International Maintenance Review Board Policy Board (IMRBPB)
Issue Paper (IP)

Initial Date: 27 Apr 2018
IP Number: IP 180
Revision / Date: 0

Title: Aircraft Health Monitoring (AHM) integration in MSG-3

Submitter: Industry (MPIG based on AHM WG proposal)

Applies To:	
MSG-3 Vol 1	X
MSG-3 Vol 2	
IMPS	X

Issue:

MSG-3 logic does not currently make use of AHM.

Main stakeholders (i.e. Operators, Regulators and TCHs) agree that application of AHM within the MSG-3 process would improve aviation safety and reliability, provide the operator with improved awareness of the state of the aircraft and enable more effective and efficient maintenance programs.

The AHM technology has been successfully proven in commercial air transport aviation in three categories of applications:

- Engine Condition Monitoring
- AHM as part of operators reliability programs
- Credit for AHM applied to MRBR scheduled maintenance requirements (a limited category consisting of very few application cases)

See Appendix 1 to this IP for examples.

MSG-3 logic should be amended to realize the benefits from AHM capabilities in scheduled maintenance development and to create a consistent industry approach. Relevant industry standards have been considered in developing this IP (e.g. SAE documents ARP6803, ARP5120, ARP6275 and AS4831A).

Problem:

The problem areas identified in pursuing the above issue are:

- A systematic approach to connect AHM functionality with failure causes associated to scheduled maintenance requirements does not currently exist in MSG-3 vol1.
- Guidance material addressing AHM as an end to end system allowing credit to be taken to adjust intervals or completely replace a requirement is not available for fixed wing applications. It should be acknowledged that the scope and foundation of guidance material developed for HUMS integration in MSG-3 vol2 is significantly different.
- Industry is unable to realize the significant unapplied benefits of AHM capabilities delivered by TCHs.

Conditional Considerations:

The following considerations condition the approach to address the problem stated above:

- If AHM is applied, TCHs would need to address PPH details applicable for AHM analysis worksheets which would include all elements contained in this IP as well as cross reference methods which would be used to associate classic tasks with AHM.

- The operators should always have the choice to decide if they would pursue or not the TCH offered option to use AHM capabilities for scheduled maintenance. This IP establishes the framework for AHM optional use.

- The scope of this IP does not include the use of AHM to support evolution of MRBR task intervals.

Assumptions:

There are three assumptions (with their associated challenges) being made in developing this IP:

1. Operator implementation of AHM for scheduled maintenance requires approval by the respective overseeing regulator. Programs with similarities to AHM capabilities (e.g. Flight Operations Quality Assurance (FOQA), Engine Condition Monitoring (ECM) may be a useful reference). These programs also involve on-aircraft sensing, data acquisition and processing, data transmission/transfer to ground personnel, ground based data analysis and associated actions. Local regulatory approvals are common for both FOQA and ECM programs (e.g. ECM required for ETOPS approval).

2. Gaining approval of AHM to be "certified for credit" for fixed wing aircraft can be successfully achieved via short term alternatives (e.g. special conditions per regulation 21.16) for early adopters, while industry stakeholders remain committed and work to develop, as needed, regulation and/or guidance material on long term. The use of AHM data within the MSG3 analysis depends on the system being accepted as certified for credit (similarly to HUMS acceptance via IP170) and is associated with recommendation to address the following:

    a. Installation (qualification of the "on-board" and the "on-ground" segments, both in terms of hardware and software).
    b. Qualification of the monitored parameters and thresholds to be representative of the directly or indirectly observed states and performance as a monitoring of system for degradation.
    c. Qualification of off-aircraft (ground based) hardware and software utilized in monitoring.
    d. Qualification of the Instructions for Continued Airworthiness of the AHMS itself.
    e. Controlled service introduction validation.

    A proposal to the Certification Management Team (CMT) to establish a standard was prepared by TCCA and presented in September 2017. The CMT delegated the effort to the Certification Authorities for Transport Airplane (CATA) group. The FAA supports the path for guidance material amendment and creation while noting that work may be needed within certification (parts 21, 23, 25, 27, 29, 33), operation (parts 43, 91, 121, 135) and possibly personnel (part 65) sections. The current FAA plan is to charter a joint AFS and AIR "tiger team" to examine AHM within US aviation sectors with the threefold objective of: creating temporary guidance for "quick adopters", creating more comprehensive

requirements for policy organizations to write guidance and monitoring those products for consistency through publication and implementation.
The AHM WG believes these efforts can best serve industry if they are harmonized with other National Aviation Authorities as well.

3. The proposed amendments to the IMPS have been prepared based on the technical aspects of AHM integration using best judgment by the AHM WG. The outcome of initiatives associated to assumption 2 (above) may necessitate future change of the proposed amendments.

Recommendations (including Implementation):

The recommendations in this section are regarding the following:

- MSG-3 vol. 1 – see below subchapter 1 (i.e. recommendations 1.1 to 1.9)
- IMPS – see below subchapter 2
- Other – see below subchapter 3

1. This IP proposes, in summary, a method to integrate AHM capability within the MSG-3 process by introducing new language and new decision tree logic (i.e. level 3). It enables the WGs to determine task type and the means whereby data acquired from AHM could be applied to defining a repetitive maintenance task or allow an alternative process to be identified. Results would be published within the MRBR. The creation of an "AHM candidate" is introduced as the starting point to assess AHM applicability and effectiveness. Several examples intended to illustrate the application of the new level of systematic top-down analysis are presented in Appendix 2 of this IP.

The following amendments are proposed for incorporation in MSG-3 Vol 1 (text to be deleted is ~~crossed~~ and text to be added is in red). Please note that the baseline text used is MSG-3 Rev 2015.1 to which applicable changes resulting from IPs adopted (post Rev 2015.1 issue) were added wherever relevant:

1.1. The sub-chapter **1-3-1. Industry Steering Committee** should be revised in order to state:

"[…] It shall be the responsibility of this committee to establish policy, decide on AHM consideration, set initial goals for scheduled maintenance check intervals, direct the activities of working groups or other working activity, carry out liaison with the manufacturer and other operators, prepare the final recommendations and represent the operators in contacts with the Regulatory Authority […]"

1.2. The point **2. Scheduled Maintenance Content** of sub-chapter **2-1-2. Approach**, as resulted post IP 158, should be revised in order to state:

"The content of the scheduled maintenance itself consists of ~~a group of scheduled tasks to be accomplished at specified intervals~~ two parts with the ~~The~~ objective ~~of these tasks~~ to identify failures and to prevent deterioration of the inherent safety and reliability levels of the aircraft:

a) A group of scheduled tasks to be accomplished at specified intervals. The tasks in scheduled maintenance may include:

(1) Lubrication/Servicing (LU/SV or LUB/SVC)

(2) Operational/Visual Check (OP/VC or OPC/VCK)

(3) Inspection/Functional Check (IN*/FC or */FNC)

* General Visual Inspection (GV or GVI)

* Detailed Inspection (DI or DET)

* Special Detailed Inspection (SI or SDI)

* Scheduled Structural Health Monitoring (S-SHM)

(4) Restoration (RS or RST)

(5) Discard (DS or DIS)

and

b) A group of alternative procedures and/or actions and/or tasks, as related to above (1) to (5), which make use of AHM capability.

An efficient program is one which schedules only those tasks necessary to meet the stated objectives. It does not schedule additional tasks which will increase maintenance costs without a corresponding increase in reliability protection."

1.3. The point **3. Method for Scheduled Maintenance Development** of sub-chapter **2-1-2.Approach** should be revised in order to state:

"[…] Items that, after analysis, have no scheduled task specified, may be monitored by an operator's reliability program and/or optionally make use of AHM. […]"

1.4. Add a new paragraph in chapter **2-3. Aircraft Systems/Powerplant Analysis Procedure** to state as follows:

"The method for determining the scheduled maintenance tasks and intervals for systems/powerplant, including components and APU's, uses a progressive logic diagram. A glossary of terms and definitions used in the logic diagram is listed in Appendix A. This logic is the basis of an evaluation technique applied to each maintenance significant item (system, sub-system, module, component, accessory, unit, part, etc.), using technical data available. Principally, the evaluations are based on the items functional failures and functional causes.

The references to and use of Aircraft Health Monitoring throughout this section requires the certification of the associated system features by the type certification staff of the Regulatory Authority. The use of AHM is limited to non-safety tasks provided the tasks are not covering CCMRs."

1.5. The sub-chapter **2-3-2. Analysis Procedure** should be revised in order to state:

"[…] Protective function statements should describe the protective function itself, and should also include the words "if" or "in the event of" followed by a brief description of the events or circumstances that would activate or require activation of the protection. For example, "To open the relief valve to atmosphere in the event of system X pressure exceeding 300 psi."

For systems providing AHM capability, all related functions of the corresponding MSIs and candidate MSIs have to be identified if they are intended to be used. After the Level 3 analysis exercise is completed, information is to be provided to the ISC in order to show that all systems/sub-systems providing AHM functionality were accounted for and its analyses has been checked for completeness.

Tasks and intervals required in the scheduled maintenance are identified using the procedures set forth herein. Both the economic and safety related tasks are included so as to produce initial scheduled maintenance tasks/intervals.

[…]

Prior to applying the MSG-3 logic diagram to an item, a preliminary work sheet will be completed that clearly defines the MSI, its function(s), functional failure(s), failure effect(s), failure cause(s) and any additional data pertinent to the item.

Examples include: ATA chapter reference, fleet applicability, manufacturer's part number, a brief description of the item, expected failure rate, hidden functions, need to be on M.E.L., redundancy (may be unit, system or system management), AHM capability (including certification considerations), parameters and outputs (data generated).

