

## FOREWORD

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The aim of this risk assessment is to identify hazards or unsafe states related to SafeNcy operation, considering the consequences on pilot/aircraft and on ATS.

It comes in addition to another safety study which verifies the proper technical functioning of the software (to be produced in next SafeNcy development phases).

## SUMMARY

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## 1. GLOSSARY

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**A/C:** Aircraft

**AFM:** Aircraft Flight Manual

**AIS:** Aeronautical Information Services



**AIM:** Aeronautical Information Management

**AIP:** Aeronautical Information Publication

**AP:** Autopilot

**ANS:** Air Navigation Services

**ANSA:** At Nearest Suitable Airport

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**ASAP:** As Soon As Possible

**ATC:** Air Traffic Control

**ATHR:** Auto throttle

**ATIS:** Automatic Terminal Information Service

**D-ATIS:** Digital ATIS

**ATS:** Air Traffic Services

**ETOPS:** Extended range operations

**FD:** Flight Director

**FIS:** Flight Information Services

**FORDEC:** FOR-DECision process (Facts-Options-Risks-Decide-Execute-Check)

**FMC:** Flight Management Computer

**FMS:** Flight Management System

**LDA:** Landing Distance Available

**MEL:** Minimum Equipment List

**METAR:** METeorological Aerodrome Report

**NOTAM:** Notice To Air Men

**PAX:** Passenger

**PINS:** Point In Space

**RFFS:** Rescue and Fire Fighting Services

**RWY:** Runway

**SRA:** Safety Risk Analysis

**TAF:** Terminal Aerodrome Forecast

**TAWS:** Terrain Awareness and Warning System

**TEFO:** Total Engine Flame Out

## 2. PROJECT PRESENTATION

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### 1.1. Description

SafeNcy is a new cockpit functionality designed to provide a flight crew (multi-pilot or single pilot) with immediate assistance in the event of an emergency.

This assistance will include the following functions:

- Immediate presentation of the most suitable diversion aerodrome or landing site, in accordance with the type of failure(s) and its consequences, taking into account the weather, the NOTAMs and the accommodation capacities of the site,
- Calculation and proposal of a 4D trajectory to get there while ensuring the regulatory and safety margins in relation to terrain and dangerous weather phenomena. The proposed vertical profile will be adapted to the type of emergency. End of trajectory is in front of the landing site at a Point in Space (PINS) optimized for the type of final approach imposed by the degraded configuration of the aircraft.
- Possibility, after validation of the SafeNcy proposal by the crew, to insert the chosen trajectory into the FMS and use the available automations (AP, FD, ATHR) depending on the failures,
- Automatic transmission to ATC of the position and the chosen trajectory, to be acknowledged by ATC

Note: during the normal phase of the flight, SafeNcy will provide this information on crew request, thus allowing the pilot(s) to improve his situation awareness.

### 1.2. Impacts

New cockpit functionality available all along the flight and which can be activated automatically or manually in the event of an emergency situation. Its use and limitations should be well understood and trained.

### 1.3. Calendar

December 2022

### 1.4. Stakeholders

#### SafeNcy Consortium



### 3. RISK ASSESSMENT INPUTS

***In this Chapter, we describe the information available for supporting our safety study in terms of inputs.***

***The objective is to identify Indicators which can feed the reflection and to imagine what is quantifiable or not. The quantification, as resulting from these inputs and various SafeNcy validations, will be used in the risk analysis chapter.***

Information:	Indicator:	Comments:
Similar system already available.	Garmin Emergency Autoland	It only covers the pilot incapacity; aircraft is supposed to be fully operational.  Not relevant for other emergencies.
Landing sites database	Airport information (AIPs)	Subject matter experts shall manually verify that the landing site database is complete and up to date.
Ad-hoc simulator	Shows landing site and trajectory proposed by SafeNcy	Expert pilots shall define numerous scenarios and localizations to feed the Ad-hoc simulator and verify its output.
Weather data	Real time aeronautical weather (TAF, METAR, pseudo METAR)	Expert pilots shall verify that weather data are correctly taken into account by SafeNcy.
Notam	All relevant NOTAMs	Expert pilots shall verify that relevant NOTAMs are correctly taken into account by SafeNcy.
Performance	Landing site technical figures and runway surface condition.	Subject matter experts shall verify that the runway length is sufficient for a degraded aircraft and that the proposed approach path is clear of terrain.
Proposed landing site	Localization	Is it the best choice? Did SafeNcy miss another better option?

