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RESEARCH

A startle and surprise management method for cabin crew

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Abstract
Startle and surprise are known to potentially incapacitate professionals who respond to emergency situations. In the aviation domain, self-management methods to prevent such incapacitation have been introduced for pilots. This study aims to explore the relevance of similar self-management methods tailored for cabin crew, using subjective evaluation by cabin crew and cabin crew instructors. First, a method was designed and refined using interviews and a focus group with nine subject-matter experts, consisting of four steps: protect, reset, check and act. Second, relevance of the method was quasi-experimentally tested by letting 15 cabin crew members apply it in a simulated firefighting scenario. After performing the scenario, they rated whether the method had positive or negative effects, was difficult or easy to use, and they retrospectively rated their perceived stress before and after applying the method. Participants positively rated the method's effectiveness and usability, and reported the method to significantly reduce perceived stress. Participants provided several suggestions for improving the method, and for approaches to integrate the method more effectively into existing protocols. The outcomes of this study provide direction on the design and use of self-management methods that can help manage startle and surprise in teams.

Keywords Flight attendants · Workload · Panic · Cognition · Performance

1 Introduction

Cabin crew can be confronted with emergency events that require them to act under extremely high pressure. For example, on February 20th, 2025, Delta Airlines flight 4819 ended up inverted after landing at Toronto Pearson airport (Transportation Safety Board of Canada 2025). Thanks to the cabin crew's quick and effective response, all occupants survived and were evacuated. A year earlier, after a runway collision during landing at Tokyo Haneda, the cabin crew was also instrumental in safely getting the passengers out of the burning aircraft (Japan Transport Safety Board, 2024). Such emergency events have two factors in common. First, they are rare and unexpected, triggering surprise (Schützwohl 1998). Second, they impose a sudden potential threat, inducing an acute increase in stress. This sudden increase in stress is also known as a startle (Martin et al. 2016). The aviation industry (European Union Aviation Safety Agency, 2014; Field et al., 2018) has recognized the importance of mitigating startle and surprise (S&S), while the terms are usually not separated and are often used interchangeably (Rivera et al. 2014).

The combination of S&S poses unique challenges to human performance (see Landman et al. 2017). Cognitive demands are high, as sensemaking activities are required to obtain situation awareness, defined as "the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning and the projection of their status in the near future" (Endsley 1995, p.36), and to perform appropriate emergency procedures. Meanwhile, the cognitive resources required for these activities are impaired by stress (Eysenck et al. 2007). Indeed, recent research shows that S&S can have negative effects on cabin crew performance (Vlaskamp et al. 2025a, b, preprint). For example, a senior cabin crew member mistakenly initiated

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the evacuation of an Airbus 320 that was about to vacate the runway, shortly after it experienced a low-speed aborted takeoff due to a loud engine failure in the dark (Air Accident Investigation Branch, 2020). The cabin crew member reported *"feeling shocked and overwhelmed"* by the circumstances of the incident. The investigators described the decision to evacuate as an *"emotional response"* and that *"weaknesses in training"* and general inexperience caused *"an overwhelming flight response"*.

S&S have been shown to impair pilot performance in simulator studies, as they can induce rushed behavior, inattentional deafness, and less effective decision-making (Casner et al. 2013; Dehais et al. 2014; Landman et al. 2017). Accident reports of crashes such as Air France flight 447 (BEA, 2012) and Colgan Air flight 3407 (National Transportation Safety Board, 2010) mention "startle" and "confusion" as contributing factors. Recently, a survey was performed to investigate the prevalence and effects of S&S in cabin crew (Vlaskamp et al. 2025a, b, preprint). It showed that 79.3% of cabin crew reported having experienced S&S. Retrospectively reported stress levels correlated with reported performance impairments. The most common reported S&S events were medical emergencies (reported by 29.7%), smoke/fire/fume events (18.3%), and unruly passengers (13.3%).

In recent years, self-management methods have been introduced for pilots to manage the potentially incapacitating effects of S&S (see, Vlaskamp et al. 2024). Such methods aim to be not event-specific, but applicable in any S&S situation. Currently developed methods (see e.g., Field et al. 2018; Landman et al. 2020; Martin 2017; Piras et al. 2023) usually contain elements of controlled breathing (see also, Röttger et al. 2020), checking with the other crewmember(s), and assessing the situation in a structured manner before responding. Experimental testing of these methods in simulator environments suggested good usability (Field et al. 2018), positive effects on performance (Landman et al. 2020), and have led to further refinements of methods (Piras et al. 2023; Vlaskamp et al. 2024). Pilots reported that they perceived benefits from a method in operational practice and appreciated having learned it (Vlaskamp et al. 2024). Also in different fields, such as defense (Lambert 2023), health care (Shaw-Metz 2023), law enforcement and emergency medicine (Lauria et al. 2017), methods of controlled breathing and situation assessment are used. For example, a technique called Voluntary Slow Breathing (VSB) has been shown to enhance executive functions and improve sports performance (Migliaccio et al. 2023).

Currently, no generally applicable method for managing effects of S&S exists for cabin crew, whereas they may possibly benefit from it in terms of performance, self-efficacy, and possibly even prevention of post-traumatic stress symptoms (Partridge and Goodman 2016). It is however unknown what the contents should be of a S&S management method for cabin crew, how it should be integrated into their current event-specific protocols, and how it should be trained. The current study therefore had the following objectives: (1) Develop a concept S&S management method for cabin crew based on existing scientific literature and training materials. (2) Let a group of cabin crew and cabin crew instructors evaluate and comment on this initial concept. Adapt the method if needed. (3) Let a group of cabin crew and crew instructors apply the concept method in a simulated firefighting scenario, and provide feedback on perceived effectiveness and usability in a quasi-experimental test. As an initial exploratory step, the study focused on self-reported user experiences and perceived effects rather than objective performance outcomes. The aim was to gather preliminary evidence regarding the acceptability and perceived value of the method and thereby to provide a basis for future, more resource-intensive research examining its impact on operational performance.

For testing, a firefighting scenario was selected because this is rather complex and involves several actions which need to be performed by memory and in coordination with a colleague. The potential difficulty of integrating a S&S management method in an already complex procedure was thought to make it a suitable benchmark scenario. Also, fire and smoke events are generally regarded as stressful (Manikath, et al. 2025), making application of the method potentially useful. We hypothesized that the method would be rated to have positive effects and be easy to use, and that participants would rate perceived stress lower following application of the method than before.

2 Phase 1: Initial concept design

From reviewing the literature on startle and surprise, and from conversations with two cabin crew training SMEs (one from cabin training management and a cabin crew training development specialist), nine principles were defined for a S&S management method for cabin crew. They are listed with their rationale and sources in Table 1.

Based on these principles, an initial concept method was formulated (see Fig. 1). As a basis for the method, a similar framework was used as that of S&S management methods for pilots (e.g., Field et al. 2018; Landman et al. 2020; Martin 2017; Piras et al. 2023). It consists of four steps: Protect, Reset, Check and Act.

The first step, "Protect", was designed to ensure self-protection from immediate harm (principle #3). This step entails the performance of the immediately required actions (principle #9) and ensures the cabin crew member is in a safe position to perform the following steps. For example, when "brace for impact" or "evacuate aircraft" is announced

Table 1 Defined principles for a cabin crew S&S management method, and rationale

#	Principle	Source or rationale
1	If possible, the method should be performed before taking any other action	To prevent acting before stress is managed and sufficient situational awareness is obtained (see also Field et al. 2018)
2	The method should be simple, easy to remember and not cognitively demanding	Pilot participants commented on method complexity and workload in Landman et al. (2020). Cabin crew do not always have an iPad or checklist at hand to aid in cognitive performance
3	The method should contain a step for personal protection, for example in case of smoke, fire or severe turbulence	SME input. Also, pilot training SME input in Field et al. (2018)
4	The method should contain a step that imposes a short delay of action to manage stress first, for instance by using a controlled breathing technique	Research among cockpit crew indicates stress causes rushed decision-making (see, Dismukes et al. 2015). The initial startle response may reduce after several seconds (Martin et al. 2016). Stress-management techniques such as controlled breathing have shown to be able to reduce stress (Cappo and Holmes 1984; Röttger et al. 2020)
5	The method should contain a step to check the wellbeing of colleagues	This may decrease stress, enhance teamwork, and was evaluated as valuable in cockpit crew research (Field et al. 2018; Vlaskamp et al. 2024; Vlaskamp et al. 2025a, b)
6	The method should address building situation awareness before acting	Situation awareness is initially compromised, or there would be no surprise. Stress may make it difficult to regain situational awareness (see a review by Landman et al. 2017) and can cause attentional narrowing (Dismukes et al. 2015)
7	The method should be universally applicable but allow for flexibility to be adapted to specific situations	SME input, and this is analogous to the methods developed for cockpit crew (Field et al. 2018; Landman et al. 2020; Piras et al. 2023)
8	The method should provide clear guidance for which actions to take	SME input. Current training mentioned to "take a deep breath", "ground" or "pause", but different advice was given in various training programs
9	The method should fit with existing procedures that are listed in the company manual (e.g., specific procedures for firefighting, medical emergencies, turbulence, general abnormal situations)	Airline company manuals and SME input

by the cockpit crew, there are immediate procedures to be performed. Also, donning an oxygen mask in case of decompression, sitting down in case of turbulence, or stepping away from toxic fumes in the case of smoke or fire, are typical actions that always take precedence for reasons of personal safety.