This work sheet is to be designed to meet the user's requirements and will be included as part of the total MSG-3 documentation for the item. […] "

1.6. The sub-chapter **2-3-3. Logic Diagram** should be revised in order to state:

"The decision logic diagrams ~~(Ref. [Figure 2-2.1])~~ ~~is~~ are used for analysis of systems/powerplant items. The logic flow is designed whereby the user begins the analysis at the top of the diagram, and answers to the "YES" or "NO" questions will dictate direction of the analysis flow.

1. Levels of Analysis

The decision logic has two levels (Level 1 and 2) enabling the development of classic tasks (Ref. [Figure 2-2.1]) and a third level (Level 3) enabling the use of AHM (Ref. [Figure 2-3-9.1]):

a) Level 1 (questions 1, 2, 3 and 4) requires the evaluation of each FUNCTIONAL FAILURE for determination of the Failure Effect Category; i.e., safety, operational, economic, hidden safety or hidden non-safety.

The response to these questions shall take into consideration all certificated operating capabilities of the aircraft (e.g., Extended Twin OPerationS / ExTended OPerationS (ETOPS), Reduced Vertical Separation Minima (RVSM), Category (Cat) III).

b) Level 2 (questions 5, 6, 7, 8 and 9, "A" through "F", as applicable) then takes the FAILURE CAUSE(S) for each functional failure into account for selecting the specific type of task(s).

At level 2, the task selection section, paralleling and default logic have been introduced. Regardless of the answer to the first question regarding "Lubrication/Servicing", the next task selection question must be asked in all cases. When following the hidden or evident safety effects path, all subsequent questions must be asked. In the remaining categories, subsequent to the first question, a "YES" answer will allow exiting the logic.

NOTE:	At the user's option, advancement to subsequent questions after deriving a "YES" answer is allowable, but only until the cost of the task is equal to the cost of the failure prevented.

Default logic is reflected in paths outside the safety effects areas by the arrangement of the task selection logic. In the absence of adequate information to answer "YES" or "NO" to questions in the second level, default logic dictates a "NO" answer be given and the subsequent question be asked. As "NO" answers are generated the only choice available is the next question, which in most cases provides a more conservative, stringent and/or costly task.

c) Level 3 - If the system offers AHM capability, a third level decision logic (i.e. Level 3) may be applied. This level enables working groups to assess failure causes covered by AHM capability associated with lubrication and servicing, detecting degradation, and detecting hidden failure.

1.7. The title of sub-chapter **2-3-8. Systems/Powerplant Task Interval Determination** should be revised in order to state: "**2-3-8. Systems/Powerplant Classic Task Interval Determination**"

1.8. A new sub-chapter should be added in **Chapter 2. Development of Scheduled Maintenance** in order to state:

"[…]

2-3-9. AHM Candidate Analysis (Third level)

1. General

The AHM Candidate category consists of the failure causes for which AHM capability exists and for which a classic task was selected following the Level 2 analysis (see definition). All AHM candidates are processed through the logic diagram of Level 3 analysis. There are three steps associated with the logic

diagram. Each step begins with an opening question intended to assess the applicability to the AHM candidate.

Each failure cause covered by AHM capability is assessed for:

- Need for lubrication and/or servicing (step 1)
- Detecting degradation (step 2)
- Detecting hidden failure (step 3 - for FEC 8 and 9 only)

The methodology assesses:

- AHM applicability to the failure cause(s)
- Time margin between AHM notification and the respective AHM procedure / action
- AHM effectiveness related to the failure cause(s)
- Whether AHM presents a full or partial alternative to a classic task

Three possible outcomes may result from the AHM candidate analysis (per Figure 2-3-9.1)

1. No AHM

2. AHM Alternative(s)

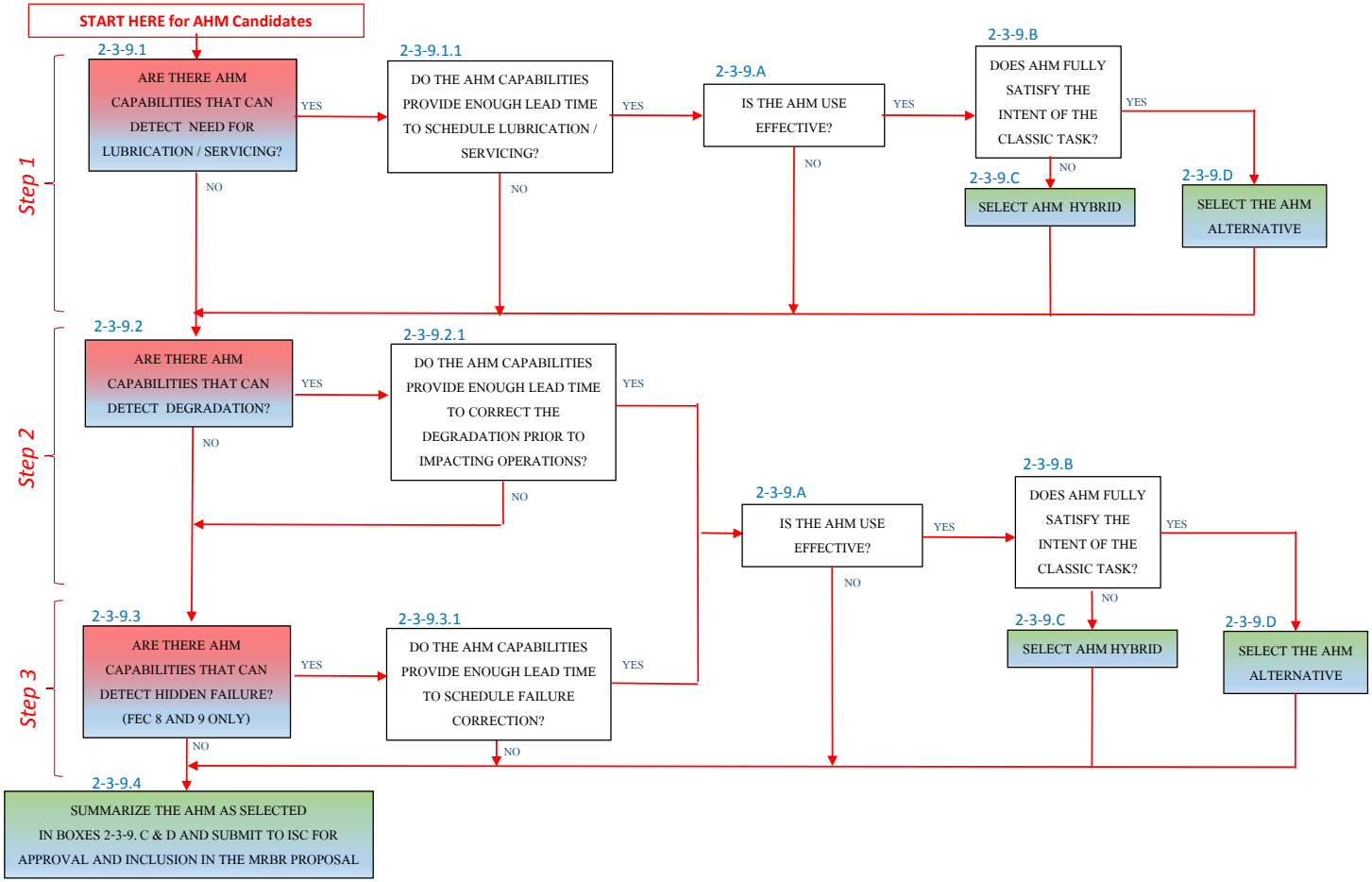
3. AHM Hybrid(s)

AHM alternative(s) and AHM hybrid(s) (i.e. above 2. and 3.) may be used instead of the classic task. The manufacturer must provide traceability to the classic task (two way). The PPH will define how these are published in the MRBR and how traceability and the link to detailed procedure documents will be ensured. Except for an AHM applicability note, the classic task remains unchanged and available. The Classic task, AHM alternative and AHM hybrid each fulfil the minimum requirements and may be individually selected by the operator. The manufacturer will provide provisions which allow the operator to switch between the Level 2 and Level 3 outcome throughout the service life of the aircraft.

The OEM must clearly identify AHM system configuration (e.g. Mod No., Option No., dash-Number) and respective AHM functionality within the AHM analysis worksheet in sufficient detail to allow the working groups to answer all questions associated with the logic flow.

Initial Date: 27 Apr 2018
IP Number: IP 180
Revision / Date: 0

Figure 2-3-9.1. Systems/Powerplant MSG-3 Logic Diagram – Level 3 Analysis



2. Step 1

Box 2-3-9.1: ARE THERE AHM CAPABILITIES THAT CAN DETECT NEED FOR LUBRICATION / SERVICING?
Parameter(s) indicating (directly or indirectly) the need for lubrication / servicing must be available to AHM.

Box 2-3-9.1.1: DO THE AHM CAPABILITIES PROVIDE ENOUGH LEAD TIME TO SCHEDULE LUBRICATION / SERVICING?
The AHM must provide timely awareness to the operator before the loss of the function in order to allow the LUB/SVC task to be scheduled at the next convenient opportunity.

In answering the question, consideration should be given to the ease in which corrective action can be applied and the time required for preparation (e.g. accomplished at an out-station/line maintenance or in a hangar, availability of parts).

Box 2-3-9.A: (as applicable to all three steps) IS THE AHM USE EFFECTIVE?
The same criteria as in Level 2 are used in determining the effectiveness of AHM.

