
Safety Risk Mitigation - Tools

(APRAST-6 Workshop)

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Safety Risk Mitigation (SRM) - Tools

Agenda

1. Definition
2. SMS and SSP expectation
3. Capability and Competency
4. Related terminologies
5. Protocol
6. Tools – Excel / BowTie
7. Discussion/ Q&A

1. SRM Definition

- ❑ A systematic process to account for the availability and adequacy of defences pertaining to a given combination (s) of related Hazard, Top Event and Consequence.

- ❑ Safety Risk Mitigation (SRM) is also known as:
 - ✓ Safety Assessment (SA)
 - ✓ Safety Risk Assessment (SRA)
 - ✓ Safety Risk Management (SRM)
 - ✓ Hazard Identification & Risk Assessment (HIRA)
 - ✓ Hazard Identification & Risk Mitigation (HIRM), etc

2. SMS and SSP SRM expectation (Annex 19)

□ SMS:

- ▶ *Hazard Identification* (SMS element 2.1)
- ▶ *Safety risk assessment and mitigation* (SMS element 2.2)

□ SSP:

- ▶ *State safety risk management* (SSP component number 2)
- ▶ *Each State shall develop and maintain a process that ensures the identification and analysis of hazards and the assessment of safety risks associated with those hazards* (SMP's proposed A19 SARP, Nov 2014)

3. SRM Capability and Competency

- SRM is the fundamental purpose of SMS implementation
- CAA SRM oversight, collaboration and performance expected
- SRM methodology and tooling required
- ❑ No proper SRM tooling or methodology = No SRM competency

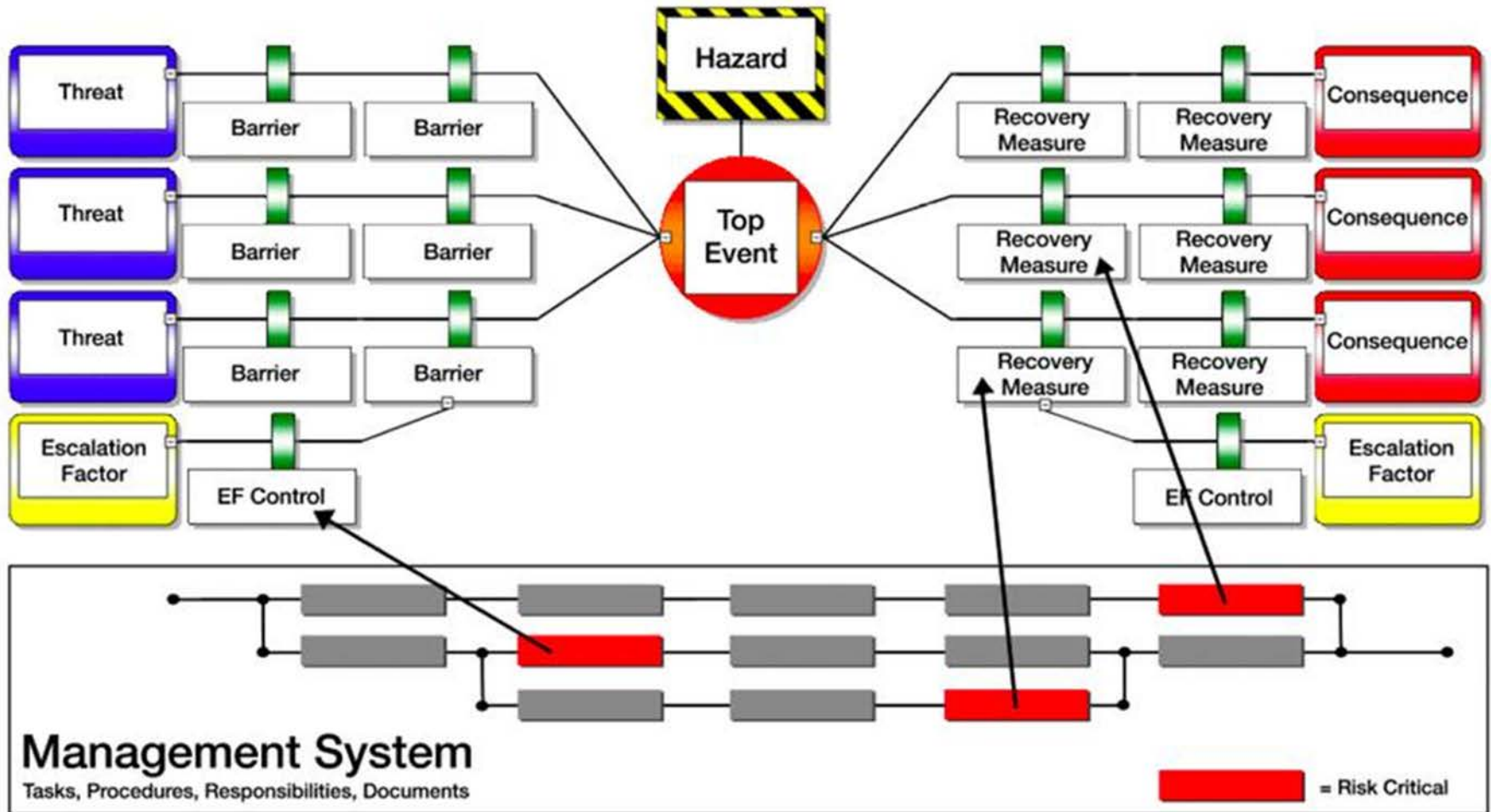
4. SRM Related Terminologies

- *Hazard*
- *Threat*
- *Unsafe situation*
- *Unsafe Event*
- *Top Event*
- *Consequence*
- *Barrier / Defence*
- *Preventive Control*
- *Recovery Measure*
- *Escalation Factor*
- *Escalation Control*
- *Severity*
- *Likelihood*
- *Risk Index*
- *Inherent Risk Index*
- *Resultant Risk Index*
- *Tolerability*
- *ALARP*

5. SRM Protocol – Basic Concept



5. SRM Protocol – BowTie Concept



6. SRM Tools

- ❑ Excel template (Doc 9859, C2-App2)
- ❑ Software (Bow-Tie)

Basic Excel SRM Template (SMM Doc 9859, C2-App2)

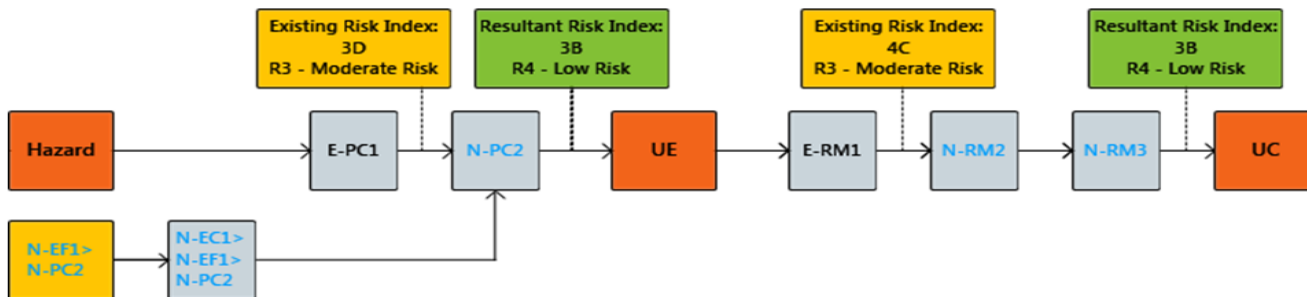
Operation/process:	Describe the process/operation/equipment/system being subjected to this HIRM exercise.
Hazard (H):	If there is more than one hazard to the operation/process, use a separate worksheet to address each hazard.
Unsafe event (UE):	If there is more than one UE to the hazard, use a separate worksheet to address each UE-UC combination.
Ultimate consequence (UC):	If there is more than one UC to the hazard, use a separate worksheet to address each UC.

	<i>Current risk tolerability (taking into consideration any existing PC/IRM/EC)</i>				<i>Resultant risk index and tolerability (taking into consideration any new PC/IRM/EC)</i>		
	Severity	Likelihood	Tolerability		Severity	Likelihood	Tolerability
Unsafe event							
Ultimate consequence							

Hazard (H)	PC	EF	EC		RM	EF	EC	
H	PC1 (Existing)	EF (Existing)	EC1 (Existing)	UE	RM1	EF (to RM1)	EC (to EF)	UC
			EC2 (New)					
	PC2 (Existing)	EF1 (New)	EC (New)		RM2	EF (to RM2)	EC (to EF)	
	PC3 (New)	EF (New)	EC (New)		RM3 (New)	EF (to RM3)	EC (to EF)	

Electronic version of Excel SRM Template

Here > >>



E-version
Output
Diagram
<<

E-PC1: Other

E-PC1: Flight, cabin and maintenance personnel are expected to report any rat sightings within an aircraft.

N-PC2: SOP

N-PC1: SOP to be put in place to require that all aircraft fuselage doors to be closed or sealed during silent hours, especially when undergoing hangar maintenance checks.

N-EF1 > N-PC2

EF>N-PC1: There may be occasions where fuselage doors cannot be closed due to their being removed or dismantled for maintenance.

N-EC1 > N-EF1 > N-PC2

EC>EF>N-PC1 : For such cases, aircraft maintenance steps leading to such doors shall be removed or backed-off from the door by at least 3 feet, during silent hours.

N-RM1: Backup System

N-RM2: A routine "C" Check Maintenance Job Card has been raised to call for inspection of all exposed aircraft internal fuselage compartments for evidence of rat droppings and necessary follow up action.

N-RM2: Special Inspn

N-RM1: Special Inspection sheet (Ref SI/ A320/ 25/ 112) has been raised to require any operational aircraft with reported sighting or evidence of rats infestation to be scheduled for de-infestation action by approved Pest Controller upon aircraft return to main base.

E-RM3: Special Inspn

E-RM1: Any operational aircraft reported with rat sighting is subject to a cabin inspection by maintenance personnel during stayover check.

6. SRM Tools

□ BowTie SRM Software



BowTie - Main application screen

The screenshot displays the main application window for BowTieXP + IncidentXP. The window title is "Untitled - BowTieXP + IncidentXP". The menu bar includes "File", "Case", "Edit", "Diagram", "View", "Tools", and "Help". A search bar is located in the top right corner.

