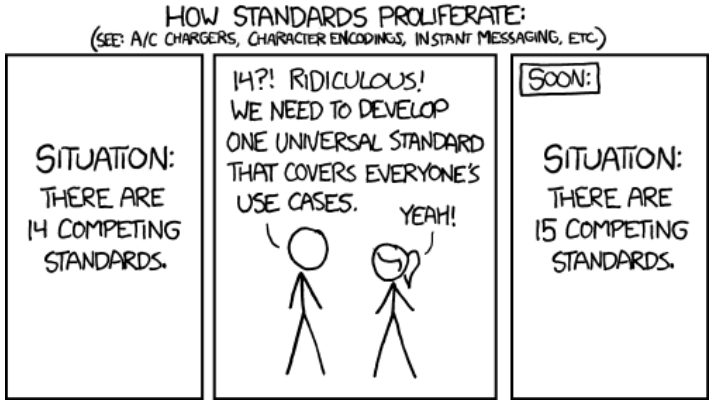
PHME Panel

Standards and Regulations- Affecting PHM Development and Application



xkcd, 2013

Welcome- Jeff Bird (PHM Society)
Provocative remarks by panelists
Dr. Rune Prytz, Stratio
Dr. Huiqi (Yvonne) Lu, University of Oxford Engineering Science Computational Health Informatics Lab
Rhonda Walthall, Collins Aerospace
Invited inputs: Lee Glazier, Head of Service Integrity at Rolls-Royce
Lots of Open Discussion

1. Boost innovation, sustainability, business cases and trust?
2. More accessible, trusted and responsive to the value chain?
3. Other priority issues?

Participate in the standards discussion group on the PHME22 smart phone app

PHM Society Standards Committee

Brian Weiss, Jeff Bird, John Madsen, Ravi Rajamani

PHM Society Role?

Society Objectives

1. Free access to PHM knowledge,
2. Interdisciplinary and international collaboration
3. Advance the engineering discipline

Observations

1. Diverse body of PHM knowledge out there: Standards, lessons learned, information, few case studies
2. Multi-disciplinary awareness and engagement is lacking: Many entrants come from single specialities
3. Wide continuing standards participation is difficult: Small companies, long time frame for development
4. To mature knowledge from theory to practice is challenging: Knowing about relevant standards across disciplines, Developing Body Of Knowledge to complement academic training
5. Data and information sharing protocols are essential but problematic: Proprietary and sector specific information

PHM Society Activities

Traditional

1. Panels
2. Special issues of journal and tutorials- subjects?
3. Program updates and on-line forum
4. Connections among current PHMers

New initiatives

1. Standards Users Group
2. PHM Standards Portal: One stop for docs, resources, forum
3. Interactions with SAE, ASME, IEEE, ISA, NIST
4. Standards Review Portal: *PHM- ISO Connect*
5. *Domain specific like Machine Learning ??*

Rolls Royce Aletheia Project

“The Aletheia Framework – a toolkit that we believe creates a new global standard for practical applications of ethical AI. Follow the checks and balances within it and organizations can be sure that their AI project is fair, trustworthy and ethical. We are applying it to accelerate our progress to industry 5.0” - Warren East, Chief Executive – Rolls Royce

Focii: Social Impact, Accuracy/Trust, Governance

With benefits, ethics and realization principles

Aletheia Framework™

the Rolls-Royce response to ensuring the development and use of Artificial Intelligence is undertaken in an ethical way

accessible, comprehensive, trustworthy, proceduralised

Observations to provoke thoughts:-

- Principle references for AI ethics – guidance, standards, regulations and legislation are all generally 75 – 125 pages long.

- A very recent Standard published on AI Bias had 23 pages of references.

Mapping ethical challenges

Social Impact

- Benefits
- Human impact
- Communications
- Potentially irreplaceable loss of skills

Accuracy/Trust

- Human safety/zero harm
- Transparency/traceability
- Bias
- Validity/explainability/ reliability
- Sparse data interpolation

Governance

- Data protection
- Export control
- Confidential information
- Cyber secure
- Accountability
- Responsibility for decisions
- Risks from re-use/ transfer across processes

