The Aerospace Industry Steering Committee on Structural Health Monitoring and Management (AISC-SHM): Progress on SHM guidelines for aerospace.

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Grant Gordon, Honeywell
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Presented by Peter Foote

International Workshop on Structural Health Monitoring,
Stanford University, 2011

Contents

- Motivation of AISC-SHM
- Background
- Interaction with ATA MSG-3
- Summary and challenges to the industry

Vision and Motivation of AISC-SHM

The AISC – SHM is an international team comprising industry, government and academic participants with a collective vision to efficiently and effectively implement structural health monitoring for a wide variety of commercial and military aerospace applications through the development of guidelines, procedures, processes and standards for implementation and certification of the technologies.

The AISC-SHM operates as a Technical Committee within SAE Aerospace (an SAE International Group) within the Aerospace Division (G-11 SHM)

Provenance

- 3rd EWSHM 2006 in Granada: Call from industry for an international '*community of practice*'
- Professor Fu-Kuo Chang, Stanford University launches AISC-SHM in Stanford, Sept 2006
- Commercial Aviation Working Group formed – 2007
- Military Aerospace working group formed - 2008
- AISC-SHM joins SAE Aerospace as a new technical document committee – 2008
- First meeting as an SAE Committee (G-11 SHM), - London Jan 2009

Provenance

- Granada 3rd EWSH
- international '*com*
- Professor Fu-Kuo
- AISC-SHM in Stan
- Commercial Aviati
- Military Aerospace
- AISC-SHM joins S
- document commit
- First meeting as a
- 2009

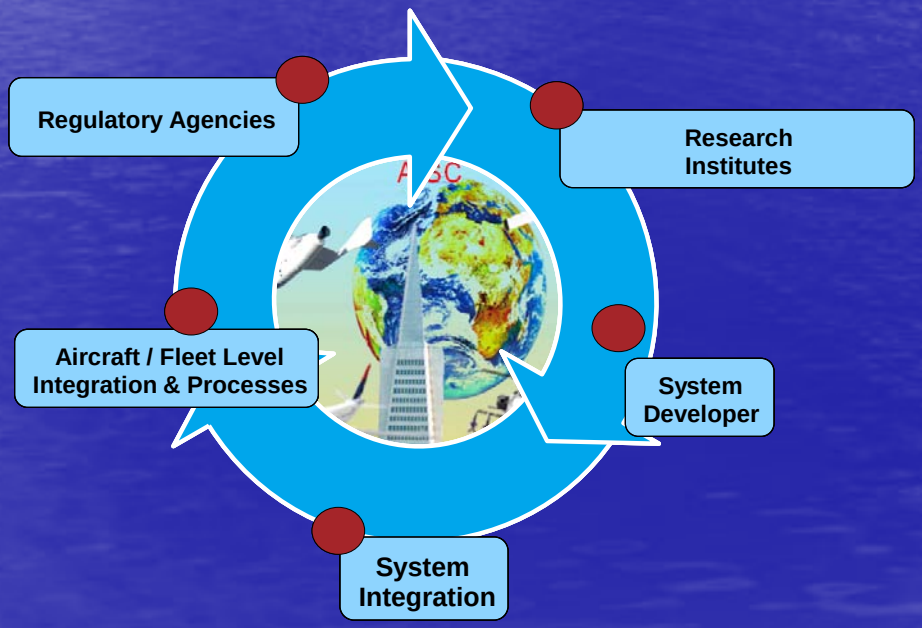
Stanford 2006

The committee focus is development of aerospace industry guidelines for structural health monitoring to achieve:

- Cross industry consensus on SHM implementation issues.
- Basis for SHM systems certification by providing the necessary guidelines (e.g. SAE ARP).
- Identification of technology gaps.
- Interface with other activities pertaining to aeronautical SHM
- Collective view among various organizations such as:
  - OEMs: aircraft manufacturers
  - Regulatory Authorities
  - System Integrators
  - Developers / Research organizations
  - Operators and their representatives

AISC-SHM membership

- Platform OEMs
- System Integrators
- Research Organizations
- Regulators
- Operators

