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Confidence Level Assessment in Enterprise Risk Management: Case Study with Focus on Oil & Gas Operational Incidents

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Abstract

Risk assessment and risk management are widely used in a variety of sectors and industries, particularly with the advent of Enterprise Risk Management (ERM) in the last two decades or so. Because it covers most types of risks and applies to most types and sizes of organizations, including private and Government, ERM has significantly expanded the application of risk concepts in the decision-making process worldwide. However, one aspect of risk assessment has not gained traction in practical applications. Specifically, although there are exceptions, typical ERM assessments and some other types of risk assessments do not include the evaluation of the confidence level associated with the risk estimates. This article presents a methodology for the assessment of the confidence level in ERMs with a case study that emphasizes operational incidents at Oil & Gas facilities. It also scrutinizes these risks with respect to risks of different nature considered in a typical ERM (corruption, less demand due to increased competition, lower earnings due to increased operational costs, inadequate insurance coverage etc.)

Keywords: Enterprise Risk Management, ERM, Confidence Level, Confidence Level Assessment, Girth Factor, Uncertainty, Cost Benefit, COSO, ISO 31010, Oil & Gas.

1.0 *Introduction*

The assessment of the confidence level in ERM has not gained traction in practical applications. In fact, although several mention the importance of considering and communicating the confidence in the determination of the level of risk, the major ERM standards do not offer methodologies for doing so (ISO 31000:2009(E) 2009) (ISO 31010-2009(E) 2009) (COSO 2004) (COSO 2012) (OMB 2016) (CFOC/PIC 2016) (Perera 2011). Decision makers may presume that the information given to them is all at the same level of

confidence or may assume that it is all high confidence, unless the assessors provide indication otherwise.

This article presents the application of a methodology to evaluate confidence levels in ERM assessments, and it may be useful in other types of risk applications as well. The methodology has qualitative (H. M. Paula 2019a) and quantitative (H. M. Paula 2019b) parts. The qualitative evaluation may be all that is needed to account for the confidence level in some ERM efforts. The quantitative evaluation is based on the qualitative evaluation, and it provides additional insight to support and facilitate decision making.

The methodology adopts Johnson's definition of confidence level:

> *"The degree of certainty (assigned by the risk assessor) that the likelihood or severity scores reflect reality"* (Johnson 2008, ii)

In this article, the "assessor" is the analyst or a team of analysts who are leading the ERM study, and the "confidence assessment" should include the knowledge and experience of all who contributed to the evaluation. "Scores" can be point-estimates of the frequency or severity of a risk scenario. If the score comes from a risk matrix with logarithmic vertical and horizontal axes, the point estimate is typically the geometric mean[1] of the limits of the assessed category. This practice that goes back to at least the 1980s (Casada, Kirkman and Paula 1990).

There are a multitude of factors related to the confidence level, including several sources of "lack of confidence" and several control/mitigation measures to improve confidence in the risk results (H. M. Paula 2019a) (Johnson 2008). Some are directly associated with data and data relevance, which focus on the quantity and quality of the data. Others relate to the depth of analysis, including analysis methodology and model quality/fidelity. Several emphasize subject matter expertise (SME), e.g., specialist, expert judgments and subjectivism. Additionally, there is a fourth group of factors that has great influence in the level of confidence: assumptions. As shown in the next section, these four groupings of factors constitute the foundation of the methodology.

2.0 ***Step-by-step Procedures***

This section presents the six steps for conducting the confidence level assessment. It illustrates the application of the methodology with an analysis of eight risk scenarios (RSs) from a multi-national, integrated oil & gas (O&G) company. Table 1 presents the RSs, and Figure 1 shows them in the Company's risk matrix.[2, 3] The six steps are:

1. ***Identify and characterize the risk scenarios of interest.*** This involves a thorough understanding of the scenario's consequence types and severity because the frequency of a scenario depends on these definitions. For example, the frequency of a labor strike

[1] *The square root of the product of the two limit values.*

[2] These are some of the dominant risk scenarios for the Company. As typical in O&G ERM applications, there were hundreds of other risk scenarios for this company. We present only eight dominant risk scenarios to keep it simple, and they are enough to illustrate the methodology.

[3] All figures and tables are at the end of the article.

that lasts a few hours/days is typically different from the frequency of a strike that lasts weeks or months. To further illustrate this step, the next section describes three of the RSs related to operational incidents (RS1, RS5 and RS8) in more detail

2. ***Evaluate the <u>qualitative</u> confidence level for the <u>severity</u> and for the <u>frequency</u> associated with each risk scenario.*** For each scenario, consider the severity and frequency separately using the Paula-Guthrie (P-G) chart from Figure 2 or the extended P-G chart from Figure 3.[4] For the severity:[5]
    a. If the assessor has an estimate of the Girth Factor (GF),[6] the P-G chart provides a direct assessment of the level of confidence (e.g., **High** for GF = 10). In this case, the assessor can move straight to Item "f." Otherwise, go through Items b, c, d and e[7]
    b. Review the data strength and select a category (**Very Strong**, **Strong**, **Medium** etc.). The P-G chart provides guidance to make this selection, depending on the nature and amount of the available data. This is the <u>final category</u> assignation for the data strength
    c. Review the analytical strength and select an initial category (**Very Strong**, **Strong**, **Medium** etc.) without accounting for SME or depth of analysis. Note that the guidance for the selection of the analytical strength is less explicit than the guidance for the data strength. If in doubt, start by assigning the same category selected for the data strength, and then adjust, depending on the assessor's evaluation of the assumptions that are involved. This is the <u>initial category</u> for the analytical strength
    d. Still for the analytical strength, move the initial category none, one or two cells to the left, based on the benefits from relevant SME and/or relevant depth of analysis, as applicable. This is the <u>final category</u> assignation for the analytical strength
    e. Using the final category assignations for the data strength and analytical strength, use the P-G chart to select the confidence level for the severity (or frequency – see Item 2f)
    f. Repeat Steps 2a, 2b, 2c, 2d and 2e for the frequency