The interface is divided into several panes:

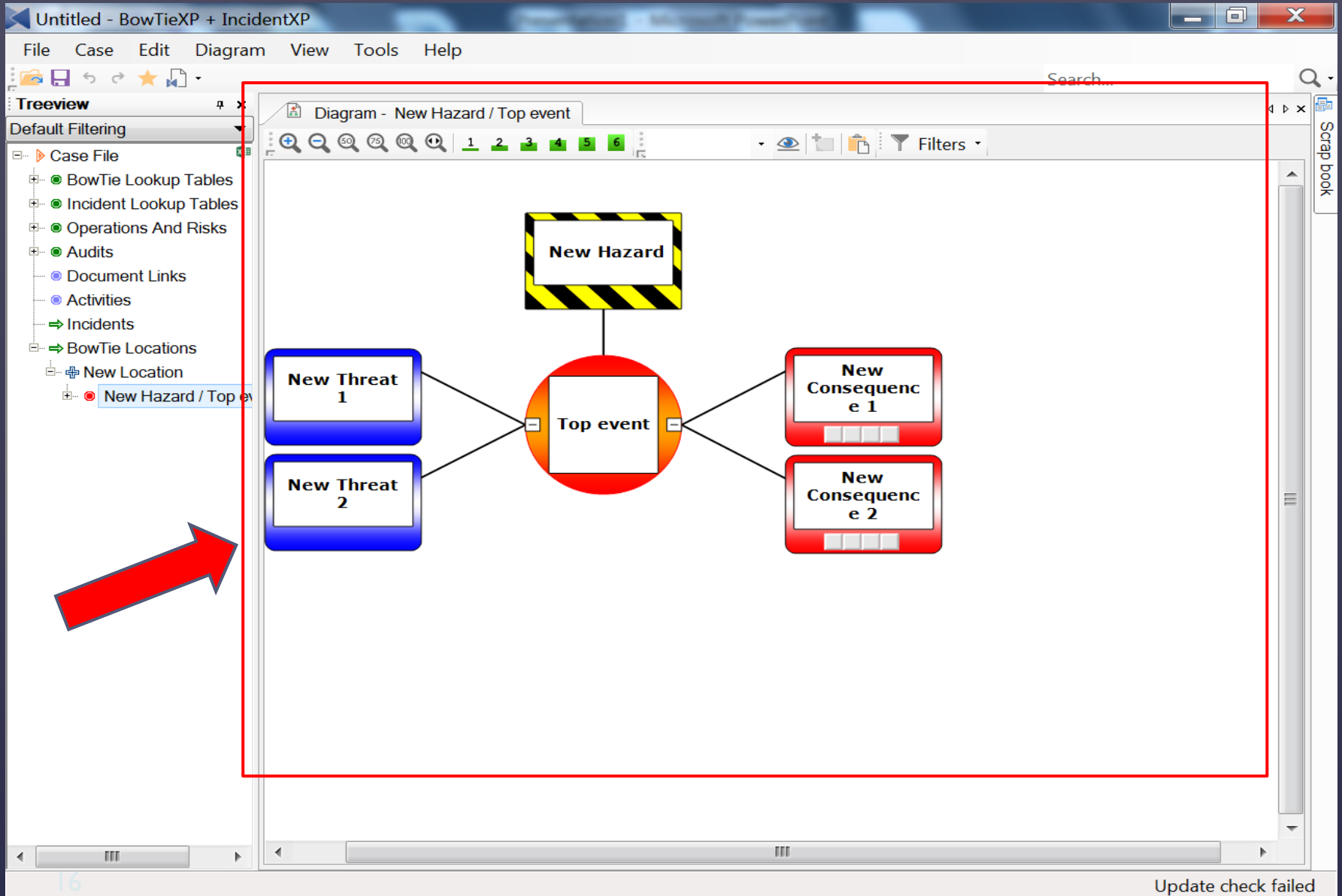
- Treeview (Left):** Shows a hierarchical structure under "Case File". The selected item is "New Hazard / Top event". Other items include "BowTie Lookup Tables", "Incident Lookup Tables", "Operations And Risks", "Audits", "Document Links", "Activities", "Incidents", and "BowTie Locations".
- Diagram (Center):** Displays a bowtie diagram with the following components:
 - New Hazard:** A yellow and black striped rectangular box at the top.
 - Top event:** A central red and orange circular node.
 - New Threat 1 and 2:** Two blue rounded rectangular boxes on the left, connected to the top event.
 - New Consequence 1 and 2:** Two red rounded rectangular boxes on the right, connected to the top event.
- Diagram - New Hazard / Top event (Top):** A toolbar with various icons for zooming, panning, and other diagram manipulation tools.
- Scrap book (Right):** A vertical sidebar for managing saved diagrams.

The status bar at the bottom right indicates "Update check failed".

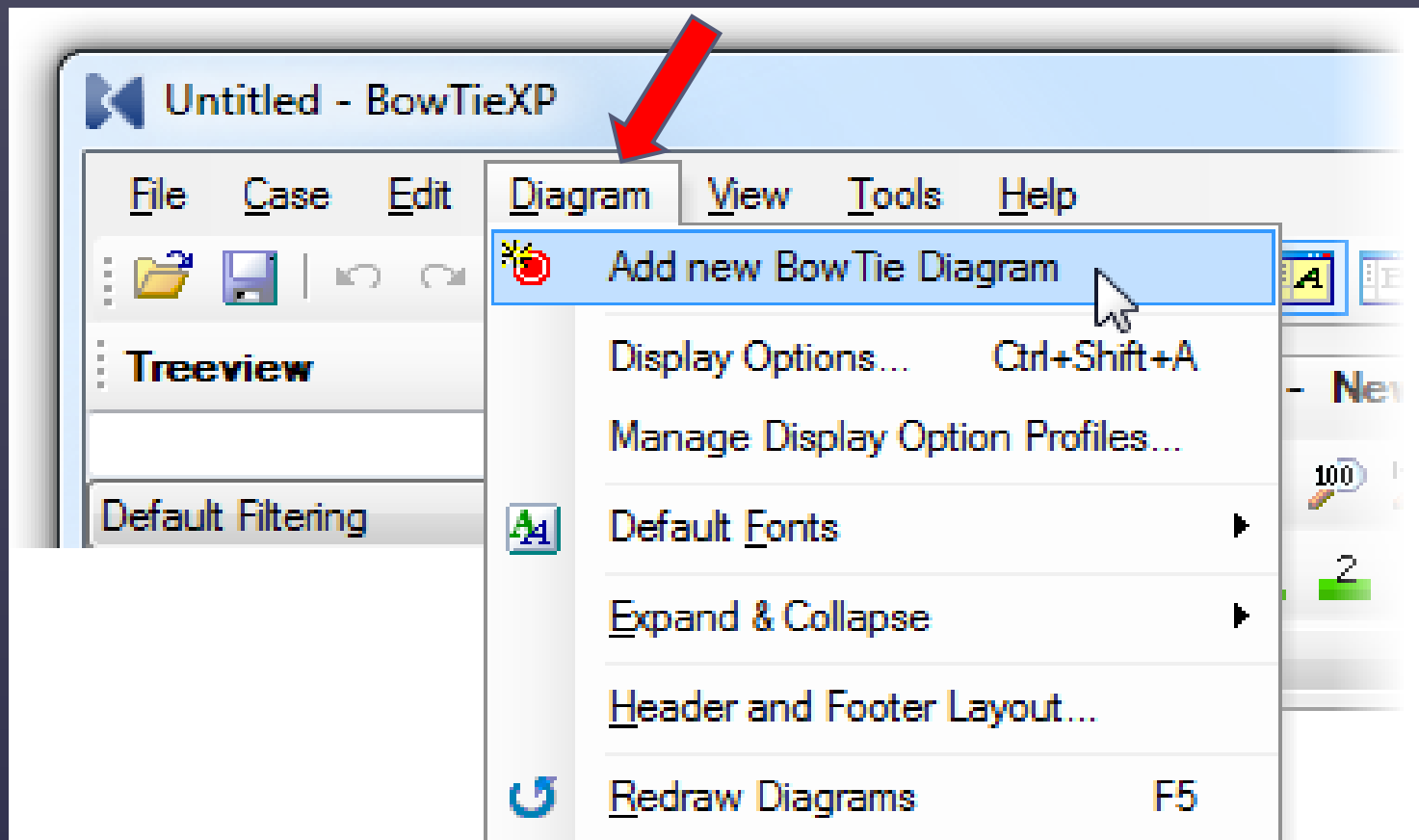
The Treeview

The screenshot displays the BowTieXP software interface. On the left, the **Treeview** pane is highlighted with a red border and a red arrow pointing to it. It shows a hierarchical structure under **Case File**, including **BowTie Lookup Tables**, **Incident Lookup Tables**, **Operations And Risks**, **Audits**, **Document Links**, **Activities**, **Incidents**, **BowTie Locations**, **New Location**, and **New Hazard / Top event**. The main diagram area on the right shows a bowtie diagram with a central **Top event** circle, two **New Threat** boxes (1 and 2) on the left, and two **New Consequence** boxes (1 and 2) on the right. A **New Hazard** box is positioned above the top event. The interface includes a menu bar (File, Case, Edit, Diagram, View, Tools, Help), a search bar, and a status bar at the bottom with the text "Update check failed".

The Diagram



Add New Bow Tie Diagram



Add Hazard & Top Event

The screenshot displays the BowTieXP software interface. The main window is titled "Diagram - New Hazard / Top event" and shows a diagram with three nodes: "New Threat 1" (blue box), "Top event" (orange circle), and "New Consequenc" (red box). A yellow and black hazard symbol box labeled "New Location: New Hazard" is positioned above the "Top event" node. A red arrow points from the "Top event" node to the "Edit Hazard" dialog box.

The "Edit Hazard" dialog box is open, showing the following fields:

- Code: OPS-H1-2015
- Hazard name: Rats
- Top event: Rats within operational aircraft cabin
- Affects: Health, Safety and Environment
- Accountable: Engineering Manager
- Description: (edit in popup)

The dialog box has tabs for "General", "Risk assessments", "Sign Off", "Headers and Footers", "Revision Info", "User Data", and "Operations". The "General" tab is selected. The dialog box has "OK", "Cancel", and "Apply" buttons at the bottom.

The Treeview on the left shows the following structure:

- Case File
 - BowTie Lookup Tables
 - Incident Lookup Tables
 - Operations And Risks
 - Audits
 - Document Links
 - Activities
 - Incidents
 - BowTie Locations
 - New Location
 - New Hazard / Top event
 - Aircraft operations
 - Hazard (OPS-H1-2014) Rat

Add New Threat/ Consequence (from Diagram)

The screenshot displays the BowTieXP software interface. The main window, titled "Diagram - New Hazard / Top event", shows a diagram with a central "Top event" node (a red circle) connected to a "New Hazard" node (a yellow and black striped rectangle) above it. Two "New Threat" nodes (blue rectangles) are connected to the left side of the "Top event" node, and two "New Consequence" nodes (red rectangles) are connected to the right side. A red arrow points from the "Add new Threat" button (a grey rectangle) to the "Top event" node. The "Add Threat" dialog box is open in the foreground, showing the "Editor" tab. The "Name" field contains "New Threat". The "Description" field is empty, with a "(edit in popup)" link below it. The "Category", "Frequency", and "Equivalent Top Event" fields are all set to "<No Value Assigned>", "<No Value Assigned>", and "<NULL> /" respectively. The "Acceptance criteria have been met" checkbox is unchecked. The dialog box has "OK", "Cancel", and "Apply" buttons at the bottom.

Untitled* - BowTieXP + IncidentXP

File Case Edit Diagram View Tools Help

Search...

