AFI Comprehensive Implementation Programme (ACIP)

ICAO Safety Management Systems (SMS) Course
Handout Nº 1 – The Anytown City Airport accident

International Civil Aviation Organization

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AFI COMPREHENSIVE IMPLEMENTATION PROGRAMME (ACIP) SAFETY MANAGEMENT SYSTEM (SMS) COURSE

Exercise Nº 02/01 – The Anytown City Airport accident

Scenario

The following fictitious scenario, based on real-life events, fully illustrates all of the safety system components. In the late hours of a summer Friday evening, while landing on a runway heavily contaminated with water, a twin-engine jet transport aircraft with four crew members and 65 passengers on board overran the westerly end of the runway at Anytown City airport. The aircraft came to rest in the mud a short distance beyond the end of the runway. There were no injuries to crew or passengers, and there was no apparent damage to the aircraft as a consequence of the overrun. However, a fire started and subsequently destroyed the aircraft.

Anytown City is a popular summer resort. The predominant weather for a typical summer day is low stratus and fog in the early morning, which gradually develops into convective cloud as the air warms. Severe thunderstorms are common in the early afternoon and persist until the late evening hours. The whole region where Anytown City is situated is *"thunderstorm country"* during summer.

The runway at Anytown is 4 520 feet long. It is a relatively wide runway with a steep downward slope to the west. It is served by a low-power, short-range, non-directional beacon (NDB), unreliable in convective weather. Runway lighting is low-intensity, and there are no approach lights or visual approach aids. It is a classic *"black-hole"* approach during night landings.

The flight had originated at the airline's main base, 400 km away. This was the second-to-last flight for the flight crew that day. They had reported for duty at 11:30 hours and were due to be relieved at 22:00 hours. The crew had been flying a different schedule for the last three weeks. This was the beginning of a new four-day schedule on another route. It had been a typical summer afternoon, with thunderstorms throughout the entire region. Anytown City had been affected by thunderstorms during the early afternoon. No forecast was available, and the pilot-in-command (PIC) had elected to delay the departure.

The flight schedule was very tight, and the PIC's decision to delay created a number of additional delays for subsequent flights. The dispatcher working the flight did not bring to the flight crew's attention the need to consider a contaminated runway operation at Anytown, and did not review the landing performance limitations with them. After a long delay, the PIC decided to add contingency fuel and depart.

Visual conditions were present at Anytown, although there were thunderstorms in the vicinity of the airport, as well as a persistent drizzle. With no other reported traffic, they were cleared for a night visual approach. After touchdown, the aircraft hydroplaned and overran the end of the runway slightly above taxiing speed.

The PIC was a very experienced pilot. He had been with the airline for many years, accumulating several thousand hours of flying time as a second-in-command (SIC) in two other types of large jet aircraft. However, he had limited experience with the aircraft type he was flying the night of the accident. He had not had the occasion to fly into Anytown before because the larger aircraft types he had been flying previously did not operate into Anytown. This was his first month as a PIC. He was a well-balanced individual, with no personal or professional behavioural extremes.

At the time of the accident the SIC was very inexperienced. He had recently been hired by the airline and had only been flying the line for about a month. He had flown into Anytown on two other occasions with another PIC, but only during the day. His training records indicated standard performance during induction into the airline's operations.

Investigation

Initially, the investigation would focus on determining what actually happened at Anytown. It was learned that it had rained heavily at the airport and that there was standing water on the runway. Readout of the flight recorders disclosed that the PIC flew the approach with excess airspeed which resulted in the airplane touching down smoothly, but well beyond the touchdown zone, and then hydroplaning off the end. It was also determined that the PIC neglected to consult the performance charts in the aircraft flight manual for the correct landing distance on a wet runway. Also, the SIC did not make the required callouts during the approach.

These unsafe flight crew actions could in and of themselves explain the overrun and focus the investigation on a conclusion of *"crew error"* as a cause for the accident. However, if one were to investigate further into the company's operational procedures and practices and look upstream for other factors influencing the crew's performance, one could identify additional active and latent failures which were present during the flight. So the investigation should not stop at the point where the crew made errors.

If the investigation were to determine whether any other unsafe acts occurred in the operation, it would discover that not only did the dispatcher fail to brief the PIC on potential problems at the airport (as required by company procedure), but that the company's agent at Anytown had not reported to the dispatcher at headquarters that heavy rain had fallen. Inspection of the runway revealed poor construction, paving and lack of adequate drainage. It was also discovered that maintenance and inspection of the NDB was not in accordance with prescribed procedures. Over the past month, other flight crews had reported on several occasions that the ground aid had given erratic indications during instrument approaches; no attempt had been made to rectify the problem.

With these facts in mind and by referring to the Reason model, it can be seen that the actions of other front-line operators were also unsafe and had an influence upon the performance of the flight crew and the outcome of the flight. These activities can be classified as active failures and are also linked to line-management and decision-makers' performance.

Next, the investigation should determine if there were any adverse pre-conditions under which the flight crew had to operate. These can be listed as follows:

1) a night non-precision instrument approach to an unfamiliar airport;
2) a poorly lit, short, wide and steeply sloping runway;
3) poor runway pavement and drainage;
4) a lack of reliable information on the performance of the NDB;
5) a lack of reliable information about the wind conditions;
6) a flight schedule which allowed only a 15-minute turnaround at Anytown;
7) an arrival delayed by two hours, compromising crew duty-time requirements;
8) an aircraft not equipped with thrust reversers;
9) an inadequately trained flight crew, inexperienced in the type of aircraft and at the airport; and
10) inadequate crash, fire, and rescue services.

The Reason model classifies these pre-conditions as latent conditions, many of which lay dormant for some time before the accident and which were the consequences of line management and decision-maker actions or inactions. For example, pairing two pilots who were inexperienced in the type of aircraft and allowing the PIC to operate into an unfamiliar airport with a non-precision approach procedure was the result of decisions made by line management. Also, the failure to follow up on reported discrepancies with the NDB and the failure to conduct adequate inspections of the airport indicate either a lack of awareness of the safety implications or a tolerance of hazards by the line management and the regulatory authority. The investigation found that pilots were not briefed on the use of performance charts for contaminated runways, nor did they practice hydroplaning avoidance techniques. These discrepancies can be attributed to both line and upper management's failure to provide adequate training.

At the roots of this occurrence were other decisions made by both upper management levels within the company and in the regulatory authorities that had a downside. Management had decided to operate a scheduled service at an airport with known deficiencies in facilities (poor lighting and approach aids, inadequate weather services). More importantly, they chose to operate without the required level of crash, fire and rescue services available at the airport. In addition, management selected this type of airplane for this route out of marketing and cost considerations, despite its unsuitability for all-weather operations at Anytown. Compounding the problem was the decision by the regulatory authority to certify the airport for scheduled air transport operations in spite of its significant safety deficiencies.

The organizational perspective portrays the interactive nature of the conditions and failures and how they can combine to defeat the defences that one might expect to find within an organizational and operational environment. It also depicts the critical importance of identifying latent failures as they relate to the prevention of accidents.

In summary, the approach to the organizational accident encourages the investigator to go beyond the unsafe actions of front line operators to look for hazards that were already present in the system and which could contribute to future occurrences. This approach has direct implications for the prevention activities of operators and regulators, who must identify and eliminate or control latent conditions.

EXERCISE 02/01

Group activity

A facilitator will be appointed, who will coordinate the discussion. A summary of the discussion will be written on flip charts, and a member of the group will brief on their findings in a plenary session.

Required task

1) Read the text related to the accident of the twin-engined jet transport at Anytown City Airport.

2) From the investigation report of the above accident, you should identify:

   a) **Organizational processes** that influenced the operation and which felt under the responsibility of senior management (i.e. those accountable for the allocation of resources);

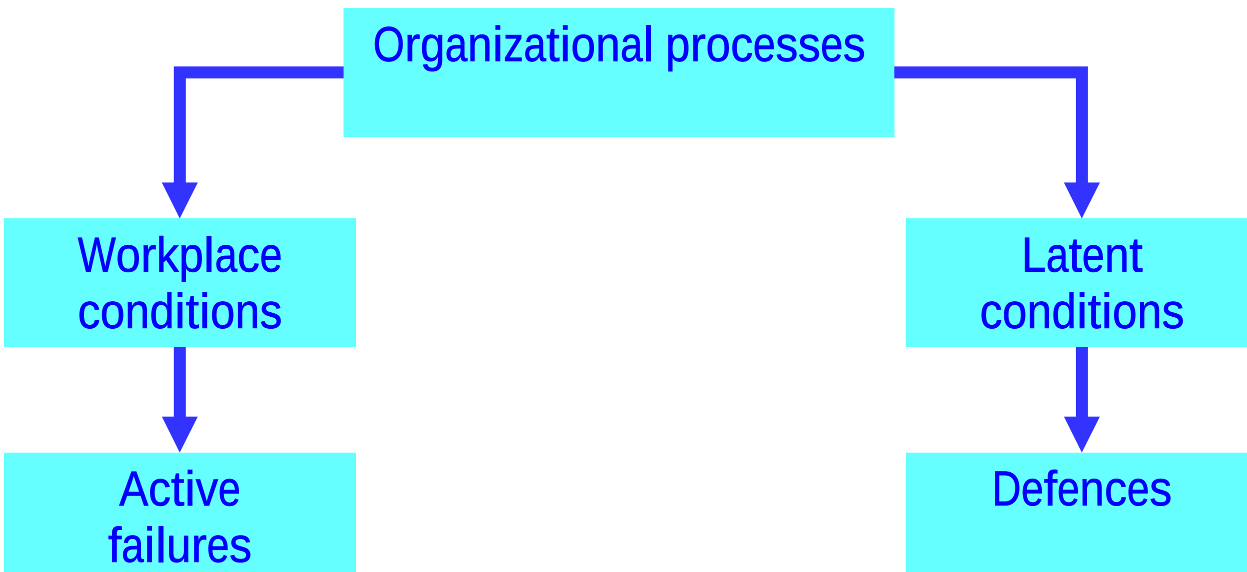
b) **Latent conditions** in the system safety which became precursors of active failures;

c) **Defences** which fail to perform due to weaknesses, inadequacies or plain absence;

d) **Workplace conditions** which may have influenced operational personnel actions; and

e) **Active failures**, including errors and violations

3) When you have concluded the above, your task is to complete the Table 02/01 – *Analysis* classifying your findings according to the Reason Model.



