



Turner & Townsend plc



Integrated Quantitative Project Risk Analysis
Structuring the Model Effectively

Palisade Energy Forum
Houston, Texas

22 Oct 09



Global footprint...

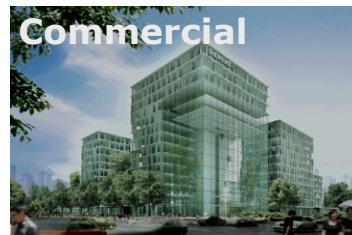
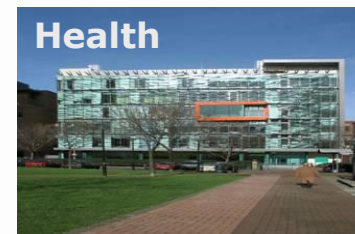


... one integrated global business

Infrastructure



Construction



Other Industries



Turner & Townsend - Key Clients



Mercedes-Benz



- Presentation Objective - Gain better understanding of how an analysis is structured will affect the results

- Comprised of:
 - Deterministic cost estimate and schedule
 - Deterministic estimate and schedule are single point basis
 - Based on same scope of work and execution plan
 - Estimate and schedule must be in alignment
 - Residual schedule and cost risk from Risk and Opportunity Matrix (Qualitative Analysis)
 - Results from schedule risk analysis

- When constructing a risk analysis model,
 - Know how to efficiently use the software package.
 - Take advantage of features
 - Understand strengths and weaknesses
 - Design intelligence into the spreadsheet
 - Take advantage of @Risk's capabilities to refer to cells
 - Don't bury hard data into formulas
 - Avoid overly long or complex formulas
 - Use error checks
 - Understand corporate level of risk acceptance / aversion
 - A risk that is acceptable in one situation may not be in another.
 - Different distributions will generate different results

- **When constructing a risk analysis model,**
 - Understand which risks are the responsibility of the project.
 - Foreign Exchange Rates – In or out?
 - Feedstock quality – In or out?
 - Structure the analysis so that it can adequately model the project risk
 - Too little detail can result in major risks being glossed over
 - Too much detail will result in a model that is cumbersome to use.
 - Use correlations where appropriate
 - Consider relationships between quantities, unit rates and schedule
 - Quantity errors will have direct impact on material costs, schedule and labor
 - Unforeseen schedule events will have an impact on time related costs and potential knock on effects after start up (liquidated damages)
 - Labor productivity risks will affect schedule, labor costs and time related activities

- **When assessing risk ranges,**
 - Conduct a risk workshop.
 - Involve those members of the project team that are the most familiar with the project.
 - At the beginning, give examples of normal and abnormal risks to help frame risk ranges
 - Hurricane strikes New Orleans – expected, in range
 - Category 5 hurricane strikes east side of New Orleans at high tide while pumps and levees fail – unexpected, outside of range
 - Understand what is included ranges
 - Quality of take offs
 - Basis for unit costs
 - Schedule impact

- **Example #1**
 - Evaluate impact of varying the levels of detail to the final results
 - 26 km fuel gas pipeline with multiple horizontal drilling sites
- **Example #2**
 - Evaluate the impact how risk is accepted / rejected can influence the result of an analysis
 - Staffing estimate where a portion of the staff charge to business unit.
 - Possibility of those staff members no longer charging to business unit but directly to the project.



- **Scope of work**
 - Process facility
 - 26 km fuel gas pipe line with several horizontal directionally drilled crossings of swamp and creeks and rivers
 - Truck and rail loading facilities
- Due to project objectives, execution plan, facility configuration and other project issues each portion of the scope can be treated as separate projects.
- For this example, only the risk for the pipeline is evaluated.



- **Levels of evaluation**
 - Scenario 1: Pipeline as single line in analysis
 - Scenario 2: Pipeline as a single cost with quantity risk
 - Scenario 3: Pipeline components with quantity risk
 - Scenario 4: Pipeline components, quantity risk and schedule risk, discrete risk events included in normal risk ranges.
 - Scenario 5: Pipeline components, quantity risk, discrete risk events excluded from normal risk ranges and modeled separately.

