



Safety Critical Systems Club: Safety Culture Working Group

A position paper for assessing and managing safety culture: SCSC-189

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The Safety Culture Working Group (SCWG) seeks to:

‘Improve safety culture in safety critical organisations, focussed on product and functional safety, by sharing examples and latest approaches collated from real life case studies’.

This position paper aims to provide high level guidance on the assessment and improvement of safety culture for organisations that design, build, assure and operate complex safety critical systems. It represents recognised good practice and can act as a benchmark and guidance.

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1 Aims of this position paper

The members of the Safety Critical Systems Club (SCSC) represent a wide range of complex and engineered systems. The role of many organisations is to specify, design, make and assure complex safety critical systems, as well as to operate these systems and learn from experience. These systems are developed for and operated within sectors including defence, nuclear power generation, oil and gas, transport (aviation, marine and rail), automobiles, health care and others.

This position paper aims to:

- Exemplify how safety culture manifests itself in the process of specifying, designing, manufacturing, operating and assuring complex safety critical systems;
- Provide guidance on good practice that organisations with safety critical activities should aim to achieve;
- Draw out key methods that are of particular importance to organisations with safety critical activities.

The paper does not aim to provide detailed guidance or worked examples. Further reading and references are offered.

While the guidance in this paper may apply equally to all safety domains, it focuses on the safety of designing, manufacturing, assuring and operating complex safety critical systems.

This position paper was produced by the Safety Culture Working Group (SCWG) of the SCSC.

2 Safety culture

2.1 What is safety culture?

The SCWG position is that the concept of safety culture is a valid and useful concept. Numerous regulators and agencies have published guidance on safety culture, its importance and the need to systematically assess and manage safety culture.

The term “culture” refers to the norms, values, beliefs, attitudes and behaviours of a group of people. This group of people may comprise a nationality, an ethnic group, members of an organisation or members of a particular profession. Any one person may participate in a range of cultures, such as those held by the organisation they work for, those held by members of their occupation, as well as their nationality and ethnicity, for example.

The term “safety culture” refers to the safety related norms, values, beliefs, attitudes and behaviours of the person’s organisation. A classic definition of safety culture is given below:

“The safety culture of an organisation is the product of individual and group values, attitudes, perceptions, competencies, and patterns of behaviour that determine the commitment to, and the style and proficiency of, an organisation’s safety management system (within the overall business management system).”

Adapted from ACSNI Human Factors Study Group, 1993[1]

This definition indicates that the safety culture of an organisation will impact the proficiency of the safety management system.

A more recent definition of safety culture by the IAEA, 2018 [2], is:

“the assembly of characteristics and attitudes in organisations and individuals which establishes that, as an overriding priority, protection and safety issues receive the attention warranted by their significance.”

Position 1.
Safety attitudes, values, perceptions & behaviours need to be assessed & managed to support safety performance

Safety culture is part of a wider organisational culture, but will have distinct values, beliefs and behaviours. Moreover, it is necessary to understand these safety related values, beliefs and behaviours, and how they influence safety performance, to be able to manage and maintain an effective safety culture. It can be useful to relate safety culture to attributes of the organisation, such as production goals and large power gradients in hierarchical organisations. This understanding will inform strategies for helping people understand how the organisation wishes to balance safety and production, or how they should ensure safety issues are communicated within a hierarchical organisation, for example.

2.2 Is safety culture the same across an organisation?

While the definitions refer to an organisation's safety culture, there is evidence that safety culture is not the same everywhere in large organisations (see Mannion and Davies, 2018, for example[3]). Various factors can influence safety culture, such that sub-cultures might emerge due to differences in experience, training, leadership, ethnicity, national culture and perceptions of organisational goals. It is likely that safety culture can differ across an organisation, such as between departments, across roles, and through levels of an organisation. Assessments of safety culture often find that, for example, operational staff have very different perceptions of the organisation's commitment to safety than senior management, while (for example) maintenance and operations departments may have different perceptions.

Position 2
Safety cultures can vary between different safety domains & between parts of an organisation

There is evidence that safety culture does vary between different safety domains, such as between occupational safety and process safety (Figure 1). This evidence includes the major accidents at Texas City refinery, Longford gas processing site, Deepwater Horizon, and British railway incidents. In each case the organisations had a strong focus on, and good performance in occupational safety. However, this did not reflect equal focus onto, and good performance in other safety areas, such as design, maintenance or operations of safety critical systems. Managers were presenting awards to staff on the Deepwater Horizon for occupational safety at the time of the blowout.

Factors that might influence whether an organisation has a singular safety culture or divergent cultures, include:

- Whether the organisation adopts an integrated approach to safety or manages each area of safety separately such as with separate occupational safety and process safety departments;
- Whether the weight of regulatory intervention focuses more on one safety domain than others; and
- Whether the organisation views one safety domain as more business critical than others.



Figure 1: Examples of safety domains

The implications of the potential for divergent safety cultures include:

- The need to understand if and how culture can vary between different parts of an organisation or between different safety domains;
- That assessment and potential intervention of safety culture might need to acknowledge the existence of separate safety domains, if cultures in an organisation differ between safety domains; and

- The need to consider how to best implement a safety culture improvement programme for it to be effective, for example, will an integrated approach to safety culture improvement across safety domains or departments be adequate? or will targeted improvements across safety domains, or departmental specific approaches, be better?

Position 3
Organisations should assess culture as it effects all aspects of safety performance

2.3 Why is safety culture important?

“Poor” safety culture within the design, safety assurance and operation of safety critical systems has been a key factor in catastrophic accidents. “Good” culture is seen as critical for successful safety performance across the design, build, assurance and operation cycle. As noted by the Haddon-Cave enquiry[4], “safety is delivered by people, not paper”.

Position 4
“Good” safety culture is critical for successful safety performance across design, build, assurance & operations

The 2006 fire and crash of the United Kingdom’s NIMROD maritime reconnaissance/strike aircraft exemplifies the role of safety culture in the assurance of system safety. A fuel leak contacted hot pipework and ignited. The Assistant Deputy Coroner stated¹:

"This cavalier approach to safety must come to an end. There were failures...[in monitoring the aircraft's safety]...that should, if the information had been correctly recorded and acted upon, have led to the discovery of this design flaw within the Nimrod fleet."

The inquiry said that there had been a failure or leadership in producing the safety case, with inadequate priority given to the safety case. There was a general “malaise” and assumption that the aircraft was safe, having entered service in 1969. The inquiry thought that fuel probably overflowed during air-to-air refuelling, using a refuelling modification fitted in 1989. The fuel was probably ignited by the Cross Feed/Supplementary (air) Conditioning Packs (SCP) duct. The SCP duct was fitted in 1979 and increased ignition risk. These were considered to be “latent” design flaws. There had been a number of previous incidents and warning signs that should have been a “wake up call”, including the rupture of the SCP duct in 2004.