## 4. ANALYSIS OF FLIGHT SAFETY OPPORTUNITIES

*In this section, we describe how SafeNcy will improve flight safety.*

Functionalities	Flight safety improvements	Comments
Landing Site database : before the flight starts, the operator completes the landing site database with all available information, static (AIP, geographical data,...) and dynamic (weather, notam, ...).	SafeNcy is selecting and validating much more landing sites than a flight crew can do during the short time allowed for flight preparation. If a ground/board link is available, dynamic data will be automatically updated in real time during the flight.	The reliability of this database is a key factor of the global safety of the system.
Availability on request before an emergency occurs.	Improved situation awareness allowing a better mental preparation and an anticipation of the decisions to be taken in case an emergency occurs.	Should the available landing sites be displayed on request or permanently?
SafeNcy when the emergency occurs.	Almost immediate proposal of a safe diversion solution and updated information for its implementation + Decision support and time saving for the initialization of the diversion.	The crew must challenge the proposal before uploading it into the FMS.

## 5. GAP ANALYSIS

**Here we describe the situation before the implementation of the project, and the situation after the deployment. If there are any concerns specific to the transition situation, they are indicated.**

**Objective: describe the Gap Analysis in the appropriate form that will allow the group to discuss each of the topics in the Gap Analysis or the obvious threats that arise from it.**

Current situation	Future / Transition	Notable differences, point of vigilance, transitional phase if necessary
In case of emergency the pilot(s) has to retrieve manually enough information to decide where to divert.	With SafeNcy they will immediately get the best and safest proposal.	Time saving and reduced workload. But pilot(s) should cross check the SafeNcy proposal before relying on it.
Pilots build their situation awareness manually.	SafeNcy will, at any time, offer extensive landing site proposals for any type of emergency	Pilots shall remain vigilant and continue to challenge any safeNcy proposal.
Pilot(s) don't have any support but their eyes when selecting an off-airport landing site.	The SafeNcy landing site database includes the best off-airport landing strips reachable by the aircraft.	Pilot(s) will have to rely entirely on SafeNcy until reaching visual contact with the landing strip.
Pilot(s) generally proceed as direct as possible towards the diversion airport.	SafeNcy may use its own calculation process to define the best 4D trajectory.	Pilot(s) must be prepared to "take action" if they don't feel satisfied with the SafeNcy 4D proposed trajectory.

## 6. RISK ASSESSMENT

*This chapter describes how the SafeNcy project generates additional threats/risks in terms of flight safety.*

*This risk analysis is done in two steps:*

- *a summary listing the apparent threats/risks.*
- *then, a group of people representative of the populations affected is brought together.*

*The group will work on the basis of the synthesis and has the following objectives:*

- 1) *The identification of the impacts of the project*
- 2) *The identification of the threats generated by the project (it is advisable to "consider the worst case reasonably possible")*
- 3) *Definition of the associated risk area(s)*
- 4) *The evaluation of the risks (weighing of the severity)*
- 5) *Reflection on possible corrective actions*
- 6) *Proposal of recommendations to guarantee an acceptable level of flight safety.*

Risk assessment working group			Date : 2x/02/2022
Members	Qualification	Fonction	
Claude GODEL	Ex Capt	Expert (retired airline captain)	
Etienne LICHTENBERGER	Ex Capt	Expert (retired airline captain)	
Jean-Marc REAL	Capt	Active pilot	
Nicolas TENOUX	FO	Active pilot	
Claude BARRET	Ex ATCO	ATS expert	
Nicolas FOTA	Safety eng.	ATM/ANS Safety expert	
Farid ZIZI	Civil Aviation eng.	FRACS project manager	

### Method:

The group chooses to list the safety processes introduced by SafeNcy and then investigates the possible threats for each of them.

**Risk index: the rationale used by the working group is the following:**

- **risk severity:** for each process, we identified possible unsafe states/hazards and determined the associated worst case reasonably possible effect accounting for the available safety barriers & mitigations.

