



Identification of usable exits in the event of a survivable crash

IISU project- Requirements analysis

ANNEX 3 : Task model

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DOCUMENT REVIEW

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1.0	June 01	First version	
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ADVERTISING

This document represents the annex n°3 of the report named « Identification of usable exits in the case of survivable crashes ». It presents the whole tasks model of the evacuation process. The task model purpose is to analyse and formalise the tasks performed by the actors achieving a given objective (e.g. Perform an evacuation).

For that purpose, it is necessary to reply to the following questions:

- Why is the task performed (task goal) ?
- Who does perform the task (which actor)?
- How is it performed (action to be taken)?
- What are the triggered events of the task(triggered event)?
- What are the information used and produced or the factors affecting the task?
- What are the links between tasks (sequential, xor, or, etc)?

The tasks model built is presented in the following diagram. Some explanations about the form used are given as follows:

- Each task is represented by a rectangle.
- Each colour (or level of grey) represents a person or a group of persons. (yellow = CC ; blue = FC ; green = CC or/and FC ; red = PAX orange = PAX and/or CC ; pink = FC or CC or PAX)
- The tasks are related to each other in a hierarchical fashion. That is to say, reading the model from left to right gives the “how to fulfil the goal of upper level” and reading it from right to left gives the “why performing the goal of the lower level”
- Six types of links exist: and, or, xor, sequential, parallel, undetermined. Except from the parallel or sequential types of link, there is **no temporal link** between the tasks. The temporal aspect will be described in the action to be taken.
- The trigger events of the tasks (trigger = event that launches a task which does not exit if the trigger is not present) are represented by a diamond-shaped box.
- Information used as input or produced as output OR factors influencing a task are represented in a rectangular box with a shadow.
- Some of the tasks are associated with the comment “to be improved”. These are the tasks that are the main concern of the IISU project.

Each of the task is described according to the following items:

- Objective: goal of the task
- Person(s): type(s) of occupants who performs the task
- Action to be taken: actions to be done to reach the goal
- Triggered events launching the task:
- Information used (or produced) or factors affecting the task

- Main results from survivable events analysis: synthesis of lessons learned for this task from the accident reports, interviews and documents analysed.
- Assistance: current assistance and requirements for improvement. The requirements came from the lessons learned

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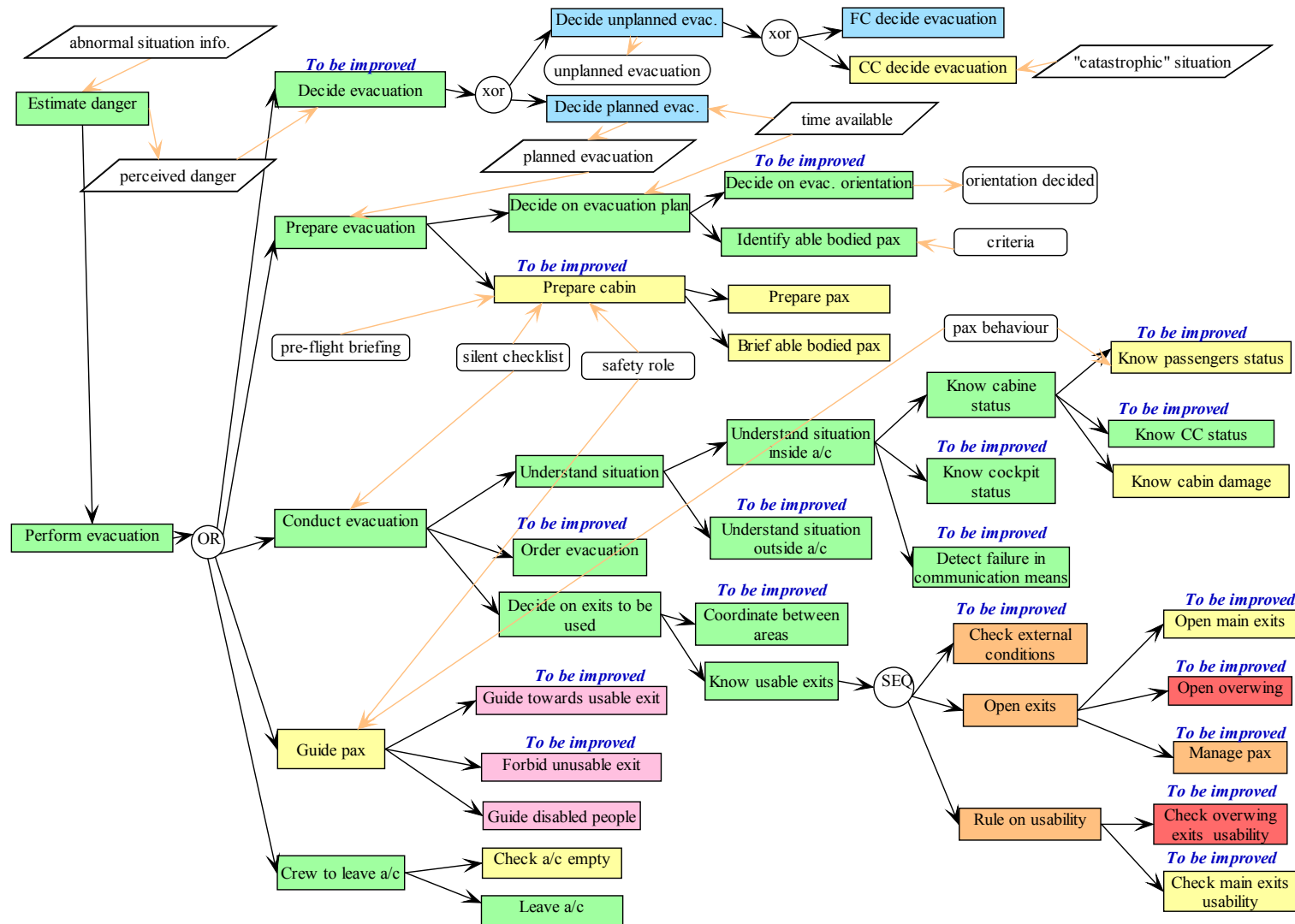


Figure n°1 : Model of the tasks performed in the evacuation process

1 TASK : ESTIMATE DANGER

- **Person(s):** CC and/or FC

- **Objective**

To evaluate the danger from the occupants safety point of view on the basis of the available information.

- **Action to be taken**

- Be informed by cockpit alerts (fire or other emergency situation).
- And/or ask information to the CC.
- And/or be informed by or ask information to the external people.

- **Information used and factors affecting the task**

Abnormal situation information: information that tells about a potential danger in the a/c.

The main situations leading to an evacuation are: fire, bomb, threat, smoke, crash, ditching, engine problem.

- **Triggered events produced**

Perceived danger: Situation that impact the safety of passengers.

The tasks launched by this event is "2.1Decide evacuation"

- **Main results from survivable events analysis**

Even if the study does not focus on this particular task, we must stress the importance of this task as an influenced factor on the evacuation process. For example, having partial information of the situation, the FC may underestimate or overestimate the danger deciding an evacuation while it is not necessary or deciding an evacuation with a delay that increases the danger during evacuation.

Extract from Nashville, B737 (8th July 1996)

*"After the aircraft had been stopped, the captain reported, he made a **public address announcement for the passengers to remain seated**. After completing the checklist, he entered the cabin and assured the passengers that fire department assistance had been requested, and ascertained that there was no fire. ... An unsuccessful attempt was made to lower the airstairs at the main entry door. The auxiliary power unit was not started because of the lack of information regarding damage to the aircraft. According to the flight crew and the cabin crew, the evacuation ... The ARFF supervisor reported to the captain that the tyres were smoking and were deflating, the right main gear became involved with fire and foam was applied to the wheels.*

*According to the flight attendants located at the forward entry door and the aft entry door, **they independently heard a fireman call "fire," which prompted each to initiate an evacuation.***

- **Assistance and improvement axis**

⇒ **Current assistance**

smoke sensors

cockpit alerts

external assistance (e.g. ATCO, other a/c flying, rescue)

2 TASK : PERFORM EVACUATION

- **Actor: CC and/or FC**

- **Objective**

To assure the safety of the a/c occupants by deciding that the situation requires an evacuation and to perform the tasks related to that evacuation.

- **Action to be taken**

See subtasks to have the details of the action to be taken.

- **Hierarchy**

⇒ **Sub Tasks**

Conduct evacuation

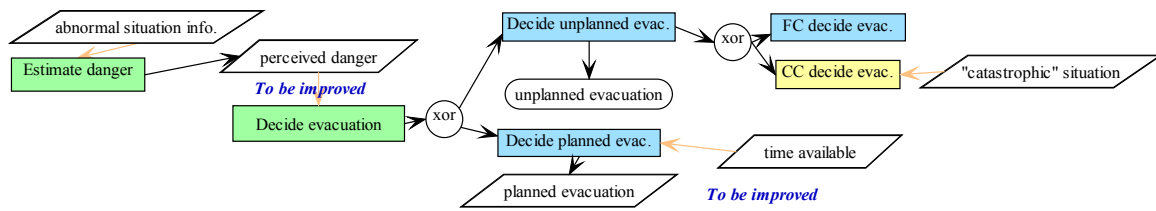
Crew to leave a/c

Prepare evacuation

Decide evacuation

Sub tasks relation: OR as each of the task can or can not be performed according to the evolution and urgency of the situation.

Figure n° 2: The following tasks describe evacuation decision making



2.1 Task : Decide evacuation

2.1.1 Task : Decide unplanned evacuation

2.1.1.1 Task : FC decide evacuation

2.1.1.2 Task : CC decide evacuation

2.1.2 Task : Decide planned evacuation

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2.1 Task : Decide evacuation

- **Person(s):** CC and/or FC

- **Objective**

To decide that occupants must leave the a/c because of an emergency situation (fire, smoke, bomb threat, ditching, overrun, etc...) that makes lives in danger.

- **Action to be taken**

Analyse the perceived danger having in mind that an evacuation is potentially dangerous (in terms of injuries)

Establish that the danger is sufficiently important providing the necessity of evacuation

Note:

According to the situation, the decision is “unplanned” or “planned evacuation”. In case of planned evacuation, the decision can change (no evacuation) because of a positive evolution of the situation. In that case, the task “2.3.2 Order evacuation” is not performed even if the cabin preparation has already been done.

- **Triggered events**

Perceived danger, produced by “1.Task: Estimate danger.”

- **Main results from survivable events analysis**

The decision can be performed while the a/c is flying or not according to the situation. (See data in chapter 3.2.1. Analysis of survivable events of the main report).

On the amount of 77 events analysed:

- 33 FC have decided the evacuation
- 11 CC have decided (and initialised) the evacuation
- 2 Passengers have decided the evacuation
- And for 31 events, it is not said

The airlines procedures explain why a lot of evacuations have been decided by the FC even if the reports often say that CC ask FC for evacuation. This decision making process is quite complex, because each situation is different (preventing for establishing clear procedures) and because the amount of situation's information is not known by each of the crew member who could decide an evacuation.

Often a CC or a FC moves around the a/c to get information about the situation. As a result, there is a lack of valuable time in the decision of evacuation.

To communicate the information, the PA or the interphone are sometimes not used or not heard because of failure or noise.

The following extract of an evacuation report shows the difficulty of communication between crew members, that has delayed the decision of evacuation.

Extract from Calgary B737 ; 1984. Phase of flight = take off aborted:

“The purser attempted to enter the flight deck but was unable to do so because the door was locked in accordance with standard company procedures. The door was unlocked in response to her knocks, and, about 45 seconds after the take-off was rejected, she entered the flight deck and informed the captain that there was fire on the back of the left wing. The first officer requested confirmation of the fire from the tower. The tower first advised the crew to

continue to proceed to a taxiway and then, after viewing the fire, to stop the aircraft in its present position. The purser re-entered the cockpit and reported that the fire was getting bad at the back.

