



WORKING PAPER

**DANGEROUS GOODS PANEL (DGP)
MEETING OF THE WORKING GROUP OF THE WHOLE**

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Agenda Item 5: Resolution, where possible, of the non-recurrent work items identified by the Air Navigation Commission or the panel
5.5: Safety management systems

SAFETY MANAGEMENT SYSTEMS

(Presented by the Secretary)

SUMMARY

This working paper provides material to further discussion on the need to establish a safety management system (SMS) for the transport of dangerous goods. It also clarifies the distinction between ICAO's definitions for safety programmes and safety management systems.

Action by the DGP-WG is in paragraph 2.

1. INTRODUCTION

1.1 At DGP-WG/06, the need to establish a safety management system (SMS) for the transport of dangerous goods by air was discussed (DGP-WG/06-WP/56, paragraph 7.7 refers).

1.2 To assist further discussion, the following is provided:

- a) Appendix A — Extract from the ICAO *Safety Management Manual (SMM)* (Doc 9859) (the complete manual is available at www.icao.int/icaonet/dcs/9859/9859.html); and
- b) Appendix B — Safety Management Systems for Commercial Air Transport Operations.

1.3 It should be noted that ICAO differentiates between safety programmes and safety management systems as follows:

- a) a *safety programme* is an integrated set of regulations and activities aimed at improving safety; and
- b) a *safety management system (SMS)* is an organized approach to managing safety, including the necessary organizational structures, accountabilities, policies and procedures.

While the concept of safety programmes and SMS is restricted to Annexes 6, 11 and 14 at present, it is possible that the concept will be expanded to include additional operational Annexes in the future.

2. ACTION BY THE DGP-WG

2.1 The DGP-WG is invited to further consider the desirability of including requirements for a SMS for the transport of dangerous goods by air.

APPENDIX A

EXTRACT FROM THE ICAO *SAFETY MANAGEMENT
MANUAL (SMM) (DOC 9859)*

Chapter 1

OVERVIEW

1.1 GENERAL

Aviation is remarkable for the giant technological leaps it has made over the last century. This progress would not have been possible without parallel achievements in the control and reduction of aviation's safety hazards. Given the many ways that aviation can result in injury or harm, those involved with aviation have been preoccupied with preventing accidents since the earliest days of flying. Through the disciplined application of best safety management practices, the frequency and severity of aviation occurrences have declined significantly.

1.2 CONCEPT OF SAFETY

1.2.1 In order to understand safety management, it is necessary to consider what is meant by "safety". Depending on one's perspective, the concept of aviation safety may have different connotations, such as:

- a) zero accidents (or serious incidents), a view widely held by the travelling public;
- b) the freedom from danger or risks, i.e. those factors which cause or are likely to cause harm;
- c) the attitude towards unsafe acts and conditions by employees (reflecting a "safe" corporate culture);
- d) the degree to which the inherent risks in aviation are "acceptable";
- e) the process of hazard identification and risk management; and
- f) the control of accidental loss (of persons and property, and damage to the environment).

1.2.2 While the elimination of accidents (and serious incidents) would be desirable, a one hundred per cent safety rate is an unachievable goal. Failures and errors will occur, in spite of the best efforts to avoid them. No human activity or human-made system can be guaranteed to be absolutely safe, i.e. free from risk. Safety is a relative notion whereby inherent risks are acceptable in a "safe" system.

1.2.3 Safety is increasingly viewed as the management of risk. Thus, for the purposes of this manual, safety is considered to have the following meaning:

Safety is the state in which the risk of harm to persons or of property damage is reduced to, and maintained at or below, an acceptable level through a continuing process of hazard identification and risk management.

1.3 NEED FOR SAFETY MANAGEMENT

1.3.1 Although major air disasters are rare events, less catastrophic accidents and a whole range of incidents occur more frequently. These lesser safety events may be harbingers of underlying safety problems. Ignoring these underlying safety hazards could pave the way for an increase in the number of more serious accidents.

1.3.2 Accidents (and incidents) cost money. Although purchasing “insurance” can spread the costs of an accident over time, accidents make bad business sense. While insurance may cover specified risks, there are many uninsured costs. In addition, there are less tangible (but no less important) costs such as the loss of confidence of the travelling public. An understanding of the total costs of an accident is fundamental to understanding the economics of safety.

1.3.3 The air transportation industry’s future viability may well be predicated on its ability to sustain the public’s perceived safety while travelling. The management of safety is therefore a prerequisite for a sustainable aviation business.

