GUIDANCE ON HOW TO CONSIDER HUMAN PERFORMANCE IN AN SMS

October 2025

This paper was prepared by the Safety Management International Collaboration Group (SM ICG). The purpose of the SM ICG is to promote a common understanding of Safety Management System (SMS) / State Safety Programme (SSP) principles and requirements, facilitating their application across the international aviation community. In this document, the term "organisation" refers to an aviation service provider, operator, business, and company, as well as aviation industry organisations; and the term "authority" refers to the regulator authority, Civil Aviation Authority (CAA), National Aviation Authority (NAA), and any other relevant government agency or entity with oversight responsibility.

The current core membership of the SM ICG includes the Aviation Safety and Security Agency (AESA) of Spain, the National Civil Aviation Agency (ANAC) of Brazil, the Bermuda Civil Aviation Authority (BCAA), the Civil Aviation Authority of the Netherlands (CAA NL), the Civil Aviation Authority of New Zealand (CAA NZ), the Civil Aviation Authority of Singapore (CAAS), Civil Aviation Department of Hong Kong (CAD HK), the Civil Aviation Safety Authority (CASA) of Australia, the Direction Générale de l'Aviation Civile (DGAC) in France, the Ente Nazionale per l'Aviazione Civile (ENAC) in Italy, the European Union Aviation Safety Agency (EASA), the Dominican Republic Civil Aviation Institute (IDAC), the Finnish Transport and Communications Agency (Traficom), the Irish Aviation Authority (IAA), Japan Civil Aviation Bureau (JCAB), the United States Federal Aviation Administration (FAA) Aviation Safety Organization, Transport Canada Civil Aviation (TCCA), United Arab Emirates General Civil Aviation Authority (UAE GCAA), and the Civil Aviation Authority of United Kingdom (UK CAA). Additionally, the International Civil Aviation Organisation (ICAO) is an observer to this group.

Members of the SM ICG:

- Collaborate on common SMS/SSP topics of interest
- Share lessons learned
- Encourage the progression of a harmonized SMS/SSP
- Share products with the aviation community
- Collaborate with international organisations such as ICAO and civil aviation authorities that have implemented or are implementing SMS and SSP

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1. Introduction

ICAO has recently discussed the human performance (HP) aspects in aviation. The Assembly resolved that[1]:

1. Member States ensure the integration of human performance considerations in the planning, design, and implementation of new technologies, systems, and processes as part of a safety management approach;

2. Member States promote and facilitate the integration of human performance elements within competency-based training programmes throughout the career of a professional; and

3. Member States include strategies which promote safe, consistent, efficient, and effective operational performance of the individual and across teams of individuals to address safety priorities.

This paper has been developed to help service providers integrate human performance considerations and solutions when establishing and maintaining a Safety Management System (SMS).

This document supplements ICAO Doc 10151 Human Performance (HP) Manual for Regulators, ICAO Doc 9683 Human Factors Training Manual, and ICAO Doc 9859 Safety Management Manual.

1.1. Applicability

When we think about human performance in aviation, we tend to focus on the frontline worker. However, these concepts apply to all aspects of the system, including interfacing entities. As you read the paper, remember that it is not just about the sharp end of the operation; it is about human performance interacting in all levels of an organisation and of the system.

1.2. Structure of This Paper

This paper is organised in two parts. The first part sets out to explain the nature of human performance in the context of SMS. Each of ICAO's four pillars of SMS is addressed, namely:

- Safety policy and objectives: Demonstrating senior management's commitment to ongoing safety improvement

- Safety risk management: Identifying hazards and assessing risks to mitigate their potential to cause harm

- Safety assurance: Verifying safety performance of the organisation and validating the effectiveness of safety risk controls

- Safety promotion: Educating personnel and developing the safety culture

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[1] ICAO Assembly Resolutions in Force (as of 4 October 2019)

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The second part of the paper includes appendices with practical examples and suggestions on how to consider human performance within your SMS.

- Appendix 1: Human Performance in SMS – Examples
- Appendix 2: Methods and Frameworks that Can Consider Human Performance in SMS

1.3. References

This paper draws from, and builds upon, content from the following:

- ICAO Human Factors Training Manual (Doc 9683)
- ICAO Human Factors Guidelines for Aircraft Maintenance Manual (Doc 8824)
- ICAO Human Performance (HP) Manual for Regulators (Doc 10151)
- ICAO Safety Management Manual (Doc 9859)
- ICAO Annex 19 – Safety Management
- ICAO TV – Human Performance https://www.icao.tv/videos/human-performance
- ICAO – Human Performance Page https://www.icao.int/safety/OPS/OPS-Normal/Pages/HP.aspx

Where the information is publicly available, we have included the link.

2. Terminology

2.1. Human Performance

Human performance (HP) refers to **how** people perform a task and represents the human contribution to system performance. Human performance is about the actions and decisions made in an aviation activity. Human performance focuses on how individuals or teams perform their work in the aviation system. Human performance provides needed flexibility and adaptability in operational systems, making human performance a valuable part of any aviation system.

2.2. Human Factors

Human Factors (HF) explains **why** people do things the way they do and makes use of that knowledge to optimize human performance. Human Factors is an applied science concerned with the application of what we know about human beings, their abilities, characteristics, and limitations[2] to their interactions in and with the world around them. Ergonomics is a subset of Human Factors and is primarily concerned with the physical function of the user equipment and environment in which work is performed. Human Factors includes anything that affects human performance.

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[2] ICAO Doc 10151, Human Performance (HP) Manual for Regulators

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2.3. Relationship Between the Two Terms

Before we consider human performance issues involved in an SMS, we need to clearly understand the terminology. The terms human performance, Human Factors, and ergonomics are sometimes confused and often used interchangeably. Although they are closely linked, they are different.

We often see human performance as an observation or description of the actions and decisions of the person within the system, whereas the application of Human Factors provides an explanation of that human performance in the system. Human Factors also tells us how to design and improve the system to optimize human performance.

3. Human Performance Principles

According to ICAO there are 5 principles that apply to human performance[3] (HP). Knowing and applying these principles helps us shape, improve, and optimize safety performance at all levels of an aviation system.

Table 1 identifies the 5 HP principles and offers some corresponding questions to help you apply the principles in an operational context. Please note that the questions listed are for illustrative purposes and are not exhaustive.

