. 1	security posts				13	year	2.444	31.923
2. 11. 2	utility buildings				13	year	2.310	30.172
2. 11. 3	administration building				11	year	5.660	62.609
2. 11. 4	services building				11	year	1.076	11.902
2. 11. 5	maintenance building				11	year	1.445	15.984
2. 11. 6	ramp building				6	year	18.000	109.110

2. 11.	7	ramp hoisting system				6	year	13.464	81.614
2. 11.	8	shaft hoisting systems				6	year	26.928	163.228
2. 11.	9	backfill material processing building				0	year	1.114	0
2. 11.	10	visitor centre				11	year	6.390	70.684
2. 12.		**Human resources**	**2117**	**2130**	**13**				**74,46**
2. 12.	1	Operator				13	year	4.506.618	58.863.839
2. 12.	2	COVRA				13	year	939.963	12.277.456
2. 12.	3	study cost for partial repository closure					ff	440.708	440.708
2. 12.	4	application and granting of the operation license					ff	553.520	553.520
2. 12.	5	control of the construction license				13	year	178.204	2.327.637
3.		**LILW and (TE)NORM waste disposal campaign**	**2130**	**2153**	**23**				**422,88**
3. 1.		**Transport system**	**2130**	**2130**	**0**				**4,16**
3. 1.	1	standard locomotive with an integrated human control cabin				3	unit	695.496	2.086.488
3. 1.	2	waste transport cart				3	unit	606.075	1.818.225
3. 1.	3	relocatable turntable				3	unit	84.453	253.359
3. 2.		**Backfilling**	**2130**	**2153**	**23**				**10,77**
3. 2.	1	backfill material				24.508	m^3	180	4.411.440
3. 2.	2	backfill operations				71	turn	89.504	6.354.784
3. 3.		**Sealing**	**2130**	**2153**	**23**				**95,01**
3. 3.	1	lining removal for seal installation				71	turn	390.000	27.690.000
3. 3.	2	seal bentonite				12.851	m^3	5.000	64.255.000
3. 3.	3	concrete support for seal				7.668	m^3	400	3.067.200
3. 4.		**Site facility construction**	**2148**	**2153**	**5**				**64,28**
3. 4.	1	post-conditioning facility				1	unit	49.227.068	49.227.068
3. 4.	2	pre-cast hall				1	unit	9.207.699	9.207.699
3. 4.	3	architect/engineer fee				58.434.767	%	10%	5.843.477
3. 5.		**Maintenance**	**2130**	**2153**	**23**				**12,95**
3. 5.	1	security buildings				23	year	4.800	110.400
3. 5.	2	utility buildings				23	year	10.000	230.000
3. 5.	3	administration building				23	year	46.750	1.075.250
3. 5.	4	services building				23	year	8.900	204.700
3. 5.	5	maintenance building				23	year	23.650	543.950
3. 5.	6	ramp building				23	year	63.000	1.449.000
3. 5.	7	shaft buildings				23	year	92.500	2.127.500
3. 5.	8	backfill material processing building				23	year	26.500	609.500
3. 5.	9	security installations				23	year	24.441	562.143
3. 5.	10	ramp hoisting system				23	year	22.000	506.000
3. 5.	11	shaft hoisting systems				23	year	44.000	1.012.000
3. 5.	12	visitor centre				23	year	129.100	2.969.300
3. 5.	13	green park area				23	year	67.600	1.554.800
3. 6.		**Insurance**	**2130**	**2153**	**23**				**11,01**
3. 6.	1	security posts				23	year	2.444	56.212
3. 6.	2	utility buildings				23	year	2.310	53.130
3. 6.	3	administration building				23	year	5.660	130.180
3. 6.	4	services building				23	year	1.076	24.748
3. 6.	5	maintenance building				23	year	1.445	33.235
3. 6.	6	ramp building				23	year	18.000	414.000
3. 6.	7	ramp hoisting system				23	year	13.464	309.672
3. 6.	8	shaft hoisting systems				23	year	26.928	619.344
3. 6.	9	backfill material processing building				23	year	1.114	25.622
3. 6.	10	visitor centre				23	year	6.390	146.970
3. 6.	11	Third-Party Liability				23	year	400.000	9.200.000
3. 7.		**Human resources**	**2130**	**2153**	**23**				**224,70**
3. 7.	1	Operator				23	year	8.407.035	193.361.805
3. 7.	2	COVRA				23	year	1.184.140	27.235.209
3. 7.	3	control of the operation license				23	year	178.204	4.098.692
4.		**HLW disposal campaign**	**2153**	**2156**	**3**				**76,11**
4. 1.		**Waste post-conditioning**	**2153**	**2156**	**3**				**11,53**
4. 1.	1	overpack				1.278	unit	5.206	6.653.268
4. 1.	2	filler				165	m^3	110	18.150
4. 1.	3	concrete buffer				8.437	m^3	400	3.374.800
4. 1.	4	envelope				198	ton	7.482	1.482.109
4. 2.		**Backfilling**	**2153**	**2156**	**3**				**2,00**
4. 2.	1	backfill material				2.441	m^3	180	439.420
4. 2.	2	backfill operations (gallery length 45 m)				33	turn	20.138	664.554
4. 2.	3	backfill operations (gallery length 200 m)				10	turn	89.504	895.040
4. 3.		**Sealing**	**2153**	**2156**	**3**				**23,01**

4. 3. 1	lining removal for seal installation				43	turn	120.000	5.160.000
4. 3. 2	seal bentonite				3.440	m^3	5.000	17.200.000
4. 3. 3	concrete support for seal				1.634	m^3	400	653.600
4. 4.	**Maintenance**	**2153**	**2156**	**3**				**4,65**
4. 4. 1	security buildings				3	year	4.800	14.400
4. 4. 2	utility buildings				3	year	10.000	30.000
4. 4. 3	administration building				3	year	46.750	140.250
4. 4. 4	services building				3	year	8.900	26.700
4. 4. 5	maintenance building				3	year	23.650	70.950
4. 4. 6	ramp building				3	year	63.000	189.000
4. 4. 7	shaft buildings				3	year	92.500	277.500
4. 4. 8	backfill material processing building				3	year	26.500	79.500
4. 4. 9	security installations				3	year	24.441	73.323
4. 4. 10	ramp hoisting system				3	year	22.000	66.000
4. 4. 11	shaft hoisting systems				3	year	44.000	132.000
4. 4. 12	visitor centre				3	year	129.100	387.300
4. 4. 13	green park area				3	year	67.600	202.800
4. 4. 14	post-conditioning facility				3	year	880.000	2.640.000
4. 4. 15	pre-cast hall				3	year	106.990	320.970
4. 5.	**Insurance**	**2153**	**2156**	**3**				**1,95**
4. 5. 1	security posts				3	year	2.444	7.332
4. 5. 2	utility buildings				3	year	2.310	6.930
4. 5. 3	administration building				3	year	5.660	16.980
4. 5. 4	services building				3	year	1.076	3.228
4. 5. 5	maintenance building				3	year	1.445	4.335
4. 5. 6	ramp building				3	year	18.000	54.000
4. 5. 7	ramp hoisting system				3	year	13.464	40.392
4. 5. 8	shaft hoisting systems				3	year	26.928	80.784
4. 5. 9	backfill material processing building				3	year	1.114	3.342
4. 5. 10	visitor centre				3	year	6.390	19.170
4. 5. 11	post-conditioning facility				3	year	145.200	435.600
4. 5. 12	pre-cast hall				3	year	27.159	81.477
4. 5. 13	Third-Party Liability				3	year	400.000	1.200.000
4. 6.	**Human resources**	**2153**	**2156**	**3**				**32,97**
4. 6. 1	Operator				3	year	9.626.737	28.880.211
4. 6. 2	COVRA				3	year	1.184.140	3.552.419
4. 6. 3	control of the operation license				3	year	178.204	534.612
5.	**Underground observation**	**2156**	**2166**	**10**				**66,74**
5. 1.	**Maintenance**	**2156**	**2166**	**10**				**15,50**
5. 1. 1	security buildings				10	year	4.800	48.000
5. 1. 2	utility buildings				10	year	10.000	100.000
5. 1. 3	administration building				10	year	46.750	467.500
5. 1. 4	services building				10	year	8.900	89.000
5. 1. 5	maintenance building				10	year	23.650	236.500
5. 1. 6	ramp building				10	year	63.000	630.000
5. 1. 7	shaft buildings				10	year	92.500	925.000
5. 1. 8	backfill material processing building				10	year	26.500	265.000
5. 1. 9	security installations				10	year	24.441	244.410
5. 1. 10	ramp hoisting system				10	year	22.000	220.000
5. 1. 11	shaft hoisting systems				10	year	44.000	440.000
5. 1. 12	visitor centre				10	year	129.100	1.291.000
5. 1. 13	green park area				10	year	67.600	676.000
5. 1. 14	post-conditioning facility				10	year	880.000	8.800.000
5. 1. 15	pre-cast hall				10	year	106.990	1.069.900
5. 2.	**Insurance**	**2156**	**2166**	**10**				**6,51**
5. 2. 1	security posts				10	year	2.444	24.440
5. 2. 2	utility buildings				10	year	2.310	23.100
5. 2. 3	administration building				10	year	5.660	56.600
5. 2. 4	services building				10	year	1.076	10.760
5. 2. 5	maintenance building				10	year	1.445	14.450
5. 2. 6	ramp building				10	year	18.000	180.000
5. 2. 7	ramp hoisting system				10	year	13.464	134.640
5. 2. 8	shaft hoisting systems				10	year	26.928	269.280
5. 2. 9	backfill material processing building				10	year	1.114	11.140
5. 2. 10	visitor centre				10	year	6.390	63.900
5. 2. 11	post-conditioning facility				10	year	145.200	1.452.000
5. 2. 12	pre-cast hall				10	year	27.159	271.590
5. 2. 13	Third-Party Liability				10	year	400.000	4.000.000
5. 3.	**Human resources**	**2156**	**2166**	**10**				**44,73**
5. 3. 1	Operator				10	year	3.615.351	36.153.510
5. 3. 2	COVRA				10	year	623.717	6.237.165
5. 3. 3	study cost for repository closure					ff	440.708	440.708

