





 Project Engineering Ltd Technical Resourcing	<h1 style="text-align: center;">TITLE PAGE</h1>		Client		Semlogistics	
			Project Name		Large Tanks	
 Milford Haven	ESTIMATION OF CAPACITY OF EXISTING API OIL-WATER SEPARATOR		Project No.		SEM-1437	
			Project Area		1,2,3,4,5	
			Calculation No.		CLC 0307	
			Calculation Type		RIGOROUS	
			IPR Category		PROPRIETARY	
		Sheet		1	of	10
<b>CALCULATION PURPOSE</b>						
To estimate the design capacity of the existing API Oil-Water Separator, 34-V-030.						
<b>REVISION HISTORY</b>						
<b>Revision</b>	<b>0</b>	<b>Signature</b>	<b>Date</b>	<b>Change History</b>		
Author	PN Speller		08/11/2010			
Checker	R Rayner		12/11/2010			
Authoriser						
<b>Revision</b>	<b>1</b>	<b>Signature</b>	<b>Date</b>	<b>Change History</b>		
Author						
Checker						
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Checker						
Authoriser						



<div>ideas</div> <div>Project Engineering Ltd Technical Resourcing</div>		SUMMARY PAGE		Client		Semlogistics		
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<div> SemLogistics™ Milford Haven</div>		ESTIMATION OF CAPACITY OF EXISTING API OIL-WATER SEPARATOR		Project No.		SEM-1437		
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				Sheet		2	of	10
ROW								Rev
1	The API Oil Water Separator capacity is at least 2074 m3/h							
2	and could be as high as 3000 m3/h							
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ROW	<b>ASSUMPTIONS</b>		No	Ref	Rev
1					
2	The dimensions of the API Separator are as shown on SEM drawing 34-EQ-5, Rev 8.		1		
3	The equipment was designed in accordance with API-421 <i>Design and Operation of Oily Water Separators</i>		2		
4	The equipment has a design operating temperature of 10°C.		3		
5	The oil to be separated has a maximum density of 850 kg/m3		4		
6	The maximum allowed droplet size to pass into the clean water is 150 microns		5		
7			6		
8			7		
9			8		
10			9		
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19			18		
20			19		
21			20		
22	<b>KNOWN INFORMATION</b>				
23					
24			1		
25	Dimensions of Separator from 34-EQ-5		2	1	
26	Water Density Data from Rogers and Mayhew		3	3	
27	Water Viscosity Data from Rogers and Mayhew		4	3	
28	Turbulence Correction Factors from API 421		5	2	
29			6		
30			7		
31			8		
32			9		
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34			11		
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				Sheet		4	of	10	
ROW	Main Body of Calculation							Ref	Rev
1	<u>EstimateDesign Flowrate</u>								
2									
3									
4	Water Temperature		10 °C						
5	Water Density		999.65 kg/m3		See page 7		3		
6	Water Dynamic Viscosity		0.00130 kg/m-s		See page 7		3		
7									
8	Oil Density		850 kg/m3						
9									
10	Droplet Removal Size		1.50E-04 m						
11			Normally assumed droplet dimension, 150 microns						
12									
13	Droplet Rising Velocity		0.001407 m/s				2		
14			Stokes Law: V = (g/18mu)*(Delta Rho)*d^2						
15									
16	Horizontal Design Velocity		0.015 m/s				2		
17			(I.e. the smaller of 15*V or 0.015m/s)						
18									
19	Channel Width		9.15 m				1		
20			From Bechtel Dwg 34-EQ-5, dimension is 30' per channel						
21									
22	Channel Depth		2.44 m				1		
23			From Bechtel Dwg 34-EQ-5, base is at 143.75', WL is 151.75'						
24									
25	Design Flowrate		0.335 m3/s		for each channel				
26			(Width*Depth*Design Velocity)				2		
27	equivalent to		1206 m3/h		for each channel				
28									
29	and		2411 m3/h		for the entire separator of 2 channels				
30	NB: If use 15Vt as design velocity, this becomes		3393 m3/h						
31									
32	Note that the depth of the channel is outside the "accepted range" for depth of 1.0 - 2.4m								
33	If 2.4m taken as the design depth, the values above change as follows:								
34	Design Velocity		Flow Per Channel		Total Flow				
35	(m/s)		(m3/s)		(m3/h)		2		
36	0.015		0.329		1186				
37	0.0211		0.464		1669				
38									
39	The depth:width ratio is also outside the accepted range of 0.3 - 0.5, at		0.27						
40	The extent to which this may affect the efficiency of the separator cannot be calculated,								
41	but would need a channel width of		8.0 m to conform.						