Reason Model

Table 02/01 – *Analysis*

Organizational processes *Activities over which any organization has a reasonable degree of direct control*	
Certification of the aerodrome	
Poor Oversight by the Regulatory body	
Deficiencies in management procedures with respect to airline operations	
Deficiencies in management procedures with respect to airport operations, maintenance,	
No actions taken in correcting identified deficiencies – normalization of deviance	
Inadequate training for flight crew	
Poor pairing of crew/ Crew rostering/scheduling	

Workplace conditions *Factors that directly influence the efficiency of people in aviation workplaces*
Standing water
Bad weather
Inexperienced crew on specified route
Credibility of SIC
Crew morale
Ergonomics – aircraft not suitable for route

Latent conditions *Conditions present in the system before the accident, made evident by triggering factors*
Runway conditions (Pavement/drainage)
Unreliable NDB
Poor Runway lighting
No approach lights/visual approach aids
Non-precision approach

Active failures *Actions or inactions by people (pilots, controllers, maintenance engineers, aerodrome staff, etc.) that have an immediate adverse effect*
Did not consult charts
Communication breakdown
No Runway Inspections
Duty time exceeded
SIC did no call-outs on approach
Excessive airspeed on approach

Defences *Resources to protect against the risks that organizations involved in production activities must confront*
Contaminated runway operation charts
Regulation – poor oversight
Training - failure to comply with SOPs and checklists
Technology - aircraft not approved for all weather operations

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AFI Comprehensive Implementation Programme (ACIP)

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Handout Nº 2 – The Anyfield Airport accident

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AFI COMPREHENSIVE IMPLEMENTATION PROGRAMME (ACIP) SAFETY MANAGEMENT SYSTEM (SMS) COURSE

Exercise Nº 03/01 – The Anyfield Airport accident

Scenario

In the early hours of an autumn Monday-morning, a twin-engined jet transport with 5 crew-members and 63 passengers on board while in its take-off run at Anyfield Airport collided with a small twin-engined propeller-driven aircraft, with only a single crew-member that had intruded the departure-runway. Both aircraft were severely damaged as a result of the collision. The subsequent fire destroyed both aircraft and was the death-cause for most of the passengers.

Anyfield Airport is a medium-sized airport, with a single runway which can be accessed (or vacated) by a number of intersections. It is a controlled aerodrome; the control-tower is located 400 meters north of the middle of the runway. Traffic-numbers are on the rise as quite a few commuter-type airlines have started operating to and from Anyfield.

Although the airport is in a region in which several foggy days a year are common, it is not equipped with a Surface Movement Radar (SMR), nor does it have special taxiway-lighting facilities for use under low visibility-conditions.

Air Traffic Control at Anyfield is slightly understaffed, but so far it was not thought necessary to impose restrictions on operations to and from Anyfield. There is a discrete frequency (Ground Control) to handle taxiing aircraft.

At the time of the collision, the average visibility was around 700 meters with fog-banks, which is just sufficient to allow the tower-controller to see the middle part of the runway. The controllers' view at the intersection where the intruding aircraft entered the runway however was obstructed by the newly constructed extension to the terminal building at Anyfield Airport.

The Air Traffic Controller (ATCO) was a very experienced controller. He had been working in ATC for many years, at several major facilities, and had been transferred to Anyfield to act as an OJT-instructor only eight months before the date of the accident.

At the time of the collision, the **ATCO1** was alone in the control-tower, as his Assistant / Ground Controller **ATCO2** – of far less experience – had briefly left the TWR to answer a call of nature. They were both completing their third consecutive nightshift, had come on duty at 22:00 hours the previous evening and were due to be relieved within thirty minutes when the accident occurred.

The crew of the jet-aircraft was experienced operators to and from Anyfield. From their point of view, on the morning of the accident there was nothing unusual in the way their flight was handled by ATC. They taxied to the runway with the extra caution required by the fog-conditions, and after being cleared for take-off they made certain they were lined up correctly on the runway-centerline before applying take-off power.

The pilot of the twin-engined piston-driven aircraft was unfamiliar with Anyfield Airport, having been sent there at short notice to collect an aircraft that had to divert into Anyfield two days earlier for weather-reasons.

Investigation

Although **ATCO1** was very experienced, he had only worked a limited number of solo-shifts in Anyfield TWR. Having validated his TWR-rating in early summer, he had been involved in giving on-the-job-training (OJT) instruction on most of his shifts after that. As a consequence of the staff-shortage he was required to work his share of nightshifts like all other controllers. The shift in which the accident occurred was only his second where he had worked at Anyfield TWR under foggy/low visibility conditions; the first had been the previous night, when there was hardly any traffic as it was the night from Saturday to Sunday.

A number of years ago there had been an incident at Anyfield involving runway-intrusion by a vehicle, under similar meteorological conditions as in this case. One of the recommendations at that time was the installation of a SMR, together with stop-bars at all runway-intersections. The authorities decided that in view of the limited number of days (with fog) that would warrant the use of a SMR, the benefit of having a SMR didn't match the costs of having one installed. The same applied for the installation of stop-bars, but in lieu of those, painted signs had been put in the grass next to the runway-intersections, informing those who noticed them there was a *"runway ahead".*

As the early morning-traffic began to come alive, **ATCO1** and **ATCO2** were each working an independent R/T-frequency. When **ATCO2** announced he had to visit the men's room for a second, **ATCO1** told him to go ahead, intending to work both frequencies by himself. In order to do so, **ATCO1** had to physically move between two control-positions in the TWR that are about three meters apart, for Anyfield TWR isn't equipped with a frequency-coupling installation. Transmissions on one frequency can't be heard by stations on the other frequency.

The piston-engined aircraft's pilot had arrived in Anyfield late the night before. After a short sleep he went to the airport quickly in order to waste as little time as possible, for his company wanted the aircraft back at its home base a.s.a.p. After the minimum of preparation needed, he went to his aircraft and called ATC for approval to taxi to the runway. He obtained the clearance and began taxiing, but soon found himself lost at the foggy, unfamiliar airport. The fact that there were no signs denominating the various taxiway-intersections didn't help much either.

The R/T-tapes showed that the piston-pilot then called G/C (by R/T) and asked for *"progressive taxi-instructions".* **ATCO2** replied by asking his position. The pilot said: *"I believe I'm approaching Foxtrot-intersection"*, to which **ATCO2** answered: *"At Foxtrot taxi straight ahead".* In fact the pilot had already passed Foxtrot, and should have turned onto the parallel taxiway. The instruction from **ATCO2**, though technically correct, caused the pilot to taxi onto the runway where the jet was in its take-off roll. Since the communications to both aircraft took place on different frequencies, neither pilot was aware of what was happening.

After the collision, it took **ATCO1** several minutes to realize something was wrong. Of course he hadn't observed the departing jet passing on the section of the runway that was visible to him, but he initially blamed that on the fog patches and/or being distracted by traffic on the G/C frequency.

And apart from the fog, **ATCO1** was unable to see the part of the runway where the collision had taken place because of the newly built extension of the terminal building blocking his view. So it was not until he wanted to transfer the departing jet to the next controller (Departure Control) that he became aware things weren't as they should be, when his transmissions to the jet remained unanswered.

ATCO2, who returned shortly after the accident, at the same time reported having no contact with the taxiing twin-prop. **ATCO1** then decided to alert the fire-brigade, but as he had no idea where to send them, more precious time was lost as the rescue-vehicles tried to make their way across the foggy airport. When they finally arrived at the accident-site, they found there was little they could do as the wreckage of the aircraft had almost burnt-out completely already.

Had a SMR been installed following the recommendation after the other incident, this would have provided the following lines-of-defense (in declining order):

- Proper taxi-instructions could have been given to the *"lost"* aircraft.
- The ATCOs would have observed the runway-intrusion.
- The collision-site would have been easily identified.
- Adequate instructions could have been given to the rescue-vehicles.

This goes for the stop-bars as well. Had they been installed, the twin-prop more likely than not wouldn't have entered the runway.

At the very least, special procedures for Low Visibility Operations (LVO) at Anyfield should have been developed and in force, limiting the number of movements at the field. The ATCOs should have been trained in working with these special procedures, ideally on a simulator, to help them cope with the unusual situation once it occurred.

In their talks with the airport-authorities, ATC management should have firmly opposed the plans for extension of the terminal-building. But, as a result of not having any input from the operational ATCOs (who were not available to attend the meetings due to staff-shortage), management wasn't even aware it would constitute a line-of-vision problem from the TWR.

ATCO1 shouldn't find himself in a position where he was forced to work two positions by himself. At all times ATC-positions should be sufficiently staffed to allow the traffic to be handled in a safe manner.

The installation of a frequency-coupler might have helped prevent the collision from occurring. As it is, these systems are considered *"optional"* by the aviation-authorities, so only few ATC-facilities have them.

Management should ensure that OJT-instructors are given the opportunity to stay current at the positions where they are supposed to teach, by scheduling the instructor for duties without trainees at regular intervals. Such duties should be sufficiently challenging of nature to allow the instructor to practice his skills (in other words: shifts without traffic may look good in a roster, but are of no value for currency-maintaining purposes)

Had there been a well-devised training-curriculum that was correlated with the duty-roster, management would have recognized that **ATCO1**, although qualified, hadn't been able to acquaint himself with working at Anyfield TWR under low visibility-conditions. Ideally, they wouldn't have scheduled him for unsupervised duty when low visibility was forecast.

Dedicated LVO-training would have made **ATCO2** aware of the dangers involved, alerting him to be more positive in guiding the lost taxiing pilot. At the very least he probably wouldn't have given the pilot irrelevant information.

It is a scientific fact that when consecutive nightshifts are worked, the performance of persons engaged in cognitive tasks (such as ATC) decreases dramatically in the second and later nights, especially between 03:00 hrs and 07:00 hrs. **ATCO1** at Anyfield was on his third nightshift in a row, which could explain why he failed to recognize a potentially dangerous situation that he wouldn't have missed under other circumstances. When designing shift-rosters for ATCOs it is advisable to keep the number of consecutive nightshifts to an absolute minimum.

Based on the meteorological forecast, and taking into account the propeller-aircraft's pilot was unfamiliar with Anyfield, it may be argued that the air operator would have done better to send two pilots to collect the aircraft. Even with limited knowledge of CRM-principles, a second pilot could have prevented the other pilot from acting the way he did.

EXERCISE 03/01

Group activity

A facilitator will be appointed, who will coordinate the discussion. A summary of the discussion will be written on flip charts, and a member of the group will brief on their findings in a plenary session.

Required task

1) Read the text related to the accident of the twin-engined jet transport at Anyfield Airport.

2) From the investigation report of the above accident, you should identify:

   a) **Organizational processes** that influenced the operation and which felt under the responsibility of senior management (i.e. those accountable for the allocation of resources);

   b) **Latent conditions** in the system safety which became precursors of active failures;

   c) **Defences** which fail to perform due to weaknesses, inadequacies or plain absence;

d) **Workplace conditions** which may have influenced operational personnel actions; and

e) **Active failures**, including errors and violations

3) When you have concluded the above, your task is to complete the Table 03/01 – *Analysis* classifying your findings according to the Reason Model.