Principle references

Good Corporation - Developing an Ethical Future for AI

EU Ethics Guidelines

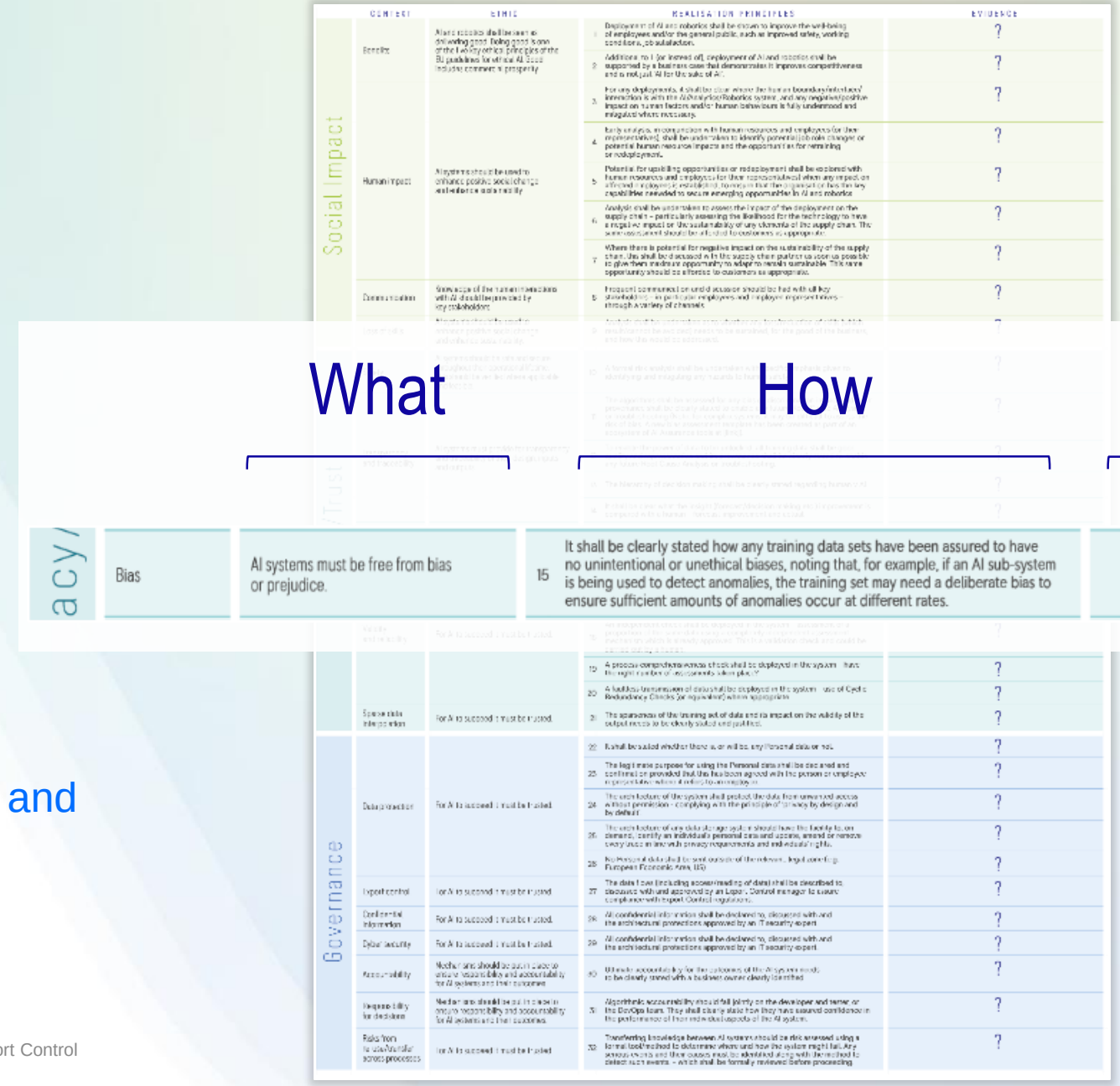
European Parliament Committee on Industry, Research and Energy – Draft Report on a comprehensive European industrial policy on artificial intelligence and robotics

Validation and Control of Artificial Intelligence (AI) in Critical Manufacturing Processes

Asilomar AI Principles

The Aletheia Framework

A practical tool for ethical and trustworthy AI



		What		How		Evidence
acy/	Bias	AI systems must be free from bias or prejudice.	15	It shall be clearly stated how any training data sets have been assured to have no unintentional or unethical biases, noting that, for example, if an AI sub-system is being used to detect anomalies, the training set may need a deliberate bias to ensure sufficient amounts of anomalies occur at different rates.	?	

Panelists and Discussion Leaders

Dr. Rune Prytz, Stratio

Dr. Huiqi (Yvonne) Lu, University of Oxford Engineering Science Computational Health Informatics Lab

Rhonda Walthall, Collins Aerospace

1. How can innovation, sustainability, business case rationalization and trustworthiness be boosted by standards and best practices?
2. How can best practices and standards be more accessible, trusted and responsive to all parts of the research, development, commercialization and asset management value chain?
3. Panelists challenge questions
    1. What are the main issues with ethics and bias … and the solutions?
    2. How should ethics and bias apply to standards etc. generally?
    3. Are tools and decision support accurate, true and fair?
    4. Operating well for good outcomes for all stakeholders?
    5. Ethically sound as standards for human experts?

stratio

Privacy and Regulations

Developing and deploying PHM systems
for machines used by humans

Background

- Predicting vehicle failures ahead of time to optimize vehicle fleet operations
- Not safety critical
- Add on solution to existing vehicles

