Product Safety Awareness Guidance

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Objective

The primary objective of this guidance material is to raise the awareness and need for promoting a culture of product safety in the aviation, space, and defense industries (AS&D). Ensuring the manufacturers, service providers, and their supply base maintains a heightened awareness of the potential safety impacts of errors during the manufacturing process is the key.

- AS&D hardware is comprised of diverse parts, from the complex to the simple, and each of the suppliers that produce these parts play an important role in the overall safety of the final product.

However, in the respective work sites, there is always a possibility that an operator can lose sight of the fact that each of the daily work tasks/operations is directly connected to the safety of the end product. The impact is particularly significant in the manufacturing and assembly work sites where product defects can be impacted by man, materials, methods, measurement, materials or even mother-nature. The challenge is to gain and hold the attention of the operator so they fully understand the potential safety impacts of the product they are manufacturing.

Scope

The **scope** of this guidance is to;

- Provide **guidelines** regarding what perspectives the organization should take when planning and implementing product safety awareness initiatives and training
- Address product safety awareness throughout the product life cycle from design to end-use for all parts that are procured, manufactured, assembled for the end product, or maintained/serviced
- Capture lessons learned, best practices, training guidance, resource links, and principles that are uniform and comply with international standards

Definition of Product Safety

Product Safety (IAQG 9100) Definition

The state in which a product is able to perform to its designed or intended purpose without causing unacceptable risk of harm to persons or damage to property.

9100 (2016) requires an organization to plan, implement and control the processes needed to assure product safety.

Examples of these processes as per 9100-2016 include:

- *assessment of hazards and management of associated risks*
- *management of safety critical items*
- *analysis and reporting of occurred events affecting or potentially affecting safety*
- *communication of these events and training of persons*

9100 Revision 2016 Focus on Product Safety

Rationale for the addition in 9100-2016

- Industry acknowledgement of the importance of increasing safety.
- Recognition of the 9100 certifications by authorities is part of IAQG strategy.

Implementation considerations

- Address product safety considerations throughout the product lifecycle.
- A full Safety Management System (SMS) as defined by ICAO (International Civil Aviation Organization) is not required by 9100, but the introduction of this new clause contributes to the SMS approach.

Methodology

This guidance material provides several examples to raise employee awareness of product safety.

The traditional “6M” Method for preemptive cause and effect analysis and post mortem for event analysis provides a suitable model to highlight product safety related incidents.

- 6M stands for man, machinery, materials, methods, measurement and mother-nature.
  - some modifications to the 6M method will be implemented to refine the focus in highlighting the need for the product safety awareness
  - a suggested method for capturing the 6M analysis is to create a Cause & Effect Diagram (Fishbone Diagram)

Traditional 6M Approach

1. **Man.** Does the personnel's technology proficiency and experience meet expectations and/or standards? Has the employee been properly trained and motivated? Does the staff have quality consciousness, sense of responsibility and discipline?

2. **Machine.** Check the facilities' stability, functionality, such as the precision, the cooling and lubrication state of all equipment. If the machinery is rusting or eroding, the production efficiency may decrease. Proactively maintain and repair equipment.

3. **Materials.** Think about the materials' components, physical and chemical properties. Examine whether different parts match well. Are the material suppliers and their processes stable or not?