*(An example of unsafe state would be "TEFO landing site proposed is out of range"; an example of safety barrier would be the crew validation ; the severity associated to that unsafe state is A because leading to catastrophic touch down at an inappropriate location).*

- **risk likelihood:** considering the barriers and mitigations already in place or introduced and validated by the project, we estimate the likelihood of occurrence of the unsafe state hazard effect, based on subject matter experts experience and on the “feedback” (section 2).

***Reminder on the coding of Severity and Likelihood:***

**Table 1. Safety risk probability table (ICAO – Doc 9859)**

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

**Table 2. Safety risk severity table**

<i>Severity</i>	<i>Meaning</i>	<i>Value</i>
Catastrophic	Aircraft / equipment destroyed Multiple deaths	A
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	B
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	C
Minor	Nuisance Operating limitations Use of emergency procedures Minor incident	D
Negligible	Few consequences	E





**Table 3. Safety risk matrix**



Safety Risk		Severity				
Probability		Catastrophic A	Hazardous B	Major C	Minor D	Negligible E
Frequent	5	A5	B5	C5	D5	E5
Occasional	4	A4	B4	C4	D4	E4
Remote	3	A3	B3	C3	D3	E3
Improbable	2	A2	B2	C2	D2	E2
Extremely improbable	1	A1	B1	C1	D1	E1

Safety Risk Index Range	Safety Risk Description	Recommended Action
A5, B5, C5, A4, B4, A3	INTOLERABLE	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.
D5, E5, C4, D4, E4, B3, C3, D3, A2, B2, C2, A1	TOLERABLE	Can be tolerated based on the safety risk mitigation. It may require management decision to accept the risk.
E1, D1, E1, B1, C1, D1, E1	ACCEPTABLE	Acceptable as is. No further safety risk mitigation required.

PROCESS N°1	SUB-PROCESSES		Unsafe State(s) Hazards	Safety Barrier(s)	Severity of Unsafe State	Likelihood of Un. State	Risk Index	Mitigation/ Comment
Initial Collection & Classification of the Static Landing Sites Data and aircraft performance data	1-1	Static landing site data: Minimum LDA, Runway lighting, strength...or combination of them ( <i>adapted to the aircraft type</i> )	Basic information inaccuracy (LDA, Runway lighting, ...) Changes over time not reported	<ul style="list-style-type: none"> <li>- Use of certified aeronautical information,</li> <li>- Initial selection process with X-check of sources</li> <li>- update process</li> <li>- AIS define one or two landing strip in the proximity of almost every aerodrome and ensure the periodic checking of its availability</li> </ul>	A	2	A2	Mitigations: <ul style="list-style-type: none"> <li>- Periodic review of initial selection.</li> <li>- Mandatory reporting of any inaccurate data by users.</li> <li>- Quality assurance process</li> </ul> Comment: AIS does not cover the landing strips (class 4 to 6), hence the risk of landing strip becoming unavailable
	1-2	Static data: Approach available (Inst approach versus Visual approach).	Basic information inaccuracy Changes over time not reported	idem	A	2	A2	Idem
	1-3	Static data: Weather report service availability	Basic information inaccuracy Changes over time not reported	idem	C	3	C3	Comment: FIS does not cover every aerodrome neither the landing strips. Mitigation: Pseudo-METAR to be developed
	1-4	Static data: Notam availability	Basic information inaccuracy Changes over time not reported	Idem	A	2	A2	Idem 1-1

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	1-5	Static data: RFFS	Basic information inaccuracy Changes over time not reported	Idem	C	1	C1	Basic information (from AIM) changes over time (from FIS). For the landing strips the RFFS field should be set to 0 (as for aerodromes without RFFS)
	1-6	Static Data: Aerodrome Opening hours	Basic information inaccuracy Changes over time not reported	Idem	D	2	D2	Idem 1-1
	1-7	Static data: ATS/ATC availability	Basic information inaccuracy Changes over time not reported	Idem	D	2	D2	Idem 1-1
	1-8	Static data: PAX and/or Aircraft Handling capacity	Basic information inaccuracy Changes over time not reported	Idem	D	2	D2	Idem 1-1
	1-9	Static data: SafeNcy landing site classification	Basic information inaccuracy Changes over time not reported	Idem	A	2	A2	Idem 1-1
	1-10	Static data: Aircraft characteristics (performance, weights, limitations, ..) database.	Basic information inaccuracy. Changes over time not reported	- Use of Manufacturer's certified information (AFM), - update process	A	2	A2	Mitigation: - Simulator validation. - Periodic review of initial selection. - Mandatory reporting of any inaccurate data by users.

