Aviation Accident Prevention as part of Royal Air Maroc Safety Management System
Outline

I. Airline Overview

II. Royal Air Maroc Integrated Safety Management System – Organizational Chart

III. SMS 1st Pilar : Policy & Safety Objectives

IV. SMS 2nd Pilar : Safety Risk Management (SRM)
   • Relevant Committees
   • SRM Process

V. SMS 3rd Pilar : Safety Insurance
   • Safety Performance Management & Measurement
   • SPI’s Monitoring – Predictive Analysis
   • Level of Safety Performance (LoSP)

VI. SMS 4th Pilar : Safety Promotion
   • Training & Education | E-Learning SMS

VII. Accident Prevention Program
   • Responsibilities & Aim of the Program
   • Safety Data Coverage (Reporting, FOQA, LOSA, Other)
   • Internal Safety Investigation Sample
I. Airline Overview

History

- 1953: Combination of Atlas Air & Air Morocco
- 1957: RAM trains its own pilots
- 1970: Creation of SNECMA Morocco Engine Services
- 1975: RAM joined IATA
- 1982: Order of 20 Boeing aircrafts
- 1989: Royal Air Maroc
- 1999: Opening of long haul network (USA, Canada, Middle East)
- 2004-2005 Open Sky
- 2009: First IOSA Certification
- 2011: Launch of Restructuration Plan
- 2012-2019: Development Plan
  - 4 ATR 72-600
  - 4 E190-100
  - 4 B737-800
  - 2 B737-8
  - 5 B787-8
  - 4 B787-9
- 2020-2021: Start of COVID-19 Recovery
- 2022-2023: RAM SMS Implementation
- 2019: June RXP SMS Implementation
- 2012: June RXP First IOSA Audit
- 2012: RXP First Flight
- 2012: Order of 20 Boeing aircrafts
- 2019: Development Plan
- 2020: Start of COVID-19 Recovery
- 2022: Development Plan
I. Airline Overview

International Network

NORTH AMERICA (5)
- Boston
- Miami
- Montreal
- New York
- Washington

SOUTH AMERICA (2)
- Rio de Janeiro
- Sao Paulo

AFRICA (29)
- Abidjan
- Accra
- Algiers
- Bamako
- Bangui
- Banjul
- Bissau
- Brazzaville
- Cairo
- Conakry
- Cotonou
- Dakar
- Douala
- Freetown
- Kinshasa
- Lagos
- Libreville
- Lomé
- Luanda
- Malabo
- Monrovia
- N'Djamea
- Niamey
- Nouakchott
- Ouagadougou
- Pointe Noire
- Praia
- Tunis
- Yaoundé

EUROPE (39)
- Amsterdam
- Athens
- Barcelona
- Berlin
- Bologna
- Bordeaux
- Brussels
- Copenhagen
- Frankfurt
- Gibraltar
- Geneva
- Istanbul
- Las Palmas
- Lisboa
- London
- Lyon
- Madrid
- Malaga
- Manchester
- Marseille
- Milano
- Montpellier
- Moscow
- Munich
- Naples
- Nantes
- Nice
- Paris
- Porto
- Roma
- Strasbourg
- Tenerife
- Torino
- Toulouse
- Valencia
- Venise
- Vienna
- Stockholm
- Zurich

ASIA (7)
- Amman
- Beijing
- Beyrouth
- Doha
- Jeddah
- Medine
- Riyadh
II. Royal Air Maroc Integrated Safety Management System

Organizational Chart

Accountable Executive

Director of Quality Security & Safety

Quality Department
SMS Department
Security Department
OHS Department

Cargo
Training
GRD Ops
FLT Ops
CAB Ops
MNT Ops
DSP
Fuel
III. | SMS 1st Pilar : Policy & Safety Objectives |
### Relevant Committees

<table>
<thead>
<tr>
<th>Multidisciplinary Committees</th>
<th>SAFETY REVIEW BOARD</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Meets twice a year with Accountable Executive</td>
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<table>
<thead>
<tr>
<th>OPERATIONS Committee</th>
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<tbody>
<tr>
<td>Meets weekly with Accountable Executive</td>
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<table>
<thead>
<tr>
<th>Safety Action Group (Ad hoc)</th>
<th>Quality, Safety &amp; Security Committee (CQSS)</th>
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<tr>
<td>Meets as requested</td>
<td>Meets twice a year</td>
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</table>