The second step, "Reset", was designed to impose a short delay before acting (principle #6) and to reduce stress (principle #4) and increase cognitive capacity. Its name was selected based on the S&S management method that was in use by the pilots of the same company as the participating SMEs and cabin crew (see, Vlaskamp et al. 2024). It consists of taking one or more deep breaths with each exhale lasting longer than each inhale. This step can be repeated if needed. Since cabin crew are likely standing instead of seated, and based on pilots' feedback that it was often skipped (Vlaskamp et al. 2024), the instruction of relaxing arms and legs was left out (principle #2).

The third step, "Check", was included to take a moment to make contact with other cabin crew members and check their mental state. Cabin crew members should look at each other and ask the other if they are okay. In case of apparent mental incapacitation, putting a hand on the other crew members' shoulder or calling them by name can be effective. Besides checking each other, this step involves checking the situation by calling out relevant observations and confirming the assessment and plan with each other, similar to methods used in the cockpit by pilots (e.g. Field et al. 2018; Piras et al. 2023). The fourth step, "Act", is to perform the actions according to the company manual (principle #9).

3 Phase 2. Interviews and focus group

3.1 Method

3.1.1 Participants

Four cabin crew instructors (P1, P2, P3, P4), who also worked as cabin crew members, participated in individual interviews. Four regular cabin crew members (P6, P7, P8, P9) and one instructor (P5) participated in a focus group session. The mean age of the cabin crew instructors was 44.7 years, $SD = 12.5$, range = 32–57 and the mean age of cabin crew members in the focus group was 48.8, $SD = 7.3$, range = 42–61. The instructors had on average 10.7 years of experience, $SD = 6.4$, range = 6–18. The cabin crew members had on average 22.0 years of working experience, $SD = 5.2$, range = 17–30. The cabin crew instructors were volunteers recruited by the cabin crew training department through e-mail. Cabin crew members from a group of 52 "safety and security ambassadors" were approached via e-mail. Participation was voluntary, unpaid and in participants' free time. Demographic characteristics are displayed in Table 2.

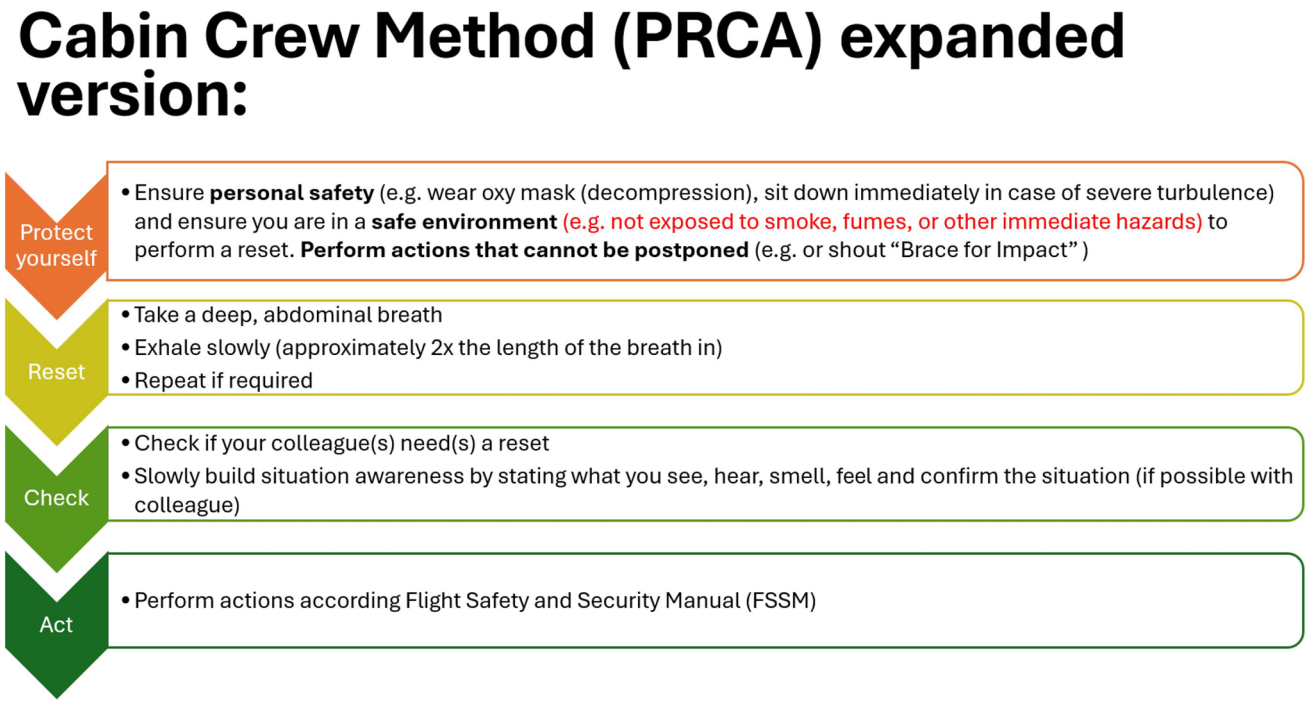


Fig. 1 An overview of the concept cabin crew S&S management method. The text in red was added after feedback from the practical testing

Ethical approval for the interviews and focus group was obtained from the Ethics Committee of Delft University of Technology (application number: 4988). All participants provided written informed consent prior to participation.

3.1.2 Procedure

The semi-structured interviews with the cabin crew instructors were performed online via Microsoft Teams, and were structured as follows:

1. Presentation using PowerPoint with an explanation of the concept S&S management method (see Appendix A), with time for questions.
2. General feedback from participants.
3. Discussion of application of the method in three situations where the method could be difficult to apply (smoke/fire/fumes, unruly passenger, and medical emergency).
4. Discussion of other abnormal events, where an open discussion was encouraged of anything that came to mind regarding application of the method, with minimal intervention from the interviewer.

The session with the focus group was also held via Microsoft Teams. The method was shared with the participants via e-mail in advance. The same structure of questions that was used in the cabin crew instructor interviews was used for the focus group. The lead researcher, an experienced (pilot) instructor and Crew Resource Management (CRM)-trainer at the company performed the interviews. Apart from the four topics, no specific questions were formulated in advance. The interviews and focus group session were automatically transcribed to text. Both the interviews and focus groups were performed in the Dutch language, and relevant quotes were translated. All participants were native Dutch speakers.