3.1. Table 1: ICAO's 5 HP principles in Practice

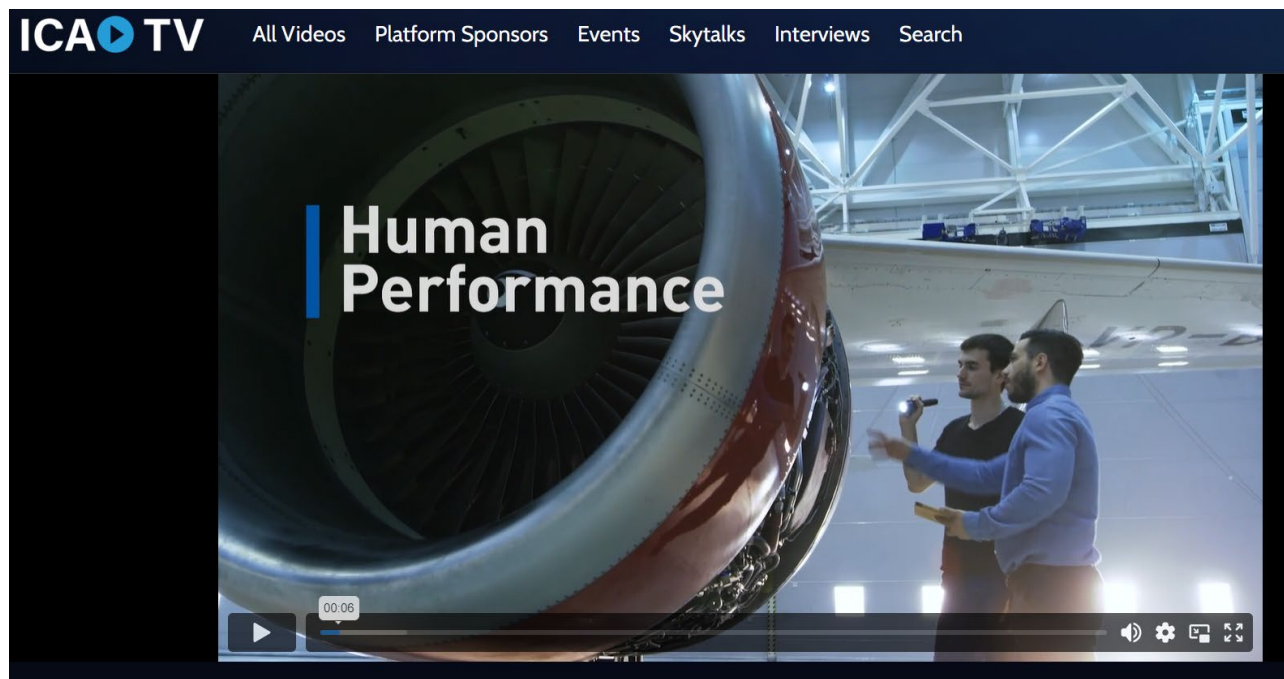| Principle	In Practice
Principle 1: People's performance is shaped by	• Are people trained so they can perform their duties competently?

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[3] ICAO Doc 10151, Human Performance (HP) Manual for Regulators

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Principle	In Practice
their capabilities and limitations	• Are people hired with the qualifications and experience we need? • Are people maintaining their competencies and currency with the programs we have? • Are people working with an optimal level of workload most of the time? • Are people's capabilities and limitations such as their vision, hearing, size and other individual characteristics understood and considered when developing tasks and procedures?
Principle 2: People interpret situations differently and perform in ways that make sense to them	• Did the actions and assessments of the people involved make sense at the time given the conditions and circumstances present during an event? • Are we working to detect drift in practices from procedures? • What knowledge and skills do people need to perform their work? • Are there cultural norms, beliefs and values influencing people's performance? • Are people learning from their experiences through the safety risk management process?
Principle 3: People adapt to meet the demands of a complex and dynamic work environment	• Do leaders appreciate that adaptation is necessary in an operational setting, and should be managed, underpinned by consideration of human performance? • What pressures and demands of work goals are driving the actions and decisions of our people? • When people 'find a way' – for better or worse, how do we learn from the experience? • When we implement a change, what steps do we take to manage it?
Principle 4: People assess risks and make trade-offs	• What activities and decisions are too risky and are people supported to stop or pause a flight or task? • What actions and decisions are beyond the risk acceptance of our organisation? • Do operational personnel know about the threats and hazards in their day-to-day work and how to manage them? • Do we provide adequate risk assessment tools and training so that operational personnel can make good decisions?

Principle	In Practice
	• Are people adapting and drifting away from how we want the work to be done? What are we doing to understand why?
Principle 5: People's performance is influenced by working with other people, technology, and the environment	• Are people working in ways that are aligned with our culture, policies and procedures? • Are peers influencing safe or unsafe practices? • Are we learning from our safety risk management and safety assurance processes? • Do we have problems keeping people in our organisation? • Are any of our people struggling with personal issues that are negatively affecting their work performance? • Do managers take an interest in their employees at an individual level - do they try to understand and truly appreciate each person doing the work and take this into consideration when allocating tasks? • Are our work processes harnessing the benefits of automation and computerized processes? Is there more we can do to be safe and efficient? • Are there any ergonomic issues that need to be addressed in our aircraft, in our hangars, in our control towers, our offices, etc.?

A video presentation explaining the 5 HP Principles can be found on ICAO TV at the following link:

Human Performance - ICAO TV

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4. Human Performance in the SMS

Integrating human performance considerations is essential to the success of any Safety Management System (SMS), as it directly influences safety outcomes across all levels of aviation operations. Every aspect of the global aviation system—whether designed, constructed, maintained, authorized, or managed—involves people. Understanding how human capabilities, limitations, and behaviours interact with the system enables organisations to develop strategies that enhance performance while managing error.

Historically, aviation safety was seen as being compromised mainly by human weaknesses and unreliability, with individual errors viewed as the primary source of failure in an otherwise safe system. More recently, the approach to improving human performance, guided by the 5 HP principles, reflects a shift from focusing solely on individual errors to recognising the positive contributions people make to safety, resilience, and efficiency. Individuals often adapt to interruptions and disturbances—such as severe weather or mechanical failures—ensuring the system continues to function effectively.

