GRFH

Groupe de Réflexion Facteurs Humains

ILLS IN THE AIR

Inter-specialism video

2018

HF TRAINER GUIDE

GRFH - Groupe de Réflexion facteurs Humains

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Presentation:

This video, produced by the French Civil Aviation Safety Directorate (DSAC), was created by the Human Factors Discussion Group (GRFH - Groupe de Réflexion facteurs Humains).
The full relevance of this film becomes apparent in the context of a Human Factors, CRM (Crew Resource Management) training course given by a CRM Trainer using this guide and after acceptance of the following user's charter.
Although based on actual events, this film is purely fictional, with aviation professionals performing their own roles. Some of the behaviours or attitudes may seem exaggerated, but they reflect the true behaviours or attitudes of the persons who experienced the actual event on which this video is based. The role they perform should in no way be interpreted as reflecting their own personality and/or their professional level.
You are asked to focus more specifically on observing the actions and behaviours of the representatives of the different specialisms so that you can discuss the way they interact and consider the efficiency level of the practices used. Finally, as an HF trainer, at the end of this video you are invited to examine the way in which the different participants handled this event.

User's charter:

This guide is designed for Human Factors trainers in different specialisms as this inter-specialism video was created with the principal teaching aim of "understanding the work of others better understanding".
This guide is not strictly speaking course material; trainers wishing to use this video must build an associated course. This guide is a framework and is designed to prevent misinterpretation of the messages.
Each CRM Trainer or Human Factors Trainer is authorised to use this "Crosstalk" video media and the necessary associated HF TRAINER GUIDE, subject to acceptance of the following conditions:

- During the introduction the participants are informed of the origin of this video media and of the teaching guide.
- The elements developed in this HF TRAINER GUIDE and film are presented without modification.
- These materials are only used for exchanges between aviation personnel and for training purposes to improve the collective promotion of aviation safety.
- These materials are provided free and cannot be sold.

All broadcasting or distribution of this guide and video on networks and outside the framework of HF training for a dedicated group according to the conditions stipulated above is prohibited and could result in legal action.

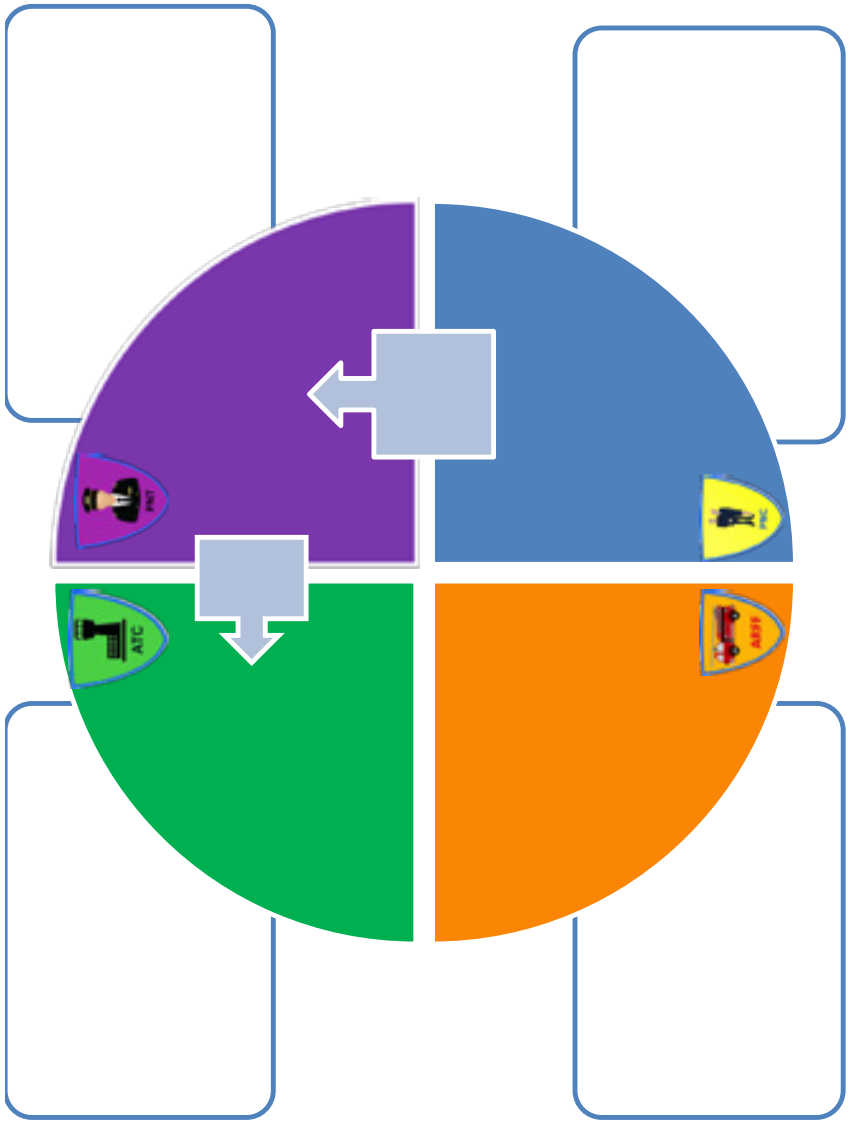
Teaching objectives:

"Understand the work of others better understanding"

The members of the “Groupe de Réflexion Facteurs Humains” set up in 2013 by the DSAC are all aviation Human Factors specialists. They wrote this scenario, filmed the scenes and created this associated guide with the aim of highlighting the following teaching objectives:

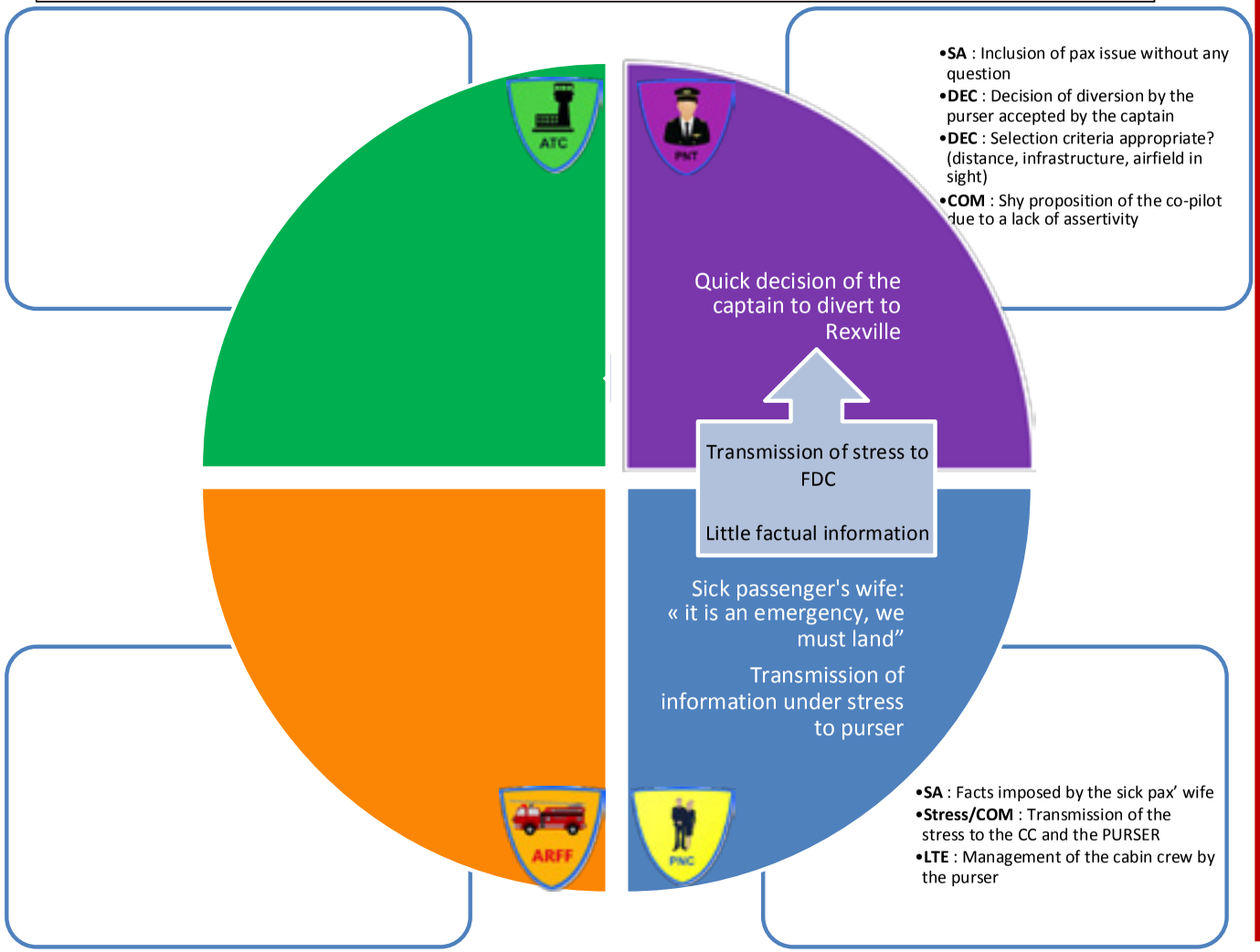
1. Establish precise communication between the participants.
2. Build a shared vision to improve situation awareness.
3. Improve leadership and teamwork.
4. Improve workload management.
5. Manage stress, crowd movements and anxiety relating to collective responses in confined environments.
6. Optimise decision-making between FDC, CC, ATC and the emergency services.
7. Achieve a resilient attitude between participants in each specialism in order to return as quickly as possible to a stable condition in the actions following a destabilisation or a disruptive incident.
8. Take into account the available resources using a high level of skill to obtain the best possible level of individual and collective performance in each situation.

Scene description :



This chart is here to show you, as facilitator, a summarized vision on a few interactions of the scenario.

Sequence 1 : Timing : from 0 min to 02:51 min



Scene description :

When the issue arises, the decision to divert is elaborated. Sickair 007 flight is cruising at FL380 when a passenger starts to complain about stomach ache. His wife, sitting next to him, calls for the flight attendant and tells her that it is an emergency. She is a doctor and demands immediate landing. The flight attendant notifies the purser stressing the fact that the sick passenger's wife is a doctor. She relays the emergency landing request. The purser reports to the captain and request to land ASAP. The captain decides to divert to Rexville using the following criteria: airfield in sight, Rexville is a big airport and the passenger will be well taken care of.

SEQUENCE 1: KEY MESSAGES

1. **Communication**:
   a. Be careful of the tone of voice used and the speech rate, the choice of words used, structure the transmission of information, etc. NITS Tool.
   b. Develop assertiveness: tools (progressive assistance, Non-violent Communication (NVC)).

2. **SA**:
   The FDC's situation awareness is based on the information provided by the CC.
   Only transmit factual information and make a clear distinction between observation and interpretation: "*there is a sick passenger, he is conscious, he has severe stomach pains, his wife is a doctor, etc.*" statements which are much more appropriate and efficient than "*it's very serious, we need to land right away!*" ".

3. **Leadership and workload management**:
   The role of the PUR is to make a list of the tasks to be performed, assign them to each person and transmit this information between the cabin and the cockpit.

4. **Stress management**:
   Stress is contagious.
   Keeping calm, breathing, describing your stress or the stress observed in others, etc.

5. **Decision**:
   When under stress, use decision aid tools: FORDEC, DECIDE, etc.

SEQUENCE 1: COMMENTS, SHEETS, TOOLS

- **Surprise effect:**

Passing the emotion between CC and the CFA, no overall analysis.
Stress is a phenomenon which appears when a factor in our environment is perceived as being a danger (physical, psychological or social danger) to oneself or to someone else.
Stress can also mobilise a whole group in a fraction of a second because it is communicated from person to person much faster than a spoken message. Therefore there is an almost immediate reaction by the whole group even if the danger has only been perceived by one or two group members. If the stress is very high and the group is not "managed" then this can turn to panic (cf. crowd movements, etc.).
During a sudden high stress a person's reasoning is reduced and spontaneous actions take precedence over analysis. (When overcome with stress, the whole mental process can become frozen, this is known as "sideration".)

- **Abdominal breathing:**

Breathing has a major and direct effect on our stress. It can mobilise our resources (dynamic breathing) or reduce our stress (relaxing breathing).
Breathing successively controls three different parts of our trunk (thorax and abdomen): the shoulders (clavicular breathing), the rib cage and the diaphragm (abdomen). We generally inhale starting from the abdomen (diaphragm), then the rib cage, then the shoulders. When exhaling, each person is different...
Remember that the dynamic effect is obtained by "working on" inhaling and that, conversely, relaxation is linked to exhaling. (I inhale freely then I exhale concentrating on my breath and by visualising the evacuation of the stress through exhaling, I prolong the exhalation a little longer than my inhalation. I repeat this sequence three times).
In all cases, taking a few seconds to breathe allows you to calm down (when you are in the thick of it, keep cool…), and this also lets you become aware of your stress.

- **Methods of communication under stress:**

Be careful of the choice of words: "*the passenger wants us to land*" rather than "*we need to land fast*"

4Ws**method**:

- **W**here? *In the cabin in row xx,*
- **W**hen? *A minute ago*,
- **W**ho*? A passenger and his wife who is a doctor*,
- **W**hat? *He has stomach pains, he is conscious, she says she can't do anything on-board the plane and asks the pilot to land quickly*.

NITS: used in many airlines by the FDC for the CC when there is time pressure.

- **N**ature of the event,
- **I**ntention (particularly for the CAPT),
- **T**ime available,
- **S**pecial instructions (everything which is not in the first three above and which is important to know…).

- **Crew decision: FORDEC**

To make a decision, the crew must define the **Facts**, then the **Options** to measure their **Risks and benefits.** The **FOR** part is therefore used to take the decision objectively based on actual elements in order to eliminate intuition and personal impressions. The **FOR** elements are shared by the crew, then comes the moment to **Decide.** During this phase it is essential that the CP gives his opinion first to avoid where possible the conformity bias with respect to the CAPT who will make the final decision. It is then time to **Execute** and to continue to **Control** the decision over time (concept of feedback loop on the start of the FORDEC).

- **Procedure for managing a sick pax by the CC:**

The PUR has the role of coordinator and of information "HUB" between the "event" and the cockpit. The CC are responsible for cabin safety and for doing everything within their power to take care of the pax. This means that the resources must be shared between these two objectives. For the pax, the CC do not have a performance obligation but an obligation to provide assistance. The CC are also responsible for informing the FDC, without delay, as soon as the problem is known and for keeping them informed of the changes in his state of health. The CC must also use the resources available in the cabin and if any persons come forward, the CC must check their professional qualifications (card issued by the medical council, medical credentials, etc.). This last point can be overridden (with the CAPT's approval) in certain circumstances.

The PUR must preferably "take a step back" with respect to the event and also focus their attention on the rest of the cabin because other risks could arise.

The management of the pax must not adversely affect cabin safety, which means that all the CC's other safety tasks (monitoring, checks, etc.) must be performed. [Feedback: when caring for an epileptic pax, smoke was seen in a toilet. This happened during the night (with half of the CCs in their bunks!)]. This creates relatively different issues on planes with 1 or 2 CC staff or on long-haul flights. That is why with a crew of three the PUR remains the supervisor and handles the communications between the cabin and the cockpit (role of leader and "communications hub"), a member of the cabin crew takes care of the pax and the third person is responsible for cabin safety and takes care of the other pax.

- **Call for doctor procedure:**

Specific to each airline… (authorisation by CAPT, medical credentials checked, equipment provided, etc.).
The CAPT remains responsible for health and hygiene on board. If in doubt, he/she will systematically seek medical advice. On aircraft equipped with SATCOM, the pilots can make a voice call to their company which will set up a "conference call" with the SAMU (or equivalent) to get medical advice. The decision made will take into account the medical advice and also the ground infrastructures (presence of hospitals) and all the operational constraints (weather, runway length, safety, etc.).

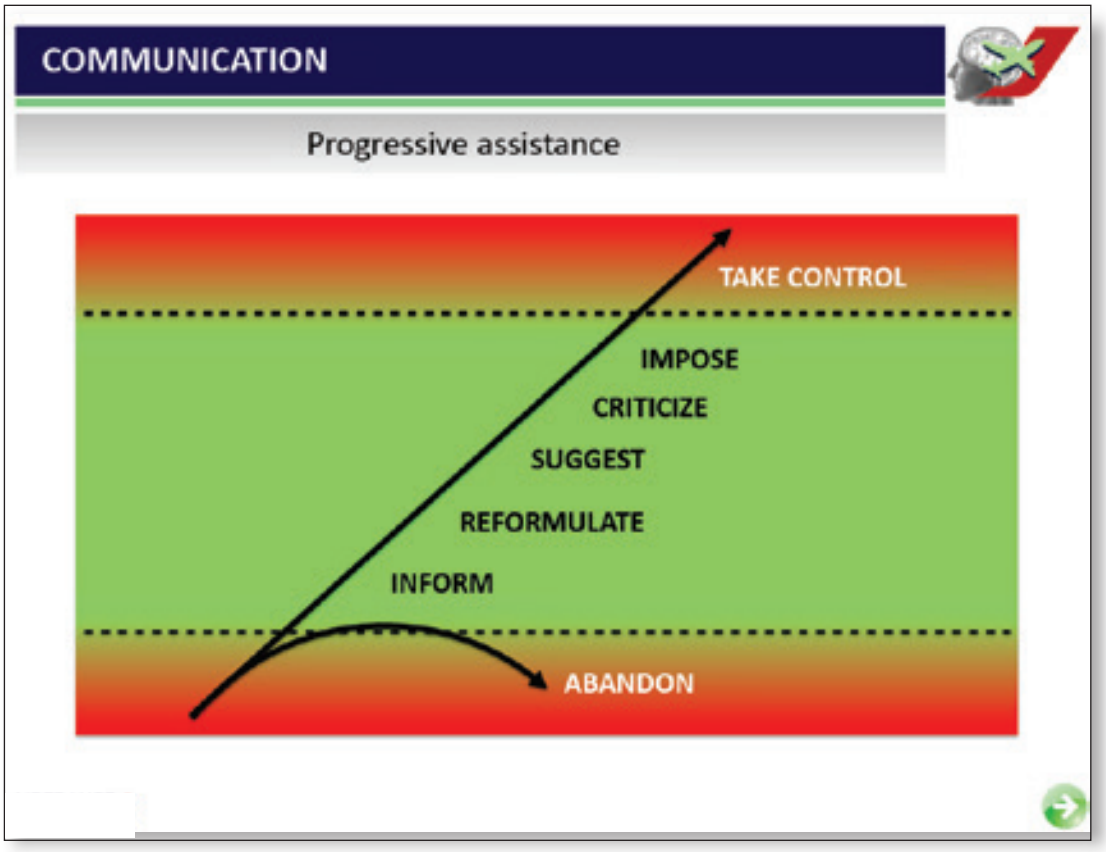
- **Workload during a diversion:**

For the CC, the workload will greatly depend on the number of CC staff present. But in all cases, a diversion disrupts the automatic reflexes and therefore involves more cognitive resources, also invalidating all the initial action plans. On long-haul flights, during the cycle of duty, the resting CC must be woken up. The passengers will have to be informed (and there will therefore be many requests in the cabin).
It will be necessary to deal with and anticipate the management of the passengers with specific needs (WCH, Baby, UM, etc.) and also prepare for the pax to be taken over by the emergency services (moving the pax, special announcements). Anticipate everything relating to hotel and catering facilities, services, or even accommodation during a stopover if necessary. In addition, the CSD must also be aware of the regulations ((s)he must often look for the regulations or agreements) while at the same time dealing with the pax (the PUR must ensure that the CC are relayed (a cardiac massage is tiring and stressful) and it will also be necessary to take care of the accompanying persons.

On some airlines the CC have a document which must be filled out before contacting the SAMU (when this is possible). It is a sheet containing the information needed by the SAMU to determine how to deal with the patient (Appendix 6).
For the FDC, the workload due to the diversion will initially be high: inform the cabin of the diversion, get out the airfield sheets, enter the approach in the FMS and give an arrival briefing. The workload then drops back to a more normal level.
This temporary workload will vary greatly according to the environment: diversion to a very familiar airfield in fine weather compared to an unknown complex airport in marginal weather.

