FLIGHT SAFETY FOUNDATION

Functional Check Flight Compendium

Functional Check Flight Compendium Introduction

Several accidents and serious incidents have highlighted the higher risk associated with conducting functional check flights (FCF). In 2011, the Flight Safety Foundation–led FCF steering team, comprising Airbus, Boeing, Bombardier and Embraer, organized a highly successful symposium to discuss the challenges to be addressed and current best practices for conducting functional check flights. Two hundred and eighty-five attendees from 41 countries attended the symposium in Vancouver.

After the symposium, the Foundation and the FCF steering team continued their work and created the Functional Check Flight Compendium. This compendium contains information that can be used to reduce the risk of functional check flights. The information contained in the guidance document is generic, and may need to be adjusted to apply to your specific aircraft. If there are questions on any of the information in the compendium, contact your manufacturer for further guidance. Our thanks to Airbus, Boeing, Bombardier and Embraer for their valuable contributions to this effort.

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Be Prepared — Check Flights and Aircraft Upsets

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Introduction

Recent events have brought into sharp focus the subject of post-maintenance check flights. This paper deals with the important subject of how to prepare and conduct such flights. Included in the broader definition of preparation is a section on selection of the right kind of people for such work. The likely causes of upsets during check flights and the recovery methods from such upsets are discussed, but the coverage is deliberately limited to the check flight situation and is not intended to be a paper on the whole subject of upset training and recovery.

The paper deals with four sections.

1. **Selection and Training of the Right People to Do the Task**
2. **Planning and Preparation for the Task**
3. **Execution**
4. **What to Do If It Goes Wrong (in a maneuvering sense)**

As in most aviation tasks, the key words in the title are "be prepared." First then let's look at selection of the right people.

1. Selection and Training of the Right People to Do the Task

There are certain characteristics of individuals that are more important in check flight work than in other tasks. In an airline, most young pilots are selected against criteria with a different objective in mind. However, check flights are a fact of life for all airlines and often the task falls to the chief pilot or other senior personnel like the fleet captain or the fleet technical pilot, who see it as a chance to get some flying time. Not all these categories of people, important as they are, may necessarily be best suited for the task nor do they necessarily have the available time to prepare in the way they should and probably would wish to. So what should we look for in a pilot or engineer who will be recruited into the checking community?

There are four pillars on which a check crewmember builds a successful career. These are knowledge, skill, aptitude and experience. "Not much difference there from my world" one may rightly say but let us look at some of these characteristics more closely in a "checking" sense.

Knowledge

A deep knowledge is clearly required of the aircraft, the theory behind the task and the role. A determined inquisitive mind is essential if one is to survive in the check flight world, and one would expect all check aircrew to be asking questions and then more questions until they receive an answer that is both "right" and makes sense. Questions coming from newcomers are especially welcome, as they keep the organization true and sharp. Disinformation and "bull" are generally easy to recognize and have no place in the checking world so the answers had better be good. Equally, an answer that was right five years ago may not be right today. Circumstances change and those changes sometimes demand a re-think. Equally, it is important to be self reliant in this regard. Don't wait for the information to come to you, go looking for it and develop good contacts and sources of quality information

Skills

Valued skills include observation, interpretation, analysis and by no means least, communication. So called "motor function" flying skills for the pilots need to be pretty good too but it may be surprising to some that pure flying coordination and technique are not necessarily the top priority as long as this aspect is at an acceptable level for the task. However, flying ability does have an impact on the capacity of the pilot to handle high workload situations and therefore it will be referred to later in the section about upsets. Some of these skills do not come naturally to some. It is necessary to think through each check point or task and decide which parameters are important. Know also when to read them and then when to record them. For the third crewmember in this situation this recording task is always secondary to acting as the safety "observer," someone with an immediate oversight of the way the check point is being conducted and someone who can therefore issue timely warnings. The process of recording data should not be the only activity. Interpretation and analysis of the data captured are where the real value is added, so the third crewmember has to be able to write and record at the same time as thinking about what it all means to the safety of the flight. Not easy!

Aptitude

Aptitude is a bit more complex. In this context, I am referring here to whether someone "thinks in the right way" and demonstrates the right judgment.

Firstly, check flight personnel need to be able to handle several apparent paradoxes. Let us take an example or two. Take the issue of when a check crewmember has to stand their ground on a given topic versus when they can afford to be flexible. If we take a situation where an aircraft may need some re-work before or after a check flight but is due on the program later in the day, you can immediately see the pressure that has to be handled in this fairly common situation and knowing when it is okay to be flexible or when a tougher stance has to be taken is part of the job. Taking another example, in a typical group discussion about, for example, a specific systems check, some people will inevitably have more knowledge than others, so the issue of when to speak from within your own knowledge and when to listen becomes a skill and a challenge. With the right level of sensitivity and awareness of each other, the team dynamic has to lead to the right answer.

Perhaps the most well known is the issue of confidence. A check crewmember has to have sufficient self confidence to make decisions when necessary and to intervene in developing situations but not so much confidence that may lead to check points being flown in conditions outside the safe limits. There are many such paradoxical situations to be faced and correctly resolved in the world of check flights. Good team members get more of these situations right than wrong.

The right type of pilot or engineer should therefore be naturally skilled at crew resource management (CRM) and be especially good at listening, but check flight CRM is very different from the normal airline route situation. A ground engineer who is acting as a functional flight check engineer may well be the person with the best knowledge of a particular system. The second pilot likewise may be a specialist on a given area so the classic cockpit leadership balance may change during a check flight and should only tip with certainty towards the captain when and if a final safety decision has to be made. In my many years as a test pilot, almost all decisions have been taken naturally as a result of mutual discussion by the testing team and have not require heavy handed "captaincy." If a given situation demands immediate response then whoever is flying at the time commences the action supported by the rest of the team and if he so desires, the captain may take control later. Often such a decision is probably more a case of ensuring that if something subsequently goes wrong, he is rightly able to take responsibility later. Clearly, in the normal airline situation, where the authority gradient is much more clearly defined, such an approach may lead to confusion and weaker decision making. Each airline will need to decide how to handle the authority gradient issue in the context of their local and national culture.

However, the trick is to ensure on check flights that all those with knowledge and useful information are really heard, whatever their level, number of rings on their jacket, nationality, gender or salary grade.

Check pilots in particular also need to be able to achieve a good balance in their activities and maintain the necessary level of self-confidence without an over developed ego. Look for people who are not trying to prove how good they are but rather how good (or bad) the aircraft is. Interestingly, this trait is also critically important in the flight display world.

In some respects this is the key difference between the checking world and the normal operational pilot world. Younger pilots spend their developing career improving their skills as a pilot and having to demonstrate that skill under test conditions. If the flight doesn't go too well the normal reaction is "it must be me" or "I am having an off day." In other words they look inwards at their own performance. The checking world is different. It demands that they become "the standard" and that they use that standard to assess the aircraft they are flying. It is the aircraft that is under examination, not the pilot. They have to look outwards. If the same type of aircraft was flown yesterday and its response through a given maneuver was "normal" but today it is not or it feels different, then what has changed? Has something altered? Is the weight and center of gravity (C of G) the same, or is it potentially something more serious like a degraded flight control system with some trim control damage?

Finally, and highest on the list of desirable characteristics, is personal integrity which is valued above everything else. The check flight specialists need to be people mentally strong enough to take responsibility for their decisions (good and bad) and then be able to live with those decisions, learn from them and communicate them to others. Hours can be wasted chasing a non-snag or flight characteristic when in fact the culprit was the pilot who had selected the wrong configuration or moved the wrong switch at the wrong time. In the development test world there is no hiding place as everything done is filmed, instrumented, telemetered and examined by teams of specialists but this is not true of the airline check flight situation where good old fashioned integrity is vital. There is no more important characteristic in this activity.

Experience

Experience (of the right kind) is extremely valuable in terms of improving judgment, prioritization of task and risk evaluation but experience can also be a great deceiver. There are many 35,000 hour airline guys, in some parts of the world, who are totally unsuited to check flight tasks. Such people have much experience of doing repetitive tasks rather than a range of different experiences against which to make good informed check flight judgments. So look beyond the hours and find out what relevant checking experience lies within the log book and how many non-routine operations have been successfully carried out by an individual. Not everyone is good at tasks that involve changes and adjustment to normal procedures.

Conclusion

This has been a quick sprint through the main characteristics that should be looked for at the interview, when selecting checking crewmembers. An attempt has been made to paint a picture in your mind of the "right" kind of person for this kind of work. If you get the people wrong, no matter how good the process, it will still be at risk. Conversely, take time selecting the right people and it will buy you many dividends in the check flight scenario.

2. Planning and Preparation for the Task

So let us now move to the planning and preparation. Many questions need to be asked and answered before the check flight takes off. We start with the need to understand the task. What exactly is the objective of the flight?

Can it be done on the ground? What state is the aircraft in? Who will be doing it? When has it got to be done? Where is it to be done? And finally, with all that information, what are the risks and what will we do if it goes wrong? Some things seem to be common to most tasks and I shall try to capture those which come up most often.

The first rule is that we need to be able to justify why a flight check is being done in the first place. Many checks can be performed successfully on the test bench. Despite our love of flying, only those checks that cannot be performed on the ground should be performed in the air. We can use GPWS as a good case in point. The "box" has all the logic fixed and it can be bench tested. The software will have been correctly tested and certificated. What is then required from a possible check flight? In reality, we only need to verify the "aircraft connections" in terms of flap signal, gear signal and radio altimeter. Such a check does not require all the modes to be flown.

Aircraft

Let's deal with the aircraft first. We will need to know exactly what servicing has been carried out and which systems have been disturbed. We will also need to know if repairs, modifications and upgrades have been applied and if so, what impact they may have on the intended flight. Some notice of the flight is therefore required because a visit to the hangar is essential to get to the bottom of most of these aircraft questions. Talk to the servicing manager and look at the log books in depth. Take care with the "can you just come down this afternoon and carry out a quick check flight" type of request. More has often been disturbed or worked on than at first appears. In the longer term develop a trustful working relationship with the mechanics in the hangar. It is amazing what they will tell you once that trust is established. Humor tends to help a lot here. If the situation does not allow that due to the use of an outstation or remote facility, try to gauge the quality of the hangar guys (and their management) and the level of pressure they have all been working under.

If the aircraft has been cleaned or painted, pay careful attention as these activities can give rise to numerous "knock on" technical issues such as pitot or angle-of-attack (AOA) sensor damage. Always do a detailed walk around before such a check flight and take time over it. There have been many examples of jacking pads left on aircraft, masking tape covering elevator hinges and over spring tabs, not to mention paint on static plates and vents being blocked by FOD following deep servicing or painting.

Remember also all those systems may have been put into the ground test position to allow certain ground checks to be completed prior to flight clearance. Know what they are and make sure that they are all correctly re-positioned to the flight position prior to flight. Apply the principle that if it can happen, it will happen, and our job as checkers is to ensure that there is no adverse effect on the flight.

You will also need to think carefully about weight and C of G for the check flight. Loading ballast in an airline is not always the easy thing it is in the manufacturer's test world and unusual C of Gs are not so common for the loads specialists. Even so, ask anyone who has been around a while in the test world and they will all have accrued a few mis-loading incidents in their lifetime. My advice would be to try to put the aircraft into a weight and loading situation with which you feel comfortable and use it as a standard for all subsequent similar flights. Set up a mid C of G if possible, avoid being on the limits and do consider the effect of the weight and C of G on the expected "feel" of the controls. Expect that the aircraft will inevitably be much lighter than the aircraft on the line. No big problem there, but think about it and consider the speeds to be used in relation to stall speed and Vmca. It may be that whilst you would normally be stall speed limited, you may now be on or near the Vmca limits. It may also be that to fully test the fuel system a specific fuel load is needed and this may drive the C of G.

Perhaps the main messages here are to know the aircraft, take control of the way the aircraft is presented for check flight and always check the C of G calculation and loading.

Crewing

Often check flights are seen by airline management as a "chance to do some flying." Understandable and tempting as this may be, they may well be the least able in terms of their ability to spend time researching and understanding the issues, keeping their flying skills at the right level and at being able to focus completely on the task and make the right technical judgments whilst handling the "pressure" to get the aircraft back on the line. Clearly, there are some management pilots who are "right" for the task but before selecting themselves a totally honest review of their workload, experience and technical type knowledge needs to be carried out. The primary role of management, with regard to check flight personnel, is to select the right people, then to let them do the job and finally be supportive in a safety sense, of their sometimes difficult decisions. Checkers need to know that they will be supported by their boss in this regard and yes, they will sometimes make mistakes too.

Having a small team of hand selected crewmembers who are properly prepared for the task is a better approach than trying to "be fair" and rotating the checking flights amongst all to give everyone the experience. A group needs to be defined consisting of sufficient support or check engineers and pilots to manage the checking workload of the airline. They should have a nominated head, who, through regular meetings with the team, reviews the schedules to be used and ensures learning from the experience gained from each flight. He can also recommend to senior management how aircraft to be checked should be presented. Such a person can also act as the liaison with the aircraft manufacturers to pick their brains and ensure that the airline receives the best advice possible from the manufacturer's test specialists. We recommend a crew of three wherever possible, so perhaps the major challenge for many airlines is to be able to integrate a ground operations engineer, a licensed quality engineer or specialist check engineer into the test crew environment in such a way that his voice is heard and his opinion weighed and valued alongside the pilot's. No easy task in some cultures.

The checks to be undertaken will determine the number of check personnel in the full checking crew.

With the increasingly complex cabins and cabin systems, several cabin engineers are used by the manufacturers in a test capacity. The basic flight deck checking group should consist of the pilots and the senior functional check engineer who may also be cabin qualified. If needed, specialist cabin engineers can also be included. Take care during depressurization checks when using a small team, as there is a risk of one crewmember being isolated in the cabin. The size of the cabin and the complexity of the systems checks in it will generally dictate the overall size of the team in the back of the aircraft.

These crews will need to be trained. It is quite possible to do this inside an airline when the expertise exists and is supported fully by management to get their people "up to speed" in a check flight sense. Some of the airlines with very large fleets have a dedicated professional department whose role is to carry out the checks on all their fleet aircraft. Equally, a new manufacturers' functional check flight course has recently been developed by Airbus with very positive results. It is not designed to generate full test qualified crews but rather to give an initial immersion into the right type of thinking and to help airline check personnel get some way up the learning ladder to prevent some basic errors. The course uses one of the Airbus aircraft types as a vehicle on which to hang the "generic" teaching on the subject and Airbus uses this type to demonstrate the level of knowledge and skills that are needed to safely carry out functional check flights. Other aeronautical training agencies also do the same sort of thing but in a much more general way. The choice is with the airline.

One final point, check flights should not be used to carry any form of passengers or people "along for the ride" or just for "the experience." Whilst appearing to be tempting for various reasons, passengers in the checking situation often lead to adding complexity, health issues and pressure to an already complex exercise. If there is a requirement to move people from A to B then carry out the check flight first and then pick up the passengers for the simple transit.

Airfield

The airfield to be used is rarely a matter of choice but it is wise to consider any implications stemming from the airfield itself. The runway capability, the height above sea level and its effect on performance, high ground and obstacles, the available navigation aids, and the active NOTAMs all need to be considered as well as the general operational situation. For example before doing a rejected takeoff or braking check, ask the question "is the operational runway the only runway in use?" and consider at what time of day the RTO will be carried out in respect to scheduled traffic. Burst a tire at a busy time and you will not be too popular. At the bigger and busier central hubs, a short flight to another quieter airfield will probably be the answer.

Air Traffic and Airspace

ATC can be our best friend or our worst enemy in a check flight. The check crew have got to ensure that they are a friend. Pre-flight ATC briefings, directly between the pilots and the controller who will look after them, are very valuable and tend to act as a positive "bond" between pilot and controller so that the controller will tend to move other traffic rather than the check aircraft. Prior to the call fax a copy of the intended flight check schedule to the ATC controller involved. A simple line profile will do, with each check recorded at the right height and configuration. If trim stability or performance is needed on a set heading put it on the one sheet profile diagram.

No briefing and the opposite happens. The controller may become irritated by the continual and seemingly illogical demands for turns and odd levels and can then add to the workload of the check crew by making things a lot more difficult.

Wherever possible a quiet ATC environment is helpful and if the ATC agency has such a quiet frequency channel it should be used. In the pure manufacturer's test environment we have dedicated controllers to ensure efficient flight separation and conflict avoidance but normally an airline does not have this privilege. However, a careful look pre-flight at the airspace and the prevailing weather can often lead to selecting a good, quiet, out of the way corner of airspace like an inactive danger area which will serve the check aircraft flight profile well. If in doubt, ask the controller for his advice and through this advice he again tacitly binds himself to the success of the mission.

Weather

During certification development flight testing, the weather criteria often drive the ability to carry out a given test. However, in the check flight world it is rare to have the privilege of waiting for perfect weather. That said, it is certainly wise to know what the bottom line is for the checks to be undertaken. It may not be wise to carry out a check of the brakes in a 30 kt crosswind for example.

