

Désorientation Spatiale et Illusions Sensorielles

prévention pour les pilotes civils ?



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MEAS

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Ministère de l'Écologie, du Développement durable et de l'Énergie

UNITED STATES AIR FORCE
AIRCRAFT ACCIDENT INVESTIGATION
BOARD REPORT



U-28A, T/N 07-0736
HURLBURT FIELD, FLORIDA



LOCATION: NEAR CAMP LEMONNIER, DJIBOUTI

DATE OF ACCIDENT: 18 FEBRUARY 2012

BOARD PRESIDENT: BRIG GEN TIMOHTY LEAHY

Conducted IAW AFI 51-503, *Aerospace Accident Investigations*



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3. CONCLUSION

The MC never lost control of the aircraft; there are no indications of mechanical malfunction; and there are no indications the crew took any actions to control or arrest the descent rate and nose down attitude. I find that the clear and convincing evidence indicates the cause of the mishap was unrecognized spatial disorientation. Additionally, I find by a preponderance of the evidence that failing to cross-check and ignoring the “Sink Rate” caution substantially contributed to the mishap.



TIMOTHY J. LEAHY

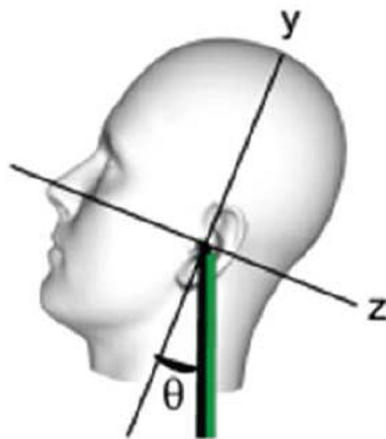
Brigadier General, USAF

President, Accident Investigation Board



Sensibilisation, Détection et Simulation

- Les illusions sensorielles sont instruites théoriquement lors des formations standardisées des pilotes civils.
- Elles le sont d'une manière pratique dans les forces armées internationales par l'intermédiaire de simulateurs.
- D'où le test effectué au GIS de Mont de Marsan pour tenter de répondre à une question :



Cette pratique du ressenti des illusions est-elle favorable pour les pilotes civils ?

Si oui, comment ?



Mont de Marsan 13 Juin 2012

Organisation du test :

- panel de pilotes expérimentés (comparaison population AA)
- suivi de la journée de formation type (théorique et pratique)
 - 4 questionnaires associés
 - enregistrements vidéos avec droits d'utilisation
 - table ronde pour débriefer la journée avec les formateurs



Phase 1

sensibilisation

Instruction théorique spécialisée:

- Les illusions visuelles
- Les illusions sensorielles d'origine vestibulaire
- Les illusions sensorielles de cause mixte et leurs mécanismes

puis application pratique sur générateur d'illusions sensorielles (20 minutes) avec suivi « live » de la séance par les autres candidats.