1.4 ICAO REQUIREMENTS

1.4.1 Safety has always been the overriding consideration in all aviation activities. This is reflected in the aims and objectives of ICAO as stated in Article 44 of the *Convention on International Civil Aviation* (Doc 7300), commonly known as the Chicago Convention, which charges ICAO with ensuring the safe and orderly growth of international civil aviation throughout the world.

1.4.2 In establishing States’ requirements for the management of safety, ICAO differentiates between safety programmes and safety management systems (SMS) as follows:

- A **safety programme** is an integrated set of regulations and activities aimed at improving safety.
- A **safety management system (SMS)** is an organized approach to managing safety, including the necessary organizational structures, accountabilities, policies and procedures.

1.4.3 ICAO’s Standards and Recommended Practices (SARPs) (see the following Annexes to the Convention on International Civil Aviation: Annex 6 — *Operation of Aircraft, Part I — International Commercial Air Transport — Aeroplanes*, and Part III — *International Operations — Helicopters*; Annex 11 — *Air Traffic Services*; and Annex 14 — *Aerodromes*) require that States establish a **safety programme** to achieve an acceptable level of safety in aviation operations. The acceptable level of safety shall be established by the State(s) concerned. While the concept of safety programmes and SMS is restricted to Annexes 6, 11 and 14 at present, it is possible that the concept will be expanded to include additional operational Annexes in the future.

1.4.4 A safety programme will be broad in scope, including many safety activities aimed at fulfilling the programme’s objectives. A State’s safety programme embraces those regulations and directives for the conduct of safe operations from the perspective of aircraft operators and those providing air traffic services (ATS), aerodromes and aircraft maintenance. The safety programme may include provisions for such diverse activities as incident reporting, safety investigations, safety audits and safety promotion. To implement such safety activities in an integrated manner requires a coherent SMS.

1.4.5 Therefore, in accordance with the provisions of Annexes 6, 11 and 14, States shall require that individual operators, maintenance organizations, ATS providers and certified aerodrome operators implement SMS accepted by the State. As a minimum, such SMS shall:

- a) identify safety hazards;
- b) ensure that remedial actions necessary to mitigate the risks/hazards are implemented; and
- c) provide for continuous monitoring and regular assessment of the safety level achieved.

1.4.6 An organization's SMS accepted by the State shall also clearly define lines of safety accountability, including a direct accountability for safety on the part of senior management.

1.4.7 ICAO provides specialized guidance material, including this manual on safety management, for the fulfilment of the SARPs. This manual includes a conceptual framework for managing safety and establishing an SMS as well as some of the systemic processes and activities used to meet the objectives of a State's safety programme.

Acceptable level of safety

1.4.8 In any system, it is necessary to set and measure performance outcomes in order to determine whether the system is operating in accordance with expectations, and to identify where action may be required to enhance performance levels to meet these expectations.

1.4.9 The introduction of the concept of *acceptable level of safety* responds to the need to complement the prevailing approach to the management of safety based upon regulatory compliance, with a performance-based approach. Acceptable level of safety expresses the safety goals (or expectations) of an oversight authority, an operator or a service provider. From the perspective of the relationship between oversight authorities and operators/service providers, it provides an objective in terms of the safety performance operators/service providers should achieve while conducting their core business functions, as a minimum acceptable to the oversight authority. It is a reference against which the oversight authority can measure safety performance. In determining an acceptable level of safety, it is necessary to consider such factors as the level of risk that applies, the cost/benefits of improvements to the system, and public expectations on the safety of the aviation industry.

1.4.10 In practice, the concept of acceptable level of safety is expressed by two measures/metrics (safety performance indicators and safety performance targets) and implemented through various safety requirements. The following explains the use of these terms in this manual:

- **Safety performance indicators** are a measure of the safety performance of an aviation organization or a sector of the industry. Safety indicators should be easy to measure and be linked to the major components of a State's safety programme, or an operator's/service provider's SMS. Safety indicators will therefore differ between segments of the aviation industry, such as aircraft operators, aerodrome operators or ATS providers.
- **Safety performance targets** (sometimes referred to as goals or objectives) are determined by considering what safety performance levels are desirable and realistic for individual operators/service providers. Safety targets should be measurable, acceptable to stakeholders, and consistent with the State's safety programme.
- **Safety requirements** are needed to achieve the safety performance indicators and safety performance targets. They include the operational procedures, technology, systems and programmes to which measures of reliability, availability, performance and/or accuracy can be specified. An example of a safety requirement is *deployment of a radar system in the State's three busiest airports within the next 12 months, with a 98 per cent availability of critical equipment*.

