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***ESPN-R***

***European Safety Promotion Network – Rotorcraft***

***Team Operations and SMS***

***RISK ASSESSMENT***

***MAINTENANCE CHECK FLIGHT***

*A template for the Aviation Community*

**Edition 1**

**02/07/2021**

**Purpose of the Maintenance Check Flight risk assessment template**

The Purpose of this template is to provide the operators a starting point for their own development of the risk assessment in support to the maintenance check flight programme required by Reg. (EU) 965/2012 - ORO.AOC.125.

This document is intended as an initial guideline and it shall be reviewed and opportunely modified by the operator/organisation to respect its own internal organisation and procedures.

This document has been initially released by Safe-IT, the Italian safety managers’ discussion group (Focal Point: s.burigana@aeronauticalsafety.com) and it has further discussed and developed by the ESPN-R working group.

Anyone can use this document to develop their own MCF manual within their company. The material is editable and disclosable.

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**RISK ASSESSMENT**

**RA 21-MCF**

**MAINTENANCE CHECK FLIGHTS**

**EDITION 0**

**REVISION 0.0** - 02/07/2021

|  |  |  |  |
| --- | --- | --- | --- |
| **Safety Manager** | **Safety Review Board**  | **CMM / QM** | **Accountable Manager** |
| I certify that the risk assessment has been carried out as per the SMM chapter 6 principles and the final risk defined accordingly. No further safety recommendations are deemed necessary. | I certify that the risk assessment has been shared with the Safety Review Board members and it was acceptable to them. | I certify that the formal process according the SMM paragraph 6.2 has been complied to. | I certify that all the identified barriers/ mitigations are implemented and that no further actions are required. The residual risk is deemed **ACCEPTABLE**. |
| Name:  | Name:  | Name:  | Name:  |
| \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_Date: *21/05/2021* | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_Date: *21/05/2021* | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_Date: *21/05/2021* | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_Date: *21/05/2021* |

*Operator’s name and address*

NOTE 1: This risk assessment is an initial guidance to the operator. The hazards, probabilities, consequences, and risk levels shall be considered as examples. The operator will need to perform their own assessment to properly fit the actual operator’s environment and operations.

NOTE 2: The classification of the Level of the MCF (Level A or B) in this example is the result of a specific risk assessment. The classification proposed herein is a SUGGESTION. The operator shall provide for its own risk analysis and Level classification.

Different approaches may be used to define Level A or B.

Reg. 965 indicates:

***SPO.SPEC.MCF.100 Levels of maintenance check flight***

*Before conducting a maintenance check flight, the operator shall determine the applicable level of the maintenance check flight as follows:*

1. *“Level A” maintenance check flight for a flight where the use of abnormal or emergency procedures, as defined in the aircraft flight manual, is expected, or where a flight is required to prove the functioning of a backup system or other safety devices;*
2. *a “Level B” maintenance check flight for any maintenance check flights other than a “Level A” maintenance check flight.*

***SPO.SPEC.MCF.140 Systems and equipment***

*When a maintenance check flight is intended to check the proper functioning of a system or equipment, that system or equipment shall be identified as potentially unreliable and appropriate mitigation measures shall be agreed prior to the flight in order to minimise risks to flight safety.*

The Operator shall define which of its MCF flight is to be considered as a Level A or a Level B MCF. This can be done with a specific risk assessment.

The following table may help the organisation on how to approach a documented definition of Level A or B MCFs.

| Way to approach the SPO.SPEC.MCF.100 | Example | PROs and CONs | Documentation |
| --- | --- | --- | --- |
| The phrase “*the use of abnormal or emergency procedures, as defined in the aircraft flight manual, is expected*” may be interpreted as: “whenever the MCF requires the pilot to execute some manoeuvres that are not described in the RFM under “normal procedures”, but are described in the abnormal or emergency section, that flight is a Level A MCF. | **LEVEL A MCF**Autorotation to verify the Nr during a power-off descent.Flight without one of the two hydraulic systems to check the correct functioning.These procedures and the way to handle the situation are described in the abnormal or emergency section of the RFM.**LEVEL B MCF**Flight to the Vne.Post-maintenance flight to verify that all systems are functioning without the exclusion of any of them during flight.These flights may be executed by referencing only to the “normal procedure” section of the RFM. | **PROs**Most MCF may be classified as Level B.**CONs**Classifying a flight as Level A or B does not clarify if a MCF is a high risk or low risk flight. For example, a post-maintenance MCF after the substitution of parts of the tail rotor (blade, pitch-change mechanism, TR hydraulic parts, etc.) is a Level B MCF because there are no abnormal or emergency procedures required to be executed during the MCF flight. Nevertheless, if the substituted component will not work properly, handling a tail rotor emergency could be very demanding. | When preparing the MCF Form (see Attachment A), the CAMO, with the help of the Operations department, shall define if the MCF is a Level A or B by verifying if any of the RFM abnormal or emergency procedures are planned to be executed during the MCF flight.An analysis of the risk level of the flight shall be done for each MCF considering the possibility of failure of the checked system. Level A or B categorisation does not give due information if the flight is a high risk or low risk.Before the flight, the pilot shall duly review the abnormal and emergency procedures related to the system to be checked and mentally prepare for using them. |
| The phrase “*the use of abnormal or emergency procedures, as defined in the aircraft flight manual, is expected*” may be interpreted as: “whenever a system shall be verified in flight for proper functioning, that system shall be considered unreliable and may fail. The pilot shall be prepared for the possible course of action to be implemented in case of checked system malfunction. The complexity and the risk level of the pre-planned or possible course of action determines the Level A or B of the MCF.  | **LEVEL A MCF**Post-maintenance flight to verify that all systems are functioning after an engine component has been replaced (starter generator, FCU, fuel nozzles, etc).In case of system malfunction, the pilot may expect an engine failure or a commanded engine shutdown in flight (OEI, autorotation if single-engine)Flight to verify the functionality of the AFCS.In case of AFCS malfunction, the pilot may expect to fly with reduced stability. In case of checked system malfunction, the pilot shall make use of abnormal or emergency procedures, or he may need a further flying skill than needed during normal flight.**LEVEL B MCF**Engine shutdown on ground by using the fuel valve or the throttles, to verify their functionality.Flight to verify any electrical component in daylight VMC.In case of checked system malfunction, the pilot will not need to execute demanding procedures. | **PROs**Level A and B classification reflects the level of demanding requirements for a pilot in case of malfunction of the checked system.**CONs**Most MCF will be classified as Level A.Possibly, MCF risk assessment may be more complex. | The risk assessment shall analyse the risk level of the handling of the flight, supposed that the checked system fails.One way to do so, is to initially analyse the abnormal and emergency procedures described in each specific aircraft type RFM and classify them as Level A or B based on the complexity and the level of risk of the manoeuvres or course of actions required.Subsequently, the MCF shall be analysed to see which of the abnormal or emergency procedures may apply to the requested maintenance flight and classify the MCF accordingly. Before the flight, the pilot shall duly review the abnormal and emergency procedures related to the system to be checked and mentally prepare for using them. |

This risk assessment example uses the second approach using 3 tables:

Table 1: Analysis by Emergency and malfunction area

With reference to the Flight Manual of each single type of aircraft in fleet, the emergency and malfunction procedures have been evaluated, classified as Level A or B and grouped in specific areas.

Table 2: Analysis by Maintenance area

Maintenance areas and the related possible emergency and malfunction procedures (from table 1) have been defined, along with the level of MCF.

Table 3: Holistic analysis of MCF

This table analyses the risks of conducting an MCF flight as an operator’s process

MCFs should be monitored through SMS, FDM if available, pilot debriefs and reports, etc. as part of the Risk Assessment, Mitigation and Management component of the internal SMS. Subsequently, a proper correction of the specific MCF defined as level A and B may be performed.

NOTE 3: The format used for this risk assessment example is the method suggested in the guidance in chapter 8 of the EHEST Safety Management Manual (Complex operators) Edition 2. However, each operator needs to utilise the format described in its own SMS documentation when performing this RA.