The AHM must be as effective as or more effective than the classic task(s) selected in Level 2 analysis according to the FEC. In assessing the AHM effectiveness, the following criteria must be satisfied by AHM, as applicable, for:

- FEC 8: it reduces the risk of failure to assure safe operations
- FEC 6&9: it reduces the risk of failure to an acceptable level
- FEC 7&9: the cost of AHM is less than the cost of potentially recurring failure

Box 2-3-9.B: (as applicable to all three steps) DOES AHM FULLY SATISFY THE INTENT OF THE CLASSIC TASK?
AHM must address all failure causes covered by the classic task.

Note:	In assessing the question consideration should include AHM capability beyond those associated with failure cause (e.g. functional failure). The way AHM mitigates the failure cause does not necessarily have to be the same as the classic task, for example a failure cause covered by a classic qualitative visual check (failure finding task) may be fully covered by quantitative AHM monitoring (potential failure finding).

Box 2-3-9.C: (as applicable to all three steps) SELECT AHM HYBRID
This is a classic task supplemented by AHM which may change scope, interval or procedure. In this case the AHM does not fully satisfy the intent of the classic task – not all failure causes are covered by AHM.

Examples of combination could be (but are not limited to):

- AHM paired with modified classic task at different interval (e.g. for partial – not all failure causes)
- Classic task scheduled by parameters from AHM (e.g. for delta P – a restore task converted to FC at a reduced interval)
- AHM data applied for scheduled checks (e.g. for Air Cycle Machine – temp records of operational environments allow for a different interval for ACM maintenance)
- AHM may provide usage parameter to aid in task interval definition

The AHM Hybrid is published within the MRBR.

Box 2-3-9.D: (as applicable to all three steps) SELECT THE AHM ALTERNATIVE
This outcome is a fully equivalent AHM alternative to the classic task. The AHM Alternative is published within the MRBR.

3. Step 2

Box 2-3-9.2: ARE THERE AHM CAPABILITIES THAT CAN DETECT DEGRADATION?
Parameter(s) indicating (directly or indirectly) functional degradation or deterioration of components must be present.

Box 2-3-9.2.1: DO THE AHM CAPABILITIES PROVIDE ENOUGH LEAD TIME TO CORRECT THE DEGRADATION PRIOR TO IMPACTING OPERATIONS?
In answering the question consideration should be given to the ease in which corrective action can be applied and the time required for preparation (e.g. accomplished at an out-station/line maintenance or in a hangar, availability of parts).

The AHM must provide timely awareness to the operator before the loss of the function in order to allow the corrective action to be scheduled at the next convenient opportunity. The working group must have a satisfactory understanding of the deterioration characteristics (e.g. P to F curve).

4. Step 3

Box 2-3-9.3: ARE THERE AHM CAPABILITIES THAT CAN DETECT HIDDEN FAILURE? (FEC 8 AND 9 ONLY)
This question is only applicable to Category 8 and 9 functional failures and only if no AHM capability to detect degradation has been identified. Parameter(s) indicating (directly or indirectly) functional failure must be present.

Box 2-3-9.3.1: DO THE AHM CAPABILITIES PROVIDE ENOUGH LEAD TIME TO SCHEDULE CORRECTIVE ACTION?
The AHM must allow the operator to identify the loss of the hidden function in order to prevent a safety, operational or economic impact in combination with a second failure (including back-up). Appropriate lead time will depend on affected function and level of redundancy. Consideration should be similar to those used in determining the interval of a failure finding tasks in level 2 analysis (e.g. consider the length of exposure time to a hidden failure and the potential consequences if the hidden function is unavailable.)

In answering the question consideration should be given to the AHM procedure which must provide detailed instructions about the mitigation action to be launched in case an alert has been triggered. This action can range from a one-time inspection up to a component replacement and needs to be followed by the operator as defined.

In answering the question consideration should be given to the ease in which corrective action can be applied and the time required for preparation (e.g. accomplished at an out-station/line maintenance or in a hangar, availability of parts).

Documentation and active management of the failure must be addressed by the operator.

Box 2-3-9.4: SUMMARIZE THE AHM AS SELECTED IN BOXES 2.3.9 C & D AND SUBMIT TO ISC FOR APPROVAL AND INCLUSION IN THE MRBR PROPOSAL. This means that all results produced by the Level 3 analysis, following the logic of boxes C and D per any of the three steps (i.e. Step 1 to 3), should be processed as detailed in the PPH.

5. Sources of Information

The following information related to AHM capability, such as but not limited to, should be available when evaluating an AHM candidate:

- All AHM parameters and messages associated with the MSI failure cause(s)
- How these parameters are expressed to the operator (Maintenance Message, Operation Center monitoring, etc.)
- The frequency the parameters are checked either by automatic (non-human intervention) or manual (human intervention) means
- Vendor/manufacturer test data or related analysis associated with any limitations (e.g. filter contamination, brake wear)
- AHM messaging informing when parameters are unavailable to support the level 3 AHM options.

6. AHM timing / frequencies

AHM allows operators to identify the need for planning and scheduling maintenance action in order to avoid costly unscheduled maintenance or AOG situations.

Timing associated with the AHM will be contained within the AHM analysis worksheet. Consideration should be given to:

- Message transmittal frequencies,
- Read out frequencies,
- Timing for action, and

- Thresholds or limits associated with a parameter.

[…]"

1.9. The **Appendix A. Glossary** should be revised in order to include the following definitions:

"[…]

Aircraft Health Monitoring (AHM)	Aircraft Health Monitoring (AHM) is the use of data generated from specific aircraft systems to determine condition, reduced resistance to failure or degradation of function for the purpose of timely scheduling maintenance actions (the use typically includes Sensing, Acquisition, Transfer, Analysis and Action(s) taken: "SATAA").
AHM Alternative	AHM that mitigates all failure cause(s) covered by a classic task.
AHM Candidate	Failure cause(s) for which AHM capability exists and for which a classic task exists.
AHM Hybrid	A combination of AHM and a task resulting in a scheduled action.
Classic Task	A task that results from Level 2 analysis.

[…]"

2. The following amendments are proposed for incorporation in IMPS (text to be deleted is ~~crossed~~ and text to be added is in red). Please note that the baseline text used is IMPS Issue 00 from April 29, 2016 to which applicable changes resulting from IPs adoption (post 2016-04-29) were added wherever relevant:

4.2.6 The TCH should ensure that their manuals contain information and procedures for accomplishing all on-aircraft maintenance tasks covered in the MRBR. If AHM alternatives are proposed by the TCH, all steps necessary for operators to perform system health assessment off aircraft, including instructions when monitoring becomes unavailable, must be published in their maintenance manuals. The TCH should also provide procedures which allow switching between the classic tasks and AHM procedures throughout the service life of the aircraft.

4.7.7 It should be understood by the applicable WG that Aircraft Health Monitoring (AHM) capabilities report data used to monitor the health status of aircraft components/functions. The MRBR should reflect the understanding that credit may be taken for the existence of AHM capabilities, within their certification limits, when applying MSG-3 logic. This approach is meant to provide more flexibility to operators' scheduled maintenance.

4.7.8 The MSI selection process should include the engine, the APU and/or propellers as applicable. That is to say, the MSG-3 logic should be followed completely, which includes MSI selection at the highest manageable level, with a top-down approach. No exceptions are

allowed for the engine, the APU and/or propellers when performing the MSI selection. AHM should be considered in the MSI selection process.

3. The following recommendations are also proposed:

Related to Assumption #1 (see page 2 of this IP), the AHM working group proposes development of new guidance material (e.g. Advisory Circular) for ground based processes as a means to create common practices for the industry.

Related to Assumption #2 (see page 2 of this IP), the AHM WG proposes to Operators, Regulators and TCHs to support interim "certification for credit" methods if/as required for enabling AHM application within MSG-3 (e.g. Certification Memorandum; Certification Special Conditions). This is proposed as a means to allow the timely progression of MSG-3 revisions towards recognition of AHM early adopters and to mitigate the costly delay imposed by the long lead time required to develop regulatory provisions and/or guidance material.

IMRBPB Position:

Date: 27 April 2018
Position: Agreed in 2018 Meeting and Closed as IP 180. Note recommendation for implementation.

Status of Issue Paper and date:
Active 27 April 2018

Recommendation for implementation:
This IMRBPB agreed Issue Paper is available to all TCHs immediately and may be used under the terms expressed in the paper and the IMPS. Experience gained with its use will be reviewed annually and revisions introduced as necessary leading to a mature process in time for inclusion into the MSG-3 2021 revision.
The basis of documenting the AHM experience and maturity should follow the recommendations in paragraph 3 of this IP.

Retroactive: No

Important Note: The IMRBPB IPs are not policy. An IP only becomes policy when the IP is adopted into the processes of the appropriate National Aviation Authority. However, before formal adoption, the IP content may be incorporated by the MRB applicant on a voluntary basis with the agreement of all parties as detailed in the program PPH.

APPENDICES 1 & 2

Note: the content of the Appendix 1 and Appendix 2 presented in the following pages is intended for reference only to support the understanding of the concepts presented by this paper. They should not be interpreted as being regulatory accepted ways to comply with the IP provisions.