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PROCESS N°2	SUB-PROCESSES		Unsafe State(s) Hazards	Safety Barrier(s)	Severity of Unsafe State	Likeli - hood of Un. State	Risk Index	Mitigation/ Comment
<b>Preflight addition of the Dynamic data to the static data</b>	2-1	LDA > A/C landing distance (weight, expected Wind, Temp., Alt. contamination, MEL items, NOTAMs + D-ATIS)	Dynamic data missing Dynamic data inaccuracy Last minute changes not reported Aircraft status not considered	- Validation and X-check of sources. - Crew and Dispatcher random check.	A	2	A2	Mitigation: - Subject matter expert random checks REC#001: ANS should equip more aerodromes with D-ATIS, with priority on ETOPS aerodromes, in order to enhance validation of landing site with SAFENCY
	2-2	Runway INST APP satisfies A/C APP requirements f(MEL items & NOTAMs + D-ATIS)	Idem	idem	A	2	A2	Idem
	2-3	Last TAF + METARs + D-ATIS Visi/Ceiling > A/C minimums with MEL items	Idem	idem	C	3	C3	Idem and additionally Mitigation to be proposed: pseudo-METAR to be developed]
	2-4	RFFS level > minimum required f(NOTAMs + D-ATIS)	Idem	idem	D	2	D2	Idem 2-1
	2-5	ATS services F(NOTAMs+ D-ATIS) > minimum required	Idem	idem	B	1	B1	Idem 2-1
	2-6	PAX and/or aircraft Handling capacity	Idem	idem	D	1	D1	
	2-7	Opening hours	idem		D	2	D2	



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PROCESS N°3	SUB-PROCESSES		Unsafe State(s) Hazards	Safety Barrier(s)	Severity of Unsafe State	Likeli- hood of Un- State	Risk Index	Mitigation/ Comment
Loading into the aircraft SafeNcy system	3-1	Extract of landing sites database uploaded into the aircraft system covers entirely the Intended flight.	SafeNcy missing landing sites in some areas where the aircraft could need an emergency landing site.	- Reliability of sorting software - Flight Crew checking + check list	A	2	A2	Mitigations: - Subject matter experts to validate the sorting software. - Conformance process Comments: Back to basics, as before SafeNcy
	3-2	Automatic loading into the aircraft SafeNcy systems.	Automatic loading failure	- Flight Crew checking + check-list	E	1	E1	Comments: Back to basics!
	3-3	Loading by the crew in case of automatic loading failure	Crew procedure error or omission	- Crew training + Check-list	A	1	A1	<i>To be manufactured</i>
	3-4	Flight Crew checking process.	Crew check omission	- Crew training + Check-list	A	1	A1	<i>To validate with developers</i>

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PROCESS N°4	SUB-PROCESSES		Unsafe State(s) Hazards	Safety Barrier(s)	Severity of Unsafe State	Likeli- hood of Un. State	Risk Index	Mitigation/ Comment
<b>Inflight Follow Up of the Landing Sites</b>	4-1	Real time ground to aircraft datalink	SafeNcy data link failure + major dynamic data change	<ul style="list-style-type: none"> <li>- Backup datalink system,</li> <li>- Crew datalink failure alert.</li> <li>- Direct exchange with AOC (airline OPS control)</li> </ul>	A	2	A2	Mitigations: - Shorter time between updates
	4-2	Dynamic data follow-up	Information out of date, inaccurate or missing, SafeNcy system miscalculation SafeNcy system failure	<ul style="list-style-type: none"> <li>- Update periodicity,</li> <li>- Automatic alarm in case of DD out of time/date</li> <li>- Crew supervision &amp; Manual update of data</li> </ul>	A	2	A2	Mitigations: - Shorter time between updates - 2 Independent SafeNcy systems O/B
	4-3	Periodic automatic update process	Time between updates too long.	- Display of last update time	A	2	A2	Mitigations: - Manual update process - Crew warning
	4-4	Manual update process	Not working	- Manual entry process	A	1	A1	Comment: To be manufactured
	4-5	Possibility to manually eliminate an ASAP or ANSA landing site proposition	Elimination of the best possible proposal	Elimination of landing site should follow crew common failure analysis	A	1	A1	Comment: To be manufactured

