Hazard Identification & Risk Mitigation (HIRM) Worksheet
Contents:

Total 13 Sheets in this Excel document

Purpose of this Worksheet (Hazard Identification & Risk Mitigation Tool):
Template for the performance and documentation of specific risk scenario (H>TE>C)
mitigation (applicable for SSP & SMS).

Sheet 1 - Hazard Identification & Risk Mitigation (HIRM) Worksheet

General Instructions for SRM Team:

1 This is a Risk Mitigation Tool. The main working document is in Sheet 4.
2 The SRM Team needs to have personnel who have relevant operations experience. The member who makes entries in the SRM worksheet needs to know HIRM.
3 Read the HIRM Procedure in Sheet 3 as well as Explanatory Notes in Sheet 2.
4 Identify one specific (credible or actual) Hazard> Top-Event>Consequence scenario for each SRM Wsht.
   Note: In an organizational environment, a specific Hazard/ Top-Event/ Consequence scenario may be assigned from the organization's Master Hazards Register (sht 10)
5 Identify the essential Operation/ Process/ Domain/ Sector/ Organization underlying this H>TE>C scenario.
   Note: If the SRM Team is required to evaluate other credible occurrence scenarios related to the given H/TE/C, such an exercise may be accomplished through the "3 Approaches" menthodology in sht 10B. All such related H>TE>C scenarios so identified may be eligible for a separate SRM exercise, using separate SRM Wsht (s); or they may be uploaded to the organization's Risk Register for subsequent follow up action.
8 Enter the specific H>TE>C information into Table A of the HIRM Worksheet (Sheet 4).
9 Proceed to discuss and fill out the rest of the HIRM Worksheet - Sht 4, 4B & 4C.
10 Follow the 10 Steps procedure within the Risk Index assessment Tables (5-1 & 5-2) to obtain the Existing & Resultant Risk Index for your Consequence.

Sheet 2: Definitions

1	**Hazard Identification & Risk Mitigation (HIRM)**	*A structured procedure to identifiy hazards/ threats within a given operation, process or area and the evaluation of preventive controls (defences, ba (s)/ consequence (s). This HIRM procedure/ process is also commonly known as Safety Assessment.*
2	**Operation/ Process**	*Description of Organization/ Operation/ Process/ Equipment wherein the Hazard is identified/ reported/ originated from.*
3	**Hazard (H)**	*A condition or an object with the potential to cause or contribute to an aircraft incident or accident.*
4	**Threat (T)**	*Threats are essentially hazards which are more imminent/ immediate/ visible (hence more threatening) to an operation; in comparison to more later Threats may be mitigated for, possibly with higher priority over more latent hazards.*
5	**Consequence (C)**	*An outcome that can be triggered by a hazard.*
6	**Top-Event (TE)** **[Unsafe Event]**	*Most credible unsafe situation/ event, not yet amounting to an Ultimate Consequence or Accident. Usually an intermediate event/ situation before a Event (Unsafe Event) is applicable only where there is a need to distinguish and establish mitigating actions upstream and downstream of such an in Consequence/ Accident). If this intermediate TE/ UE state is not applicable for a particular operation, then it may be bypassed as appropriate.*
7	**Preventive Control (PC)**	*A mitigating action or defence to block or prevent a Hazard/ Threat from escalating into a Top-Event (Likelihood Control).* *Existing PCs refer to current/ known/ established PCs which have been in place before the current HIRM exercise.* *New PCs refer to new/ additional/ modified PCs being recommended, proposed or which have been put in place as a result of the current HIRM exerc*
8	**Recovery Measure (RM)**	*A mitigating action, barrier or defence to block or prevent a Top-Event from escalating into an Ultimate Consequence or Accident (Likelihood Control)* *Existing RMs refer to current/ known/ established RMs which have been put in place before the current HIRM exercise.* *New RMs refer to new/ additional/ modified RMs being recommended, proposed or which have been put in place as a result of the current HIRM exe*
9	**Severity Control (SC)**	*A mitigating action, barrier or defence to mitigate (reduce) the extent of damage/ impact resulting from a TE or Consequence (Severity Control).*
10	**Barrier**	*A generic term, referring to a PC, RM or SC.*
11	**Barrier Quality**	*Quality attributes of a given Barrier, including - Effectiveness, Cost-benefit, Practicality, Acceptability, Enforceability & Durability.*
12	**Barrier Strength Value (BSV)**	*The risk-mitigating quality/ strength/ robustness Value (quantitative) of a specific Barrier (PC/ RM).*
13	**Consolidated BSV**	*The Consolidated (SUM) Barrier Strength Value of a package of Barriers (PCs/ RMs) which are put in place to mitigate against a given TE/ UC.*
14	**Escalation Factor (EF)**	*Apparent deficiency/ factor/ condition which may weaken the effectiveness or BSV of a Preventive Control (or Recovery measure). Use where applica*
15	**Unintended Consequence (UC)**	*The introduction of new hazards and related safety risks associated with the implementation of any mitigation alternative, e.g. an effective risk man an adverse impact on another operational sector of aviation.*
15	**Escalation Control (EC)**	*A mitigating action or defence to block or prevent an Escalation Factor from compromising or weakening a Preventive Control (or Recovery Measure*
16	**Risk Index (RI)**	*Risk Index refers to the combined Likelihood & Severity values of a Consequence.*
17	**Existing Risk Index & Tolerability**	*Existing Risk Index and Tolerability is that which is derived based on Existing PCs/ RMs only.* *Note: If an Existing Risk Index (and its corresponding Tolerability descriptor) is deemed intolerable, then the evaluation of New (additional) PCs/ RM Index to a more acceptable/ tolerable level. This may include modification or enhancement of existing PCs/ RMs.*
18	**Resultant Risk Index & Tolerability**	*Resultant Risk Index and Tolerability assessment is based on the combined Existing PCs/ RMs plus the New PCs/ RMs put in place as a result of the c*