In Airbus the minimum weather for a first flight of a new build aircraft is defined. If full authority flight control checks or envelope protection checks are to be done then some clear vertical airspace between clouds is needed. Autoland systems are checked out in Cat 1 conditions before they are used for real, and a lot of attention is paid to avoiding icing layers in the descent for the low speeds handling. Even small amounts of icing can significantly change the onset of buffet speeds and the schedule speeds at which warnings operate.

So as part of the flight preparation and in the cool of the office it is best to define the rules of the game that will be applied from a meteorological point of view. Apply as few rules as possible, as this will allow the greatest flexibility for the check crews. Apply only as many rules as may be needed to ensure safety. But then they must be respected — always.

Checklists

Bearing in mind the more normal airline "standards driven" operational situation, the normal checklist should be used but check crew may need to be able to think and work "outside" the standard checklist (whilst still understanding and recognizing its importance) and be comfortable doing so. Emergency checklists should still be used when required but they should be used for guidance and not treated as if they are the Holy Grail. No checklist can cover all check situations.

Test Schedules

Different approaches to check schedules are used. A different check schedule can be developed for each type of check flight to be carried out or a master reference check schedule can be created where certain checks are crossed through if they are not applicable. The document should not only have the item to be checked but also any associated safety warnings written before the check together with the success criteria and the maximum tolerances allowed. Where a check demands the approach towards a hard limit like a VFe limit, then the NOT BEYOND figures need to be clearly written as this will form part of the mini item briefing later in the execution phase. Avoid writing a check over two pages if possible and certainly avoid having the safety warning detached from the check to be done. Better to have gaps on the pages. Also as check flights rarely work out as planned, format the schedule to make it easy to handle and use in a different order but take care with this. Certain checks should be carried out before others, e.g. low speed handling before approaches.

Airbus currently offers its customers an In-Service Aircraft Flight Test Manual (ISAFTM) which can be used as a reference by customer airlines to create their own check schedules. Along with the data provided, the other factors mentioned above should all be taken into account in the final airline version. The process of generating one's own check schedules is important, as it forces the discipline of thinking about all the factors mentioned and ensures a better pre-flight preparation.

3. Execution

Okay, so now the right people have been selected and as much preparation as possible has been done. It is time to fly, but in this paper there is no intention of going through a check schedule item by item. This is well covered in our Technical Flight Familiarization Course. The emphasis has deliberately been on preparation. However, some of the good things to do and some good general practices that should be followed will be mentioned.

Let us start with the briefing. No matter what the level of advance preparation certain things will change just before the flight and they need to be covered at a preflight briefing.

Briefing

Some guidelines on the briefing are useful here.

1. All involved parties need to be present and listening. Let us remember that this is a preflight briefing, not a long maintenance diatribe on what has been done item by item to the aircraft. Such data should already have been reviewed and frankly, most of us can only remember a certain amount of detailed information at a time. The briefing is run by the captain or the check engineer and needs to stay relevant to the flight. By all means have background technical people there to answer any questions that may arise.

2. Everyone must understand the task, their role in that task, the planned check sequence and the way in which the flight will be conducted. Any limits and key words should be agreed.

3. The weather needs to be specifically briefed with regard to any impact on 2. above.
4. ikewise the airfield and ATC and airspace situation must be reviewed.
5. A brief flight risk assessment should be made. This deals with the practical "what will we do if this or that happens" question. It is not a deep engineering risk assessment but rather a review of the sequence assuming that things may not always go exactly as planned. It should include the things most likely to cause a problem and the fallback plan should they happen.

Those sections of the flight that are primarily a pure flying activity (like flight control checks or low speed handling) will be identified, as will those which are essentially systems related (like a de-pressurization check) and it will be decided who is flying and who is monitoring. Always have one person fully focused on flying. I have seen many situations where the whole crew gets "involved" in the detail of the check sequence. There is absolutely nothing wrong in having one crewmember quietly listening to the discussion but focused on the basic flying.

This preflight briefing will be later supported by mini "in-flight briefings" that will be made before certain phases of the check sortie to remind everyone what is coming next, what the limits are and what action needs to be taken by whom in the event of certain situations arising.

Getting Airborne

The preflight preparation should consider any need for FMS programming regarding fuel transfer and also backup flight plans in case the maneuvers flown early in the plan erase waypoints. Also electrical checks can sometimes cause some interesting computer responses on modern aircraft.

As stated, it is expected that most airlines would use the standard checklists in the run-up to getting airborne in their normal way. The difference is that a third crewmember will probably be present in the jump seat. His or her role is to record data and to monitor the work of the pilots in a nonintrusive way but with a right of intervention should something occur that he doesn't understand or that he thinks may be incorrect.

Over the years and irrespective of the correct use of checklists, I have developed a personal habit (along with most of the test fraternity) of always carrying out a quiet final configuration check just before takeoff and also just before landing.

Takeoff

In the manufacturer's test world, some specialist flight test engineers are included in the takeoff brief so as to allow them the right to call STOP, as a key word command. The circumstances under which they would exercise this right are discussed and carefully considered and if in doubt they say nothing. In the airline world such a protocol probably would not be appropriate (subject to the experience and training) and I would recommend staying as close to the local standard practice as possible. In general, the flight deck should be quiet and free of unnecessary "chat" and certainly so below FL100. Careless words can be misinterpreted and sometimes create a dangerous response.

Switching

Switching and system selection needs to be thought about. Who switches and how? In general a two man principle on all switching actions should be used, with one person pointing at the switch and then after verification that it is indeed the right switch, the selection is made. Some may consider this as overkill but there have been cases where due to poor switching discipline, engines have been "accidentally" shut down and also hydraulics and electrics systems lost when APUs have been inadvertently switched off on acceptance flights. Under stress bad things can happen and its best to develop good practices right from the start.

Actually, in the manufacturer's world, the principle is carried a bit deeper than this and it is normal to have two members of the three man check team always "in the loop." Normally the pilot flying (PF) is allowed to concentrate on that task whilst the pilot not flying/pilot monitoring (PNF/PM) and the engineer focus on system switching safety. It is also easy for one person to get "buried," for example whilst carrying out radio checks (normally the PNF/PM) but under those situations it is essential that the nonflying third member is in the loop with the person on the controls and aware of what is happening in a general flying sense. Conusion over aircraft system response and switching errors must be avoided by only carrying out one check at a time.

Communication

Really good crew communication throughout is required. Key words are sometimes useful. These can include commands such as STOP or GO AROUND but there are also some unwritten but absolutely clear rules for events such as one crewmember not being comfortable with the test progression. If any test check crewmember says "I am not happy" the active pilot recovers immediately and the crew reviews the situation. Likewise if someone declares themselves as being "out of it" through workload or whatever, again, a recovery is carried out and then a re-brief to ensure all crewmembers are mentally on the same test point with the same level of understanding of the plan. Even silences need to be "listened to" as they can tell you that another less experienced crewmember may be concerned about something. After a while it is possible to develop a "nose" for when it's not going according to plan and that is the time to slow it down and think about what is happening and whether the plan still makes sense. The pacing has to be led by the slowest crewmember but of course there are situations where ATC has no choice but to dictate the check pace such as when you are in the pattern or on the approach. Often the aircraft may be carrying a snag or two by this stage and the impact has to be continually re-assessed against the "remain to do" checks. This is where good check crews work together to continually formulate a new and safe plan of action.

As regards external communication, if there are radio problems then the safe continuation of a check flight quickly becomes very challenging and it may well be wiser to concentrate on getting on the ground safely to get the radios fixed before continuing with other checks.

Workload

Workload also has to be continually assessed on an individual and group basis. One person may become overloaded for a short while but if two out of the three reach this state then the situation can become very critical very quickly. The whole crew must never be allowed to reach this state, so if the test crew is only a two person crew the increased threat is obvious. A third check qualified crewmember for this type of work is to be strongly recommended.

One of the problems with workload is that it can rise very quickly and in such a way that the individual concerned, although aware that he or she is working too hard, is unable to take the decisions that will reduce that potentially dangerous situation. The person involved may even be unable to "see" the problem, never mind the solution.

So as the workload increases the crew has to prioritize the tasks. Firstly, and always, the safety of the aircraft is secured. Easy to say but often this requires some tough decisions to be made and sometimes ones that local management may not be too happy with. If the crew has a problem that they do not understand they should put the aircraft back on the ground while they think about it. There is no room for "pressing on" when a situation is not understood and may be potentially dangerous or worse, catastrophic.

Secondly, the objective is to secure good quality check or test data. There is no point in being there to gather poor data that the engineers cannot use. Finally, the whole process should be carried out as expeditiously as possible. It is not a pleasure flight although when done well it's extremely enjoyable. The objective is to re-clear the aircraft so that it can back into the air quickly and earning revenue with passengers on board.

Snag Resolution

The whole purpose of a check flight is be able to give an aircraft a clean bill of health, so it is not surprising that if a snag is found there is a desire to find out as much as possible about that snag to help the mechanics. Laudable as this may sound it can lead quickly to some very unhealthy situations. Great care needs to be taken when "snag chasing." The implications of one failure needs to be understood across all the systems affected as do the implications of selecting certain associated systems into a degraded mode so as to "isolate" a snag. Remember too that there may be another dormant but unreported snag in the system already, which when coupled with the original snag and the crew switching may put the aircraft into a serious risk area. We tend to think, with modern aircraft, that everything is captured by the BITE system or is presented to us through the flight warning computers but this is not so. We return to the issue of integrity and if the crew do not know ALL the ramifications of complex and multiple switching actions then they should not do it. Put the aircraft on the ground, examine the situation very carefully, call the manufacturer if in doubt and only then proceed after having tried to fix the problem.

I have never known an anomalous indication on an aircraft to appear for no reason. Some are small, some have little operational significance, some are intermittent (the worst kind) but there is always a reason. It is no good just hoping a snag has somehow just "gone away." It may indeed not be easy to reproduce the symptoms or it may be limited to certain very precise flight or meteorological conditions but it will still be there and if left, this type of snag has a habit of returning at the worst possible moment. In my experience, sometimes the smallest of apparent issues can lead to failure scenarios with some very serious consequences. Watch out particularly for snags associated with "enabling" functions like weight on wheels switches. Their impact can be seen over several systems. Pressure controllers are another area where a snag can turn from fairly benign to serious pretty quickly.

Tricky Test Points

Some checks are certainly more difficult to fly than others or some may have a more immediate impact if they go wrong. The failure of a generator to come back on line does not have the same immediately damaging effect as allowing the speed to exceed Vmo by too much. So it is sensible to treat the "tricky test points" with the care they demand and not to rush them. Think about them on the ground carefully and decide how they should be flown and what the "break off" point is. These tricky tests can include speed limit checks, envelope boundary checks, depressurizations, initial handling checks, low speed checks and of course some engine checks.

It is also important that no one becomes tempted to "take a look at" some of the certification test points. There are many "interesting" experiences in this category where hardened development test crews can earn lots of beer telling stories over the bar. Taking one example like Vmca definition, fuel starvation on some types of aircraft has occurred in the past on this test (which is done at very low altitude) causing the remaining engine to stop. The lowest I have heard of was 400 ft agl. Not pleasant. No, the job of the checker is not to try to re-define the basic certification criteria of the aircraft. Those criteria have been flown and examined by experts under strict weather conditions and rigorously controlled conditions. The checker's job is to check "this" line aircraft against a predefined and approved airworthiness standard or to clear a reported squawk or snag.

Different Flight Plans

With a modern aircraft check flight there are several "plans" being conducted at the same time. You have the desired planned check schedule. You have the approved air traffic flight plan which may involve some "on airways" flying and will often start with some sort of procedural departure. The FMS may have to be set up to a slightly different plan to ensure some functions work as they should, like fuel burn logics. There is also the flight warning computer flight phase plan which may throw "stored" snags at you at predetermined times and you also have an ATC frequency handover plan which drives the communication world and to some extent the workload. Finally, God controls the most important "plan" and it's called "the weather."

The crew's job is to safely carry out the check points whilst also conducting this orchestra of differing plans, not all of which are in sequence and not all want to align conveniently. It's not unusual to have a check point set up and ready only to be asked to change frequency, squawk and then head straight towards a cumulonimbus! Or you may require an altitude or a block of altitudes only to run out of the ideal bit of airspace in which to do the next point. Patience is required and it is this aspect that benefits most from preplanning, a good weather examination and pre-consultation with the ATC guys. It may be that on some days it simply becomes impossible and the sensible conclusion is to keep it safe and call it a day. Such judgments are not easy as they often have a considerable cost implication.

The Day/Night Question

Each organization will need to make a decision on the question of whether to carry out check flights by day only or by day and night. In my mind, there is no major issue with carrying routine checks at night provided the meteorological conditions are VFR. However, there are nights when you can see for miles and there are other nights when it is inky black out there with no moon to assist. The combination of night and IFR should start to ring a warning bell or two and certainly will increase the workload on the crew a lot. So it is recommended that a daylight flight is better, particularly for smaller airlines where these types of flight are flown less often and the crew currency may be lower. Also, after a significant deep service, the flight should commence in daylight if at all possible. In Airbus production testing, the last possible takeoff time for a first flight is related to the time of useful daylight so that at least the first slow speed handling checks can be carried out in daylight and VFR. If there are any serious weather concerns, a day only flight is the logical decision.

Cabin Systems

Increasingly this area of testing, as said before, is becoming more and more important. Complex seat systems and entertainment systems prevail and it is worth getting to know basically how they work. With the new larger aircraft, there is much closer integration between cabin systems and the flight deck, so no longer are cabins "something back there." They are check areas that have to be thought about quite hard.

This whole paper could have dealt with pressurization issues that have occurred during testing but in order to be brief it is worth thinking about emergency oxygen if a depressurization is planned. Plan which oxygen sets the crew will use. The typical therapeutic oxygen bottles may be "a bridge too far" for someone working in the back of the aircraft to get to. Try getting one out of its stowage and in use in 20 secs and remember that if you are in the cabin checking something you may have to walk some distance to get to the bottle. A better idea is to select and allow a few well-placed oxygen masks to drop in the event of a full depressurization, so that the cabin checker can immediately take a seat and then breathe oxygen with the nearest passenger system. Think also about communication with the guys in the back and ensure the ability to inform them of what is going on and when to be strapped in. Likewise, there are many tasks they can help with like wing inspections and they will need to be able to communicate with the cockpit crew.

4. What to Do If It Goes Wrong (in a Maneuvering Sense)

In a routine check flight, the highest risk of a crew losing control falls into three phases: Firstly, whenever the workload reaches a critical level due to a possible combination of multiple system snags, changes in the check plan, poor weather, communication and / or difficult ATC conditions coupled normally to a final "triggering" issue. Secondly, during the flight control handling check, especially in marginal weather and thirdly during the low speed handling verification phase if sensible check flight "guidelines" are not followed. Whilst these represent the most likely causes of check flight problems, maintenance issues also represent a serious threat. The likelihood of a servicing error being duplicated for example on both engines is much higher under these post-maintenance and heavy check scenarios.

In the first case above, the crew must be aware of the overall crew workload and as previously stated the whole crew must not reach a critical workload condition. Someone, normally the captain, has to make it clear that until the technical systems issues are resolved or their implications fully understood, no more check points will be carried out. Entering a hold or asking for a vector away from the airfield, to give thinking time, are other workload reducing techniques.

Regarding the control checks, two cases exist, aircraft with an envelope protection system and those without. For those with a serviceable and working envelope protection, an upset during the flight control handling checks should not occur as the aircraft should not reach attitudes that are difficult to recover from, provided that the protection system is fully serviceable. Of course that may be the reason for the check flight in the first place, so it is always best to assume that the protections may not work. In fact all good check pilots assume that the system will not work as advertised until it proves it does, rather than the other way around.

Perhaps one word of warning is necessary with regard to the selection of nose down pitch angles in the flight control check or high speed warning checks. If a pilot is too aggressive in terms of his control inputs he can exceed Vmo or Mmo fairly quickly, even with envelope protection in force. The protection is designed to protect from an accidental exceedance and not from a determined 10 to 15 degree nose down pitch attitude with power applied and a high rate of speed increase. In general, as with all aircraft in this class, care should always be taken with high speed trends and nose down pitch angles. We see many cases during deliveries of pilots allowing the nose to drop well below the horizon with power applied during flight control checks. The objective has to be to stay within the normal envelope unless approved to exceed it to check a specific system.

Without envelope protection, the pilot must maintain VFR conditions and pre-decide and brief to which bank angle and pitch limits he will fly the aircraft. He must then stick to that brief and demand that the PNF/PM warns him as he approaches the limits he has set. Although it's fun to do, there is little value with the large passenger class of aircraft in exceeding 45 degrees of bank by much or of exceeding 20 degrees nose up or 10 degrees nose down. The "feel" and characteristics of the controls can certainly be checked inside these limits.