PROCESS N°5	SUB-PROCESSES		Unsafe State(s) Hazards	Safety Barrier(s)	Severity of Unsafe State	Likelihood of Un. State	Risk Index	Mitigation/ Comment
<b>Aircraft position and available energy update</b>	5-1	Aircraft position follow up	Wrong aircraft position in SafeNcy system inducing wrong landing sites proposals and wrong 4D trajectories.	<ul style="list-style-type: none"> <li>- Monitoring of the SafeNcy Aircraft position versus the actual FMS position</li> <li>- Pilot's monitoring</li> </ul>	C	3	<b>C3</b>	Comments: If SafeNcy is part of the FMS, it should not happen. If safeNcy is not synchronized with the FMS position, it can happen but the pilots will identify the issue when using the FMS for the diversion. Mitigation: pilots ignore the SafeNcy proposal.
	5-2	Height above landing site follow-up (based on aircraft barometric altitude/ geometric GPS altitude)	Height follow-up error (inducing wrong energy management)	<ul style="list-style-type: none"> <li>- Monitoring of the SafeNcy Aircraft altitude versus the actual altitude.</li> <li>- Transition altitude included in the landing site database</li> <li>- Pilot's monitoring</li> </ul>	A	2	<b>A2</b>	Comments: If SafeNcy is part of the FMS, it should not happen. If still happens it can be catastrophic. But pilots should quickly identify the issue. Comment: QNH may be provided for landing strips through area-QNH or Pseudo-METAR
	5-3	Aircraft actual weight follow-up	Wrong aircraft weight.	<ul style="list-style-type: none"> <li>- Pilot monitoring</li> <li>- use of a safety margin</li> </ul>	C	3	<b>C3</b>	Comments: Aircraft weight should not be a major factor in terms of range but can be an issue regarding landing performance.
	5-4	Available range (available energy) follow-up	Range error, proposed landing site not reachable.	<ul style="list-style-type: none"> <li>- Pilot monitoring</li> <li>- range calculation including a safety margin</li> </ul>	A	1	<b>A1</b>	Comments: Can be catastrophic in a TEFO case or if SafeNcy is not able to continuously update the situation during the diversion.


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				- SafeNcy continuous update of the situation during the diversion.				
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PROCESS N°6	SUB-PROCESSES		Unsafe State(s) Hazards	Safety Barrier(s)	Severity of Unsafe State	Likeli- hood of Un. State	Risk Index	Mitigation/ Comment
Assessment by the flight crew of the Aircraft Failure(s)/ Emergency type	6-1	Automatic detection of the failure, Choice of emergency type (TEFO, ASAP, ANSA, other) by SafeNcy system	Failures assessment error by SafeNcy system, Wrong type of emergency proposed	<ul style="list-style-type: none"> <li>- Crew supervision, the pilots take action and insert the right emergency/failure type</li> <li>- Sim. Crew training</li> <li>- Crew X-check procedures</li> </ul>	C	3	C3	Comments: the SafeNcy emergency menu allows the pilot to select the right failure and resulting aircraft state at any time.
	6-2	Manual selection of the failure and/or type of emergency by the crew	Failures assessment error by the crew Crew insertion error (stress, hurry up syndrome)	<ul style="list-style-type: none"> <li>- FORDEC</li> <li>- Sim. Crew training</li> <li>- Crew X-check procedures</li> </ul>	A	2	A2	Mitigations: <ul style="list-style-type: none"> <li>- Possibility, at any time, to manually insert a different failure/emergency</li> </ul>