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# General

## Revisions

|  |  |  |  |
| --- | --- | --- | --- |
| **Ed.** | **Rev.** | **Date** | **Element** |
| **0** | **0.0** | **21/05/2021** | **New edition** |
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|  |  |  |  |
|  |  |  |  |

## Definitions

|  |  |
| --- | --- |
| **Level A maintenance check flights** | Flights where the use of abnormal or emergency procedures, as defined in the aircraft flight manual, is expected, or where a flight is required to prove the functioning of a backup system or other safety devices |
| **Level B maintenance check flights** | Any maintenance check flights other than a “Level A” maintenance check flight  |
| **Maintenance check flight** | A flight of an aircraft with an airworthiness certificate or with a permit to fly which is carried out for troubleshooting purposes or to check the functioning of one or more systems, parts or appliances after maintenance, if the functioning of the systems, parts or appliances cannot be established during ground checks and which is carried out in any of the following situations:1. as required by the aircraft maintenance manual (‘AMM’) or any other maintenance data issued by a design organisation approval (DOA) holder being responsible for the continued airworthiness of the aircraft;
2. after maintenance, as required by the operator or proposed by the organisation responsible for the continuing airworthiness of the aircraft;
3. as requested by the maintenance organisation for verification of a successful defect rectification;
4. to assist with fault isolation or troubleshooting;
 |
| **Test Flight** | A pre-certification flight, usually carried out by the manufacturer. Test Flights are not dealt with in this manual |

|  |  |
| --- | --- |
| **Continuing Airworthiness**(Operator)**:** | meaning all of the processes ensuring that, at any time in its operating life, the aircraft complies with the airworthiness requirements in force and is in a condition for safe operation |
|  |  |
| **Continued Airworthiness**(DOA Holder)**:** | all the actions associated with the upkeep of a type design and the associated approved data through life |

## Synonyms and acronyms

|  |  |
| --- | --- |
| **AGL****AMM** | Above Ground LevelAircraft Maintenance Manual |
| **ATC** | Air Traffic Control |
| **ATL** | Airplane Technical Log |
| **ATS** | Air Traffic Service |
| **CFIT** | Controlled Flight Into Terrain |
| **CFS****DOA** | Check Flight ScheduleDesign Organisation Approval |
| **FSTD** | Flight Simulator Training Device |
| **HTL** | Helicopter Technical Log |
| **LOC-I** | Loss Of Control – In flight |
| **MCF** | Maintenance check flights |
| **MEL****OEM** | Minimum Equipment ListOriginal Equipment Manufacturer |
| **RA****RFM** | Risk AssessmentRotorcraft Flight Manual |
| **TCM** | Technical Crew Member |
| **TE** | Top Element |
| **TS** | Task Specialist |
| **VFR** | Visual Flight Rules |
| **VMC** | Visual Meteorological Conditions |

# Purpose

This risk assessment studies the augmented risks and the related barriers related to the maintenance check flights (MCFs) operations.

# Type of operation and brief description

A significant number of aviation accidents and serious incidents occur during non-revenue flights. Among them, a particular case is maintenance check flights (MCFs). These flights, under the control of the operator, may be required to assist in the identification of a defect, to complete certain maintenance instructions, to verify that maintenance has been properly performed, or to avoid operational disruptions after major maintenance.

During the execution of a maintenance check flight and in order to fulfil its objective, there is often the need to operate the aircraft differently from what is the normal aircraft operation (e.g. trying to reproduce in flight a fault discovered on ground for troubleshooting).

Performing this flight without additional precautions may not be safe.

# Working group participants

This RA has been discussed and developed by:

|  |  |  |  |
| --- | --- | --- | --- |
| **Competence** | **Name** | **Position** | **Comment** |
| Risk Assessment competence |  |  |  |
| Type ops competence |  |  |  |
| MCF competence |  |  |  |
| Type Airworthiness competence |  |  |  |
| … |  |  |  |

This RA has been reviewed by the Safety Review Board.

This RA has been approved, and the final risk level has been accepted, by the Accountable Manager.

# Data used

This risk assessment is based on internal data and on aviation industry information. [Include internal source references e.g., past maintenance flights safety reports]

# Description of the analysis method

This RA is based on the study of the maintenance check flight operations that could pose an augmented level of risk.

This risk assessment will identify the hazards and events related with the MCF, and it will describe the associated likelihoods and the possible consequences of the events, and it will list the barriers that will reduce the overall risk of the operations.

A final risk level will be determined along with its acceptance status.

The risk level is illustrated using a Risk Matrix (see Appendix 1).

# External context

## Rules and regulations

This MCF manual includes rules set down by the following EU Regulations and related AMCs and GMs:

* Reg. (EU) 965/2012 – Last amended by Reg. (EU) 2020/745 of 05/06/2020

In particular, the Maintenance Check Flight has been introduced by:

* Reg. (EU) 2019/1384 of 04/09/2019

Following is a summary of the relevant applicable rules. [NOTE: Transcription of the regulatory text is not necessary in the operator’s MCF risk assessment. The following text has been inserted for operator’s convenience and may be deleted]

The ORO.AOC.125 requires operators to comply with the Maintenance Check Flight organisation, defined as non-commercial flights, and under the provisions in Part-SPO or Part-NCO, as necessary.

*ORO.AOC.125 Non-commercial operations of an AOC holder with aircraft listed on its AOC*

1. *(…)*
2. An AOC holder shall comply with:
3. Annex VIII (Part-SPO) when conducting maintenance check flights with complex motor-powered aircraft;
4. Annex VII (Part-NCO) when conducting maintenance check flights with other than complex motor-powered aircraft.
5. An AOC holder conducting operations referred to in points (a) and (b) shall not be required to submit a declaration in accordance with this Annex.

(…)

The following sections describe the provisions for the execution of the Maintenance Check Flights:

 MCF with **complex** motor-powered aircraft

* Reg. (EU) 965/2012 - ANNEX VIII (Part-SPO)

SUBPART E: SPECIFIC REQUIREMENTS

SECTION 5 – MAINTENANCE CHECK FLIGHTS (MCF)

MCF with **other than complex** motor-powered aircraft

* Reg. (EU) 965/2012 - ANNEX VII (Part-NCO)

SUBPART E: SPECIFIC REQUIREMENTS

SECTION 6 – MAINTENANCE CHECK FLIGHTS (MCF)

Reg. (EU) 2018/1139 (Basic Regulation) refers the definition of such aircraft to the repealed Reg. (EU) 216/2008 (former Basic Regulation):

*Article 140*

*Transitional provisions*

1. *(…)*
2. *Not later than 12 September 2023 the implementing rules adopted on the basis of Regulations (EC) No 216/2008 and (EC) No 552/2004 shall be adapted to this Regulation. Until adaptation, any references in those implementing rules to:*
	1. *(…)*
	2. *‘complex motor-powered aircraft’ shall be understood as a reference to point (j) of Article 3 of Regulation (EC) No 216/2008;*

The repealed Reg. (EU) 216/2008 (former Basic Regulation) defines:

*Article 3*

*Definitions*

*(…)*

1. *‘complex motor-powered aircraft’ shall mean:*
2. *an aeroplane:*
* *with a maximum certificated take-off mass exceeding 5 700 kg, or*
* *certificated for a maximum passenger seating configuration of more than nineteen, or*
* *certificated for operation with a minimum crew of at least two pilots, or*
* *equipped with (a) turbojet engine(s) or more than one turboprop engine, or*
1. *a helicopter certificated:*
* *for a maximum take-off mass exceeding 3 175 kg, or*
* *for a maximum passenger seating configuration of more than nine, or*
* *for operation with a minimum crew of at least two pilots, or*
1. *a tilt rotor aircraft*

Reg. (EU) 965/2012 - ANNEX I – DEFINITIONS gives the definition of the Maintenance Check Flight:

*(76a) ‘maintenance check flight (‘MCF’)’ means a flight of an aircraft with an airworthiness certificate or with a permit to fly which is carried out for troubleshooting purposes or to check the functioning of one or more systems, parts or appliances after maintenance, if the functioning of the systems, parts or appliances cannot be established during ground checks and which is carried out in any of the following situations:*

1. *as required by the aircraft maintenance manual (‘AMM’) or any other maintenance data issued by a design approval holder being responsible for the continuing airworthiness of the aircraft;
Note: this should read “continued airworthiness” and is wrongly described in the regulation*
2. *after maintenance, as required by the operator or proposed by the organisation responsible for the continuing airworthiness of the aircraft;*
3. *as requested by the maintenance organisation for verification of a successful defect rectification;*
4. *to assist with fault isolation or troubleshooting;*

Article 9aa of Reg. (EU) 965/2012 (cover regulation) relieves from attending an MCF course to pilots-in-command that have check flights experience before 25 September 2019.

