INCIDENTS THAT DEFINE PROCESS SAFETY

John Atherton, BP plc (retired)

Frederic Gil, BP plc

Center for Chemical Process Safety
New York, New York

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It should not be necessary for each generation
to rediscover principles of process safety
which the generation before discovered.
We must learn from the experience of others
rather than learn the hard way.
We must pass on to the next generation
a record of what we have learned.

Jesse C. DUCOMMUN
Vice-President, Manufacturing and a
director of American Oil Company in 1961;
Process Safety pioneer and instigator of a unique series
of booklets on process safety

Tomorrow's truth is fed by yesterday's mistake.

Antoine Saint-EXUPERY
French WWII fighter pilot and poet

Past failures are future wisdom.

Greg ELIS
Engineer and philosopher

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CONTENTS

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FOREWORD

By JOHN MOGFORD
Executive Vice President, Safety & Operational Capability
Investigation team leader of the Texas City Isomerisation explosion

Walking on the grounds of the trailer park near the Isomerisation unit in Texas City where fifteen of our colleagues lost their lives and hundreds were injured was the most difficult experience of my career. Two years later, I strongly believe that an essential element to raise Process Safety awareness in our industry is to make sure that lessons from such past incidents are widely shared and known by all.

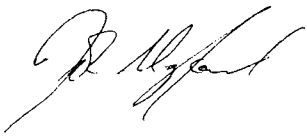
This book is based on one of a series of booklets first published by BP in the 1960s when the need to pass on the lessons of the past to the widest audience possible was recognized as an essential part of ensuring safe operations. This need has not diminished with time in any way as the industry becomes more competitive, process units become more complex, and society increases demands for industry to consider the wider environment, which includes not only the health and safety of its workforce and contractors, but also the communities that surround its sites.

Many of the incidents described here did not happen in our industry, and many have received widespread public attention in the press and media, and been addressed by the TV and film industries. Nevertheless the lessons that can be learned from them are very relevant, and help to widen our vision when faced with the challenges of today. The first edition of this booklet was published by BP in January 2005. This second edition, published in book form by the Center for Chemical Process Safety (CCPS), includes an account of and the lessons from the tragic accident that occurred at BP's Texas City refinery on March 23, 2005, as well as accounts of more than 45 other incidents that help define Process Safety.

Integrity Management is one of the cornerstones of BP's Safety and Operations philosophy, designed to keep our own people and everybody else affected by our operations safe and free from harm. I strongly recommend you take the time to read it carefully. The usefulness of this book is not limited to any single group within our community; it contains many important lessons from "incidents that define Process Safety" that equally apply to commercial, technical, and management personnel. It is only by appreciating the challenges and demands

on others that we, individually, can make our greatest contribution to the health and safety of all of our stakeholders.

Remember that we all have a duty to share our experience with others since this is one of the most effective means of communicating lessons learned and avoiding safety incidents in the future.



John Mogford

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1. INTRODUCTION

The objective of this book is not to replace investigation reports: each of the incidents described below led to hundreds, if not thousands, pages thick reports and many specialized books have been written by experts (see short bibliography after each incident section). However, it is felt that there is a need to disseminate more widely and with a simple, user-friendly tool, the main lessons from major past incidents. Unfortunately, young graduates or even experienced technicians have often never heard of Flixborough or Piper Alpha. And if they did, few of them have received enough information to be able to transfer lessons to their current activities.

This book's only ambition is to be an awareness-raising tool and to give the useful references that may be needed for more detailed analysis. These documents come from articles published in the specialized press and are intended for educational purposes only. Some errors may appear, caused by lack of information, inaccurate information or necessary simplification of the hundreds of pages published on each incident by investigators. Their use must thus be limited to the promotion of safety awareness on the basis of general recommendations.

Note on the arbitrary classification of the incidents: These incidents have been classified under what the authors believe are the major failing that led to the accident. However, all accidents have a number of contributing causes and many authors may well choose to list a particular incident under another heading (e.g. the Piper Alpha incident has been classified under "Permit to Work" but can equally be considered under heading such as "auditing", "lack of HAZID", "Design"...). Therefore, readers should make their own judgment as to how they wish to use this information to drive particular elements within their own safety management systems and training programmes.

