EMERGENCY SITUATIONS FOR PILOTS

1. Introduction

Emergency situations in aviation are subdivided into two categories:

- Emergency manoeuvres
- Emergency procedures

On the IVAO network, tools generating random failures are possible either through the simulator or during the use of external software. Users must not overdo the failure occurrence rate (failures are forbidden during exams).

This document has been written based on real procedures used on turbojet aircraft.

You should keep in mind after reading this document:

- the procedures to be done following an emergency situation
- the ATC communications to perform
- a simple methodology with a short list of actions

2. Basics during an emergency situation

When an emergency situation occurs, it is very important to do the right actions:

The first imperative is to fly the aircraft according to the obstacles, at a speed adapted to the aircraft configuration.

- To do this, it is highly recommended to engage all available and fully functional automatic flight controls in order to stay calm and to be available.
- Do not forget that in case of an emergency situation, the situation is critical and adverse weather conditions are deteriorating factors.

At the end of the emergency procedure, always perform a technical and operational assessment, considering the consequences of the loss of another redundant system, and make the necessary decisions for the rest of the flight (resume or divert).

3. Distress and urgency messages

Some situations require notifying the Air Traffic Services and nearby traffic in priority because of the high risk of collision. The crew will then use specific messages that are imperative to know. The messages are mainly distress and urgency messages.

3.1. Distress message

The distress message is a request for immediate assistance.
It has priority over any other radio communications. It imposes radio silence for all other users of the frequency. In an international context, it is preferably emitted in English in order to be understood by the greatest number of people.

It includes the following elements:

- MAYDAY MAYDAY MAYDAY (three times)
- Callsign (flight number or registration)
- Short description of the situation
- Position, course and speed
- Captain's intentions

Some of these elements may be omitted if it is obvious that ATC knows them, like for example the position if the airplane just took off or is under radar service.

In addition, the crew must set its transponder to squawk code 7700.

To cope with the situation, the crew needs to be completely free when flying the aircraft, and may have to perform an emergency landing in the following minutes. ATC will therefore clear the nearby airspace and will stand ready to answer any request from the crew.

For any remaining radio communications, the word "MAYDAY" will be added at the end of the call sign to easily recognise it: flight AF1234 then becomes flight AF1234 MAYDAY.

Note: MAYDAY derives from the French word "m'aider" which means "help me".

3.2. Urgency message

The urgency message is not a request for immediate assistance.
In the order of priority of the messages, this message is the second one.

It is made of the following elements:

- PAN PAN PAN PAN PAN PAN (pronounced: [/pæn/])
- Callsign (flight number or registration)
- Short description of the situation
- Position, course and speed
- Captain's intentions

The crew is free to set, or not, the transponder to squawk code 7700, or may be asked to do so by ATC.

Although the on-board situation is serious, the crew has it under control. ATC will issue clearances allowing the flight to perform the necessary emergency procedures (fuel jettisoning, diverting to a better equipped airfield, etc…)

For any remaining radio communications, the word "PAN PAN" will be added at the end of the call sign to easily recognise it: flight AF1234 then becomes flight AF1234 PAN PAN.

It is possible to change the level of seriousness at any time: after transmitting a MAYDAY, it is possible to switch for a PAN PAN if the situation improves. It is also true for switching from a PAN PAN to a MAYDAY if the situation worsens

There are other messages related to specific emergency situations. They will be dealt with later.

3.3. Captain's responsibility

When in danger, the captain is able to make any decision in order to solve this situation, including breaking the effective laws, procedures and clearances.

On the IVAO network, it is forbidden to simulate failures in order to get a higher priority over other traffic.

4. Emergency manoeuvres

They are immediate actions that should be performed from memory without delay because the safety of the flight is directly concerned.

