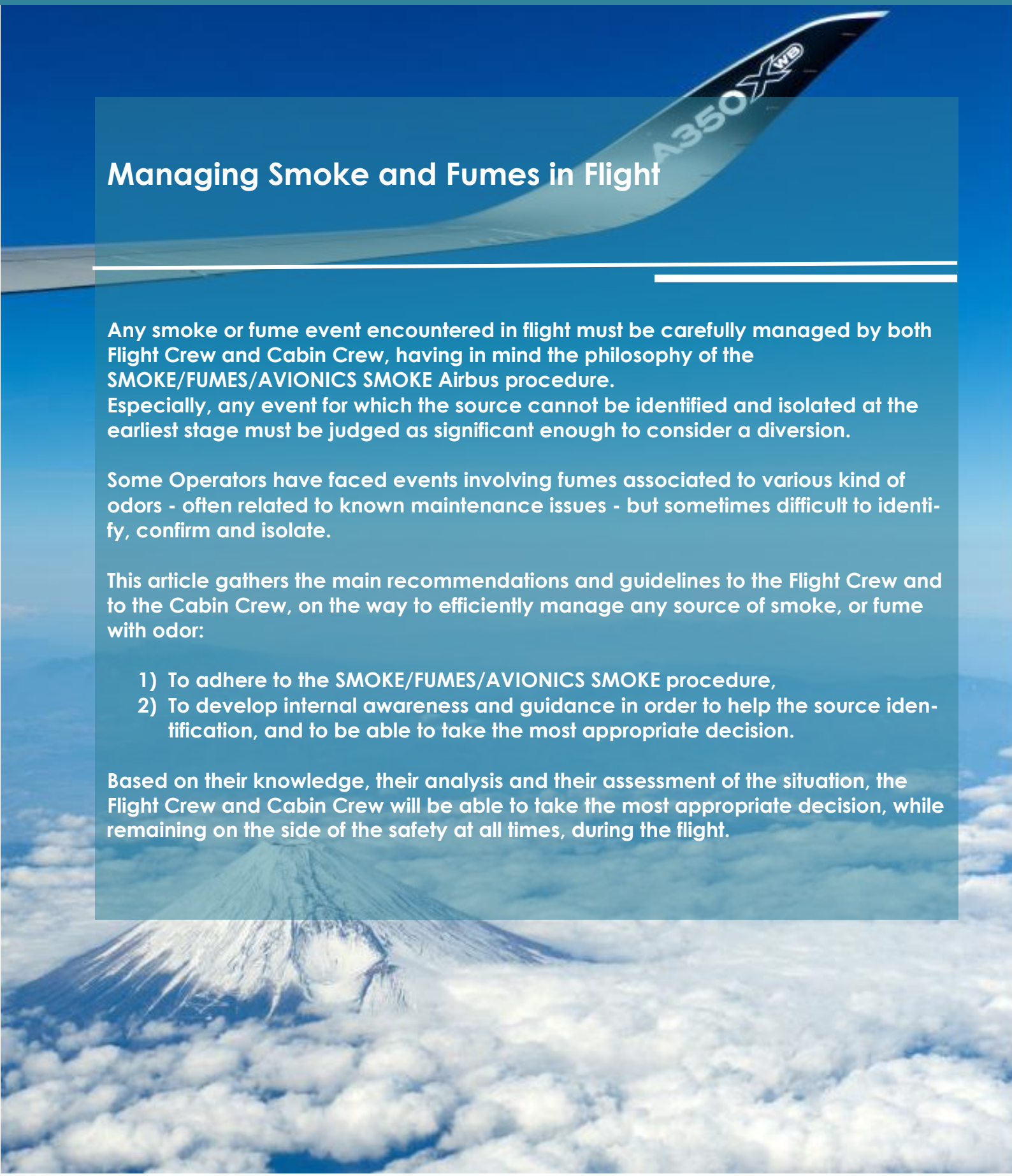
# Summary



## Managing Smoke and Fumes in Flight

Any smoke or fume event encountered in flight must be carefully managed by both Flight Crew and Cabin Crew, having in mind the philosophy of the SMOKE/FUMES/AVIONICS SMOKE Airbus procedure.
Especially, any event for which the source cannot be identified and isolated at the earliest stage must be judged as significant enough to consider a diversion.