- **Assertiveness:**

Ability to defend one's opinions without encroaching on those of others. The CP may have lacked assertiveness to put forward his viewpoint (continuation to the destination).
Progressive assistance offers different steps in the way in which to formulate your viewpoint.



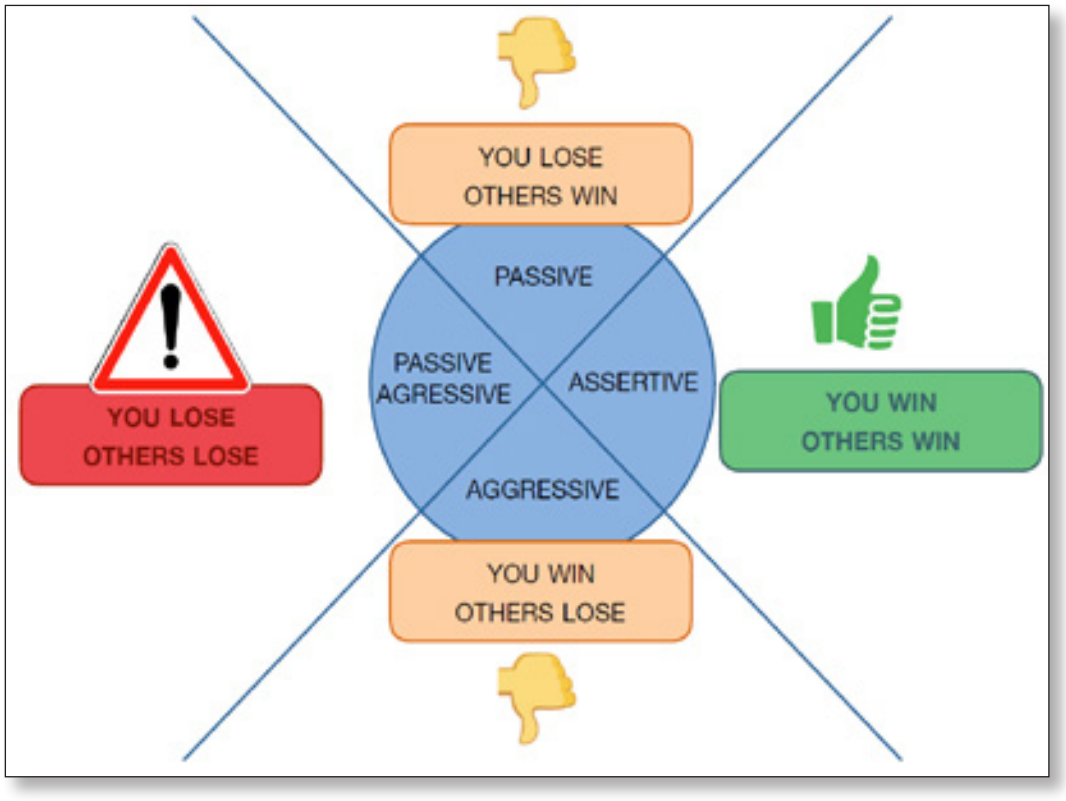
In a situation of exchange between 2 interlocutors, there are 4 standard attitudes:

Passive: I attach greater importance to my interlocutor and his ideas than to myself. Therefore I do not express my disagreement and I adopt the other person's opinion. In this configuration, he/she is the "winner" and I am the "loser". However, the crew loses!

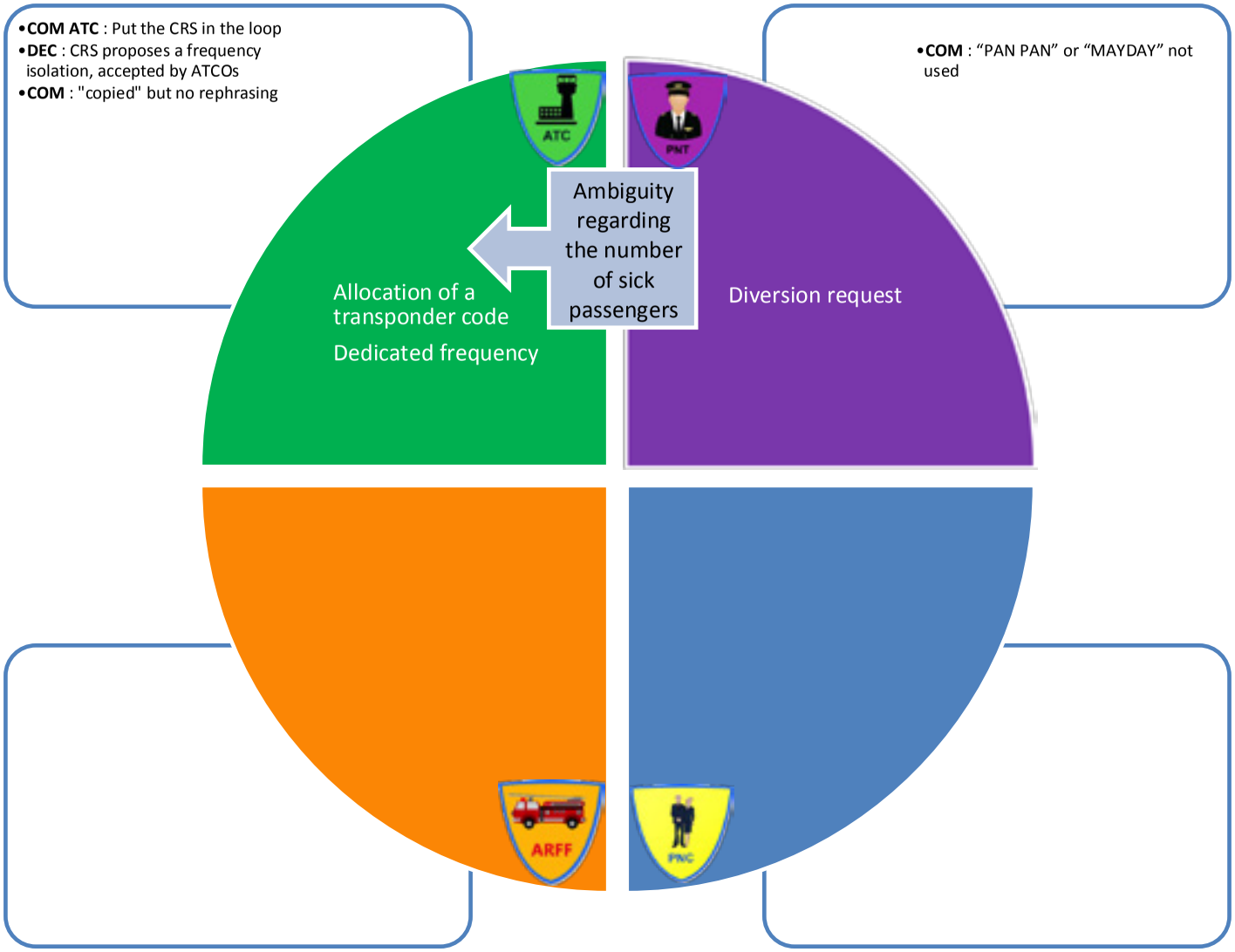
Aggressive: I attach greater importance to myself and to my ideas than to my interlocutor. Therefore I always aggressively defend my ideas because they must be accepted. Therefore I "win", the other "loses" but the crew still does not win.

Passive-Aggressive (or manipulative): I avoid open conflict by pretending to adopt the other's ideas, to be able to fight them better later ("I knew that it was not a good idea", "when I tell my colleagues what he/she did to me") and impose my ideas by demeaning his/hers... This is the most dangerous configuration because it indicates a very high risk of conflict and lack of synergy.

Assertive: My interlocutor and his/her ideas are as important as my ideas and myself. There is a perfect balance between these 2 very important elements (as if each of us acted on a set of scales which remain permanently balanced). This attitude allows for an exchange which is both respectful and constructive, making it possible to reach a consensus.



Sequence 2 : Timing : from 02:52 min to 03:50 min



Scene description :

When the The FDC requests ATC to divert to Rexville due to "sickness on board". The radar controller (RC) clears Sickair only FL360 due to traffic while the planner controller (PC) warns the control room supervisor (CRS), modifies the flight plan, coordinates the flight to the surrounding sectors to set the conditions of the diversion (not shown here). The PC grabs the corresponding checklist. The FDC is asked to squawk a specific code (5677). The CRS proposes to isolate the aircraft frequency.

SEQUENCE 2: KEY MESSAGES

1. **Communication**:
   a. ATC: Precise communication otherwise reformulation and removal of doubt (questions).
   b. FDC: Use the emergency expressions appropriate to the situation: PAN PAN.
   c. FDC/ATC communication necessary to build a common action plan: Use of NITS.

2. **Situation awareness**:
   The use of a transponder code allows an integrated visualization for the ATC.

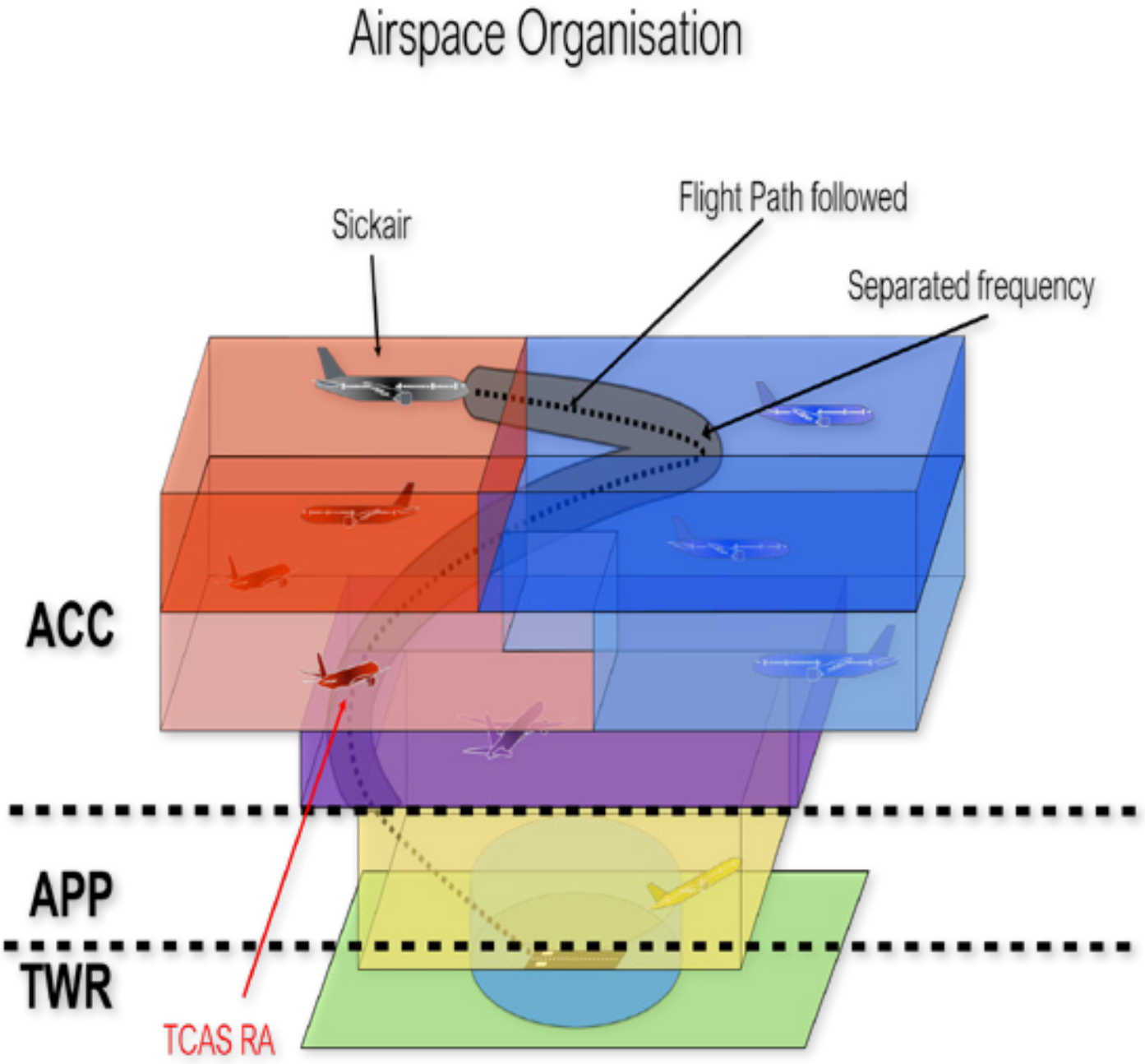
3. **ATC workload management**:
   Think of a frequency management strategy to optimise the assistance provided.

4. **Stress and Procedures**:
   Use of ATC reflex sheets (Appendix 5).

SEQUENCE 2: COMMENTS, SHEETS, TOOLS

- PC says: "I am making the change":

By default, the controllers in charge of a sector only visualise the flights which concern them (there are too many flights to clearly distinguish them all). All the other flights are "filtered", therefore it is necessary to coordinate all unplanned flights in a given sector (by clearly identifying them). This coordination is time consuming and increases the workload. Some special XPDR codes facilitate visualisation (visualisation of all layers, specific indication, specific colour) and therefore coordination.



See animation provided with the video and the guide.

- Reflex sheets (appendix 5): They are used to avoid forgetting any important element.

- **Use of code 5677**:

Transponder code 5677 (France only) is used to visualise all layers with indication "ATTN" (attention) in white on line 0 of the radar label. The neighbouring sectors and those below will visualise the aircraft, which will assist in coordination.

➔ For the ATC, a special XPDR code (7700, 5677, etc.) improves the awareness of the common situation and encourages coordination.

- **Frequency management strategy**:

The **FDC** require frequency isolation. This enables them:
- to concentrate on their problem (no spurious communications),
- to have fewer frequency changes (interruptions, distractions, etc.),
- each ATC message is only for them and all FDC requests will be dealt with.

Important: it is mandatory to inform them of this: because if not expressed verbally, this could incorrectly lead the pilots to think that there is no traffic in the vicinity. This is illustrated in the video by the impression that there is a low workload and a very light radio environment.

On the **ATC** side, frequency isolation can be more difficult to set up. It is first necessary to ask oneself the following questions:
- is it appropriate to add a frequency change to the pilot's workload (e.g. contraindication for a Mayday)?
- if I change the frequency of the other aircraft, without CPDLC (Controller Pilot Data Link Communication, see appendix 2), will the frequency be continually occupied for 1 to 2 minutes, and is this compatible with the attention necessary for the aircraft to be dealt with?
- is an all-layer visualisation comprehensible (perhaps too many aircraft visualised) ?
- will the technical means be operational (radar range, radio range, telephone lines, etc.)?

In terms of workload, the frequency isolation will require the following from the controllers dedicated to this frequency:
- a great amount of coordination, sometimes with non-adjacent sectors and with which there will be no scheduled telephone contact (e.g. a line with the approach if no regular service).
- the necessity to display all the layers (possible overloading of the image).

Areas of reflection for respecting the FDC's requests while remaining within what is technically possible:
- to avoid the pilots having to make too many frequency changes: successive coordinations to obtain level delegations and therefore shunt sectors, thus reducing the number of frequency changes (the neighbouring sectors delegate their space and clear the area of their traffic if necessary),
- to avoid overloading the frequency:
  - ✓ The upstream sectors can delay the transfer of aircraft not immediately necessary and/or ask them to monitor the frequency (monitor 118.155). In an electronic environment the controllers of the affected sector will visualise the traffic which has been transferred and which has not been called.
  - ✓ The sector concerned can request other aircraft to monitor the frequency because an emergency is on course: "all stations monitor frequency …".

- **Efficient communication under stress with the ATC**

The formulation of the message leaves doubt about the number of sick passengers on board (plural or singular).

The use of NITS (Nature of the event, Intentions, Time available, Specific instructions) is fast, simple and generates an identical "readback" from the receiver of the message.

Best practice possible following this video concerning the situation between the FDC and ATC or between ATC positions.

- FDC: "Sickair 007 to ATC, we confirm 1 sick male passenger on board, request medical diversion to Rexville, landing scheduled from 14:00 h (or in 20 minutes), request rapid descent and to be directed by radar headings on approach".

- ATC: "ATC to Sickair 007, I confirm 1 sick male passenger on board, you request medical diversion to Rexville for a landing scheduled around 14:00 h and you request rapid descent and to be directed by radar headings on approach".

- **PANPAN / MAYDAY**:

Reminder of the definitions:

MAYDAY distress situation – Threat of serious and imminent danger, immediate emergency assistance is required.

PAN PAN emergency situation – Very urgent message to be transmitted concerning the safety of an aircraft, ship or other vehicle, or the safety of any person on board.

In this case, a PANPAN message associated with concrete elements (number of passengers concerned, type of problem, time available) would have allowed the problem to be more clearly expressed to the ATC.

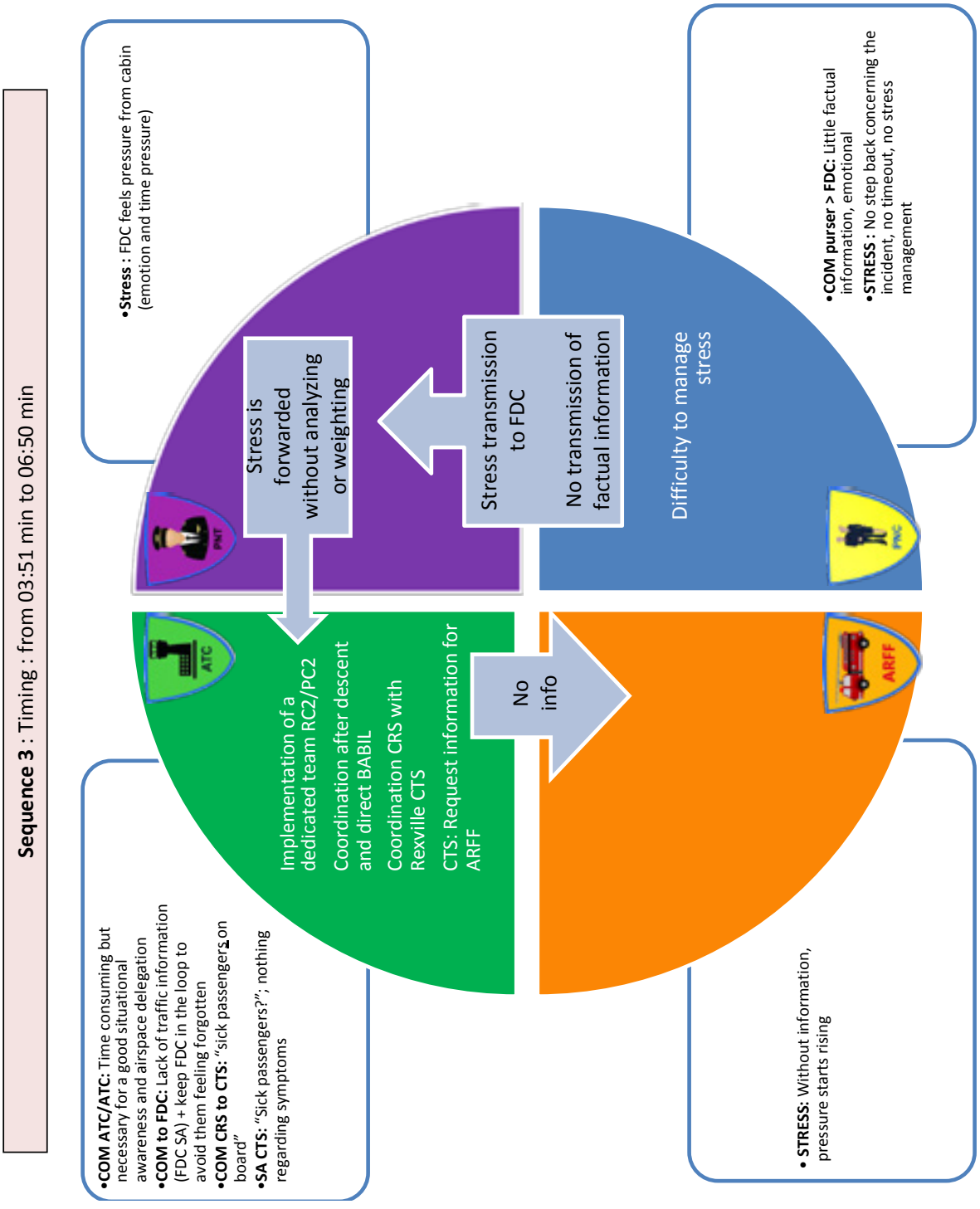
Pilots sometimes tend not to put the state of the situation in their call sign e.g. "Sickair 007" instead of "Sickair 007 PAN PAN". Maintaining the awareness of this state is a collective cooperation obligation to ensure a good collective awareness of the situation.