<table>
<thead>
<tr>
<th>Quality &amp; Safety Technical Committee (CTQS)</th>
<th>Security Committee (CTS)</th>
<th>EOHS Technical Committee (CTST)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meets weekly</td>
<td>Meets weekly</td>
<td>Meets Quarterly</td>
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<thead>
<tr>
<th>Local Committees</th>
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</thead>
<tbody>
<tr>
<td>FOQA Committee</td>
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<tr>
<td>Meets Quarterly</td>
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<table>
<thead>
<tr>
<th>Mini-CTQS Committees</th>
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<tbody>
<tr>
<td>Meet twice a month</td>
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</table>
IV. | SMS 2nd Pilar: Safety Risk Management |
SRM Process

- Safety Reporting System
- Activity Analysis
- Change Risks
- Other Internal & External data

Hazard Identification

Main Causes & Factors Identification
- Root Cause Analysis (RCA)
- Technical, Human, Procedural, Environmental & Organizational Factors

Risk Assessment by relevant committee
- Existing Defences Analysis
- Risk Evaluation (Probability, Severity)
- Risk Tolerability

Corrective Action Plan (CAP)
- Risk mitigation by relevant Committee
- Risk Reevaluation & Tolerability
- Responsibilities assignment
- Implementation Schedule

Corrective Action Review (CAR)
- Control & Surveillance Measures to check effectiveness of the CAP
<table>
<thead>
<tr>
<th>Safety Performance Management Process</th>
<th>Requirements</th>
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<tbody>
<tr>
<td>Safety Objectives</td>
<td>Outcome-oriented</td>
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<tr>
<td>Safety Performance Indicators (SPI)</td>
<td>Lagging Indicators</td>
</tr>
<tr>
<td>Safety Performance Targets (SPT)</td>
<td>S.M.A.R.T</td>
</tr>
<tr>
<td>Safety Triggers</td>
<td>Mitigation actions may need to be taken beyond Mean +1 SD, +2 SD or + 3 SD</td>
</tr>
<tr>
<td>Acceptable Level of Safety Performance (ALoSP)</td>
<td>ALoSP to be achieved is established by the Safety Review Board (SRB), then measured &amp; demonstrated by company’s entities</td>
</tr>
</tbody>
</table>
V. | SMS 3rd Pilar: Safety Insurance

SPI’s Monitoring – Predictive Analysis

An SPI must be **STABLE & CAPABLE**

### SPI X

- **Moy + 1SD**
- **Moy + 2SD**
- **Moy + 3SD**
- **Objectif**
- **Moyenne réalisée**

<table>
<thead>
<tr>
<th>Q1 2020</th>
<th>Q2 2020</th>
<th>Q3 2020</th>
<th>Q4 2020</th>
<th>Q1 2021</th>
<th>Q2 2021</th>
<th>Q3 2021</th>
<th>Q4 2021</th>
<th>Q1 2022</th>
<th>Q2 2022</th>
<th>Q3 2022</th>
<th>Q4 2022</th>
<th>Q1 2023</th>
<th>Q2 2023</th>
<th>Q3 2023</th>
<th>Q4 2023</th>
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<tr>
<td>0.00</td>
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### SPI with High Impact

- **Stability (2021)**
  - Alert Level not breached?
  - Target Level achieved?
- **Capability (2021)**
  - Yes / 4 pts
  - Yes / 3 pts

- **Stability (2022)**
  - Alert Level not breached?
  - Target Level achieved?
- **Capability (2022)**
  - Yes (II+I) / 4 pts
  - No / 0 pts

- **Stability Prediction (2023)**
- **Capability Prediction (2023)**
  - Yes [1*] / 4 pts
  - Yes / 3 pts
V. SMS 3rd Pilar: Safety Insurance

Safety Performance Management & Measurement

<table>
<thead>
<tr>
<th>SPI Criticity Achievement 2022</th>
<th>SPI Criticity Prediction 2023</th>
<th>SPI Criticity 2012 / 2023</th>
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<tbody>
<tr>
<td>SPI 1</td>
<td>SPI 1</td>
<td>Very Critical SPI</td>
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<tr>
<td>SPI 2</td>
<td>SPI 2</td>
<td>SPI 5 Stabilize below the alert levels and drive the target in 2023</td>
</tr>
<tr>
<td>SPI 3</td>
<td>SPI 3</td>
<td>Critical SPI</td>
</tr>
<tr>
<td>SPI 4</td>
<td>SPI 4</td>
<td>SPI 2 Monitor alert levels and drive the target in 2023</td>
</tr>
<tr>
<td>SPI 5</td>
<td>SPI 5</td>
<td>Tolerable SPI</td>
</tr>
<tr>
<td>SPI 6</td>
<td>SPI 6</td>
<td>SPI 7 Drive the target in 2023</td>
</tr>
<tr>
<td>SPI 7</td>
<td>SPI 7</td>
<td>Acceptable SPI</td>
</tr>
<tr>
<td>SPI 8</td>
<td>SPI 8</td>
<td>SPI 1 Monitor in 2023</td>
</tr>
<tr>
<td>SPI 9</td>
<td>SPI 9</td>
<td>SPI 3</td>
</tr>
<tr>
<td>SPI 10</td>
<td>SPI 10</td>
<td>SPI 4</td>
</tr>
</tbody>
</table>

