EUROCONTROL / FAA
ACTION PLAN 15 SAFETY

Safety Culture in Air Traffic Management
A White Paper

December 2008

EUROCONTROL

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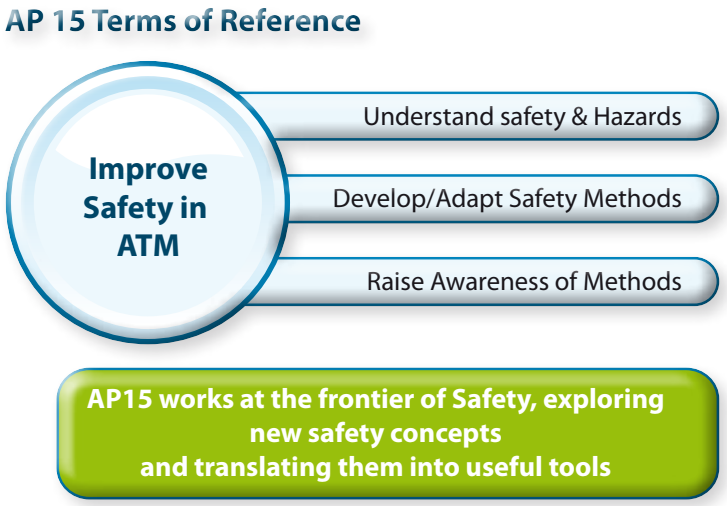
FOREWORD

The EUROCONTROL / FAA Action Plan 15 on Safety Research is aimed at advancing Safety concepts and practices in Air Traffic Management, via the sharing of expertise from its membership. It has three main axes: understanding system safety, developing new approaches to assess and improve safety, and disseminating its results into the industry. AP15 came into existence in 2003 and its current terms of reference run until 2010. Safety Culture is one of its principal activities in the 2007-2010 timeframe.



AP15 Membership

- **EUROCONTROL** - Barry Kirwan [Co-chair], Eric Perrin, Herman Nijhuis
- **FAA** - Joan Devine [Co-chair], Jim Daum, Dino Piccione, Steve French, Alfredo Colon
- **NATS** (UK) – David Bush
- **DFS** (Germany) – Joerg Leonhardt & Joachim Vogt
- **ENAV** (Italy) – Alessandro Boschiero
- **DSNA** (France) – Sebastien Barjou
- **NLR** (the Netherlands) – Henk Blom
- **AVINOR** (Norway) – Anne Chavez
- **LFV** (Sweden) – Billy Josefsson

For further information:

barry.kirwan@eurocontrol.int
joan.devine@faa.gov

Additional thanks to Marinella Leone, Tony Licu, Eve Grace-Kelly, Kathryn Mearns, Chris Johnson, Nigel Makins, Anna Wennerberg, Amel Sedaoui, Jean Paries, Rachael Gordon and Richard Kennedy.

EXECUTIVE SUMMARY

This White Paper is built on the collaboration between EUROCONTROL, the FAA, and a number of ANSPs with a common area of interest, namely Safety Culture. Safety Culture is the way safety is perceived, valued and prioritised in an organisation. It reflects the real commitment to safety at all levels in the organisation. Safety Culture is not something you 'get' or buy, it is something an organisation has. Safety Culture can therefore be positive, negative or neutral. Its essence is in what people believe concerning the importance of safety, including what they think their peers, superiors and leaders really believe about safety's priority. Although this may sound 'fuzzy', it can have a direct impact on safe performance. If someone believes that safety is not really important, or can be sacrificed temporarily, then workarounds, cutting corners, or making unsafe decisions or judgements will be the result.

This White Paper has four objectives:

1. **Understand the concept** of Safety Culture, where it has come from, its relevance to ATM, and its interaction with Safety Management Systems (SMS).
2. See **how Safety Culture can be measured** and addressed, to understand the typical measurement process, and the implications for an ANSP's resources, and what a Safety Culture Survey can deliver.
3. To understand the basics of **improving Safety Culture**: although this is perhaps the least advanced aspect at this stage, a range of approaches is emerging.
4. Know the **ATM Safety Culture goals of the FAA and EUROCONTROL**.

The White paper therefore addresses a number of questions:

1. Understanding Safety Culture

- What does Safety Culture mean?
- Where does it come from?
- Why is it so important?
- What are its key elements?
- What do positive/negative Safety Cultures look like?
- How are Safety Culture and SMS related?
- What is Safety Culture Maturity?

2. Measuring Safety Culture

- How is it measured?
- What does a typical assessment entail?
- What type of results does it deliver?
- Does the Safety Culture approach have 'validity'?

3. Improving Safety Culture

- How do you improve Safety Culture?
- Leadership at CEO level
- Safety leadership
- Safety education
- Safety mindfulness
- Changing behaviour

4. Safety Culture Mission Statements from EUROCONTROL/FAA

It is hoped this White Paper will help inform ANSPs and other organisations who are embarking on the 'Safety Culture journey', by 'unpacking' the concept, answering frequently asked questions, and showing what the approach looks like in practice.

INTRODUCTION

Air Traffic Management (ATM) is a very safe industry – both in terms of quantitative measures such as incident and accident rates, and also qualitative measures such as the perceptions of the travelling public. The industry is currently expanding to cope with increased levels of traffic, coupled with fundamental changes to how ATM services are provided. In this era of expansion and change, one of the biggest challenges that the ATM industry currently faces is identifying the crucial ingredients of effective safety management, and the measures the industry should adopt to maintain its exceptional safety performance. Safety Culture is seen as fundamental for safety performance in a number of industries (including nuclear, chemical, off-shore oil and gas, and rail), and ATM is no exception.

The term Safety Culture has been in use over the past several years in ATM, but it is not always clear what is meant by this term, nor how exactly it relates to the ATM industry, nor how it is measured and improved. This White Paper seeks to explain the concept of Safety Culture and its key elements, techniques and processes. It also aims to explain the relationship between Safety Culture and Safety Management Systems (SMS), and the reason why Safety Culture is still important even though a good SMS may be in place.

Safety Culture improvement in ATM is a major strategic safety objective in Europe and the United States, both in the short term, and throughout the SESAR and NextGen programmes.

Figure 1: Safety Culture

What does it mean, in practical terms?

First, there is usually no intention to cause unnecessary risk. Rather, safety can be temporarily eroded because people are trying to get the job done. Here are a few examples of Safety Culture 'scenarios':

- A controller trying to optimise heavy air traffic, and respond to pilot requests for higher levels, may encounter more difficult tactical control later on when the aircraft need to descend;
- Engineers need to keep working on essential maintenance, although they are aware they may be degrading the controller's radar picture;
- A supervisor notices two controllers are looking tired, but there is only twenty minutes before they are relieved, and the traffic is slow, so he waits;
- A safety assessment team reaches a borderline safety conclusion concerning a new, key operation that will secure company jobs for the next ten years. Operations people involved believe they can handle all the safety scenarios assessed with ease, but one of the safety assessors is convinced there are genuine risks. The other members of the safety team involved think he is being over-cautious;
- During a temporary staff resource shortage, the Board has to decide whether to limit capacity or not, until the shortage is resolved.

These examples are in the 'grey areas', which occur frequently, where there are no hard and fast rules, and where what we believe about safety and its importance will strongly influence our decisions.

Our individual judgements and beliefs about safety come from two main sources, aside from the official rules: our experience, and our peers. Most of the time we learn from watching and listening to others.

Think of it this way – imagine you are driving your car and approach a red light at night, and it stays red for a long time. Eventually other cars start driving through it, and the ones behind you start honking their horns at you to go through it too. What would you do? The lesson is that our peers, as well as our bosses, can determine how we think about safety at work – others can lead us to 'bend' the rules when we know deep down they should not be bent. The only way to prevent this is to have all people in the organisation concerned with safety – what has been called 'safety mindfulness'. This is Safety Culture.