- **Time pressure**:

Since the available time is considered to be short by the FDC, they do not fully appreciate the importance of clear, simple and appropriate communication to the ATC. This is essential so that the rest of the chain put in place for the diversion and the fire service can better prepare for the emergency: "number of sick pax, status, age, sex, additional information necessary to take care of the pax.

Scene description :

The ATC organizes and coordinates the diversion in a busy airspace. The dedicated team of controllers must rapidly consider the situation and coordinate the descent with the surrounding sectors. As it takes time, the purser insists again on the urgency of the situation communicating his stress to the FDC. The diversion information is transmitted to Rexville tower. The impatient captain insists on the urgency of the situation to ATC. Transfer to the isolated frequency with a readback error.



SEQUENCE 3: KEY MESSAGES

1. **Communication and stress**:
   a. Communicate efficiently between CC and FDC to allow the transmission of information necessary for the fire services.

   b. Important: do not add stress (the PUR coming to the cockpit does not add value in managing the incident).

   c. For the ATC: "A little explanation can avoid a lot of stress". Remember the traffic information in particular. Adapt the communication to the situation (concise and reassuring).

   d. Non-intrusive communication facilitates a "non-aggressive" atmosphere. The use of questions prevents this: "is there any news? would you like me to give you a rundown on the situation's development?" ".

2. **Workload management:**
   In the case of an unscheduled route and emergency situation, the ATC can use certain headings, at least at the beginning, to give the crew the time to get organised.

3. **Workload management and resilience:**
   The FDC must make a clear distribution of tasks, be resilient to avoid over-focussing, an ill-adapted vigilance level, and omissions.

4. **Optimisation of available resources**:
   Benefits/risks playoff for the ATC to combine clearance and frequency transfer.

SEQUENCE 3: COMMENTS, SHEETS, TOOLS

- **Tasks performed by the controllers during an unscheduled transfer**:

The general principle is to use the "ATC flight plan" (important: in this case the ATC processes the filed flight plan) and/or the radar system so that the flight elements such as call sign, departure and destination airfields (in this case the new destination) reach the sectors which will be affected by this flight. Phone coordination is then necessary from the initial sector to inform of the specific conditions of this flight, followed by a frequency transfer to the new sector which will manage the continuation of the flight according to the elements provided. This may relate to diversions such as that presented but also stormy situations in which the avoidance routes taken by the pilots take them out of the planned sectors. It is then necessary to inform and possibly transfer the flights if the new route greatly impacts the neighbouring sector. That is why the en-route controllers ask for an estimated avoidance time, in order to be able to anticipate these possible transfers.

In this case it is more complicated than in the case of an unscheduled transfer For the RC2/PC2, it will not only be a question of taking charge of Sickair007 but also the entire air situation around the flight and on all the layers. Neither the flight plans of the other sectors nor the aircraft interfering with the frequency will be available to them. The aim is to coordinate a descent "as far as possible" without having to change frequency. This takes time and is even more complicated when the traffic is dense.

- **FDC perception and expectations**:

For the FDC, the air traffic congestion under the Sickair007 is not perceived at all. The diversion implies multiple coordination tasks by the ATC. The crew is unaware of the complexity of the situation generated for the ATC. They may then have the impression that no one is attending to their problem => increased stress.
The CAPT insists that this is an emergency to the ATC: The minimal answer given by the controller does not convince the pilot that his problem has been taken seriously.

Question for trainees: Should the controller add something to her message to clearly express that she understands the emergency on board? Must she tell the crew the reasons why a descent is impossible? Yes, in fact it is recommended (cf. key message 1.c.). The film illustrates a "zero" communication by RC1 which is not necessarily representative of the general case. However, in these cases, and especially if the surrounding traffic is dense, the difficulty is finding a compromise between "necessary" information and interfering. There is obviously no question of explaining everything that is happening to the pilots but a brief explanation such as "we are organizing to send you on a quiet frequency so you can express your needs, just a few minutes more" or "We understand you've got a sick passenger, we are trying to organise your descent safely… We need few more minutes for that. Do you confirm your **emergency state?**".
Here the ATC is split between 2 "messages" which are:

- In case of emergency on board, avoid disturbing the pilots who may have on-board priorities to handle.
- Try to give a minimum of clear explanations to share the situation awareness.

The use by the pilots of emergency expressions such as **"Panpan" or "Mayday"** generates responses which have different intensities. For example, it will be easier to clear the airspace around the plane in order to accelerate the descent.

- **Time pressure and stress:**
  The waiting time always seems too long when we are in a hurry. Tense wait. Interruption of CC tasks.

- **Communication:**

When in contact with Rexville tower, few information transmitted concerns the taking care of the sick pax on the ground.
The control room supervisor is aware of the information needed for the emergency services. He also has access to the reflex sheet. However he is dependent on the sector and on the information obtained from the CAPT. The problem is then finding an appropriate moment to ask for this information.

- CC:
  - The communication between CC members then between CC and FDC has transmitted more emotion (and stress) than information. The controllers lack information on the passenger's symptoms. Apart from the fact that there are sick passenger(s) on board, no other actual information is transmitted (e.g. about the type of problem, cardiac, infectious, traumatic, obstetric, etc., about the state of consciousness of the pax, about the pax's vital parameters, whether the pax is taken care of by a health professional, about the pax's location in the cabin, etc.).

  - There is no added value in the PUR coming to the cockpit (he does not bring additional information, nor does he receive any), nor is it the moment to for the FDC and CC to draw an action plan. Finally, the only effect of the CFA coming to the cockpit is to communicate more stress to the FDC and unnecessarily interrupt tasks. This insistence is perceived as very tiring, irritating and stressful by the person who is disturbed. The CFA disturbs but with a benefit for himself: he shares his stress and reduces his responsibility for the situation.

    Important! There is no question of prohibiting the PUR from coming to the cockpit, but the risk of interrupting the tasks must be counterbalanced by the benefit in terms of communication, shared situation awareness, or the creation of a common strategy.

- ATC: The CRS still cannot provide any information because the pilot has not been asked yet. The CRS's priority is to inform Rexville of the arrival of this unscheduled flight so that they can get organised. However, the CRS does not inform the CTS of the information needs, perhaps because he knows that the reflex sheet contains what is necessary.
- ARFF: The diversion time is just sufficient for the ARFF to organise the emergency means necessary for the aircraft's arrival. Number of vehicles needed, doctor or not, aircraft parked in isolated area, etc.

- **Direct "BABIL" and frequency change**:

RC1 transfers the aircraft to the next sector "early" (as soon as possible according to the coordination with the dedicated sector). RC1 thinks she is doing the right thing by giving a point but the crew is unfamiliar with this route and will have difficulty with the point; they would prefer a heading, which is more efficient and easier (and, above all, faster according to their perception).
Pedagogy with controllers: pause and have a discussion about a point or a heading? (cf. key message no. 2).
A diversion entails reprogramming the flight systems, getting out the documentation and restarting a flight plan. These tasks take time and require cross checks during which the headings proposed instead of point names can facilitate the management of the available resources.
In the case of a straight route to a point which is not on the flight plan, it can be better to spell out the WPT to help the crew. A radar heading reduces the workload of the crew, which then only have to concentrate on the final approach elements (ILS-approach path).
For the ATC: (cf. key message no. 4) Benefits/risks playoff to combine clearance and frequency transfer. Time

saving but risk of not being able to detect and correct an incorrect readback either because the controller has "mentally" moved on to something else, or has been interrupted or because the pilot has immediately "switched" and is no longer on the frequency to hear the correction.

- **Readback:**

Teaching topic on readback and its validation. Did the trainees notice the readback error?

CC: It can also be a good idea to discuss the readback error with the CC by asking the trainees if they noticed something abnormal in the communication between the ATC and the FDC.
Play them the last audio exchange of the sequence. If they do not find the error, point it out to them. The greater the difficulty they have in finding the error, the greater the teaching values.
This is because the error shows to what extent the "cockpit" can be "fragile" and how great the risk of task interruption can be, even if in this passage the readback error is not due to an interrupted task, and even less to an interruption caused by the CC.

- **Workload management and resilience:**

The clear distribution of tasks between the PF and PM, CAPT and copilot is not implemented. This can create omissions or maintain an inadequate level of vigilance. The pilots must become highly resilient again as soon as possible to recover with the rest of the crew from the suddenness of the situation and from the latent disorganisation.
Resilience: Intrinsic ability of a system or individual to adjust its/their way of functioning before, during or after changes and disruptions, so that its/their activity can continue in expected or unexpected conditions ; the aim is to maintain safety. (E. Holnagel, Resilience Engineering in Practice, 2010).
Resilience requires:

Mental flexibility:

- Necessary to recognise and respond to situations for which there is no established procedure.
- Decision-making adapted to a unique situation.
- Do not limit yourself to standardised solutions, adapt them.
- Remain open to a change of situation, monitor it.

Adapting performance:

- Correct inappropriate actions with an appropriate and measured response (reduce the lack of reaction, overreactions and inappropriate hesitations).
- Respond with an action appropriate for the actual situation.

Principles:

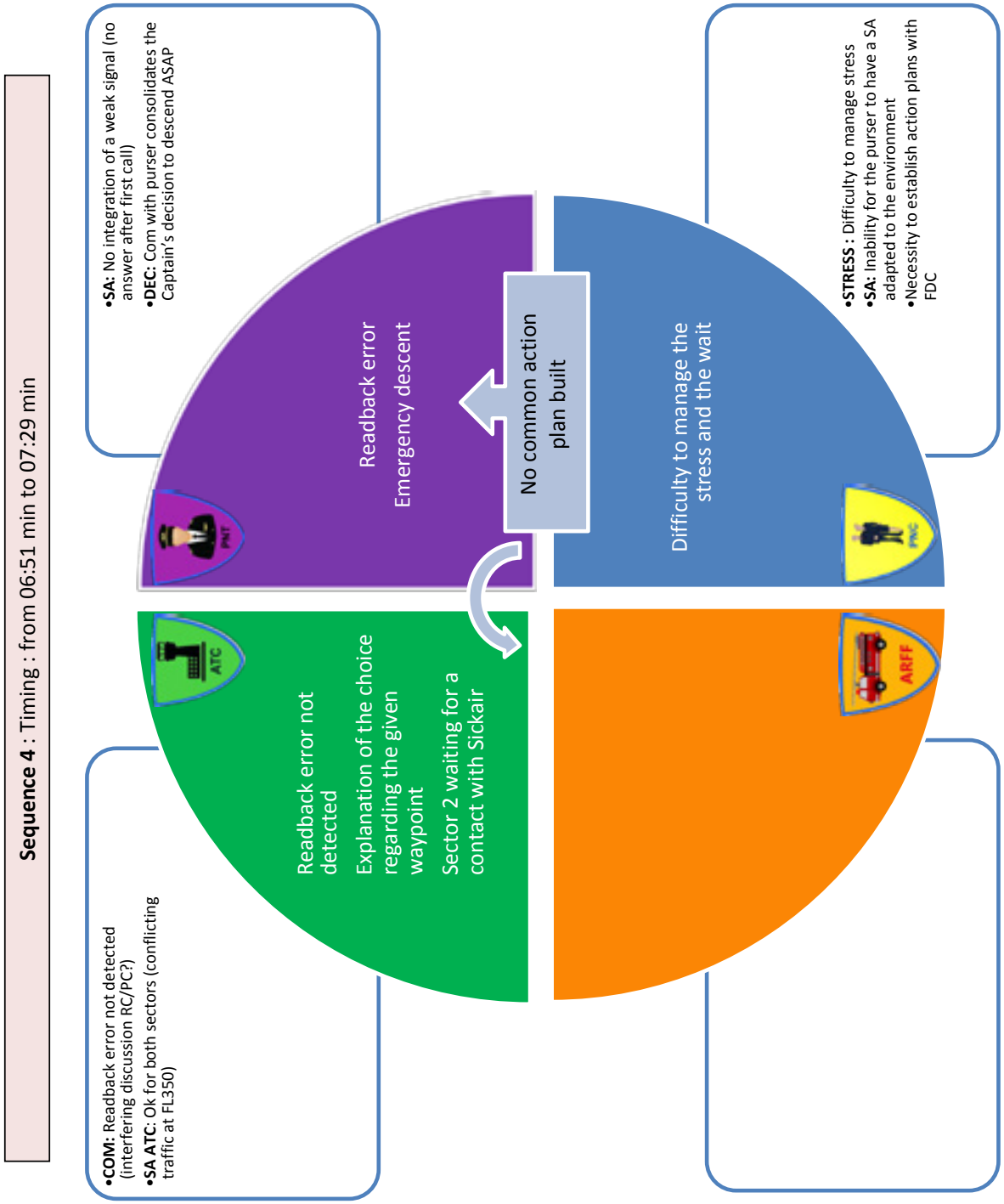
- Learn: know what has happened.
- Anticipate: find out and know what to expect.
- Monitor: know what to look for.
- Respond: know what to do and be able to do it.

For the FDC, it is a question of obtaining precise elements (NITS) from the CC in order to be able to regain a shared situation awareness and then draw up a clear action plan shared with the other participants (ATC, ARFF and CC) to return to a stable situation.

Scene description:

The FDC doesn't find the BABIL waypoint given by ATC and, following the readback error, doesn't manage to contact them to get vectors. The captain, after a contact with the cabin, interprets without confirmation that the situation is worsening. The FDC decides to perform an emergency descent to save time.

Sequence 4 : Timing : from 06:51 min to 07:29 min



SEQUENCE 4: KEY MESSAGES

1. **Communication**:
   a. Importance of listening carefully, beware of interruptions.

   b. ATC to FDC: Wait a few seconds before switching to possibly correct the speaker.

   c. FDC best practice: Log into the CPDLC (Appendix 2) as soon as possible.

2. **CC stress due to the forced wait**:
   Collect the necessary information, coordinate with the FDC, inform the pax and use stress management techniques.

3. **Decision, the emergency descent to FL 100**:
   The contact with the cabin encourages the pilot to make a rapid descent. The pilot will use a known procedure: emergency descent. It is therefore highly likely that he remains in this mental thought pattern and that he descends to FL100.

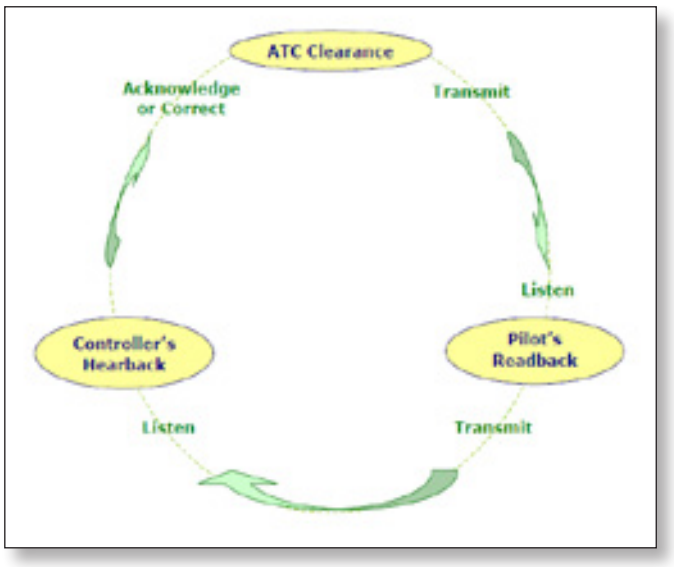
4. **Optimisation of available resources**:
   Low individual and collective performance by the team due to the incorrect use of the available resources.

SEQUENCE 4: COMMENTS, SHEETS, TOOLS

- **Communication**:

ATC: non-perception of the readback. Importance of listening carefully, being aware of interruptions during the phases, whether they are mental (moving on to the next problem in your head) or physical (PC/RC discussion , CRS intervention, oral coordination "on the flight", like that presented in the film with "we have sent you Sickair".

ATC to FDC: Importance of readback. Wait a few seconds before "switching" to make a correction if necessary (see Appendix 1).



Skyclip: Readback Hearback
https://www.skybrary.aero/index.php/Solutions:SKYclips

Use of CPDLC: The frequency transfer by CPDLC avoids this readback error which has become relatively frequent since the arrival of 8.33. The French CRNAs are equipped with CPDLC for the frequency transfer. Concerning the approaches, the CPDLC is only used for departure clearance. Not all airports are equipped with them (see Appendix 2).
https://www.ecologique-solidaire.gouv.fr/communication-air-sol-data-link

Training strategy with the pilots: pause and have a discussion.
The pilots are unaware of the lack of response from control.

- **Decision to perform an emergency descent**:

Control's silence exacerbates the wait (see comments on dedicated frequency). Referring to the emergency descent contributes to the situation's confusion. An emergency descent without ATC clearance is very hazardous and does not resolve the conflicts "at the wave of a magic wand". In this case, control does its best and luck helps.

The crew has the feeling that using the magic joker to regain control of the decision process is dangerous on the FDC side because it immediately stops the shared collaborative aspect and becomes a "diktat". This completely upsets the risk management balance, pushing it towards an in-flight collision. "I try to save a life by risking the loss of hundreds. "

- **Debate, Mayday concept:**

Is it appropriate here? Is it a way to get priority?
ATC answer: Yes certainly, the ATC will deal with it in a different way if the emergency is communicated to it.