*Article 9aa - Flight crew requirements for maintenance check flights*

*A pilot having acted, before 25 September 2019, as a* *pilot-in-command on a maintenance check flight that in accordance with the definition in point SPO.SPEC.MCF.100 in Annex VIII is categorised as a Level A maintenance check flight, shall be given credit for the purpose of complying with point SPO.SPEC.MCF.115(a)(1) of that Annex. In that case, the operator shall ensure that the pilot-in-command receives a briefing on any differences identified between the operating practices established before 25 September 2019 and the obligations provided in Section 5 of Subpart E of Annex VIII to this Regulation including those derived from the related procedures established by the operator.*

The following table summarises the requirements for the maintenance check flights:

|  | **Requirements** | **Complex**motor-powered aircraft | **Other than complex**motor-powered aircraft |
| --- | --- | --- | --- |
| **Level A** maintenance check flights(use of abnormal or emergency procedures, as defined in the aircraft flight manual, is expected, or where a flight is required to prove the functioning of a backup system or other safety devices) |  | Ref. **SPO**.SPEC.MCF | Ref. **NCO**.SPEC.MCF |
| MCF manual | x | R |
| MCF SOP (flight procedures) | R | R |
| MCF documented flight programme | x |  |
| MCF checklist (flight and in-flight assessment procedures) |  | x |
| Pilot selection | x |  |
| Pilot MCF course | Yes. Course grandfathered for pilots acting as MCF pilot-in-command before 25/09/2019 (Art. 9aa) | Selected by the operator.No MCF course required.NOTE: AMC1 NCO.SPEC.MCF.120 states that “*The operator may select a flight instructor*”. |
| Pilot minimum experience | x |  |
| Pilot MCF recency | x |  |
| Co-pilot or TS on board | x |  |
| TS course | x | x |
| **Level B** maintenance check flights(other than a Level A maintenance check flight) |  | Ref. **SPO**.SPEC.MCF | Ref. **NCO**.SPEC.MCF |
| MCF manual | R | R |
| MCF SOP (flight procedures) | R | R |
| MCF documented flight programme | R |  |
| MCF checklist (flight and in-flight assessment procedures) |  | x |
| Pilot selection | x |  |
| Pilot MCF course |  |  |
| Pilot minimum experience |  |  |
| Pilot MCF recency |  |  |
| Co-pilot or TS on board |  |  |
| TS course | x | x |

R - recommended

## Approvals/authorisations

No specific approval or authorisation.

## Environmental conditions

[Describe the area where the MCF will be executed, e.g., flat/hilly/mountainous terrain, emergency landing sites availability, inside/outside CTRs and ATZs, etc.]

## Stakeholders and their potential interest

[Include stakeholders e.g.:

* External Part 145 organisation
* Customers for a maintenance organisation
* (…)]

# Internal context

## Internal documents and references

Maintenance Check Flight (MCF) Manual.

## Type(s) of aircraft

Entire [Operator] fleet.

## Personnel and qualifications

* Trained MCF pilots selected by [Operator]
* Trained MCF Task Specialists

## Combination/similarity with other operations/SOP

None.

## Other RA to be referenced/used/considered/plugged in

[List any reference document]

# Task analysis

Following is an analysis of the phase of flight where this risk assessment applies. The analysis is focused only on those elements that may increase the operational risk.

| **TE Ref.** | **Top Element** | **(Unwanted) Event** |
| --- | --- | --- |
|  | Common |  |
| TE 001 | Preparation | Aircraft status not in standard conditions |
| TE 002 | Pilots not skilled in the use of abnormal and emergency procedures |
| TE 003 | Loading | Aircraft CG near limits |
| TE 004 | Prefight | Aircraft improperly set for the flight |
| TE 005 | MCF flight (all phases) | Failure of the checked system |
| TE 006 | Failure of other-than-checked system |
| TE 007 | Multiple failures |
| TE 008 | Emergencies requiring an immediate or as-soon-as-possible landing |
| TE 009 | Pilot high workload |
|  | Start | N.A. |
|  | Taxi | N.A. |
|  | Take-off | N.A. |
|  | Departure | N.A. |
|  | Cruise | N.A. |
|  | Descent | N.A. |
|  | Approach | N.A. |
|  | Landing | N.A. |
|  | Taxi | N.A. |
|  | Parking | N.A. |
|  | Maintenance | N.A. |

# Analysis

Below is the analysis of the hazards identified, the events, likelihoods, possible consequences, the barriers implemented and the level of final risk.

MCFs show two major areas of increased safety risk:

* Risks related to the specific maintenance check flight to be carried out and the possibility that the tested system would fail.
* In case the tested system would fail, the related abnormal or emergency manoeuvres and procedures are not properly carried out

Therefore, two separate analyses have been performed:

* Analysis related to the system to be checked and determination of the Level of MCF (Table 1 and 2 in Annex 2 and 3)
* Holistic analysis of the MCF activity

## Meteorological conditions

Maintenance check flights shall be conducted in day VMC with continuous visual reference to landmarks whenever possible. In case the flight is performed in conditions other than day VMC, a risk assessment shall be performed by the pilot-in-command before the flight, identifying the possible consequences related to the specific systems to be checked and identifying safety barriers. Contingency actions shall be determined in advance.

## Analysis of the MCF by checked system

Reg. (EU) 965/2012 - SPO.SPEC.MCF.140 Systems and equipment states:

*When a maintenance check flight is intended to check the proper functioning of a system or equipment, that* *system or equipment shall be identified as potentially unreliable and appropriate mitigation measures shall be agreed prior to the flight in order to minimise risks to flight safety.*

In order to determine the level of the MCF flight, the following conditions have been taken as a reference:

* The probability that the checked system would fail has been set to “Frequent – 5” (see the Risk Matrix in Appendix 1) in order to study the risk level assuming that the system is unreliable
* The pilot is properly trained in the aircraft malfunction and emergency procedures
* The pilot is duly informed about the systems that underwent maintenance actions
* The pilot has the proper information about the systems to be checked and has received the check procedures required by the maintenance manual or set forth by the CAMO
* The pilot has received a list of the affected systems and is aware of the possible malfunction and emergency procedures to be followed in case of system failure
* The pilot-in-command has performed the required briefing and the necessary risk assessment before the flight

The CAMO will extract the necessary information from the tables 1 and 2 (annex 2 and 3) and insert it into the MCF form to be handed to the pilot-in-command before the flight.

Tables 1 and 2 show the list of possible malfunctions and emergency procedures the pilot may face during the MCF, the possible consequences, the suggested contingency actions, the risk level in case the emergency should arise (likelihood set to its maximum) and the Level of MCF (A or B).

## Holistic analysis of MCF

The following table analyses the whole MCF activity.

### Table 3 - MCF activity

| **TE no.** | **Revised on** | **Description** | **Consequence** | **Most significative regulatory barriers (if any)** | **Likeli-****Hood** | **Seve-****rity** | **Risk****before** | **Additional barriers implemented (if any)** | **Likeli-****Hood** | **Seve-****rity** | **Risk****after** | **Ref. docu-****mentation** | **Notes** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| TE 001 | 14/06/2020 | Aircraft status not in standard conditions | The aircraft released for an MCF flight may be in a non-standard condition due to an incomplete maintenance status o due to a non-operative aircraft preparation | 1. Inoperative systems or instruments
2. CG near limits (see TE 003)
3. Unexpected flight behaviour
 | 1. Mass and balance
2. Pilot’s recurrent training (TR, OPC, etc.)
3. Pilot’s MCF course (Level A complex)
 | 4 | C | T | 1. List of inoperative systems and instruments
 | 2 | C | A | 1. MCF Form
 |  |
| TE 002 | 14/06/2020 | Pilot not skilled in the use of abnormal and emergency procedures | The pilot may be not proficient in the use of abnormal or emergency procedures related to the system to be checked | 1. CFIT
2. LOC-I
 | 1. Pilot’s recurrent training (TR, OPC, etc.)
2. Pilot’s MCF course (Level A complex)
 | 2 | C | A |  | 2 | C | A |  |  |
| TE 003 | 14/06/2020 | Aircraft CG near limits | The aircraft released for an MCF flight may be in a non-standard condition or not completely operatively prepared, and with a different position of the basic CG than usual | 1. LOC-I
 | 1. Mass and balance
 | 1 | D | A |  | 1 | D | A |  |  |
| TE 004 | 14/06/2020 | Aircraft improperly set for the flight | Due to maintenance operations, the aircraft may be not completely fit for the flight (open latches, loose object left in the vanes, etc.) | 1. Aircraft damage
2. LOC-I
3. CFIT
 |  | 3 | C | T | 1. Attentive pre-flight inspection by pilot-in-command
2. Pilot-in-command pre-flight with support by an engineer
 | 2 | C | A | 1. MCF Manual
2. MCF Manual
 |  |
| TE 005 | 14/06/2020 | Failure of the checked system | In-flight failure of the system under check | 1. CFIT
2. LOC-I
 | 1. Pilot’s recurrent training (TR, OPC, etc.)
2. Pilot’s MCF course (Level A complex)
 | 2 | C | A |  | 2 | C | A |  | Check tables 1 and 2 for a more detailed analysis.Herein risk takes into consideration also the real likelihood of a malfunction. |
| TE 006 | 14/06/2020 | Failure of other-than-checked system | In-flight failure of systems not under check | 1. CFIT
2. LOC-I
 | 1. Pilot’s recurrent training (TR, OPC, etc.)
2. Pilot’s MCF course (Level A complex)
 | 2 | C | A |  | 2 | C | A |  |  |
| TE 007 | 14/06/2020 | Multiple failures | System under check may fail in combination with other systems | 1. CFIT
2. LOC-I
 | 1. Pilot’s recurrent training (TR, OPC, etc.)
2. Pilot’s MCF course (Level A complex)
 | 2 | C | A |  | 2 | C | A |  |  |
| TE 008 | 14/06/2020 | Emergencies requiring an immediate or as-soon-as-possible landing | An emergency may require an immediate or as-soon-as-possible landing | 1. CFIT
2. Aircraft damage
 |  | 2 | D | T | 1. MCF area selection with availability of suitable emergency landing sites
 | 2 | C | A | 1. MCF Manual
 | The availability of a suitable emergency landing area will reduce the potential outcomes of an emergency event |
| TE 009 | 14/06/2020 | Pilot high workload | Pilot may be overloaded due to several overlapping tasks (flight, radio communications, data transcription, nearby traffic, etc.)  | 1. CFIT
2. LOC-I
3. MCF data not properly recorded
 | 1. Co-pilot on board and/or
2. Task Specialist on board
 | 2 | B | A |  | 1 | B | A |  |  |

# Analysis of risk

A summary (summation) of the initial risk, final risk and acceptance criteria is described below.