Modern SMS practices must recognise the importance of assessing human contributions not only when things go wrong, but also when they go right. This includes understanding why actions made sense to individuals at the time, given the conditions and circumstances. By acknowledging that people can be both the source of and solution to safety risks, organisations can better support safe and effective operations.

ICAO Annex 19 stresses the importance of embedding the 5 HP principles into safety management processes. We can accomplish this by, for example:

- Identifying potential threats to human performance;

- Designing operational tasks, procedures, equipment, and environments that respect human capabilities and limitations; and

- Fostering a culture that encourages open communication and reporting through learning from past events.

To manage human performance in the aviation system effectively, organisations need:

- Clearly documented individual safety management responsibilities;

- A positive safety culture including processes and procedures to encourage open hazard and occurrence reporting;

- Management of change processes that consider evolving tasks and the broader impact of changes at the individual level;

- Robust training programs;

- Fatigue management strategies; and

- Decision-making tools to support personnel under stress or uncertainty.

Incorporating human performance considerations into the SMS helps us identify related safety trends, offering insights that drive continuous safety improvements. It is important that safety data and information are analysed to recognise those risks related to variable human

performance and human limitations. Particular attention should also be made to understanding factors at the operational and organisational level. People contribute both positively and negatively to aviation safety. Ultimately, maintaining a focus on human performance ensures that SMS are comprehensive, effective, and aligned with the overarching goal of maintaining and enhancing aviation safety.

5. Safety Policy and Objectives

To address the way that your organisation influences human performance there must be senior level support[4] to implement effective safety management. For example, a workplace with a positive safety culture is where safe and professional practices are not only expected normal behaviours but are routinely reinforced and supported by management, even when there are considerable time and customer pressures present. In this type of organisation, personnel will tend to 'do it by the book' and take the time to ensure appropriate work practices, inspections, cross-checks, and signoffs are carried out. In this case, the organisation's positive safety culture has influenced human performance. If, however, management overlooks routine shortcuts and workarounds taking place to enable quicker turnarounds and faster task completion, a 'near enough is good enough' attitude will prevail. This could ultimately result in the acceptance of lower standards of work and degraded safety performance.

Your safety policy and objectives should capture human performance considerations. Policies, processes, and procedures should be clear, concise and workable, with the aim of[5]:

- Understanding and applying knowledge about human capabilities and limitations;
- Acknowledging that making mistakes is human;
- Identifying threats and managing errors;
- Improving human performance;
- Enabling human resilience and contributions to safety;
- Reducing the unwanted consequences of variability in human performance; and
- Harnessing the benefits of adaptable and flexible human performance.

A documented safety policy that identifies and promotes positive safety behaviours is only the first step to human performance integration within your safety culture.

The second step is for leadership and management to consistently demonstrate their commitment to safety, aligning their own behaviour with stated values and priorities and providing overt support for people who demonstrate positive safety behaviours and performance. Senior leadership must show a clear commitment to enhancing human performance for all personnel, contractors, and stakeholders involved in operations. It is critical that employees know they can provide feedback to management without fear of retribution. A 'just-culture' foundation

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[4] ICAO Annex 19 - Management Commitment is the first element within the Safety Policy and Objectives pillar.

[5] ICAO Doc 9859, Safety Management Manual

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is essential to identify trends, learn from past events, inform policies and objectives, and clearly define acceptable and unacceptable performance within the operations.

Setting safety objectives should be a dynamic exercise. Safety objectives must be shaped not just by feedback and your organisational goals but also considering the 5 HP principles and the promotion of a positive, people-focused, safety culture.

6. Safety Risk Management

6.1. General Considerations

When identifying hazards, assessing safety risk, and implementing risk controls, it is important to consider the hazards that interact with human performance and how well human-centred risk controls work. For example, a well-trained pilot would be considered part of the effective risk controls for mitigation of runway excursion but is likely to be less effective where the pilot is impaired to any degree.

Critical to understanding human performance in risk management is the collection and analysis of safety data. This can be collected from various sources, including mandatory and voluntary safety reports or investigations. Analysis should focus on both what went wrong and what went right, including why actions made sense to the respective individuals at the time. Analysing safety data represents an important opportunity to examine the interactions between the human and other system components. Some key human performance considerations for safety reporting and data analysis include:

- Is there a positive safety culture including a clear non-punitive safety reporting policy endorsed and demonstrated by senior management?

- Is the reporting process simple and user-friendly?

- Do people understand what to report and how?

6.2. Hazard Identification

Considering human performance is critical to effective hazard identification. This requires moving beyond simply labelling incidents as 'human error' and instead conducting deeper analysis of contributing factors. Some questions to ask in relation to hazard management and human performance include:

- Are the human performance issues involved with hazards clearly understood by your safety and management teams?

- Are workplace or organisational factors that increase the error potential for hazards, such as high workload, distractions or inadequate equipment availability or design, considered?

- Is there a standard process to investigate and analyse human performance issues?

As part of the risk assessment processes it is important to understand that not all controls will be effective to manage all human performance considerations. When developing controls to manage human performance risks, it is important to understand the underlying factors that negatively impact human performance and ways to improve human performance.

Some examples of risk controls associated with human performance include[6]:

- **Fatigue Management:** Fatigue can significantly impair performance. Effective management includes policies to ensure fatigue contributing factors are recognised and included in the design of work practices and rosters, regulated work hours, rest periods, education, monitoring for signs of fatigue, and responsibilities for fatigue risk management.

- **Training:** Continuous training keeps personnel up to date with the latest procedures and technologies and helps maintain their competence in performing their duties.

- **Communication:** Clear and effective communication is essential to avoid misunderstandings that could lead to human performance errors. This includes both verbal and non-verbal communication.

- **Stress and Workload Management:** High-stress levels, including time pressure, can negatively impact decision-making and human performance.

- **Human-Centred Design:** Designing equipment and systems that are intuitive and user-friendly can improve human performance.

- **Teamwork and Collaboration:** Effective teamwork and collaboration among all aviation personnel are essential for safe and efficient operations. Peer pressure and self-esteem may cause both positive and negative impacts on their safety behaviours.

- **Practicing a Just Culture:** The protection to report safety-related concerns, hazards and events, non-punitive error reporting, trust and mutual respect, encouragement of participation, and reduction of authority gradients are essential elements to support human role in positive safety culture and psychological safety.