Important note to readers: This book has been designed so that:

- *Any chapter can be read independently (i.e. a reader only interested in Management of Change can read only that chapter without the need to read previous chapters);*
- *Any incident description can also be read independently so that a reader only interested in oil industry incidents can read only these. (However, each non-petrochemical incident is complemented with short summaries of incidents with similar causes in the petrochemical Industry.)*

The table below is an attempt to rank the consequences of major accidents in each of the categories shown, against different levels of financial and reputation loss (Incidents highlighted in red are described in this book, while those in blue are mostly well known and used purely as illustrations). *Source for costs: Marsh report "The 100 largest losses 1972-2001"*

Health and Safety: On-site Workers	Health and Safety: Public	Environmental Impact	Equivalent Financial Loss	Reputation
>200 acute or chronic fatalities Courrieres, Asbestos	>50 acute or chronic fatalities Mexico City Bhopal; Oppau; Texas City 1947; Chernobyl; Minamata 1932–1968	>100,000 bbls of oil in sensitive coastal waters; >1,000,000 bbls of oil in other coastal waters Exxon Valdez. Prolonged regional/global contamination Chernobyl; Minamata 1932–1968	>$10 billion Chernobyl	Global outrage, global brand damage and/or affecting international legislation. Piper Alpha, Texas City 2005, Flixborough, Seveso
>50 acute or chronic fatalities Piper Alpha; Betelgeuse; Blaye silos	>10 acute or chronic fatalities Toulouse	>10,000 bbls of oil in sensitive coastal waters. >100,000 bbls of oil in other coastal waters. Amoco Cadiz, Erika Short term damage at regional level Sandoz warehouse fire. Prolonged contamination affecting extensive nature conservation or residential Seveso	$1–10 billion Texas City 2005, Piper Alpha, Exxon Valdez, Skikda	International media coverage. Regional outrage, for example North America, Europe. Regional brand damage. Likely to lead to change of regulations at regional level. Three Miles Island, Buncefield
>10 acute or chronic fatalities Flixborough; Feyzin, Texas City 2005, P-36 Petrobras; Pasadena; Skikda	1 or more acute or chronic fatalities. Multiple permanent injuries or irreversible health effects	>10,000 bbls Oil, >1,000 bbls Oil in sensitive area, >100Te of classified material. Alvenus 1984, Sea Prince 1995; Motiva Long Term damage affecting extensive area.	$100 million – $1 Billion Pasadena, Toulouse, La Mède, Norco, Flixborough, P-36 Petrobras, Turkey earthquake (refinery only), Grangemouth HCK, Longford	Regional media coverage or Severe National Outrage. Threat of, or Loss of License to Operate for affected business/site. Likely to lead to change of regulations at National Level. La Mède, Longford, Courrieres, West Pharmaceuticals, CTA Acoustics
1 or more acute or chronic fatalities. Multiple permanent injuries or irreversible health effects La Mède; CTA; West Longford; Puertollano; HMS Glasgow	Permanent injury or irreversible health effect affecting single person. Non permanent injuries or short term health effects affecting multiple people. HF Marathon	Uncontained release of Reportable quantity. e.g. >100 bbls Oil, less if in sensitive location or >10 Te classified material. Extensive Short Term pollution/contamination. Prolonged pollution/contamination affecting limited area.	$1–100 million Milford Haven, Humber FCCU, Tosco Hydrocracker, Betelgeuse, Mexico	National media attention or Severe Local Outrage. Prosecution by regulator.

2. BLIND OPERATIONS

This section examines incidents where those operating equipment were unaware of the actual situations they were in. Another title for this section could have been "impact of poor communication/information handling". Two of these are from the aircraft industry, and one from the nuclear industry. In summary, they represent:

- Incomplete information (Pan Am 1736 / KLM 4805)
- Unclear information transfer (MD 83 / Shorts 330)
- Overwhelmed with too much information (Three Mile Island).