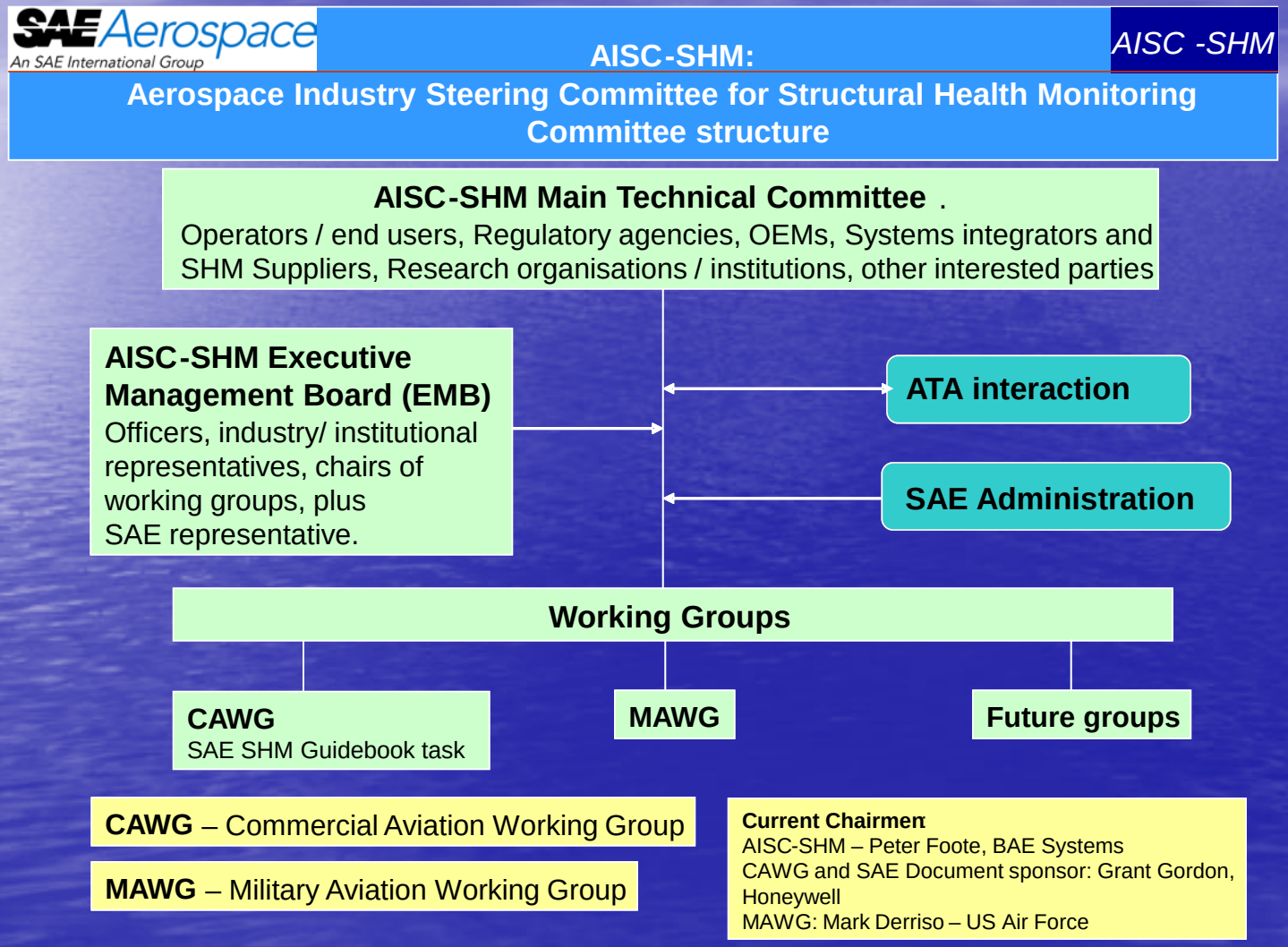


Airbus (EADS)
AFRL
BAE Systems
Boeing
Bombardier
EASA
Embraer
FAA
FHI
GE
Honeywell
NASA
NAVSEA
RIMCOF
Sandia
Stanford Uni.
Univ. of Tokyo

AISC-SHM mission

- The mission of the AISC-SHM is to provide an approach for standardizing integration and certification requirements for SHM of aerospace structures, which will include system maturation, maintenance, supportability, upgrades and expansion. The goal is to develop a guidebook specifying approaches for SHM usage on Air and Space vehicles and to identify technology gaps leading to SHM utilization.

Organization and Responsibilities



The committee is also known as G-11 SHM within the SAE International Aerospace Division

Creation of an SAE International, Aerospace Recommended Practices Document on the implementation of SHM for aerospace.

SAE Aerospace
An SAE International Group

AEROSPACE RECOMMENDED PRACTICE

ARPxxxx

Issued | Proposed Draft (Date) (OrigDate)

Guidance on Structural Health Monitoring for Aerospace Applications

RATIONALE

The development of Structural Health Monitoring (SHm) technologies to achieve Structural Health Management (SHM) objectives in aerospace applications is an activity that spans multiple engineering disciplines. It is also recognized that many stakeholders: Regulatory Agencies, Airlines, OEM's, Academia and equipment suppliers are crucial to the process of certifying viable SHm solutions. Thus common language, framework and recommended practices are needed to promote fruitful and efficient technology development.