5. 3. 4	application and granting of the dismantling and decommissioning license					ff	112.940	112.940
5. 3. 5	control of the operation license				10	year	178.204	1.782.040
6.	**Repository closure**	**2166**	**2174**	**8**				**118,47**
6. 1.	**Backfilling galleries and ramp**	**2166**	**2170**	**4**				**28,78**
6. 1. 1	backfill material				130.080	m^3	180	23.414.400
6. 1. 2	backfill operations				10	turn	537.023	5.370.229
6. 2.	**Sealing galleries and ramp**	**2170**	**2171**	**1**				**17,04**
6. 2, 1	gallery lining removal for seal installation				11	turn	390.000	4.290.000
6. 2. 2	ramp lining removal for seal installation				1	turn	735.000	735.000
6. 2. 3	seal bentonite (gallery seals)				1.991	m^3	5.000	9.955.000
6. 2. 4	seal bentonite (ramp seal)				302	m^3	5.000	1.510.000
6. 2. 5	concrete support (gallery seals)				1.188	m^3	400	475.200
6. 2. 6	concrete support (ramp seal)				196	m^3	400	78.400
6. 3.	**Sealing shafts**	**2170**	**2171**	**1**				**6,03**
6. 3. 1	dismantling hoisting system				2	unit	400.000	800.000
6. 3. 2	ad hoc rent of 2 temporary hoisting systems				1	years	1.000.000	1.000.000
6. 3. 3	dismantling and removal of the shaft interior				1.000	m	1.050	1.050.000
6. 3. 4	seal bentonite				604	m^3	5.000	3.020.000
6. 3. 5	concrete support for seal				392	m^3	400	156.800
6. 4.	**Backfilling shafts**	**2171**	**2172**	**1**				**3,53**
6. 4. 1	backfill material				19.635	m^3	180	3.534.300
6. 5.	**Dismantling and decommissioning nuclear facilities**	**2166**	**2168**	**2**				**8,86**
6. 5. 1	post-conditioning facility				8.859.540	unit	1	8.859.540
6. 6.	**Site dismantling and clearance**	**2172**	**2174**	**2**				**3,74**
6. 6. 1	security infrastructure				37.283	unit	1	37.283
6. 6. 2	utility buildings				176.184	unit	2	352.368
6. 6. 3	administration building				86.343	unit	1	86.343
6. 6. 4	services building				16.410	unit	1	16.410
6. 6. 5	maintenance building				22.048	unit	1	22.048
6. 6. 6	visitor centre				71.485	unit	1	71.485
6. 6. 7	backfill material processing building				16.989	unit	1	16.989
6. 6. 8	pre-cast hall				414.284	unit	1	414.284
6. 6. 9	air-lock ramp building				1.098.290	unit	1	1.098.290
6. 6. 10	levelling of soil and sowing of grass				11.000	m^2	5	55.000
6. 6. 11	clear road surface and parking lots				74.500	m^2	21	1.564.500
6. 7.	**Human resources**	**2166**	**2174**	**8**				**50,49**
6. 7. 1	Operator				8	year	5.974.773	47.798.184
6. 7. 2	COVRA				8	year	157.976	1.263.810
6. 7. 3	control of the dismantling and decommissioning license				8	year	178.204	1.425.632

Planning input data

Start disposal campaign 2130
Duration site preparation 2 years
Duration repository construction 13 years

Section	construction time years
Shaft and ramp construction	7
Ramp	7
Shaft 1	7
Shaft 2	7
Main + sec. gallery construction	1
Disposal galleries LILW/NORM	5
Disposal galleries HLW	5
Pilot facility	0 Included in HLW

2143

Construction time	length m	turns -	excavation days	crossings days	total time years	TBM -
Main gallery	1000	0	50	0	0,1	2
Sec. galleries	6000	10	150	188	0,9	4
A l galeries	7000	10	200	187,5	1	

Construction time	length m	turns -	excavation days	crossings days	total time years	TBM -
disposal LILW/NORM	14200	71	355	1331	5	4
disposal HLW	3710	45	185,5	1688	5	2 Including pilot

Secondary gallery	1	year
Disposal gallery 200m	0,1	year
Disposal gallery 50m	0,1	year

Disposal campaign 1 23 years

Waste	Number	Disposal rate /day	Disposal time days		
200L	140000	50	2800	2163	50
600L	0	0	0		0
1000L	12000	25	480	2166 LOG tot 2167	25
1500L	0	0	0		0
Konrad	9060	5	1812	2151 VOG tot 2152	5
			5092		

161060

Disposal campaign 2 3 years

Waste	Number -	Disposal rate -/day	Disposal time days
Spent RR Fuel	75	2	38
CSD-V	478	2	239
CSD-C	625	2	313
ECN	100	2	50
	1278		640

2168 HABOG tot 2169

Supercontainers	-
CSD-V + CSD-C	478
SRRF+ECN	175
Totaal	1278

0

Disposal rate -/day
2
2
2

Duration underground observation phase 10 years
Duration repository closure 8 years

Section	closure time years
Backf lling galleries and ramp	4
Sealing ga leries, ramp and shafts	1
Backf lling shafts	1
Dismantling and decommissioning post-conditioning fac lity	2
Site dismantling and clearance	2

Duration post-operational phase 100 years

Duration

	START	END	DURATION
	2115	2274	159
1 Site preparation	2115	2117	2
2 Repository construction	2117	2130	13
3 Disposal campaign 1	2130	2153	23
4 Disposal campaign 2	2153	2156	3
5 Underground observation phase	2156	2166	10
6 Repository closure	2166	2174	8
7 Post-operational phase	2174	2274	100

OPERATOR & COVRA

		reference		cost	index type	indexed cost
blood test administration personnel	[4]	p. 121	2008	228,51	w	255,76
blood test controlled zone	[4]	p. 121	2008	153,73	w	172,06

meal ticket	5
number of days in operation	226
average number of working days per employee	206
number of working hours per year	1650

salary code	salary [EUR/hour] 2012
100	178,55
101	94,38
102	64,72
103	54,73
104	49,37

salary code	salary [EUR/hour] 2012
200	315,29
201	163,94
202	118,53
203	100,57
204	90,50

Study cost repository construction

	salary code	salary [EUR/hour]	involvement [hours]	cost [EUR]
project manager	201	163,94	1400	229516
follow-up of the studies	201	163,94	700	114758
follow-up of the studies	202	118,53	1400	165942
license application documents	201	163,94	700	114758
license application documents	202	118,53	1400	165942
secretary	204	90,5	1000	90500
				881416

Study cost repository closure

	salary code	salary [EUR/hour]	involvement [hours]	cost [EUR]
project manager	201	163,94	700	114758
follow-up of the studies	201	163,94	350	57379
follow-up of the studies	202	118,53	700	82971
license application documents	201	163,94	350	57379
license application documents	202	118,53	700	82971
secretary	204	90,5	500	45250
				440708

REGULATOR

construction license

application (incl. environmental impact assessment)	301760 euro
granting	1007040 euro

operation license

application (incl. environmental impact assessment)	175880 euro
granting	377640 euro

dismantling and decommissioning license

application (incl. environmental impact assessment)	81470 euro
granting	31470 euro

license control

annual cost	178204 euro/year

Wage index

year	index
2001	7,4990
2002	7,8905
2003	8,1173
2004	8,3116
2005	8,5392
2006	8,7846
2007	8,9295
2008	9,1367
2009	9,5314
2010	9,6200
2011	9,7547
2012	10,0464
2013	10,3546
2014	10,4985

Construction industry price index

year	index
2001	540
2002	547
2003	560
2004	590
2005	612
2006	648
2007	665
2008	695
2009	670
2010	690
2011	705
2012	729
2013	739
2014	744

Heavy machinery and equipment price index

year	index
2005	94,1
2006	95,4
2007	97,3
2008	99,2
2009	101,1
2010	99,7
2011	101,2
2012	107,5
2013	108,8
2014	108,1

Function	Headcount	Salary [EUR/hour]	Phase 1 Site preparation	Phase 2 Repository construction	Phase 3 Disposal campaign LILW and (TE)NORM	Phase 4 Disposal campaign HLW waste	Phase 5 Underground observation phase	Phase 6 Repository closure	Phase 7 Post-operational phase	work location (ADM: administration; CZ: controlled zone)
General management			100%	100%	100%	100%	100%	100%	50%	
chief executive officer	1	85,00	1,0	1,0	1,0	1,0	1,0	1,0	0,5	ADM
secretary	1	35,00	1,0	1,0	1,0	1,0	1,0	1,0	0,5	ADM
Human resources			50%	100%	100%	100%	50%	100%	0%	
legal advisor	1	56,00	0,5	1,0	1,0	1,0	0,5	1,0	0,0	ADM
administrative assistant	2	30,00	1,0	2,0	2,0	2,0	1,0	2,0	0,0	ADM
Finance			100%	100%	100%	100%	50%	100%	0%	
financial controller	1	56,00	1,0	1,0	1,0	1,0	0,5	1,0	0,0	ADM
accountant	2	56,00	2,0	2,0	2,0	2,0	1,0	2,0	0,0	ADM
Contracts			100%	100%	100%	100%	50%	100%	0%	
contract specialist	1	140,00	1,0	1,0	1,0	1,0	0,5	1,0	0,0	ADM
administrative assistant	1	30,00	1,0	1,0	1,0	1,0	0,5	1,0	0,0	ADM
Archival			0%	100%	100%	100%	50%	100%	50%	
knowledge management officer	1	56,00	0,0	1,0	1,0	1,0	0,5	1,0	0,5	ADM
filing clerk	2	24,00	0,0	2,0	2,0	2,0	1,0	2,0	1,0	ADM
ICT			50%	100%	100%	100%	50%	100%	0%	
ICT coordinator	1	45,00	0,5	1,0	1,0	1,0	0,5	1,0	0,0	ADM
ICT assistant	1	30,00	0,5	1,0	1,0	1,0	0,5	1,0	0,0	ADM
Visitors Centre			0%	100%	100%	100%	100%	100%	100%	
supervisor	1	33,00	0,0	1,0	1,0	1,0	1,0	1,0	1,0	
receptionist	1	30,00	0,0	1,0	1,0	1,0	1,0	1,0	1,0	
touring guide	3	33,00	0,0	3,0	3,0	3,0	3,0	3,0	3,0	
Service management			0%	100%	100%	100%	50%	100%	0%	
service manager	1	56,00	0,0	1,0	1,0	1,0	0,5	1,0	0,0	
secretary	1	30,00	0,0	1,0	1,0	1,0	0,5	1,0	0,0	
General maintenance (non-industrial site infrastructure)			0%	100%	100%	100%	50%	100%	0%	
supervisor	1	45,00	0,0	1,0	1,0	1,0	0,5	1,0	0,0	
maintenance technician	4	36,00	0,0	4,0	4,0	4,0	2,0	4,0	0,0	
materials/stock manager	1	27,00	0,0	1,0	1,0	1,0	0,5	1,0	0,0	
Radiological laboratory			0%	0%	100%	100%	100%	100%	0%	
radiological laboratory technician	1	37,00	0,0	0,0	1,0	1,0	1,0	1,0	0,0	ADM+CZ
laboratory assistant	1	24,00	0,0	0,0	1,0	1,0	1,0	1,0	0,0	ADM+CZ
Land survey (surface + underground)			100%	100%	100%	100%	100%	100%	0%	
land surveyor	1	56,00	1,0	1,0	1,0	1,0	1,0	1,0	0,0	ADM+CZ
assistant land surveyor	1	56,00	1,0	1,0	1,0	1,0	1,0	1,0	0,0	ADM+CZ
Fire brigade			50%	100%	100%	100%	50%	50%	0%	
fire brigade captain	1	45,00	0,5	1,0	1,0	1,0	0,5	0,5	0,0	ADM+CZ
Site security management			50%	100%	100%	100%	100%	100%	100%	
security manager	1	45,00	0,5	1,0	1,0	1,0	1,0	1,0	1,0	
Permanent security outer perimeter			0%	100%	100%	100%	100%	100%	100%	
entry/exit control guard	4	30,00	0,0	4,0	4,0	4,0	4,0	4,0	4,0	
patrol guard	4	30,00	0,0	4,0	4,0	4,0	4,0	4,0	4,0	
Daytime reinforcement outer perimeter			100%	100%	100%	100%	100%	100%	100%	
entry/exit control guard	1,5	30,00	1,5	1,5	1,5	1,5	1,5	1,5	1,5	
patrol guard	1,5	30,00	1,5	1,5	1,5	1,5	1,5	1,5	1,5	
Permanent security inner perimeter			0%	100%	100%	100%	100%	100%	0%	
entry/exit control guard	4	30,00	0,0	4,0	4,0	4,0	4,0	4,0	0,0	
patrol guard	4	30,00	0,0	4,0	4,0	4,0	4,0	4,0	0,0	
Daytime reinforcement inner perimeter			0%	100%	100%	100%	100%	100%	0%	
entry/exit control guard	1,5	30,00	0,0	1,5	1,5	1,5	1,5	1,5	0,0	
General tasks			0%	50%	100%	100%	50%	100%	0%	
operational safety coordinator	1	45,00	0,0	0,5	1,0	1,0	0,5	1,0	0,0	ADM+CZ
nuclear safety coordinator	1	56,00	0,0	0,5	1,0	1,0	0,5	1,0	0,0	ADM
environmental protection coordinator	1	56,00	0,0	0,5	1,0	1,0	0,5	1,0	0,0	ADM
general QA coordinator	1	56,00	0,0	0,5	1,0	1,0	0,5	1,0	0,0	ADM
Emergency management			0%	0%	100%	100%	0%	0%	0%	
emergency manager	1	56,00	0,0	0,0	1,0	1,0	0,0	0,0	0,0	ADM
Site monitoring			0%	0%	100%	100%	50%	100%	50%	
site monitoring coordinator	1	56,00	0,0	0,0	1,0	1,0	0,5	1,0	0,5	ADM
Waste conformity			0%	0%	100%	100%	0%	0%	0%	
waste conformity manager	1	54,00	0,0	0,0	1,0	1,0	0,0	0,0	0,0	ADM+CZ
Follow-up team			100%	100%	100%	0%	0%	100%	0%	
construction engineer	1	56,00	1,0	1,0	1,0	0,0	0,0	1,0	0,0	ADM
geotechnical engineer	1	56,00	1,0	1,0	1,0	0,0	0,0	1,0	0,0	ADM
electro-mechanical engineer	1	56,00	1,0	1,0	1,0	0,0	0,0	1,0	0,0	ADM
nuclear engineer	1	56,00	1,0	1,0	1,0	0,0	0,0	1,0	0,0	ADM
Industrial operations management department			0%	0%	100%	100%	0%	0%	0%	
industrial operations manager	1	54,00	0,0	0,0	1,0	1,0	0,0	0,0	0,0	ADM+CZ