From the above list, these incidents may appear far from Petrochemical Industry concerns. However, one must not forget that in our Industry, as in the Nuclear and Aviation Industry, board operators (like air controllers) are isolated from the field, communicating with process units only through radio/telephone and visualising the plant only from virtual computer representations.

Clarity of information is vital to understanding the situations in which we find ourselves. When the unexpected happens, there is a natural tendency to interpret the events in the context of ones own experience, despite evidence to the contrary. A "mind set" can be established that is very hard to shift. A mind set can also be influenced by stress. In the case of the KLM/Pan Am incident, the captain of the former was extremely anxious to take off, as the duty hours still available to his crew were sufficiently restricted that there was doubt over whether they could complete the return flight. To have to abandon a flight away from the home base would have led to extreme disruption for the airline and passengers.

In the case of Three Mile Island, the operators were getting erroneous signals from instrumentation that developed a mind set in them that the reactor core was covered. It was not.

The MD 83/Shorts 330 incident arose because of an assumption that the latter aircraft would line up behind the former. The information that could tell the air traffic controller that the two aircraft were at different locations and could not line up in this way was in front of his eyes, but he had not been alerted to it. There are clear parallels with Piper Alpha here.

On the face of it, therefore, it could be assumed that there was nothing anybody could have done about these incidents. However, looking closely, there

are three important areas that could have prevented or limited the consequences of the events:

- Learning lessons from outside the boundaries of ones own experience. There is a vast amount of information available to the manager, engineer and operator that can help them in times of crisis, but managing such a vast quantity of information is always a challenge.
- Exercising major accident scenarios. In this way it is possible to live the main elements of the event before it happens and set a system of rules, and/or purchase additional equipment to mitigate the event when it happens.
- Ensure that when a situation occurs that invalidates rules based on current hazard identification and risk assessment, a robust Management of Change programme is available, with the management will to revisit these.

When faced with the unforeseen, the tendency is always to move forward quickly. However, experience shows us that this can often be a false judgement as the consequences of getting it wrong can far outweigh what are perceived to be short term gains.

The incident that occurred at Texas City ISOM unit on March 23, 2005 can also be considered as a blind operation. Although there was clear evidence that the ISOM Raffinate Splitter column was filling with no bottom offtake, situation awareness was not achieved until too late.

Sometimes people create their own blindness either through lack of awareness of what is going on resulting from a lack of training or experience, or through external factors such as stress. It is good practice when faced with a situation that appears to be a bit out of the ordinary, to step back and take a thorough look at all the evidence, or ask a colleague to do that for you.

MAJOR AIRPLANE CRASH AT TENERIFE AIRPORT, PAN AM 1736/KLM 4805, March 27, 1977

Just after 17:00 on March 27, 1977, a KLM Boeing 747 started its take off run at Los Rodeos airport, Tenerife. Before if could become airborne, it collided with a Pan Am Boeing 747 that was traveling in the reverse direction along the runway to reach its take off point. The collision and subsequent fires destroyed both planes, and 583 people lost their lives.

At 12:30 p.m. the same day a bomb had exploded in the main terminal at the Las Palmas Airport at the Canary Islands capital, which had resulted in the closure of that airport. Inbound flights were diverted to the Los Rodeos airport on Tenerife. The airport at Tenerife did not have the capacity of Las Palmas airport, with the result that Los Rodeos became very congested. Two Boeing 747's were diverted to Los Rodeos, Pan Am 1736 and KLM 4805. The Pan Am flight had arrived after the KLM one and was parked next to it on the apron, just short of the departure end of Runway 12. The passengers on the Pan Am flight remained on board, but those on the KLM flight had been allowed to deplane into the airport terminal. The KLM captain was anxious to get back in the air as the number of duty hours his crew had left before they were forced to take a break were running very close to what was required to enable the plane to make the return trip back to Amsterdam after dropping the passengers off at Las Palmas. Accordingly, he decided to refuel at Los Rodeos to save time for his turn around.

Tenerife, March 27, 1977, a Boeing 747 taking off collides with a Boeing 747 taxiing on the runway: 538 dead.