What is Safety Culture, and where does it come from?

The term Safety Culture came into popular use after being mentioned in the summary report by the International Nuclear Safety Advisory Group (INSAG) as one of the causes of the Chernobyl nuclear power accident in the Ukraine (IAEA, 1986). The IAEA (International Atomic Energy Agency) report introduced the concept to explain the organisational errors and operator violations that laid the conditions for the disaster. Since that time, 'poor Safety Culture' has been identified among the causes of numerous high-profile accidents in other industries, such as the fire at King's Cross underground station (Fennell, 1998); the sinking of the Herald of Free Enterprise passenger ferry (Sheen, 1987), the passenger train crash at Clapham Junction (Hidden, 1989), the disasters of the Space Shuttles Challenger (Rogers, 1986) and Columbia (Gehman, 2003), the Überlingen mid-air collision accident (Ruitenberg, 2005), and the BP oil refinery accident (Baker et al., 2005).

Safety Culture has been addressed by various high-profile researchers in sectors such as the Oil and Gas industry (Flin et al., 1998), (Cox and Cox, 1991), (Mineral Concil of Australia, 1999) and air transport (Gordon et al., 2006), (Ek, 2006), (Wiegmann et al. 2003), (Patankar et al., 2005) as well as in the sector of nuclear safety (Ostrom et al., 1993), (Meshkati, 1997), (Carroll, 1998), and more recently the rail and medical domains.

To understand Safety Culture's origins, it is necessary to explain what is meant by **organisational culture.** Employee awareness, understanding and motivation, and similarly 'soft' phenomena such as their attitudes, perceptions and beliefs are all wrapped-up within this concept of 'organisational culture'. The influence of culture is something that is often taken for granted by those working in the organisation, but it has an implicit and very strong influence on the safe behaviour of staff and contractors, including not just front-line operational staff/contractors but also managers, directors and Chief Executive Officers (CEOs), as well as system support and maintenance staff. Organisational culture means '*the way things are done around*

here.' Wherever we work, we are in an organisational culture and '*get used to it*'; it is usually only when someone new arrives that they really notice the culture, and how it affects the way people work.

Figure 2 – Other Industries & Safety Culture

Safety Culture is therefore a sub-dimension of organisational culture. There is not a recognised universal definition, but Safety Culture can simply be described as ***"the way safety is done around here*** – emphasising that it is concerned with the realities of safety, and not necessarily what people say should be done" (EUROCONTROL, 2007).

In more formal terms Safety Culture "is the product of individual and group values, attitudes, competencies and patterns of behaviour that determine commitment to, and the style and proficiency of, an organisation's health and safety management." Advisory Committee for Safety on Nuclear Installations (HSC, 1993, p. 23).

This definition can be enriched pointing out that an organisation's Safety Culture is not only made up of the individuals' attitudes. Safety Culture reflects individual, group and organisational attitudes, norms and behaviours and it consists of the value of, priority of, and commitment to, air navigation safety.

Safety Culture in ATM

For ATM, exploring this field is a fairly recent attempt to advance understanding of the different organisational, cultural and managerial influences on safety. Safety has always been a core value for ATM. Safety Culture aims to ensure it stays that way and flourishes in ATM organisations, remaining at the forefront of people's minds, whether they are controllers on duty, maintenance staff supporting essential systems, or managers allocating resources and planning the future strategies for their organisations. In this way, the small problems and weaknesses that can grow to become accidents can be identified and stopped at their source. Safety Culture will therefore enhance the 'resilience' of ATM organisations.

A simple model of Safety Culture is shown in Figure 3 (Gordon et al, 2007). This figure highlights the potential disparity between what may be said about safety, and what is actually done. This conflict is underpinned by people's real beliefs about how their organisation values safety, and so affects their own behaviour and, hence, real safety outcomes. Therefore, when examining Safety Culture, it is important not to rely only on official documents such as the Safety Management System (SMS), and even observation of behaviour may not be sufficient. It is necessary to probe people's real beliefs about safety, including their values and perceptions of others' values too, especially their peers and superiors. This is usually achieved by a mixture of carefully worded anonymous questionnaires, as well as focus groups where people discuss safety issues they are concerned about, usually animated by a facilitator.

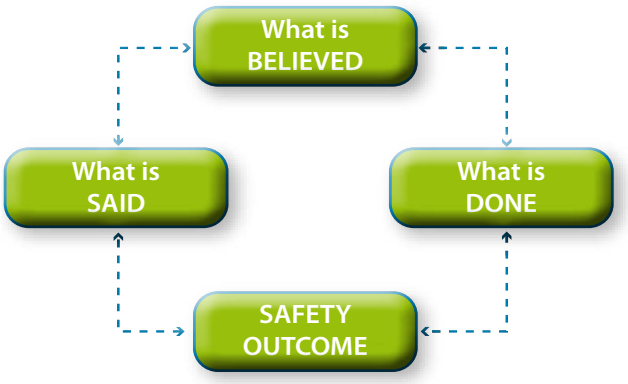


Figure 3: Simplified Safety Culture Model

Why is Safety Culture so important?

In the context of Figure 3, the '*doing*' part of ATM has evolved over a number of decades with a strong sense of safety. This 'evolved' safety has led to a generally positive Safety Culture in air navigation service providers – they could not be so safe without such a high value attached to safety. The arrival of SMS recently in ATM is principally concerned with the '*what is said*' part of safety: the policies and procedures for safety assurance, which should be translated into action, and should also reinforce the belief, amongst all, that safety has importance in the corporate mindset. But in a period of change, whether institutional change, commercial pressures or rapid growth such as are happening today, or systemic changes as will happen by 2025 via SESAR in Europe and NextGen in the USA, the priority given to safety and the safety implicit in ATM today can come under threat. Change and pressure can of course lead to positive benefits, but they can also distract people from safety, as well as introduce vulnerabilities into the system which are sometimes hard to see before they accumulate into potential accident chains. Safety Culture aims to keep the collective mind of the organisation, through its entirety of individual minds, continually focused on safety. A strong Safety Culture begins with leadership commitment to making safety a priority in every decision. Steps forward can still be made, and must be made, but they must be safe ones. If people believe that safety is not the priority, or, for example, not today's priority, this will influence their actions and decisions, allowing unsafe conditions, then actions, and ultimately accidents, to occur. **The '*belief*' part of safety must therefore be addressed, understood, and corrected if necessary – and this is the domain of Safety Culture.**

What are the key elements of Safety Culture?

In the literature there are many relevant insights concerning the characteristics of Safety Culture, e.g. for Reason (1997), Safety Culture encompasses the following aspects (Figure 4):

1. **Reporting Culture,** which encourages employees to divulge information about all safety hazards that they encounter.
2. **Just Culture,** which holds employees accountable for deliberate violations of the rules but encourages and rewards them for providing essential safety-related information.
3. **Flexible Culture,** which adapts effectively to changing demands and allows quicker, smoother reactions to off-nominal events.
4. **Learning Culture,** which is willing to change based on safety indicators and hazards uncovered through assessments, audits, and incident analysis.

Figure 4: Key components of Safety Culture

The four subcomponents – reporting culture, just culture, flexible culture, and learning culture – combine to form a safety-conscious, ***informed culture,*** where a safety system integrates data from incidents, accidents and near misses and combines them with information from proactive measures such as safety audits and climate surveys. An informed culture has the following characteristics:

- Leadership commitment
- Open communication
- Just environment
- Involvement of everyone at all levels of the organisation
- Learning throughout the organisation
- Effective decision-making process
- Actions/Implementation
- Follow-up, feedback, and reporting

To these characteristics, we can add three further aspects:

1. **Risk Perception** which requires that individuals at all organisational levels need to have coherent perceptions and judgements of the seriousness of risks, as these perceptions affect risk-handling behaviour and appropriate decisions with regards to safety issues.
2. **Attitudes to safety** in relation to the balance between safety and capacity.
3. **Safety-related behaviour** which has to do with directly complying with procedures, roles and regulations, but also to aspects such as coaching, recognising, communicating, demonstrating and actively caring about safety[1].