    Table 2 presents the results of Step 2 for the eight risk scenarios (fourth and seventh columns for the severity and frequency, respectively). For illustration of this step

[4] The P-G chart considers the four groupings of factors mentioned earlier. Two of them appear explicitly on the vertical axis (<u>data and data relevance</u> under data strength) and horizontal axis (<u>assumptions</u> under analytical strength). Data strength refers to the amount and nature of the data. Analytical strength refers to assumptions, including modeling assumptions and the assumptions about the relevance of the data. Because they are key to making and addressing assumptions, the P-G chart considers both "***<u>SME</u>***" and "***<u>depth of analysis</u>***" as modifiers to the analytical strength.

[5] The assessor can start with either the severity or the frequency evaluation. We find it more efficient to start with the severity because the frequency assessed value is often tied to the definition of the consequence, as mentioned in Step 1.

[6] The ratio of the upper bound value (95^{th} percentile) to the lower bound value (5^{th} percentile) of a variable of interest.

[7] Even when GFs are available and the assessor can move straight to Item f, we suggest proceeding through Items b, c, d and e. It provides a second option for estimating the confidence level. The second option may confirm the assignment from the first option, which is reassuring. Otherwise, it gives the assessor the opportunity to reflect on the reasons for the discrepancy and to select the most reasonable option.

and the use of the P-G chart, the next section presents the rationale used in Step 2 for RS1, RS5 and RS8

3. ***Evaluate the qualitative confidence level for the risk scenario.*** Using the severity and frequency assignments from Step 2, evaluate the confidence level for the risk scenario from Figure 4. The last column in Table 2 and Figure 5 show these results for each of the eight risk scenarios
4. If proceeding to the quantitative confidence level analysis***, start with the qualitative confidence levels determined for the severity and frequency in Step 2***. For easy reference, Table 3 repeats these evaluations for the eight dominant risk scenarios (third and fourth columns, respectively). Note that this first step of the quantitative analysis is just looking up the results of Step 2. It is presented as a step to highlight that the inputs to the quantitative analysis come from Step 2 and not Step 3
5. ***Use Figure 6 to get the multiplier for each risk scenario***. This is a simple look up of the multiplier based on the confidence level for the severity and for the frequency. The sixth column in Table 3 shows the multipliers for each of the eight risk scenarios
6. ***Apply the applicable multiplier to estimate the scenario's risk accounting for the impact of the confidence level*** – see Table 3:
    a. For each risk scenario, multiply the frequency by the severity to estimate risk
    b. Normalize the results by dividing the risk for each scenario by the highest risk (RS3 in Table 3). This is useful to focus on the relative level of risk for the scenarios. The second column in Table 3 shows the normalized risk results
    c. Multiply each normalized risk by its respective multiplier from Step 5. This is the revised risk, which considers the confidence level assessment (seventh column in Table 3)
    d. Renormalize the risk estimates (last column in Table 3)

3.0 *Details of the Qualitative Methodology for Selected Risk Scenarios*

This section illustrates the details of the qualitative methodology for three of the risk scenarios considered in the previous section. We selected these scenarios to focus the article on O&G operational incidents. Other publications provide details about the other types of risk scenarios (Paula and Soto Ogaz 2019a) (Paula and Soto Ogaz 2019b). For each risk scenario, we will follow Steps 1, 2 and 3 from the previous section:

- RS1 – Operational Hazards Resulting in Fatality
- RS5 – Loss of Containment in the Marketing Infrastructure
- RS8 – Environmental Restrictions and Regulations

One final observation before proceeding with this section is that the main objective of the confidence level analysis is not to ratify the assignments of the severity or frequency categories in the risk matrix. It focuses on the evaluation of the ***confidence level*** (or "certainty") associated with these assignments. But since the assessor will be reviewing the severity and frequency assignments during the confidence level assessment, this analysis can generate questions and suggestions for modifying some of these assignments.

3.1.1. RS1 – Operational Hazards Resulting in Fatality

Step 1 – The Company operates at many sites in multiple countries, and it has upstream, midstream and downstream activities. Thus, its employees and contractors are exposed to several types of hazards typical of these operations, including work at elevated heights, around sources of energy (electricity, steam etc.), in confined spaces, in excavations and near heavy load lifting. Also, workers are exposed to hazards during transportation (vehicles, helicopters, marine etc.). At this Company, most of the incidents associated with these hazards resulted in a single fatality per incident, which is a Severity Category 4 in the Company's risk matrix (RS1).[8]

To estimate the frequency for this risk scenario, the ERM team considered the Company experience over a period of 16 years. Figure 7 shows the 3-year rolling average of the number of fatal incidents.[9] The trend line shows an increasing incident rate. This was due to an increase in the number of such incidents in year 6 and then again in years 10-12. These in turn, were the result of an expansion of the company's businesses. More operating sites entail more activities, which results in more personnel exposure to hazardous conditions. In response to the increase in the total incident rate, the company instituted several additional and improved controls. The new or improved controls had a positive impact, as indicated by the downward trend in years 11 through 14.

Step 2 – Consider the severity first. Since the risk scenario is, by definition, an event that involves one fatality, it could be argued that the level of confidence for the severity assignment is 100%. In this case, the burden on the assessor would be to evaluate the confidence level for the frequency assignment that best matches the "perfectly-defined" severity level. However, it is unrealistic to assume that we can pinpoint "one fatality" with certainty. Traffic accidents, for example, may involve one or several people within the vehicle. Thus, if historically the number of fatalities has been 1 for this type of event for one company, there is no guarantee that it will always be this way. In general, we suggest that the confidence level for well-defined consequences is **Very High** (or possibly **High to Very High**), which would be the case for RS1. The data strength and the analytical strength are "**Strong**" in the P-G chart.