Sht 3: HIRM (Safety Assessment) - Generic Procedure

1	Fill out Table A in the main spread sheet (Sheet 4). Be precise in naming each entity, especially the Hazard. (Refer Sheet 2 for definitions of each entity)
2	Annotate Table A items (1, 2, 3 & 4) descriptions - Operation, Hazard, Top Event & Consequence (This information will be auto repeated in Table B).
3	Annotate Existing PC identifier codes (columns 2 to 11) and/ or E-RM identifier codes (columns 31 to 40) within the relevant PC/ RM (10 categories) columns as illustrated.
4	Where a PC/ RM may be affected (compromised) by an EF (Escalation Factor) or result in an unintended consequence (UC), then the EF/UC & EC (Escalation Control) columns (12, 13, etc) should be activated and annotated accordingly for that PC/ RM. The actual PC/RM/EF/UC/EC descriptions are to be annotated in their respective description boxes as provided. The same applies for SCs (Severity Controls), except that these do not have EF & EC, and should be evaluated qualitatively.
5	Based on the Existing PCs/ RMs and SCs being in place, assess the Existing Risk Index (Severity & Likelihood) of the projected C. Follow the 10 Steps instructions within the two Existing Risk Index calculation Table 5-1.
6	If the Existing Risk Index's Tolerability is unacceptable to the SRM team/ organization (eg Extreme/ High risk/ Moderate risk), proceed to evaluate possible enhancement of Existing PCs/ RMs/ SCs and/ or recommend New (additional) PCs/ RMs/ SCs in order to further mitigate (reduce) the Risk Index to an acceptable level.
7	When enhanced and/ or New PCs/ RMs/ SCs are identified/ declared (together with the Existing PCs/ RMs/ SCs), proceed to assess the Resultant Risk Index (Severity & Likehood) of the projected C. Follow the 10 Steps instructions within the Resultant Risk Index calculation Table 5-2.
8	Upon completion of the whole risk mitigation worksheet, proceed to fill out the Safety Risk Mitigation (SRM) Report Form (sht 10). This Form will serve as the formal cover report (documentation) of the completed SRM exercise.
9	This completed SRM Form should then be copied to the HIRM administration office, so that necessary update/ closure of the organization's Hazards Master Register (sht 11) concerning the SRM status of this particular H>TE>C scenario can be made.

Considerations when performing SRM:

Human factors analysis - During assessment of a PC, RM, EF, UC or EC which apparently involve complex human factor (HF) elements, it may be appropriate for the risk mitigation team to request for HF analysis support as applicable. This will ensure that existing or new barriers recommended are not compromised by unexpected human performance limitations.

Cost & Benefits analysis - For SRM projects where new/ enhanced mitigating actions (barriers/ defenses) would involve substantial financial investment or organizational changes, it would be appropriate for the SRM procedures to call for an appropriate CBA or impact assessment (management of Change) before final approval of the SRM project by management.

3A. Safety Risk Mitigation (SRM) Process

1. Annotate required H, TE & C information in Table A (Sheet 4).

2. H, TE & C information is automatically repeated in Table B, columns 1, 30, 59 accordingly.

Perform risk mitigation between the Hazard and the Top Event as follows:

3. Identify and annotate Existing Preventive Controls (E-PCs) and Existing Recovery Measures (E-RMs) in applicable columns provided (2 to 11, 31 to 40). Also identify any Severity Controls (E-SCs) in columns 31-44.

4. An EF or UC which is not mitigated for by an EC may compromise the BSV of the associated PC. To avoid double counting of BSV, any identified EC to mitigate the EF or UC should be grouped under the E-PC. Alternatively, a N-PC may replace the E-PC having an EF or UC and in which case, the BSV of the E-PC (with the EF or UC) should not be counted when determining the CBSV of the E-PCs and N-PCs in Step 4 of Table 5-2. Repeat this process for RMs.

5. Based on the annotated E-PCs, N-PCs and E-SCs, assess the Existing Risk Index (Severity & Likelihood) & its Tolerability in columns 43-44. Follow the 10 Steps in Table 5-1 to obtain the E-RI of the C.

6. If the Existing Risk Index & Tolerability is deemed unacceptable, then proceed to enhance or recommend New Preventive Controls (N-PCs) and New Recovery Measures (N-RMs) in applicable columns provided (16-25, 45-54). If possible, enhance or recommend New Severity Controls (N-SCs) in columns 45-58.

7. Assess the Resultant Risk Index & Tolerability (columns 59-60) of the C, based on the E-PCs and E-RMs plus the N-PCs and N-RMs, as well as the N-SCs (if any). Follow the 10 steps in Table 5-2 to obtain the R-RI of the C.

8. Upon completion of SRM Worksheet, proceed to fill out the SRM Report form (Sheet 10).

Risk Index (Severity & Likelihood) Assessment Process

Input	Process	Output

| Description of the Outcome (C) | Evaluate impact of the Outcome to 7 Areas [Sht 4C] | Consolidated Severity value of the Outcome identified eg: *3 (Moderate)* — 1 |

| Identified Severity value of the Outcome [Output #1] | Take note of applicable ONB & CBSV-Likelihood Table for the identified Severity value [Sht 4A, Table 3] | Applicable ONB & CBSV-Likelihood Table also noted eg: *ONB 4 & Table 4(iii)* — 2 |

| Each Barrier (PC/RM) | Assess each Barrier's Quality score [Sht 4B, Table 1] → Correlate Total Barrier Quality score with Barrier Strength Value [Sht 4B, Table 2] | Barrier Strength Value for each barrier obtained — 3a |

| Severity Controls (SC) | Assess the SCs qualitatively [Sht 4C, Figure 3] → Revise Severity value of the Consequence | Revised Severity value of the Consequence — 3b |

Compare total number of Barriers with the ONB value [Sht 4, Table 5, step 2]	If number of barriers is equal to or less than ONB value eg: *4 or less* → Add up all the BSVs of all barriers	Consolidated BSV obtained (for all barriers) — 4(a)
	OR	OR	OR
	If number of barriers is more than ONB eg *more than 4* → Add up the best BSVs, of the optimum number of barriers	Consolidated BSV obtained (for optimum number of barriers) — 4(b)

| Consolidated BSV obtained [Output 4(a) OR 4(b) as applicable] | Refer to the applicable CBSV-Likelihood Table (as indicated in Sht 4A, Table 3) to obtain the required Likelihood value | Required Likelihood value obtained — 5 |

Output 3b (Severity value) + Output 5 (Likelihood value) = Risk Index (of the Outcome)

Sht 4 Hazard Identification & Risk Mitigation (HIRM) Worksheet

A

1. AREA/ OPERATION/ EQUIPMENT:	[Aircraft Take-Off/Climb Operations]
2. HAZARD / THREAT [H/T]:	[Inclement weather during climb-out]
3. TOP-EVENT [TE]:	[Inadvertent flight into inclement weather/ storm during departure]
4. CONSEQUENCE [C]:	[LOCI - due to inclement weather (windshear/ down draft)]

B

>>>>>>>>>>>>>>>>>>>>>>>>>>>> **Top Event Mitigation** >>>>>>>>>>>>>>>>>>>>>>>>>>>>   >>>>>>>>>>>>>>>>>>>>>>>> **Ultimate Consequence Mitigation** >>>>>>>>>>>>>>>>>>>>>>>>

Existing Preventive Controls [E-PC] | New Preventive Controls [N-PC] | Existing Recovery Measures [E-RM] | ERI & T | New Recovery Measures [N-RM] | RRI & T

Hazard / Threat: [Inclement weather during climb-out]

Top-Event: [Inadvertent flight into inclement weather/ storm during departure]

Existing Risk Index: 2B Tolerable

Resultant Risk Index: 1B Acceptable

Consequence: [LOCI - due to inclement weather (windshear/ down draft)]