Diagram - New Hazard / Top event

Treeview

Default Filtering

Case File

- BowTie Lookup Tables
- Incident Lookup Tables
- Operations And Risks
- Audits
- Document Links
- Activities
- Incidents
- BowTie Locations
- New Location
 - New Hazard / Top event
 - Rats / Rats infestation
 - Threats
 - Rats migration in
 - Rats migration in
 - Rats migration in
 - Consequences
 - Actions

New Hazard

New Threat 1

New Threat 2

Top event

Add new Threat

New Consequence 1

New Consequence 2

Add Threat

Editor User Data Operations Document Links

Name: New Threat

Description: (edit in popup)

Category: <No Value Assigned>

Frequency: <No Value Assigned>

Equivalent Top Event: <NULL> /

Acceptance criteria have been met

OK Cancel Apply

Add New Threat/ Consequence (from Tree-view)

The screenshot displays the BowTieXP software interface. On the left, the 'Treeview' pane shows a hierarchical structure of project elements. A red arrow points from the 'Threats' folder in the treeview to the 'Add Threat' dialog box. The main diagram area shows a central 'Top event' node connected to a 'New Hazard' node above it, and two 'New Threat' nodes (labeled 'New Threat 1' and 'New Threat 2') to its left. To the right of the 'Top event' are two 'New Consequence' nodes (labeled 'New Consequence 1' and 'New Consequence 2'). A 'Filters' toolbar is visible above the diagram. The 'Add Threat' dialog box is open, showing the following fields:

- Name: New Threat
- Description: (empty text area with a scroll bar)
- Category: <No Value Assigned>
- Frequency: <No Value Assigned>
- Equivalent Top Event: <NULL> /
- Acceptance criteria have been met

Buttons for 'OK', 'Cancel', and 'Apply' are located at the bottom of the dialog box.

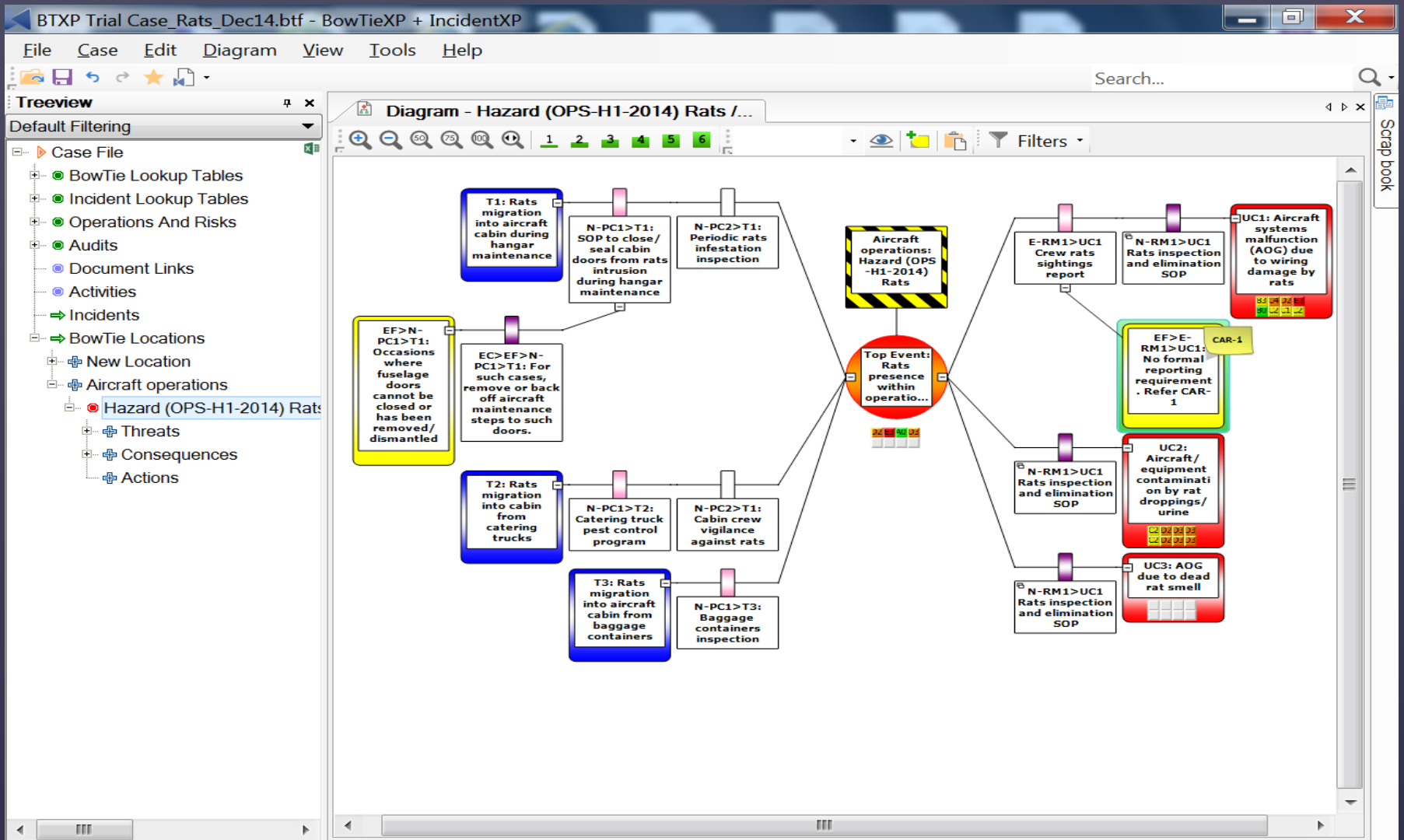
Editor

The screenshot displays the 'Editor' window for 'BowTieXP + IncidentXP'. The main workspace shows a diagram titled 'Diagram - New Hazard / Top event'. The diagram consists of a central 'Top event' node (a red circle) connected to four surrounding nodes: 'New Hazard' (a yellow and black striped rectangle at the top), 'New Threat 1' (a blue rounded rectangle on the left), 'New Threat 2' (a blue rounded rectangle at the bottom left), 'New Consequence 1' (a red rounded rectangle on the right), and 'New Consequence 2' (a red rounded rectangle at the bottom right). A red arrow points from the 'New Threat 1' node to an 'Edit Threat' dialog box that is open in the foreground. The dialog box has a title bar 'Edit Threat' and a close button. It contains several tabs: 'Editor', 'User Data', 'Operations', and 'Document Links'. The 'Editor' tab is active and shows the following fields:

- Name: 'New Threat 1' (text input)
- Description: (text area) with a link '(edit in popup)'
- Category: '<No Value Assigned>' (dropdown)
- Frequency: '<No Value Assigned>' (dropdown)
- Equivalent Top Event: '<NULL> /' (dropdown)
- Acceptance criteria have been met: (checkbox, currently unchecked)
- View Criteria... (button)

At the bottom of the dialog are 'OK', 'Cancel', and 'Apply' buttons. The background interface includes a menu bar (File, Case, Edit, Diagram, View, Tools, Help), a toolbar, a search bar, and a treeview on the left showing a hierarchical structure of the case file.

Example of a completed SRM project Diagram



Success. Save time was 0.1 seconds

Update check failed



Copy Completed Diagram to clipboard

The screenshot displays the BowTieXP software interface. The main window shows a hazard diagram titled "Hazard (OPS-H1-2014) Rats /...". The diagram features a central "Top Event: Rats presence within operatio..." (red circle) connected to various barriers and consequences. The barriers include:

- T1: Rats migration into aircraft cabin during hangar maintenance
- T2: Rats migration into cabin from catering trucks
- T3: Rats migration into aircraft cabin from baggage containers
- EC-EF>N-PC1>T1: For such cases, remove or back off aircraft maintenance steps to such doors.
- N-PC1>T1: SOP to close/ seal cabin doors from rats intrusion during hangar maintenance
- N-PC2>T1: Periodic rats infestation inspection
- N-PC1>T2: Catering truck pest control program
- N-PC2>T1: Cabin crew vigilance against rats
- N-PC1>T3: Baggage containers inspection
- E-RM1>UC1: Crew rats sightings report
- N-RM1>UC1: Rats inspection and elimination SOP
- N-RM1>UC1: Rats inspection and elimination SOP
- EF>E-RM1>UC1: No formal reporting requirement. Refer CAR-1
- UC1: Aircraft systems malfunction (AOG) due to wiring damage by rats
- UC2: Aircraft/ equipment contamination by rat droppings/ urine
- UC3: AOG due to dead rat smell

The "File" menu is open, and the "Copy to Clipboard" option (Ctrl+Alt+C) is highlighted with a red arrow. Other menu options include "Add new BowTie Diagram", "Add new Timeline Diagram", "Add new BSCAT Diagram", "Add new Tripod Diagram", "Add new BFA Diagram", "Add new RCA Diagram", "Display Options...", "Manage Display Option Profiles...", "Default Fonts", "Header and Footer Layout...", "Redraw Diagrams", "Save Diagram As...", and "Export to Visio".

BTXP/ Diagram/ Copy to Clipboard/ paste >



Quiz

- ▶ Risk Index value is derived from the severity and likelihood of a Hazard.

TRUE / FALSE

FALSE

Risk Index (Severity X Likelihood) pertains to a Top Event or Consequence

Quiz

- ▶ The Likelihood of an Event or Consequence, should be correlated to the number of Barriers as well as their strength or quality

TRUE / FALSE

TRUE

In Summary

- Safety Risk Mitigation is a key SMS-SSP process
- Need to establish SMS-SSP SRM capability and competency
- Use currently available SRM Tools (eg BowTie software, Excel template) or develop your own