Ateliers sur les illusions visuelles

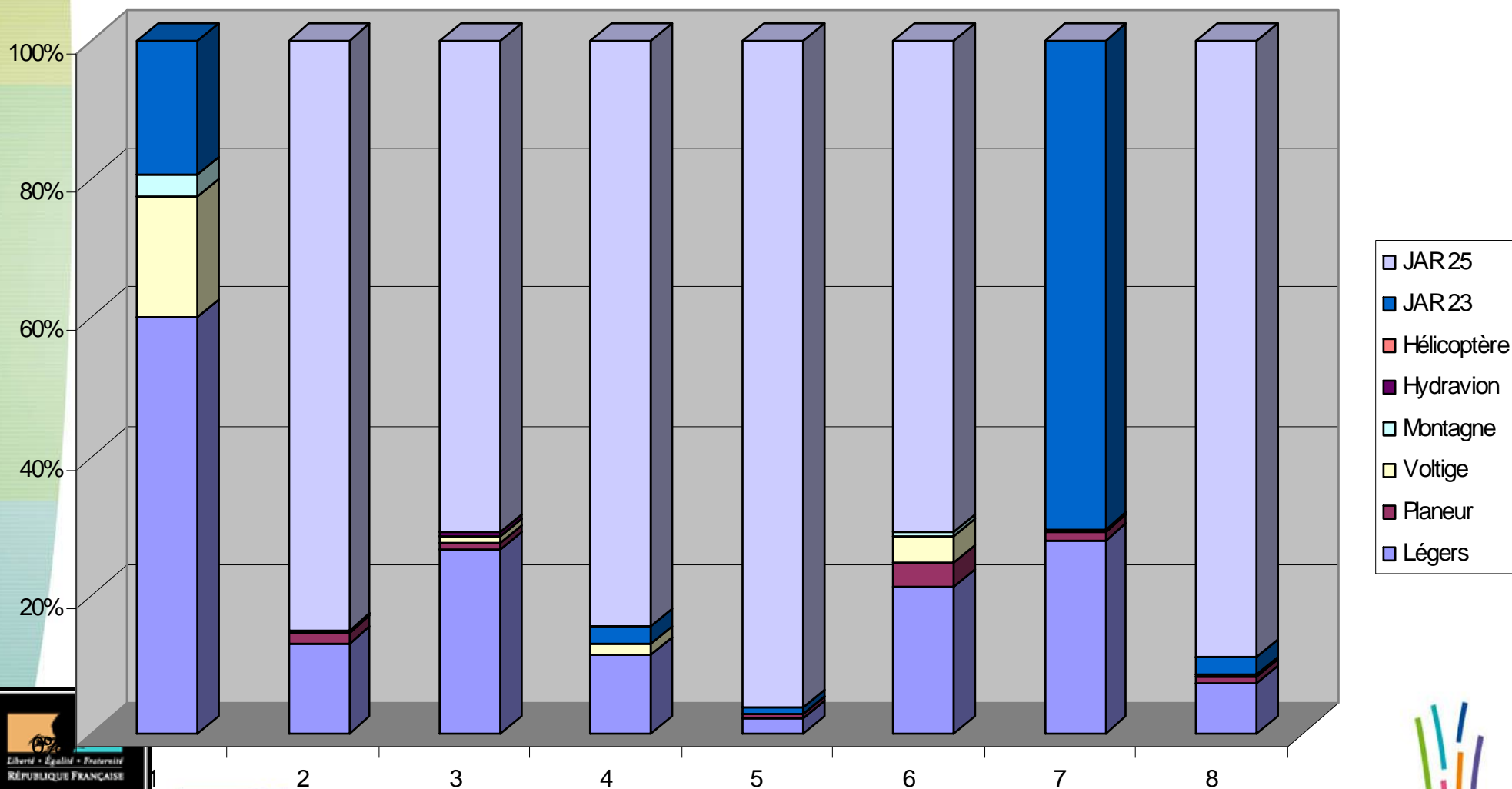
1 Groupe de 12 personnes maximum

Durée : 1 journée



Panel choisi

8 pilotes expérimentés de provenances diverses



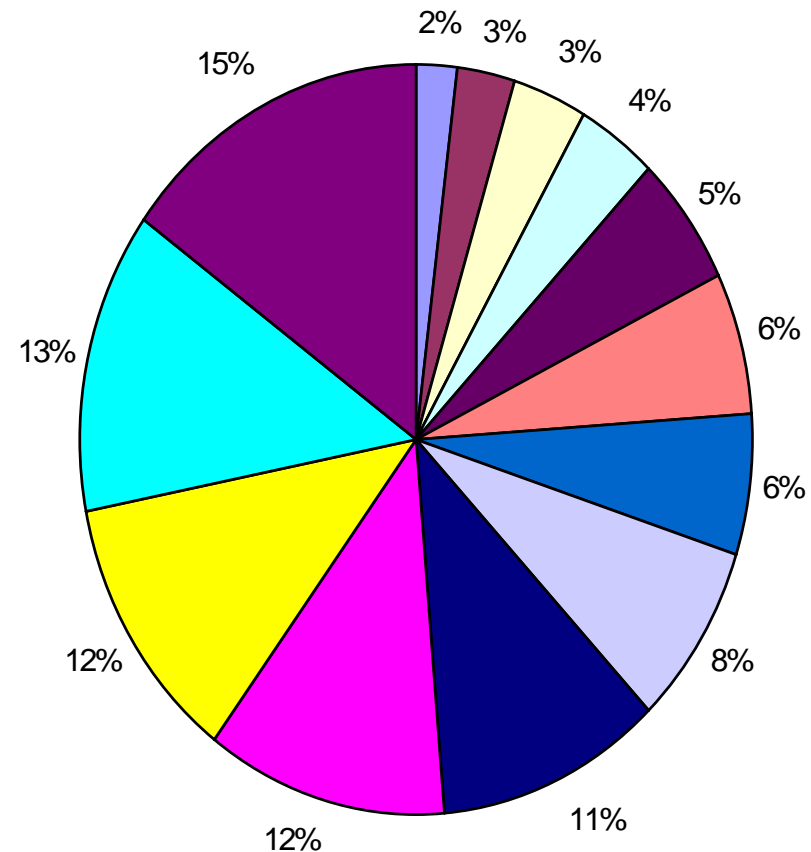
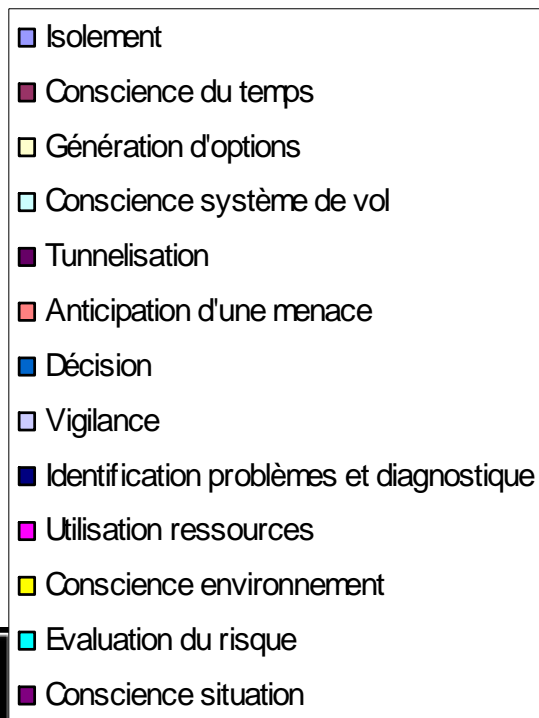
Questionnaire avant expérimentation

Résultats

- 100 % disent connaître les illusions sensorielles et les ont déjà ressenties
- 1 seul pilote pense pouvoir donner un classement personnel des effets avant test
- 1 seul pilote pense avoir une conscience claire du phénomène avant test
- questions multiples que se posent les pilotes avant test.

Questionnaire « à chaud » juste sorti du GIS

« Je viens de pratiquer des exercices qui influent mon appréciation de : »
(réponses à choix multiples avec pondération d'importance)