Regarding the frequency, one way to evaluate the frequency (and the associated confidence level) is to consider the data for the last 16 years. There have been 19 fatal incidents in the last 16 years, which for the evaluation of the confidence level is statistically **Very Strong**[10] (see Figure 3). Per Step 2c, the initial analytical strength is also **Very Strong**. However, many of the activities associated with the hazards mentioned in Step 1 have changed. For example, there were changes in the number of employees and contractors commuting in one or more of the operating regions. Also, as mentioned previously, the Company implemented new and improved controls. Thus, the assessor must adjust the frequency estimate to account for these changes. It can be argued that the analytical strength has dropped to **Medium** because there

[8] The assessors can define other risk scenarios to reflect incidents that result in different severity levels, either more severe or less severe than RS1. For example, one risk scenario could represent multiple fatalities, and others could represent severe injuries, minor injuries etc.

[9] The figure shows 14 (instead of 16) years because it considers the three-year rolling average, which cannot be evaluated for the first two years of data.

[10] Specific event data with at least 9 occurrences.

are several or somewhat material assumptions. In the P-G chart, a **Very Strong** data strength with **Medium** analytical strength result is a **High** confidence level.

A second way of evaluating the frequency is to limit the period to the more recent data (e.g., the last 5 years). There were 4 fatalities in this period, thereby for the evaluation of the confidence level, the data strength would be **Strong**. Since the time period is more recent, the data are more appropriate or "relevant." The analytical strength is better than in the previous paragraph because there are fewer or less immaterial assumptions; it is considered **Strong**. These assignments for the data and analytical strengths result is a **High** confidence level.

In this case, the confidence level for the frequency score is **High** in both ways of evaluation. This is not unusual in risk evaluations: if we broaden the time period to have more data, the data strength increases but the analytical strength decreases and vice versa. That is, changing the time period moves the confidence level ***along*** a diagonal in the P-G chart but not necessarily to a ***different*** level, as illustrated in Figure 8. In fact, the goal of the confidence level analysis is to identify the best diagonal in the P-G chart to represent the level of confidence. This comment applies to the severity and to the frequency. During the evaluation of the confidence level, the assessor may consider using different time periods to either confirm the assessment or to identify discrepancies. The former confirms that the assessor found the "best" diagonal, and the latter indicates the need for further considerations. [11]

Step 3 – This step is always simple. The confidence assignment for the severity is **Very High** and the confidence assignment for the frequency is **High**. Figure 4 shows that the confidence level for the risk scenario is **High**.

3.1.2. RS5 – Loss of Containment in Marketing Infrastructure

Step 1 – This risk scenario addresses loss of containment from one of the Company's pipelines, and it represents a loss of containment that results in multiple fatalities. This type of incident has not happened in the 50 years of operation of this pipeline. However, similar events have occurred involving other companies (NTSB 2002).

Step 2 – Similar to previous discussions, we assume that the confidence level for this well-defined consequence is **Very High**. For the frequency, there have been many incidents

[11] When there are two or more ways of evaluating the severity or frequency score, the level of confidence should be the one associated with the way the assessor chose to assign the score.

Source: (NTSB 2002)

involving loss of containment from this pipeline in the last two decades. However, none of them were catastrophic in the sense of the severity considered for RS5. Thus, for the purpose of using the P-G chart, there are no occurrences with the severity of RS5, and the data strength and initial analytical strength are **Very Weak**. The assessors evaluated this risk scenario using the available data and a Monte Carlo risk simulator. Thus, if we give credit to depth of analysis, the analytical strength becomes **Weak**, and the confidence level for the frequency is **Very Low to Low**.

Step 3 – With confidence levels of **Very High** for the consequence and **Very Low to Low** for the frequency, Figure 4 suggests that the confidence level for the risk scenario is **Very Low to Low**.

3.1.3. RS8 – Environmental Restrictions and Regulations

Step 1 – The Company is routinely audited by the environmental agencies in the countries/regions where it operates. Additionally, these agencies require that the Company investigates incidents, including near misses that have or could have caused environmental impacts. As a result of these internal and external investigations, the Company receives several notifications of potential non-compliances. In most cases, these issues are addressed and resolved to the satisfaction of all parties. However, in some cases the issue can escalate, resulting in penalties, temporary suspensions and even overturning of the license to operate. RS8 considers these potential incidents resulting from environmental issues.

Step 2 – The Company has extensive experience with previous and current non-compliance issues, including sanctions at its operating sites. This provides extensive background to evaluate the severity, thereby the confidence level is **Very High** (**Very Strong** data strength and analytical strength).

The extensive experience applies to the frequency estimate as well, but there are probably more assumptions because RS8 involves uncertainties about the actions of the regulatory agencies. The latter may have political influences in some countries, and is generally more unpredictable (i.e., requires more analysis assumptions.) Thus, the data strength is **Very Strong** for the frequency, but the analytical strength may be **Strong** to **Very Weak**, depending on the level of assumptions. The assessor assumed **Weak** based on our level of knowledge for this risk scenario. With **Very Strong** data strength and **Weak** analytical strength, the confidence level for the frequency is **Medium to High** per the P-G chart.

Step 3 – With **Very High** confidence on the consequence assignment and **Medium to High** confidence on the frequency assignment, the confidence level for RS8 is **Medium to High** (Figure 4).