Integrated Project Risk Analysis – Example #1 – Estimate Summary



Project: Big Oil Company, North America								
Scope: Soup to Nuts								
By: J. O'Connor								
Sheet: Surface Facilities								
C	D	E	F	G	H	I	J	K
		Base	Allowances	Subtotal	Forward	Subtotal	Contingency	Total
WBS	Description	Value	Design	Base Est	Escalation	Escalated		Cost
12.02	Materials							
12.02.01	Pipeline Materials	1,596.00	54.00	1,650	260	1,910		1,910
12.03	Construction			-		-		-
12.03.01	Pipeline			-		-		-
12.03.01.01	ROW Surveying	498		498	78	576		576
12.03.01.02	ROW Clearing / Timber removal	845	50	894	141	1,035		1,035
12.03.01.03	Horizontal Boring	2,382	238	2,620	413	3,033		3,033
12.03.01.04	Pipeline Installation	7,141	205	7,346	1,157	8,503		8,503
12.03.01.05	Connection Fee	1,690		1,690		1,690		1,690
Subtotal Construction		14,151	547	14,698	2,049	16,747	-	16,747

Integrated Project Risk Analysis – Example#1 – Risk Input



Client: ,								
Project: ,								
Scope:								
By: J. O'Connor								
Sheet: Risk Input								
C	D	E	F	G	H	I	J	K
Item	Description	Estimated Value	Most Probable	Over Est. (High) %	Under Est. (Low) %	Low Value P10	High Value P90	Comments
Cost Risks								
3	Pipeline	16,747						
Schedule Risk								
9								
11	Pipeline - Schedule Risk	1.0000						
Pipeline								
40	ROW Access & maintenance	-						
41	Surveying	498						
42	Tie-in @ supply line	-						
43	Pipeline quantity (km)	27.60						
44	Pipeline Unit Cost	60						
45	HDD PC 7&8 Qty (Lm)	1,195						
46	HDD Crossing PC5 Qty (Lm)	200						
47	HDD Crossing PC6 Qty (Lm)	250						
48	HDD Crossing PC3 Qty (Lm)	350						
49	HDD Crossing Unit Cost	1.19						
50	Pipeline Construction Mhrs	30,000						
51	Pipeline Construction Labor Cost	0.13						
52	Pipeline Construction Material Cost	0.01						
53	Pipeline Construction Equipment Cost	0.09						
54	Pipeline Construction S/C Cost	0.03						
55	Pipeline Construction Design Allowance	6.4%						
56	Engineering Pipeline Hrs	1,804.55						
57	Engineering Pipeline Rate	0.11						
58	Third Party Services - Pipeline	75.24						
59	Third Party Services Rate - Pipeline	1.00						
60	Connection Fee	1,690.00						
60	Subtotal Pipeline Real Term	14,698						
61	Fwd Esc - Pipeline	13.95%						
62	Subtotal - Pipeline	16,747						