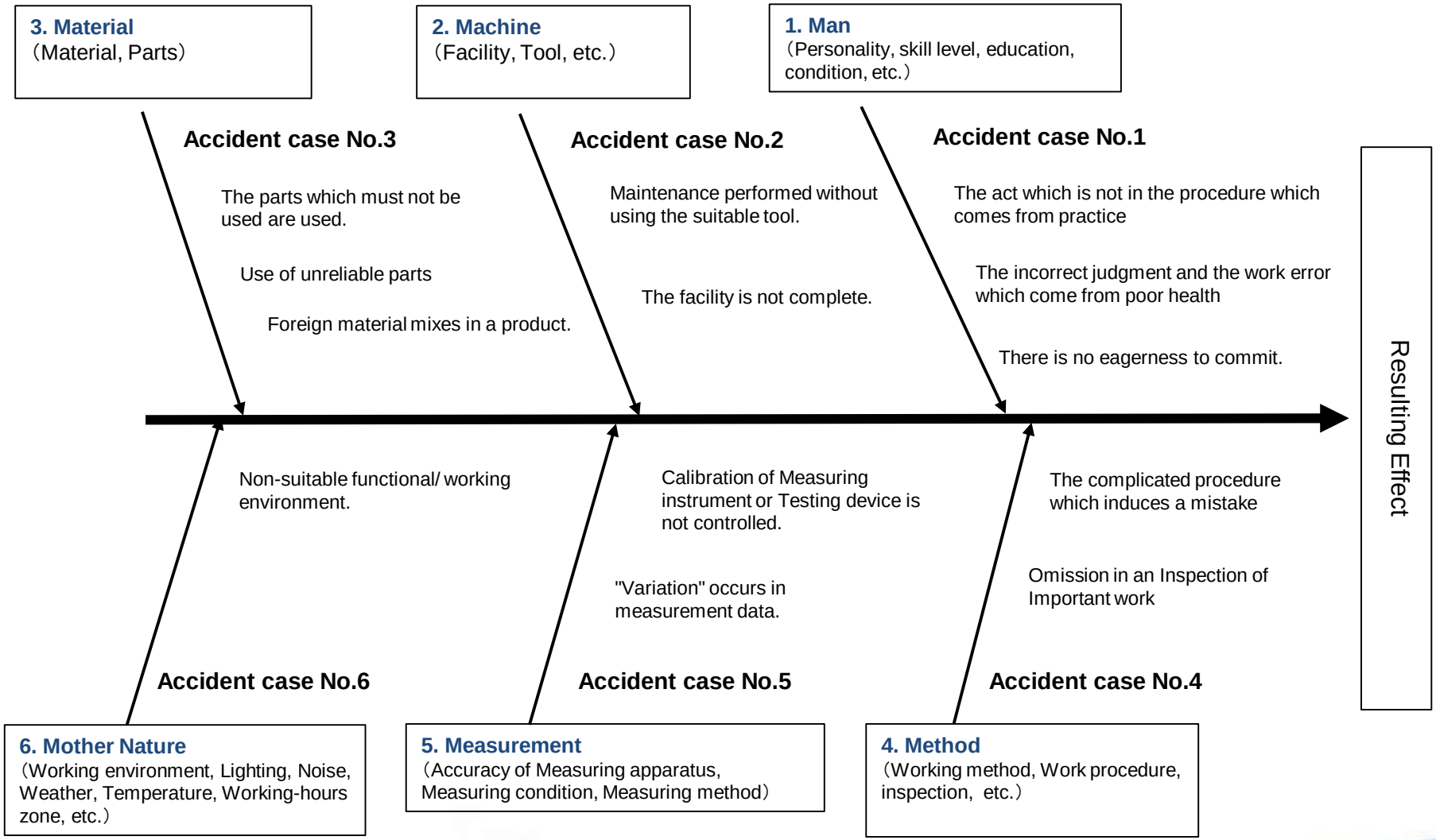
Traditional 6M Approach

4. **Method.** To be more specific, the methodology, methods or techniques that may affect or impact a process or set of processes in the manufacturing operations. Other factors include workflow, choice of technical parameters, technical guidance and the preciseness and execution of workflow.

5. **Measurement.** Factors to be considered for correct results: gauge, method, calibration, accuracy, appropriate resolution, operator's fatigue, and readability of the results.

6. **Mother-nature**. The environment in production field, including temperature, humidity, noise disturbance, vibrancy, lightening, and indoor pollution will all influence the products or service.