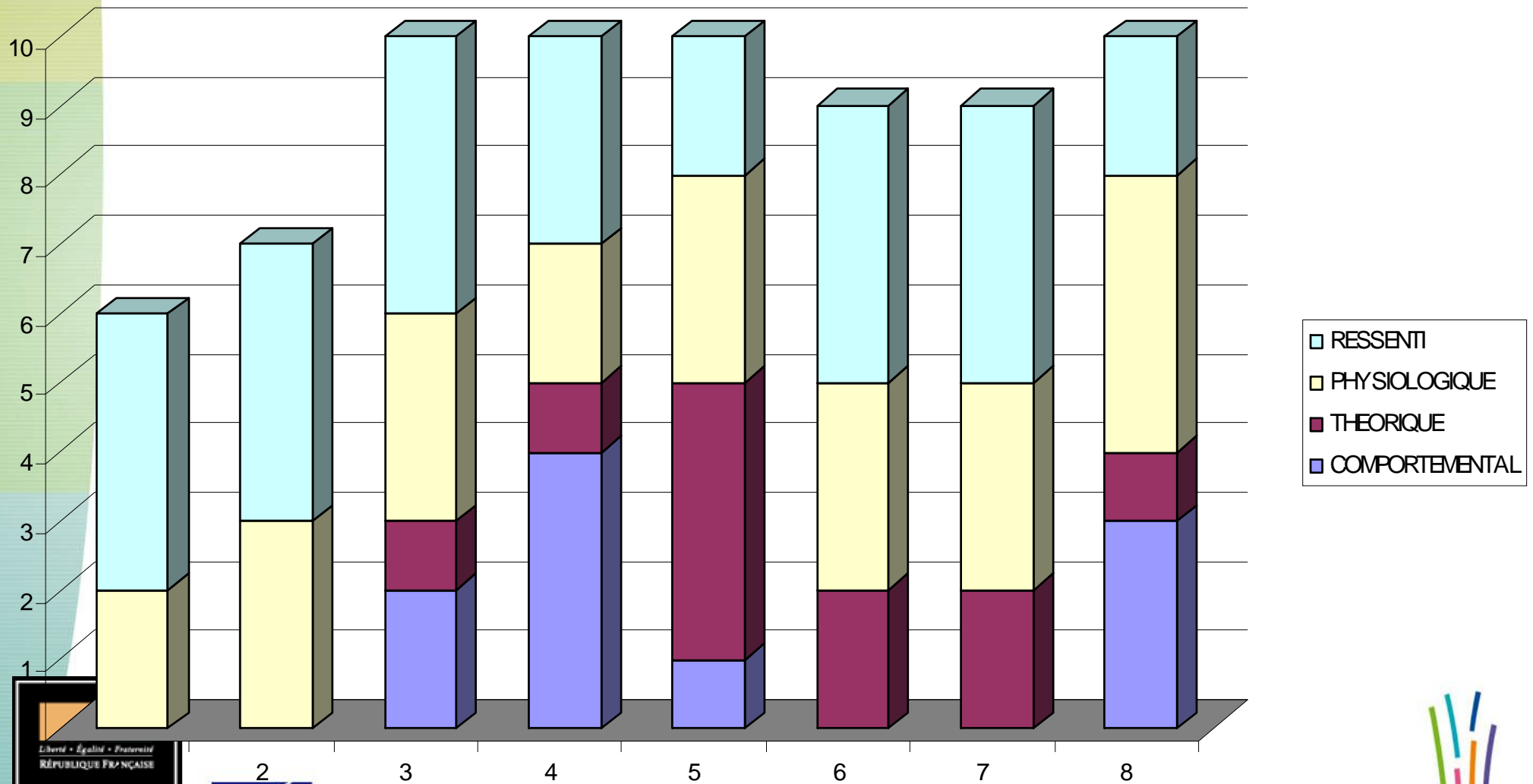
Questionnaire à froid bilan fin de journée

- Réponses validées par l'utilisation du test NASA TLX
- A l'issu de cette journée, l'instruction civile existante est elle suffisante ? **NON à 100%**
- La conduite à tenir face aux situations en vol demande à être mieux développée → travail sur la simulation avec des exercices tirés de phases de vol.
- **100%** pensent avoir maintenant une conscience claire des phénomènes
- 7 pilotes peuvent maintenant établir un classement personnel de ces phénomènes.
- 7 pilotes ont trouvé les réponses aux questions qu'ils se posaient avant la séance.



La journée vous a-t-elle apporté de nouvelles connaissances ?

Si oui dans quels domaines ? (classés avec pondération)



Cette journée a-t-elle modifié votre ou vos ?

	1	2	3	4	5	6	7	8
Connaissances	OUI	OUI	OUI	OUI	OUI	NON	OUI	OUI
Analyse	N/A	N/A	OUI	OUI	OUI	OUI	OUI	OUI
Future pratique	N/A	N/A	OUI	OUI	OUI	N/A	OUI	OUI
Méthode d'instruction	N/A	N/A	OUI	OUI	OUI	N/A	OUI	OUI
Manière de travailler	N/A	N/A	OUI	OUI	OUI	N/A	OUI	OUI



Phase 2 Traduction sur le vol

Prevent / Avoid / Detect / Mitigate /

Recover

monde.

exemple
Marsan

- Zone rouge: plupart des travaux en cours dans le monde.
- Les remises de gaz haute énergie paraissent être un exemple
- Zone bleue: Pistes explorées suite au test de Mont de Marsan
Ex : étude PARG (BEA)
- Position tête basse des 2 pilotes (PF + PM)
- Circuits visuels et gestion des informations
- Non détection de mouvements « très confortables »
- « Enveloppe » en mécanique du vol
- Reconnaissance de situations accidentogènes



A330 Incident – 2007

« After initiating a go around **at night** over the sea, the altitude capture mode activated, **the pilot flying pitched down to level off.**

The IAS increased towards VFE.

Instead of keeping a leveled flight path, the pilot flying kept a prolonged pitch down input.