planning coordinator	1	54,00	0,0	0,0	1,0	1,0	0,0	0,0	0,0	ADM
secretary	1	29,00	0,0	0,0	1,0	1,0	0,0	0,0	0,0	ADM
Post-conditioning facility			0%	0%	0%	100%	0%	0%	0%	
shift supervisor	1	36,00	0,0	0,0	0,0	1,0	0,0	0,0	0,0	CZ
operator	14	30,00	0,0	0,0	0,0	14,0	0,0	0,0	0,0	CZ
radiological protection supervisor	2	38,00	0,0	0,0	0,0	2,0	0,0	0,0	0,0	CZ
QA supervisor	1	33,00	0,0	0,0	0,0	1,0	0,0	0,0	0,0	CZ
waste bookkeeper	1	33,00	0,0	0,0	0,0	1,0	0,0	0,0	0,0	CZ
administrative assistant	1	22,00	0,0	0,0	0,0	1,0	0,0	0,0	0,0	CZ
maintenance technician – foreman	1	36,00	0,0	0,0	0,0	1,0	0,0	0,0	0,0	CZ
maintenance technician	4	27,00	0,0	0,0	0,0	4,0	0,0	0,0	0,0	CZ
Precast hall for supercontainer concrete components			0%	0%	0%	100%	0%	0%	0%	
shift supervisor	1	36,00	0,0	0,0	0,0	1,0	0,0	0,0	0,0	
operator	4	30,00	0,0	0,0	0,0	4,0	0,0	0,0	0,0	
administrative assistant	1	22,00	0,0	0,0	0,0	1,0	0,0	0,0	0,0	
Underground operations support department			0%	100%	150%	150%	50%	50%	0%	
underground shift supervisor	1	45,00	0,0	1,0	1,5	1,5	0,5	0,5	0,0	CZ
underground radiological protection supervisor	1	38,00	0,0	1,0	1,5	1,5	0,5	0,5	0,0	CZ
maintenance technician – foreman	1	45,00	0,0	1,0	1,5	1,5	0,5	0,5	0,0	CZ
maintenance technician	3	36,00	0,0	3,0	4,5	4,5	1,5	1,5	0,0	CZ
Shaft and ramp operation and maintenance department			0%	0%	150%	150%	50%	100%	0%	
supervisor (mechanical)	1	45,00	0,0	0,0	1,5	1,5	0,5	1,0	0,0	CZ
supervisor (electrical)	1	45,00	0,0	0,0	1,5	1,5	0,5	1,0	0,0	CZ
maintenance electrician	5	36,00	0,0	0,0	7,5	7,5	2,5	5,0	0,0	CZ
maintenance mechanic	5	36,00	0,0	0,0	7,5	7,5	2,5	5,0	0,0	CZ
Mine rescue team			0%	0%	150%	150%	0%	50%	0%	
team captain	1	56,00	0,0	0,0	1,5	1,5	0,0	0,5	0,0	CZ
Waste disposal department			0%	0%	150%	150%	0%	0%	0%	
waste cart pilot	2	55,00	0,0	0,0	3,0	3,0	0,0	0,0	0,0	CZ
waste cart co-pilot	2	55,00	0,0	0,0	3,0	3,0	0,0	0,0	0,0	CZ
operator preparing the next disposal gallery section	2	55,00	0,0	0,0	3,0	3,0	0,0	0,0	0,0	CZ
Backfilling of disposal galleries			0%	0%	150%	150%	0%	0%	0%	
shift supervisor	1	36,00	0,0	0,0	1,5	1,5	0,0	0,0	0,0	CZ
radiological protection supervisor	1	38,00	0,0	0,0	1,5	1,5	0,0	0,0	0,0	CZ
operator	3	30,00	0,0	0,0	4,5	4,5	0,0	0,0	0,0	CZ
Sealing of disposal galleries			0%	0%	100%	100%	0%	0%	0%	
shift supervisor	1	36,00	0,0	0,0	1,0	1,0	0,0	0,0	0,0	CZ
operator	5	30,00	0,0	0,0	5,0	5,0	0,0	0,0	0,0	CZ
Backfilling and sealing of access galleries, shafts and ramp			0%	0%	0%	0%	0%	300%	0%	
shift supervisor	1	36,00	0,0	0,0	0,0	0,0	0,0	3,0	0,0	CZ
operator	2	30,00	0,0	0,0	0,0	0,0	0,0	6,0	0,0	CZ

OPERATOR HUMAN RESOURCES								
Total headcount	**[persons]**	20	65	120	147	55	88	20
Total salary cost	**[EUR/year]**	1.690.425	4.290.825	8.043.750	9.228.450	3.436.125	5.691.675	1.117.050
Various expenses (1% of the salary cost)	**[EUR/year]**	16.904	42.908	80.438	92.285	34.361	56.917	11.171
Overall personnel cost	**[EUR/year]**	1.707.329	4.333.733	8.124.188	9.320.735	3.470.486	5.748.592	1.128.221

BOARD OF DIRECTORS	**[EUR/year]**	25.000	25.000	25.000	25.000	25.000	25.000	25.000

EXTERNAL SERVICES								
People working in the administration zone	**[persons]**	17	25	34	30	16	29	3
People working in the controlled zone	**[persons]**	0	0	3	3	3	3	3
Medical services	**[EUR/year]**	0	0	20.812	25.458	9.714	15.306	0
Catering services	**[EUR/year]**	22.035	72.885	135.035	165.545	62.150	98.875	22.600
Office support	**[EUR/year]**	51.000	75.000	102.000	90.000	48.000	87.000	9.000

TOTAL COST	**[EUR/year]**	**1.805.364**	**4.506.618**	**8.407.035**	**9.626.737**	**3.615.351**	**5.974.773**	**1.184.821**

cost item in the OPERA cost calculation		reference			estimated cost item	cost [EUR]	index type	cost indexed to 2014 [EUR]	remarks or additional calculations
1.1.1.	nominal cost of land purchase	[4]	p. 94	2013	1 m² industry land (> 10 ha)	35	fixed	35	item 1.2.1 in the ONDRAF/NIRAS spreadsheet [4]
1.1.2.	notary fee	[4]	p. 94	2013	percentage of purchase cost	0,057%			in the ONDRAF/NIRAS cost evaluation a flat fee of 2.449,20 euro is assumed for the first 250.095 euro (item 1.2.4 in the ONDRAF/NIRAS spreadsheet) and a percentage on the amount above 250.095 euro (item 1.2.3 in the ONDRAF/NIRAS spreadsheet); here the percentage is applied on the whole amount and not only on the amount above 250.095 euro
1.2.1.	landscaping	[9]	p. 78	2007	landscaping 1 m²	25	c	28	
1.2.2.	roads and parking lots	[9]	p. 78	2007	1 m² road or parking	185	c	207	
1.2.3.	green park area	[9]	p. 78	2007	1 m² green park	30	c	34	
1.2.4.	architect/engineer fee site preparation works	[4]	p. 94	2013	percentage of construction cost	4%			item 1.4.6 in the ONDRAF/NIRAS spreadsheet
1.2.5.	sewage system	[9]	p. 78	2007	site sewage system	850.000	c	950.977	
1.2.6.	connection of site to utilities networks and sewage	[15]	p. 4	2008	connection to network 1500 m from site	1.300.000	c	1.391.655	
1.3.1.	utility building	[9]	p. 78	2007	100 m² utility building (including architect and engineering fee)	350.000	c	391.579	
1.4.1.	security post construction	[9]	p. 78	2007	construction of 48 m² security post	55.200	c	61.758	1150 euro/m² construction cost
1.4.2.	security post furniture	[9]	p. 78	2007	furniture 1 security post	75.000	c	83.910	
1.4.3.	fence	[9]	p. 78	2007	1 m fence	80	c	90	
1.4.4.	perimeter gate	[9]	p. 78	2007	construction of 1 perimeter gate	9.000	c	10.069	average between the two types of gates (the inner gate and personnel gate on the one hand and the nuclear and industrial transport gates on the other hand) which cost has been estimated at 8.000 euro and 10.000 euro respectively
1.4.5.	monitoring system	[9]	p. 78	2007	closed-circuit television system monitoring	350.000	c	391.579	
1.4.6.	access control system	[9]	p. 78	2007	access control system	150.000	c	167.820	
1.4.7.	automatic entrance detection system	[16]	p. 1	2010	detection system per perimeter length of 1400 m	101.360	c	109.293	the detection system considered in the memo is for a perimeter of 4x75 m and its cost was estimated at 21.720 euro; this cost was multiplied with 4,67 to estimate the cost for a 1400 m long perimeter
1.4.8.	architect/engineer fee	[9]	p. 78	2007	percentage of construction cost	10%			
2.1.1.	shaft construction	[9]	p. 92	2007	construction of a shaft (depth: 500 m, internal diameter: 5 m), including the construction of a breakout	40.205.000	c	44.981.233	an interpolation is made between the estimated costs for constructing (including breakout) the personnel shaft (internal diameter: 4 m; depth: 250 m) and the construction shaft (internal diameter: 6 m; depth: 250 m); the interpolated cost is doubled to come to an estimation for a shaft with a depth of 500 m
2.1.2.	shaft hoisting system	[9]	p. 92	2007	shaft hoisting system	4.080.000	c	4.564.692	an interpolation is made between the cost estimations for the hoisting system of the personnel shaft (internal diameter: 4 m; depth: 250 m) and the construction shaft (internal diameter: 6 m; depth: 250 m); the interpolated cost is doubled to come to an estimation for a shaft with a depth of 500 m
2.1.3.	ramp construction	[10]	p. 33	2012	construction of a ramp (depth: 500 m, internal diameter: 5 m)	50.685.506	c	51.728.418	an evaluation of the construction of a shaft and ramp in the ONDRAF/NIRAS disposal concept shows that constructing a ramp would cost 15% more than constructing a shaft
2.1.4.	ramp hoisting system	see cost item 2.1.2							
2.1.5.	casting ramp floor	[9]	p. 92	2007	casting 1 m³ concrete	400	fixed	400	
2.1.6.	architect/engineer fee	[4]	p. 94	2013	percentage of construction cost	5%			the ONDRAF/NIRAS cost evaluation assumed 5% or 10% architect/engineering fees on the repository construction depending on the repository part (items 2.1.4, 2.2.4, 2.4.4, 2.5.4, 2.7.6, 2.9.2 and 2.10.2 in the ONDRAF/NIRAS spreadsheet) ; the use of an overall fee of 5% here is justified by the study costs related to repository construction that were included in the human resources during the site preparation phase
2.2.1.	TBM	[9]	p. 92	2007	TBM (gallery diameter: 3.7 m)	4.441.935	m	4.934.976	intrapolation based on the cost estimations for disposal gallery (gallery diameter: 3 m) and access gallery (gallery diameter: 6 m): TBM cost proportional to the gallery diameter; the assembly and dismantling cost proportional to the square of the gallery diameter
2.2.2.	assembly TBM	[9]	p. 92	2007	assembly of a TBM (gallery diameter: 3.7 m)	533.711	m	592.951	
2.2.3.	dismantling TBM	[9]	p. 92	2007	dismantling of a TBM (gallery diameter: 3.7 m)	139.962	m	155.497	
2.2.4.	lining installation	[9]	p. 92	2007	installation of 1 m concrete wedge block lining (gallery diameter: 3.7 m)	11.120	c	12.441	interpolation between the cost estimations for the lining installation for disposal and access gallery; the cost is proportional to the lining volume
2.2.5.	casting floor	see cost item 2.1.5.							