42									
43	Applying the limiting depth of 2.4m and width of 8.0m with a velocity of 0.015 m/s gives								
44	Flow per channel		0.288 m3/s						
45			1037 m3/h						
46	Total API Flow		2074 m3/h						
47									
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ROW	Continuation Page							Ref	Rev
1	<b><u>Check Separator Length</u></b>								
2									
3	Horizontal Design Velocity	0.015 m/s	VH						
4	Droplet Rising Velocity	0.0014 m/s	Vt						
5									
6	VH/Vt	10.66							
7									
8	Correction Factor	1.53	(See Page 9)				2		
9									
10	Minimum Length	39.8 m	L = F*(VH/Vt)*Depth				2		
11									
12	Actual Length	53.7 m	From Bechtel Dwg 34-EQ-5				1		
13									
14	<u>Therefore Actual Length exceeds minimum required</u>								
15									
16	<b><u>Check Horizontal Area</u></b>								
17									
18	Minimum Area	364 m2	A = F * Q / Vt				2		
19									
20	Actual Area	491 m2							
21									
22	<u>Therefore Actual Area exceeds minimum required</u>								
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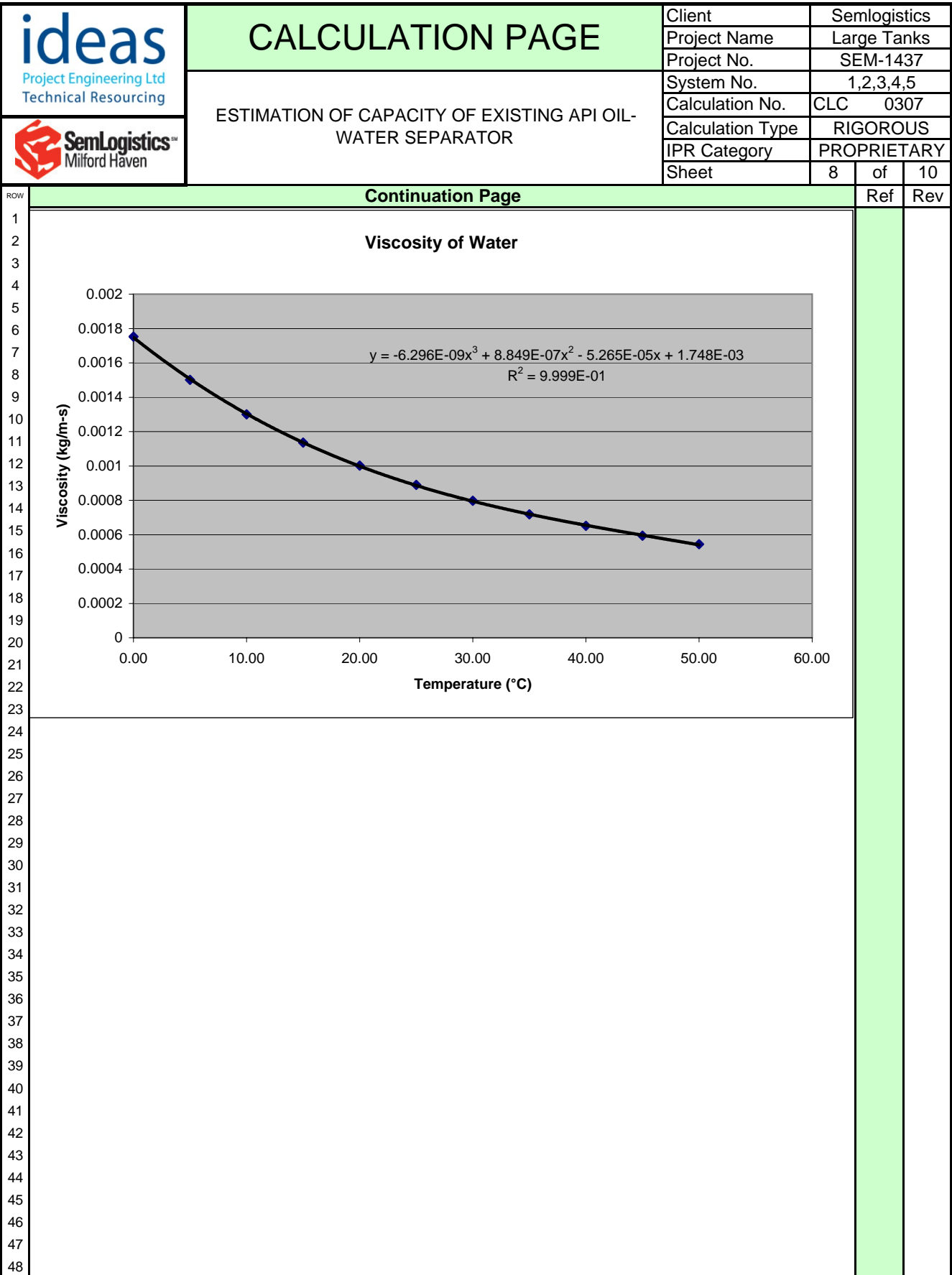


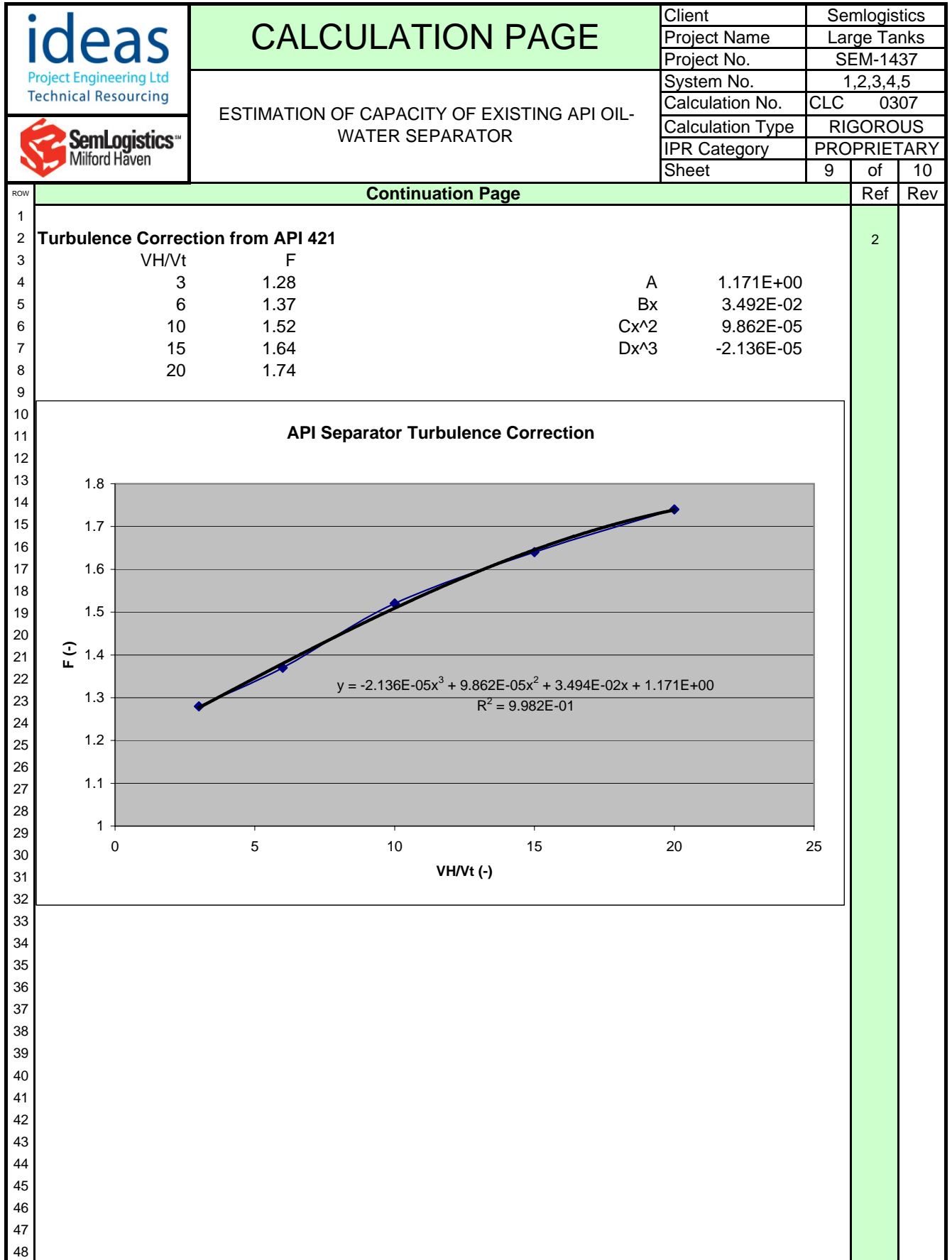
		CALCULATION PAGE					Client		Semlogistics			
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ROW	Continuation Page										Ref	Rev
1	<b>Capacity Check - By Substitution</b>											
2												
3	Since the dimensions of the separator are a function of the turbulence correction factor, which is											
4	itself a function of the actual horizontal velocity, VH, we can select different values for the design											
5	flowrate that give the actual dimensions of the separator.											