E-PC1, E-PC2, E-PC3 ... E-PC8
N-PC1, N-PC2 ... N-PC8
E-RM1, E-RM2, E-RM3 ... E-RM8
N-RM1, N-RM2, N-RM3, N-RM4 ... N-RM8

Description tables

Description of Existing Preventive Controls [E-PC]	BSV
E-PC1: Pilot review weather Report before departure [F/Ops SOP 2.5].	3
EF/UC>E-PC1:	
EC>EF/UC>E-PC1:	
E-PC2: Pilot use of airborne weather radar [F/Ops SOP 4.2].	4
EF/UC>E-PC2:	
EC>EF/UC>E-PC2:	
E-PC3: Pilot request for deviation due to bad weather [F/Ops SOP 5.1].	4
EF/UC>E-PC3:	
EC>EF/UC>E-PC3:	
E-PC4:	0
E-PC5:	0
E-PC6:	0
E-PC7:	0
E-PC8:	0

Description of New Preventive Controls [N-PC]	BSV
N-PC1: This is an illustrative New PC description.	5
N-PC2: This is an illustrative New PC description.	4
N-PC3:	0
N-PC4:	0
N-PC5:	0
N-PC6:	0
N-PC7:	0
N-PC8:	0

Description of Existing Recovery Measures [E-RM]	BSV
E-RM1: Pilot trained in UPRT [F/Ops 2.5.1].	3
E-RM2: Autopilot System will mitigate upset conditions [FCOM 3.1.2]	2
EF/UC>E-RM2: This is an illustrative EF description.	
EC>EF/UC>E-RM2: Nil (No available EC for time being).	
E-RM3: Pilot perform Upset Recovery when required [FCOM 4.1.2]	3
E-RM4:	0
E-RM5:	0
E-RM6:	0
E-RM7:	0
E-RM8:	0

Description of New Recovery Measures [N-RM]	BSV
N-RM1: This is an illustrative New RM description	1
N-RM2: This is an illustrative New RM description	4
N-RM3: N-RM3: This is an illustrative New RM description	2
N-RM4: N-RM4: This is an illustrative New RM description	3
N-RM5:	0
N-RM6:	0
N-RM7:	0
N-RM8:	0

<<< Unhide additional **PC/ RM** rows here where applicable.

<<< Unhide SC Rows here where applicable.

Description of Existing Severity Controls [SC] to mitigate C	Description of New Severity Controls [SC] to mitigate C
E-SC1:	N-SC1:
E-SC2:	N-SC2:

5-1. Existing Risk Index [Hazard > Consequence]

1 Severity level of Consequence [Sht 4C] >> **B**

2 Consequence's Optimum No of Barriers (ONB) [Sht 4A, Table3] >> **6**

3 Applicable CBSV-Likelihood Table [Sht 4A, Table 3] >> **4 (iv)**

4 BSV of E-PCs and Existing-RMs [Sht 4B]:

	BSV		BSV
E-PC1	3	E-RM1	3
E-PC2	4	E-RM2	2
E-PC3	4	E-RM3	3
E-PC4	0	E-RM4	0
E-PC5	0	E-RM5	0
E-PC6	0	E-RM6	0
E-PC7	0	E-RM7	0
E-PC8	0	E-RM8	0

5 CBSV (SUM) of E-PCs and E-RMs >> **19**

6 CBSV of ONB (Applicable if No of E-PCs and E-RMs is > ONB) >> **NA**
(SUM of best BSVs up to ONB)

7 CBSV of Consequence (CBSV in Step 5 or 6, whichever is applicable) >> **19**

8 Existing Likelihood of Consequence (Table of item 3) >> **2**

9 Existing Risk Index of Consequence [Pairing of Step 1 + 8] >> **2B**

10 Existing Tolerability of Consequence [Sht 8] >> **Tolerable**

5-2. Resultant Risk Index [Hazard > Consequence]

1 Severity level of Consequence [Sht 4C] >> **B**

2 Consequence's Optimum No of Barriers (ONB) [Sht 4A, Table3] >> **6**

3 Applicable CBSV-Likelihood Table [Sht 4A, Table 3] >> **4 (iv)**

4 BSV of E-PCs, N-PCs, E-RMs, and N-RMs [Sht 4B]:

	BSV		BSV		BSV		BSV
E-PC1	3	N-PC1	5	E-RM1	3	N-RM1	1
E-PC2	4	N-PC2	4	E-RM2	2	N-RM2	4
E-PC3	4	N-PC3	0	E-RM3	3	N-RM3	2
E-PC4	0	N-PC4	0	E-RM4	0	N-RM4	3
E-PC5	0	N-PC5	0	E-RM5	0	N-RM5	0
E-PC6	0	N-PC6	0	E-RM6	0	N-RM6	0
E-PC7	0	N-PC7	0	E-RM7	0	N-RM7	0
E-PC8	0	N-PC8	0	E-RM8	0	N-RM8	0

5 CBSV (SUM) of E-PCs, N-PCs, E-RMs and N-RMs [Note comment flag] >> **38**

6 CBSV of ONB (Applicable if No of PCs and RMs is > ONB) >> **24**
(SUM of best BSVs up to ONB)

7 CBSV of Consequence (CBSV in Step 5 or 6, whichever is applicable) >> **24**

8 Resultant Likelihood of Consequence (Table of item 3) >> **1**

9 Resultant Risk Index of Consequence [Pairing of Step 1 + 8] >> **1B**

10 Resultant Tolerability of Consequence [Sht 8] >> **Acceptable**

Sheet 4A - Risk Index Assessment Tables <<<

Follow the 10 steps procedure in Sheet 4, Table 5 to obtain the Risk Index.
Supporting Tables 1, 2, 3 & 4 are as follows:

Table 1 - Barrier Strength Value (BSV)

Barrier Strength	Barrier Strength Description	Barrier Strength Value (BSV)*
Poor	Weak, superficial or insignificant Barrier	1
Fair	Barely viable or adequate Barrier	2
Satisfactory	Reasonable or acceptable Barrier	3
Good	Effective, recognised and established Barrier	4
Excellent	Best or most robust Standard/ Regulation/ Practice	5

* Refer to Sheet 4B for supporting guidance on BSV assessment.

Table 2 - Consolidated Barrier Strength Value (CBSV) Assessment

Barrier Sequence No (PC/ RM)	Assessed BSV (for each Barrier)
1	2
2	4
3	3
4	3
5	2
6	1
7	
8	
	15
	12

Note to Optimum CBSV**:
Where actual number of barriers exceed the Optimum Number of Barriers (ONB) in Table 3, select the barriers with the highest BSVs to obtain your CBSV.

15 <<< CBSV (BSV of all barriers)

12 <<< Optimum CBSV** (BSV of optimum barriers only, where applicable)

Table 3 - Optimum Number of Barriers & Applicable CBSV-Likelihood Tables

Severity Value of Consequence	Severity Descriptor	Optimum Number of Barriers (ONB)	Max CBSV (ONB x 5 [Max BSV])	Applicable CBSV-Likelihood Table
E	Negligible	2	10	Table 4 (i)
D	Minor	3	15	Table 4 (ii)
C	Major	4	20	Table 4 (iii)
B	Hazardous	6	30	Table 4 (iv)
A	Catastrophic	8	40	Table 4 (v)

*Note to Optimum CBSV: Optimum Number of Barriers (ONB) multiplied by 5 (highest BSV).