3.1.3 Dependent measures

The video recorded interviews were transcribed using the Microsoft Teams automatic transcription. Transcripts of the interviews were reviewed immediately after the session to correct the automatic transcription while memory was still fresh. Approximately four hours of interview data was transcribed. Braun and Clarke's (2006) reflexive thematic analysis was used to analyze the interview and focus group data, as it is suitable for providing analyses of people's experiences in relation to an issue and for analyzing factors that influence a particular phenomenon (Braun and Clarke 2006). The method consists of six steps:

1. Familiarizing oneself with the data
2. Generating codes
3. Constructing themes
4. Reviewing potential themes
5. Defining and naming themes
6. Producing the report

Table 2 Survey questions

Question	Answer format
"How would you rate the net effectiveness (i.e., the total of positive and/or negative effects) of the PRCA method?"	Seven-point Likert scale, ranging from "large negative effect" to "large positive effect"
"Which positive effects did you experience? (if any?)"	Open question
"Which negative effects did you experience? (if any?)"	Open question
"How would you rate the usability of the PRCA method?"	Seven-point Likert scale, ranging from "very difficult to use" to "very easy to use"
"Which aspects of the method did you find difficult to use? (if any?)"	Open question
"Which aspects of the method did you find easy to use? (if any?)"	Open question Open question
"Which steps of the PRCA method did you apply?"	Fully/partly/not applied
"How much stress did you experience before using the PRCA method?"	0–10 Likert-type scale ranging from 0 (no stress) to 10 (extreme stress), based on Houtman and Bakker's (1989) anxiety thermometer
"How much stress did you experience after using the PRCA method?"	0–10 Likert-type scale ranging from 0 (no stress) to 10 (extreme stress), based on Houtman and Bakker's (1989) anxiety thermometer
"If the method helped you to reduce stress, can you describe how it helped you?" with an open answer field	Open question
"Did the PRCA method interfere with the ABC procedure? If yes, please explain how." (ABC = company firefighting procedure)	Yes/no and a field for open comments
"What improvements or changes would you suggest for the PRCA method? (if any?)."	Open question

Bragaru et al.(2013) recommend commencing data analysis during the data collection period. This approach was chosen for this research. The transcripts were coded immediately after each interview, and data grouped into themes. The aim was to identify possible new topics that would be useful to discuss and to see if data saturation had been reached.

3.1.4 Analysis

The software package QDA Miner Lite was used for the thematic analysis. The transcripts were coded inductively by the first author. Related codes were grouped into broader themes. Themes and relevant quotes were subsequently translated into English. Of the relevant coded quotations, 25% (19) were were then triangulated by one of the co-authors and discussed until full agreement was reached. Initial agreement was 95%. Saturation was assumed to have been reached when no new themes emerged from the focus group after the four interviews.

3.2 Results

3.2.1 Emerging themes

From the interviews with cabin crew instructors five themes emerged (see, Fig. 2. The focus group did not yield any new themes or subthemes but provided a richer variety of quotes. As such, it was assumed that saturation was reached.

3.2.1.1 Theme 1A: Complex situations: medical procedure All participants agreed that the method was applicable in a medical event. However, as apparent from the theme "urge to act fast", this urge to act fast was also present in a medical emergency or life-threatening situations. One participant admitted "*I would struggle more with this because I think: No, someone is dying, so I must act immediately"*. Another participant emphasized the benefit of checking their colleague especially in medical cases: "*You don"t always know what the situation is medically, but don't forget that many colleagues have already experienced traumatic events in their private lives"*.

3.2.1.2 Theme 1B: Complex situations: smoke, fire, fumes Smoke, fire and fumes events were the events where the urge to act was perceived to be the greatest. Participant 10 stated that they thought *"flames require immediate action and would make it difficult to use the method."* Participant 6 said: "*Indeed, smoke and fire are the most dangerous situations on board. The instinct is to act immediately because there is a direct threat to the operation and yourself."* However, the same participant also pointed to the risk of rushed actions, especially in firefighting, for example forgetting to wear protective gloves or a mask: *"It has been mentioned before by one of you—I don't remember who—but we tend to act without protection. If we see something leaking from an overhead bin, we instinctively reach out to touch it, smell it, or listen to identify it. If there's a fire, we grab the extinguisher and start trying to put it out."* Participant 8 believed the method would save time, as actions would be more effective: *"But if there were a way to manage the freeze-fight-flight response—like through breathing exercises—I think we wouldn't actually lose any time."* Participant 2 agreed: "*Resets won't slow down the ABC [firefighting procedure] model."* Participant 8 added: "*I personally have a lot of confidence in pausing before acting in smoke and*

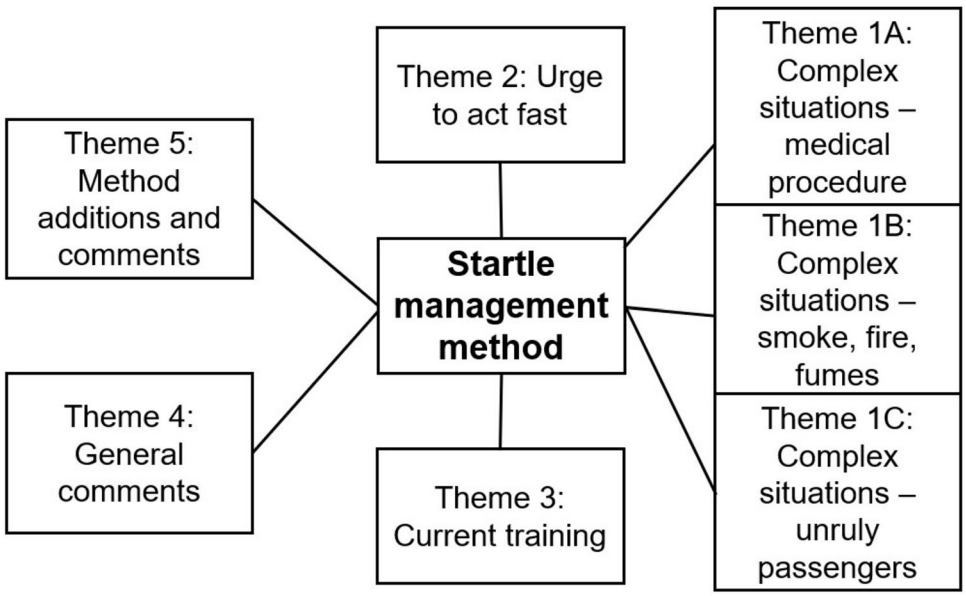


Fig. 2 Themes from the interviews and focus group

fire events." Participant 10 voiced concern about passenger reactions: "*I think you're dealing with passengers who will become uneasy. That can be challenging because if we take two seconds to pause, they might already want to act and start extinguishing the fire themselves. People want to see action—it reassures them."*

3.2.1.3 Theme 1C: Complex situations: unruly passengers The cabin crew instructors were positive about the application of the method in cases with unruly passengers. Current training already advises a moment of "pause" and taking a step back (fitting with "protect yourself"), which could include one or more deep breaths, according to Participant 2. Two instructor participants (4 and 5) made an exception for psychologically unstable passengers: "*[the method is applicable] unless someone suddenly starts hitting you. Like when a copilot was once threatened with glass"*. In the focus group, two participants expressed doubt about taking time to breathe, as "*the aggressor might see it as a sign of weakness".*

3.2.1.4 Theme 2: Urge to act fast Without being prompted, all cabin crew instructors and the focus group discussed the urge to act fast at various points. Participant 4: "*I can imagine that in a medical incident, I would struggle more with this [method, red.] because I think, "No, someone is dying, so I must act immediately", even though those ten seconds [for the reset] could be crucial".* Participant 5: *"(...) we are more doers. I have also experienced this myself—immediately going into action mode and then realizing: "Oh, I brought a medical kit, but oops, I forgot the key." So sometimes, taking those ten seconds is more valuable than jumping straight into action"*. Participant 3 stated: "**:** *The problem with fire incidents is that colleagues often forget to put on their PBE* [Protective Breathing Equipment, red.] *because they immediately jump into action (...). The smoke alone causes so much stress and pressure that the biggest priority becomes figuring out where the smoke is coming from or extinguishing the flames.*" One participant emphasized that the method should be trained well, out of concern that one cabin crew member using the method and the other jumping into action could cause confusion. One non-instructor participant was of the opinion that smoke or fire required immediate action.