During the low speed handling checks it is always prudent to ensure sufficient height for recovery from a stalled condition even if there is no intention of stalling (there should be no need to with incidence-protected aircraft). The primary objective of these checks is to ensure that the handling of the aircraft on the approach and during the later landing will be as expected.

Three factors deserve special mention in the case of the low speed handling checks: the rate of speed reduction, the effect of trim and the pitching effect of powerful low-mounted engines. An excessive rate of speed reduction can give rise to many problems. The whole thing happens too fast for some pilots who are not trained to observe and check all the various warnings, so it is best to take it slowly and make the speed reduction progressive. There is also an additional risk of entering a stall dynamically and going more deeply into an out-of-control situation. This must be avoided. Aim for the classic 1 kt per sec rate of speed reduction as evidenced by a 10 kt speed trend line (if you have it available).

The historical classic recovery from an approach to the stall involved the use of power to increase speed towards a normal flight condition whilst minimizing the height loss. The recovery from a stalled condition requires that the AOA be reduced first to ensure a satisfactory stall recovery and then the application of a progressive increase in power. In recent times, with modern wing design, it has become clear that the precise point of stall is less easy to recognize, in terms of pilot recognition, and therefore all approach to the stall and stall conditions should be treated in the same way. In simple terms, treat all such situations as a full stall. The first action has to be to reduce the angle of attack of the wing by pitching the nose down. Remember that increasing power on low-mounted engines will tend to increase the angle of attack and if power is applied too aggressively and before reducing the AOA, there is a significant risk of re-stalling or remaining in a stalled condition. Similarly, increasing speed will cause a secondary nose-up pitching effect which will also need to be controlled through the recovery maneuver.

Never forget that during a full aircraft check flight the crew is there to ensure that the primary control system and the warnings are working correctly. Provided that the alpha values at Green Dot and VLS are okay there should be no need to reduce further but if it is airline policy to also check the alpha protection and alpha floor functions then that should certainly be sufficient to prove the system software integrity. Recovery should then be initiated immediately. There should be no need to go as far as V min and certainly not to the stall itself.

Typically, trimable tailplanes have roughly twice the aerodynamic power of the elevators. Therefore, in conventional aircraft, trim no slower than 1.3 VS for the check configuration, in the speed reduction phase. In aircraft with envelope protection, be aware of the tailplane position and the control law the aircraft is in, as it may be necessary to consider the trim during a recovery if there has been a failure in the “normal” control system.

Throughout these checks it is important for the handling pilot to maintain one hand on the throttles and to be operating them manually. We recommend having the flight directors switched off and the flight velocity vector in sight. As said above, with low-mounted engines, applying full power aggressively at very high alphas will lead to a significant pitching effect and if the tail plane has been incorrectly manually trimmed on unprotected aircraft, or there has been a system failure leading to a high alpha condition in a protected aircraft, a possible loss of control and upset condition can be the result. In a recent accident, according to the report from the investigation, the tailplane continued trimming due to a fault in the AOA system, well below the alpha protection point, so that when full power was eventually applied, the aircraft suffered a strong pitch up and entered an upset and then finally an out-of-control condition. The act of reducing power under these circumstances as a recovery agent cannot be overemphasized but it may not be entirely instinctive with a high nose attitude. In fact all power applications need to be carried out with care at these low speed test points.

In order to prepare for low speed checks, the rules need to be set and followed. Firstly, have enough height available in which to recover should things go wrong. Secondly, stay VFR, thirdly select manual thrust levers. Fourthly, know what alpha values you would associate with and expect to see for each warning level. Finally, have someone in the check crew monitor the alpha values carefully throughout the speed reduction. The pilots can also monitor alpha in a rough sense by noting the delta between the flight path velocity vector and the pitch attitude. If it doesn’t look right, stop the deceleration and investigate. A crewmember may have read the wrong weight tables or there may be a system failure of some sort but stop and check — don’t press on.

So the real trick, as always, is to avoid these upset and out-of-control situations by good planning, preparation and discipline. Should one occur, the biggest difficulty is in diagnosing the problem, whilst at the same time being in a severe, potentially overloaded workload situation. After all, you would not be in this situation if you completely understood what had caused it to go wrong.

There is no one convenient answer but my advice is to simplify the problem. When a crew "loses the place" completely in a handling sense, they probably have a little more time than they think to sort it out and regain control before they will enter a potentially disastrous upset. But it won't feel like that. They should not over-react with power or control inputs. The last action taken has probably triggered the current condition so if the height and speed situation allows it, consider reversing that action. If it was a power increase, take control of the thrust levers manually and reduce power to a mid-range. Seek to select either a straight and level attitude or a climb if close to the ground, then hold the attitude. Check engines and energy. Ask the other crewmembers how they see the situation, make the effort to listen and if need be relinquish control to the other pilot who may "see" the way out of the upset before you. Systematically check the basics — Attitude? Energy? Configuration? Instruments? — to see if you can sort out the confusion. Have you missed a key warning, or an annunciator message?

One final bit of advice — take great care with the use of rudder. Modern rudders are not intended to be used other than for engine failure control and for reducing the drift at landing. They are not an upset control device and the certification requirements on passenger aircraft do not demand that the rudder design should allow repetitive opposite full deflections of this control.

I have tried to take you through the upset and "out of control" situations that are most likely in the check flight scenario but let's remember that it's better not to allow the aircraft to get into an upset condition in the first place. Avoidance is always better than recovery.

Conclusion

The key is to prepare thoroughly on the ground and to ensure the best information and knowledge is available to the well selected and correctly trained crew. Once airborne, the most common weakness in the overall checking "system," of aircraft and crew, will probably be the active pilot as he is the most likely to become overloaded in a workload sense. Therefore, well communicated and timely support from the rest of the check crew is critical in ensuring the success of the check mission. It is the role of the captain to encourage such communication. It is the duty of all crewmembers to be active in a communication sense. The challenge for the crew is to avoid critical crew workload levels by excellent preparation, by mini-briefings and by being ready for the unexpected as they conduct each test. Superior flying skills help as they allow a greater concentration on the communication aspects of the whole operation.

So the final messages are: Select the crews well, train them properly, brief your plan for the flight carefully including the ATC and airspace agencies, and then fly the plan in a defensive manner with escape routes planned and being failure-minded. Finally, communicate well and no matter what pressures exist, always default to the safer decision.

I wish you good check flights and remember always that good and thorough preparation is the key.

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Preparation

Functional Check Flights
Preflight Preparation and Considerations

Risk mitigation Is key

While a functional check flight (FCF) is very different from a developmental test flight, many of the considerations are the same. It must be approached from a methodical point of view with a sharp focus on what the objective of the flight is and all of the potential risks associated with it. Every flight involves risk. Testing of any nature will usually involve an elevated level of risk. Understanding this risk is the first step in risk mitigation. Asking a series of questions is highly beneficial in arriving at this critical understanding.

Why?

The first step is to assess and determine the true objective of the check. In other words, why is the flight required? What is being checked? Is there another option? There might be a whole host of reasons given for doing an FCF such as post-maintenance check or change of ownership. Each of these reasons may be perfectly legitimate but each reason should drive its own objective and expected outcome. An FCF for a specific maintenance item would typically focus on the normal, backup and alternate function of that system. On a more generic FCF associated with a change of ownership it would be more appropriate to focus on strictly normal operations. One of the biggest risks with no value added is to go up and fly unnecessary checks with no specific reason to do so.

Functional check flights are not certification test fights. There should be never be a situation where an airplane is flown outside of any aircraft flight manual (AFM) limits or to meet certification performance specifications. Any item that can be tested and verified with a ground check should be checked in this manner. Warning systems are there to advise the flight crew that they are flying in an unsafe condition. All of these factors need to be considered when making the determination that a flight is required.

Key Questions:

What is the objective of the flight?

Are there other alternatives to achieve the required objective?

Which systems have been worked on?

Which systems have been disturbed?

Have adverse outcomes been considered, evaluated and briefed?

What?

Hand in hand with why a flight is required is a very restrictive assessment of what is being checked. Making this decision is affected by a number of factors, such as an in-depth knowledge of airplane systems, how components react differently on the ground vs. in-flight, what redundancies are built into a particular system, and whether systems can be degraded and then recovered while airborne. Doing a detailed analysis can result in even more questions and all of these questions need to be asked, explored and understood. Once understood, then the risk associated with each of these checks needs to be understood and then it needs to be asked if this level of risk is worth the information to be obtained.

Key Questions:

What systems are being checked?

Will any systems be intentionally degraded?

Will any system protections be lost?

Will any limitations be approached?

Will any limitations be exceeded, e.g. over-speed?

What are the criteria for discontinuing a check before the expected outcome has been achieved?

What might expected and unexpected behaviors look like?

Who?

A check flight is not a standard flight, so it is not safe to assume that any pilot is qualified. There is a strong incentive for any professional pilot to want to do these flights and to believe they are qualified. Check flights can be excellent learning opportunities and add to a pilot's experience base, but they should not automatically be considered training events. In many cases the checks and the overall flight may seem so benign that any rated pilot can do the flight. In every case there needs to be a thorough understanding of the overall risk involved, and the crew complement and experience must be appropriate for the risk level of the flight.

Key Questions:

Who is the PIC?

Who is the SIC?

What is their training?

What is their experience?

What is their currency?

Are other crew members required?

Are unnecessary crew personnel planning to be on board?

Where?

Depending on the checks to be performed, a functional check flight has the potential to interfere with normal air traffic operations. Flight parameters can dictate changes in course, altitude or speed, which may need to be coordinated with air traffic control (ATC) in advance. Established work areas, pre-coordinated routing and advance discussions with ATC controllers can all help to alleviate these issues.

Key Questions:

Will this be done on airways, vectors or random routing?

Does this require coordination with ATC?

Can this be done in a designated work area?

Is terrain separation a factor?

What is the minimum safe altitude for the activities being done and does this take terrain separation into consideration?

When?

What may seem to be an insignificant aspect of conducting a check flight may be one of the most important. Normal flight operations are routinely conducted 24 hours a day and seven days a week. Night flying, adverse weather and disruptive crew rest cycles are all taken as given for almost any operation. For functional check flights each of these needs to be given additional scrutiny. In general, test operations are rarely done at night. FCF operations should be treated with the same level of caution. Taking a modified airplane with weather at minimums for landing adds an increased level of risk that may not be warranted. While most aircrews are used to working odd hours and usually believe they are up to any task, the data is clear that performance is degraded when working out of a normal circadian rhythm or when tired.

Key Questions:

Is weather a consideration?

Are special takeoff criteria warranted?

Are special landing criteria warranted?

Is icing a factor?

Is turbulence a factor?

Will this be done after sunset?

What are the crew rest considerations?

Will this be done at the high or low of the crew's circadian rhythm?

When was the last day of rest for the crew?

How many hours has the crew been on duty?

How many hours did the crew work the day before?

How many hours of rest did the crew get in the last 24 hours?

Did the crew have adequate time to fully prepare for the FCF flight?

How?

Once the determination has been made that a flight will be conducted, the last step in preparation is to give thought to some of the in-flight conditions that will be encountered. While it is important to continue to make the distinction between a test flight and a check flight, it is appropriate to bring the same test discipline to an FCF that would be used in an engineering test flight. It is critical to brief the flight in advance, know what is to be accomplished, know what individual crew responsibilities are, and build a plan that incorporates all of the relevant factors discussed so far. It is important to understand the distinction between normal procedures and check procedures and be prepared for the likelihood of encountering non-normal situations. There is risk in planning for success, and it is much safer to take a defensive posture and assume there will be failures. Each crew must be fully prepared for any eventuality. Crews must be aware of how they will transition between normal and check procedures, how they will transition between checks, understand when it is okay to do checks in parallel or when they must be done in sequence. Crews must be prepared to do limited troubleshooting but must also be aware of the risks associated with troubleshooting a problem they may not fully understand. They must know when an adverse outcome will be cause for termination of a check and when an outcome or group of outcomes will be cause for termination of the flight. Good crew resource management (CRM) is fundamental to a safe operation and this alone may be complicated by the fact that the crew can be composed of three or more individuals, not two. Who is the most experienced, who are the system experts and what will be done in the event of an adverse situation?

Key Questions:

Which checks are going to be performed?

What is the sequence of events?

Are unique checklists required?

Are data sheets required for collection of information?

What role does each crew member have?

Have all questions been reviewed and considered?

Summary

An FCF must never be treated as a routine flight without careful consideration of multiple factors. In many cases an FCF is probably not even warranted and a simple discovery flight using 100% normal procedures is more appropriate. In those cases where an FCF is conducted, risk mitigation, through a series of in-depth question,s is critical to the safe operation.

Ground Checks

Preflight Activities

In order to understand the work completed on the aircraft, a thorough briefing with the maintenance personnel / facility that has completed the work is of extreme importance. The type of flight and depth of testing should then be agreed with all parties involved.

It is also of great importance that once an agreement has been reached, the flight should be completed as agreed, with no deviations, additions or changes. If required, additional flights should be performed.

The preflight checks assume that all necessary documentation has been properly completed and reviewed and the aircraft has been released for flight.

The following documentation-may be required

Certificate of airworthiness (if applicable)

Aircraft flight release

Special flight permit/RSI (restriction and/or special instruction) or equivalent (if applicable)

RVSM operations letter of authority

Weight and balance

Maintenance logs (airspeed table, compass swing, RVSM altitude table, etc.)

NCR (non-conformance report) or equivalent

Aircraft configuration data

Aircraft manuals (AFM, etc.)

Confirmation that all return-to-service items are complete.

Exterior Checks

To confirm the condition of the aircraft, a thorough walk-around is necessary. In addition to the standard walk-around items, extra checks should be included in the plan.

Exterior checks walk-around will ensure the condition of the following:

- Proximate area free of potential FOD
- No covers installed
- All vents, intakes and exhausts unobstructed
- Flight control surfaces and structures clear, not damaged or missing, with no leaks
- All probes, ports and vents are clear and not damaged
- Pitot and static probes and surrounding areas are clear with no wrinkles
- All critical surfaces are clear of contamination
- No fluid leaks from components, drains and panels, airplane skin condition
- Gear struts with proper extension, no leaks
- Tires and brakes acceptable condition for flight
- Engines inlet and exhaust are clear, panels secured, reversers stowed
- APU inlet and exhaust are clear, panels secured
- All doors and panels not in use closed and latched
- Antennas not damaged and not inadvertently painted
- External lights clean with no damage

Threats – Use of clear tape to cover vents. Damage to probes due to stepping or impact from ground staging. Length of time since last flight.

Additional items should include:

- Batteries, condition and secure
- Engine fire bottles, pressure and condition
- APU Fire bottles, pressure and condition
- Cargo compartment smoke detectors, condition
- Hydraulic system accumulators, normal pressure and pre-charge
- Brake accumulators, normal pressure and pre-charge
- Fuel panel check (fuel quantity)
- Check for FOD in all access areas (cargo compartments, avionics bays, wheel wells, etc.)
- Oxygen bottle, pressure and condition
- Circuit breaker panels located away from the cockpit (as applicable to aircraft type)
  – Avionics bay
  – Equipment bay
- All equipment that has been identified in the maintenance logs has been serviced and/or replaced
- No loose equipment in cargo compartment.

Threats – FOD

Interior Checks

The cockpit and cabin interior checks will ensure the condition of the following:

- Cockpit emergency equipment to include flashlights, fire extinguishers, crash ax, protective breathing equipment (PBE), life vests
- Cabin emergency equipment to include flashlights, fire extinguishers, PBE, life preservers, life rafts (if available), door slides (if equipped), megaphone (if installed), first aid kit (if required)
- Circuit breaker panels closed or collared (if applicable)
- Main door(s), service door(s) and all emergency exits functional.
- Flight deck, flight crew, and flight attendant seats operate normally
- Ballast (if required) secured

Ground Checks

The following systems checks are not in any specific order and do not replace standard procedures. A checklist with the proper sequence should be prepared in accordance to specific aircraft systems and the intent of the flight check. Components that have a back-up / alternate / redundancy capability should have both systems checked. When conducting the various system tests, ensure system "Caution," "Warning," and "Aural Warnings" test properly.