Examples of ATAs having aircraft system functions monitoring and MSI monitoring where AHM is involved:

1. ATA 21: Cooling and Refrigeration Unit
2. ATA 24: SSPC monitoring
3. ATA 27: Fuel Penalty Monitoring Function
4. ATA 28: Fuel Transfer and Feed Pumps
5. ATA 29: Engine Driven Pump performance
6. ATA 32: Braking System
7. ATA 35: Oxygen System

Examples for National Aviation Authority approved AHM use/credit in the Operator AMP:

1. MRB task 21-018-00 Restore the Lavatory and Galley Ventilation Power Electronics Cooling System Liquid Heat Exchanger Barrier Filter. (AHM partly satisfies this task)
2. MRB task 73-005-01/02 Visually Check for FUEL FILTER approaching bypass message on the Left/Right Engine. Note: Inspect and clean Fuel Strainer at Fuel Filter change. (ECM fully satisfies this task)
3. MRB task 79-010-01/02 Visually Check for OIL FILTER APPROACHING BYPASS MESSAGE on the Left/Right Engine. (ECM fully satisfies this task)

Example of AHM as part of operator's reliability programs

Case example background regarding implementation elements:

- Term Jan 2016 – Dec 2016
- Number of Aircraft in fleet 27
- Model [redacted]

- Total FH 103,789
- Total FC 17,397
- Avg. # of AHM mx actions initiated /month 16
- Avg. # of delay avoidances / month 9
- Avg. term of SATAA* process 94 hours
- Total # AHM msgs/faults reported & analyzed 2630
- AHM Performance impact +70 basis points (.70%)
- Reliability of fleet w/AHM 99.1%
- # of delays in term w/AHM 163
- #of delays in term w/o AHM (calc) 271
- Reliability of fleet w/o AHM (calc) 98.4%

* The sequence of AHM sensing, data acquisition, transmission, analysis and maintenance action

Specific SATAA records:

#1

ATA	Description
36	The RH Man Temp Sensor shows signs of imminent failure or an FDE [Fail Man Temp Sensor 1 1].

**********TECHNICAL SERVICE ITEM**********
MANIFOLD PRESSURE/TEMP
****
AHM IS REPORTING THE RH MANIFOLDTEMP SENSOR SHOWING SIGNS OF IMMINENT FAILURE . PLEASE COMPLY WITH THE FOLLOWING REQUEST
RECOMMENDATIONS:

REMOVE AND REPLACE THE RH MANIFOLD DUAL TEMPERATURE SENSOR M36006
IAW AMM 36-22-01-000-801 & 36-22-01-400-801

TSICPT13Nov16 13:44 HKG
R & R'D #2 ENG MANIFOLD DUAL TEMPERATURE SENSOR AND
PERFORMED RIGHT AIR SUPPLY CONTROL SYSTEM TEST
PASSED,ALSO NO LEAK FOUND AND NO FAULT MSG SHOWN
IAW AMM 36-22-01-4. ENT BY: 499528 RPT BY:499528

#2

ATA	Description
36	The LH FAMV shows signs of pending failure or an FDE [Fail Closed 1].

MTSI 890 36-10 3830
**********TECHNICAL SERVICE ITEM**********
AHM LT FAMV IMMINENT
****
AHM IS REPORTING SIGNS OF LT FAMV DEGRADATION OR IMMINENT FAILURE.
PLEASE COMPLY WITH THE FOLLOWING REQUEST

RECOMMENDATIONS:
Remove and replace the LT FAMV IAW AMM 36-11-16-4-4. Tag removed
part as "removed per AHM prognostic failure program."
COMPLETE ICN LEE 610259 06Dec16 02:25

AFTER REPLACEMENT OF LH FAMV, AHM PROGNOSTIC IS SHOWING A POSSIBLE
RVDT FAULT FOR LH FAMV. PLEASE REPLACE LH FAMV PER M/M 36-11-16-4. TAG REMOVED PART AS
REMOVED PER AHM PROGNOSTIC FAULT.

#3

ATA	Description
36	The RH HPSOV shows signs of imminent failure or an FDE [Fail Closed].

**********TECHNICAL SERVICE ITEM**********
AHM - HPSOV RELIABITY
****
PLEASE REPLACE THE HPSOV AND DOSUMENT ITS REMOVAL DUE TO THE AHM IMMINENT FAILURE PROGRAM.

RECOMMENDATIONS:
Please set up to remove and replace the RIGHT HPSOV per AMM 36-11-07-4-4.
COMPLETE NRT YANAGISAWA 910946 01Oct16 04:46

Inertial unit restoration 2-3-9.2/2-3-9.B/2-3-9.D

MRBR Task TODAY

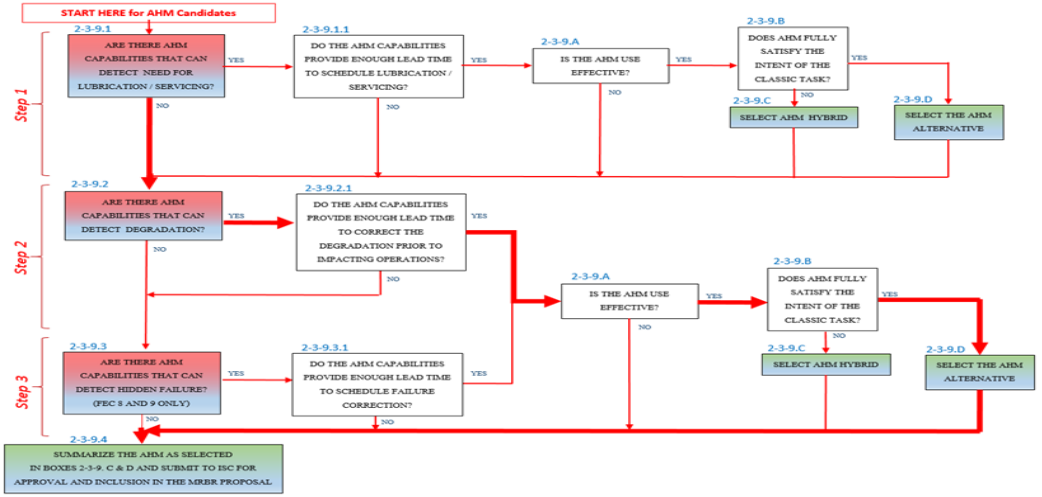
MRBR task ref.	TASK CODE	TASK Description	FEC	Threshold	Interval	Task Applicability
Xx0000-000015-M	RST	Remove Inertial Units for Calibration	9	N/A	5 YE	ALL

SYSTEM INFO

4 Inertial Unit (IU) per A/C.
Inertial Units dedicated to mission operation.
Failure / Degradation of one IU is not detectable on A/C. In case one IU is faulty / degraded, A/C works with the 3 remaining IU.
IU calibration is applicable and effective.
MRBR interval is 5 YE based on Vendor Recommendations.

AHMS INFO

Each IU data is stored in A/C recorder. Information could be downloaded from recorder and analyzed in a ground station. IU incipient degradation is detected. Message that recommends IU Calibration



MRBR Tasks FUTURE

MRBR task ref.	TASK CODE	TASK Description	FEC	Threshold	Interval	Task Applicability
Xx0000-000015-M	RST	**Remove Inertial Units for Calibration**. NOTE: there is AHM capability available to fulfill this requirement	9	N/A	5 YE	ALL
AHMS1	FNC	**Inertial Unit data readout analysis from CDS.** NOTE: Approved alternative mean of compliance of Classic Task MRBR xx-0015-M	9	N/A	6 MO	AHMS

Initial Date: 27 Apr 2018
IP Number: IP 180
Revision / Date: 0

Appendix 2

MSI xx-xx		
Functional Failure	FEC 9	Fails to monitor angular speed and acceleration through one Inertial Unit.
Associated Failure Cause and Task	Failure Cause:	One Inertial Unit fails
	Resulting task:	MRBR ref: xx0000-000015-M RST: Remove intertial Unit for Calibration. Interval 5 YE. Applicablity ALL.
AHM Candidate		
2-3-9.1 ARE THERE AHM CAPABILITIES THAT CAN DETECT NEED FOR LUBRICATION / SERVICING?	No	There is no need of lubrication or servicing for the Inertial Units.
2-3-9.2 ARE THERE AHM CAPABILITIES THAT CAN DETECT DEGRADATION?	YES	There is AHM capability able to detect degradation of Inertial Unit by analyzing Inertial unit data automatically recorded. This "in flight" recorded information could be downloaded from A/C recorder and analized in CDS. (ground station). Degradation of the Inertial unit will be detected by the anaylisis of data downloaded.
2-3-9.2.1 DO THE AHM CAPABILITIES PROVIDE ENOUGH LEAD TIME TO CORRECT THE DEGRADATION PRIOR TO IMPACTING OPERATIONS?	YES	IU degradation could be detected before impacting operations.
2-3-9A IS THE AHM USE EFFECTIVE?	YES	It is effective to detect incipient degradation of the funcion (AHM will detect degradation of each inertial unit). AHM IU data analisis will optimize the interval of IU calibration. IU will be calibrated when necessary after detection of IU degradation.
2-3-9B DOES AHM FULLY SATISFY THE INTENT OF THE CLASSIC TASK?	YES	AHM procedure can detect degradation of the IU, therefore it fully satisfy the intent of the avoid classic task.
2-3-9-D SELECT THE AHM ALTERNATIVE		AHM Procedure: AHM xxx Ref. Inertial Unit data readout analysis from CDS. NOTE: Approved alternative mean of compliance of Classic Task MRBR xx0000-000015-M
2-3-9.4 SUMARIZE THE AHM AS SELECTED IN BOXES 2-3-9.C &DAND SUBMIT TO ISC FOR APPROVAL AND INCLUSION IN THE MRBR PROPOSAL		**AHM Procedure:** AHM xxx Ref. Inertial Unit data readout analysis from CDS. NOTE: Approved alternative mean of compliance of Classic Task MRBR xx0000-000015-M **CLASSIC MRBR task:** xx0000-000015-M task description updated. Remove Inertial Units for Calibration. NOTE: there is AHM capability available to fulfill this requirement
SUMMARIZE THE IMPACT AND SUBMIT TO ISC FOR APPROVAL AND INCLUSION IN THE MRBR		
AHM requirement/ procedure		**AHM Procedure: AHM xxx Ref.** **Inertial Unit data readout analysis from CDS. (minimum interval every 6 MO)** **NOTE: Approved alternative mean of compliance of Classic Task MRBR xx0000-000015-M** AHM Procedure: AHMx (approved alternative means of compliance of the Classic Task xx0000-00005-M) Description: Health Monitoring on Inertial Unit Interval : Data collection (Parameters) --> every flight with system operative. IU Data are automatically recorded in a memory located on A/C. Data analysis (Process) Recommended interval at least every 6MO Procedure: go to A/C. REmove Disk from A/C. Insert Disk on Ground Station, start data analisys. Refer to GSE applicable/ Personnel involved (Skill)/ Engineering Analyses/ Maintenance Actions/ Deviation information.
MRBR classic task description updated --> to include traceability with approved AHM capability		MRBR xx0000-000015-M task description updated. Remove Inertial Units for Calibration. Interval 5 YE. **NOTE: there is AHM capability available to fulfill this requirement**

