Contents

Hazardous **Weather as a Primary cause of aircraft accidents**

- It is of great significance to identify and clarify the circumstances and the causes of any aircraft accident;
  - this will help to avoid any similar accident in the future. Weather is regarded amongst others as one of the main cause of aircraft accidents and incidents.

- Different weather hazards such as Thunderstorms, Microburst from Thunderstorms, Mountain Wave turbulence, Clear air turbulence (CAT), Wind shear, Poor visibility and Fog, etc. have been the cause for numerous aircrafts accidents and incidents.
  - In some instances passengers were injured, some even lost their lives and some aircraft suffered structural damages.
  - CAT has been the cause of numerous incidents where commercial aircraft passengers have been injured and sometimes died (De Villiers1998).

- **Weather as a Primary cause of aircrafts accidents**

- **The Safety Link, Vol.1 No. 5 • Nov/Dec 2001** : The single most important factor in general aviation flight safety is the decision of a pilot to begin or to continue with a flight in unsuitable weather conditions

Incidents :

- *1 June 2009 – Air France Flight 447 – in the Atlantic*
- *13 April 2013 – Lion Air Flight 904 – Indonesia*
- *29 December 2012 – Red Wings Airlines Flight 9268 - Russia*
- *17 December 2012 – Amazon Sky AN-26 - USA*
- *4 April 2011 – UN flight 834 – in DRC*
- *8 July 2011 – Hewa Bora Airways Flight 952 – DRC*
- *25 January 2010 – Ethiopian airlines flight 409 – Mediterranean sea*
- *5 May 2007 – Kenya Airways flight 507 – Douala*
- *8 December 2005 – Southwest Airlines flight 1248 – Chicago*
- *13 January 2004 – Uzbekistan Airways Flight 1154 – Uzbekistan*
- *1 June 1999 – American Airlines flight 1420 – USA*
- *20 April 1998 – Air France flight 422 – Bogata*

Hazardous **Weather as a Primary cause of aircraft accidents**

228 fatalities: Air France Flight #447 over the Atlantic Ocean on June 1, 2009

583 fatalities: Tenerife, Canary Islands, Spain on March 27, 1977

275 fatalities: Iran Ilyushin Military Aircraft near Kerman, Iran on February 19, 2003

228 fatalities: Korean Air Flight #801 in Guam on August 6, 1997

234 fatalities: Garuda Indonesia Flight #152 near Medan, Indonesia on September 26, 1997

203 fatalities: China Air Flight #676 in Taiwan on February 16, 1998

- **Weather forecaster's role**: *to advice the pilot about the prevailing and expected weather conditions en-route, but the decision to fly remains with the pilot based on his knowledge, understanding and experience.*

- **The Safety Link, Vol.1 No 5, Nov/Dec 2001**: *Weather has been attributed to be a major factor in most fatal accidents: over 80% of Controlled Flight into Terrain (CFIT) accidents happened when the pilot either continued flying into adverse weather or did not appreciate the actual effects of the weather conditions*

- **South African Civil Aviation Authority (SACAA) Annual financial statement, 2005**: *Aircraft accidents **also impact financially** on the aviation industry. In its financial year 2004/2005, the SACAA **spent R6 million** on accidents and incidents Investigations.*

- **Office of the Federal Coordinator for Meteorology, 1999, p.vii):** *The financial implication of the weather on aircraft accidents is a persisting problem **even in fully developed countries**. Weather is a factor in roughly 23% of all aviation accidents and annually **costs the US an estimated $3 billion** for accident damage and injuries, delays, and unexpected operating costs*

Some links to aircraft accidents/incidents involving the weather

- https://skybrary.aero/articles/accident-and-serious-incident-reports-wx

- https://en.wikipedia.org/wiki/Category:Airliner_accidents_and_incidents_caused_by_weather

- https://www.wunderground.com/blog/weatherhistorian/top-10-deadliest-weatherrelated-aviation-accidents-on-record.html

- https://en.wikipedia.org/wiki/List_of_accidents_and_incidents_involving_commercial_aircraft

- https://www.baaa-acro.com/country/kenya?page=6

- https://www.aviation24.be/airports/wilson-airport/aeronav-air-cessna-208-caravan-crashes-in-kenya-killing-both-pilots/

- https://rmets.onlinelibrary.wiley.com/doi/full/10.1002/met.1686

What is SIGMET information?