4.0 ***Results***

Figure 9 shows the risk scenarios with the confidence level analysis excluded (vertical axis) and included (horizontal axis). These are the normalized and renormalized risks from Table 3, respectively. Note that RS1, RS6 and RS8 are ranked the same by normalized risk in Table 3 and in the vertical axis in Figure 10. The dash line in Figure 11 shows this more visibly. And they appear in the same risk cell in the Company's risk matrix shown in Figure 1. That is, they seem to pose the same level of risk to the Company. However, the renormalized risk shows that they are different (see dash-dot lines in Figure 11). In fact, RS6 poses twice the risk posed by RS1. Without the extra "dimension' provided by the confidence level evaluation, all 3 risk scenarios seem to pose the same level of risk because they project on the same point in the vertical axis in Figure 11. With the added "dimension" provided by the confidence level evaluation, they project into distinct points in the horizontal axis.

The impact of the confidence level is even more evident for RS2 and RS7, which are more dominant than operational risks in this case study. Note that RS2 and RS7 are ranked the same in the second column in Table 3 and on the vertical axis in Figure 9. Also, they appear in the same risk cell in the Company's risk matrix (Figure 1). That is, without the confidence level analysis, both the qualitative and the quantitative risk assessments suggest that RS2 and RS7 pose similar risk to the Company. However, RS2 poses 8 times more risk than RS7 when we account for the confidence level. This can be seen in the last column in Table 3 or in the horizontal axis in Figure 9. The reason is that the GF for RS2 is higher, indicating less confidence. Because there is less confidence on the risk estimate for RS2, it is ranked higher.

The impact of "lack of confidence" can even reverse the order of the risk scenarios on the risk scale. RS4, for example, is 2.5 times higher risk than RS5 in the normalized risk in Table 3. However, RS4 represents only 60% of the risk from RS5 in the renormalized risk ranking.

The insights just presented are not available without the confidence level analysis. We get a hint of these insights from the qualitative analysis of the confidence level. For example, Figure 5 shows RS1, RS6 and RS8 in the same risk cell, but it indicates **High** confidence for RS1, **Low** confidence for RS6 and **Medium to High** confidence for RS8. Therefore, both the qualitative and the quantitative analyses provide useful and consistent insights. The supplemental value of the quantitative analysis is that it provides a measure that helps the Company ***rank*** the different risk scenarios. This ranking is useful in risk reduction decisions, including cost-benefit analysis, where the decision makers focus first on the elements with the highest rank (Paula, Lorenzo and Costa Jr. 2015). And this ranking is generally different from the ranking provided without the confidence level analysis.

Another angle to consider in the confidence level analysis is the focus of the decision making. If the risk is high and the confidence is high, the resources would focus on risk reduction. If the risk is high and the confidence is low, the resources would focus on first improving the confidence and then on reducing the risk. Figure 14 shows this concept in a graphical format (Guthrie 2018).

5.0 Concluding Remarks

The analysis of the confidence level presented in this article contributes to key aspects for the successful completion of a risk assessment (Cross and Ballesio 2003) (ABS Consulting 2003). By adding the evaluation of the confidence level, it enhances completeness and comprehensiveness of ERM studies. Because it offers a systematic approach, it helps improve consistency, tractability and documentation of the analysis. And since it uses categories to express the level of confidence, it is straightforward and consistent with the concept of risk matrixes so widely used in ERM and other types of risk assessments. By considering the key factors/sources of lack of confidence, the methodology brings more credibility and realism to the evaluation. And finally, it is simple enough to be efficient in ERM applications, particularly if using the criteria from Figure 2.

One important observation is that the quantitative analysis can be performed very quickly and straightforwardly once the qualitative analysis is completed – just apply a multiplier to the normalized risk estimates and renormalize them. Thus, it is a simple, powerful tool to supplement the qualitative analysis. Another important observation is that the quantitative confidence level evaluation can have a significant impact on the ranking of risk scenarios. The examples from a multi-national, integrated O&G company shows this very clearly.

Finally, some analysts argue that there is so much uncertainty in some of the quantitative results that quantification may not be useful. The insights provided in Figures 9 and 10 show quite the opposite. The extra "dimension" in the horizontal axis in the figures refine the ranking of the risk scenarios. This is useful regardless of the level of confidence (or lack of).

The existence of uncertainty or variability is no excuse for skipping the quantitative analysis of the confidence level or the quantitative ERM altogether. They are ingrained in the decision-making process and ***ignoring uncertainty or variability will not make them go away.***

6.0 Acknowledgements

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Table 1 — Eight Dominant Risk Scenarios

- Risk Scenario 1 (RS1) – Operational Hazards Resulting in Fatality
- Risk Scenario 2 (RS2) – Carelessness or Illegitimate Acts
- Risk Scenario 3 (RS3) – Less Demand Due to Increased Competition
- Risk Scenario 4 (RS4) – Lower Earnings Due to Increased Operational Costs
- Risk Scenario 5 (RS5) – Loss of Containment in the Marketing Infrastructure
- Risk Scenario 6 (RS6) – Inadequate Insurance Coverage
- Risk Scenario 7 (RS7) – Inadequate Project Management
- Risk Scenario 8 (RS8) – Environmental Restrictions and Regulations

		Severity Category					
		1	**2**	**3**	**4**	**5**	**6**
Frequency Category	6				**RS5**		**RS3**
	5					**RS4**	**RS2** **RS7**
	4						**RS1** **RS6** **RS8**
	3						
	2						
	1						