Battery Power (according to specific aircraft design / architecture)

Electrical

- Batteries voltage and load, acceptable for flight
- Emergency / Battery buses powered

Fire and Overheat Detection

- Emergency equipment powered and operable, including engines fuel shut-off valve (SOV) and APU fuel SOV, hydraulic SOV, fire extinguishing bottles armed and ready
- Fire detection and extinguishing tests

Oxygen Masks

- Oxygen masks / intercom test

Instruments (primary and standby, as applicable)

- EFIS/Multi-function displays (including reversionary modes) and back-up instruments powered and aligned

Cockpit and Cabin Lighting

- LAMP Tests
- Specific cockpit lighting available
- Emergency cabin / exterior lights operable

AC external or APU power (according to specific aircraft design / architecture)

NOTE

APU start may be delayed if external power is available

Electrical

- Batteries voltage and load, acceptable for flight
- All AC electrical buses powered
- All DC electrical buses powered
- All standby buses powered

Instruments

- Instrument checks, including
  – Air data instruments source selector test
  – Inertial (IRUs)
  – Navigation

Ground Checks Continued

- Flight management systems
- Communication panel test
- CVR test

Hydraulics

- All hydraulic systems (electrically powered)
- Pressures
- Temperatures
- Quantities

Passenger Cabin Systems

- Passenger address system
- Seat lighting
- Air systems
- Passenger cabin management system (CMS)
- Passenger seat functions

Flight Controls

- Flight control checks, proper movement/travel, deflection, feel forces and breakout
- Leading edge flaps or slats operation
- Trailing edge flaps operation
- Flight and ground spoiler operation
- Primary and back-up systems
- Trim checks
  – Ailerons
  – Rudder
  – Horizontal stab
- Stall protection systems (if applicable)
- Autopilot functions (if applicable)

Ground Checks (Engines Operating)

APU start

- Check normal start parameters and operation

Engine Start (APU or external air as required)

- Observe normal engine start parameters, check for abnormal indications
- Check idle parameters
- Confirm proper electrical distribution and loads on all buses
- Turn engine generators off and confirm proper back-up power
- Check for hydraulic power from engine-driven pumps, check temperatures, pressures and quantities
- Flight controls, check for proper movement
- Check instruments for proper alignment and readiness

Electrical Checks

- Batteries voltage and load, acceptable for flight
- All AC electrical buses powered
  - Check that main generators are within limits and that proper single generator electrical distribution and loads are on appropriate buses.
  - Check appropriate bus ties powered
- All DC electrical buses powered
  - Check that essential buses are within limits
  - Check that appropriate bus ties are powered

Environmental and Pressurization Systems

- Check for air systems' normal operation, including pressurization, air conditioning and anti-icing
- Cockpit and cabin automatic control
- Cockpit and cabin manual control
- Manual pressurization control
- Emergency depressurization control

Low Speed Taxi

- Check parking brake
- Check brakes from both seats and individual pedals
- Check braking with anti-skid off.
- Check proper operation from nosewheel steering (tiller and pedals)
  - Turning radius
  - Rudder pedal steering
  - Tiller forces
  - Aircraft tracking
- Check thrust reverser proper operation at *idle*.

Ground Checks (Engines Operating) Continued

- Flight instruments verified
  - – ADI
  - – Slip/skid indicator
  - – Standby compass
  - – Standby instrument

Threats –Tire pressures too low or uneven, brake bleeding needed, reverser locks left in place

Ensure all doors, overhead bins and panels remain secure

Threats – Oven contamination leading to smoke, door /exit warnings due to vibration and poor micro-switch setup

High Speed Taxi

- Refer to flight phase high speed taxi

Threats – Weight leading to high energy absorption, crosswind effects, oil-contaminated brakes, uneven tire wear

Flight Checks

Air Conditioning

1 – Introduction

1.1 Reasons for checks: Almost all checks concerning air conditioning can be performed on the ground. However, some anomalies may not be perfectly identified on the ground, such as the cabin temperature repartition, due to the very low outside temperature at cruise altitude. Smells after decontamination are not always well detected on the ground, as it may need an association of high temperature demand with specific flight conditions (generally low speed and rather high thrust). Such checks may also be carried out after modifications or repairs on the system.

1.2 Temperatures: Depending on aircraft type, temperature variations may be commanded from the cockpit and/or the cabin. The values at different locations can be checked either on the cabin or cockpit screen. In case of troubleshooting, it is recommended to stabilize the aircraft in cruise conditions with the same temperature demand in all zones until all temperatures are well stabilized. which takes generally 5 to 6 minutes. Depending on the problem and the results, this check could be repeated with a different commanded temperature. If there is no specific issue, it can just be verified that all the temperatures are changing according to the demand, without waiting for a full stabilization. In this last situation, the checks can even be performed during the initial climb.

1.3 Zones: Obviously, the observations will be made for the cabin but, in case of general check, it should also be verified that the cargo, crew rest area(s) and the cockpit temperatures could be commanded as required.

1.4 Odors: It is not uncommon to have abnormal smells in an aircraft in specific conditions. In this case, a decontamination is performed on the ground and generally it should be sufficient. However, before having passengers on board, especially for a long haul, it may be wise to perform a check in flight. The aircraft manufacturer can give the adapted profile for this type of check. It may not be necessary to perform a long flight, but it is sufficient to go in the critical conditions for the observations. Most of the time, at takeoff, with low speed and high thrust, without any odor, it can be anticipated that the problem is solved. In some cases, the odors may appear when pack compressor temperatures reach higher values and this may not happen until upper cruise levels. The crew should be prepared to use oxygen masks in the case of strong unpleasant odors.

1.5 Task sharing: Due to the fact that this type of check does not interfere with the basic pilot tasks, it can be performed by an additional crew member. A document should be prepared to take note of the different temperature values, valve positions, bleed pressure, and other relevant data.

2 – Briefing

The briefing should include:

- The flight conditions to be stabilized for the checks (if any).
- The observations to be made and the parameters to be noted.

3 – Procedure

- Stabilize the aircraft as planned.
- Adjust the commanded temperatures as required and record all relevant observations.
- In the case of “decontamination” flight, perform the actions as recommended by the aircraft manufacturer.

4 – Key issue

- Specific flight conditions in the case of “decontamination” flight.

Air Data Systems

1 – Introduction

1.1 Reasons for the checks: The target of the anemometric checks is to confirm that air data systems are within acceptable tolerances and, if necessary, that the aircraft is in conformity with the RVSM regulations. Other reasons to perform these checks include cases of damage or repair around the static probes.

1.2 Altitudes: A general "gross error" check can be performed immediately after takeoff just to ensure that all systems are functioning. The specific checks generally need to be performed at various altitudes. The flight conditions, altitude and Mach, can be obtained from the manufacturers.

1.3 Other measurements: The stabilizations may give the opportunity to check other parameters such as temperatures and angles-of-attack (AoAs). The validation of the AoA is performed in level flight where the AoA should be equal to the pitch attitude, with a given tolerance (in the range from 0.5° to 1° depending on aircraft type).

1.4 Tolerances: There are very precise corrections in the air data computers, and therefore there is usually very little difference between the information given by the various computers, unless there is an anomaly. However, the stand-by instruments are usually not well corrected and there might be discrepancies as a function of altitude and speed or Mach. The tolerances given by the manufacturers between all measurements must obviously be known before the flight

2 – Briefing

For each check, the briefing is straightforward: altitude and speed or Mach for stabilization and the list of parameters to be noted.

3 – Procedure

- Stabilize the aircraft at the requested altitude and speed or Mach, preferably with autopilot and autothrottle engaged to be more precise in the measurements.
- Take note of altitude, indicated airspeed, Mach, temperature for all air data computers and for the stand-by instruments. Check that recorded data are within tolerances.

4 – Key Issues

Flight conditions for measurements

- Tolerances

Anti-Ice and De-Icing Systems

1 – Introduction

1.1 Reasons for the checks: These checks may need to be performed after repairs or for troubleshooting of one or several of the anti-ice or de-icing systems.

1.2 Various types of anti-ice and de-icing devices: There are many systems to be anti-iced or de-iced on an aircraft and, for each of them, the operation depends upon the aircraft and the choices made by the manufacturer. To simplify, we can consider four main parts: the airframe, the engines (mainly the air intakes), the propellers, if any, and some sensors. De-icing and anti-icing may be performed thanks to hot air, boots for the airframe, electrical heating, and glycol injection on smaller airplanes. Various sensors are permanently anti-iced, such as pitot and AoA sensors.

1.3 Types of checks: The checks are only a functional check by switching the systems on. A warning should immediately indicate a failure. Most of the checks can be performed on the the ground. There are exceptions for some systems, such as those using hot air, due to limitations linked with lack of cooling by airflow.

- Bleed air: For systems with bleed air, it is recommended to keep it on for a sufficient duration to be sure that there is no anomaly in the heating regulation.
- Electrical: This type of de-icing functioning can generally be observed via the load variation on the electrical buses or generators. Some heating anomalies may be indicated immediately. However, an overheat situation may take some time to trigger.
- Boots: An observer in the cabin will confirm the operation. In some cases, for the empennage, no observation may be possible in flight, but it can be done on the ground. In addition, the pressure variations in the system during the various sequences can indicate proper functioning.

1.4 Limitations: The crew should check for any restriction on the use of the various systems, such as duration, outside temperature and altitude to adapt the flight profile accordingly.

1.5 Weather conditions: Flying in icing conditions is not required for these checks, as the target is not to perform flight tests in the worst icing environment.

1.6 Automatic and manual modes: Some aircraft have manual and automatic modes, either to warn about icing conditions, or to switch on automatically the anti-ice devices. If flying in icing conditions, it is not recommended to wait for the warning to switch the systems on to avoid risk of damage to the aircraft.

2 – Briefing

For each system check, the briefing should include the acceptable conditions for the check and the observations to be made for the validation.

3 – Procedure

For each system to be checked:

- Establish the aircraft in acceptable flight conditions and switch on the system.
- Perform the checks as indicated in 1.3.

4 – Key issue

- Limitations for use of the various anti-ice and de-icing devices.

APU

1 – Introduction – safety issues

1.1 Altitudes: There are generally three maximum altitudes concerning the APU: relight, use of generator(s) and use of bleed air (packs). On twin aircraft operating extended operations (ETOPS), most of the time, maximum altitude for relight and use of electricity correspond to the ceiling.

1.2 FADEC and limitations: On all modern aircraft, the APU is controlled by a FADEC, which, generally, takes care of the limitations. Nevertheless, the team in charge of the checks must know them to ease troubleshooting. There might be a wide variety of limitations, such as times for various relight sequences, maximum engine gas temperature (EGT), number of relight attempts permitted in a given time, starter cooling time, Mach for operation, maximum electrical loads, limitations on bleed and anti-icing.

1.3 Electrical checks: When checking the APU, electrical loads may have to be reduced prior to transferring to the APU generator, depending on limitations. There is no added value to transfering the loads of all aircraft generators onto the APU, even if not a limitation, and in case of an anomaly such as an unexpected APU shutdown, the aircraft would be in an emergency electrical situation.

1.4 Cold soak: In order to validate the APU relight, there may be a requirement for a cold soak, which could be done by flying some hours in cruise. The aircraft manufacturer can provide information on this requirement.

2 – Briefing

For relight, the briefing should include:

- A recall of the various sequences and which parameters have to be noted and possibly timed.
- The task sharing: timing, presentation of information.
- The various limitations in the flight conditions.

For electrical or bleed checks:

- Review of the procedure.
- Parameters to be noted.

3 – Procedure

3.1 For relight:

- Configure displays as necessary for the check.
- Start the APU and take notes of the various sequences and parameters as briefed.

3.2 For electrical checks:

- Take note of parameters with the APU generator off.
- Reduce the load on the engine generator to be transferred onto the APU as required.
- Switch off the engine generator and check that the APU generator comes on line. Monitor for stable N and EGT values after a short period and take note of the parameters, including electrical load.
- Switch back on the engine generator and check that the APU generator is disconnected.
- Repeat as necessary with other engine(s).
- Some aircraft with multiple generators and electrical buses may have specific logics that need to be

APU Continued

- reviewed on the ground before starting all these checks and briefed again before the checks. The sequence of checks has to be adapted accordingly.
- Before switching off the APU, check that its generator is not on line.

3.3 For bleed checks:

- Check acceptable altitude and anti-ice on or off, according to the limitations.
- Take note of APU parameters with its bleed valve closed.
- Close the bleed valves from the engines and check that APU bleed air is sent to the packs. Monitor and take note of the parameters, including bleed pressure.
- Switch the engine bleed air back on.

4 – Key issue

- Limitations for relight, electrical system and bleed.

Autopilot and Autothrottle

1 – Introduction

1.1 Reason for the check: The reason for the check may be the troubleshooting of an anomaly on the autopilot or on the autothrottle which has not been reproduced on the ground. The guidelines given here cover automation linked with the guidance of the aircraft.

1.2 Various guidance modes: All information concerning these types of checks for autoland, all other types of approaches and go-around are given in the landing and go-around modules.

Numerous modes could be checked, such as: altitude, standard climb, idle descent, vertical speed, flight management vertical guidance, heading, track, navigation, and turn characteristics. This list is not exhaustive and depends on aircraft type.

Depending on the issue on the aircraft, the checks may be performed only on one autopilot and autothrottle or on all the systems installed on board.

1.3 Protections: The aircraft may be equipped with protections at low and/or high speed, such as an autopilot automatic disconnection, an automatic thrust increase or decrease or a modification of the guidance mode. The crew should know all the details of the logics, including possible variations of some limitations with weight. When the check of these protections is carried out the crew must be well aware of the speed limit corresponding to the configuration. This limit is to be approached slowly and a "not to exceed" value decided before the check.

1.4 Disengagement: Standard engagement and disengagement means will obviously be verified. If it appears necessary to check the disconnection systems linked to forces, it should be done smoothly. Due to the potential significant transient motion, a public address should be made to ask all observers to remain seated. The disconnection by the pedals must not be checked as, if the applied force is too high, there is a risk of placing too-high loads on the fin. Note that the more recent fly-by-wire aircraft are well protected against this risk, but it is still recommended not to do it.

1.5 Limitations or specificities: There may be some limitations or specific characteristics in the operation of the autopilot that need to be known by the crew.

1.6 Preparation: Due to the number of checks that may be performed during the flight, a checklist and a document to take note of the results should be prepared on the ground.

2 – Briefing

Except for the disengagements, all the checks correspond to standard operation of the aircraft, so there is no need to perform a specific briefing. However, coordination is necessary:

- With crewmembers, for the force disengagement checks.
- With ATC for the various maneuvers.

3 – Procedure

- Perform the guidance modes checks according to the plan.
- Before the disengagements by force, ensure that the cabin is secured (all observers seated).

4 – Key issues

- Limitations and specific characteristics.
- Operation of the autopilot and the autothrottle when approaching the minimum and maximum speeds.

Cabin Checks

1 – Introduction

1.1 Reason for the checks: The cabin checks may have to be performed for troubleshooting of a specific issue on the aircraft or after important modifications have been made in the cabin.

Some of the cabin checks are described in other modules: for example, depressurization, air conditioning, noise and vibrations.

1.2 The ground and flight checks: A majority of cabin checks can be carried out on the ground with just electrical power and, for some of them, with bleed air. Nevertheless all cannot be performed on the ground and, when it is necessary to confirm the condition of the cabin, a flight has to be planned.

1.3 General organization: Due to the number of checks, if the intent is to verify the full cabin, it may be wise to plan the checks in two steps: on the ground and then in flight, with some free time in between to be able to perform corrective actions.

1.4 Aircraft preparation: The aircraft should be prepared as if it was a standard flight with passengers: everything properly stowed, water tanks full, etc. Some items may not yet be installed. The impact on the checks should be carefully reviewed before the flight and the list should obviously be kept updated. If it is the case for galley equipment, the circuit breakers must be pulled and secured accordingly.

1.5 Persons on board: If the purpose of the flight is a full verification of the cabin, it is recommended to have on board several experienced technicians. For large aircraft, long haul, there are generally many systems and options to validate and it may take several hours.

1.6 Flight preparation: Due to the number of tasks, a detailed checklist has to be prepared on the ground. It should include the task sharing between the various crew members. The flight phase where the verifications are planned should also be indicated in order to ensure the coordination with the flight crew.

1.7 Procedures: For takeoff and landing, SOP should be used in order to monitor all the logics of the various systems. During the other flight phases, deviation to SOP may be possible, typically if the flight crew needs to perform other checks. In all cases, a good coordination is required.

1.8 Altitude: A number of checks depend on flight conditions. If possible, it is recommended to perform some of them at the ceiling or close to it, as they may depend on pressurization and small fuselage deformation could affect the result. Other verifications may be performed in climb or in descent.

2 – Briefing

Except for specific issues, there is no need for a new briefing in flight with the cockpit crew, after agreement on the ground on the list of checks. The way in which the flight deck crew and the cabin crew will communicate has to be covered.

If necessary, a briefing may be performed in flight between the cabin technicians in order to ensure proper coordination.

3 – Procedures

3.1 Evacuation system: The test of the system should be performed during the ground checks or before the flight.

3.2 Doors and slides: Slides should be armed and disarmed in line with SOP. All indications should be normal on the doors and on the various panels in the cockpit and the cabin.

Cabin Checks Continued Continued

An evaluation of door noise should be done, if necessary, in cruise conditions.

3.3 Internal doors: Doors concerned are for lavatories, cockpit, access to the various crew rests, stowage areas, etc. The verification should be made at the ceiling when the deformation of the airframe is at its maximum. There should be no blockage when opening or closing. All indications should be normal.