2.2.6.	outfitting (electricity, fire protection)	[9]	p. 92	2007	outfitting of 1 m concrete wedge block lining (gallery diameter: 3.7 m)	1.044	c	1.168	interpolation between the cost estimations for the equipment for disposal and access gallery; the cost is proportional to the lining volume
2.2.7.	architect/engineer fee	see cost item 2.1.6							
2.3.1.	TBM	see cost item 2.2.1							
2.3.2.	assembly TBM	see cost item 2.2.2							
2.3.3.	dismantling TBM	see cost item 2.2.3							
2.3.4.	lining installation	see cost item 2.2.4							
2.3.5.	gallery crossing construction	[9]	p. 92	2007	construction of a crossing between 2 galleries with an equal inner diameter of 3.7 m at a depth of 500 m	1.590.000	c	1.778.887	the construction cost is assumed to be similar to the construction of a crossing between galleries with inner diameters of 6.0 m and 3.0 m at a repository depth of 250 m
2.3.6.	casting floor	see cost item 2.1.5.							
2.3.7.	outfitting (electricity, fire protection)	see cost item 2.2.6							
2.3.8.	architect/engineer fee	see cost item 2.1.6							
2.4.1.	TBM	see cost item 2.2.1							
2.4.2.	assembly TBM	see cost item 2.2.2							
2.4.3.	dismantling TBM	see cost item 2.2.3							
2.4.4.	lining installation	see cost item 2.2.4							
2.4.5.	end plug	[9]	p. 92	2007	casting 1 m^3 concrete	400	fixed	400	
2.4.6.	crossings	see cost item 2.3.5.							
2.4.7.	casting floor	see cost item 2.1.5.							
2.4.8.	outfitting (electricity, fire protection)	see cost item 2.2.6							
2.4.9.	architect/engineer fee	see cost item 2.1.6							
2.5.1.	TBM	[9]	p. 92	2007	TBM (gallery diameter: 2.2 m)	2.741.935	m	3.046.281	extrapolation based on the cost estimations for disposal gallery (gallery diameter: 3 m) and access gallery (gallery diameter: 6 m): TBM cost proportional to the gallery diameter; the assembly and dismantling cost proportional to the square of the gallery diameter
2.5.2.	assembly TBM	[9]	p. 92	2007	assembly of a TBM (gallery diameter: 2.2 m)	220.244	m	244.690	
2.5.3.	dismantling TBM	[9]	p. 92	2007	dismantling of a TBM (gallery diameter: 2.2 m)	52.908	m	58.781	
2.5.4.	lining installation	[9]	p. 92	2007	installation of 1 m concrete wedge block lining (gallery diameter: 2.2 m)	8.180	c	9.152	extrapolation between the cost estimations for the lining installation for disposal and access gallery; the cost is proportional to the lining volume
2.5.5.	end plug	see cost item 2.4.5.							
2.5.6.	gallery crossing construction	[9]	p. 92	2007	construction of a crossing between 2 galleries with an inner diameter of 3.7 m and 2.2 m at a depth of 500 m	1.590.000	c	1.778.887	the construction cost is assumed to be similar to the construction of a crossing between galleries with inner diameters of 6.0 m and 3.0 m at a repository depth of 250 m
2.5.7.	casting floor	see cost item 2.1.5.							
2.5.8.	outfitting (electricity, fire protection)	[9]	p. 92	2007	outfitting of 1 m concrete wedge block lining (gallery diameter: 2.2 m)	521	c	583	extrapolation between the cost estimations for the equipment for disposal and access gallery; the cost is proportional to the lining volume
2.5.9.	architect/engineer fee	see cost item 2.1.6							
2.6.1.	TBM	see cost item 2.5.1							
2.6.2.	assembly TBM	see cost item 2.5.2							
2.6.3.	dismantling TBM	see cost item 2.5.3							
2.6.4.	lining installation	see cost item 2.5.4							
2.6.5.	end plug	see cost item 2.4.5.							
2.6.6.	crossings	see cost item 2.5.6							
2.6.7.	casting floor	see cost item 2.1.5.							
2.6.8.	outfitting (electricity, fire protection)	see cost item 2.5.8							
2.6.9.	architect/engineer fee	see cost item 2.1.6							
2.7.1.	TBM (gallery diameter 3,7 m)	see cost item 2.2.1							
2.7.2.	assembly TBM (gallery diameter 3,7 m)	see cost item 2.2.2							
2.7.3.	dismantling TBM (gallery diameter 3,7 m)	see cost item 2.2.3							
2.7.4.	lining installation (gallery diameter 3,7 m)	see cost item 2.2.4							
2.7.5.	end plug secondary gallery	see cost item 2.4.5.							
2.7.6.	casting floor secondary gallery	see cost item 2.1.5.							
2.7.7.	outfitting (electricity, fire protection) secondary gallery	see cost item 2.2.6							
2.7.8.	TBM (gallery diameter 2,2 m)	see cost item 2.5.1							
2.7.9.	assembly TBM (gallery diameter 2,2 m)	see cost item 2.5.2							
2.7.10.	dismantling TBM (gallery diameter 2,2 m)	see cost item 2.5.3							
2.7.11.	lining installation (gallery diameter 2,2 m)	see cost item 2.5.4							
2.7.12.	end plug disposal gallery	see cost item 2.4.5.							
2.7.13.	casting floor disposal gallery	see cost item 2.1.5.							