TABLE OF CONTENTS

Target pub.date: 2012

SAE ARPXXXX

Guidelines contents

- Scope (air vehicle, air frame, structural components)
- Applicable documents (existing standards, related guidelines etc)
- Background (context of SHM in aircraft support processes and structural design philosophies, overview of technologies)
- Introduction to SHM systems. (Functional elements of structural health management systems based on condition and usage monitoring techniques)
- Fields of application (How SHM can be used, intended function, concepts of operation)
- SHM system requirements (What must SHM systems and techniques do)
- Qualification
- V&V
- Certification

How to assure that chosen SHM solutions meet functional, operational and regulatory requirements

- Military annex (differentiation of military and civil implementation)

Division of effort

Team (alphabetic): Airbus (EADS), AFRL,BAE Systems, Boeing, Bombardier, Embraer FHI, Hahn Spring, Honeywell, NASA, NAVSEA, RIMCOF, Sandia, Stanford Uni., Univ. of Tokyo

Section	Lead
Scope	Boeing
Applicable documents	Honeywell
Background	Boeing
Introduction to SHM systems	BAE Systems
Fields of application	Airbus and Boeing
SHM system requirements	Airbus
Qualification V&V Certification	Hahn Spring (Consultant) and Sandia plus team
Military annex	AFRL

Illustrative work in progress

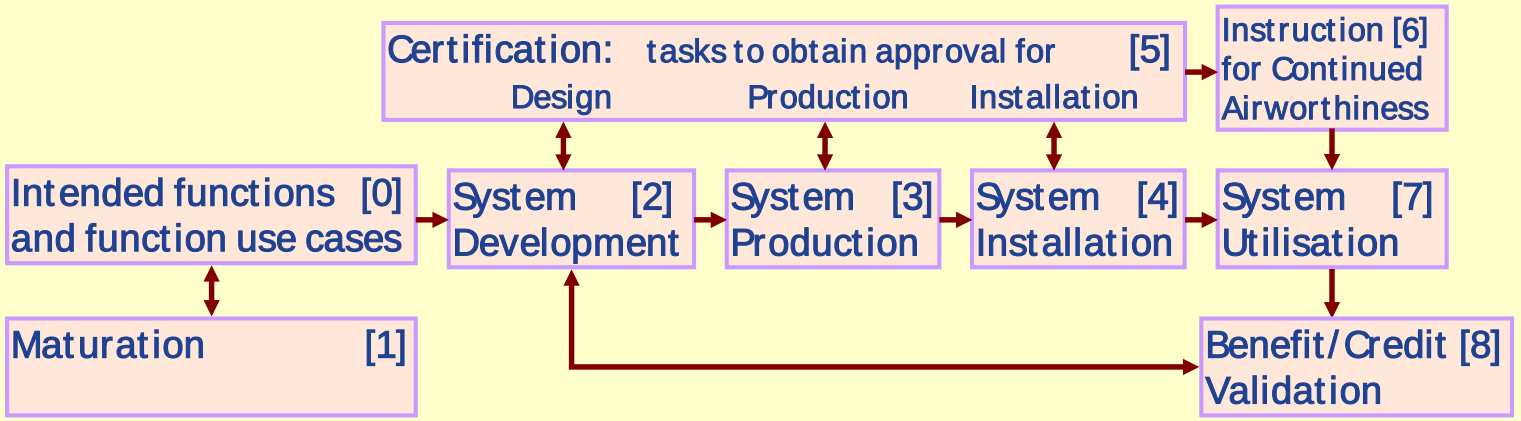


Figure 1(a): Evolution and certification of SHM systems, a simplified diagram

Expected Organisation

[0] any	Regulator: **R** (FAA, DOD, MOD)
[1] any	Aircraft manufacturer: **A**
[2] S, O, A	SHM system manufacturer: **S**
[3] S, O, A	Operator: **O**
[4] S, O, A	Technology developer: **T** (small companies/academia)
[5] R, S, O, A	
[6] R, S	
[7] O	
[8] O, S, R, A, T	

Illustrative work in progress.....