- **Stress:**

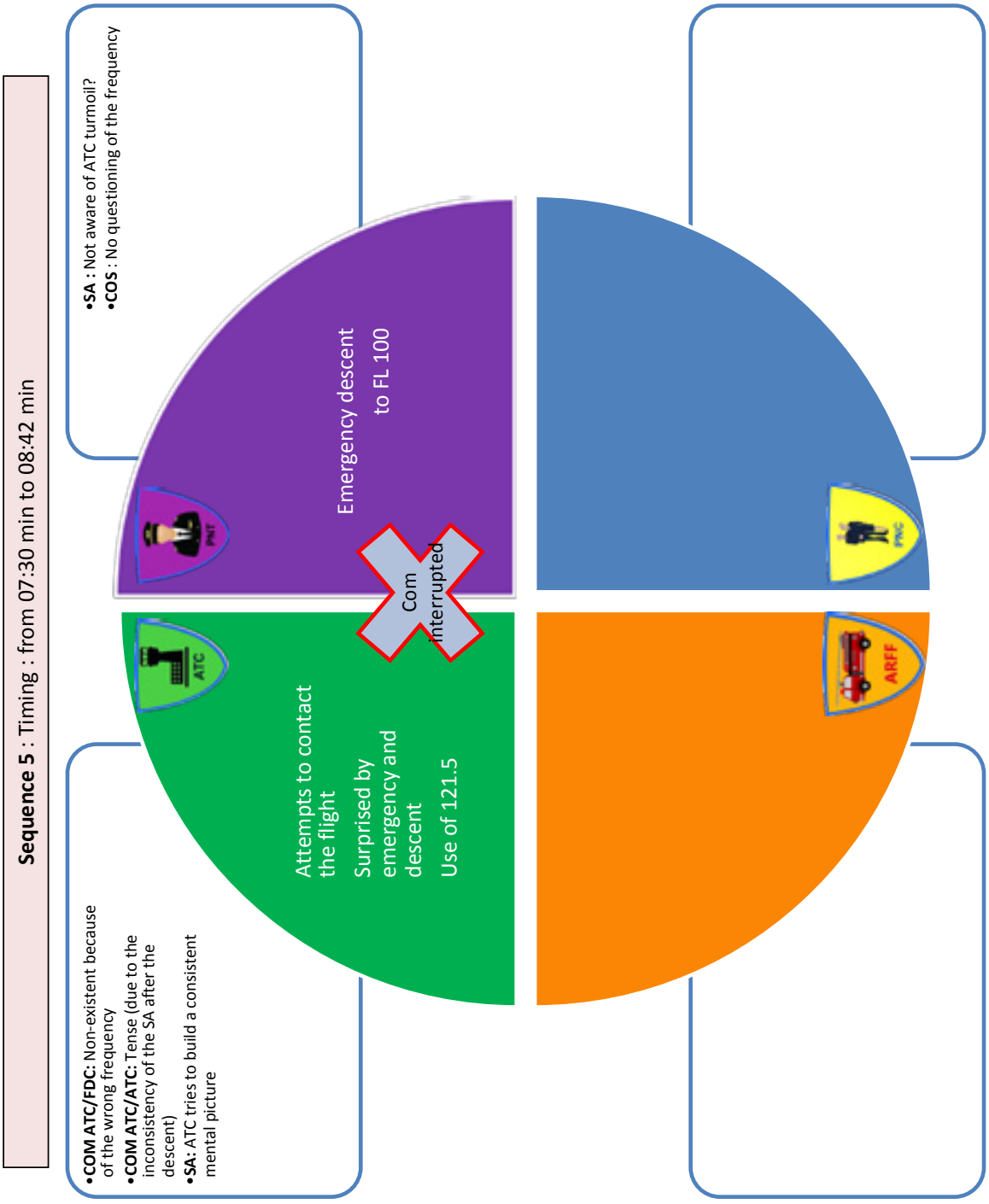
CC: How do we manage this type of situation in which there is a forced wait and which involves a risk of increasing our stress?
Solutions:
CC and FDC must coordinate with each other about the communication and the type of information to be given to the pax.
CC members must coordinate with each other in the same way.
For the CC, find, and for the PUR get someone to find, all the information necessary for the FDC, control, SAMU (if radio link possible) and ARFF.
For the PUR, include the CC in the analysis of the situation and ask them about the risks and the possible strategies.
Put the stress felt into words, apply the stress management techniques.

FDC: Did the stress prevent the crew from realising that they were on the wrong frequency? Our internal state can limit our ability to detect weak signals. Performance deteriorates due to the disruption of the available resources. During intensely stressful phases, our hearing ability is reduced by the central nervous system.

Scene description:

The FDC declares an emergency on the wrong frequency and begins an emergency descent to FL100. The ATC, after multiple calls, realizes that the aircraft is descending. The controllers cannot understand that the aircraft could descend without a clearance and think it is an error. ATC initiates to switch on 121.5 to restore communication.

Sequence 5 : Timing : from 07:30 min to 08:42 min



SEQUENCE 5: KEY MESSAGES

1. **Communication**:

   a. **Lack of radio contact**:

   For the ATC: "lack of radio contact" reflex sheet, think of 121.5
   For the FDC: monitor 121.5

   b. **Use of the XPDR code and of the emergency expressions**:

   For the FDC: the code is as important as the expressions because it involves the whole of the ATC chain in the loop.
   For the ATC: if there is an EMRG, there is an awareness that the pilots will not necessarily have the time to communicate + Flight management takes priority => action focused on other flights.

SEQUENCE 5: COMMENTS, SHEETS, TOOLS

- **Normal procedure in the absence of radio contact:**

For the ATC: We begin by trying to contact the flight and by also confirming the frequency: "Sickair007 Rexville on 118.115 how do you read? ". Since the entry into service of the 8.33, a display error in the last digit means that the aircraft can hear but cannot be received.
We then try to contact it by requesting a readback by IDENT (in the case of the aircraft being unable to transmit). We then check that the aircraft is not still on the previous frequency. We finally try to contact it by another means. In this case it is the RC2 who calls on frequency 121.5. This is sometimes done by the CRS (if the sector is responsible for this). Finally, if necessary, the CRS can try to get into contact by ACARS if the aircraft is equipped with it.
Note: for information, not all control towers can transmit on frequency 121.5. Such is the case for Nantes, for example, which has only one receiver. If the case arises, the CTS must ask the CRS of the Brest en-route centre (CRNA-O) to attempt to contact the aircraft for him/her.
RC1 is already responsible for checking on her frequency, RC2 will therefore perform the 121,5 test. Discussion on the distribution of tasks between sectors.
For the FDC: The monitoring of this frequency is systematic on VHF 2 (except for ATIS or when contacting the airline), even if this frequency is sometimes polluted by spurious messages.
When there is no answer on a new frequency, the crew does not ask itself if there is a possible display error. The culture of doubt consists in listening to the dissonant information (no answer) and of studying it (why? where is the error?).
If there is no reply on a frequency, the pilots normally switch back to the previous frequency and can find a frequency in the documentation (cards) corresponding to the sector if there is still no reply.

- **Management of the surprise effect on the ATC side:**

Controllers' surprise when they see the aircraft descend. Initial reaction: try to **understand** what is happening to be able to **make a decision** and **act**, then finally to **monitor** the situation (normal mental work cycle).
If a bias of habit is added to the mental thought pattern: for a controller, if an aircraft descends, it must have been authorized to do so.
➔Therefore the RC2 shouts at and "accuses" his colleague RC1 => for the ATC: impact on intersector cooperation? Concept of confidence?
Second notion to explain the descent and EMRG = pressurisation failure.

- **Distress code displayed:**

Is this code justified? Does it give a priority? ATC reply: Yes definitively, a Mayday announcement and/or XPDR code 7700 triggers the following by the ATC:

- special attention given to the aircraft in difficulty,
- immediate assistance,
- priority given to this aircraft.

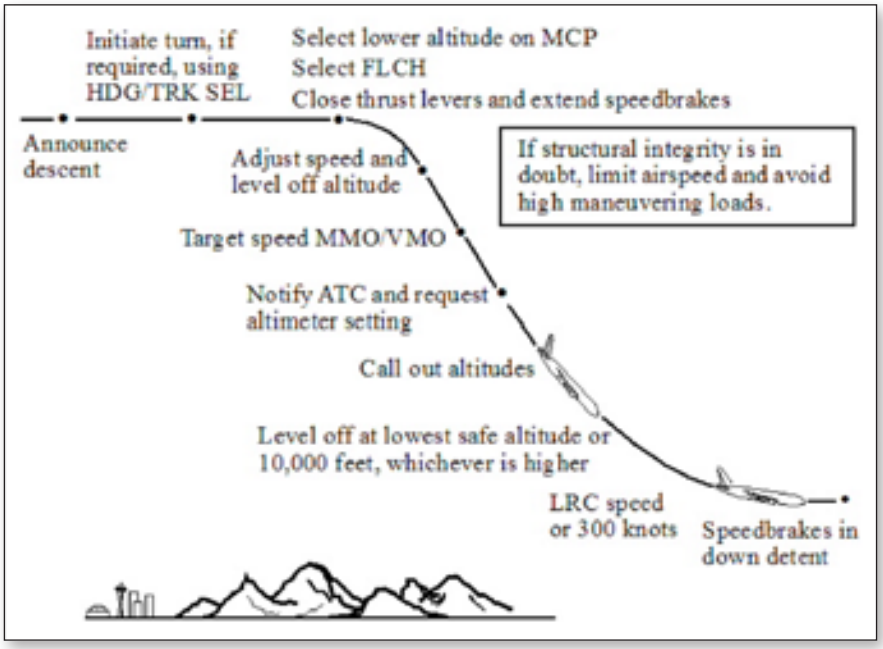
When the aircraft has landed, no explanations will be asked for from the crew directly by the ATC. If the event had an impact on air traffic, the Quality of Service Dept. will subsequently contact the Flight Safety Dept. for an explanation/debriefing (feedback).
The "Mayday" announcement by the CAPT is not sufficient to solve his/her problems... In this specific case the radio announcement is not heard but the EMRG code is seen and the plane's descent observed => for the FDC if there is not time to communicate, **remember to transmit a Code 7700 in priority.**

The purpose of the announcement is to inform the ATC of the emergency. The pilots generally do not have time for dialogue. However, the ATC will tend to try to find out the assistance needs. A best practice would be to integrate a formulation which indicates to the ATC that they do not have the time for discussion. For example, "Mayday, mayday, mayday, callsign, ..., STAND BY" (used by BAW). The ATC would then know about the emergency and would take the actions to clear the airspace around the aircraft. The CRS could implement anticipatory actions and the ATC would wait until the pilots are available.
This short message could then be more effective if sent as soon as possible. For example, the term UNABLE is used when it is not possible to execute an ATC order during a TCAS RA. Would it be an idea to use it in the example case: "unable to comply" or "unable to answer yet" followed by "call you back when available"?

- XPDRcode:

Visualised by all layers in red. Everyone is immediately informed (even the air force) and therefore participate in the awareness of the common situation.

- 7700 + descent to FL100 is generally associated by the ATC with an emergency descent following a pressurisation problem or fire on board.



For the ATC: if there is an EMRG, there is an awareness that the pilots will not necessarily have the time to communicate , for example during an emergency descent due to a depressurisation, priority will be given to survival (FDC, CC, pax oxygen masks), the flight path (descent), then the communications.
=> actions focused on other flights.

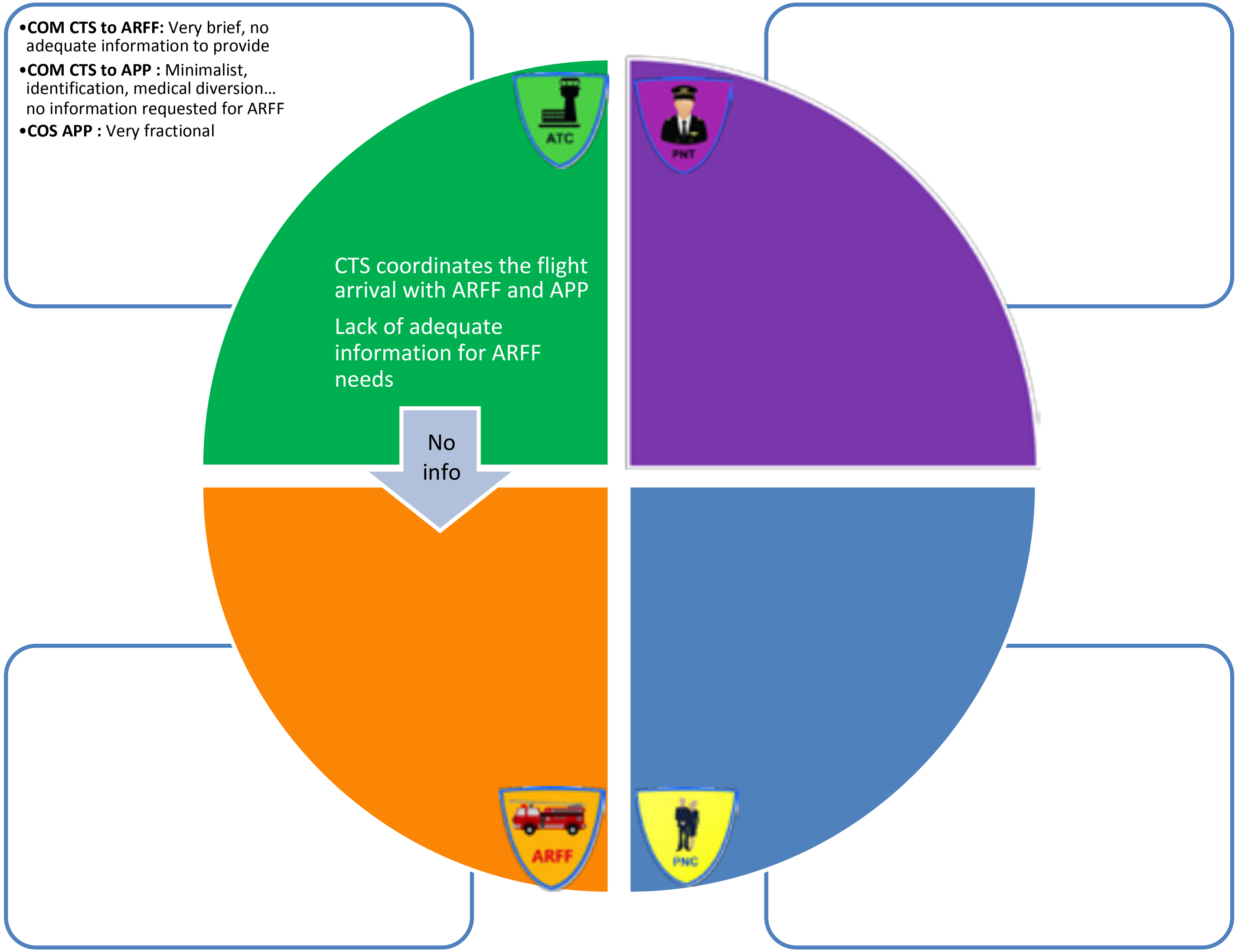
FDC debate: to manoeuvre (in the horizontal or vertical plane) in the absence of radio contact (e.g. overloaded frequency), what XPDR code should be used?

=>If management of an emergency problem on board, then 7700.
=>If "flight" problem, such as avoiding cumulonimbus, then 5677?
=>If radio failure, then radio failure procedure and 7600
The ATC's objective is to:

- Visualise the aircraft (reminder: the aircraft in the layers above/below are not visualised).
- Know that the FDC does not comply with ATC clearance.

This allows the airspace to be cleared around the aircraft, which is flying in an unexpected manner.

Sequence 6 : Timing : from 08:43 min to 09:23 min



Scene description:

Attempt to prepare the ground accommodation. Rexville control tower supervisor calls the ARFF supervisor to notify him about the arrival of an aircraft with a medical emergency.

SEQUENCE 6: KEY MESSAGES

1. **Communication**: Communication of the necessary information to the ARFF.

2. **Situation awareness**: Use of a Threat and Error Management (TEM) procedure to share the same plan of action.

SEQUENCE 6: COMMENTS, SHEETS, TOOLS

- **Communication**:

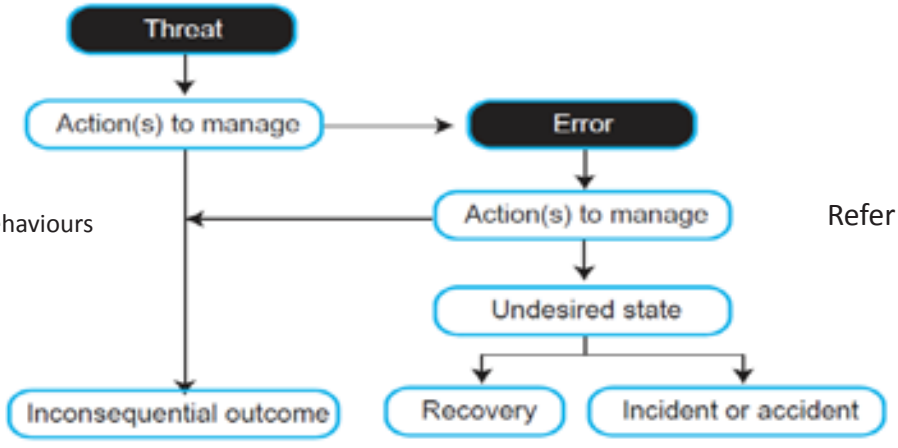
The fact that the telephone is hung up rapidly does not give the fire chief the time to ask questions. The CRS has other tasks and does not yet have information to give.
Little actual information: consequence of the initial communication between the PUR and PIL, then the following communications which did not provide any further relevant information.
For the ARFF: A "Medical Emergency" contact sheet could be established with "RED" symptoms boxes which highlight the severity or keywords (e.g.: Coma, Respiratory insufficiency, Chest pain, Cardiac arrest, Decompensated shock, etc.). But this type of sheet or procedure is the responsibility of the airline's medical department and/or the training department. The ARFF needs to have an idea on the severity of the patient's condition so that the SAMU (decision authority in France) can decide on the medical means to be sent to the aircraft which declared the medical emergency. Important: in most countries the doctor does proceed to the spot and it is the EMT teams (very high level emergency workers) or even paramedical teams (PARAMEDICS) which perform this type of intervention.
The CTS is aware that she does not have the necessary information for the firemen. She also has a reflex sheet but does not perform removal of doubt to check with the fireman that it is this information he needs.
Firemen used to manage stressful situations strictly apply this withdrawal without attempting to call the tower back many times to obtain the missing information. They try to adapt as well as possible to a situation which has not been defined by the previous stakeholders.

- **Impossibility of sizing the emergency response**:

For the ARFF: getting a flash message about the diversion does not allow for the necessary means to take charge of the injured person(s) to be prepared in good conditions.
The initial contact with the firemen by Rexville TWR is also intended to "prepare for the aircraft's arrival" but is too unclear and incomplete.
The fireman receiving the call expects to be called back rapidly by the tower about the missing elements.
The ARFF must "size" its means (SAMU or not, access to the aircraft by Airstair or airbridge, aircraft weight for the fire risk, etc.). In addition, the initial information relayed by many correspondents is often imprecise in a stressful context. For example, the "sick passenger" information is often transformed into "six passengers" when there are many correspondents (one ambulance per patient is necessary). Therefore there is big difference between 6 ambulances and 1 ambulance!

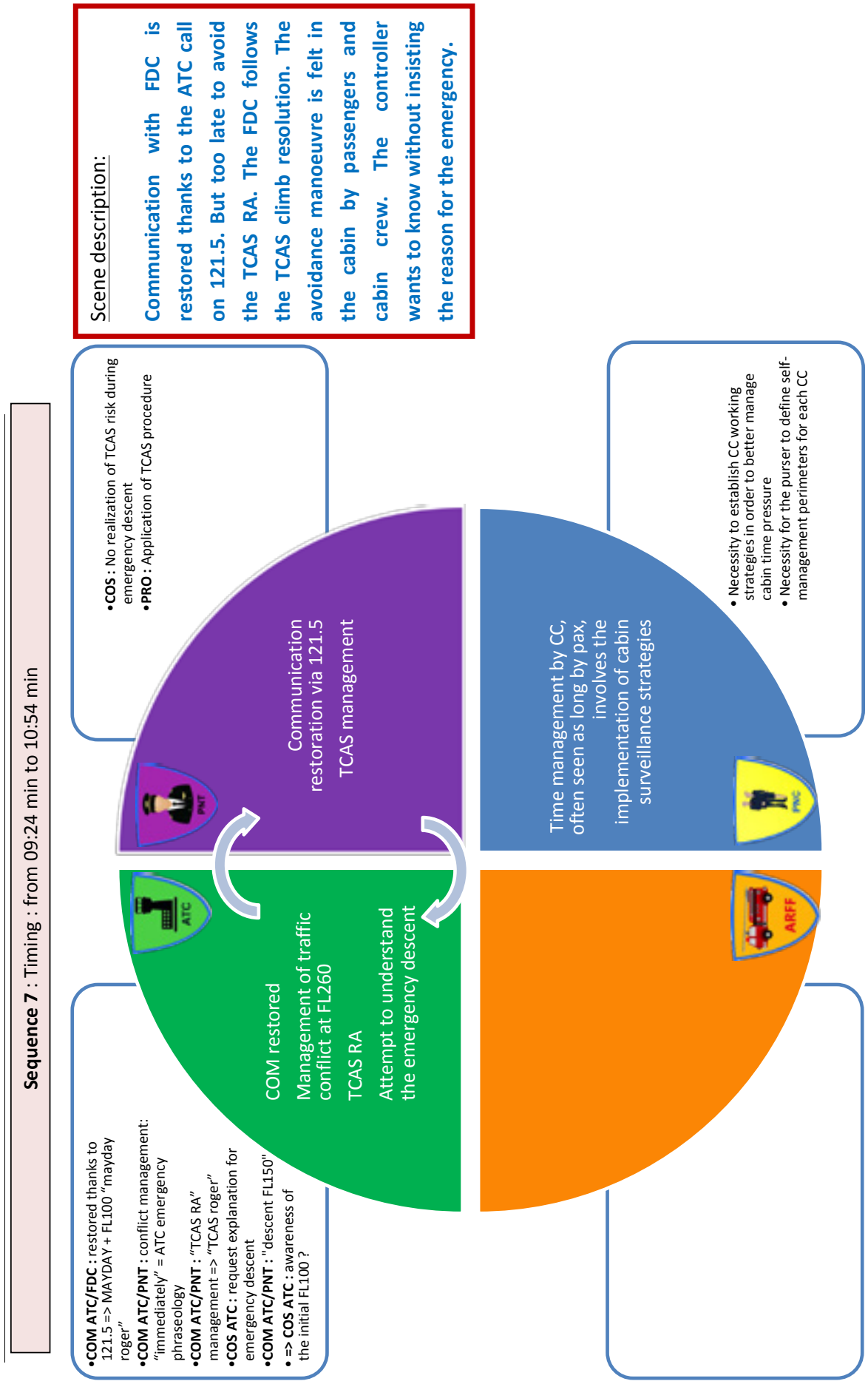
- **Situation awareness and TEM approach**:

The use of the TEM allows the same mental thought pattern to be shared and therefore the same action plan.