Figure 1 — The Eight Risk Scenarios in the Company's Risk Matrix

Paula-Guthrie Confidence Criteria

P-G Chart with Girth Factors within Parenthesis			Analytical Strength		
			Strong (S)	**Medium (M)**	**Weak (W)**
			• Few or mostly immaterial assumptions	• Several or somewhat material assumptions	• Numerous or fairly material assumptions
			<-- Consider moving one cell to the left when benefiting from relevant "SME"† knowledge and experience **or** relevant "depth of analysis" <-- Consider moving two cells to the left when benefiting from both relevant "SME" knowledge and experience **and** relevant "depth of analysis"		
Data Strength	**Strong(S)**	• Specific event data with at least 4 occurrences	High (10)	Medium to High (18)	Medium (32)
	Medium(M)	• Specific event data with 3 occurrences or • Plentyful generic data or • Well-thought-out pseudo data	Medium to High (18)	Medium (32)	Low to Medium (56)
	Weak(W)	• Specific event data with 2 or fewer occurrences or • Limited generic data or • Pseudo data	Medium (32)	Low to Medium (56)	Low (100)

† Subject Matter Expertise

Figure 2 — Confidence Criteria

Expanded Paula-Guthrie Confidence Criteria

P-G Chart with Girth Factors within Parenthesis			Analytical Strength				
			Very Strong (VS)	**Strong (S)**	**Medium (M)**	**Weak (W)**	**Very Weak (VW)**
			• No or only immaterial assumptions	• Few or mostly immaterial assumptions	• Several or somewhat material assumptions	• Numerous or fairly material assumptions	Numerous or highly material assumptions
			<-- Consider moving one cell to the left when benefiting from relevant "SME"† knowledge and experience **or** relevant "depth of analysis" <-- Consider moving two cells to the left when benefiting from both relevant "SME" knowledge and experience **and** relevant "depth of analysis"				
Data Strength	**Very Strong (VS)**	• Specific event data with at least 9 occurrences	Very High (3.2)	High to Very High (5.6)	High (10)	Medium to High (18)	Medium (32)
	Strong (S)	• Specific event data with at least 4 occurrences	High to Very High (5.6)	High (10)	Medium to High (18)	Medium (32)	Low to Medium (56)
	Medium (M)	• Specific event data with 3 occurrences or • Plentyful generic data or • Well-thought-out pseudo data	High (10)	Medium to High (18)	Medium (32)	Low to Medium (56)	Low (100)
	Weak (W)	• Specific event data with 2 occurrences or • Limited generic data or • Pseudo data	Medium to High (18)	Medium (32)	Low to Medium (56)	Low (100)	Very Low to Low (320)
	Very Weak (VW)	• Specific event data with 1 or no occurrences or • Sparse generic data or • Mostly judgement	Medium (32)	Low to Medium (56)	Low (100)	Very Low to Low (320)	Very Low (1,000)

† Subject Matter Expertise

Figure 3 — Expanded Confidence Criteria

Table 2 — Summary of the Results from the Qualitative Analysis

Risk Scenario	Severity			Frequency			Confidence for the Risk Scenario
	Strength		Confidence Level for the Severity	Strength		Confidence Level for the Frequency	
	Data	Analytical		Data	Analytical		
RS1	Very Strong	Very Strong	Very High	Very Strong	Medium	High	High
				Strong	Strong		
				Medium	Very Strong		
RS2	Very Strong	Very Strong	Very High	Very Weak	Very Weak	Very Low	Very Low
RS3	Very Strong	Very Strong	Very High	Very Weak	Weak	Very Low to Low	Very Low to Low
RS4	Very Strong	Very Strong	Very High	Very Strong	Strong	High to Very High	High
RS5	Very Strong	Very Strong	Very High	Very Weak	Weak	Very Low to Low	Very Low to Low
RS6	Very Strong	Very Strong	Very High	Very Weak	Medium	Low	Low
RS7	Very Strong	Very Strong	Very High	Very Strong	Very Strong	Very High	High to Very High
RS8	Very Strong	Very Strong	Very High	Very Strong	Weak	Medium to High	Medium to High