Reason Model

Table 03/01 – *Analysis*

Organizational processes *Activities over which any organization has a reasonable degree of direct control*	
Inadequate staffing / allocation of resources	Attending of construction meeting
- not enough atc	
- only 1 pilot to pick the plane on an unknown aerodrome and bad weather	
Scheduling	
- atc currency	
- 3 consecutive nightshifts	
- one atc for 2 positions	

Workplace conditions *Factors that directly influence the efficiency of people in aviation workplaces*
experience with airfield layout - OJT
Ergonomics
Workforce stability - shortage of staff
Morale – 3 nightshifts in a row
Weather - fog

Latent conditions *Conditions present in the system before the accident, made evident by triggering factors*
ATC understaffing
Terminal building
Position of the control tower (400m)/no smr

Active failures *Actions or inactions by people (pilots, controllers, maintenance engineers, aerodrome staff, etc.) that have an immediate adverse effect*
ATCO did not challenge ambiguous position report by twin-engine pilot
Management did not implement smr/signs/LVO/stop bars
Management failure to stop the extension of the terminal building

Defences *Resources to protect against the risks that organizations involved in production activities must confront*
Regulation
1 **Progressive taxi instructions**
2 No LVO procedures
Technology
1 no SMR
2 no ATC coupling
3 no taxiway lighting
4 inadequate signage
Training
1 no training for specific conditions

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AFI Comprehensive Implementation Programme (ACIP)

ICAO Safety Management Systems (SMS) Course
<u>Handout N° 3</u> – International airport construction work

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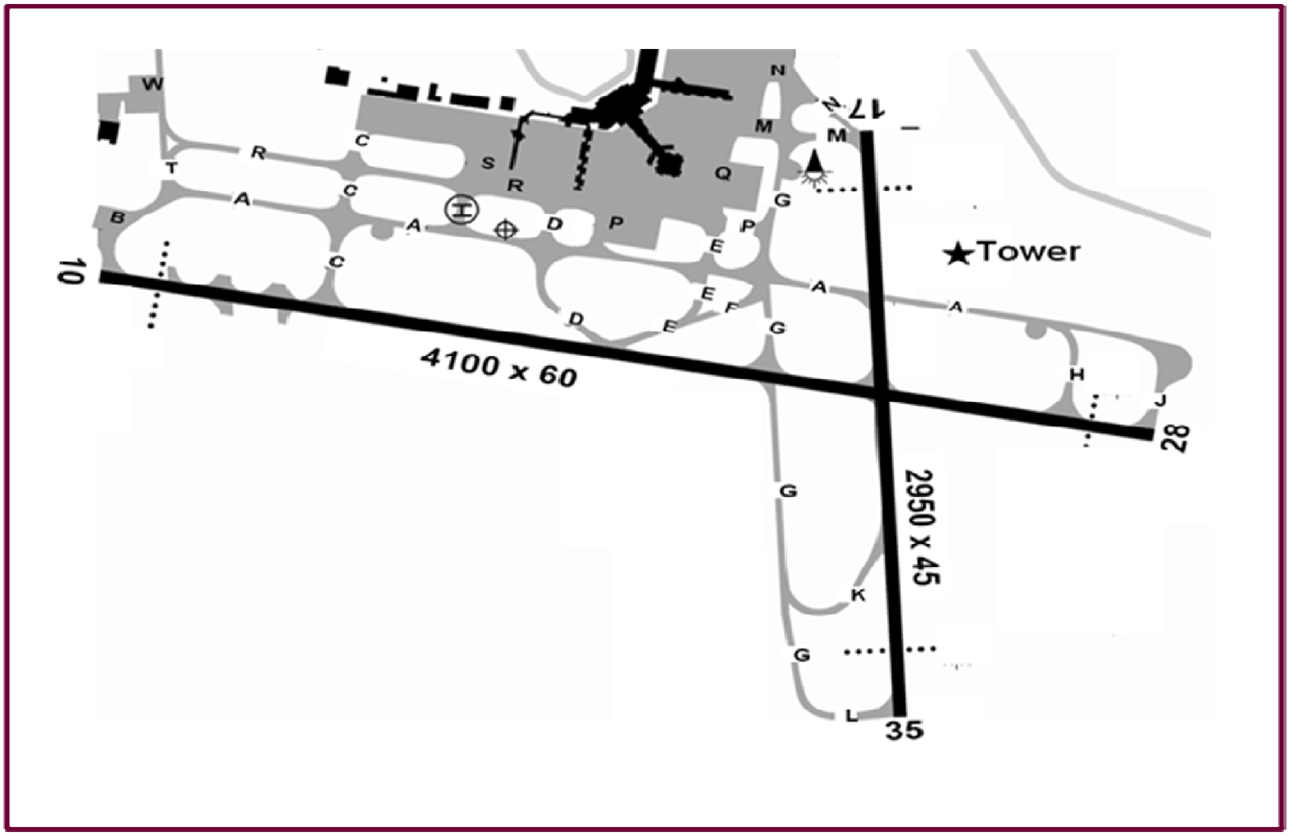
AFI COMPREHENSIVE IMPLEMENTATION PROGRAMME (ACIP) SAFETY MANAGEMENT SYSTEM (SMS) COURSE

Exercise 04/01 – International airport construction work

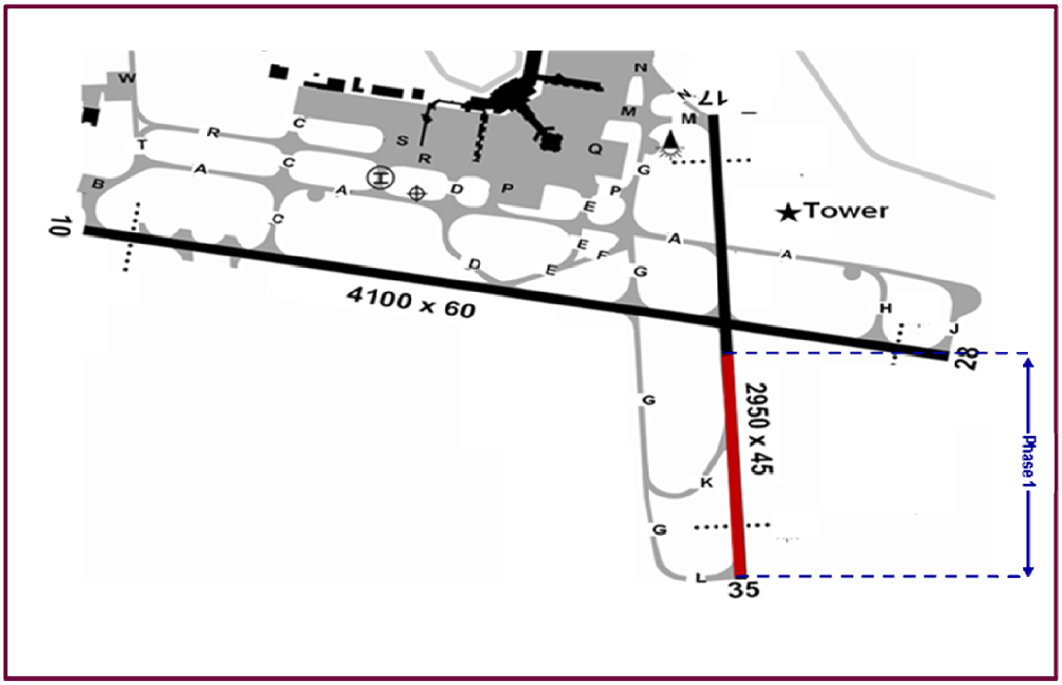
Scenario

Construction project to enlarge and repave one of the two crossing runways at an international airport (150,000 movements a year). It's a three-phase construction project.

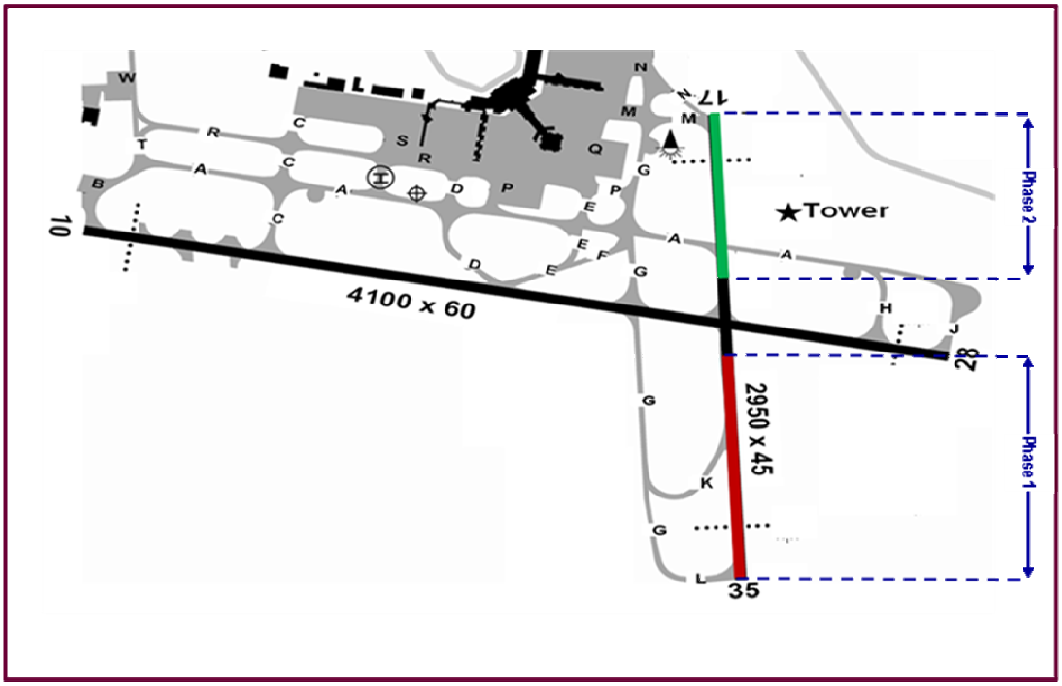


Scope of the work

- **Phase 1:**
  - o Increase the width of runway 17-35 from 45 to 60 meters from a point 200 m from the intersection with runway 10-28 to the south and strengthen the runway (from asphalt to concrete) to increase its Pavement Classification Number (PCN).
  - o Estimated time to complete the work:
    - Seven (7) months.



- **Phase 2:**
  - Increase the width of runway 17-35 from 45 to 60 meters from a point 200 m from the intersection with runway 10-28 to the north and strengthen the runway (from asphalt to concrete) to increase its PCN.
  - Estimated time to complete the work:
    - Seven (7) months.