PROCESS N°7	SUB-PROCESSES		Unsafe State(s) Hazards	Safety Barrier(s)	Severity of Unsafe State	Likelihood of Un. State	Risk Index	Mitigation/ Comment
SafeNcy Landing Site selection process after Failure/ Emergency	7-1	TEFO landing site proposal	Out of range or obvious catastrophic outcome	<ul style="list-style-type: none"> <li>- Crew validation</li> <li>- Conservative range calculation (Margin)</li> <li>- SafeNcy continuous update of the situation during the diversion.</li> </ul>	A	2	A2	Mitigations: - Possibility, any time during the diversion, to manually request a new proposal
	7-2	ASAP landing site proposal	Not adapted to the type of emergency (Fire) or too far away.	<ul style="list-style-type: none"> <li>- Crew validation</li> <li>- Crew training,</li> <li>- Crew decision making training</li> <li>- SafeNcy continuous update of the situation during the diversion.</li> </ul>	B	2	B2	Mitigations: Possibility, any time during the diversion, to manually request a new proposal
	7-3	ANSA landing site proposal	Not the nearest or not suitable.	<ul style="list-style-type: none"> <li>- Crew validation</li> <li>- Crew training,</li> <li>- Crew X-check procedures</li> <li>- SafeNcy continuous update of the situation during the diversion.</li> <li>- DSPTCH flight follow up</li> </ul>	D	2	D2	Comments: New Crew decision possible any time since it is an ANSA situation
	7-4	Other emergency landing site proposal (specific	Landing site not adapted	<ul style="list-style-type: none"> <li>- Crew validation</li> <li>- Crew training,</li> </ul>	D	2	D2	Comments:



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		emergency e.g. Bomb alert, depressurization)		<ul style="list-style-type: none"> <li>- Crew decision making training,</li> <li>- DSPTCH back up</li> </ul>				New Crew decision possible any time since it is an ANSA situation
	7-5	<p>Proposed diversion aerodrome acknowledged by ATS</p> <p>Note: applicable to diversion aerodromes serviced by ATS</p>	<p>Potential unsafe state:</p> <ul style="list-style-type: none"> <li>- Pilot-validated diversion aerodrome not available for landing (e.g. runway blocked, actual weather is adverse)</li> <li>-</li> </ul> <p>Examples of causes:</p> <ul style="list-style-type: none"> <li>- Pilot fails to communicate the correct proposed diversion aerodrome (e.g. pilot(s) decide to change diversion landing site and does not inform ATC)</li> <li>- ATS acknowledges an inadequate proposed diversion aerodrome failing to report the unavailability for landing ]</li> </ul>	<ul style="list-style-type: none"> <li>- D-ATIS (where available) enables updated actual RWY landing status onboard SAFENCY system]</li> <li>- Cross check by ATC and inform of potential additional hazard</li> <li>-</li> </ul>	A	2	A2	<p>Safety recommendation: ANS should equip more aerodromes with D-ATIS, with priority on ETOPS aerodromes, in order to enhance validation of landing site with SAFENCY</p> <p>Pilot to request alternative solution by SafeNcy if additional hazard consequent</p>


PROCESS N°8	SUB-PROCESSES		Unsafe State(s) Hazards	Safety Barrier(s)	Severity of Unsafe State	Likelihood of Un. State	Risk Index	Mitigation/ Comment
Calculation and Validation of the Diversion 4 D Trajectory	8-1	Calculation is performed according to FCOM data, Speed is maintained in the operational limits, taking into account the current failures	Error in the SafeNcy A/C performance data base, The calculation does not correctly integrate the limitations due to the failure	<ul style="list-style-type: none"> <li>- Ad hoc simulator to allow subject matter experts to validate SafeNcy output.</li> <li>- SafeNcy continuous update of the situation during the diversion.</li> <li>- Pilot monitoring.</li> <li>- Use of safety margin</li> </ul>	B	3	B3	Comments: Crew must validate and monitor the 4D trajectory.
	8-2	Horizontal path is optimized	Horizontal path not adapted, too complicated	<ul style="list-style-type: none"> <li>- Software validated using ad hoc sim</li> <li>- SafeNcy continuous update of the situation during the diversion.</li> </ul>	C	3	C3	Comments: Crew validation and monitoring of the 4D trajectory, manual correction
	8-3	Vertical path is adapted to the emergency	Wrong vertical profile proposed	<ul style="list-style-type: none"> <li>- 19 vertical profiles available in the SafeNcy database.</li> <li>- Software validated using ad hoc sim</li> <li>- continuous update of the</li> </ul>	B	2	B2	Comments: Subject matter experts to verify for each emergency type that it is linked to the right vertical profile