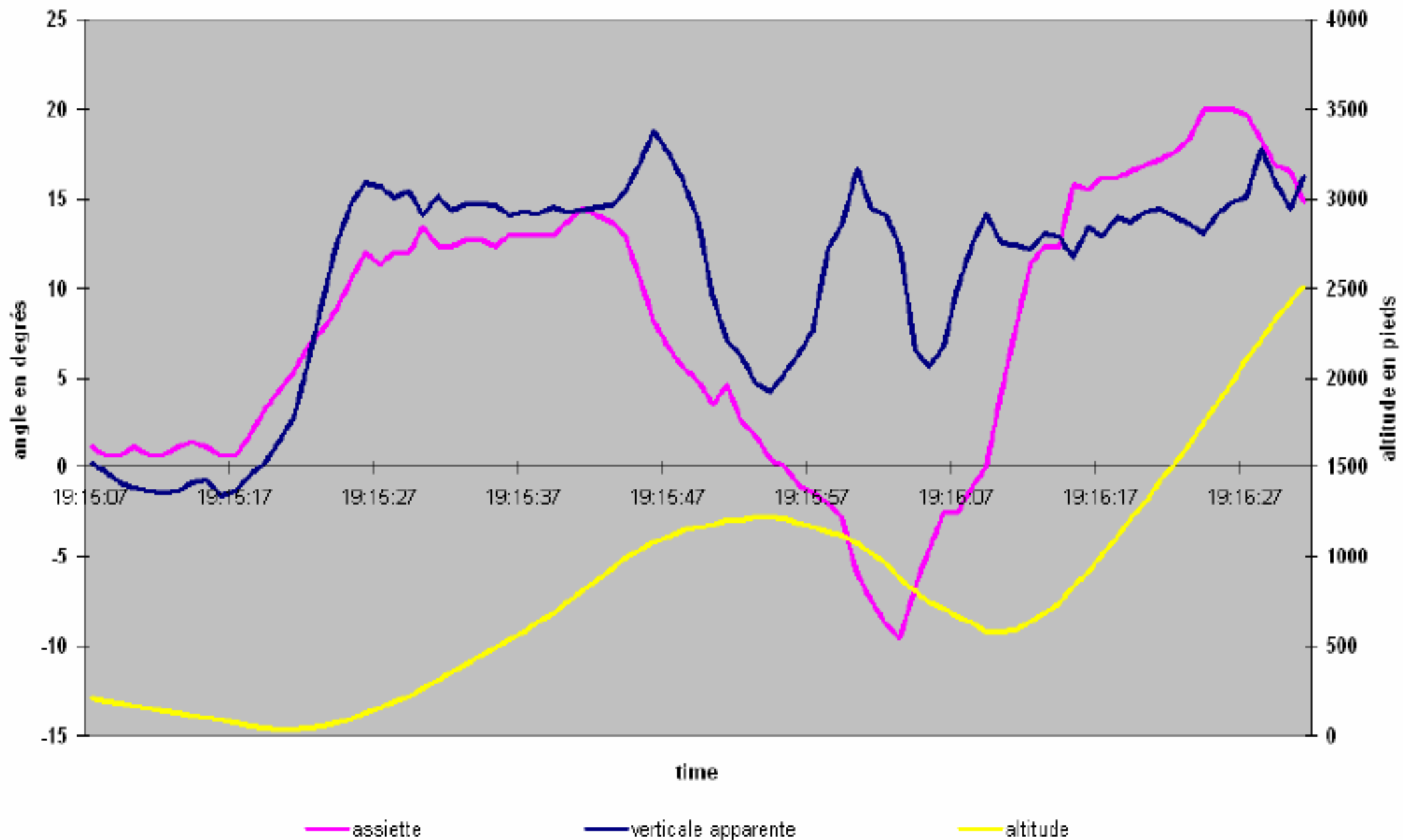
Attitude reached **- 9°**, vertical speed - **4000ft/mn.**

The GPWS activated and the climb was resumed.

The minimum altitude was 600 ft over the sea.