The safety case was considered a ‘tick box’ exercise. The safety case was reported to be rushed and to contain significant errors and omissions. 40% of hazards were left ‘open’ and 30% were ‘unclassified’, including the Cross Feed/SCP duct hazard. Outstanding risks were sentenced in an unrealistic basis. The Cross Feed/SCP duct hazard was classified as “Tolerable”.

If the safety case had been drawn up properly, the latent design flaws introduced by the modifications to the plane could have been identified and the accident could have been avoided.

This incident brought a focus of interest onto the role of safety culture in the design, build, safety assessment and in service management of complex safety-critical systems.

Two other examples are summarised below.

Accident case study 1: VSS Enterprise crash, 2014

The Virgin Space Ship (VSS) crash occurred on October 31, 2014, when the VSS *Enterprise*, a SpaceShipTwo experimental spaceflight test vehicle operated by Virgin Galactic, suffered a catastrophic in-flight breakup during a test flight. The SS2 was meant to unlock a feather mechanism at 1.4 Mach to ensure it was in position during re-entry. The feather flap assembly with twin tailbooms upwards to stabilise attitude and increase drag on re-entry. The feather mechanism was deployed too early while still under rocket propulsion at 0.8 Mach. The feathering mechanism then began moving due to aerodynamic forces on the tail and inertial loads and the craft disintegrated.

Cockpit image recording showed that the pilots’ voices were strained, with high levels of vibration

¹ BBC. Nimrod fleet 'should be grounded'
<https://web.archive.org/web/20080526020807/http://news.bbc.co.uk/1/hi/uk/7416627.stm> Accessed January 2023.

and loads from acceleration. It is thought that the pilot deployed the mechanism early due to high workload and stress in the short time span available, just ~30 seconds for three tasks recalled from memory. The conditions of high acceleration and vibration had not been replicated in simulator training and the pilot had no recent experience of this effect.

The hazard analysis had recognised this to be a single point catastrophic failure but had not considered the possibility of error of premature unlocking of feather mechanism. It assumed pilots would always operate correctly due to training/simulation runs. The craft operated under an experimental licence from Federal Aviation Authority (FAA) who found that the hazard analysis did not meet requirements but issued a waiver and did not determine if there was mitigation against single point (human) failure. The US National Transport Safety Board (NTSB[5]) found that:

“An FAA/AST² evaluator added that there was “a lot of pressure, political pressure” to issue experimental permits, even when FAA/AST evaluators were uncomfortable with an application, which diminished AST’s safety culture.” (p60)

“FAA/AST management appeared to be more concerned about ensuring that the FAA’s authority in this emerging industry was not being exceeded beyond defined limits and maintaining the timeframe in which to approve experimental permit applications.” (p6)

“Many of the safety issues that we will hear about today arose not from the novelty of a space launch test flight, but from human factors that were already known elsewhere in transportation.” NTSB chairman Christopher Hart

SS2 has since been modified with an automatic mechanical inhibit device to prevent locking or unlocking of the feather during safety-critical phases.

Accident case study 2: Mid Staffordshire NHS Foundation Trust, 2005-2008

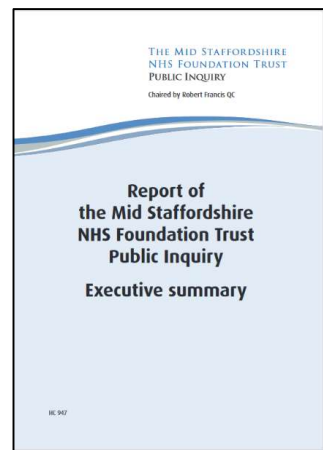
In 2007 concerns were raised about the mortality rate of patients at Mid Staffordshire NHS Foundation Trust, with potentially hundreds of more deaths occurring in a three year period (2005-2008) than expected for this type of hospital. A subsequent public inquiry [6] reported that in this period, “..conditions of appalling care were able to flourish” and persist, including a lack of basic care of patients. The inquiry concluded that the failings were:

“... primarily caused by a serious failure on the part of a provider Trust Board. It did not listen sufficiently to its patients and staff or ensure the correction of deficiencies brought to the Trust’s attention.

Above all, it failed to tackle an insidious negative culture involving a tolerance of poor standards and a disengagement from managerial and leadership responsibilities.



Figure 2: VSS Enterprise Space Ship Two and NTSB crash scene



² AST - Associate Administrator for Commercial Space Transportation

This failure was in part the consequence of allowing a focus on reaching national access targets, achieving financial balance and seeking foundation trust status to be at the cost of delivering acceptable standards of care.”

The organisational culture resulted in a focus on business performance rather than patients and their safety, with a tolerance of poor standards, and lack of managerial accountability. Many recommendations were made, such as to foster a common culture that put the patient first, openness, candour and transparency about matters of concern. This example shows that safety culture includes maintaining ethical behaviours when under competing commercial and programme pressures.

2.4 What stages in the system lifecycle should organisations address?

Safety culture is a critical aspect of the entire system lifecycle through typical phases of design, build, operation and disposal/termination. Organisations should assess safety culture at each phase as the culture can influence all aspects of safety performance, including but not limited to:

Position 5
Organisations should assess culture along the entire system lifecycle

- The specification and design of systems;
- The procurement, manufacture and testing of systems;
- Assurance, such as safety assessment and safety cases;
- Operation and maintenance of systems;
- Learning lessons from operational experience.

This does not necessarily require an assessment of culture across the lifecycle of every system. Assessment may be performed of culture in a design function, cutting across all systems, for example. However, there may be value in major projects to perform project specific assessments, especially where these are large enough to have project specific organisations.

Some examples of behaviours and attitudes that are specific to a stage in the system lifecycle and safety domain include:

- **Design:** The extent to which inherent safety is prioritised in the specification and design of a new system.
- **Safety assessment and assurance:**
 - The tolerance of single points failures within safety assessment and approval of systems.
 - The ‘openness’ of hazard identification workshops.
- **Safety engineering:** The time taken to close out design actions.
- **Maintenance:** The acceptance of maintenance concessions permitting operation of systems with faults, temporary engineering or incomplete maintenance, including accepting long term concessions and renewal of concessions.
- **Operation:** The willingness of staff to report concerns about the state of repair of systems, near misses and operational problems. The propensity of management to recognise safety concerns and invest time and resources into their resolution.