 **Deterministic Estimate**

Integrated Project Risk Analysis – Example #1 – Populated Risk Analysis



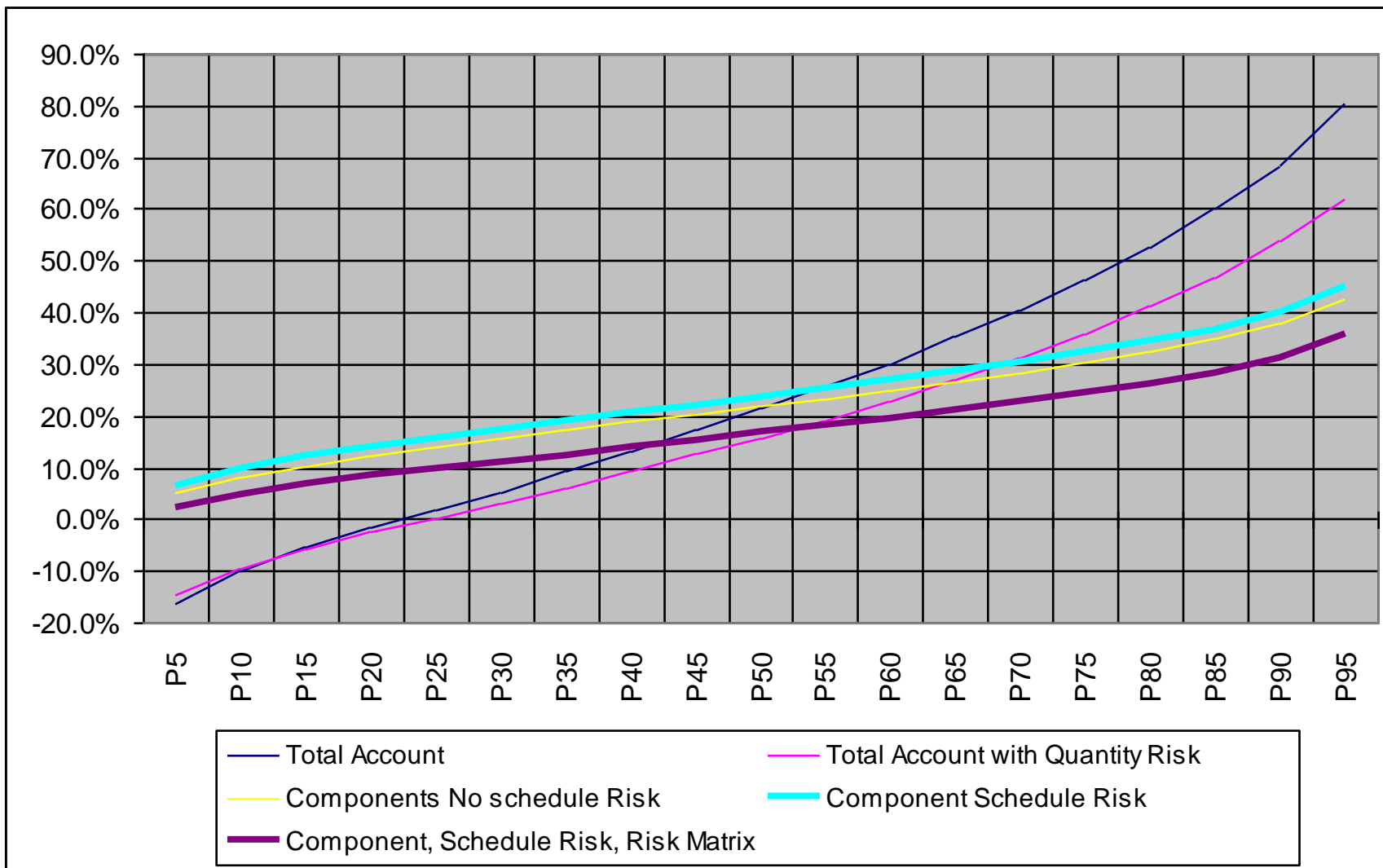
Client: ,								
Project: ,								
Scope:								
By: J. O'Connor								
Sheet: Risk Input								
C	D	E	F	G	H	I	J	K
Item	Description	Estimated Value	Most Probable	Over Est. (High) %	Under Est. (Low) %	Low Value P10	High Value P90	Comments
Cost Risks								
3	Pipeline	16,747	20,806.14	9.2%	70.5%	15,201.40	28,559.17	
Schedule Risk								
9								
11	Pipeline - Schedule Risk	1.0000	1.04	-0.9%	8.1%	1.01	1.08	
Pipeline								
40	ROW Access & maintenance	-	-	0.0%	0.0%	-	-	
41	Surveying	498	497.70	0.0%	0.0%	497.70	497.70	
42	Tie-in @ supply line	-	-	0.0%	0.0%	-	-	
43	Pipeline quantity (km)	27.60	28.79	1.0%	10.9%	27.32	30.60	
44	Pipeline Unit Cost	60	63.76	0.0%	15.0%	59.78	68.75	
45	HDD PC 7&8 Qty (Lm)	1,195	2,223.76	5.0%	200.0%	1,135.25	3,585.00	
46	HDD Crossing PC5 Qty (Lm)	200	283.49	5.0%	100.0%	190.00	400.00	
47	HDD Crossing PC6 Qty (Lm)	250	354.37	5.0%	100.0%	237.50	500.00	
48	HDD Crossing PC3 Qty (Lm)	350	496.11	5.0%	100.0%	332.50	700.00	
49	HDD Crossing Unit Cost	1.19	1.14	15.0%	5.0%	1.01	1.25	
50	Pipeline Construction Mhrs	30,000	33,257.97	5.0%	30.0%	28,500.00	39,000.00	
51	Pipeline Construction Labor Cost	0.13	0.14	5.0%	15.0%	0.12	0.15	
52	Pipeline Construction Material Cost	0.01	0.01	10.0%	30.0%	0.01	0.01	
53	Pipeline Construction Equipment Cost	0.09	0.10	5.0%	35.0%	0.08	0.12	
54	Pipeline Construction S/C Cost	0.03	0.04	5.0%	15.0%	0.03	0.04	
55	Pipeline Construction Design Allowance	6.4%	0.06	0.0%	0.0%	0.06	0.06	
56	Engineering Pipeline Hrs	1,804.55	1,882.41	5.0%	15.0%	1,714.32	2,075.23	
57	Engineering Pipeline Rate	0.11	0.11	5.0%	10.0%	0.10	0.12	
58	Third Party Services - Pipeline	75.24	106.65	5.0%	100.0%	71.48	150.48	
59	Third Party Services Rate - Pipeline	1.00	1.00	0.0%	0.0%	1.00	1.00	
60	Connection Fee	1,690.00	1,799.67	5.0%	20.0%	1,605.50	2,028.00	
60	Subtotal Pipeline Real Term	14,698	18,259.73	9.2%	70.5%	13,340.95	25,063.90	
61	Fwd Esc - Pipeline	13.95%	0.14	0.0%	0.0%	0.14	0.14	
62	Subtotal - Pipeline	16,747	20,806.14	9.2%	70.5%	15,201.40	28,559.17	