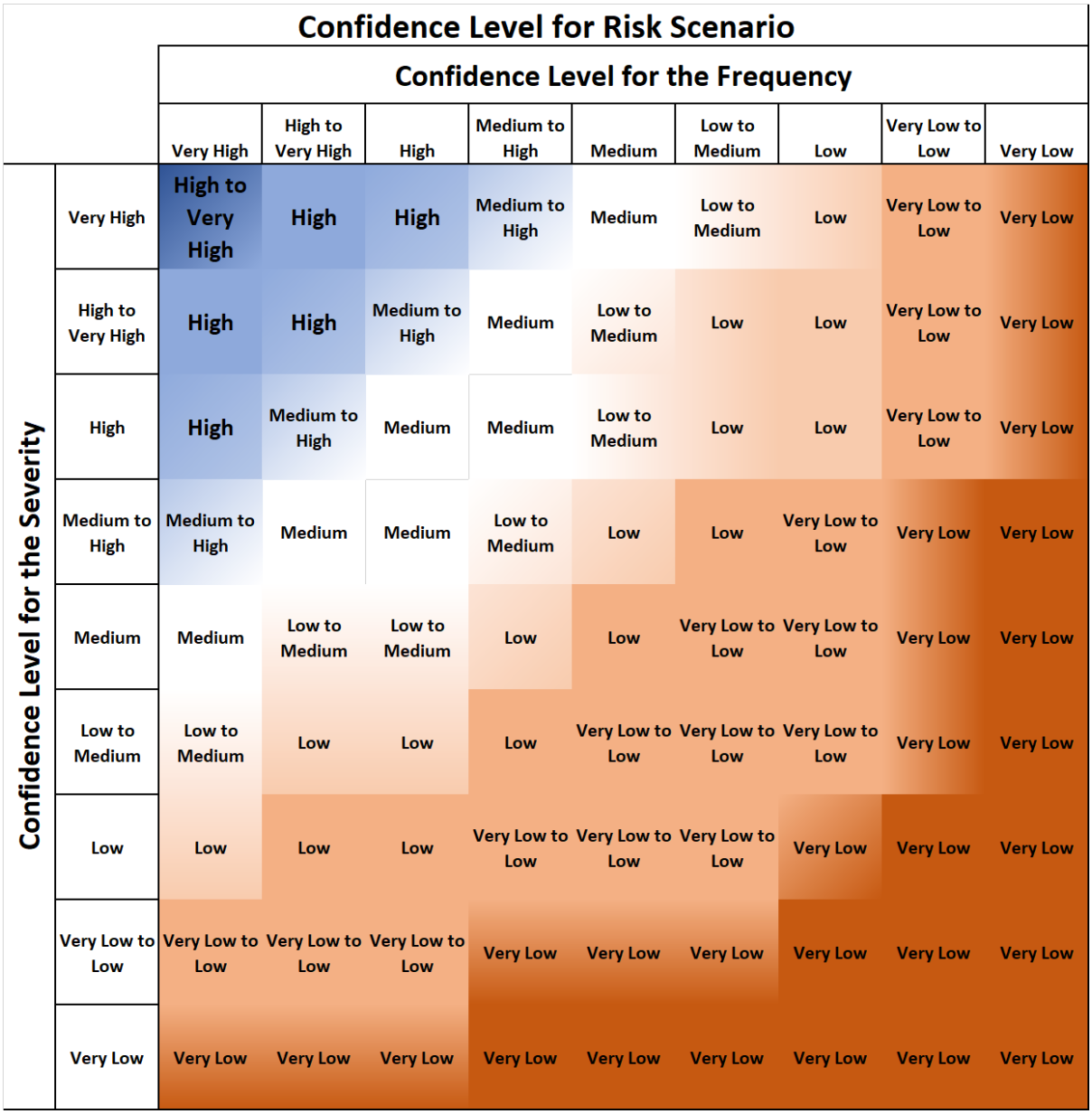

Figure 4 — Confidence Level for the Risk Scenario

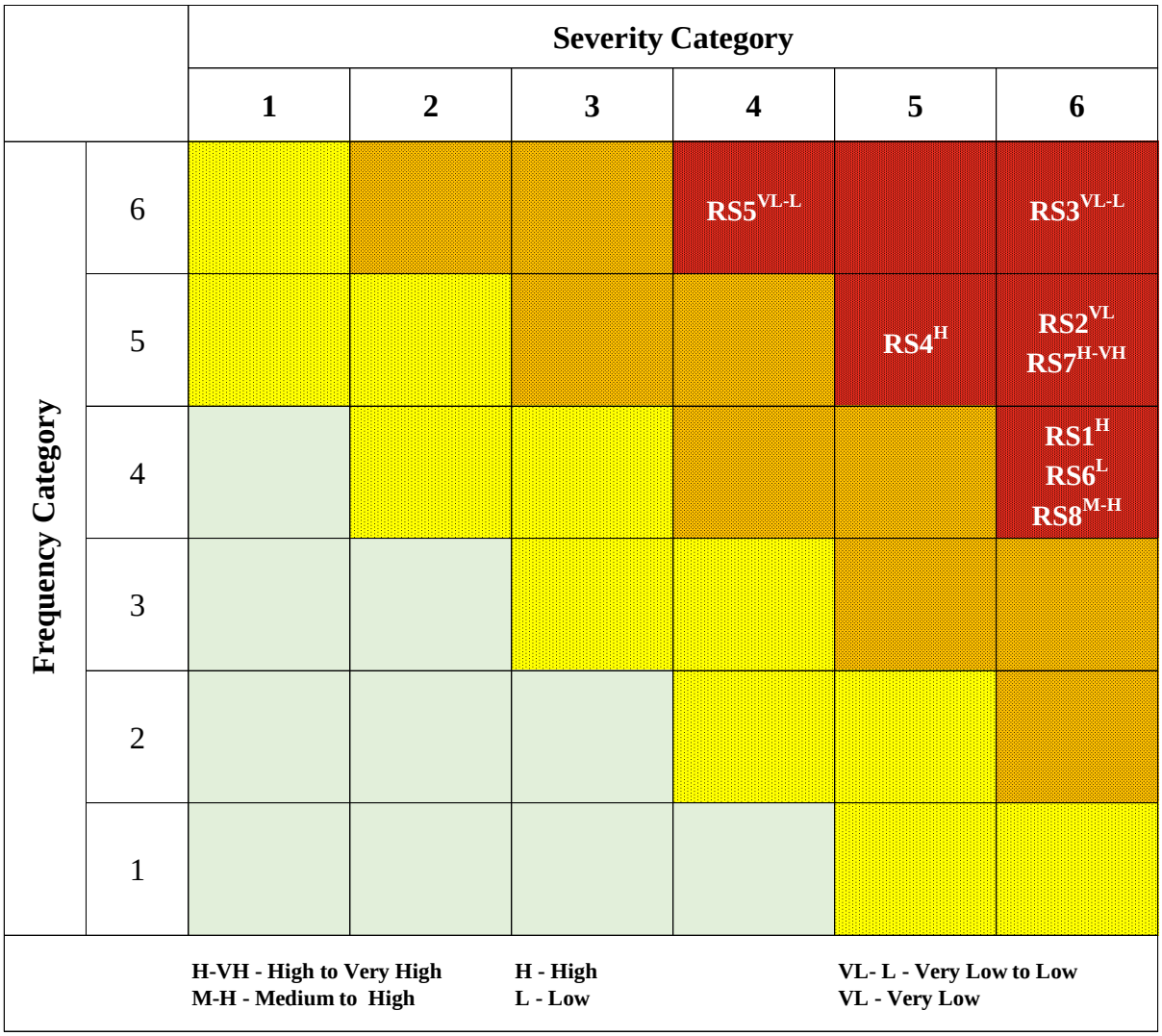

Figure 5 — Qualitative Confidence Levels for the Eight Risk Scenarios

Table 3 — Quantitative Confidence Level Analysis for the Eight Dominant Risk Scenarios							
Risk Scenario (RS)	**Normalized Risk**	**Confidence Level**		**GF for RS**	**Multiplier for RS**	**Revised Risk**	**Renormalized Risk**
		Severity	**Frequency**				
RS3	1.00	**VH**	**VL-L**	354	4.9	4.91	1.00
RS7	0.25	**VH**	**VH**	5.1	1.1	0.28	0.058
RS2	0.25	**VH**	**VL**	1,100	9.6	2.41	0.49
RS6	0.10	**VH**	**L**	115	2.8	0.28	0.058
RS8	0.10	**VH**	**M-H**	22	1.6	0.16	0.032
RS1	0.10	**VH**	**H**	13	1.4	0.14	0.028
RS4	0.025	**VH**	**H-VH**	8	1.2	0.03	0.006
RS5	0.010	**VH**	**VL-L**	354	4.9	0.049	0.010
VH − Very High **H-VH** High to Very High		**H −** High **M-H** − Median to High		**L** − Low **VL-L** − Very Low to Low			**VL** − Very Low

Confidence Level Multiplier										
		Confidence Level for the Frequency								
		Very High	High to Very High	High	Medium to High	Medium	Low to Medium	Low	Very Low to Low	Very Low
Confidence Level for the Severity	Very High	1.1	1.2	1.4	1.6	1.8	2.3	2.8	4.9	9.6
	High to Very High	1.2	1.3	1.5	1.7	2.0	2.4	3.1	5.3	10
	High	1.4	1.5	1.6	1.9	2.2	2.7	3.4	5.9	12
	Medium to High	1.6	1.7	1.9	2.1	2.5	3.1	3.9	6.8	13
	Medium	1.8	2.0	2.2	2.5	3.0	3.7	4.6	8.0	16
	Low to Medium	2.3	2.4	2.7	3.1	3.7	4.5	5.6	9.8	19
	Low	2.8	3.1	3.4	3.9	4.6	5.6	7.1	12	24
	Very Low to Low	4.9	5.3	5.9	6.8	8.0	9.8	12	21	42