At 15:00 Las Palmas airport reopened. The Pan Am flight was ready to leave immediately as all passengers were on board, but it's route to the departure runway was blocked by the KLM plane. It then took almost two hours for the KLM passengers to re-board and the aircraft to be refueled. During this period, fog had

started to settle at Los Rodeos, with visibility falling to 900 ft (270 metres) in some places. In order for the two aircraft to reach the take off point on runway 12, they had to taxi back down that runway as other diverted aircraft blocked the taxiways. KLM 4805 was instructed to "back track" along the runway and perform a 180° turn to face the direction for take off. By this time the controllers in the Los Rodeos Control Tower could no longer see the runway or the two aircraft.

Three minutes later, Pan Am 1736, which had been holding short of the runway, was instructed to taxi along Runway 12 and to leave it at the third taxiway on the left, and to confirm when they had left the runway. The captain of the Pan Am found the air traffic controller's (ATC's) accent difficult to understand and asked for confirmation, which was given. Meanwhile, the KLM aircraft had reached the end of the runway and completed its turn, and was now facing the Pan Am flight. The KLM captain opened the throttles to start the take off, but was challenged by his first officer as to whether they had received final clearance to take off. This was sought while the KLM aircraft was held on the brakes. As the first officer was reading back the instructions given by the ATC, his captain released the brakes and KLM 4805 started the take-off roll. In order to let the ATC know exactly what was happening, the KLM first officer radioed "We are now at take off". The ATC acknowledged, "OK, standby for take off, I will call you".

This sequence of communications was causing extreme anxiety in the Pan Am cockpit, with the captain radioing to the ATC "No, we are still taxiing down the runway". The ATC acknowledged the message asking for Pan Am 1736 to report back when it had cleared the runway leaving the runway clear for the KLM flight to take off. However, the Pan Am crew were having difficulty identifying the third taxiway on the left, compounded with difficulties in understanding the ATC, and had in fact gone past it. What appears to have happened is that the KLM and Pam Am messages were sent simultaneously, with only the "OK" being heard by the KLM flight crew due to a loud noise lasting almost 4 seconds in the KLM cockpit. Confusion still remained amongst the KLM flight crew with their flight engineer now querying whether the

Pan Am aircraft was still on the runway. His concerns went unheard as the KLM aircraft accelerated into its take off.

Seconds before the impact, both aircraft flight crews saw each other. The Pan Am captain tried to pull his aircraft over to the right, while the KLM captain tried to climb. Despite leaving marks of a 65 foot (20 metre) "tail drag" on the runway, the KLM aircraft had attained insufficient speed to climb over the other Boeing 747, skidding over the top of its fuselage, and shearing off the tail. The KLM aircraft stayed in the air for only a few seconds longer before slamming down onto the runway and bursting into flames 500 feet (150 metres) further on.

The investigation concluded that the most probable cause of the accident was that the KLM aircraft had taken off with the absolute certainty that it had been cleared to do so, through misunderstanding of communications.

Integrity Management

Hazard Evaluation and Management – it is assumed that procedures for parking and taxiing aircraft would have been made at Los Rodeos airport based on the available facilities, and this would have been done against some form of risk assessment. In this case the number of aircraft that had been diverted created serious congestion, which invalidated that risk assessment based set of rules. The presence of fog exacerbated the situation. The prudent thing to have done was for the air traffic controllers to have established a formal set of rules for the day based on the situation they were faced with. Instead, they appeared to make it up as they went along. At least one of the two flight crews involved in this accident was concerned about whether they had sufficient duty hours left to be able to complete their return journey to Amsterdam. The stress imposed by this could well explain the perceptions that developed in the mind of the KLM captain in respect of the location of the Pan Am aircraft.

Major Accident Potential – this accident approached a worst case event, with two of the largest passenger aircraft in the world colliding with total loss of life. The fact that both aircraft were not filled to capacity was the only thing that prevented a higher death toll. Prevention of such an event should have been in the forefront of any change to procedures necessary because of unusual circumstances, rather than what appears to have been a race to get the diverted aircraft in the air again.