Background

Predicting vehicle failures ahead of time

to optimize vehicle fleet operations

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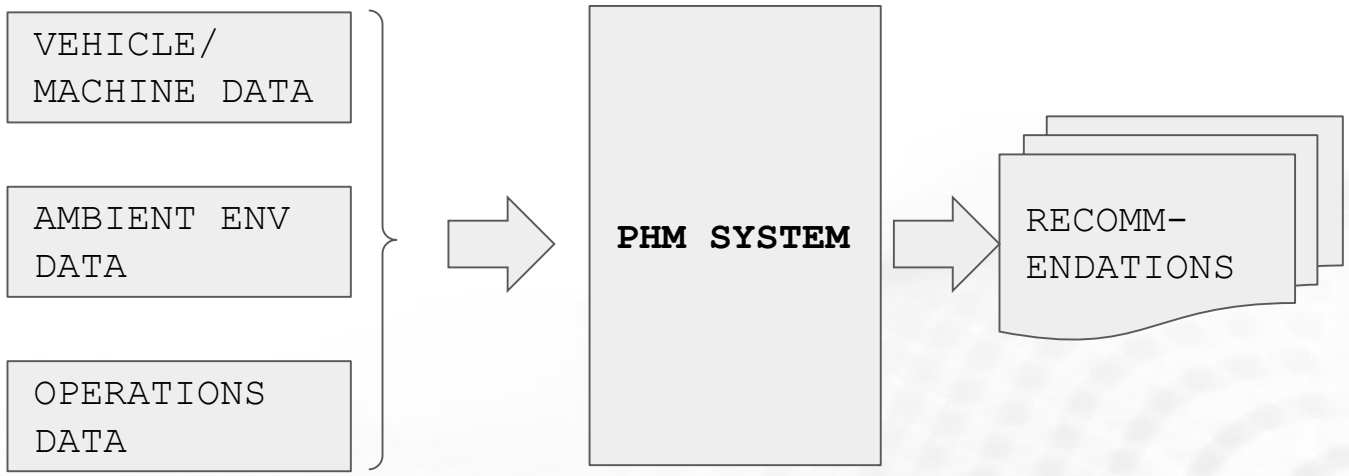

Problem formulation

The better we describe the machines historic use the more precise we can predict its future

More detailed data will inevitably reveil patterns and information not only related to the primary goal. I.e. PHM.

Problem formulation

The better we describe the machines historic use the more precise we can predict its future

More detailed data will inevitably reveal patterns and information not only related to the primary goal. I.e. PHM.

The longer historic data records improve generalization and faults covered.

Longer history may also reveal which patterns that are not related to PHM.

Example

Maintenance personnel in the workshop uses a fleet management tool with PHM support in order to plan their upcoming work

They discover a pattern

- There is always one bus indicating significantly higher wear rate
- It is not always the same bus

Example

Maintenance personnel in the workshop uses a fleet management tool with PHM support in order to plan their upcoming work

The increased wear pattern is found to be correlated with the same driver being assigned to said bus.

They discover a pattern

- There is always one bus indicating significantly higher wear rate
- It is not always the same bus

The privacy of the driver has been violated since he has indirectly been monitored, identified and linked to undesired behavior.

Questions of the audience

1. What technical or non-technical best practices have you developed to ensure privacy in real world data?

1. Have you used any standard to ensure the necessary privacy is met?

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TURIN (Italy) - 6/8 July 2022

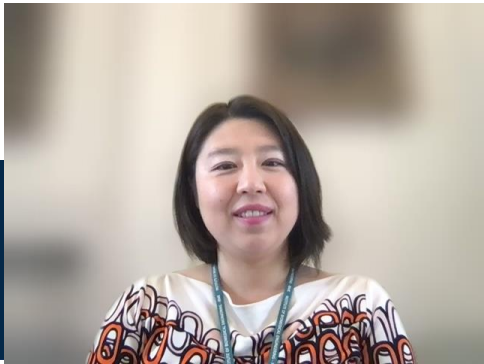
Artificial Intelligence and Machine Learning Regulatory Frameworks and Standards

Dr. Huiqi (Yvonne) Lu, Engineering Science, University of Oxford

lab

Computational
Health
Informatics

Royal Academy of Engineering



Governance

- **Regulatory Frameworks and Standards**: Regulate AI technologies to be developed responsibly, work as advertised, and are safe for industry users and customers.
- **Evaluation and Validation**: Evaluation based on regulations and standards; validation externally and locally.
- **Guidelines**: Procurement, development and use of AI.
- **Liability and Accountability**

EU AI Regulation – what it means for industries

Unacceptable-risk AI systems

- Subliminal, manipulative, or exploitative techniques causing harm
- Real-time, remote biometric identification systems used in public spaces for law enforcement
- All forms of social scoring

High-risk AI systems

- Systems that evaluate consumer creditworthiness
- Recruiting or employee-management systems
- Systems utilizing biometric identification in nonpublic spaces
- Safety-critical systems (eg, systems that would put the health of citizens at risk due to failure)
- Any systems used in the administration of justice