In this category, we list:

- Aborted take-off
- Stall
- GPWS alert
- Windshear alert
- TCAS alert

4.1. Aborted take-off

This manoeuvre must be performed without delay if a significant failure appears during the take-off roll. It is distinguished as a low-speed range up to 100KT where a large amount of failures are taken into account, and a high-speed range beyond 100KT and up to V1, in which only the engine failures and fires are taken into account.

The following sequence of actions should be executed from memory:

- Thrust reduction
- Apply maximum breaking action
- Maximum spoilers or speed brake deflection
- Reversers on remaining engines if applicable.

Timeliness is a decisive factor to limit the risk of runway excursion if the manoeuvre is initiated at high speed. In addition, brake overheating may lead to a blaze which risks requiring the emergency evacuation of all people aboard the aircraft.

The broadcast of a MAYDAY is fully justified in order to get the intervention of the airport firefighting services as quickly as possible.

4.2. Stall

Even if this situation remains extremely remote, one should be able to recover from it…
It is identified by an alarm, the type of which depends on the flown aircraft (stick shaker, sound alarm, red warning light, etc…) but nonetheless remains imperative to identify.

The following sequence of actions should be executed from memory:

- Disconnection of autopilot and auto throttle
- Simultaneously, substantial reduction of pitch and maximum thrust application if required
- Level the wings
- Spoilers or speed brake retraction
- Do not alter the landing gear and flaps configuration

When the situation is under control, a MAYDAY message can be useful following the captain's analysis.

4.3. GPWS Alert

The Ground Proximity Warning Systems (GPWS) is a device which aims to trigger an alarm when the aircraft is getting too fast close to the ground. It works with both the barometric altimeter and the radio altimeter indications when the aircraft is below 2500 feet above the ground.
Additional modes can trigger the alarm if the landing gear or the flaps configuration is not suitable, if the aircraft has a negative vertical speed after take-off, or if the glideslope deviation is too large on final.

In the most modern versions called EGPWS standing for Enhanced GPWS, a database allows to draw the terrain on the navigation display, along with a ground proximity warning and an alarm to avoid to land outside of existing runways.

In IMC conditions or during night time, if the warning light and the alarm sounds “PULL UP”, the following manoeuvre must be initiated immediately:

- Disconnection of autopilot and auto throttle
- Simultaneously, pitch-up attitude of at least 20° and maximum thrust
- Level the wings
- Spoilers or speed brake retraction
- Do not alter the landing gear and flaps configuration

During daytime and fair visibility conditions of the obstacles, the pilot can correct the flightpath.

The crew has to take the initiative to broadcast a distress or an urgency message, if required, depending on the situation.

4.4. Windshear alert

Modern aircraft are equipped with systems allowing detecting windshear. When the alarm “WINDSHEAR” is triggered, the system provides guidance through the flight director and/or the autopilot. The pitch-up attitude to be flown initially is around 15°, except in case of ground proximity, leading to the application of the GPWS procedure.
We also find the following items:

- Level the wings
- Spoilers or speed brake retraction
- Do not alter the landing gear and flaps configuration

A Pilot Report (PIREP) should be sent to ATC to report the occurrence of this dangerous weather phenomenon and notify surrounding aircraft.

Some Airborne Weather Radar (AWR) are also equipped with predictive windshear detection, allowing the avoidance of the risky area.

4.5. TCAS alert

The Traffic Collision Avoidance System (TCAS) relies on airplane transponders to prevent mid-air collisions.

In the case of a Traffic Advisory (TA) alert, the crew stands ready for a possible manoeuvre.

If a Resolution Advisory (RA) alert is triggered, the crew applies the following emergency manoeuvre:

- Disconnection of autopilot and auto throttle
- Adopt a suitable pitch in accordance with the area represented in red or green on the PFD or on the VSI, following the display type of the aircraft.
- Report to ATC with specific message “TCAS RA”. This message means that the crew follows the orders commanded by the TCAS, which can be contradictory to the clearances or requests from the controller.
- At the end of the alarm, get back to the initial clearance. Notify ATC and file an AIRPROX to trigger an investigation which will consist in determining the cause of this alert.