3 The assessment of safety culture

3.1 Is it good practice to assess safety culture?

The assessment of safety culture is relevant good practice and is common practice amongst many safety critical organisations. Various tools, techniques, and methods have been developed, for example:

Position 6
The assessment of safety culture is relevant good practice

- **Nuclear:** IAEA's General Safety Requirements (GSR) Part 1 [7] require regulators to consider safety culture when conducting inspections and provides guidance on how to do assessments in IAEA SR 83. This includes self-assessment of safety culture by nuclear licensees. The IAEA's "traits of a healthy nuclear safety culture" have been made into a staff survey.
- **Energy:** The Energy Institute offer the Hearts and Minds [8] safety culture assessment toolkit for use across oil and gas, petrochemical and other energy sectors.
- **Rail:** The European Union Agency for Railways performed safety climate survey as part of its safety programme [9]. The Agency has developed a safety culture model and assessment method that can be used by EU member states. The United Kingdom's Rail Safety and Standard's Board provide a safety culture assessment toolkit[10].
- **Healthcare:** NHS England [11] conducted focus groups to understand the NHS safety culture as parts of its development of a patient safety strategy. The Manchester Patient Safety Framework is available for use in healthcare [12]. The Health Foundation [13] notes that:

"Measuring safety culture or climate is important because the culture of an organisation and the attitudes of teams have been found to influence patient safety outcomes and these measures can be used to monitor change over time."

- **Aviation:** The United Kingdom's Civil Aviation Authority [14] self-assesses its safety culture, as does the Eurocontrol [15]
- **Defence:** The regular assessment of safety culture is cited as best practice (termed Full Assurance) by the United Kingdom's Ministry of Defence [16] as follows "Health and Safety culture and behaviour surveys are completed and responded to on a regular basis." (p13)

The methods cited above have been tried and tested over a number of decades and they are advocated for use along with other guidance to help develop improvement plans, to benchmark and track progress over time. As with all assessment methods, there is continual research to further develop and validate safety culture assessment methods, and all assessments should be completed and interpreted by competent persons.

3.2 What are the purposes of safety culture assessment?

Assessment can serve a number of purposes including:

- Insights to support improvements, such as:
 - Strengths and weaknesses
 - Which departments or roles have stronger-weaker cultures?
 - What are the factors contributing to poorer culture?
- An understanding of the current culture and hence an indication of the need to improve;
- Tracking over time whether culture is steady, improving or declining;
- Demonstrating to stakeholders that the organisation is a responsible and safe operator.

Position 7
Assessment should aim to profile, measure & assess the adequacy of safety culture, and provide insights to inform improvements

It can also be noted that the absence of incidents does not necessarily mean that safety is being achieved, especially with low frequency major accident risks, or where the effect of behaviour (such as during design) is not revealed until a later point in time such as when the system is first operated. An assessment of safety culture can provide insights into safety performance especially where incident rates are not a reliable nor practical measure of safety performance.

3.3 What approaches have been applied to the assessment of safety culture?

3.3.1 Approaches

As noted above, the aims of assessment should include the development of a profile of safety culture and the “level” of culture to sufficient depth of understanding to inform judgement on the adequacy of safety culture, decisions on the need for improvements and the nature of those improvements. As culture cannot be directly measured, it is commonly inferred from a blended approach of behaviour observation, management system review, and questioning to determine perceptions, attitudes, norms and values.

Position 8
A combination of methods should be used to assess safety culture

Combining methods

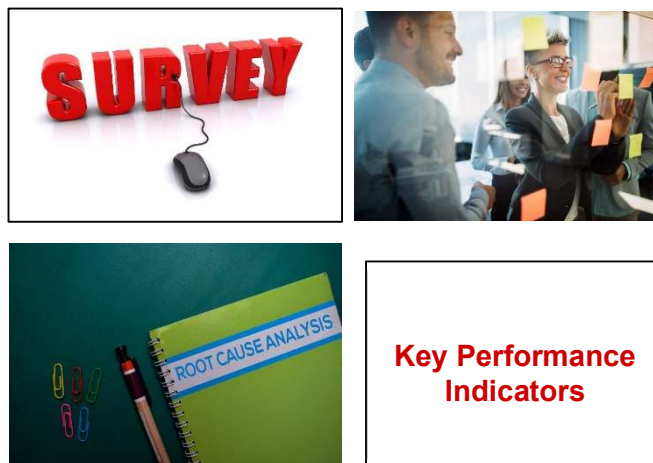
A combination of methods can provide support for measuring and understanding safety culture. It is recognised good practice and is common practice amongst many safety critical organisations.

Assessment usually combines methods, usually staff surveys, workshops, root cause analysis and key performance indicators such as frequency of near miss reporting, as illustrated in Figure 3.

- Surveys can capture the perceptions of large numbers of people, supports measurement and comparison of responses between roles, departments and organisations.
- Workshops can provide in-depth understanding of attitudes and perceptions.
- Root cause analysis of incidents can provide insights into the role of attitudes and behaviours within incidents.
- Key Performance Indicators can provide a measure of organisational performance on “cultural” practices such as reporting and leadership.

All assessments involve sampling, such as surveying perceptions of (for example) 50% of staff, or running workshops with (for example) 5% of staff. As with all approaches to assessment, good survey and analysis practice needs to be applied, and uncertainties in the results need to be identified and acknowledged. A combination of methods allows findings to be triangulated, cross referenced and cross validated, adding weight to conclusions.

Figure 3: Combining assessment methods to measure and understand safety culture



3.3.2 Common methods

There are numerous assessment methods. Many methods have been tailored to the needs of specific sectors, such as for healthcare, rail, nuclear power and oil and gas. Methods tailored for a sector have the advantages of using terminology that respondents can understand, and use examples of attitudes and behaviour specific to the respondents' activities and safety issues. Common approaches and their advantages and disadvantages are shown in Table 1.

Table 1: Common methods for assessing safety culture

Approach	Pros	Cons
Staff surveys/ Questionnaires	<p>Practical approach to engaging many people in assessment of culture</p> <p>Enables comparison between parts of an organisation, between roles and between people according to (for example) years of experience.</p>	<p>Requires good survey management to secure a representative and valid response rate</p> <p>Requires good psychometric design to avoid "socially desirable responses"</p>
Workshops & focus groups & interviews	<p>Provide insights and examples of behaviours to help understand culture and the roots of culture</p> <p>People feel engaged and listened to</p>	<p>Resource intensive to engage many people</p> <p>Requires significant time to analysis and theme responses</p>
Critical incident analysis	<p>A "hard" form of evidence that can provide deep insights</p>	<p>Only provides insights into adverse events and does not represent strengths</p> <p>Significant incidents may not have occurred</p>
KPIs	<p>A "hard" indicator</p>	<p>Do not provide any insights or understanding of roots of performance</p> <p>Can be difficult to measure safety behaviours</p>
Observation	<p>A "hard" form of "evidence.</p> <p>Can capture positive as well as negative behaviours</p>	<p>Resource intensive</p> <p>Intrusive</p> <p>Observed people may change their behaviour when observed</p>
Document Review	<p>Helps to understand and profile safety management systems, policies and expectations</p>	<p>Only provides context and is not a measure of culture or behaviour. .</p>

3.3.3 Examples of assessments

Three examples of assessment are noted below. These exemplify the alternative approaches of a) assessing all safety domains together, b) assessing different safety domains in parallel and c)

assessing a single safety domain. They also exemplify; the use of multiple methods such as surveys and workshops; using results to compare between departments and roles; identifying strong and weak elements of culture; using results to inform action plan; and tracking change over the years.