Brake Wear 2-3-9.2/2-3-9.B/2-3-9.D

MRBR Task TODAY

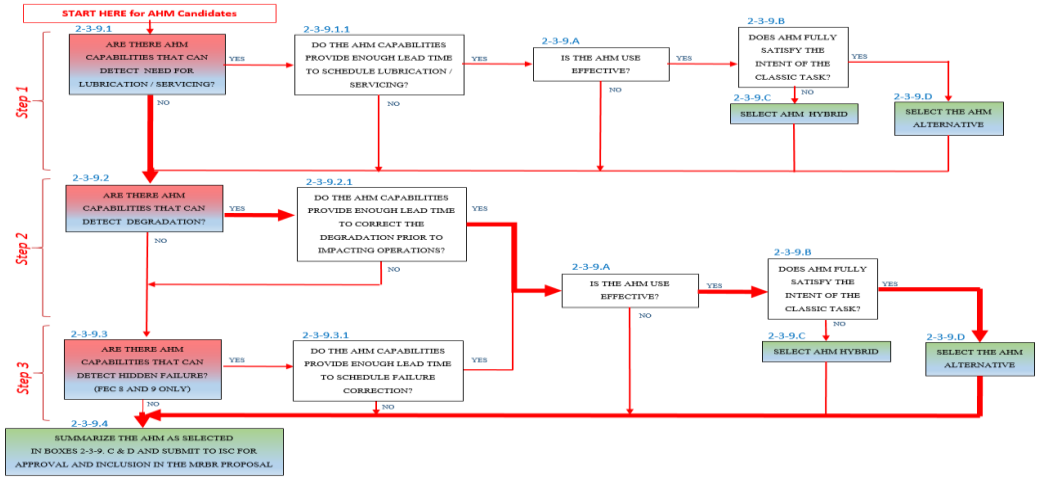
MRBR task ref.	TASK CODE	TASK Description	FEC	Threshold	Interval	Task Applicability
32-170-00	VCK	Visually check for BRAKE wear	9	N/A	100 FC	ALL

SYSTEM INFO

The Electric Brake Actuator Controllers electronically determine brake-wear state based on motor-resolver output from each Electric Brake Actuator. Brake wear data is displayed on the Landing Gear Brakes maintenance page for each brake position.

AHMS INFO

Break wear data (percent remaining) is available both on and off the aircraft via the Landing Gear Brakes maintenance page. In addition, a MMSG for the brake wear is available as a precursor to the eventual FDE. Monitoring may be used to create actionable awareness of brake wear approaching limit as set in MMSG. Any of the three options could be used as an alternative to visual inspection



MRBR Tasks FUTURE

MRBR task ref.	TASK CODE	TASK Description	FEC	Threshold	Interval	Task Applicability
32-170-00	VCK	**Visually check for BRAKE wear** NOTE: there is AHM capability available to fulfill the intent of this requirement.	9	N/A	100 FC	ALL
AHM 32-170-01	AHM	**Break Wear (Percent Remaining) Limit Alert** NOTE: Approved as alternative mean of compliance of Classic Task MRBR 32-170-00	9	N/A	AHM	ALL

Functional Failure	FEC 9	Fails to provide proper braking force in response to system
Associated Failure Cause and Task	Failure Cause:	Brake assembly worn beyond the limit of mechanical failure
	Resulting task:	Visually check for Brake wear
AHM Candidate		
2-3-9.1ARE THERE AHM CAPABILITIES THAT CAN DETECT NEED FOR LUBRICATION / SERVICING?	NO	Lubrication/Servicing is not applicable for this failure cause because there is no consumable to replenish.
2-3-9.2 ARE THERE AHM CAPABILITIES THAT CAN DETECT DEGRADATION	YES	Brake wear data is available both on and off aircraft via Landing Gear Brakes maintenance page.
2-3-9.1.1 DO THE AHM CAPABILITIES PROVIDE ENOUGH LEAD TIME TO CORRECT THE DEGRADATION PRIOR TO IMPACTING OPERATIONS?	YES	Maintenance Messages can be created with customizeable limits based on operator preference. Once Brake Wear has reached the appropiate threshhold, corrective action to replace the brakes can be initiated.
2-3-9A IS THE AHM USE EFFECTIVE?	YES	Utilizing AHM will alert the operator prior to functional failure.
2-3-9B DOES AHM FULLY SATISFY THE INTENT OF THE CLASSIC TASK?	YES	The purpose of the classic task to monitor brake wear to determine functional degradation. The AHM also fulfills this intent..
2-3-9-D SELECT AHM AS ALTERNATIVE TO CLASSIC TASK		Classic task not applicable to operators using an AHM program. No alternative MRBR task created.
2-3-9.4 SUMMARIZE THE AHM AS SELECTED IN BOXES 2-3-9. C & D AND SUBMIT TO ISC FOR APPROVAL AND INCLUSION IN THE MRBR PROPOSAL		AHM fully precludes a scheduled maintenance task. Brake Wear can be monitored via the maintenance page or messages can be sent to the operator once certain limits have been reached.. Classic Task 32-170-00 updated with applicability note to state only applicable to operators not utilizing AHM
SUMMARIZE THE IMPACT AND SUBMIT TO ISC FOR APPROVAL AND INCLUSION IN THE MRBR		
AHM requirement/procedure		1a) Wait for maintenance message or 1b) Monitor brake wear via maintenance page 2) Schedule Brake replacement within set time frame.
MRBR classic task description updated --> to include traceability with approvedAHM capability		MRBR 32-170-01 Visually check for Brake wear AIRPLANE NOTE: Applicable to operators not utilizing AHM Alternative 32-170-01. See Appendix X for more information

Hydraulics Internal Leakage – Functional Check 2-3-9.2/2-3-9.B/2-3-9.D

MRBR Task TODAY

MRBR task ref.	TASK CODE	TASK Description	FEC	Threshold	Interval	Task Applicability
29-0x0-00	FNC	Functional Check of the gross internal leakage of the Hydraulic System	9	N/A	24000 FH	ALL

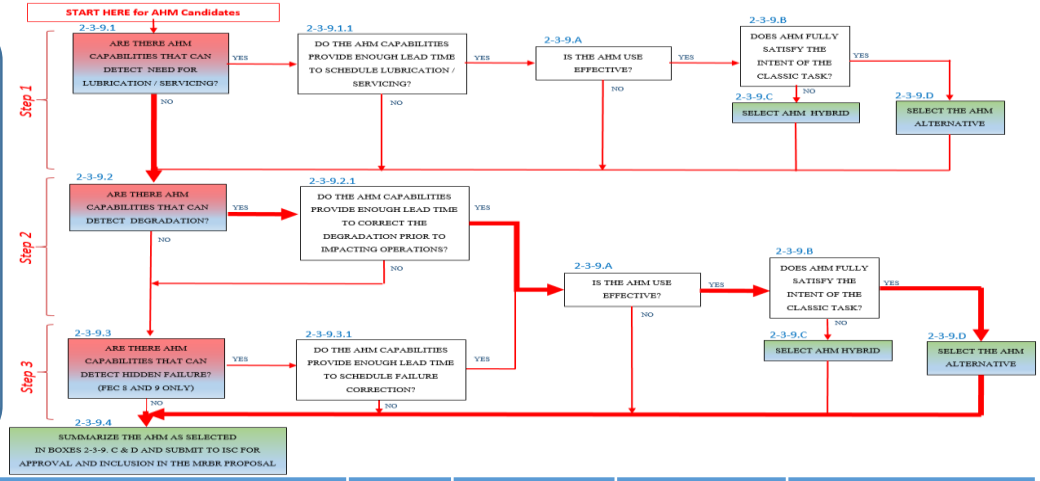
SYSTEM INFO

Functional Check is accomplished by measuring the time it takes for a hydraulic system to depressurize from a high pressure to a low pressure.

- 3000psi at beginning of test
- Power removed, system begins depressurizing
- Reaches 500psi after 15 seconds
- If time to reach 500 psi is > 5 seconds, system passes

AHMS INFO

Internal Leakage Bleed Down Time measured and available after every flight for review or alerting.