Some Operators have faced events involving fumes associated to various kind of odors - often related to known maintenance issues - but sometimes difficult to identify, confirm and isolate.

This article gathers the main recommendations and guidelines to the Flight Crew and to the Cabin Crew, on the way to efficiently manage any source of smoke, or fume with odor:

1) To adhere to the SMOKE/FUMES/AVIONICS SMOKE procedure,
2) To develop internal awareness and guidance in order to help the source identification, and to be able to take the most appropriate decision.

Based on their knowledge, their analysis and their assessment of the situation, the Flight Crew and Cabin Crew will be able to take the most appropriate decision, while remaining on the side of the safety at all times, during the flight.

## Dealing with the Events

# The Context

### The Airbus procedure

The SMOKE/FUMES/AVIONICS SMOKE procedure covers all the cases of fire, smoke and fumes.

A smoke is quite easy to identify because the Flight Crew and Cabin Crew will be able to see it and also to smell it: most of the time, it will have a given odor, perceptible by the crew.

Concerning the fume, it corresponds to something that is not seen by the Flight Crew or Cabin Crew, but that is perceived:

- By causing irritation in the eyes, the nose, or on the breathing, or

-Because it has an odor.

So, depending on the source, a fume may be either associated to an odor, or not.

In this article, the word "fume" therefore means "a fume associated to an odor".

**What are the differences between smoke, fumes and odors?**

**SMOKE:**
"The product of burning materials made visible by the presence of small particles (ICAO)"

**FUMES:**
"Gaseous compounds which are not visible (ICAO)"

**ODOR:**
"A particular smell especially an unpleasant one"

**Odors may either come from smoke or from fumes**

## Dealing with the Events

### The Main Challenges

**Complex and dynamic events**

Any fire, smoke or fume event is a complex and dynamic one:

- Complex, because at the start of the event, most of the time, the crews do not know about its source and its severity, and they have to quickly recover the management of the situation by taking appropriate decisions.
- Dynamic, because of the time it takes a fire to spread: without any intervention, a fire may become uncontrollable within 10 minutes; meaning that, if efficient actions are not taken early enough, the situation may escalate in few minutes.

**The three key drivers: time, communication and source identification:**

1) Time:

As stated in the FAA AC 120-80, various Regulatory Authorities have conducted fire tests. The results have shown that fires left to spread into the overhead area of the aircraft become uncontrollable after 8-10 minutes. In addition, studies have also shown that if the crew allows a hidden fire to progress without any intervention, the Flight Crew may have less than 15-20 minutes to land the aircraft.

Therefore, the Flight Crew must anticipate a diversion at the earlier stage of the event, meaning as soon as the first signs of fire, smoke, or fume with odor are detected.

2) Communication:

Because the situation may rapidly escalate and become out of control, a two way communication between the cockpit & cabin is of the utmost importance, from the earlier stage of the event. That is why all Airbus cockpit & cabin smoke procedures include an early step asking that the Flight Crew and the Cabin Crew communicate with each other.

3) Source identification:

If the source of smoke or fumes are located in accessible areas, or in areas monitored by smoke detectors (that will trigger ECAM alerts or local warnings), they can be quite easily identified. For example, the rack of the GSM on board, the cargo area, the crew rests, or the lavatories.