The timeliness and the strict respect of the TCAS orders are required conditions to avoid the mid-air collision.

Always comply with the TCAS orders regardless of what the ATC says.

5. Emergency procedures and checklists.

Emergency procedures are all the actions that should be performed by the crew in order to cope with various situations, predicted by the aircraft manufacturer, endangering flight safety.
There are a very few fortunately.

They are listed in the Quick Reference Handbook (QRH), and/or through the ECAM/EICAS. The emergency procedures require a quick reaction and begin with a few items to review from memory.

Most of these failures are dealt with through emergency checklists, which should be performed calmly by reading the sequence of items, one after another, and executing the appropriate actions with attention.

In all circumstances, the first imperative is to fly the aircraft before starting any procedure or checklist! It would be regrettable to crash into an obstacle while being focused on shutting down an engine!

Each aircraft having its own characteristics, and therefore its own emergency procedures or checklists, we will study in this document some common examples that can be found on almost every airplane.

At the end of these emergency procedures or checklists, if there is still a danger or if the faulty component cannot be physically checked, it is recommended to land as soon as possible.

Depending on the aircraft manufacturer, the display states:

- “Land As Soon As Possible” or “Land ASAP”
- “Land on the nearest suitable airport”

But, depending on the situation, the diversion can last from a few minutes, for an engine fire after takeoff, up to several hours, if the incident happens right in the middle of an ocean crossing.

Let’s not forget that, except under special authorisation, air transport is only approved with twin-engine aircraft at least. The loss of an engine then implies a landing ASAP.

5.1. Emergency procedures

FIRE is the worst enemy of the airplane, both inside or outside. A QUICK REACTION is essential. Dealing with fire is therefore naturally an emergency procedure.

5.1.1. Engine fire, large damage or split

This procedure deals with the worst failures that may happen to an engine.

The first priority will always be to manage the flightpath, taking into account the asymmetrical thrust, and at take-off, the gear retraction.

A procedure must not be started below 400ft AGL.

Items to be performed from memory are as follows, only after identifying carefully at 100% the faulty engine through the different alarms and indicators:

- Thrust lever on idle
- Fuel cut-off set OFF/CLOSE
- Fire switch set ON

The last switch will cause all engine-related circuits, likely to be a source of fire, to be isolated: fuel, hydraulics, pneumatics and electrics.

This action should be sufficient to solve the issue in general and to contain the fire.

However, if the fire alarm is still active, trigger the first extinguisher. 30 seconds later, if the fire is still burning, trigger the second extinguisher.

Broadcasting a MAYDAY message is necessary in this case.

Adjust the altitude depending on the performances of the aircraft for N-1 engine operations.
As soon as possible, broadcast a MAYDAY message indicating the new flightpath if it differs from the clearance. If the fire is under control, the flight can be resumed with downgrading the severity with a PAN PAN message.

Once the emergency phase is terminated (fire under control and flaps retracted), a few additional items in the checklist will remain to be treated in order to set the circuits in accordance with the situation.

A technical assessment of the whole aircraft must be performed before communicating the intentions for the rest of the flight to ATC. If a diversion is decided, a suitable and accessible alternate airfield must be selected (infrastructures and weather conditions), which may be the departure airfield.

To land as soon as possible is compulsory for a twin-engine aircraft.

N-1 engine landing requires a specific preparation appropriate to every aircraft.

5.1.2. Smoke in the cabin

Whatever is the source of the smoke, it is urgent to protect the crew with an oxygen mask and to establish communications in these particular conditions.

The search for the source of the smoke, which can be from the pneumatics, electrics, etc… will be done through an appropriate emergency checklist and can last for some time.

Cargo holds can be equipped with extinguishers. However, it will not be possible to check visually that the fire has been extinguished.
For a fire in the passenger cabin, the quick reaction of the flight attendants is essential.