Integrated Project Risk Analysis – Example#1 Tabular Results

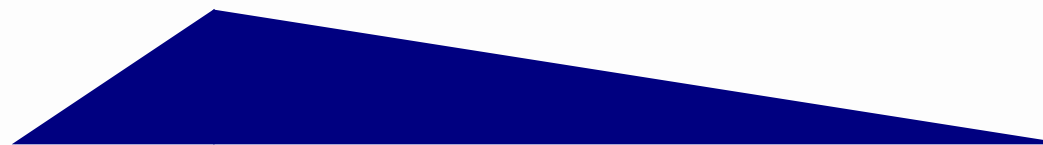


	Scenario 1 Total Account	Scenario 2 Total Account with Quantity Risk	Scenario 3 Components No schedule Risk	Scenario 4 Component Schedule Risk	Scenario 5 Component, Schedule Risk, Risk Matrix
P5	-16.1%	-14.3%	5.0%	6.3%	2.4%
P10	-9.9%	-9.6%	8.2%	9.8%	4.9%
P15	-5.4%	-5.5%	10.4%	12.2%	6.7%
P20	-1.5%	-2.5%	12.4%	14.2%	8.4%
P25	1.9%	0.4%	14.0%	15.9%	9.8%
P30	5.2%	3.0%	15.6%	17.5%	11.1%
P35	9.3%	6.1%	17.3%	19.1%	12.4%
P40	13.1%	9.3%	18.9%	20.7%	13.9%
P45	17.5%	12.6%	20.4%	22.2%	15.4%
P50	21.5%	15.8%	21.9%	23.7%	16.8%
P55	25.9%	19.1%	23.4%	25.3%	18.1%
P60	30.0%	22.8%	25.1%	27.1%	19.5%
P65	35.6%	27.0%	26.7%	28.8%	20.9%
P70	40.6%	31.1%	28.4%	30.5%	22.7%
P75	46.3%	35.8%	30.3%	32.4%	24.4%
P80	52.6%	41.1%	32.5%	34.4%	26.3%
P85	60.4%	46.9%	35.0%	36.8%	28.5%
P90	68.5%	53.7%	38.1%	40.0%	31.4%
P95	80.6%	62.0%	42.8%	44.9%	35.9%

Integrated Project Risk Analysis – Example#1 Graphic Results

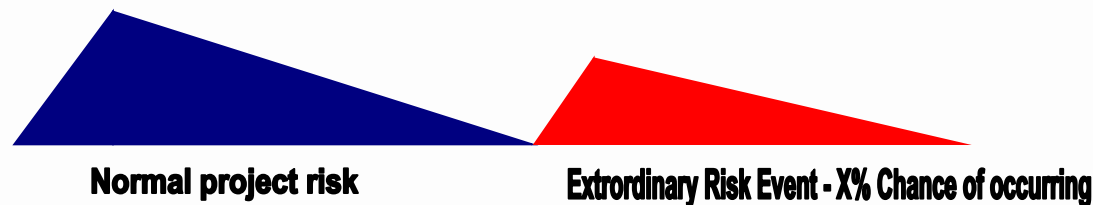


- Lower level of detail results in greater extremes of results
 - Scenarios 1, 2 and 3 reflect impact of increasing level of detail on results
- Including schedule risks and correlations can have an impact
 - Scenarios 3 and 4 reflect correlation of schedule impact time related costs
- Modeling discrete risk events separately can better assess risks
 - Scenario 4