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				situation during the diversion.				
	8-4	Initial local contingency procedures are applied (Oceanic, national, etc.)	Error in SafeNcy contingency procedures, SafeNcy safety contingency procedures not up to date	- SafeNcy database must be up to date	C	3	C3	Idem
	8-5	Safety margins to terrain are applied, taking into account the current failures	Too close to terrain	- Terrain database must be reliable - Lateral and vertical margins to be applied	A	2	A2	Mitigations: - TAWS  Comments: Crew validation and monitoring of the 4D trajectory, manual correction
	8-6	Safety margins to marginal weather are applied, taking into account the current failures	Entering dangerous weather phenomena	- Metsafe data must be reliable - use of weather radar (if available) by pilots	C	3	C3	Mitigations: - DSPTCH back up  Comments: Crew validation and monitoring of the 4D trajectory, manual correction

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PROCESS N°9	SUB-PROCESSES		Unsafe State(s) Hazards	Safety Barrier(s)	Severity of Unsafe State	Likeli- hood of Un. State	Risk Index	Mitigation/ Comment
<b>Activation of the Diversion to the proposed landing site and the 4 D Flight Path</b>	9-1	Horizontal Flight Path insertion into the FMS	Links between SafeNcy and the FMC inaccurate or not taking in account the aircraft failures	<ul style="list-style-type: none"> <li>- FMS subject matter expert validation.</li> <li>- Crew X-checks</li> </ul>	D	2	D2	Comments: Crew validation and monitoring of the 4D trajectory, Manual take over by the crew in case of insertion difficulties
	9-2	Vertical Flight Path insertion into the FMS	Links between SafeNcy and the FMC inaccurate or not taking in account the aircraft failures	<ul style="list-style-type: none"> <li>- FMS subject matter expert validation</li> <li>- Crew X-checks</li> </ul>	D	2	D2	Idem
	9-3	Speed/Mach insertion into the FMS	Links between SafeNcy and the FMC inaccurate or not taking in account the aircraft failures	<ul style="list-style-type: none"> <li>- FMS subject matter expert validation</li> <li>- Crew X-checks</li> </ul>	D	2	D2	Idem

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PROCESS N°10	SUB-PROCESSES		Unsafe State(s) Hazards	Safety Barrier(s)	Severity of Unsafe State	Likeli- hood of Un- State	Risk Index	Mitigation/ Comment
<b>A/C - ATC automated Commu- nication</b>	10-1	Except for an ANSA diversion, Datalink Emergency message informing ATC of the diversion aerodrome (including SOB (Souls on Board) + landing site coordinates if class 4, 5 and 6) + Same information via Synthetic emergency voice message on VHF 121,5	Message not sent or Incorrect message (e.g. pilot(s) decide to change diversion landing site)	<ul style="list-style-type: none"> <li>- New updated messages if diversion landing site changes</li> <li>- Transponder mode S</li> <li>- Code 7700</li> </ul>	D	2	<b>D2</b>	Mitigations: - Pilot voice message  Comments: ATC can request update via voice message.
	10-2	Automatic transmission of A/C position, altitude and speed and VS	Wrong data sent down due to aircraft failure.	<ul style="list-style-type: none"> <li>- Transponder mode S</li> <li>- Code 7700</li> <li>- SafeNcy eliminates outlier data</li> </ul>	D	2	<b>D2</b>	Mitigations: - triggering of Autonomous Distress Tracking (ADT) mode - ELT transmission (GADSS) - Pilot voice message
	10-3	Automatic transmission of intended track to the ATC + + Reports of trajectory changes (lateral or vertical) via Synthetic emergency voice message on VHF 121,5	ATC not receiving any data or wrong data	<ul style="list-style-type: none"> <li>- Transponder mode S</li> <li>- 7700</li> <li>- voice message</li> </ul>	D	2	<b>D2</b>	Comments: ATC contacts aircraft by voice message. If VHF available, voice message is used to inform surrounding airspace users