1- Westrum (1999) and Fleming (2000) identified further characteristics that can be easily related to Reason's. Further sets of characteristics were also identified by Wiegmann et al. (2002), Hudson (2003), Gordon et al. (2006), and Ek (2006).

What do positive or negative Safety Cultures look like?

"Organisations with a positive Safety Culture are characterised by communications founded on mutual trust, by shared perceptions of the importance of safety, and by confidence in the efficacy of preventative measures." (HSC, 1993: p.23). However, such definitions are rather abstract, so it is useful to explain what positive and negative Safety Cultures look like. The following extracts (Tables 1 & 2, from EUROCONTROL, 2006) refer to two different situations that lead to different levels of safety performance, in the context of safety event reporting.

In general, poor Safety Culture means that safety is sacrificed, even when people are saying that safety comes first – hence practice differs from theory or policy.

Simple examples would be where staff concerns about safety are consistently not addressed; where there appears to be no learning from past events; where safety cases state the system is safe but operational people believe an accident is imminent; or where safety is believed to be someone else's responsibility. Safety Culture 'mismatches', where management and controllers/engineers do not share the same beliefs about safety, or where their behaviours are in opposition, can often be detected in organisations, whether in ATM or other industries. Such a pattern reflects negative Safety Culture because it means that safety will not be addressed coherently or effectively throughout the organisation. If the management and controllers share the same beliefs about safety and behave accordingly, this pattern usually reflects positive Safety Culture (unless the whole organisation believes safety is not the priority!).

	MANAGEMENT	OPERATIONAL STAFF
What was BELIEVED	■ Both controllers and management believe they should submit reports of all occurrences. ■ Both controllers and management believe human errors exist and reports are an important basis for learning and improving safety.	
What was DONE	■ Management does not punish those who report; instead they are supported and the report is addressed. ■ The controller reports the incident to the supervisor and they discuss the incident.	
OUTCOME	■ Controllers and management trust each other, and a just culture, where occurrences are freely reported, exists.	

Table 1 - Example of Positive Safety Culture

	MANAGEMENT	OPERATIONAL STAFF
What was BELIEVED	■ Investigations of operational errors are necessary to determine problem areas and identify substandard controllers.	■ Investigations are used to assign blame to lower-level employees and do not examine other problems.
What was DONE	■ Designed investigation process without coordination with employees.	■ Refused to cooperate fully with investigations.
OUTCOME	■ Investigations of operational errors place blame on individual employees and fail to uncover underlying problems. ■ Persistence of a blaming culture prevents implementation of an effective investigative process. ■ Similar operational errors continue to recur.	

Table 2 - Example of Negative Safety Culture

A positive Safety Culture would be one where everyone knew their role with respect to safety, and believed that everyone in the organisation was truly committed to safety, because there was clear safety leadership, activity, and commitment in terms of resources. Safety would be discussed frequently at all levels in the organisation, and would be the first agenda item in the Board's weekly meeting. There would be a clear safety strategy, and anyone could raise a safety issue with impunity; operational staff could also report events without fear of any recrimination or even of losing face amongst their peers. Anyone in the organisation could explain to a visitor what the safety risks for the organisation were, and what the ongoing measures were to improve safety. Such organisations do exist; an example is the U.S. Navy's SUBSAFE programme (Patankar, et al., 2005).

What is the relation between Safety Culture & a Safety Management System?

Although it has been recognised that the existence of an appropriate and comprehensive Safety Management System (SMS) is necessary for maintaining and improving the safety of ATM operations, it may not be sufficient to guarantee adequate safety performance. A SMS will not assure safety if it is not used properly, and thus all the staff involved in the provision of ATM services need to be properly aware of its existence, understand its basis, and be motivated to use the SMS that is in place or being developed or implemented. A positive Safety Culture can be a strong enabler to ensure the SMS works in practice. The reverse can also be true: implementing a good SMS can be an enabler for Safety Culture. Organisations are managed by organisational practices, which affect both performance and reliability of safety systems. A well-developed SMS can therefore serve as an accelerator of Safety Culture (Reason 1993, 1997). Therefore **SMS and Safety Culture are inter-dependent: SMS embodies the competence to achieve safety, whereas Safety Culture represents the commitment to achieving safety** (see Figure 5). In ATM in some countries, e.g. Switzerland, SMS and Safety Culture are jointly addressed. They are "like body and soul".

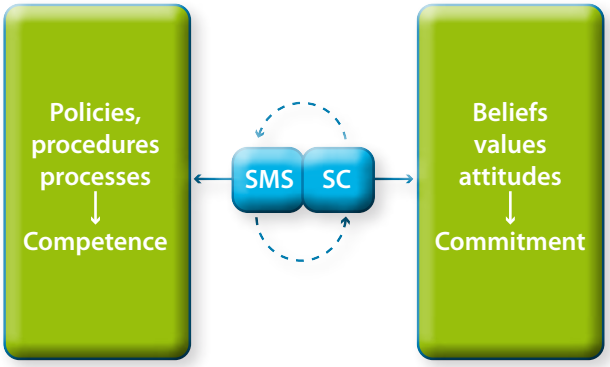


Figure 5: Inter-dependency between SMS and Safety Cultutre

SMS and Safety Culture can be worked on together or independently. The strength of treating Safety Culture and safety management in tandem is that the approach can sometimes translate or focus Safety Culture improvement needs into tangible improvements to the SMS. An alternative approach is to retain some distance between the two areas. This still allows feedback on where a SMS may not actually be working in practice (e.g. a technical problem in the error reporting system that stops people from bothering to report incidents), while allowing a focus on deeper cultural issues that can be unearthed during Safety Culture surveys, e.g. regional differences in safety attitudes, or problems of mistrust between different sections or layers in the organisation (e.g. operational staff believing the SMS is just 'for show' or to 'protect' management).

Safety Culture takes time to grow and change: a SMS can be implemented, whereas a Safety Culture cannot, though it can be re-directed. Safety Management Systems can be explained explicitly as they allow a formalised safety within the ATM system by writing down a tangible and documented system of management policy and procedures. In contrast Safety Culture is harder to expound as it is more difficult to identify Safety Culture features and characteristics (e.g. group attitudes, perception and beliefs) that can influence the effectiveness of safety management activities (Kennedy and Kirwan, 1995). Safety Culture is inevitably more '*fuzzy*' than SMS.

SMS and Safety Culture are seen as inter-dependent, rather than SMS as part of Safety Culture or vice versa: if either one is seen as a sub-element of the other, something is lost. They have the same general aim of maintaining and improving safety.

What is Safety Culture Maturity?

In some industries, such as the software, oil & gas and energy industries, capability maturity models have been defined and adopted to facilitate the enhancement process of Safety Culture. These capability maturity models aim to assist organisations to understand the level of maturity of their culture. In recent years a sliding scale of Safety Culture from poor to excellent has been proposed (Fleming, 2000). Several industries have referenced and worked to adopt this model. In the European ATM experience some initial Safety Culture measures have utilised a scale of maturity of Safety Culture between different ANSPs.

The Safety Culture Maturity Model in Figure 6 is used to identify the level of maturity of an organisation's culture and is adopted in the oil and gas industry to plan improvements in order to achieve the desired Safety Culture enhancement.