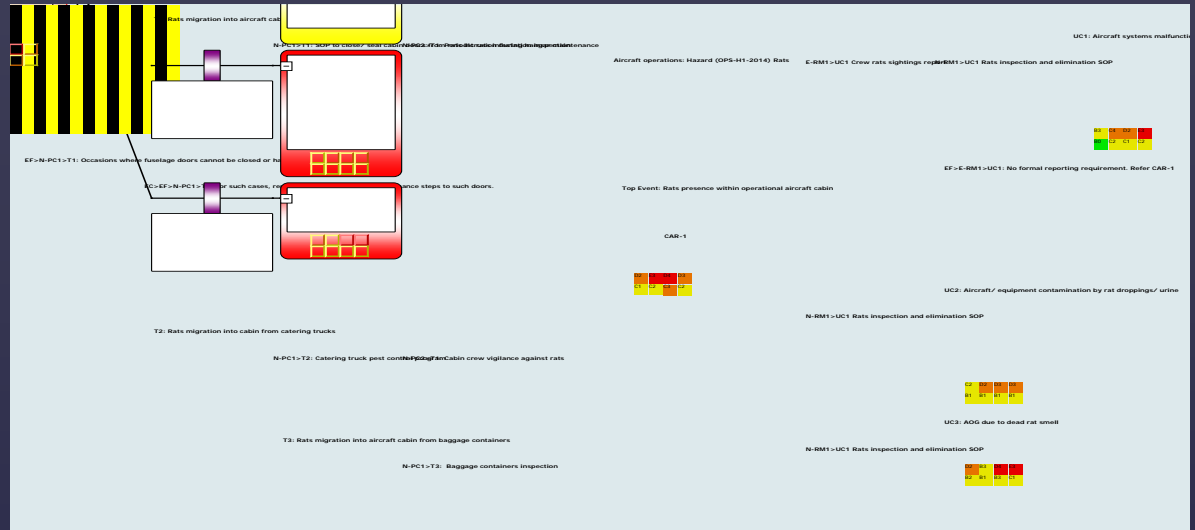
Discussion / Questions

Safety Risk Mitigation - Tools

Sheet 4 Hazard Identification & Risk Mitigation (HIRM) Worksheet [Safety Assessment] 9 Feb 2015																																																																										
Table A																																																																										
1. OPERATION/PROCESS	[Describe the Operation/Process/Equipment being subject to this HIRM (Safety Assessment) exercise]																																																																									
2. HAZARD/THREAT	[Describe the assigned or targeted Hazard. If more than one Hazard, address them under separate HIRM Sheet]																																																																									
3. UNSAFE EVENT (UE)	[Describe the projected Unsafe Event. If more than one Unsafe Event, address them under separate HIRM Sheet]																																																																									
4. ULTIMATE CONSEQUENCE (UC)	[Describe the projected Ultimate Consequence. If more than one Consequence, address them under separate HIRM Sheet]																																																																									
Table B																																																																										
Unsafe Event Mitigation (as applicable)																																																																										
Hazard / Threat	Existing Preventive Controls (E-PC)																	Existing R&T	New Preventive Controls (N-PC)																	Residual R&T	Unsafe Event	Existing Recovery Measures (E-RM)																	Existing R&T	New Recovery Measures (N-RM)																	Residual R&T	Ultimate Consequence
	[Grid for E-PCs]																		[Grid for N-PCs]																			[Grid for E-RMs]																		[Grid for N-RMs]																		
[Describe the Hazard/Threat]	[Grid for E-PCs]																	[Risk Index]	[Grid for N-PCs]																	[Risk Index]	[Describe projected Unsafe Event (UE)]	[Grid for E-RMs]																	[Risk Index]	[Grid for N-RMs]																	[Risk Index]	[Describe projected Ultimate Consequence]
Description of Existing Preventive Controls (E-PC)	[Grid for E-PCs]																	Description of New Preventive Controls (N-PC)	[Grid for N-PCs]																	Description of Existing Recovery Measures (E-RM)	[Grid for E-RMs]																	Description of New Recovery Measures (N-RM)	[Grid for N-RMs]																			

<< Excel

Bow-Tie >>



Hazard Identification & Risk Mitigation (HIRM) Worksheet [Safety Assessment]

10-Mar-15

Contents:

- Sheet 1 Working Group (Workshop) Instructions >>
- Sheet 2 Definitions >>
- Sheet 3 HIRM (Safety Assessment) Procedure [Jan14] >>
- Sheet 3A HIRM schematic >>
- Sheet 4 Hazard Identification & Risk Mitigation (HIRM) Worksheet (Table A & B) [Jul 14] >>**
- Sheet 5 Severity Table [Nov 13] >>
- Sheet 6 Likelihood Table [Jan 14] >>
- Sheet 6A Barrier Strength Value (BSV) Table [Feb 15] >>
- Sheet 6B Consolidated Barrier Strength Value (CBSV) to Likelihood Correlation [Feb 15] >>
- Sheet 7 Risk Index Matrix (Severity x Likelihood) [Jan 14] >>
- Sheet 8 Risk Tolerability Table [Jan 14] >>
- Sheet 9 Risk Index Category to Barrier Scope Correlation Guide [Oct 14] >>
- Sheet 10 Safety Risk Mitigation Report (Form) >>
- Sheet 11 HIRM Master Register (5 Mar 2014) >>
- Sheet 12 Hazards prioritization procedure (Mar14) >>
- Sheet 13 Example of a completed HIRM Worksheet [Oct 14] >>
- Sheet 14 Bow-Tie Methodology >>
- Sheet 15 Systems SRM Task Scoping >>

Purpose of this Worksheet (Hazard Identification & Risk Mitigation Tool):

Template for the performance and documentation of individual hazard and risk mitigation process. (applicable for SSP & SMS)

General Instructions for Discussion Group:

- 1 This is a Risk Mitigation exercise using attached HIRM template (Excel Sheet).
- 2 Elect a group discussion coordinator and also have some one to make entries (laptop) in the HIRM Worksheet
- 3 Read the HIRM Procedure in [Sheet 3](#) as well as Explanatory Notes in Sheet 2.
- 4 Discuss and decide on one specific Hazard for this HIRM exercise.
Note: In an operational environment, a specific Hazard would be assigned from the organization's Master Hazards Register (sht 11)
- 5 Identify the Operation/ Process associated with this Hazard.
- 6 Project/ evaluate what is that single ultimate/ possible/ most credible Consequence from this Hazard.
- 7 If applicable, project what is that (intermediate) Unsafe Event/ Situation which can occur before that ultimate Consequence.
- 8 Enter the identified information from items 4, 5 & 6 into Table A of the HIRM Worksheet (Sheet 3).
- 9 Proceed to discuss and fill out the rest of the HIRM Worksheet ([PCs](#), [RMs](#), [EFs](#), [ECs](#), [E-RI](#), [R-RI](#)).
- 10 Be prepared to share your completed Worksheet and comments with others. Otherwise, please annotate your group/ individual feedback/ comments below and forward/ email to the workshop facilitator as applicable.

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Sheet 2: Definitions

06 Feb15

1	Hazard Identification & Risk Mitigation (HIRM)	A structured procedure to identify hazards/ threats within a given operation, process or equipment and the evaluation of preventive controls (defences, barriers) to mitigate against the projected 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)	Undesirable condition or object which may cause or contribute to an Unsafe Event or Ultimate Consequence. A hazard must be specifically described and validated before commencing SRM process. Only permanent or recurring hazards may warrant SRM process.
4	Threat (T)	Threats are essentially hazards which are more imminent/ immediate/ visible (hence more threatening) to an operation; in comparison to more latent or less apparent (generic) hazards. Known or anticipated Threats should be proactively mitigated for, possibly with higher priority over more latent hazards.
5	Unsafe Event (UE)	Most credible unsafe situation, not yet amounting to an Ultimate Consequence or Accident. Usually an intermediate event/ situation before an Ultimate Consequence/ Accident. Identification of an Unsafe Event is applicable only where there is a need to distinguish and establish mitigating actions upstream and downstream of such an intermediate event (before the Ultimate Consequence/ Accident). If this intermediate UE state is not applicable for a particular operation, then it may be bypassed as appropriate.
6	Ultimate Consequence	Ultimate event or accident; most credible ultimate outcome.
7	Preventive Control (PC)	A mitigating action or defence to block or prevent a Hazard/ Threat from escalating into an Unsafe Event or Ultimate Consequence. 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 exercise.
8	Recovery Measure (RM)	A mitigating action, barrier or defence to block or prevent an Unsafe Event from escalating into an Ultimate Consequence or Accident. Existing RMs refer to current/ known/ established RMs which have been 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 exercise.
9	Barrier	A generic term, referring to a PC or RM, or a set thereof.
10	Barrier Strength Value (BSV)	The Value of a specific Barrier's (PC/ RM) quality or strength.
	Consolidated Barrier Strength Value (CBSV)	The Consolidated (SUM) Value of a set (line) of Barrier's (PCs/ RMs) pertaining to a given UE/ UC.
11	Escalation Factor (EF)	Possible latent or organizational condition/ factor which may weaken the effectiveness of a Preventive Control (or Recovery measure) . Use where applicable only.
12	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) . Use where applicable only.
13	Risk Index (RI)	Risk Index refers to the combined Likelihood & Severity of an Unsafe Event or Ultimate Consequence, as projected (anticipated) from an identified Hazard .
14	Existing Risk Index & Tolerability	Determination of Existing Risk Index and Tolerability shall take into consideration Existing PCs/ RMs only. If the Existing Risk Index's Tolerability is unacceptable, it is then apparent that evaluation of New (additional) PCs/ RMs would be necessary to reduce the Risk Index to a new acceptable level. This may include modification or enhancement of existing PCs/ RMs.
15	Resultant Risk Index & Tolerability	Resultant Risk Index and Tolerability is based on the combined Existing PCs/ RMs together with the New PCs/ RMs put in place as a result of the completed risk management exercise.

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Sht 3: HIRM (Safety Assessment) Procedure

3-Feb-15

1	Fill out Table A. Be very precise in naming each entity, especially the Hazard. (Refer Sheet 2 for definitions of each entity)
2	Annotate Table A item descriptions (2, 3 & 4) into their respective columns (1, 30, 59) in Table B.
3	Annotate <u>existing</u> PCs identifier codes (columns 2 to 11) and/ or RMs identifier codes (columns 31 to 40) within the relevant PC/ RM (10 categories) columns as illustrated. For supplementary guidance on PC/ RM categories consideration, refer to Sht 9.
4	Where a PC/ RM may be affected (compromised) by an EF (Escalation Factor), then the EF & EC (Escalation Control) columns (12, 13, etc) should be applied and completed accordingly for that PC/ RM. The actual PC/RM/EF/EC descriptions may be annotated in the boxes as illustrated below the main Worksheet. Alternatively, these descriptions may be annotated in a separate Tab of the Excel sheet.
5	Based on these existing PCs/ RMs being in place, assess the Existing Risk Index (Severity & Likelihood) of the projected UE/ UC. Annotate result in column 14/ 43 as applicable. (Refer Severity, Likelihood, BSV and CBSV>Likelihood Tables in Sheets 5, 6, 6A and 6B). Note: The Likelihood component of each UE/ UC's Risk Index is to be derived from the Consolidated Barrier Strength Value (CBSV) to Likelihood correlation Table in sheet 6A and 6B.
6	Based on Existing Risk Index obtained above, annotate its corresponding Tolerability description (Sheet 8) in column 15/ 44 as applicable.
7	If the Existing Risk Index's Tolerability is unacceptable (eg Extreme/ High risk), proceed to re-evaluate possible enhancement of Existing PCs/ RMs or New (additional) PCs/ RMs in order to reduce the Risk Index to an acceptable level.
8	With any modified or New PCs/ RMs in place, together with the Existing PCs/ RMs, proceed to re-assess the Resultant Risk Index (Severity & Likelihood) of the projected UE/ UC as applicable. Annotate result in column 28/ 57 as applicable. (Refer Tables in Sheets 5, 6, 6A and 6B). Note: The Likelihood component of each UE/ UC's Resultant Risk Index is to be derived from the Consolidated Barrier Strength Value (CBSV) to Likelihood correlation Table in sheet 6A and 6B.
9	Based on the Resultant Risk Index obtained above, annotate its corresponding Resultant Tolerability description (Sheet 8) in column 29/ 58 as applicable. This Resultant Risk Index & its corresponding Resultant Tolerability description is the final outcome of the HIRM (Safety Assessment) exercise.
10	Upon completion of the risk mitigation exercise, proceed to fill out the Safety Risk Mitigation (SRM) Report Form (sht 10). This Form will serve as the formal report (and record) of the completed SRM exercise.
11	This completed SRM Form should then be routed to the SMS-HIRM administration office, so that necessary update of the Hazards Master Register (sht 11) concerning the completion status of this particular Hazard can be made.