3.2.1.5 Theme 3: Current training The cabin crew instructors expressed that incorporating the proposed cabin crew startle management method would not be a big change from current training. Participant 4, an instructor, stated*: "Look, at the moment, in all ABC [firefighting and medical] procedures we train, it is always mentioned: take your time. For example, take a moment in the galley to prepare your oxygen bottle, or take your time in the galley to remove the pin from the Halon extinguisher."* Participant 3 similarly stated: *"That is what we also teach: slow down before you speed up."* Two instructors remarked that the effects of startle, surprise and stress were also often visible in training. For example, Participant 5 said:" *It's funny to experience that some people completely panic and have no idea what*

to do [in training] *even though we've trained for it so many times."*

3.2.1.6 Theme 4: General comments All participants viewed the method as a positive development. Example comments were "*I would love to implement this" (Participant 5), "I would start using this tomorrow. Bring it on!" (Participant 2)* and *"Very clear. Most crew members are familiar with it because in training we discuss the cockpit [S&S management] training. It's a clear step-by-step process with four steps—not too many bullets, which helps" (Participant 3).* Participant 4 stated*: "I find it very logical and would really support it if it became part of our process—and be communicated that way as well. Yes."*

3.2.1.7 Theme 5: Method additions and comments This theme dealt with possible improvements in the description of the steps of the method. Four additions to the method were proposed by Participant 2: adding a "*check if your own reset was effective*", adding a step where you "*tense and relax muscles*", adding a description of signs of startle and surprise to the method description for easier recognition and "*adding that you can also apply the method alone"*. Although useful to mention in training, the lead researcher decided not to add these to the method as they were deemed to increase the complexity too much. Useful suggestions, again by Participant 2 for training the method were to "*add a leaflet with additional clarification*" and "*allow for partial application.*" Participant 3 found the description "*very clear*", while another called it "*visually pleasing*".

Fig. 3 The interior of the Flame Aviation fire training device. This picture shows a laptop fire scenario

3.3 Conclusions of phase 2

Based on Phase 1 results, no changes were made to the initial concept S&S management method for the practical testing stage. Although we deemed the additions suggested by participants to be relevant, we decided to prioritize simplicity of the method over these additions.

4 Phase 3. Simulator trial

4.1 Method

4.1.1 Participants

Ethical approval for the testing in the fire training device was obtained from the same committee (application number: 5298). All participants provided written informed consent before participating. The practical test in the fire scenario was conducted with a sample of 15 participants, of which ten were cabin crew instructors and five were not. All but two crew instructors were also active as cabin crew members. The mean age of participants was 47.3 years, $SD = 11.08$, range = 30–60 years old. Mean working experience was 20.9 years, $SD = 12.02$, range = 1–39 years. The participants were volunteers recruited by the cabin crew training department through company communication channels. The main criterium was availability on the experiment days. One participant participated in both the interview (phase 1) and the practical experiment (phase 2), the other participants were newly recruited, some on the day of participation. Due to their roles, all participants had received training in fire extinguishing and had received regular fire training in the same fire training device. Participation was voluntary, unpaid and in participants' free time.

4.1.2 Apparatus

The test was carried out in a state-of-the-art fire training device designed by Flame aviation, type V7000 Brigade (see Fig. 3). The device was in use by an airline company

and was made available to the lead researcher in between regular training sessions. The device can simulate various fire and smoke events. A qualified operator operated the device. Training fire extinguishers, fire protection gloves and smoke hoods were used.

4.1.3 Procedure

The participants were e-mailed a short PowerPoint presentation, contained in the Appendix, that explained the S&S management method. Some participants were recruited on the day of the experiment, and they were given a leaflet describing the method. Before entering the fire training device, the lead researcher explained the steps of the method once more, and there was room for questions. Participants evaluated the S&S management method during one scenario which they performed during a session consisting of either an oven fire, a laptop fire, or a luggage bin fire. Not all participants could evaluate the same scenario, as different scenarios were used to retain an element of surprise when participants had observed the first scenario. Three scenarios were used that were similar in difficulty, with only the location of the fire and a few details in the required procedure differing. (e.g., removing power sources). The simulation included real smoke and flames, with additional audio sounds of screaming passengers. Participants were not informed in advance which scenario they would be presented, to retain an element of surprise. Participants wore protective overalls, fire gloves and protective breathing equipment. Firefighting was carried out in groups of three as per the company procedure. Some participants participated in more than one scenario, but participants evaluated only the first scenario they participated in but participated in more to create teams of three. Evaluation was done on paper, before any discussion among the participants.

Scenario 1 (oven fire) was evaluated by nine participants. Scenario 2 (laptop fire) was evaluated by four participants and Scenario 3 (luggage bin fire) was evaluated by two. One effectiveness rating and one usability rating was missing (different participants).

All scenarios required the same firefighting procedure. The company firefighting procedures listed in the company manual consisted of:

1. Assigning roles ("attacker", "buddy" and "communicator").
2. Obtaining fire equipment
3. Identifying the source of fire
4. Removing the power source if applicable
5. Using Protective Breathing Equipment (PBE)
6. Extinguishing the fire
7. Identifying the cause of the problem
8. Monitoring for re-ignition/

The "buddy" cabin crew member has a supportive role, while the communicator informs the cockpit crew and passengers.

4.1.4 Dependent measures

To assess the implementation and effectiveness of the S&S management method, a paper survey was completed after the scenario in the fire training device. The questions are listed in Table 2.

4.1.5 Statistical analysis

The majority of the outcomes are descriptive. Free text comments of the post-experiment survey were were not formally analyzed, instead quotes were selected that best illustrated the survey results. The ratings for effectiveness and usability were analyzed with a Wilcoxon signed-rank test to compare them to the midpoint of the scale and the ratings for stress level before and after using the S&S management method were compared using a Wilcoxon signed rank tests. *p*-values for significance were set to 0.05. Non-parametric tests were chosen due to the small sample size and violation of normality as determined using Shapiro-Wilk tests. Effect sizes were considered to be small for r = 0,1, medium for r = 0,3 and large for r = 0,5 (Steyn 2020). Exact two-tailed p-values were calculated using the exact distribution of the Wilcoxon signed-rank statistic as implemented in the Real Statistics Resource Pack. Tied absolute differences were assigned average ranks and tie corrections were applied where appropriate. Continuity correction was used when calculating the standardized test statistic (Z). Cases with zero differences were excluded from the ranking procedure in accordance with the standard Wilcoxon signed-rank test methodology. A sensitivity analysis conducted in G*Power indicated that, with α = .05 and *power* = .80, the study was sufficiently powered to detect effects of at least d = 0.72 (n =14, usability and effectiveness) or 0.69 (n=15, stress comparison) or larger in strength.

4.2 Results

4.2.1 Effectiveness of the method

Fourteen participants provided a rating for effectiveness. A one-sample Wilcoxon signed-rank test showed that effectiveness ratings were significantly more positive than the neutral midpoint (i.e., 4) of the 7-point Likert-type scale, with a large effect size, T=*7.0,* Z=2.86, p=0.002 (two-tailed, exact), r=0.76. This indicates that participants rated