To land as soon as possible will be required in most cases

At the first alarm, the crew must stand ready for a possible diversion in the case the situation would worsen (search for an emergency alternate airfield, routing to this one and broadcast of a MAYDAY message…)

CAUTION: with smoke in the cabin, passengers' oxygen masks should not be dropped as they are using a mix of cabin air (including smoke) and pure oxygen, and should be used only in case of decompression.

These procedures cannot be performed on the IVAO network and are given for your information.

5.1.3. Multiple engine flameout

This rare situation can happen in the case of flights through volcanic ashes, in case of fuel leak or contaminated fuel, and even more rarely when flying through very dense cloud layers with heavy precipitation or severe icing.

As usual, the first priority is to maintain an adequate flightpath, in particular if all engines went out.

In this case, a glide with an adequate speed (around 250kts) must be established to maintain at least one windmilling engine and/or to get a proper functioning of the RAT (Ram Air Turbine) in order to have a minimum hydraulic, and possibly electric, power.

The procedures or checklists will vary significantly depending on the aircraft type and in particular with the number of engines.

However, one common point is to always attempt to restart the faulty engines if the time and conditions allow it, as many times as necessary.

Broadcasting a MAYDAY message is compulsory in this case.

5.1.4. Sudden decrease in cabin pressure

At the standard cruising altitudes, occupants' survival is seriously threatened in case of severe failure of the pressurisation system of the aircraft.

Two urgent requirements: protect all occupants with oxygen masks and descend rapidly to an altitude allowing normal breathing..

So, the procedure will include the following items:

- Don the oxygen mask and establish communications between both pilots
- Drop passengers' oxygen masks (even if it is automatic)
- Initiate an emergency descent to FL100 (or MSA if MSA > FL100). The method can vary depending on the aircraft type, but we always find the same items:
    - Throttle lever on idle
    - Initiate the descent, at VMO/MMO except if structural damages are suspected, preferably using the autopilot
    - Extend spoilers
    - Leave the airway or the track flying a different course, or an offset. In some regions, the method to leave a route is regulated (MNPS, Russia, etc…)
    - Broadcast a MAYDAY message as soon as possible.

In addition to the risk of hypoxia, the rate of descent being relatively high, the risk of mid-air collisions is high in busy airspaces.
Furthermore, the initiation of the descent must be performed with precision to avoid being too fast, or on the contrary, descending too slowly.

Once the airplane is stabilised at FL100 or at MSA, perform a complete technical and sanitary assessment, and decide on the rest of the flight (possible diversion). It will be necessary to take into account the increased consumption of fuel at FL100 compared to flying at cruise flight level (nearly twice).

5.1.5. Incoherent speed indications

Flight displays are supplied with various air data sources. It can happen that different instruments (anemometer, PFD ASI) show different indications.

It is not always easy to tell if one of the indications remains reliable and usable. Also, it is not trivial to determine the systems that may be contaminated by false information.

When in doubt, a procedure allows flying the airplane with preselected pitch and thrust, while waiting a free moment to perform a precise technical assessment:

- Autopilot OFF
- Autothrottle OFF
- Flight Director OFF
- Set pitch and thrust accordingly to the phase of the flight.

A MAYDAY message must be broadcast as soon as possible

5.1.6. Insufficient Fuel Quantity

When the fuel quantity reaches a minimal value in one of the main fuel tanks, an alarm is triggered leading to the realization of an emergency checklist.

If this minimal quantity is reached in all the main fuel tanks, it is urgent to land as soon as possible. A MAYDAY FUEL message will then be broadcast.

IVAO applicability: it is forbidden to pretend or to choose to be low on fuel. During events or exams, it is mandatory to take the necessary fuel to perform several holding patterns. In case of a low fuel situation, you may be diverted to another airport.

Per regulations, this moment is in general defined as the state at which the total on-board fuel quantity is less than the final reserve, corresponding to 30 minutes of flight at holding speed, at 1500ft over the airfield.