Total duration: about 15 seconds

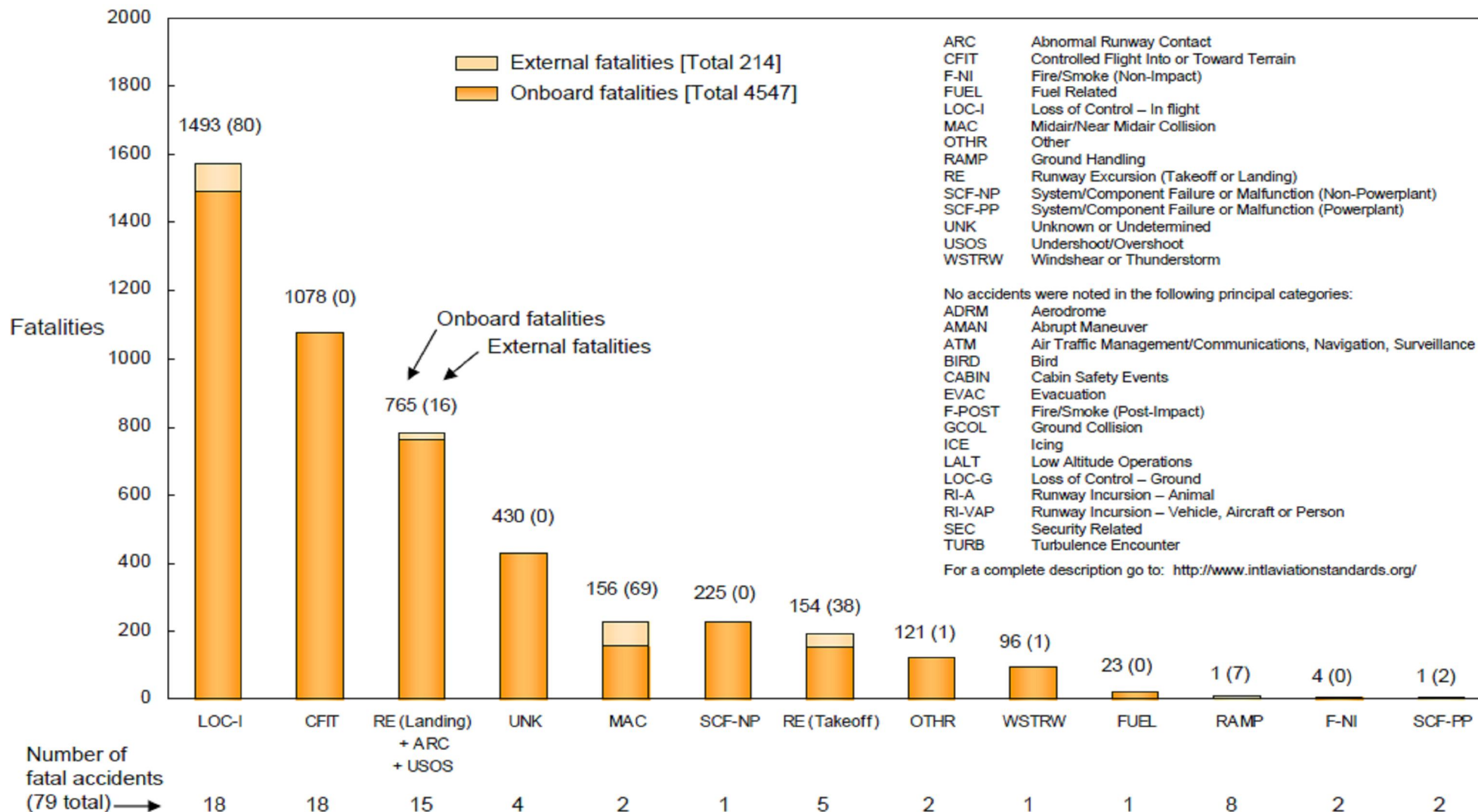
verticale apparente



Fatalities by CAST/ICAO Common Taxonomy Team (CICTT)

Aviation Occurrence Categories

Fatal Accidents – Worldwide Commercial Jet Fleet – 2002 Through 2011



Note: Principal categories as assigned by CAST.