Source: Safety behaviours
CASA

Refer to appendix 8


Scene description:
Communication with FDC is restored thanks to the ATC call on 121.5. But too late to avoid the TCAS RA. The FDC follows the TCAS climb resolution. The avoidance manoeuvre is felt in the cabin by passengers and cabin crew. The controller wants to know without insisting the reason for the emergency.
Sequence 7 : Timing : from 09:24 min to 10:54 min
•COM ATC/FDC : restored thanks to 121.5 => MAYDAY + FL100 "mayday roger"
•COM ATC/PNT : conflict management: "immediately" = ATC emergency phraseology
•COM ATC/PNT : "TCAS RA" management => "TCAS roger"
•COS ATC : request explanation for emergency descent
•COM ATC/PNT : "descent FL150"
• => COS ATC : awareness of the initial FL100 ?
COM restored
Management of traffic conflict at FL260
TCAS RA
Attempt to understand the emergency descent
ATC
•COS : No realization of TCAS risk during emergency descent
•PRO : Application of TCAS procedure
Communication restoration via 121.5
TCAS management
PNT
Time management by CC, often seen as long by pax, involves the implementation of cabin surveillance strategies
• Necessity to establish CC working strategies in order to better manage cabin time pressure
• Necessity for the purser to define self-management perimeters for each CC
PNC
ARFF

SEQUENCE 7: KEY MESSAGES

1. **Communication**:
    a. CC: Debate on how to get information from the cockpit at a time that can be sensitive?
    b. Right from the start of the incident the PUR and FDC must coordinate with each other and organise their exchanges.
    c. ATC: use "MAYDAY Roger" to confirm that the emergency has been acknowledged.
    d. Use of emergency expressions (avoidance). Important: if TCAS RA then "TCAS Roger". Remember to clearly announce the clearance used after the "clear of conflict" for possible removal of doubt with the ATC.

2. **Situation awareness**:
    e. Requires the PUR to set up efficient teamwork to manage the sick person but also to reassure the other passengers. And not forgetting that having a good knowledge of the time remaining is necessary. The FDC must inform the CC when possible.
    f. Develop the awareness of the TCAS risk situation about an emergency descent.

3. **Crew teamwork**:
    CC: how to work in synergy, creation of an action plan, distribution of tasks.

4. **Workload management**:
    Clear the airspace around the aircraft in case of emergency => avoid taking avoidance action with respect to traffic in an emergency (may not be possible).

SEQUENCE 7: COMMENTS, SHEETS, TOOLS

- **Management of the conflict with FL250 traffic**:

For the FDC:

- The safety net corresponds to "our" TCAS → the ATC will use emergency expressions ("Immediately" and major heading changes.

However, the initiating actions are not the same as for an RA. Most of the time, the safety net will be triggered upstream and the tool indicates a future loss of separation (depending on the standard used in this space).

ATC: use of emergency expressions (avoidance): this changed on 12 October 2017, now: … to "avoid traffic"

The control actions given to re-establish the separation are no longer valid when a TCAS RA is initiated. The controllers know this but do not know when the RA is initiated. There is therefore a possibility of simultaneous and perhaps contradictory orders. A recent recommendation asks the controllers to prioritise heading changes rather than climb/ descent action to avoid a contradictory action to the TCAS ones at the flight level.

For the ATC: Important: if TCAS RA then "TCAS Roger", no action on the flight until the pilot has announced "Clear of conflict". Important: the pilots return to the initial clearance after the "Clear of conflict" except if counter order => clearly confirm or deny the clearance to the pilots. To invalidate a pilot self-clearance: "Negative …" repeat the unexpected element (FL150 in this case).

- How to manage the "Clear of conflict" (makes announcement then goes to the FL?).

Note: the initially authorised FL is perhaps no longer valid.

For the ATC: management of the TCAS

Strictly respect the expression ("TCAS Roger") in spite of the controllers' desire to resolve the conflict by giving a heading, an FL, traffic info.

In any case, not all the FDC are available to communicate because of the stress and because of the increased workload generated by the TCAS RA.

- **The ATC attempts to understand the situation**:

The controller tries to understand the change to an emergency condition but does not start a conversation which could become argumentative and pollute the real-time management. First and foremost he also wants to know if other problems which may require other types of assistance (aircraft failure) are in progress.

- **CC: Lack of information from the cockpit**:

Pedagogy with the CC, pause and have a discussion:

Opportunity and risk of calling the cockpit when managing a TCAS RA?

How can we communicate with the cockpit during an incident to minimise the risks?

The cabin crew may wonder "why are we climbing? ", which is the same type of questioning as that of the ATC "why are you descending and why 7700? " (sequence 5 ATC/ATC and sequence 7 ATC/FDC). These are attempts to gain new understanding of the situation after the perception of inconsistencies.

- **TCAS management by the crew**:

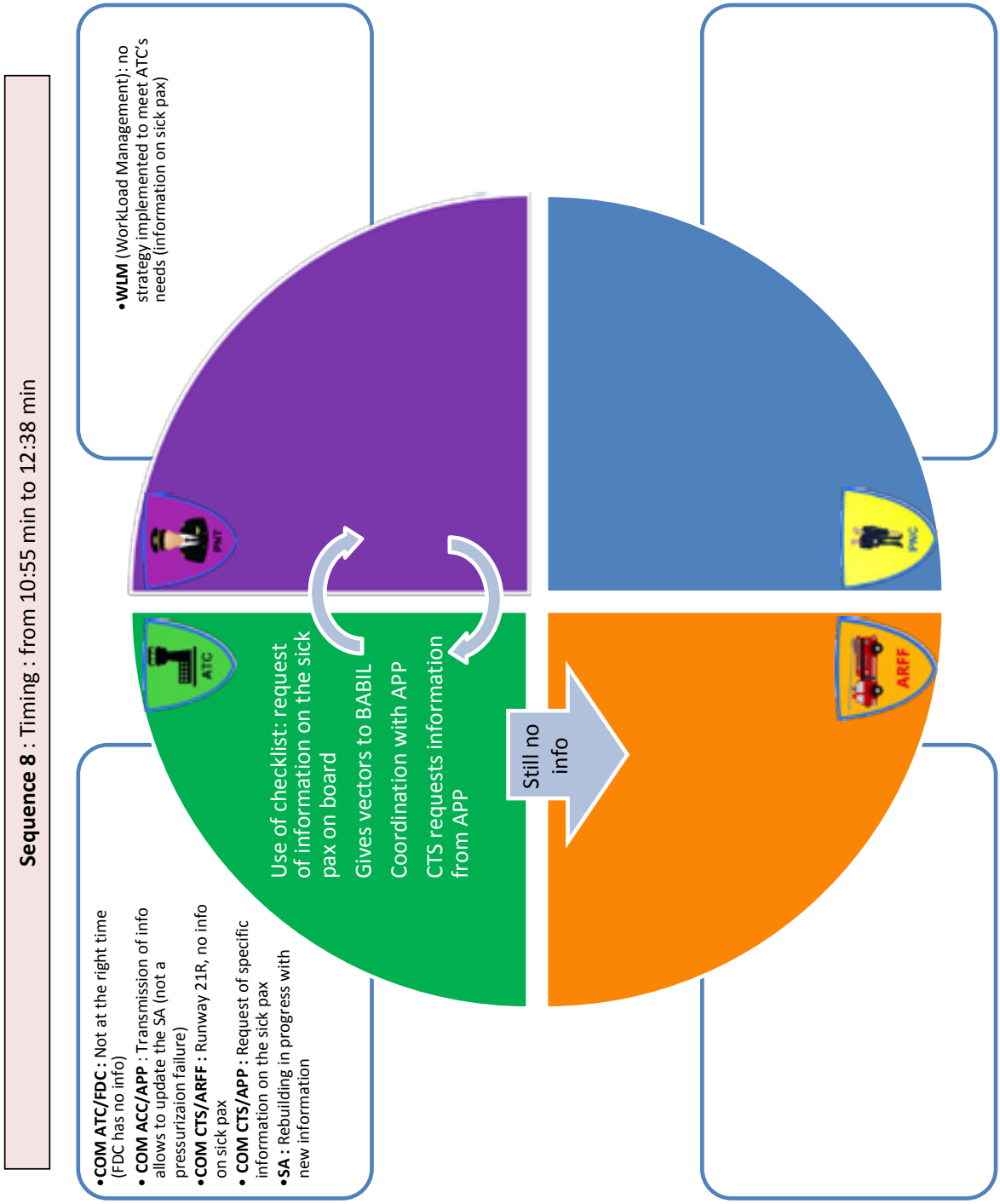
During an emergency descent the high rate of descent can prevent the crew from having a good mental picture of the surrounding traffic (non-conflictual TCAS information) and can lead to a TCAS RA (Resolution Advisory) without TA (Traffic Advisory). In the case of TCAS RA the pilot will follow the TCAS orders and simply announce to the ATC (TCAS RA). There is then a very high workload (manual control, change of action plan, interior and exterior monitoring) combined with a high level of surprise. When the TCAS ends (clear of conflict) the crew still needs a few tens of seconds to get the aircraft back onto its initial flight path and switch the various automatic systems back on again. A TCAS RA always results in filling out an ASR.

- **Areas for reflection**:

Right from the start of the incident it is necessary to establish a strategy (rules) between the PIL and the PUR concerning the way to communicate during the rest of the flight but perhaps also concerning the announcements to the pax, the measures to be taken in the cabin, etc.
Define or redefine the area of action of each of the participants.

Scene description:

The controller requests necessary information to manage the medical emergency. But the pilots postpone the transmission of this information and focus on the flight path, and especially on BABIL waypoint. The missing items are required by the ARFF and Rexville tower.



Sequence 8 : Timing : from 10:55 min to 12:38 min

SEQUENCE 8: KEY MESSAGES

1. **Communication**:
   a. Remember to use for the ATC the formula "when ready" or "when able".

   b. Communication and its techniques, by the use of tones, intonations and different terms, allow the "receiver" to understand the level required: informative, or synonymous with desired action.
      Examples of different actions requested in a message: "if you can", "when possible", "waiting for your information" "elements required with high priority level".

   c. Explicit communication, circulation of information.

2. **Workload management**:
   a. Importance for the firemen to have information about the medical emergency to size the emergency means. If the emergency services receive the elements too late, this could force the persons managing the emergency situation (firemen, etc.) to rush. The fireman in charge of the hotline can call back later to try to get the missing information with a time limit: "I will need certain information 10 minutes before the plane lands…"

   b. The management of the priorities appears different in each specialism. The ATC's request for the reflex sheet elements should trigger an urgent and rapid reply from the FDC to stop the questioning by the Rexville services. A participant's immediate priority should not prevent him/her from making the necessary effort to answer the requests from the other participants.

   c. FDC: implementation of workload management strategy.

SEQUENCE 8: COMMENTS, SHEETS, TOOLS

- **Communication:**

In an "abnormal" situation, use the formula "when ready" which allows the team to communicate at the appropriate time (thus avoiding interrupting the checks, etc.).

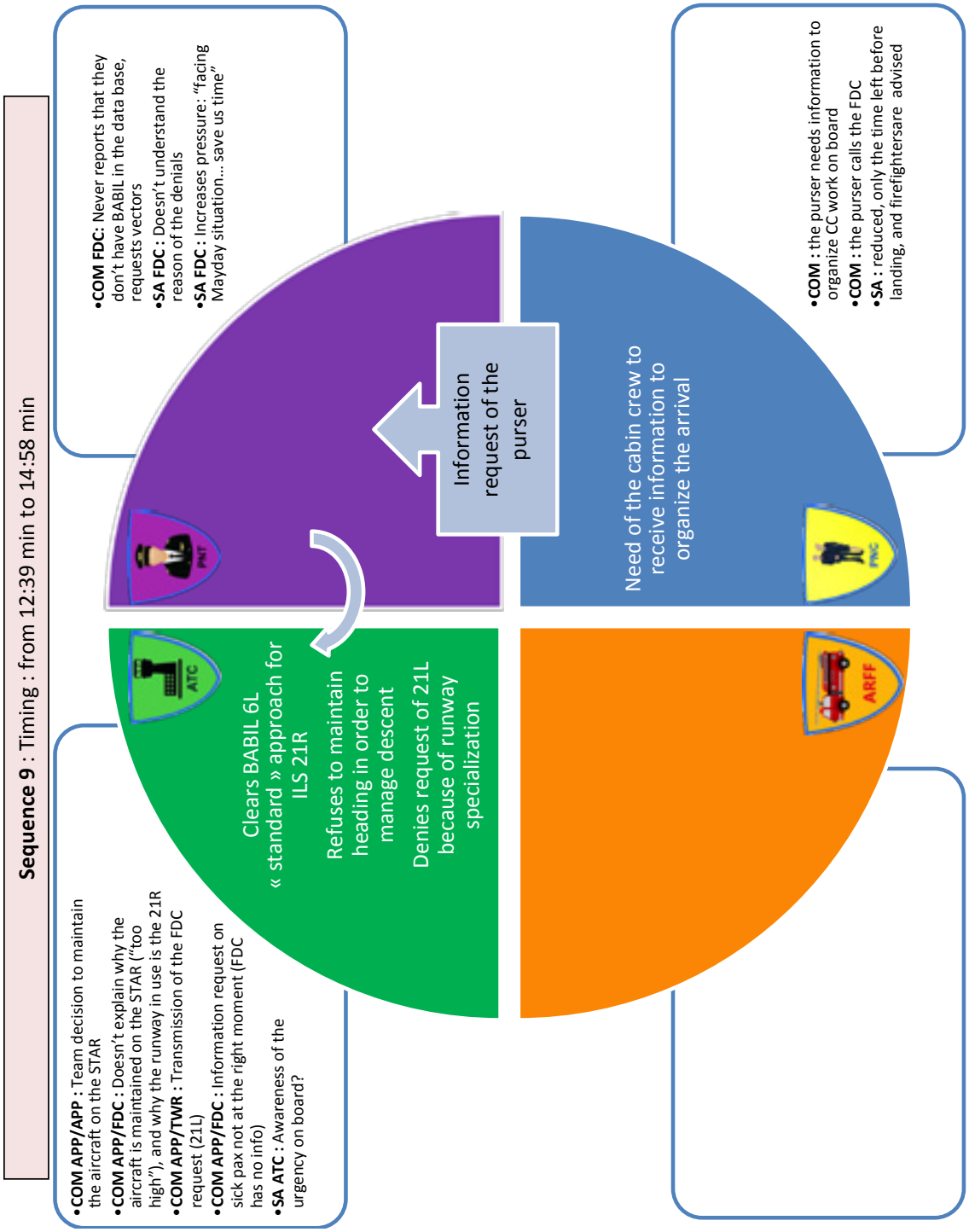
- **Workload management strategy**:

a. The crew does not really take into account the ATC's need for information ("I'll do that later " is perhaps not a very satisfactory strategy). Consider a shared strategy (between pilots, but also with the ATC) with a rendezvous point: "I will give you that in 5 minutes" "call me back in 5 minutes, I will have the information", etc.

b. What are the resources which the crew devotes to finding the medical information necessary for the firemen?
The lack of information at the start of the incident will have an impact throughout the incident, hence the importance right from the start to take your time, analyse the situation with others to describe it as "factually" as possible.
The ATC's logic is to control the flow of arrivals by the IAFs. Difficulty to obtain information for "later" when managing an emergency. The ATC's priority is different from that of the firemen.

Scene description:

The aircraft, after switching to Rexville approach, is cleared BABIL6L and ILS 21R at 3000 ft. The FDC requests to continue on heading, which is denied because the aircraft is too high for a direct approach (risk of non compliant approach). New attempt from ATC to have information on the medical emergency. The FDC insists to have runway 21L in order to speed up the approach but the aircraft being too high, the ATC refuses. The purser intervenes to know if the aircraft is going to land soon. A last minute change of runway, which could seem an easy solution, can turn out to be a major cause of disorganization for rescue and control services.



SEQUENCE 9: KEY MESSAGES

1. **Communication**:
   ATC: Communicate and give the explanation.

2. **Situation awareness**:
   The ATC and the FDC need to share a common action plan (STAR, radar heading, shortened route, etc.).

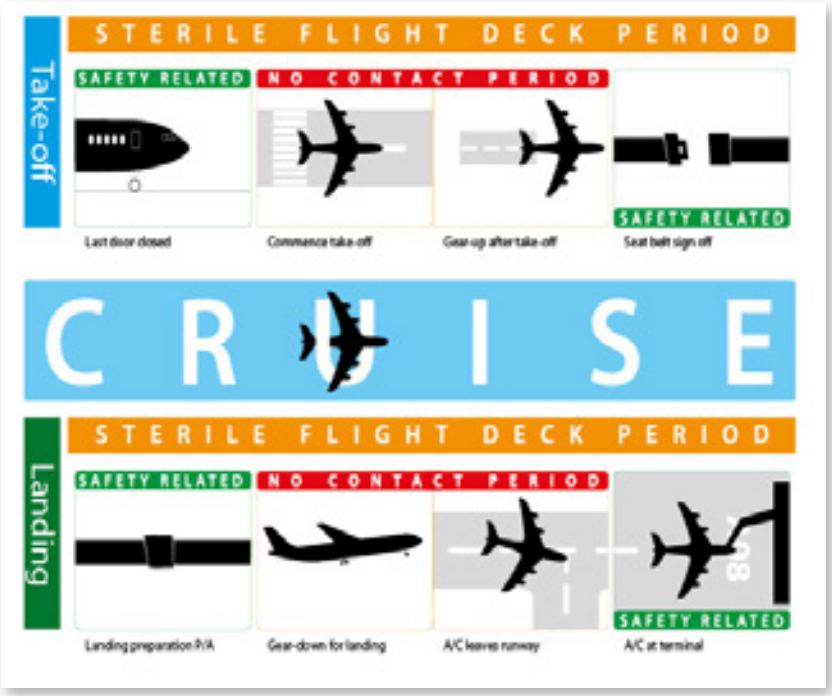
3. **Workload management during a diversion**:
   a. FDC: Priority management and awareness of interruptions (AOV tool Appendix 3).

   b. Although the aircraft has priority, it cannot disrupt a whole platform where not necessary.

SEQUENCE 9: COMMENTS, SHEETS, TOOLS

- Workload management:

During a diversion the workload is high for everyone, especially for the FDC.
It is also a situation in which we lose the "comfort" of the reflexes of a routine situation. It is therefore a situation where the risk increases (the distance from an accident is reduced). It is in this type of situation that the CRM principles of crew teamwork must be fully implemented. In this sequence (as in sequence no. 7) the communication between the CC and the FDC is necessary but may possibly introduce risks (interrupted tasks, incomprehension, misunderstanding, omissions, etc.).



Example of a sterile cockpit rule

Although at this precise moment it is no longer possible to take time to agree on operating " rules" between the FDC and the CC, the communications must not be less " carefully considered".
The communications must also respect the sterile cockpit procedure which protects the critical flight phases such as landing, takeoff and when the aircraft is flying below FL 100. During these phases the pilots only perform the tasks concerning flying the aircraft and the CC only talk to the pilots for safety-related problems.