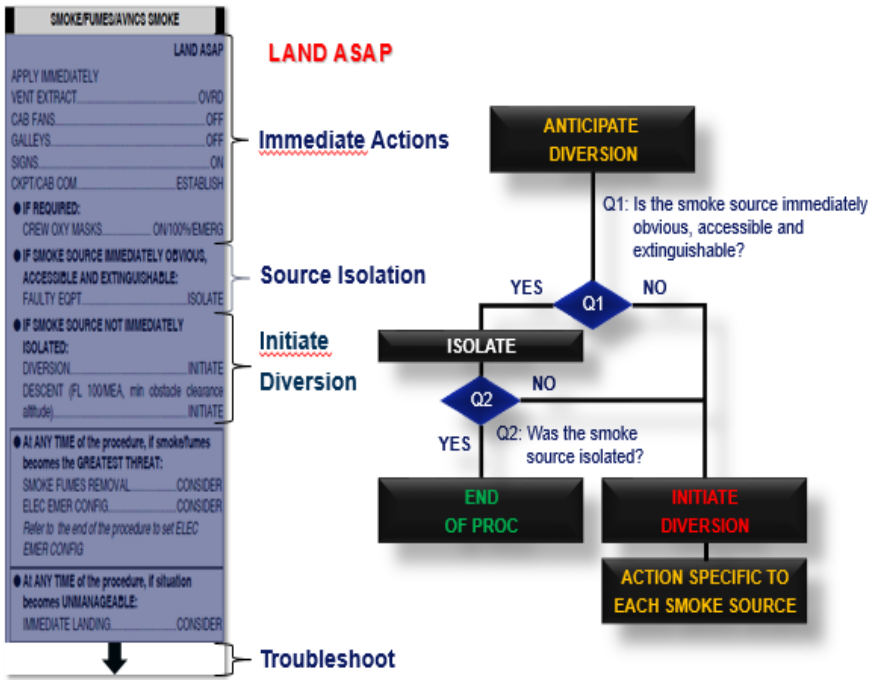
However, other sources are more difficult to locate and to be confirmed because they are located in areas that are not easily accessible, or that are not monitored by detectors, like the air conditioning ducts, or some cabin equipment (e.g: IFE seat boxes). In this case, the human factors play a key role in the detection: sometimes smoke or fumes are not the first signs of an impending fire; therefore, any indications such as abnormal warm surfaces, unusual noises or odors, as well as passenger observations must be carefully taken into account. Finally, some areas, like the avionics bay are equipped with detectors but they are not accessible to precisely confirm the source isolation.

# Adhering to the SMOKE Philosophy

## A single Entry Point & Key Actions

**When should Pilots refer to the SMOKE/FUMES/AVIONIC SMOKE procedure?**
They will refer to the QRH procedure after the AVIONIC SMOKE ECAM alert, or if the Flight Crew or the Cabin Crew detect some fire, smoke or fumes, with or without the triggering of alert (ECAM alert or local warning).
Then, considering the wide range of possible smoke and fumes (with or without odors) sources and situations, the procedure is the reference to provide clear & efficient actions to deal with these events.
Also, as stated in the FAA AC120-80 about "In-flight fires": "*any fume can be the indication of an impending fire that is growing up*": Airbus is in line with the FAA, as we also require that Flight Crew and Cabin Crew always carefully manage any signs, including fumes with odors.

**Key actions to manage the event and avoid any escalation of the situation:**
The Airbus smoke procedure is designed to manage all kinds of events in the most efficient way, and copes with the most critical ones, including the electrical fire.




**What are the key points of the SMOKE/FUMES procedure philosophy?**

The SMOKE FUMES procedure provides a single entry point for all the fire, smoke and fumes events. From the beginning of an event, it ensures that the Flight Crew anticipate a diversion, protect themselves and communicate with the Cabin Crew. This philosophy applies for all cases, and even more when the Flight and Cabin Crews have not immediately and clearly identified the source of the event and are not able to isolate it. This ensures that we always remain on the side of the safety.

# Adhering to the SMOKE Philosophy

## Key Role of the Flight Crew

**Remaining on the side of the safety**
When the Flight Crew enter the SMOKE/FUMES/AVIONICS Smoke procedure, they will anticipate the diversion, meaning that they will establish the mindset for their strategy, check the Alternate airfields and contact the ATC to inform about their intentions.
At the same time, the PM will perform the immediate steps of the procedure: these actions are quick, simple and reversible and they prevent any recirculation of the smoke in the cockpit or cabin. These steps also ensure the protection of the Flight Crew and communication with the Cabin Crew.