1.4.11 A range of different safety performance indicators and targets will provide a better insight of the acceptable level of safety of an aviation organization or a sector of the industry than the use of a single indicator or target.

1.4.12 The relationship between acceptable level of safety, safety performance indicators, safety performance targets and safety requirements is as follows: *acceptable level of safety* is the overarching concept; *safety performance indicators* are the measures/metrics used to determine if the acceptable level of safety has been achieved; *safety performance targets* are the quantified objectives pertinent to the acceptable level of safety; and *safety requirements* are the tools or means required to achieve the safety targets. This manual focuses primarily on safety requirements, i.e. the means to achieve acceptable levels of safety.

1.4.13 Safety indicators and safety targets may be different (for example, the safety indicator is *0.5 fatal accidents per 100 000 hours for airline operators*, and the safety target is *a 40 per cent reduction in fatal accident rate for airline operations*), or they may be the same (for example, the safety indicator is *0.5 fatal accidents per 100 000 hours for airline operators*, and the safety target is *not more than 0.5 fatal accidents per 100 000 hours for airline operators*).

1.4.14 There will seldom be a national acceptable level of safety. More often, within each State there will be different acceptable levels of safety that will be agreed upon by the regulatory oversight authority and individual operators/service providers. Each agreed acceptable level of safety should be commensurate with the complexity of the individual operator's/service provider's operational context.

1.4.15 Establishing acceptable level(s) of safety for the safety programme does not replace legal, regulatory, or other established requirements, nor does it relieve States from their obligations regarding the *Convention on International Civil Aviation* (Doc 7300) and its related provisions. Likewise, establishing acceptable level(s) of safety for the SMS does not relieve operators/service providers from their obligations under relevant national regulations, and those arising from the *Convention on International Civil Aviation* (Doc 7300).

Examples of implementation

1.4.16 **State safety programme.** An oversight authority establishes an *acceptable level of safety* to be achieved by its safety programme that will be expressed by:

- a) 0.5 fatal accidents per 100 000 hours for airline operators (*safety indicator*) with a 40 per cent reduction in five years (*safety target*);
- b) 50 aircraft incidents per 100 000 hours flown (*safety indicator*) with a 25 per cent reduction in three years (*safety target*);
- c) 200 major aircraft defect incidents per 100 000 hours flown (*safety indicator*) with a 25 per cent reduction over the last three-year average (*safety target*);
- d) 1.0 bird strike per 1 000 aircraft movements (*safety indicator*) with a 50 per cent reduction in five years (*safety target*);
- e) no more than one runway incursion per 40 000 aircraft movements (*safety indicator*) with a 40 per cent reduction in a 12-month period (*safety target*); and
- f) 40 airspace incidents per 100 000 hours flown (*safety indicator*) with a 30 per cent reduction over the five-year moving average (*safety target*).

1.4.17 The *safety requirements* to achieve these safety targets and safety indicators include:

- a) the oversight authority accident prevention programme;
- b) a mandatory occurrence reporting system;
- c) a voluntary occurrence reporting system;
- d) a bird strike programme; and
- e) the deployment of radar systems in the State's three busiest airports within the next 12 months.

1.4.18 **Airline operator SMS.** An oversight authority and an airline operator agree on an *acceptable level of safety* to be achieved by the operator SMS, one measure of which — but not the only one — is 0.5 fatal accidents per 100 000 departures (*safety indicator*); a 40 per cent reduction in five years (*safety target*) and — among others — the development of GPS approaches for airfields without ILS approaches (*safety requirement*).

1.4.19 **Service provider and aerodrome operator SMS.** An oversight authority, an ATS provider and an aerodrome operator agree on an *acceptable level of safety* to be achieved by the provider and operator SMS, one element of which — but not the only one — is no more than one runway incursion per 40 000 aircraft movements (*safety indicator*); a 40 per cent reduction in a 12-month period (*safety target*) and — among others — the establishment of low visibility taxi procedures (*safety requirement*).

1.4.20 Chapter 5 contains further information on safety performance indicators and safety performance targets.

1.5 STAKEHOLDERS IN SAFETY

1.5.1 Given the total costs of aviation accidents, many diverse groups have a stake in improving the management of safety. The principal stakeholders in safety are listed below:

- a) aviation professionals (e.g. flight crew, cabin crew, air traffic controllers (ATCOs) and aircraft maintenance engineers (AMEs)¹);
- b) aircraft owners and operators;
- c) manufacturers (especially airframe and engine manufacturers);
- d) aviation regulatory authorities (e.g. CAA, EASA and ASECNA);
- e) industry trade associations (e.g. IATA, ATA and ACI);
- f) regional ATS providers (e.g. EUROCONTROL);
- g) professional associations and unions (e.g. IFALPA and IFATCA);

1. Annex 1 — *Personnel Licensing* also offers the possibility of referring to these persons as aircraft maintenance technicians or aircraft maintenance mechanics. This manual will refer to them as aircraft maintenance engineers (AMEs).