2.7.14.	outfitting (electricity, fire protection) disposal gallery	see cost item 2.5.8							
2.7.15.	architect/engineer fee	see cost item 2.1.6							
2.8.1.	fan main system	[11]	p. 59	2013	Korfmann fan (AL 14-900 (90 kW))	30.500	c	30.706	
2.8.2.	fan auxiliary system	[11]	p. 59	2013	Howden fan (Type VRE 0710/610 W 145/11)	15.500	c	15.605	
2.8.3.	main duct	[11]	p. 59	2013	1 m duct (diameter: 1000 mm)	200	c	201	
2.8.4.	10 m spiral duct connecting ducts of crossings galleries	[11]	p. 59	2013	10 m spiral duct (diameter 1000-400 mm)	470	c	473	
2.8.5.	regulation gate at gallery crossing	[11]	p. 60	2013		300	c	302	
2.8.6.	ducts in the disposal galleries	[11]	p. 59	2013	1 m duct (diameter: 400 mm)	125	c	126	
2.8.7.	architect/engineer fee	[4]	p. 95	2013	percentage of construction or installation cost	10%			items 2.12.1.2, 2.12.2.3 and 2.12.3.6 in the ONDRAF/NIRAS spreadsheet
2.9.1.	visitor centre	[17]	p. 4	2009	550 m² visitor centre	1.420.100	c	1.576.947	2840 euro/m² (architect and engineering fee included) = 2582 euro/m² (architect and engineering fee excluded)
2.9.2.	exhibition room furbishing	[17]	p. 4	2009	200 m² exhibition room	516.400	c	573.435	
2.9.3.	administration building	[7]	p. 76	2007	935 m² administration building	1.715.250	c	1.919.017	a smaller administration building is assumed in the OPERA cost evaluation (935 m² instead of 1266,5 m²) and the estimated cost is therefore reduced with 1150 EUR2007/m²
2.9.4.	services building	[7]	p. 77	2007	178 m² services building	325.987	c	364.713	
2.9.5.	maintenance building	[7]	p. 77	2007	473 m² maintenance building	438.000	c	490.033	
2.9.6.	ramp building	[7]	p. 92	2007	1260 m² ramp building	5.454.545	c	6.102.529	estimated cost (“air lock option”; ventilation not included) reduced with 10% as in architect/engineering fee of 10% was included in the estimation
2.9.7.	backfill material processing building	[7]	p. 92	2007	925 m² backfill material processing building	337.500	c	377.594	estimated cost reduced with 10% as in architect/engineering fee of 10% was included in the estimation
2.9.8.	geotextile under rock dump	[4]	p. 95	2013	1 m² geotextile	4	c	4	item 2.11.7 in the ONDRAF/NIRAS spreadsheet
2.9.9.	geotextile over rock dump	[4]	p. 95	2013	1 m² geotextile	4	c	4	item 2.11.8 in the ONDRAF/NIRAS spreadsheet
2.9.10.	non-fertile soil cover on rock dump	[4]	p. 95	2013	1 m³ non-fertile soil	3	fixed	3	items 2.11.1, 2.11.2 and 2.11.3 in the ONDRAF/NIRAS spreadsheet
2.9.11.	fertile soil cover on rock dump	[4]	p. 95	2013	1 m³ fertile soil	16	fixed	16	items 2.11.4, 2.11.5 and 2.11.6 in the ONDRAF/NIRAS spreadsheet
2.9.12.	architect/engineer fee	[4]	p. 95	2013	percentage of construction cost	10%			items 2.15.1.5, 2.15.2.4 and 2.15.3.3 in the ONDRAF/NIRAS spreadsheet
2.10.1.	security buildings	[4]	p. 79	2013	maintenance of 96 m² security building	4.800	fixed	4.800	
2.10.2.	utility buildings	[4]	p. 79	2013	maintenance of 200 m² utility buildings	10.000	fixed	10.000	
2.10.3.	administration building	[4]	p. 79	2013	maintenance of 935 m² administration building	46.750	fixed	46.750	
2.10.4.	services building	[4]	p. 79	2013	maintenance of 178 m² services building	8.900	fixed	8.900	
2.10.5.	maintenance building	[4]	p. 79	2013	maintenance of 473 m² maintenance building	23.650	fixed	23.650	the annual maintenance cost amounts 50 euro/m²
2.10.6.	ramp building	[4]	p. 79	2013	maintenance of 1260 m² ramp building	63.000	fixed	63.000	
2.10.7.	shaft buildings	[4]	p. 79	2013	maintenance of 1850 m² shaft buildings	92.500	fixed	92.500	
2.10.8.	backfill material processing building	[4]	p. 79	2013	maintenance of 530 m² backfill material processing building	26.500	fixed	26.500	
2.10.9.	security installations	[4]	p. 79	2013	maintenance cost for the security installations	24.441	fixed	24.441	it is assumed that the security installations are replaced every 30 years; therefore their annual maintenance is 3,3% of their installation cost (incl. 10% architect and engineering fee)
2.10.10.	ramp hoisting system	[4]	p. 79	2013	annual maintenance of the ramp hoisting system	22.000	fixed	22.000	the same cost as for the maintenance of the shaft hoisting system (cost item 2.9.11) is assumed; the ramp cable is 10 times longer, but the loads on the ramp cable are much smaller as well
2.10.11.	shaft hoisting systems	[4]	p. 79	2013	annual maintenance of 1 shaft hoisting system	22.000	fixed	22.000	twice (to take account of the larger depth of the shafts in the OPERA concept) the cost estimated by ONDRAF/NIRAS based on experience from the maintenance of the hoisting system of the 2nd shaft of HADES: (1) 10.000 euro cable needs to be replaced every 10 years and (2) the annual cost for safety checks by a control agency amounts 10.000 euro
2.10.12.	visitor centre	[4]	p. 79	2013	percentage of the exhibition roob furbishing	129.100	fixed	129.100	it is assumed that the exhibition room of the visitor centre will be refurbished every 4 years; therefore its annual maintenance is 25% of the cost for furbishing the exhibition room
2.10.13.	green park area	[4]	p. 79	2013	annual maintenance cost for 26 ha	67.600	fixed	67.600	cost estimated by ONDRAF/NIRAS based on following assumptions: (1) a gardener costs 25 euro/hour and can maintain 25 ha in 1 year (1.600 hours) and (2) replanting vegetation costs 50.000 euro/ha and this needs to be done gradually every 50 years
2.11.1.	security posts	[4]	p. 79	2013	insurance cost for the security posts	2.444	fixed	2.444	
2.11.2.	utility buildings	[4]	p. 79	2013	insurance cost for the utility buildings	2.310	fixed	2.310	
2.11.3.	administration building	[4]	p. 79	2013	insurance cost for the adminstration building	5.660	fixed	5.660	
2.11.4.	services building	[4]	p. 79	2013	insurance cost for the services building	1.076	fixed	1.076	
2.11.5.	maintenance building	[4]	p. 79	2013	insurance cost for the maintenance building	1.445	fixed	1.445	an approximative value of 0.33% of the construction or installation cost as assumed as insurance

2.11.6.	ramp building	[4]	p. 79	2013	insurance cost for the ramp building	18.000	fixed	18.000	an approximative value of 0,33% of the construction or installation cost as assumed as insurance cost based on experience with the BELGOPROCESS surface installations
2.11.7.	ramp hoisting system	[4]	p. 79	2013	insurance cost for the ramp hoisting system	13.464	fixed	13.464	
2.11.8.	shaft hoisting systems	[4]	p. 79	2013	insurance cost for the shaft hoisting system	26.928	fixed	26.928	
2.11.9.	backfill material processing building	[4]	p. 79	2013	insurance cost for the backfill material processing building	1.114	fixed	1.114	
2.11.10.	visitor centre	[4]	p. 79	2013	insurance cost for the visitor centre	6.390	fixed	6.390	
3.1.1.	standard locomotive with an integrated human control cabin	[12]	p. 55	2013	standard locomotive with an integrated human control cabin	700.000	m	695.496	
3.1.2.	waste transport cart	[12]	p. 55	2013	waste transport cart including coupling system	610.000	m	606.075	
3.1.3.	relocatable turntable	[12]	p. 57	2013	relocatable turntable	85.000	m	84.453	
3.2.1.	backfill material	[18a]	p. 139	2014	1 m^3 cellular concrete (foam concrete)	180	fixed	180	average between 127 euro/m^3 and 232 euro/m^3
3.2.2.	backfill operations	[9]	p. 92	2007	equipment to backfill 200 m gallery	80.000	c	89.504	20% of the estimated cost to backfill 1000 m disposal gallery
3.3.1.	lining removal for seal installation	[9]	p. 91	2007	removal of 10 m lining (inner diameter: 3.7 m)	390.000	fixed	390.000	the cost for filling the volume when increasing the gallery with 35% with bentonite was assumed to be representative for the cost for removing the gallery lining
3.3.2.	seal bentonite	[9]	p. 92	2007	1 m^3 bentonite	5.000	fixed	5.000	
3.3.3.	concrete support for seal	see cost item 2.1.5.							
3.4.1.	post-conditioning facility	[9]	p. 92	2007	post-conditioning facility for vitrified high-level waste	44.000.000	c	49.227.068	estimated cost reduced with 50% as 10% architect/engineering fee and 40% uncertainty margin were included in the estimation
3.4.2.	pre-cast hall	[9]	p. 92	2007	pre-cast hall for supercontainer concrete components	8.230.000	c	9.207.699	estimated cost reduced with 10% as an architect/engineering fee was included in the estimation
3.4.3.	architect/engineer fee				percentage of the construction cost	10%			the estimated costs for the post-conditioning facility and pre-cast hall were reduced with 10% as the estimations included the architect/engineering fee (see cost items 3.3.1 and 3.3.2 in the ONDRAF/NIRAS spreadsheet [4])
3.5.1.	security buildings	see cost item 2.10.1.							
3.5.2.	utility buildings	see cost item 2.10.2.							
3.5.3.	administration building	see cost item 2.10.3.							
3.5.4.	services building	see cost item 2.10.4.							
3.5.5.	maintenance building	see cost item 2.10.5.							
3.5.6.	ramp building	see cost item 2.10.6.							
3.5.7.	shaft buildings	see cost item 2.10.7.							
3.5.8.	backfill material processing building	see cost item 2.10.8.							
3.5.9.	security installations	see cost item 2.10.9.							
3.5.10.	ramp hoisting system	see cost item 2.10.10.							
3.5.11.	shaft hoisting systems	see cost item 2.10.11.							
3.5.12.	visitor centre	see cost item 2.10.12.							
3.5.13.	green park area	see cost item 2.10.13.							
3.6.1.	security posts	see cost item 2.11.1.							
3.6.2.	utility buildings	see cost item 2.11.2.							
3.6.3.	administration building	see cost item 2.11.3.							
3.6.4.	services building	see cost item 2.11.4.							
3.6.5.	maintenance building	see cost item 2.11.5.							
3.6.6.	ramp building	see cost item 2.11.6.							
3.6.7.	ramp hoisting system	see cost item 2.11.7.							
3.6.8.	shaft hoisting systems	see cost item 2.11.8.							
3.6.9.	backfill material processing building	see cost item 2.11.9.							
3.6.10.	visitor centre	see cost item 2.11.10.							
3.6.11.	Third-Party Liability	[4]	p. 79	2013	annual 3rd party liability in the field of nuclear energy	400.000	fixed	400.000	
4.1.1.	overpack	[14]	p. 11	2006	1 carbon steel overpack for 2 CSD-V canisters	4.503	w	5.206	
4.1.2.	filler	[4]	p. 79	2013	1 m^3 mortar	110	fixed	110	
4.1.3.	concrete buffer	[4]	p. 79	2013	1 m^3 concrete for supercontainer buffer	400	fixed	400	
4.1.4.	envelope	[4]	p. 79	2013	1 ton stainless steel	7.482	fixed	7.482	
4.2.1.	backfill material	see cost item 3.2.1.							
4.2.2.	backfill operations	[7]	p. 92	2007	equipment to backfill 45 m gallery	18.000	c	20.138	4,5% of the estimated cost to backfill 1000 m disposal gallery
4.2.3.	backfill operations	see cost item 3.1.2.							
4.3.1.	lining removal for seal installation	[9]	p. 91	2007	removal of 10 m lining (inner diameter: 2.2 m)	120.000	fixed	120.000	the cost for filling the volume when increasing the gallery with 35% with bentonite was assumed to be representative for the cost for removing the gallery lining