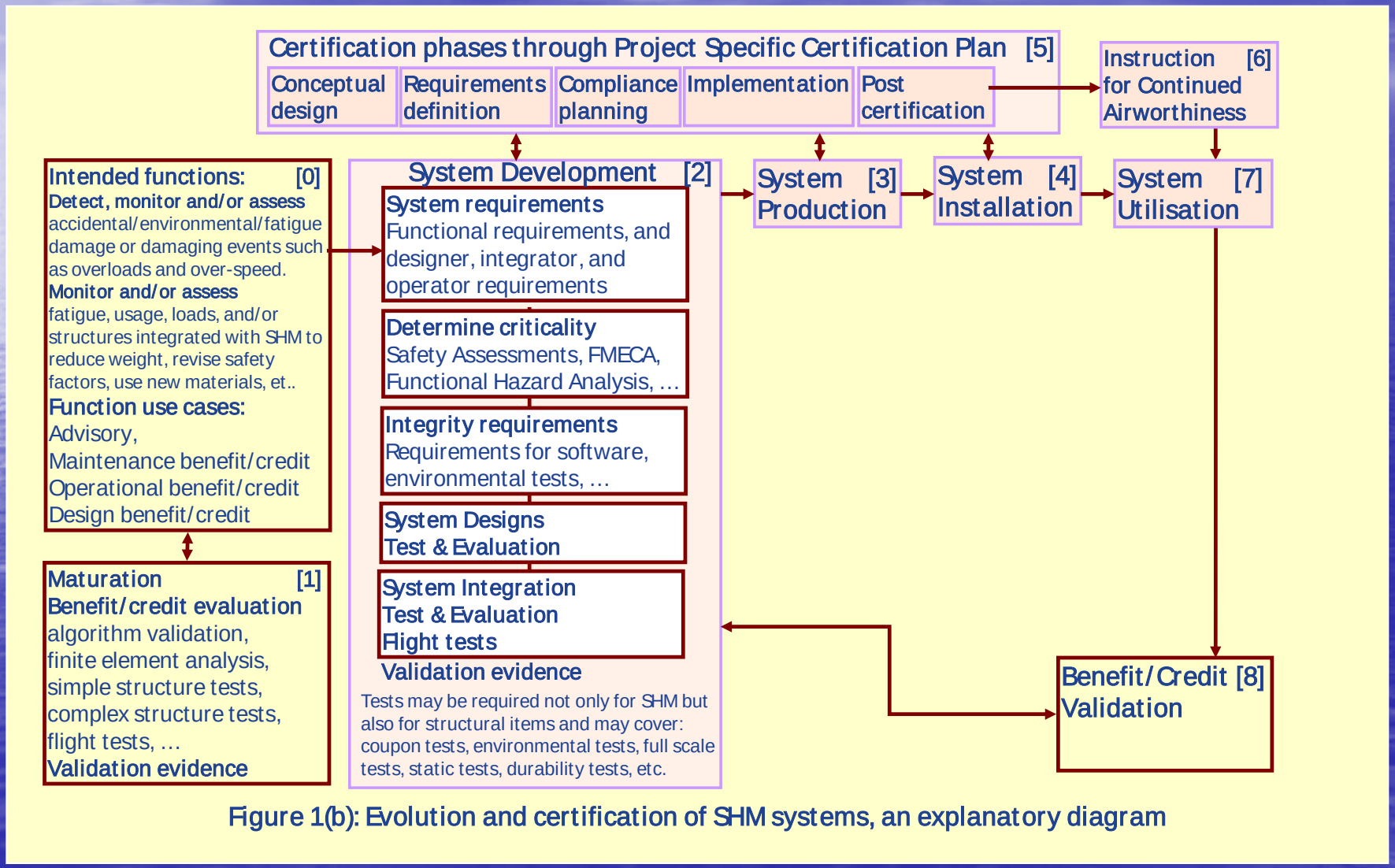


Figure 1(b): Evolution and certification of SHM systems, an explanatory diagram

Illustrative work in progress.....