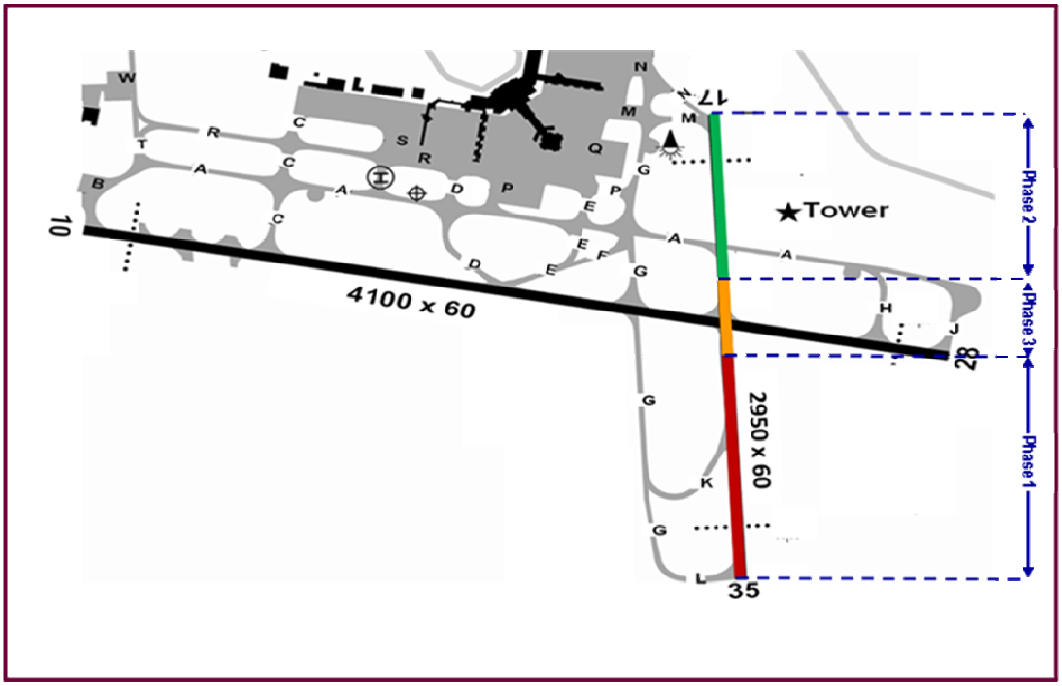


- **Phase 3:**

    - Complete the construction work of runway 17-35 for the central area of the last 400 m at the intersection of runway 17-35 and runway 10-28 (from asphalt to concrete), increasing its width from 45 to 60 meters and its PCN.

    - Estimated time to complete the work:

        - Two (4) months.



- **Runway utilization during the construction work**

    - Continuous utilization of runway 10-28 during the three-phase of runway 17-35 construction project. *[To maintain regular aerodrome operations (production) and existing margins of safety (protection) in the operations during the runway construction project].*

    - Length of runway 10-28 is currently 4.100 m and during Phase 3 its length will be reduced, leaving a distance of 2.600 m for aircraft operations measured between threshold 10 and the intersection of runway 10-28 with taxiway Golf.

Group activity

A facilitator will be appointed, who will coordinate the discussion. A summary of the discussion will be written on flip charts

A member of the group will brief on their findings in a plenary session.

Your task

1) Identify the hazards using brainstorming techniques.
   a) Brainstorm a list of possible hazards, their components and their consequences *(use a flip chart)*.
2) Complete the attached log *(Table 04/01)* as follows:
   a) List type of operation or activity
   b) State the generic hazard *(hazard statement)*
   c) Identify specific components of the hazard
   d) List hazard-related consequences
3) It is recommended to conduct the hazard identification and analysis per each construction phase of runway 17-35.

TABLE 04/01 – HAZARD IDENTIFICATION

Nº	Type of operation or activity	Generic hazard (hazard statement)	Specific components of the hazard	Hazard-related consequences
	Phase 1			
1	*Air Traffic Services*	*Aerodrome construction.*	*Single runway operation* *Runway Capacity* *Taxiway Congestion* *Separation* ***PHASE 2*** ***Runway as Taxiway*** ***Closure of A & N taxiway*** ***Human Error*** **Phase 3** **Shorter Runway** **Economic**	*Traffic delay* *Increase number of ATMs – stress/workload on ATC* *Time delays/Traffic Delay* *Possible Collision* ***Increased delays (collision)*** ***Delays*** ***Disastrous*** **Overrun runway** **Loss of Revenue**
2	Aerodrome Operations	Aerodrome construction	F.O.D. Access Control Frequent Movement of Construction Vehicles / equipment Untrained Workers **PHASE 2** **Dust** **Phase 3** **Shorter Runway** **Economic**	Ingestion Security breech Collision Collision & Runway incursion **Reduced Visibility** **Overrun runway** **Reduction in revenue**

Nº	Type of operation or activity	Generic hazard (hazard statement)	Specific components of the hazard	Hazard-related consequences
	Phase 1			
3	Airline Operations	Aerodrome construction	Single runway operation FOD **PHASE 2** **Phase 3** **Shorter Runway** **Economic**	Flight Schedule Delays Slot Time Increase Fuel Consumption Delay ETA Passenger Complaints Increase Workload Ingestion-damage **Same problems above but the consequences are increased.** **Overrun runway** **Loss of revenue**
4				

Nº	Type of operation or activity	Generic hazard (hazard statement)	Specific components of the hazard	Hazard-related consequences
	Phase 1			
5				
6				
7				
8				

Nº	Type of operation or activity	Generic hazard (hazard statement)	Specific components of the hazard	Hazard-related consequences
	Phase 1			
9				
10	AOC	FUEL	COST	

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ICAO Safety Management Systems (SMS) Course
<u>Handout N° 4</u> – Accident Boeing B-747 at Taipei International Airport

Group 1

International Civil Aviation Organization

TABLE 05/01 – HAZARD IDENTIFICATION AND RISK MITIGATION

Nº	Type of operation or activity	Generic hazard	Specific components of the hazard	Hazard-related consequences	Existing defences to control risk(s) and risk index	Further action to reduce risk(s) and resulting risk index
1	*Aerodrome operations*	Aerodrome Construction Runway 05 R closed	Inadequate taxiway lighting, markings, signage and no runway guard lights	Inadequate guidance for taxi leading to poor judgement and loss of situational awareness	Airfield inspection for light intensity reading and general inspection Risk index: 4A Risk Intolerable: Unacceptable under existing circumstances	Review policies on aerodrome lighting inspections Review procedures in the aerodrome operations manual Reinforce frequency of runway inspections Update training for aerodrome operations personnel Install lights like stop bars, remove threshold and marking. Risk index: 1C Risk tolerability: Acceptable after review of the operation
			No Construction Warning/Hazard Lights	Fatal Accident or Collision	NOTAM Risk index: 3 A Risk Intolerable: Unacceptable under existing circumstances	Barriers with obstruction lights Runway closure marking and X's More precise NOTAM, Constant update on aerodrome condition on ATIS. Risk index: 1D Risk tolerability: Acceptable after review of the operation

Nº	Type of operation or activity	Generic hazard	Specific components of the hazard	Hazard-related consequences	Existing defences to control risk(s) and risk index	Further action to reduce risk(s) and resulting risk index
2	Aircraft Operations	Aerodrome Construction	Inadequate taxiway lighting, markings, signage and no runway guard lights	Loss of situational awareness	PVD, PFD and ILS Charts ,Aircraft heading reference, NOTAM, Crew resource management Risk index: 4A Risk Intolerable: Unacceptable under existing circumstances	Review all procedures Follow notams Review crew resources management Risk index: 1C Risk tolerability: Acceptable after review of the operation
	Aircraft Operations	Poor Crew Resource Management	Human Error	Accident or Incident	CRM Training PVD ,Charts consultation, Follow Cockpit Procedures Risk index: 3A Risk Intolerable: Unacceptable under existing circumstances	Review CRM Training Procedures , Follow all electronic system in cockpit, Review PVD procedures, Review cockpit procedures Review the safety Culture change Risk index: 3 C Risk tolerability: Acceptable after review of the operation

Nº	Type of operation or activity	Generic hazard	Specific components of the hazard	Hazard-related consequences	Existing defences to control risk(s) and risk index	Further action to reduce risk(s) and resulting risk index
3	Aerodrome Operations & Aircrafts Operator	Bad Weather	Poor Visibility	Collision	Airfield Lighting , Signage, Marking and ATIS Risk index: 3 A Risk Intolerable: Unacceptable under existing circumstances	Implement SMR High intensity lighting Training Update S.O.P.s Risk index: 2 C Risk tolerability: Acceptable after review of the operation

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AFI Comprehensive Implementation Programme (ACIP)

ICAO Safety Management Systems (SMS) Course
***Handout N° 5** – Cuzco International Airport operation*

International Civil Aviation Organization

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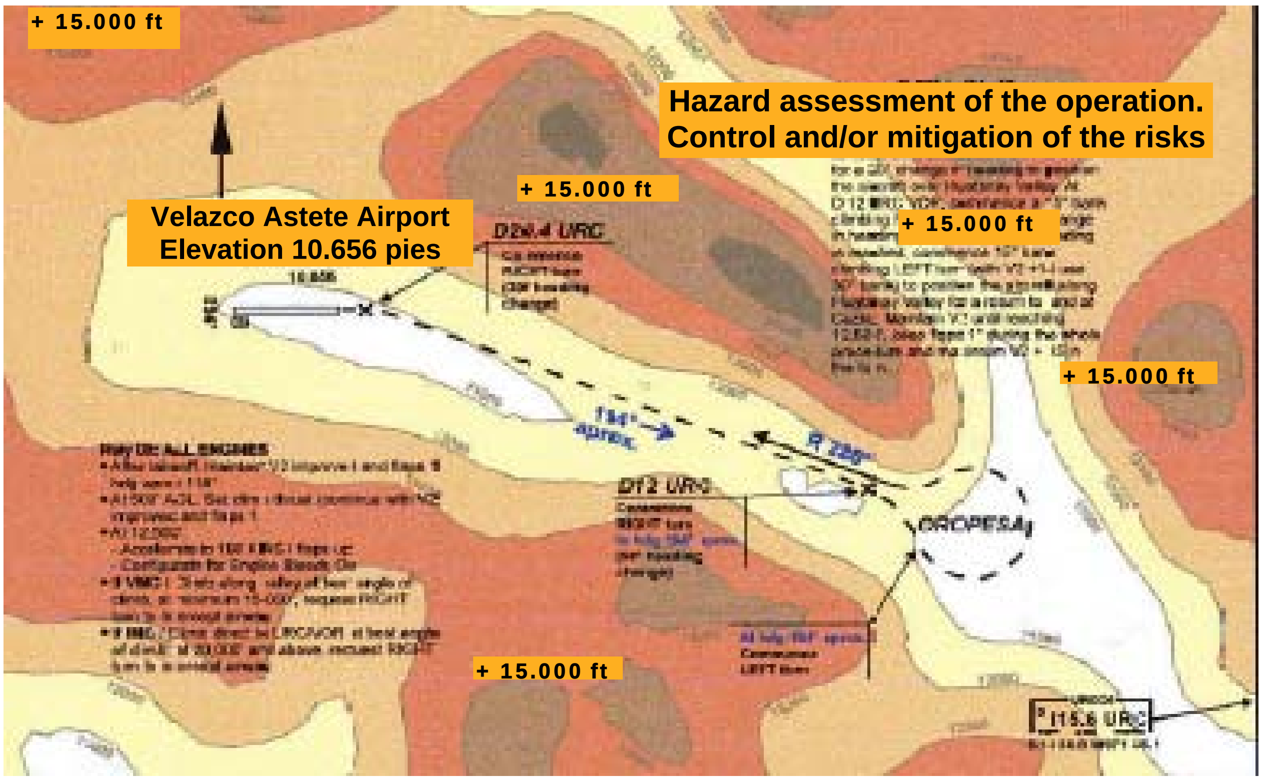
AFI COMPREHENSIVE IMPLEMENTATION PROGRAMME (ACIP)
SAFETY MANAGEMENT SYSTEM (SMS) COURSE

Exercise 08/01 – Cuzco International Airport operation

Scenario

This is a proposed airline operation with a commercial twin-engine jet aircraft (e.g. B-737, MD-80, A-320, etc.) at Cuzco International Airport.