Management of Change – this is a classic management of change situation where a thorough review of the situation is required in order to ensure that it could be resolved safely.

Protective Systems – in flight operations, clear, concise communications is the vital last step to ensure aircraft safety. Mandatory protocols are in place, which in this case were not complied with. When messages are received they are repeated back to the sender before action is taken to ensure that the entire message had been correctly received. The fact that there was an unusual loud noise heard on the flight deck of the KLM aircraft due to simultaneous transmissions should have caused them to stop and check on what had actually been transmitted.

Competent Personnel and Procedures – the investigation found that both flight crews and the air traffic controllers were properly trained and certified. However, the stress of the situation that resulted from the diversion of so many aircraft after a terrorist incident at Las Palmas was sufficient to influence proper judgement in those who were supposedly trained to react well in a crisis.

Emergency Response – sudden closure of an airport for whatever reason should have been a scenario that had been well rehearsed in the past. When developing flight plans, aircrew have to identify an alternate airport and ensure that they have sufficient fuel on board to safely reach that location, even if it means returning to the place of origin. Dispersal of the aircraft diverted from Las Palmas to a number of other airports would have lessened the impact on Los Rodeos.

Incidents of a Similar Nature

There are numerous incidents where lack of effective or accurate communication could have resulted in a fatal accident with major damage to plant and the environment. The following two are described to demonstrate that a simple misunderstanding can easily lead to an extremely dangerous situation. In the first incident, considerable work had been done to prevent such a situation arising, but this was completely compromised in a busy, stressful environment.

Australian Refinery – Pipework Modification Incident:

A contract pipe fitter partially cut through a pipeline containing butane. The area was evacuated but fortunately the incident did not escalate.

The incident occurred during a scheduled process unit turnaround. As major piping modifications were being carried out in a very limited time frame considerable preparation had been done to identify sections of piping for removal and replacement. Specifically assigned personnel were rigidly administering Permit-to-Work control.

A pipe fitter was allocated to the removal of pipework, and his supervisor explained to the pipe fitter the extent of the work. The intention of the supervisor

was that he would then obtain a Hot Work Permit from the assigned authority. However other work distracted him from doing this immediately, during which time the pipe fitter commenced work. He started cutting through a butane rundown line with an electrically operated angle grinder. He had partially cut through the line when he noticed a leak that he immediately reported to the Permit Control Supervisor. All hot work was stopped and the area evacuated. Fortunately a large system of downstream piping had been depressured for the installation of battery limit blinds and only a fraction of the normal rundown pressure was present.

Road tanker rollover, USA

A road tanker (tank truck) was in route from Whiting, Indiana plant to a customer in Texas with a load of elevated temperature H-110 S Polybutene (UN3257) when tractor unit and trailer were involved in a slow rollover incident. The driver reported no injuries and no product was released. Approximately 0.5 gallons (2 litres) of diesel fuel is reported to have spilled. The Sheriff, local police, the Crosby Fire and Hazmat team, the operating company and several manufacturer's employees responded to the scene. Response crews transferred the material to another clean trailer for delivery to customer.

The driver was provided with incorrect directions to the customer site. The weather was very foggy at the time of the incident and the driver did not see a "No Thru Truck" sign. The truck and trailer arrived at a dead end tee intersection. As the driver attempted to slowly (<5 mph) turn around to the left, the rear trailer tires slid off the road. This resulted in the trailer sliding into the ditch and the cab and trailer rolling over. The cab remained on the road, on its side, with the trailer extending into the ditch at an 8 o'clock angle from the trailer top domes.

Although this incident resulted in minimal damage and no injuries, there was a potential for a fatal accident and/or major spillage.