MRBR Tasks FUTURE

MRBR task ref.	TASK CODE	TASK Description	FEC	Threshold	Interval	Task Applicability
29-0x0-00	FNC	**Functional Check of the gross internal leakage of the Hydraulic System** NOTE: there is AHM capability available to fulfill the intent of this requirement.	9	N/A	24000 FH	ALL
AHM 29-0x0-01	AHM	**Functional Check of the gross internal leakage of the Hydraulic System s** NOTE: Approved as alternative mean of compliance of Classic Task MRBR 29-0x0-00	9	N/A	AHM	ALL

Hydraulics Internal Leakage – Functional Check 2-3-9.2/2-3-9.B/2-3-9.D

AHM Alternative – Scheduled Task Replacement

AHM Alternative available:

Internal Leakage Bleed Down Time measured after every flight

Captures full intent of the classic Functional Check

2) INTERNAL LEAKAGE BLEED DOWN TIME

	LEFT	CENTER	RIGHT
INIT PRESSURE	[redacted]71	[redacted]33	[redacted]16
FINAL PRESSURE	513	1016	513
INIT TEMPERATURE	31	36	32
DELTA TIME (SEC)	63.0	7.0	61.0

Operators utilizing AHM will be able to remove the classic Functional Check from their maintenance program with no scheduled task replacement

Functional Failure	FEC 9	Fails to provide hydraulic power to user systems
Associated Failure Cause and Task	Failure Cause:	High Internal Leakage
	Resulting task:	Functionally Check gross internal leakage of Hydraulic System
AHM Candidate		
2-3-9.1ARE THERE AHM CAPABILITIES THAT CAN DETECT NEED FOR LUBRICATION / SERVICING?	NO	Lubrication/Servicing is not applicable for this failure cause because there is no consumable to replenish.
2-3-9.2 ARE THERE AHM CAPABILITIES THAT CAN DETECT DEGRADATION	YES	Internal Leakage bleed down time is measured after every flight and results can be viewed via AHM.
2-3-9.1.1 DO THE AHM CAPABILITIES PROVIDE ENOUGH LEAD TIME TO CORRECT THE DEGRADATION PRIOR TO IMPACTING OPERATIONS?	YES	Internal Leakage will gradually increase with functional degradation. Once the appropiate threshold is reached (TBD), operators will be able to schedule corrective action at their next base check opportunity.
2-3-9A IS THE AHM USE EFFECTIVE?	YES	Utilizing AHM will alert the operator prior to functional failure.
2-3-9B DOES AHM FULLY SATISFY THE INTENT OF THE CLASSIC TASK?	YES	The purpose of the classic task to measure internal leakage to determine functional degradation. The AHM measures the same parameter.
2-3-9-D SELECT AHM AS ALTERNATIVE TO CLASSIC TASK		Classic task not applicable to operators using an AHM program. No alternative MRBR task created.
2-3-9.4 SUMMARIZE THE AHM AS SELECTED IN BOXES 2-3-9. C & D AND SUBMIT TO ISC FOR APPROVAL AND INCLUSION IN THE MRBR PROPOSAL		AHM fully precludes a scheduled maintenance task. Internal Leakage Bleed Down time will be monitored based on an operators approved AHM program. Classic Task 29-0x0-00 updated with applicability note to state only applicable to operators not utilizing AHM
SUMMARIZE THE IMPACT AND SUBMIT TO ISC FOR APPROVAL AND INCLUSION IN THE MRBR		
AHM requirement/procedure		1) Monitor INTERNAL LEAKAGE BLEED DOWN TIME in the AHM for each of the hydraulic systems (Left/Center/Right) 2) Once DELTA TIME (SEC) is lower than 5 sec for Center or 20 sec for Left/Right schedule corrective action for next base check.
MRBR classic task description updated --> to include traceability with approvedAHM capability		MRBR 29-0x0-00 Functional Check of the gross internal leakage of the Hydraulic System AIRPLANE NOTE: Applicable to operators not utilizing AHM Alternative 29-0x0-01. See Appendix X for more information

Hydraulic System Reservoir Quantity Indicator 2-3-9.2/2-3-9.A/2-3-9.B/2-3-9.D

MRBR Task TODAY

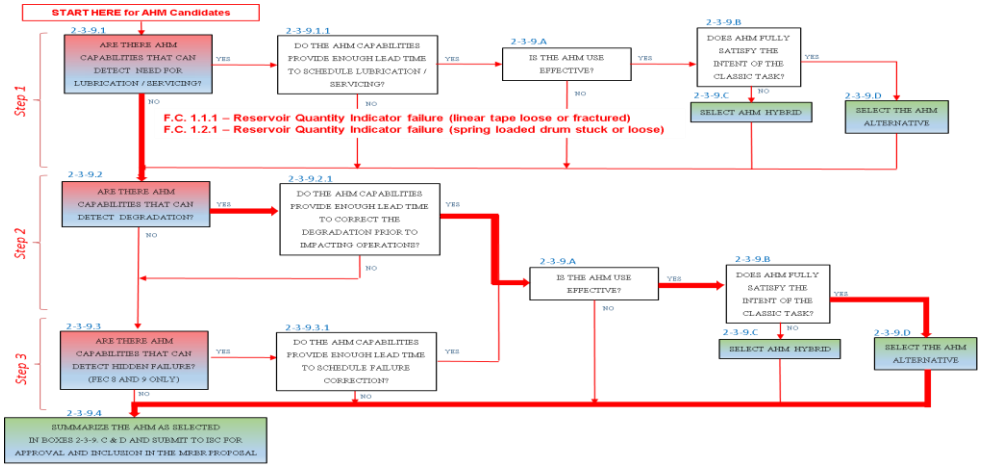
MRBR task ref.	TASK CODE	TASK Description	FEC	Threshold	Interval	Task Applicability
29-30-01	OPC	Operational Check of Hydraulic Systems Reservoir Quantity Indicator	9	N/A	1500 FH	ALL

SYSTEM INFO

One Quantity Indicator installed at back of the Hydraulic Reservoir. Reservoir Quantity Indicator provides Hydraulic quantity indication to the MAU. The operational check at 1500 FH is applicable and effective to detect the functional failure.

AHMS INFO

The Quantity indicator provides constant readings of Hydraulic fluid level and its readings will be used to capture indicator behavior variations and it will be recorded by QAR. They should be downloaded and analyzed (measured value will be compared with a baseline curve) by ground station engineering.



MRBR Tasks FUTURE

MRBR task ref.	TASK CODE	TASK Description	FEC	Threshold	Interval	Task Applicability
29-30-01	OPC	**Operational Check of Hydraulic Systems Reservoir Quantity Indicator.** NOTE: there is AHM capability available to fulfill the intent of this requirement.	9	N/A	1500 FH	ALL
AHM 29-30-01	AHM	**Reservoir Quantity Indicator data readout** NOTE: Approved as alternative mean of compliance of Classic Task MRBR 29-30-01	9	N/A	14 days	ALL

Initial Date: 27 Apr 2018
IP Number: IP 180
Revision / Date: 0

Appendix 2

MSI 29-30 Failure Cause

FUNCTIONAL FAILURE	FEC 9	1.1 Provide a 100% or invalid fluid quantity visual indication. 1.2 Provide incorrect fluid quantity visual indication.
ASSOCIATED FAILURE CAUSES AND CLASSIC LEVEL 2 TASK	Failure Cause:	1.1.1 Reservoir Quantity Indicator failure (linear tape loose or fractured). 1.2.1 Reservoir Quantity Indicator failure (spring loaded drum stuck or loose).
	Resulting task:	MRBR ref: 29-30-01 at 1500 FH OPC : Operational Check of Hydraulic Systems Reservoir Quantity Indicator

AHM Candidate - 1.1.1 - Reservoir Quantity Indicator failure (linear tape loose or fractured).

2-3-9.1 ARE THERE AHM CAPABILITIES THAT CAN DETECT NEED FOR LUBRICATION / SERVICING?	NO	There is no need of lubrication or service on Reservoir Quantity Indicator
2-3-9.2 ARE THERE AHM CAPABILITIES THAT CAN DETECT DEGRADATION?	YES	There is AHM capability to detect degradation thru quantity indication readings. The system standard operation provides constant operational readings and degradation detection is possible when compared with standard behaviors.
2-3-9.2.1 DO THE AHM CAPABILITIES PROVIDE ENOUGH LEAD TIME TO CORRECT THE DEGRADATION PRIOR TO IMPACTING OPERATIONS?	YES	Measured values will be compared with baseline curve in order to show degradation level . Reservoir Quantity Indicator failure (spring loaded drum stuck or loose) can be detected 5 days before impacting operations.
2-3-9.A IS THE AHM USE EFFECTIVE?	YES	It is effective to assure the proper system operation avoiding lost of quantity indication and reduction of unscheduled maintenance.
2-3-9.B DOES AHM FULLY SATISFY THE INTENT OF THE CLASSIC TASK?	YES	AHM procedure can detect degradation of the Reservoir Quantity Indicator failure (linear tape loose or fractured) and also detect the Failure Cause Reservoir Quantity Indicator failure (spring loaded drum stuck or loose) in accordance with AHM candidate 1.2.1 analysis.
2-3-9-C SELECT THE AHM ALTERNATIVE	-	AHM Procedure AHM 29-30-01 is selected as alternate mean of compliance of Classic Task 29-30-01.
2-3-9.4 SUMMARIZE THE AHM AS SELECTED IN BOXES 2-3-9. C & D AND SUBMIT TO ISC FOR APPROVAL AND INCLUSION IN THE MRBR PROPOSAL	-	**AHM requirement/procedure** AHM Procedure: AHM 29-30-00 (approved as alternative means of compliance of Classic Task 29-30-01) Description: Reservoir Quantity Indicator data readout. Interval : Data collection at 5 days Data analysis at 14 days Procedure: GSE applicable/Personnel involved (Skill)/ Engineering Analyses/Maintenance Actions/Deviation information. **MRBR classic task description updated:** MRBR 29-30-00 task description updated to include AHM note. Operational Check of Hydraulic Systems Reservoir Quantity Indicator at 1500 FH. NOTE: there is AHM capability available to fulfill the intent of this requirement.

AHM Candidate 1.2.1 - Reservoir Quantity Indicator failure (spring loaded drum stuck or loose).