4.3.2.	seal bentonite	see cost item 3.2.2.							
4.3.3.	concrete support for seal	see cost item 2.1.5.							
4.4.1.	security buildings	see cost item 2.10.1.							
4.4.2.	utility buildings	see cost item 2.10.2.							
4.4.3.	administration building	see cost item 2.10.3.							
4.4.4.	services building	see cost item 2.10.4.							
4.4.5.	maintenance building	see cost item 2.10.5.							
4.4.6.	ramp building	see cost item 2.10.6.							
4.4.7.	shaft buildings	see cost item 2.10.7.							
4.4.8.	backfill material processing building	see cost item 2.10.8.							
4.4.9.	security installations	see cost item 2.10.9.							
4.4.10.	ramp hoisting system	see cost item 2.10.10.							
4.4.11.	shaft hoisting systems	see cost item 2.10.11.							
4.4.12.	visitor centre	see cost item 2.10.12.							
4.4.13.	green park area	see cost item 2.10.13.							
4.4.14.	post-conditioning facility	[4]	p. 79	2013	maintenance of the post-conditioning facility	880.000	fixed	880.000	it is assumed that the maintenance cost of the post-conditioning facility is 3% of its construction cost; this is reduced with 30% (to 2%) as maintenance costs are already partly included in the human resource costs for general maintenance
4.4.15.	pre-cast hall	[4]	p. 79	2013	maintenance of the pre-cast hall facility	106.990	fixed	106.990	it is assumed that the maintenance cost of the pre-cast hall is 2% of its construction cost; this is reduced with 30% (to 1,3%) as maintenance costs are already partly included in the human resource costs for general maintenance
4.5.1.	security posts	see cost item 2.11.1.							
4.5.2.	utility buildings	see cost item 2.11.2.							
4.5.3.	administration building	see cost item 2.11.3.							
4.5.4.	services building	see cost item 2.11.4.							
4.5.5.	maintenance building	see cost item 2.11.5.							
4.5.6.	ramp building	see cost item 2.11.6.							
4.5.7.	ramp hoisting system	see cost item 2.11.7.							
4.5.8.	shaft hoisting systems	see cost item 2.11.8.							
4.5.9.	backfill material processing building	see cost item 2.11.9.							
4.5.10.	visitor centre	see cost item 2.11.10.							
4.5.11.	post-conditioning facility	[4]	p. 79	2013	insurance cost for the post-conditioning facility	145.200	fixed	145.200	approximative value for the insurance of the BELGOPROCESS surface installations
4.5.12.	pre-cast hall	[4]	p. 79	2013	insurance cost for the pre-cast hall	27.159	fixed	27.159	approximative value for the insurance of the BELGOPROCESS surface installations
4.5.13.	Third-Party Liability	see cost item 3.6.11.							
5.1.1.	security buildings	see cost item 2.10.1.							
5.1.2.	utility buildings	see cost item 2.10.2.							
5.1.3.	administration building	see cost item 2.10.3.							
5.1.4.	services building	see cost item 2.10.4.							
5.1.5.	maintenance building	see cost item 2.10.5.							
5.1.6.	ramp building	see cost item 2.10.6.							
5.1.7.	shaft buildings	see cost item 2.10.7.							
5.1.8.	backfill material processing building	see cost item 2.10.8.							
5.1.9.	security installations	see cost item 2.10.9.							
5.1.10.	ramp hoisting system	see cost item 2.10.10.							
5.1.11.	shaft hoisting systems	see cost item 2.10.11.							
5.1.12.	visitor centre	see cost item 2.10.12.							
5.1.13.	green park area	see cost item 2.10.13.							
5.1.14.	post-conditioning facility	see cost item 4.3.14.							
5.1.15.	pre-cast hall	see cost item 4.3.15.							
5.2.1.	security posts	see cost item 2.11.1.							
5.2.2.	utility buildings	see cost item 2.11.2.							
5.2.3.	administration building	see cost item 2.11.3.							
5.2.4.	services building	see cost item 2.11.4.							
5.2.5.	maintenance building	see cost item 2.11.5.							
5.2.6.	ramp building	see cost item 2.11.6.							
5.2.7.	ramp hoisting system	see cost item 2.11.7.							
5.2.8.	shaft hoisting systems	see cost item 2.11.8.							

5.2.9.	backfill material processing building	see cost item 2.11.9.							
5.2.10.	visitor centre	see cost item 2.11.10.							
5.2.11.	post-conditioning facility	see cost item 4.4.11.							
5.2.12.	pre-cast hall	see cost item 4.4.12.							
5.2.13.	Third-Party Liability	see cost item 3.5.11.							
6.1.1.	backfill material	see cost item 3.2.1.							
6.1.2.	backfill operations	[7]	p. 92	2007	equipment to backfill 1.000 m gallery section	440.000	c	537.023	120% of the estimated cost to backfill 1000 m disposal gallery
6.2.1.	gallery lining removal for seal installation	see cost item 3.3.1.							
6.2.2.	ramp lining removal for seal installation	[7]	p. 92	2007	removal of 10 m lining (inner diameter: 3,7 m)	735.000	fixed	735.000	the cost for filling the volume when increasing the gallery with 35% with bentonite was assumed to be representative for the cost for removing the gallery lining
6.2.3.	seal bentonite (gallery seals)	see cost item 3.3.2.							
6.2.4.	seal bentonite (ramp seal)	see cost item 3.3.2.							
6.2.5.	concrete support (gallery seals)	see cost item 2.1.5.							
6.2.6.	concrete support (ramp seal)	see cost item 2.1.5.							
6.3.1.	dismantling hoisting system	[4]	p. 99	2013	cost for dismantling the shaft hoisting system	400.000	fixed	400.000	the cost for dismantling the shaft hoisting system in the ONDRAF/NIRAS concept was estimated at 200.000 euro (items 7.2.1, 12.3.1 and 12.5.1 in the ONDRAF/NIRAS spreadsheet [4]; based on the cost for removing the hoisting system in the Konrad 2 shaft); as the OPERA shafts are twice as deep, this cost is doubled
6.3.2.	ad hoc rent of 2 temporary hoisting systems	[4]	p. 103	2013	annual rent for 1 temporary hoisting system	1.000.000	fixed	1.000.000	the rental cost for 1 temporary shaft hoisting system was estimated at 500.000 euro/year by ONDRAF/NIRAS for a 250 m deep shaft; as the OPERA shafts are twice as deep, this cost is doubled
6.3.3.	dismantling and removal of the shaft interior	[4]	p. 99	2013	removal of shaft interior equipment over 1 m	1050	fixed	1.050	items 7.2.2, 12.3.2 and 12.5.2 in the ONDRAF/NIRAS spreadsheet [4]; based on the cost for removing the Konrad 2 shaft interior equipment (total cost for removing the shaft interior equipment was 1.050.000 euro; shaft depth is 1000 m) (done in 2007-2009)
6.3.4.	seal bentonite	see cost item 3.3.2.							
6.3.5.	concrete support for seal	see cost item 2.1.5.							
6.4.1.	backfill material	see cost item 3.2.1.							
6.5.1.	decommissioning and dismantling post-conditioning facility	[4]	p. 102	2013		8.800.000	c	8.859.540	ONDRAF/NIRAS experience (cf. IPM from cAt project)
6.6.1.	security posts	[4]	p. 79	2013		37.032	c	37.283	ONDRAF/NIRAS experience (cf. IPM from cAt project)
6.6.2.	utility buildings	[4]	p. 79	2013		175.000	c	176.184	ONDRAF/NIRAS experience (cf. IPM from cAt project)
6.6.3.	administration building	[4]	p. 79	2013		85.763	c	86.343	ONDRAF/NIRAS experience (cf. IPM from cAt project)
6.6.4.	services building	[4]	p. 79	2013		16.299	c	16.410	ONDRAF/NIRAS experience (cf. IPM from cAt project)
6.6.5.	maintenance building	[4]	p. 79	2013		21.900	c	22.048	ONDRAF/NIRAS experience (cf. IPM from cAt project)
6.6.6.	visitor centre	[4]	p. 79	2013		71.005	c	71.485	ONDRAF/NIRAS experience (cf. IPM from cAt project)
6.6.7.	backfill material processing building	[4]	p. 79	2013		16.875	c	16.989	ONDRAF/NIRAS experience (cf. IPM from cAt project)
6.6.8.	dismantling pre-cast hall	[4]	p. 79	2013		411.500	c	414.284	ONDRAF/NIRAS experience (cf. IPM from cAt project)
6.6.9.	air-lock ramp building	[4]	p. 79	2013		1.090.909	c	1.098.290	ONDRAF/NIRAS experience (cf. IPM from cAt project)
6.6.10.	levelling of soil and sowing of grass	[4]	p. 79	2013	levelling 1 m^2 soil and sowing grass	5	c	5	ONDRAF/NIRAS experience (cf. IPM from cAt project)
6.6.11.	clear road surface and parking lots	[4]	p. 79	2013	break up 1 m^2 road and sowing grass	21	c	21	ONDRAF/NIRAS experience (cf. IPM from cAt project)

Review
Kostenbegroting

Nucleaire eindberging

Review
Kostenbegroting

Nucleaire eindberging

	Opdrachtgever	Opdrachtnemer
Contactgegevens:	COVRA N.V. Spanjeweg 1 4455 TW Nieuwdorp	Postbus 125 5680 AC Best
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Opgesteld:	5.1.2e
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INHOUDSOPGAVE

1 ALGEMEEN

1.1 Inleiding

De afgelopen jaren is onder leiding van COVRA het onderzoeksprogramma eindberging radioactief afval (OPERA) uitgevoerd naar een veilige, lange termijn opberging van radioactief afval in Nederland. Binnen het onderzoeksprogramma is een kostenbegroting opgesteld voor de verdere voorbereiding, het ontwerp en de uitvoering van deze eindberging.
BouwQ heeft in opdracht van COVRA een onafhankelijke review uitgevoerd van de kostenbegroting inclusief het bijbehorende uitgangspuntenrapport.

1.2 BouwQ

BouwQ BV verricht technische controles vanaf planvorming tot en met uitvoering van bouwwerken. BouwQ streeft naar een zo groot mogelijke zekerstelling van het voldoen aan technische en functionele eisen van bouwwerken. BouwQ voert haar controlewerkzaamheden risicogestuurd uit volgens de protocollen die in samenwerking met grote opdrachtgevers zoals Rijkswaterstaat, ProRail en technische verzekeraars zijn opgesteld.
BouwQ is NEN-EN-ISO 9001 gecertificeerd en in het bezit van het Certificaat Erkenning TIS.

1.3 Leeswijzer

In hoofdstuk 2 wordt een toelichting gegeven op de uitgevoerde werkzaamheden. In hoofdstuk 3 wordt ingegaan op de systematiek en opzet van de kostenbegroting. In hoofdstuk 4 wordt de kostenbegroting inhoudelijk gecontroleerd door het uitvoeren van enige steekproeven. In hoofdstuk 5 worden enige technische risico's behandeld die mogelijk een groot financieel gevolg hebben. In hoofdstuk 6 wordt afgesloten met de conclusie en enige aanbevelingen.

2 TOELICHTING UITVOERING REVIEW

2.1 Vraag van de opdrachtgever

COVRA heeft BouwQ gevraagd een onafhankelijke review uit te voeren op de volgende aspecten van de kostenbegroting:

- De toegepaste ramingssystematiek inclusief de toegepaste onzekerheidsmarges.
- De volledigheid van de opgenomen kostenposten in relatie tot de uit te voeren werkzaamheden.

Aanvullend is BouwQ gevraagd waar mogelijk aanbevelingen te doen voor onderwerpen die verder onderzocht zouden kunnen worden bij het vervolg van het onderzoeksproject OPERA.

2.2 Invulling van de werkzaamheden

Bij de uitvoering van de onafhankelijke review zijn door BouwQ de volgende stappen doorlopen:

1. Bespreking van de vraag van COVRA aan BouwQ (uitgevoerd op 24 februari 2017)
2. Bestuderen en beoordelen kostenbegroting en uitgangspuntenrapport
3. Overleg tussen het projectteam van BouwQ en COVRA (uitgevoerd op 6 juni 2017):
    - Bespreking eerste bevindingen
    - Afstemming over onduidelijkheden en stellen van vragen
    - Opvragen aanvullende informatie
4. Afronden review kostenbegroting en uitgangspuntenrapport inclusief verwerken nieuwe informatie uit de bespreking
5. Opstellen concept rapportage inclusief mogelijke bevindingen, risico's en aanbevelingen
6. Controleronde COVRA op concept rapportage, mogelijkheid tot reageren
7. Opstellen definitieve rapportage 'Onafhankelijke review kostenbegroting eindberging radioactief afval'.