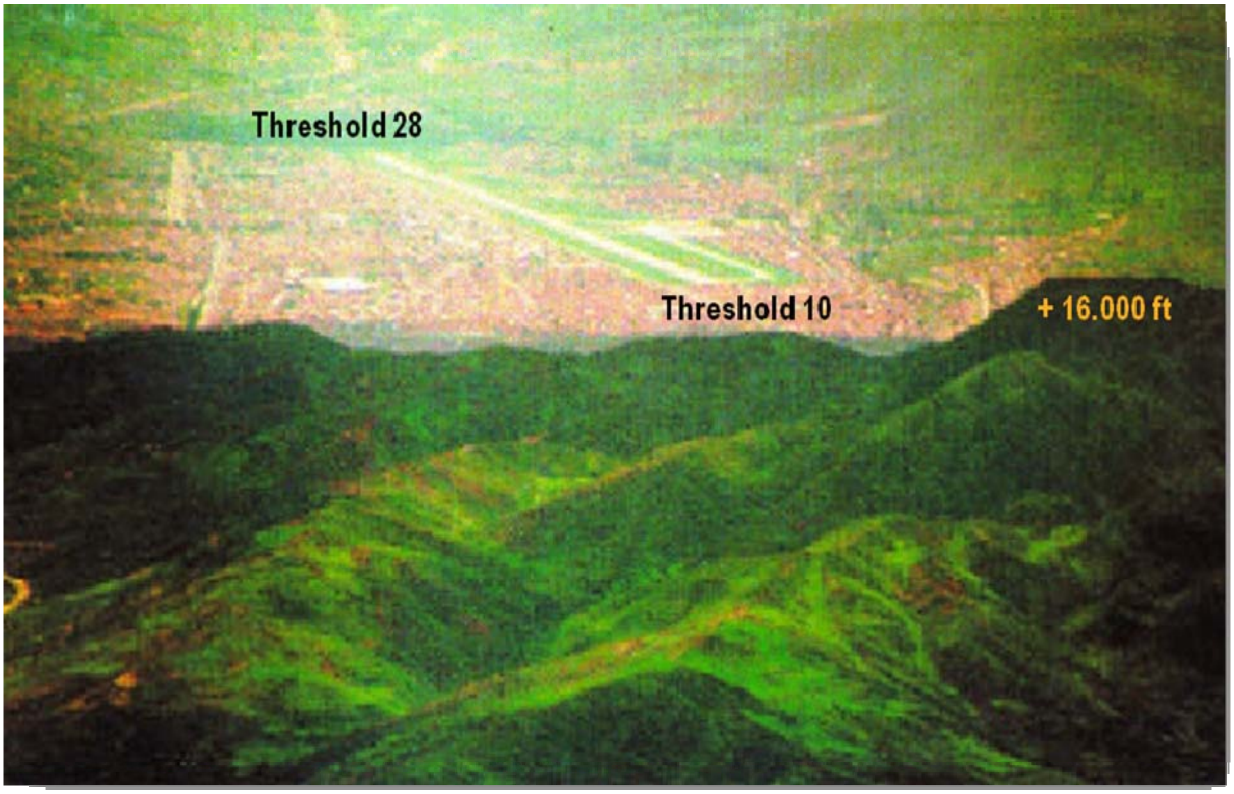


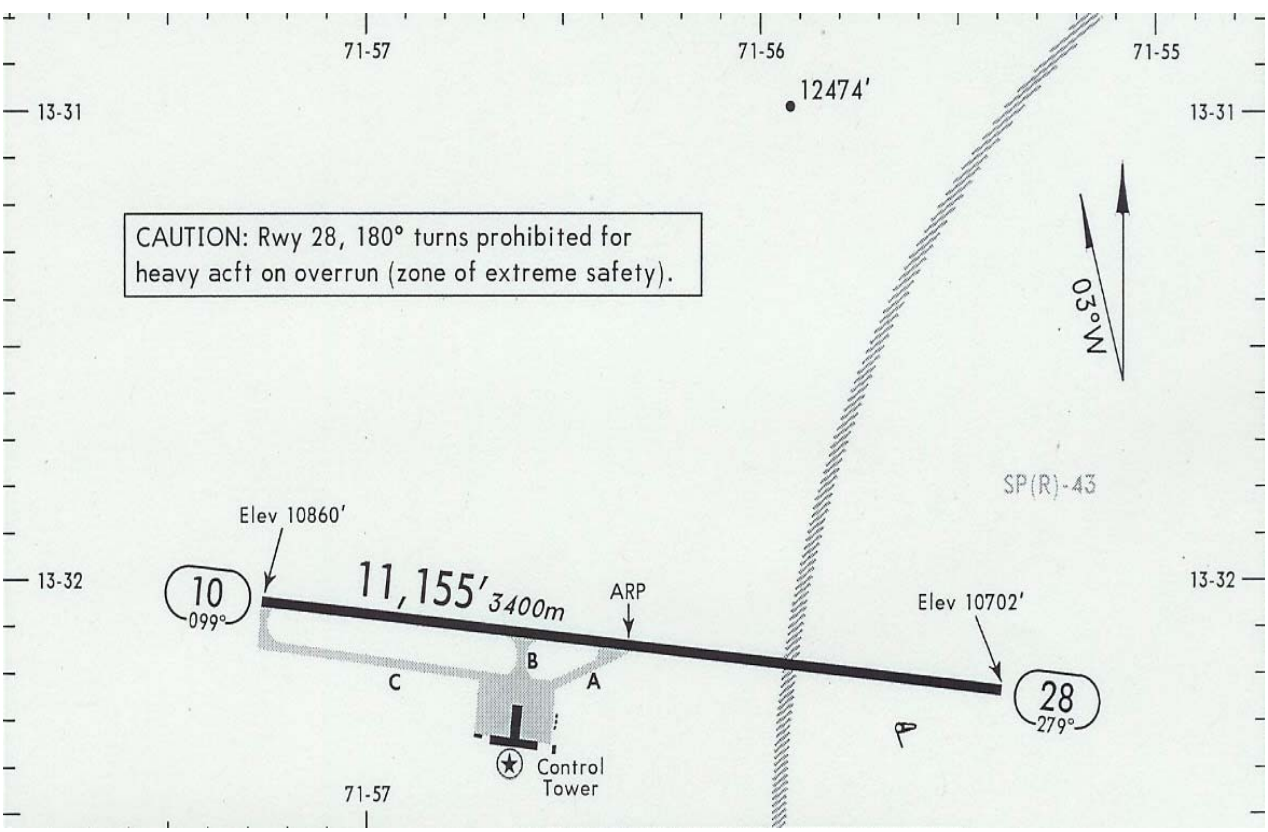
1. Cuzco Airport characteristics and operation

- VMC and day-light aircraft operation
- Landing on runway 28 only.
- Take-off on runway 10 only.
- In case of engine fire, engine-out or emergency condition return to airport is mandatory, except if the aircraft's weight and performance allow the aircraft to comply with obstacle clearance net trajectory.
- Katabatic wind forces tailwind take offs from approximately 16:00 hours daily.
- No ILS approach is available.
- VOR used for instrument letdown (URCOS) not located at the aerodrome.


Velazco Astete Airport
Elevation 10.656 ft
Threshold 28


+ 16.000
Threshold 10
Velazco Astete
City of Cuzco
Threshold 28


Threshold 28
Threshold 10
+ 16.000 ft


71-57
71-56
71-55
12474'
13-31
13-31
CAUTION: Rwy 28, 180° turns prohibited for
heavy acft on overrun (zone of extreme safety).
03°W
SP(R)-43
Elev 10860'
13-32
13-32
10
099°
11,155' 3400m
ARP
Elev 10702'
28
279°
B
C
A
Control
Tower
71-57

2. What is the safety concern?

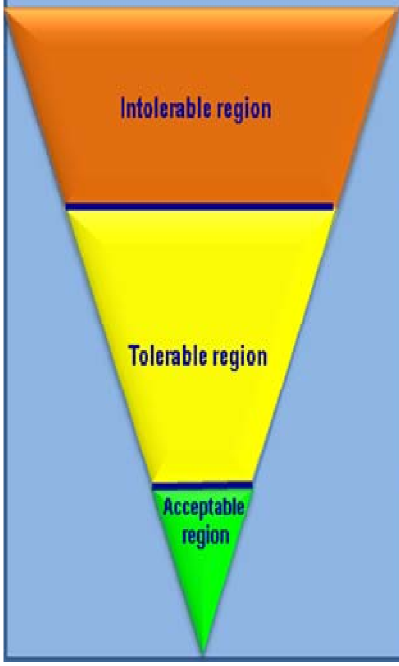
- Issues to be considered:
  - o Aerodrome infrastructure
  - o Navigational radio aids
  - o Weather conditions
  - o Aircraft performance
  - o Take-off obstacle clearance net path
  - o En-route obstacle clearance net path (trajectory)
  - o In-flight procedures
  - o Documentation
  - o Training
    - Pilots and cabin crew
    - Flight dispatchers
    - Safety ground crew

3. Risk assessment matrix

Probability of occurrence		
Qualitative definition	**Meaning**	**Value**
Frequent	Likely to occur many times *(has occurred frequently)*	**5**
Occasional	Likely to occur some times *(has occurred infrequently)*	**4**
Remote	Unlikely, but possible to occur *(has occurred rarely)*	**3**
Improbable	Very unlikely to occur *(not known to have occurred)*	**2**
Extremely improbable	Almost inconceivable that the event will occur	**1**

Severity of occurrences		
Aviation definition	**Meaning**	**Value**
Catastrophic	➢Equipment destroyed. ➢Multiple deaths.	**A**
Hazardous	➢A large reduction in safety margins, physical distress or a workload such that the operators cannot be relied upon to perform their tasks accurately or completely. ➢Serious injury. ➢Major equipment damage.	**B**
Major	➢A significant reduction in safety margins, a reduction in the ability of the operators to cope with adverse operating conditions as a result of increase in workload, or as a result of conditions impairing their efficiency. ➢Serious incident. ➢Injury to persons.	**C**
Minor	➢Nuisance. ➢Operating limitations. ➢Use of emergency procedures. ➢Minor incident.	**D**
Negligible	➢Little consequences	**E**

Risk probability		Risk severity				
		Catastrophic A	Hazardous B	Major C	Minor D	Negligible E
Frequent	5	5A	5B	5C	5D	5E
Occasional	4	4A	4B	4C	4D	4E
Remote	3	3A	3B	3C	3D	3E
Improbable	2	2A	2B	2C	2D	2E
Extremely improbable	1	1A	1B	1C	1D	1E



Risk management	Assessment risk index	Suggested criteria
Intolerable region	5A, 5B, 5C, 4A, 4B, 3A	Unacceptable under the existing circumstances
Tolerable region	5D, 5E, 4C, 4D, 4E, 3B, 3C, 3D, 2A, 2B, 2C	Acceptable based on risk mitigation. It might require management decision
Acceptable region	3E, 2D, 2E, 1A, 1B ,1C, 1D, 1E	Acceptable

4. Group activity

A facilitator will be appointed, who will coordinate the discussion. A summary of the discussion will be written on flip charts, and a member of the group will brief on their findings in a plenary session.