The analysis of hazards related to the MCF flights shows a “tolerable” risk level, reduced to a final “acceptable” risk level by the implementation of the listed safety barriers.

The following is the count of the risk levels associated with the possible consequences.

|  |  |  |
| --- | --- | --- |
| **RISK ANALYSIS - RISK COUNT** |  | **RISK ANALYSIS - RISK COUNT** |
| **BEFORE THE INTRODUCTION OF THE BARRIERS** |  | **AFTER THE INTRODUCTION OF THE BARRIERS** |
|  | 1 | 2 | 3 | 4 | 5 |  |  | 1 | 2 | 3 | 4 | 5 |
| A |  |  |  |  |  |  | A |  |  |  |  |  |
| D | **1** | **1** |  |  |  |  | D | **1** |  |  |  |  |
| C |  | **4** | **1** | **1** |  |  | C |  | **7** |  |  |  |
| B |  | **1** |  |  |  |  | B | **1** |  |  |  |  |
| A |  |  |  |  |  |  | A |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  | **ACCEPTANCE COUNT** | **LEGEND:****A** - Acceptable**T** - Tolerable**N** - Non-Acceptable | **ACCEPTANCE COUNT** |  |
|  |  | A | T | N | A | T | N |  |
|  |  | **6** | **3** |  | **9** |  |  |  |

# Recommendations

No safety recommendations.

# Conclusions

Based on the analysis, it is believed that the maintenance check flights can be performed with an acceptable residual risk level.

# Appendix 1 – Risk analysis methodology

The risk level of the potential consequences is assessed using the below risk matrix.

|  |  |
| --- | --- |
| **RISK SEVERITY** | **RISK PROBABILITY** |
| IMPROBABLE (1) | RARE (2) | LOW (3) | PROBABLE (4) | FREQUENT (5) |
| CATASTROPHIC (E) | **1 E** | **2 E** | **3 E** | **4 E** | **5 E** |
| CRITICAL (D) | **1 D** | **2 D** | **3 D** | **4 D** | **5 D** |
| MAJOR (C) | **1 C** | **2 C** | **3 C** | **4 C** | **5 C** |
| MINOR (B) | **1 B** | **2 B** | **3 B** | **4 B** | **5 B** |
| NEGLIGIBLE (A) | **1 A** | **2 A** | **3 A** | **4 A** | **5 A** |

The following table shows the definition of the probability (likelihood) of the possible consequence of the indicated hazard:

|  |  |  |
| --- | --- | --- |
| **RISK PROBABILITY** | **MEANING** | **Value** |
| **FREQUENT** | **Likely to occur many times.** Has already occurred in the Company (Freq. > 3 times per year). It has occurred frequently in the history of the aviation industry. | **5** |
| **PROBABLE** | **Likely to occur sometimes.** Has already occurred in the Company (Freq. < 3 times per year). Has occurred infrequently in the history of the aviation industry. | **4** |
| **LOW** | **Unlikely to occur, but possible.** Has already occurred in the Company at least once or. He has occurred in the history of the aviation industry. | **3** |
| **RARE** | **Very unlikely to occur.** Not known to have occurred in the Company but has already occurred at least once in the history of the aviation industry. | **2** |
| **IMPROBABLE** | **Almost inconceivable that the event will occur.** It has never occurred in the history of the aviation industry. | **1** |

The following table shows the definition of severity levels of the possible consequence of the indicated hazard:

|  |  |  |
| --- | --- | --- |
| **SEVERITY OF OCCURRENCE** | **MEANING** | **Value** |
| **PERSONNEL** | **ENVIRONMENT** | **MATERIAL VALUES & ASSETS** | **REPUTATION** |
| **CATASTROPHIC** | Multiple fatalities | Massive effects (pollution, destruction, etc.) | Catastrophic financial lossDamage > 1 M | International impact | **E** |
| **CRITICAL** | Fatality | Effects difficult to repair | Severe financial loss with long term effectsDamage < 1 M | National impact | **D** |
| **MAJOR** | Serious injuries | Noteworthy local effects | Substantial financial lossDamage < 250K | Considerable impact | **C** |
| **MINOR** | Light injuries | Little impact | Financial loss with little impactDamage < 50K | Limited impact | **B** |
| **NEGLIGIBLE** | Surface or no injuries | Negligible or no effects | Financial loss with negligible impactDamage < 10K | Light or no impact | **A** |

Values in red indicate an "unacceptable" risk level, the values in yellow indicate a "tolerable" risk level, while the values in green indicated an "acceptable" risk level.

Each of the listed levels requires specific action by responsible staff who have the appropriate authority to accept the associated level of risk.

| **Level of****Risk****Actions** | **Unacceptable**Risk too high to continue operations | **Tolerable**The level of risk can be tolerated as long as appropriate safety barriers have been defined and implemented | **Acceptable**The level of risk can be accepted |
| --- | --- | --- | --- |
| Action Required | Prohibit/suspend operations. Bring the risk level to "tolerable" or "acceptable" | Implementation of appropriate safety barriers | No further safety barriers are required. Additional safety barriers if deemed necessary |
| Validation of the level of riskfor the continuation of operations | Safety manager | Safety manager | Safety manager |
| Authorization to the continuation of operations | Operations cannot be authorized | Accountable Manager | No specific authorisations are necessary |

# Appendix 2 – Level A and B classification by emergency and malfunction area

This table is used to classify the MCF flight as Level A or Level B based on the aircraft emergency and malfunction areas.

Whenever a MCF flight is performed, the checked system is supposed to be not reliable, thus a malfunction or an emergency procedure, as described in the RFM, shall be executed. The difficulty and/or the conceivable consequences of the possible system failure drives the classification of the Level A or B of the MCF.

NOTE 1: The following table is an example based on Leonardo AW139 helicopter. A proper study shall be made for each aircraft type in the fleet.

NOTE 2: The table may be an appendix to the MCF risk assessment or it can be moved in an dedicated external document.

Note: the likelihood has been set to maximum (5) as the checked system or equipment has been identified as potentially unreliable.