Although the Safety Culture maturity model is appealing and is used in the oil and gas industry, its scientific basis is not yet fully endorsed elsewhere. Therefore, in ATM there is an idea to improve Safety Culture by measuring, planning and acting, and then measuring again, but without necessarily using a Safety Culture maturity framework. However, some ANSPs may choose to follow this framework, as it allows an implicit benchmarking of their organisation.

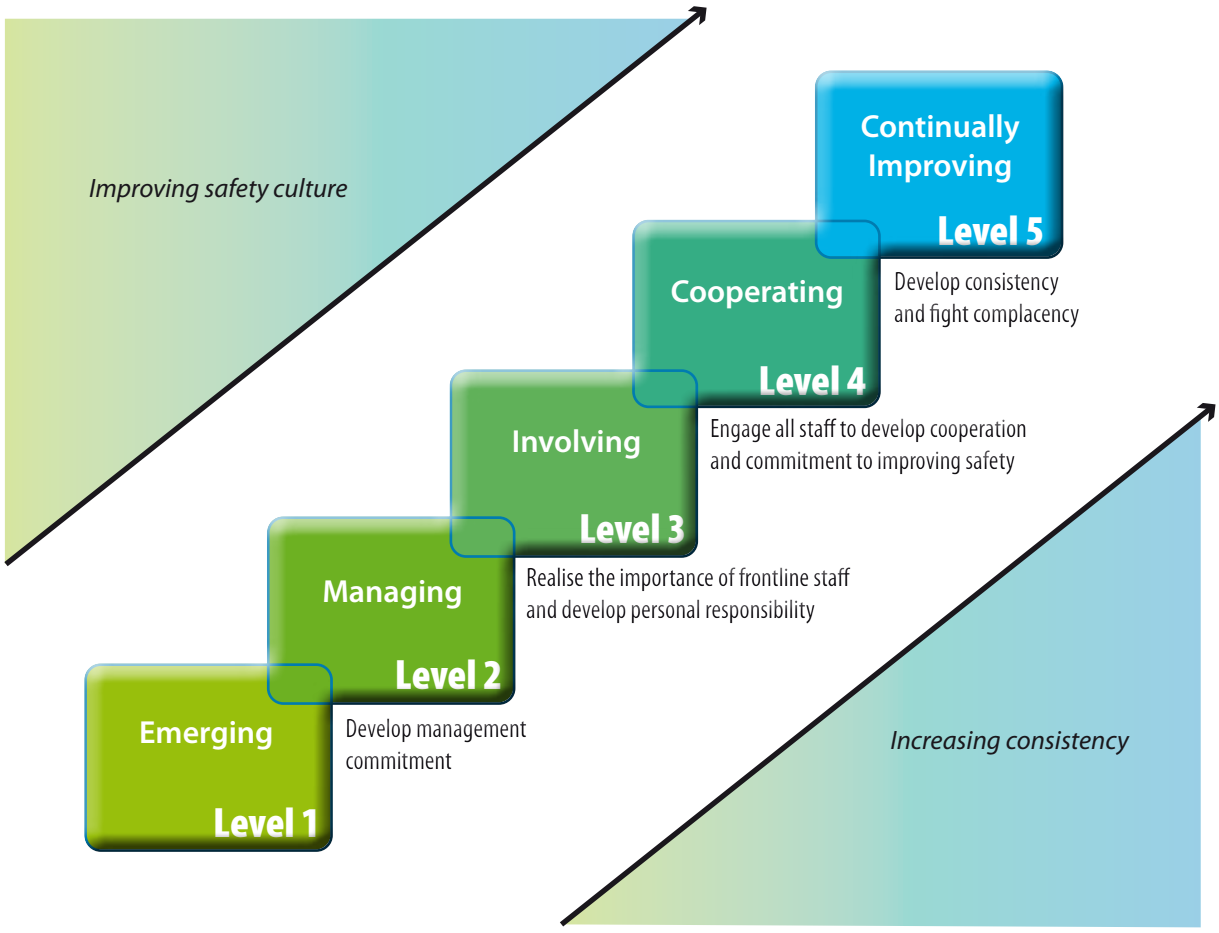


Figure 6: Safety Culture Maturity Model (© The Keil Centre, UK)

2. MEASURING SAFETY CULTURE

In order to understand and shape Safety Culture, an organization must first determine its own Safety Culture, its strengths and weaknesses, and its Safety Culture variations, whether these are between different work areas or regional units (large organisations are usually a group of inter-related sub-cultures rather than one large homogeneous culture). Some approaches are described below.

How is Safety Culture measured?

An organisation that decides to improve its Safety Culture should follow a systematic, closed-loop process. A typical enhancement process is presented in Figure 7. The first step consists of defining what Safety Culture is and understanding what is meant by Safety Culture in an air traffic management organisation. This requires identifying the characteristics of Safety Culture to look at, and their sub-components. These first two steps are important because to measure Safety Culture effectively, an organisation must define and describe what it is attempting to measure. The next (3rd) step of the process enters the assessment stage, where the organisation carries out or commissions a survey to measure its own Safety Culture. Surveys and other techniques contribute to the identification of strengths and weaknesses of the Safety Culture (4th step). On the basis of this assessment an Action Plan is developed (5th step), and then actions are effected to improve Safety Culture (6th step). After a reasonable period (e.g. at least two years), Safety Culture can be assessed again iteratively to determine if the situation has improved.

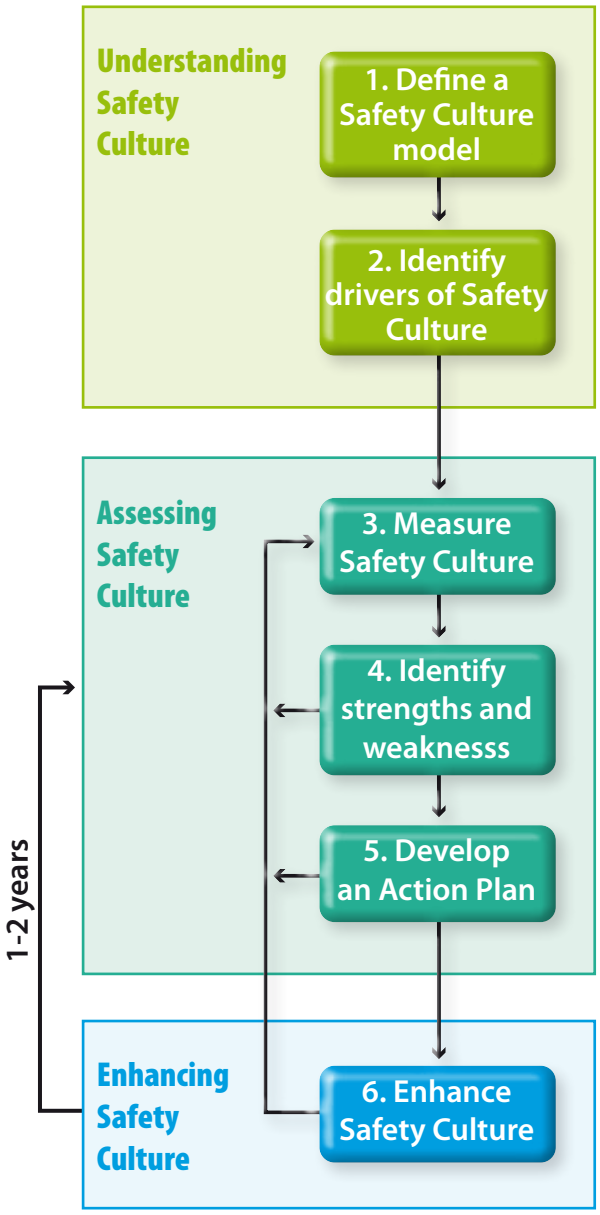


Figure 7: Safety Culture Enhancement Process

The iteration timeframe depends on the time required to carry out the assessment, the definition of the plan and the time to put in place all the actions of the plan and mature the enhancement. The presence and commitment of internal 'champions' in the organisation can help to speed up this process. However, the iteration should not occur too quickly, as Safety Culture takes time to change; too rapid an iteration risks reinforcing pre-existing beliefs (Turner, 1992).