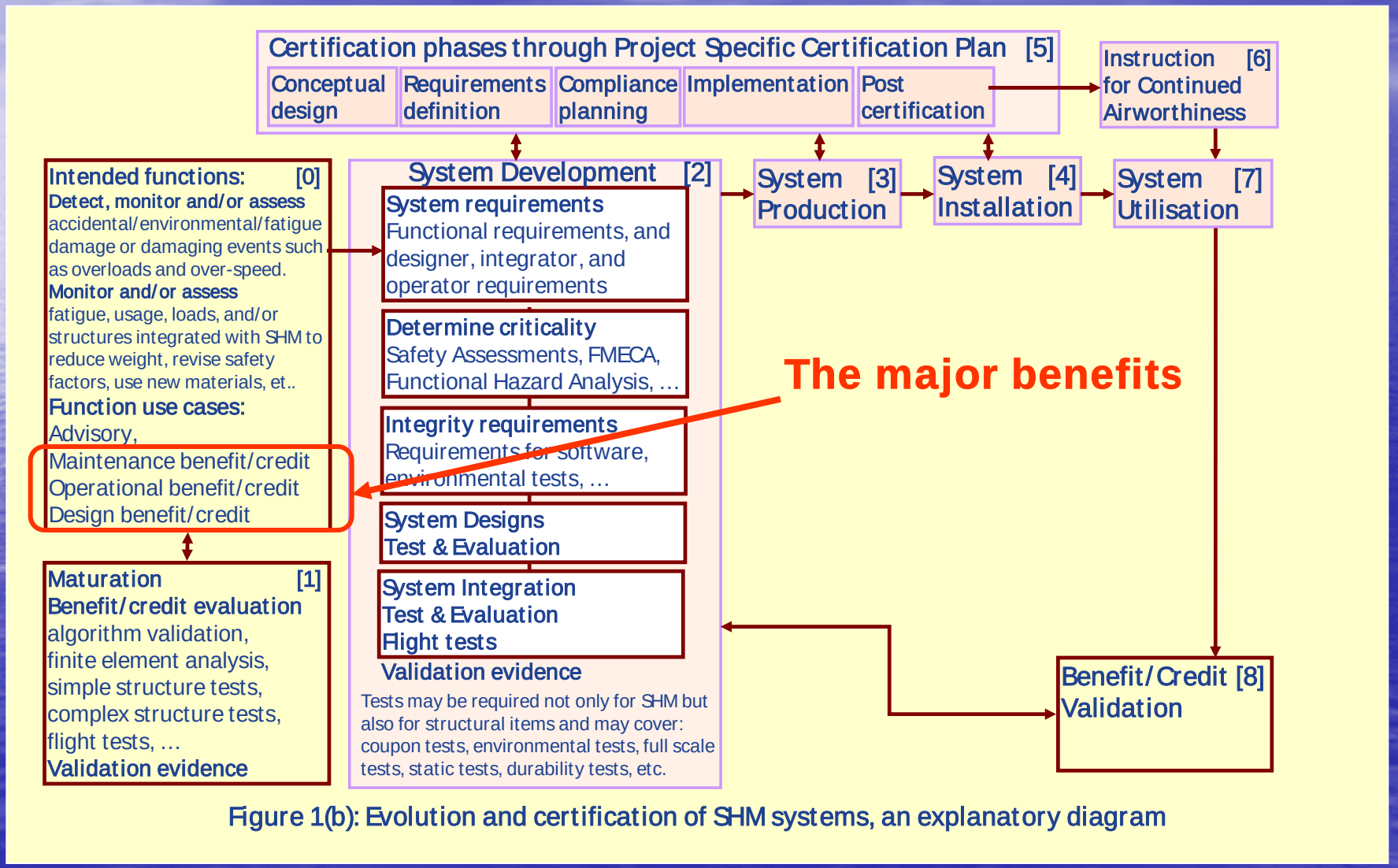


Figure 1(b): Evolution and certification of SHM systems, an explanatory diagram

Working definitions and examples of credits / benefits

- **The maintenance credit/benefit** functions achieve specific improved maintenance tasks that can replace existing tasks or can be considered as Alternative Means of Compliance (AMOC) to existing inspection tasks. Examples of such tasks are (a) detect a falsely reported hard-landing event and eliminate the inspection required after the event, (b) detect structural damage at fixed scheduled intervals (S-SHM), (c) indicate need/opportunity to change maintenance planning (turning unscheduled into scheduled maintenance) etc.

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- **The operational credit/benefit** functions achieve improved operational, management and structural integrity tasks that can replace existing tasks or can result in maintenance planning benefits as increasing inspection intervals. For example, load and fatigue monitoring functions can be used to adjust scheduled task intervals or trigger crack inspection tasks.

