

## **Appendix 9A**

### **Shell and Caltex Major LPG Failure Case Tables**

## Route 9

### RiskProf Inputs

Risk Data  
 Spreadsheets V  
 Consequence Models < V

Risk Data  
 Spreadsheets V  
 Consequence Models < V

Concept *.cpt	Risk Data *.rdf	Lethality *30_l.dat	Met Data *.met	Concept *ff.cpt	Risk Data *.rdf	Lethality *30_l.dat	Met Data *.met	Pop Data *.pop
shda9rff	sh-ffrd2	4phicons.dat	tsingyid	shda9rff	sh-ffrd2	4phicons.dat	tsingyid	tyf-shed
shni9rff		ffd430_l.dat	tsingyin	shni9rff		ffd430_l.dat	tsingyin	tyf-shen
shpe9rff		ffb230_l.dat	tsingyip	shpe9rff		ffb230_l.dat	tsingyip	tyf-shep
		ffd130_l.dat		*fb.cpt	*fb.rdf	ffd130_l.dat	*nd.met	*.pop
		fff130_l.dat				fff130_l.dat		
shda35fb	sh@35mfb	pfd430_l.dat	tsday_nd	shda35fb	sh@35mfb	pfd430_l.dat	tsday_nd	tys@35md
shni35fb	sh@35mfb	pfb230_l.dat	tsnighnd	shni35fb	sh@35mfb	pfb230_l.dat	tsnighnd	tys@35mn
shpe35fb	sh@35mfb	exnd30_l.dat	tspeaknd	shpe35fb	sh@35mfb	exnd30_l.dat	tspeaknd	tys@35mp
		fbnd30_l.dat				fbnd30_l.dat		
				shda@gfb	sh@grafb		tsday_nd	tys@g-sd
				shni@gfb	sh@grafb		tsnighnd	tys@g-sn
				shpe@gfb	sh@grafb		tspeaknd	tys@g-sp
								@ground level
								@ground level
								@ground level

### RiskProf Outputs

Individual Risk Contours

PLL Lists  
 FN Curves

Shell	Failure Case Frequency Calculation				Shell	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	0.050	0.2					4.0E-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	0.050	0.8					1.6E-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			
		2.8E-4	60	1	1	2.20E-03	10%			3.7E-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			
		2.8E-4	60	1	1	2.20E-03	90%			3.3E-5
<b>Case A</b>	<b>5</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	60	2.52	1	5.20E-02	10%			3.1E-6
<b>Case A</b>	<b>6</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	60	2.52	1	5.20E-02	90%			2.8E-5
<b>Case B</b>	<b>1</b>	<b>Marine Loading Arms</b>				<b>Rupture Full bore</b>				
		Base Frequency	Cargo unloadings	Modifier		Release Prob	Size Distribution			
		1.3E-4	60	1	0.2	1	10%			1.6E-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			
		1.3E-4	1	1	1	1	90%			1.2E-4
<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	100%			4.3E-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			
		1.4E-4	1	1	1	1	4.5%			6.5E-6
								Full	Pr	Freq /yr
								half-full	0.41	2.63E-6
								20% full	0.19	1.23E-6
									0.41	2.63E-6
<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		
		1.4E-4	1	1	1	6.5%	9.4E-6	
<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		
		1.4E-4	1	1	1	35.6%	5.1E-5	
<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		
		1.4E-4	1	1	1	0.535	7.7E-5	
<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	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	Prob	Size Distribution		
		7.10E-07	3000	0.034	1	0.12	8.7E-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	Prob	Size Distribution		
		7.10E-07	3000	0.034	1	0.29	2.1E-5	
<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	Prob	Size Distribution		
		7.10E-07	3000	0.034	1	0.59	4.3E-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	3000	7.20E-04	1	0.1	1	1.5E-7
<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	3000	1.00	1	0.1	1	3.9E-5

Caltex	Failure Case Frequency Calculation				Caltex	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	0.050	0.2				4.0E-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	0.050	0.8				1.6E-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	100%		4.3E-5
<b>Case C</b>	<b>1</b>	<b>LPG Storage spheres : Tank Leak</b>				<b>Catastrophic</b>		
	Base Frequency	Tanks (each of 3)			Release Prob	Size Distribution		
	4.4E-4	1	1	1	0.1	4.5%	2.0E-6	90% full
					0.6		1.2E-5	50% full
					0.3		6.0E-6	20%
<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		
	4.4E-4	1	1	1	1	6.5%		2.9E-5
<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	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 release tankers/yr	Modifier prob		Release 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 release tankers/yr	Modifier prob		Release 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 release tankers/yr	Modifier prob		Release 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 release tankers/yr	Modifier 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 release tankers/yr	Modifier prob		Chartek modfactor	Size Distribution		
		1.30E-07	1600	1.00	1	0.1	1	2.1E-5	