Limited- and minimal-risk AI systems

- AI chatbots
- AI-enabled video and computer games
- Spam filters
- Inventory-management systems
- Customer- and market-segmentation systems
- Most other AI sy

EU Regulation into Effect – Preparations

- **EU and Non-EU Products**: developed in the EU use worldwide; developed outside of the EU but used within the EU.
- **Risk-specific Requirements for AI Systems**: develop risk-management infrastructure, data governance and management, technical preparations (accuracy, robustness, ethical, human oversight, and cybersecurity), and post-market monitoring pipelines.
- **Timeline**

ISO Standards in AI

- ✓ *ISO/IEC 38507:2022*: Information technology — Governance of IT — **Governance implications of the use of artificial intelligence by organizations**
- ✓ *ISO/IEC 23053:2022*: **Framework for Artificial Intelligence (AI) Systems Using Machine Learning (ML)**
- ✓ *ISO/IEC TR 24372:2021*: Information technology — Artificial intelligence (AI) — **Overview of computational approaches for AI systems**
- ✓ *ISO/IEC TR 24030:2021*: Information technology — Artificial intelligence (AI) — **Use cases**
- ✓ *ISO/IEC TR 24029-1:2021*: Artificial Intelligence (AI) — **Assessment of the robustness of neural networks**
- ✓ *ISO/IEC TR 24027:2021*: Information technology — Artificial intelligence (AI) — **Bias in AI systems and AI aided decision making**
- ✓ *ISO/IEC TR 24028:2020*: Information technology — Artificial intelligence — **Overview of trustworthiness in artificial intelligence**
- ✓ *ISO/IEC TR 20547-5*: Information technology — **Big data reference architecture**
- ✓ *ISO/IEC 20546:2019*: Information technology — Big data — **Overview and vocabulary**

IEEE Standards in AI + Industry

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- ✓ *IEEE 2801-2022*: Approved Draft Recommended Practice for the **Quality Management of Datasets for Medical Artificial Intelligence**
- ✓ *IEEE 2671-2022*: Approved Draft Standard for General Requirements of **Online Detection Based on Machine Vision in Intelligent Manufacturing**
- ✓ *IEEE 2941-2021*: Standard for **Artificial Intelligence (AI) Model Representation, Compression, Distribution, and Management**
- ✓ *IEEE 7010-2020*: Recommended Practice for Assessing the **Impact of Autonomous and Intelligent Systems on Human Well-Being**
- ✓ *IEEE 3527.1-2020*: **Standard for Digital Intelligence** (DQ) —Framework for Digital Literacy, Skills, and Readiness
- ✓ *IEEE C37.237-2018*: Standard for Requirements for **Time Tags Created by Intelligent Electronic Devices**—COMTAG
- ✓ *IEEE 1232.3-2014*: Guide for the Use of **Artificial Intelligence Exchange and Service Tie to All Test Environments** (AI-ESTATE)
- ✓ *IEEE 1445-2016*: Standard for **Digital Test Interchange Format** (DTIF)
- ✓ *IEEE 1686-2007*: IEEE Standard for **Substation Intelligent Electronic Devices** (IEDs) **Cyber Security Capabilities**
- ✓ *IEEE 1636.2-2010*: Standard for Software Interface for Maintenance Inform and Analysis (SIMICA): **Exchangin Action Information *via*** the Exten Language (**XML**)

Case Study: Assessing factors that impact confidence in AI-derived information during clinical decision making

Clinician Attitudes

- Experience with AI and innovations.
- Clinical evidence

Clinical Context

- Levels of clinical risk, degree of human oversight in AI decision-making flow

AI Model Design

- Format of AI (diagnosis, risk score, or recommendation) and clinical characteristics that involved

Cognitive biases

- Automation bias, aversion bias, alert fatigue, confirmation bias and rejection bias

Recommendations for Healthcare Industries

- A robust and flexible legal framework
- Future-proof in its fundamental regulatory choices
- Risk-based regulatory approach

Questions for the audience

1. What AI-related standards would you like PHM to develop?
2. Which standards are most relevant for your area of interest and why?