Table 1

| **Malfunction or Emergency area** | **Emergency procedures** | **Malfunction procedures** | **Consequence** | **Contingency action** | **Risk before** | **Safety barrier** | **Risk after** | **Note** | **MCF level** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Rotor | Rotor-overspeed |  | Rotor-overspeed | Return to baseLand on airportOff airfield precautionary landingAutorotation | 5 D | Rotor speed system verification on ground-run and hovering before flight | 5 B | Rotor speed system functionality verification on ground excludes major problems in flight | A |
| Rotor under-speed |  | Rotor under-speed | If in an intentional autorotation (e.g., NR check) – Apply powerIf NR low during flight (e.g., NR regulator, engine(s) failure) – Initiate autorotation | 5 D | Rotor speed system verification on ground-run and hovering before flight | 5 B | Rotor speed system functionality verification on ground excludes major problems in flight | A |
| Rotor vibrations |  | Rotor out of balance | Return to base | 5 A |  | 5 A |  | B |
| Engine - Ground |  | Engine hot startEngine manual startingManual on ground start procedure | Engine hot start | Engine shout-downAbort mission | 5 B |  | 5 B |  | A |
| Engine - Flight | Engine drive shaft failureEngine idleEngine failureEngine failure recognitionSingle engine failureSingle engine failure in hover (5 to 10 ft)Single engine failure on take off category BSingle engine failure during cruiseSingle engine landing category BEngine shutdown in emergencyEmergency/post crash shutdownEngine systemsEngine oil pressure lowEngine EEC failEngine power turbine overspeed detect failure | Engine malfunctionsCompressor stallUnusual engine noiseEngine limit exceedanceEngine oil temperatureEngine oil pressure highEngine chip detectorEngine fire detector systemEngine control leverEngine control lever positionEngine mode select switchEngine power turbine overspeedEngine electronic control dataDegradation of engine control functionsTorque limiterInter turbine temperature limiterEngine restart in flight procedureManual in flight restart procedureEngine shutdown using ECL/manualEngine and rotor parameters miscompareEngine analogue sensor failure2.5 minute rating  | One engine inoperative (OEI)All engine inoperative | Return to baseLand on airportOff airfield precautionary landing | 5 D | Engine(s) performance verification on ground-run and hovering before flight | 5 B | Engine(s) functionality verification on ground excludes major problems in flight | A |
| Double engine failure |  | All engine inoperative (AEI)Autorotation | Autorotation | 5 D | Engine(s) performance verification on ground-run and hovering before flight | 5 B | Engine(s) functionality verification on ground excludes major problems in flight | A |
| Fuel |  | Fuel filter by-passFuel heaterFuel pressure low | One engine inoperative (OEI) | Return to baseLand on airportOff airfield precautionary landing | 5 D | MCF flight over sparsely populated areas with autorotative landing spaces available | 5 B |  | A |
| Fuel  |  | Fuel icingFuel heaterFuel systemFuel lowFuel pressure lowDouble fuel pump failureAbnormal fuel consumptionFuel contents gauging unit failureFuel contents gauging unit test system failureFuel low sensor failureFuel probe failure | All engine inoperative (AEI) | Autorotation | 5 D | MCF flight over sparsely populated areas with autorotative landing spaces available | 5 B |  | A |
| Autorotation | Entry in autorotationAutorotative landing procedure on landAutorotative landing procedure on water |  | Autorotation | Autorotation | 5 D | MCF flight over sparsely populated areas with autorotative landing spaces available | 5 B |  | A |
| Fire - Ground | Engine bay fire (ground)Engine exhaust fire after shutdownCockpit / cabin fire (ground)Electrical fire/smoke (ground)Wheel brake fire |  | Fire on ground | Engine shout-downAbort mission on ground | 5 C | Support personnel off-board during start-upFirefighters on station | 5 B | Early fire detection reduces consequences magnitude | A |
| Fire - Flight | FireEngine bay fire (flight)Baggage bay fireCockpit / cabin fire (flight)Electrical fire/smoke (flight)Wheel brake fire |  | Fire in flight | Return to baseOff airfield precautionary landing | 5 D | MCF flight over sparsely populated areas with emergency landing spaces available | 5 B |  | A |
| Transmission | Transmission system failuresMain gearboxOil pressure lowOil pressure low (continued)Oil temperature high | Drive systemMain gearbox overtorqueMain gearbox chip detectorMain gearbox oil filterMain gearbox oil lowMain gearbox input bearing temperatureMain gearbox input oil pressureGearbox chip detect unit malfunctionGearbox chip detector sensor failure | Main gearbox and connected systems failure | Return to baseOff airfield precautionary landing | 5 C | MCF flight over sparsely populated areas with emergency landing spaces available | 5 B |  | A |
| Main rotor | Main rotor controls binding | Rotor speed selector | Rotor speed control failure | Return to baseOff airfield precautionary landingAutorotation | 5 C | MCF flight over sparsely populated areas with emergency landing spaces available | 5 B |  | A |
| Tail rotor | Tail rotor system failuresYaw control diagnosticsTail rotor drive failureTail rotor control system failureTail rotor control binding | Intermediate or tail gearbox chip detectorIntermediate or tail gearbox oil lowIntermediate gearbox oil temperature highTail rotor gearbox oil temperature high | Tail rotor failure | Return to baseOff airfield precautionary landingAutorotation | 5 C | MCF flight over sparsely populated areas with emergency landing spaces available | 5 B |  | A |
| Hydraulic |  | Hydraulic systemHydraulic pressure lowHydraulic fluid overheatingHydraulic fluid level lowHydraulic pump 1, 2 or 4 failureMain valve seizure in main or tail rotor servo | Flight control(s) failureHydraulically driven system(s) failure | Return to baseOff airfield precautionary landing | 5 D | Full flight controls test on ground before flight | 5 B | Flight controls test on ground excludes major problems in flight | A |
| Flight control – Ground |  | AP test abort | AP failure | Engine shout-downAbort mission on ground | 5 A |  | 5 A |  | B |
| Flight control – Flight |  | Autopilot failAutopilot offAutopilot axis offAutopilot axis disengageAttitude system offAFCS trim failurePitch, roll, yaw trim failMistrimAFCS degradedSAS degradedCyclic force trim off or failCyclic force trim release failureCollective force trim off or failCollective force trim release failureAFCS quick disconnect procedure | Degraded aircraft stabilityIn flight loss of control (LOC-I) | Return to baseLand on airportOff airfield precautionary landing | 5 D | Full flight controls test on ground before flight | 5 B | Flight controls test on ground excludes major problems in flight | A |
| Display unit |  | Display unit malfunctionsPrimary or/and multifunctional flight display unit failurePFD/MFD display failuresDisplay unit overheatingDisplay unit degradedPrimary and multifunctional flight display messagesAttitude display failureHeading display failureRAD ALT failureCAS warning message list discrepancyADS failureFailure of CAS dataMAU message on PFDDisplay unit graphic malfunctionEngine state indication on PFD and MFDFailure of PI displayFailure of NF displayDecision height captionAHRS miscompareADS miscompareRAD ALT miscompareLOC/GS miscompareCAS caution message list discrepancyLoss of glideslope or VOR dataFMS PFD messages | Reduced attitude, engine, or navigation information to pilotIn flight loss of control (LOC-I) | Return to baseLand on airportOff airfield precautionary landing | 5 B | Day VMC MCF flight | 5 A |  | B |
| Avionics |  | AvionicsAHRS failureADS failureAural warning system failureAvionic faultModular avionics unit overheat/failMultifunction control display unitOverheatingSystem configuration failureValidate configurationFlight data recorder failureCockpit voice recorder failureFlight management system failureGPS failFMS/GPS miscompareFMS/GPS miscompare unavailableAircraft never exceed speed miscompareAircraft never exceed speed | Reduced attitude, engine, or navigation information to pilotIn flight loss of control (LOC-I) | Return to baseLand on airportOff airfield precautionary landing | 5 B | Day VMC MCF flight | 5 A |  | B |
| Communication |  | Communication systemVHF overheatAudio panel failureMRC overheatMiscellaneous | Radio failureICS failure | Return to base | 5 B | Day VMC MCF flight | 5 A |  | B |
| Electrical | Electrical systemDouble dc generator failureExtended flight endurance after double dc generator failureServices available on essential bus 1 and 2Services lost during bus failures | ElectricalSingle DC generator failureDC generator overheatBus tie open | Electrical black-outRadio failureICS failureIn flight loss of control (LOC-I) | Return to baseOff airfield precautionary landing | 5 B | Day VMC MCF flight | 5 A |  | B |
| Battery | Main and auxiliary battery hot | Main battery offAuxiliary battery offLoss of main and/or auxiliary battery supplyDC main bus failure | Electrical black-outRadio failureICS failureIn flight loss of control (LOC-I) | Return to baseOff airfield precautionary landing | 5 B | Day VMC MCF flight | 5 A |  | B |
| Landing gear | Landing gear fails to lock down | Normal landing gear pressure lowEmergency landing gear pressure lowNosewheel unlocked (in flight)Park brake malfunctionPark brake onWeight on wheels switch failureLanding gear retractedLanding gear fails to raise | Landing gear failure on landingDynamic rollover on ground | Return to baseLand on airport | 5 B |  | 5 B |  | A |
| Ice protection |  | Ice protectionPitot heater failurePitot heater off | IcingUnreliable instrumentsIn flight loss of control (LOC-I) | Return to baseOff airfield precautionary landing | 5 C | Day VMC MCF flightOutside icing conditions | 5 A |  | B |
| Environmental control |  | Environmental control systemVent fan failureNose avionic fans failure | Engine spillage failureDegraded performanceCompressor stallAutorotation (single engine a/c) | Return to baseLand on airport | 5 C | Single engine performance requiredMCF flight over sparsely populated areas with emergency landing spaces available | 5 B |  | A |
| Lightning | Lightning strike |  | Electrical failureAvionics failureRadio failureStructural damage | Return to baseLand on airportOff airfield precautionary landing | 5 B | Day VMC MCF flight | 5 A |  | B |
| Static port | Static port obstruction |  | Unreliable instrumentsIn flight loss of control (LOC-I) | Return to base | 5 B | Day VMC MCF flight | 5 A |  | B |
| Doors | Emergency exits | Cockpit door openCabin door openBaggage bay door openExternal power socket door open | Aerodynamic-related problemsDoor detachmentStructural damage | Return to baseOff airfield precautionary landing | 5 B | Do not fly high speed unless required by the maintenance check procedure | 5 B |  | A |

# Appendix 3 – Level A and B classification by maintenance area

This table is used to classify the MCF flight as Level A or Level B based on the maintenance areas with reference to table 1 - Malfunction and emergency procedure areas.

The system that has undergone the maintenance, or the system to be checked in flight, is analysed for the possible malfunction or emergency procedures that could be used in flight by the pilot. Based on this, the related Level of the MCF flight is determined.

NOTE 1: The following table is an example based on Leonardo AW139 helicopter. A proper study shall be made for each aircraft type in the fleet.

NOTE 2: The table may be an appendix to the MCF risk assessment or it can be moved in an dedicated external document.

Note: the likelihood has been set to maximum (5) as the checked system or equipment has been identified as potentially unreliable.