Then, the Flight Crew will assess if the source of the event is obvious, accessible and extinguishable, based also on the information provided from the cabin. The Flight Crew will rapidly analyze the situation, and take the most appropriate decision: confirm and isolate the source if feasible, or initiate a diversion in the case of any doubt about the situation.
It is important to highlight that, as shown on the diagram, the diversion can be avoided at this stage, if identification of the source and its isolation are confirmed by both the Flight Crew and Cabin Crew.

If, for any reason, all crewmembers are not able to confirm the source of the event, or if the situation is not under control (e.g the source is not properly isolated), the Flight Crew will initiate the diversion and apply the next steps of the procedure:

- The "At any time" steps of the procedure (considering Removal of Smoke, Emergency Electrical configuration and Immediate Landing): the Flight Crew read them to keep them in mind. If the situation becomes out of control, the Flight Crew must apply them at any time of the event.
  It is important to remember that the objective of the REMOVAL of SMOKE procedure is to remove any dense smoke from the cockpit. It does not help to identify the source of the smoke.

- The troubleshooting steps: the Flight Crew will apply them in an attempt to identify and stop the source of the fire/smoke/fume.
  The three main possible sources are the air conditioning, the cabin equipment and electrical equipment/avionics/undetermined sources. They are based on in-service experience and listed from the most probable one (air conditioning source) to the least probable one (electrical source).

# Adhering to the SMOKE Philosophy

## Key Role of the Cabin Crew

In the cabin, the Cabin Crew is responsible for effectively dealing with in-flight emergency that involves smoke, or fumes with odors. Therefore, they must be aware of the importance of taking immediate action to determine the source of the event.

**Working as a Team**
As previously explained, the involvement of the entire crew (Flight and Cabin Crew) from the beginning of the event is key.
As time is critical, the Cabin Crew must immediately:

- Assess the situation and try to identify the source as quick as possible
- Communicate all information and coordinate the actions
- Provide regular updates on the evolution of the situation
- Apply the corresponding procedure (e.g CCOM - Basic Firefighting procedure).

**Effective Communication**
All Crewmembers must use common references in order to rapidly and efficiently share the necessary information, in order to help the Flight Crew in their decision making process.
It is also important that the Cabin Crew are provided with exhaustive information that will help them assess and attempt to distinguish between all the possible sources of contaminants (e.g ventilation, cabin equipment, oil leaks, etc…)
Each Operator should define common references that will be part of their internal Training/Awareness.

**Awareness and Training**
To support the above-listed behaviors, Airbus provides relevant guidelines in the FCOM, the FCTM, and also in the CCOM and the "Getting to Grips with Cabin Safety" brochure.
In addition, some Regulatory Authorities issued dedicated Bulletins to emphasize to all Operators the importance of developing specific internal guidance and awareness for the Flight Crews and the Cabin Crews.
More details are given in the next Chapter.

## Efficiently Managing the Odors

### Materials and Recommendations for Operators

**Materials from Airbus:**
Operators will find helpful materials in the following Airbus Operational documentation:

- The SMOKE/FUMES/AVNCS SMOKE procedure (FCOM & QRH) that is the reference for management of any fire, smoke or fumes ( and their associated odor)
- The FCTM, SMOKE/FUMES/AVNCS SMOKE procedure-FCTM Technique chapter
- The CCOM ABNORMAL & EMERGENCY procedures- SMOKE & FIRES
- The CCOM SAFETY OPERATIONAL AWARENESS-CABIN SMOKE AWARENESS
- The "Getting to Grips with Safety" brochure.

In addition, several Maintenance related documentation are available, including:

- Various ISI documents (e.g ISI 21.00.00019 about Cabin Air Quality, or ISI 21.21.00011 that provides Troubleshooting advice),
- Various Maintenance procedures for decontamination and cleaning.

The main points addressed in these documents are:

- How to efficiently manage these events, while ensuring the safety of the flight
- Considerations about diversion and when it can be avoided
- The table of odors with their possible cause. This table is based on what is encountered in operations, and enables the Flight Crew to increase their knowledge and enhancing the communication between the cockpit and the cabin
- How to anticipate as much as possible these odors events with appropriate troubleshooting, decontamination and cleaning.