Docklands Light Railways: Safety culture maturity assessment of all safety domains

Docklands Light Railways (KeolisAmey Docklands - KAD) assessed safety culture using a combination of a staff survey and workshops [17]. The assessment was repeated every two years to track the success of improvement. The assessment used a variation of the Hearts and Minds Pathological to Generative maturity model (a pre-defined 5-point maturity evaluation scale was used to evaluate the results), with questions amended to apply to railway operations. As KAD adopted a holistic approach to all areas of safety (rail, passenger, occupational health and safety, assault and mental health), a single assessment covered all domains of health and safety. The assessment covered 10 elements of safety culture, such as leadership, communications and learning, with an assessment of each element.

The assessment compared maturity levels between departments and between staff, middle and senior management, as well as providing a measure of safety culture maturity for the organisation as a whole. The assessment also provided measures for each element of safety culture, such as leadership versus communications. This helped identify strengths and weaknesses. As stated in the paper:

“Use of such an evaluation scale also supported KAD to identify weaker and stronger areas, with respect to the ten elements and different workforce groups, as well as allowing them to judge the acceptability of their overall safety culture maturity.”¹⁷

The workshops from across KAD provided insights into the factors underlying culture and examples to help understand the perceptions of organisational culture.

The results were used to inform improvement plans.

DE&S: Acquisition safety culture

The UK MoD's Defence Equipment and Support agency developed, validated and applied a safety culture measure of its acquisition safety culture [], namely a staff questionnaire. The agency key roles included specifying safety requirements for new equipment, safety assurance and safety cases. The assessment focused on this single safety domain and measured a range of elements of safety culture. Results were developed for each department and the organisation as a whole, helping to identify priority areas and elements of culture to focus on. The assessment was completed annually to inform annual plans and to track improvement in acquisition safety culture.

BAE Systems: Assessment of product safety and workplace safety culture

BAE Systems developed, validated and applied a safety culture maturity assessment toolkit [18]. This was a variation on the Hearts and Minds toolkit, with questions amended to apply to defence products and workplace safety in a design and manufacturing environment. The toolkit comprised a combination of staff surveys, workshops, incident reviews, observations and document reviews.

Two questionnaires were developed, one for product safety and one for workplace safety. The two safety domains were assessed in parallel, across a range of elements of culture.

As with KAD, the assessment compared maturity levels between departments and between staff, middle and senior management, as well as providing a measure of safety culture maturity for the organisation as a whole. The assessment also provides measures for each element of safety culture, such as leadership versus communications. This helped identify strengths and weaknesses. The results were used to inform improvement plans.

3.3.4 Interpreting assessment results

Spotting strengths and weaknesses

It is common practice to use assessments to identify strengths and weaknesses, and for this to be used to inform what needs to change and the prioritisation of changes. Many aspects provide results per element of safety culture, such as leadership vs communications. Those elements with poorer scores are treated as weaknesses and priorities for change.

Understanding underlying factors

Where assessments have used “insight methods” such as workshops, this may provide information of the nature of weaknesses and their causes. For example, communication may be considered inconsistent, or too infrequent or mixed messages or does not reach all parts of the organisation. These insights and examples drawn from feedback can help elaborate changes.

Assessing the adequacy of safety culture and need for change

Some methods provide a view of the “level” of safety culture, such as pathological versus proactive. Some methods provide a measure such as 80% of people agree that (for example) communication is effective. These qualitative and quantitative results can be used to inform a judgement of the adequacy of current culture and the distance to the desired level of safety culture. As noted in section 3.5, a high standard of safety performance and culture is commonly expected of organisations responsible for safety critical systems and operations. This standard may be expressed as a “level” (such as proactive) or by fulfilment of a safety culture model such as the just culture model. The assessment may be used to compare an organisation to these expectations, and thereby inform a judgement of the extent to which improvement is needed.

3.4 What does a “good” safety culture look like?

3.4.1 An overview

There are many models of safety culture which are intended to represent what “good” looks like, with some listed in Table 2.

Position 9
Organisations should use a valid and recognised model of safety culture to inform their improvements.

Table 2: Some common models of effective safety cultures

Model	Comments	References
Hearts and Minds	Originated in oil and gas. Variations of this model have been used in other sectors including defence, health care, rail and other sectors.	Energy Institute https://heartsandminds.energyinst.org/
Just culture	Widely used in health care, aviation and nuclear sector. Tools used for its implementation have evolved in response to lessons learned.	NHS England guide https://www.england.nhs.uk/patient-safety/a-just-culture-guide/
HSE's safety climate	Primarily an assessment tool but the measured elements represent what a good culture comprises	Health and Safety Executive https://books.hse.gov.uk/Safety-Climate-Tool
INPO attributes of an effective nuclear safety culture	Widely used in nuclear sector. While originated in nuclear sector, the attributes are considered to be universally applicable.	World Association of Nuclear Operators Traits of a Healthy Nuclear Safety Culture https://www.wano.info/resources/traits-of-a-healthy-nuclear-safety-culture?lang=en-GB

Model	Comments	References
RSSB safety culture toolkit	A safety culture maturity model with guidance on how to improve culture	Rail Safety and Standards Board (RSSB) https://safetyculturetoolkit.rssb.co.uk/home.aspx
MAA safety culture assessment	A variation of Just Culture with additional elements added.	Military Aviation Authority Safety Culture Evaluation Framework https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/870454/MAA_Safety_Culture_Evaluation_Framework_MAS.xls

3.4.2 Common elements of “good” safety culture.

There are many representations of safety culture. This paper offers a view of the common elements of “good” safety culture, as cited in these models, in Figure 4. The assessment methods noted in section 3.3 are used to determine the extent to which an organisation fulfils these criteria, as a form of “goodness” measure.

Figure 4: Common elements of a “good” safety culture



There is extensive guidance on these elements in the models cited in Table 2. These elements are summarised below:

- **Leadership:** This includes visible, active commitment from the board; establishing effective 'downward' communication systems and management structures; and integration of good health and safety management with business decisions (Health and Safety Executive³)
- **Management accountability:** Management's acceptance of responsibility for safety performance as well as having clear understanding of one's roles and responsibilities.
- **Communications and engagement:** The extent and effectiveness of two-way communication regarding safety, respecting and listening to views and opinions.
- **Shared values, norms and beliefs:** The extent to which all stakeholders have a common set of values, norms and beliefs regarding safety.
- **Openness, fairness and trust:** A shared sense of trust that people will be treated fairly such as in the event of an accident, with openness and transparency. Wherein the wider causes of incidents are identified and learned from, rather than a retributive culture of blaming individuals.
- **Questioning and challenge culture:** Willingness and inclination to ask questions, challenge decisions, assumptions, conditions and actions. And the willingness and inclination of people to positively receive, acknowledge and respond effectively to questions and challenges, irrespective of relative status and authority.
- **Mindful intolerance of erosion of safety standards:** The extent to which people consciously monitor safety decisions, actions and planning, actively recognise changes to safety standards and challenge any acceptance of reduced safety standards.
- **Learning culture:** The willingness, inclination and ability to learn from events.
- **Proactive culture of continuous improvement:** The extent to which people suggest ways to improve performance and respond to suggestions as well as foreseeing risks and pre-empting these.