Some references to read more:

- Aviation Safety Network, website: http://aviation-safety.net/specials/tenerife/spanish-1.htm

MD 83/SHORTS 330 CRASH AT PARIS CHARLES DE GAULLE, FRANCE, May 25, 2000

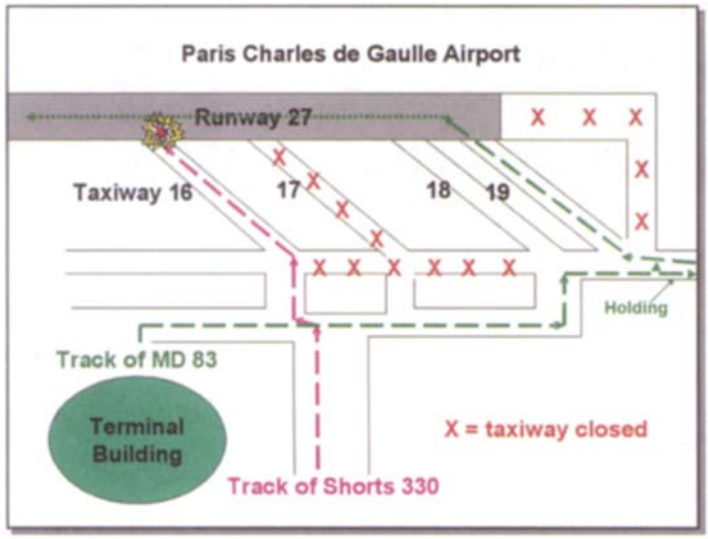
An MD 83 aircraft was cleared to take off from runway 27 at Paris Charles de Gaulle airport, and had started its take off run. A Shorts 330 was then cleared to line up and take off after the MD 83. The local air traffic controller (LOC) believed that the two aircraft were at the extreme end of the runway but the Ground Controller had cleared the Shorts to enter the runway from an intermediate taxiway. The Shorts entered the runway at the same moment as the MD 83 was reaching its rotation speed. The MD 83's wing tip sliced into the cockpit of the Shorts killing one pilot and injuring the other. The MD 83 aborted its take off and was only slightly damaged. All persons on board, 6 crew and 151 passengers, survived the accident unharmed. The Shorts aircraft was severely damaged; it only had the pilot and co-pilot on board with no passengers.

At 00:12 on May 25, 2000, the MD 83, bound for Madrid, left the stand at the airport's Terminal 1 with clearance to taxi to the holding area for runway 27. About 10 minutes later the crew reported a technical problem and asked to be put on hold. They were told to wait on taxiway 18. At 00:29 the MD 83 crew were asked to change their radio frequency to that of the Ground Controller, who subsequently confirmed their location.

The Shorts 330 left the freight area at 00:38 en route to Luton, UK, carrying cargo. It was cleared to the holding area for runway 27. While on their way to the holding area, the crew were asked whether they wanted to take off after entering the runway from an intermediate access taxiway, and their request to use taxiway 16 was granted.

At 00:47, the MD 83 had solved its technical problem and was cleared to return to runway 27. They were also asked to change back to using the control tower frequency, which they did. At 00:48 the MD 83 was advised by the control tower to line up on runway 27 after a Boeing 737 had landed. At 00:50, the

Boeing 737 had cleared the runway and the MD 83 given clearance for take off. Five seconds later the Shorts 330 was cleared to line up on runway 27 as



"number 2", indicating that it should take off after the MD 83. However, the two aircraft were in different locations, with the result that the MD 83 was taking off from the end of the runway at the same time as the Shorts entered the runway at an intermediate point. The crew of the Shorts was looking for aircraft "number 1", which was to take off before it, as they moved onto the runway. When they saw the MD 83 bearing down on them, they braked, but the MD 83 had by that time accelerated to the point where it could rotate and climb. It was at that point they saw the Shorts 330 and, despite the MD 83 trying to take, off three seconds later impact occurred. The left wingtip of the MD 83 struck the right hand propeller of the Shorts 330 and sliced through its cockpit.

At the time of the accident, construction work at the airport had taken taxiway 17 out of service. This is located between taxiway 16 used by the Shorts 330 and the end of the runway. Taxiway 17 was barricaded from the operational areas by barriers and lit by halogen lights mounted about 3 metres (10 feet) above the ground pointing downwards. From 20:30 to 04:30 ten vehicles were working on taxiway 17, each with a flashing yellow light. Drizzle was falling at the time of the accident, which would have created random reflections of the working and yellow flashing lights possibly masking the anti-collision lights of other aircraft, otherwise the night was clear with light winds. However, the presence of a dip in the runway between the threshold and the point at which taxiway 16 joined, the lights from the construction and the background of lights from an airport terminal made it very difficult for the crew of the MD 83 to see the Shorts, particularly as they had no reason to look out for it.