Skybrary on sterile cockpit:
www.skybrary.aero/index.php/Sterile_Flight_Deck

The pilot gives priority to flying his aircraft rather than finding information about the sick person on board (no task sharing).
The tower controller's decision to leave the aircraft on 21R must be known by the approach. This is the case.

Impact of a change of runway: management of two dedicated runways: with parallel runways, one is used for takeoffs, the other for landings. In this way the capacity is optimal. If the strategy changes (in this case, landing an aircraft on a takeoff runway), there will be departure delays and possibly conflicts between aircraft on finals.

- Awareness of the shared situation:
  a. Explanations of intentions:
     The pilot does not explain:
     - The reason why he wants to stay on the heading (does not have BABIL in the database)
       In the case of a diversion en route, on some aircraft it is possible that the FMS does not have the airfield's STAR, nor any information on the airfield itself (e.g.
       ELLX on B777). For a diversion to an airfield not in the Database, the crew will need radar guidance if this is available.
     - Justification of the request for 21L

     APP does not explain:
     - The reason why it wants to leave the aircraft on the STAR (ensure the glide path interception)
     - The reason why 21L is unavailable (reserved for departures).

This lack of communication does not facilitate the overall situation awareness and therefore does not facilitate cooperation. This also creates frustration and can increase stress.
In such cases, it is important that **each person gives the reason for his message**: the pilot who wants to turn onto the base leg certainly estimates that he is able to lose altitude rapidly, whereas the ATC wants him to stay on the STAR because he thinks he is too high... The situation awareness is no longer shared…

b. ATC: Communicate and give the explanation:
   - Announce the distance to the threshold to the crew ("you are high for the threshold distance") allows all the participants to have the same mental picture of the situation (explanation of the choice of standard arrival).
   - Propose an alternative (standard procedure or guidance to assist the management of the plan). A request from the ATC such as "what do you intend to do?" relatively early in the sequence would allow everyone to have the same situation awareness and share the same action plan (choice of runway?).

c. Flight path management: With modern aircraft equipped with FMS + ND, the crew has an excellent picture of their position with respect to the runway and also of their ability to descend and/or reduce speed. However, they only have a very partial picture of the other constraints affecting their flight path (other traffic, traffic on the ground, control zones, etc.) In this situation, the crew may be tempted to take the initiative concerning its flight path. If there is no conflict, it could be considered that the crew is allowed to decide the flight path changes: "call me back when you start reducing speed" "descent at your convenience" "call me back when you want to turn on to the base leg".
   Note: the opposite case is also true: a crew which wants to concentrate on managing a serious failure and on who will delegate the flight path to control so that it handles the radar guidance.

- **Crew teamwork:**

If the subject of the crew's organisation was not covered during sequence 7, it can be covered during this sequence.

The crew must not have to establish the rules of its cooperation and more specifically of its communication at this moment during the flight; this must be done during the initial moments of the event, or even better, during the briefing.

Get the trainees to discuss the best way to communicate during this diversion.

Areas for reflection: before communicating, ask yourself the questions:

"At this moment, what is the workload of the person I want to communicate with?"

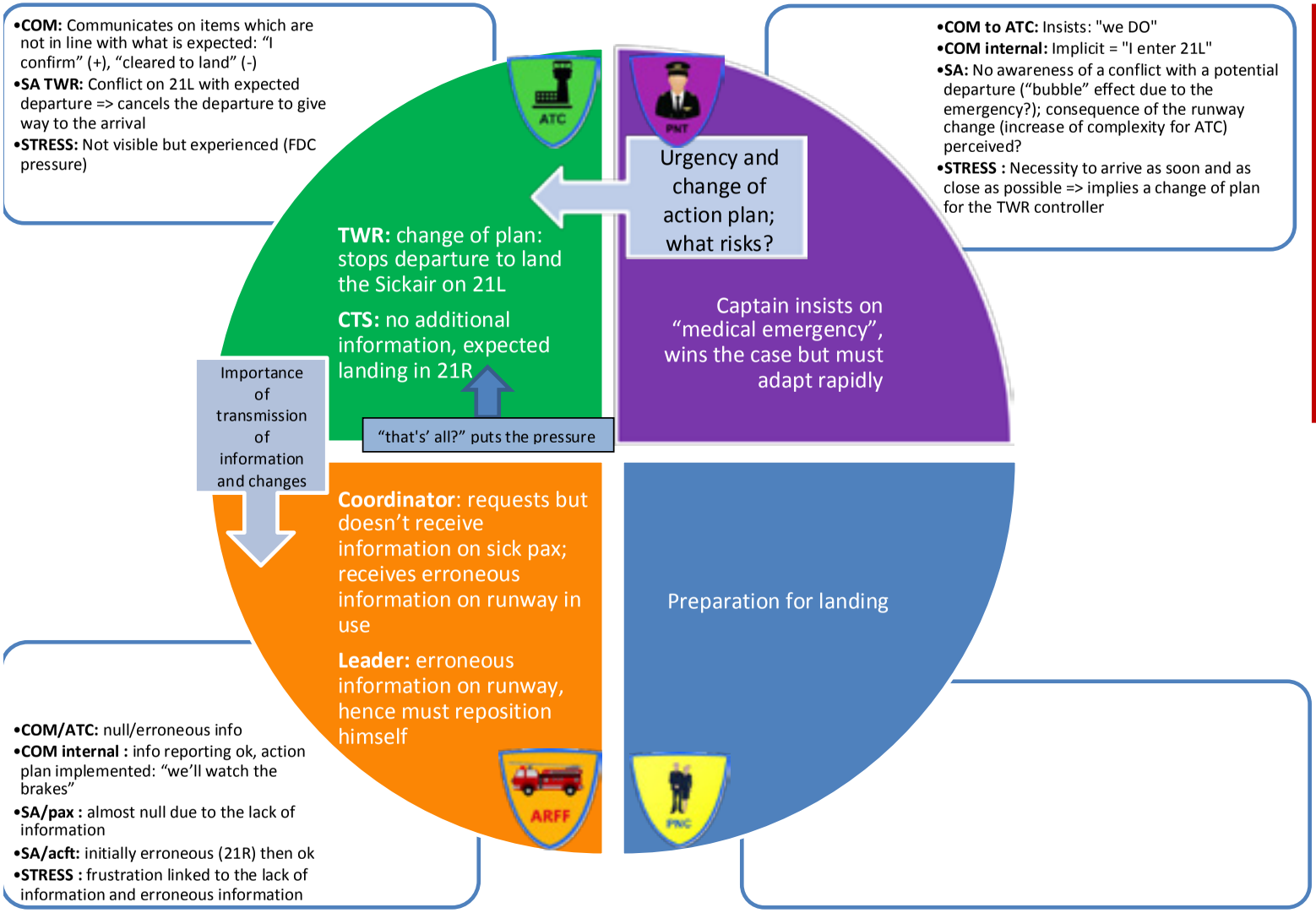
"Why do I want to communicate?"

"What do I have to say of any importance? What do I need?"

"Is it worth the risk of interrupting the FDC?" Or "Is what I have to tell them (or ask them) more important than what they are doing?"

The "NITS" (mnemonic for communicating essential information) can also be covered during this sequence.

Sequence 10 : Timing : from 14:59 min to 17:44 min



Scene description :

During the approach to Rexville, FDC demands a runway change that involves an increase of workload for ATC and generates a change of positioning for the ARFF.

SEQUENCE 10: KEY MESSAGES

1. **Communication:**

   a. ATC: CTS/sector. Remember to communicate to improve the awareness that the two entities have of the situation.
   b. Ground/on board: be able to find the "right moment", be able to recognise the other's heavy workload phases.

   c. Communication of a change: to avoid the risk of waits, remove doubt and request confirmation.

2. **Situation awareness:**

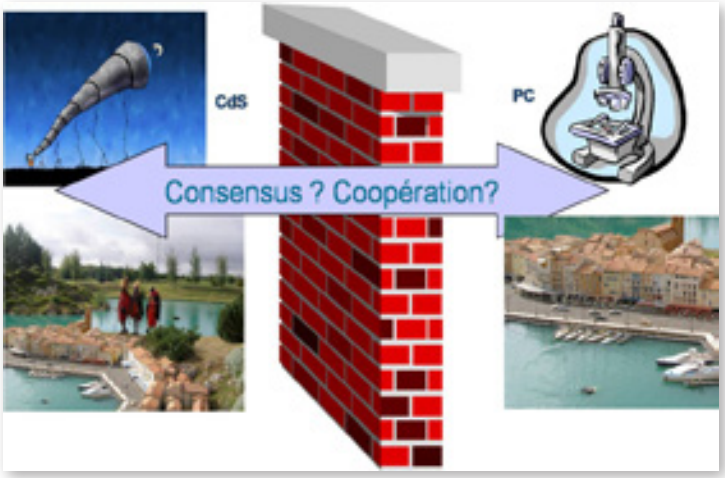
   Share the action plans to improve cooperation. "What do you intend to do?" and traffic information.

SEQUENCE 10: COMMENTS, SHEETS, TOOLS

- **Communication**: "No COM, no SA and vice versa"

▪ Concerning the sick person, the CTS cannot give the information requested by the ARFF **because she does not have it**, in spite of the CRNA controllers' requests to the pilots. However, the CTS does not give any further explanation to the ARFF coordinator which could justify this lack of information. The aircraft has declared and made an emergency descent, the pilots may be very busy and not have the time to ask for, then transmit, this information. These explanations could not only improve the ARFF's situation awareness but also reduce its frustration and any induced stress.

▪ Concerning the aircraft and the runway, the CTS gives 21R which is valid given the information she has available to her. She cannot know about the **LOC controller's** change of plan because he **does not inform her of it**.



The CTS (or the CRS at the CRNA) is the **hub of all the external communications** in the control sector/ position. It is therefore essential that he/she relays the information we know, at all times, and our intentions, so that he/she has an accurate overall picture of the situation.

▪ The main problem of communication is that it consumes resources. In addition, if it is not expected, it creates an interruption which can generate an incident. This is especially the case during the heavy workload phases when the pilot is very busy flying the aircraft, or during the heavy workload phases at the ATC. During final approach and especially on short final, the pilots have an enormous amount of parameters to manage and monitor and are therefore very busy. An interruption would be extremely counterproductive (see appendix 3 on AOVs to find out the areas of vulnerability in various flight phases).

- ATC change of plan: "significant implications"

▪ Pilots and controllers work with action plans. These action plans are defined in different reference documents ("aircraft" level for the FDC, "traffic situation" level for the ATC), and can sometimes be contradictory and create misunderstandings, tensions and stress. The difficulty is finding a way and the time to communicate to share them. In an emergency situation this necessity to communicate is rendered difficult by the time pressure in particular.

▪ The ATC's change of plan is directly linked with the pilot insisting on the notion of emergency and priority "We DO request priority" (heavy use of the paraverbal mode). This type of pressure is double-edged and can encourage the ATC to take greater risks to satisfy this emergency.

  - The direct initial consequence of the change of plan is the increased consumption of the mental resources of the LOC controller who must "reconfigure" himself and ensure that he has taken into account all the new elements of the situation. This excessive consumption of resources can generate errors and/or increase the time pressure and therefore the stress.
  - In the specific case of a landing on a runway other than that initially planned, he must, in particular coordinate with his ground controller colleague (not seen in the film) to avoid a "traffic jam", and at worst, ends up being counterproductive by immobilising the plane which has the emergency. For example, the case is even more complicated when there is only one runway, because if the flight with the emergency exits the end of the runway, it will end up nose to nose with the departure which has been maintained.

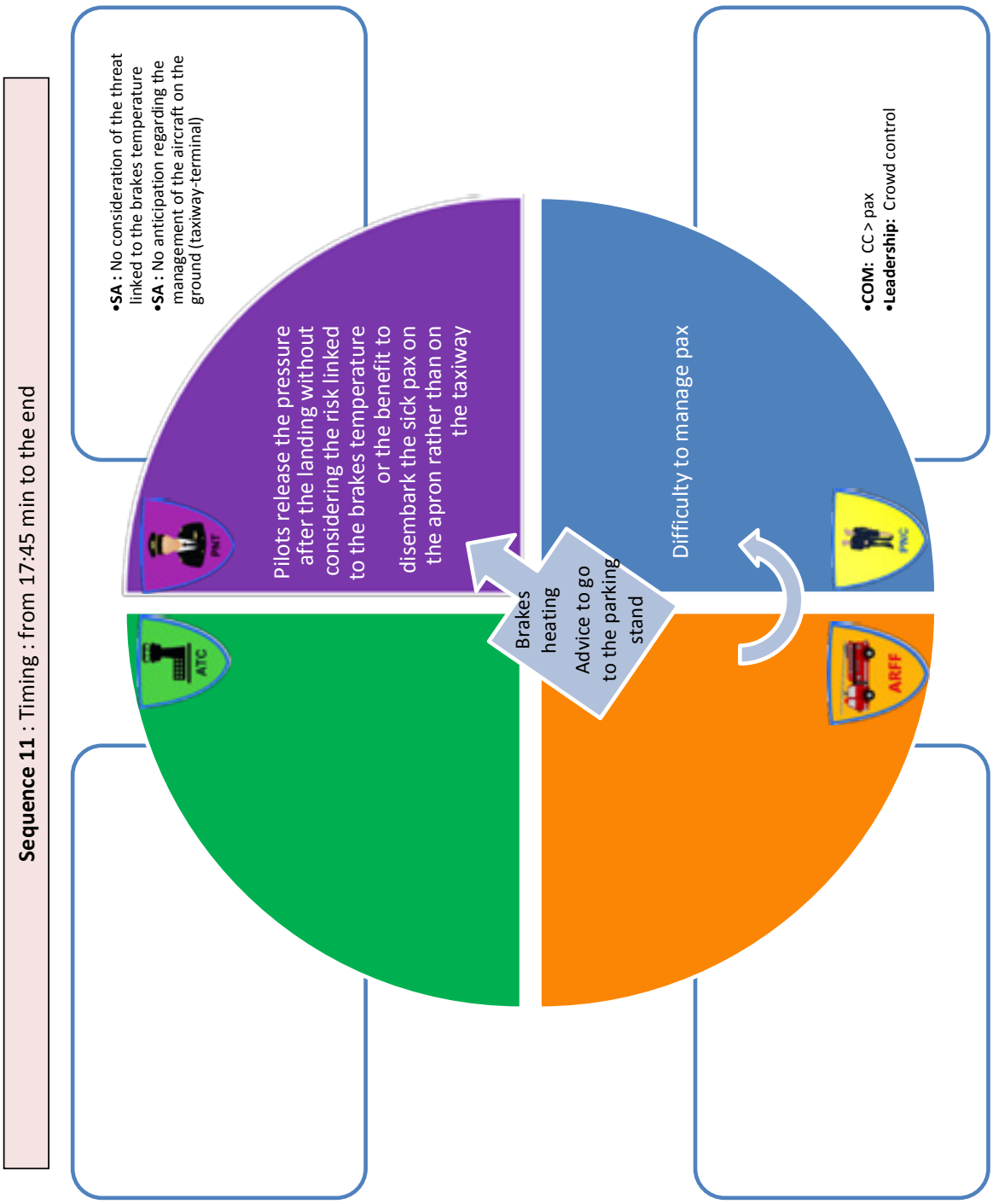
- Communication of the change: "Confirmation, removal of doubt and implicit message"
  - Each action plan creates objectives and expectations for their achievement. These expectations, especially if they are reinforced by pressure (commercial, technical, personal), are the source of many pitfalls for our brain. In the present case, during the clearance to land, the major risk is that the change of runway (L instead of R) is not perceived by the pilots who are "resigned" to landing on 21R. => if the action plan changes (particularly if this is done suddenly and at a late stage) it is important to rely on the elements which no longer correspond to these expectations, by the use of "I confirm" or "I repeat" (importance of the paraverbal).
  - "I am entering you into 21L". What does this mean? represent? for the 2 pilots? "I am entering runway 21L in the FMS for you".
  - Implicit communication is very frequently used between two people (FDC, ATC or other) or small groups used to working together or governed by common procedures. This communication has the advantage of reducing the amount of resources committed. It can contain much more than what is expressed by the words alone, in particular a mental picture and an action plan. In case of change, what is the risk of this implicit communication?

- **Insistence on 21L**: "Bubble and party lines effect"
  - The insistence of the pilots to have 21 L gives the impression that they are not aware of the "conflicts" generated by this type of change. Do they have the time to take the ATC's constraints into account? Does the on-board management of the emergency situation create a "bubble effect" centred on the aircraft? What is the awareness of the situation in the air? The ATC's management right from the start (at the CRNA) could have generated a "bubble effect". With the aircraft isolated on a frequency, this may give the impression that it is alone. Can a "party lines" help the pilots to build up a picture of the situation?

- **ARFF intervention**: Intervention on the runway
  - If there is a sick person on board, the firemen are planned to intervene at the parking stand, especially to facilitate access on board the aircraft.
  - Some technical emergencies require an intervention on the runway or on the tarmac. Which emergencies? (If there is no specific request by the pilot during a "sick person aboard" diversion, no firemen are deployed on the tarmac. The firemen "intervene" for more critical technical or weather situations such as LVP under a certain level of RVR, aircraft PAN PAN with indication of a landing gear or hydraulic problem, after an aborted take off to check brake temperature, etc.) => here is the reason of the intervention on the tarmac is unclear…What could it be?
    During a diversion or a quick return flight (QRF) the ARFF must not ignore the possible consequences of this situation, i.e.:
    Causes: pax with medical emergency = Take charge of patient (first aider and/or medical personnel).
    Consequences: Landing with a high weightand brake fire risk, lack of handling means (Airstair, marshaller, etc.), lack of knowledge of the airfield by the FDC (presence of a "Follow Me" to quickly guide the plane to the "gate", etc.).

Scene description :

After landing, the aircraft vacates the runway and stops on the taxiway. ARFF advises for the aircraft to go to the parking stand. During taxiing, ARFF notices smoke release from the landing gear that will turn out without consequence. On apron, despite the cabin crew announcement, passengers stand up and disturb rescue service intervention.
Strong intervention from purser to make passengers sit down.



SEQUENCE 11: KEY MESSAGES

1. **Situation awareness**:
   a. It is easier to get the sick passenger off the plane at the apron.

   b. High breaking: The relaxation of the FDC after landing means that they do not take into account the landing gear fire risk due to the brake discs overheating after high breaking action.

2. **Leadership and crowd management**:
   Firm announcement for the pax to remain seated. Ensure that the instruction is observed.

SEQUENCE 11: COMMENTS, SHEETS, TOOLS

- **Communication:**

Start a discussion on the use of the frequency between ARFF and pilot.
"Direct" PEQ/ARFF communication avoids errors or interpretations.
Example:

- The ATC informs of a leak of corrosive liquid on "A4" 8L on a B 74F. ARFF interprets it as a leak of corrosive liquid on the most dangerous poison gas in the world in pallet 8 Left position. It was a leak of corrosive liquid on a 1.4 explosive (1.4 transformed into A4). The 8L was the drill code for the corrosive substance (8 = corrosive and L = "Low" corrosiveness).
- The ATC initiates an Accident Status for the GTR stand fire… It was a fire on the PHR!

The ARFF is in contact with the ground control frequency and only directly communicates with the pilots when the aircraft is at the apron. They will nevertheless be aware of the information shared by the pilots on this ground frequency.

- **Situation awareness, anticipation:**

Heavy braking: The heavy braking was overshadowed by the medical emergency. The focus on the sick passenger overshadowed this technical aspect. The diversion under a hurry up syndrome (Medical emergency) can mean that the consequences of a landing with high weightare overlooked (brake overheating). The ATC like the ARFF, in addition to the flight path and taking charge of the patient, must also anticipate the problems inherent in this scheduled arrival. (Guidance by Follow Me, stopover means such as: airstair, marshaller, GPU, taking charge of emergencies outside the airport, etc.). A brake fire is always possible after landing at H + 15 minutes, etc.

