

## **Appendix 9B**

### **ESSO and CRPC Major LPG Failure Case Tables**

ESSO	Failure Case Frequency Calculation				Esso	Release Frequency	
	Base Frequency		Factors				
<b>Case A</b>	<b>1</b>	<b>LPG Import by ship; tank failure;</b>				<b>Rupture Full</b>	
	Tank Rupture	Tanks per ship	Presence at Jetty	Fraction of time tank full			
	2.00E-06	2	0.038	0.2			3.0E-8
<b>Case A</b>	<b>2</b>	<b>LPG Import by ship; tank failure;</b>				<b>Rupture Half Full</b>	
	Tank Rupture	Tanks per ship	Presence at Jetty	Fraction of time tank full			
	2.00E-06	2	0.038	0.8			1.2E-7
<b>Case A</b>	<b>3</b>	<b>LPG Import by ship; Collision tank leak;</b>				<b>Catastrophic</b>	
	Freq of Impact	LPG Ships per year			Release Prob	Size Distribution	
	7.4E-5	30	1		1 0.001484	10%	3.3E-7
<b>Case A</b>	<b>4</b>	<b>LPG Import by ship; Collision tank leak;</b>				<b>100 mm hole</b>	
	Freq of Impact	LPG Ships per year			Release Prob	Size Distribution	
	7.4E-5	30	1		1 0.001484	90%	3.0E-6
<b>Case B</b>	<b>1</b>	<b>Marine Loading Arms</b>				<b>Rupture Full bore</b>	
	Base Frequency	Arms (each of 2)	Modifier		Release Prob	Size Distribution	
	3.8E-3	1	1		1 1	10%	3.8E-4
<b>Case B</b>	<b>2</b>	<b>Marine Loading Arms</b>				<b>Leak 50mm</b>	
	Base Frequency	Arms (each of 2)	Modifier		Release Prob	Size Distribution	
	3.8E-3	1	1		1 1	90%	3.4E-3
<b>Case B</b>	<b>3</b>	<b>Jetty pipeline</b>				<b>Leak 150 mm</b>	
	Base Frequency		Modifier		Release Prob	Size Distribution	
	4.3E-5		1	1	1 1	100%	4.3E-5
<b>Case C</b>	<b>1</b>	<b>LPG Mounded Storage Tanks : Tank Leak</b>				<b>Catastrophic</b>	
	Base Frequency	Tanks (each of 3)			Release Prob	Size Distribution	
	1.5E-4	1	1		1 0.4	4.5%	2.7E-6 100% full
					0.2		1.4E-6 50% full
					0.4		2.7E-6 20%full
<b>Case C</b>	<b>2</b>	<b>LPG Storage spheres : Tank Leak</b>				<b>100mm hole</b>	
	Base Frequency	Tanks (each of 3)			Release Prob	Size Distribution	
	1.5E-4	1	1		1 0.425	6.5%	4.1E-6 100% full
					0.15		1.5E-6 50% full
					0.425		4.1E-6 20%full

<b>Case C</b>	<b>3</b>	<b>LPG Storage spheres : Tank Leak</b>			<b>25 mm hole</b>		
	Base Frequency	Tanks (each of 3)		Release Prob	Size Distribution		
	4.4E-4	1	1	1	1	35.6%	1.6E-4
<b>Case C</b>	<b>4</b>	<b>LPG Storage spheres : Tank Leak</b>			<b>5 mm hole</b>		
	Base Frequency	Tanks (each of 3)		Release Prob	Size Distribution		
	4.4E-4	1	1	1	1	0.535	2.4E-4
<b>Case D</b>	<b>1</b>	<b>Filling Pipeline</b>			<b>Leak 150 mm</b>		
	Base Frequency		Modifier	Release Prob	Size Distribution		
	4.3E-5		1	1	1	100%	4.3E-5
<b>Case D</b>	<b>2</b>	<b>Cylinder Filling</b>			<b>Leak</b>		
	Base Frequency	Number of cylinders	Modifier	Release Prob	Size Distribution		
	1.5E-5	18	1.8	1	1	100%	4.9E-4
<b>Case D</b>	<b>3</b>	<b>Road Tanker Filling</b>			<b>Leak 100 mmm</b>		
	Base Frequency	Number of cylinders	Modifier	Release Prob	Size Distribution		
	8.5E-3	1	1.8	1	1	100%	1.5E-2
<b>Case D</b>	<b>4</b>	<b>Road Tanker on Road</b>			<b>Rupture</b>		
	Base Frequency	Number of tankers/yr	release prob	Prob	Size Distribution		
	7.10E-07	1600	0.034	1	1	0.12	4.6E-6
<b>Case D</b>	<b>5</b>	<b>Road Tanker on Road</b>			<b>Leak 100 mm</b>		
	Base Frequency	Number of tankers/yr	release prob	Prob	Size Distribution		
	7.10E-07	1600	0.034	1	1	0.29	1.1E-5
<b>Case D</b>	<b>6</b>	<b>Road Tanker on Road</b>			<b>Leak 5 mm</b>		
	Base Frequency	Number of tankers/yr	release prob	Prob	Size Distribution		
	7.10E-07	1600	0.034	1	1	0.59	2.3E-5
<b>Case D</b>	<b>7</b>	<b>Road Tanker on Road</b>			<b>BLEVE</b>		
	Base Frequency	Number of tankers/yr	release prob	Chartek modfactor	Size Distribution		
	7.10E-07	1600	7.20E-04	1	0.1	1	8.2E-8
<b>Case D</b>	<b>8</b>	<b>Road Tanker loading</b>			<b>BLEVE</b>		
	Base Frequency	Number of tankers/yr	release prob	Chartek modfactor	Size Distribution		
	1.30E-07	1600	1.00	1	0.1	1	2.1E-5