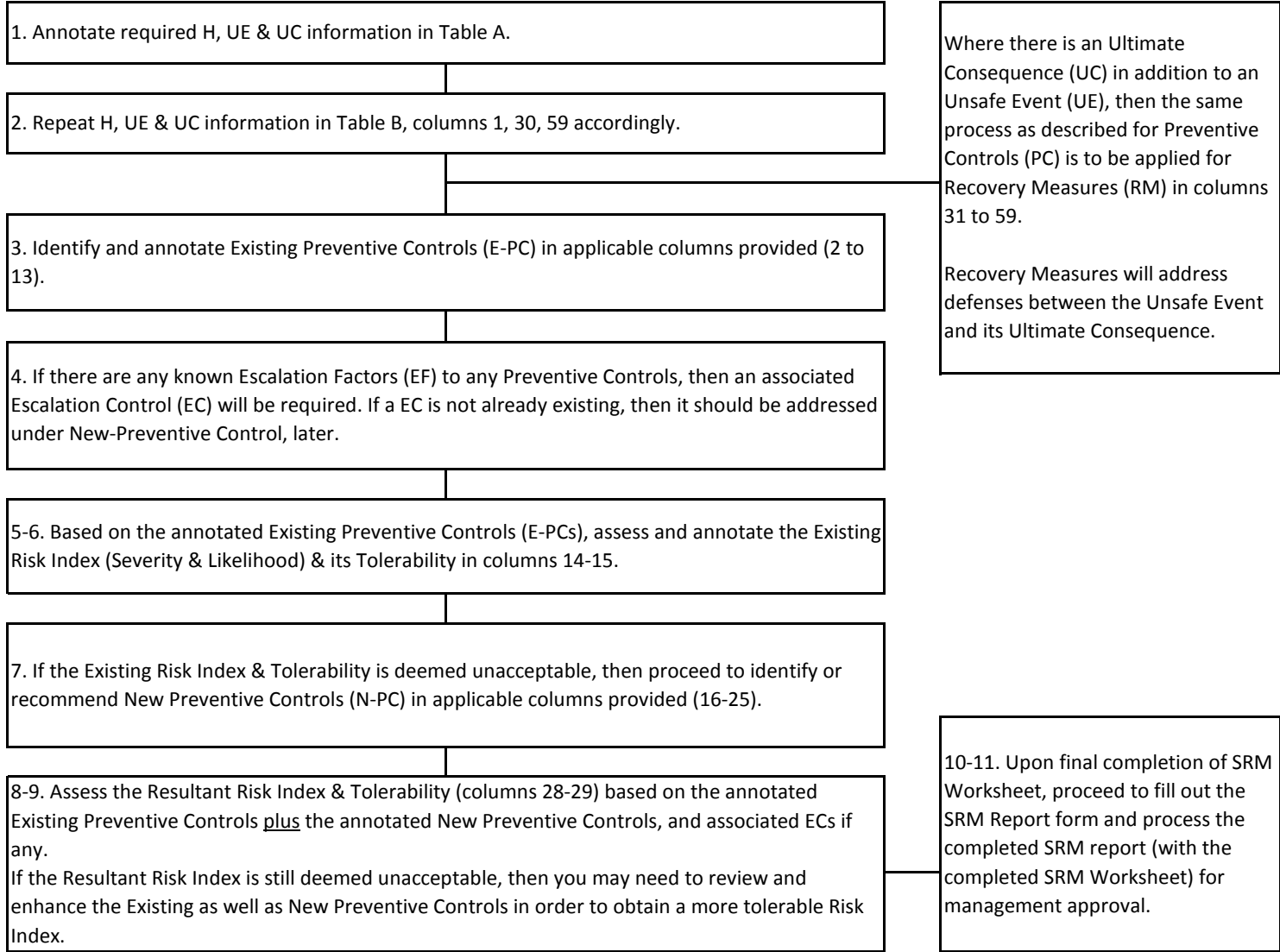
Special considerations when performing SRM:

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

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

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Safety Risk Mitigation (SRM) Process - Schematic



Sheet 5: Severity Table (Basic)

11-Nov-13

Level	Descriptor	Severity Description (customise according to nature of organization's operations)
1	Insignificant	No significance to aircraft related operational safety.
2	Minor	Degrade or affect normal aircraft operational procedures or performance.
3	Moderate	Partial loss of significant/ major aircraft systems or result in abnormal F/Ops procedure application.
4	Major	Complete failure of significant/ major aircraft systems or result in emergency F/Ops procedure application.
5	Catastrophic	Loss of aircraft or multiple lives.

Severity Table (Alternate)*

Level	Descriptor	Severity Description (customise according to nature of organization's operations)					
		Safety of Aircraft	Physical Injury	Damage to Assets	Potential Revenue Loss	Damage to Environment	Damage to Corporate Reputation
1	Insignificant	No significance to aircraft related operational safety.	No injury	No Damage	No Revenue Loss	No Effect	No implication
2	Minor	Degrade or affect normal aircraft operational procedures or performance.	Minor injury	Minor Damage <\$__	Minor Loss <\$__	Minor Effect	Limited Localised Implication
3	Moderate	Partial loss of significant/ major aircraft systems or result in abnormal F/Ops procedure application	Serious injury	Substantial Damage <\$__	Substantial Loss <\$__	Contained Effect	Regional Implication
4	Major	Complete failure of significant/ major aircraft systems or result in emergency F/Ops procedure application	Single fatality	Major Damage <\$__	Major Loss <\$__	Major Effect	National Implication
5	Catastrophic	Aircraft/ Hull Loss	Multiple fatality	Catastrophic Damage >\$__	Massive Loss >\$__	Massive Effect	International Implication

*Note (Alternate Severity Table): If more than 1 severity description column is applied, use the highest severity level annotated only i.e ignore the lesser projected severity number (s) of the other columns. Example: If a consequence is projected as "moderate" under "Physical Injury" as well as "catastrophic" under "Damage to Environment", then use "catastrophic" as the overriding applicable severity.

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Sheet 6: Likelihood Table

7-Jan-14

Level	Descriptor	Likelihood Description
E	Certain/ frequent	Is expected to occur in most circumstances.
D	Likely/ occasional	Will probably occur at some time.
C	Possible/ remote	Might occur at some time.
B	Unlikely/ improbable	Could occur at some time.
A	Exceptional/ impossible	May occur only in exceptional circumstances.

Note: The Likelihood (Level) of a given UE/ UC is to be correlated from the "Barrier Strength Index (BSI)" of its line of PCs/ RMs. This Barrier Strength Index (sht 6A) is derived from the quantity and quality of the PCs/ RMs (Barrier) preceding the UE/ UC.

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Sheet 6A: Barrier (PC/ RM) Strength Value

5-Feb-15

Barrier Sequence No.	Barrier Strength Value (BSV)				
	Poor	Fair	Satisfactory	Good	Excellent
1	1	2	3	4	5
2	1	2	3	4	5
3	1	2	3	4	5
4	1	2	3	4	5
5 (or more)	1	2	3	4	5

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

How to calculate the Consolidated Barrier Strength Value (CBSV) for a given set of Barriers (PCs/ RMs). Example:

Assuming that there are 4 identified Barriers (Seq Nos 1, 2, 3 & 4 as highlighted), and that each of the 4 Barriers have been assessed to have their individual Barrier Strength Values (BSV) as 2, 4, 3 and 2 respectively (as highlighted). Thus the Consolidated (summation) BSV for these 4 Barriers will be:

Barrier Sequence No.	BSV	
1	2	Fair
2	4	Good
3	3	Satisfactory
4	2	Fair
	11	<< Consolidated BSV [summation]

Notes:

- 1) Maximum possible Consolidated Barrier Strength Value is "25" (5 Barriers with BSV of 5 each).
- 2) Minimum possible Consolidated Barrier Strength Value is "0" (Zero Barrier).
- 3) Where there are more than 5 Barriers (to any specific UE/ UC), the CBSV shall be the summation of those 5 Barriers with the highest individual BSVs.

Upon obtaining the Consolidated Barrier Strength Value ("11" in above example) from this BSV section, proceed to Sheet 6B (CBSV>Likelihood Correlation) to obtain the Risk-Likelihood Level pertaining to this Consolidated Barrier Strength Value.

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Sheet 6B: Consolidated Barrier Strength Value to Likelihood Correlation

Consolidated Barrier Strength Value (CBSV Range)	Likelihood (of UE/ UC)	
	Level	Descriptor
20 > 25	A	Exceptional/ impossible
15 > 19	B	Unlikely/ improbable
10 > 14	C	Possible/ remote
5 > 9	D	Likely/ occasional
0 > 4	E	Certain/ frequent

Note: Based on the Consolidated Barrier Strength Value of "11" obtained in the CBSV calculation example in Sheet 6A, the Likelihood Level for the relevant UE/ UC Risk Index would be "C" (Possible/ Remote).

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Sheet 7: Risk Index Matrix (Severity x Likelihood)

7-Jan-14

Likelihood	Severity				
	1. Insignificant	2. Minor	3. Moderate	4. Major	5. Catastrophic
A. (exceptional/ impossible)	Negligible (1A)	Negligible (2A)	Low (3A)	Low (4A)	Moderate (5A)
B. (unlikely/ improbable)	Negligible (1B)	Low (2B)	Low (3B)	Moderate (4B)	Moderate (5B)
C. (possible/ remote)	Low (1C)	Low (2C)	Moderate (3C)	Moderate (4C)	High (5C)
D. (likely/ occasional)	Low (1D)	Moderate (2D)	Moderate (3D)	High (4D)	Extreme (5D)
E. (certain/ frequent)	Moderate (1E)	Moderate (2E)	High (3E)	Extreme (4E)	Extreme (5E)

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Sheet 8: Risk Tolerability Table