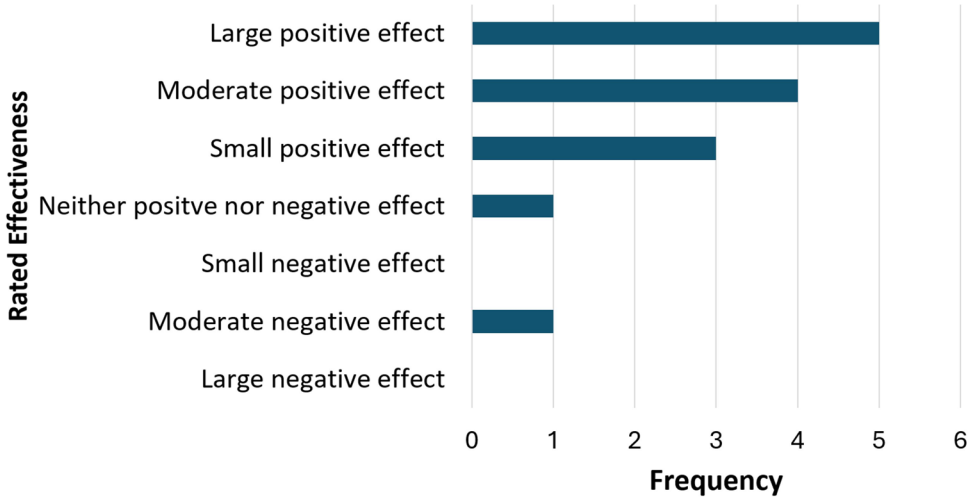


Fig. 4 Rated effectiveness of the method by number of participants

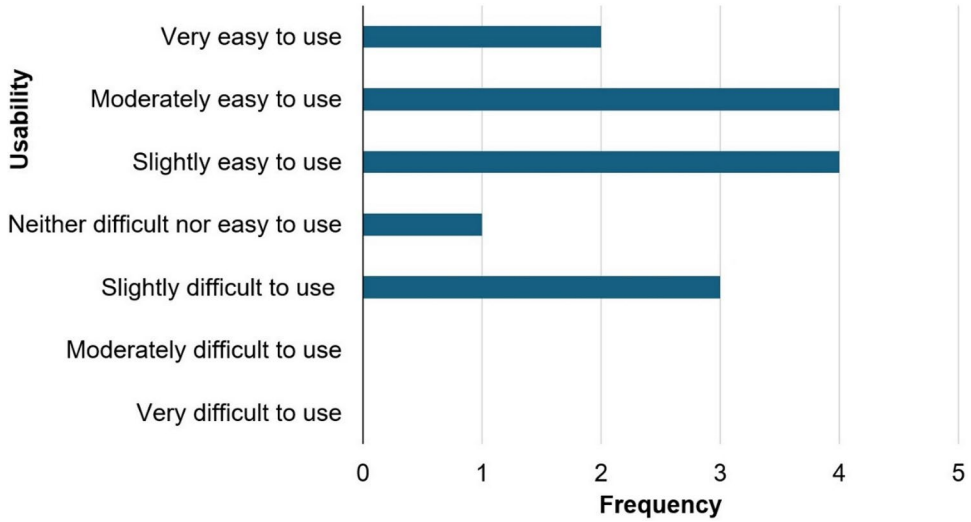


Fig. 5 Usability ratings per number of participants

the effectiveness as predominantly positive. The average rating was 5.71 (i.e., between a small and moderately positive effect) on the 1–7 score scale, see Fig. 4. One participant, a non-instructor, rated it as having a negative effect (i.e., as 2: moderate negative effect), whereas all other answers ranged between 4 (neither negative nor positive effect) and 7 (large positive effect). Instructors ($n=10$) scored method effectiveness as 5.89 on average, non-instructors ($n=4$) as 5.00. Data from one participant was missing.

On the open question regarding perceived positive effects of using the method, seven participants reported "*feeling calmer*" or "*more relaxed*" as an effect. For six, it improved the process of obtaining situation awareness, for two it increased confidence, and two felt more "*aware*". One participant reported feeling more like a team and one more decisive. "*I felt calmer and was better able to judge what was happening. More alert.*" and "*It brings you calmness in a stressful moment, both physically and mentally.*" were typical answers. The instructor who operated the fire training device in the first two sessions remarked that the fire-fighting with the method seemed *"less influenced by stress and more controlled"*.

Asked for naming any negative effects, eight participants answered "none". Three participants remarked they had to wait for the others, as time required for performing the method differed. Two remarked it took "focus" to perform the method. One remarked feeling "rushed", and one reported finding the "Protect" step ambiguous.

4.2.2 Usability of the method

Fourteen participants provided a rating for usability. A one-sample Wilcoxon signed-rank test indicated that responses for usability were significantly above the neutral midpoint

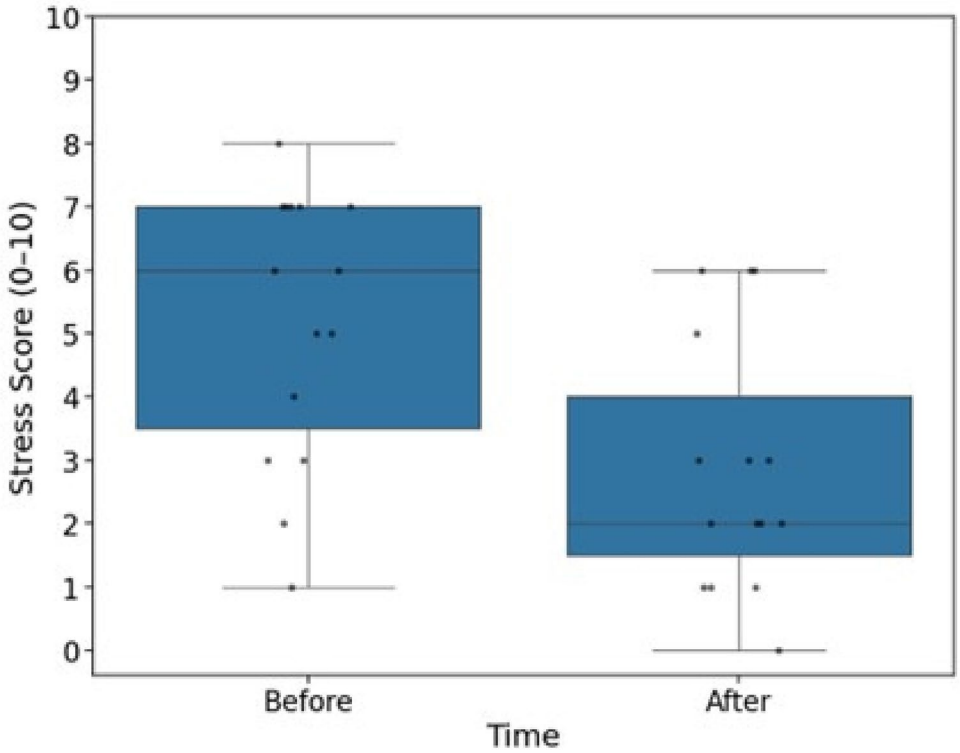


Fig. 6 Stress scores before and after method use per participant

(i.e., 4) of the 7-point Likert scale, $T=10.5$, $Z=2.6412$, $p=0.005$ (two-tailed, exact), $r=0.71$, indicating positive usability perceptions. Three participants gave a rating of 3 (slightly difficult to use), while ten gave positive ratings, and one a neutral rating, see Fig. 5.

The "Protect" step, which consisted of ensuring personal safety and performing actions that cannot be postponed, was applied fully by 12 participants, partially by one, and skipped by two. The "Reset" step was applied fully by 12, and partially by three participants. The "Check" step was applied fully by nine, partially by three, and not at all by three. The "Act" step was applied fully by all.

Aspects considered easy to use (open question) were the deep breaths (by $n=6$), *"building situation awareness"* ($n=3$) and *"checking one's colleague"* ($n=2$). Other answers mentioned once each were "*personal safety*", "*doing it before actions [listed in the company manual]*" and "*following the steps*". By far the most difficult reported aspect of application was the *"urge to act"* (n=7). Others mentioned "*remembering or performing all steps*" ($n=3$), "*the clarity of the "Protect" step*" ($n=2$) and "*timing the method*" ($n=2$). For the "Protect" step, there was lack of clarity whether this entailed wearing Protective Breathing Equipment (PBE) or just stepping clear of the smoke: "*In case of smoke/fire, Protect can be ambiguous: do you wear the PBE or take distance?".*

In one case, discussion between participants on whether to perform the method or wear the PBE was observed to cause a delay in action. Observing smoke caused several participants to prioritize donning the PBE, which prevented communication. In one case it was unclear if "Protect" also involved wearing gloves. This caused interference with the firefighting steps, for example "removing power" was difficult wearing gloves. This difficulty of applying the "Protect" step was also reported as comment on the question on interference of the method with the ABC firefighting procedure. One participant indicated that they feared application of the method could be perceived as inaction by passengers.

4.2.3 Stress reduction

A Wilcoxon signed-rank test revealed a statistically significant reduction in perceived stress following use of the S&S management method, $T=0.0$, $Z=-3.27$, $p<0.001$, with a large effect size, $r=0.88$. Fifteen paired observations were available. One pair produced a difference of zero and was excluded from the ranking procedure.

Self-reported stress ratings (see, Fig. 6) before using the method were on average 5.20, median = 6, *IQR* = 3.5 and immediately after using the method these were 2.87, median = 2, *IQR* = 2.5. Fourteen out of 15 participants reported a reduction in stress immediately after using the method. One participant reported no change, but their stress level before applying the method was already very low (i.e.: a rating of 1 before as well as after, see Fig. 6).

4.2.4 Interference with standard operating procedures

Reported interference of the method with the standard firefighting procedure was limited. Eight participants reported no interference at all, two felt that the firefighting was delayed, one forgot to take equipment, one felt that everyone was ready for firefighting at a different moment due to method, and one felt that wearing the PBE interfered with performing the "Reset" step.