What does a typical assessment entail?

Questionnaires (see Table 3) are the common starting point to investigate Safety Culture. A carefully-devised questionnaire can pose relevant questions on beliefs and attitudes about safety to the entire organisation and, because such questionnaires are usually anonymous, they can give clear feedback about general Safety Culture, and can indicate strengths and weaknesses either across the organisation, or in particular parts of the organisation. Questionnaires are particularly useful in contrasting different opinions and attitudes about safety in different work groups or, for example, highlighting differences between regions in the same organisation.

However, reliance on questionnaires alone is not recommended for Safety Culture investigation or measurement. There are several reasons to go beyond a simple questionnaire. First of all, people sometimes give the picture they want to show, which does not always reflect reality. This happens because, for example, managers want to give a certain impression of their organisation and employees may try to hide their opinion so as not to be blamed, or for social desirability; i.e. desiring to be accepted by other people.

A second reason lies behind the definition of Safety Culture and safety climate: since most questionnaires have their origins in the *safety climate* literature. The two concepts do not have the same meaning, despite being used interchangeably in the literature (Cox and Flin, 1998). A *safety climate* questionnaire survey is a quantitative method that can be used alone as a means to take a snap-shot of the state of an organisation's safety. *Safety Culture* requires more qualitative methods as it is concerned with the more enduring underlying culture. The Cox and Cox (1996) point of view sees culture likened to *personality*, whereas climate is likened to *mood*.

Safety Culture, however, is not only a matter of individuals' perceptions on the day of the survey, but is a matter of enduring attitudes which will underpin safety behaviour. If we want to understand thoroughly people's beliefs, values and these enduring attitudes, which are more continuous characteristics over time and reflect the 'heart' of safety in an organisation, we have to include further tools in the Safety Culture measurement approach. The Safety Culture questionnaire can be seen as an initial overall health check – what are needed afterwards are more precise diagnostic tools.

	Strongly disagree	Disagree	Neither	Agree	Strongly agree
1. Appropriate responses are made after an incident to address the reasons why the incident occurred.	1	2	3	4	5
2. Everyone at my Unit feels that safety is their own responsibility - there is proactive participation by all staff in safety initiatives.	1	2	3	4	5
3. People who raise problems are seen as trouble-makers.	1	2	3	4	5
4. Even if the system fails, we are still expected to achieve the targets that are set for us.	1	2	3	4	5
5. The organization says "it is committed to safety" but actually has other higher priorities.	1	2	3	4	5
6. Only my manager has responsibility for safety.	1	2	3	4	5

Table 3 – Example Safety Culture Questions

It is therefore useful to have other sources of data, including observation, interviews and workshops or focus groups. The application of different tools is advisable considering the strengths and weaknesses of each single tool. Using multiple methods enables a 'triangulation' process to pinpoint more accurately the true characteristics of an organisation's Safety Culture. Observation can give a richer feedback about people's behaviour. The questionnaire can collect a considerable pool of data, and the interviews and workshops can help interpret and explore respondents' points of view. Two examples of successfully using this approach are the surveys and culture workshops from US Navy Safety Center, and the Organisational Safety Assessments (OSA) from the US Air Force Center. A number of European Member States as well as EUROCONTROL have also applied a 'triangulation' process based on a mixture of questionnaire and focus group methods.

Due to the complexity of the selection and customisation of 'triangulation' processes it is advisable (but not mandatory) to appoint an external and competent agency/consultancy service to carry out the delicate task of assessing Safety Culture. The allocation of this task to 'outsiders' can sometimes more easily advance the recognition of Safety Culture strengths and weaknesses. It is also necessary to have the buy-in of staff in the organisation, whether controllers, engineers or managers, as otherwise the results may be too easily dismissed. Typically a Safety Culture intervention therefore requires an internal 'champion' to prepare the way for the survey, and help it all along the way through to follow-up of action plan implementation and, ultimately, a review after two or three years to see if Safety Culture has actually improved. Figures 8-10 expand upon this process.

The typical steps in the process of carrying out a Safety Culture intervention are expanded upon in the next two pages.

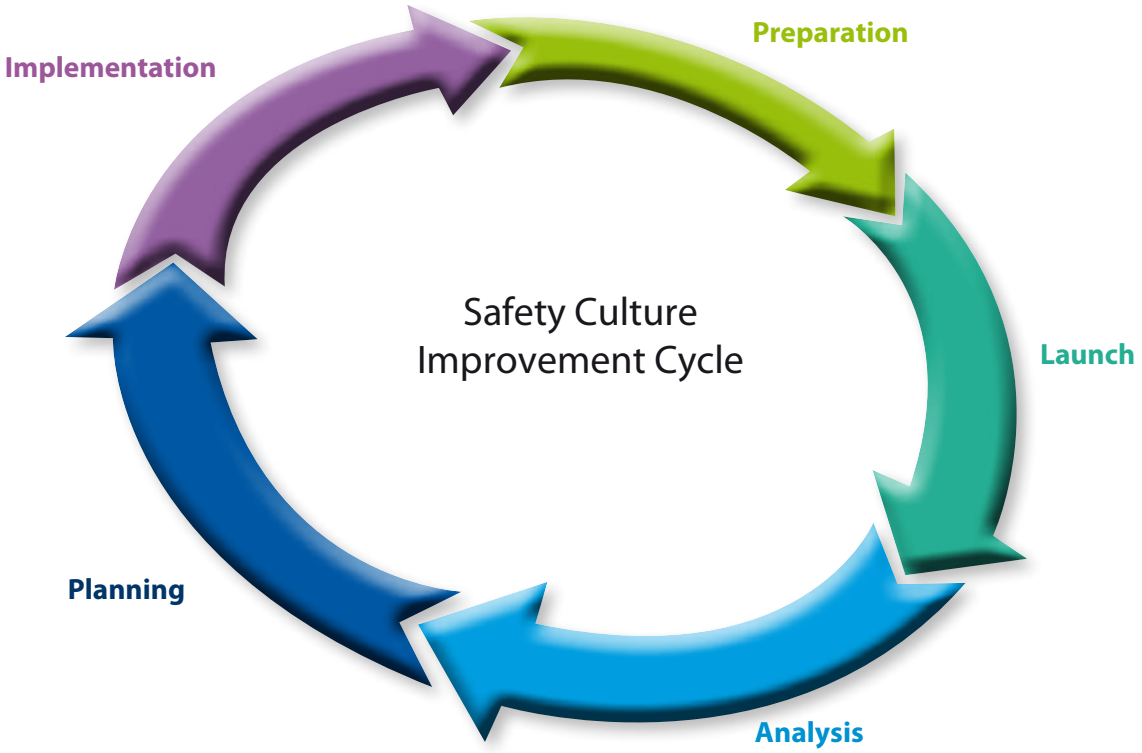


Figure 8 – The Safety Culture Intervention Process

PREPARATION

1. **Discussions between an external agency and the safety champion** – the safety champion is made aware of the process, what to expect, timescales, etc., and the champion may also make the study team aware of any relevant factors, e.g. recent incidents and accidents, re-organisations, SMS implementation, etc.
2. **Internal discussions and awareness-raising to prepare for survey** – the safety champion needs to get the buy-in of his or her management and staff, and decide the scope of the survey (e.g. it could be limited to a working population such as controllers or engineers, or include all operational staff and managers, or consider regional centres and towers, or include everyone in the organisation).
3. **Determination of timescale for the survey** – the organisation will discuss when the survey should start, e.g. avoiding very busy periods such as the summer, or potential clashes with other surveys or safety initiatives or structural changes to the organisation.
4. **Setting up a launch event for management & staff** – typically advertising a series of presentations on a particular launch date, to ensure attendance of key staff and management, as well as allowing transparency of the process to anyone who wishes to find out more about it.