7-Jan-14

Risk Index Description (Severity x Likelihood)		Risk Index #	Risk Level	Risk Tolerability / Action (Guidance)
Severity	Likelihood			
Catastrophic (5)	Certain / Frequent (E)	5E	R1 - Extreme Risk	STOP OPERATION OR PROCESS IMMEDIATELY. Unacceptable under existing circumstances. Do not permit any operation until sufficient mitigating actions have been implemented to reduce risk index to R3 or lower if possible. Top Management approval of risk mitigation actions and acceptability required before commencement of affected operation.
Catastrophic (5)	Likely / Occasional (D)	5D		
Major (4)	Certain/ Frequent (E)	4E		
Catastrophic (5)	Possible / Remote (C)	5C	R2 - High Risk	WARNING. Ensure that risk assessment has been satisfactorily completed and declared preventive controls are in place. Senior management approval of completed risk assessment before commencement of the operation or process.
Major (4)	Likely / Occasional (D)	4D		
Moderate (3)	Certain / Frequent (E)	3E		
Catastrophic (5)	Unlikely / Improbable (B)	5B	R3 - Moderate Risk	CAUTION. Perform or review risk mitigation as necessary. Departmental approval of risk assessment required.
Catastrophic (5)	Exceptional / Impossible (A)	5A		
Major (4)	Possible/ Remote (C)	4C		
Major (4)	Unlikely / Improbable (B)	4B		
Moderate (3)	Likely / Occasional (D)	3D		
Moderate (3)	Possible/ Remote (C)	3C		
Minor (2)	Certain / Frequent (E)	2E		
Minor (2)	Likely / Occasional (D)	2D		
Insignificant (1)	Certain / Frequent (E)	1E		
Major (4)	Exceptional / Impossible (A)	4A	R4 - Low Risk	REVIEW. Risk mitigation or review is optional.
Moderate (3)	Unlikely / Improbable (B)	3B		
Moderate (3)	Exceptional / Impossible (A)	3A		
Minor (2)	Possible/ Remote (C)	2C		
Minor (2)	Unlikely / Improbable (B)	2B		
Insignificant (1)	Likely / Occasional (D)	1D		
Insignificant (1)	Possible/ Remote (C)	1C		
Minor (2)	Exceptional / Impossible (A)	2A	R5 - Negligible Risk	NO ACTION REQUIRED. Acceptable as is. No formal risk mitigation required.
Insignificant (1)	Unlikely / Improbable (B)	1B		
Insignificant (1)	Exceptional / Impossible (A)	1A		

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Sheet 9: Risk Index Level to Barrier (PC/ RM) Scope Correlation

31-Oct-14

Risk Index		Risk Index No	Existing Risk Index Category	Barrier Scope (Type) in relation to Risk Index Category (as applicable)												Barrier Regulation/ Control Level		
Severity	Likelihood			1. ERP	2. Backup System	3. Abnormal Procedure	4. Scheduled Maint.	5. SOP	6. Special/ Duplicate Inspn	7. GM	8. Orgn Approval	9. Personnel Approval	10. TRNG	11. Regulation	12. Others (specify)	International/ Regional organization	CAA	Service Provider
Catastrophic (5)	Certain / Frequent (E)	5E	R1 - Extreme Risk	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
Catastrophic (5)	Likely / Occasional (D)	5D		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Major (4)	Certain/ Frequent (E)	4E		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Catastrophic (5)	Possible / Remote (C)	5C	R2 - High Risk	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
Major (4)	Likely / Occasional (D)	4D		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
Moderate (3)	Certain / Frequent (E)	3E		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
Catastrophic (5)	Unlikely / Improbable (B)	5B	R3 - Moderate Risk	Optional	Optional	Yes	Yes	Yes	Optional	Yes	-	Yes	Optional		Optional	Optional	Yes	
Catastrophic (5)	Exceptional / Impossible (A)	5A		Optional	Optional	Yes	Yes	Yes	Optional	Yes	-	Yes	Optional		Optional	Optional	Yes	
Major (4)	Possible/ Remote (C)	4C		Optional	Optional	Yes	Yes	Yes	Optional	Yes	-	Yes	Optional		Optional	Optional	Yes	
Major (4)	Unlikely / Improbable (B)	4B		Optional	Optional	Yes	Yes	Yes	Optional	Yes	-	Yes	Optional		Optional	Optional	Yes	
Moderate (3)	Likely / Occasional (D)	3D		Optional	Optional	Yes	Yes	Yes	Optional	Yes	-	Yes	Optional		Optional	Optional	Yes	
Moderate (3)	Possible/ Remote (C)	3C		Optional	Optional	Yes	Yes	Yes	Optional	Yes	-	Yes	Optional		Optional	Optional	Yes	
Minor (2)	Certain / Frequent (E)	2E		Optional	Optional	Yes	Yes	Yes	Optional	Yes	-	Yes	Optional		Optional	Optional	Yes	
Minor (2)	Likely / Occasional (D)	2D		Optional	Optional	Yes	Yes	Yes	Optional	Yes	-	Yes	Optional		Optional	Optional	Yes	
Insignificant (1)	Certain / Frequent (E)	1E	Optional	Optional	Yes	Yes	Yes	Optional	Yes	-	Yes	Optional		Optional	Optional	Yes		
Major (4)	Exceptional / Impossible (A)	4A	R4 - Low Risk	-	Optional	-	Optional	Optional	-	Optional	-	Optional	Optional	-	-	Optional	Optional	
Moderate (3)	Unlikely / Improbable (B)	3B		-	Optional	-	Optional	Optional	-	Optional	-	Optional	Optional	-	-	Optional	Optional	
Moderate (3)	Exceptional / Impossible (A)	3A		-	Optional	-	Optional	Optional	-	Optional	-	Optional	Optional	-	-	Optional	Optional	
Minor (2)	Possible/ Remote (C)	2C		-	Optional	-	Optional	Optional	-	Optional	-	Optional	Optional	-	-	Optional	Optional	
Minor (2)	Unlikely / Improbable (B)	2B		-	Optional	-	Optional	Optional	-	Optional	-	Optional	Optional	-	-	Optional	Optional	
Insignificant (1)	Likely / Occasional (D)	1D		-	Optional	-	Optional	Optional	-	Optional	-	Optional	Optional	-	-	Optional	Optional	
Insignificant (1)	Possible/ Remote (C)	1C	-	Optional	-	Optional	Optional	-	Optional	-	Optional	Optional	-	-	Optional	Optional		
Minor (2)	Exceptional / Impossible (A)	2A	R5 - Negligible Risk	-	-	-	-	Optional	-	Optional	-	-	Optional	-	-	-	Optional	
Insignificant (1)	Unlikely / Improbable (B)	1B		-	-	-	-	Optional	-	Optional	-	-	Optional	-	-	-	Optional	
Insignificant (1)	Exceptional / Impossible (A)	1A		-	-	-	-	Optional	-	Optional	-	-	Optional	-	-	-	Optional	

Note: This Table is a guide to the possible scope of PC/ RM categories which should be considered (where applicable) in relation to the relevant Risk Index Levels. In principle, a wider scope of Barriers can be expected for higher risk levels. Consideration of the 10 categories (or more) of Barrier types will ensure that they are not inadvertently omitted.

SAFETY RISK MITIGATION REPORT

Organization Name		Report No:
Operation / Process / Equipment		Date:
Hazard Description		Department:
		Section:
Hazard ID / Code*		Reserved
Project start date	Project completion date	Next Review Date
Documents Attached:		
Item	Document	
1	Schematic output of the completed SRM project.	
2	Completed HIRM Worksheet.	
3	Highlights of changes to Operation/ Process/ Equipment or Defenses resulting from this SRM project.	
4	Attachments (substantiation documents, drawings, references, standards, exceptions, etc.), if any	
5	Next Review/ Others:	
<p>SRM Project Team Leader:</p> <p>_____</p> <p style="text-align: center;">Date Name/ Signature Designation</p>		
<p>SRM Project Team Members:</p> <p>_____</p>		
<p>Reviewed by SMS/ SRM Office/ Facilitator:</p> <p>_____</p> <p style="text-align: center;">Date Name / Signature Designation</p>		
<p>Approved by Department Head:</p> <p>_____</p> <p style="text-align: center;">Date Name of Division Head Signature</p> <p style="text-align: center;">Note: Upon approval, forward original Copy to SMS Office for HIRM Master Register update</p>		
<p><small>*Hazard Code: SSS-OOO-DDDDD-HHH-YY [Sector ID - Organization ID - Dept ID - Hazard # - Year] SRM Report Form: xxx 9 Feb 2013</small></p>		

ATTACHMENT 1. Schematic Output of SRM Project

ATTACHMENT 2. Completed HIRM Worksheet

ATTACHMENT 3. Highlight of Changes to Operation/ Process/ Equipment or Defenses

Organization name: <i>Alpha Airline</i> 5-Mar-14														
Hazard Identification & Risk Mitigation (HIRM) - Master Register														
Item	Operation/ Process/ Equipment	Hazard / Threat (H)		Unsafe Event (UE) [Projected]		UE Prelim Risk Level (R1, 2, 3, 4, 5)	Ultimate Consequence (UC) [Projected]		UC Prelim Risk Level (R1, 2, 3, 4, 5)	HIRM Project Leader		Risk Mitigation Project Status		
	Description	ID Code	Description		Description			Description			Dept	Name	Date Activated	Date Completed / Rot Ref
1	Pest control within A320 aircraft fuselage/ cabin.	OPS- ALPHA- TECH- H1-L2- 13	One large rat sighted in aircraft control cabin during cruise. (Refer N- xxxx, Tech Log No 24687 for previous rat sighting by cabin crew on 20 Jan)	a)	Aircraft wiring/ equipment damage by rat (s)	Moderate R3 (3xD)	a)	Aircraft system(s) malfunction due to wiring/ equipment damage by rat (s).	Moderate R3 (3xC)	A320 fleet				
				b)	Cabin environment/ food contamination by rat droppings/ ...	Low R4 (2xC)	b)	Transmission of rat related disease to crew/ passengers	Moderate R3 (4xC)	Cabin Crew / Inflight Catering				
2														

Hazard / Threat ID Code:

1. Sector > 2. Organization > 3. Hazard Type > 4. Hazard # > 5. Risk level > 6. Year [SSS > OOOO > TTTT > ### > RL > YY]

- 1 **Sector:** AGA / ANS / OPS / DMO / AMO / MDO* / GHO*
- 2 **Organization:** Five letters code (eg ALPHA - Alpha Airline)
- 3 **Hazard Type:** ENV / TECH / DG / GHO / ORGN / HF
- 4 **Hazard #:** Hazard number (max 999) as assigned by the organization concerned within a given Year.
- 5 **Risk Level:** Hazard prioritization Level [R1 (Extreme)/ R2 (High)/ R3 (Moderate)/ R4 (Low)/ R5(Negligible)] based on risk index of the hazard's projected Unsafe Event (UE) or Ultimate Consequence (UC) as applicable. Refer sht 8 - Tolerability table
- 6 **Year:** Year when the Hazard was registered in the organization's Hazard Register.

Examples of Hazard ID Code:

- 1 **OPS-ALPHA-TECH-H1-R2-13** [Air Operations - Alpha Airline - Technical - Hazard #1 - R2 (High risk) - Year 2013]
- 2 **AGA-GATB-ENV-H5-R3-12** [Aerodrome - Timbaktu Airport - Environment - Hazard #5 - R3 (Moderate risk) - Year 2012]

*MDO- Aeronautical materials distribution organizations, including fuel supply.

*GHO - Before flight aircraft ground handling operations, including cargo handling.

Note: Refer **sheet 12** for an illustration of how this registered Hazard "**OPS-ALPHA-TECH-H1-L2-13**" is followed up with a Safety Risk Mitigation (SRM) process.