As the fire continued to increase in size, the flight attendants attempted to contact the flight crew. The number two flight attendant, seated in the rear of the aircraft, attempted to notify the flight deck of the fire by using the aircraft interphone system. Although the signal tone was heard on the flight deck, it went unanswered because the first officer mistook the tone for that associated with the passenger flight attendant call button. The number two flight attendant continued in his attempts to contact the flight deck and also began to call the front cabin flight attendant station to inform the purser of a fire at the back.

In all, 1 minute 55 seconds elapsed before the flight attendants initiated an emergency evacuation.”

The following example is a case of communication problem between the aft area of the a/c and the forward area.

Extract from Pensacola MD88; 1996

The FC entered the cockpit and asked if the cabin should be evacuated. Because no cockpit indication of a fire, the captain told her not to initiate an evacuation. The FC used a megaphone to tell passengers to remain seated. The first officer stated that he made a similar announcement on the PA system after power was restored and that he again attempted to contact the CC with the interphone but was not successful. The CC in the aft section of the a/c had initially initiated an evacuation after attempting unsuccessfully to contact the FC by interphone.

- **Assistance and improvement axis**

⇒ **Current assistance**

no assistance except from the checklist evacuation

⇒ **Requirement**

Procedure

- Clarification of the responsibilities, procedures and interactions between crew members for the decision must be made. This clarification should be done on the basis of the identification of scenarios, with caution that all the situations are unique.
- Procedure of acknowledgement in communication activity using intercom should reduce the problem of misunderstanding in decision making process and in communication of the decision.

Communication tool

- Improve communication means from the reliability point of view

Training

Improving the co-operation between crew members to enable the FC to have a realistic knowledge of the situation in order to make the correct decision at the right time. Training involving FC and CC together should be efficient.

- **Hierarchy**

Upper Tasks Perform evacuation

⇒ **Sub Tasks**

Decide planned evacuation

Decide unplanned evacuation

Sub tasks relation: XOR

2.1.1 Task : Decide unplanned evacuation

- **Person(s):** CC and/or FC

- **Objective**

According to the urgency of the situation, the FC or CC decides that the occupants' safety requires an immediate evacuation.

The situation is as follows :

- the crash has not been "anticipated"
- the a/c is aground AND the estimation of danger necessitates an evacuation.

- **Action to be taken**

- On the basis of the situation perceived the crew decide that occupants must leave the a/c as soon as possible.
- The decision is under the influence of the training, the experience and the potential stress or panic.

- **Information used and factors affecting the task**

Situation perceived: perception of the situation on the basis of information coming from different sources. The main situations are: fire outside, fire inside, smoke in cabin, ditching, crash, bomb threat.

- **Information produced**

Unplanned evacuation decision: evacuation that must be performed right now preventing any cabin preparation. This decision launch 2.3.2 Task Order evacuation.

- **Triggered events**

No time available: the danger estimated necessitates an immediate evacuation

- **Main results from survivable events analysis**

Upon the accidents analysed, the majority was unplanned evacuation which means that the crew had no time either to decide on an evacuation orientation or to prepare the cabin.

- Number where there was not an evacuation plan: 34/77 (44%)
- Number where there was an evacuation plan: 21/77 (27,5%)
- Number for which it is not said: 22/77 (28,5%)

A study made by the NTSB, see [6] presents the following results:

The unplanned evacuations occur most often after emergencies during take Off and Landing. They are far more common.

The 46 accidents analysed provide the following statistics:

- Unplanned evacuations : 31/46 (67%)
- Following crew planning for a possible evacuation: 14/31 (45%)
- Result of an event occurred at the gate, take-off or Landing: 24/31(77,5%)
- Result of an event occurred in-flight event: 7/31 (22,5%)

The difference between the proportions found in the two studies may be explained by the lack of information in the CAA data-base (no information for 28,5%).

In a few cases, the decision is taken by the passengers themselves who estimate their life in danger.

For example : extract from Pensacola, MD88, 1996

"The captain stated that because there was no cockpit indication of a fire, he told her not to initiate an evacuation.[...] the captain directed the first officer aft to inspect the cabin. The first officer saw that the overwing exits were open, and he heard engine noise.[...] A male passenger, who was seated in an overwing emergency exit row (row 26), told Safety Board investigators that during the takeoff roll he heard a "pop" and that passengers then began unbuckling their seat belts, running, and screaming for him to open the exit. He said that he opened the overwing exit while the aircraft was still moving about 30 miles per hour even though he was not certain that this was the proper action to take. He later told investigators that he wished he had been given some guidance for when to open the exit. According to his statement, he stepped out onto the left wing and jumped off the front leading edge after seeing fire coming from the left engine. Other passengers came out of the window exit "frantically," and he said he helped people off the wing until they stopped coming.[...] About 25 passengers had exited the aircraft and that some passengers were on the wings and runway."

- **Assistance and improvement axis**

- ⇒ *Current assistance*

- no assistance except of checklist (if time available to use it)

- **Hierarchy**

Upper Tasks:

Decide evacuation

- ⇒ *Sub Tasks*

FC decide evacuation

CC decide evacuation

Sub tasks relation: XOR

2.1.1.1 Task : FC decide evacuation

- **Person(s):** FC

- **Objective**

FC decide that occupants must leave the a/c because their life are estimated in danger

- **Action to be taken**

- According to the perceived situation the FC decides an immediate evacuation

- The decision is followed by its communication using the PA and/or alarm evacuation (according to the airline)

- **Main results from survivable events analysis**

In the accidents analysed, most of the time, it seems that the decision is taken by the FC even if a CC have asked for it. It seems that this way of doing is conform to the majority of airlines procedure.

- **Assistance and improvement axis**

⇒ *Current assistance*

No specific assistance for the decision except evacuation checklist

- **Hierarchy**

Upper Tasks: Decide unplanned evacuation

2.1.1.2 Task : CC decide evacuation

- **Person(s):** CC

- **Objective**

CC to decide that occupants must leave a/c because of:

- a serious structural damage (e.g. hole etc...),
- or an uncontrolled fire or smoke in cabin,
- or a ditching,
- and/or (according to the airline) an impossibility of communicating with FC.

- **Action to be taken**

- Diagnosis that the situation is “catastrophic”
- Potentially make a collective decision
- Inform FC and other CC using the Evacuation alarm (and /or Interphone and or move around the a/c according to the airline procedure and to the communication means status)

- **Information used and factors affecting the task**

Safety role: CC must switch from the commercial role to the safety role : he/she must become assertive and firm

The attributes of this role are: training, airline culture, experience, uniform. The level of valorisation of the safety role by the airline is an important affected factor because it is directly related to the amount and quality of the CC training regarding safety features and on the image passengers and FC have about the role of CC. CC Safety training and recognition of their safety role by the a/c occupants impact directly the decision making, the cabin preparation, and the guidance of passengers.

- **Triggered events**

“catastrophic” situation: according to the airlines, the situation in which the CC is “allowed” to decide an evacuation is different.

Some examples :

- situation judged as catastrophic, that is to say : ditching, important structural damage, smoke and/or fire that can not be controlled.
- communication between CC/FC impossible.

- **Main results from survivable events analysis**

In the 77 accidents analysed ; it is explicit that 11/77 CC have decided the evacuation which represents 14%. What must be stressed is that CC have a significant role in the evacuation decision since they often ask the pilot to decide an evacuation.

The following extract presents an example where CC have decided evacuation despite the FC announce because of their own estimation of the danger.

Extract from Nashville, B737 (8th July 1996)

*“After the aircraft had been stopped, the captain reported, he made a **public address announcement for the passengers to remain seated**. After completing the checklist, he entered the cabin and assured the passengers that fire department assistance had been requested, and ascertained that there was no fire.*

According to the flight attendants located at the forward entry door and the aft entry door, they independently heard a fireman call "fire," which prompted each to initiate an

evacuation of the aircraft by closing the cabin doors, rearming the evacuation slides by re-engaging the girt bar, and re-opening the doors activating the slides. The captain, who was in his seat in the cockpit, was not notified that an evacuation was being initiated, nor did the flight attendants located at the front and rear cabin entry doors, communicate with each other regarding the conditions, or that an evacuation was being initiated. The captain stated he heard noises in the cabin and noted that an evacuation was being initiated and elected not to change the evacuation order.”

Another example where only the CC was able to perform his duty.

Extract from Denver DC9, 1987

In snow conditions while taking off the control of the aircraft was lost and as a result it crashed off the right side of the runway and came to rest inverted. The 2 pilots, 1 flight attendant and 25 passengers were killed. The male flight attendant seated on the right side of the aft jump seat realised that the aircraft was going down and tried to assume the brace position but the force on him was too great and he could not move his hands. He yelled commands "Bend Over, Heads Down" but wasn't sure he could be heard because the noise was so loud. When the aircraft came to a stop he tried to open the rear tailcone exit but due in back pain realised that he would not be able to open the door alone. He gained the assistance of a few passengers to clear away debris and open the door.

In the upper task 2.1 “Decide evacuation” examples stress the problem of communication and procedures that may delay an evacuation or at contrary may lead to conduct a non necessary evacuation.

The readiness of all the reports and other study such as [2] confirm the fact that decide an evacuation is a complex task because of the variety of the situations.

- **Assistance and improvement axis**

⇒ *Current assistance*

No assistance except procedures.

- **Hierarchy**

Upper Tasks: Decide unplanned evacuation

2.1.2 Task : Decide planned evacuation

- **Person(s):** FC

- **Objective**

To establish the potential necessity of an evacuation while the flight is in the following situation:

- flying,
- AND /OR the situation is insufficiently clear to decide on an immediate evacuation.

- **Action to be taken**

Same as unplanned evacuation But a planned evacuation is always decided by the FC

From the decision process point of view, deciding a planned evacuation is critical because FC know that evacuation is potentially dangerous and that CC and passengers might have a reaction of panic difficult to be managed by the CC.

- **Information used and factors affecting the task**

Situation perceived (see 2.1.1 “Decide unplanned evacuation”)

- **Triggered events**

Time available because the danger estimated allows to wait before evacuation (medium urgency) or the situation awareness is insufficient to decide firmly on evacuation..

What must be stressed is that it is the **perception** of the time available which affect the decision and not the real time available. Therefore, for example if the FC is not completely aware of the severity of the situation, he perceives that he has time to decide which can delay a necessary evacuation.

- **Triggered events produced**

Planned evacuation: Evacuation that is sufficiently anticipated to allow the preparation of the cabin
The task launched is 2.2”Prepare cabin”

- **Main results from survivable events analysis**

In the 77 accidents analysed:

Number where there was an evacuation plan: 21

One of the most representative example of planned evacuation is the accident in Tahiti, 1993, overrun of a B747 where the crew had time to plan the evacuation in order to make it as safe as possible.

- **Assistance and improvement axis**

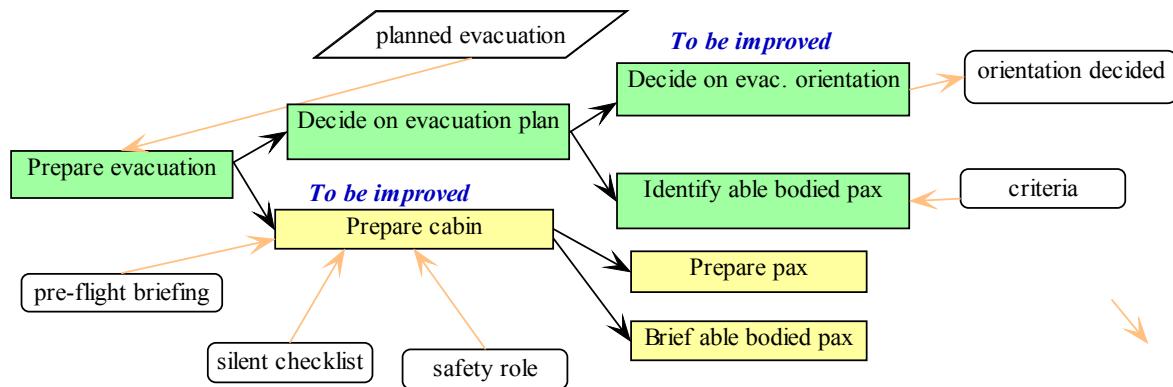
⇒ *Current assistance*

- no assistance except of check list

- **Hierarchy**

Upper Task: Decide evacuation

Figure n°3 : The following tasks concern the cabin preparation



2.2 Task : Prepare evacuation

2.2.1 Task : Decide on evacuation plan

2.2.1.1 Task : Decide evacuation orientation

2.2.1.2 Task : Identify able bodied passengers

2.2.2 Task : Prepare cabin

2.2.2.1 Task : Prepare passengers

2.2.2.2 Task : Brief able bodied passengers

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2.2 Task : Prepare evacuation

- **Person(s):** CC and/or FC

- **Objective**

To decide on the orientation of evacuation and to prepare the passengers in order to process an evacuation as fluent as possible avoiding injuries.