2.3 Documenten binnen de scope

De review is uitgevoerd op de volgende documenten en bestanden die digitaal van COVRA zijn ontvangen:

Uitgangspuntenrapport:

- Evaluation of the overnight cost of the OPERA disposal concept in Boom Clay (zonder datum/versienummer)

Excel-bestand:

- Kostenschatting for onafhankelijke review

De volgende referentie documenten zijn ter info gebruikt bij de review:

- Disposal facility design (2007)
- NIROND TR 2009-15 E signed
- ONDRAF-NIRAS cost evaluation 2013
- Costing calculation_COVRA_Belgische_kengetallen
- Tabellen uit Evaluation of the overnight cost versie 18 juni 2014 voorzien gegevens relevant voor Nederland
- Figuur met het meest recente Nederlandse ontwerp van de eindberging

2.4 Personele inzet

De werkzaamheden zijn binnen BouwQ uitgevoerd door een projectteam bestaande uit de volgende medewerkers:

- Jos Rooijakkers (Directeur BouwQ, scope contractmanagement en uitvoeringstechnieken infrastructuur)
- 5.1.2e (5.1.2e, scope uitvoeringstechnieken infra met focus op boortunnels)
- 5.1.2e (5.1.2e, scope systematiek en inhoud kostenbegroting)

3 SYSTEMATIEK EN OPZET VAN DE KOSTENBEGROTING

3.1 Inleiding

De opzet van de eindberging m.b.t. het ontwerp, uitvoering en organisatie is door COVRA grotendeels overgenomen van de Belgische Nationale Instelling voor Radioactief Afval en verrijkte Splijtstoffen, ONDRAF/NIRAS. Dit geldt ook voor de systematiek en opzet van de kostenbegroting. Waar nodig zijn aanpassingen doorgevoerd m.b.t. de Nederlandse situatie. Het Nederlandse ontwerp van de eindberging wijkt af van het Belgische, bijvoorbeeld door de grotere diepte. Dit is ook verwerkt in de kostenbegroting van COVRA.
Het uitgangspuntenrapport 'Evaluation of the overnight cost of the OPERA disposal concept in Boom Clay' beschrijft in detail de systematiek en opzet van de kostenbegroting van de eindberging.
De cijfermatige onderbouwing van de kostenbegroting is opgenomen in het Excel-bestand 'Kostenschatting for onafhankelijke review'.
Opgemerkt wordt dat ONDRAF/NIRAS voor onderzoek reeds een ondergronds laboratorium (HADES) in de Boomse klei heeft aangelegd inclusief toegangsshafts en tunneldelen. De ervaringen van ONDRAF/NIRAS zijn verwerkt in het ontwerp van de eindberging en de kostenbegroting.

Opmerking BouwQ
Het uitgangspuntenrapport is nog niet aangepast op de laatste wijzigingen die zijn doorgevoerd in het Nederlandse ontwerp van de eindberging. De beschrijvingen van de uitgangpunten met betrekking tot de onderbouwingen van de eenheidsprijzen in het rapport zijn nog wel van toepassing.
Dit betekent dat de gegevens waaronder het ontwerp, de planning en de bedragen in de kostenopstelling uit het uitgangspuntenrapport niet volledig overeenkomen met de gegevens uit het Excel-bestand 'Kostenschatting for onafhankelijke review'. Het uitgangspuntenrapport zal op deze punten nog aangepast worden door COVRA. Dit was bij aanvang van de opdracht van BouwQ bekend.
Het Excel-bestand 'Kostenschatting for onafhankelijke review' bevat de meest recente keuzes en informatie over het Nederlandse ontwerp, de projectplanning en het kostenoverzicht van de eindberging. Deze gegevens zijn daarom door BouwQ gereviewed.

3.2 Opzet kostenbegroting

In hoofdstuk 3 'Cost calculation' van het uitgangspuntenrapport wordt de opzet van de kostenbegroting beschreven. De kostenbegroting volgt 7 projectfases:

1. Site preparation
2. Repository construction
3. Disposal campaign of LILW and (TE)NORM waste
4. Disposal campaign of HLW
5. Underground observation phase
6. Repository closure
7. Post-closure phase

Voor elke projectfase is duidelijk omschreven welke activiteiten binnen de fase worden uitgevoerd. Daarbij wordt ingegaan op de planning van werkzaamheden (zowel bij de voorbereiding, de bouwmethodiek, het plaatsen van de afvalcontainers als het afsluiten van de eindberging) als de hoeveelheden (aantal gebouwen, oppervlakte werkterrein, lengte en diameter tunnels, hoeveelheden te plaatsen containers, etc.).
De uitgangspunten voor de planning en hoeveelheden per fase zijn overgenomen in de kostenbegroting en voorzien van een kostprijs per eenheid, prijspeil 2014.
De verschillende kostprijzen zijn opgenomen in de tabbladen 'base data', 'unit cost data', 'operator' en 'COVRA'. Het tabblad 'unit cost data' bevat de meeste eenheidsprijzen en deze zijn voorzien van gedetailleerde aanvullende informatie zoals een referentie en onderbouwing.
Binnen het Excel-sheet worden alle genoemde hoeveelheden per fase vermenigvuldigt met de betreffende eenheidsprijs en dit levert de kostprijs 'Calculated Cost'.
Deze kostprijs betreft de zgn. 'overnight cost' oftewel de kosten van het project alsof het binnen '1 nacht' wordt uitgevoerd waardoor de invloed van rente buitenbeschouwing kan worden gelaten.

Opmerking BouwQ
De werkwijze om op basis van uitgangspunten voor een projectplanning, organisatie, ontwerp, en uitvoeringsmethode te komen tot hoeveelheden met eenheidsprijzen vormt de kern van elke kostenbegroting. De opzet van de kostenbegroting is duidelijk en de toegepaste eenheidsprijzen zijn voorzien van een gedetailleerde onderbouwing met referenties. De kostenbegroting is om deze redenen goed te beoordelen door een externe partij zoals BouwQ.
BouwQ heeft geen verdere opmerkingen op de opzet van de kostenbegroting.
In hoofdstuk 4 wordt verder inhoudelijk ingegaan op de toegepaste hoeveelheden en eenheidsprijzen.

3.3 Toepassing van onzekerheidsmarges

De eerste werkzaamheden op locatie staan momenteel gepland voor het jaar 2115 en het project bevindt zich momenteel in een zeer conceptueel stadium. Voor het ontwerp en de uitvoering van de eindberging zijn aannames gedaan over de toepassing van innovatieve, deels nog te ontwikkelen technologieën. Daarom worden marges toegepast op de berekende kosten die de onzekerheden representeren verband houdend met de looptijd van het project en van de gebruikte technologieën.
De onzekerheidsmarges voor de kostenbegroting zijn door COVRA net als ONDRAF/NIRAS bepaald op basis van een methode van het Amerikaanse Electric Power Research Institute. Deze EPRI-methode gaat uit van de toepassing van twee onzekerheidsmarges, een projectmarge (afhankelijk van de fase waarin het project zich bevindt) en een technologiemarge (afhankelijk van de ontwikkelfase van de toe te passen technieken). De marges worden opgeteld bij de berekende kosten.

Voor de projectmarge zijn vier niveaus gedefinieerd:

1. Simplified planning (conceptual screening): 30–50% margin
2. Preliminary planning (feasibility study): 15–30% margin
3. Detailed planning (budgeting stage): 10–20% margin
4. Final or near-final planning (tendering stage): 5–10% margin

De door COVRA toegepaste projectmarges bevinden zich voor het grootste gedeelte tussen de 20 – 30 %. Dit komt volgens de EPRI-methode overeen met niveau 2 ‘preliminary planning (feasibility study)’.

Voor de technologiemarge zijn vijf niveaus gedefinieerd:

1. New concept for which little or no comparison exists: ≥ 40% margin
2. New design for which a preliminary design analysis has been performed: 30–70% margin
3. New design for which a more advanced design analysis has been performed, possibly involving prototype testing: 20–35% margin
4. Modified design derived from an existing design already commonly used in the industry: 5–20% margin
5. Design commonly used in the industry: ≤ 10% margin

De door COVRA toegepaste technologiemarges bevinden zich voor de bouw van de eindberging voor het grootste gedeelte tussen de 10 – 30 %. Dit komt volgens de EPRI-methode overeen met niveau 3 en 4.

De door COVRA toegepaste technologiemarges voor het plaatsen van het afval en het sluiten van de eindberging bevinden zich voor het grootste gedeelte tussen de 10 – 50 %. Dit komt volgens de EPRI-methode overeen met de niveaus 1, 2, 3 en 4.

Uiteindelijk leidt de optelling van alle toegepaste marges tot een totaal van 27% projectmarge en 24% technologiemarge t.o.v. de ‘total calculated cost’ oftewel totaal 51%, zie tabel 1.

		Project margin		Technological margin	
		%	[MEur]	%	[MEur]
	Calculated cost [MEur]				
1. Site preparation	116	37%	43	1%	1
2. Repository construction	998	29%	290	28%	277
3. LILW and (TE)NORM waste disposal campaign	423	20%	85	20%	86
4. HLW disposal campaign	76	20%	15	28%	21
5. Underground observation	16	83%	13	38%	6
6. Repository closure	116	21%	25	18%	21
TOTAL	**1744**	27%	**471**	24%	**411**
TOTAL COST (Margins included)	**2626**				

Tabel 1. Calculated cost eindberging met marges

3.4 Opmerking BouwQ

De toepassing van de onzekerheidsmarges volgens de EPRI-methode door COVRA is goed onderbouwd en inzichtelijk. Het project is gezien de planning en uit te voeren bouwwerkzaamheden uniek in Nederland. Er zijn op dit moment geen vergelijkbare projecten uitgevoerd die één-op-één kunnen dienen als referentie voor het kostenniveau en de toe te passen onzekerheidmarges.
Volgens de ervaring bij grote complexe Nederlandse infrastructuurprojecten is de toepassing van ca. 30 à 50% onzekerheidsmarge in een vroege projectfase gebruikelijk. Dit komt goed overeen met de kostencalculatie voor de eindberging.

De toepassing van de EPRI-methode is gezien de ervaring van het Belgische ONDRAF/NIRAS een logische en praktische keuze van COVRA en leidt tot een goed onderbouwde toepassing van onzekerheidsmarges binnen de kostenraming.
BouwQ merkt wel op dat de EPRI-methode niet aansluit op de manier van begroten die in Nederland veelal wordt toegepast bij grote bouwprojecten, de SSK (Standaardsystematiek voor kostenramingen). Bij de SKK wordt op basis van een risicobeschouwing per kostenpost een onzekerheidsmarge bepaald volgens een normale kansverdeling. Deze werkwijze opent de weg naar het uitvoeren van Monte Carlo analyses, een beproefde methode om uitspraak te kunnen doen over de verwachte kosten van een project inclusief de kans op overschrijding hiervan. Omdat de SKK zowel binnen de overheid als het bedrijfsleven (bouwsector) wordt gebruikt is hierover veel deskundigheid aanwezig in Nederland. BouwQ doet de aanbeveling om op termijn de kostenopstelling op te stellen volgende de SKK en het kostenaspect inclusief risicobeschouwing mee te nemen bij het vervolg van het OPERA-onderzoeksprogramma.

4 INHOUD KOSTENBEGROTING IN RELATIE TOT HET ONTWERP

4.1 Inleiding

BouwQ heeft een inhoudelijke beoordeling uitgevoerd van de kostenbegroting door het steekproefsgewijs controleren van afmetingen en hoeveelheden op basis van het ontwerp en de planning. Daarbij is een beoordeling uitgevoerd van de eenheidsprijzen van materialen, uitvoeringsmethoden en tarieven van personeel.

4.2 Resultaat inhoudelijke steekproeven kostenbegroting

Per beoordeelde kostenpost (zoals in het Engels genoemd in de kostenbegroting) worden enige opmerkingen gemaakt.