- **Task, Job, and Procedure Design:** Identifying tasks or jobs that are more prone to human performance limitations and variability. Then, designing procedures that are standardized, for easy comprehension and practical applications and address the areas of identified human performance risks. Ensuring critical job roles have backup to avoid over-reliance on specific individuals (redundancy). Then, reinforcing the importance of the stringent use of procedures and checklists to reduce reliance on memory processes.

6.3. Structured Approach to Risk Managing Human Performance

Identifying hazards and assessing the risks related to human performance in aviation systems is challenging because the system is complex. Human performance is influenced by context and is highly adaptable. This adaptability is critical for the safe functioning of the aviation system. There are a wide range of internal and external influences on people that interact in different ways. This makes it challenging to predict how these influences will impact human performance. The performance of people and the systems they operate in will depend on the many conditions

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[6] https://www.icao.int/safety/OPS/OPS-Normal/Pages/HP.aspx

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involved including the task being performed, the tools and equipment being used, the environment, and the context.

Knowledge of Human Factors can help you to identify hazards and assess safety risks in this challenging environment. A systematic approach that combines qualitative and quantitative methods is the most effective, that goes beyond just identifying what happened and asking why it happened. That is identifying and understanding the contributing factors and what organisational and work-related conditions are more likely to negatively impact human performance.

Methods and frameworks to guide effective safety risk management and safety assurance are included in Appendix 2.

7. Safety Assurance

7.1. Safety Performance Monitoring and Measurement

The adaptability and variability of human performance in aviation usually makes evaluating the associated risks more challenging than assessing risks from technology and the environment.

Safety data systems are designed to track outcomes, for example: technical failures, runway incidents, and unstable approaches. To understand how human performance is influenced and impacted by the circumstances and conditions involved in these occurrences and why these outcomes happened, we need to collect, analyse, and monitor human performance data along with its context.

Safety performance indicators can help you monitor and measure how well your SMS is achieving positive human performance contributions and outcomes. For example:

Occurrences: Monitoring the patterns in safety occurrences that involve a Human Factors element (positive or negative) helps assess and manage the associated risk. Tracking trends and patterns using taxonomies that respect the 5 HP principles (but are not limited to them).

Normal Operations: Monitoring normal operations for best practices and procedural drift can provide safety performance information. In some cases, procedures may need to be modified, training enhanced, or design improved.

Training: Human Factors training (initial and recurrent) is critical. Examples include Human Factors, Crew Resource Management, and Threat and Error Management training. Monitoring the number of eligible personnel who have completed the training should provide a leading measure of the effectiveness of your Human Factors training policy.

7.2. Continuous Improvement – Data-Driven Decision Making

Analysing safety performance indicators and using a feedback loop to make data-driven decisions will drive continuous improvement. Systematically collecting and analysing safety data related to human performance allows organisations to identify trends, assess gaps, and take proactive steps to address emerging risks.

Some examples of data to evaluate the effectiveness of risk controls associated with human performance include:

- **Fatigue Management:** Fatigue-related occurrence reports, self-reporting fitness for duty issues due to fatigue, flight duty time exceedances

- **Training:** Performance observations from operational training

- **Communication:** Safety report descriptions of breakdowns in communication and alternatively when communication prevented a situation from worsening or recovered a situation

- **User-Centred Design:** Design feedback or hazard report detailing an aspect of human performance associated with a new or changed design

- **Teamwork and Collaboration:** Situations of interpersonal conflict or breakdowns in teams or alternatively data regarding crew resource management and threat and error management

7.3. Change Management

Change is an inevitable part of progress. The global aviation system is introducing change on an almost continual basis, and individual organisations follow suit to adapt. These changes offer potential for improvement but also come with safety risks that must be managed. The most common change drivers include:

- Technological Evolution

- Process Reviews

- Crisis

- Consumer Habit Changes

- Organisational Restructuring

Change management is a collective term for all approaches to prepare, support, and help individuals, teams, and organisations to make organisational or operational change. There are various change management models available to organisations. Some examples include the Awareness, Desire, Knowledge, Ability and Reinforcement (ADKAR) Model, Kotter's 8 Step, or the McKinsey 7-S frameworks which are all designed to assist with and formalise the adoption of change.

Change management should always consider human performance. While many change management models exist, they all include stakeholder identification and management. Prior to implementing a change, a change management process should be used to ensure the desired outcomes are achieved without compromising safety performance.

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Here is a 7-step change management process[7]:

1. Define the Change

2. Identify Key Stakeholders

3. Align Change with Relevant Plans

4. Assess the Change

5. Develop and Implement an Action Plan

6. Continuous Monitoring

7. Review the Change

Integrating the 5 Human Performance (HP) principles into your change management process enhances both the effectiveness of implementation and the focus on safety. Change management inherently involves multiple human performance considerations, including cultural dynamics, leadership styles, resistance to change, levels of commitment, and communication strategies.

It is important to assess human performance risks and opportunities not only resulting from the change itself but also emerging during its planning and implementation. Key questions to consider include:

- Does the change alter how tasks are performed or how people interact within the organisation?

- Does it require new knowledge, skills, or the processing of unfamiliar information?

- Does it introduce new technology or automation?

- Is the change occurring alongside other changes?

If the answer to any of these is yes, additional human performance risks must be addressed as part of the change risk assessment. A proactive approach to these considerations supports safer, more resilient, and more successful change outcomes.

8. Safety Promotion

In a safety management system (SMS), the **promotion component** refers to the activities, strategies, and processes through which a positive safety culture is encouraged, recognized, and advanced within an organisation. Human performance plays a significant role in this component, as it directly influences how safety behaviours, attitudes, and practices are fostered and sustained across the workforce. The effects of human performance in the promotion component of an SMS can be understood through several key areas.

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[7] SM ICG, Change Management at the State Level (2022)

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8.1. Culture

Human performance influences safety culture. When personnel at all levels are motivated, engaged, and understand the importance of safety, they are more likely to adopt and promote safe behaviours. Positive human performance is influenced by the following:

- **Leadership Commitment**: Managers and supervisors who prioritize safety through clear communication, visible support for safety initiatives, and a commitment to continuous improvement can drive a culture of safety. Employees who see safety promoted through leadership will be more likely to embrace and promote safety practices themselves.