3.4.3 Restorative Just Culture

Recent work (Dekker et al, 2022 [20]) has explored the idea of “restorative just culture”, especially in areas such as healthcare, and where people have been harmed by an event. This concept builds on the element of openness, fairness and trust in Figure 4. As stated by Dekker et al, 2022:

“In the wake of an incident, restorative practices ask who are impacted, what their needs are and whose obligation it is to meet those needs. Restorative practices aim to involve participants from the entire community in the resolution and repair of harms to create a sustainable just, restorative culture.”

The concept aims to further help to counter the tendency of organisations and people who have suffered harm, to identify who is “to blame”, to assign culpability and possibly to seek retribution. These tendencies, while understandable, are thought to deter people from reporting and learning from near misses, errors and mishaps, and thereby stop organisations from learning from events and preventing incidents.

Restorative just culture therefore aims to help engage all stakeholders in a process that identifies who has been impacted by an incident and aims to “repair” harm to them. This includes listening to harmed persons, appreciating their perspectives and developing their trust in the implementation of changes. For example, it advises on the management of conversations, embedding civility and respect. It goes on to advise on how to acknowledge harm and to express remorse. This may lead to forgiveness and re-integrating staff who was involved in an event back into the organisation. By supporting “restorative justice”, this approach aims to help learn lessons that help prevent future events rather than just seeking retribution against individuals.

³ <https://www.hse.gov.uk/leadership/essentialprinciples.htm>

A restorative just culture checklist has been published by Professor Sidney Dekker⁴.

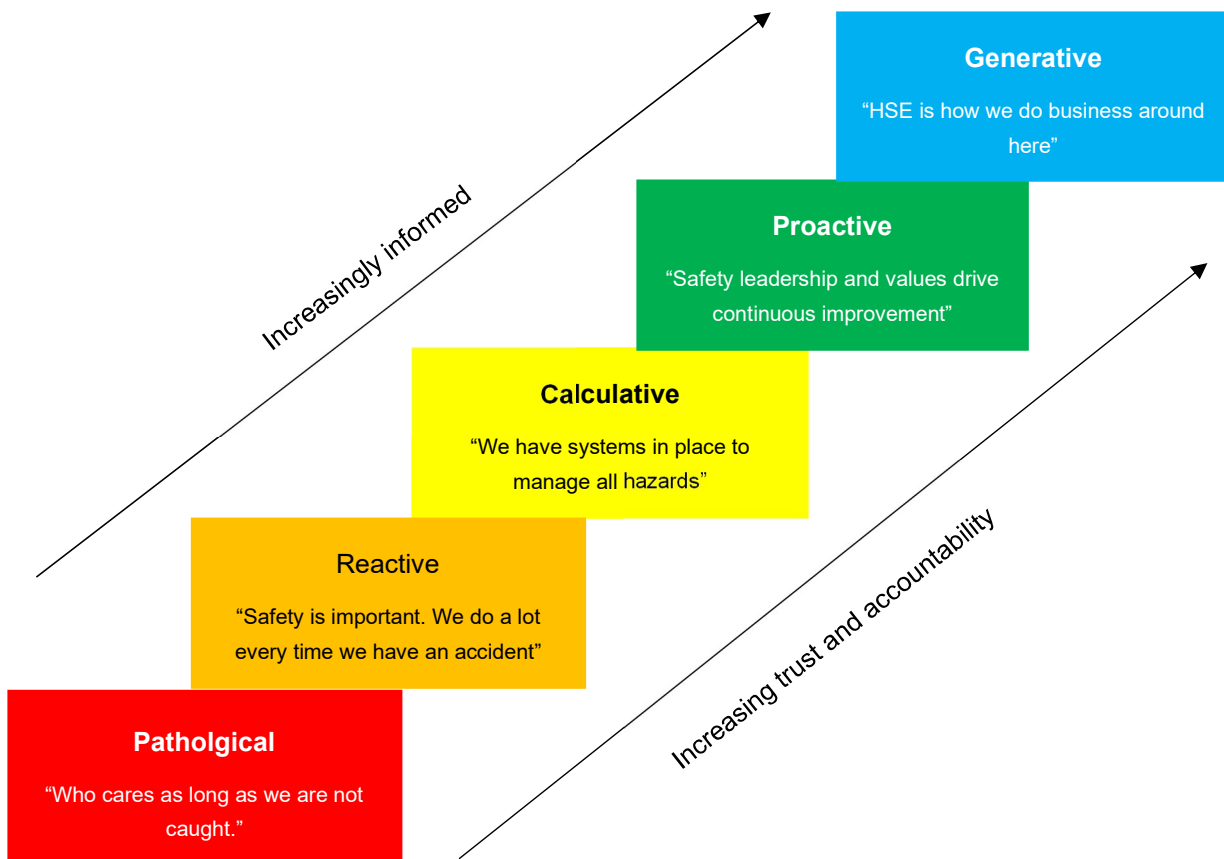
3.5 What standard of safety culture should organisations aim to achieve?

Some models of safety culture describe a “maturity scale”, rather than a singular set of attributes to be achieved. These “maturity models” help to characterise the organisation’s current culture and put it on a progressive “scale”.

One such “maturity model” is the aforementioned Hearts and Minds toolkit (see Figure 5 [8]).

Position 10
Organisations with the potential to contribute to catastrophic accidents should have a proactive culture of continuous improvement, as a minimum.

Figure 5: Hearts and Minds safety culture maturity model (Energy Institute)



A “pathological” (also known as dysfunctional”) culture is typified by prioritising objectives such as reputation, finance, legal liability and schedule over safety to an extent that safety is adversely affected. For example, people who raise safety concerns may be penalised, such as their employment being terminated; safety assessments are not done to avoid identifying safety issues that may create future legal liabilities due to “guilty knowledge”; safety defects are hidden to avoid legal liability.

A “reactive” culture entails only acting on safety in response to an adverse event, such as an accident or enforcement action from a regulatory. The response is limited to the causes of the event and lessons learned for underlying or common causes are neither sought nor acted on.

⁴ <https://www.safetydifferently.com/wp-content/uploads/2018/12/RestorativeJustCultureChecklist-1.pdf> Accessed October 2023.

A “calculative” culture aims to understand and comply with the law and minimum standards, without aiming to understand and minimise risk. The organisation is focused on management systems and compliance, and does not take ownership of foreseeing risks or ways of improving safety performance.