CAUTION: The flight has the priority for landing, but the captain will have to justify his emergency declaration as he is facing severe sanctions in case of wrong statement.

The pilot must always make sure to have enough fuel for the entire flight duration, and must add the route reserve, final reserve and alternate fuel. If delay at arrival is forecast, the pilot must add the fuel quantity corresponding to the expected holding time.

One should keep in mind that the regulatory reserves are a minimum and that it can be rapidly insufficient in an adverse environment (weather, busy airspace, failure, etc…). It is therefore interesting to have an idea of the total fuel flow of an aircraft in various configurations.

For example, for the Boeing 747, one holding pattern consumes 1 ton of fuel. When extending the landing gear, this total fuel flow is multiplied by two.

If the pilot thinks the fuel will be a problem, and before starting to consume the final reserve fuel, he can say to the controller “minimum fuel”.

5.1.7. Medical emergency

The physical inability of one of the pilots is an emergency situation which implies to broadcast a MAYDAY message and to land as soon as possible.

The remaining pilot must perform alone, and without crosscheck all tasks usually intended to be done by the technical crew, and can be helped by ATC.

When it is a passenger or a flight attendant, the decision is up to the captain after taking into account a medical assessment by a physician coincidentally amongst passengers or by emergency medical service contacted by SATCOM or radio.

These medical emergency procedures are given for your information. There is no practical use of these procedures on the IVAO network except in the case of a specific and supervised event.

5.2. Emergency checklists

Emergency checklists are established by the aircraft manufacturer, and possibly modified by the operator. They allow the crew to face adequately series of failures endangering the safety of the flight.

They do not require urgent reactions. So, they will be performed by reading items one after another, and by doing the prescribed actions (DO LIST).

The various circuits can differ subsequently from one aircraft type to another. It is then difficult to make a precise study of these emergency checklists. Only a few general items will be treated.

5.2.1. Engine failure

Apart from fire, large damage or split engine procedures and multiple engine flameout procedures already treated earlier, various failures can affect the engines.

- One engine failure: the checklist is the same as the one for an engine fire (minus fire switch and extinguisher activation) for both an engine flameout and a commanded shutdown
- A surge or exceeding engine parameters can lead to shut down the engine
- The oil circuit can be a source of problem: a pump failure, a high temperature or a leak can be the reason to shut down an engine
- Reversers can be unserviceable.

A PAN PAN message is required

For a twin-engine aircraft, it is mandatory to land as soon as possible after the loss of one engine.

5.2.2. Air conditioning and pressurisation failure

Failures may affect the engine bleed air, the pneumatics, the packs or the pressurisation system.

In some cases, the technical assessment can lead to the use of emergency backup circuits.

The PAN PAN message will be at the initiative of the crew

5.2.3. Loss of hydraulics

The loss of a hydraulic circuit will have consequences on the flight controls, on the flaps and slats configuration, on the landing gear configuration and on the brake application.

Corresponding emergency checklists will allow using emergency backup systems thanks to another circuit or another source of energy. The severity of the failure will depend on the number of affected hydraulic circuits.

The PAN PAN message will be justified as specific conditions will be required for landing.

5.2.4. Loss of electrics

Because of modern electrically-powered aircraft, they are certainly the most complicated failures to deal with, especially when you have to assess their consequences.

In this case too, emergency checklists will allow limiting their effects on the aircraft.

The MAYDAY or the PAN PAN message is adequate in this case following the conclusion of the crew regarding the number of affected circuits and their importance which could result in a distress situation.

5.2.5. Fuel shortage

Leakage, unserviceable pump, cross feed failure, tank imbalance, low fuel temperature, etc… There are many reasons that can lead to use a fuel-related emergency checklist, which can be very singular to one particular aircraft.

Some equipped aircraft are also able to jettison partially while in-flight.