Brake overheating issue:
3 key elements define the brake overheating: aircraft weight, approach speed and length of runway used.
On a "time critical" diversion, the aircraft can land with a much higher weight than the max landing weight (especially true on long-haul aircraft).
Some failures can affect the approach speed (flap/slat failure).
If the runway is short or if the crew brake sharply to take a specific clearance taxiway. (we can suppose that we are in this scenario).
Conversely, the runway conditions (wet, snow, etc.) affect the braking distance but not the overheating of the tyres.

Decision: choice of location of the ARFF's intervention:
Wanting to stop an aircraft on the taxiway to get the firefighters to intervene as quickly as possible can cause major delays during sick passenger disembarkation operations due to the equipment which has to be brought to the plane (stairs, etc.).
The rapid access by the emergency services to the sick passenger must also remain a priority (Article 223.5 of the French Criminal Code).
ATC: The intervention of the firefighters "at the runway exit" is only envisaged at the specific request of the pilots (e.g. aircraft technical problem) or if there are specific weather conditions at the airfield (strong wind, fog, etc.). Both the taxiways and the runway are the responsibility of the ATC (unlike the parking aprons which are the operator's responsibility) therefore any immobilisation of the aircraft, rescue operation, etc. on the taxiway theoretically requires the ATC's authorisation. Due among other things to the consequences on the management of the platform.

- **Crowd management:**

The passengers in the cabin form a crowd (group of persons without clearly developed links and without specific organisation, etc.). This crowd must be managed by the CC, i.e. they must ensure that the pax behave as they (the CC) want them to.
Start the discussion among the trainees on the actions to be taken, the attitudes to be adopted to "efficiently manage" the passengers.
Ask the trainees questions about the first announcement made in a "commercial" tone of voice, and about the announcement made by the purser.
Open the discussion about the fact that "crowd management" is not limited to the incident, the management begins with the arrival of the first passenger on board, by the way we position ourselves and the way we communicate with the pax.
The behaviour of the passengers during an incident will depend on the perception they have of us right from the moment they arrive on board.

- **Leadership (CC/PAX):**

Possibility to expand the discussion of the CC to leadership.
To succeed in his/her tasks in the best possible conditions, a good leader must have good "followers" who perfectly understand the messages and tasks to be carried out, approve the options and follow the instructions. Leadership and followership are linked.
The CC must "manage" the cabin. I.e. they must ensure that the pax behave as expected. But being a leader means having other skills (see appendix 4). Ask the trainees questions about the meaning of "being cabin leaders".
Areas for reflection:

- A leader is recognised and accepted by his/her team members but how does this work with the pax?
- A leader reassures because (s)he is competent and can show the direction to follow but how does this work with the pax?
- A leader who has charisma is respected by his/her team but how does this work with the pax?
- etc.

In each discussion with the trainees, ensure that they do not just make declarations of intentions disconnected from all pragmatism but that they describe the actual attitudes, words, positioning in the cabin and the distribution of the roles.

- Unlike the emergency services which have many actions to carry out, the crew are often recognised for their great professionalism but also for their difficulty in controlling their emotions due to the small number of emergency medical situations they have to deal with.

The confinement of the cabin, the cruising flight, the feeling of "responsibility" for the lives of the PAX, the time pressure and the pressure of the surrounding passengers are all constraints which have to be managed. The CC's initial training is also closely concerned with the "diagnosis of the patient" whereas that of the FDC is based on managing the aircraft's technical aspect.

GLOSSARY

Abbreviations/acronyms	Meaning
21R/21L	Runway 21 Right or 21 Left
5677	Transponder code allowing all the layers to be visualised with the indication "ATTN" (attention) in white on line 0 of the radar label (France only)
7600	Transponder code corresponding to a radio failure
7700	Transponder code corresponding to an emergency situation
8.33	Corresponds to the spacing between two frequencies (8.33 KHz)
ACC	Air Control Centre CRNA in French.
AOV	Areas Of Vulnerability
APP	Approach, the approach controller handles the volume between that handled by LOC controller and that handled by the en-route control;
ARFF	Aircraft Rescue and Fire-Fighting
ASR	Air Safety Report
ATC	Air Traffic Control
ATS	Air Traffic Services (includes ATC, flight info, alert, etc.)
PUR	Purser
CSD	Cabin Service Director (on wide-bodied aircraft only, accompanied by one or more PUR)
CAPT	Captain
CRS	Control Room Supervisor
CTS	Control Tower Supervisor
PC	Planning Controller (detects the conflicts, manages the entry integration and the exit configuration (coordinates with the surrounding sectors)
COM	Communication
SA	Situation Awareness
CPDLC	Controller Pilot Data Link Communication
RC	Radar Controller (manages the frequency, resolves the conflicts)
CRNA	French en-route air navigation centre (en-route centre)
DEC	Decision
EMRG	Emergency
EMT	Emergency Medical Team (in the USA)
FL	Flight Level
FMS	Flight Management System

FMS ND	Flight Management System and NAV Display
SRT	Safety and Rescue Training
WLM	Workload Management
IAF	Initial Approach Fix
LOC	LOC controller, manages the LOC position. Controls the movements on the runway and in the circuit (downwind , final, etc.). LOC stands for "local".
LTE	Leadership, Teamwork
NITS	Nature of the event, Intentions, Time available, Specific instructions (tool used in many airlines by the FDC for the CC when there is time pressure)
CP	Copilot
4Ws	Where, When, Who, What (Method of communication under stress)
Party line	It is when a pilot can hear the exchanges between the ATC and the other pilots. "Party" means a sort of group or community. This listening which is referred to as "floating" because it is not necessarily attentive, sometimes gives a better understanding of the actual situation. This has already saved dangerous situations. The most classic situation is that of the pilot of an aircraft cleared for takeoff on a runway and who hears that another aircraft is cleared to cross the runway. At the minimum he will ask the ATC to clarify. The party line also works in a control tower (a regional control centre seems more compartmentalised). The controllers are close to each other and a phrase heard from the adjacent controller is sometimes valuable. Controller errors are therefore corrected by colleagues.
Pax	Passengers
PCs	"First controller" in the plural. The word "first" refers to administrative concepts (they are highly qualified). We make a distinction between the RC1: the first Radar Controller (the one who watches the radar and speaks to the pilots) and the PC1: first Planning Controller (who mans the telephone and assists the RC1 to manage the situation correctly with opinions, cross-check, etc.
PF	Pilot Flying
PLOC	Prolonged Loss Of Communication Relatively long (not specified, to be assessed based on context) loss of communication. This can happen following an on-board failure, a frequency error, an insufficient radio range, an omission (the pilot turned the volume down and forgot to turn it up again).
PM	Pilot Monitoring
CC	Cabin Crew

FDC	Flight Deck Crew (comprising the **CAPT** (Captain and the **CP** (Co-pilot). Aboard the aircraft, one of them will be the **PF** (**P**ilot **F**lying) responsible for flying the aircraft, the other is the **PM** (**P**ilot **M**onitoring) in charge of monitoring the flight path
PRO	Procedures
QRF	Quick Return Flight Return following a technical problem.
SAMU	French Emergency medical assistance service
SATCOM	Satellite Communication
GC	Ground Controller (manages the taxiways and the parking apron exits)
SOP	Standard Operations Procedures
TCAS	Traffic Collision Avoidance System
TCAS RA	Traffic Collision Avoidance System Resolution Advisory
TEM	Threat and Error Management
TWR	Tower
TWY	Taxiway
UM	Unaccompanied Minor
WCH	Wheelchair: Person with reduced mobility
XPDR	Transponder

APPENDIX 1: FREQUENCY CHANGE (WWW.SKYBRARY.AERO)

Description

The process of changing frequency offers many possibilities for communication failure if the pilot subsequently selects the wrong frequency.

Frequency change occurrences are often of short duration because the pilot realises on checking in that he/she is on the wrong frequency: either the frequency is silent, in which case the pilot returns to the previous frequency, or it is active, in which case the controller directs the pilot to the correct frequency.

Frequency change incidents can have serious consequences if the pilot is unable to re-establish contact quickly. This might occur if the previous frequency is very busy, or if the aircraft is out of range of the previous controlling station.

Frequency change occurrences often occur in areas of high density air traffic, especially during climb and descent, where many frequency changes are required as the aircraft is passed from one agency to another. Since these occasions coincide with periods of high pilot work-load, there is an enhanced likelihood that an error in copying the frequency or in setting it correctly will go undetected.

Frequency change errors are equally common in low-workload situations, perhaps because the pilots are more relaxed, or concentrating on some routine issue. Moreover, it may take longer to detect loss of communication than when working a busy frequency.

Effects

Communication breakdown may result in:

- Loss of situation awareness;
- Inability to respond to further clearance or to emergency instructions, e.g. avoiding action.

Defences: At present, good radio discipline is the best defence against loss of communication following frequency change.

Typical Scenarios

- Controller assigns incorrect frequency;
- Pilot mis-hears frequency assignment (perhaps due to radio interference);
- Pilot hears frequency correctly but makes an error when setting it;
- Pilot sets frequency correctly but fails to select radio;
- Pilot mis-sets volume or squelch control;
- Pilot anticipates next frequency (expectation of clearance) and selects it on the panel, but ATC assigns another frequency.

Contributory Factors

- Frequency congestion;
- Radio interference;
- Call sign confusion;
- Language;
- Pilot workload.

Solutions

- **Operators**
    - Ensure that flight crews, cabin crews and ground engineers are aware of the loss of communications issue through publicity.
    - Ensure that SOPs for copying, setting and cross-checking frequency changes, and for loss of communication are sound, and that they are followed by all pilots.
    - Install radio anti-blocking devices if appropriate.
    - To aid returning to the previous frequency if communications are lost, leave the previous frequency on the pre-select until a new frequency is allocated.

- Establish policy for the wearing of headsets which requires their use by both pilots at all times on piston/turboprop and short haul jet flights - say up to 2 hours - and clearly establishes the circumstances on which they are not required to be worn, if any.

- **Pilots**
    - Do not switch immediately to the next sector frequency following read back of controller's instruction. Ensure confirmation of your read back is received.
    - Always follow standard procedures for copying, setting and cross-checking RTF frequencies. As soon as a loss of communication is suspected, check radio equipment settings and audio panel settings and carry out a radio check.
    - If any part of a message for you is garbled or unclear, request confirmation or clarification.
    - Always use headsets during times of high RTF loading. Always wear a headset when members of the flight crew are involved in other tasks and may not be monitoring the RTF.
    - If the squelch control is adjusted to reduce the effect of interference, take care to ensure that transmissions from ATC or other aircraft are not cut out.
    - Always report any radio interference experienced whether or not it affected safe operation.
    - Make use of other aircraft to relay messages when operating at extreme range or when poor propagation is suspected.
    - If PLOC is suspected, select 121.5 MHz and listen out for any transmission from intercepting aircraft.

- **Controllers**
    - Do not pass RTF frequency changes as part of a multi-part clearance.
    - Do not delay passing any vital instruction until after a frequency change (e.g. heading or level change to avoid confliction).
    - Pay close attention to read-back of RTF frequency changes and correct any error.
    - On observing or being informed of radio interference, arrange for transfer of affected aircraft to another RTF frequency.

- Report any radio interference to the appropriate national authorities.
- If loss of communication is suspected, attempt to contact the aircraft by other means, including relay through other aircraft, through the previous operating agency/RTF frequency and through the operator, who may be able to contact the aircraft by other means, e.g. SELCAL or ACARS.
- If attempts to restore two-way communications with the aircraft are unsuccessful, inform the appropriate military authorities. Keep the military authorities informed of action taken by the ATS unit as well as any further action intended.
- When contact is not quickly established, do not delay precautionary clearance to conflicting aircraft on frequency on the assumption that contact will soon be established.

See also: Skyclips: https://www.skybrary.aero/index.php/Solutions:SKYclips

APPENDIX 2: DATALINK AIR-GROUND COMMUNICATION (SOURCE: DGAC)

Datalink air-ground communication

Datalink is a new air-ground communication technology available for providing the frequency transfer service in the whole of our upper airspace.

Controller/pilot communications by datalink: safety and future capacity

The CPDLC (Controller-Pilot Datalink Communications) is the generic term for the ground/air communications via Datalink.

The initial functions of the Datalink were put into service in the five DSNA en-route control centres in 2015 and 2016.

Crews will be proposed three different Datalink services:

DLIC: DataLink Initiation Capability, used to connect to the various other service

- **AMC**: ATC Microphone Check, used to warn crews in case of permanent transmission (microphone blocked) making radiocommunications impossible.
- **ACM**: ATC Communications Management, allows frequency transfers by Datalink.

On the control position's "radar" screen, a lightning symbol beside the flight callsign indicates its eligibility for a frequency transfer by Datalink. By simply clicking on a flight's label, the controller checks the following sector's information and the associated frequency. He may decide to validate the sending of a frequency transfer by Datalink instruction.
A "CONTACT [atsUnit][frequency]" message is then sent to the crew and a "box" appears around the lightning symbol to symbolise the transfer in progress.

If, however, after a certain time the reply confirming that the frequency to be contacted has been taken into account on the aircraft side has not been received, a "Revert To Voice" alert will appear. The controller will then immediately revert to voice to clarify the situation with the following expressions: "DISREGARD CPDLC TRANSFER MESSAGE; CONTACT [AtsUnit][Frequency]".

The use of the frequency transfer by Datalink secures the transmission of the correct frequency to be contacted. The frequency sent can be directly loaded into the aircraft Radio Management Panel.

Eligibility for the IOC Datalink phase

Airline operators wishing to use CPDLC in French airspace do not need to make themselves known in advance.
From 10 August 2017, the IOC CPDLC are declared operational for aircraft with ARINC equipment. Since 2016, the ARINC VDL 2 network in France has been continuously updated to meet the CPDLC technical requirements.

Benefits for crews and airline operators

Safety

- Reduces overloaded frequency situations
- Recentres the air traffic controllers on their priority tasks: the guarantee of safe and efficient separation and of smooth arrival sequences

- Reduces the number of misunderstandings.

More efficient communications

- Reduces the number of messages to be repeated,
- The frequency transfer takes place at the best moment,
- Simplifies pilot/controller communications thanks to the use of preformatted messages

Capacity

- More precise and more rapid communications with the air traffic control
- **The increase in the capacity of the French airspaces is estimated between 3% (with the present air traffic management systems) and 15% (with 4-flight, the DSNA's future en-route traffic management system)**

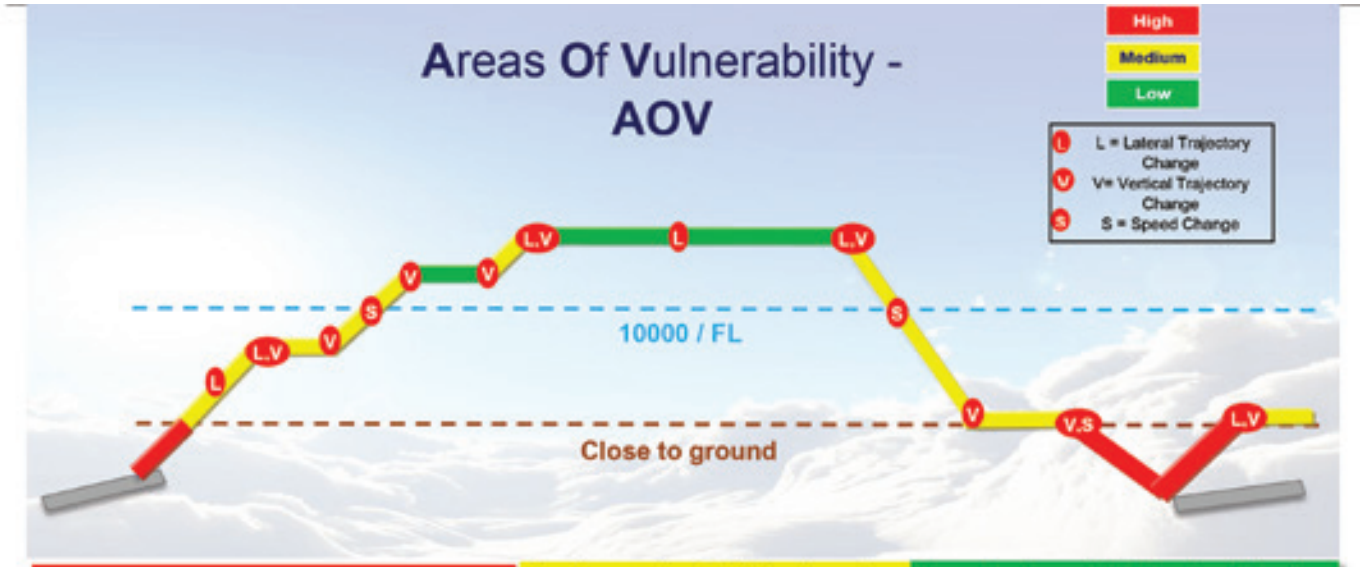
And where do human beings fit in?

In all cases, voice remains the primary communication means between pilots and controllers and takes priority over all CPDL dialogue, for example to remove a doubt or make a correction.
The front line players (pilots & controllers) are the only ones who are able to estimate when it becomes necessary to return to radiocommunications and the moments when the electronic environment is at full potential.
The ACM service (frequency transfer by datalink) must be used in the absence of time pressure, in quite normal situations and when the following sector planned by the system is the one to which the controller wishes to transfer the flight.

More information on the Skybrary Skyclips page below:

https://www.skybrary.aero/index.php/Solutions:SKYclips

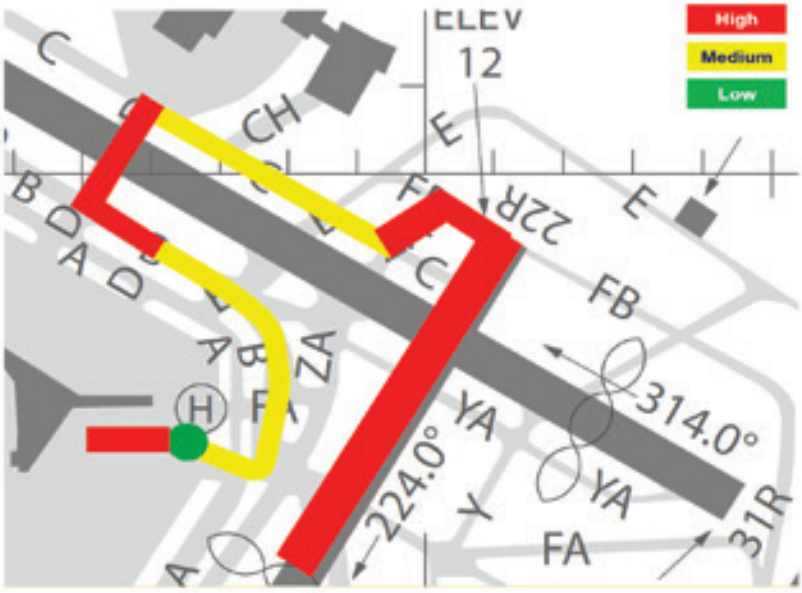
APPENDIX 3: AREA OF VULNERABILITY



Highest vulnerability to aircraft path deviations. These are segments where the path is changing or when the consequences of a path deviation are most immediate and severe. In high AOVs the time available to detect	Medium vulnerability to aircraft path deviations. These are segments where the time available to detect and correct an air/ground deviation is reduced.	Lowest vulnerability to aircraft path deviations. These are segments where the air/ground path is stable.

Three types of AOVs exist (Aeras of Vulnerability) : LOW- MEDIUM - HIGH

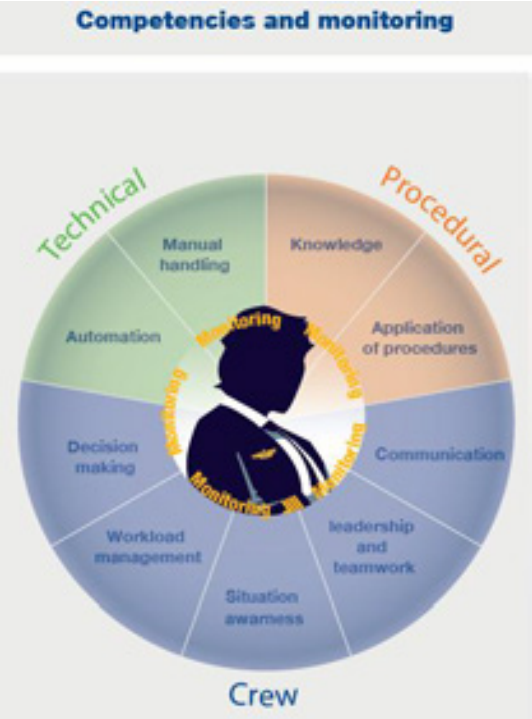
depending on the available time to detect and correct any gap (trajectory, energy management or aircraft configuration).