- **Peer Influence**: Workers are often influenced by the behaviour of their peers. If safety-conscious employees are recognized and promoted, they set an example for others.

- **Presence of Just Culture**[8]: Fostering an environment where employees can openly share safety concerns or near-miss reports without fear of reprisal is critical to establishing a fully engaged safety culture. Reporting positive actions and contributions can contribute to the overall learning within an organization.

8.2. Training and Skill Development

Training is a key element in the promotion of the organisation's SMS. Human performance directly impacts how individuals understand and apply safety protocols, risk management techniques, and emergency procedures.

Not only do people need to be trained and competent to perform their roles but they should also be trained to understand human performance aspects of safety. Human performance training is a key element of SMS integration. Knowledge and awareness of the 5 HP principles help shape, improve, and optimize human performance within the aviation system.

- **Competency and Confidence**: Effective training programs that cater to human learning styles and provide realistic, scenario-based simulations improve knowledge and practical competence. This helps employees to react appropriately in safety-critical situations.

- **Adaptability and Continuous Improvement**: Human performance can vary due to conditions such as fatigue, stress, or distractions and it adapts to the procedures, processes, and systems in our organisations. One crucial aspect that safety promotion addresses is ongoing skill development and knowledge retention. This could involve refresher training, scenario-based drills, or feedback mechanisms to ensure knowledge retention and skill improvement derived from learning from the SMS outputs.

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[8] "Roadmap to a Just Culture: Enhancing the Safety Environment," GAIN Working Group E, (2004): https://flightsafety.org/files/just_culture.pdf

"A Roadmap to a Just Culture: Enhancing the Safety Environment," *Flight Safety Digest* (2005): 1-34, https://skybrary.aero/sites/default/files/bookshelf/6121.pdf

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8.3. Feedback Mechanisms and Recognition

Feedback systems are often used to encourage positive behaviours and correct unsafe practices. How you evaluate and respond to human performance can shape future behaviour.

- **Positive Reinforcement**: Recognizing and rewarding safe practices or improvements in safety behaviours enhances motivation and promotes further positive human performance. Incentives, acknowledgment, or career advancement tied to safety achievements reinforce the importance of safe practices.

- **Constructive Feedback**: When human performance does not align with safety expectations, feedback that is corrective, but supportive helps employees understand what went wrong and how to improve. This promotes a learning environment rather than one of blame, leading to continuous improvement in performance.

8.4. Employee Engagement and Ownership of Safety

Human performance in the promotion of safety also involves engaging employees in the SMS process. Workers who feel ownership over safety are more likely to contribute positively to safety outcomes.

- **Empowerment and Involvement**: When employees are encouraged to participate in safety audits, safety meetings, or hazard identification processes, they take an active role in promoting safety. Human performance can be enhanced when individuals feel empowered to take responsibility for their own safety and the safety of others.

- **Communication**: Effective communication channels are essential for promoting safety. Human performance affects how well information about hazards, safety procedures, and lessons learned is communicated across the organisation.

Human performance has a profound effect on the promotion component of an aviation SMS. It influences the development of a safety culture, the effectiveness of training programs, the success of feedback systems, and the engagement of employees in safety activities. By focusing on the Human Factors conditions that drive safe behaviour and ensuring that human performance is actively considered and managed, an aviation organisation can significantly enhance its overall safety outcomes.

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Appendix 1: Human Performance in SMS – Examples

This section includes several examples to illustrate how human performance principles can be applied in different scenarios. The diversity of the examples is intentional, highlighting that the core concepts and principles are more important than the specific way they are applied. Considering human performance effectively means thinking critically about how individuals and teams carry out their work, asking yourself what principles may be at play in different scenarios, and using that awareness to adapt your approach.

Example 1: Safety Policy and Objectives

Here is an example of how to consider the 5 HP principles in relation to SMS Component 1 – Safety Policy and Objectives.

Policy and Objectives Element	HP Principle	To Consider in Practice
1.1 Management commitment	**Principle 1**: People's performance is shaped by their capabilities and limitations	• Does senior management recognize people's skills, attitudes and knowledge and are these clearly articulated in policy? • Does senior management act in practice according to their commitment? • Is there assurance that personnel are adequately trained to do their work? • Does the policy affirm that procedures are in place to provide adequate supervision where staff capability is under development?
	Principle 3: People adapt to meet the demands of a complex and dynamic work environment	• Does management recognise the value of adaptability in achieving goals and its importance in getting work done? • Have adaptations been identified and managed through appropriate processes?
1.2 Safety accountability and responsibilities	**Principle 5**: People's performance is influenced by working with other people, technology,	• Has management clearly documented and communicated the organisational structure, reporting lines, and safety responsibility/accountability? • Does the safety policy clearly identify the importance of reporting and is endorsed by senior management?

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Policy and Objectives Element	HP Principle	To Consider in Practice
	and the environment	• Has the system description been written with reference to the 5 HP principles? • Are people provided with the environment, equipment, and procedures to perform their tasks safely and efficiently?
1.3 Appointment of key safety personnel	**Principle 3:** People adapt to meet the demands of a complex and dynamic work environment	• Do senior managers understand and promote an appreciation that risky adaptations may occur when key personnel are either not in place (understaffing), or ineffective? • Do senior managers accept that where key personnel are not appointed, negative adaptations may result?
1.4 Coordination of emergency response planning	**Principle 2:** People interpret situations differently and perform in ways that make sense to them	• Are emergency procedures well considered, trained, and communicated so that personnel do not need to improvise or adopt sub-optimal solutions that meet their own needs?
1.5 SMS documentation	**Principle 1:** People's performance is shaped by their capabilities and limitations	• Is it recognized by the organisation that documentation is both an enabler and limiter, and that it can enhance human performance or cause detriment to it. • Does the organisation foster an informed culture reinforced through robust documentation?
	Principle 4: People assess risks and make trade-offs	• Are all safety-critical processes documented? **Note:** The absence of good documentation presents a risk to SMS functioning. SMS documentation must be of a high standard in order to prevent personnel developing their own trade-offs within the SMS. This is particularly relevant in core and safety critical tasks such as risk management.

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Example 2: SMS Interfaces

Here are examples of how to consider the 5 HP principles in the interfaces within an SMS. Safety Management Systems do not operate in isolation, and the criticality of Interface Management is recognised as a key component in SMS. **Every** interface will involve **people** and human performance/Human Factors principles should always be considered as part of the interface system description and management.