- **Action to be taken**

According to the time available:

- Review procedures
- Communicate between FC and CC to be aware of the potential consigns
- Prepare passengers for the landing and an orderly evacuation
- Identify if there is some restriction for evacuation (because of fire, smoke, water, obstacle)

- **Triggered events**

Planned evacuation

- **Main results from survivable events analysis**

The main factor influencing the preparation is the time available.

- **Assistance and improvement axis**

⇒ *Current assistance*

Alerts, external people or passengers can assist FC and CC to prepare evacuation

- **Hierarchy**

Upper Tasks: Perform evacuation

⇒ *Sub Tasks*

Decide on evacuation plan

Prepare cabin

Sub tasks relation: SEQ

2.2.1 Task : Decide on evacuation plan

- **Person(s):** CC and/or FC

- **Objective**

To identify way of leaving a/c and able bodied passengers in order to prepare evacuation as much as possible

- **Action to be taken**

- Use knowledge about the situation to choose evacuation orientation and use criteria to identify bodied able passengers

The process is under the influence of experience, training, personality, collective behaviour and stress

- **Main results from survivable events analysis**

See sub-tasks

- **Assistance and improvement axis**

⇒ *Current assistance*

no assistance except of the airlines procedure for cabin preparation

- **Hierarchy**

Upper Tasks: Prepare evacuation

⇒ *Sub Tasks*

Decide evacuation orientation

Identify able bodied passengers

Sub tasks relation: IND

2.2.1.1 Task : Decide evacuation orientation

- **Person(s):** CC and/or FC

- **Objective**

To decide and communicate the side of the a/c that will be used for evacuation because of the danger location (e.g. fire)

- **Action to be taken**

- Potentially:

- communicate between flight crew to interpret alarms,
- FC to ask CC for giving information that can be collected in the cabin,
- and/or to ask for external help (ATCO in tower, rescue, other a/c...).

- On the basis of these information, decide on restriction for evacuation (if any)

- **Information produced**

Orientation decided: this information is important to be communicated to all the occupants before evacuation process if time available.

- **Main results from survivable events analysis**

On the 77 events analysed, it was clear in 21 of them that there was an evacuation orientation decided.

(We do not know for 22). In 7/21, the orientation decided has not been followed. Most of these change have occurred in fire situation.

According to [6] the communication between CC and FC to prepare the evacuation is made using interphone in 37% of the cases analysed.

Having partial information, the choice of evacuation orientation is not obvious and sometime irrelevant particularly if the FC makes the diagnosis only on the basis of alarms. Therefore, CC sometimes take initiative to open doors that were not advice by the FC.

- In fire situation: the choice is related to the distance between fire and doors.

Example: 1983, B747, Johannesburg:

"...The commander decided to evacuate from the left hand side of the aircraft i.e. the side away from the fire...This just left two operable slides in use so the cabin crew member at door 1 Right, on his initiative, deployed the slide at that position since he could see that the fire was away from that door."

- In ditching situation: the choice is related to the attitude of the a/c and the water depth

- **Assistance and improvement axis**

- ⇒ *Current assistance*

- No technical assistance.

- ⇒ *Requirements*

- Assistant tool*

- Centralising information about cabin conditions or external conditions should help in having the relevant information to check if restrictions are required. Ideally, this centralisation would necessitate a global view of the external conditions and internal conditions. Such a centralisation has to be studied further.

The other axes of improvements are the same as those for the task 2.1 “Decide evacuation” since the problem of information dispatched between crew members is the same

- **Hierarchy**

Upper Tasks: Decide on evacuation plan

2.2.1.2 Task : Identify able bodied passengers

- **Person(s):** CC

- **Objective**

To anticipate which passengers could help for opening the exit, helping other passengers, etc...

- **Action to be taken**

Use criteria and personal intuition

- **Information used and factors affecting the task**

Criteria: human characteristics such as: able to understand, positioning airline crew/staff, military/ship crew or similar, males travelling alone, physical ability, calm nature.

- **Main results from survivable events analysis**

No information from the events analysis.

- **Assistance and improvement axis**

⇒ *Current assistance*
no assistance

- **Hierarchy**

Upper Tasks: Decide on evacuation plan

2.2.2 Task : Prepare cabin

- **Person(s):** CC

- **Objective**

To prepare the passengers in order to process an evacuation as fluent as possible avoiding injuries:

- To keep passengers calm
- To improve the chance that passenger will properly brace for the emergency landing
- To flight attendants, the time to inform passengers of what to expect (to avoid surprises during the evacuation: slides non available, ...)

- **Action to be taken**

- Prepare passengers for the landing and an orderly evacuation:
- Brace instructions
- Guidance on exit usage
- In case of ditching inform passenger about the water emergency procedure and equipment
- Inform the able bodied passengers about what they could be asked to do (make the passengers waiting for slide inflating, help the CC to open the door, help passengers down the slide).
- Check that everybody have understood.

The preparation is under the influence of:

- CC training and personality (e.g. resistance to the stress)
- time available for cabin preparation,
- and passengers reaction (stress, panic etc...).

- **Information used and factors affecting the task**

Silent Checklist: airlines procedure recommend CC to mentally do the checklist before take-off and before landing. It should help to react with efficiency in case of emergency. Having or not done it should have an influence on the CC behaviour in cabin preparation. (Interviews of CC who have experimented an evacuation mention the importance of the checklist).

Safety role: CC must switch from the commercial role to the safety role : he/she must becomes assertive and firm. It is particularly important in this task because it is the moment to alert the passengers if they are not aware of the situation, or to show them that CC are competent in safety actions and able to manage such a situation (avoid panic and dangerous behaviours).

Pre-flight briefing : safety information given to the passengers before take off has an influence on the cabin preparation for evacuation. The factors related to briefing efficiency are: briefing content, communication safety information given to the passengers before take off has an influence on the cabin preparation for evacuation used, CC attitude, passengers' attention capture.

Concerning the **passengers' attention capture** the study made by the NTSB [6] has proposed and analysed questionnaires filled up by 377 passengers who were involved in evacuation. The results found are presented in following:

- 13% watch none of the briefing
- 48% watch at least 75% of the briefing

Reasons:

- 54% had already seen it before: they don't watch the briefing
- 15% indicates that briefing is common knowledge (no need to watch it)
- 6% is reading
- 3% is sleeping
- 2% obstructed view

The U.S. National Transportation Safety Board (NTSB), in a 1985 report (in [7]), said, "In an aeroplane environment, passengers are passive participants who, for the most part, are unaware of 'why' the safety information they are given is important. ». Many reasons for inattention are given in the article referenced" [7].

One example of dangerous passengers behaviour is given in following:

Extract from Los Angeles (B737) the 1st February 1991:

*" [...] flight attendants were heard yelling repeated commands 'get down, stay down'. After the impact with the building, the flight attendants commanded the passengers to release their seatbelts. The two rear flight attendants and several **passengers had unbuckled their seatbelts after the first impact and were thrown forward** when the aeroplane struck the building."*

The problem of the risk of saturation is also mentioned for briefing in [7]: "Any reduction in the non critical items -to provide shorter, less cluttered and more focused pre-departure briefings - would help reduce passenger information overload. Fewer non critical items would increase the likelihood of passenger attention to the briefing and increase the likelihood of passengers remembering the information."

- **Main results from survivable events analysis**

Reports analysed and bibliography red on the subject put in evidence three main items sources of difficulty in cabin preparation: the time available, the content and the form of the briefing. Mainly from the content and form point of view cabin preparation requirements are close to the pre-flight briefing.

NTSB Safety Recommendation A-85-93 (In [6]) said, "Some passengers on board air carrier airplays have contributed to their own injuries or deaths because they were not prepared to respond appropriately to emergencies. ... The preparation of passengers for emergencies depends mainly on **flight attendant oral briefings before takeoff**, the information contained in the printed **briefing cards**, videotaped safety briefings and **other instructions**, sometimes given during the process of the **emergency itself**." U.S. Federal Aviation Administration (FAA) AdvisorCircular (AC) 121-24B, Passenger Safety Information Briefing and Briefing Cards,(see [7])said that an alert, knowledgeable person has a greater probability of surviving an emergency situation in a transport category airline than an unprepared person.

Time available to prepare the cabin:

Most of the events are unplanned providing quite any time to prepare the cabin, that is why pre-flight briefing is so much important.

If the evacuation is planned, one of the main difficulty that has been stressed by the NTSB study in [6] is the management of the time available for cabin preparation, which is specific to each situation. In general, airlines' manuals do not specify the time to conduct a briefing and provide little directions on how to provide a short briefing.

In [7]A common finding of several studies of passenger-education methods is that cabin crews may face an overwhelming workload during an emergency if large numbers of passengers do not know how to use safety equipment such as exit doors, oxygen masks, flotation cushions and life

preservers. Flight attendants cannot predict passenger behaviour; therefore, the best practice is to **build a foundation of shared knowledge** during the **pre-departure safety briefing**.

Content of the briefing:

In [7] Robert Molloy, Ph.D., transportation research analyst at NTSB, said that survey questionnaires were sent to people who were passengers on 18 a/c types of the 46 evacuation flights studied, and 457 passengers responded. The study included a survey of passengers' recollections "People who said that the safety briefing was helpful in their evacuations, cited the value of information about exit locations. Those who said that the briefing was not helpful wanted more information about exit routes, how to use a slide and how to get off a wing. This information had been available to them on safety cards, however.

Safety card:

Concerning the safety cards, the NTSB study gives the following information (in [6]):

- they consist of a supplement of the oral safety briefing
- they are different for each model and type of aeroplane
- information are consistent with the air carrier's procedures.

Some statistics on 431 passengers are given concerning the feeling of the passengers about the safety cards:

- 68% don't read it (89% say that they had read it before)
- 44% neither read it nor listen to the oral briefing
- Only 27% read the it and listen the verbal briefing
- 59% (of people who read the safety card) say that it is useful :
 - to identify exit location
 - to know how to use slides
 - to locate emergency lights

The study also says that the comprehension of the safety cards is low. A recommendation is made to develop test and standards to assure the minimum level of acceptable comprehension. (AC 121-24A).

• **Assistance and improvement axis**

⇒ ***Current assistance***

- airline procedure, safety cards

⇒ ***Requirements***

Procedure

- **1)** To improve the pre-flight briefing from the content and form point of view in order to focus on specific information according to the flight, and to improve attention capture. A publication AC121-24B (FAA) presented in [6] helps to guide air carriers in the development of their safety briefings. It includes or suggests:
 - A list of the material that must be covered
 - An awareness of the difficulty in motivating passengers to attend to the safety information (to make a briefing as attractive and interesting as possible, to increase passenger attention). This awareness comes with advise for flight attendants: be animated, speak clearly and slowly, maintain eye contact with the passengers, suggest the use of a recorded videotape.