3.4 Air conditioning: When the checks follow major cabin maintenance, it is recommended to perform the basic checks mentioned in the air conditioning module.

3.5 Noise, vibrations: Specific attention from the technicians is required on this subject, as it is difficult to link this item to a special check. They should be permanently attentive to detect any potential anomaly in this area.

3.6 Galleys: All the functions of the galleys should be verified in flight: oven, air chiller, and water taps, with special attention to possible water leakage and drainage.

3.7 Lavatories: All lavatories should be checked in cruise, with a verification of absence of water leakage and proper drainage.

3.8 Lights: The lighting system is a specific choice for each company. The list of verifications has to be established accordingly. Except if some logics are linked to flight operations, all checks could be done on the ground.

3.9 Cabin crew control panels: All the functions of the panels for command or control of the systems should be verified. It could be done at the opportunity of the various checks and most of the work can be performed on the ground.

3.10 Cabin crew interphone: The interphone calls between the different stations should be verified (which could obviously be done on the ground). On large aircraft, with a high number of cabin crew positions, the checks may take a rather long time.

3.11 Passenger entertainment: There are numerous functions on all new large aircraft. Obviously, it is not possible to verify in detail each function for each seat, but a minimum has to be done. In summary, all the screens should be activated to detect a potential anomaly on any of them. The in-flight entertainment (IFE) system should be launched to confirm that there is no global malfunction. A review of the key functions could be made: video, camera, airshow, live TV, etc. If time permits, individual checks could be made on some seats.

This verification should be properly coordinated with the flight crew. The reason is that some of the flight deck checks could lead to electrical transient, generally not compatible with a proper functioning of the IFE. It is recommended that the cockpit crew delay the electrical checks until IFE checks are completed.

3.10 SATCOM, GSM, Wi-Fi: Proper functioning can be performed via some calls (for the SATCOM, do not forget the company credit card!) and internet contacts.

3.15 Stowage: Check that there is no anomaly with all compartments, as minor structural deformations in cruise, when pressurized, can affect the rigging.

3.16 Humidifier: Check that there is no condensation at the end of the flight.

4 – Key issue

- Preparation of the checklist for the flight.

Cabin Noise and Vibrations

1 – Introduction

1.1 Reason for the check: The origin of abnormal cabin noises and vibrations is generally rather difficult to find. They may have various origins: doors, wing root fillets and seals (so-called "Karman noise"), hydraulic pumps, etc. Most of them cannot be reproduced on the ground as they are linked to the aerodynamic flow. Therefore, when the level of noise or vibrations is considered to be unacceptable for the passengers and nothing has been found on the ground, there is no other solution than to perform a specific flight for troubleshooting.

During the post–heavy maintenance check flight, it is also recommended to check that there are no abnormal noises and vibrations, and if some are found to determine their origin before putting the aircraft back in service.

1.2 Types of checks and maneuvers: Before flight and depending on the reported origin of the noise, a troubleshooting strategy has to be decided. To ease the research, it may be decided to perform load factor maneuvers, high speed, high angle-of-attack, climb at cruise altitude, depressurization, switching on and off of various systems, and engine RPM variations. Below, guidance is given for some common types of noise.

1.3 Persons on board: To ease the research of the noise, it is generally recommended to have, in the cabin, several technicians experienced in this domain. A good global coordination is necessary with the flight deck, via the public address, as the technicians will very often stand up.

1.4 Door noise: The doors are a frequent source of noise. For the noisy door, by listening all around, it is possible to detect where the noise is coming from and it will guide the maintenance team for the various possible riggings.

1.5 Karman noise: Small anomalies on the installation of the wing root fillets and seals may create some aerodynamic noises when in flight such as whistling and vibrations, but the origin is very difficult to detect visually on the ground. These noises may vary with the angle-of-attack and therefore with the aircraft weight for given flight conditions. In flight, the target is to get a precise idea of the location of the noise. If it is present in level flight, the location will be easy to determine (e.g., between rows xx and yy). If noise persists, contact the manufacturer.

1.7 Ventilation noise: In case of abnormal ventilation noise, the troubleshooting will be performed by switching off in turn the relevant systems such as fans and packs. The level of noise may depend on flight conditions and it should mainly be checked in cruise.

1.8 Hydraulic noises: Some hydraulic pumps may be noisy. The identification could be performed by switching off the various pumps in turn until the faulty one has been identified. As for the ventilation, the level of noise may depend on the flight conditions and except in case of very loud noise, the judgment of acceptability should be made in cruise.

1.9 Other noises and vibrations: There are many other possible sources for abnormal noise and vibrations. For some of them, it is very difficult to identify the origin as it may be transmitted by the airframe. In case of difficulty, it is recommended to review the issue with the aircraft manufacturer, as there is a good probability that it has already found the problem on one of its aircraft!

1.10 Effect of an empty aircraft: Typical noises associated with hydraulic pumps or other systems can be amplified in an airplane without passengers and cargo.

Cabin Noise and Vibrations Continued

2 – Briefing

The briefing is straightforward: it is a description of the succession of actions to be performed.

As most of the noises are identified from the cabin, the briefing should be performed with the technicians working in the back of the plane.

3 – Procedure

- Perform the action as planned.
- Ensure the proper coordination with the technicians in the cabin using the public address system.

4 – Key issue

- Coordination with the technicians in the cabin.

Delta P Max and Safety Valves

1 – Introduction – safety issues

1.1 Reason for the checks: The reason may be a repair of the safety valves or troubleshooting of the pressurization system.

1.2 Altitude: As the difference of pressure between the cabin and the outside (Delta P) will reach its maximum, if the check is performed at too low an altitude, the cabin altitude may go below zero. If the value reaches a high negative value, this may have adverse consequences on some systems. Therefore it should be made at high or medium altitude (FL300 is generally fine).

1.3 "Not to exceed" Delta P: If exceeding significantly the maximum Delta P, the structure may be damaged. Therefore, a "not to exceed" value for the check has to be decided. It could be chosen 0.1 psi above the maximum tolerance for the safety valve opening. In any case, do not exceed published limitations. It is also recommended to reduce the cabin vertical speed when approaching this value, especially if the manual pressure control is slow to react.

1.4 Comment on the procedure: The decrease of cabin altitude is obtained using the manual control. It is recommended to limit the cabin rate of descent. 1000 ft/min is an acceptable value, and then reduced to 500 ft/min when approaching the target.

1.5 Displays and warning: It may be that because of small differences in tolerances, the warning appearance is not fully in line with the status of the valve. As an example, the warning for Delta P can appear just before or just after the opening of the safety valve. Therefore, it is possible to increase Delta P until the warning and the opening of the valve are obtained, until reaching the "not to exceed" value.

1.6 Aircraft with multiple safety valves: Again, due to tolerances in the setting of the valves, all may not open exactly at the same time. If the aircraft is equipped with a system allowing the monitoring of all valves, it is possible to continue to increase Delta P until they are all opened (or the "not to exceed value" reached). Note that some good specialists may be able to recognize, thanks to the noise, the opening of each safety valve, even if not visible, due to the noise.

1.7 Risk of depressurization: Due to the fact that the crew is manipulating the pressurization system, an anomaly leading to a depressurization cannot be excluded. Therefore some precautions should be taken to ensure immediate availability of oxygen for all persons on board. It could be done using walk-around bottles or being prepared for passengers' masks dropping.

1.8 Return to normal operations: The return to normal operations must be done smoothly, by controlling the cabin vertical speed, until a normal Delta P is reached. The value depends on the conditions of the checks and it is recommended to come back close to the normal operational situation. Only then should the system be put back in the Auto mode if that is the normal operating situation, as there may be some severe pressure fluctuations otherwise.

2 – Briefing

The briefing should include:

- The flight conditions for the check (mainly altitude).
- The procedure used to reach the Delta P max.
- The nominal value for Delta P max and tolerances.
- The "not to exceed" value.

Delta P Max and Safety Valves Continued

- The observations to be made and the parameters to be noted.
- The "recovery" procedure and the conditions to go back to normal operations for the aircraft.

3 – Procedure

- Stabilize the aircraft at the planned altitude.
- Increase Delta P, using cabin vertical speed mode, up to the opening of the safety valve(s). Note: Values may be slow to change and lag valve operation.
- Continue as necessary to increase Delta P to get the warning and opening of all valves, but do not go above the "not to exceed" value. Take note of all information, valves positions, warnings, etc.
- When the check is completed, use the recovery procedure to go back to normal Delta P and cabin altitude.

4 – Key issues

- Altitude for the check.
- Delta P for warnings and safety valve openings.
- "Not to exceed" Delta P.

Depressurization

1 – Introduction – safety issues

1.1 Associated risks: Depressurization can be a dangerous check, either because some people on board may have physical troubles at high altitude or because there is a technical problem. Aircraft manufacturers carrying out this type of check on new aircraft have been confronted with both situations. For these reasons, it is recommended to perform this check only in case of absolute necessity and also with minimum crewmembers and technicians. It is important that all people on board are physically fit enough to carry out these checks. The ability to equalize the pressure in the ears is critical.

1.2 "Limited" depressurization: A lot of verifications may be performed with a "limited" depressurization such as the check of all the warnings, without going up to a high cabin altitude for the automatic mask dropping. Mask dropping can be performed on the ground or manually in flight. In addition, there are other means to check the pressure sensor activating the automatic dropping.

1.3 Use of oxygen masks: The crew oxygen masks should be tested before the check and used during all the depressurization, or at least when the cabin altitude is above 10,000 ft. In the cabin, the non-crewmembers must be briefed on the check and on the use of oxygen. It is recommended that they remain seated with portable oxygen bottles available and ready to be used.

1.4 Cabin altitude limit: A "not to exceed" cabin altitude must be decided before the depressurization. It should never be more than 100 or 200 ft above the upper tolerance limit for the altitude sensor. This value must be verified in the documentation before the flight, as it is not the same on all aircraft types.

1.5 Aircraft option for high altitude airports: Some aircraft using high altitude airports have an option to modify the altitude for automatic mask dropping (from 13,500 ft to around 16,000 ft) and possibly the altitude for some warnings. It is strongly recommended not to do the check in flight with the option activated. If performed, all persons in the cabin should use oxygen from portable bottles during the check. Again, the exact value for minimum and maximum cabin altitude for masks dropping must be verified before the flight.

1.6 Task sharing: The cockpit crew must be fully dedicated to this check, with no other verifications ongoing. Obviously, the procedure/indication appearing and calling for emergency descent will not be followed. On some aircraft many warnings will appear. It is recommended that one of the pilots, preferably the pilot not flying/pilot monitoring (PNF/PM), clear the unnecessary procedure lines on the display and present the appropriate system pages to the engineer taking notes.

1.7 Cabin crew: As this check is generally associated with verifications in the cabin, it is fundamental to have on board a cabin crew trained for this specific check or at least which has received a dedicated briefing on the procedures and associated risks. This crewmember must also take care of technicians in the cabin, if any, who should be seated close together for this entire check.

1.8 Initial altitude: While it would be easier to perform this check at the aircraft ceiling because the cabin altitude is at its maximum, it is recommended to do it at a lower level. In case of system operation anomaly, this reduces the final cabin altitude reached and decreases the time of an emergency descent if one is required.

1.9 Ways to accelerate the depressurization: Leak rates vary on aircraft depending on age and type. For those aircraft where the leak rate is rather low with packs off, the depressurization could last a long time. Depending on aircraft type, some valves or vents may be opened to increase the leak rate. The way to operate them has to be reviewed on the ground, before the flight. In case of doubt on the procedure the aircraft manufacturer must be consulted.

Depressurization Continued

1.10 Failure or anomaly: The crew must be ready to repressurize at any time and be prepared for an emergency descent. This could happen if there is a sudden rapid increase in the cabin altitude or runaway of the control system. The task sharing for this situation has to be briefed. Recommendation: PF in charge of the emergency descent and of the communication with ATC, and PNF/PM in charge to reestablish the pressurization with the engineer. The PNF/PM or the engineer should announce the situation to the cabin. This task sharing may be different from the standard emergency descent procedure due to the special initial situation.

1.11 Specific procedure: On some recent aircraft, the check of all the warnings can be made without switching off bleeds and packs, by using the cabin rate control. Whenever possible, it is recommended to use this system to increase cabin altitude.

2 – Briefing

Due to the risks associated with this check, a thorough briefing must be performed, first on the ground for all participants, then in flight for the cockpit and for the cabin. Participants should be advised of the medical risks associated with this check.

- In the cabin, the technicians must be briefed by a cabin crewmember on the use of basic on-board oxygen and the portable oxygen bottle. They should be told to remain seated except if they have to perform specific tasks.
- The cockpit briefing, preferably done by the additional crewmember, must include:

  – The target of the check.

  – The various actions with the task repartitions.

  – The standard sequence of events.

  – The "not to exceed" cabin altitude.

  – The use of oxygen masks.
- The PF should then make a briefing on the procedures in case of anomaly:

  – Repressurization with task repartition.

  – Emergency descent.
- The ATC should be informed of the check planned and of a possible risk of emergency descent.

3 – Procedure

- In the cockpit, before starting any action, the cockpit crew must be informed of the completion of the briefing in the cabin.
- The aircraft has to be prepared in line with the check order: signs off, check of cabin altitudes on different computers… according to the specific aircraft.
- The ATC has to be informed of the beginning of this check.
- The crewmember conducting the check switches off bleeds and packs or opens the outflow valve(s) to raise the cabin altitude. The result of the action may be checked on the appropriate displays. The leak rate should be monitored via the cabin rate of climb. If it is obviously too high, packs and bleeds have to be switched back on or the outflow valves closed.

Depressurization Continued

- Depending on aircraft characteristics, the depressurization may be accelerated by opening additional valves. This should only be done when the basic leakage rate is stabilized and viewed as normal.
- During the depressurization, the crewmember takes note of all warnings and events. To be more efficient, a specific document should be prepared for that. In the meantime, as it is a dynamic phase, the PNF/PM should clear the non-pertinent information which may appear automatically, and prepare the system pages for the crewmember to ease his task.
- When all the planned events have been recorded or the "not to exceed" altitude reached, the aircraft must be repressurized by closing the opened valves and switching on bleeds and packs. Depending on aircraft system characteristics, it may be advisable not to switch back on all pressurization systems simultaneously, but to observe a delay between selections.
- The repressurization can be done in automatic mode or may be accelerated in manual mode. Some checks may have to be performed with a high cabin altitude, depending on the reason for the flight. In this case, the rate of descent of the cabin has to be adjusted in order to perform all the required verifications.

4 – Key issues

- Altitude for the check.
- Task repartition.
- Recovery procedure in case of anomaly.
- "Not to exceed" cabin altitude.
- Briefing on oxygen use.
- Medical risks for all persons on board.

Electrical System

1 – Introduction – safety issues

1.1 Reason for the check: All functional checks on the electrical system can normally be done on the ground, and therefore there is usually no need to carry out a flight for these checks. However it may be performed for specific troubleshooting needs.

1.2 System architecture: All the checks are highly dependent on the architecture of the electrical system: number of bus bars, redundancies, and automatic reconfigurations. Therefore there is not a single methodology for the checks valid for all aircraft types. Only general guidance can be given.

1.3 List of checks: All the checks should be performed initially on the ground. As there are many possible reconfigurations, it is recommended, in flight, to limit the checks to the situations of a single failure of one element, such as bus bars transfer in case of one generator or one TR failure. A lot of aircraft systems may be affected by the various reconfigurations and therefore a very precise checklist should be prepared with the actions to be followed and observations to be made. In case of doubt, contact the aircraft manufacturer.

1.4 Aircraft status: It is critical to know the precise modifications performed on the specific aircraft that is being checked. As the architecture of systems develops with time, it is important to match the check schedule with the correct configuration.

1.5 Limitations: There might be some limitations of electric load for specific electrical configurations that have to be known by the crew. The procedures for the checks must take them into account with either a manual reduction of the load before the check or the verification that the automatic load reduction is operative.

1.6 APU: It is recommended to have the APU available for the check, even if its generator is switched off, as it could be used as back-up in case of another failure. All the electrical checks linked to the APU are detailed in the APU module.

1.7 Safety issues: The switching must be done carefully to avoid any error that could endanger the aircraft. The same recommendation is valid when recovering a normal configuration.

It is wise to carry out these checks in uncongested airspace, away from a terminal area. Electrical spikes during power transfers can, on certain equipment, cause transient anomalies with approach aids. To avoid this situation and the workload associated with its resolution, ensure that the aircraft is fully back to its normal state prior to commencing any approach.

2 – Briefing

The briefing should include:

- The procedure applicable for the checks.
- The observations to be made on the availability of the various systems and their configuration, and the parameters to be noted, including electrical loads.
- The specific limitations.

3 – Procedure

- Apply the procedure according to the checklist prepared for the check.
- Monitor the status of all the systems and take note of the relevant parameters, including electrical loads.
- At the end of the check verify that the aircraft is back in a standard configuration.