Table 4 (i): CBSV-Likelihood Correlation [ONB - 2 (Max CBSV - 10)]

CBSV Range	Likelihood Value	Likelihood Descriptor
0-1	5	Frequent
2-3	4	Occasional
4-5	3	Remote
6-7	2	Improbable
8-10	1	Extremely improbable

Table 4 (ii): CBSV-Likelihood Correlation [ONB - 3 (Max CBSV - 15)]

CBSV Range	Likelihood Value	Likelihood Descriptor
0-2	5	Frequent
3-5	4	Occasional
6-8	3	Remote
9-11	2	Improbable
12-15	1	Extremely improbable

Table 4 (iii): CBSV-Likelihood Correlation [ONB - 4 (Max CBSV - 20)]

CBSV Range	Likelihood Value	Likelihood Descriptor
0-3	5	Frequent
4-7	4	Occasional
8-11	3	Remote
12-15	2	Improbable
16-20	1	Extremely improbable

Table 4 (iv): CBSV-Likelihood Correlation [ONB - 6 (Max CBSV - 30)]

CBSV Range	Likelihood Value	Likelihood Descriptor
0-5	5	Frequent
6-11	4	Occasional
12-17	3	Remote
18-23	2	Improbable
24-30	1	Extremely improbable

Table 4 (v): CBSV-Likelihood Correlation [ONB - 8 (Max CBSV - 40)]

CBSV Range	Likelihood Value	Likelihood Descriptor
0-7	5	Frequent
8-15	4	Occasional
16-23	3	Remote
24-31	2	Improbable
32-40	1	Extremely improbable

Sheet 4B

Barrier Strength Value (BSV) to Barrier Quality Correlation

A)   Seven Barrier Quality Elements (BQE):

1.   Effectiveness:
Extent to which Barrier will be effective in preventing or mitigating the H>TE or TE>C scenario.

2.   Cost-Benefit:
Extent to which benefits of Barrier will outweigh the costs.

3.   Practicality:
Extent to which Barrier can be readily implemented, in terms of competency and resources.

4.   Acceptability:
Extent to which Barrier is consistent with all stakeholders' expectations or requirements.

5.   Enforceability:
Extent to which Barrier can be monitored or surveyed for compliance/ implementation.

6.   Durability:
Extent to which Barrier will be sustainable and maintainable.

7.   Disinclination (to unintended consequences)
Extent to which Barrier will NOT contribute to unintended consequences

B)   Barrier Quality Element (BQE) Score Criteria

Barrier Quality	Score
Excellent	5
Good	4
Satisfactory	3
Fair	2
Poor	1

Table 1 - Seven Barrier Quality Elements (BQE) Score Sheet   << Hide/ Unhide extra PC & RM Rows (5-8) as required >>

Note (Escalation Factors/Unintended Consequences): When scoring the 7 Barrier Quality Elements below, do take into consideration any declared Escalation Factor or Unintended Consequence (in sht 4) for each PC/ RM; especially where there is no Escalation Control (EC) to mitigate that EF/UC. Diminish the score accordingly for those Barrier Quality Element (s) deemed impacted by an EF/UC of the PC/RM. Insert a comment flag within that PC/RM's Barrier Quality Element descriptor cell (in this Table) to account for this EF/UC-impacted (diminished) BQE score. When subsequently an acceptable EC should become available (to resolve the EF/UC), then the diminished PC/RM score may be restored accordingly.

	E-PC1	E-PC2	E-PC3	E-PC4	E-PC5	E-PC6	E-PC7	E-PC8	N-PC1	N-PC2	N-PC3	N-PC4	N-PC5	N-PC6	N-PC7	N-PC8	E-RM1	E-RM2	E-RM3	E-RM4	E-RM5	E-RM6	E-RM7	E-RM8	N-RM1	N-RM2	N-RM3	N-RM4	N-RM5	N-RM6	N-RM7	N-RM8
1. Effectiveness	3	4	4						5	4							3	3	3						1	4	2	3				
2. Cost-benefit	4	4	4						5	4							2	3	3						1	4	2	3				
3. Practicality	3	4	4						5	4							2	2	3						1	4	2	3				
4. Acceptability	3	3	3						5	4							2	2	4						1	4	2	3				
5. Enforceability	2	4	3						5	4							4	2	4						1	4	2	3				
6. Durability	3	4	4						5	4							2	3	3						1	4	2	3				
7. Disinclination (to unintended consequences)	4	3	2						5	4							3	1	2						1	4	2	3				

Total Weighted Barrier Quality Score

Barrier Quality Element [SMM 5.3.59, 3rd Ed]

	E-PC1	E-PC2	E-PC3	E-PC4	E-PC5	E-PC6	E-PC7	E-PC8	N-PC1	N-PC2	N-PC3	N-PC4	N-PC5	N-PC6	N-PC7	N-PC8	E-RM1	E-RM2	E-RM3	E-RM4	E-RM5	E-RM6	E-RM7	E-RM8	N-RM1	N-RM2	N-RM3	N-RM4	N-RM5	N-RM6	N-RM7	N-RM8
1. Effectiveness	9	12	12	0	0	0	0	0	15	12	0	0	0	0	0	0	9	9	9	0	0	0	0	0	3	12	6	9	0	0	0	0
2. Cost-benefit	4	4	4	0	0	0	0	0	5	4	0	0	0	0	0	0	2	3	3	0	0	0	0	0	1	4	2	3	0	0	0	0
3. Practicality	3	4	4	0	0	0	0	0	5	4	0	0	0	0	0	0	2	2	3	0	0	0	0	0	1	4	2	3	0	0	0	0
4. Acceptability	3	3	3	0	0	0	0	0	5	4	0	0	0	0	0	0	2	2	4	0	0	0	0	0	1	4	2	3	0	0	0	0
5. Enforceability	2	4	3	0	0	0	0	0	5	4	0	0	0	0	0	0	4	2	4	0	0	0	0	0	1	4	2	3	0	0	0	0
6. Durability	3	4	4	0	0	0	0	0	5	4	0	0	0	0	0	0	2	3	3	0	0	0	0	0	1	4	2	3	0	0	0	0
7. Disinclination (to unintended consequences)	8	6	4	0	0	0	0	0	10	8	0	0	0	0	0	0	6	2	4	0	0	0	0	0	2	8	4	6	0	0	0	0
Total Weighted Barrier Quality Score >>	32	37	34	0	0	0	0	0	50	40	0	0	0	0	0	0	27	23	30	0	0	0	0	0	10	40	20	30	0	0	0	0
Correlated BSV >>	3	4	4	0	0	0	0	0	5	4	0	0	0	0	0	0	3	2	3	0	0	0	0	0	1	4	2	3	0	0	0	0

Table 2 – Barrier Quality to BSV Correlation

Barrier Quality Score Range	BSV
10 to 17	1
18 to 25	2
26 to 33	3
34 to 41	4
42 to 50	5

Table 3 - Barrier Strength Value (BSV)

Barrier Strength	Barrier Strength	Barrier
Poor	Weak, superficial or	1
Fair	Barely viable or	2
Satisfactory	Reasonable or	3
Good	Effective, recognised	4
Excellent	Best or most robust	5

* Refer to Sheet 4B for supporting guidance on BSV assessment.