U.S. Department
of Transportation
**Federal Aviation
Administration**

Advisory Circular

Subject: PILOT'S SPATIAL DISORIENTATION

Date: 2/9/83
Initiated by: AFO-840

AC No: 60-4A
Change:

1. PURPOSE. To acquaint pilots with the hazards of disorientation caused by loss of visual reference with the surface.

2. CANCELLATION. Advisory Circular 60-4, Pilot's Spatial Disorientation, dated February 9, 1965, is canceled.

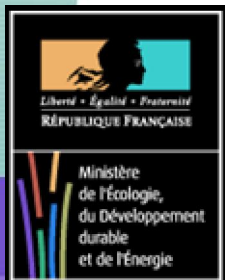
3. DISCUSSION.

a. The attitude of an aircraft is generally determined by reference to the natural horizon or other visual references with the surface. If neither horizon nor surface references exist, the attitude of an aircraft must be determined by artificial means from the flight instruments. Sight, supported by other senses, allows the pilot to maintain orientation. However, during periods of low visibility, the supporting senses sometimes conflict with what is seen. When this happens, a pilot is particularly vulnerable to disorientation. The degree of disorientation may vary considerably with individual pilots. Spatial disorientation to a pilot means simply the inability to tell which way is "up."

b. During a recent 5-year period, there were almost 500 spatial disorientation accidents in the United States. Tragically, such accidents resulted in fatalities over 90 percent of the time.

c. Tests conducted with qualified instrument pilots indicate that it can take as much as 35 seconds to establish full control by instruments after the loss of visual reference with the surface. When another large group of pilots were asked to identify what types of spatial disorientation incidents they had personally experienced, the five most common illusions reported were: 60 percent had a sensation that one wing was low although wings were level; 45 percent had, on leveling after banking, tended to bank in opposite direction; 39 percent had felt as if straight and level when in a turn; 34 percent had become confused in attempting to mix "contact" and instrument cues; and 29 percent had, on recovery from steep climbing turn, felt to be turning in opposite direction.

d. Surface references and the natural horizon may at times become obscured, although visibility may be above visual flight rule minimums. Lack of natural horizon or surface reference is common on overwater flights, at night, and especially at night in extremely sparsely populated areas, or in low visibility conditions. A sloping cloud formation, an obscured horizon, a dark scene spread with ground lights and stars, and certain geometric patterns of ground lights can provide inaccurate visual information for aligning the aircraft correctly with the actual horizon. The disoriented pilot may place the aircraft in a dangerous attitude. Other factors which contribute to disorientation are



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4. RECOMMENDED ACTION.

a. You, the pilot, should understand the elements contributing to spatial disorientation so as to prevent loss of aircraft control if these conditions are inadvertently encountered.

b. The following are certain basic steps which should assist materially in preventing spatial disorientation.

(1) Before you fly with less than 3 miles visibility, obtain training and maintain proficiency in aircraft control by reference to instruments.

(2) When flying at night or in reduced visibility, use your flight instruments, in conjunction with visual references.

(3) Maintain night currency if you intend to fly at night. Include cross-country and local operations at different airports.

(4) Study and become familiar with unique geographical conditions in areas in which you intend to operate.

(5) Check weather forecasts before departure, en route, and at destination. Be alert for weather deterioration.

(6) Do not attempt visual flight rule flight when there is a possibility of getting trapped in deteriorating weather.

(7) Rely on instrument indications unless the natural horizon or surface reference is clearly visible.