2-3-9.1ARE THERE AHM CAPABILITIES THAT CAN DETECT NEED FOR LUBRICATION / SERVICING?	NO	There is no need of lubrication or service on Reservoir Quantity Indicator
2-3-9.2 ARE THERE AHM CAPABILITIES THAT CAN DETECT DEGRADATION?	YES	There is AHM capability to detect degradation thru quantity indication readings. The system standard operation provides constant operational readings and degradation detection is possible when compared with standard behaviors.
2-3-9.2.1 DO THE AHM CAPABILITIES PROVIDE ENOUGH LEAD TIME TO CORRECT THE DEGRADATION PRIOR TO IMPACTING OPERATIONS?	YES	Measured values will be compared with baseline curve in order to show degradation level . Reservoir Quantity Indicator failure (spring loaded drum stuck or loose) can be detected 5 days before impacting operations.
2-3-9.A IS THE AHM USE EFFECTIVE?	YES	It is effective to assure the proper system operation avoiding lost of quantity indication and reduction of unscheduled maintenance.
2-3-9.B DOES AHM FULLY SATISFY THE INTENT OF THE CLASSIC TASK?	YES	AHM procedure can detect degradation of the Reservoir Quantity Indicator failure (spring loaded drum stuck or loose) and also detect the failure cause Reservoir Quantity Indicator failure (linear tape loose or fractured) in accordance with AHM candidate 1.1.1 analysis.
2-3-9-C SELECT THE AHM ALTERNATIVE	-	AHM Procedure AHM 29-30-01 is selected as alternate mean of compliance of Classic Task 29-30-01.

Service Pressure Regulator Filter 2-3-9.2/2-3-9.A/2-3-9.B/2-3-9.D

MRBR Task TODAY

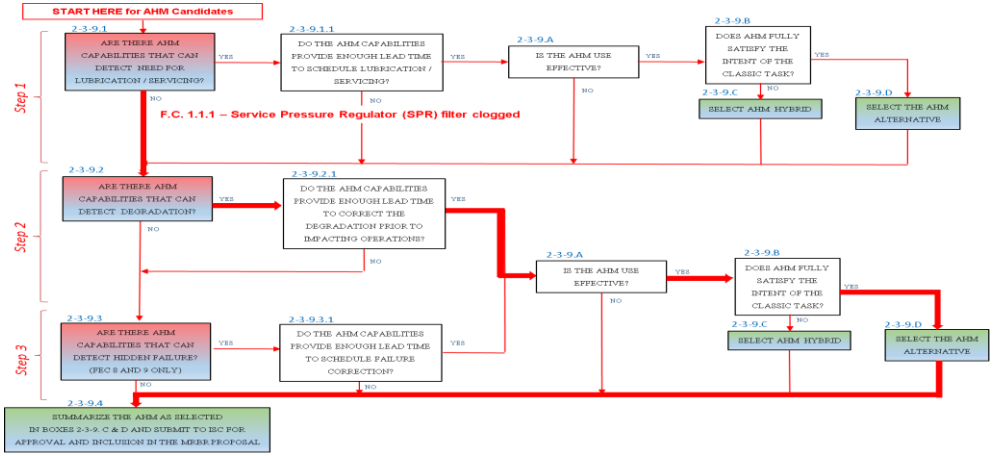
MRBR task ref.	TASK CODE	TASK Description	FEC	Threshold	Interval	Task Applicability
21-51-00	RST	Restoration (Cleaning) of Service Pressure Regulator Filter	9	N/A	750 FH	ALL

SYSTEM INFO

One filter installed at the inlet of the service pressure regulator valve (Cooling Pack System). Air pressure regulator provides regulated and constant supply pressure to air valves. This air is filtered by the filter. Cleaning of the filter at 750 FH is applicable and effective to reduce pack failure rates.

AHMS INFO

Differential Pressure sensor installed between filter and SPR inlet will be used to capture pressure variations and it will be recorded by QAR. They should be downloaded and analyzed (measured value will be compared with a baseline curve) by ground station engineering.



MRBR Tasks FUTURE

MRBR task ref.	TASK CODE	TASK Description	FEC	Threshold	Interval	Task Applicability
21-51-00	RST	**Restoration (Cleaning) of Service Pressure Regulator Filter** NOTE: there is AHM capability available to fulfill the intent of this requirement.	9	N/A	750 FH	ALL
AHM 21-51-00	AHM	**(SPR Filter) Differential pressure data readout** NOTE: Approved as alternative mean of compliance of Classic Task MRBR 21-51-00	9	N/A	7 days	ALL

MSI 21-51 Cooling Pack

FUNCTIONAL FAILURE	FEC 9	1.1 Main Pack System degraded performance (temperature control or ventilation rates).
ASSOCIATED FAILURE CAUSES AND CLASSIC LEVEL 2 TASK	Failure Cause:	1.1.1 Service Pressure Regulator (SPR) filter clogged.
	Resulting task:	MRBR ref: 21-51-00 at 750 FH RST: Restoration (Cleaning) of Service Pressure Regulator (SPR) filter

AHM Candidate - 1.1.1 Service Pressure Regulator (SPR) filter clogged.

2-3-9.1 ARE THERE AHM CAPABILITIES THAT CAN DETECT NEED FOR LUBRICATION / SERVICING?	NO	There is no need of lubrication or service of Service Pressure Regulator (SPR) filter
2-3-9.2 ARE THERE AHM CAPABILITIES THAT CAN DETECT DEGRADATION?	YES	There is AHM capability to detect degradation by information of Differential Pressure Sensor. Pressure difference is used as na indicator for filter clogging.
2-3-9.2.1 DO THE AHM CAPABILITIES PROVIDE ENOUGH LEAD TIME TO CORRECT THE DEGRADATION PRIOR TO IMPACTING OPERATIONS?	YES	Measured values will be compared with baseline curce in order to show clogging level. Filter clogging can be detect Xx hours before impacting operations.
2-3-9.A IS THE AHM USE EFFECTIVE?	YES	It is effective to assure the proper system operation avoiding filter clogging and reduction of unscheduled maintenance.
2-3-9.B DOES AHM FULLY SATISFY THE INTENT OF THE CLASSIC TASK?	YES	AHM procedure can detect degradation of the filter in order to replace the classic task.
2-3-9.D SELECT THE AHM ALTERNATIVE	-	AHM alternative task: AHM 21-51-00 is selected as alternate mean of compliance of the classic task 21-51-00.
2-3-9.4 SUMMARIZE THE AHM AS SELECTED IN BOXES 2-3-9. C & D AND SUBMIT TO ISC FOR APPROVAL AND INCLUSION IN THE MRBR PROPOSAL	-	**AHM requirement/procedure** AHM Procedure: AHM 21-51-00 (approved as alternative means of compliance of Classic Task 21-51-00) Description: (SPR Filter) Differential pressure data readout NOTE: Approved as alternative mean of compliance of Classic Task MRBR 21-51-00 Interval : Data collection at 2 days Data analysis at 7days **MRBR classic task description updated:** a. To include traceability with approved AHM capability b. MRBR 21-51-00 task description updated to include AHM note. Restoration (Cleaning) of Service Pressure Regulator (SPR) filter at 750 FH NOTE: There is AHM capability available to fulfill this requirement.

Oil Change 2-3-9.1/ 2-3-9.B /2-3-9.C

MRBR Task TODAY

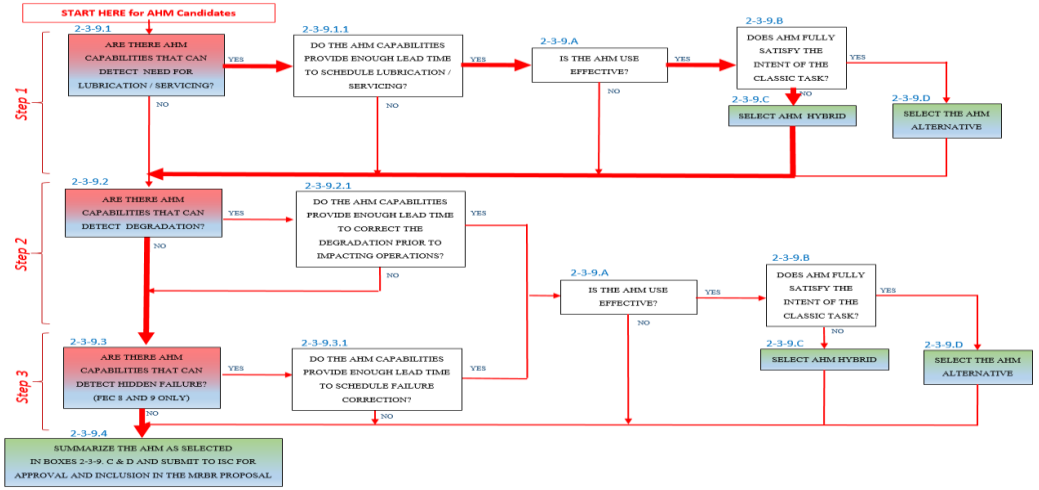
MRBR task ref.	TASK CODE	TASK Description	FEC	Threshold	Interval	Task Applicability
24-0x0-00	SVC	Change Oil	6	N/A	1500 FH	ALL

SYSTEM INFO

Oil sump volume between full and the bottom of the "normal" range is 1500 cc. The input shaft seal leakage is designed to control oil leakage to a maximum of 1 cc per flight hour in normal operation. The oil sump volume is sized to provide a minimum of 1500 FH in the "normal range assuming the maximum allowable leakage rate. Suggested 3000 FH interval for oil and filter replacement.

AHMS INFO

Oil level / sump volume available for monitoring each flight. Actual leakage rate instead of assumed leakage rate can be used for task scheduling. Leakage rate does not address oil quality or filter clogging.