Impact-Score to Severity-Value Correlation

Fig 1 - Seven Impact Areas:
1. **Pax / Public [Safety]** (4x weighted)**:**
Extent to which TE/C compromise/ impact people or passenger safety
2. **Employee/ Worker [Safety]** (3x weighted)**:**
Extent to which TE/C compromise/ impact employee or worker safety
3. **Product / Service [Quality]** (2x weighted):
Extent to which TE/C compromise/ impact service or product quality
4. **Asset/ Financial [Loss]:**
Extent to which TE/C result in loss of financial/ physical assets
5. **Reputation [Loss]:**
Extent to which TE/C result in loss of organizational or national reputation
6. **Aviation Security [Breach]:**
Extent to which TE/C compromise/ breach aviation or company security
7. **Environmental [Damage]:**
Extent to which TE/ C result in damage to environment

Fig 2 - Impact Levels Table

Impact Levels	Score
Very High	5
High	4
Moderate	3
Low	2
Negligible	1
Nil	0

Fig 3 - Consequence [C] Impact Score Sheet

		CONSEQUENCE		
Top Event / Consequence (auto) >>>	[LOCI - due to inclement weather (windshear/ down draft)]			
Severity Controls (SC) as replicated from Sht 4 [Row 58] >> << (Unhide additional SC rows here, as reqd)	Existing Severity		Resultant Severity	
	E-SC1:		N-SC1:	
	E-SC2:		N-SC2:	
Seven Impact Areas	Impact Score (Existing Severity)	Weighted score	Impact Score (Resultant Severity)	Weighted score
1. Pax / Public - safety [4x]	4	16	4	16
2. Employee/ Worker - safety [3x]	4	12	4	12
3. Product / Service - quality [2x]	4	8	4	8
4. Asset/ Financial - loss	2	2	2	2
5. Reputation - loss	3	3	3	3
6. Aviation Security - breach	0	0	0	0
7. Environmental - damage	0	0	0	0
Consolidated Impact Score >>		41		41
*Consolidated Severity Value >>		B		B

Fig 4 – Consolidated Impact Score to Severity Value Correlation

Consolidated Impact Score Range	Consolidated Severity Value
1 to 12	E
13 to 25	D
26 to 38	C
39 to 51	B
52 to 65	A

*Note: This "Consolidated Severity Value" is automatically repeated in Item 1 of Table 5-1/2/3/4 of the SRM Worksheet #4.

A) Basic Severity Table [Safety Impact to - People & Assets]

Level	Descriptor	Severity Description (customise according to nature of organization's operations)
E	Negligible	Few consequences
D	Minor	• Nuisance • Operating limitations • Use of emergency procedures • Minor incident
C	Major	• A significant reduction in safety margins, a reduction in the ability of operational personnel to cope with adverse operating conditions as a result of an increase in workload or as a result of conditions impairing their efficiency • Serious incident • Injury to persons
B	Hazardous	• A large reduction in safety margins, physical distress or a workload such that operational personnel cannot be relied upon to perform their tasks accurately or completely • Serious injury • Major equipment damage
A	Catastrophic	• Aircraft / equipment destroyed • Multiple deaths

B) Integrated Severity Table

Severity Level		Seven Impact Areas						
		Public/ Pax safety (1)	Worker/ Employee safety (2)	Service/ Product quality (3)	Asset/ Financial loss (4)	Reputation loss (5)	Av Security compromise (6)	Environmental damage (7)
E	Negligible	No injury	No injury	Not affected	No financial Loss	No Loss	No Breach	No Damage
D	Minor	Minor injury	Minor injury	Minor Non-conformance	Minor Loss < $__	Minor Loss	Localised Breach	Limited Localised Damage
C	Major	Serious injury	Serious injury	Substantial Non-conformance	Substantial Loss < $__	Contained Loss	Organizational Breach	National Damage
B	Hazardous	Single fatality	Single fatality	Major Non-conformance	Major Loss < $__	Major Loss	National Breach	Regional Damage
A	Catastrophic	Multiple fatalities	Multiple fatalities	Critical Non-conformance	Massive Loss > $__	Massive Loss	Global Breach	Global Damage

Table 3 - Optimum Number of Barriers & Applicable CBSV-Likelihood Tables

Severity Value of TE/ C	Severity Descriptor	Optimum Number of Barriers (ONB)	Max CBSV (ONB x 5 [Max BSV])	Applicable CBSV-Likelihood Table
E	Negligible	2	10	4 (i)
D	Minor	3	15	4 (ii)
C	Major	4	20	4 (iii)
B	Hazardous	6	30	4 (iv)
A	Catastrophic	8	40	4 (v)

*Note to Optimum CBSV: Optimum Number of Barriers (ONB) multiplied by 5 (highest BSV).

Table 4 (i): CBSV-Likelihood Correlation [ONB - 2 (Max CBSV - 10)]

CBSV Range		Likelihood Value	Likelihood Descriptor
0	1	5	Frequent
2	3	4	Occasional
4	5	3	Remote
6	7	2	Improbable
8	10	1	Extremely improbable

Table 4 (ii): CBSV-Likelihood Correlation [ONB - 3 (Max CBSV - 15)]

CBSV Range		Likelihood Value	Likelihood Descriptor
0	2	5	Frequent
3	5	4	Occasional
6	8	3	Remote
9	11	2	Improbable
12	15	1	Extremely improbable

Table 4 (iii): CBSV-Likelihood Correlation [ONB - 4 (Max CBSV - 20)]

CBSV Range		Likelihood Value	Likelihood Descriptor
0	3	5	Frequent
4	7	4	Occasional
8	11	3	Remote
12	15	2	Improbable
16	20	1	Extremely improbable

Table 4 (iv): CBSV-Likelihood Correlation [ONB - 6 (Max CBSV - 30)]

CBSV Range		Likelihood Value	Likelihood Descriptor
0	5	5	Frequent
6	11	4	Occasional
12	17	3	Remote
18	23	2	Improbable
24	30	1	Extremely improbable

Table 4 (v): CBSV-Likelihood Correlation [ONB - 8 (Max CBSV - 40)]

CBSV Range		Likelihood Value	Likelihood Descriptor
0	7	5	Frequent
8	15	4	Occasional
16	23	3	Remote
24	31	2	Improbable
32	40	1	Extremely improbable