They give the opportunity to precise to the pilots phases fro which they will have to :

- Elaborate a strategy to prioritize and efficiently allocate the tasks within the crew.
- Manage the tasks interruptions and disruptions.
- Adapt the monitoring.

APPENDIX 4: EXAMPLES OF SKILLS MODELS



APPENDIX 5: EXAMPLES OF ATC REFLEX SHEETS IN FORCE IN A CRNA (JANUARY 2018 VERSION)

3-MALADE A BORD

ACTIONS

CR

Accusé réception de la situation.....transmis

Situation	MAYDAY x3	PANPAN x3	Malade à bord
Accusé Réception	MAYDAY roger, Squawk 7700	PANPAN roger, Squawk 5677	Roger

Type d'assistance..... demandé
Silence des autres a/c.....envisagé
Détails sur malade.....demandés
Donner la priorité à l'avion.....envisagé

CO

CDS.....prévenu
Secteurs concernés.....prévenus
CMCC (PSA).....prévenu
CCER BB.....prévenu
Zones militaires impactées.....gestionnaire prévenu
Détails sur malade.....communiqués
Météo si déroutement.....cherchée

CO/CR

Assistant.....demandé
SNER.....utilisé

Page 1 : Actions

3-MALADE A BORD

INFORMATIONS

Informations à demander :

Nature du problème / Nature of the problem	☐
Age /Age	☐
Sexe /Sex, Gender	☐
Respire / Breath Conscient / Conscious Ouvre les yeux / Open his eyes Parle / Speak Douleur (où) / Pain (where)	☐
Personne ayant établi le diagnostic/person who diagnosed	☐
Antécédents médicaux / Medical history	☐
Où se trouve le passager dans l'avion / where's the passenger in the plane (pour positionner les escaliers à l'arrivée)	☐

Remarque :

Les SAMU de Nantes, Toulouse, Lyon ont une fréquence (122,975) particulière qui n'est pas veillée en permanence et qui a une portée limitée. Si besoin, les contacter via les CDQ des approches.

Vocabulaire :

Demandez-vous une assistance à l'arrivée ?
Do you request medical assistance on arrival ?

Crise cardiaque.....A heart attack
Attaque cérébrale.....A stroke
Crise d'epilepsie.....Epileptic fit or seizure
S'évanouir.....To faint/to collapse/to pass out
Traumatisme crânien.....Head trauma

Brûlure.....A burn
Contusion.....A bruise
Blessure.....An injury
Hémorragie.....A haemorrhage
Plaie (profonde/superficielle).....A cut/a wound (deep/superficial)
Membre cassé.....Broken limb

Couveuse.....An infant incubator
Femme enceinte.....A pregnant woman
Commencer le travail.....To go into labor

Empoisonnement alimentaire.....Food poisoning

Pages 2 Informations

APPENDIX 6: EXAMPLES OF MEDICAL EMERGENCY SHEETS

Fiche Médicale d'Urgence

A RENSEIGNER AVANT LE CONTACT AVEC LE SAMU DE PARIS

Renseignements concernant le vol		*Renseignements concernant le patient*	
Date :	N° de vol :	NOM :	Prénom :
Temps de vol restant :	Heure GMT :	Nationalité :	Age :
Présent à bord: MEDECIN	PARAMEDICAL	Sexe : M F	

Motif principal d'appel : Heure de survenue de l'incident :

Conscience

Perte de conscience Si reprise, durée de la perte de connaissance |_|_|_| minutes
Réagit à la parole à la douleur ne réagit pas
Convulsions Durée :
Agitation Comportement anormal
Paralysie Localisation : Heure de survenue :

Respiration

Difficulté respiratoire Fréquence respiratoire |_|_| /min
Toux Oxymètre |_|_|_| % SpO2

Cœur et état circulatoire

Palpitations Douleur thoracique Arrêt Cardiaque Fréquence cardiaque |_|_|_| /min
Sueurs Pâleur Pression artérielle |_|_|_| / |_|_|_| mmHg

Général

Glycémie |_|_|_| mg/dl Température |_|_|,|_| °C
Douleur Localisation : Irradiation : Intensité :

Traumatisme Localisation : Nature :
Saignement Localisation : Abondance :
Brûlure :
Intoxication : Alcool Médicament Autre (préciser) :
Allergie Démangeaisons
Vomissements Diarrhée
Grossesse en cours Date du terme : Nombre de grossesses antérieures :
Perte des eaux/saignement Contractions Fréquence : |_|_| minutes Durée : |_|_| secondes

Antécédents du patient

Médicaux :
Chirurgicaux :
Traitement en cours :
A-t-il déjà présenté ce problème ? Si oui, quel a été le diagnostic :

Prise en charge réalisée

Allongé PLS Pansement Immobilisation Oxygène Débit : |_|_| l/min Massage Cardiaque Externe
Défibrillateur Nombre de chocs délivrés : |_|_| Durée estimée de la Réanimation |_|_|_| min
Traitement réalisé (nature, dose) :
Injections : Intra musculaire Intra veineuse
ECG

Evolution / Commentaires

Air France DP.MC/SAMU de Paris – Juillet 2012

Emergency Medical Form

TO BE COMPLETED BEFORE CONTACTING THE EMERGENCY MEDICAL DEPARTMENT: SAMU DE PARIS

Information about the flight		*Information about the patient*	
Date:	Flight no:	SURNAME:	First Name:
Remaining flight time:	GMT:	Nationality:	Age :
ON BOARD: DOCTOR	PARAMEDICAL	Sex: M F	

Main raison for calling: Time of onset:

Consciousness

Unconscious If recovered, duration of unconsciousness: |_|_|_| minutes
Responds to talk to pain no reaction
Convulsions Duration:
Agitation Abnormal behaviour
Paralysis Localization: Time of occurrence:

Breathing

Trouble breathing Breathing rate: |_|_| /min
Cough Oxymeter: |_|_|_| % SpO2

Heart and circulatory conditions

Palpitations Thoracic pain Heart arrest Heart Rate: |_|_|_| /min
Sweating Pallor Blood pressure: |_|_|_| / |_|_|_| mmHg

Condition

Blood Sugar: |_|_|_| mg/dl Temperature |_|_|,|_| °C
Pain Site: Radiation: Intensity:

Trauma Site: Nature:
Bleeding Site: Volume:
Burn:
Intoxication: Alcohol Drug Others (specify):
Allergy Itching
Vomiting Diarrhea
Current pregnancy Term / EDD: Number of previous pregnancies:
Loss of water/bleeding Contractions Frequency: |_|_| minutes Duration: |_|_| seconds

Past history

Medical:
Surgical:
Current treatment:
Has he ever had this type of faintness? If so, what was the diagnosis:

Performed medical management

Lying down Recovery position Dressing Immobilization Oxygen Flow:|_|_| l/min
External Cardiac Massage Defibrillator # of shocks delivered: |_|_| Duration of Resuscitation: |_|_|_| min
Treatment performed (nature, dose):
Injections: Intra muscular Intra venous
ECG

Evolution / Comments

APPENDIX 7: EMERGENCY DESCENT CHECKLIST

EMER DESCENT

CREW OXY MASKS ——— USE
SIGNS ——— ON
EMER DESCENT ——— INITIATE

○ If A/THR not active:

THR LEVERS ——— IDLE

SPD BRK ——— FULL

○ When descent established:

SPEED ——— MAX/APPROPRIATE

• If structural damage suspected:

MANEUVER WITH CARE
CONSIDER L/G EXTENSION

ENG MODE SEL ——— IGN
ATC ——— NOTIFY
EMER DESCENT (PA) ——— ANNOUNCE
ATC XPDR 7700 ——— CONSIDER
CREW OXY MASKS DILUTION ——— NORM
MAX FL: 100 / MEA-MORA

○ If CAB ALT above 14 000 ft:

OXYGEN PAX MASK MAN ON ——— PRESS

//END

Lors d'une descente d'urgence :

1. Protection équipage : mise en place des masques.

2. Gestion de la trajectoire : mise en descente vers le niveau 100 ou altitude de sécurité pour retrouver une altitude ne nécessitant plus de masque à oxygène. Dans cette vidéo l'équipage reproduit le schéma mental d'une descente d'urgence et donc descend vers le FL 100.

3. Communication : Information ATC, PNC, PAX.

Components of the TEM model

The TEM model (THREAT and ERROR MANAGEMENT) consists of three basic elements, from the flight deck crew viewpoint: the aircraft's threats, errors and undesired states. It makes the assumption that the threats and errors are part of daily life in aviation and that the flight deck crews must manage them because they can generate undesired aircraft states. The flight deck crews must also manage the undesired aircraft states because they could become dangerous. Management of undesired states is an essential component of the TEM model and is as important as threat management and error management because it is the last chance to avoid a dangerous situation and therefore to preserve the flight's safety margins.

Threats:

A threat is an event or error which is outside the control of the flight deck crew, which increases the operational complexity and which must be managed to maintain the safety margin. During a standard flight, the flight deck crew must manage various contextual complexity elements, for example unfavourable weather conditions, an airport surrounded by high mountains, an overcrowded airspace, operating anomalies and errors committed by other persons outside the cockpit (e.g. air traffic controllers, cabin crew members and maintenance technicians). The TEM model considers these elements to be threats because they can all affect the flight by reducing the safety margins.

Some threats can be anticipated; the flight deck crews know them or expect them. Therefore they can avoid the consequences of a storm by deciding in advance the measures they will take, or prepare themselves during approach, to land at an overcrowded airport, by closely monitoring the other aircraft.

Some threats happen suddenly and without warning, like an operating anomaly. In such cases the flight deck crews must apply the skills and knowledge they gained during their training or through their operational experience.
Some threats may not be obvious or directly observable for a flight deck crew immersed in an operational context. To detect them, a safety analysis may be necessary. They are latent threats (e.g. equipment design problems, optical illusions and short stopover times).
Whether the threats are foreseeable, unforeseeable or latent, the flight deck crew's efficiency in managing them is measured, among other things, by its ability to anticipate them long enough in advance to be able to deal with them by taking the appropriate countermeasures.
Threat management is a component of error management and of the management of the undesired aircraft states. Although the link which exists between a threat and an error is not necessarily simple (i.e. it is not always possible to establish a linear relationship between a threat, an error and an undesired state, or to match them one by one), records show that badly managed threats are normally linked with flight deck crew errors which in turn are often linked with the undesired aircraft states. Threat management is the most proactive solution for maintaining the in-flight safety margins because it tackles the source of the situation which is compromising safety. As threat managers, the flight deck crews are the last line of defence preventing the threats from affecting the flight.

Table 1 gives examples of threats, grouped into two basic categories from the TEM model. Whether they are foreseen or occur suddenly, the environmental threats must be managed in real time by the flight deck crews. The organisational threats can be controlled (i.e. eliminated or at least reduced) at the source by the organisations; these are generally latent threats. The flight deck crews remain the last line of defence, but the organisations can reduce the threats in advance.

Table 1. Examples of threats

Environmental threats	Organisational threats
• Weather conditions: storms, turbulence, icing, wind shear, crosswinds/tailwinds, very low/high temperatures. • ATC: air traffic congestion, TCAS RA/TA, ATC directive, ATC error, ATC language problem, non-standardised conventional ATC expressions, change of runway by the ATC, ATIS communication, measurement units (QFE/ metres). • Airport: contaminated/short runway, contaminated taxiway, signals/markings absent/imprecise/ discoloured, birds, non-operational aids, complex surface traffic procedures, airport constructions. • Airfield: high relief, slope, absence of references, "black hole". • Other: similar callsigns.	• Operational constraints: delays, late arrivals, equipment changes. • Aircraft: operating failure, event/anomaly concerning the automatic systems. • Cabin: error by a crew member, distraction due to an event in the cabin, interruption, safety of cabin doors. • Maintenance: maintenance event/error. • Ground: ground service event, de-icing, ground crew error. • Regulations: event/error concerning formalities. • Documentation: manually introduced error, error on a chart. • Other: event concerning crew assignments.

Errors:
An error is defined as an action or inaction by the flight deck crew which
results in deviations from the intentions or expectations of the organisation or flight deck crew.
Non-managed or badly managed errors are often the source of undesired aircraft states. In the operational context, the errors tend to reduce the safety margins and increase the probability of undesired events.
The errors may be spontaneous (i.e. have no direct link with precise and obvious
threats), linked with threats or be part of a chain of errors. As examples, we can mention the inability to maintain the stabilised approach parameters, selection of an inappropriate automatic mode, omission of a mandatory announcement and misinterpretation of an ATC authorisation.

Whatever the type of error, the impact on safety depends on the flight deck crew
detecting and resolving the error before it results in an undesired aircraft state and in a dangerous outcome. That is why one of the objectives of the TEM is to understand error management (i.e. detection and resolution) rather than only focusing on the causes of the errors (i.e. causality and commission of errors). From the safety viewpoint, the operational errors detected and quickly resolved (i.e. well managed) do not result in undesired aircraft states and do not reduce the flight safety margins; they are therefore without importance for operations. In addition to encouraging safety, good error management is a successful example of human performance which represents an advantage for learning and training.
Understanding how errors are managed is then as important as - if not more important than - knowing
the prevalence of the different types of errors. It is necessary to know when an error has been detected and by whom, the measures which were subsequently taken and the outcome of the error. Some errors are detected and resolved rapidly, thus becoming of no consequence for operation, whereas others remain unnoticed or are badly managed. A badly managed error is defined as an error which is linked to another error or which causes another error or an undesired aircraft state.

Table 2 gives examples of errors, grouped into three basic categories from the TEM model. In the TEM concept, the errors must be "observable". The model therefore takes the "primary interaction" as reference point for the definition of the categories.
The TEM model classifies errors based on the primary interaction of the pilot or of the flight deck crew at the moment the error is committed. Therefore, for an error to be in the aircraft flying error category, the pilot or the crew must be interacting with the aircraft (via the controls, automatic systems or on-board systems). For an error to be classified as a procedural error, the pilot or crew must be interacting with a procedure (e.g. checklists and SOP). For an error to be classified as a communication error, the pilot or the crew must be interacting with people (e.g. the ATC, the ground crew and the other members of the crew).

The aircraft flying errors, procedural errors and communication errors may be unintentional or result from intentional nonobservance. Similarly, classification into any one of the three categories can depend on elements relating to competency (i.e. skill or knowledge deficiencies and training system deficiencies).
To preserve the simplicity of the approach and to avoid confusion, the TEM model does not consider intentional nonobservance or skill or knowledge deficiencies as being separate categories but rather as subsets of the basic categories.

Table 2. Examples of errors

Aircraft flying errors	• Flying/flight controls: vertical/lateral or speed deviations; setting errors: flaps/air brakes, thrust reversers or power settings. • Automatic systems: errors: altitude, speed, heading, autothrottle, mode; incorrect data entry. • Systems/radio/instruments: air conditioning units, anti-icing, incorrect altimeter; fuel control setting errors, airspeed bug errors, radiofrequency tuning errors. • Taxiing: attempt to turn onto an incorrect taxiway/runway; taxiing speed too high; nonobservance of the short stop; missed taxiway/runway.
Procedural errors	• SOP: failure to cross check the data entered into automatic systems. • Lists of checks: incorrect call or incorrect answer; elements omitted, list performed late or at the wrong time. • Announcements: omitted/incorrect. • Briefings: briefings omitted/elements missed. • Documentation: recording of incorrect weight and balance data, of incorrect fuel data, ATIS, clearance data, incorrect interpretation of elements on printed documents; incorrect entries in the aircraft log book, incorrect application of procedures relating to the MEL.
Communication errors	• Crew consisting of external personnel: missed calls, incorrect interpretation of instructions, incorrect readback, communication of the incorrect clearance, taxiway, gate or runway. • Pilot-to-pilot: Communication error between crew members or misinterpretations.

Undesired aircraft states:

An undesired aircraft state corresponds a position or speed deviation caused by the flight deck crew, incorrect use of flight controls or incorrect configuration of the systems resulting in a reduction of the safety margins. The undesired aircraft states resulting from inefficient management of threats or errors may result in compromising situations and reduce the flight safety margins. The undesired aircraft states are often considered to be incident or accident thresholds and must be managed by the flight deck crews.

Here are examples of undesired aircraft states: lining up on the wrong runway for landing, exceeding the ATC speed restrictions during approach, long landing on short runway requiring maximum braking. Events caused by equipment malfunctions or air traffic controller errors can also reduce the safety margins, but they could be treated as threats.

The undesired aircraft states can be efficiently managed and the safety margins re-established. The flight deck crew's actions can also result in an additional error, an incident or an accident.
Table 3 gives examples of undesired aircraft states, grouped into three basic categories from the TEM model.

Table 3. Examples of undesired aircraft states

Flying the aircraft	• Flying (trim). Vertical, lateral and speed deviations • Unnecessary exposure to a weather phenomenon. • Unauthorised entering into an airspace. • Operating outside the aircraft's limits. • Unstable approach. • Continuing the landing after an unstable approach. • Long, "floating", firm or off the runway centre line.
Taxiing	• Taxiing to the wrong taxiway/runway. • Wrong taxiway, apron or gate; wrong holding point.
Incorrect aircraft errors	• Incorrect configuration of the systems. • Incorrect configuration of the flight controls. • Incorrect configuration of the automatic systems. • Incorrect configuration of the engines. • Incorrect configuration of the weight and balance.

Knowing how to change from error management to the management of undesired aircraft states is an important learning and training element for flight deck crews. Example: the flight deck crew does not load the correct approach into the flight management computer (FMC). They notice the error later during a cross check before the final approach fix (FAF).

However, instead of using a basic mode (e.g. heading) or flying the aircraft manually on the desired flight path, the two crew members try to load the correct approach before reaching the FAF. Result: the aircraft flies "around" the runway line-up flight path, starts its descent late and begins an unstabilised approach. The example illustrates a situation where the flight deck crew becomes "locked" in error management mode instead of changing to undesired aircraft state management mode. The TEM model helps to show the flight deck crews that, in undesired aircraft states, their basic task consists of managing the situation and not the error which caused it. It also illustrates how easy it is to become locked in error management mode.

From the teaching and training viewpoint, it is just as important to make a clear distinction between the undesired aircraft states and the outcomes. An undesired aircraft state is a transitional state between a normal operational state (e.g. a stabilised approach) and an outcome. However, an outcome is a final state, or more especially a state which must be reported (incident or accident). Example: a stabilised approach (normal operational state) becoming an unstabilised approach (undesired state) resulting in a runway excursion (outcome).

The impacts of this distinction on training and the corrective measures are high.
During the undesired state, by applying an approved TEM the flight deck crew has the possibility to correct the situation and return to normal operation state and thus re-establish the safety margins. In the case of an outcome of the situation, it is impossible to return to a normal operational state or to re-establish the safety margins.

Countermeasures:

In the context of the normal course of their duties the flight deck crews must use countermeasures to prevent threats, errors, and undesired aircraft states from reducing the flight safety margins. The checklists, briefing, announcements and SOP, as well as personal strategies and tactics are examples of countermeasures. The flight deck crews devote a great deal of time and effort to applying the countermeasures to maintain the safety margins during the flight. The observations made during the training and the checks would indicate that up to 70 % of a flight deck crew's activities can be linked with applying countermeasures.

All the countermeasures necessarily correspond to the crew's actions. However, some are based on the "actual" resources of the aeronautical system. Since these resources are already present in the system when the flight deck crew members arrive for work, they are considered to be systemic countermeasures. Here are some examples:

- Airborne collision avoidance system (ACAS);
- Ground proximity warning system (GPWS);
- Standard operating procedures (SOP);
- Checklists;
- Briefing (oral explanation);
- Training.

CONTENTS

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