Table 2

| **Maintenance area** | **Malfunction or Emergency area** | **Consequence** | **Contingency action** | **Risk before** | **Safety barrier** | **Risk after** | **Note** | **MCF level** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Flight Control | Any Flight Control System verification, disturbance, or repair | Flight control – Ground | AP failure | Engine shout-downAbort mission on ground | 5 A |  | 5 A |  | B |
| Flight control – Flight | Degraded aircraft stabilityIn flight loss of control (LOC-I) | Return to baseLand on airportOff airfield precautionary landing | 5 D | Full flight controls test on ground before flight | 5 B | Flight controls test on ground excludes major problems in flight | A |
| Engine(s) | Any engine(s) component or system, including Fuel Control Units, inlet and exhaust systems, engine(s) controls, starter/generators, gauges, indicators, valves, probes and associated electronic systems | Engine – Ground | Engine hot start | Engine shout-downAbort mission | 5 B |  | 5 B |  | A |
| Engine – Flight | One engine inoperative (OEI)All engine inoperative (AEI)Autorotation | Return to baseLand on airportOff airfield precautionary landingAutorotation | 5 D | Engine(s) performance verification on ground-run and hovering before flight | 5 B | Engine(s) functionality verification on ground excludes major problems in flight | A |
| Autorotation | Autorotation | Autorotation | 5 D | MCF flight over sparsely populated areas with autorotative landing spaces available | 5 B |  | A |
| Fire – Ground | Fire on ground | Engine shout-downAbort mission on ground | 5 C | Support personnel off-board during start-upFirefighters on station | 5 B | Early fire detection reduces consequences magnitude | A |
| Fire – Flight | Fire in flight | Return to baseOff airfield precautionary landing | 5 D | MCF flight over sparsely populated areas with emergency landing spaces available | 5 B |  | A |
| Display unit | Reduced attitude, engine, or navigation information to pilotIn flight loss of control (LOC-I) | Return to baseLand on airportOff airfield precautionary landing | 5 B | Day VMC MCF flight | 5 A |  | B |
| Electrical | Electrical black-outRadio failureICS failureIn flight loss of control (LOC-I) | Return to baseOff airfield precautionary landing | 5 B | Day VMC MCF flight | 5 A |  | B |
| Environmental control | Engine spillage failureDegraded performanceCompressor stallAutorotation (single engine a/c) | Return to baseLand on airport | 5 C | Single engine performance requiredMCF flight over sparsely populated areas with emergency landing spaces available | 5 B |  | A |
| Main and tail rotor | Main and tail rotor track and balance, systems disturbance, overhaul, or replacement | Main rotor | Rotor speed control failure | Return to baseOff airfield precautionary landingAutorotation | 5 C | MCF flight over sparsely populated areas with emergency landing spaces available | 5 B |  | A |
| Tail rotor | Tail rotor failure | Return to baseOff airfield precautionary landingAutorotation | 5 C | MCF flight over sparsely populated areas with emergency landing spaces available | 5 B |  | A |
| Hydraulic | Flight control(s) failureHydraulically driven system(s) failure | Return to baseOff airfield precautionary landing | 5 D | Full flight controls test on ground before flight | 5 B | Flight controls test on ground excludes major problems in flight | A |
| Flight control – Ground | AP failure | Engine shout-downAbort mission on ground | 5 A |  | 5 A |  | B |
| Flight control – Flight | Degraded aircraft stabilityIn flight loss of control (LOC-I) | Return to baseLand on airportOff airfield precautionary landing | 5 D | Full flight controls test on ground before flight | 5 B | Flight controls test on ground excludes major problems in flight | A |
| Engine start and shout down | Any check covering engine start and shout down, including high-wind start, accelerations and deceleration, and emergency shout down | Engine – Ground | Engine hot start | Engine shout-downAbort mission | 5 B |  | 5 B |  | A |
| Fire – Ground | Fire on ground | Engine shout-downAbort mission on ground | 5 C | Support personnel off-board during start-upFirefighters on station | 5 B | Early fire detection reduces consequences magnitude | A |
| Augmented stabilisation, autopilot | Any check involving augmented stabilisation, autopilot, or any system acting on flight controls | Flight control – Ground | AP failure | Engine shout-downAbort mission on ground | 5 A |  | 5 A |  | B |
| Flight control – Flight | Degraded aircraft stabilityIn flight loss of control (LOC-I) | Return to baseLand on airportOff airfield precautionary landing | 5 D | Full flight controls test on ground before flight | 5 B | Flight controls test on ground excludes major problems in flight | A |
| Performance measurement | Any in flight performance measurement, included engine performance, power check, and autorotation | Rotor-overspeed | Rotor-overspeed | Return to baseLand on airportOff airfield precautionary landingAutorotation | 5 D | Rotor speed system verification on ground-run and hovering before flight | 5 B | Rotor speed system functionality verification on ground excludes major problems in flight | A |
| Rotor under-speed | Rotor under-speed | Autorotation | 5 D | Rotor speed system verification on ground-run and hovering before flight | 5 B | Rotor speed system functionality verification on ground excludes major problems in flight | A |
| Engine – Flight | One engine inoperative (OEI)All engine inoperative (AEI)Autorotation | Return to baseLand on airportOff airfield precautionary landingAutorotation | 5 D | Engine(s) performance verification on ground-run and hovering before flight | 5 B | Engine(s) functionality verification on ground excludes major problems in flight | A |
| Autorotation | Autorotation | Autorotation | 5 D | MCF flight over sparsely populated areas with autorotative landing spaces available | 5 B |  | A |
| Environmental control | Engine spillage failureDegraded performanceCompressor stallAutorotation (single engine a/c) | Return to baseLand on airport | 5 C | Single engine performance requiredMCF flight over sparsely populated areas with emergency landing spaces available | 5 B |  | A |
| Hydraulic | Any hydraulic component (pump, valves, etc.) and related systems (landing gear, rotor brake, flight controls, etc.) | Hydraulic | Flight control(s) failureHydraulically driven system(s) failure | Return to baseOff airfield precautionary landing | 5 D | Full flight controls test on ground before flight | 5 B | Flight controls test on ground excludes major problems in flight | A |
| Flight control – Ground | AP failure | Engine shout-downAbort mission on ground | 5 A |  | 5 A |  | B |
| Flight control – Flight | Degraded aircraft stabilityIn flight loss of control (LOC-I) | Return to baseLand on airportOff airfield precautionary landing | 5 D | Full flight controls test on ground before flight | 5 B | Flight controls test on ground excludes major problems in flight | A |
| Landing gear | Landing gear failure on landingDynamic rollover on ground | Return to baseLand on airport | 5 B |  | 5 B |  | A |
| Electric system | Any electric system component | Engine – Ground | Engine hot start | Engine shout-downAbort mission | 5 B |  | 5 B |  | A |
| Engine – Flight | One engine inoperative (OEI)All engine inoperative (AEI)Autorotation | Return to baseLand on airportOff airfield precautionary landingAutorotation | 5 D | Engine(s) performance verification on ground-run and hovering before flight | 5 B | Engine(s) functionality verification on ground excludes major problems in flight | A |
| Fuel | One engine inoperative (OEI)All engine inoperative (AEI) | Return to baseLand on airportOff airfield precautionary landingAutorotation | 5 D | MCF flight over sparsely populated areas with autorotative landing spaces available | 5 B |  | A |
| Display unit | Reduced attitude, engine, or navigation information to pilotIn flight loss of control (LOC-I) | Return to baseLand on airportOff airfield precautionary landing | 5 B | Day VMC MCF flight | 5 A |  | B |
| Avionics | Reduced attitude, engine, or navigation information to pilotIn flight loss of control (LOC-I) | Return to baseLand on airportOff airfield precautionary landing | 5 B | Day VMC MCF flight | 5 A |  | B |
| Communication | Radio failureICS failure | Return to base | 5 B | Day VMC MCF flight | 5 A |  | B |
| Electrical | Electrical black-outRadio failureICS failureIn flight loss of control (LOC-I) | Return to baseOff airfield precautionary landing | 5 B | Day VMC MCF flight | 5 A |  | B |
| Battery | Electrical black-outRadio failureICS failureIn flight loss of control (LOC-I) | Return to baseOff airfield precautionary landing | 5 B | Day VMC MCF flight | 5 A |  | B |
| Landing gear | Landing gear failure on landingDynamic rollover on ground | Return to baseLand on airport | 5 B |  | 5 B |  | A |
| Ice protection | IcingUnreliable instrumentsIn flight loss of control (LOC-I) | Return to baseOff airfield precautionary landing | 5 C | Day VMC MCF flightOutside icing conditions | 5 A |  | B |
| Environmental control | Engine spillage failureDegraded performanceCompressor stallAutorotation (single engine a/c) | Return to baseLand on airport | 5 C | Single engine performance requiredMCF flight over sparsely populated areas with emergency landing spaces available | 5 B |  | A |