Risk Index #	Risk Level
5A	Intolerable
5B	Intolerable
4A	Intolerable
5C	Intolerable
4B	Intolerable
3A	Intolerable
5D	Tolerable
4C	Tolerable
3B	Tolerable
2A	Tolerable
5E	Tolerable
4D	Tolerable
3C	Tolerable
2B	Tolerable
1A	Tolerable
4E	Tolerable
3D	Tolerable
2C	Tolerable
1B	Acceptable
3E	Acceptable
2D	Acceptable
1C	Acceptable
2E	Acceptable
1D	Acceptable
1E	Acceptable

Sheet 5

A) Basic Severity Table [Safety Impact to - People & Assets]

Level	Descriptor	Severity Description (customise according to nature of organization's operations)
E	Negligible	Few consequences
D	Minor	• Nuisance • Operating limitations • Use of emergency procedures • Minor incident
C	Major	• A significant reduction in safety margins, a reduction in the ability of operational personnel to cope with adverse operating conditions as a result of an increase in workload or as a result of conditions impairing their efficiency • Serious incident • Injury to persons
B	Hazardous	• A large reduction in safety margins, physical distress or a workload such that operational personnel cannot be relied upon to perform their tasks accurately or completely • Serious injury • Major equipment damage
A	Catastrophic	• Aircraft / equipment destroyed • Multiple deaths

Sheet 6: Likelihood Table

Level	Descriptor	Likelihood Description
5	Frequent	Likely to occur many times (has occurred frequently)
4	Occasional	Likely to occur sometimes (has occurred infrequently)
3	Remote	Unlikely to occur, but possible (has occurred rarely)
2	Improbable	Very unlikely to occur (not known to have occurred)
1	Extremely improbable	Almost inconceivable that the event will occur

Note: The Likelihood (Level) of a given Consequence is to be correlated from the "Barrier Strength Value (BSV)" of its line of PCs/ RMs. This Barrier Strength Value (sht 4A) is derived from the quantity and quality of the PCs/ RMs (Barrier) preceding the TE/ Consequence.

Sheet 7: Risk Index Matrix (Severity x Likelihood)

Likelihood	Severity				
	A. Catastrophic	B. Hazardous	C. Major	D. Minor	E. Negligible
5. (frequent)	Intolerable (5A)	Intolerable (5B)	Intolerable (5C)	Tolerable (5D)	Tolerable (5E)
4. (occasional)	Intolerable (4A)	Intolerable (4B)	Tolerable (4C)	Tolerable (4D)	Tolerable (4E)
3. (remote)	Intolerable (3A)	Tolerable (3B)	Tolerable (3C)	Tolerable (3D)	Acceptable (3E)
2. (improbable)	Tolerable (2A)	Tolerable (2B)	Tolerable (2C)	Acceptable (2D)	Acceptable (2E)
1. (impossible)	Tolerable (1A)	Acceptable (1B)	Acceptable(1C)	Acceptable (1D)	Acceptable (1E)

Sheet 8: Risk Level & Tolerability Table

Risk Index #	Safety Risk Description	Recommended Action
5A	Intolerable	**STOP OPERATION OR PROCESS IMMEDIATELY.** Take immediate action to mitigate the risk or stop the activity. Perform priority safety risk mitigation to ensure additional or enhanced preventative controls are in place to bring down the safety risk index to tolerable.
5B		
5C		
4A		
4B		
3A		
5D	Tolerable	**REVIEW.** Can be tolerated based on the safety risk mitigation. It may require management decision to accept the risk.
5E		
4C		
4D		
4E		
3B		
3C		
3D		
2A		
2B		
2C		
1A		
3E	Acceptable	**NO ACTION REQUIRED.** Acceptable as is. No further safety risk mitigation required.
2D		
2E		
1B		
1C		
1D		
1E		

Sheet 9   SRM Report Form

Document

Sheet 10   **Hazard & Risk Management Database** (Register)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
		Hazard Registration						Risk Management							SRM Task/ Project Status*				
Item	Area/ Operation/ Equipment	Hazard [H] / Threat [T]					Top-Event [TE] (Reported / Projected)*	Consequence [C] (Reported / Projected)*	Recommended Action			SRM Project Assignment			SRM Project Completion				
		Generic Hazard/ Threat (Original Report)	Specific Hazard/ Threat*	Hazard ID Code	Source of Hazard Information*	Hazard Nature/ Frequency			Conventional Corrective Action*	SRM Action* [Yes / No]	Action Priority Level* (H, M, L)	Orgn/ Dept / Sect	Project I/C	Date Activated	Date Completed & SRM Rpt Ref	Consequence — Existing Risk Index	Resultant Risk Index	Next Review Date	Remarks
Example	A320 aircraft operation.	Rats in vicinity of aircraft	[H] – One large rat sighted by cabin crew in A320 aircraft during cruise	OPS-ALPHA-H1-M-013	Inflight incident notification report ref: A320/ OPS/ 012/ 2005.		Nil	Aircraft wiring/ equipment damage by rats (projected).			Medium	A320 Operations	ABC						
1																			
2																			
3																			

Hazard ID Code:

Sector (1) - Organization (2) - Hazard No (3) - Priority Level (4) - Year (5)

1 **Sector**: AGA / ANS / OPS / DMO / AMO / MDO* (*MDO - Materials Distribution Organizations, including fuel distribution)
2 **Organization**: Five letters code (eg ALPHA - Alpha Airline)
3 **Hazard No**: Hazard number (eg H001) as assigned by the organization concerned within a given Year.
4 **Priority Level**: Hazard prioritization Level [High (Accident), Medium (Serious Incident), Low (Incident)].
5 **Year**: Year when the Hazard was registered in the organization's Hazard Register.

Hazard ID Code Illustration:

a) **OPS-ALPHA-H001-M-013** [Air Operations - Alpha Airline - Hazard #1 - Moderate Priority - Year 2013]
b) **AGA-GATB-H005-L-012** [Aerodrome - Timbaktu Airport - Hazard #5 - Low Priority - Year 2012]

*Explanatory Notes:

1 **Specific Hazard/ Threat**: If more than one Hazard/ Threat identified, register such additional Hazard/ Threat under new row/ item
2 **Source of Information**: Hazard information as may be extracted from - Voluntary Hazard Rpt, Occurrence Notification/ Investigation Rpt, Internal Audit Rpt, External Audit Rpt, Hazard Survey Rpt, Operational Data Review Rpt
3 **Reported/ Projected (C):** Annotate C description as a "Reported" occurrence or a "Projected" occurrence. If multiple H>TE>C combinations involved, register each combination under a new Row (Each single H>TE>C combination will constitute one potential SRM)
4 **Corrective Action**: If the Hazard can be effectively eliminated through conventional corrective action (eg disposal, repair, replacement, modification), annotate YES with the action taken/ recommended. Otherwise annotate NO.
5 **SRM Action**: Annotate YES to indicate systematic SRM action is recommended (or has been taken already). Annotate NO if systematic SRM action is not recommended (or not necessary).
6 **Priority Level**: SRM or Corrective Action Priority Level based on (Annex 13) occurrence category of the projected (or reported) Top-Event or Consequence. Accident - High; Serious Incident - Medium; Incident - Low.
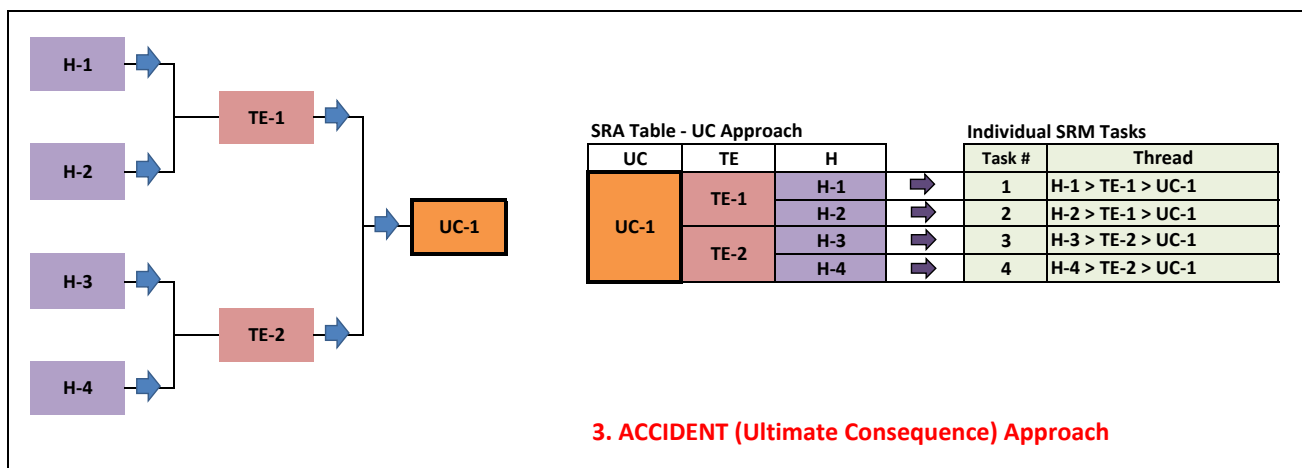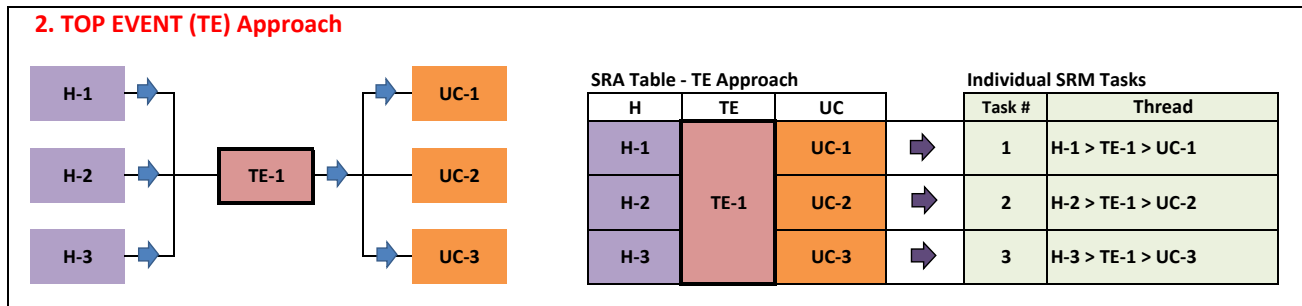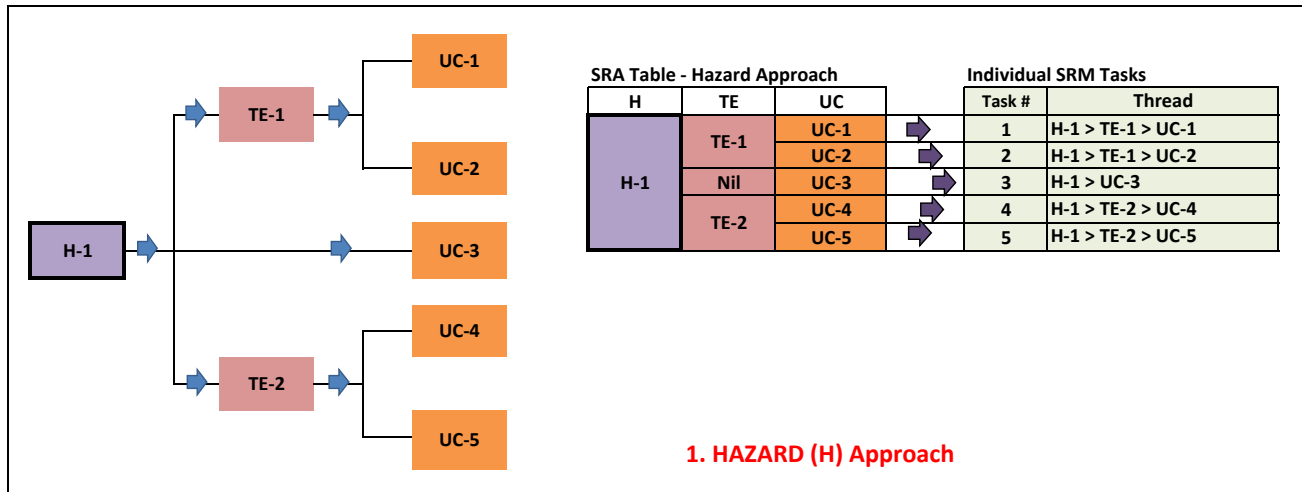7 **SRM Task/ Project Status:** This column for registration of assigned (new) SRM project, or a previously completed SRM project (with respect to the specific H>TE>C thread).

Note: Refer sheet 13 for an illustration of how this registered Hazard "OPS-ALPHA-H1-M-013" is followed up with a Safety Risk Mitigation (SRM) process.

Possible additional Code (Hazard Type): ENV, Tech, ORG, Human (CICTT)

Sheet 10B - Three approaches to identify H>TE>UC SRM threads <<<

1. HAZARD (H) Approach

SRA Table - Hazard Approach

H	TE	UC
	TE-1	UC-1
		UC-2
H-1	Nil	UC-3
	TE-2	UC-4
		UC-5

Individual SRM Tasks

Task #	Thread
1	H-1 > TE-1 > UC-1
2	H-1 > TE-1 > UC-2
3	H-1 > UC-3
4	H-1 > TE-2 > UC-4
5	H-1 > TE-2 > UC-5

2. TOP EVENT (TE) Approach

SRA Table - TE Approach

H	TE	UC
H-1		UC-1
H-2	TE-1	UC-2
H-3		UC-3

Individual SRM Tasks

Task #	Thread
1	H-1 > TE-1 > UC-1
2	H-2 > TE-1 > UC-2
3	H-3 > TE-1 > UC-3

3. ACCIDENT (Ultimate Consequence) Approach

SRA Table - UC Approach

UC	TE	H
	TE-1	H-1
		H-2
UC-1	TE-2	H-3
		H-4

Individual SRM Tasks

Task #	Thread
1	H-1 > TE-1 > UC-1
2	H-2 > TE-1 > UC-1
3	H-3 > TE-2 > UC-1
4	H-4 > TE-2 > UC-1

Within a given SRM Project, regardless of the above three H>TE>UC collation approach taken, the intent is to identify all the various H>TE>UC threads. Each H>TE>UC thread will then constitute a potential SRM Task. The given SRM Project is deemed to be completed, when every thread of the identified H>TE>UC combinations have been individually subjected to a SRM exercise, where applicable.