- h) international aviation organizations (e.g. ICAO);
- i) investigative agencies (e.g. United States NTSB); and
- j) the flying public.

1.5.2 Major aviation safety occurrences invariably involve additional groups which may not always share a common objective in advancing aviation safety, for example:

- a) next of kin, victims, or persons injured in an accident;
- b) insurance companies;
- c) travel industry;
- d) safety training and educational institutions (e.g. FSF);
- e) other government departments and agencies;
- f) elected government officials;
- g) investors;
- h) coroners and police;
- i) media;
- j) general public;
- k) lawyers and consultants; and
- l) diverse special interest groups.

1.6 APPROACHES TO SAFETY MANAGEMENT

1.6.1 With global aviation activity forecast to continue to rise, there is concern that traditional methods for reducing risks to an acceptable level may not be sufficient. New methods for understanding and managing safety are therefore evolving.

1.6.2 Safety management may therefore be considered from two different perspectives — traditional and modern.

Traditional perspective

1.6.3 Historically, aviation safety focused on compliance with increasingly complex regulatory requirements. This approach worked well up until the late 1970s when the accident rate levelled off. Accidents continued to occur in spite of all the rules and regulations.

1.6.4 This approach to safety **reacted** to undesirable events by prescribing measures to prevent recurrence. Rather than defining best practices or desired standards, such an approach aimed at ensuring minimum standards were met.

1.6.5 With an overall fatal accident rate in the vicinity of 10^{-6} (i.e. one fatal accident per one million flights), further safety improvements were becoming increasingly difficult to achieve using this approach.

Modern perspective

1.6.6 In order to keep safety risks at an acceptable level with the increasing levels of activity, modern safety management practices are shifting from a purely reactive to a more **proactive** mode. In addition to a solid framework of legislation and regulatory requirements based on ICAO SARPs, and the enforcement of those requirements, a number of other factors, some of which are listed below, are considered to be effective in managing safety. It must be emphasized that this approach complements, or is in addition to, the obligations of States and other organizations to comply with ICAO SARPs and/or national regulations.

- a) application of scientifically-based risk management methods;
- b) senior management's commitment to the management of safety;
- c) a corporate safety culture that fosters safe practices, encourages safety communications and actively manages safety with the same attention to results as financial management;
- d) effective implementation of standard operating procedures (SOPs), including the use of checklists and briefings;
- e) a non-punitive environment (or just culture) to foster effective incident and hazard reporting;
- f) systems to collect, analyse and share safety-related data arising from normal operations;
- g) competent investigation of accidents and serious incidents identifying systemic safety deficiencies (rather than just targets for blame);
- h) integration of safety training (including Human Factors) for operational personnel;
- i) sharing safety lessons learned and best practices through the active exchange of safety information (among companies and States); and
- j) systematic safety oversight and performance monitoring aimed at assessing safety performance and reducing or eliminating emerging problem areas.

1.6.7 No single element will meet today's expectations for risk management. Rather, an integrated application of most of these elements will increase the aviation system's resistance to unsafe acts and conditions. However, even with effective safety management processes, there are no guarantees that all accidents can be prevented.

1.7 USING THIS MANUAL

Purpose

1.7.1 The purpose of this manual is to assist States in fulfilling the requirements of Annexes 6, 11 and 14 with respect to the implementation of SMS by operators and service providers.

Target audience

1.7.2 The methods and procedures described in this manual have been compiled from experience gained in the successful development and management of aviation safety activities by aviation operators, ATS providers, aerodromes and maintenance organizations. In addition, the manual embodies best practices from sources such as governments, manufacturers and other reputable aviation organizations.

1.7.3 Application of the guidance material herein is not limited to operational personnel. Rather, it should be relevant to the full spectrum of stakeholders in safety, including senior management.

1.7.4 In particular, this manual is aimed at those personnel who are responsible for designing, implementing and managing effective safety activities, namely:

- a) government officials with responsibilities for regulating the aviation system;
- b) management of operational organizations, such as operators, ATS providers, aerodromes and maintenance organizations; and
- c) safety practitioners, such as safety managers and advisers.