5. Your task

1. List the type of operation or activity.
2. State the generic hazard(s)
3. State the specific components of the hazard(s).
4. State the hazard-related consequences and assess the risk(s).
5. Assess existing defences to control the risk(s) and resulting risk index.
6. Propose further action to reduce the risk(s) and resulting risk index.
7. Establish individual responsibility to implement the risk mitigation
8. Complete the attached log *(Table 08/01).*

6. Utilization of the hazard identification and risk management log

- From Table 08/01 – *Hazard identification and risk management* log below is used to provide a record of identified risks and the actions taken by nominated individuals. The record should be retained permanently in order to provide evidence of safety management and to provide a reference for future risk assessments.
- Having identified and ranked the risks, any existing defences against them should be identified. These defences must then be assessed for adequacy. If these are found to be less than adequate, then additional actions will have to be prescribed. All actions must be addressed by a specified individual (usually the line manager responsible) and a target date for completion must be given. The *Hazard identification and risk management log* is not to be cleared until this action is completed.
- An example is given to facilitate the understanding in the use of the table.

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TABLE 08/01 – HAZARD IDENTIFICATION AND RISK MANAGEMENT

Type of operation or activity	Generic hazard	Specific components of the hazard	Hazard-related consequences	Existing defences to control risk(s) and risk index	Further action to reduce risk(s) and resulting risk index	Responsible person
Flight operations	All weather operations at an aerodrome where one of the two parallel runways is closed due to a construction work. *(Example only, not related to the present case study)*	Aircraft taking off or landing on a closed runway. *(Example only, not related to the present case study)*	Aircraft colliding foreign object. *(Example only, not related to the present case study)*	1. NOTAM issued by the aerodrome manager to notified users on the construction work on the closed runway. 2. ATIS 3. Aerodrome layout available in the national AIP 4. New signage and lighting 5. Company operations manual 6. Dispatch performance manual 7. Aircraft operating manual 8. Flight crew competency requirements in AWOP. 9. Recurrent training 10. CRM training *(Example only, not related to the present case study)* *Risk index: 3A* *Risk tolerability: Unacceptable under the existing circumstances*	1. Ensure that flight dispatchers and operations officers inform flight crew on the risk of taking mistakenly the closed runway. 2. Ensure that flight crew is aware of the current layout of the aerodrome. 3. Issuance of company NOTAM concerning the closed runway and new routing on the movement area. 4. Review of the Low Visibility Operations (LVO) during training sessions. 5. Review procedures in the Company Operations Manual and Route Manual. *(Example only, not related to the present case study* *Risk index: 1A* *Risk tolerability:*	1. Director of the operations control centre (OCC) 2. Chief pilot 3. Head of Flight operations engineering 4. Flight training manager 5. Head of Documentation Department *(Example only, not related to the present case study)*

Type of operation or activity	Generic hazard	Specific components of the hazard	Hazard-related consequences	Existing defences to control risk(s) and risk index	Further action to reduce risk(s) and resulting risk index	Responsible person
					Acceptable after review of the operation	

Type of operation or activity	Generic hazard	Specific components of the hazard	Hazard-related consequences	Existing defences to control risk(s) and risk index	Further action to reduce risk(s) and resulting risk index	Responsible person
Flight operations	Aerodrome Infrastructure	*No ILS Approach*	▪ *Limited Operations (Aerodrome inaccessible in IMC conditions)*	*Regulation:* *SOPs/Checklists/Charts/AIP* *Technology:* *VOR* *GPWS* *Radio Communications* *ATIS/QNH* *Training:* *CRM* *Risk index: 4D* *Risk tolerability: Tolerable*	*Regulation:* *1. Develop specific operational procedures for the flight crew* *Technology:* *2.. Require installation of ILS* *Training:* *3. Enhanced CRM* *4. Check ride for the flight crew* *Risk index: 3D* *Risk tolerability: Tolerable*	1. Chief pilot 2. Regulatory Authority 3. Flight training manager 4. Flight training manager
			▪ *Loss of revenue (Flight Delays and/or cancellations)*	*Risk index: 4D* *Risk tolerability: Tolerable*	*Risk index: 3D* *Risk tolerability: Tolerable*	
			▪ *Controlled Flight Into Terrain (CFIT)*	*Risk index: 3A* *Risk tolerability: Unacceptable*	*Risk index: 2A* *Risk tolerability: Tolerable*	

Type of operation or activity	Generic hazard	Specific components of the hazard	Hazard-related consequences	Existing defences to control risk(s) and risk index	Further action to reduce risk(s) and resulting risk index	Responsible person
	Terrain	*High surrounding terrain*	▪ *CFIT* ▪ *Accident/Incidents (Take off obstacle clearance net path and En-route obstacle clearance)*	***Regulation:*** *SOPs/Checklists/Charts/AIP* ***Technology:*** *VOR* *GPWS* *Radio Communications* ***Training:*** *CRM* *Risk index: 3A* ***Risk tolerability: Unacceptable***	***Regulation:*** *1. Develop specific operational procedures* ***Technology:*** *2.Installation of EGPWS* ***Training:*** *3. Enhanced CRM* *Risk index: 2A* ***Risk tolerability: Tolerable***	1. Chief Pilot 2.Director of Maintenance 3. Flight training manager
	Weather	*Tailwind on takeoff*	*Runway overruns*	***Regulation:*** *SOPs/Checklists* ***Training:*** *CRM* *Risk index: 3B* ***Risk tolerability: Tolerable***	***Regulation:*** *1. Develop specific procedures* ***Training:*** *2. Enhanced CRM* *Risk index: 2B* ***Risk tolerability: Tolerable***	1. Chief Pilot 2. Flight training manager

Type of operation or activity	Generic hazard	Specific components of the hazard	Hazard-related consequences	Existing defences to control risk(s) and risk index	Further action to reduce risk(s) and resulting risk index	Responsible person

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AFI Comprehensive Implementation Programme (ACIP)

ICAO Safety Management Systems (SMS) Course
Handout N° 6 – Collision between two aircraft at Milano-Linate International Airport

Group 1

Exercise 1 - SMS Regulation

REPUBLIC OF GROUP 1

Civil Aviation Regulations – Safety Management System

1. Statutory basis

This regulation is promulgated under the statutory authority in the Republic of Group 1 Aviation Act 2008.

2. Scope

This regulation specifies the requirements for the Safety Management System (SMS) in accordance with **Annex 1** (Personnel Licensing), **Annex 6** (Operation of Aircraft Part I and III), **Annex 8** (Airworthiness of Aircraft), **Annex 11** (Air Traffic Services), **Annex 13** (Accident Investigation) and **Annex 14** (Aerodromes).

This regulation shall apply to the above service providers.

3. Applicability

Effective 1st November 2010, the required service providers shall comply to the said requirements of the Civil Aviation Act and the regulation on SMS.

4. References

ICAO Annexes 1, 6, 8, 11, 13 and 14

ICAO Doc 9859, Second Edition (Safety Management Manual)

Advisory Circular No. 123 (Safety Management System)

UKCAA CAP784

5. Definitions

Accident

Acceptable Levels of Safety (ALoS)

Authority

Director General

Hazard

Incident

Risk

Risk Management

Consequence

Safety Management System (SMS)

State Safety Programme (SSP)

Standards and Recommended Practices (SARPs)

Service Provider

6. Safety policy and objectives

Management commitment and responsibility

Safety accountabilities

Appointment of key safety personnel

Coordination of emergency response planning

SMS documentation

Safety risk management

Hazard identification

Risk assessment and mitigation

Safety assurance

Safety performance monitoring and measurement

The management of change

Continuous improvement of the SMS

Safety promotion

Training and education

Safety communication

EXERCISE 2 HAZARD IDENTIFICATION AND RISK MANAGEMENT

Type of operation or activity	Generic hazard	Specific components of the hazard	Hazard-related consequences	Existing defences to control risk(s) and risk index	Further action to reduce risk(s) and resulting risk index	Responsible person
Flight operations	All weather operations at an aerodrome where one of the two parallel runways is closed due to a construction work. *(Example only, not related to the present case study)*	Aircraft taking off or landing on a closed runway. *(Example only, not related to the present case study)*	Aircraft colliding foreign object. *(Example only, not related to the present case study)*	1. NOTAM issued by the aerodrome manager to notified users on the construction work on the closed runway. 2. ATIS 3. Aerodrome layout available in the national AIP 4. New signage and lighting 5. Company operations manual 6. Dispatch performance manual 7. Aircraft operating manual 8. Flight crew competency requirements in AWOP. 9. Recurrent training 10. CRM training *(Example only, not related to the present case study)* *Risk index: 3A* *Risk tolerability: Unacceptable under the existing circumstances*	1. Ensure that flight dispatchers and operations officers inform flight crew on the risk of taking mistakenly the closed runway. 2. Ensure that flight crew is aware of the current layout of the aerodrome. 3. Issuance of company NOTAM concerning the closed runway and new routing on the movement area. 4. Review of the Low Visibility Operations (LVO) during training sessions. 5. Review procedures in the Company Operations Manual and Route Manual. *(Example only, not related to the present case study* *Risk index: 1A* *Risk tolerability: Acceptable after review of the operation*	1. Director of the operations control centre (OCC) 2. Chief pilot 3. Head of Flight operations engineering 4. Flight training manager 5. Head of Documentation Department *(Example only, not related to the present case study)*