In [8] concerning the passengers attention capture, the authors conclude that FAA should conduct research and explore creative and effective methods that use state-of-the-art

technology to convey safety information to passengers. The presented information should include a demonstration of all emergency evacuation procedures, such as :

- . How to open the emergency exits
 - . Exit the aircraft
 - . How to use the slides
- **2)** Concerning the **time available** for the briefing before evacuation, the procedures should detail the way to prepare a cabin in different time availability conditions (priority, attitude to adopt ...)
- **3)** Concerning the **bodied able passengers** specifically, the reports do not put in evidence any influence of the quality of briefing made on the passengers behaviour. Nevertheless, some descriptions of the difficulty in opening and using over-wing exits lead to the recommendation for all the airlines to perform a specific briefing for those passengers. This briefing is specifically important in the case when an aborted take-off can lead to an overrun ended in the water. For that particular case, over-wing exits have priority
- **4)** To stress the safety role of CC, for all airlines to integrate a distinctive sign in their uniform (e.g. orange cap at BA). This sign must be emphasised when the CC want passengers to be aware that they are going to practise their safety role.

Training

- Practical training should include realistic scenarios of evacuation to make the CC familiar with the various ways to prepare a cabin according to different time availability.

- **Hierarchy**

Upper Tasks: Prepare evacuation

⇒ **Sub Tasks**

Prepare passengers

Brief able bodied passengers

2.2.2.1 Task : Prepare passengers

- **Actor: CC**

- **Objective**

To make passengers having the best behaviour as possible during crash and/or evacuation.

- **Action to be taken**

Each CC is responsible of a set of passengers according to his post:

- explain and show the brace position
- ask passengers for reading the card
- check seat belt
- show the nearest exit
- help if needed
- potentially move passengers
- in case of ditching explain how to use the specific equipment
- assure that passengers have understood (acknowledgement)

- **Main results from survivable events analysis**

For the 77 accidents analysed, the reports do not describe in details the passengers preparation.

A briefing was explicitly mentioned in 17 reports. Despite the lack of information in the reports but according to the nature of the evacuation described, it seems that any briefing has been made for the other accidents.

Concerning specifically the ditching, lack of information for passengers is stressed in the reports:

For example, the issue of managing personal flotation is confusing. Life vests differ in style and function not only from aeroplane to aeroplane, but they can also vary within the same aeroplane. This means that the vest used for the pre-flight briefing is, in some cases, different from the vests that the passengers would use.

Extract from accident in Botany Bay, 1994; DC3:

*« The aircraft carried life rafts and life jackets sufficient for all passengers and crew. The crew reported that **3 types of life jackets were carried**. However, **5 different types were recovered**, all of which differed in colour, packaging or the manner in which they were secured or fitted. There were 8 life jackets of the type demonstrated by the flight attendant during her pre-takeoff briefing of the passengers. **The location and fitting of the life jacket shown on the passenger safety card also differed from that of the life jacket demonstrated during the safety briefing.***

Many life jackets were displaced during the impact sequence. 8 passengers reported that life jackets had moved forward within the luggage racks or the cabin. 12 passengers encountered difficulty in locating a life jacket, and 9 passengers experienced some difficulty in fitting the jacket. 11 reported that the instructions provided by the flight attendant were inappropriate to the jacket provided at their location. With the exception of all crewmembers and 1 passenger, all occupants donned a life jacket prior to leaving the aircraft. ”

Moreover, among airlines, cabin crewmembers offer conflicting advice to passengers on when and how to use life vests. The ‘correct’ procedure for proper inflation of life vests needs to be established.

- **Assistance and improvement axis**

- ⇒ *Current assistance*

- In some aircraft and according to the airline procedure, a pre-recorded message can be used during the preparation.

- ⇒ *Requirements*

- 1- To improve the **pre-flight briefing** from the content and form point of view in order to focus on specific information according to the flight, and to improve attention capture.

- A Publication AC121-24B (FAA) presented in [6] helps to guide air carriers in the development of their safety briefings. It includes or suggests :

- a list of the material that must be covered
 - an awareness of the difficulty in motivating passengers to attend to the safety information (to do a briefing as attractive and interesting as possible, to increase passengers attention). This awareness comes with advises for flight attendants:
 - be animated
 - speak clearly and slowly
 - maintain eye contact with the passengers
 - suggest the use of recorded videotape

- In [7] concerning the passengers attention capture, the authors conclude that FAA should conduct research and explore creative and effective methods that use state-of-the-art technology to convey safety information to passengers. The presented information should include a demonstration of all emergency evacuation procedures, such as :

- How to open the emergency exits
 - Exit the aircraft
 - How to use the slides

- 2- Concerning the time available for the **briefing before evacuation**, the procedures and training should focus on the way to prepare a cabin in different time available (priority, attitude to adopt ...)

- **Hierarchy**

- Upper Tasks: Prepare cabin

2.2.2.2 Task : Brief able bodied passengers

- **Person(s):** CC

- **Objective**

To explain and show actions that could be done by these passengers to help evacuation

- **Action to be taken**

For main exit:

explain actions that will be done by the CC

- crew harness operation
- door operation
- manual inflation
- if ditching [slide-raft separation]
- assisting passengers from the slide

For overwing exit:

- potentially move passengers
- explain passengers adjacent to the window how to open it:

1) either on the order of the CC or after having check external conditions

2) open the door

- **Main results from survivable events analysis**

For the 77 accidents analysed, the reports do not describe this briefing. What is important to be stressed is that the pre-flight briefing for passengers seating next to the overwing exits is not the same according to the airline.

- **Assistance and improvement axis**

⇒ ***Current assistance***

- procedure displayed on the exit

⇒ ***Requirements***

Results of the reports analysis do not put in evidence an influence of the quality of briefing on the passengers behaviour. But some descriptions of difficulty for opening and using overwing exits lead to the recommendation for all the airlines to perform a specific briefing for those passengers.

This briefing is specifically important to be done when an aborted take-off can lead to an overrun ended in the water. For that particular case, overwing exits have priority.

- **Hierarchy**

Upper Tasks: Prepare cabin

2.3 Task : Conduct evacuation

- **Actor:** CC and/or FC

- **Objective**

To guide the occupants toward the usable exits with the most fluidity as possible while avoiding injuries.

- **Action to be taken**

See subtasks

- **Information used and factors affecting the task**

Silent Checklist: having or not done it may have an influence on the CC behaviour in conducting the evacuation.

Cabin preparation : having time to do it in good conditions have a positive influence on evacuation process (mainly reducing injuries).

- **Main results from survivable events analysis**

See subtasks

- **Assistance and improvement axis**

⇒ *Current assistance*

- interphone, PA, emergency lights, evacuation alert

- airline procedures

⇒ *Requirements*

see each of the subtasks

- **Hierarchy**

Upper Tasks: Perform evacuation

⇒ *Sub Tasks*

Understand the situation

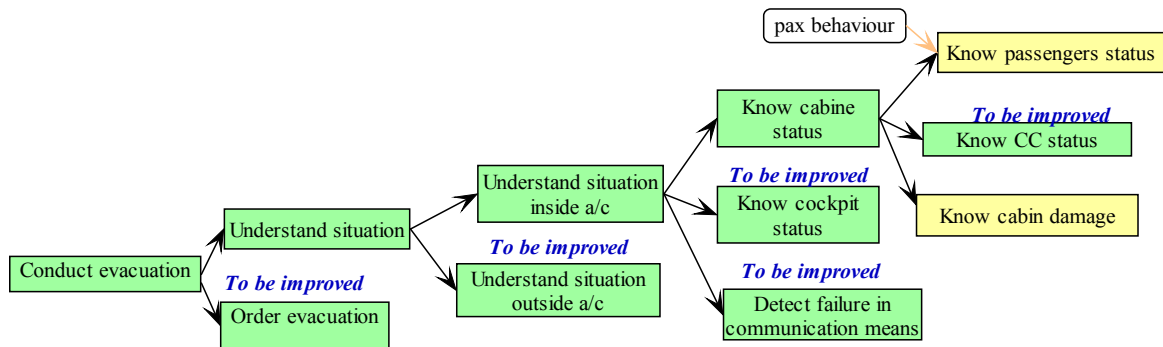
Decide on exits to be used

Guide passengers

Guide disabled people

Order evacuation

Figure n°3 : The following tasks concern the understanding of the situation and the evacuation order



2.3 Task : Conduct evacuation

2.3.1 Task : Understand the situation

2.3.1.1 Task : Understand situation inside a/c

- 2.3.1.1.1 Task : Know cabin status.....**Error! Bookmark not defined.**
 - 2.3.1.1.1.1 Task : Know passengers status**Error! Bookmark not defined.**
 - 2.3.1.1.1.2 Task : Know CC status.....**Error! Bookmark not defined.**
 - 2.3.1.1.1.3 Task : Know cabin damage.....**Error! Bookmark not defined.**
- 2.3.1.1.2 Task : Know cockpit status.....**Error! Bookmark not defined.**
- 2.3.1.1.3 Task : Detect failure in communication means**Error! Bookmark not defined.**

2.3.1.2 Task : Understand situation outside a/c

2.3.2 Task : Order evacuation

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2.3.1 Task : Understand the situation

- **Actor: CC and/or FC**
- **Objective**

To estimate the urgency and difficulty of the evacuation.

All the cabin crew may be faced with a unique evacuation scenario. Therefore, cabin crew must address the overall situation to decide the best course of actions to ensure a safe and rapid evacuation of passengers.

- **Action to be taken**

see sub-tasks

According to the characteristics of the evacuation, FC and CC have more or less time, information and communication means at their disposal to understand the situation.

- **Main results from survivable events analysis**

see subtasks

- **Assistance and improvement axis**

⇒ *Current assistance*

- no assistance except communication means such as interphone, PA

⇒ *Requirements*

- see subtasks

- **Hierarchy**

Upper Tasks: Conduct evacuation

⇒ *Sub Tasks*

Understand situation inside a/c

Understand situation outside a/c

2.3.1.1 Task : Understand situation inside a/c

- **Person(s):** CC and/or FC

- **Objective**

To be aware of the situation inside a/c that could hinder or help evacuation

- **Action to be taken**

see subtasks

- **Main results from survivable events analysis**

see sub tasks

- **Assistance and improvement axis**

⇒ *Current assistance*

Communication means such as interphone, PA, smoke alert

⇒ *Requirements*

See subtasks

- **Hierarchy**

Upper Tasks: Understand the situation

⇒ *Sub Tasks*

Know cockpit situation

Detect failure in communication means

Know cabin status

2.3.1.1.1 Task : Know cabin status

- **Person(s):** CC and/or FC

- **Objective**

Be aware of the internal environment and of the human behaviour and resources in order to adapt the evacuation process

- **Action to be taken**

- For FC: ask information to CC
- For CC: observe and communicate each other

- **Main results from survivable events analysis**

Some accidents describe problem of communication in the a/c that makes the situation awareness insufficient. In the area close to the problem (fire, structural damage) passengers reaction and behaviour are described very different from other areas. (E.g. In some accidents evacuation have begun in one part of the a/c while the other part was not aware of it ; see guide passengers task).

- **Assistance and improvement axis**

⇒ *Current assistance*

- **Hierarchy**

Upper Tasks: Understand situation inside a/c

⇒ *Sub Tasks*

Know passengers status

Know CC status

Know cabin damage

2.3.1.1.1.1 *Task : Know passengers status*

- **Person(s):** CC

- **Objective**

Be aware of the psychological status of the passengers and associated behaviour in order for CC to adapt their behaviour

- **Action to be taken**

- Observe and communicate to each others

- **Information used and factors affecting the task**

Passengers behaviour

- **Main results from survivable events analysis**

Several factors influence the passengers psychological and physiological conditions. The main important are:

- Causes of evacuation (e.g. following or not an impact influences mainly the physical injuries),

- Planned/unplanned evacuation influences the psychological reaction of fear (a planned evacuation improves the evacuation process if the passengers are well prepared but may lead to panic behaviour).