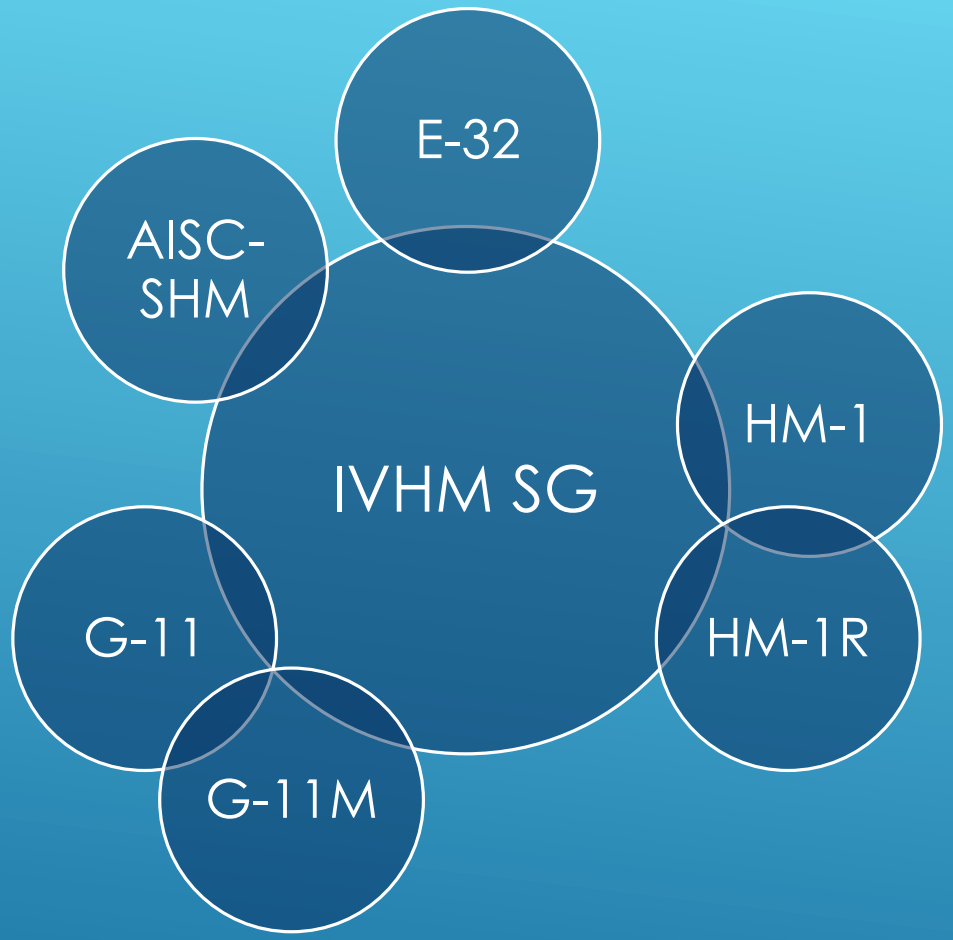
STANDARDS AND REGULATIONS AFFECTING PHM DEVELOPMENT AND APPLICATION

Rhonda Walthall
PHM Fellow, Collins Aerospace
SAE Fellow
PHM Society Fellow

July 9, 2022

IMPLEMENTATION OF AHM INTO THE MSG-3 ANALYSIS

- On June 20, 2022, the IMRBPB voted to accept the implementation of IP-180 into the MSG-3 analysis
- TC holders may now use AHM as an alternative means of compliance to scheduled maintenance for non-safety critical items



SAE PHM STANDARDS COMMITTEES

IVHM STEERING GROUP

Development of a single definition and taxonomy of IVHM

Identification of how and where IVHM could be implemented

Development of a roadmap for IVHM standards

Identification of future IVHM technology and regulatory needs

Recommendation of technical standards requirements

- Coordinates IVHM and health management standards developed by current and future SAE committees
- Provides leadership for the aerospace and IVHM communities

Sep 29 – Austin, Texas, USA
Spring 2023 - TBD

HM-1 COMMITTEE STANDARDS

18 Documents Published:

- **ARP6803** – IVHM Concepts, Technology, and Implementation Overview
- **ARP6407** – IVHM Design Guidelines
- **ARP6883** – Guidelines for Writing IVHM Requirements for Aerospace Systems
- **AS4831A** – Software Interfaces for Ground-Based System Monitoring
- **JA6268** – Design & Runtime Information Exchange for Health-Ready Components
- **JA6097** – Using a Reliability Model to Optimize Maintenance Costs
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- **ARP7122** – Utilizing Aircraft Integrated Health Management for Airworthiness Credits
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- **ARP6887** – V&V of IVHM Systems
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Oct 11-13, 2022 – Lisbon, Portugal
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- **AS5395** – HUMS Data Interchange Specification

1 Document soon to be in WIP:

- Data Interchange Specification for HUMS

Inaugural Meeting in August: Huntsville AL USA

E-32 STANDARDS

8 Documents In WIP:

- **ARP5987A** – A Process for Utilizing Aerospace Propulsion Health Management for Maintenance Credit
- **ARP6835** – Propulsion System Monitoring for Continued Airworthiness
- **ARP1587C** – Aircraft Gas Turbine Engine Health Management System Guide
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- **AIR1871D** – Lessons Learned from Developing, Implementing and Operating a Health Management System for Propulsion and Drive Train Systems
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- 4 thermocouple documents

Mar 29-31, 2022 – Madrid, Spain
Fall 2022 – San Diego, CA
Spring 23 – Long Island, NY – Meeting #100!