The explanation of why the Shorts did not see the MD 83 until the last moment is to do with the angle at which taxiway 16 joins runway 27. Before lining up a pilot always makes a visual check of the runway to confirm that it is clear. However, taxiway 16 joins runway 27 at an angle of 20° to allow high speed exit of landing aircraft. The Shorts 330 has a visual field that extends 120° to either side of the centre line. Simple geometry shows that the Shorts 330 would have had to make at least a 40° turn to the right to have had any chance of seeing the end of runway 27. Measurements taken after the event showed that there were no fixed obstacles at the height of the Shorts cockpit windows that would have obscured the end of the runway from the point at which taxiway 16 entered the runway.

Additional flights to and from Spain were scheduled for May 23–25 as the 2000 European Football League of Champions cup final (Madrid vs. Valencia) was held in Paris at that time. Special measures were taken to keep normal airport operations in place until much later in the day, to bring in additional controllers, and to set up a special operations to ensure proper liaison between airport services

during this particularly busy period. The LOC on duty at the time was an instructor who was re-familiarizing himself with Paris Charles de Gaulle airport. He had developed a mindset that all aircraft taking off from runway 27 were to be routed to the end of that runway. The offer made to the Shorts 330 to use an intermediate entry point using taxiway 16 was made and agreed by the Ground Controller, but this information was not directly passed to the LOC. Information on aircraft movements and locations was written onto paper slips. The slip containing the reference to the Shorts 330 taxiway prepared by the Ground Controller was passed to the LOC by the person in overall command of the control tower, by putting it onto a board with a number of other slips. There was no verbal conversation highlighting that the Shorts 330 was to enter the runway from an intermediate taxiway. The fact that the LOC had not had to handle any flights that used an intermediate taxiway to enter the runway strengthened his assumption that the Shorts would take off from the end of that runway.

The air traffic control picture was further compounded by the problems with the MD 83. The original plan was for this aircraft to take off from runway 27. However, when that aircraft reported problems, it was diverted off the taxiway to the holding point for runway 26. The Ground Controller then revised the take off plan to use runway 26 if and when the technical problem was resolved. The paper slip used to communicate information between controllers was amended by hand. When the technical problem was resolved, the Ground Controllers suggestion for the MD 83 to take off from runway 26 was reversed and it returned to runway 27 threshold. The paper slip was again amended by hand and passed to the LOC, who was possibly distracted over the large number of amendments and crossings out.

Normally, the crews of departing aircraft listen to everybody else's instructions and can quickly pick up an inadvertent conflict. At the time of the accident communications with the MD 83 were being made in French and with the Shorts 330 in English. The latter were not aware of what was being said to the former, while the former thought that the Shorts was behind them.

Previous similar near misses at Paris Charles de Gaulle:

1. A Shorts 330 had lined up on a runway entering from an intermediate access taxiway at the same time as a Boeing 747 had been cleared to take off from the runway threshold occurred on April 6, 1998. The flight crew of the other aircraft saw the Shorts on the runway and filed an "Airprox"* report.

2. On May 17, 1999, an aircraft had been given clearance to line up on a runway from an intermediate access taxiway, while another aircraft had

been given clearance to take off from the runway threshold. Both aircraft were Boeing 737's. An Airprox report was filed.

3. Between January and June 2000, 20 runway incursion incidents were reported at the airport, 16 with the potential for a collision to take place while an aircraft was taking off, and 4 while an aircraft was landing.

* The agreed definition of an Airprox is a situation in which, in the opinion of a pilot or a controller, the distance between aircraft as well as their relative positions and speed have been such that the safety of the aircraft involved was or may have been compromised. (UK Civil Aviation Authority, Airprox Board)

However, at the time of the accident, the processing of the Airprox reports for the two above near misses had not taken place.