- A/c size and extension of the problem can make some passengers aware of the danger while others passengers are not informed. It can lead to very different passengers behaviours according to the area.

- Phase of flight: In a Canadian study [1] the researchers found that passengers tend to be less prepared to evacuate a/c when an emergency happens during landing phase. Possibly they are tired and more relaxed after a long flight or perhaps they have forgotten the evacuation information that was presented at the safety briefing before takeoff.

- CC authority, level of control and competence that influence passengers confidence.

More the CC are aware of those factors more they are able to react appropriately.

- **Assistance and improvement axis**

⇒ *Current assistance*

No assistance

⇒ *Requirements*

Training

Make the CC get used to understand and manage generic psychological status of passengers. This acquisition may benefit from training such as CRM and exercises.

- **Hierarchy**

Upper Tasks: Know cabin status

2.3.1.1.1.2 *Task : Know CC status*

- **Person(s):** CC and/or FC

- **Objective**

For the CC (and eventually the FC) to be aware of the availability of the CC in order to help at an exit if required

- **Action to be taken**

- In some airlines, if the evacuation alarm has been pressed : the absence of acknowledgement from a given CC informs about the potential disability of this CC.
- otherwise the other CC are informed by verbal communication or visual assessment

- **Main results from survivable events analysis**

A few accidents have described CC disability. Most of the time they are able to perform their tasks. However, each CC can be isolated because of communication means failure or a/c damage which make their task difficult.

- **Assistance and improvement axis**

⇒ *Current assistance*

- no assistance except of the evacuation alert acknowledgement for some of the airlines

⇒ *Requirements:*

Procedure

It should be useful to get information about CC status for each crew member in the case of a crash where some of the aircraft areas are isolated from others (ditching and impact situations are the most concerned by this need). At least, the generalisation of a signal acknowledgement should be studied while taking account of the potential failure of technical means (intercom and PA). This procedure is already included at British Airways.

- **Hierarchy**

Upper Tasks: Know cabin status

2.3.1.1.1.3 *Task : Know cabin damage*

- **Person(s):** CC

- **Objective**

Identify cabin deterioration or obstacle that could hinder the move of passengers

- **Action to be taken**

- To observe and to communicate between CC and passengers

- **Main results from survivable events analysis**

On the 77 accidents analysed ; the typology of cabin problems is as following :

Cabin Fire: 22

Smoke in the cabin : 20

Obstacle in the cabin (shoes, luggage, trolleys, seats, debris, dividers,...): 16

Fuselage damage: 12

The most frequent problem are the smoke and the fire.

- **Assistance and improvement axis**

⇒ **Current assistance**

- no assistance

⇒ **Requirements**

Provide more information to all the crew members should help deciding on the evacuation scenario (help the identification of reachable exits). This requirement can be linked to the “Know CC status” one. Individual communication means such as “micro-header” could be a solution but provides other constraints and potential confusion (phraseology, communication rules) that should be discussed further.

- **Hierarchy**

Upper Tasks: Know cabin status

2.3.1.1.2 Task : Know cockpit status

- **Person(s):** CC and/or FC

- **Objective**

To be aware of the availability of flight crew and escape means existence and functioning

- **Action to be taken**

- In some airlines, according to the procedures, the evacuation alarm has been pressed: the absence of acknowledgement from the FC informs of their potential disability.

- Otherwise the CC are informed by verbal communication or visual assessment

- **Main results from survivable events analysis**

PA and Interphone failed often in crash situation. In other situations such as ditching, substantial damage have completely separated the cockpit from the cabin.

Example of substantial damage having completely separated the cockpit from the cabin; extract from Boston DC 10, 1982:

*...The aircraft veered to avoid the approach light pier at the departure end of the runway and slid into the shallow water of **Boston Harbour**. The aircraft came to rest immersed in water up to the wings at high tide and in a slightly nosedown attitude. **The nose section, which included the cockpit area and first row of main cabin passenger seats, separated from the fuselage.***

A problem of communication between cockpit and cabin seems to be a problem mainly for evacuation decision and initialisation. In fact, each CC being responsible for evacuation process, it is not in that phase that they really lack of FC presence.

- **Assistance and improvement axis**

⇒ **Current assistance**

- CC using Interphone to contact FC

⇒ **Requirements**

Procedure

Same requirements as for Task 2.3.1.1.1.2: "Know CC status"

- **Hierarchy**

Upper Tasks: Understand situation inside a/c

2.3.1.1.3 Task : Detect failure in communication means

- **Person(s):** CC and/or FC
- **Objective**

Be aware of the functioning of the communication means between CC and FC that are useful means to decide on evacuation strategy (if any) and to co-ordinate evacuation.

- **Action to be taken**

- Use communication means to check if they work

- **Main results from survivable events analysis**

In the 77 accidents analysed problem of communication are often mentioned. These problems are related to failure or to bad audibility or misunderstanding:

Communication means failure:

PA non usable: 8 cases (according to [6], in 12,5% of the evacuations studied PA was not functioning)

CC/FC was not aware that her PA announcement were not audible in all the aircraft: 2

Lack of sufficient megaphones:2 cases

PA usable but not used: 1 cases

Megaphone non usable (wet): 1 cases

Evacuation signal not operating: 1 cases

Audibility and understanding problem:

Noise: 8 cases

Broken fuselage: 2 cases

Examples:

- 1 Pilot thought that the evacuation order was heard in the cabin whereas the PA was not functioning.

- 1 CC had not heard the plan

- 1 CC shouted to not used overwing exits, were not heard

- 1 CC were attempting to calm passengers when the first CC used PA to order evacuation (they did not heard)

- **Assistance and improvement axis**

⇒ **Current assistance**

No assistance : a failure is detected while trying to use the means.

⇒ **Requirements**

Communication tool

- Requirements to improve the communication means have been established by APSYS study[3]. It seems that the autonomy of communication means is a strong requirement. It should minimise the problem of failure.

Procedure

Providing information about communication means functioning should be useful (e.g.: FC who were not sure that they were heard or not by the cabin ; CC who have hesitated to launch an

evacuation because of no communication with FC). For example, an acknowledgement from the CC when the FC uses the PA could be helpful for the cockpit to know if the announcement has been heard

For example, an acknowledgement from the cabin when the FC uses the PA could be helpful for the cockpit to know if the announce has been heard.

- **Hierarchy**

Upper Tasks: Understand situation inside a/c

2.3.1.2 Task : Understand situation outside a/c

- **Person(s):** CC and/or FC

- **Objective**

To be aware of situation outside a/c that could cancel evacuation decision or that could hinder or help evacuation.

- **Action to be taken**

- Communicate via R/T in order to get external information
- Communicate with other CC and FC to get information from other areas of the a/c

- **Main results from survivable events analysis**

Having the global situation awareness is not obvious because of the different status of a/c areas and because of the communication difficulty. Reports mention often that the CC move to have information about the situation. (The PA or interphone are not used in case of failure or noise: see “detect failure in communication means”).

- According to the situation, information such as a/c attitude, fire location, water depth are necessary to choose the exits to be used. Reports stress that getting this knowledge is often time consuming.

For example, in case of overrun it has not been obvious if the whole a/c was in the water or not

Example of problem to understand the situation; extract from Boston DC 10, 1982:

The flight attendants at exit doors could not see outside through the moisture covered window. Even after she became aware that the aircraft had stopped, the senior flight attendant in the rear hesitated to order the evacuation because she knew that an engine was still running, and she was not aware of any structural damage, heavy smoke or flames, or other crewmembers' having started any evacuation.

Additionally, she had not received orders to evacuate from the captain.

The flight attendant in the forward cabin went aft to advise the senior attendant that the fuselage had broken and the passenger evacuation had begun.

Manchester's event (august 1985) is also an illustration of the difficulty of having the global situation awareness. FC have parked in such a position that allows tower's people to localise the fire.

The difficulty is much more important if the event takes place in darkness.

- **Assistance and improvement axis**

- ⇒ **Current assistance**

- No assistance except communication means PA, interphone, communication with external people.

- ⇒ **Requirements:**

- Assistant tool

- It is quite obvious when reading the reports that crew members need a better view of the external world (aircraft attitude, fire location, water depth are necessary information to choose the exits to be used). What should be improved is : better external knowledge and better communication –mainly in the case of large aircraft.

See also task 2.3.3.1.1. “Check external conditions” for which the requirements are the same concerning the need of external knowledge

- **Hierarchy**

Upper Tasks: Understand the situation

2.3.2 Task : Order evacuation

- **Person(s):** CC and/or FC
- **Objective**

To order evacuation right now to all the occupants

- **Action to be taken**

Prerequisite: aircraft stopped before evacuation.

- FC or CC to order the evacuation via PA or Megaphone or voice or evacuation alarm pressed
- check that emergency light works or switch it on

Note :

The procedure is not exactly the same according to the airlines: in some of them, CC can press evacuation alarm button (which is near some of the doors) while in other ones, CC must ask the FC to press the alarm from the cockpit.

- **Main results from survivable events analysis**

Reports shows that PA is often used for ordering evacuation (according to [6] 75% of the accidents have involved PA to initiate evacuation). The order includes orientation evacuation if it exists.

In some accidents there is a different timing in ordering and initialising evacuation according to the extend of danger related to the size of the a/c and the PA functioning status. A danger can be localised in a given area, and not perceived in other area.

This event is also mentioned in 2.3.1.1.3 Detect failure in communication means

Therefore, some accidents have required a move around the a/c to be informed that an evacuation is ordered or has already been launched.

Examples :

1 Pilot thought that the evacuation order was heard in the cabin whereas the PA was not functioning.

1 CC had not heard the orientation of evacuation (according to [6] 11% of the CC do not hear the P announce)

1 CC were attempting to calm passengers when the first CC used PA to order evacuation (they did not heard)

In a recent accident in Taipeis Chiang Kai Shek International Airport (Oct.31-2000) all electrical power was lost during the crash : PA was dead; CC did not hear the command to evacuate from the cockpit

Extract from Boston, 1982, ditching:

“The rear cabin flight attendants did not immediately realise that the aircraft had stopped because the loud noise and high vibrations of the No. 2 engine camouflaged the impact.

Even after she became aware that the aircraft had stopped, the senior flight attendant in the rear hesitated to order the evacuation because she knew that an engine was still running, and she was not aware of any structural damage, heavy smoke or flames, or other crewmembers’ having started any evacuation.

Additionally, she had not received orders to evacuate from the captain.

The flight attendant in the forward cabin went aft to advise the senior attendant that the fuselage had broken and the passenger evacuation had begun.”

Extract from Johannesburg, 1983, fire

“The commander was informed that the fire was further intensifying and so he ordered the evacuation from the left hand side of the aircraft i.e. the side away from the fire. With the commander’s agreement, the co-pilot activated the evacuation alarm signal.

At this stage of the flight the evacuation slides had not yet been selected to the automatic operation position but, in fact, the cabin crew selected the slides to ‘automatic’ prior to opening the doors. All the doors were opened on the left hand

side together with No. 2 door on the right hand side; the cabin crew member at that position had not heard the commander’s instruction to open the left hand doors only.”

Note : this situation may become more frequent in VLTA.

Another situation to be taken into account is the cancellation of a planned evacuation. Having decided a planned evacuation, the FC can change their mind because the situation does not need an evacuation any more. In that case, it has been observed that occupants that have been prepared want to evacuate : it is very difficult from a psychological point of view to cancel evacuation.

- **Assistance and improvement axis**

⇒ **Current assistance**

- Evacuation alarm
- PA as a communication means for all occupants
- Megaphone as a communication means in the cabin

⇒ **Requirements**

Procedure

- At least improve the communication means by acknowledgement (i.e. be aware of the correct functioning and of the correct understanding)
- To stress the safety role of CC, for all airlines to integrate a distinctive sign in their uniform (e.g. orange cap at BA). See also Task 2.2.2. “Prepare cabin”.
- This task being closely related to Task 2.1 “Decide evacuation”, it would be improved by the clarification of the role and the decision making process proposed for “Decide evacuation”.