None of these three cultures are likely to support the required level of safety performance for a safety critical system with the potential for major accidents. Organisations with the potential to contribute to catastrophic accidents tend to be expected to have a “proactive” culture of continuous improvement, as a minimum.

4 Improving safety culture

4.1 What are the common approaches to improving safety culture?

4.1.1 Overview

There is extensive experience in the improvement of safety culture which offers many lessons learned. These lessons learned should be understood and used to inform improvement programmes.

4.1.2 Lessons learned on improving safety culture

Some lessons learned on tactics for improving culture include:

- Defining and communicating clear behavioural expectations and values, such as not tolerating ‘Open’ hazards in safety cases;
- Communicating a clear “case” for why safety culture needs to change or adopt a particular model;
- Engaging all sections of staff and other affected persons in the definition of objectives, and change plans – thereby securing their understanding and “buy in”;
- Consistently exemplifying the behaviours through day-to-day decision making and actions, such as not accepting ‘concessions’ that permit operating equipment that has known design flaws.

Position 11
Lessons learned from past experience should be applied to safety culture improvement programmes

In mature organisations people may have behaved in a certain manner for many years, with implicit or explicit endorsement of these behaviours and values. Sentient staff are more likely to engage with change where they can understand the “case” for change and agree with the validity and importance of these changes. Engaging people in assessments, understanding new safety performance requirements and the need for change, helps build understanding and engagement with change. The clear articulation of new behaviours, with examples specific to roles and functions, helps people to “operationalise” new values and the implications for how they perform their roles.

Culture can take a long time to change. People need to believe that there is a “real” intent to change and that the organisation truly wants people to adopt the new behaviours. This requires the communication and exemplification of new behaviours to be sustained and to be consistent amongst senior managers. One or more “totemic” event can undermine peoples’ perception of the validity and sustainment of new expectations.

Some lessons learned on pitfalls include:

- Be aware of the potential perverse effect of targets, such as to report a target number of safety observations or reduce the frequency of incidents, particularly the potential for the suppression of reporting and target chasing.
- Failing to exemplify positive behaviours when a serious incident occurs, and instead reverting to a “blame culture” such as to satisfy demands for “holding individuals to account”.

- Inconsistency in exemplification of new behaviours, especially by senior management, undermining perception of an organisation’s “true” expectations.
- Failing to change those aspects of safety management that are perceived to represent poor safety culture.

People may judge the “true” intent and truthfulness of a change programme by observed behaviours and actions, with minority examples of contrary behaviour given more weight than majority positive behaviours.

4.1.3 How should organisations plan safety culture improvement?

As with all change programmes, safety culture improvement needs to be planned. This should include:

- Having a realistic timescale – recognising the magnitude of changes and the time taken for people to change their perceptions. This is typically in the order of years for major improvements in safety culture.
- Sequencing actions- are there poor management behaviours that need to change before people will believe in the change intent? Is there a need to first make some improvements, such as in the delivery of training, to resolve adverse perceptions? Do new behavioural expectations need to be “operationalised” per role before people are expected to change? The sequence of actions should be informed by the results of assessments, which should provide insights into barriers to and opportunities for change.
- Resourcing – the allocation of staff time and resource needs to match the magnitude of changes. Failure to progress actions can undermine confidence in the programme.
- Communication plans – clear cascaded communication of plans, progress and outcomes helps to maintain confidence and engagement.
- Ongoing engagement – sustaining engagement, such as forums, surveys and workshops helps to exemplify the principle of engagement and ensure feedback is received on perceptions of the programme.

Position 12
Safety culture improvement programmes should be planned and managed just like other change programmes and major projects

Any major culture change programme requires, like any other change programme, management – with change managers, steering committees, review milestones and business support.

4.1.4 How can progress be tracked?

Progress is commonly tracked by a combination of:

- a) Verifying implementation of changes;
- b) Seeking feedback from staff on their perceptions of changes;
- c) Re-assessment of safety culture;
- d) Changes in safety performance indicators.

While the implementation of changes and staff feedback can be acquired in the short term, it is common to re-assess safety culture on an annual or bi-annual basis, noting the typical extended time needed for culture to change.

While some organisations also track safety performance indicators, such as incident rates, these may be a product of many factors. It can be difficult to disaggregate the contribution of any one initiative to a change in performance. Moreover, in some safety domains, such as design and manufacture, the incident rate may be very low and may not provide a reliable measure of safety performance. Therefore, reliance is often placed on the a) to c) methods.

4.1.5 Case studies

Some examples of successful safety culture are given below. It is important to note, as elaborated in section 5, that a “good” safety culture may be eroded. The successful implementation of change does not mean that it can be assumed that the culture remains positive. As noted in 5.3, actions are needed to maintain an effective safety culture.

Defence contractor

The contractor provided design, manufacture and maintenance services for complex safety critical equipment. Key aspects of their approach to improving safety culture included:

- A six year programme with year one focused on assessment and understanding, then a progressive five year sequence of changes, followed by two years of consolidation.
- A sustained management team to develop and implement changes.
- The plans were informed by the results of a safety culture survey.
- A clear statement of the desired level of safety performance.
- Drew on the Just Culture model to scope the desired culture and define behavioural expectations.
- Articulation of behaviour expectations of leaders and of the organisation.
- A sustained communications programme of clearly branded messages.
- Implementation supported by workshop based engagement.
- Enabling leaders to support new culture by training in non-technical and Human Factors skills.
- Development and implementation of safety management systems to support new behaviours, such as near miss reporting and safety meetings.

The impact was tracked by use of safety reporting trends.

Rail operator

The aforementioned rail operator (Keolis Amey Docklands- KAD) carried out a staff safety culture survey and a set of workshops across all departments and grades [17]. The assessment was drawn on to develop an improvement plan. The plan also drew on the Safety Differently framework.

KAD expressed an aspiration to have a ‘Proactive’ safety culture in all business areas. Key parts of the strategy included:

- A set of corporate objectives were defined in support of this culture aspiration, such as “A ‘just’ culture that is transparent, fair and with clear responsibilities” and “Learning when we get things wrong”.
- As noted in the reference, each of HSQE objective was assigned an accountable manager, with responsibility for management of the objective, and an executive sponsor, “charged with overseeing effective delivery of the objective and helping to remove any obstacles to delivery”.
- A set of behavioural expectations were defined including “Safety is everyone’s responsibility – we all lead by example” and “Team work and open communication underpins good safety”.
- Specific actions were developed and implemented in support of these objectives, such as new ways of reporting safety issues, changes to safety committees, and HS&E roadshows.
- The improvement plan was endorsed and supported from the top down, with supervisors undertaking leadership for safety training.

Progress was tracked by performing the same safety culture survey every two years, tracking results for the organisation as a whole and per department. KAD also identified positive behavioural markers through which to proactively measure safety attitudes and behaviours. Examples include, incidence of people wearing better than required PPE, constructive challenge of safety practices.