Electrical System Continued

4 – Key issues

- Checklist for actions and observations.
- Specific limitations.

Emergency Electrical System

1 – Introduction – safety issues

1.1 System architecture: When basic electrical sources have all been lost, i.e., no more generators are available on the engines or APU, on most transport aircraft electrical power for a limited number of systems is provided by another means which could be a generator connected to the ram air turbine or to a hydraulic system. Other configurations may also exist.

1.2 Reason for the check: All functional checks of the emergency electrical system can normally be done on the ground and therefore there is usually no need to perform a flight for this check. However it may be done for specific troubleshooting needs.

1.3 Procedure: For obvious safety reasons, the check must not be performed by switching off the aircraft generators. On most aircraft, there are techniques to force this configuration by simulating some failures. The best procedure for this check can be obtained from the aircraft manufacturer. It should include the way to recover after the the check.

1.4 Safety issues: Even if, for the check, there is no need to be in an emergency situation from a system point of view, it is often necessary to switch off some or parts of the electrical or hydraulic systems. Therefore, the switching must be done carefully to avoid any error that could endanger the aircraft. The same recommendation is valid when recovering a normal configuration.

1.5 Weather: Consider the weather prior to carrying out this type of check. It must be assumed that that it may be impossible to regain all or some of the services that will be lost during the check.

1.6 Available systems: The available systems in emergency electrical configuration are not the same on all aircraft and the list of all these systems should be known by the crew, used for flight preparation and available in flight.

Depending on aircraft type, there may be several configurations, typically one for the flight up to approach and the other one for approach and landing. The available systems are different in these configurations.

1.7 Limitations: There might be some specific limitations for these configurations that have to be known by the crew. They could be the consequences of the procedure used, the switching performed and/or linked to the emergency electrical configuration. As examples, the autopilot may or may not be available or there could be some limitations on flight control authority.

1.8 Checklist: As a lot of aircraft systems are generally affected by the reconfiguration, it is recommended to prepare a very precise checklist to be followed for the actions and observations.

1.9 Failure cases: It is strongly recommended not to perform this check in case of a known failure of the electrical or hydraulic systems and also whenever it may affect the flight control systems.

2 – Briefing

The briefing should include:

- The procedure to activate the emergency electrical configuration.
- The associated task repartition.
- The observations to be made on the availability of the various systems and their configuration, and the parameters to be noted.
- The specific limitations.

Emergency Electrical System Continued

- If necessary, the mean to activate the other configuration, if any.
- The recovery procedure.

3 – Procedure

- Stabilize the aircraft.
- Apply the procedure to activate the emergency electrical configuration.
- Monitor the status of all the systems according to the checklist prepared and take note of the relevant parameters.
- If necessary, activate the other emergency electrical configuration and perform the relevant observations.
- When the check is completed, use the recovery procedure.

4 – Key issues

- Procedure to activate the emergency electrical configuration.
- List of available systems.
- Specific limitations.

Engine Parameters and Vibration

1 – Introduction

1.1 Reasons for the checks: The verification of all engine parameters may be necessary for troubleshooting and sometimes to check the temperature margins for old engines, as there may be some limitations if they are operated in very hot conditions with a small temperature margin. An engine check may also be needed to confirm the presence or absence of "rumble" or vibration.

1.2 Stabilization: As the parameters must be perfectly stabilized, the autothrottle system must be disconnected and the engine thrust or power set manually. The aircraft manufacturer can give the speeds and altitudes recommended for the check. If the check is planned for confirming the temperature margin, the maximum thrust on the concerned engine should be stabilized for some minutes. The aircraft manufacturer can give the procedure for this specific verification.

1.3 Engine parameters: On modern aircraft, the engine parameters are permanently recorded in order to get a database to detect immediately potential degradation. During this check, it is recommended to take note of all the engine parameters. A specific document should be prepared for this purpose.

1.4 "Rumble" or vibration: If the check is to confirm the presence or absence of "rumble" or vibration, engine "sweeps" through the likely or known band of engine rpms will identify the presence and magnitude of any anomaly. It may be necessary to increase to a higher cruise speed prior to starting the sweep as significant speed loss may occur at high altitude if one engine is reduced towards idle power.

2 – Briefing

For engine parameters, the briefing is straightforward, as it is just necessary to confirm the measurement conditions: speed, altitude and thrust or power.

For the check of "rumble" or vibration, the procedure has to be detailed, including the usual range of thrust where the anomaly may appear as it is not always around the maximum thrust.

3 – Procedure

- Establish the aircraft in the planned conditions with the appropriate thrust or power and the autothrottle disconnected. Take note of all the engine parameters available on the prepared document.
- If the check is to confirm the presence or absence of "rumble" or vibration, perform the applicable procedure.

4 – Key issues

- Flight conditions for engine parameter verifications.
- Procedure for confirmation of presence or absence of "rumble" or vibration.

Engine Relight

1 – Introduction – safety issues

1.1 Types of relights: Two types of engine relight can be considered: windmilling or starter assisted.

1.2 Specific procedures: In order to avoid engine damage, a specific procedure must generally be followed. Often, the engine manufacturer recommends minimum times: at idle before shutdown, when shut down, and at idle after relight.

1.3 Choice of altitude: The maximum altitude is different for the two types of relight, and generally higher for the windmilling. There is also a minimum speed in both cases, again higher for the windmilling.

The crew has first to determine the ceiling of the aircraft with one engine shut down at the speed planned for the relight and at the estimated weight. If the aircraft cannot be stabilized at the planned altitude (possibly for a twin), there are two solutions: either reduce the altitude of the check until the flight conditions can be stabilized, or start from a higher altitude, descending with one engine out while maintaining the speed. The starting altitude must take into account the minimum times required by the procedures and limitations with engine at idle then shut down, and also the rate of descent with the remaining engine at maximum thrust. To do this, the crew will obviously need access to the up-to-date relight envelope. The flight profile may be defined such that shutdown and relight are performed after a descent from altitude, which will save the time to cool down at idle, then with engine shut down.

The minimum altitude depends on the type of aircraft. The failure of a second engine has to be anticipated in terms of performance (time during which altitude could be maintained, rate of descent) and maybe handling (quad with two engines out on same side). Risks are obviously higher for a twin. High mountainous areas should be avoided in performing these checks. If the ceiling for "starter assisted" is at FL200, then a minimum altitude such as FL180 or FL150 is acceptable above low ground for a twin.

1.4 APU: On twin engine aircraft, the APU must be operative before shutting down an engine to take over the electrical load in case of failure of the other one and possibly to deliver bleed pressure for a "starter assist" relight.

2 – Briefing

The briefing should include:

- The specific procedures for shut down and relight.
- The task sharing: who is in charge to shut down the engine and to relight. Recommendation: the PNF/PM should do this while the PF keeps control of the aircraft and monitors the ATC frequency.
- A review of the maximum engine temperature. If there are three crewmembers aboard, it should be monitored by at least two crewmembers (generally the additional crewmember and the PNF/PM).
- ATC should also be briefed on the check to be performed. The controllers should be aware, before starting, that the aircraft will be "operating single engine or one engine out" and later that all engines are recovered and normal. This will ensure the priority needed if things do not work out as planned.

3 – Procedure

- The aircraft is positioned at proper altitude and speed with APU running (twin engines).
- The engine is set at idle for the specified time, and the speed is maintained using remaining engine(s). For a twin, it might be in descent with the remaining engine at maximum thrust.
- The engine is shut down for at least the specified time.

Engine Relight Continued

- When in the proper conditions (speed and altitude), the restart procedure is launched again following the checklist. All engine parameters must be monitored. The designated crewmember must check that there is no anomaly in the sequence, and should time the various steps (ignition, fuel flow, valve closure, idle, etc.) and take note of the various parameters. A specific document has to be prepared before the flight to ease this task.
- After relight, the engine has to remain at idle for at least the specified time. Then a progressive and slow increase of the thrust should be made, up to max thrust to check that the engine is functioning properly.
- Due to the fact that the engine will be shut down for a rather short time, some steps of the engine shut-down procedure may be omitted, such as specific switching for fuel balancing and transfer. However, this has to be decided during the initial briefing on the ground and the consequences on the check and safety have to be assessed.

4 – Key issues

- Engine manufacturer procedures.
- All engine parameter monitoring.
- Be prepared for an immediate relight.

Flight Controls

1 – Introduction – safety issues

1.1 Reasons for the check: Flight control checks are very critical and can be dangerous if not properly planned or executed. Except for checks specified in the AMM, there is generally no reason to perform flight control verifications.

Some related checks are described in other modules such as lateral trim and spoilers checks (hydraulic module).

1.2 Safety: Due to the associated risks, unless specifically covered in the aircraft documentation, it is strongly recommended to discuss the issue with the aircraft manufacturer before a decision to launch a flight.

Some phenomena that may affect flight controls are not always described in detail in the aircraft documentation, as they should never appear during operations. As an example, high frequency vibrations due a limit cycle oscillation (LCO) on a flight control surface should never be found. One of the possible reasons is free play on servo-controls, but it may be more complicated and therefore, the manufacturer should be contacted.

For particular checks, it may be necessary to switch off some parts of systems: hydraulic, computers, etc. The switching must be done carefully to avoid any error that could endanger the aircraft. The same recommendation is valid when recovering to a normal configuration.

In some countries, flights including maneuvers with risks or needing particular skills may be considered as test flights and therefore may require a specific rating.

1.3 Task sharing: For this type of check, the task sharing has to be well defined. It may be different from the usual PF/PNF if it facilitates the execution.

In all cases, any crewmember should be entitled to call “stop” and the PF should immediately initiate recovery actions.

1.4 Preparation and rehearsal: For any check that puts the aircraft in an unusual situation, the precise list of tasks should be prepared and then a rehearsal should be made in a simulator with the same technical crew in order to review the procedures, confirm the task sharing and gain experience. This preparation should include recovery from normal and unplanned outcomes.

1.5 Persons on board: For all tests related to flight control issues, except lateral trim, it is recommended to have on board only the necessary crewmembers and technicians. Ensure that they are all strapped in for significant maneuvers.

1.6 Limitations: It may be wise for the execution of the check to put in place some specific limitations and “not to exceed” values before recovery. This should include minimum height for stopping handling maneuvers.

1.7 Weather conditions: The weather conditions for the checks have to be adequate for the maneuvers planned: generally daylight and out of the clouds.

2 – Briefing

The briefing should include:

- The flight conditions for the check.
- The description of the planned maneuvers.

Flight Controls Continued

- The precise task sharing.
- The limitations and "not to exceed" values as required.
- The recovery procedure if needed.

3 – Procedure

- Ensure that the aircraft is in the correct configuration.
- Perform the action as planned on the ground and confirmed at the briefing.
- Monitor the relevant parameters to check that there is no anomaly.
- If any crew member calls "stop," recover immediately.
- Return the aircraft to the desired configuration

4 – Key issues

- Decision to perform the flight and the associated specific maneuvers.
- Coordination with the aircraft manufacturer as necessary.
- Specific limitations and "not to exceed" values if needed.
- Task sharing.

Fuel Jettison

1 – Introduction

1.1 Reasons for the checks: After heavy repairs or modifications on the fuel system, it may be useful to perform a check of the jettison, possibly associated with the verification of the fuel transfer sequences.

1.2 Fuel distribution: A specific distribution of the fuel in the various tanks may be needed according to the specifics of the aircraft, as immediate transfers from some tanks to others are sometimes associated with the jettison. The check of the jettison will also involve the verification of all these transfers.

1.3 Altitude and speed: In order to avoid unnecessary pollution, even if the amount of fuel jettisoned is small, it is recommended not to perform this check at low altitude and low speed. As an example, 10,000 ft AGL or above, flaps up at maneuvering speed are acceptable conditions. Some countries may also have specific regulations about jettison areas.

1.4 Cabin crew: It is recommended to position an observer in the cabin to check the fuel flow out of the wing valves. He should transmit immediately his observations to the cockpit using the public address system.

1.5 Automatic and manual modes: Some aircraft have manual and automatic modes to stop the jettison. In this last case, the jettison stops when reaching a given amount of fuel on board or in a tank. Only one or both modes may be checked.

1.6 APU: If the APU has been used prior to the jettison check, it is recommended to shut it down before starting the check.

1.7 Limitations: Check for specific configuration requirements.

2 – Briefing

The briefing should be performed with the observer and include:

- The sequence of actions for the cockpit crew.
- The observations to be made on the fuel display (fuel transfers, etc.)
- The communication between cockpit and cabin observer.

3 – Procedure

- Establish the aircraft in the required flight conditions.
- Start preparing the jettison and stop before last action.
- When the observer announces that he is ready, start the jettison.
- Monitor all the sequences on the fuel display. A specific document should be prepared to take notes. The observer should announce the flow coming out
- The jettison may stop manually or automatically. Check that all the valves go back in the required position. The observer should announce the end of the fuel flow.

4 – Key issue

- Logic of all transfers to be observed.

Fuel Transfer

1 – Introduction

1.1 Reasons for the checks: Some aircraft have numerous fuel tanks with complex transfer logics and minor failures may block a transfer sequence and force the system to revert to a failure mode. Therefore, after heavy repairs or modifications on the fuel system, it may be useful to perform the verification of the fuel transfer sequences.

1.2 Fuel distribution: A specific distribution of the fuel in the various tanks may be necessary to check the transfer logic without performing a very lengthy flight where all the tanks are transferred in a fully standard way. Most of the time a small amount of fuel in each tank allows all the checks to be performed. The aircraft manufacturer can recommend the optimum loading.

1.3 Flight profile: The flight profile is aircraft specific and should be established in order to check a maximum of transfer logic, according to the specific aircraft type. This may require a specific FMS flight plan.

1.4 Flight preparation: Information about when to observe each sequence should be indicated in the flight order, such as passing a given altitude in climb or descent, fuel quantity in a given tank, specific timing (possible delay), time to destination.

2 – Briefing

A briefing should be made before the flight so that the crew keeps in mind the various sequences and timings for a proper observation.

3 – Procedure

For automatic transfer no specific procedure is required. The flight profile has to be followed in order to obtain the required sequencing for fuel transfer. For manual transfer follow the manufacturer's recommended procedure.

4 – Key issue

- Logic of all transfers to be observed.

Go-Around

1 – Introduction

1.1 Reasons for the check: Logic in various aircraft systems are linked to the go-around phase and, for troubleshooting, checks of some of them may help. On the ground, a check of individual computers may reveal the reason for an anomaly, but the global "picture" can only be viewed on an actual go-around.

1.2 Various systems concerned: Triggering a go-around by the appropriate means will modify the status of numerous automatic functions. A non-exhaustive list is given below:

- Go-around thrust (not always maximum thrust).
- Vertical guidance mode.
- Horizontal guidance (Heading, Track, Nav, etc.)
- Autothrottle mode.
- Possible disengagement of some systems or changes for some others depending on aircraft specifics (speed brakes retraction, flight director modes, etc.)

1.3 Flight conditions: Depending on the specific items to be checked it may not be necessary to be on approach. In this case the go-around may be performed at an appropriate altitude.

1.4 Weather conditions: If performed on the approach, there is no restriction on the weather conditions except that these checks should not be performed under Cat 2 or Cat 3 conditions with a very low altitude for triggering the go-around, as in this situation, standard procedures should be followed without being distracted by the need to observe and record data.

1.5 Automatic or manual mode: As the target is to check all the automatic functions, it is recommended to perform the go-around in fully automatic mode.

2 – Briefing

From the activation of the go-around, all events will occur very quickly; therefore, all members of the crew must be carefully briefed on what they have individually to observe. The briefing should include:

- The initial status for the automatic functions engaged.
- The altitude for the go-around initiation.
- The list of parameters and information to be noted.
- The task sharing.
- The "recovery" process.

3 – Procedure

- Establish the aircraft in the planned guidance modes.
- At the defined altitude (if on approach), trigger the go-around and take note of all the parameters and information as briefed.
- Revert to normal flight according to the procedures defined.

4 – Key issue

- Specific automatic functions of the aircraft linked to the go-around.

GPWS and EGPWS

GPWS and EGPWS airborne checks are basically not necessary. The self-test incorporated in the equipment is generally sufficient.

If flight checks are felt to be required, the manufacturer should be contacted for guidance.

In any case, the crew must be aware that airborne checks are difficult to perform and include risks. They should only be performed when absolutely necessary and by a well-trained crew.

High Speed Taxi – Acceleration Stop

1 – Introduction – safety issues

1.1 General comments: These tests are generally not recommended, except in specific circumstances. One of the reasons to perform them could be to check that airspeeds are alive and valid at reasonably high speed, following painting or removal from storage, where the probes should have been protected. The thrust reverser check could also be performed at high speed, knowing that the functioning can basically be checked during a the ground run, brake/auto brake anomaly check and possibly other troubleshooting.