- **SIG**nificant **MET**eorological information
  - aeronautical meteorological (MET) Information concerning en-route weather and other phenomena in the atmosphere that may affect the safety of aircraft operations; OR
  - MET information pertaining to specified en-route hazardous weather phenomena,
    - known as Significant Meteorological (SIGMET) information
  - The **preparation and issuance** of information advising pilots and other aeronautical personnel of **weather conditions likely to affect the safety of international air navigation are important functions** of **aerodrome meteorological offices** and **meteorological watch offices** (MWOs).

SIGMET information

- – Originated by an MWO
  - – Exist **primarily to prepare and issue information on potential hazardous en-route weather phenomena**
  - – **in their area of responsibility**- Flight Information Regions (FIR) or control areas
  - – This information is called **SIGMET** and **AIRMET** information.
- – **MWOs use tropical cyclone and volcanic ash advisories to prepare SIGMET information for tropical cyclones and volcanic ash clouds.**
- – The **issuance of warnings of hazardous weather conditions at or near aerodromes**, including wind shear warnings, is usually the **primary responsibility of aerodrome meteorological offices.**

MET Information for the different phases of the flight

Flight Phases	Pre-flight	Parking (TWR)	Taxing (TWR)	Take-off /Manoeuvre (TWR)	En-route (FIC/ACC)	Approach (APP)	Landing (TWR)
MET	TAF	MET REPORT	MET REPORT	MET REPORT	SIGMETs	MET Report	MET Report
	SIGMET Information	SPECIAL	SPECIAL	SPECIAL	SPECIAL	SPECIAL	SPECIAL
	AIRMET (if applicable)	AD WRNGs	AD WRNGs	WS WRNGs	AIREP	SIGMETs	WS WRNGs
	METAR SPECI MET REPORT				VA Advisory	WS WRNGs	
	Take-off Forecasts				TC Advisory		
	Flight Documentation				SWX Advisory		
	Aerodrome WRNGs						
	VA Advisory						
	TC Advisory						
	SWX Advisory						
	Briefings						

Contribution of SIGMET Information

<u>Source</u> : Doc 8896 - Manual of Aeronautical Meteorological Practice

Guidance material

- ICAO guidance material concerning the provision of SIGMET information:
    - Annex 3 - Meteorological Service for International Air Navigation, Chapter 3 and Appendix 6.
        - Chapter 3
    - AFI eANP, Vol II Part V,
        - Tables MET II-1 and MET II-2

- Additional Guidance on SIGMET contained:
    - **ICAO Doc 8896**, *Manual of Aeronautical Meteorological Practice;* **ICAO Doc 9377**, *Manual on Coordination between Air Traffic Services, and Aeronautical Information Services and Aeronautical Meteorological Services;* and
    - **ICAO 10003**, *Manual on the ICAO Meteorological Information Exchange Model*

Guidance material

- AFI Regional Requirements:

  – AFI eANP Vol II, Part V

  - Mandatory requirements related to the MET facilities and services to be implemented by States in accordance with the Regional air navigation agreements
  - SIGMET messages disseminated to other MET offices in accordance with the AFI Met Bulletin Exchange Scheme (AMBEX)

  – AFI Regional SIGMET Guide

  - Prepared by ESAF/WACAF Regional Offices
  - Reviewed and updated to keep in line
  - Intended to assist the MWOs in ESAF/WACAF in preparing and disseminating SIGMET information
  - Provides detailed information on the format of SIGMET messages as specified by Annex 3.
  - Explanations of the format are accompanied by examples based on region-specific meteorological phenomena

Importance of SIGMETs?

- warning information and hence it is of highest priority

  – The purpose of SIGMET information

  – to advise pilots of the occurrence or expected occurrence of potentially hazardous en-route weather phenomena

- timely transmission of SIGMET information to pilots

  – by ATS units and /or through VOLMET and D-VOLMET

  – Special air-reports transmitted by pilots to ATS units and forwarded to MWO's

    - one of the valuable sources to prepare SIGMET

- Coordination between MET, ATS and pilots

  – crucial for the successful implementation of the SIGMET service

Importance of SIGMETs Cont.

- SIGMET provides information on **hazardous meteorological phenomena**, which may **affect safety of aircraft operations**; hence, they are considered a **high priority** among other types of meteorological information provided to the aviation users.

- *Safety impact:* SIGMETs are issued for the following weather-impacted reasons: **Severe Icing**. **Severe or Extreme Turbulence**, **Dust storms** and/or **Sand storms** lowering visibilities, etc. SIGMETs related to **Dust Storms, Sand Storms and Volcanic Ash** are issued not only because of the visibility challenges such phenomena can create, but **because the particles can severely damage the engines of aircraft.**

- *Environmental impact*: **More precise planning for mitigation of hazardous meteorological conditions,** as well as space weather, produces **safer and more efficient routes**, **less fuel burn**, and **reduction of emissions due to fewer ground hold/delay** actions and environmentally optimized routing.