4.2.5 Suggestions for improvement

Several improvements were suggested. Mainly suggestions centered around the "Protect" step. Four participants found the step unclear, a suggestion was made to change to wording to "are you safe?" instead of "personal safety", and two emphasized the need for a clearer description of what the step exactly entails. Three participants suggested that sufficient training with the method would be essential and one suggested integrating the steps into the firefighting (ABC) procedure.

5 Discussion

Based on SME input, literature and existing airline training materials, a concept S&S management method was developed for cabin crew, with the aim to be applicable in a wide range of potentially startling and surprising situations. The current study provides the first data on SME and users' evaluations of the effectiveness and usability of such a method.

The interviews with cabin crew instructors and the focus group of cabin crew members confirmed that the proposed method was expected to be effective in a wide variety of scenarios and could be integrated into standard operating procedures. The idea of a S&S management method, a first for the cabin crew domain, was well received by the participating cabin crew and cabin crew instructors. Several suggestions were made to add elements to the method; however, these were not adopted because they would increase its complexity. Useful training-related suggestions included emphasizing that the method can be applied individually and that partial application may still be beneficial.

Practical testing in a fire extinguishing scenario showed that the participants rated the method as having a significantly positive instead of negative or neutral general effect. Participants described the perceived positive effects generally as feeling more calm, controlled and focused due to performing the method. In line with this, they rated perceived stress significantly lower after compared to before applying the method. All participants except one reported feeling less stressed after applying the method. This aligns with findings from the evaluation of a similar method for cockpit crew (Vlaskamp et al. 2025a, b). One participant remarked that performing the method together enhanced "team-spirit". Teamwork is an important part of Crew Resource Management training (Kolander 2019).

The method was also rated as significantly easy instead of difficult or neutral to use. Only three participants skipped a step of the method. Most participants experienced no interference at all with the existing firefighting procedures, whereas the most-reported interference was a delay in acting. Regarding usability of the method, the focus group mentioned that it may be difficult to suppress the urge to act immediately. Several participants' comments confirmed the urge to act immediately was indeed present in our simulated firefighting scenario. One cabin crew member may rush into action while the other is performing the S&S management method. Extensive training of the method may be required to prevent lack of coordination and skipping of steps. With sufficient training and repetition, the method can become more automatic, reducing the likelihood of skipped steps. Also, it may be important to explain in training that it is likely to feel unintuitive to perform a S&S management method in situations where it is most needed (a principle termed the "startle paradox" (Vlaskamp et al. 2025a, b). However, even incomplete execution can have perceived positive effects, as was shown in cockpit crew research (Vlaskamp et al. 2025a, b). Taking a moment to evaluate before taking action to avoid incorrect, rushed decisions has been a recommendation in pilot training (Field et al. 2018) and in health care training (Rall et al. 2008). Interviewed SMEs commented that it is precisely this urge to act too fast that often leads to omissions of procedures, for example forgetting to bring protective gloves.

Participants also raised concerns about the way the method can be perceived by the passengers. In particular, some felt that the steps "Reset" and "Check" can possibly give the impression that the cabin crew member is inactive,

or do not know what to do. The way these steps are performed (e.g. with confident posture and callouts, not lasting too long, not in front of passengers if possible) could be further refined. We suggest that the method is trained with an emphasis on performing the steps decisively, with confident posture, if possible together, and using callouts. In some cases, the reset can be performed while fetching emergency equipment. These measures ensure that confidence is expressed towards passengers (preventing them from taking action themselves), and they may also instill confidence in the cabin crew. Testing with naïve observers or evaluations of the method in practice may provide a more conclusive answer to this issue. Experimental testing of the method with naive observers could also confirm or disconfirm these concerns. Passenger aggression is also common and causes emotional distress for cabin crew members (Rösch et al. 2024). Concerns were voiced about applying the method when dealing with a violent passenger whereby it might aggravate the situation or further provoke the passenger when they could feel ignored. However, current training already emphasizes taking actions to "manage your emotions" without specifying which, and most SMEs thought the "Reset" step from the method would serve this purpose. Some flexibility in adapting the method to the situation should be trained. For example, in an "unruly passenger" situation, the "Check" step might be more simple.

During practical testing in a fire training device, four participants indicated that the "Protect" step was somewhat ambiguous. The step is intended as a check to confirm conditions are safe to perform the method. This entails being clear of smoke, and only when smoke is an immediate threat, the PBE needs to be donned first. Three participants found it hard to judge if visible smoke meant they should wear PBE immediately, and opinions on this sometimes differed within a team. More guidance was desired for applying this step of the method in the firefighting scenario. To address this, the text:" not exposed to smoke, fumes, or other immediate hazards" was added to the method (see Fig. 1). However, it is impossible to provide precise guidance for all scenarios. Differences in interpretation and execution will have to be addressed in training, and crew made aware that timing for wearing the PBE might differ among cabin crew members.

Several limitations of the exploratory study should be considered. First, practical evaluation was limited to a simulated firefighting scenario. Further evaluation of the method's use in different scenarios would be valuable, as each poses unique threats and requires different procedures. These should be evaluated by a qualified observer. The simulated nature of the scenario is likely to cause less stress than a real emergency, making it easier to apply an S&S management method. Second, the practical evaluation was done mainly by cabin crew instructors. Regular cabin crew members might be less proficient in firefighting than instructors and thus find it harder to combine standard operating procedures with the S&S management method. Third, the participants only received a short briefing on the method and its underlying principles, and no practice in using the method. A more extensive briefing, as well as practicing the method in different situations, would likely lead to the method being easier to use. Fourth, the lead researcher was employed as a pilot at the same airline. While this familiarity with cabin procedures was advantageous for understanding the operational context, it also presents a potential source of bias. Fifth, all participants were drawn from the same Western European airline. While this limits the exploration of potential cultural and organizational differences, it ensured a consistent operational context and comparable work procedures. Sixth, retrospective measures of stress and effectiveness were used, potentially biasing the results. Seventh, due to operating in groups, the ratings within the same groups may not be independent, reducing statistical power. Finally, no control group was included, thus it cannot be determined with absolute certainty whether the reported reduction in stress was attributable to the PRCA method itself. or to other factors. As a next step, a randomized controlled trial could be used to determine the method's effects compared to baseline training.

This study provides the first concept of a S&S management method for cabin crew members, as well as a first evaluation of its perceived effectiveness and usability by cabin crew. Research on frontline resilience indicates that rigid, prescriptive approaches may be insufficient and that operators must adjust procedures to situational demands (Steen et al. 2024). Our initial findings suggest that a more generic S&S management method may offer a valuable tool for cabin crew members to manage their emotional response in a wide range of sudden and unexpected abnormal events, allowing for better application of event-specific protocols.

Appendix 1 PowerPoint slides for interviews and Focus Group

Developing a startle management method for cabin crew

TU Delft KLM Cranfield University

What is startle and surprise?

- **Startle:** an involuntary reaction to an intense stimulus, such as a sudden loud noise (Rivera et al. 2014)

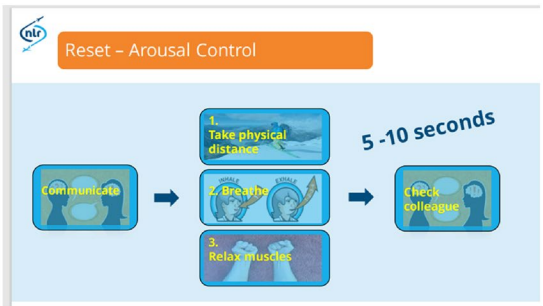
Example: a loud bang during the landing roll-out

- **Surprise:** "a cognitive-emotional response to something unexpected, which results from a mismatch between one's mental expectations and perceptions of one's environment" (Rivera et al., 2014).