Interfaces	HP Principle	To Consider in Practice
Internal and external interfaces	**Principle 1:** People's performance is shaped by their capabilities and limitations	• Have you considered the level of training and experience of people in the interfacing organisation? • Have you considered the workload and pressure of the interfacing organisation in your risk management?
	Principle 2: People interpret situations differently and perform in ways that make sense to them	• Is the interfacing organisation doing things differently? **Note:** Just because the interfacing organisation does things differently does not make it wrong. The safety cultural principles of flexibility and learning will support continuous improvement.
	Principle 3: People adapt to meet the demands of a complex and dynamic work environment	• If the interfacing organisation implements a change, how will it impact on your own organisation?
	Principle 4: People assess risks and make trade-offs	• Have you compared the acceptability of risk of the interfacing organisation? How will you manage these differences?
	Principle 5: People's performance is influenced by working with other people, technology, and the environment	• Have you considered how the interfacing organisation differs from your own? How will you manage expectations? **Note:** Examples of differences include levels of resource; employment of

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Interfaces	HP Principle	To Consider in Practice
		technology; operating environment; culture (safety, organisational, etc.).
3rd Party Service Provider Interfaces 1. Identify all external service providers 2. Define the boundaries of each interface arrangement 3. Identify how each interface is reviewed 4. Identify the scope of data or service provided across the interface 5. Include procedures for identifying potential hazards and applying mitigations across the interface arrangement	**Principle 1:** People's performance is shaped by their capabilities and limitations	• Are qualifications, training and experience levels of personnel in external service providers the same or better than your own staff?
	Principle 2: People interpret situations differently and perform in ways that make sense to them	• Are roles and responsibilities clearly defined and communicated to personnel in both organisations? • What differences training should be provided to staff for alignment?
	Principle 3: People adapt to meet the demands of a complex and dynamic work environment	• What types of data or service analytics will be essential for personnel in both organisations to adapt to changes and challenges? How can these be shared and utilized by both organisations? • What training or support mechanisms will be implemented to ensure that staff of both organisations are equipped to interpret and act on the provided data?
	Principle 4: People assess risks and make trade-offs	• What collaboration and feedback mechanisms are available to facilitate mutual understanding and alignment when managing risk appetites of personnel in both organisations?
	Principle 5: People's performance is influenced by working with other people, technology, and the environment	• How can both parties communicate effectively to facilitate needed flexibility to account for routine differences and changes in each organization?

Example 3: Safety Assurance and Safety Risk Management Following an Event

Here is an example of how to consider the 5 HP principles in Safety Risk Management Component 2 and Safety Assurance Component 3, initiated from an event. Consider an event where a ground handling operation damages an aircraft.

Safety Assurance and Safety Risk Management - Initiated from an Event	HP Principles	To Consider in Practice
1. Safety report filed by operational personnel	**Principle 1:** People's performance is shaped by their capabilities and limitations **Principle 2:** People interpret situations differently and perform in ways that make sense to them **Principle 3:** People adapt to meet the demands of a complex and dynamic work environment **Principle 4:** People assess risks and make trade-offs **Principle 5:** People's performance is influenced by working with other people, technology, and the environment	• Are operational personnel trained in the 5 HP principles? • Do employees feel safe reporting hazard and safety information? • Does the safety report format include a prompt to encourage individuals to include human performance considerations in their reports? • Does the safety report format include a prompt to encourage individuals to include details of the conditions at the time of the event?
2. Safety report received by organisation	**Principle 1:** People's performance is shaped by their capabilities and limitations **Principle 2:** People interpret situations differently and perform in ways that make sense to them **Principle 3:** People adapt to meet the demands of a complex and dynamic work environment **Principle 4**: People assess risks and make trade-offs	• Does the organisation handle the safety reports according to just culture? • Does management approach the event from a learning lens? • Is the context and the human performance included in the safety report?

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Safety Assurance and Safety Risk Management - Initiated from an Event	HP Principles	To Consider in Practice
	Principle 5: People's performance is influenced by working with other people, technology, and the environment	
3. Safety investigation into event	**Principle 1:** People's performance is shaped by their capabilities and limitations **Principle 2:** People interpret situations differently and perform in ways that make sense to them **Principle 3:** People adapt to meet the demands of a complex and dynamic work environment **Principle 4:** People assess risks and make trade-offs **Principle 5:** People's performance is influenced by working with other people, technology, and the environment	• Are safety investigators trained in relevant human performance concepts including Human Factors, to be able to establish which human performance principles might have contributed to an event? • Does the safety investigation consider the 5 HP principles? • Does the investigation describe the actions, decisions, conditions, and circumstances present at the time of the event? **Note:** Frequently safety investigations describe what people should have done or did not do (e.g. the operator did not follow the procedure) rather than describe what people did (e.g. the operator drove the vehicle inside the protected area). To consider human performance you must begin by describing what people did or decided. To make progress, we must understand the human performance. • Does the safety investigation answer "did

Safety Assurance and Safety Risk Management - Initiated from an Event	HP Principles	To Consider in Practice
		the actions and assessments make sense at the time, given the conditions and circumstances present?" **Note:** The 5 HP principles can used as questions to elaborate the analysis of the event.
4. Conclude the safety investigation with the identification of hazards that are present for future operations.	**Principle 1:** People's performance is shaped by their capabilities and limitations **Principle 5:** People's performance is influenced by working with other people, technology, and the environment	• Are the conclusions of the safety investigation described as hazards for further analysis? • Do the hazard statements apply the 5 HP principles? • Does the investigation identify causes and contributing factors at the individual, task, and organisational levels, considering the system?
5. Assess the risks associated with the identified hazards	**Principle 1:** People's performance is shaped by their capabilities and limitations **Principle 4:** People assess risks and make trade-offs **Principle 5:** People's performance is influenced by working with other people, technology, and the environment	• What risks may result from human performance interactions with the system? • What level of risk is estimated? **Note:** Human performance is adaptable and variable, and the aviation system is complex; qualitative assessment is often helpful with descriptions of the context.

