

SAVOIR FDIR Handbook update - ADCSS 2022

Presenter: Silvana Radu
Contributors: Benedicte Girouart, Paulo Rosa

25/10/2022

1. Scope
2. Composition and support
3. Updated planning and timeline
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6. Update outcome: RAMS clarifications
7. Update outcome: minor lessons learned
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European Space Research
and Technology Centre
Keplerlaan 1
2201 AZ Noordwijk
The Netherlands
T +31 (0)71 565 6565
F +31 (0)71 565 6040
www.esa.int

DOCUMENT

SAVOIR FDIR Handbook



Prepared by SAVOIR
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Agence spatiale européenne

- ✓ Identify missions or technologies for which common FDIR design and processes recommended in the first issue of the handbook are not applicable or require tailoring
- ✓ Identify minor aspects within the handbook that are needed for update in order to be aligned with other existing handbooks or technical notes
- ✓ Revise overall handbook and alignment with ECSS
- ✓ Gather lessons learned from satellite manufacturers and mission operators on FDIR and integrate those lessons learned in the handbook

Ensure the handbook can be used for a large range of types of missions, including with regards to new niches such as Close Proximity Operations, high autonomy, use of AI/ML, etc.

- ✓ At the SAVOIR Advisory Group meeting #51, the SAG has decided to continue the FDIR working group for the elaboration of the second issue of the SAVOIR FDIR.

Composition and support

From ESA side:

Name expert	Expertise
Andrei Oganessian	Avionics, SW
Andrew Brown	PA, RAMS
Andrew Wolahan	System, CPO
Benedicte Girouart	GNC, AOCS
Charles Lahorgue	Constellations, RAMS, FDIR
Cristophe Honvault	Software
Christoph Steiger/ Caglayan Guerbuez	Operations
David Pena Hidalgo	Software
Jean-Loup Terraillon	Savoir, MBSE
Laurent Hili	CDHS, AI/ML
Marcel Verhoef	MBSE, SW
Mauro Caleno	Software
Massimo Casasco/ David Sanchez	GNC, AOCS
Roger Walker/ delegated	CubeSats
Silvana Radu	RAMS, CPO, CubeSats, MC
Ferdinando Tonicello	Power



Co-chairs:

- Silvana Radu
- Benedicte Girouart

Composition and support

From industry side:

Name expert	Organisation
Dave Thomas/ Thomas Chabot	ADS
Stephanie Bourbouse	ADS
Nathalie Pons	CNES
Aurelie Strzepek	CNES
Lennart Andersson	RUAG
Olivier Rigaud	TAS
Orion Azzis	TAS
Stefano Di Vito	TAS
Matthias Hopping	OHB
Machel Gordon	OHB
Paulo Rosa	Deimos



Support to ESA Co-chairs:

- Paulo Rosa

To be continued by Deimos for the duration of the activity.

Deimos main tasks:

- Organise splinters
- Support convergence towards a consensus



- Maintain the shared repository
- Gather the lessons learned from industry
- Keep minutes of meetings
- Prepare status reports



... and the most important => perform the update of the FDIR Handbook.

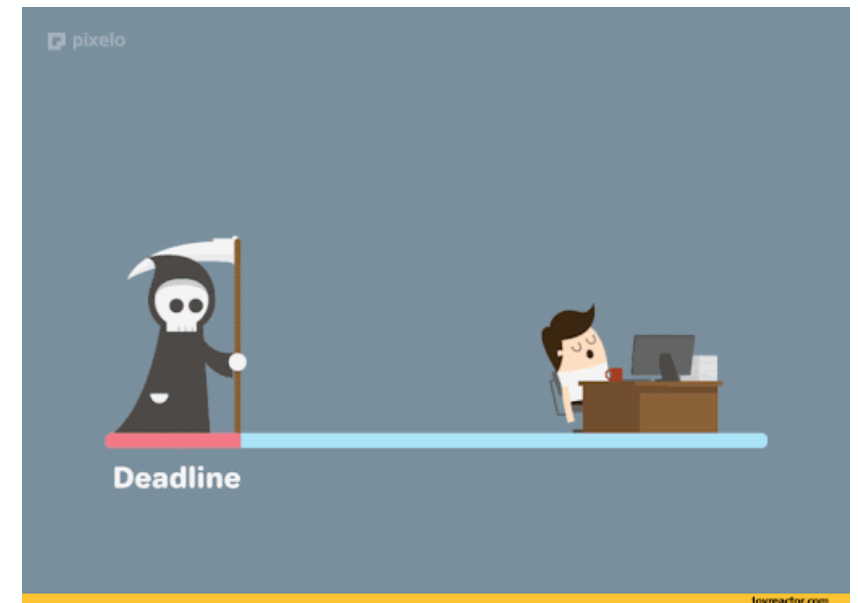
Updated planning and timeline

- Schedule shifted with ~3 months -> waiting for inputs coming from ongoing activities
- Update of the handbook (partially performed) took longer due to understaffing
- Next meeting: mid-checkpoint 15/11/2022

Scope of mid-checkpoint:

- to show to the WG the status of the update
- To provide the updated doc for review and agree on review process
- Review to be performed by WG members by 13/01/2023

Meeting 6 to be held in person (hybrid) in February 2023!