AISC-SHM STANDARDS

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1 Document in WIP:

- **ARP6821** – Guidance for Assessing the Damage Detection capability of Structural Health Monitoring Systems

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Meets in conjunction with IWSHM at Stanford

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No meetings planned

HOW TO GET INVOLVED

- Contact SAE Committee Manager, Kevin Bires: kevin.bires@sae.org

Questions for the audience

1. What PHM standards would you like to see developed?
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STANDARDS AND REGULATIONS AFFECTING PHM DEVELOPMENT AND APPLICATION

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July 9, 2022

- On June 20, 2022, the IMRBPB voted to accept the implementation of IP-180 into the MSG-3 analysis
- Introduces Level 3 decision logic to determine if AHM can be used in conjunction with existing scheduled maintenance tasks (hybrid) or as an alternative to these tasks
- Applicable only to non-safety critical fault effects
- Allows TC holders to use AHM as an alternative means of compliance for initial and continued airworthiness determinations

IMPLEMENTATION OF AHM INTO THE MSG-3 ANALYSIS

Existing Maintenance Tasks

Level 1

Each Functional Failure is evaluated to determine the Failure Effect Category

- Catastrophic, Critical, Major, etc.
- Safety, operational, economic, hidden safety, hidden non-safety
- ETOPS, RVSM, Cat III

Level 2

The Failure Causes for each Functional Failure is used to select the specific type of maintenance task(s) required

AHM Alternative

Level 3

Each Failure Cause is evaluated to determine if: the IAHM system could

- detect the need for lubrication and servicing, detect degradation, or detect hidden failures
- detect the above conditions with enough lead time to schedule corrective action
- be effective
- satisfy a full or partial alternative to a classic task

MSG-3 2022 will include the Level 3 analysis

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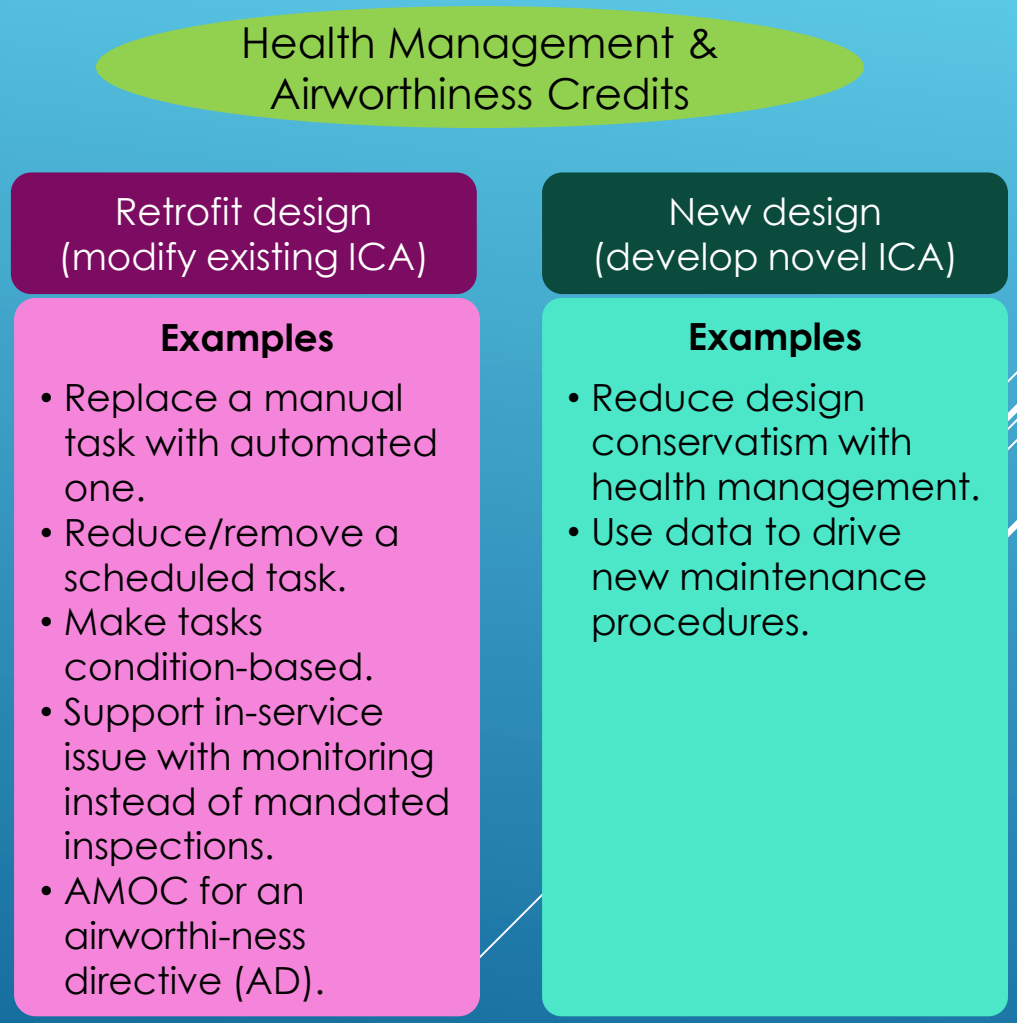
ARP5987A