Level of Safety Performance (LoSP)

<table>
<thead>
<tr>
<th>Achievement 2022</th>
<th>Prediction 2023</th>
</tr>
</thead>
<tbody>
<tr>
<td>80%</td>
<td>82%</td>
</tr>
</tbody>
</table>

LoSP 2022 Accepted by SRB (Yes/No)

<table>
<thead>
<tr>
<th>Yes</th>
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</table>

Minimum Acceptable Level of Safety Performance / ALoSP 2023

| 85% |
Royal Air Maroc **Level of Safety Performance** (LoSP) is monitored, measured and expressed in figures to give company’s senior managers a quick and easy way to indicate the organization’s safety performance, and an idea of the health status of the Safety Management System.
VI. | SMS 4th Pilar: Safety Promotion |
Training & Education | E-learning SMS - Safety Communication
VP Quality Security & Safety is responsible for Royal Air Maroc’s Accident Prevention Program, its performance and its integration into the Safety Management System.

- The aim of this program is to reduce the risk of accidents by identifying flight safety hazards, potential consequences, and developing and implementing countermeasures to reduce the risk.

- Safety investigations on accidents, serious incidents or operational incidents are essential component of Royal Air Maroc’s Accident Prevention Program.
VII. Accident Prevention Program

Safety Data Coverage

Accidents

Incidents

Normal Operations

Voluntary Incident Reports

LOSA

QAR

Mandatory Incident Reports

Accident Investigation
VII. Accident Prevention Program

Safety Reporting

Air Safety Reports Occurrence type

FLIGHT MANAGEMENT EVENTS: Q1 2022 - Q4 2022

ATM EVENTS: Q1 2022 - Q4 2022

Reported Birdstrikes Ratio Distribution (per 1,000 trips) Q1 2019 - Q4 2022
Develop objective and predictive information to enhance safety

Capturing and analysing flight data to determine if the flight deviated from a safe operating envelope

Identifying trends

Promoting action to correct potential problems.

FOQA agreement signed with Royal Air Maroc pilots

VII. Accident Prevention Program
Flight Data Analysis Program
Monitored data:

- TAT PROBE Anomaly | LOC-I Precursor Excessive power during taxi-out / in | Ground Damage/Jet Blast Precursor
- Exceedance Limitation
- Long Landing | Runway Excursion Precursor
- Hard landing | ARC Precursor
- Go Around due Unstabilized Approach | Positive Safety Culture Precursor
- Unstabilized Approach – UA | Runway Excursion Precursor
- Excessive Tailwind | Runway Excursion Precursor
- High pitch angle at Take-off | LOC-I Precursor
- High pitch rate at Take-off | LOC-I Precursor
- Slow Rotation | Runway Excursion Precursor
- EGPWS SINK RATE | CFIT Precursor
- EGPWS GLIDE SLOPE | CFIT Precursor
- EGPWS PULL UP | CFIT Precursor
- EGPWS TOO LOW TERRAIN | CFIT Precursor
- EGPWS TOO LOW FLAPS | CFIT Precursor
- EGPWS BANK ANGLE | LOC-I Precursor
- EGPWS (ALL)
- Late Config setting at LDG | Runway Excursion Precursor
- Gear down selection height (Interception height above 2500 ft AGL)
- High Lateral Acceleration Events | ARC Precursor
LOSA uses trained observers to collect data about pilot behaviour and its situational context on “normal” flights from observers seats on the flight deck.

Such monitoring allows the capture of data which can characterise pilot strategies for managing "threats, errors and undesirable states".

The audits are conducted under strict no-jeopardy conditions; therefore, flight crews are not held accountable for their actions and errors that are observed. During flights that are being audited, observers record and code:

• Potential threats to safety;
• How the threats are addressed;
• The errors such threats generate;
• How flight crews manage these errors;
• Specific behaviours that have been known to be associated with accidents and incidents.
VII. Accident Prevention Program
Other Safety levers

I. Regular IATA Operational Safety Audit (IOSA)


III. Safety Collaboration with the oneworld Best Practices Safety Group (oBPSG)
   Regular meetings and information sharing between group members about safety metrics updates and Top safety issues.