Major topics tackled

1. Alignment with ESA mission classification
2. CubeSats/Small Sats performing complex missions
3. **Close Proximity Operations (e.g. in-orbit servicing, ADR, etc.)**
4. **Use of RAMS analysis for FDIR definition**
5. Use of MBSE in FDIR definition
6. Use of AI and ML for FDIR
7. **Identify constellations gaps**
8. **Identify ground segment gaps**
9. **Establish timeline of FDIR concept definition**
10. **Disposal**
11. **FDIR tools recommendation**
12. Verification approach for FDIR
13. **NewSpace**

Meeting
6 ->
02/2023
Topics
1,2,12

Decision to
postpone for next
update or to
merge within
mission
classification

Update outcome: CPO use cases

CPO use cases drafted as per template:

1. Cooperative rendezvous without capture and formation flying
2. Cooperative rendezvous with capture
3. Non-cooperative rendezvous without capture
4. Non-cooperative rendezvous with capture

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1 USE CASES TEMPLATE

1.1 Definition

*Introduction to the use case, describing the typical mission objectives, S/C attributes, main challenges (not focused on FDIR)
(1-2 paragraph)*

1.2 Drivers for FDIR

*Why is it different from the "standard case"?
Description of the main challenges in terms of FDIR and why the current version of the HB does not handle it properly (e.g., for CPO, the main difference could be risk of uncontrolled collision with the target, the need for the FDIR to allow for a controlled collision, i.e., capture, etc.)
(1 paragraph)*

1.3 Tailoring Needs

*How is it different from the "standard case"?
Very short introduction or kept empty, as the tailoring needs are addressed in the following subsections
(1 paragraph or less)*

1.3.1 Specific Terms and Definitions

*Define specific terms if necessary
(1 paragraph or table)*

1.3.2 Changes to the FDIR Process

*Indicate the steps that require changes and define those changes
Add a note here that the full process can be found in pages ...
(1 paragraph per step and/or a table (preferable) for the overall process)*

1.3.3 Required Updates to the DRL

*Specify if there are any updates needed to the DRL
(1 paragraph or table)*

1.4 Example Missions

*List missions that could fall within this use case
(1 table)*

1.5 Lessons Learned

*Bullet list of lessons learned related to this use case
(1 page or less)*

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SAVOIR FDIR Handbook - Use Cases Template

Date 11/11/2021 Issue 0 Rev 1

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Update outcome: CPO use cases