**Materials from some National Regulations:**
Some National Authorities also published Safety bulletins and guidelines, to complement Airbus materials and highlight the importance of a tailored guidance and awareness:

- The FAA SAFO " Procedures for addressing odors, smoke and/or Fumes in flight"
- The FAA & CAA " Research into Fire, Smoke or Fumes occurrences on Transport airplanes"
- The ICAO Circular 344-AN/202 "Guidelines on education, Training and reporting practices related to fume events"
- The Australian CASA Safety Bulletin.

# Efficiently Managing the Odors

## Materials and Recommendations for Operators

**Tailored guidance and awareness on odors recognition:**
Education on the recognition of odors is the first and most challenging step, because the ability to clearly identify an odor in the cockpit or in the cabin involves subjectivity and, at the same time requires training.

- Subjectivity: Studies have shown that an odor perception is based on some personal associations that we make, together with a brain analysis. In addition, the personal conditions (health, age, psychology…) of everyone has an effect on the perception and the interpretation of a given odor.
- In-flight conditions: The humidity and temperature conditions on board the aircraft can also have a significant impact on the odor. Especially, the drier the cabin air is, the less the odor will be accurately perceptible. For example, depending on the environmental conditions, an oil smell can sometimes rather be described as mouldy or as a dirty sock smell, than oil itself.
  There can also be other sources with typical odor coming from volatile substances like cleaning agents, sprays or nail polish…
- In addition, if not recognized rapidly, an odor perception may be lost after a time lapse.

Therefore, education and tailored training on odors (based on the most frequent events that the Operator experiences and the table on odors provided in the FCTM and CCOM) is of the utmost importance to ease their recognition. The Operator can, for example, produce samples of odors in order to train on how to identify them and determine what their source may be. The Operator must also define internally common naming, based on straightforward criteria.

**Mapping of the Odors:**
The training on odor recognition and naming can be even more efficient when a relationship is made between all of the following:

- A reference document of the odors that are regularly encountered
- The corresponding possible location of these odors (e.g galleys, ceiling panels)
- The possible sources identified on a given aircraft (e.g ovens, coffee makers, IFE boxes, or ventilation supply).

This mapping will also obviously take into account the overall operational context: Use of APU on ground, single engine taxi, single pack operations, de-icing procedure, and overall environmental conditions (e.g hot & humid conditions, cold soak, etc)