Communication tool

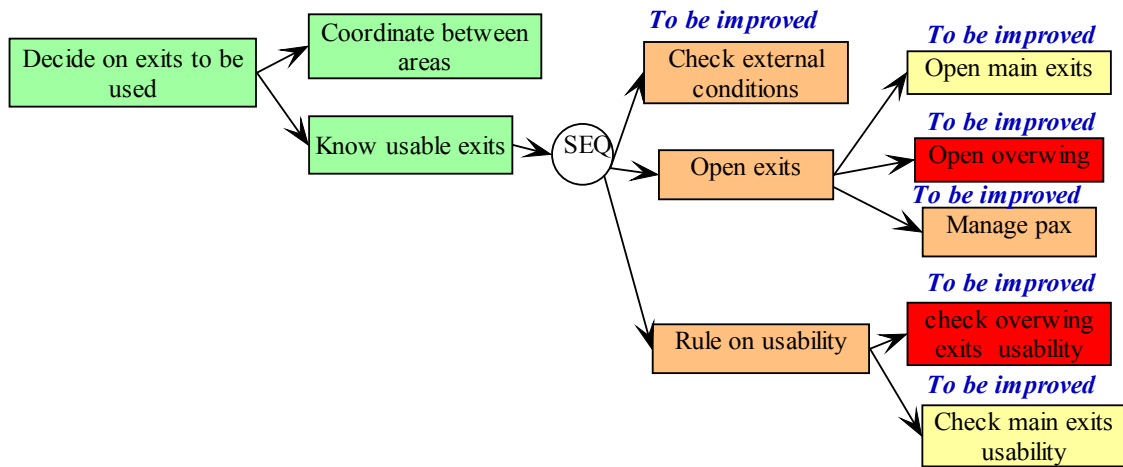
See also Task 2.3.1.1.3. “Detect failure in communication means”.

- This task being closely related to 2.1

- **Hierarchy**

Upper Tasks: Conduct evacuation

Figure n°4 : The following tasks concern the decision on exits to be used



2.3.3 Task : Decide on exits to be used

2.3.3.1 Task : Know usable exit

2.3.3.1.1 Task : Check external conditions

2.3.3.1.2 Task : Open exit

2.3.3.1.2.1 Task : Open main exits

2.3.3.1.2.2 Task : Open overwing

2.3.3.1.2.3 Task : Manage passengers

2.3.3.1.3 Task : Rule on usability

2.3.3.1.3.1 Task : Check overwing exit usability

2.3.3.1.3.2 Task : Check main exit usability

2.3.3.2 Task : Co-ordinate between a/c areas

Error! Bookmark not defined.

Error! Bookmark not defined.

Error! Bookmark not defined.

Error! Bookmark not defined.

Error! Bookmark not defined.

Error! Bookmark not defined.

Error! Bookmark not defined.

Error! Bookmark not defined.

Error! Bookmark not defined.

Error! Bookmark not defined.

Error! Bookmark not defined.

2.3.3 Task : Decide on exits to be used

- **Person(s):** CC and/or FC

- **Objective**

To status and decide on the usable exits to direct passengers. The decision is flexible as the situation moves.

- **Action to be taken**

- Each CC in charge of a door checks the usability of his/her door
- Potentially CC to communicate to each others and with the FC in order to get information about external and internal conditions

- **Main results from survivable events analysis**

Most of the time, this task is made at the same time as the task of guiding passengers.

The urgency of the evacuation does not allow CC and FC to build a detailed actions plan before conducting evacuation process.

For more information about events analysed, see subtasks

- **Assistance and improvement axis**

⇒ *Current assistance*

no assistance

⇒ *Requirements*

see subtasks

- **Hierarchy**

Upper Tasks: Conduct evacuation

⇒ *Sub Tasks*

Know usable exit

Co-ordinate between a/c areas

2.3.3.1 Task : Know usable exit

- **Person(s):** CC and/or FC
- **Objective**

to identify the exits that can be used that is to say:

- no fire close to the exit
- complete opening
- slide inflated and correctly positioned

- **Action to be taken**

See subtasks

- **Main results from survivable events analysis**

NTSB study (see [6]) provides some statistics of the types of exits used in 46 evacuations:

- Floor level exits used: 67/125
- Type III overwing exits used: 44/121
- Floor level exits were not used because of being blocked: 34/58 (58,5%)
- Type III exits were not used because of being blocked: 32/77 (41,5%)
- All exits used: 4/46 cases of evacuation

These results show that using all the exits is a rare case and doors being blocked is frequent.

For example, the recent accident in Taipei Chiang Kai Shek (oct 2000) has sustained failure in many doors and escape slides:

- *2 doors could not be opened: they were located at the portion of the aft fuselage resting on the ground*
- *2 doors could not be used because of the fire raging outside*
- *2 doors were destroyed by fire*
- *Problems: partially opened, deflated slides, slides consumed by fire, slides ballooned into the cabin*

See subtasks to have more details.

- **Assistance and improvement axis**

⇒ **Current assistance**

no assistance (except human assistance)

⇒ **Requirements**

see subtasks

- **Hierarchy**

Upper Tasks: Decide on exits to use

⇒ **Sub Tasks**

Check external conditions

Open exit

Rule on usability

Sub tasks relation: SEQ

2.3.3.1.1 Task : Check external conditions

- **Person(s):** Passengers and/or CC
- **Objective**

For each CC managing a door, and eventually for passengers next to an overwing exit to check that the external conditions allows to use the exit in a safe manner.

- **Action to be taken**

- Look outside through the window
- Take account of the information coming from other crew members.

- **Information used and factors affecting the task**

Orientation decided: when existing, this information lead the CC towards the exits that should be used. CC responsible of unusable exit must forbid it.

- **Main results from survivable events analysis**

All the external conditions can not be checked through the window.

Sometimes, a CC half-open the door to have a best vision (or to check level of water in case of ditching)

In at least 2 accidents, reports describe that CC have disarmed slide, opened the door to check external condition and closed the door: this action can lead to a lack of time that would have been non acceptable in case of evacuation urgency.

Some examples of external situations that prevented from opening doors:

Fire: 17

Engine still running on: 1

Fire is the most critical cause preventing from opening the exit.

For the overwing exits, passengers must normally wait for crew instruction to start the checking and open the door. But on their personal assessment, they may start the task (judiciously or injudiciously)

- **Assistance and improvement axis**

⇒ **Current assistance**

no assistance.

⇒ **Requirements:**

Assistant tool

- According to the characteristics of the diagnosis (several potential causes of non usability, decisions and decisions based on partial and sudden information are always put into question), the best tool for this task remains human. The ideal case would be to provide information such as :
 - the water depth and the distance between the cabin floor and water in the case of ditching,
 - the exact positioning of a fire,
 - the structural deformation or the external obstacles that prevent opening of the doors.

But integrating sensors to detect, in real time, this information seems unrealistic for the following reasons:

- . because it requires a combination of several sensors,
- . because these sensors should be very reliable

and because CC workload is high: he/she has no time to spare to interpret information

- **Hierarchy**

Upper Tasks: Know usable exit

2.3.3.1.2 Task : Open exit

- **Person(s):** passengers and/or CC

- **Objective**

To open the exits that have been detected usable from the external conditions point of view.

- **Action to be taken**

- For the main exits, CC open them
- For the overwing exits, passengers open them

For CC, silent checklist and training are influenced factors. For passengers, briefing and safety cards are influenced factors.

For all, psychological status influence the behaviour

- **Main results from survivable events analysis**

One main difference between overwing and floor exit is the person in charge of opening the door (passengers or CC). It has an obvious consequence on the necessary information to be given to those people. CC are trained but not passengers, that is why during the flight, passengers must be carefully informed.

see sub-task for detailed comments

- **Assistance and improvement axis**

- ⇒ *Current assistance*

Assistance is made of safety card, procedure written on the doors, silent check list to remember the procedure

- ⇒ *Requirements*

See subtasks

- **Hierarchy**

Upper Tasks: Know usable exit

- ⇒ *Sub Tasks*

Open main exits

Open overwing

Manage passengers

2.3.3.1.2.1 Task : Open main exits

- **Person(s):** CC

- **Objective**

To open an exit after having check that external conditions are correct

- **Action to be taken**

- Check that the door is in automatic mode
- Open the door (use procedure according to the a/c type)
- Potentially ask for help to the bodied able passengers

- **Main results from survivable events analysis**

1- Opening an exit is sometimes made while the **checking of external conditions is not complete** because of the small size of the window.

2- The reports mention difficulty or impossibility of opening the doors:

Impact (deformation, half buried,...):10 doors

Utilisation (impossible to be opened,...):10 doors

Slide impaired opening:10 slides

Obstruction outside:4 cases

Obstruction inside:2 cases

One example shows the potential danger when opening the doors:

Extract from Habsheim (A320-100) the 26th June 1988:

“ The purser, with the help of at least one passenger and an air hostess from another airline (who was in the cockpit as a passenger during the flight), pushed the door. The door opened suddenly and the purser and the passenger fell out of the aircraft and were covered by the escape slide.”

3- Some “**human errors**” have also been reported:

2 accidental door disarming

1 passengers who open a door not enough to make the slide inflating

1 CC inadvertently pulled the release handle when she attempted to use the manual inflation handle (both handles are quite similar)

4- Reports have also shown that passengers can have an **assistant role** to open the door:

Help CC to open the door, make the passenger waiting for slide inflating, help to inflate the slide.

On the contrary, passengers can have a **reaction hindering** the evacuation process due to panic:

Example: CC being jostled by passengers while opening doors (because all occupants have been informed of evacuation at the same time.

- **Assistance and improvement axis**

⇒ **Current assistance**

Except from procedures displayed on the doors, no assistance

⇒ **Requirements**

Training

- For CC, information and training should be improved to avoid human errors especially if CC flies on different types of aircraft. (The best improvement would be to homogenise doors in all aircraft, but it seems unrealistic to recommend a retroactive correction).

Procedure

Passengers may be able to assist if they were better informed on the opening procedure (briefing) but we must pay attention that under panic they might decide to open a door while FC or CC have not asked them to do so.

- **Hierarchy**

Upper Tasks: Open exit

2.3.3.1.2.2 Task : Open overwing

- **Person(s)**: passengers

- **Objective**

To open an overwing exit if required

- **Action to be taken**

- Passengers must remind procedure or read it
- Passengers must open the door and stow it
- Potentially to ask for help from other passengers or CC

- **Main results from survivable events analysis**

In the reports read it is explicitly said that 12 overwing exits were opened.

Some problems have been mentioned :

- Problem to open overwing exit (one passenger trapped on her seat by the door): 1 case
- Passengers unable to open a overwing due to fear: 1 case
- Some accidents have reported that overwing doors have been opened while CC and FC forbid Passengers to do it.
- In other reports, passengers have opened them and use them while the evacuation order has not been given.

A study made by the Canadian (see [1]) in 1989 found that only 29 % of the passengers read the safety information cards that give instructions on how to open emergency exits. The authors have analysed 21 reports of events that most of them took place in Canada. In 3 cases passengers have problem for operating and using overwing exits. The NTSB report concluded that passengers occupying exit row seats have frequently demonstrated a lack of knowledge and determination to open exit doors under emergency situations.

Another study made by the NTSB (see [6]) on 46 events that took place between 1997 and 1999 give interesting information:

They found that the overwing exits are used in the 28% of the analysed evacuations.

The difficulties stressed are related to their opening and to their stowing. The factors related to the problems are :

- Problem due to person who operates the door: women, young and old people.
- Problem of misunderstanding of the instructions (different language)
- Problem of lack of listening to the crew instruction (i.e open the door while it is forbidden).
- Door's weight (2 people are often necessary to move it).
- Difficulty related to the design of the overwing exit: passengers must put the shoulder into the hatch and push. The hatch is to be turned and either placed on the exit row seats or thrown out the opening which is not obvious for the passengers.
- Exit hatch can fall inward, trapping a passenger next to the exit.

