Supplementary file for: G.A. Bendrick, S.A. Beckett & E.B. Klerman 2016. Human fatigue and the crash of the airship *Italia. Polar Research 35*. Correspondence: Gregg A. Bendrick, National Aeronautics and Space Administration, Armstrong Flight Research Center, PO Box 273, Mailstop 4822, Edwards Air Force Base, CA 93523-0273, USA. E-mail: gregg.a.bendrick@nasa.gov

(1) Regarding the design changes that Nobile implemented so that the gas pressure release valves would not freeze, he wrote:

> I had been studying the phenomenon since 1916, without being able to put my finger on its causes. I had not succeeded in determining in what measure the intrinsic humidity of the hydrogen and that of the surrounding air contributed towards ice formation. The best thing to do was to provide against both, so far as it was possible. This was done, partly by using hydrogen compressed to the density of several tens of atmospheres, and partly by covering each group of valves (which were placed on the back of the ship) with a light cap which protected it against the external humidity. (1961: 273-274)

(2) Regarding the expansion of gas resulting from thermal heating, Eckener explains:

> The gas expanded as the atmospheric pressure decreased and, on the ship reaching "pressure height", blew off through the automatic valves. Up to then the situation had not become too serious, because, after the pressures had been equalized, the ship had again attained equilibrium. However, the ship had risen above the top of the fog and was now floating above the clouds in bright sunshine. The hot rays of the sun heated the gas, causing it to expand further, and large amounts escaped through the automatic valves. (1958: 188)

At this point—above the clouds—that Nobile ordered the restart of the engines and a descent back into the fog bank. Eckener explains:

> Here the previous loss of gas proved fatal. The "superheat" of the gas was quickly lost by cooling, and the volume of gas remaining in the cells was so greatly diminished that the resulting lift no longer sufficed to support the ship in the air. (1958: 188)

(3) Specific examples of fatigue-related aviation accidents include: Korean Air Flight 801 (6 August 1997) in Guam (NTSB 2000); American Airlines Flight 1420 (1 June 1999) in Little

Rock, AK (NTSB 2001); Colgan Air Flight 3407 (12 February 2009) in Buffalo, NY (NTSB 2010); and a US Air Force C-5 cargo aircraft close-call (Armentrout 2006).

References

Armentrout J.J., Holland D.A., O'Toole K.J. & Ercoline W.R. 2006. Fatigue and related human factors in the near crash of a large military aircraft. *Aviation Space and Environmental Medicine 77*, 963–70.

Durmer J.S. & Dinges D.F. 2005. Neurocognitive consequences of sleep deprivation. *Seminars in Neurology 25*, 117-129.

Eckener K. 1958. A note on the technology and development of the zeppelin airship. In H. Eckener: *My zeppelins.* Pp. 185–216. London: Putnam & Co.

NTSB (National Transportation Safety Board) 2000. *Controlled flight into terrain, Korean Air Flight 801, Boeing 747-300, HL7468, Nimitz Hill, Guam, August 6, 1997. Aircraft Accident Report NTSB/AAR-00/01*. Washington, D.C.: National Transportation Safety Board.

NTSB (National Transportation Safety Board) 2001. *Runway overrun during landing, American Airlines Flight 1420, McDonnell Douglas MD-82, N215AA, Little Rock, Arkansas, June 1, 1999. Aircraft Accident Report NTSB/AAR-01/02.* Washington, D.C.: National Transportation Safety Board.

NTSB (National Transportation Safety Board) 2010. *Loss of control on approach, Colgan Air, Inc., Operating as Continental Connection Flight 3407, Bombardier DHC-8-400, N200WQ, Clarence Center, New York, February 12, 2009. NTSB/AAR-10/01*. Washington, D.C.: National Transportation Safety Board.

Nobile U. 1961. *My polar flights: an account of the voyages of the airships Italia and Norge.* F. Fleetwood, trans. London: Frederick Muller.