# Efficiently Managing the Odors

## Materials and Recommendations for Operators

**Internal Reporting:**
The Operator must also ensure an accurate and standardized way to report odor events

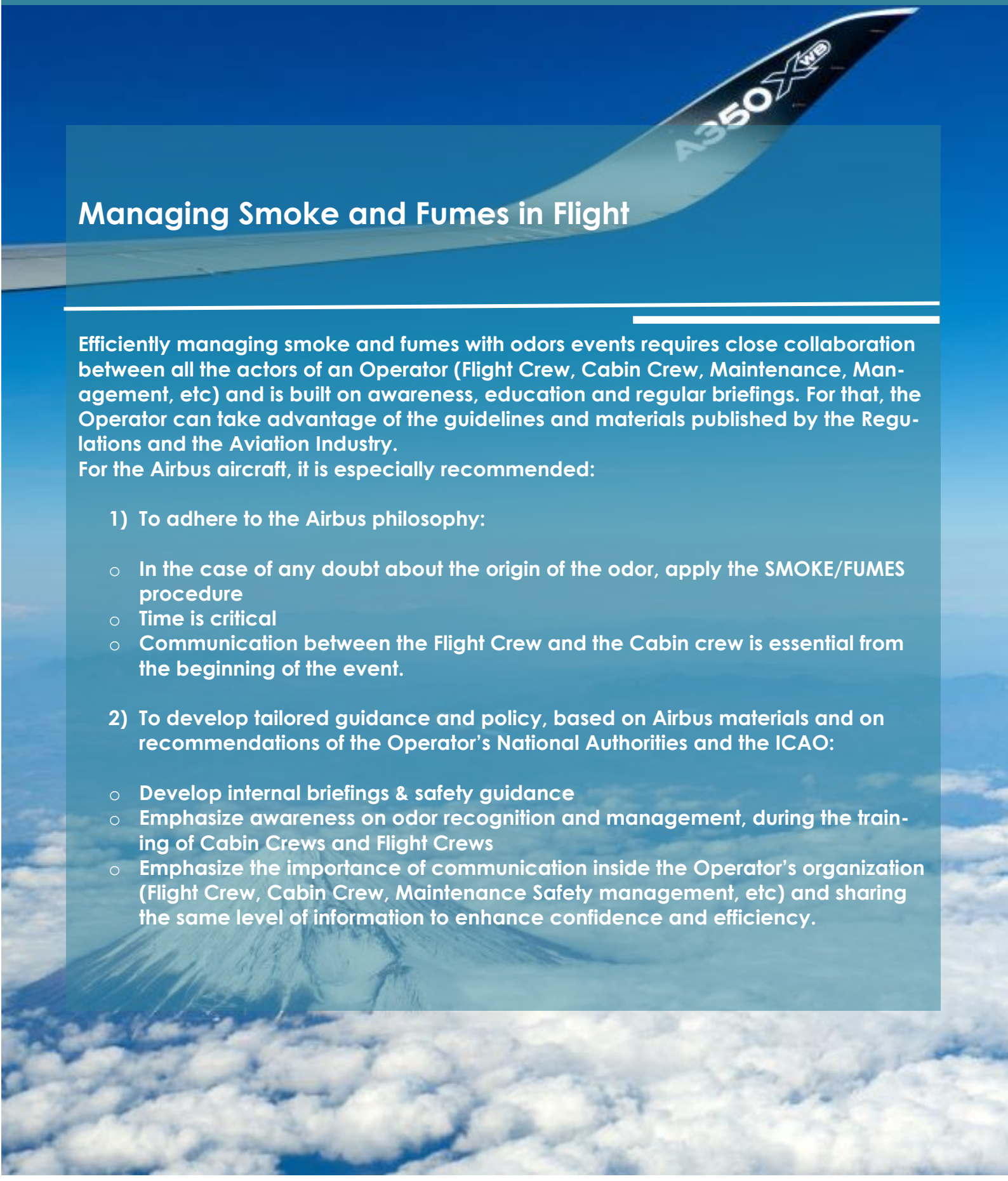
- From cabin to cockpit
- From cockpit & cabin to maintenance.

For that, the logbook may be enriched by tailored reporting sheets (refer to the example provided in the ICAO Circular 344-AN/202). The Operator can also create a specific reporting sheet (common template for the entire crews) to get consistent data such as:

- Nature and intensity of the odor
- Any visible signs, such as haze or mist
- Exact location in the cabin
- Phase of the flight and duration of the event/reoccurrence
- Actions taken and coordination of foreseen actions
- Affected Passengers or Crewmembers, with a description of symptoms
- Relocation of Passengers (when possible)

This data will help to interpret root causes, assess the operational impact, and monitor the trends over time (i.e frequency, severity and response to the events).
This collaborative work between the Flight Crew, the Cabin Crew and with the Maintenance staff will help them to assess the situation and take appropriate action.

# Conclusion




## Managing Smoke and Fumes in Flight

Efficiently managing smoke and fumes with odors events requires close collaboration between all the actors of an Operator (Flight Crew, Cabin Crew, Maintenance, Management, etc) and is built on awareness, education and regular briefings. For that, the Operator can take advantage of the guidelines and materials published by the Regulations and the Aviation Industry.
For the Airbus aircraft, it is especially recommended:

1) To adhere to the Airbus philosophy:

- In the case of any doubt about the origin of the odor, apply the SMOKE/FUMES procedure
- Time is critical
- Communication between the Flight Crew and the Cabin crew is essential from the beginning of the event.

2) To develop tailored guidance and policy, based on Airbus materials and on recommendations of the Operator's National Authorities and the ICAO:

- Develop internal briefings & safety guidance
- Emphasize awareness on odor recognition and management, during the training of Cabin Crews and Flight Crews
- Emphasize the importance of communication inside the Operator's organization (Flight Crew, Cabin Crew, Maintenance Safety management, etc) and sharing the same level of information to enhance confidence and efficiency.