Safety Assurance and Safety Risk Management - Initiated from an Event	HP Principles	To Consider in Practice
6. Identify risk controls	**Principle 5:** People's performance is influenced by working with other people, technology, and the environment	• What changes can you implement to optimize human performance? • What influences do other people, technology and equipment, the environment, the procedures, training and task design have on human performance? • Have you applied Human Factors knowledge to the development of your risk controls?
7. Prioritize risk controls for implementation	**Principle 4:** People assess risks and make trade-offs	• What trade-offs being made in the selection of risk controls? • Have you initiated a change management process?
8. Develop safety action plan with safety performance indicators	**Principle 1:** People's performance is shaped by their capabilities and limitations **Principle 5:** People's performance is influenced by working with other people, technology, and the environment	• Are your safety performance indicators and targets (positive and negative) linked to human performance metrics and measures? • Have you considered observations of human performance in normal operations as an indicator?
9. Implement safety action plan and measure and monitor safety performance indicators	**Principle 3:** People adapt to meet the demands of a complex and dynamic work environment **Principle 4:** People assess risks and make trade-offs	• How are people adopting the changes (risk controls)? • Are people adapting in positive or negative ways to the changes (risk controls)? • Are you seeing any trade-offs between efficiency and thoroughness during

Safety Assurance and Safety Risk Management - Initiated from an Event	HP Principles	To Consider in Practice
		implementation and maintaining the changes?
10. Evaluate and measure safety performance and effectiveness of risk controls and continuously improve	**Principle 3:** People adapt to meet the demands of a complex and dynamic work environment **Principle 5:** People's performance is influenced by working with other people, technology, and the environment	• After some time, are there any changes to how people are adopting the changes (risk controls)? • After some time, do you see people adapting in positive or negative ways to the changes (risk controls)? • After some time, are you seeing any trade-offs between efficiency and thoroughness during implementation and maintaining the changes?

Example 4: Safety Performance Indicators

Here is an example of how to consider the 5 HP principles in developing safety performance indicators (SPIs).

Safety Assurance	HP Principle	To Consider in Practice
• Safety audits and inspections • Interpretation of data • Safety investigations	**Principle 1:** People's performance is shaped by their capabilities and limitations	• Do individuals have the competencies to critically assess systems and identify shortcomings? • Are differences in expertise and perspectives leading to inconsistent gap identification? • Are safety performance indicators impacted by subjectivity or bias? How? • Are quantitative measures fixed and 'factual', or do they represent qualitative data?
	Principle 2: People interpret situations differently and perform in ways that make sense to them	• Are individuals influenced by previous experiences or assumptions? • Have relevant metrics been identified? • Have you provided your people with adequate guidance about how you want them doing audits and inspections? • Are interpretations being impacted by biases?
	Principle 3: People adapt to meet the demands of a complex and dynamic work environment	• Are there sufficient people and resources to deliver on safety objectives? • Does the workload allow individuals to effectively accomplish their objectives or is the lack of resources generating sub optimal adaptation?
	Principle 4: People assess risks and make trade-offs	• Are safety performance indicators being selected due

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Safety Assurance	HP Principle	To Consider in Practice
		to availability of data, or the presence of actual risks? • Are the safety performance indicators being effectively assessed for relevance? • Are appropriate safety performance targets being selected to ensure an acceptable level of safety? • Are there goal-conflicts influencing the audit focus and direction (pathway)?
	Principle 5: People's performance is influenced by working with other people, technology, and the environment	• Are cross-functional teams engaging effectively or working in isolation? • Is the way you are collecting, measuring and monitoring data compromising its reliability? e.g. technology, manual input and handling, knowledge and experience of data analysts.

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Example 5: Change Management

Here is an example of how to consider the 5 HP principles in change management. Consider the situations of changing an aircraft type in your organisation or establishing a new base.

Change Management Process	HP Principle	To Consider in Practice
1. Define the Change 2. Identify Key Stakeholders 3. Align Change with Relevant Plans at the State level 4. Assess the Change 5. Develop and Implement an Action Plan 6. Continuous Monitoring 7. Review the Change	**Principle 1:** People's performance is shaped by their capabilities and limitations	• Have the sources and effects of fear, frustration, depression, denial, and increased stress[9] been identified? • Does the change have an impact on fatigue and workload? • Does the change imply processing of new information, require new knowledge, or new skill sets?
	Principle 2: People interpret situations differently and perform in ways that make sense to them	• Has 'Readiness' vs 'Resistance' been identified as part of stakeholder management? • Have all individuals and stakeholders been given an opportunity to provide input to change management?
	Principle 3: People adapt to meet the demands of a complex and dynamic work environment	• Has the working environment changed? • Are there sufficient people and resources to deliver change safely? • Have business risks been inadvertently transferred to an individual through commercial pressures? • Does the change take place in parallel with other changes?
	Principle 4: People assess risks and make trade-offs	• Does the change have an impact on elements/practices not immediately associated with the change?

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[9] The Kubler-Ross Change Curve

Change Management Process	HP Principle	To Consider in Practice
		• Has the reason for change been successfully promoted?
	Principle 5: People's performance is influenced by working with other people, technology, and the environment	• Do the stakeholders understand the change? • How do you know they understand it? • Are there any additional training requirements? • How could your organisational culture impact or influence the proposed change? • Does the change alter tasks performed by personnel or how they interact with others within the organisation? • Does the change involve new technology or automation?

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Appendix 2: Methods and Frameworks that Can Consider Human Performance in SMS

SMS Component, Element, Process	Methods and Frameworks
1. Sources of data	• **Occurrence data**: Mandatory, voluntary, etc. • **Inspection and audit data**: Observations, findings, etc. • **Surveys and Interviews**: Qualitative data from staff at all levels about perceived risks, performance issues, safety culture, safety climate • **Observational studies**: Observable performance from operational settings e.g. SIM checks, line checks, Line-operational Safety Audits, approved check pilot monitoring rides, qualifying events in an Advanced Qualification Program • **Training Records**: Data from competency-based training and assessment (CBTA), evidence-based (EBT) training, or any other training methodology used.
2. Risk assessment and analysis Note: Some of these methods were designed specifically with human performance in mind while some can be used with Human Factors frameworks applied.	• **SWOT Analysis**: A strategic technique used to assess what an organization is facing; it identifies strengths, weaknesses, opportunities and threats. • **FMEA** (Failure Mode and Effects Analysis): A systematic, step-by-step approach to identify and prioritize possible failures in a design, manufacturing or assembly process, product, or service. It is a common risk analysis tool. The goal of this proactive tool is to mitigate or eliminate potential failures. • **HAZOPS** (Hazard and Operability Studies): Identify hazards in operational procedures associated • **System Description and Task Analysis:** Explain the interactions among the hardware, software, people and environment that make up the system in sufficient detail to identify hazards and perform risk analysis. Job task analysis identifies, analyses, and documents human tasks within a system with the goal of identifying hazards and risk factors requiring mitigation • **STPA** (System-Theoretic Process Analysis)[10]**:** A hazard analysis techniques based on an extended model of accident causation. STPA assumes that accidents can also be cause by unsafe interactions of system components, none of which may have failed.