- **Assistance and improvement axis**

⇒ **Current assistance**

- information displayed on the door
- assistance from other passengers or CC

⇒ **Requirements**

Design overwing exits that are easier to open (e.g lighter, do not necessitate to throw it out the a/c) should improve significantly the task of opening, reducing the time required and then accelerating the evacuation process.

Procedure

Concerning passengers, it seems important to make sure that passengers occupying over-wing seats respect the criteria (being physically able and understanding how the exit is operated) and to generalise the specific briefing. (see also requirements of Task 2.2.2. "Prepare cabin").

• **Hierarchy**

Upper Tasks: Open exit

2.3.3.1.2.3 Task : Manage passengers

- **Person(s):** Passengers and/or CC

- **Objective**

To avoid panic and dangerous behaviour during the identification of usable exits

- **Action to be taken**

- Ask people for waiting
- If two CC for one exit, one CC manage the passengers while the other check exit.

- **Main results from survivable events analysis**

Reports stress the assistant role of the passengers while CC are opening the doors.

- Passengers said “sit down, stay calm”: 1 case
- Help CC to open the door, make the passengers waiting for slide inflating, help to inflate the slide : 2 cases

On the contrary, it has been found that panicked passengers can hinder the exit opening. (e.g. CC being jostled by passengers while opening doors)

Extract from Malaga (DC10) the 13th September 1982:

“The evacuation took place slowly because the passengers picked up their carried luggage before evacuating. In the third cabin, besides the problems brought about by hand-carried luggage, a bottleneck resulted due to the number of passengers, most of them on the left aisle, that were trying to reach door L3”

- **Assistance and improvement axis**

⇒ **Current assistance**

No assistance

⇒ **Requirements**

Training

- Make the CC used to understanding and managing the generic psychological status of passengers. Managing a crowd of people that is either tired or not aware of the danger or are panicked due to attitude of the aeroplane. Aptitude to react in such situations could be benefited from training such as CRM and simulation.

This requirement is covered by Task 2.3.1.1.1.1 “Know passengers status”.

- **Hierarchy**

Upper Tasks: Open exit

2.3.3.1.3 Task : Rule on usability

- **Person(s):** Passengers and/or CC

- **Objective**

To conclude about the usability or non usability of the exits opened before helping the occupants to leave the a/c.

- **Action to be taken**

- Check that external conditions are not dangerous
- Check that slides are correctly inflating and positioned.

- **Main results from survivable events analysis**

See subtasks

- **Assistance and improvement axis**

⇒ *Current assistance*

No assistance except from some of the safety cards

- **Hierarchy**

Upper Tasks: Know usable exit

⇒ *Sub Tasks*

Check overwing exit usability

Check main exit usability

2.3.3.1.3.1 *Task : Check overwing exit usability*

- **Person(s):** Passengers

- **Objective**

Passengers to check that external conditions are not dangerous (water, obstacles etc...).

Note :

It is not clear if passengers have in their duty to check outside conditions after opening the door.

- **Action to be taken**

- Look at the external environment

- **Main results from survivable events analysis**

In an urgency situation and because of lack of knowledge, passengers have the tendency to leave the a/c through the overwing without having checked the external conditions or having thought about what they are going to do once they are on the wing.

Another problem is that passengers are not sufficiently informed about their duties of checking the usability of the exits.

- **Assistance and improvement axis**

⇒ *Current assistance*

No assistance

⇒ *Requirements*

Procedure

Clarify the role of passengers in this task. Include related information in briefing.

- **Hierarchy**

Upper Tasks: Rule on usability

2.3.3.1.3.2 *Task : Check main exit usability*

- **Person(s):** CC

- **Objective**

CC to check that slides are inflating correctly and/or that external conditions are not dangerous (water, obstacles etc...)

- **Action to be taken**

- Look at the complete inflating of the slide and correct positioning
- Potentially ask to a CC or to a passenger to use the slide in order to check external conditions and help passengers if those conditions are bad

- **Main results from survivable events analysis**

Reports mention a lot of problems that are related to the slides:

The main problems arisen are: (figures means numbers of slides)

Fire (burst or deflate): 5

Inflation problems: 9

Water hindered: 4

Misalign : 5

Deflate, split: 3

Too short: 2

Slide deployed inside: 2

Incline too steep: 1¹

Incline too low: 1

Utilisation (bar,..):4

A/c position: 5

Problem of transformation in raft: 1

?: 5

Another particularity is the **evolution of the exits usability** that provides the necessity to check exit usability several times:

Cases where doors were partially used:

Slide problems: 14

Fire: 7

Attitude A/c: 1

Outside debris: 1

There are several causes of non usability of a given exit related to the external conditions, doors or slides themselves.

In case of fire, the evolution is an important factor. In at least two cases (Nairobi 1974 and Manchester 1985) the opening of door has increased the danger.

¹ Noting that the optimal angle for slides is about 36 degrees, the Canadian researchers in [1] found that, at angles of 48 degrees or higher, "the evacuees have a tendency to hesitate before entering the slide because of its steep appearance," and evacuations tend to progress more slowly.

Extract from Nairobi (B747-130) the 20th November 1974:

“Once the aircraft was stationary the fire spread rapidly and the inner left wing exploded. Wing panels were thrown clear of the main wreckage but the fire spread towards the centre fuselage and worked its way forward. The flight crew had opened the top cabin escape hatch creating a chimney effect with the result that the cockpit was destroyed by fire drawn forward from the fuselage.”

Moreover, the usability is a status that can change during evacuation process. To diagnosis that a given exit is usable is a real time decision making process, based on partial information and always put in question.

- **Assistance and improvement axis**

- ⇒ *Current assistance*

No assistance

- ⇒ *Requirements*

Assistant tool

Provide a better external view at each exit (for fire, distance to the ground or to the water, obstacle). As for “Check external conditions” (Task 2.3.3.1.1.), this task requires a real-time diagnosis, always put into question according to the evolution of the situation. It leads to envisaging a solution such as extending vision capabilities and improving communication.

- **Hierarchy**

Upper Tasks: Rule on usability

2.3.3.2 Task : Co-ordinate between a/c areas

- **Person(s):** CC and/or FC

- **Objective**

Communicate with Passengers and CC in order to make the evacuation as fluent as possible using optimally the exits

- **Action to be taken**

- CC responsible of an exit asks for information about outside and inside conditions using interphone or voice

- CC responsible of an exit informs other CC and FC about conditions using interphone or voice

- - CC not responsible of an exit to move around the a/c to transmit and get information.

- **Main results from survivable events analysis**

Several accidents have shown that a given exit can be usable only part of time mainly for two reasons:

- difficulty in operating the exit that lead to delay in using it

- evolution of the danger.

The main problem in co-ordination is communication. In accident reports we can see that a CC responsible of an exit sometimes moves around the a/c to co-ordinate with other CC (asking a passenger to stay at the door) which provides a potential danger when leaving the exit and a lost of time.

Extract from Athens (DC8) the 7th January 1979:

“The crew was giving the appropriate instructions for quick evacuation and passengers were leaving the aircraft normally at the front. However the loss of the PA system meant that no information regarding the use of the exits could be transmitted. As a result confusion was created to the passengers in the central area of the aircraft who could not use the overwing exits due to the external fire.”

The problem of co-ordination may increase for the VLTA

- **Assistance and improvement axis**

- ⇒ **Current assistance**

No assistance

- ⇒ **Requirements**

There is a necessity to improve communication between CC and FC. What is needed is to enable to transmit the following:

- that a given exit is not operable

- that a given CC is disabled

- that there is a jam somewhere

- that a given exit is usable but not used

Two roles of a CC must be taken into account separately: CC in charge of an exit and CC not in charge of an exit. The first ones must stay close to the door while the second ones move around the aircraft to retrieve or transmit information and to guide passengers.

Requirements for CC in charge of an exit:

- Be aware of the usable exits in case of non usability of their own exit,
- Inform others about their exit status
- They have a lot to do in case of evacuation: we should avoid distraction and a significant addition of tasks to be carried out.

Assistant tool

- Therefore, it seems that the solution is to introduce a tool that informs a CC at each door about the usability of the other exits (an indicator such as a warning light and/or a sound indicator) and that asks him/her to press a button to inform others of the usability of his/her own exit.

Requirements for CC not in charge of an exit:

- Be aware of the psychological status of passengers and their consequent behaviour
- Be informed of obstacles inside the cabin
- Be informed about congested/free exit

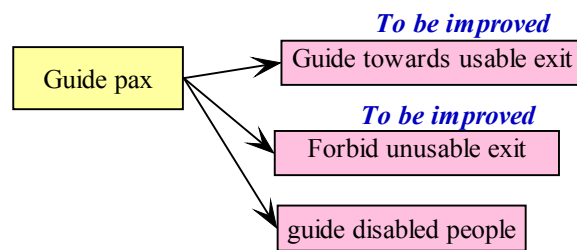
Communication tool

According to the size of the aircraft, the solution should be different. Look, hear, talk and move seems to be sufficient in the case of a small aircraft except if damage prevents them from moving. Avoidance of movement in a big aircraft should be spared so as to use the time available more efficiently. A communication tool such as a headset should be studied.

- **Hierarchy**

Upper Tasks: Decide on exits to use

Figure n°5 : The following tasks concern the guidance of passengers



2.3.4 Task : Guide passengers

2.3.4.1 Task : Guide towards usable exit

2.3.4.2 Task : Forbid unusable exit

2.3.4.3 Task : Guide disabled people

Error! Bookmark not defined.

Error! Bookmark not defined.

Error! Bookmark not defined.

Error! Bookmark not defined.

2.3.4 Task : Guide passengers

- **Person(s):** CC

- **Objective**

To direct passengers towards an usable exit making the evacuation as fluid as possible.

- **Action to be taken**

- Each CC (if able to) directs passengers toward the door (mainly by voice)
- Potentially forbid an unusable exit
- Potentially help down the slide or make a passenger helping down the slide.

- **Information used and factors affecting the task**

Safety role: training, airline culture, experience, uniform are impacted the ability of a CC to switch from his commercial role to his safety role and the recognition of his safety role by the passengers. The ability of ensuring the safety role is a very important factor in the guidance of the passengers.

Passengers behaviour: according to the urgency of the situation, to the extent of awareness of the danger and to the flight phase, behaviours will be different requiring different attitude by the CC.

- **Main results from survivable events analysis**

See subtasks

- **Assistance and improvement axis**

⇒ *Current assistance*

- emergency light or “photo-luminescent lines”
- megaphone

⇒ *Requirements*

see subtasks

- **Hierarchy**

Upper Tasks: Conduct evacuation

⇒ *Sub Tasks*

Forbid unusable exit

Guide towards usable exit

2.3.4.1 Task : Guide towards usable exit

- **Person(s):** CC or FC or Passengers

- **Objective**

To guide passengers as quickly as possible towards the usable exits applying the following consigns:

- Shout evacuation commands to passengers
- Maintain passenger flow at their exit
- Manage any aggressive behaviour to exit through your door
- Take carry-on baggage from passengers
- Protect themselves from being thrown out the aircraft
- Relay information about the status of their doors to others FA

- **Action to be taken**

Each CC is in charge of his or her door:

- if two lines on the slide CC ask to form two lines
- ask to jump
- optional:
 - push people
 - ask to leave without luggage
 - ask one or two passengers to go first and help other occupants down the slide.
 - stop the evacuation at one given exit becoming unusable and redirect passengers towards an other door (that redirection requires the task “Co-ordinate between areas”).

- **Main results from survivable events analysis**

Actor of guidance:

In the reports analysed, the actors that took a role of guidance are as follows:

- CC: 26
- CC + Passengers : 10
- CC+FC: 6
- FC: 2
- FC + Passengers: 1
- FC + CC + Passengers : 2 (those passengers were off duty crew members)
- ?: 30

In most of the events CC are involved in the guidance process.