Example 6M Cause and Effect Diagram



Man Impact Assessment

Man contributions to cause and effect of Product Safety include:

- Education / Insufficient training
- Personal Certifications
- Out of station work / substitutes
- Employee motivation
- Human Factors
  - Stress
- Health of the employee
  - Proper mindset
  - Attitude, Focus, Distraction
  - Proper attire
  - Psychological aspects
- Management
  - Attention / commitment
  - Instruction
  - Relationship

Machine Impact Assessment

Machine contributions to cause and effect of Product Safety include:

- Understanding of machine operation
  - Appropriate selection for the operation / capacity analysis
  - Set-up / calibration
  - Maintenance – Scheduled Preventative Maintenance (PMs), reliability & maintainability
  - Operational documentation & associated continuous training update
- Tooling condition
  - Controls
  - Scheduled Preventive Maintenance
- Safeguards
  - Numerical Control (NC) Programs
  - Program Controls

Materials Impact Assessment

Materials contributions to cause and effect of Product Safety include:

- Conformity
  - Material Testing
  - Certifications / approved sources
  - Contamination / defects
- Bulk material management
- Suspected Unapproved Parts (ref IAQG SCMH 3.5)
  - Counterfeit and fraudulent parts
  - Part substitution
- FOD (ref. IAQG SCMH 3.4)
  - External and Internal
- Material handling
  - Damage during processing
  - Shelf life (Life limited)
  - Cleanliness, temperature and humidity control during processing
  - Preservation
  - Lifetime controls

Methods Impact Assessment

Methods contributions to cause and effect of Product Safety include:

- Human Factors (ref IAQG SCMH 3.6)
- Quality Management System
- Risk Analysis (ref IAQG SCMH 7.3)
  - DFMEA – Design Failure Mode Effects & Analysis
  - PFMEA – Process Failure Mode Effects & Analysis
  - Risk map
- Accurate Planning (ref IAQG SCMH 3.8)
- Design changes / Configuration Management (ref IAQG SCMH 7.5)
- Inspection & Control Plans
- Drawing interpretation
- Chemistry standards
- Shipping/receiving/preservation

Note: Reference IAQG 9145 Advanced Product Quality Planning (APQP) Standard

Measurement Impact

Measurement contributions to cause and effect of Product Safety include:

- Selection of appropriate measurement tools & equipment
- Calibration & accuracy of inspection tools & equipment
- Measurement System Analysis (MSA)
- Statistical Product Acceptance (Reference 9138, SCMH 3.7)
- Statistical Process Control (SPC) (Reference 9103, SCMH 3.1)
- Data collection & variation
  - Measurement variation
- Critical Items & Key Characteristics (Reference 9103, SCMH 3.1)
- Control of records & record retention
- Controlled environment
- Measurement system conversion (ex. metric/US)

Mother-Nature Impacts

Mother-nature and/or environmental contributions to cause and effect of Product Safety include:

- Environmental impacts
  - Temperature
  - Humidity
  - Dust
  - Particulate contaminants
  - Pollution
- Acts of nature (Atmospheric)
  - Weather conditions
  - Lightning
- Noise
- Vibration

Product Safety Related Examples

To adequately demonstrate the importance and attention on product safety at all levels within an organization real world examples will be used to highlight:

- The problem and related underlying issues
- The impact to human life and property
- The reasons why
- The lessons learned

Accident Case No. 1 - Man

Commercial Airline Accident

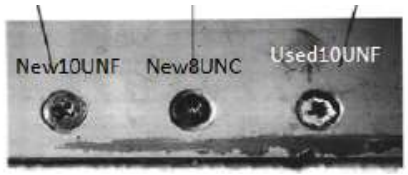
Underlying Issue – Man choosing to install via his experience versus following documented planning and verbal guidance with no inspection oversight.