5. CONCLUSION. You and only you have full knowledge of your limitations. Know these limitations and be guided by them.



KENNETH S. HUNT
Director of Flight Operations



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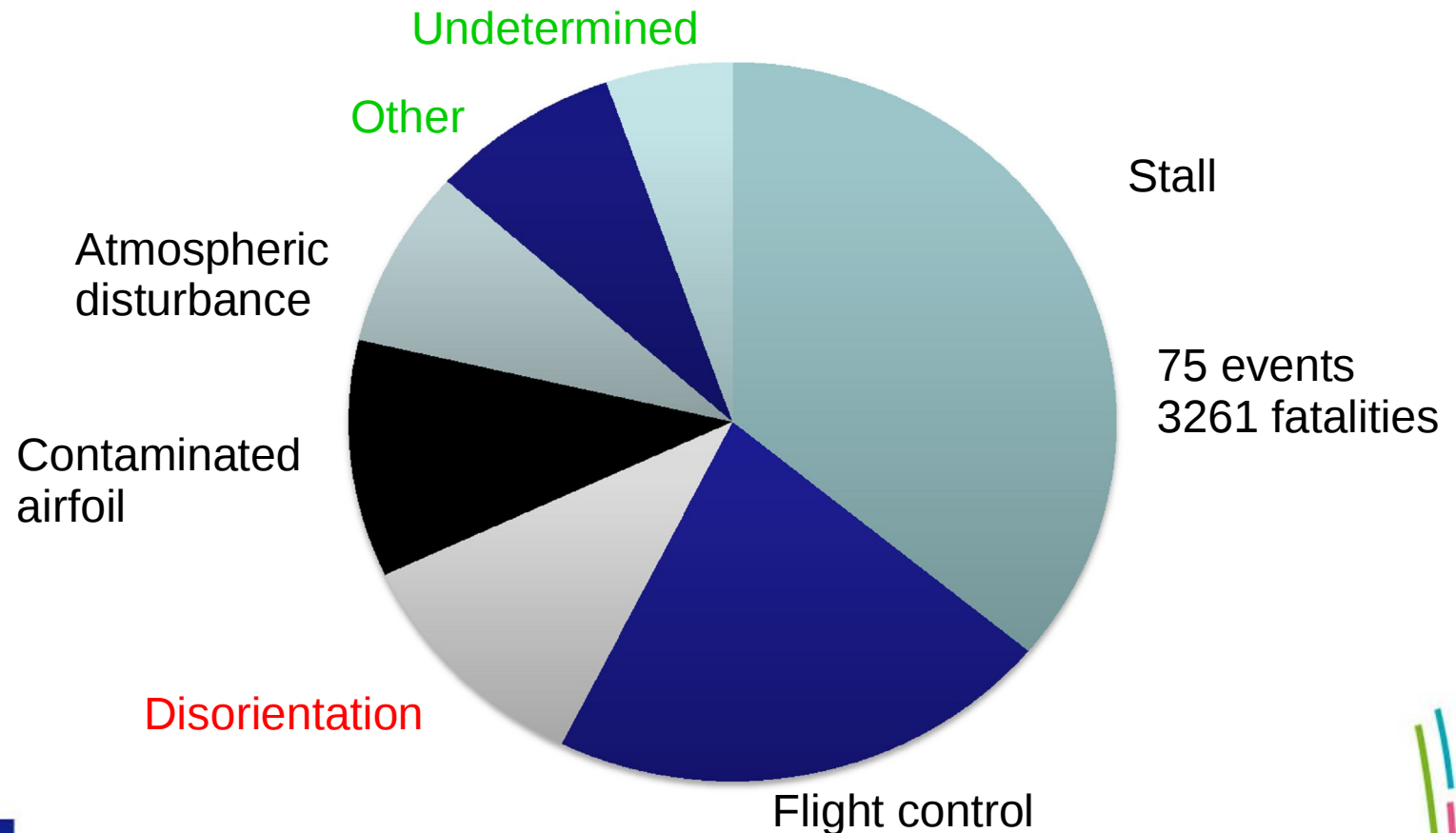
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Mid-Level "Requirements"

Upset and Loss-of-Control Events in Transport Airplanes, 1993-2007

Lambregts, A.A., et. al., "Airplane Upsets: Old Problem, New Issues, AIAA Paper 2008-6867, AIAA Modeling and Simulation Conference, Honolulu, HI, 2008



Analysis of 126 Accidents with 6087 Fatalities from 1979 – 2009 (30

Years)

Detailed Analysis of LOC Sequences
(52 Unique Sequences

Identified)

7-10 Generalized Sequences \geq 85% Accidents/Fatalities

Vehicle Problem / External Hazard

-

Inappropriate Crew Response

-

- Vehicle Upset

LOC Precursor Sequence:

- Vehicle Impairment, Fault, Failure, Damage
- External Hazard or Disturbance
- Poor Situational Awareness / Distraction
- **Spatial Disorientation** (Poor Visibility)
- Mode Confusion (System Complexity)
- **Abnormal Attitudes**
- Abnormal Trajectory
- Stall/Departure



Pistes

- Formation pratique des instructeurs ?
- Vidéo de révision en 3D (IASA)?
- Exercices de sensibilisation au simulateur ?
- Révisions dans les ECP ou cours ?
- Passage de connaissances très théoriques en mécanique du vol → maîtrise enveloppe ?
- Guide de bonnes pratiques ?
- Initiation au simulateur ?
- Affiches de promotion de la sécurité ?



Thanks for your attention



«Learn from the gaps done by each other !
Because
you will never live long enough to make them all...»



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Sam Levenson

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