5 Maintaining an effective safety culture

5.1 Why might a good safety culture be eroded?

There are well known examples of organisations that had been regarded to be industry leaders, subsequently suffering major accidents due to the erosion of their safety culture (Dekker, 2012 [20]). The Haddon-Cave inquiry (Charles Haddon-Cave QC, 2009 [29]) concluded that safety had been sacrificed for cost, quoting an officer stating that:

“There was no doubt that the culture of the time had switched. In the days of the RAF chief engineer in the 1990s, you had to be on top of airworthiness. By 2004 you had to be on top of your bud get if you wanted to get ahead.”

Position 13
Organisations should explicitly recognise the potential for the erosion of safety culture and actively monitor signs of such erosion

Boeing was portrayed (New York Times, 2020⁵), with respect to internal communications released to the inquiry about the 737 Max, as:

“For generations, Boeing represented the pinnacle of American engineering.....But the newly released messages portray a company that appears to have lost its way.Once relentlessly focused on safety and engineering, Boeing employees are shown obsessing over the bottom line. Though Boeing is one of the American government’s biggest contractors, the F.A.A. was viewed as a roadblock to commercial goals that would “impede progress” when it tried to “get in the way.”

Safety culture can be eroded slowly and imperceptibly. Where safety culture is being eroded, at least in part, due to change in leadership and/or new organisational imperatives, this creates challenges with respect to a potential loss of corporate memory and new imperatives that may change the approach to safety. The erosion of safety culture may be masked by other organisational changes, distracting attention. It can also be that some people are aware of the erosion of safety, but are not heard.

Some observed reasons for the erosion of safety culture are noted in Figure 6.

⁵ New York Times, Natalie Kitroeff. <https://www.nytimes.com/2020/01/10/business/boeing-737-employees-messages.html> Accessed May 2023

- Changes in organisational imperatives leading to a greater focus on objectives such as delivering new products, increased throughput, reduced costs – sometimes coinciding with a change in leadership;
- A loss of corporate memory of past incidents and the rationale for safety requirements, sometimes involving a change in leadership and subject matter experts leaving the organisation. This was highlighted in healthcare - the quick turnover of senior execs led to loss of corporate memory and lack of appropriate safety oversight structures (Kirkup, 2022 [22]).



Figure 6: Reasons for erosion of safety culture

- A reduction in the weight given to opinion of subject matter experts, such as engineers or safety specialists, especially where there are new business imperatives and new leadership lack (for example) appreciation of systems engineering.

The achievement of safety often includes the introduction of safeguards (engineered, managerial and administrative) to protect against past safety issues such as near misses, incidents and defects. With the passage of time and loss of experienced personnel, the reasons for these safeguards and the risks exemplified by past events can be forgotten or judged to no longer be relevant. Where new leadership lack an appreciation of the lessons learned from past events, and instead focus on new business imperatives, safety concerns can be over ridden and dismissed and the opinions of safety and other specialists devalued below these new imperatives.

A “poor” safety culture can also be one that relies too much and too statically on engineered, managerial and administrative safeguards and expects that everything will be ‘fine’ as long as people follow the rules. “Good” safety culture ‘embraces’ the complexity of systems and appreciates that the changing nature of risk and the complexity and uncertainty inherent in the system can undermine safeguards or render them out dated.

5.2 What are the signs and symptoms of an eroding safety culture?

A challenge with the erosion of safety culture is that it can be slow and may not be easy to recognise. Some indicators of an eroding safety culture are shown in Figure 7. These include what are termed “weak signals”. Some behavioural signals include where people normalise lower standards, accept decisions and practices that were previously rejected, accept work arounds as normal practice or are silent about poor safety decisions. The challenge in detecting “weak signals” can be exacerbated if leaders demand “hard” evidence of safety concerns, for example, to change business decisions, or view the expression of safety concerns to be disruptive, a threat to the organisation or as opposition to organisation’s goals. Organisation may also not have the mechanisms to detect “weak signals”.

This leads to the idea of safety intelligence and safety wisdom (Future Sky Safety Consortium, undated [23]), whereby safety information is effectively drawn upon in safety decision making. The Future Sky Safety Consortium defines these as follows.

“Safety Intelligence is generally being used to refer to the various sources of quantitative information an organisation may use to identify and assess various threats. This has traditionally been incident data and other safety information on precursor events which, when put together, can give reasonable predictions about likely accidents and measures to avoid them.

Safety Wisdom refers to the judgement and decision-making of those in senior positions who must decide what to do to remain safe and how they also use quantitative and qualitative information to support those decisions. This could be proactively in relation to a future or emerging threat, or reactively to an accident that has happened to another similar organisation.”

Safety Wisdom includes using intelligence to maintain safety under pressure and to anticipate the next threat, thereby mitigating the erosion of safety standards.

Figure 7: Signs of erosion of safety culture



5.3 How can the erosion of a good safety culture be prevented?

5.3.1 Introduction

Some tactics for guarding against the erosion of safety culture are noted below. It is important to note that safety culture can be eroded slowly and imperceptibly. Where safety culture is being eroded, at least in part, due to change in leadership and/or new organisational imperatives, this creates challenges with respect to a potential loss of corporate memory and new imperatives that may change the approach to safety. The erosion of safety culture may be masked by other organisational changes, distracting attention. It can also be that some people are aware of the erosion of safety, but are not heard.

Position 14
Organisations should have a set of checks and balances to detect and guard against erosion of safety culture. These should include formal processes and a culture of unease, openness and challenge – that looks for “weak signals” of lower standards.

5.3.2 Formal checks and balances

There are a battery of formal checks and balances that can help recognise, challenge and control the erosion of safety culture. These are noted below.

- **Independent safety function and independent assurance**

The operation of independent checks on safety performance and decisions can help detect and mitigate erosion of safety. This may take the form of audits by safety departments or external auditors, over sight by safety committees, peer review by other organisations and regulatory inspection. For these functions to be effective they require:

- True independence;
- “High level patronage” – an ability to report to and influence senior leadership;
- The capability to perform the checks
- Respect and recognition as an authoritative voice.

- **Management of Organisational Change**

Some organisations have formal Management of Organisational Change processes, over seen by independent committee. They tend to assure that change is recognised and managed, risks are assessed, transition and implementation plans are robust and that the impact of changes are tracked post-implementation.

For example, in the United Kingdom, the CSM-RA Common Safety Method is used for rail risk evaluation and assessment by the RSSB⁶. The CSM RA defines a common European risk management process, and its use is mandatory for all significant changes, whether they are ‘technical’ (engineering), operational or organisational.

- **Key Performance Indicators**

Standard safety KPIs can be used to track trends in indicators of tolerance of lowered standards, such as duration of engineering concessions, number of engineering concessions, time taken to close out safety actions from risk assessments or audits. Similarly, safety culture surveys can be repeated, such as every year or two, and tracked over time.

