



Failure Analysis and Prevention for the Air Logistics Center Engineer

Course Description: Failure mechanisms in typical aircraft structure are presented along with methods to identify each mechanism and its potential impact on structural integrity and life. Various laboratory and field techniques are presented to evaluate structural components to include nondestructive inspection and fractographic/metallographic analysis. Failure prevention methodologies are discussed including component redesign (changes in geometry, material selection and material processing), changes in operation (e.g., flight restrictions) and application of coatings.

Instructors: USAF Academy's Center for Aircraft Structural Life Extension

Primary Citations: Donald J. Wulpi, *Understanding How Components Fail*, 2nd ed. ASM International, 1999.
Norman E. Dowling, *Mechanical Behavior of Materials*, 2nd ed., Prentice Hall, Inc., 1999.

Course Goals: Students will understand how structural components fail. They will use this understanding to analyze failed components and determine the causes of failure as well as make recommendations to prevent future occurrences of failure.

Course Objectives: Upon completion of this course, students will be able to:

1. **Analyze** structures for the mechanisms of failure by elastic and plastic deformation, linear elastic fracture mechanics, fatigue, corrosion and wear.
2. **Identify** and **differentiate** between observable fractographic features that indicate failures caused by yielding, fracture, fatigue, corrosion and wear in metals.
3. **Identify** the elements of failure in composite materials.
4. **Recommend** qualitative and quantitative changes to prevent future occurrences of failure.
5. **Understand** the history and impact of structural failure upon Air Force operational readiness and its Aircraft Structural Integrity Program.

Target Student: A company grade officer or GS-9/11/12 with a B.S. (minimum) in mechanical engineering or aeronautical engineering or engineering mechanics and one to five years of aircraft structures experience.

ADDITIONAL COURSE CITATIONS

- Boyer, H.E., and Gall, T.L., eds., ASM Metals Handbook - Desk Edition, ASM International, Materials Park, OH, 1985.
- Davis, J.R., ed., Corrosion: Understanding the Basics, ASM International, Materials Park, OH, 2000.
- Davis, J.R., ed., Aluminum and Aluminum Alloys, ASM International, Materials Park, OH, 1993.
- Dickson, J.I., ed., Failure Analysis: Techniques and Applications - Conference Proceedings, ASM International, Materials Park, OH, 1992.
- Cartz, Louis, Nondestructive Testing, ASM International, Materials Park, OH, 1995.
- Feld, Jacob and Carper, Kenneth L., Construction Failure, John Wiley & Sons, Inc., New York, 1997.
- Gibala, R. and Hehemann, R.F., eds., Hydrogen Embrittlement and Stress Corrosion Cracking, American Society for Metals, Metals Park, OH, 1984.
- Gordon, J.E., Structures: Or Why Things Don't Fall Down, Da Capo Press, New York, 1978.
- Gordon, J.E., The New Science of Strong Materials, Princeton University Press, Princeton, NJ, 1968.
- Hutchings, F.R. and Unterweiser, P.M., Failure Analysis: The British Engine Technical Reports, American Society for Metals, Metals Park, Ohio, 1981.
- Levy, Matthys and Salvadori, Mario, Why Buildings Fall Down, W.W. Norton & Co., New York, 1994.
- Naumann, F.K., Failure Analysis: Case Histories and Methodology, American Society for Metals, Metals Park, OH, 1983.
- Pilkey, W. D., Peterson's Stress Concentration Factors, 2nd Edition, Wiley Interscience, 1997.
- Petroski, Henry, To Engineer is Human, Vintage Books, New York, 1982.
- Petroski, Henry, Design Paradigms: Case Histories of Error & Judgement in Engineering, Cambridge University Press, Cambridge, UK, 1994.
- Powell, G.W., et al, A Fractographic Atlas of Casting Alloys, Battelle Press, Columbus, OH, 1992.
- Powell, G.W., ed., ASM Handbook, Volume 11: Failure Analysis and Prevention, ASM International, Materials Park, OH, 1986.
- Raj, B., Jayakumar, T., and Thavasimuthu, M., Practical Non-Destructive Testing, ASM International, Materials Park, OH, 2002.
- Schlager, Neil, Breakdown, Visible Ink Press, Detroit, MI, 1995.
- Uhl, R.C., ed., Handbook of Case Histories in Failure Analysis, ASM International, Materials Park, OH, 1992.
- Witherell, Charles E., Mechanical Failure Avoidance – Strategies & Techniques, McGraw-Hill, New York, 1994.