<b>CRC</b>	<b>Failure Case Frequency Calculation</b>							<b>Release Frequency</b>	
	<b>Base Frequency</b>			<b>Factors</b>					
<b>Case A</b>	<b>1</b>	<b>LPG Import by ship; tank failure;</b>					<b>Rupture Full</b>		
	Tank Rupture	Tanks per ship	Presence at Jetty	Fraction of time tank full					
	2.00E-06	2	0.086	0.2			6.9E-8		
<b>Case A</b>	<b>2</b>	<b>LPG Import by ship; tank failure;</b>					<b>Rupture Half Full</b>		
	Tank Rupture	Tanks per ship	Presence at Jetty	Fraction of time tank full					
	2.00E-06	2	0.086	0.8			2.8E-7		
<b>Case A</b>	<b>3</b>	<b>LPG Import by ship; Collision tank leak;</b>					<b>Catastrophic</b>		
	Striking / Passing	LPG Ships Passing per year	Passing per visit	Tug assist Modifier	Release Prob	Size Distribution			
	4.0E-6	50	13	0.5	0.052	10%	6.8E-6		
<b>Case A</b>	<b>4</b>	<b>LPG Import by ship; Collision tank leak;</b>					<b>100 mm hole</b>		
	Striking / Passing	LPG Ships Passing per year	Passing per visit	Tug assist Modifier	Release Prob	Size Distribution			
	4.0E-6	50	13	0.5	0.052	90%	6.1E-5		
<b>Case B</b>	<b>1</b>	<b>Marine Loading Arms</b>					<b>Rupture Full bore</b>		
	Base Frequency	Arms (each of 2)	Modifier		Release Prob	Size Distribution			
	3.8E-3	1	1.8		1	1	10%	6.8E-4	
<b>Case B</b>	<b>2</b>	<b>Marine Loading Arms</b>					<b>Leak 50mm</b>		
	Base Frequency	Arms (each of 2)	Modifier		Release Prob	Size Distribution			
	3.8E-3	1	1.8		1	1	90%	6.2E-3	
<b>Case B</b>	<b>3</b>	<b>Jetty pipeline</b>					<b>Leak 150 mm</b>		
	Base Frequency		Modifier		Release Prob	Size Distribution			
	4.3E-5		1	1.8	1	1	100%	7.7E-5	
<b>Case C</b>	<b>1</b>	<b>LPG Mounded Storage : Tank Leak</b>					<b>Catastrophic</b>		
	Base Frequency	Tanks (each of 3)			Release Prob	Size Distribution			
	4.4E-4	1	1		1	1	4.5%	2.0E-5	
<b>Case C</b>	<b>2</b>	<b>LPG Mounded Storage : Tank Leak</b>					<b>100mm hole</b>		
	Base Frequency	Tanks (each of 3)			Release Prob	Size Distribution			
	4.4E-4	1	1		1	1	6.5%	2.9E-5	
<b>Case C</b>	<b>3</b>	<b>LPG Mounded Storage : Tank Leak</b>					<b>25 mm hole</b>		

		Base Frequency	Tanks (each of 3)			Release Prob	Size Distribution	
		4.4E-4	1	1		1	35.6%	1.6E-4
<b>Case C</b>	<b>4</b>	<b>LPG Mounded Storage : Tank Leak</b>				<b>5 mm hole</b>		
		Base Frequency	Tanks (each of 3)			Release Prob	Size Distribution	
		4.4E-4	1	1		1	0.535	2.4E-4
<b>Case D</b>	<b>1</b>	<b>Filling Pipeline</b>				<b>Leak 150 mm</b>		
		Base Frequency		Modifier		Release Prob	Size Distribution	
		4.3E-5	1	1.8		1	100%	7.7E-5
<b>Case D</b>	<b>2</b>	<b>Cylinder Filling</b>				<b>Leak</b>		
		Base Frequency	Number of cylinders	Modifier		Release Prob	Size Distribution	
		1.5E-5	18	1.8		1	100%	4.9E-4
<b>Case D</b>	<b>3</b>	<b>Road Tanker Filling</b>				<b>Leak 100 mmm</b>		
		Base Frequency	Number of cylinders	Modifier		Release Prob	Size Distribution	
		8.5E-3	1	1.8		1	100%	1.5E-2
<b>Case D</b>	<b>4</b>	<b>Road Tanker on Road</b>				<b>Rupture</b>		
		Base Frequency	Number of release tankers/yr	prob		Release Prob	Size Distribution	
		7.10E-07	625	0.034		1.8	1	0.12
								3.3E-6
<b>Case D</b>	<b>5</b>	<b>Road Tanker on Road</b>				<b>Leak 100 mm</b>		
		Base Frequency	Number of release tankers/yr	prob		Release Prob	Size Distribution	
		7.10E-07	625	0.034		1.8	1	0.29
								7.9E-6
<b>Case D</b>	<b>6</b>	<b>Road Tanker on Road</b>				<b>Leak 5 mm</b>		
		Base Frequency	Number of release tankers/yr	prob		Release Prob	Size Distribution	
		7.10E-07	625	0.034		1.8	1	0.59
								1.6E-5
<b>Case D</b>	<b>7</b>	<b>Road Tanker on Road</b>				<b>BLEVE</b>		
		Base Frequency	Number of release tankers/yr	prob		Chartek modfactor	Size Distribution	
		7.10E-07	625	7.20E-04		1.8	0.1	1
								5.8E-8
<b>Case D</b>	<b>8</b>	<b>Road Tanker loading</b>				<b>BLEVE</b>		
		Base Frequency	Number of release tankers/yr	prob		Chartek modfactor	Size Distribution	
		1.30E-07	625	1.00		1.8	0.1	1
								1.5E-5