Normal project risk + Extraordinary risk event

- Scenario 5





- **Scope of work is Owner's cost for a project**
 - Currently one of the projects group does not charge salaries directly to the project. Their salaries are covered in corporate overhead. Only their expenses are charged directly to the project.
- **Costs are broken out by the various groups supporting the project.**
- **Analysis evaluates man-hour quantity risk, unit rate risk and schedule risk.**
- **Direct correlation set between schedule and man-hour quantity risk.**
- **3 Scenarios**
 - Scenario 1 – No possibility that the project will incur their salary costs
 - Scenario 2 – Possibility the project will incur their salary costs.
 - Scenario 3 – Project accepts the cost of salaries will be paid for by the project.

Integrated Project Risk Analysis – Example #2 Model Extract

Client: Major Client, USGC
 Project: Big Expansion, USGC
 Scope: Project Program
 By: J. O'Connor
 Sheet: Risk Input

Scenario 2 – Possibility the project will incur salary costs.

C	D	E	F	G	H	I	J	K
Item	Description	Estimated Value	Most Probable	Over Est. (High) %	Under Est. (Low) %	Low Value P10	High Value P90	Comments
Cost Risks								
1	S5 Owners Cost	16,756	19,060	23.16%	213.12%	12,875	52,467	
Schedule Risk								
2								
3	S5 Owners Cost Schedule	1.0000	1.1175	8.70%	30.43%	0.9130	1.3043	
Owners Cost								
Staffing								
9	Owner Project Support Team							
10	Owner Support Staff (Staff -Qtr)	132.3	138	20.00%	30.00%	105.84	171.99	
11	Owner Support Staff Rate (\$/Qtr)	-	-	0.00%	0.00%	-	63,000.0	Discrete
12	Owner Expenses USD/qtr / Person	1,000	1,065	15.00%	30.00%	850.0	1,300.0	
13	Owner Burdens	45%	53%	0%	40%	45%	63%	
14	Sub-total Owner Project Support Team	132.3	146.9	32.00%	17481.65%	90.0	23,260.5	

Riskdiscrete({0, 47000, 63000},{.75, .10, .15})