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[10] Leveson, N. and Thomas, J. (2018) *STPA Handbook.* Last accessed 08-04-2025, STPA Handbook (MIT-STAMP-001).

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SMS Component, Element, Process	Methods and Frameworks
3. Apply Human Factors Frameworks, Models and Analysis Methods	• **SHEL**[11] (Software, Hardware, Environment, Liveware): Evaluate the system components and their interactions for influences on human performance in the system and optimize performance of the system through effective mitigations. • **TEM**[12] (Threat and Error Management Model): Evaluate events and normal operations to manage threats, errors, and undesired states, proactively or reactively. • **Swiss Cheese Model**[13]: Identify the possibility for active and latent failures within system components and their interfaces with other system components and apply defences-in-depth to increase the resilience of the system. • **4PS** (Philosophy, Policy, Procedure, Practice)[14]: The 4PS framework supports and guides the design and development of written forms of work-as-imagined in ways that support work-as-done in practice. • **Learning Review**[15]: The learning review explores the human contribution to accidents, safety, and normal work by facilitating the understanding of the factors and conditions that influence human actions and decision through sensemaking. • **STAMP** (Systems-Theoretic Accident Model and Processes)[16]: The STAMP model and processes use system theory to analyse accidents, particularly system accidents. • **CAST (Causal Analysis based on Systems Theory)[17]:** The CAST model and analysis method includes all causes, reduces hindsight bias, takes a system's view of human performance, provides a blame-free explanation of why the loss occurred, uses a comprehensive accident causality model that emphasizes why the controls that were created to prevent the particular type of loss

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[11]   ICAO Doc 9683, Human Factors Training Manual, pp. 1-1-3 to 1-1-5.

[12]   ICAO Doc 9803, Line-operations Safety Audit Manual, pp. 2-1 to 2-5.

[13]   Reason. J. (2016) Organisational Accidents Revisited. CRC Press.

[14]   Barshi, I, Degani, A., Mauro, R., Loukopoulou, L. (2017). Guiding the Practice: The 4PS. HindSight, Vol 25. pp. 50-53. Last assessed 08-04-2025 HS25: Guiding the practice: The 4Ps | SKYbrary Aviation Safety

[15] Pupulidy I. and Vesel, C. (2017). The Learning Review: Adding to the accident investigation toolbox. Proceedings of the 53rd ESReDA Seminar, Ispra, Italy, 14-15. Last accessed 09-04-2025, https://www.safetydifferently.com/wp-content/uploads/2018/08/171024TheLearningReview.pdf

[16] Leveson, N. (2019). A New Accident Model for Engineering Safety Systems. Aeronautics and Astronautics Department, Massachusetts Institute of Technology last accessed 08-04-2025 safetyscience-single.pdf

[17] Leveson, N. (2019). Causal Analysis based on System Theory Handbook. MIT Last accessed 09-04-2025 http://sunnyday.mit.edu/CAST-Handbook.pdf

SMS Component, Element, Process	Methods and Frameworks
	were not effective in the case at hand and how to strengthen the safety control structure to prevent similar losses in the future. • **FRAM (Functional Resonance Analysis Method)[18]: M**odels the functions that are needed for everyday performance to succeed. This model of everyday performance can then be used to explain specific events, by showing how functions can be coupled and hose the variability of everyday performance sometimes may lead to unexpected and out-of-scale outcomes – either good or bad. • **HFACS**[19] (Human Factors Analysis and Classification System): A structured approach to categorize human error. • **SHERPA** (Systematic Human Error Reduction and Prevention Approach): Evaluate tasks to identify potential human errors. • **Safe Operating Envelope**[20]: Identify work processes, competing pressures, and detect practical drift through safety performance measurement.
4. Modelling and Simulation	• **Human in the loop simulations**: simulate scenarios to observe human performance under various conditions and stressors. E.g. Simulator checks, CBTA, EBT, etc. • **Cognitive task analysis**: identify cognitive processes involved in critical tasks.
5. Risk Mitigation Strategies	• **Training Program Enhancement**: Develop targeted training assessing identified HP issues • **Workload Management**: Establish and implement strategies to balance workload effectively among crew members. • **CRM and TEM**: Foster teamwork and communication to improve HP. • **Human-Centred Design (HCD)**: Research and design policies, procedures and processes, organisational system design around HP • **Fatigue risk management system**:
6. On-going Monitoring and Reporting	• **Develop SPIs**: Monitor HP over time. • **Hazards and Incident Reporting Systems**: Encourage reporting of safety concerns and near-misses related to HP.

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[18] The Functional Resonance Accident Model | SKYbrary Aviation Safety

[19] Human Factors Analysis and Classification System (HFACS) | SKYbrary Aviation Safety

[20] Woods, D., Schenk, J., and Allen, T. (2009). An Initial Comparison of Selected Models of System Resilience in: C.P. Nemeth, E. Hollnagel and S. Dekker (eds.), Resilience Engineering Perspectives, Volume 2: Preparation and Restoration. CRC Press. p. 78.

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SMS Component, Element, Process	Methods and Frameworks
	• **Flight Data and other Normal Operations Monitoring**: Monitor normal operations to identify trends in human performance. • **Line-Operations Safety Audit (LOSA)**: A structured programme of observation of front line activities built around the Threat and Error Management (TEM) concept. • **Training records**: Monitor training performance and competency.
7. Feedback and continuous improvement loop	• **Continuous improvement**: Regularly assess and refine risk assessment processes based on new data and insights • **Safety Culture**: Promote a culture where safety is prioritized, and employees feel empowered to voice concerns about HP issues.

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