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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	<p>a) Project the Hazard's worst possible consequence</p> <p>b) Project this consequence's likely occurrence classification ie it will be deemed to be an accident, serious incident or incident?</p> <p>c) The Hazard's prioritization is thus:</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>Projected Consequence</th> <th>Hazard Level</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">Accident</td> <td style="text-align: center;">Level 1</td> </tr> <tr> <td style="text-align: center;">Serious Incident</td> <td style="text-align: center;">Level 2</td> </tr> <tr> <td style="text-align: center;">Incident</td> <td style="text-align: center;">Level 3</td> </tr> </tbody> </table>	Projected Consequence	Hazard Level	Accident	Level 1	Serious Incident	Level 2	Incident	Level 3	<p>a) Project the Risk Index number (based on the Severity & Likelihood matrix) of the hazard's worst possible consequence.</p> <p>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)</p> <p>c) The Hazard's prioritization is thus:</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>Projected Risk Index</th> <th>Hazard Level</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">Extreme Risk</td> <td style="text-align: center;">R1</td> </tr> <tr> <td style="text-align: center;">High Risk</td> <td style="text-align: center;">R2</td> </tr> <tr> <td style="text-align: center;">Moderate Risk</td> <td style="text-align: center;">R3</td> </tr> <tr> <td style="text-align: center;">Low Risk</td> <td style="text-align: center;">R4</td> </tr> <tr> <td style="text-align: center;">Negligible Risk</td> <td style="text-align: center;">R5</td> </tr> </tbody> </table>	Projected Risk Index	Hazard Level	Extreme Risk	R1	High Risk	R2	Moderate Risk	R3	Low Risk	R4	Negligible Risk	R5
Projected Consequence	Hazard Level																					
Accident	Level 1																					
Serious Incident	Level 2																					
Incident	Level 3																					
Projected Risk Index	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.																				

Note:

From a practical viewpoint, Option 1 would be more viable than Option 2 for the purpose of a simpler and faster classification system. The purpose of such a classification system is to facilitate hazards sorting and prioritization for risk mitigation action. Once each hazard is classified, it would be apparent that they may be sorted as Level 1, 2, 3 or R1, R2, R3, R4, R5 for Option 1 and 2 respectively. Priority or attention for risk mitigation may then be assigned according to their level classification, as appropriate.

Hazards may need to be categorized and sorted by areas (eg flight operations, maintenance, workshops, etc) or by sectors (eg ATS, AGA, AMO. OPS, etc) as applicable, before the above hazard prioritization process. Hazards which are deemed to be purely Worker-Workplace (occupational safety) related with no impact on aviation systems safety may need to be separately processed for action by relevant function of the organization responsible for industrial/ occupational safety systems.

Table A	Hazard Identification & Risk Mitigation (HIRM) Worksheet [Risk mitigation illustration] Oct 14	
1. OPERATION/ PROCESS:	Pest control within A320 aircraft fuselage/ cabin.	
2. HAZARD / THREAT (HT):	Rat (s) infestation within an operational A320 aircraft fuselage/ cabin	Hazard Code: OPS-ALPHA-TECH-H1-L2-13
3. UNSAFE EVENT (UE):	Rat (s) infestation confirmed through rat sightings or evidence of aircraft wiring damage by roden activities.	
4. ULTIMATE CONSEQUENCE (UC):	Multiple aircraft system(s) failure or malfunction (due to electrical wiring damage by rats).	

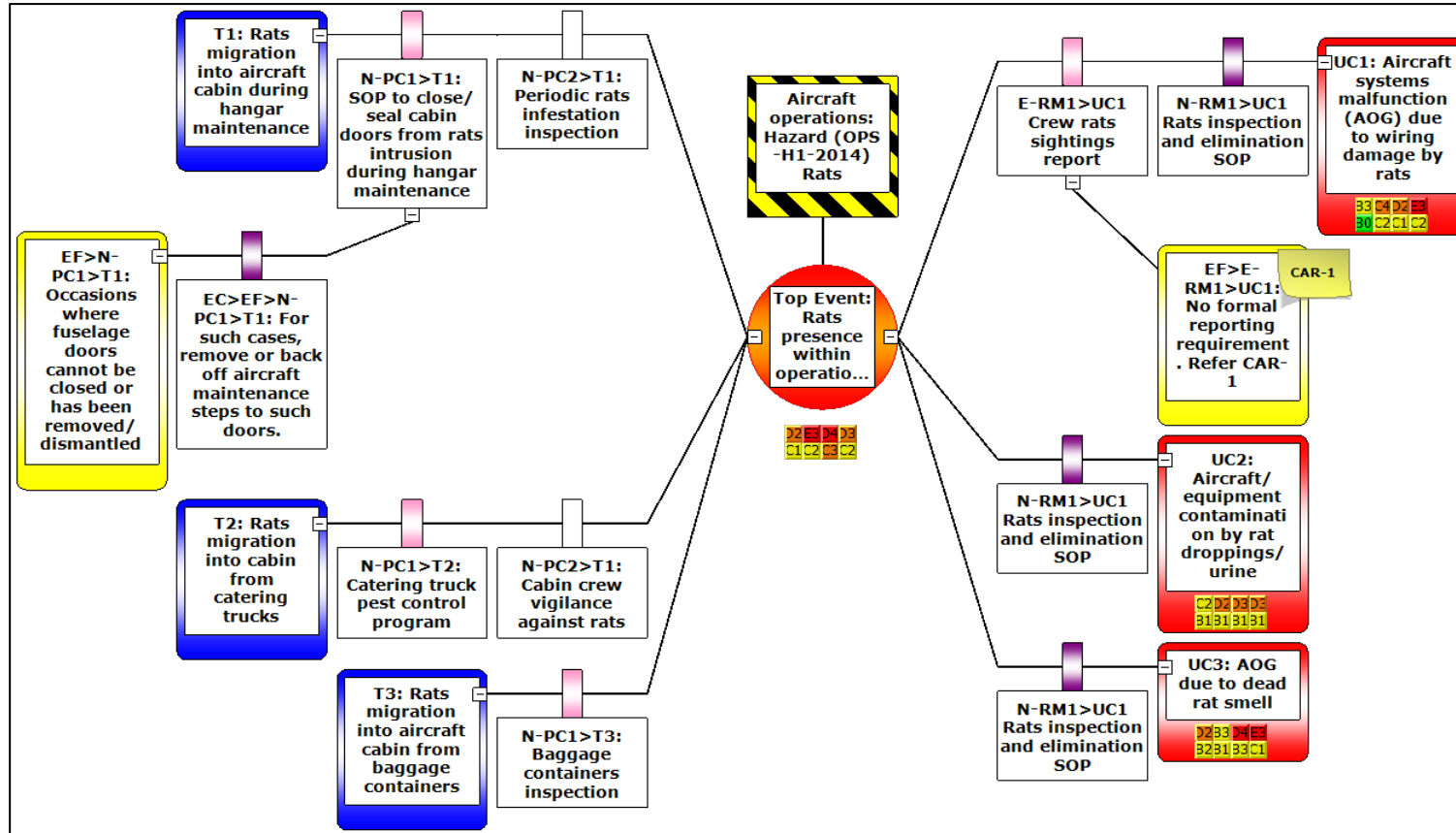
Table B		Unsafe Event Mitigation (as applicable)																																																									
Hazard / Threat	Existing Preventive Controls [E-PC]													New Preventive Controls [N-PC]													Resultant RI & T	Unsafe Event	Existing Recovery Measures [E-RM]													New Recovery Measures [N-RM]													Resultant RI & T	Ultimate Consequence			
	Ultimate Consequence Mitigation (as applicable)																																																										
	Rat (s) infestation within an operational A320 aircraft fuselage/ cabin		R3 - Moderate Risk													R4 - Low Risk													R4 - Low Risk	R3 - Moderate Risk													R4 - Low Risk														R4 - Low Risk	Multiple aircraft system(s) failure or malfunction (due to electrical wiring damage by rats)	

Description of Existing Preventive Controls [E-PC]	Description of New Preventive Controls [N-PC]	Description of Existing Recovery Measures [E-RM]	Description of New Recovery Measures [N-RM]
<p>E-PC1: Flight, cabin and maintenance personnel are normally expected to report any rat sightings within an aircraft.</p> <p>EF>E-PC1: No documented procedure/ instruction for such reporting expectation.</p>	<p>N-PC1: SOP to be put in place to require flight crew and maintenance personnel to report rats sighting within aircraft cabin.</p> <p>N-PC2: SOP to be put in place to require that all aircraft fuselage doors to be closed or sealed during silent hours, especially when undergoing hangar maintenance checks.</p> <p>EF>N-PC2: There may be occasions where fuselage doors cannot be closed due to their being removed or dismantled for maintenance.</p> <p>EC>EF>N-PC2: For such cases, aircraft maintenance steps leading to such doors shall be removed or backed-off from the door by at least 3 feet, during silent hours.</p>	<p>E-RM1: Any operational aircraft reported with rat sighting is normally subjected to a cabin inspection by maintenance personnel during stayover check.</p>	<p>N-RM1: Special Inspection sheet (Ref SI/ A320/ 25/ 112) has been raised to require any operational aircraft with reported sighting or evidence of rats infestation to be scheduled for de-infestation action by approved Pest Controller upon aircraft return to main base.</p> <p>N-RM2: A routine "C" Check Maintenance Job Card has been raised to call for inspection of all opened aircraft internal fuselage compartments for evidence of rat droppings and necessary follow up action. Ref: MJC-1C-53-45; SI/ A320/ 25/ 112.</p>

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Sheet 15:

How a Bow-Tie Output Diagram can look like



UAS Operational Safety Assessment - Task Scoping (by Operational Environment, UAS Configuration & Hazard>Top Event)