A PROCESS FOR UTILIZING AEROSPACE PROPULSION HEALTH MANAGEMENT SYSTEMS FOR AIRWORTHINESS CREDIT

- First version published in 2018.
- New version incorporates major terminology change: "Airworthiness Credits" replacing "Maintenance Credits," to emphasize both initial airworthiness and continued airworthiness.
- Has input from major engine OEMs and regulators.
- Is the basis for ARP7122.
- Emphasizes the end-to-end nature of the HM function involving onboard and offboard elements.
- Presents guidelines for HM systems that are certified during initial type certification and for systems that are approved for retrofit.



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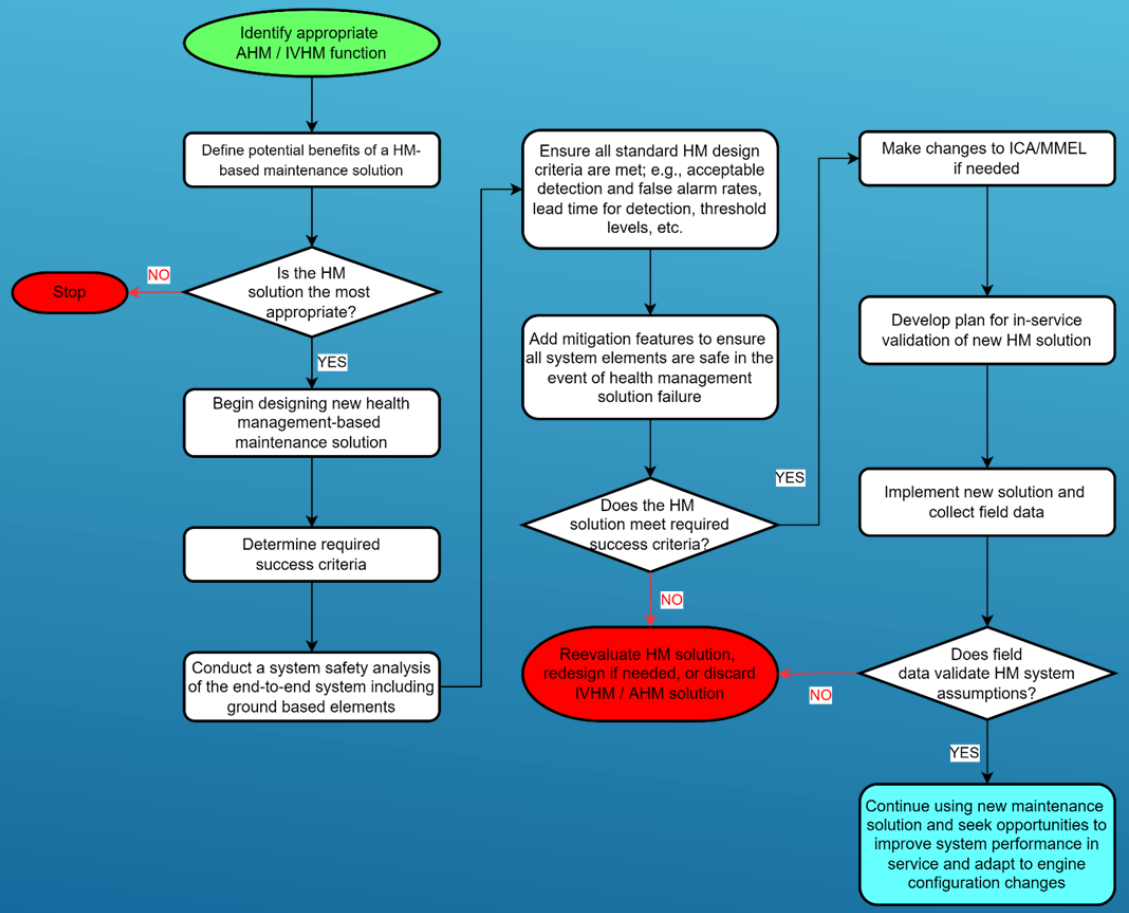
ARP7122A