6												
7	Flowrate	1200	1300	1400	1500	1600	m3/h-channel					
8	VH	0.0149	0.0162	0.0174	0.0187	0.0199	m/s					
9	VH/Vt	10.61	11.49	12.38	13.26	14.15						
10	Corr F	1.53	1.55	1.58	1.60	1.62		2				
11	Min L	39.5	43.6	47.7	51.8	56.1	m	2				
12	Min A	361.8	398.5	436.1	474.3	513.0	m2	2				
13												
14	<u>By this method, each channel has been designed for 1500m3/h</u>											
15												
16												
17	<b>Check height over weir</b>											
18												
19	Francis Formula	Q = 1.84*B*D^1.5		C&R Vol 1 3ed Eq 5.43				4				
20												
21	Flowrate (m3/h)	1200	1300	1400	1500	1600	1700					
22	(m3/s)	0.33	0.36	0.39	0.42	0.44	0.47					
23	Width of Weir (m)	9.15	9.15	9.15	9.15	9.15	9.15					
24	Liquid Depth (m)	0.07	0.08	0.08	0.08	0.09	0.09					
25												
26	Approximately	0.46 m from WL to top of concrete, so unlikely to overtop.										
27		Approximately 380mm freeboard at maximum flowrate										
28												
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ROW		Continuation Page						Ref	Rev
1		Density and Viscosity Data for Water						3	
2		Reference: Rogers and Mayhew Thermodynamic and Transport Properties of Fluids, 3ed, 1982.							
3									
4		Temperature		Density		Viscosity			
5		°C		kg/m3		kg/m-s			
6		0.01		999.8		0.001752			
7		5		999.9		0.001501			
8		10		999.7		0.001300			
9		15		999.0		0.001136			
10		20		998.2		0.001002			
11		25		997.0		0.000890			
12		30		995.6		0.000797			
13		35		994.0		0.000718			
14		40		992.2		0.000651			
15		45		990.2		0.000594			
16		50		988.1		0.000544			
17									
18		Coefficients							
19		A		9.998E+02		1.748E-03			
20		Bx		5.896E-02		-5.265E-05			
21		Cx^2		-7.770E-03		8.849E-07			
22		Dx^3		3.841E-05		-6.296E-09			
23									
24		Density of Water							
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No	NAME/EDITION	PAGE NO / RELEVANT SECTION			ISBN	Rev
1	34-EQ-5, Rev 8 Oil Water Separator Layout	Section 2.1 - Design				
2	API 421 Design and Operation of Oily Water Separators, 1st Edition Feb 1990					
3	GFC Rogers and YR Mayhew., <i>Thermodynamic Properties of Fluids and Liquids, 3rd edn</i>	p10 Saturated Water and Steam			0 631 12891 3	
4	JR Coulson and JF Richardson., <i>Chemical Engineering, Volume 1, 3rd edn</i>	Section 5.3.8 The Notch, or Weir			0 08 021015 5	
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ATTACHMENTS						
Attachment 1		Attachment 2		Attachment 3		Attachment 4