- **Failure to provision SIGMET information in accordance with ICAO MET related SARPs** will keep in-flight aircrafts out of information on en-route hazardous weather phenomena which may adversely affect the safety of aircraft operations.

Role of SIGMETs

- One of the factors considered **in flight planning**

- May influence **route selection**

- Information on SEV or Extreme phenomena **may lead to cancellation /delaying /re-routing of flight**

- Large responsibility for **safety of crew and passengers**

- **In-flight up linking /VHF communications** for unexpected hazardous phenomena

Coordination….. WHO ? What are the roles of different Units and Service providers?

- SIGMET messages are issued by MWOs which maintain 24/7 basis watch in their AoR (FIR/ACC)
- **MWO to** :
  - Supply SIGMET information to associated air traffic services units;
  - Disseminate SIGMET information when required by regional air navigation agreement
  - Issue SIGMET according to VAAC advisory information, special air-reports on volcanic ash and any other relevant information and/or measurements available
  - Maintain close coordination to be maintained between the MWO and the associated ACC/FIC to ensure that information on volcanic ash included in SIGMET and NOTAM messages is consistent.
- **Aircraft /pilots to**: ATS
- Coordination with the corresponding **MWOs, AMOs and RSMCs**

For WHOM?

- **In-flight crew**, pre-take-off, (AOC), ATM;
- Modern aircraft receive **uplinked information**;
- Operators are supplied with SIGMET information mainly from aerodrome meteorological offices;
- **ATM** copied for **common awareness**;
- SIGMETs are transmitted to **OPMET databanks** and to the international centres responsible for operation of the aeronautical fixed service (AFS) Internet-based services.
- **Meteorological Watch Offices** (MWOs);
- **WAFCs** and to other meteorological offices **in accordance with regional air navigation agreements**.
- **SIGMET messages for volcanic ash** shall also be disseminated to the **volcanic ash advisory centre (VAAC)**.
- SIGMET messages are to be available **at departure aerodromes for the whole route**

WHEN to issue a SIGMET?

- **Criteria for phenomena** included in SIGMET messages **are met**
- Those **criteria** that should be known (A3, App.6:§1, §4 refer).
- **Proactivity** rather than **reactivity** in processing SIGMET information

How do we react?

- **WC SIGMET**
  - When a tropical cyclone develops/ has entered/ expected to enter/develop in your FIR
    - Issue a WC SIGMET without delay
  - STEP 1
    - Information received
  - STEP 2
    - Prepare WC SIGMET
  - STEP 3
    - Transmit the WC SIGMET

How do we react?

- **WV SIGMET**
  - When a volcanic eruption and/or ash is observed or reported in your FIR- issue a VA SIGMET **without delay**
  - This applies even when the ash has entered your FIR from another FIR (or is expected to). When a volcanic ash cloud crosses multiple FIRs, VA SIGMETs **must be issued for all of the FIRs**
    - Issue a WV SIGMET **without delay**
  - STEP 1
    - Information received
  - STEP 2
    - Prepare WV SIGMET
  - STEP 3
    - Transmit the WV SIGMET

Thunderstorm

Dust/Sandstorm

How do we react?

- **WS SIGMET**
  - When any of the following phenomena are occurring or expected to occur in your FIR
    - [Phenomena: Tropical Cyclone (**TC** + cyclone Name if known); thunderstorms, heavy duststorms HVY **DS;** heavy sandstorms **HVY SS;** severe turbulence **SEV TURB;** severe mountain waves **SEV MTW;** severe icing **SEV ICE;** radioactive cloud]
    - **Refer to Annex 3:App. 6** to the Convention related to the International Civil Aviation of phenomena covered by SIGMET.
    - Issue a WS SIGMET **without delay**
  - STEP 1
    - Information received
  - STEP 2
    - Prepare WS SIGMET
  - STEP 3
    - Transmit the WS SIGMET

Thunderstorm

Dust/Sandstorm

HOW are Phenomena determined for inclusion in SIGMET ?

- MWO to use local data (Weather Radar, Lightning detection, etc.)
- Give **best estimate of danger area boundaries**
- Anywhere, **Area of responsibility** of the MWO
- Use of **PIREPS /AMDAR**
- Contact to ATM
- NWP and **satellite images**
- Knowledge of **regional/national climatology**

Conclusion

The impact of hazardous weather:

- on aircraft safety

  – Significant damage to aircraft and often casualties

- Financial loss

  – Enormous effects on the economy of e.g. CAAs

  – puts a variety of aviation organisations at risk due to the related financial implications