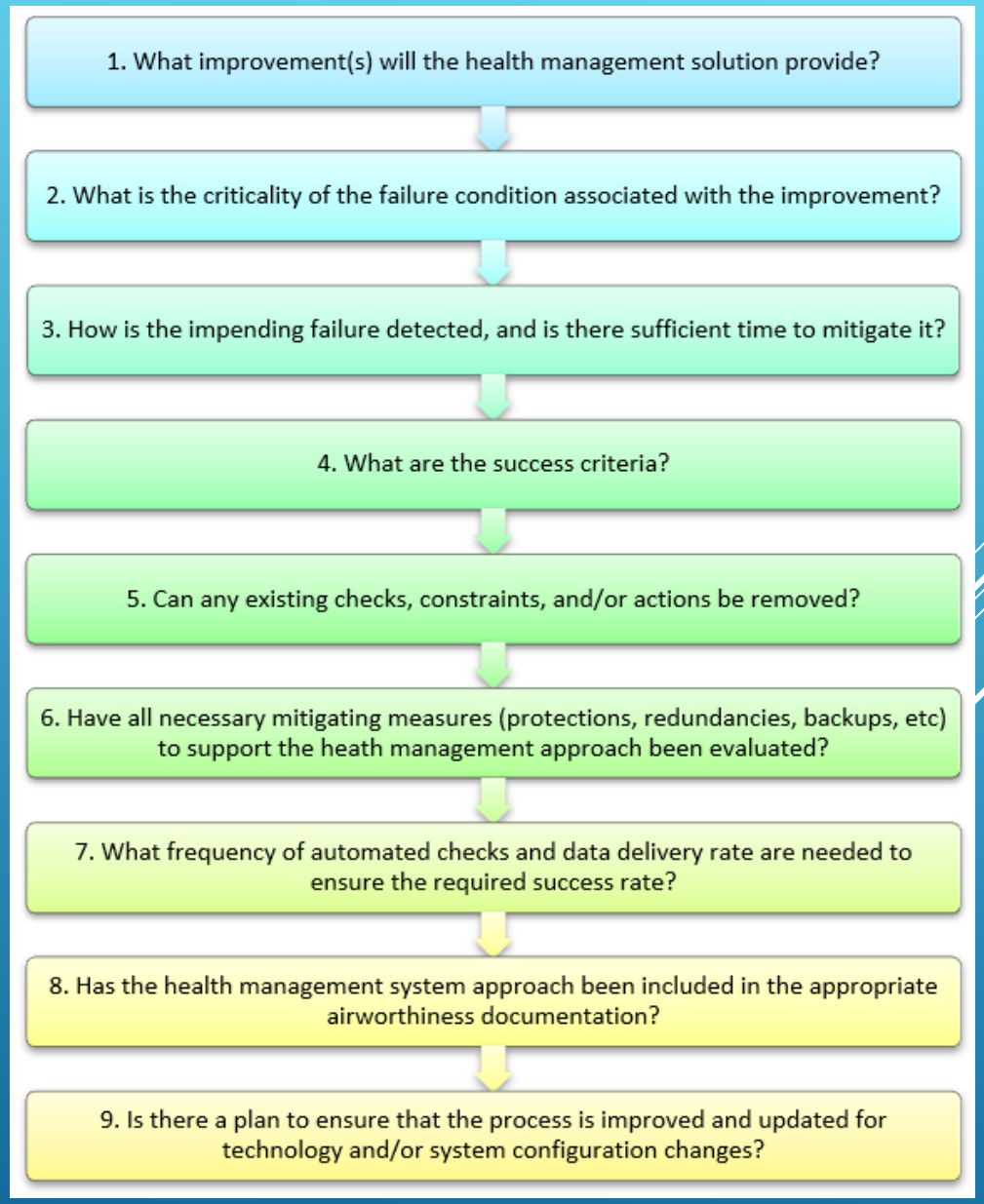
UTILIZING AIRCRAFT IVHM SYSTEMS FOR AIRWORTHINESS CREDIT



Target Publication:
EOY2022

ARP5987A AND ARP7122

- Considers EHM and Integrated Vehicle Health Management (IVHM) systems to be end-to-end processes with on- and off-board elements.
- Outlines a high-level process for obtaining approval for any EHM or IVHM system.
- Leaves the details of the guidance steps up to the applicants and their dialog with regulators.
- Extends the IP-180 Level 3 analysis from non-safety critical failure effects categories to all categories (FEC 5-9).
- Provides examples in the appendix to guide applicants on how to obtain approval for airworthiness credits for a system or component.



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phmsociety

Open Discussion

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2. How can best practices and standards be more accessible, trusted and responsive to all parts of the research, development, commercialization and asset management value chain?
3. Which standards are most relevant for your area of interest and why?
4. What PHM and AI-related standards would you like PHM to develop?

Others?

At the end of the session, what are your priorities for PHM Standards:

Way Forward- Get Involved!

- IJPHM papers and communications

  Indexed in the Emerging Sources Citation Index
  - Submit an abstract
  - Submit an abstract for the Standards Special Issue
- Updates on standards in progress
  - *PHM Standards Portal* - what else would be useful there?
  - Standards Users Group - join
  - Forum discussions or Slack channel - participate
- Standards Review Process
  - *PHM-ISO connect:* want to help?
  - Other Standards Development Organizations- want to help?
- What else would be useful?

  Standards forum: https://www.phmsociety.org/forum/592

Please complete the evaluation of the session on the VERT app.
Thank you
Hope to see you contribute your ideas and time for PHME24