The following example presents a situation where communication problems and passengers reaction made the evacuation process difficult. An improvement in the communication and outside situation visibility should help occupants to manage such a situation.

Extract from Dallas (DC10) the 14th April 1993:

“ At one point during the evacuation from 3-R, passengers bunched up on the right wing because of the steepness of the slide from the wing to the ground. A flight attendant saw a

hold-up at the top of the slide and came out on the wing. Noting the steepness of the slide, the high number of older passengers attempting to evacuate, and the passenger pileup at the bottom of the slide, the flight attendant told the passengers on the wing that they would have to return to the cabin and use another exit. At the same time, some passengers said that a flight attendant inside the cabin, behind the group of people trying to exit onto the right wing, told them that they would have to move quickly from the aircraft because of a fire out the left side cabin windows."

Role and behaviour of the passengers:

Passengers may have an **active assistant role** in evacuation process. Some examples are given in following:

- In one case, some passengers had memorised the number of rows between their seat and the exit
- One Passenger said "sit down, stay calm"
- 11 reports mention that passengers help each other (to reach exit, to leave a/c, to release seat belt).

But on the contrary, behaviour such as panic or fatigue can **impair evacuation process**:

- 1 talk about bottleneck next to an open exit
- 1 altercation between passengers at an open exit
- 2 cases where passengers did not remained at the bottom of the slide to help other passengers
- 1 case in which some confusion appear when passengers have to change their route because of exit that became unusable (after having been used).

Reports mention some **resistance behaviour**:

- 1 mention difficulty to make the passengers react quickly enough (they were not aware of fire)
- 1 passengers who unwill to jump into slides.

Some reported facts show that there is sometimes a lack of respects of the crew's consign, especially concerning the personal items:

- Passengers who take personal items: 6 cases
- Unbuckle the seatbelt before a/c stops: 2 cases
- Passengers went over seat back to avoid congested aisles: 2 cases
- Passengers evacuated without any order: 2 cases
- Passengers evacuating through another exit than those recommended by the CC : 2 cases
- Passengers evacuated through the fuselage: 1 case

The Canadian study see [1] adds some information that confirm what we have found:

They have analysed that in 11 instances during the 21 evacuations studied, some passengers behaved inappropriately and complicated the evacuation. That obstructive behaviour ranged from overt panic (screaming, hysteria or over aggressive actions) to the negative panic of frozen inaction. For example, in the Calgary evacuation, passengers in the first seven rows ignored urging of the cabin attendant at the open door and tried to leave the plane via the opposite door. Passengers later said that they had headed for the left door because they had entered the a/c via that door.

The study made by the NTSB (see [6]) gives information about the problem of passengers picking up their luggage. In training CC are taught to maintain a constant flow of passengers out an emergency exit, but not passengers who insist on retrieving their carry-on luggage before evacuating which make slower the evacuation.

On the 46 events analysed, they found that 50% of the passengers attempt to remove a bag during the evacuation.

The reasons are:

Money, wallet, credit cards : 53%

Job items: 31%

Keys: 29%

Medicines: 24%

Signals and communication means:

The reports analysed mention problems of lights and communication means:

- Emergency light not operating in 3 cases (according to [6], in 5% of the events analysed, Emergency lights were not functioning).
- Emergency light ok but insufficient: CC used a flash light in 1 case
- Lack of sufficient megaphones in 2 cases

In the recent accident in Taipeis Chiang Kai Shek International Airport (Oct.31-2000),_except from L4 emergency exit light all emergency lights and floor path lights did not illuminate.

In case of smoke, some reports tell that emergency light are insufficient to guide toward the exit.

Sometimes the CC do not used the megaphone even if they recognise that it is an efficient means because they are afraid to make passengers panicked.

“Human error” in using the communication means:

Some errors have been reported, perhaps due to lack of training or to fear.

- 1 emergency lighting has been turned off
- 1 problem with the volume button of a megaphone

Main “obstacle” hindering evacuation = smoke

In the 77 events studied, the obstacles hindering evacuation are represented as follows:

Cabin Fire: 22

Smoke in the cabin : 20

Obstacle in the cabin (shoes, luggage, trolleys, seats, debris, dividers,...): 16

Fuselage damage: 12

Passengers: 2

Obscurity: 5

Passengers picking up their carried luggage: 3

Obstacles outside: 2

Passengers piled up at the bottom of the slide:2

Water: 5

Heat:1

Reports show that smoke and fire are the most frequent “obstacles” impairing the evacuation process.

Note: It should be interesting to investigate if passengers’ panic is often related to fire/smoke in the cabin

The study made by Canadian see [1] have analysed 21 accidents between 1978 and 1991. They have concluded that fire and smoke are the more important problem in evacuation:

Example: After a cabin fire forced the landing of a Canadian DC-9 in Cincinnati, Ohio, U.S., in 1983, for example, the location of two passengers' bodies indicated that, in their attempt to get out of the aircraft, they had unknowingly passed an available exit.

In the United States, an analysis by the FAA's Civil Aeromedical Institute found that smoke inhalation and/or burns were the primary causes of death in about 95 percent of the fatalities during evacuations."

Canadian officials have rejected proposals to provide "smokehoods" for passengers, mainly because one study indicated: " In nine of the evacuations studied, fire and smoke blocked egress from some of the normally available exits. And in three evacuations, smoke and toxic fumes inhaled by passengers limited their mental and physical stamina, obstructing or prohibiting their attempts to reach, operate and negotiate emergency exits or egress through breaks in the fuselage."

- **Assistance and improvement axis**

- ⇒ *Current assistance*

Emergency light or "Photo luminescent" lines

- ⇒ **Requirements:**

- Assistant tool

- Assistance is mainly required in case of smoke, providing a guidance that is rapidly perceptible by humans : visual means seems to be insufficient. Combining both visual and audio signals has to be studied further.
- Another assistance should be studied in case of passenger re-routing (when a given exit becomes unusable or when a jam occurs while another exit is free). Providing real time information to the CC (and the passengers) about the exits that are usable, (see also Task 2.3.3.2 "Co-ordinate between aircraft areas".)

- Training

Train CC to react as efficiently as possible faced with a crowd of panicked people.
(Task 2.3.1.1.1.1.: "Know passengers status" and Task 2.3.3.1.2.2: "Manage passengers")

- **Hierarchy**

Upper Tasks: Guide passengers

2.3.4.2 Task : Forbid unusable exit

- **Actor:** CC or FC or Passengers

- **Objective**

To prevent passengers from using the unusable exit and to redirect passengers toward usable exit

- **Action to be taken**

- CC stay at the exit to avoid that passengers try to use it or he asks a passenger to replace him
- CC redirect passengers towards the opposite door if available

- **Main results from survivable events analysis**

Forbid an exit and redirect passengers is quite always source of panic. Often people do not understand what is happening and particularly if the exit has been used part of time and becomes unusable. This situation is observed mainly in case of fire.

- **Assistance and improvement axis**

Current assistance

no assistance

⇒ **Requirements:**

Assistant tool

A physical means to forbid a given exit route should enable the relevant CC to go and help elsewhere. This idea should be studied further as it seems that the airlines' procedures strongly recommend that CC stay close to the door of his/her responsibility..

- **Hierarchy**

Upper Tasks: Guide passengers

2.3.4.3 Task : Guide disabled people

- **Actor:** CC or FC or Passengers

- **Objective**

To manage disabled people evacuation according to the airline procedure

- **Action to be taken**

- Make assistant aware of their role of guidance
- Make disabled people leaving by the nearest exit
- and after other passengers.

- **Main results from survivable events analysis**

No information in the events analysed

- **Assistance and improvement axis**

⇒ *Current assistance*

No assistance

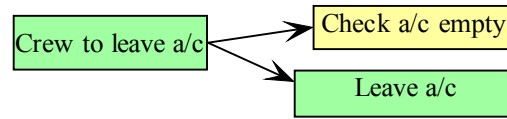
⇒ *Requirements*

Our study has not focused on this particular task.

- **Hierarchy**

Upper Tasks: Conduct evacuation

Figure n°6 : The following tasks concern the crew leaving the aircraft



- 2.4 Task : Crew to leave a/c**
- 2.4.1 Task : Check a/c empty**
- 2.4.2 Task : Leave a/c**

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2.4 Task : Crew to leave a/c

- **Actor:** CC and/or FC
 - **Objective**
To assure that the a/c is empty and leave it.
- **Action to be taken**
 - CC check a/c before leaving it by his exit if usable.
 - Note : according to the airlines, the procedures and consigns are different:
Some of them ask FC to leave a/c first (to help evacuation outside)
Some others ask captain to leave a/c at the end of occupants evacuation
- **Main results from survivable events analysis**
No information that could lead to improvement proposition
- **Assistance and improvement axis**
No assistance
- **Hierarchy**
Upper Tasks: Perform evacuation
⇒ **Sub Tasks**
Check a/c empty
Leave a/c

2.4.1 Task : Check a/c empty

- **Actor:** CC
- **Objective**
Each CC to check that his area of responsibility has been evacuated
- **Action to be taken**
 - Each CC must talk and go around his in charge area using a flashlight.
- **Main results from survivable events analysis**
This task is mentioned in some reports analysed but without any potential improvement axis
- **Assistance and improvement axis**
No assistance
- **Hierarchy**
Upper Tasks: Crew to leave a/c

2.4.2 Task : Leave a/c

- **Actor:** CC and/or FC
- **Objective**
To use the exit to leave a/c

- **Action to be taken**

same as other passengers

- **Main results from survivable events analysis**

No information in the reports that lead to improvement axis

- **Assistance and improvement axis**

⇒ *Current assistance*

No assistance

- **Hierarchy**

Upper Tasks: Crew to leave a/c

REFERENCES

1. Canadian report of airliner evacuations cites six safety recommendations (cabin safety crew) 1995, vol 30 No4
2. Etude règlementaire sur les évacuations d'urgence; (société Dedale pour le compte du SFACT) 1999.
3. Etude sur les Moyens d'Information Equipage (société APSYS pour le compte du SFACT) en cours ; 2001
4. "Les personnels navigant cabine sur vols long-courrier : une approche du métier et de ses caractéristiques" (mémoire de Stéphane Deharvengt; Diplôme Universitaire -bases facteurs humains pour la conception de systèmes Hommes Machine en aéronautique)
5. Exit locating devices, aircraft structural strengthening and improved crew drills called "most practicable" accident-survivability factors (cabin safety crew) 1995, vol 30 No4
6. Safety Study: Emergency Evacuation of Commercial Airplanes ; NTSB ; NTSB/SS-00/01.
7. Investigation to Focus on Human Factors and Emergency Evacuation (Air Safety Week) 2001 Vol 15 N°10.
8. Cabin Crew must capture passengers' attention in predeparture safety briefings (Cabin Crew Safety) 2000, Vol 35 N° 4.
9. CAA accidents database; version 2001
10. Analysis of Training for Emergency Water Landings Questions Assumptions, Inconsistencies (Cabin crew safety) 1998, Vol 33 N°6.
11. BEA ; Accident survenu le 13SEP1993 a Tahiti
12. JAR-ops réglementation for cabin crew related to evacuation
13. Analysis of structural factors influencing the survivability of occupants in aeroplane accidents Cherry & associates; CAA paper 06011; European union DGVII RGW)
14. Compiled by S. Deharvengt, F-DGAC for the JSSI Occupant Safety and Survivability Ad-Hoc : Research studies on prioritisation in post crash passenger survivability group ; version 1 march 2000
15. Continuing Study of Non accident. Evacuations may help Reduce Passenger Injuries (Cabin crew safety) 1998; Vol 33 N°2
16. Sudden Impact – A Flight Attendant's Story of Courage and Survival (Cabin crew safety) 1995; Vol 30 N°2 & 3
17. Les PNC à l'intérieur de l'équipage comme collectif de travail. CETCOPRA, Octobre 2000