	Very Low	9.6	10	12	13	16	19	24	42	82

Figure 6 — The Confidence Level Multiplier

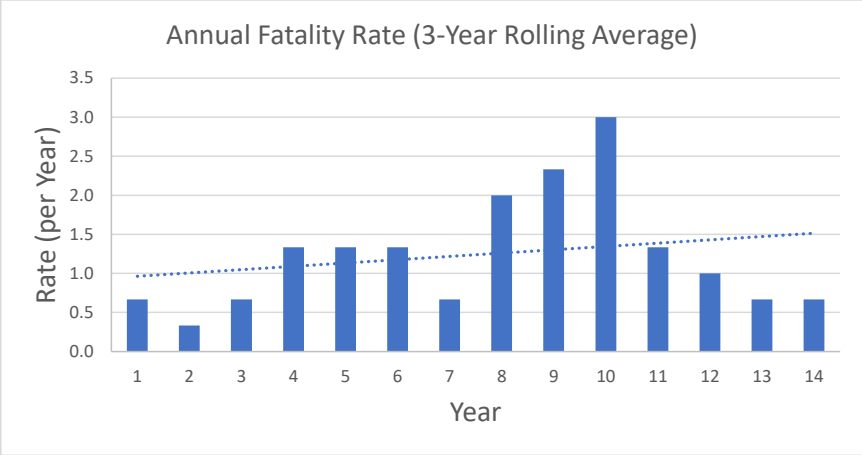

Figure 7 — Historical Experience Related to RS1

Expanded Paula-Guthrie Confidence Criteria

P-G Chart with Girth Factors within Parenthesis			Analytical Strength				
			Very Strong (VS)	Strong (S)	Medium (M)	Weak (W)	Very Weak (VW)
			• No or only immaterial assumptions	• Few or mostly immaterial assumptions	• Several or somewhat material assumptions	• Numerous or fairly material assumptions	Numerous or highly material assumptions
			<-- Consider moving one cell to the left wh knowledge and experience **or** relevant "de <-- Consider moving two cells to the left w "SME" knowledge **and** experience and rele				
Data Strength	Very Strong (VS)	• Specific event data with at least 9 occurrences	Very High (3.2)	High to Very High (5.6)	High (10)	Medium to High (18)	Medium (32)
	Strong (S)	• Specific event data with at least 4 occurrences	High to Very High (5.6)	High (10)	Medium to High (18)	Medium (32)	Low to Medium (56)
	Medium (M)	• Specific event data with 3 occurrences or • Plentyful generic data or • Well-thought-out pseudo data	High (10)				Low (100)
	Weak (W)	• Specific event data with 2 occurrences or • Limited generic data or • Pseudo data	Medium to High (18)	Medium (32)	Low to Medium (56)	Low (100)	Very Low to Low (320)
	Very Weak (VW)	• Specific event data with 1 or no occurrences or • Sparse generic data or • Mostly judgement	Medium (32)	Low to Medium (56)	Low (100)	Very Low to Low (320)	Very Low (1,000)