Type of operation or activity	Generic hazard	Specific components of the hazard	Hazard-related consequences	Existing defences to control risk(s) and risk index	Further action to reduce risk(s) and resulting risk index	Responsible person
				Risk index: *Risk tolerability:*	*Risk index:* *Risk tolerability:*	
				Risk index: *Risk tolerability:*	*Risk index:* *Risk tolerability:*	

EXERCISE 3 – GANTT CHART FOR THE SMS IMPLEMENTATION PLAN

Nº	Component/element	Date: Year 1				Date: Year 2				Date: Year 3				Date: Year 4			
		T1	T2	T3		T1	T2	T3		T1	T2	T3		T1	T2	T3	
	Phase 1 –Planning SMS implementation																
	Management Commitment – appointment of accountable executive																
	SMS Planning and working group created																
	System Description & Gap analysis																
	Safety Policy and Objectives																
	Safety accountabilities and appointment of key safety personnel																
	Coordination of the emergency response planning (ERP)																
	Internal and External coordination of ERP																
	SMS Documentation																
	Safety Management Systems Manual development (SMSM)																
	Development of Safety training requirements and programme of training																
	Safety Promotion-Communication																

Nº	Component/element	Date: Year 1				Date: Year 2				Date: Year 3				Date: Year 4			
		T1	T2	T3		T1	T2	T3		T1	T2	T3		T1	T2	T3	
	Phase 2 – Reactive Safety																
	Hazard identification – using existing sources to collect reactive info on hazards																
	Safety risk management – development and adoption of risk matrix																
	Phase 3 Proactive and predicative safety management process																
	hazard identification - review of sources to collect proactive and predictive information on hazards																
	Safety risk management - review risk matrix for proactive and predictive safety management processes																
	Phase 4 Safety Assurance																
	Safety performance monitoring and measurement – establishment of levels of performance by identifying safety indicators, targets, action, gaining approval from the state . Collection of safety information for studies and analysis to improve performance																
	Management of Change - Establishing a formal process for the management of change which is to identify changes within the organization which may affect established processes and services																
	SMS continuous improvement - proactive evaluation of facilities, equipment, documentation and individual performance																

Nº	Component/element	Date: Year 1				Date: Year 2				Date: Year 3				Date: Year 4			
		T1	T2	T3		T1	T2	T3		T1	T2	T3		T1	T2	T3	
	Continuous Process																
	SMS Documentation																
	SMS Communication																
	SMS Training																

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AFI Comprehensive Implementation Programme (ACIP)

ICAO Safety Management Systems (SMS) Course
Handout N° 6 – Collision between two aircraft at Milano-Linate International Airport

International Civil Aviation Organization

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AFI COMPREHENSIVE IMPLEMENTATION PROGRAMME (ACIP) SAFETY MANAGEMENT SYSTEM (SMS) COURSE

Exercise 10/02 – Collision between two aircraft at Milano-Linate International Airport

1. Narrative

A brand new Cessna 525A Citation Jet 2, **D-IEVX**, arrived at Milano-Linate International Airport following a flight from Köln, Germany. The Cessna was to carry out a return flight to Paris-Le Bourget, carrying two pilots, a Cessna sales manager and a prospective customer. The plane arrived at 06:59 and was taxied to the general aviation apron, also known as **"West apron"** *(See diagram below).* It was a foggy morning at Milano-Linate International Airport and one of the passenger flights parked on the **"North apron"** was **SAS MD-87** flight **SK686,** which was being prepared for a flight to Copenhagen, scheduled to depart at 07:35. At 07:41, the pilot of the MD-87 **SK686** contacted **Linate Ground Control** for his engine start clearance, as the boarding of 104 passengers had been completed. The Ground Controller cleared the pilot to start engines and advised that the slot time for takeoff of the flight was at 08:16. Thirteen minutes later flight **SK686** was cleared to taxi to runway **36R**: *"Scandinavian 686, taxi to the holding position Cat III, QNH 1013 and please call me back entering the main taxiway."*

A few minutes later, the Cessna Citation pilot requested permission to start the engines. The Ground Controller then gave start-up clearance. The Ground Controller then requested flight **SK686** to contact the Tower Controller. From this moment on, the MD-87's crew and the Cessna's crew were tuned on two different radio frequencies. At 08:05 the pilots of the Cessna received taxi clearance: *"Delta Victor Xray, taxi north via **Romeo 5**, QNH 1013, call me back at the stop bar of the ... main runway extension."*

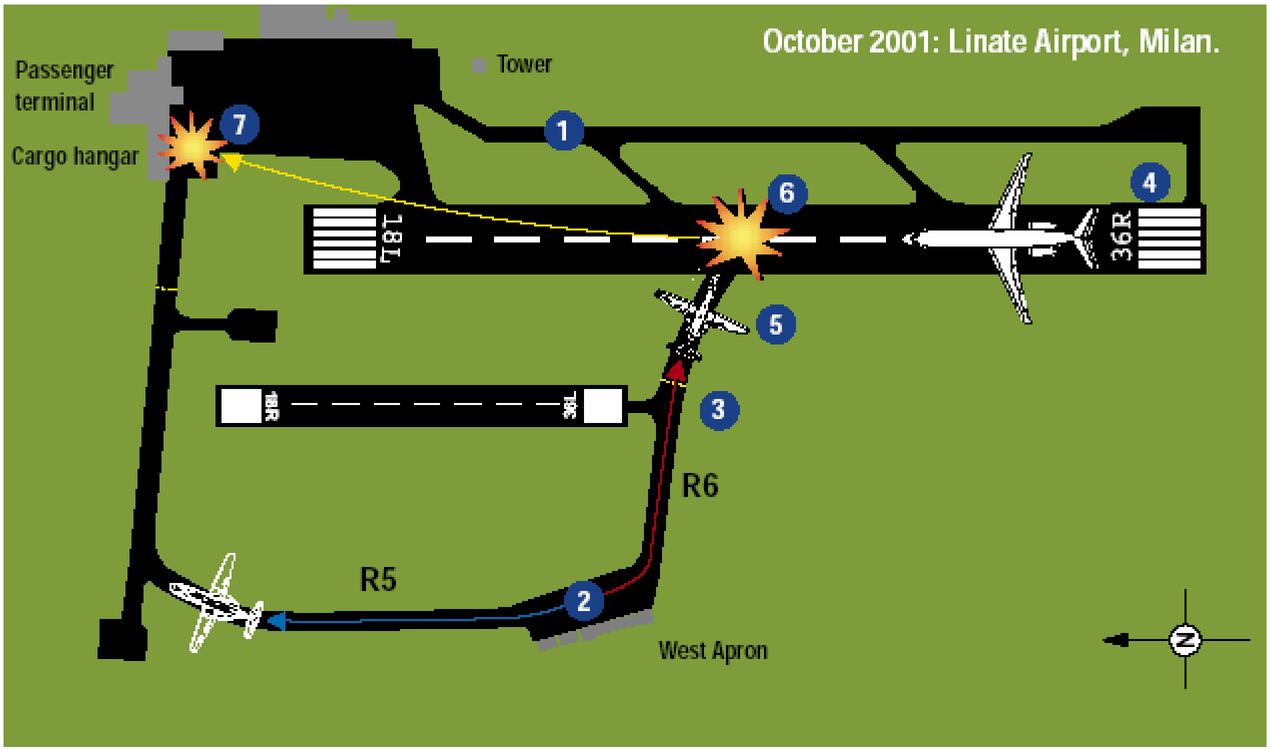
The pilot acknowledged by saying: *"Roger via **Romeo 5** and ... 1013, and call you back before reaching main runway."*

The Cessna started to taxi from the general aviation parking position, following the yellow taxi line. After reaching the position where the yellow taxi line splits into two diverging directions, the pilot erroneously took the taxi line to right and entered taxiway ***Romeo 6***. At 08:09 the Ground Controller cleared the Cessna to continue its taxi on the **North Apron**. At the same time the Tower Controller cleared the MD-87 for takeoff: *"...Scandinavian 686 Linate, clear for takeoff 36, the wind is calm report rolling, when airborne squawk ident."* The pilot advanced the throttles and acknowledged the clearance: *"Clear for takeoff 36 at when...airborne squawk ident and we are rolling, Scandinavian 686."* When the MD-87 was speeding down the runway, the Cessna crossed the runway holding sign and entered the active runway **18L/36R**.

At 08.10:21 the nose landing gear of the MD-87 had left the ground and main gears were extending the shock absorbers but the main wheels were still on the ground at airspeed of 146 knots (270, 5 km/h).

At that moment the MD-87 crew probably saw a glimpse of the Cessna through the fog and reacted with additional large nose-up elevator. At that moment the MD-87 collided with the Cessna Citation Jet. The right wing of the MD-87 sustained damage at the leading edge and the right hand main landing gear leg broke off. It damaged the right flap and struck the N° 2 engine which then separated from the pylon. The pilot of the MD-87 gradually advanced the throttles and then the aircraft was airborne for a total of 12 seconds, reaching an estimated height of about 35 feet (11 meters). The left hand engine suffered a noticeable thrust reduction as a result of debris ingestion, which became insufficient to sustain flight.

The airspeed had increased up to 166 knots (307,6 km/h), but the MD-87 descended abruptly making contact with the runway with the left hand main gear, the truncated right hand main gear leg and the tip of the right hand wing. Prior to touch down the pilot reduced engine thrust and after ground contact the engine reverse levers were activated and deployed (on the left hand engine only). Maximum available reverse thrust was selected and the brakes applied. The plane skidded past the grass overrun area, across a service road, crashing sideways into a baggage handling building, which partly collapsed. This building was located 20m/67 feet to the right of the runway, and 460m/1500 feet from the runway end.



Legend

1. Flight **SK686** taxied to the holding point for runway 36R. Heavy fog had delayed the flight by more than one hour. While the visibility was improving, RVR was still only 225 metres.
2. The Cessna Citation parked at the West Apron was cleared to taxi via taxiway **Romeo 5** and to report reaching the first holding point. The pilot read the clearance back correctly, but entered taxiway **Romeo 6**.
3. The Cessna Citation's pilot called for clearance to proceed from the **Romeo 5** holding point though it was in fact at the **Romeo 6** holding point.
4. Flight **SK686** was cleared for take-off.
5. The Cessna Citation crossed the holding point for runway **36R-18L**.
6. The two aircraft collided.
7. The stricken MD-87 skidded off the runway into a baggage hangar adjacent to the passenger terminal.


5

2. Investigation

After analysis of evidence available and information gathered, it can be assumed that the immediate cause for the accident has been the runway incursion in the active runway by the Cessna Citation. The obvious consideration is that the human factor related action of the Cessna Citation crew – during low visibility conditions – must be weighted against the scenario that allowed the course of events that led to the fatal collision; equally it can be stated that the system in place at Milano-Linate Airport was not geared to trap misunderstandings, let alone inadequate procedures, human errors and faulty airport layout.