LAUNCH

5. **Presentations by external people** – hosted by the champion with the backing at senior/top management level, to board and staff (separately or jointly); presentations to separate work groups as decided beforehand.
6. **Launch of the questionnaire** – (in the appropriate national language) either by dissemination of hard-copy or by electronic means, e.g. the organisation's intranet.
7. **Encouragement** – during the process by the champion and management. The aim is to have the questionnaires carried out by at least 40% of the identified target groups, and ideally 70-80%. If the returns are less than 30%, there is a real danger the results will not be representative of the organisation.
8. **Transmission** – completed questionnaires are sent directly back to the external analysis team.

ANALYSIS

9. **Analysis of questionnaire results** – initial statistics highlighting strengths and weaknesses, as well as statistical variability, followed by more detailed statistics (optional) using exploratory factors analysis to determine the key aspects of Safety Culture for the particular organisation in question. Issues for further investigation by workshop are identified.
10. **Interviews (optional)** – external consultants interview people in the organisation individually and confidentially to gain further information and corroboration on key points highlighted by the questionnaire.

11. **Workshops (preferred)** – workshops are run, typically 4 – 6 workshops during a two-day period, each with two external facilitators, tackling clusters of issues (e.g. 'just culture'; or priority of safety, etc.) with a small group (e.g. 4-6) of organisational personnel. There are three main aims: ensure the external analysts' understanding from the questionnaire is correct and complete; discuss the causes of the issues; and identify candidate solutions. Because the causes may be diverse, it is recommended that groups themselves are diverse (e.g. engineering, controller, management). It is then the facilitators' job to ensure that everyone gets a fair say, and all opinions are aired. Standard facilitation techniques (e.g. post-its, flipcharts, pareto voting; etc.) are used in the sessions. An example of effective Safety Culture workshops are those developed and implemented by the United States Naval Safety Center, and by the US Air Force: http://www.safetycenter.navy.mil/culture.
12. **Preparation of Report** – by the analysis team. No benchmarking with other organisations occurs, but strengths and weaknesses are summarised, and clustered into major insights and considerations for improvement, along with discussion of causes and potential improvement measures. Appendices give full disclosure of statistics, and the statistical summaries for each question answered in the questionnaire, both generally and broken down by different groupings, as well as information gleaned from the workshops.

PLANNING

13. **Presentation of Results** – the analysis team presents the results to management, and also to general staff or particular sub-groups (controllers, engineers, etc.).
14. **Planning** – the Analysis team will discuss provisional recommendations either with the Board, or an appointed staff team, to determine appropriate ways forward, and to inform an Action Plan. Usually such an Action Plan is a mixture of potential 'quick wins' and more long-term solutions.
15. **Publication of the Plan** – the Action Plan, or elements of it, should be announced within the organisation, so that people, particularly those who participated, can see that there is a result of their efforts. Elements may also be published in a more general Safety Strategy document.

IMPROVEMENT

16. **Implementation** – during the next 18 months an appointed task force reporting to the Board should be involved in orchestrating the changes and recording their progress.
17. **Review** – After a suitable period the task force should determine whether it is time to measure whether Safety Culture has been improved. This can be anywhere between 18 months and three years, but should be no longer. At this stage, the process may recommence.
18. **Sharing of Experience** – It is recommended, as good Safety Culture practice, that experiences are shared amongst ANSPs in terms of actions that work, and those that do not appear to work in their organisation. This will lead to a better understanding of how to improve Safety Culture in ATM.

Figure 9 illustrates the core of the analysis process (steps 9 – 12).

Figure 9 – Core Analysis Process

An example of the type of results found from a questionnaire analysis is shown in Table 4.

Top 4 Favourable Responses	Top 4 Unfavourable Responses
Team meetings are helpful to communicate concerns and collect ideas for improvements	People avoid getting involved in safety because their opinions are ignored
I need to be committed to safety - it is not just the organisation that needs to be committed	Confidential reporting systems encourage people to report incidents [respondents disagreed]
Everyone shares the responsibility for safety in this organisation	The budgets for projects are sufficient to allow us to address safety properly [respondents disagreed]
Controllers provide information about systems to maintenance personnel to keep the systems working properly (and vice-versa)	I have to work around procedures to get things done

Table 4 – Example of types of Results from Questionnaire Analysis

Table 5 then shows the types of insights in terms of improvement areas that can be gained, this time in the area of incident reporting.

Safety Culture Themes	Priority Issue	Ways Forward
Incident Reporting & Feedback	Resources, long-term vision & teams	Develop a long range plan and vision document on the way forward for the ANSP. This document should also address the resolution of staffing issues identified in the survey and more effective teaming aspects for incident analysis
	Incident reporting process	Make more use of Human Factors classifications in incident analyses; develop means of compensating for identified problem areas across incidents
	Information flow	Sharpen the focus and output media from the incident analysis (e.g. via reports and discussion groups), incorporating involvement of more operational expertise, and ensuring its impact on procedures and working methods where appropriate
	Technicians safety input	Ensure that technician expertise on technical failures that can affect operations is fed into simulation and contingency training planning

Table 5 – Example Recommendations

Figure 10 shows an example of the timings of the Safety Culture process, from initial launch of the survey, through to development of an improvement strategy, and ultimately to a second (or third, etc.) Safety Culture survey to see if improvements have been realised.

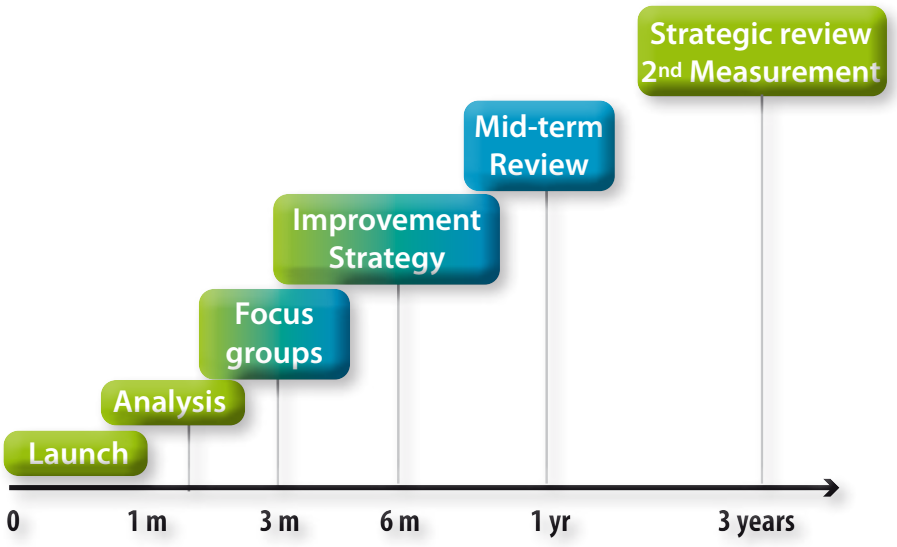


Figure 10 – Example of Safety Culture Process Timeline

Are the measures valid?

There are three over-riding questions concerning validity when discussing Safety Culture:

- Do the questionnaires have validity? (Are they responded to in a meaningful way? Do they measure what they are intended to measure?)
- For the users, does it help them understand and improve their Safety Culture?
- Does improved Safety Culture lead to improved safety?