⁶ <https://www.rssb.co.uk/-/media/Project/RSSB/RssbWebsite/Documents/Registered/Standards/2020/09/16/10/37/GEGN8646-Iss-1.pdf>

5.3.3 Retention of organisational memory and a mature and resilient safety leadership.

The loss of corporate memory, sometimes termed “corporate amnesia” includes where an organisation forgets or dismisses memory of past events and the reasons for safeguards, standards and arrangements. This is often associated with a loss of continuity in staff, such as due to retirement, staff turnover or organisational change, especially change in middle or senior leadership. Some common mitigations of loss of corporate memory include:

- Succession planning with a period of briefing and knowledge transfer;
- Onboarding and mentoring processes for new staff;
- Maintaining a culture where experts and experienced people are respected and listened to;
- Retention of expert functions within the organisation, at least to act as “intelligent customers”.

It is important that there are no “ceilings” to succession planning and on-boarding. Directors, managers and supervisors all equally need to engage in knowledge transfer.

Equally important is a culture that values “lessons learned” from past experiences and does not dismiss these as being no longer relevant (“that was then”) or “distances by differencing” (a view that the lessons does not apply to us because we are different).

5.3.4 Organisational mindfulness, chronic unease and combating “normalisation of deviance”

Most major accidents are preceded by the display of the types of behaviours noted in Figure 7 and reports of safety concerns, near misses or incidents. Even where there are independent checks and balances, the absence of “hard” or “immediate” evidence of safety problems can cause challenges from independent checks to be dismissed or downplayed. Organisations need to adopt a set of attitudes and behaviours to mitigate the tendency to downplay the “weak signals” of poorer safety. They need to recognise that long periods of success can cause complacency. These attitudes are referred to as organisational mindfulness (Liu et al 2023 [24]), chronic unease (Fruhen, 2014 [25]) and combating “normalisation of deviance” (Furst, 2021 [26]):

Organisational mindfulness entails being alert to the types of behaviours noted in Figure 7, recognising and challenging these behaviours and “weak signals”. It includes maintaining a sense of chronic unease, scepticism, and challenging the normalisation of deviance. Organisations need to adopt a set of attitudes and behaviours to mitigate the tendency to downplay the “weak signals” of poorer safety. They need to recognise that long periods of success can cause complacency.

There is a range of “mindfulness tactics” that may be drawn on. All of these tactics are facilitated by an open organisational culture where people feel safe to speak up and are listened to, and where people are “honest” about safety performance and their decisions.

Some key “tactics” are summarised below.

Chronic unease - scepticism

Consciously **practising a sense of “chronic unease”**. This is a sense of healthy scepticism. Instead of saying “we have not had an accident for a long time”, you ask “Are there any weaknesses in our safety that we have over looked”. It is adopting a probing and questioning attitude, challenging assumptions about the current state of safety and exploring vulnerabilities. This requires people to maintain “an open mind”, to be receptive to “bad news” and challenge, listen to people’s opinions and concerns and to not demand “hard evidence” of safety concerns before investigating them. Five attributes of chronic unease are shown in Table 3.

Table 3: Attributes of chronic unease (reproduced from TÜV Rhineland, Risktec⁷)

Five attributes of chronic unease	
Vigilance	Being alert to weak indicators of risks like near misses, process upsets and localised failures
Propensity to worry	An emotional tendency to worry about risk and safety
Pessimism	A personal tendency to resist complacent and anticipate failure
Requisite imagination	Ability to imagine and visualise possible worst-case scenarios
Flexible thinking	Ability to question assumptions, considering many aspect of a problem and not jumping to conclusions

Challenging the “normalisation of deviance”

The “normalisation of deviance” refers to the period (usually long) where unsafe practices become considered normal, where lower standards of safety become accepted, early signs of potential major accidents are dismissed or re-interpreted and people are de-sensitised to safety issues. This may combine with an unofficial code of “organisational omerta”, a “culture of silence” regarding tolerance of unsafe practices and unsafe design. Martin Anderson offers the following eight questions as a test of whether an organisation is “normalising deviance”.

Table 4: Preventing the normalisation of deviance

Preventing the normalisation of deviance
Eight questions to identify and manage deviations before they become the “new normal”.
1. What behaviours, working practices or conditions do you accept today that you would not have previously accepted?
2. What standards are routinely not observed, or what ‘short-cuts’ are taken on a daily basis?
3. Do you operate with safety critical equipment not working, or in a degraded state?
4. Are systems operated in a significantly different manner than originally intended?
5. Do you change rules of what is acceptable in order to allow the deviations which experience tells you can be tolerated?
6. What rules are routinely broken by the majority, in order to ‘get the job done’?
7. Are certain alarms or warnings routinely ignored, perhaps even seen as ‘nuisance alarms’?
8. Do you make key decisions after in-depth analysis and objective assessment, or do you use past successes to redefine what is acceptable?
Copy from Martin Anderson by private correspondence Humanfactors101.com

⁷ Chronic unease - the hidden ingredient in successful safety leadership RISKworld issue 25 spring 2014 pg 2 <https://risktec.tuv.com/wp-content/uploads/2018/09/chronic-unease-2.pdf>

Normalisation is a social process, where new norms are created and accepted by a group. To combat normalisation of lower standards, a whole group collaborative intervention may be required to help re-set norms. Factual exploration of the risks, safety standards and how current practices compare to these may help shift perceptions and hence norms. This can also be supported by clear leadership regarding what is acceptable and what the organisation's expectations are.

Finally, the maintenance of effective safety leadership, that maintains a high priority for safety and commitment to honestly assess safety performance, risks and to make objective safety decisions is key.

6 Concluding points

Safety culture is equally relevant to the design, safety assessment and manufacture of systems as to operations and maintenance. Organisations responsible for safety critical systems and operations can help achieve high standards of safety performance by proactively assessing and improving their safety culture. This is good practice and a common expectation. There is an extensive body of experience, guidance and tried and tested methods that can be drawn on. A proactive and sustained approach to safety culture helps to maintain trust and confidence in the capability of an organisation, its values and behaviour.

As with all areas of safety science, further studies could help provide rigorous evidence about the impact of safety culture on performance and the impact of interventions intended to have an impact on safety culture.

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8 Further reading

8.1 General reading

Civil Aviation Authority: <https://www.caa.co.uk/safety-initiatives-and-resources/how-we-regulate/state-safety-programme/safety-promotion/safety-culture/>

Eurocontrol Just Culture: <https://www.eurocontrol.int/initiative/just-culture>

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International Atomic Energy Agency: Safety and Security Culture: <https://www.iaea.org/topics/safety-and-security-culture> Accessed November 2023

Office for Nuclear Regulation: Safety Culture Guide for Inspectors: https://www.onr.org.uk/operational/tech_insp_guides/ns-insp-gd-070.pdf Accessed November 2023

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