Integrity Management

Hazard Evaluation and Management – the events surrounding this incident were that a major sporting activity had placed an increased demand on the airport systems. Hazard identification and risk assessment are invariably linked to a safe operating envelope. In this case, the safe operating envelope was extended, as it was necessary to extend the hours of airport operations. This meant that additional staff would have to be brought in, some of whom were not as up to date on airport operations as the regular staff.

Major Accident Potential – collision of aircraft on the runway is a major event with potentially catastrophic consequences. In this case, the fact that there were no injuries to passengers and crew on the MD 83 was more to good fortune than pilot or air traffic controller skills. The fact that there had been a number of near misses over the recent past involving aircraft that had joined a runway at an intermediate taxiway should have alerted the authorities to the potential for a major accident.

Management of Change – is a powerful concept but relies heavily on the recognition that a change has taken place. It is easy to dismiss change as of little consequence when the airport would be busy for a few hours longer than normal, or when maintenance work was going on at runway 17. However, the implications for staffing turned out to be critical.

Protective Systems – the air traffic control procedures have in built protective measures, but in this case they clearly failed. The design of the paper slips used to transfer information is well established. However, the practice of amending by hand (in the case of the MD 83 this happened twice) could well have distracted the LOC during a critical time. The information on the location of the Shorts 330 was in front of him, but he did not see it.

Even with the most sophisticated technology, the simple human element can still prevent a disaster from occurring. It is the practice of all airline pilots to look for other aircraft when entering a runway. Because of the angle at which the taxiway entered the runway, it was impossible for the Shorts 330 flight crew to look back along the runway unless they made a major turn away from the direction they intended to take off from. A hazard identification and risk assessment of the use of intermediate taxiways to enter runways may well have highlighted this and caused some form of mitigating measure to be put in place.

Competent Personnel and Procedures – there is no doubt that everybody involved in this incident was properly qualified and certified. However, even people judged competent by having the proper qualifications and certificates need to constantly exercise their skills to remain fully competent. Where a person is removed from their area of competence for other duties, they need to undertake a thorough re-orientation to return to it irrespective of the limits of certification. In this case a combination of lack of familiarity, awareness, stress and perhaps tiredness appears to have made a major contribution to this accident.

Incident Investigation – there would appear to be a significant number of near misses that occurred before this accident. It is important that all near miss reports are scrutinised and appropriate action taken promptly to avoid the top event from happening. This takes resources, which may be in short supply in today's highly commercial environment. However, the consequences of not taking prompt action can be clearly seen here.

Incidents of a Similar Nature

Advent of remote control rooms

It is easy to see how the move to building control rooms remote from process units can have a similar consequence. Traditionally, control rooms were built on the process unit in close proximity to the plant with control room or board operators having direct sight of the equipment through large windows. They were also in direct communication with the outside operators who would invariably enter the control room to discuss and observe the results of process changes made in the field. They also shared messing and changing facilities.

Remote control rooms have many advantages, not least in reducing the number of people at risk on a plant. However, they can have the disadvantage that the control room/board operator can build a mental picture of what is happening on the unit that may be divorced from reality, despite the use of radio communication with the outside operators. The Three Mile Island accident is a case in point.

There are safety critical issues associated with the change from the traditional style of control room to a remote facility, as both control room/board and field operators will have to adopt new, unfamiliar, working practices – sometimes against a backdrop of challenging industrial relations if reduced manning is a consequence. These issues should be addressed through a robust management of change programme involving all stakeholders.

Piper Alpha Fire and Explosion, July 6, 1988

At the end of the working day, the Maintenance Supervisor placed the Work Permit covering the spare condensate pump on the control room console without making any verbal report to the operators who were in discussion at the time. More information on the Piper Alpha incident is contained in the Work Permits section of this book.

Some references to read more:

- Bureau Enquêtes-Accidents Report "Accident on May 25, 2000 at Paris Charles de Gaulle (95) to aircraft F-GHED operated by Air Liberté and G-SSWN operated by Streamline Aviation.