=((E25*E26*E15)*(1+E28)+(E27*E25))/1000

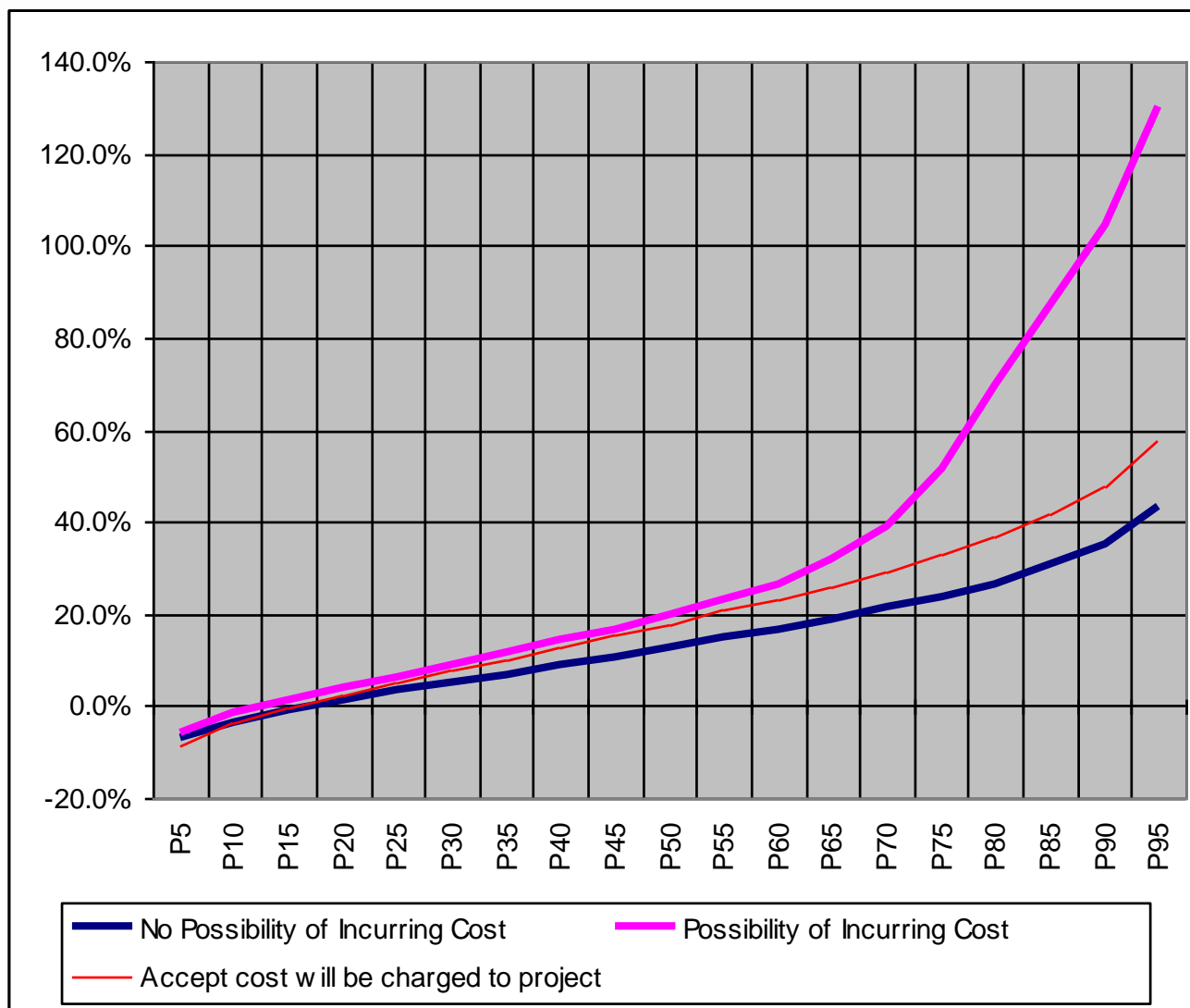
- E15 = Schedule Risk
- E25 = Owners Supprt Staff
- E26 = Owner Support Staff Rate
- E28 = Owners Burden
- E27 = Owner Expense

Integrated Project Risk Analysis – Example#2 Tabular Results



	Scenario 1 No Possibility of Incurring Cost	Scenario 2 Possibility of Incurring Cost	Scenario 3 Accept cost will be charged to project
P5	-7.0%	-5.8%	-8.5%
P10	-3.5%	-1.6%	-3.8%
P15	-0.9%	1.4%	-0.5%
P20	1.4%	4.1%	2.5%
P25	3.4%	6.4%	5.1%
P30	5.1%	9.0%	7.8%
P35	6.9%	11.4%	10.3%
P40	8.8%	14.2%	12.9%
P45	10.6%	16.8%	15.3%
P50	12.5%	19.8%	17.8%
P55	14.8%	23.0%	20.7%
P60	16.7%	26.6%	23.4%
P65	18.9%	32.0%	26.1%
P70	21.4%	39.2%	29.3%
P75	23.9%	51.3%	32.9%
P80	26.6%	69.8%	36.6%
P85	30.5%	87.1%	41.7%
P90	35.2%	104.5%	47.8%
P95	43.1%	130.1%	58.0%

Integrated Project Risk Analysis – Example#2 Graphic Results





- **Scenario #1**
 - Ignores the possibility of salaries being charged to the project. In effect it treats the risk as a change order to the project. The project budget will be adjusted to accept the change as it is outside of the original scope of work
- **Scenario #2**
 - The project accepts the risk may occur and chooses to fund a portion of the risk. Depending on what level of contingency the project decides to use will affect the funding level
- **Scenario #3**
 - Accepts the salaries will be charged to the project. At that point the salary cost becomes part of the base estimate. The risk then is centered around the accuracy of the salary rates.



- The level of detail in an analysis can have a slight to minor impact on the contingency level around the P50 but have major impacts on the ends (P10 to P90)
- Having sufficient details in the analysis to model the project specific risk is key to a successful analysis.
- Understand how risks are to be addressed
 - Accepted - funded in base cost
 - Funded – excluded from base estimate but included in analysis
 - Rejected – Outside of project scope. Not funded
- The model must reflect the way a project is to be executed to be valid.