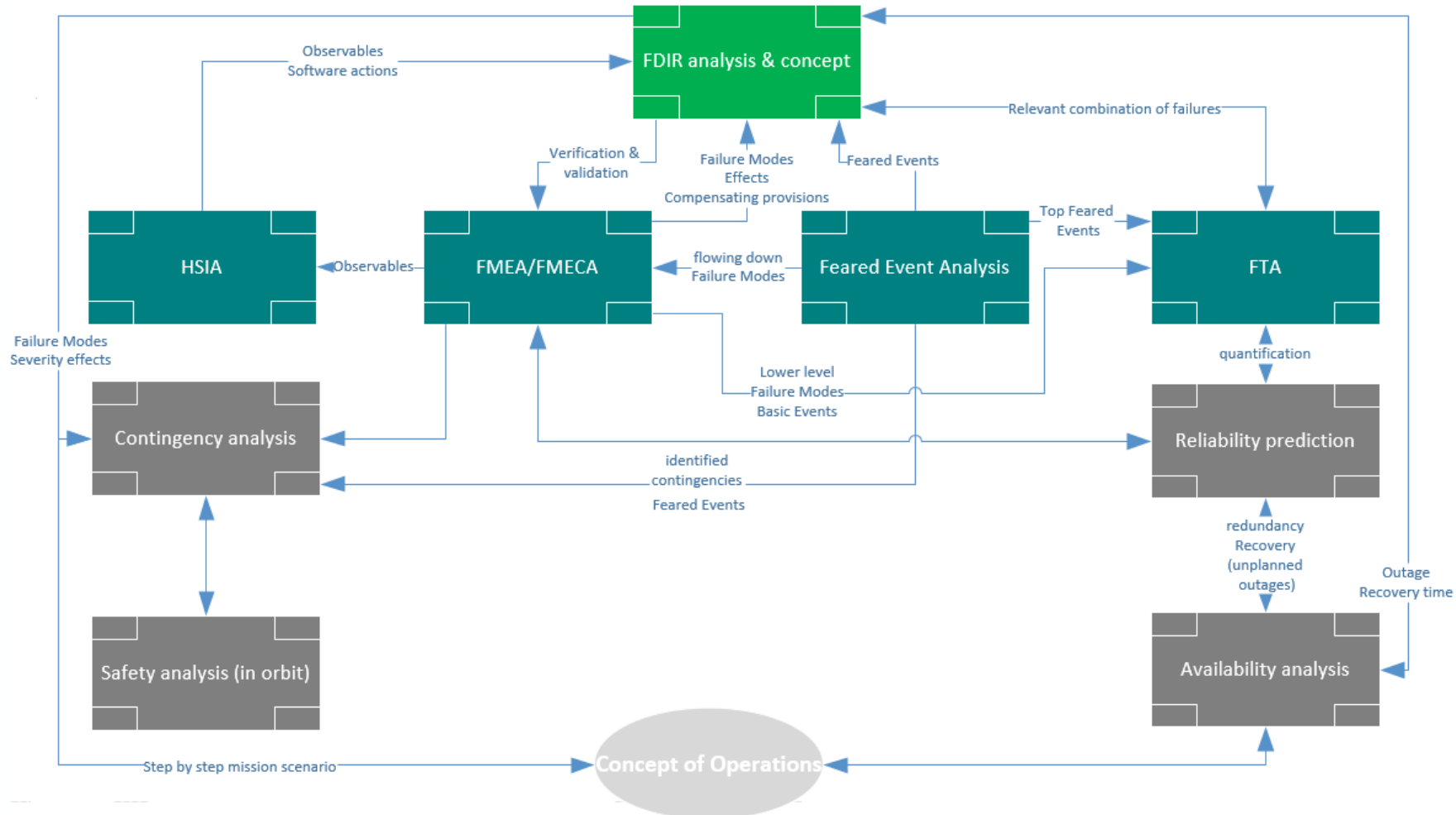
Missions and lessons learned and designs considered when updating:

- Proba-3
- PRISMA
- ClearSpace-1
- Mars Sample Return – Earth Return Orbiter (MSR-ERO)
- e.inspector

Updated, reviewed internally (co-chairs) and ready to be sent for review within the FDIR WG.

Update outcome: RAMS clarifications

Direct contribution to FDIR
 Indirect contribution to FDIR



Purpose:

- To better showcase the interaction between FDIR and RAMS (it is often noticed that this aspect is a constant lack in projects)
- To provide an easier read of the interactions between analysis.

Update outcome: RAMS clarifications

Analysis 1	Analysis 2	Output Analysis 1 to Input Analysis 2
FMEA/FMECA	FDIR	FM, effects equipment/subsystem/system, compensating provisions (serving to recovery), observables (serving to detection/identification)
FDIR	FMEA/FMECA	Verification and validation of implemented functions
FMEA/FMECA	HSIA	FM, observables
HSIA	FDIR	Observables, SW actions, effects of failure upon SW/HW
Availability analysis	FDIR	Planned and unplanned outages
FDIR	Availability analysis	Time to perform a recovery action
Availability analysis	CONOPS	Overall system availability and unavailability
CONOPS	Availability analysis	Concept of operations, planned outages
Contingency analysis	CONOPS	Contributes to FOM
FTA	FDIR	Relevant combinations of failures to be accounted for within the FDIR design
FEA	FDIR	Top feared events for which FDIR shall be design in order to react accordingly
Reliability prediction	FDIR	Indirect contribution through redundancy scheme

Purpose:

- Table to be added in order to clarify inputs and outputs coming from each analysis.

Update outcome: minor lessons learned

Minor points raised – 50, among which several can be mentioned as being more interesting:

- Dependency analysis revision
- Minor RAMS aspects revision and alignment with ECSS
- Bringing updated version of the handbook in line with the generic OIRD evolution
- Alignment of handbook with decisions and updates ongoing within the PUS C WG
- Alignment of handbook with ongoing discussions within the SAVOIR Power WG
- Integration of basic assumptions within the update of the handbook



80% of minor lessons learned were incorporated within the current version of the update of the SAVOIR FDIR Handbook.

Way forward

- Perform mid check-point meeting and review 11/22
- Continue with the remaining topics 02/23-04/23
- Perform update of the remaining topics 05/23
- Send for review to the FDIR WG second part of the update 05/23
- Send updated handbook to SAG for review 06/23

Tight schedule but...



Thank you, Questions?



Space Team Europe