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PROCESS N°11	SUB-PROCESSES		Unsafe State(s) Hazards	Safety Barrier(s)	Severity of Unsafe State	Likeli - hood of Un. State	Risk Index	Mitigation/ Comment
<b>Diversion follow-up (updating of emergency criteria)</b>	11-1	Worsening of the emergency	Selected landing site is no longer adapted	- SafeNcy continues to update the situation during the diversion and can propose a new landing site	B	3	B3	Mitigations: - Pilot monitoring - Pilot takes action - Pilot manually enters the worse emergency into SafeNcy and requires a new proposal. Comments: New landing site involves to perform a new ATS acknowledgement process as per 7-5
	11-2	Real time Range calculation shows a need for a closer landing site.	Intended landing site no longer reachable	- SafeNcy continues to update the situation during the diversion and can propose a new landing site	A	2	A2	Idem

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	11-3	Worsening of weather conditions	Approach and landing at the intended landing site may no longer be possible.	<ul style="list-style-type: none"> <li>- real time update of Dynamic data</li> <li>- SafeNcy continues to update the situation during the diversion and can propose a new landing site</li> </ul>	B	3	B3	Idem
	11-4	Landing site no longer adapted	Landing site closed for some reason	<ul style="list-style-type: none"> <li>- Pilot + Dispatch monitoring</li> <li>- Initial ATS acknowledgement of diversion aerodrome would reduce the exposure</li> <li>- In case of RWY closure/blocking after ATC acknowledgement, ATC would inform the pilot</li> </ul>	A	2	A2	<p>Comments: Once the diversion aerodrome is acknowledged by ATS (as per 7-5), ATS will ensure that the RWY will be available at the expected landing time In case of no ATS, once the diversion airport is informed of the emergency there is little chance that the aircraft will not be accepted in priority.</p> <p>Mitigation: Alternative choice by SafeNcy</p>



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PROCESS N°12	SUB-PROCESSES		Unsafe State(s) Hazards	Safety Barrier(s)	Severity of Unsafe State	Likeli- hood of Un. State	Risk Index	Mitigation/ Comment
Final approach	12-1	Delivery PINS	Not adapted to the aircraft state	<ul style="list-style-type: none"> <li>- SafeNcy chooses between different emergency scenario (vertical profiles), each one ending at an adequate delivery pins</li> <li>- Pilot monitoring</li> </ul>	B	2	B2	Comments: Pilot monitoring can lead to pilot taking action to correct the path.
	12-2	Delivery PINS	Aircraft too high or too low or wrong speed.	<ul style="list-style-type: none"> <li>- SafeNcy continues to update the situation during the diversion and can change the 4D path to reach the delivery pins as expected</li> <li>- Pilot monitoring</li> </ul>	B	3	B3	Idem

## 7. ACTION PLAN

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Ref	Process	Action	Specific mitigation	Person in charge	Deadline
1	5-3 5-4 7-1 8-1 8-5 8-6	Calculation shall include margins	Safety Margins to be defined	ENAC UPC METSAFE	Done
2	8-2	Horizontal trajectory validation	Subject matter experts validation	Pilots	Done
3	8-3	Vertical trajectory validation	Subject matter experts validation	Pilots	Done

## 8. CONCLUSION

Risk acceptability
<p>The SRA members consider that SafeNcy as a whole <b>improves the global safety of the flight</b> in case of emergency. Pilots will gain a much <b>better situation awareness</b> allowing them to take the right decision.</p> <p>Nevertheless, the final decision and responsibility <b>remains with the flight crew</b>. SafeNcy should be considered as a <b>decision-making aid</b>.</p> <p>The complexity of a real emergency makes it difficult to put into equations and algorithms all the processes needed to safely land a damaged aircraft. Therefore, the SRA members recommend the <b>use of safety margins</b> for each calculation.</p> <p>By doing so, the risk of SafeNcy leading the crew into a dead end will be <b>considered acceptable</b>.</p> <p>Through the exchange of the trajectory and diversion aerodrome with ATC, SafeNcy will <b>enhance the efficiency of rescue services</b> and anticipate aircraft landing.</p>

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## 9. ASSOCIATED DOCUMENTS

Comments:

All Project Documents developed in the frame of SafeNcy development project