1.7.5 Users should find sufficient information herein for the justification, initiation and operation of a viable SMS.

1.7.6 The manual is not prescriptive. However, based on an understanding of the philosophy, principles and practices discussed herein, organizations should be able to develop an approach to safety management suited to their local conditions.

Manual contents

1.7.7 This manual targets a wide audience ranging from State aviation regulators to operators and service providers. It also aims to address all levels of personnel in these organizations from senior management to front-line workers. Chapters 1 to 3 contain an introduction to safety management. Chapters 4 to 11 cover the management of safety. Safety management systems are dealt with in Chapters 12 to 15. Chapters 16 to 19 address applied safety management.

1.7.8 The manual is not designed to be read from the beginning to the end. Rather, users are encouraged to focus on their areas of interest, depending on their level of knowledge and experience in the area of aviation safety management.

1.7.9 Throughout this manual, the use of the male gender should be understood to include male and female persons.

Acknowledgements

1.7.10 In developing this manual, ICAO has drawn heavily on the work, writing and best practices of many organizations and individuals. While the source of all such material cannot be identified, ICAO would like to acknowledge, in particular, inputs from the following States: Australia, Canada, New Zealand, the United Kingdom and the United States; manufacturers: Airbus Industrie and The Boeing Company; consultants: Integra; service providers: European Organisation for the Safety of Air Navigation (EUROCONTROL) and the Airports Council International (ACI); private author: Richard W. Wood; and others: Global Aviation Information Network (GAIN) and Flight Safety Foundation (FSF).

Relationship to other ICAO documents

1.7.11 This manual provides guidance for fulfilling the requirements of the SARPs of Annexes 6, 11, and 14 with respect to the implementation of safety programmes and SMS. Some of these requirements are expanded upon in the *Procedures for Air Navigation Services — Aircraft Operations* (PANS-OPS, Doc 8168), *Procedures for Air Navigation Services — Air Traffic Management* (PANS-ATM, Doc 4444), and the *Manual on Certification of Aerodromes* (Doc 9774).

1.7.12 The manual should also assist States in the fulfilment of the SARPs of Annex 13 — *Aircraft Accident and Incident Investigation* with respect to the investigation of accidents and incidents, including recommendations to States for the promotion of safety by the analysis of accident and incident data and by the prompt exchange of safety information.

1.7.13 This manual should also serve as a companion document for other ICAO documents, including:

- a) *Airworthiness Manual* (Doc 9760), which provides guidance for the conduct of a continuing airworthiness programme;
- b) *Human Factors Digest No. 16 — Cross-Cultural Factors in Aviation Safety* (Cir 302), which presents the safety case for cross-cultural factors in aviation;
- c) *Human Factors Guidelines for Aircraft Maintenance Manual* (Doc 9824), which provides information on the control of human error and the development of countermeasures to error in aviation maintenance;
- d) *Human Factors Guidelines for Air Traffic Management (ATM) Systems* (Doc 9758), which assists States in the consideration of Human Factors issues when purchasing and implementing CNS/ATM-related technology;
- e) *Human Factors Guidelines for Safety Audits Manual* (Doc 9806), which provides guidelines for preparing for, or conducting, a safety oversight audit that includes consideration of human performance and limitations;
- f) *Human Factors Training Manual* (Doc 9683), which describes in greater detail much of the underlying approach to the human performance aspects of safety management in this manual;
- g) *Line Operations Safety Audit (LOSA)* (Doc 9803), which presents information on the control and management of human error and the development of countermeasures to error in operational environments;
- h) *Manual of Aircraft Accident and Incident Investigation* (Doc 9756), which provides information and guidance to States on the procedures, practices and techniques that can be used in aircraft accident investigations;
- i) *Manual on Certification of Aerodromes* (Doc 9774), which describes the salient features of an SMS to be included in the aerodromes manual for certified aerodromes;
- j) *Preparation of an Operations Manual* (Doc 9376), which provides detailed guidance to operators in such areas as training and the supervision of operations, and includes direction on the need to maintain an accident prevention programme;

- k) *Safety Oversight Audit Manual* (Doc 9735), which provides guidance and information on standard auditing procedures for the conduct of ICAO Safety Oversight audits; and
- l) *Training Manual* (Doc 7192), Part E-1 — *Cabin Attendants' Safety Training*, which provides guidance for the training of cabin crew required by Annex 6.²

2. A change of terminology from “cabin attendant” to “cabin crew” became applicable in 1999 (see Annex 6 — *Operation of Aircraft*). The term “flight attendant” is sometimes used in the industry.

APPENDIX B

SAFETY MANAGEMENT SYSTEMS FOR COMMERCIAL AIR
TRANSPORT OPERATIONS