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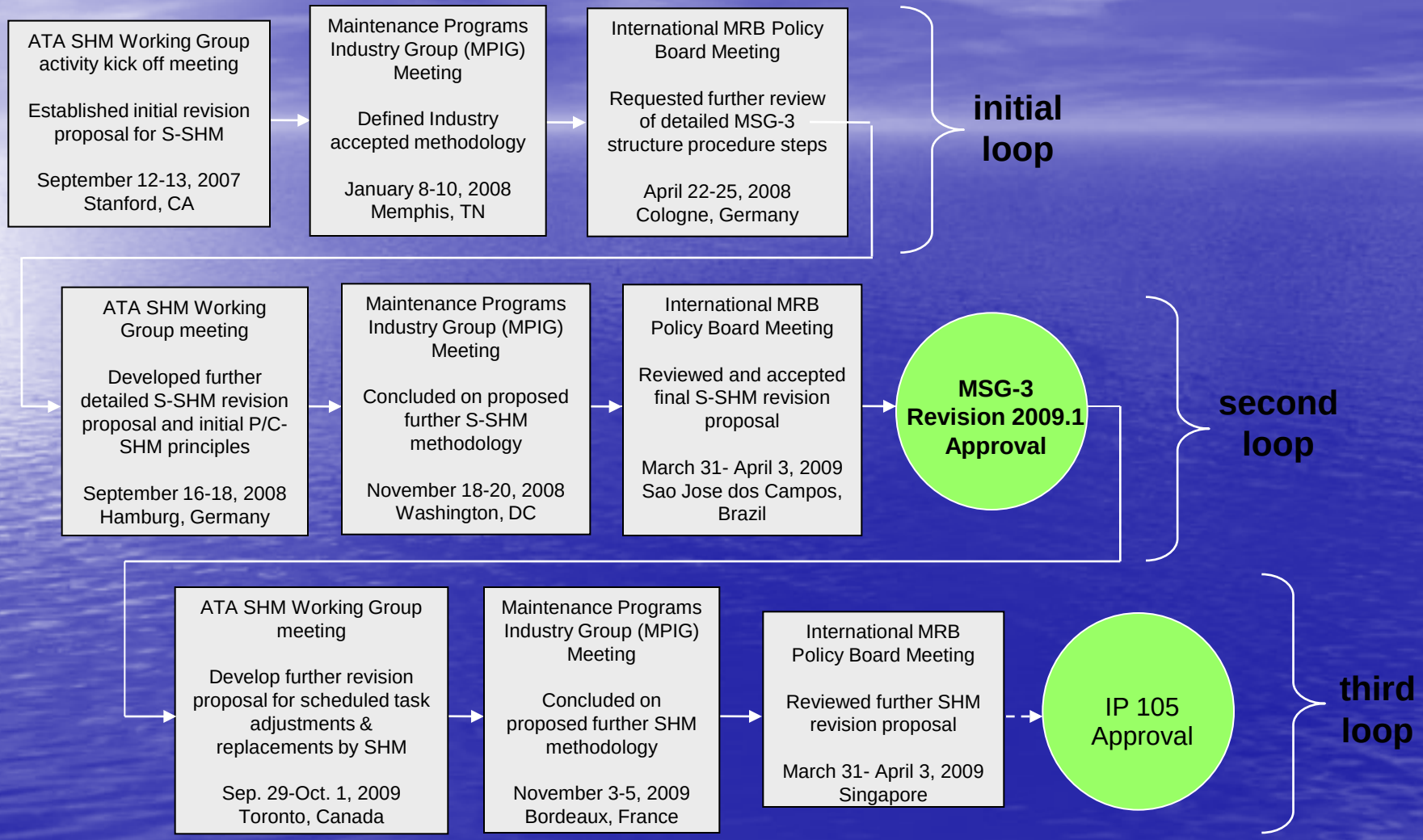
Interaction with ATA MSG-3

MSG-3 Document Revision Process

who is the "ATA MSG-3 SHM WG?"

Courtesy ATA and Lorenz Wenk, Airbus

MSG-3 SHM revision history



Courtesy ATA and Lorenz Wenk, Airbus

Working definitions and examples of credits / benefits

Embodied in MSG-3 IP 2009-1

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SHM in MSG-3 revision 2009.1

An S-SHM task:

- *would be a generic AMM task procedure **without** Non-Destructive Test Method (NTM)*
- *can be carried out with aircraft type rating **without** additional training*
- *uses technology with built in go/no-go determination capability*
- *significantly reduces human factors*

The fixed interval avoids operational issues!

- *No unplanned operational interruptions*
- *Safe operation within the interval scope per definition*
- *Potential SHM technology failure will be evident when performing the task*

Courtesy ATA and Lorenz Wenk, Airbus

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Aspiration and logical end goal for SHM to fully utilize its capability….IP 105

SHM in MSG-3 IP105

SHM Operation Mode

- **Scheduled SHM (S-SHM)** – from IP92, no change
- **Automated SHM** - SHM technology which does not have a pre-determined interval at which maintenance action much takes place, but instead relies on the system to inform maintenance personnel that action must take place