Note: Original document in / SRA_3 Approaches_R2

Hazard Prioritization Procedure (Illustration)

	OPTION 1 (Basic)	OPTION 2 (Advanced)
Criteria	Prioritization in relation to the Hazard's worst possible consequence (incident severity) category.	Prioritization in relation to the Risk Index (severity & likelihood) category of the Hazard's worst possible consequence.
Methodology	a) Project the Hazard's worst possible consequence b) Project this consequence's likely occurrence classification ie it will be deemed to be an accident, serious incident or incident? c) The Hazard's prioritization is thus: | Projected Consequence	Hazard Level
---	---
Accident	Level 1
Serious Incident	Level 2
Incident	Level 3		a) Project the Risk Index number (based on the Severity & Likelihood matrix) of the hazard's worst possible consequence. b) With reference to the related Tolerability matrix, determine the Risk Index's Tolerability level, such as Extreme Risk, High Risk, Moderate Risk, Low Risk, Negligible Risk) c) The Hazard's prioritization is thus: | Projected Risk Level	Hazard Level
---	---
Extreme Risk	R1
High Risk	R2
Moderate Risk	R3
Low Risk	R4
Negligible Risk	R5	
Remarks	This Option 1 takes into consideration the severity of the Hazard's projected Consequence only.	This Option 2 takes into consideration the severity & likelihood of the Hazard's projected Consequence – a more comprehensive criteria than Option 1.
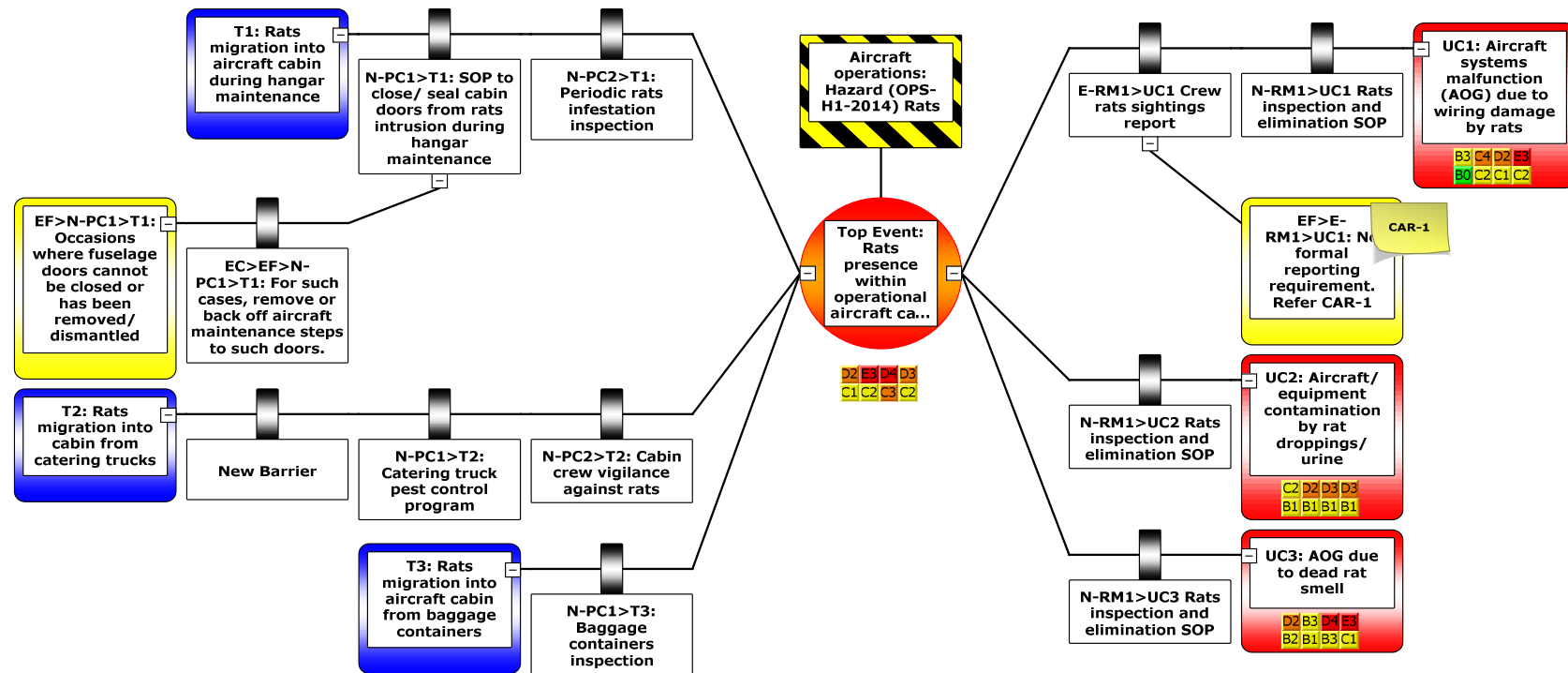
BTXP OEM website: http://cgerisk.com/
Trial software download, etc

When performing HIRM for a given Process/ Operation with anticipated multiple Threats-Consequences, the BTXP SRM process should be done in 2 stages:

Stage 1 : Brainstorm all credible Hazards/ Threats, Top Events and Consequences associated with that given Operation. Make a Listing of all credible (H>TE>C) incident scenarios from this brainstorming stage.

Stage 2: Given that BTXP has a "Top Event" centric protocol, the SRM project team will then initiate one BTXP Diagram for each of the Top Events identified in stage 1. From each single TE, the team will then project and annotate all possible upstream Threats (Hazards) as well as all possible downstream Consequences in relation to that particular TE, in the Diagram. Thus, if there were say 10 TEs identified in Step 1, then there may be 10 separate BTXP Diagrams generated, in this Stage 2.

Stage 3: For each of the 10 BTXP (Stg 2) Diagrams generated, the assigned SRM team (or sub-teams) will then address each specific H>TE>C thread (scenario) from the Stage 2 Diagrams. Hence, for a given Stage 2 Diagram, there may be say 3 separate threads of H>TE>C scenarios.

Step 4: From each of these isolated single H>TE>C scenario, the SRM team will then generate individual BTXP Diagrams. Within each of these "Single Thread Diagrams", the SRM team will then evaluate the PCs & RMs and the rest of the risk mitigation process including the Resultant (Residual) Risk Index.

The SRM team's intent/ task is to make sure that each of these single H>TE>C scenarios will have an adequate package of PCs and RMs to obtain a tolerable Resultant risk index.