The first question is a statistical one, and is concerned with what is called 'construct validity' – are we measuring what we think we are measuring? This is an important question due to the sometimes vague nature of Safety Culture. A questionnaire that has not been carefully developed could be measuring other things, for example, such as the SMS rather than Safety Culture, or even something more global like employee satisfaction. The way this is tested is using statistical techniques such as *Exploratory Factor Analysis* which needs a large number of responses to the questions. The method enables the analysts to see if different factors that are believed to be elements of Safety Culture, for example *priority of safety, trust*, etc., are 'recognised' by the respondents. For the EUROCONTROL Safety Culture Measurement Tool, for example, the original model of Safety Culture was based on a survey of four ANSPs which led to three main factors, and a total of thirteen sub-factors. However, later analysis, whilst supporting the original three main factors (Priority of Safety; Involvement in Safety, and Learning), could not reliably discriminate between the thirteen sub-factors. Instead, the sub-factors shown in Figure 11 were supported. Additionally, the detailed statistical analysis highlighted that a number of the questions were overlapping too much, and so some of these were culled or replaced by more precise questions. A third major result from the validation study of this questionnaire was that it needed to be segregated for different organisational groups, e.g. controllers (and assistants and supervisors), maintenance/technical/engineering (including supervisors), and management.

Statistical validation studies can therefore be useful in ensuring the questionnaires are 'hitting the mark', as well as refining the approach to obtain more accurate insights. However, to do this type of analysis requires large samples, usually at least 300 responses. Validation of Safety Culture questionnaires in ATM is therefore an ongoing process.

In the case of NAV-Portugal, this ANSP carried out two entirely independent Safety Culture surveys, using two different questionnaires developed by different agencies (EUROCONTROL and the University of Lisbon).

Figure 11: Elements of Safety Culture as derived from Statistical Analysis of Questionnaire responses for several European ANSPs

Both surveys happened within six months of each other. What was interesting was the high degree of agreement in the insights into the strengths and weaknesses of the organisation with respect to Safety Culture. This was not measurable statistically, but the organisation effectively had almost identical messages from the two independent surveys. A major difference however, was that one had been more widespread than the other, and had found significant regional variations (the former had mainly focused on the headquarters and main air traffic control centre).

The question of whether the results are useful to the organisation is not amenable to statistics; rather it is a qualitative indicator. The key question is whether the intervention leads to action by the organisation to improve their Safety Culture. In two specific cases in Europe, following the intervention, the ANSPs embarked on a major Safety Culture 'campaign' to improve Safety Culture across the whole organisation. Several other ANSPs are now either developing or have in place strategic action plans based on the findings of their surveys and workshops. One ANSP is already planning its second Safety Culture survey in 2009.

The longer term question of whether improved Safety Culture leads to improved safety (e.g. according to incidents and accidents), is much harder to prove, firstly because it takes time and requires a proper baseline measurement followed by a Safety Culture intervention, implementation of changes, re-assessment of Safety Culture, and re-evaluation of safety indicators. This is quite an undertaking for an organisation, and it is too early for ATM to have such results. Even in other industries, such evidence is rare. Instead there is usually qualitative evidence and a general conviction concerning the process (e.g. in nuclear power and oil and gas sectors of industry). A second problem in validating Safety Culture in this way is that during such a long period, e.g. of several years between the two measurements of Safety Culture, many other factors will have changed, and probably there will have been other safety improvements. This makes it difficult to determine whether Safety Culture led to an improvement in safety, or whether such improvement was due to the other changes.

A further consideration is the fact that Safety Culture is more often cited as a cause or strong contributing factor of accidents (e.g. Uberlingen mid-air collision, and Milan Linate runway collision). The ATM industry needs to understand how poor Safety Culture is a threat, and then to manage such a threat. Since SMS does not normally/usually encompass requirements for Safety Culture (although at least one European ANSP stipulates the need for regular Safety Culture surveys in its SMS), a Safety Culture survey is seen as a means to manage potential Safety Culture weaknesses. Therefore, the effect of Safety Culture on actual safety is more indirect, though the impact of poor Safety Culture becomes palpable after an accident.

In scientific terms, Safety Culture fits into what is known as '**Pragmatic Research**'. Pragmatic research focuses its attention on 'messy situations' that are real-life environments where major driving factors cannot be scientifically 'controlled', nor their influences fully explained. Validity is approached in a more descriptive way. Research methods in a real environment are effectively validated by the adoption rate of the practioners within the community of practice associated with the field (Brown, 1992), (Hodkinson, 2004), (Zaritsky et al., 2003) [e.g. as in the case of the Safety Culture Maturity approach in the North Sea Oil and Gas sector]. Nowotny (2000) calls knowledge of what has been validated by the multidisciplinary community of practice 'socially robust', meaning that it has been developed in, and for, the real-life context outside the laboratory and can be used by practitioners. This notion of pragmatic research appears to describe perfectly the approach of Safety Culture, which is ultimately more about improving safety than having high statistical integrity. At the time of production of this White Paper, ten European ANSPs have embarked on the 'Safety Culture Journey' representing fully a quarter of ECAC Member States, and more are already signing up.

3. IMPROVING SAFETY CULTURE

How do you improve Safety Culture?

In the previous section we talked about diagnostic tools to measure Safety Culture. Once we have identified Safety Culture weaknesses thanks to these tools, we can pass to the application of other behaviour-based tools and techniques for improving Safety Culture by addressing specific safety behaviours. These tools are named intervention tools. In the literature (see Straughen) behavioural interventions and safety leadership are mapped against the Safety Culture maturity model. In this way the tools are selected taking into account the assessed level of organisation's safety maturity. In the present paper we simply state that the techniques are identified to enhance the weakness of the organisational Safety Culture, making the most of existing strengths. The most common techniques are linked to safety leadership, behavioural intervention and training interventions.

Leadership from the Top

At the Board and CEO level, there are several practical steps that can be taken which will send a strong Safety Culture message through the organisation:

- The CEO and management in general asking questions about safety, showing an interest in tangible safety issues
- The CEO chairing the organisation's Safety Committee, and asking questions such as 'what are our safety risks? What is being done about them? Is it enough? How do we know?'
- Informing the whole organisation, via internal media, of the key safety risks and actions underway to mitigate them
- Safety as the first item on weekly Board meetings.
- Supporting the notion of Just Culture
- Allocation of funds to safety efforts
- Ensuring a strong and empowered safety department
- In tough high-level safety vs. capacity decisions, safety coming out on top can have a marked impact (actions speak louder than words)
- Visiting operational centres, towers, maintenance and technical workplaces, etc., and talking with people about safety
- Safety 'campaigns'
- Launching, and then acting on the results of a Safety Culture survey.

Safety Leadership

A positive Safety Culture has effective communications and good organisational learning amongst its characterising features. These features are correlated with positive organisational management. Whilst strong Safety Culture can exist at any level in an organisation, the higher up the organisation, the easier it is to cascade down Safety Culture, and the less there is the need to 'fight against the tide' to work in a completely safe manner. Therefore, strong Safety Culture is often linked to the availability of competent and safety-committed managers.

In fields such as aviation, nuclear energy and the oil and gas industry, several safety leadership programmes, e.g. via Crew Resource Management (Flin et al., 2000), have been run with success (Straughen et al.). Safety leadership programmes consist in developing specific safety behaviours involving initial skills training. These programmes are not simply knowledge-based; they provide participants with an overview of their organisation's safety performance, which improves their situational awareness. On the basis of the identified weaknesses and strengths of the current situation, managers are taught how to demonstrate their own commitment and how to involve their subordinates in safety activities, such as hazard reporting, motivating other people to behave in such a way to achieve goals set in view of meeting safety performance targets.