IV. Training
   In order to enhance personal skills and abilities, Royal Air Maroc invested and is seeking to invest on professional development in the following topics:
   - Safety Management System Training
   - Safety Risk Assessment Training
   - Accident & Incident Investigators
   - Human Factors & Crew Resource Management Training
   - Fatigue Risk Management System Training
   - Root Cause Analysis
On August 15, 2021, a safety investigation was triggered by VP Quality, Safety & Security after tires blowout at landing of RAM 1400 while Anti-skid system was Inoperative

**Synoptic:**
During landing of flight AT1400, operated by CN-RNP, on runway 06 at OUJDA-ANGADS airport on August 15, 2021, the crew was notified after landing by a cabin crew emergency call of an engine fire on the left side of the aircraft.

The crew immediately confirmed the information with the control tower and informed the fire-fighting services. After full stop of the aircraft, the crew applied the "ENGINE FIRE ON THE GROUND" checklist, and when it comes to evacuate, they were advised by the fire service that there was no fire, just smoke from the burst tires on the left landing gear, and that the situation did not require an emergency evacuation.

The aircraft remained grounded on runway 06 due to the burst tires. The aircraft had been dispatched with DDM 32-02-02 concerning a failure of the anti-skid system.
Take off time from GMMN: 2211 z
Landing time at GMFO: 2259 z
Crew: 6 (2 PNT + 4 PNC)
Total passengers on board: 141

Beginning of black traces 500 m from threshold 06

Beginning of destruction of the internal tire 600 m from the threshold
Start of destruction of the outer tire 700 m from the threshold
Beginning of traces of contact of the rim with the ground 800 m from the threshold
Aircraft immobilized 1500 m from the threshold
Captain Air Safety Report (ASR):

AT1400 CNRNP dispatched with DDM 32-02-02 (HIL 1546-C) Allowed maximum take off weight 62.4T (landing limitation at OUD with application of the DDM via OPT 59.7T + trip). takeoff weight 60.5T. Landing weight 58.2T, Vref F40 132 kt, landing distance 2500m. After landing, while decelerating I received an emergency call from the cabin warning me of an engine fire on the left side, when the plane stopped we called the control tower and the fire. The aircraft remained on the axis until complete stop. We performed the CL engine fire on the ground, at the evacuation is needed item the firefighters were already on site around the plane and confirmed that there was no smoke or fire and that the area was secure, we then proceeded to a rapid disembarkation. Upon verification, we noticed that the two left tires had burst which led to the rims touching the ground and causing the sparks.
Flight Data Analysis

Vitesse Sol

- 0.22 G Equivalent AUTOBRAKE 3
- 0.4 G Heavy Braking
Tire Damage or Anti-Skid defect 2001 - 2021

- **Tire Burst (MEL 32-02)**: 5
- **Transducer Problems**: 2
- **Landing reported without problem**: 1
- **Tire damage (other)**: 6
VII. | Accident Prevention Program|
Internal Safety Investigation Sample

Tire Damage Ratio / Number of MEL applications
2015 - 2021

- Number of application times of the MEL 32 -02
- Tire bursts
Root Cause Analysis:

After a debriefing session with the crew, the analysis carried out by the Safety Management System department shows that the probable root cause of this event is the over braking input, which was not compatible with the length and conditions of the runway.

Risk assessment:

Using the ICAO risk assessment matrix:

- Probability: **LOW**
- Severity: **MAJOR**
- Risk Index: **3C**
- Acceptability: **ACCEPTABLE WITH MITIGATION**
Safety Recommendations:

1. A simulator session for the flight crew in conditions similar to those of the flight, to review with an instructor the braking with ANTI SKID INOP and the landing sequence as set by the manufacturer on Flight Crew Manuals.

2. Modify the MEL 32-02 so that it becomes a NOGO on departure from CMN home base.

3. Limit the number of sectors outside CMN to a maximum of 2, with MEL 32-02 is applied.

4. Rearrange wording of the new MEL taking into account these first two during FLT/MNT OPS coordination meetings.

5. Train the Antiskid Inoperative operational procedure during the recurrent simulator training (starting with session C).

6. Modify the B737 NG Antiskid Inoperative operating procedure to include the use of:
   - Flaps 40.
   - Full available runway length.
   - Use maximum reverse thrust
   - Distribute an OSI “Safety bulletin” to all flight crews as feedback on the event
THANK YOU