More years of data; more

Fewer years of data; fewer

' Subject Matter Expertise

Figure 8 — Impact of Time Period

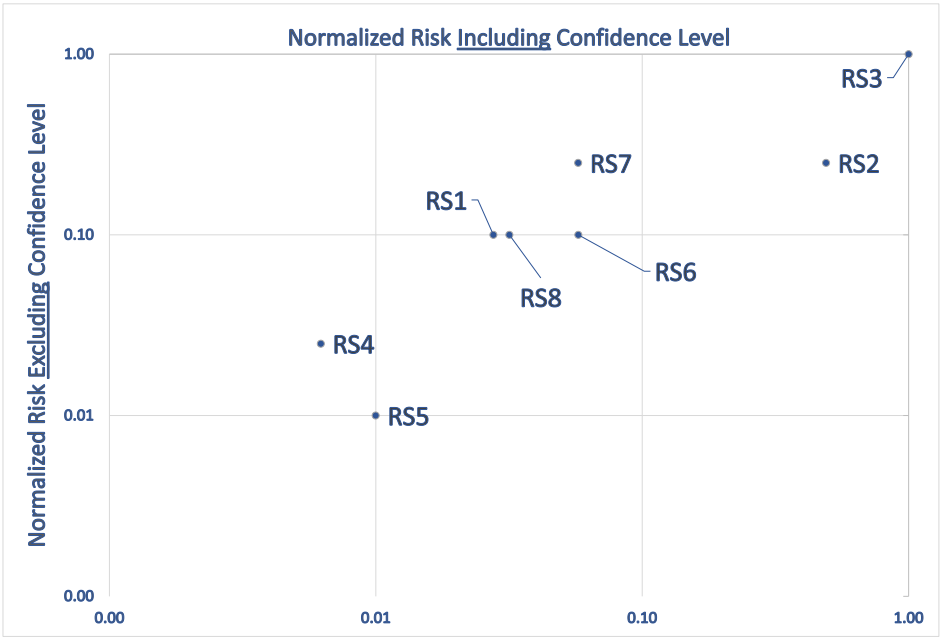

Figure 9 — Risk Estimates with and without the Confidence Level Analysis

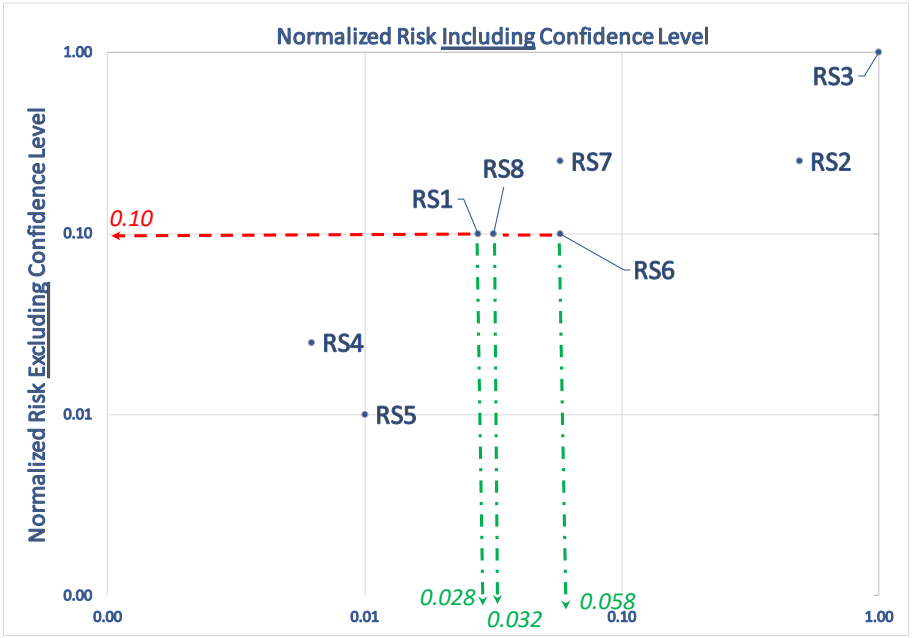

Figure 10 — RS1, RS6 and RS8 with and without the Confidence Level Analysis

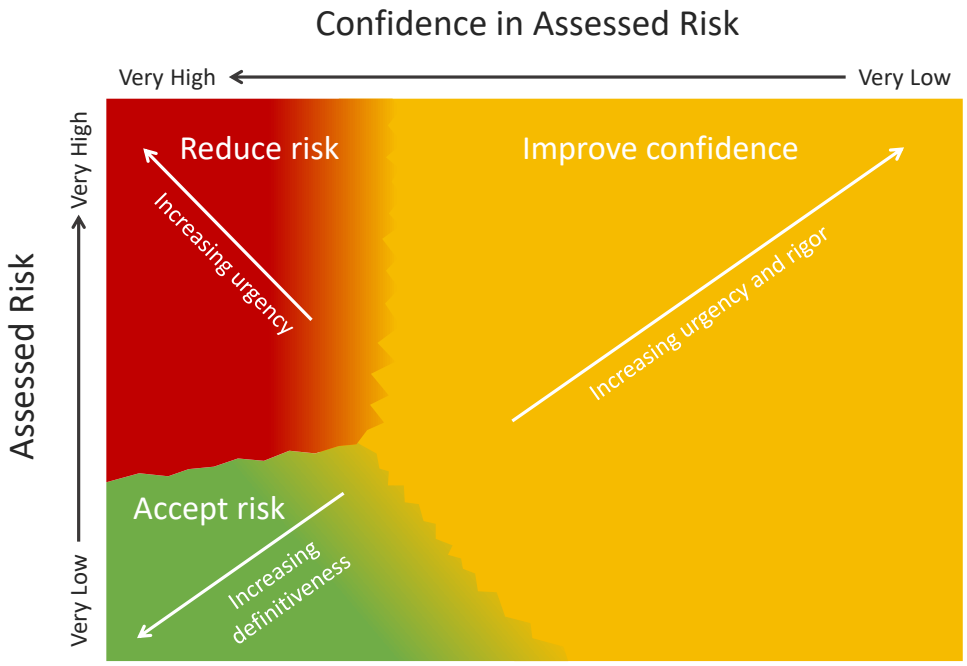

Figure 11 — Guthrie's Assessed Risk and Confidence