MRBR Tasks FUTURE

MRBR task ref.	TASK CODE	TASK Description	FEC	Threshold	Interval	Task Applicability
24-0x0-00	SVC	**Change Oil** NOTE: there is AHM capability available to fulfill the intent of this requirement.	6	N/A	1500 FH	ALL
AHM 24-0x0-01	AHM	**Change Oil** NOTE: Approved as alternative mean of compliance of Classic Task MRBR 24-0x0-00	6	N/A	AHM *INTERVAL NOTE*: not to exceed 3000 FH	ALL

Functional Failure	FEC 6	Fails to provide electric power from a single VFSG
Associated Failure Cause and Task	Failure Cause:	VFSG Fails
	Resulting task:	Change VFSG Oil @ 1500FH
AHM Candidate		
2-3-9.1ARE THERE AHM CAPABILITIES THAT CAN DETECT NEED FOR LUBRICATION / SERVICING?	YES	Oil level / sump volume is available for monitoring each flight.
2-3-9.1.1 DO THE AHM CAPABILITIES PROVIDE ENOUGH LEAD TIME TO SCHEDULE LUBRICATION / SERVICING?	YES	Rate of oil loss can be monitored to determine optimum time to service prior to reaching functional failure.
2-3-9A IS THE AHM USE EFFECTIVE?	YES	Utilizing AHM will prevent functional failure from occurring.
2-3-9B DOES AHM FULLY SATISFY THE INTENT OF THE CLASSIC TASK?	NO	While AHM detects level of oil and will notify the operator once oil levels are getting low. It does not detect oil quality which can also lead to functional failure.
2-3-9-C SELECT AHM HYBRID		Same as Classic Task with a different interval. New MRBR Task: 24-0x0-01 Change Oil (AHM) Interval: AHM-determined, not to exceed 3000FH
2-3-9.2 ARE THERE AHM CAPABILITIES THAT CAN DETECT DEGRADATION	NO	AHM does not detect degradation of oil quality
2-3-9.3 ARE THERE AHM CAPABILITIES THAT CAN DETECT HIDDEN FAILURE (FEC 8 & 9 ONLY)	N/A	FEC 6
2-3-9.4 SUMMARIZE THE AHM AS SELECTED IN BOXES 2-3-9. C & D AND SUBMIT TO ISC FOR APPROVAL AND INCLUSION IN THE MRBR PROPOSAL		New MRBR Task 24-0x0-01 applicable only to operators utilizing an AHM program at an AHM-defined interval not to exceed 3000FH. Classic Task 24-0x0-00 updated with applicability note to state alternative task via usage of AHM available.
SUMMARIZE THE IMPACT AND SUBMIT TO ISC FOR APPROVAL AND INCLUSION IN THE MRBR		
AHM requirement/procedure		1) Monitor oil levels provided by parameter abc-123 2) Plot oil loss and determine when oil level will fall 1500cc below maximum level 3) Schedule oil servicing task (MRBR 24-0x0-01) prior to reaching that level 4) If it will take greater than 3000FH from last servicing task to reach 1500cc threshold, schedule task to be performed at or prior to to reaching 3000FH
MRBR classic task description updated --> to include traceability with approvedAHM capability		MRBR 24-0x0-00 Change Oil AIRPLANE NOTE: Applicable to operators not utilizing MRBR task 24-0x0-01

Recirculation Air Filter 2-3-9.2/2-3-9.A/2-3-9.B/2-3-9.C and 2-3-9.2/2-3-9.3/2-3-9.4

MRBR Task TODAY

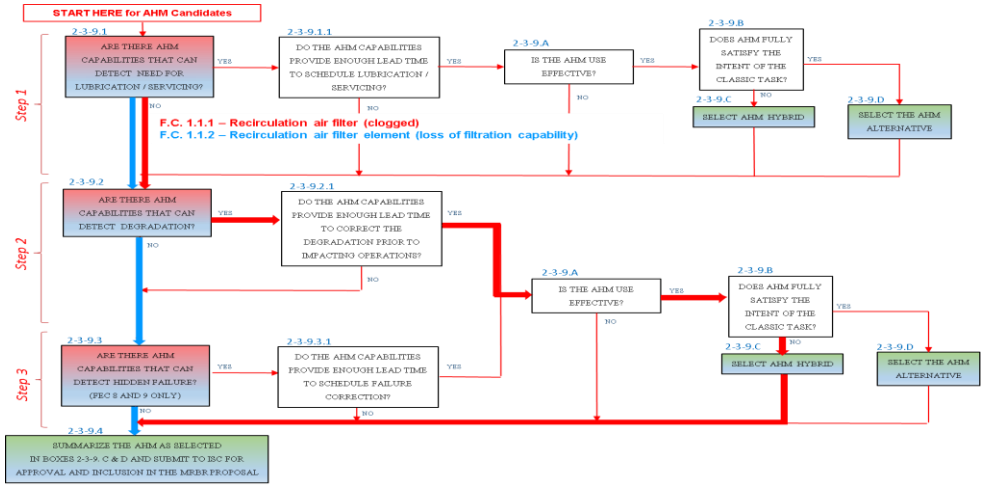
MRBR task ref.	TASK CODE	TASK Description	FEC	Threshold	Interval	Task Applicability
21-24-01	DIS	Discard of Recirculation Air Filters.	9	N/A	1000 FH	ALL

SYSTEM INFO

One filter installed at the inlet of each Recirculation Fan (Recirculation System). Recirculation Fans provide recirculating air back into the distribution system, which is filtered by the filter. Discard of the filter at 1000 FH is applicable and effective to reduce air contamination.

AHMS INFO

Differential Pressure sensor installed between filter and Recirculation Fan will be used to capture pressure variations, which will be recorded by QAR. They should be downloaded and analyzed (measured value will be compared with a baseline curve) by ground station engineering.



MRBR Tasks FUTURE

MRBR task ref.	TASK CODE	TASK Description	FEC	Threshold	Interval	Task Applicability
21-24-01	DIS	Discard of Recirculation Air Filters. NOTE: there is AHM capability available to extend this task interval.	9	N/A	1000 FH	ALL
AHM 21-24-01	AHM	**Recirculation Air Filter indication data readout with discard limit of Recirculation Air Filters at 5000 FH.** NOTE: Approved as alternative mean of compliance of Classic Task MRBR 21-24-01	9	N/A	7 days	ALL

MSI 21-24 Recirculation

FUNCTIONAL FAILURE	FEC 9	1.1 Fails to provide recirculation air back into the distribution system. 1.2 Fails to provide filtration of recirculation air.
ASSOCIATED FAILURE CAUSES AND CLASSIC LEVEL 2 TASK	Failure Cause:	1.1.1 Recirculation air filter failure (clogged) 1.2.1 Recirculation air filter element failure (loss of filtration capability)
	Resulting task:	MRBR ref: 21-24-01 at 1000 FH DIS : Discard of Recirculation Air Filters.

AHM Candidate 1.1.1 - Recirculation air filter failure (clogged)

2-3-9.1ARE THERE AHM CAPABILITIES THAT CAN DETECT NEED FOR LUBRICATION / SERVICING?	NO	There is no need of lubrication or service on Recirculation air filter
2-3-9.2 ARE THERE AHM CAPABILITIES THAT CAN DETECT DEGRADATION?	YES	The recirculation system is featured with a differential pressure sensor, which acquires parameter to be compared with an applicable standard in order to show clogging level.
2-3-9.2.1 DO THE AHM CAPABILITIES PROVIDE ENOUGH LEAD TIME TO CORRECT THE DEGRADATION PRIOR TO IMPACTING OPERATIONS?	YES	Recirculation air filter failure (clogged) can be detected XX hours before impacting operations.
2-3-9.A IS THE AHM USE EFFECTIVE?	YES	It is effective because the AHM maximizes the component usage time (remaining useful life) and reduces maintenance executions at each 1,000 FH with costs reduction.
2-3-9.B DOES AHM FULLY SATISFY THE INTENT OF THE CLASSIC TASK?	NO	AHM procedure can not detect all degradation modes of the Recirculation air filter element, not detecting the Failure Cause "Recirculation air filter element failure (loss of filtration capability)" in accordance with AHM candidate 1.2.1 analyses
2-3-9.C SELECT AHM HYBRID	-	AHM Hybrid Procedure: AHM 21-24-00 is selected as alternate mean of compliance of classic Task 21-24-01.
2-3-9.4 SUMMARIZE THE AHM AS SELECTED IN BOXES 2-3-9. C & D AND SUBMIT TO ISC FOR APPROVAL AND INCLUSION IN THE MRBR PROPOSAL	-	**AHM requirement/procedure** AHM Hybrid Procedure: AHM 21-24-00 (approved alternative mean of compliance of classic Task 21-24-01) Description: Recirculation Air Filter indication data readout with discard limit of Recirculation Air Filters at 5000 FH. Interval : Data collection at each 2 days Data analysis at each 7 days Procedure: GSE applicable/Personnel involved (Skill)/ Engineering Analyses/Maintenance Actions/Deviation information **MRBR classic task description updated:** MRBR 21-24-01 task description updated to include AHM note. Discard of Recirculation Air Filters at 1000 FH NOTE: there is AHM capability available to extend this task interval

AHM Candidate 1.2.1 - Recirculation air filter element failure (loss of filtration capability)

2-3-9.1ARE THERE AHM CAPABILITIES THAT CAN DETECT NEED FOR LUBRICATION / SERVICING?	NO	There is no need of lubrication or service on Recirculation air filter
2-3-9.2 ARE THERE AHM CAPABILITIES THAT CAN DETECT DEGRADATION?	NO	The recirculation system does not have any sensor to detect the recirculation air filter element degradation (loss of filtration capability).
2-3-9.3 ARE THERE AHM CAPABILITIES THAT CAN DETECT HIDDEN FAILURE??	NO	The recirculation system does not have any sensor to detect the recirculation air filter element failure (loss of filtration capability).