1.2 Choice of speeds: As a rule, the minimum speed which allows a complete validation of the parameters to be checked should be used. With aircraft having a groundspeed readout, consideration should be given as to which speed source to use (The groundspeed or indicated airspeed) and the effect on that choice by the prevailing wind conditions. Due to computation time, there might be a slight delay in the display of the groundspeed, and that could lead to increasing the maximum speed reached if this parameter is used.

1.3 Energy in the brakes and temperatures: Specific precautions must be taken to avoid overheating the brakes, and the energy that would be put into the brakes should be estimated before each run. If the documentation available does not provide sufficient information, the aircraft manufacturer should be consulted to validate the planned checks. As a general procedure, no check should be launched when the brake temperatures are displayed in amber. When no brake temperature is available, cooling time is necessary between two checks, depending on the maximum speed reached. It may be advisable to perform an inspection of the brakes between two runs.

1.4 Runway condition: It is recommended, if possible, not to carry out such a check on a recently wet, flooded or contaminated runway.

1.5 Runway length: The crew has to verify that the runway length is compatible with the check planned with braking and/or thrust reversers and with the expected runway condition.

1.6 Thrust reversers: If the correct functioning of a reverser is the reason for the acceleration stop, all should be checked prior to the run and all must be selected at the deceleration point to ensure symmetrical deceleration and easy directional control.

2 – Preliminary checks

A check of the brakes on both sides needs to be performed: assessment of the efficiency, pedal deflection, pressure (if available), etc. Alternate and emergency braking should also be checked, according to aircraft specifics.

In thrust reverser checks, a functioning check at idle has to be performed during a ground run.

3 – Briefing

The briefing should include:

- The test objective.
- The description of the order of the actions by all crewmembers: thrust setting, speed for thrust reduction, type of braking (auto or manual, max or high, etc.), thrust reversers, speed for end of check, etc.
- The review of the data to be checked.

4 – Procedure

- Ensure that the rudder pedals are correctly locked and that the feet are close to the brakes.

High Speed Taxi – Acceleration Stop Continued

- Aircraft aligned on the runway, set thrust using normal takeoff procedures.
- Accelerate to the planned speed. Check that there is no anomaly on lateral control.
- When reaching the speed, set engines at idle and use the brakes as decided or the automatic braking system and/or the thrust reversers. Particular vigilance must be used in the first two or three seconds following the onset of braking, as it is in this period that any major anomaly will become evident. Check that braking is symmetrical. Monitor the remaining distance on the runway to adapt the braking. If things do not go as planned, be ready to cancel braking and maintain directional control initially by use of rudder and then, after the aircraft has slowed, with the nosewheel steering. Spoiler deployment has to be checked at the beginning of the deceleration as it has a significant effect on stopping ability and brake temperatures.
- After vacating the runway, monitor brake temperatures. There should not be too much scatter and it is a good way to confirm that all the brakes were active. If installed, use of brake fans should be delayed until temperatures can be properly assessed. Some tolerances may be given by the aircraft manufacturers. However, some differences may be found between aircraft sides in manual braking (heavy foot!) or in automatic braking due to crosswind. Even a light crosswind can induce significant asymmetries in temperatures.

5 – Key issues

- Stop speed.
- Energy in the brakes.
- Brake temperatures.

High Speeds

1 – Introduction – safety issues

1.1 Speed margins: High speed checks may be done either to prove the VMO and MMO warnings or for troubleshooting. In any case, a speed slightly above VMO or MMO can be reached without damaging the aircraft. The AMM gives speeds above which an inspection is mandatory. They may be 20 kt above VMO and 0.04 above MMO as an order of magnitude, but obviously this depends on the aircraft type. To avoid the risk of overstressing the aircraft, if it is necessary to trigger the warning, the approach to this speed must be slow.

- A "not to exceed" value should be decided. As a recommendation, VMO + 10 kt and MMO + 0.01 is generally acceptable, but it has to be checked with the AMM to ensure that it provides a sufficient margin to avoid inspections.

1.2 Range of altitudes: The range of altitudes for VMO and MMO checks are different and must be known by the crew: MMO at high altitude and VMO at lower altitude. It is recommended not to perform this check at the crossover altitude for VMO and MMO in order to avoid confusion in the limiting parameter.

1.3 Turbulence: These checks should not be performed in a turbulent environment, as there may be associated wind speed variations, which could suddenly increase the speed.

1.4 Engines thrust: The check should be performed in level flight or, if that is not possible, with a minimum rate of descent, with a high thrust on the engines. Low thrust, and of course idle, should be avoided, because in case of sudden acceleration due to turbulence, it would be more difficult to reduce quickly the speed.

2 – Briefing

The briefing should include:

- The target of the test.
- The parameters to be noted.
- The values of speed / Mach where the warning is anticipated.
- The "not to exceed" speed / Mach.
- The procedure for the acceleration and deceleration.

3 – Procedure

For this procedure, it is assumed that the target is to reach the VMO or MMO warning, the procedure being the same in both cases.

- The altitude for starting the check has to be in the range of VMO or MMO as required.
- The thrust is adapted to get a slow acceleration, less than 1 kt per second, at least when approaching the red line. When close to the expected value for the warning, the rate of acceleration can be easily controlled with thrust so as to reach it slowly. For the MMO check, it may be necessary to descend slightly. However, it is recommended to minimize the rate of descent (500 to 1000 ft/min is generally fine) with a sufficient thrust; otherwise there is a risk of "chasing" MMO as, when descending, the speed (IAS) to reach MMO is increasing.
- When the warning is obtained, the engines are set at idle and a smooth pull-up may be initiated. Airbrakes may also be used.

High Speeds Continued

4 – Key issues

- Range of altitude for VMO and MMO.
- "Not to exceed" speed or Mach.
- Thrust during the acceleration.
- Possible sudden speed increase due to wind variation.

Hydraulic System

1 – Introduction – safety issues

1.1 Reason for the checks: The reason is generally a heavy repair on the aircraft or troubleshooting. Most, if not all, functional checks can normally be performed on the ground. Therefore there is usually no need to perform a specific flight for this check. It may also be carried out to identify a noisy hydraulic pump, as it may depend on speed and altitude.

1.2 Safety issues: As, for this check, some hydraulic circuit(s) have to be depressurized, all selections have to be done with great care to avoid any error that could endanger the aircraft. The same recommendation is valid when recovering to a normal configuration.

As a general principle, the configuration for the checks should be such that a failure must not put the aircraft in a critical situation. As an example, on an aircraft with a classical three-hydraulic-circuit architecture, switching off two of them at the same time should be avoided.

1.3 List of checks: No standard list of verifications can be made, due to the wide variety of architectures for the hydraulic systems on the various aircraft types. In case of doubt on the checks that can be performed safely, the aircraft manufacturer should be consulted. If the check is complex with a lot of items, it is recommended to establish a detailed checklist and to follow it very carefully.

1.4 Limitations: There might be some specific limitations when a hydraulic system is switched off and they have to be known by the crew. It may be the case for the flight controls, depending on aircraft type.

1.5 Spoiler checks: Generally the servo-controls of the spoilers are activated by a single hydraulic circuit. When the hydraulic pressure comes off, the corresponding spoiler(s) must remain flush on the wing. This check must obviously be performed with the aircraft perfectly stabilized, flying constant heading, with no control input.

1.6 Flight control checks: According to aircraft type, some specific checks may be performed. However, in case of doubt about the usefulness, it is recommended to review the issue with the manufacturer (refer to Flight Controls module).

2 – Briefing

The briefing should include:

- The flight conditions for the check.
- The description of the procedure to obtain the required configuration.
- The observations to be made and the parameters to be noted.
- The recovery procedure.

3 – Procedure

- Stabilize the aircraft in the defined conditions.
- Apply the planned procedure, following carefully the checklist. Simultaneously, at each step, monitor and take note of all the relevant parameters.
- When the check is completed, use the recovery procedure.

4 – Key issues

- Specific check procedures.
- Limitations.

Landing Gear

1 – Introduction – safety issues

1.1 Reasons for checks: After heavy maintenance where parts of the landing gear and/or associated doors have been removed or repaired, it may be useful to perform in flight a landing gear maneuver and possibly an emergency extension. Obviously, this must be checked first on the ground with the aircraft on jacks. But in flight, due to aerodynamic deformation and pressurization, the landing gear may not work as on the ground. Some proximity sensors may not be activated due to a very small drift in relative location, which could stop the sequence. Also, locking devices may not be in a perfect position to engage.

1.2 Landing gear retraction and extension: The normal functional check of the landing gear is straightforward and does not necessitate specific comments. The operation may or may not need to be timed according to aircraft manufacturer procedures. Tolerances for the operation, if any, have to be checked in the documentation.

1.3 Emergency extension: The emergency landing gear extension is an abnormal procedure and once the landing gear has been extended, it should not be retracted. However, when this is done for maintenance reasons, the landing gear may be retracted following a procedure specific to each aircraft type and given by the aircraft manufacturer. It is recommended to perform this "reset" whenever possible in order to avoid landing in a failure case mode that, on some types, leaves some gear doors open or nosewheel steering inoperative. As this "reset" procedure is not proposed for transport operations, there may be transitory anomalies in displays and warnings. The crew should be aware of them.

1.4 Speed and configuration: The maximum speed for emergency extension may be lower than for normal maneuver due to the fact that some large gear doors may remain opened. It is also possible to have configuration restrictions. The crew must know all these limitations.

1.5 Timing: For normal operation, when times are given, it is between the start of the maneuver and the closure of the last door. Therefore, if required, the timing has to be performed using the landing gear display page and not the green lights or arrows giving the position of the gear itself. For emergency extension, the timing is generally up to obtaining all green lights.

1.6 Anomaly situation: In the case of an anomaly in the sequence or in the indications, no attempt at troubleshooting should be made in flight. If the gear is down and locked (generally one set of green lights is a sufficient confirmation) with discrepancies or doors still opened, refer to the checklist as some systems may possibly be lost, but the gear should not be retracted.

If anomalies appear during retraction, a crewmember should take note of all relevant information, then the landing gear should be lowered according to the abnormal checklist, without further troubleshooting. This action must not be performed at the last minute, but before starting the approach in order to avoid rushing through an unusual procedure and taking the risk of a go-around.

2 – Briefing

For normal maneuver, there is nothing specific to brief.

For the emergency extension, the briefing should include the configuration, the speed, the emergency extension checklist and the specific reset procedure.

3 – Procedure

The procedure given below is an overview for the emergency extension, but it must obviously be adapted to the specific aircraft.

Landing Gear Continued

- Aircraft stabilized in level flight at the planned speed.
- Display the landing gear page for sequence monitoring.
- Apply the procedure for emergency extension. Timing as necessary.
- When the landing gear is down: normal lever down.
- Apply “reset” procedure given by the aircraft manufacturer to close the landing gear doors.
- Retract the landing gear normally.

4 – Key issues

- Emergency gear extension procedure and speed.
- “Reset” procedure.

Landing

1 – Introduction – safety issues

1.1 Reasons for checks: There are numerous reasons to perform checks during a landing. It could be trouble-shooting for mechanical systems such as logic for reversers or spoilers deployment or checks of brakes, or guidance linked to the various types of approach.

1.2 Types of approach: If the check is linked with a mechanical anomaly at landing, any type of approach can be performed: manual with or without flight director and/or autothrottle. If it is related to a guidance issue, various types of approaches could be performed, such as ILS or RNAV. In this case, it is recommended to keep the highest level of automation possible to monitor all potential defects.

1.3 Autoland: When the check is not performed in CAT 3 conditions, which is the case most of the time, it may be possible to perform an autoland on a runway not approved for CAT 3 operations. However, some precautions must be taken. Before the flight, the runway should have been validated for this type of check by performing several autolands with an aircraft whose autoland capability is not in question. Among the possible traps, the type of surface just before the threshold is very important. As an example, a small dike, barrier or ditch very close to the threshold can create radio-altitude fluctuations upsetting the start of the flare.

The intention to perform an autoland must be announced to the ATC in order to avoid having an aircraft at the holding point, close to the glideslope antennas. The overfly of the LOC antennas by aircraft taking off may create some short duration perturbations on the LOC indications.

As usual in an autoland, the pilot must be ready to take over any time and perform a go-around.

1.4 Other types of approach: According to the equipment of the aircraft and the intent of the flight, other types of approaches may be carried out: manual, GPS, RNAV, VOR, etc. The crew must be aware of the limitations and minima for the approach planned and particularly of the conditions for the autopilot disconnection, if any. The intent of the check may not only be the guidance when established on the proper trajectory, but also the interception itself.

1.5 Radio altimeters (RA): One of the targets of the flight could be the check of the RA callouts. Generally, this is an option for each airline, which can choose its RA logic. Before the flight, the crew should review the callouts and a crewmember may check that the announcements are in accordance with the airline choice. Same comment is valid for the logic of the warnings when approaching and reaching the minima for the type of approach considered.

1.6 Approach procedure: The procedure is based on the SOP. However, it is recommended to stabilize the aircraft rather early, in order to have sufficient time to observe the guidance by the autopilot and the quality of the speed tracking by the autothrottle, which means that flaps and landing gear should be extended earlier than usual.

1.7 Braking: According to the check planned, the autobrake system may be used or not. If the goal is a check of the automation, it should preferably be armed.

It may be advisable not to activate the brake fans, if installed, immediately in order to observe the temperature increase on the brakes and check for abnormal variations. A significant difference between these temperatures may indicate a lack of braking on one or several wheel(s) or the opposite, too strong braking on one or some of them. This could be detected by the crew at landing, but the observation of the temperatures will indicate the affected wheels.

Landing Continued

1.8 Reversers and spoilers: Except in case of specific troubleshooting, reversers and spoilers should be used as per the SOP. If a check is being carried out on the spoiler deployment with reverser selection, then care must be taken to ensure correct spoiler position. As with the SOP, once a thrust reverser selection has been made it means that a full stop must be performed.

1.9 Go-around: Some of the checks mentioned in this chapter are compatible with a go-around check.

1.10 Task sharing: All these checks should be performed according to the SOP and there is generally no reason to deviate. However, in some airlines certain callouts are not performed and in this case, it may be useful to make them, to ease the task of the other crewmember. A document should be prepared before the flight to take note of all the events.

2 – Briefing

The briefing should include:

- The basic briefing for the planned approach, including use of spoilers, reversers, autobrake, etc.
- Possible differences compared with the SOP, such as callouts.
- The observations to be made and the parameters to be noted.
- The task sharing for specific observations.

3 – Procedure

- Perform a standard approach and landing, as briefed, according to SOP.
- Monitor the relevant parameters and perform all observations as planned.

4 – Key issues

- Radio altimeter callouts for the aircraft type.
- Possible use of a specific runway for autoland check.

Lateral Trim

1 – Introduction

1.1 Reasons for the checks: Significant modifications or repairs on flight control surfaces may necessitate a lateral trim check in flight. It may also be recommended in case of major mechanical repair on the aircraft.

1.2 Configurations, altitudes and speed: It is not necessary to check this trim in all configurations: one check in clean and one in landing configuration is sufficient to detect potential anomalies. However, on some aircraft, all lateral surfaces are not active at all speeds or Mach and therefore, two checks may be necessary in clean configuration: with and without these surfaces active. The flight conditions may be indicated in the documentation or can be obtained from the manufacturer.

1.3 Initial stabilization: This check may necessitate a preliminary stabilization with the autopilot engaged to obtain the right trimming. To save time, it is recommended to start flying with the autopilot well in advance and take note of the value only when the trims and flight control surfaces are well stabilized.

1.4 Tolerances on flight controls and/or trim positions: The tolerances on flight controls and/or trim positions for given flight conditions are given in the documentation or by the aircraft manufacturer. They must be known by the crew to validate the check.

1.5 Weather: This check can only be performed in calm weather conditions as very often the flight control position tolerances are small and therefore the surfaces must be well stabilized during the measurements.

1.6 Fuel balance: The fuel must be properly balanced in the tanks. It is even more important for outer tanks (if any).

1.7 Autopilot mode: The measurements must be performed in Heading mode for the autopilot, as in Track or Navigation mode, a heading change with some bank angle is possible in case of lateral wind variation. The autothrottle should be used in order to have symmetrical thrust.

2 – Briefing

The briefing is straightforward: configuration, altitude, speed, autopilot and autothrottle modes.

It is worth briefing ATC that this check will require a stabilization of several minutes without level and heading change.

3 – Procedure

- Establish the required aircraft configuration and flight conditions. Check fuel balance and note fuel quantities in all tanks.
- Let the aircraft stabilize with the autopilot engaged.
- When stabilized, take note of flight controls and trim positions.

4 – Key issue

- Tolerances for flight controls and trim positions.

Low Speeds

1 – Introduction – safety issues

1.1 General comments: Low speed checks should only be performed if there is a specific need for troubleshooting or validation of a mechanical repair. Due to the associated risks, a thorough preparation is necessary.

1.2 Configurations: If these checks have to be performed, it is probably not necessary to do them in all configurations. Generally, one or two configurations are sufficient to obtain the results: clean and/or landing and in this order if both are planned. It is also worth ensuring that the CG is not near a limiting value.