Problem – Cockpit windscreen blew out during flight

Impact – Pilot was almost ejected through the opening

Why – Incorrect type of fasteners were installed in the cockpit windscreen frame assembly

Post-Flight Inspection of fasteners



Lessons Learned –

- Maintenance manager did not confirm use of the fasteners selected for the application.
- Employee should have selected proper hardware for the specific installation and application rather than using personal judgment
- Failure to follow planning:
  - Although the installer was advised to use the A211-8D screw he did not listen and used the A211-8C.
  - The installer recognized there was something different about the screw fit but chose to ignore the misfit.

Source: Japanese Ministry of Land, Infrastructure, Transport, & Tourism

Accident Case No. 2 - Machine

Space Industry, Apollo 1, AS-204 Command Module Fire

Underlying Issue – Unsafe conditions unrecognized – complacency probably a key factor, unfueled module was considered low-risk and non-hazardous test

Problem – On-pad fire in Command Module during "Plugs Out" test on Jan 27, 1967

Impact – Three astronauts perished, Virgil Grissom, Edward White II, and Roger Chaffee

Why – Contributors included a cabin sealed with a hatch cover that could not be quickly removed at high pressure, a pure oxygen atmosphere at higher than atmospheric pressure, and an ignition source "vulnerable wiring carrying spacecraft power"

Lessons Learned – Complacency can creep into what are otherwise extremely vigilant & disciplined programs

- Mature, successful programs can be especially vulnerable
- That, "it" has been trouble-free is no guarantee that "it" is flawless
- Need to foster an alertness for what can go wrong
  - Insufficient attention to the routine and obvious can be catastrophic
  - Have fresh eyes look at the "it" and question what can go wrong (verbal hazard analysis)
- Increased Hazard analysis and awareness
- Increased safety procedures

Source: NASA, Report of the Apollo 204 Review Board

Accident Case No. 3 - Material

Commercial Airline Accident

Underlying Issue – Material Defect

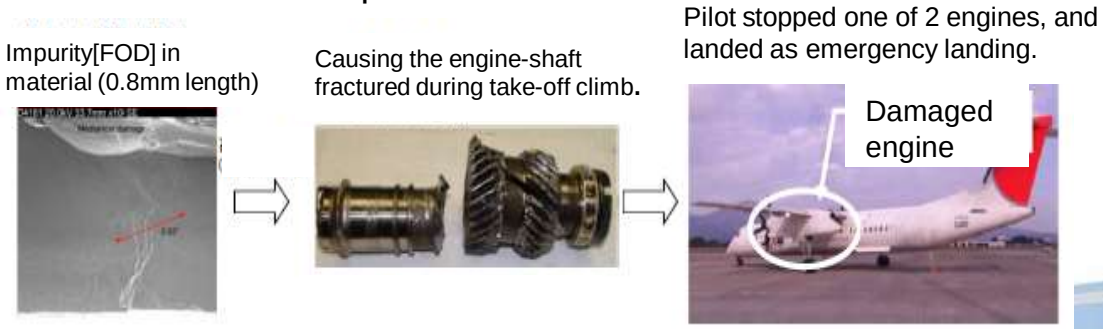
Problem – Engine gear failure due to raw material contamination

Impact – Engine failure, but because dual engine aircraft no loss of life or injury

Why – Contamination of raw stock not detected before gear manufacturing

Lessons Learned –

- Ensure there is a robust inspection process to eliminate contamination of the raw material.
- The importance of a heightened awareness and oversight of inspection processes required of raw material suppliers.
- It is impossible to find material defects in post-process (e.g. assy. line). Quality assurance of material is important (critical). Therefore, it is mandated to manage supplier quality.
- Ensure that the raw stock supplier understands the importance of their material as it relates to the criticality of the product usage.



Source: Japanese Ministry of Land, Infrastructure, Transport & Tourism

Accident Case No. 4 – Methods

Commercial Airline

Underlying Issues – Failsafe design, failure to follow a service bulletin, and assembly error.