Example: The sudden dropping of the oxygen masks during an (unnoticed) slow decompression. ("This can't be happening")

Cockpit crew startle management method:

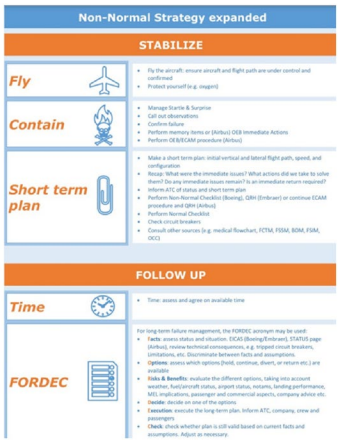
Proven positive effects on situation awareness and decision making



Cockpit crew "non-normal strategy"

- Helps with priority setting
- Has a logical sequence

- Cabin crew does not have a "NNS"
- Contains a step "protect yourself"



Suggested Cabin Crew Method:

Protect yourself
- Ensure **personal safety** (e.g. wear oxy mask (decompression), sit down immediately in case of severe turbulence) and **perform actions that cannot be postponed** (e.g. shout "Brace for Impact") and ensure you are in a **safe environment** to perform a reset)

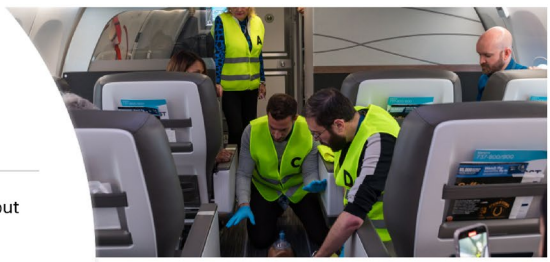
Reset
- Take a deep, abdominal breath
- Exhale slowly (approximately 2x the length of the breath in)
- Repeat if required

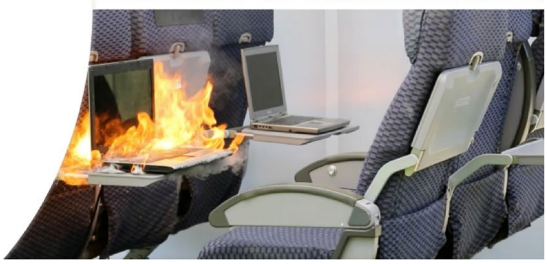
Check
- Check if your colleague(s) need(s) a reset
- Slowly build situation awareness by stating what you see, hear, smell, felt and confirm the situation (if possible with colleague)

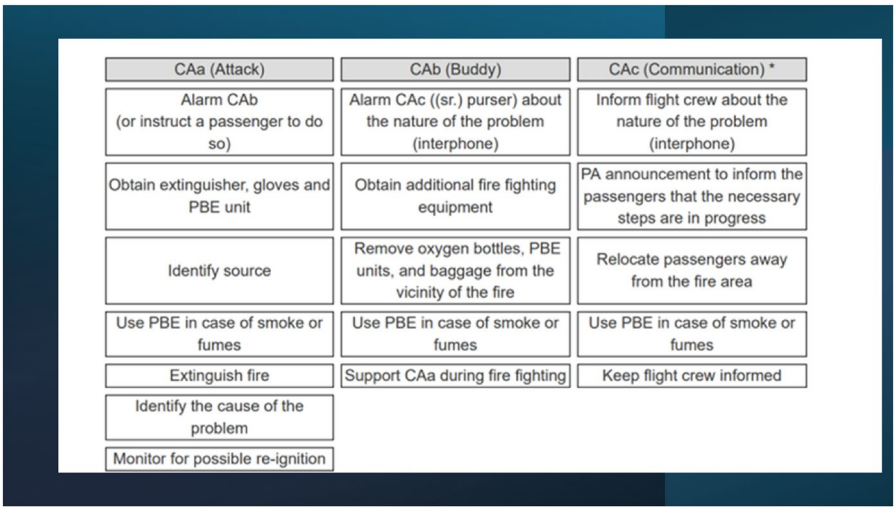
Act
- Perform actions according FSSM

For the focus group I would like your input on:

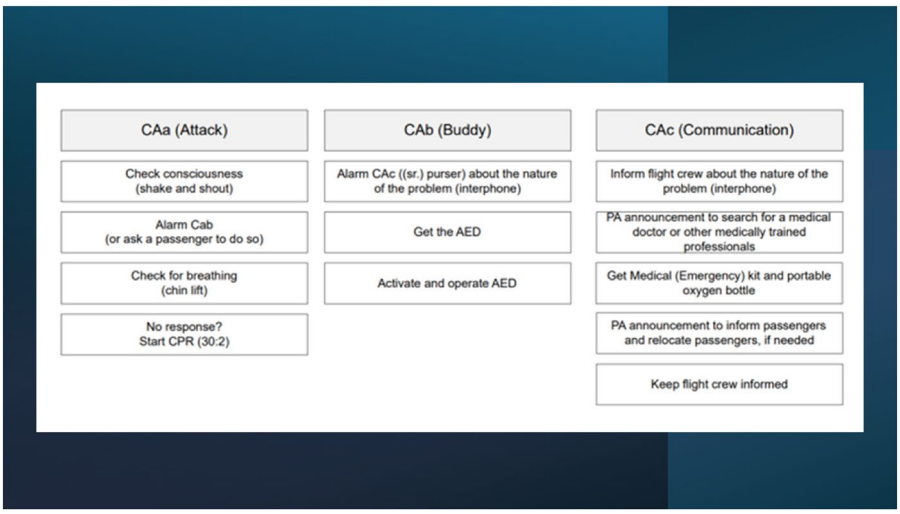
- Smoke fire fumes ABC
- Unruly passenger
- Medical ABC







CAa (Attack)	CAb (Buddy)	CAc (Communication) *
Alarm CAb (or instruct a passenger to do so)	Alarm CAc ((sr.) purser) about the nature of the problem (interphone)	Inform flight crew about the nature of the problem (interphone)
Obtain extinguisher, gloves and PBE unit	Obtain additional fire fighting equipment	PA announcement to inform the passengers that the necessary steps are in progress
Identify source	Remove oxygen bottles, PBE units, and baggage from the vicinity of the fire	Relocate passengers away from the fire area
Use PBE in case of smoke or fumes	Use PBE in case of smoke or fumes	Use PBE in case of smoke or fumes
Extinguish fire	Support CAa during fire fighting	Keep flight crew informed
Identify the cause of the problem		
Monitor for possible re-ignition		



CAa (Attack)	CAb (Buddy)	CAc (Communication)
Check consciousness (shake and shout)	Alarm CAc ((sr.) purser) about the nature of the problem (interphone)	Inform flight crew about the nature of the problem (interphone)
Alarm Cab (or ask a passenger to do so)	Get the AED	PA announcement to search for a medical doctor or other medically trained professionals
Check for breathing (chin lift)	Activate and operate AED	Get Medical (Emergency) kit and portable oxygen bottle
No response? Start CPR (30:2)		PA announcement to inform passengers and relocate passengers, if needed
		Keep flight crew informed

Emergency on Ground (incl RTO and possible evacuation)
Smoke, fire fumes (Smoke, fumes, open fire, concealed fire, hot cup overheating, lavatory smoke alarm, lavatory waste container fire extinguisher, portable electronic device fire/smoke, lithium battery fire (on flight deck).
Evacuation Required (sudden)
Premeditated emergency landing
Go around
Decompression
Brace for impact
First Aid/AED (pax or crew)/Medical ABC
(Sudden) turbulence
Abnormal (general)
Unruly passenger
Dangerous goods incident

Author contributions Daan Vlaskamp: Conceptualization; Methodology; Investigation; Data curation; Formal analysis; Writing—original draft. James Blundell: Methodology; Validation; Supervision; Writing—review & editing. Annemarie Landman: Methodology; Validation; Supervision; Writing—review & editing. Eric L. Groen: Supervision; Writing—review & editing. M.M. van Paassen: Supervision; Writing—review & editing. Olaf Stroosma: Supervision; Writing—review & editing. Max Mulder: Supervision; Writing—review & editing.

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Data availability The data that support the findings of this study are not publicly available due to privacy and confidentiality agreements with participants. Anonymized data may be made available by the corresponding author on reasonable request and pending ethical approval.

Declarations

Conflict of interest The authors declare no conflict of interest.

Ethical approval Ethical approval for the interviews and focus group was obtained from the Ethics Committee of Delft University of Technology (application number: 4988). Ethical approval for the simulator testing was obtained from the same committee (application number: 5298). All participants provided written informed consent prior to participation. All procedures were conducted in accordance with the principles of the Declaration of Helsinki.