1.3 Minimum speed: The value of the last speed corresponding to stall warning, stick shaker, stick pusher or AoA max (protected aircraft) is obviously very important and must be clearly stated before the check. A margin of 2 to 3% (3 or 4 kt) can be subtracted to get a "not to go below" speed. If this speed is reached without obtaining the planned warning, the check must be aborted.

- When the AoA information is available, it can also be used as a "not to exceed" value by adding 2 degrees onto the expected value.

1.4 Icing: Low speed must only be performed with an aircraft having no ice accreted. If there is a doubt, the additional crewmember should go in the cabin and check the leading edges of the wings.

1.5 Weather conditions: This check and associated recovery must be performed clear of clouds. It should not be performed in a turbulent area as it could lead to a too-high AoA.

1.6 Altitude: Low speed checks should be performed with a minimum altitude of 8,000 ft AGL. Generally, clear of high ground, a block of altitude between FL100 and FL150 can be requested to the ATC.

2 – Preliminary checks

On most modern aircraft, a specific tool gives access to a lot of parameters in flight. If available, a check of the AoAs should be performed before the low speed to be sure that they are valid.

The aircraft can be stabilized in level flight at around 1.5 VS in a clean configuration to check the values of AoAs. All of them should correspond to the reference value, within a generally accepted tolerance of 0.5 to 1 degree. If no reference value is available, AoA can be checked in level flight. Under these conditions, the AoA is equal to pitch attitude.

The crew should also check that AoAs are alive (not blocked). When pulling slightly on the stick or the control column, all AoAs should increase. Another way is to extend slightly the speedbrakes (for aircraft using spoilers for this function): at the extension, the AoAs should immediately increase.

In case of anomaly, the test must be aborted.

3 – Briefing

- In addition to the briefing performed on the ground, a final briefing should be made stating the values of the speeds that are anticipated according to the weight at the time of the check.
- The "not to go below" speed should be clearly indicated.

4 – Procedure

- The minimum altitude of the block given by the ATC should be selected to avoid descending inadvertently below.
- Flight director and autopilot should be switched off.

Low Speeds Continued

- Selection of the proper aircraft configuration.
- The aircraft should be stabilized at around 1.4 VS of the configuration, engines at idle (some aircraft). The crewmember takes note of all parameters: weight, CG, speed, trim, etc. It is recommended to prepare a specific document to ease this task.
- The rate of deceleration should be rather slow, not more than 1 kt per second and even less at the end. The pilot should try to have a sustained action to pull on the stick or the control column and, except if the deceleration is really too fast, never reduce his pressure. The reason is that, if the pilot moves the control forward from a previous position, the AoA will decrease and some speed indications linked to AoA may become unstable and imprecise.
- The various characteristic speeds are announced by the PF and checked by the PNF/PM. All other events, depending on aircraft type: automatic thrust increase, autotrim stop, etc., are also announced in terms of speeds. The engineer takes note of all this information. If possible, in parallel, he can use the AoA indications available in the specific tool in the cockpit and the PNF/PM may also read these AoA values as required.
- When reaching the stall warning, stick shaker, or stick pusher (if authorized), the speed is noted and the test is over.
- For protected aircraft, a stabilization at AoA max can be performed, printing out all parameters when stable.
- The recovery procedure is the one recommended by the manufacturer. Care should be taken to coordinate the rate of thrust increase with elevator control.

5 – Key issues

- No icing.
- Minimum altitude.
- AoA validation (if possible).
- “Not to go below” speed.
- Recovery procedure.

Radio Navigation

1 – Introduction

1.1 Reason for the checks: The reason for this check may be a need for troubleshooting of one or several systems.

1.2 Types of systems: Numerous types of radio navigation systems exist or have existed. We will concentrate on those that are more used today. All systems or options considered below may not be available on all aircraft types.

1.3 Functioning or full check: For several systems, it is possible to make a simple functional check or a full check where the range of emission and reception is verified. This last check allows validating all the on-board installation, including the antennas.

1.4 Preparation: On ground, a list of several radio stations and beacons with their frequencies should be prepared. A data record sheet should be associated to ease the task in flight.

1.5 Ranges:

VOR and DME: They have well calibrated power transmission and therefore, it is possible to use ranges based on distances according to altitude. As an order of magnitude, around FL300, for a standard VOR or DME, the minimum distance should be about 170 NM with a correction of + or – 5 NM per 2,000 ft. The auto-decoding may be verified at a lower distance, in order to have a better signal quality. Checks at low altitude in mountainous areas should be avoided.

ADF: The usual range accepted for all altitudes is 50 NM.

VHF: It is sometimes difficult to know the power of the VHF transmitter on the ground, therefore an accepted value is 150 NM at FL300 with the same correction rule as the VOR.

1.6 Choice of altitude: For some navigation systems such as VOR or DME, in areas where there are a lot of beacons, it is wise to perform the range check at a medium altitude, as otherwise the aircraft could receive several beacons on the same frequency. This could lead to a false conclusion.

1.7 Accuracy: The usually accepted accuracies for the various systems are as follows:

VOR: 3°

DME: 0.2 NM or 0.25% of the distance

ADF: 5°

1.8 Radio checks: During these verifications, it is recommended to deviate from the SOP with the PF monitoring the ATC and the PNF/PM performing the checks. It should also be noted that due to the potentially high communication workload on the PNF/PM, these checks should not be carried out while other checks are ongoing, especially when operating with only two crewmembers.

When carrying out radio checks on a frequency other than ATC, the active ATC frequency should be written down before commencing the series of checks. If the ATC is transferred to another radio set prior to starting the checks, an immediate contact with the ATC should be made to confirm its serviceability.

2 – Briefing

There is nothing specific to brief, except the task sharing when checking the radios on a different frequency than the ATC.

Radio Navigation Continued

3 – Procedure

3.1 VHF: The check can start at the appropriate range with a VHF not used with the ATC. Checks may be performed with a specific "8.33 kHz" frequency. The SELCAL, if installed, has also to be checked. Then the ATC could be transferred to a VHF already verified and, after a radio check with ATC, the checks can restart with the other radio sets.

3.2 HF: The HF radios can be checked with any service center, knowing that depending of the time of the day, some frequencies are more adapted than others. The SELCAL should also be checked.

3.3 VOR: At the appropriate range, depending on altitude (refer to 1.5), check the audio ident, accuracy of positioning using the navigation means (FMS, IRS and GPS). Check also the auto-decoding, possibly at a lower distance.

3.4 DME: Checks are generally coupled with the VOR, obviously without the auto-decoding.

3.5 ILS: The ILS check is a verification of the quality of the reception signal from GS and LOC at a sufficient distance from the runway, audio ident and auto-decoding.

3.6 ADF: At the appropriate distance, check the quality of the reception, audio ident, auto-decoding and accuracy of indication. Be careful to select or not the BFO function according to the type of beacon. During thunderstorm activity, signal perturbations can be anticipated.

3.7 TCAS: Check the availability of the traffic information in the various modes: TA/RA, All Traffic, Above, Below, etc.

3.8 ATC: Check with the air traffic controller the altitude report and the ident mode for all systems.

3.9 Weather radar: Check for all the weather radars the pictures with the different modes (terrain, map, turbulence, etc.), the possibility to adjust the tilt between the extreme values, the gain and possibly the ground clutter suppression. For the most recent radars with memories, check the associated functions: altitude, azimuth, etc.

3.10 SATCOM: Check the cockpit channels with a phone call on each of them.

3.11 GPS: No specific check, except that the number of satellites received is sufficient, generally above 6 or 7. A drift in position not detected by a warning is very unlikely.

3.12 IRS: The IRSs have their own monitoring systems based on drifts of groundspeed and position compared to GPS, according to time. The groundspeeds and positions should be recorded at the end of such flights.

3.13 FMS: Again, there is no specific check as FMS position is based on IRS and GPS, and a warning should indicate any significant drift. A monitoring of position may be performed from time to time and be recorded at the end of the flight.

3.14 CPDLC: If, in the area of the check flight, an equipped ATC center is available, some verification may be performed. The ATC should be briefed before, as some of the requests may not be in line with classical air navigation practices. Depending on the aircraft equipment, the checks can be performed with VHF and/or HF and/or SATCOM data link. After login to the appropriate center, the crew can make specific requests such as "at xxx, direct to yyy" and check all the warnings and recall.

4 – Key issues

- Preparation and record data sheet.
- Precautions to avoid losing the active ATC frequency during VHF checks.

Ram Air System

1 – Introduction – safety issues

1.1 Reasons for the check: The reason may be a repair of the ram air mechanisms or the airframe.

1.2 Altitude: As the aircraft will be depressurized for this check, it must be performed below FL100 and preferably lower (take care of the ears of all persons on board!).

1.3 Comments on the procedure: Before opening the ram air door, the aircraft must be almost depressurized. Two techniques may be used: either switch off the bleed air or the packs and progressively let the difference of pressure between cabin and outside (Delta P) come close to zero, or manually adjust the cabin vertical speed. The minimum Delta P to open the ram air should be indicated in the manufacturer documentation.

1.4 Opening of the ram air: Depending on the aircraft, there may be specific procedures for opening the ram air. They must be followed for this check.

2 – Briefing

The briefing should include:

- The flight conditions (altitude).
- The procedure used to reduce Delta P.
- The review of the procedure to open the ram air (from the checklist).
- The observations to be made when opening the ram air.

3 – Procedure

- Stabilize the aircraft at the planned altitude and reduce Delta P, using the technique decided, until reaching the agreed value.
- Open the ram air following the standard procedure for the aircraft type. Check that all valves and doors are in the correct position.
- Close the ram air and re-establish the standard configuration.

4 – Key issues

- Altitude for the check.
- Maximum Delta P to open the ram air.

Ram Air Turbine

1 – Introduction – safety issues

1.1 Ram Air Turbine (RAT) associated functions: Depending on aircraft type, a RAT may be used to provide hydraulic or electrical power in an emergency situation. Obviously the way to perform the check is highly dependent on the architecture of the various aircraft circuits and therefore only general recommendations can be given here.

1.2 Reason for the checks: The reason is generally a repair of the RAT or troubleshooting. All functional checks can normally be performed on the ground, therefore there is usually no need to perform a specific flight for this check. The only valid reason for carrying out a full airborne extension is if there is doubt about the release mechanism when subject to airloads.

1.3 Extension procedure: In a "standard" flight, the extension of the RAT in flight is obtained when reaching an emergency situation. The check must not be performed this way, by disabling many devices, for obvious safety reasons. On all aircraft, there are "tricks" to extend the RAT by simulating failures. The best procedure for this check can be obtained from the aircraft manufacturer. This procedure should also include the way to recover after the verification.

1.4 Safety issues: Even if, for the check, there is no need to be in an emergency situation from a system point of view, it is very often necessary to switch off part of the electrical or hydraulic circuit. Therefore, the switching(s) must be done carefully to avoid any error that could endanger the aircraft. The same recommendation is valid when recovering a normal configuration.

1.5 Speeds: The RAT needs a minimum aircraft speed to operate. It is recommended to perform the extension at a higher speed. If it is considered as necessary to check the operation at the minimum speed, it should be done with care to avoid going below that. This minimum speed has been guaranteed by flight tests for certification and there is a small margin before losing the efficiency of the RAT, but the target of the check is not to validate this margin.

1.6 Limitations: There might be some specific limitations when using the RAT that have to be known by the crew.

1.7 RAT check: The functioning of the RAT itself is validated by checking that its rpm is nominal. For the associated systems, hydraulic and/or electrical, the check is specific to each aircraft type according to the architecture.

1.8 Landing with RAT extended: While there is generally no limitation indicated in the aircraft procedures when landing with the RAT extended because it is an emergency situation, it may be advisable on some aircraft types, when performing the check, not to extend the thrust reversers or to keep them at idle. The reason is to protect the blades of the RAT from potential damage from gravel or dust projected by the thrust reversers. Depending on the relative position of the engines and of the RAT, the aircraft manufacturer can give guidance on this issue according to the aircraft type. As this is a procedure that is not applicable for the check itself, but for the final landing, it should be indicated clearly in the flight program for the landing phase.

Similarly, pebbles thrown up by the wheels can damage the RAT blades depending on the geometry and relationship of the RAT to the wheels. Therefore, the relative risk of the need of the check versus the potential for damage should be assessed on an aircraft-to-aircraft basis.

When the RAT is a freefall-type extension, set landing configuration before RAT actuation.

Ram Air Turbine Continued

2 – Briefing

The briefing should include:

- The flight conditions for the check (initial speed).
- The procedure used to trigger the RAT extension and the associated task repartition.
- The observations to be made and the parameters to be noted.
- The minimum speed if it is intended to decelerate.
- The "recovery" procedure.

3 – Procedure

- Stabilize the aircraft at the planned speed.
- Apply the procedure to extend the RAT.
- Monitor all the relevant electrical and hydraulic RAT parameters.
- If necessary, decelerate toward the minimum speed, monitoring the parameters and mainly the RAT rpm.
- When the check is completed, use the recovery or landing with RAT deployed procedure.

4 – Key issues

- Procedure to extend the RAT.
- Nominal RAT rpm.
- Minimum speed.
- Procedure for landing with RAT deployed.
- Thrust reverser extension.

Takeoff

1 – Introduction

1.1 Execution: The takeoff should generally be carried out following the SOP of the airline or manufacturer. An additional crewmember in the cockpit may perform supplementary verifications for some parameters.

1.2 Task sharing: Even though all procedures are conducted according to the SOP, some specific issues may need an assessment. As an example, is the aircraft taxiing straight at very high speed? Are the wheel or stick forces in line with the usual characteristics of the aircraft? Therefore a task sharing has to be agreed between the crewmembers on observation and recording.

1.3 Safety issues: There is no specific safety issue compared to a standard takeoff, except that the possibility of a rejected takeoff may be higher, depending on the reason for the check and what has been done during maintenance. More than ever, all the takeoff parameters must be carefully checked.

If something is not as planned, the priority becomes safely flying the aircraft.

The importance of being precise and complete in the pre-takeoff checks cannot be overstressed.

1.4 Engines: In the SOP, the check of the engines is mainly the verification of the symmetry, the conformity of the power or thrust with the target value and the fact that all parameters are "in the green." One may want to get a picture of all these parameters at a given speed. Knowing that on some aircraft, a number of parameters vary continuously, a solution for the aircraft equipped, is to make a "print" of all these parameters at a given speed via the appropriate tool. For the aircraft not equipped, the key parameters can be noted at the correct speed, while the others, or those not changing a lot with the speed, can be noted before or after the target speed. This is the task of the additional crewmember.

1.5 Speeds comparison: According to the SOP, the speeds have to be compared at a given value. However, for this type of flight check, a more precise verification may be necessary and the wording may be slightly adapted to ease the detection of precise differences such as one hundred … top (hack)". In the meantime, the additional crewmember can take note of the difference with the stand-by instrument.

1.6 Lateral control: As for the high speed taxi, it should be checked that there is no anomaly on lateral control, knowing that due to crosswind or runway lateral slope, pilot judgment might be biased.

1.7 Longitudinal control: During the rotation phase, the stick or control column forces should be in line with what is known on this aircraft type and the airplane has to be "in trim" when airborne. An anomaly could be caused by a CG issue or an improper setting of the trim or the rigging of the trimming system.

1.8 Modes engagement: During the initial rolling phase and then when airborne, it should be checked that the engagement of the various guidance modes is in line with what has been selected and with the aircraft logic.

1.9 Specific parameters monitoring: Depending on the aircraft and the reasons for the flight, there might be requirements to check some systems parameters (such as bleed pressure and hydraulic during gear retraction) and/or make some observations (such as vibrations and smells). If available on the aircraft, a "print" of the parameters can be performed, when appropriate, by the flight engineer.

2 – Preliminary checks

The pre-flight checks must be fully carried out paying specific attention to the configuration and the flight control checks. This is especially true if some unusual taxiing checks prior to takeoff have been performed which may have interfered with the routine or the configuration.

Takeoff Continued

If no high speed taxi has been performed before and depending on the reason for the flight, preliminary checks similar to what is indicated in the high speed taxi module of this document may be recommended. It should include a check of the brakes on both sides (assessment of the efficiency, pedal deflection, and pressure if available). Alternate braking could also be checked, according to the aircraft type.

If a maintenance action has been made on thrust reversers, it may be wise to perform a functioning check at idle, unless this has been done during a ground run.

3 – Briefing

The briefing should include:

- The standard takeoff briefing as per SOP.
- The specific actions and observations to be made with the task sharing between the crew members.
- Depending on the reason for the flight, a safety briefing addressing unusual items could be made.

4 – Procedure

- Perform a standard takeoff according to SOP.
- Monitor the relevant parameters and perform all observations as briefed.
- In case of anomaly, concentrate on approved procedures.

5 – Key issue

- Concentrate on SOP.