Perhaps one of the key goals here is to ensure that everyone has a clear picture of their own safety accountabilities, for their job and level in the organisation. This is best achieved by discussions between supervisors/managers and the controllers or other groups (e.g. maintenance and engineering), rather than simply re-stating official rules etc. Safety accountabilities must be expressed in people's own language for Safety Culture to be effective – this holds true whether for a maintenance technician, or the CEO.

Safety Education

Traditional training interventions and safety literature are useful when organisations are shown to have a poor Safety Culture. The training brings the entire organisation to the same basic level of understanding. In general, the training concerns the introduction of a safety management system, which should be in place before starting the application of any other technique. Safety training must be pertinent with the job, and, if possible, integrated into job training. Safety training is important also for managers who need to keep up-to-date with work practices and safety legislation. However safety promotion and safety training are seen as "passive approaches traditionally used to win people's heart and minds" (Cooper, 2001); and training courses and safety propaganda alone do not guarantee an appropriate commitment of the organisation's staff.

Safety 'Mindfulness'

Each person at each level in the organisation will have an idea of what the risks are. The trick is to build a coherent and collective safety 'mind' so that, as a whole, the organisation can work to control and reduce risks. This does not mean that everyone's picture is the same – this is not practical – rather, it means that the pictures and perspectives 'add up', so that a CEO and a controller, for example, can have a meaningful discussion about the latest incident.

The International Atomic Energy Agency (IAEA) has recently been considering this by determining what are the main safety 'functions' (e.g. this would be safe separation in ATM), what the challenges are to those functions (e.g. level busts), and also what are the controls (e.g. STCA & TCAS), mechanisms (e.g. clearances and readbacks) and provisions (e.g. radar update frequency & integrity) to prevent loss of control of safety. In the same way, a CEO will be concerned mainly with high level challenges, whereas a safety director may be focusing as well on the safety functions, and a controller or engineer may be working at the 'provision' or 'mechanism' level. What is needed is a living dialogue horizontally and vertically in the organisation so that the organisation as a whole has all the pieces of the picture, and better and more practical ideas to address the issue. This will give the organisation a better 'Risk Picture', and a more effective risk management process.

Changing Behaviour

Unsafe behaviours serve as the triggers for numerous accidents. System design can introduce some negative features in the workflow process, which may induce unsafe behaviours of the operators. Improving behavioural safety consists in addressing unsafe behaviours by proactively focusing people's attention on them. People become aware of their potential to cause, or prevent, harm. In this way people realise and control these mechanisms or negative behavioural patterns, even in the presence of negative system features.

Whilst there have been numerous approaches to behaviour modification (whether managers or staff) in other industries, the best tools for ATM are less clear, and perhaps need development and testing. Such tools could build, for example on Team Resource Management, or on the observation of normal operations and safe behaviour, as are currently being explored by certain ANSPs. This is therefore an area still under review.

Can Safety Culture be improved?

On the basis of the evaluation of the strengths and weaknesses identified from the assessment phase, it is possible to develop an enhancement strategy. The strategy is then agreed by the ANSP, taking into account the organisation's vision and mission. It should consist of an elaborated, feasible and systematic plan of action. The identified actions should be traced back to the findings of the Safety Culture assessment and be tied in with the business plan to guarantee the required management and resource support. The definition of an Action Plan is an elaborated process since Safety Culture itself evolves over time: organisations do not exist frozen in time, so Safety Culture will also be always in a process of change. Management policies and procedures will change as well as training regimes and so on. The aim of Safety Culture improvement is to apply 'positive safety pressure' during a period of change, whether such change is initiated internally, or driven by external forces, or both. Culture can take years to change, and requires a constant and consistent drive in the safety direction. Otherwise, there will be a drift back towards 'the norm'. It is like fighting gravity: the gravity will always be there, and if the safety effort stops, or loses its way, whether through external pressures or internal complacency about safety, then culture will slide backwards in safety terms, often without realising it, until a serious incident or accident causes a sharp 'correction' in risk perception. This latter path is the hard path; and history has shown that some organisations do not learn even after major accidents, so that accidents repeat.

Therefore, 'drivers' of Safety Culture must be identified. Cultural drivers can be divided in 2 groups: organisational drivers and 'key individuals'. Organisational drivers are the internal and external drivers on behaviour (e.g. re-organisations; cost-reduction pressure; new procedural requirements and legislation or standards; etc.). Key individuals and groups, such as CEO, management, supervisors, safety personnel and employees, can greatly influence culture through what they do, what they say and what they believe. This is the strength of Safety Culture – it can be an individual choice about what type of organisation, and what type of industry, we want to work in. The choice, and the challenge, is ours, every day.

4. HIGH LEVEL STRATEGY FOR U.S. AND EUROPE

European Mission

A number of European ANSPs have already engaged in exploring, measuring and enhancing Safety Culture in their own organisations, and several ANSPs have begun to share their insights and lessons learned. EUROCONTROL has embarked on an initiative to develop an approach for any ANSP to utilise for its organisation, and is supporting and collaborating with a number of ANSPs in a multi-year programme of European Safety Culture enhancement. The principal aims are as follows:

- Develop a toolbox of methods to enable ANSPs to assess and improve their Safety Culture
- Assist ANSPs in such assessment and improvement activities where assistance is required
- Encourage all Member States to carry out a Safety Culture Survey to understand their ANSP's strenghts and weaknesses (whether assisted by EUROCONTROL or other organisations) by 2013
- Engage European Chief Executives in understanding and promulgating Safety Culture
- Act as a launching pad for an ANSP-led partnership on developing Safety Culture in European ATM, impacting across the whole of Europe
- Foster the sharing of lessons learned in Safety Culture
- Share ideas with its FAA partners on Safety Culture approaches.
- Ensure a robust Safety Culture exists in European ATM by 2013, prior to the main SESAR Operational improvement implementation phase of ATM advancement in Europe.

U.S. Mission

The U.S. has begun the process of completely changing its air transportation system, to meet future demands of two or three times the current level of traffic. Pressures to increase capacity will require that the current level of safety be improved. The transformed system (NextGen) is relying on the implementation of Safety Management Systems (SMS) to ensure that the level of safety remains acceptable to the flying public. It is also recognised that without an improved Safety Culture, the SMS may not achieve its goals. Within the FAA, Safety Culture improvement has been addressed in parallel with SMS implementation in the following ways:

- Develop a baseline for the FAA's Safety Culture via upper & middle management interviews, and employee surveys
- Develop and implement non-punitive safety reporting systems that encourage employees to identify safety hazards
- Train air traffic control facilities to conduct Crew Resource Management Training, to examine safety issues within a facility, using employee suggestions to develop solutions
- Support human factors research to validate the assumption that Safety Culture improvements will lead to actual safety performance improvements in the organisation
- Increase safety awareness for all employees through improved safety communications
- Develop innovative and effective training to enhance Safety Culture throughout the organisation.

CANSO

(the Civil Air Navigation Services Organisation) is also developing a Strategic Safety Culture vision for its members, with similar aims to enhance the Safety Culture of its members in a comparable timeframe to EUROCONTROL and FAA (2012-13).

5. SUMMARY AND CONCLUSIONS

In the past half-decade, Safety Culture in ATM has progressed from being a vague and misunderstood concept, to becoming a valued new process for improving safety. Efforts have been made to 'get it right', by underpinning the approach with thorough research and development, before applying it for real in ANSPs. This effort is now realising tangible benefits.

The real challenge remains, however, of transitioning from a Safety Culture measurement stage to an improvement stage – we need to learn how to improve, and share such lessons. Next comes the challenge of having Safety Culture improvement driven by the ANSPs themselves, raising the whole ATM industry up in Safety Culture terms, and sustaining this throughout the future changes facing ATM globally. This will not be easy, but the net benefit will be a successful and highly safe industry, which is what ATM has always aimed to be.

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