Land purchase
De eenheidsprijs voor de aankoop van land is relatief hoog indien wordt uitgegaan van land in dunbevolkt gebied met weinig bebouwing en bouwgrond.

Tunnels
De eenheidsprijzen van de aanschaf van de TBM's, de assembly, dismantling en het aanbrengen van lining per meter tunnel van de verschillende diameters zijn door BouwQ getoetst aan de hand van een eigen boortunnelmodel. De toegepaste eenheidsprijzen komen binnen een bandbreedte van 20% overeen met het eigen boortunnelmodel.

Construction and outfitting shafts and ramp
De hoeveelheden zijn in overeenstemming met het ontwerp.
De eenheidsprijs van de ramp (ca. € 50 miljoen) is naar onze mening te laag ingeschat.
Een eigen inschatting van BouwQ voor de kosten van een ramp met een lengte van 5.000m en een inwendige diameter van 5,0 m komt uit op orde van grootte € 80 – 100 miljoen.
De ramp wordt verder behandeld in hoofdstuk 5.

Construction and outfitting main gallery
De Construction and outfitting secondary galleries wordt gerealiseerd met twee TBM's. In de planning op het voorblad wordt uitgegaan van 4 TBM's.
De hoeveelheid van de post 2.3.3 "dismantling TBM" is naar onze mening ook 10 in plaats van 5.
De toegepaste eenheidsprijzen zijn akkoord.

Construction and outfitting LILW and (TE)NORM disposal galleries
De eenheidsprijs van de aanschaf en assembly en dismantling van de tunnelboormachines met een kleinere diameter zou iets verlaagd kunnen worden ten opzichte van de eenheidsprijzen voor de TBM's van de main en secondary galleries.
De hoeveelheden en overige eenheidsprijzen zijn akkoord.

Construction and outfitting non-heat-emitting HLW disposal galleries
De eenheidsprijzen van de aanschaf en assembly en dismantling van de tunnelboormachines zouden iets verlaagd kunnen worden ten opzichte van de eenheidsprijzen van de TBM's van de main en secondary galleries.

Construction and outfitting heat-emitting disposal galleries
Hoeveelheden en eenheidsprijzen zijn akkoord

Construction and outfitting the pilot facility
In de raming lijken de kosten van de realiseren van de secondary gallery te ontbreken.

Ventilation system
Hoeveelheden en eenheidsprijzen zijn akkoord.

Site facility construction
De kosten van de bouw van de Shaft buildings (1.850 m2) lijken te ontbreken.

Maintenance
Hoeveelheden en eenheidsprijzen zijn akkoord.

Insurance
De insurance van de Shaft Buildings ontbreken in de raming

LILW and (TE)NORM waste disposal campaign
Akkoord. Kleine aanpassing insurance Shaft buildings

HLW disposal campaign
Akkoord. Kleine aanpassing insurance Shaft buildings

Underground observation
De kosten van Insurance en Human resources worden niet meegeteld bij de totale kosten van de Underground observation. Hierdoor komen de totale kosten 7 + 45 = € 52 miljoen te laag uit. De marges van deze kosten worden overigens wel correct meegenomen.

		Project margin		Technological margin	
		%	[MEur]	%	[MEur]
5. Underground observation	16	83%	13	38%	6
5. 1, Maintenance	16	20%	3	10%	2
5. 2, Insurance	7	20%	1	0%	0
5. 3, Human resources	45	20%	9	10%	4

Kleine aanpassing insurance Shaft buildings

Uitsluitingen
In de raming zijn de volgende zaken uitgesloten:

- Compensation of owners of land not included (page 14)
- Potential reforestation is not included (page 15)
- Kosten van het transport van de waste van de huidige locatie naar de site maken geen onderdeel uit van de raming.
- De raming is exclusief BTW.

4.3 Consequentie van de aanpassingen voor de kostenbegroting

Het resultaat van de steekproeven heeft positieve en negatieve effecten op de raming. BouwQ schat in dat bij het verwerken van alle opmerkingen de totale kostprijs inclusief marges uitkomt op € 2.700 miljoen. Ten opzichte van de kostprijs van € 2.626 miljoen uit de huidige kostenbegroting betekent dat een beperkte verhoging van ca. 3 %.

5 TECHNISCHE RISICO'S MET EEN SUBSTANTIEEL FINANCIEEL GEVOLG

5.1 Inleiding

BouwQ heeft het ontwerp van de eindberging beoordeeld op technische risico's. Gezien de kennis en ervaring van BouwQ lag de focus daarbij op bouwtechnische risico's. In het kader van de huidige vroege projectfase wordt enkel ingegaan op risico's die een relatief groot financieel gevolg kunnen hebben. Het doel van de beoordeling op technische risico's is aanbevelingen te doen voor onderwerpen die meegenomen kunnen worden bij het vervolg van het OPERA onderzoeksprogramma.

5.2 Resultaat beoordeling technische risico's

Bouwlogistiek

De bouwlogistiek van het boren van een kilometers lang tunnelcomplex op 500 m diepte dient niet onderschat te worden. De diepte, lange afstanden, beperkte toegangsmogelijkheden (aantal en oppervlakte/doorsnede) in combinatie met relatief kleine tunneldiameters en het ontbreken van ondergrondse opslagmogelijkheden zullen zorgen voor een logistieke puzzel. Dit heeft groot effect op de aan- en afvoer van materialen (grout, liningsegmenten, ontgraven grond, personeel). Alle genoemde zaken werken kostenverhogend t.o.v. gerealiseerde (kortere, minder diepe) boortunnelprojecten.
Voorbeeld logistieke onzekerheden:

- Tijdens de periode dat het maximale aantal TBM's gelijktijdig tunnels boort moeten voldoende segmenten en grout naar de TBM's vervoerd worden om de boorsnelheid van 10 à 20 meter per dag te kunnen halen. Indien transport te lang duurt i.v.m. de afstanden/diepte of de shafts en ramp een 'bottleneck' vormen zal de boorsnelheid moeten verminderen wat van invloed is op de uitvoeringsplanning. Wellicht zijn meer shafts noodzakelijk.
- Misschien is het vanuit bouwlogistiek wenselijk te starten met de aanleg van een grote ondergrondse ruimte voor opslag van segmenten, verblijfsruimte personeel of zelfs een groutcentrale o.i.d. De keuze hiervoor zou op dit moment al gemaakt kunnen worden.
- Misschien is het vanuit bouwlogistiek wenselijk de diameter van bepaalde tunneldelen groter te maken (om elkaar met voertuigen te kunnen passeren).

Waterdichtheid

In (west) Nederland is sprake van slappe grondlagen en hoge grondwaterstanden. Bij alle ondergrondse werkzaamheden, tunnelbouw etc. in Nederland speelt dit aspect een hoofdrol. Dit is onvergelijkbaar met tunnelbouw in andere delen van Europa waar tunnels soms in droge omstandigheden handmatig worden gegraven (voorbeeld Madrid). Ook bij een aantal nog te ontwikkelen technische oplossingen, bijvoorbeeld voor de aansluiting van tunneldelen zal waterdichtheid en het risico op lekkage een rol spelen.

COVRA heeft aangegeven dat volgens de ervaring van het Belgische ONDRAF/NIRAS waterdichtheid inderdaad een rol speelt maar voornamelijk bij de aanleg van de shafts en ramp in de grondlagen boven de Boomse klei. De kleilaag zelf is erg waterondoorlatend wat juist het risico op lekkage bij de tunnelbouw verkleint.

Uitvoering van de ramp

De toegang of 'ramp' bevat volgens het ontwerp dat BouwQ in eerste instantie heeft ontvangen een aantal relatief krappe bochten. Met de huidige boortunneltechniek lijken deze bochten niet uitvoerbaar.
De kostenbegroting van de ramp is niet gebaseerd op een specifiek ontwerp maar op de kostenbegroting van een verticale schaft vermeerderd met 15%. Omdat het ontwerp van de ramp wezenlijk anders is dan van de schacht doet BouwQ de aanbeveling een schetsontwerp van de ramp uit te werken op basis van de huidige bouwtechnieken en vervolgens een beter onderbouwde kostenbegroting op te stellen.

6 CONCLUSIE EN AANBEVELINGEN

BouwQ heeft in opdracht van COVRA een onafhankelijke review uitgevoerd op de kostenbegroting van de nucleaire eindberging. De review omvat de toegepaste ramingssystematiek inclusief de toegepaste onzekerheidsmarges en de volledigheid van de opgenomen kostenposten in relatie tot de uit te voeren werkzaamheden.
De opzet van de kostenbegroting is duidelijk en de toegepaste eenheidsprijzen zijn voorzien van een gedetailleerde onderbouwing met referenties. De kostenbegroting is om deze redenen goed te beoordelen door een externe partij zoals BouwQ.
De toepassing van de onzekerheidsmarges volgens de EPRI-methode door COVRA is goed onderbouwd en inzichtelijk. Volgens de ervaring bij grote complexe Nederlandse infrastructuurprojecten is de toepassing van ca. 30 à 50% onzekerheidsmarge in een vroege projectfase gebruikelijk. Dit komt goed overeen met de 51% marge die door COVRA is toegepast in de kostencalculatie voor de eindberging.

BouwQ doet de aanbeveling om op termijn de kostenopstelling op te stellen volgens de Nederlandse standaardsystematiek voor kostenramingen (SKK) en het kostenaspect inclusief risicobeschouwing mee te nemen bij het vervolg van het OPERA-onderzoeksprogramma.
De eenheidsprijzen worden nu jaar op jaar geïndexeerd. BouwQ doet de aanbeveling eigen onderbouwingen van de belangrijke posten in de kostenbegroting samen te stellen met hoeveelheden en eenheidsprijzen uit Nederlandse bronnen. De kostenbegroting kan dan periodiek, bijvoorbeeld eens in de vijf jaar, herijkt worden naar het werkelijke kostenniveau. Dit voorkomt dat het kostprijsniveau door langdurige ‘jaar op jaar indexatie’ uit de pas gaat lopen.

BouwQ heeft een inhoudelijke beoordeling uitgevoerd van de kostenbegroting door het steekproefsgewijs controleren van afmetingen en hoeveelheden op basis van het ontwerp en de planning. Daarbij is een beoordeling uitgevoerd van de eenheidsprijzen van materialen, uitvoeringsmethoden en tarieven van personeel.
Het resultaat van de steekproeven heeft positieve en negatieve effecten op de raming. BouwQ schat in dat bij het verwerken van alle opmerkingen de totale kostprijs inclusief marges uitkomt op € 2.700 miljoen. Ten opzichte van de kostprijs van € 2.626 miljoen uit de huidige kostenbegroting betekent dat een beperkte verhoging van ca. 3 %.

BouwQ ziet technische risico’s op het gebied van een complexe bouwlogistiek, het optreden van lekkages en het ontwerp van de ramp. Om deze reden wordt aanbevolen onderzoek uit te laten voeren naar de bouwlogistiek tijdens het boren van het tunnelstelsel om de impact hiervan op de bouwkosten en -planning beter in te kunnen schatten.
Verder wordt aanbevolen een schetsontwerp van de ramp uit te werken op basis van de huidige bouwtechnieken en hiervoor een beter onderbouwde kostenbegroting op te stellen.