10-Mar-15

		UAS Generic Hazards (GH) & Top Events (TE)	UAS Configuration								
			< 7 KG				> 7 KG {<100Kg}				
			No PayLoad [NPL]		Pay Load [PL]		No PayLoad [NPL]		Pay Load [PL]		
			Non-Commercial [NC]	Commercial	Non-Commercial [NC]	Commercial	Non-Commercial [NC]	Commercial	Non-Commercial [NC]	Commercial	
UAS Operating Environment	Above 200FT (<1000FT)	1 GH: UAS operation in vicinity of RPPD# Areas & Facilities (RPPD) TE: Close proximity of operating UAS to RPPD# Areas & Facilities	RPPD:<5>200:<7:NPL-NC	RPPD:<5>200:<7:PL-NC	RPPD:<5>200:<7:NPL-C	RPPD:<5>200:<7:PL	RPPD:<5>200:>7:NPL-NC	RPPD:<5>200:>7:PL-NC	RPPD:<5>200:>7:NPL-C	RPPD:<5>200:>7:PL	
		2 GH: UAS operation in vicinity of People/ Animals (PA) TE: Close proximity of operating UAS to people/ animals	PA:<5>200:<7:NPL-NC	PA:<5>200:<7:PL-NC	PA:<5>200:<7:NPL-C	PA:<5>200:<7:PL	PA:<5>200:>7:NPL-NC	PA:<5>200:>7:PL-NC	PA:<5>200:>7:NPL-C	PA:<5>200:>7:PL	
		3 GH: UAS operation in vicinity of Built-up Areas (BuA) TE: Close proximity of operating UAS to buildings/ installations	BuA:<5>200:<7:NPL-NC	BuA:<5>200:<7:PL-NC	BuA:<5>200:<7:NPL-C	BuA:<5>200:<7:PL	BuA:<5>200:>7:NPL-NC	BuA:<5>200:>7:PL-NC	BuA:<5>200:>7:NPL-C	BuA:<5>200:>7:PL	
		4 GH: UAS operation in vicinity of Inland Water Bodies/ reservoirs (IWB) TE: Close proximity of operating UAS to Inland Water Bodies/ reservoirs	IWB:<5>200:<7:NPL-NC	IWB:<5>200:<7:PL-NC	IWB:<5>200:<7:NPL-C	IWB:<5>200:<7:PL	IWB:<5>200:>7:NPL-NC	IWB:<5>200:>7:PL-NC	IWB:<5>200:>7:NPL-C	IWB:<5>200:>7:PL	
		5 GH: UAS Off-Shore operation (OS) TE: Close proximity of operating UAS to marine vehicles and installations	OS:<5>200:<7:NPL-NC	OS:<5>200:<7:PL-NC	OS:<5>200:<7:NPL-C	OS:<5>200:<7:PL	OS:<5>200:>7:NPL-NC	OS:<5>200:>7:PL-NC	OS:<5>200:>7:NPL-C	OS:<5>200:>7:PL	
		6. GH: Designated/ Approved UAS operating Areas (DA) TE: Close proximity of operating UAS to people/ facilities within DA.	DA:<5>200:<7:NPL-NC	DA:<5>200:<7:PL-NC	DA:<5>200:<7:NPL-C	DA:<5>200:<7:PL	DA:<5>200:>7:NPL-NC	DA:<5>200:>7:PL-NC	DA:<5>200:>7:NPL-C	DA:<5>200:>7:PL	
	Below 200FT	1 GH: UAS operation in vicinity of RPPD# Areas & Facilities (RPPD) TE: Close proximity of operating UAS to RPPD# Areas & Facilities	RPPD:<5><200:<7:NPL-NC	RPPD:<5><200:<7:PL-NC	RPPD:<5><200:<7:NPL-C	RPPD:<5><200:<7:PL	RPPD:<5><200:>7:NPL-NC	RPPD:<5><200:>7:PL-NC	RPPD:<5><200:>7:NPL-C	RPPD:<5><200:>7:PL	
		2 GH: UAS operation in vicinity of People/ Animals (PA) TE: Close proximity of operating UAS to people/ animals	PA:<5><200:<7:NPL-NC	PA:<5><200:<7:PL-NC	PA:<5><200:<7:NPL-C	PA:<5><200:<7:PL	PA:<5><200:>7:NPL-NC	PA:<5><200:>7:PL-NC	PA:<5><200:>7:NPL-C	PA:<5><200:>7:PL	
		3 GH: UAS operation in vicinity of Built-up Areas (BuA) TE: Close proximity of operating UAS to buildings/ installations	BuA:<5><200:<7:NPL-NC	BuA:<5><200:<7:PL-NC	BuA:<5><200:<7:NPL-C	BuA:<5><200:<7:PL	BuA:<5><200:>7:NPL-NC	BuA:<5><200:>7:PL-NC	BuA:<5><200:>7:NPL-C	BuA:<5><200:>7:PL	
		4 GH: UAS operation in vicinity of Inland Water Bodies/ reservoirs (IWB) TE: Close proximity of operating UAS to Inland Water Bodies/ reservoirs	IWB:<5><200:<7:NPL-NC	IWB:<5><200:<7:PL-NC	IWB:<5><200:<7:NPL-C	IWB:<5><200:<7:PL	IWB:<5><200:>7:NPL-NC	IWB:<5><200:>7:PL-NC	IWB:<5><200:>7:NPL-C	IWB:<5><200:>7:PL	
		5 GH: UAS Off-Shore operation (OS) TE: Close proximity of operating UAS to marine vehicles and installations	OS:<5><200:<7:NPL-NC	OS:<5><200:<7:PL-NC	OS:<5><200:<7:NPL-C	OS:<5><200:<7:PL	OS:<5><200:>7:NPL-NC	OS:<5><200:>7:PL-NC	OS:<5><200:>7:NPL-C	OS:<5><200:>7:PL	
		6. GH: Designated/ Approved UAS operating Areas (DA) TE: Close proximity of operating UAS to people/ facilities within DA.	DA:<5><200:<7:NPL-NC	DA:<5><200:<7:PL-NC	DA:<5><200:<7:NPL-C	DA:<5><200:<7:PL	DA:<5><200:>7:NPL-NC	DA:<5><200:>7:PL-NC	DA:<5><200:>7:NPL-C	DA:<5><200:>7:PL	
	Above 200FT (<1000FT)	1 GH: UAS operation in vicinity of RPPD# Areas & Facilities (RPPD) TE: Close proximity of operating UAS to RPPD# Areas & Facilities	RPPD:>5>200:<7:NPL-NC	RPPD:>5>200:<7:PL-NC	RPPD:>5>200:<7:NPL-C	RPPD:>5>200:<7:PL	RPPD:>5>200:>7:NPL-NC	RPPD:>5>200:>7:PL-NC	RPPD:>5>200:>7:NPL-C	RPPD:>5>200:>7:PL	
		2 GH: UAS operation in vicinity of People/ Animals (PA) TE: Close proximity of operating UAS to people/ animals	PA:>5>200:<7:NPL-NC	PA:>5>200:<7:PL-NC	PA:>5>200:<7:NPL-C	PA:>5>200:<7:PL	PA:>5>200:>7:NPL-NC	PA:>5>200:>7:PL-NC	PA:>5>200:>7:NPL-C	PA:>5>200:>7:PL	
		3 GH: UAS operation in vicinity of Built-up Areas (BuA) TE: Close proximity of operating UAS to buildings/ installations	BuA:>5>200:<7:NPL-NC	BuA:>5>200:<7:PL-NC	BuA:>5>200:<7:NPL-C	BuA:>5>200:<7:PL	BuA:>5>200:>7:NPL-NC	BuA:>5>200:>7:PL-NC	BuA:>5>200:>7:NPL-C	BuA:>5>200:>7:PL	
		4 GH: UAS operation in vicinity of Inland Water Bodies/ reservoirs (IWB) TE: Close proximity of operating UAS to Inland Water Bodies/ reservoirs	IWB:>5>200:<7:NPL-NC	IWB:>5>200:<7:PL-NC	IWB:>5>200:<7:NPL-C	IWB:>5>200:<7:PL	IWB:>5>200:>7:NPL-NC	IWB:>5>200:>7:PL-NC	IWB:>5>200:>7:NPL-C	IWB:>5>200:>7:PL	
		5 GH: UAS Off-Shore operation (OS) TE: Close proximity of operating UAS to marine vehicles and installations	OS:>5>200:<7:NPL-NC	OS:>5>200:<7:PL-NC	OS:>5>200:<7:NPL-C	OS:>5>200:<7:PL	OS:>5>200:>7:NPL-NC	OS:>5>200:>7:PL-NC	OS:>5>200:>7:NPL-C	OS:>5>200:>7:PL	
		6. GH: Designated/ Approved UAS operating Areas (DA) TE: Close proximity of operating UAS to people/ facilities within DA.	DA:>5>200:<7:NPL-NC	DA:>5>200:<7:PL-NC	DA:>5>200:<7:NPL-C	DA:>5>200:<7:PL	DA:>5>200:>7:NPL-NC	DA:>5>200:>7:PL-NC	DA:>5>200:>7:NPL-C	DA:>5>200:>7:PL	
	> 5 km from aerodrome	Above 200FT	1 GH: UAS operation in vicinity of RPPD# Areas & Facilities (RPPD) TE: Close proximity of operating UAS to RPPD# Areas & Facilities	RPPD:>5><200:<7:NPL-NC	RPPD:>5><200:<7:PL-NC	RPPD:>5><200:<7:NPL-C	RPPD:>5><200:<7:PL	RPPD:>5><200:>7:NPL-NC	RPPD:>5><200:>7:PL-NC	RPPD:>5><200:>7:NPL-C	RPPD:>5><200:>7:PL
			2 GH: UAS operation in vicinity of People/ Animals (PA) TE: Close proximity of operating UAS to people/ animals	PA:>5><200:<7:NPL-NC	PA:>5><200:<7:PL-NC	PA:>5><200:<7:NPL-C	PA:>5><200:<7:PL	PA:>5><200:>7:NPL-NC	PA:>5><200:>7:PL-NC	PA:>5><200:>7:NPL-C	PA:>5><200:>7:PL
			3 GH: UAS operation in vicinity of Built-up Areas (BuA) TE: Close proximity of operating UAS to buildings/ installations	BuA:>5><200:<7:NPL-NC	BuA:>5><200:<7:PL-NC	BuA:>5><200:<7:NPL-C	BuA:>5><200:<7:PL	BuA:>5><200:>7:NPL-NC	BuA:>5><200:>7:PL-NC	BuA:>5><200:>7:NPL-C	BuA:>5><200:>7:PL
		Below 200FT	4 GH: UAS operation in vicinity of Inland Water Bodies/ reservoirs (IWB) TE: Close proximity of operating UAS to Inland Water Bodies/ reservoirs	IWB:>5><200:<7:NPL-NC	IWB:>5><200:<7:PL-NC	IWB:>5><200:<7:NPL-C	IWB:>5><200:<7:PL	IWB:>5><200:>7:NPL-NC	IWB:>5><200:>7:PL-NC	IWB:>5><200:>7:NPL-C	IWB:>5><200:>7:PL
			5 GH: UAS Off-Shore operation (OS) TE: Close proximity of operating UAS to marine vehicles and installations	OS:>5><200:<7:NPL-NC	OS:>5><200:<7:PL-NC	OS:>5><200:<7:NPL-C	OS:>5><200:<7:PL	OS:>5><200:>7:NPL-NC	OS:>5><200:>7:PL-NC	OS:>5><200:>7:NPL-C	OS:>5><200:>7:PL
			6. GH: Designated/ Approved UAS operating Areas (DA) TE: Close proximity of operating UAS to people/ facilities within DA.	DA:>5>200:<7:NPL-NC	DA:>5>200:<7:PL-NC	DA:>5>200:<7:NPL-C	DA:>5>200:<7:PL	DA:>5>200:>7:NPL-NC	DA:>5>200:>7:PL-NC	DA:>5>200:>7:NPL-C	DA:>5>200:>7:PL

#RPPD - Restricted, Prohibited, Protected & Danger areas/ facilities

Sheet 2 - Explanatory Notes

Sheet 3 - Bow-Tie Output Diagram illustration.

Sheet 4 - UAS SRM Tables

Sheet 5 - UAS Risk Tolerability Table

Note: The Risk Index Tolerability category (color code) for each cell is meant to be derived from its Consequence(s)' highest Resultant Risk Index value. This value is manifest upon due completion of the safety assessment (bow-tie) exercise, in the context of the UAV parameters as defined for that cell. The present applied color coding (above) is only illustrative.

GT/ UAS_SRM_Project_Task Codes_wth Risk Tolerability

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