The PAN PAN message is at the initiative of the crew.

5.2.6. Unserviceable flight controls

Apart from their power source failure, the flight controls can be also affected by blockage or deterioration of their panels.

Some of these situations can lead to perform an approach with a low-flaps setting. The reference landing speed must be increased, and so must be increased the landing distance.

A jammed pitch trim can also lead to a difficult high-speed approach.

In most cases, the PAN PAN message will be necessary.

5.2.7. Unserviceable landing gear and loss of brakes

As well as for the flight controls, the landing gear may suffer from jamming or deteriorations compromising its normal and emergency functioning.

CAUTION! Flying with an extended landing gear substantially increases the total fuel flow. Before starting any long checklists, it is necessary to check if enough fuel is aboard!!!

If the gear cannot be retracted, pay attention to the maximum landing gear extended speed (VLE). To attempt another retraction/extension, the maximum landing gear operating speed (VLO) can be even lower!

If the landing gear is not extending, either partially or completely, the corresponding emergency checklists will attempt to solve the problem. The result will lead to elect a strategy for landing and ATC.

Regarding the brakes, depending on runway length and condition, and on the severity of the loss, a diversion may be decided.

The PAN PAN message will be required in most cases.

5.2.8. Unserviceable instruments

With instruments, being very different from one aircraft to another, it is complicated to state general points on dealing with possible failures and loopholes. At least, we can tell the consequences which are almost the same as for the electric failures since it is difficult to draw a complete assessment.

It will be also necessary to check if the requirements to fly in some regulated airspaces are still met (MNPS, RVSM, etc…), and if the ability to perform some precision approaches is still maintained. In general, the documentation includes a recapitulative table.
These regulatory restrictions could possibly result in a diversion.

The PAN PAN message remains at the initiative of the crew.

5.2.9. Radio failure

Aircraft have several radio sets: a failure of all of them is improbable but still possible, in particular if it comes from the mixing set of all radio signals. Other systems (HF, SatCom and ACARS) can possibly allow to inform ATC and to weaken the severity of the situation.

The radio failure can be single or double:

- Loss of reception
- Loss of emission
- Loss of both reception and emission

In case of loss of reception:

- Set squawk to 7600 (COMM FAIL)
- Switching over to GUARD 121.500MHz
- Blind transmission on the frequency to inform ATC of further intentions
- Resume flight according to IFR operations under communication failure

In case of loss of emission:

- Set squawk to 7600 (COMM FAIL)
- Remain on current frequency
- ATC shall request a squawk IDENT after noticing squawk 7600
- The pilot will follow ATC's instructions and will use "IDENT" to confirm these instructions only upon ATC request.

In case of loss of both reception and emission:

- Set squawk to 7600 (COMM FAIL)
- Resume flight according to IFR operations under communication failure
- The pilot may expect to be escorted by a military aircraft to an alternate airfield

5.2.10. Passenger evacuation

Several situations considered in the emergency procedures and checklists, and others totally unexpected, can lead to a complicated landing with runway excursion, engines or brakes on fire, collapsing of the landing gear, etc…

Before anything else, it is necessary to broadcast a MAYDAY message in order to get the airport emergency services as fast as possible and inform ATC that the runway will be closed for quite some time!

Items may vary but they will always include:

- Public addressing to alert cabin crew
- Outflow valve opened to maximum position: if cabin pressure is higher than ambient pressure, opening the door will be impossible.
- Engine shutdown
- Fire switch activated and APU started
- If a fire alarm is active, trigger the corresponding extinguisher
- Trigger the evacuation phase through a message in the cabin and a specific signal

An evacuation is highly risky: the panic, the steep slope of the slides, the probable adverse outside conditions will cause irremediable wounds. It is necessary to think hard before making this decision, but not for too long, because when the danger is real, time is essential.

These procedures for passenger evacuation are only given for information purposes. There is no application of these procedures on the IVAO network.