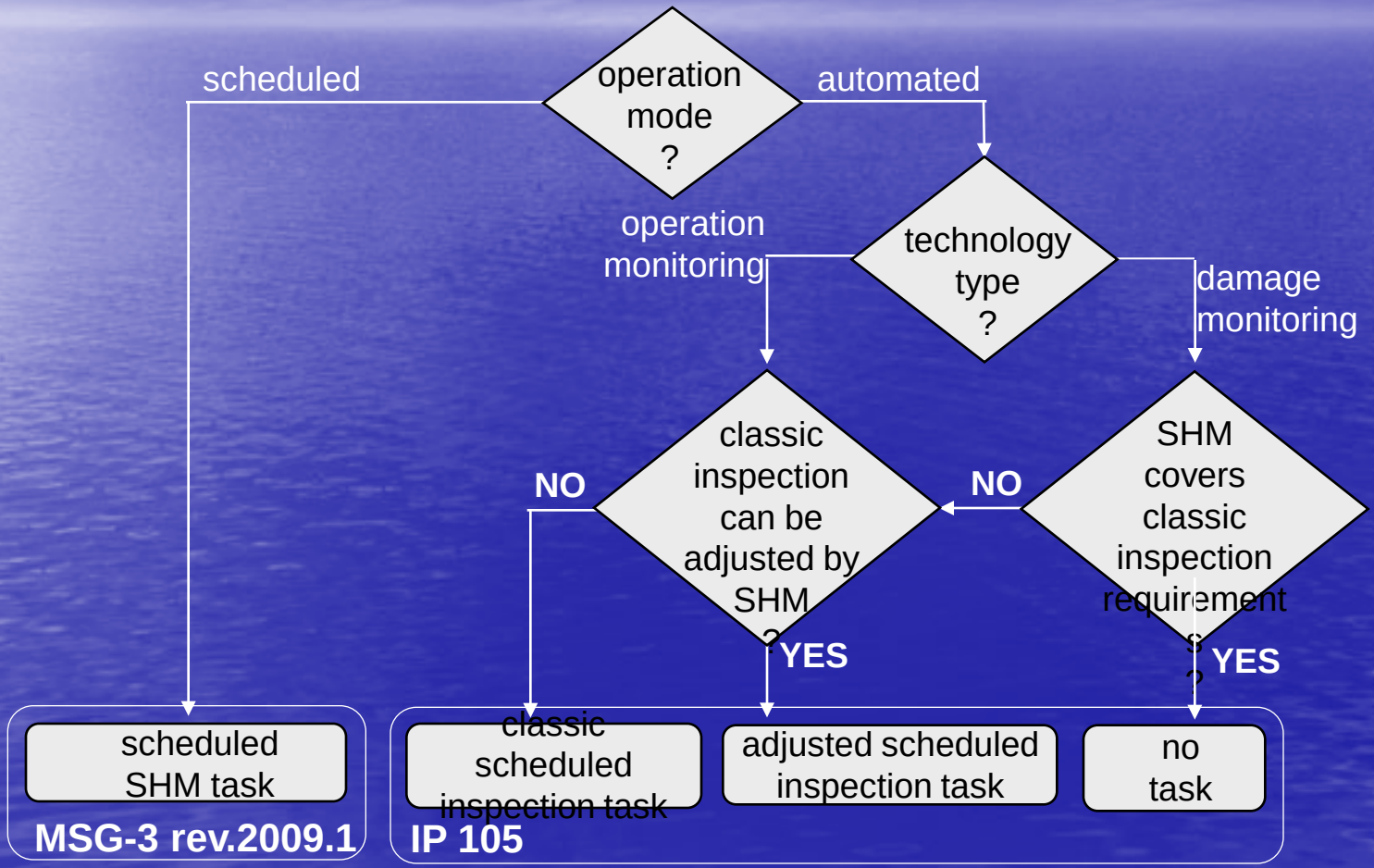
SHM Technology Type

- **Damage Monitoring System** – SHM technology that uses sensors to **directly** monitor structure for deterioration conditions
- **Operation Monitoring System** – SHM technology that uses sensors which do **not directly** check the structure for damage, but instead correlate various measurements (e.g. environment conditions, loads) to make an inference to the probability or likelihood of damage