Problem – Immediately upon completion of taxi to the apron the ground engineers observed fuel gushing from an area near the number 2 engine. The pilot shut off the fuel supply to the engines after he was alerted by the ground engineer about the leak. Fuel from the leak flowed beneath the aircraft towards the no. 1 engine.

Impact – The fuel ignited and the fire ultimately engulfed the airplane. Passengers and crew escaped but the aircraft was a complete loss.

Why – Inadequate design (machine) and lack of discipline to follow service instructions and assembly.

Lessons Learned –

- The designer should perform risk/safety analysis, DFMEA and failsafe design features. Additionally, design for manufacturing and maintenance should be incorporated.
- Compliance education should be reinforced to ensure service bulletins are followed.
- Employee should follow planning and engineering design drawings to ensure proper part assembly.
- Ensure there is adequate dialogue between the operator and manager to ensure compliance and issues are raised.

Source: Japanese Ministry of Land, Infrastructure, Transport, & Tourism

Accident Case No. 5 – Measurement

Commercial Airline

Underlying Issue – Improper maintenance procedures led to failure of the pylon structure.

Problem – Engine separation leading to loss of the aircraft May 25, 1979

Impact – All aboard plus two on the ground perished (273 total)

Why – The occurrence of repeated flange to clevis impacts induced during maintenance because improper tolerances.

Lessons Learned –

- Accurate, timely, and proactive flow of information within organizations, and across organizational interfaces is essential to maintain safety
- Failure of ground handling procedures can be fatal
- It is vital to have formal acceptance by manufacturers of critical maintenance procedures performed by operators
- When things go wrong during critical operations, it is vital to have a incident report and thorough assessment of potential damage.

Source: NTSB TSB-AAR-79-17, A/C Accident Report DC-10 Dec 21, 1979

Accident Case No. 6 - Mother-Nature

Commercial Airline Accident US Airways Flight 1549, 15 Jan 2009

Underlying Issue – A flock of migratory birds crossed the flight path of the airliner upon climb out from airport.

Problem – Aircraft unavoidably flew through a flock of large birds causing aircraft damage.

Impact – Loss of aircraft, potential loss of life, 155 passengers and crew safe but could have lost their life

Why – Loss of thrust due to engine Foreign Object Damage (FOD)

Lessons Learned – Improved in-flight engine alerting, improved engine bird-ingestion certification testing, enhanced abnormal checklist design, improved aircraft ditching procedures, increased passenger safety controls, life-vest stowage and donning, and passenger education. Value of experienced crew resource management during an accident. Highlighted the need for bird-strike procedure training.

Source: Report: NTSB/AAR-10/03 PB2010-910403

Training Plan & Considerations

- Each organization should create training programs to heighten the sensitivity of product safety throughout the life cycle of the product:
  - Design
  - Development & Testing
  - Manufacturing
  - Assembly
  - Inspection and measurement
  - Shipping, storage, and preservation
  - Transportation, docking, undocking
  - Installation into next higher assembly
  - End-use and Maintenance/Service

- Train each employee on the application and use of the product, process, or service they are responsible for.

Training Guidance

- Supply Chain Management Handbook offers compliance education recommendations and provides an easily adaptable training template that can be adapted to include product safety topics.
  - 7.8 Compliance Education
    - 7.8.1 Compliance Education Introduction
    - 7.8.2 Compliance Education Guidance
    - 7.8.3 Compliance Education Training Template
- Effective delivery methods include classroom, e-learning, self-education, and videos.

Training Goals and Summary

(1) Understand the importance of product safety

(2) Understand the functions of our own products, and the way they are used by the end users

(3) Understand the impact that our own work has on product safety

(4) Understand that often, some small things may have critical consequences

(5) Create appropriate training material to meet your specific company culture and products

Do you have comments about the Product Safety Awareness Guidance?

You may provide feedback via the SCMH,
go to www.iaqg.org/scmh accept the terms and conditions
then click on “Contact Us” or “Take Survey”.