The following list highlights immediate and systemic causes that led to the accident:

- The visibility was low, between 50 and 100 meters.
- The traffic volume was high.
- The lack of adequate visual aids.
- The Cessna Citation crew used the wrong taxiway and entered the runway without specific clearance.
- The failure to check the Cessna Citation crew qualification.
- The nature of the flight might have exerted certain pressure on the Cessna Citation crew to commence the flight despite the prevailing weather conditions.
- The Cessna Citation crew was not aided properly with correct publications (AIP Italy-Jeppesen) lights (red bar lights and taxiway lights), markings (in deformity with standard format and unpublished, S4) and signs (non-existing TWY R6) to enhance their situational awareness.
- Official documentation failed to report the presence of unpublished markings (S4, S5, etc.) that were unknown to air traffic managers, thus preventing the ATC staff from interpreting the ambiguous information from the Cessna Citation crew, a position report mentioning **S4**.
- Radio communications were not performed using standard phraseology (read back) or were not consistently adhered to (resulting in untraced misunderstandings in relevant radio communications).
- Operational procedures allowing high traffic volume (high number of ground movements) in weather conditions as were current the day of the accident (reduced visibility) and in the absence of technical aids.
- Radio communications were performed in Italian and English language.
- ATC personnel did not realize that Cessna Citation was on taxiway **Romeo 6**.
- The ground controller issued a taxi clearance toward north (main) apron although the reported position **S4** did not have any meaning to him.
- Instructions, training and the prevailing environmental situation prevented the ATC personnel from having full control over the aircraft movements on ground.
- The aerodrome standard did not comply with ICAO Annex 14; required markings lights and signs did not exist (**Romeo 6**) or were in dismal order and were hard to recognize especially under low visibility conditions (**Romeo 5** - **Romeo 6**), other markings were unknown to operators (**S4**).

- No functional Safety Management System (SMS) was in operation.
- The competence maintenance and requirements for recent experience for ATC personnel did not comply fully with ICAO Annex 1.
- The Low Visibility Operations (LVO) implementation by ENAV did not conform to the requirements provided in the corresponding and referenced ICAO Doc 9476.

The combined effect of these factors, contemporaneously present on the 8th of October 2001 at Milano-Linate Airport, have neutralized any possible error corrective action and therefore allowed the accident.

3. Epilogue

In April 2004 four officials accused of negligence and multiple manslaughter were sentenced to jail terms ranging from 6½ to 8 years. Judges gave eight-year prison sentences to the director of the Milano-Linate Airport and the air traffic controller who was on duty at the time. The former CEO of Italy's air traffic control agency ENAV and the person who oversees Milan's two airports, there were sentenced to six years and six months each.

4. Risk assessment matrix

Probability of occurrence		
Qualitative definition	**Meaning**	**Value**
Frequent	Likely to occur many times *(has occurred frequently)*	**5**
Occasional	Likely to occur some times *(has occurred infrequently)*	**4**
Remote	Unlikely, but possible to occur *(has occurred rarely)*	**3**
Improbable	Very unlikely to occur *(not known to have occurred)*	**2**
Extremely improbable	Almost inconceivable that the event will occur	**1**

Severity of occurrences		
Aviation definition	**Meaning**	**Value**
Catastrophic	➢Equipment destroyed. ➢Multiple deaths.	**A**
Hazardous	➢A large reduction in safety margins, physical distress or a workload such that the operators cannot be relied upon to perform their tasks accurately or completely. ➢Serious injury. ➢Major equipment damage.	**B**
Major	➢A significant reduction in safety margins, a reduction in the ability of the operators to cope with adverse operating conditions as a result of increase in workload, or as a result of conditions impairing their efficiency. ➢Serious incident. ➢Injury to persons.	**C**
Minor	➢Nuisance. ➢Operating limitations. ➢Use of emergency procedures. ➢Minor incident.	**D**
Negligible	➢Little consequences	**E**

Risk probability	Risk severity				
	Catastrophic A	Hazardous B	Major C	Minor D	Negligible E
Frequent 5	5A	5B	5C	5D	5E
Occasional 4	4A	4B	4C	4D	4E
Remote 3	3A	3B	3C	3D	3E
Improbable 2	2A	2B	2C	2D	2E
Extremely improbable 1	1A	1B	1C	1D	2E

Risk management	Assessment risk index	Suggested criteria
Intolerable region	5A, 5B, 5C, 4A, 4B, 3A	Unacceptable under the existing circumstances
Tolerable region	5D, 5E, 4C, 4D, 4E, 3B, 3C, 3D, 2A, 2B, 2C	Acceptable based on risk mitigation. It might require management decision
Acceptable region	3E, 2D, 2E, 1A, 1B ,1C, 1D, 1E	Acceptable

EXERCISE 10/02

5. Group activity

A facilitator will be appointed, who will coordinate the discussion. A summary of the discussion will be written on flip charts, and a member of the group will brief on their findings in a plenary session.

6. Your task

Task N° 1

1. List the type of operation or activity.
2. State the generic hazard(s)
3. State the specific components of the hazard(s).
4. State the hazard-related consequences and assess the risk(s).
5. Assess existing defences to control the risk(s) and resulting risk index.
6. Propose further action to reduce the risk(s) and resulting risk index.
7. Establish individual responsibility to implement the risk mitigation
8. Complete the attached log *(Table 10/01).*

7. Utilization of the hazard identification and risk management log

- From Table 10/01 – *Hazard identification and risk management* log below is used to provide a record of identified risks and the actions taken by nominated individuals. The record should be retained permanently in order to provide evidence of safety management and to provide a reference for future risk assessments.
- Having identified and ranked the risks, any existing defences against them should be identified. These defences must then be assessed for adequacy. If these are found to be less than adequate, then additional actions will have to be prescribed. All actions must be addressed by a specified individual (usually the line manager responsible) and a target date for completion must be given. The *Hazard identification and risk management log* is not to be cleared until this action is completed.
- An example is given to facilitate the understanding in the use of the table.

8. Task Nº 2

1. The Accident Investigation Board has identified that no functional Safety Management System (SMS) was in operation at Milano-Linate International Airport. Therefore you should:

   a) Develop a SMS implementation plan for Milano-Linate International Airport.

   b) Complete the attached Gantt chart *(Table 10/02).*

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TABLE 10/01 – HAZARD IDENTIFICATION AND RISK MANAGEMENT

Type of operation or activity	Generic hazard	Specific components of the hazard	Hazard-related consequences	Existing defences to control risk(s) and risk index	Further action to reduce risk(s) and resulting risk index	Responsible person
Flight operations	All weather operations at an aerodrome where one of the two parallel runways is closed due to a construction work. *(Example only, not related to the present case study)*	Aircraft taking off or landing on a closed runway. *(Example only, not related to the present case study)*	Aircraft colliding foreign object. *(Example only, not related to the present case study)*	1. NOTAM issued by the aerodrome manager to notified users on the construction work on the closed runway. 2. ATIS 3. Aerodrome layout available in the national AIP 4. New signage and lighting 5. Company operations manual 6. Dispatch performance manual 7. Aircraft operating manual 8. Flight crew competency requirements in AWOP. 9. Recurrent training 10. CRM training *(Example only, not related to the present case study)* *Risk index: 3A* *Risk tolerability: Unacceptable under the existing circumstances*	1. Ensure that flight dispatchers and operations officers inform flight crew on the risk of taking mistakenly the closed runway. 2. Ensure that flight crew is aware of the current layout of the aerodrome. 3. Issuance of company NOTAM concerning the closed runway and new routing on the movement area. 4. Review of the Low Visibility Operations (LVO) during training sessions. 5. Review procedures in the Company Operations Manual and Route Manual. *(Example only, not related to the present case study* *Risk index: 1A* *Risk tolerability: Acceptable after review of the operation*	1. Director of the operations control centre (OCC) 2. Chief pilot 3. Head of Flight operations engineering 4. Flight training manager 5. Head of Documentation Department *(Example only, not related to the present case study)*

Type of operation or activity	Generic hazard	Specific components of the hazard	Hazard-related consequences	Existing defences to control risk(s) and risk index	Further action to reduce risk(s) and resulting risk index	Responsible person
Flight Operations	Adverse Weather	*Low Visibility*	*Collision*	*- Runway/Taxiway Markings and lighting* *- Signages* *- Stop bars* *- LVO procedures* *- Charts* *Risk index: 3A* *Risk tolerability: Unacceptable under existing circumstances*	*Improved markings* *Improved signages* *Review LVO procedures to conform with ICAO Doc 9476* *Provision of current AIP - Jeppessen Charts* *Installation of SMR* *Risk index: 2A* *Risk tolerability: Tolerable*	Director of Aerodrome Operations Director of Aerodrome Operations Director of Aerodrome Operations Flight Operations Manager Director of ATS

Type of operation or activity	Generic hazard	Specific components of the hazard	Hazard-related consequences	Existing defences to control risk(s) and risk index	Further action to reduce risk(s) and resulting risk index	Responsible person
Air Traffic Services	Poor Communication	Non-usage of standard phraseology	*Collision*	*-ATS Regulations/procedures* *- ATC training* *Risk index: 3A* *Risk tolerability: Unacceptable*	*Revise ATS regulations to include English Language proficiency requirements.* *Develop specific LVO training package for ATCOs* *Strict compliance with the use of Standard phraseology* *Risk index: 2C* *Risk tolerability: Tolerable*	DG CAA Director of ATS DG CAA
Aerodrome Operations	Poor Airport layout	*Inadequate Markings and Signages*	*Runway Incursion*	*-Runway/taxiway markings and Signages* *- Certification of aerodrome* *- continuing surveillance of Aerodrome activities* *- Stop bars* *Risk index: 3B* *Risk tolerability: Unacceptable*	*Improve markings and signages* *Aerodrome certified in compliance with ICAO Annex 14 Requirements* *Increased inspections* *Risk index: 2C* *Risk tolerability: Tolerable*	Director of Aerodrome Operations DG CAA DG CAA

Type of operation or activity	Generic hazard	Specific components of the hazard	Hazard-related consequences	Existing defences to control risk(s) and risk index	Further action to reduce risk(s) and resulting risk index	Responsible person
Regulatory	Lack of compliance with International Standards	Inexistence of SSP/SMS and English Language proficiency requirements.	*- Continuing application of traditional reactive approach to managing safety* *- Communication error leading to possible Runway incursion*	*- ATS requirements* *-Certification of Aerodrome* *-Continuing surveillance of Aerodrome activities* *Risk index: 3B* *Risk tolerability: Unacceptable*	*Development and Implementation of SSP/SMS* *Development of ATS requirements with respect to English Language proficiency.* *Risk index: 2C* *Risk tolerability: Tolerable*	DGCAA DGCAA

TABLE 10/02 – GANTT CHART FOR THE SMS IMPLEMENTATION PLAN

Nº	Component/element	Date: January 08				Date: February 08				Date:				Date:			

Nº	Component/element	Date: January 08				Date: February 08				Date:				Date:			