| Lightning | Electrical failureAvionics failureRadio failureStructural damage | Return to baseLand on airportOff airfield precautionary landing | 5 B | Day VMC MCF flight | 5 A |  | B |
| Air spillage | Any air spillage component, including cabin ventilation, air conditioning, and heating | Engine – Ground | Engine hot start | Engine shout-downAbort mission | 5 B |  | 5 B |  | A |
| Engine – Flight | One engine inoperative (OEI)All engine inoperative (AEI)Autorotation | Return to baseLand on airportOff airfield precautionary landingAutorotation | 5 D | Engine(s) performance verification on ground-run and hovering before flight | 5 B | Engine(s) functionality verification on ground excludes major problems in flight | A |
| Ice protection | IcingUnreliable instrumentsIn flight loss of control (LOC-I) | Return to baseOff airfield precautionary landing | 5 C | Day VMC MCF flightOutside icing conditions | 5 A |  | B |
| Environmental control | Engine spillage failureDegraded performanceCompressor stallAutorotation (single engine a/c) | Return to baseLand on airport | 5 C | Single engine performance requiredMCF flight over sparsely populated areas with emergency landing spaces available | 5 B |  | A |
| APU | Any APU component including ground rotor retainment system | Engine – Ground | Engine hot start | Engine shout-downAbort mission | 5 B |  | 5 B |  | A |
| Engine – Flight | One engine inoperative (OEI)All engine inoperative (AEI)Autorotation | Return to baseLand on airportOff airfield precautionary landingAutorotation | 5 D | Engine(s) performance verification on ground-run and hovering before flight | 5 B | Engine(s) functionality verification on ground excludes major problems in flight | A |
| Fire – Ground | Fire on ground | Engine shout-downAbort mission on ground | 5 C | Support personnel off-board during start-upFirefighters on station | 5 B | Early fire detection reduces consequences magnitude | A |
| Fire – Flight | Fire in flight | Return to baseOff airfield precautionary landing | 5 D | MCF flight over sparsely populated areas with emergency landing spaces available | 5 B |  | A |
| Main rotor | Rotor speed control failure | Return to baseOff airfield precautionary landingAutorotation | 5 C | MCF flight over sparsely populated areas with emergency landing spaces available | 5 B |  | A |
| Ice protection | IcingUnreliable instrumentsIn flight loss of control (LOC-I) | Return to baseOff airfield precautionary landing | 5 C | Day VMC MCF flightOutside icing conditions | 5 A |  | B |
| Environmental control | Engine spillage failureDegraded performanceCompressor stallAutorotation (single engine a/c) | Return to baseLand on airport | 5 C | Single engine performance requiredMCF flight over sparsely populated areas with emergency landing spaces available | 5 B |  | A |
| Fuel system | Any fuel system component, including tanks, interconnections, pumps, valves, and heat exchangers | Engine – Ground | Engine hot start | Engine shout-downAbort mission | 5 B |  | 5 B |  | A |
| Engine – Flight | One engine inoperative (OEI)All engine inoperative (AEI)Autorotation | Return to baseLand on airportOff airfield precautionary landingAutorotation | 5 D | Engine(s) performance verification on ground-run and hovering before flight | 5 B | Engine(s) functionality verification on ground excludes major problems in flight | A |
| Fuel | One engine inoperative (OEI)All engine inoperative (AEI) | Return to baseLand on airportOff airfield precautionary landingAutorotation | 5 D | MCF flight over sparsely populated areas with autorotative landing spaces available | 5 B |  | A |
| Autorotation | Autorotation | Autorotation | 5 D | MCF flight over sparsely populated areas with autorotative landing spaces available | 5 B |  | A |
| Fire – Ground | Fire on ground | Engine shout-downAbort mission on ground | 5 C | Support personnel off-board during start-upFirefighters on station | 5 B | Early fire detection reduces consequences magnitude | A |
| Fire – Flight | Fire in flight | Return to baseOff airfield precautionary landing | 5 D | MCF flight over sparsely populated areas with emergency landing spaces available | 5 B |  | A |
| Electrical | Electrical black-outRadio failureICS failureIn flight loss of control (LOC-I) | Return to baseOff airfield precautionary landing | 5 B | Day VMC MCF flight | 5 A |  | B |
| Anti-icing, de-icing systems | Anti-icing and de-icing systems, included the related electric and hot air components, ice accretion measurement components and systems, windshields heaters, anti-ice structures and screens | Engine – Ground | Engine hot start | Engine shout-downAbort mission | 5 B |  | 5 B |  | A |
| Engine – Flight | One engine inoperative (OEI)All engine inoperative (AEI)Autorotation | Return to baseLand on airportOff airfield precautionary landingAutorotation | 5 D | Engine(s) performance verification on ground-run and hovering before flight | 5 B | Engine(s) functionality verification on ground excludes major problems in flight | A |
| Electrical | Electrical black-outRadio failureICS failureIn flight loss of control (LOC-I) | Return to baseOff airfield precautionary landing | 5 B | Day VMC MCF flight | 5 A |  | B |
| Ice protection | IcingUnreliable instrumentsIn flight loss of control (LOC-I) | Return to baseOff airfield precautionary landing | 5 C | Day VMC MCF flightOutside icing conditions | 5 A |  | B |
| Environmental control | Engine spillage failureDegraded performanceCompressor stallAutorotation (single engine a/c) | Return to baseLand on airport | 5 C | Single engine performance requiredMCF flight over sparsely populated areas with emergency landing spaces available | 5 B |  | A |
| Navigation system | Any navigation system and any electronic related system, including FMS, integrated maps, and their representation in the cockpit | Display unit | Reduced attitude, engine, or navigation information to pilotIn flight loss of control (LOC-I) | Return to baseLand on airportOff airfield precautionary landing | 5 B | Day VMC MCF flight | 5 A |  | B |
| Avionics | Reduced attitude, engine, or navigation information to pilotIn flight loss of control (LOC-I) | Return to baseLand on airportOff airfield precautionary landing | 5 B | Day VMC MCF flight | 5 A |  | B |
| Electrical | Electrical black-outRadio failureICS failureIn flight loss of control (LOC-I) | Return to baseOff airfield precautionary landing | 5 B | Day VMC MCF flight | 5 A |  | B |
| Lightning | Electrical failureAvionics failureRadio failureStructural damage | Return to baseLand on airportOff airfield precautionary landing | 5 B | Day VMC MCF flight | 5 A |  | B |
| Landing gear | Any landing gear component and extension/retraction system | Hydraulic | Flight control(s) failureHydraulically driven system(s) failure | Return to baseOff airfield precautionary landing | 5 D | Full flight controls test on ground before flight | 5 B | Flight controls test on ground excludes major problems in flight | A |
| Electrical | Electrical black-outRadio failureICS failureIn flight loss of control (LOC-I) | Return to baseOff airfield precautionary landing | 5 B | Day VMC MCF flight | 5 A |  | B |
| Landing gear | Landing gear failure on landingDynamic rollover on ground | Return to baseLand on airport | 5 B |  | 5 B |  | A |
| Air data system | Any air data system component, included data input, output, representation and storage | Electrical | Electrical black-outRadio failureICS failureIn flight loss of control (LOC-I) | Return to baseOff airfield precautionary landing | 5 B | Day VMC MCF flight | 5 A |  | B |
| Flight control surface | Any flying control surface change, repair, balance, calibration, or re-rig (including trim tabs) | Rotor vibrations | Rotor out of balance | Return to base | 5 A |  | 5 A |  | B |
| Autorotation | Autorotation | Autorotation | 5 D | MCF flight over sparsely populated areas with autorotative landing spaces available | 5 B |  | A |
| Main rotor | Rotor speed control failure | Return to baseOff airfield precautionary landingAutorotation | 5 C | MCF flight over sparsely populated areas with emergency landing spaces available | 5 B |  | A |
| Tail rotor | Tail rotor failure | Return to baseOff airfield precautionary landingAutorotation | 5 C | MCF flight over sparsely populated areas with emergency landing spaces available | 5 B |  | A |
| Flight control – Ground | AP failure | Engine shout-downAbort mission on ground | 5 A |  | 5 A |  | B |
| Flight control – Flight | Degraded aircraft stabilityIn flight loss of control (LOC-I) | Return to baseLand on airportOff airfield precautionary landing | 5 D | Full flight controls test on ground before flight | 5 B | Flight controls test on ground excludes major problems in flight | A |
| Any incident and accident-related structural repair | Any incident and accident-related structural repair | Doors | Aerodynamic-related problemsDoor detachmentStructural damage | Return to baseOff airfield precautionary landing | 5 B | Do not fly high speed unless required by the maintenance check procedure | 5 B |  | A |
| Air sensor | Any air sensor and related systems and instruments, including static ports, pitot tubes, air instruments/data systems, and related connections, temperature sensors, and probes | Autorotation | Autorotation | Autorotation | 5 D | MCF flight over sparsely populated areas with autorotative landing spaces available | 5 B |  | A |