References

Japan Transport Safety Board. (2024) *Aircraft accident investigation interim report: Bombardier DHC-8–315 JA722A and Airbus A350–941 JA13XJ*. Tokyo: JTSB. https://jtsb.mlit.go.jp/eng-air_report/interim20241225-JA722A_JA13XJ.pdf

Bragaru M, van Wilgen CP, Geertzen JHB, Dekker R (2013) Barriers and facilitators of participation in sports: a qualitative study on Dutch individuals with lower limb amputation. PLoS ONE 8(3):e59881. https://doi.org/10.1371/journal.pone.0059881

Air Accidents Investigation Branch. (2020) *AAIB bulletin 09/2020: Airbus A320–214 OE-LOA*. Aldershot: AAIB. https://www.gov.uk/aaib-reports

Braun V, Clarke V (2006) Using thematic analysis in psychology. Qual Res Psychol 3(2):77–101. https://doi.org/10.1191/1478088706qp063oa

Bureau d'Enquêtes et d'Analyses. (2012) *Final report on the accident on 1 June 2009 to the Airbus A330–203 F-GZCP operated by Air France flight AF447 Rio de Janeiro–Paris*. Paris: BEA

Cappo BM, Holmes DS (1984) The utility of prolonged respiratory exhalation for reducing physiological and psychological arousal in non-threatening and threatening situations. J Psychosom Res 28(4):265–273. https://doi.org/10.1016/0022-3999(84)90048-5

Casner SM, Geven RW, Williams KT (2013) The effectiveness of airline pilot training for abnormal events. Hum Factors 55(3):477–485. https://doi.org/10.1177/0018720812466818

Dehais F, Causse M, Vachon F et al (2014) Failure to detect critical auditory alerts in the cockpit: evidence for inattentional deafness. Hum Factors 56(4):631–644. https://doi.org/10.1177/0018720813510735

Dismukes R, Goldsmith TE, and Kochan JA (2015) Effects of acute stress on aircrew performance: literature review and analysis of operational aspects (NASA Technical Report). NASA. https://ntrs.nasa.gov/api/citations/20190002685/downloads/20190002685.pdf

Endsley MR (1995) Toward a theory of situation awareness in dynamic systems. Hum Factors 37(1):32–64. https://doi.org/10.1518/001872095779049543

Eysenck MW, Derakshan N, Santos R, Calvo MG (2007) Anxiety and cognitive performance: attentional control theory. Emotion 7(2):336

Field JN, Boland EJ, van Rooij JM, Mohrmann JFW, and Smeltink JW (2018) *Startle effect management* (Report No. NLR-CR-2018–242). European Aviation Safety Agency

Houtman ILD, Bakker FC (1989) The anxiety thermometer: a validation study. J Pers Assess 53(3):575–582

Kolander CK (2019) Flight and cabin crew teamwork: improving safety in aviation. In: Kanki B, Helmreich R, Anca J (eds) Crew resource management. Academic Press, pp 407–420

Lambert HH (2023) What do Navy SEALs and CPAs have in common? Mental Toughness. New Account 792:14

Landman A, Groen EL, Van Paassen MM, Bronkhorst AW, Mulder M (2017) Dealing with unexpected events on the flight deck: a conceptual model of startle and surprise. Hum Factors 59(8):1161–1172

Landman A, van Middelaar SH, Groen EL, van Paassen MM, Bronkhorst AW, Mulder M (2020) The effectiveness of a mnemonic-type startle and surprise management procedure for pilots. Int J Aerosp Psychol 30(3–4):104–118. https://doi.org/10.1080/24721840.2020.1763798

Lauria MJ, Gallo IA, Rush S, Brooks S, Spiegel R, Weingart SD (2017) Psychological skills to improve emergency care providers' performance under stress. Ann Emerg Med 70(6):884–890. https://doi.org/10.1016/j.annemergmed.2017.03.018

Manikath E, Li WC, Piotrowski P (2025) Emergency = emergency? Usability evaluation of a novel emergency alerting system for cabin emergencies. Transp Res Procedia 88:225–233. https://doi.org/10.1016/j.trpro.2025.05.028

Martin WL, Murray PS, Bates PR, Lee PSY (2016) A flight simulator study of the impairment effects of startle on pilots during unexpected critical events. Aviat Psychol Appl Hum Factors 6(1):24–32. https://doi.org/10.1027/2192-0923/a000094

Martin WL (2017) *Developing startle and surprise training interventions for airline training programs* [Conference presentation]. PACDEFF Flight Crew Forum. https://pacdeff.com/wp-content/uploads/2017/08/PACDEFF-FC-Forum-Presentation-on-Startle.pdf

Migliaccio GM, Russo L, Maric M, Padulo J (2023) Sports performance and breathing rate: what is the connection? A narrative review on breathing strategies. Sports (Basel) 11(5):103. https://doi.org/10.3390/sports11050103

Partridge C, Goodman T (2016) Psychological problems among cabin crew. Aviation mental health. Routledge, pp 227–239

Piras M, Landman A, van Paassen MM, Stroosma O, Groen EL, and Mulder M (2023) Easy as ABC: a mnemonic procedure for managing startle and surprise. In: Proceedings of the 22nd International symposium on aviation psychology (p. 39). Wright State University. https://corescholar.libraries.wright.edu/isap_2023/31

Rall M, Glavin R, Flin R (2008) The '10-seconds-for-10-minutes principle.' Bull R Coll Anaesth 51(2):614

Rivera J, Talone AB, Boesser CT, Jentsch F, Yeh M (2014) Startle and surprise on the flight deck: similarities, differences, and prevalence. Proc Hum Factors Ergonomics Soc Annu Meet 58(1):1047–1051. https://doi.org/10.1177/1541931214581219

Rösch A, Chernak E, Blundell J (2024) Air rage from the sharp end: cabin crew perspectives on disruptive passenger behaviour in Europe and its impact on occupational safety and well-being. Int J Occup Saf Ergon 30(4):1196–1207. https://doi.org/10.1080/10803548.2024.2383055

Röttger S, Theobald DA, Abendroth J, Heusser P (2020) The effectiveness of combat tactical breathing as compared with prolonged exhalation. Appl Psychophysiol Biofeedback 45(3):227–236. https://doi.org/10.1007/s10484-020-09485-w

European Aviation Safety Agency. (2014, June 26). *Notice of Proposed Amendment 2014–17: Crew resource management (CRM) training* (Rulemaking Directorate). European Union Aviation Safety Agency. https://www.easa.europa.eu/en/downloads/17394/en

Schützwohl A (1998) Surprise and schema strength. J Exp Psychol Learn Mem Cogn 24(5):1182–1199. https://doi.org/10.1037/0278-7393.24.5.1182

Shaw-Metz JL (2023) Coming up for air: breathwork practice for stress management in the healthcare setting. J Interprof Educ Pract 30:100594. https://doi.org/10.1016/j.xjep.2022.100594

Steen R, Norman JE, Bergström J, Damm GF (2024) Dark knights: exploring resilience and hidden workarounds in commercial aviation through mixed methods. Saf Sci 175:106498. https://doi.org/10.1016/j.ssci.2024.106498

Steyn HS (2020) Non-parametric tests with effect sizes. North-West University

Transportation Safety Board of Canada (2025) *Air transportation safety investigation A25O0021: Preliminary report*. Gatineau, QC: TSB. https://www.tsb.gc.ca/eng/rapports-reports/aviation/2025/a25o0021/a25o0021-preliminary.html

Vlaskamp D, Landman A, van Rooij JM, Blundell J (2025a) Recovery from startle and surprise: a survey of airline pilots' operational experience using a startle and surprise management method. Int J Ind Ergon 107:103733. https://doi.org/10.1016/j.ergon.2025.103733

Vlaskamp D, Landman A, van Rooij JM, Li WC and Blundell J (2024) Airline pilots' perceived operational benefit of a startle and surprise management method: a qualitative study. In: Proceedings of the 2nd International conference on cognitive aircraft systems (pp. 29–34). SciTePress. https://doi.org/10.5220/0012927800004562

Vlaskamp D, Pollitt A, Blundell J, Landman A, Groen EL, van Paassen MM, Stroosma O, and Mulder M (2025) *Cabin crew startle and surprise: Occurrence and impact* [Preprint]. **Research Square**. https://doi.org/10.21203/rs.3.rs-8158472/v1

National Transportation Safety Board. (2010). Loss of control on approach: Colgan Air, Inc., operating as Continental Connection Flight 3407, Bombardier DHC-8-400, N200WQ, Clarence Center, New York, February 12, 2009 (NTSB/AAR-10/01) https://www.ntsb.gov/investigations/AccidentReports/Reports/AAR1001.pdf