Courtesy ATA and Lorenz Wenk, Airbus

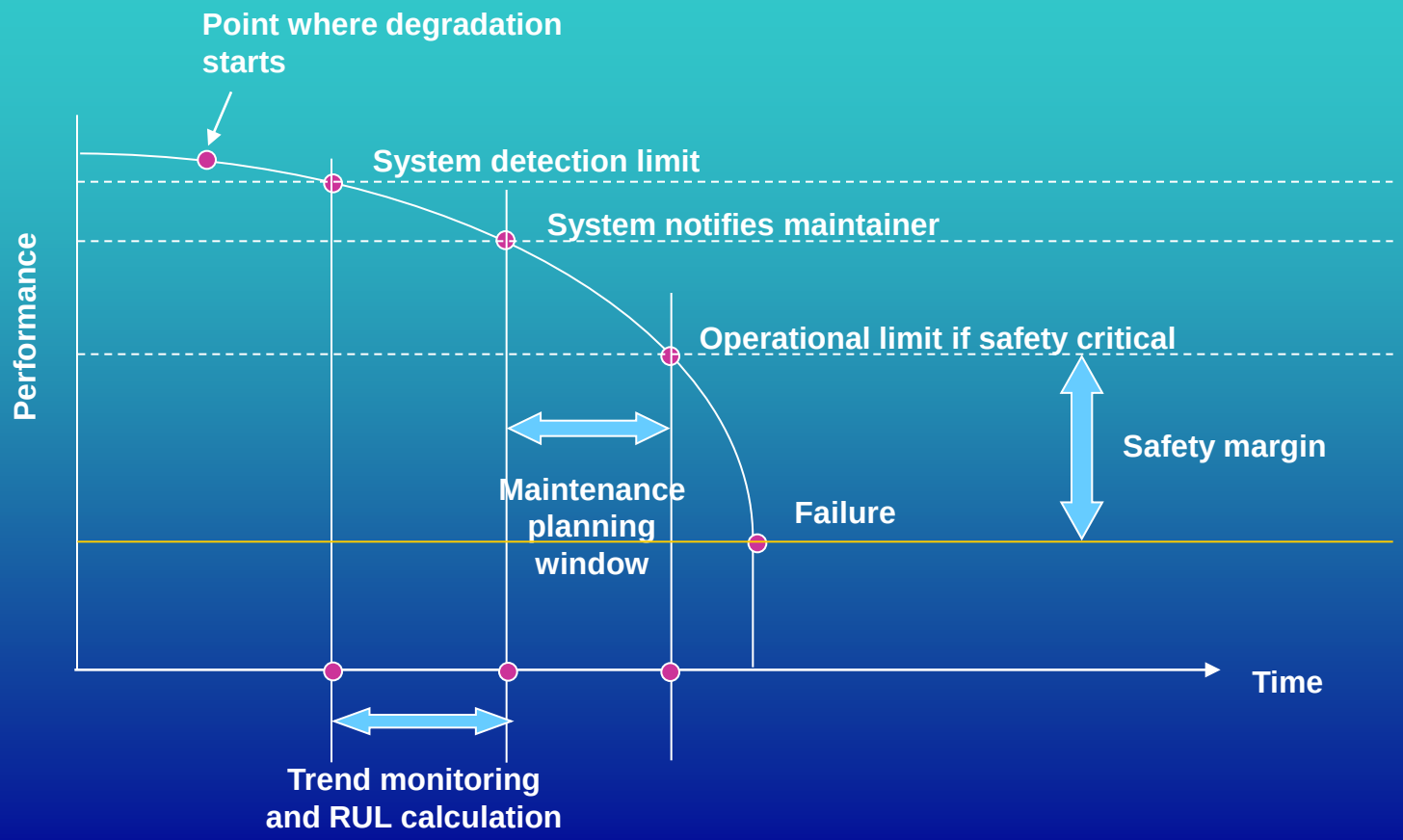
SHM in MSG-3 IP105

Principle SHM evaluation procedure



Courtesy ATA and Lorenz Wenk, Airbus

Automated SHM allows true CBM



In Summary

- The AISC-SHM is preparing SAE International Aerosapce Recommended Practices guidelines for the implementation of SHM for aerospace application
- Target date for publication 2012
- The group draws on a wide range of OEMs, integrators, regulators and technology providers
- The AISC overlaps with the ATA MSG-3 revision process via the ATA MSG-3 SHM Working Group
- Successful revisions and Issue Papers from the ATA working group will be reflected in the AISC guidelines.

Challenge to the industry

- Issue guidelines for implementation of SHM using wide consultation with industry, regulator and user communities.
- OEMs, Technology Developers and suppliers must join efforts to present real S-SHM and A-SHM applications proposals to Regulatory Authorities in the next couple of years: only this will convince all stakeholders of the value of SHM.

Contacts and links

www.sae.org

http://structure.stanford.edu/AISC

AISC-SHM Committee chairman: Peter Foote (peter.foote@baesystems.com)
Guidelines document sponsor and Chair of Commercial Aviation Working Group:
Grant Gordon (grant.gordon@honeywell.com)
Chair of Military Aviation Working Group: Mark Derriso (Mark.Derriso@wpafb.af.mil)

Acknowledgements

- SAE International
- The Air Transport Association
- Members of SAE Aerospace Technical Committee G-11 SHM
- ATA MSG-3 SHM working group

Public Hearing

- 11:20 Room HC 200-002 (Basement meeting room)
- Informal Q&A / discussion on guidelines with members of the AISC-SHM team.