| Display unit | Reduced attitude, engine, or navigation information to pilotIn flight loss of control (LOC-I) | Return to baseLand on airportOff airfield precautionary landing | 5 B | Day VMC MCF flight | 5 A |  | B |
| Avionics | Reduced attitude, engine, or navigation information to pilotIn flight loss of control (LOC-I) | Return to baseLand on airportOff airfield precautionary landing | 5 B | Day VMC MCF flight | 5 A |  | B |
| Electrical | Electrical black-outRadio failureICS failureIn flight loss of control (LOC-I) | Return to baseOff airfield precautionary landing | 5 B | Day VMC MCF flight | 5 A |  | B |
| Ice protection | IcingUnreliable instrumentsIn flight loss of control (LOC-I) | Return to baseOff airfield precautionary landing | 5 C | Day VMC MCF flightOutside icing conditions | 5 A |  | B |
| Environmental control | Engine spillage failureDegraded performanceCompressor stallAutorotation (single engine a/c) | Return to baseLand on airport | 5 C | Single engine performance requiredMCF flight over sparsely populated areas with emergency landing spaces available | 5 B |  | A |
| Lightning | Electrical failureAvionics failureRadio failureStructural damage | Return to baseLand on airportOff airfield precautionary landing | 5 B | Day VMC MCF flight | 5 A |  | B |
| Static port | Unreliable instrumentsIn flight loss of control (LOC-I) | Return to base | 5 B | Day VMC MCF flight | 5 A |  | B |
| Gyroscopic system | Any gyroscopic system and instrument, included the information transfer to the aircraft systems | Flight control – Flight | Degraded aircraft stabilityIn flight loss of control (LOC-I) | Return to baseLand on airportOff airfield precautionary landing | 5 D | Full flight controls test on ground before flight | 5 B | Flight controls test on ground excludes major problems in flight | A |
| Display unit | Reduced attitude, engine, or navigation information to pilotIn flight loss of control (LOC-I) | Return to baseLand on airportOff airfield precautionary landing | 5 B | Day VMC MCF flight | 5 A |  | B |
| Avionics | Reduced attitude, engine, or navigation information to pilotIn flight loss of control (LOC-I) | Return to baseLand on airportOff airfield precautionary landing | 5 B | Day VMC MCF flight | 5 A |  | B |
| Electrical | Electrical black-outRadio failureICS failureIn flight loss of control (LOC-I) | Return to baseOff airfield precautionary landing | 5 B | Day VMC MCF flight | 5 A |  | B |
| Lightning | Electrical failureAvionics failureRadio failureStructural damage | Return to baseLand on airportOff airfield precautionary landing | 5 B | Day VMC MCF flight | 5 A |  | B |
| Pneumatic system | Any pneumatic system and related sub-systems | Ice protection | IcingUnreliable instrumentsIn flight loss of control (LOC-I) | Return to baseOff airfield precautionary landing | 5 C | Day VMC MCF flightOutside icing conditions | 5 A |  | B |
| Environmental control | Engine spillage failureDegraded performanceCompressor stallAutorotation (single engine a/c) | Return to baseLand on airport | 5 C | Single engine performance requiredMCF flight over sparsely populated areas with emergency landing spaces available | 5 B |  | A |
| Aircraft storage | First flight following an aircraft storage period | Engine – Ground | Engine hot start | Engine shout-downAbort mission | 5 B |  | 5 B |  | A |
| Engine – Flight | One engine inoperative (OEI)All engine inoperative (AEI)Autorotation | Return to baseLand on airportOff airfield precautionary landingAutorotation | 5 D | Engine(s) performance verification on ground-run and hovering before flight | 5 B | Engine(s) functionality verification on ground excludes major problems in flight | A |
| Fuel | One engine inoperative (OEI)All engine inoperative (AEI) | Return to baseLand on airportOff airfield precautionary landingAutorotation | 5 D | MCF flight over sparsely populated areas with autorotative landing spaces available | 5 B |  | A |
| Battery | Electrical black-outRadio failureICS failureIn flight loss of control (LOC-I) | Return to baseOff airfield precautionary landing | 5 B | Day VMC MCF flight | 5 A |  | B |
| Aircraft dismantling and re-assembly | Following dismantling and re-assembly of aircraft | Engine – Ground | Engine hot start | Engine shout-downAbort mission | 5 B |  | 5 B |  | A |
| Engine – Flight | One engine inoperative (OEI)All engine inoperative (AEI)Autorotation | Return to baseLand on airportOff airfield precautionary landingAutorotation | 5 D | Engine(s) performance verification on ground-run and hovering before flight | 5 B | Engine(s) functionality verification on ground excludes major problems in flight | A |
| Fuel | One engine inoperative (OEI)All engine inoperative (AEI) | Return to baseLand on airportOff airfield precautionary landingAutorotation | 5 D | MCF flight over sparsely populated areas with autorotative landing spaces available | 5 B |  | A |
| Autorotation | Autorotation | Autorotation | 5 D | MCF flight over sparsely populated areas with autorotative landing spaces available | 5 B |  | A |
| Fire – Ground | Fire on ground | Engine shout-downAbort mission on ground | 5 C | Support personnel off-board during start-upFirefighters on station | 5 B | Early fire detection reduces consequences magnitude | A |
| Fire – Flight | Fire in flight | Return to baseOff airfield precautionary landing | 5 D | MCF flight over sparsely populated areas with emergency landing spaces available | 5 B |  | A |
| Transmission | Main gearbox and connected systems failure | Return to baseOff airfield precautionary landing | 5 C | MCF flight over sparsely populated areas with emergency landing spaces available | 5 B |  | A |
| Main rotor | Rotor speed control failure | Return to baseOff airfield precautionary landingAutorotation | 5 C | MCF flight over sparsely populated areas with emergency landing spaces available | 5 B |  | A |
| Tail rotor | Tail rotor failure | Return to baseOff airfield precautionary landingAutorotation | 5 C | MCF flight over sparsely populated areas with emergency landing spaces available | 5 B |  | A |
| Hydraulic | Flight control(s) failureHydraulically driven system(s) failure | Return to baseOff airfield precautionary landing | 5 D | Full flight controls test on ground before flight | 5 B | Flight controls test on ground excludes major problems in flight | A |
| Flight control – Ground | AP failure | Engine shout-downAbort mission on ground | 5 A |  | 5 A |  | B |
| Flight control – Flight | Degraded aircraft stabilityIn flight loss of control (LOC-I) | Return to baseLand on airportOff airfield precautionary landing | 5 D | Full flight controls test on ground before flight | 5 B | Flight controls test on ground excludes major problems in flight | A |
| Avionics | Reduced attitude, engine, or navigation information to pilotIn flight loss of control (LOC-I) | Return to baseLand on airportOff airfield precautionary landing | 5 B | Day VMC MCF flight | 5 A |  | B |
| Communication | Radio failureICS failure | Return to base | 5 B | Day VMC MCF flight | 5 A |  | B |
| Electrical | Electrical black-outRadio failureICS failureIn flight loss of control (LOC-I) | Return to baseOff airfield precautionary landing | 5 B | Day VMC MCF flight | 5 A |  | B |
| Landing gear | Landing gear failure on landingDynamic rollover on ground | Return to baseLand on airport | 5 B |  | 5 B |  | A |
| Ice protection | IcingUnreliable instrumentsIn flight loss of control (LOC-I) | Return to baseOff airfield precautionary landing | 5 C | Day VMC MCF flightOutside icing conditions | 5 A |  | B |
| Environmental control | Engine spillage failureDegraded performanceCompressor stallAutorotation (single engine a/c) | Return to baseLand on airport | 5 C | Single engine performance requiredMCF flight over sparsely populated areas with emergency landing spaces available | 5 B |  | A |
| Static port | Unreliable instrumentsIn flight loss of control (LOC-I) | Return to base | 5 B | Day VMC MCF flight | 5 A |  | B |
| Doors | Aerodynamic-related problemsDoor detachmentStructural damage | Return to baseOff airfield precautionary landing | 5 B | Do not fly high speed unless required by the maintenance check procedure | 5 B |  | A |
| Ground run | Any ground run for post-maintenance, trouble shooting, system control or measurement, power check | Engine – Ground | Engine hot start | Engine shout-downAbort mission | 5 B |  | 5 B |  | A |
| Fire – Ground | Fire on ground | Engine shout-downAbort mission on ground | 5 C | Support personnel off-board during start-upFirefighters on station | 5 B | Early fire detection reduces consequences magnitude | A |
| Transmission | Main gearbox and connected systems failure | Return to baseOff airfield precautionary landing | 5 C | MCF flight over sparsely populated areas with emergency landing spaces available | 5 B |  | A |
| Flight control – Ground | AP failure | Engine shout-downAbort mission on ground | 5 A |  | 5 A |  | B |
| Power check | In-flight power check when performed not in conjunction or in consequence to any maintenance, troubleshooting or system verification | Engine – Flight | One engine inoperative (OEI)All engine inoperative (AEI)Autorotation | Return to baseLand on airportOff airfield precautionary landingAutorotation | 5 D | Engine(s) performance verification on ground-run and hovering before flight | 5 B | Engine(s) functionality verification on ground excludes major problems in flight | A |