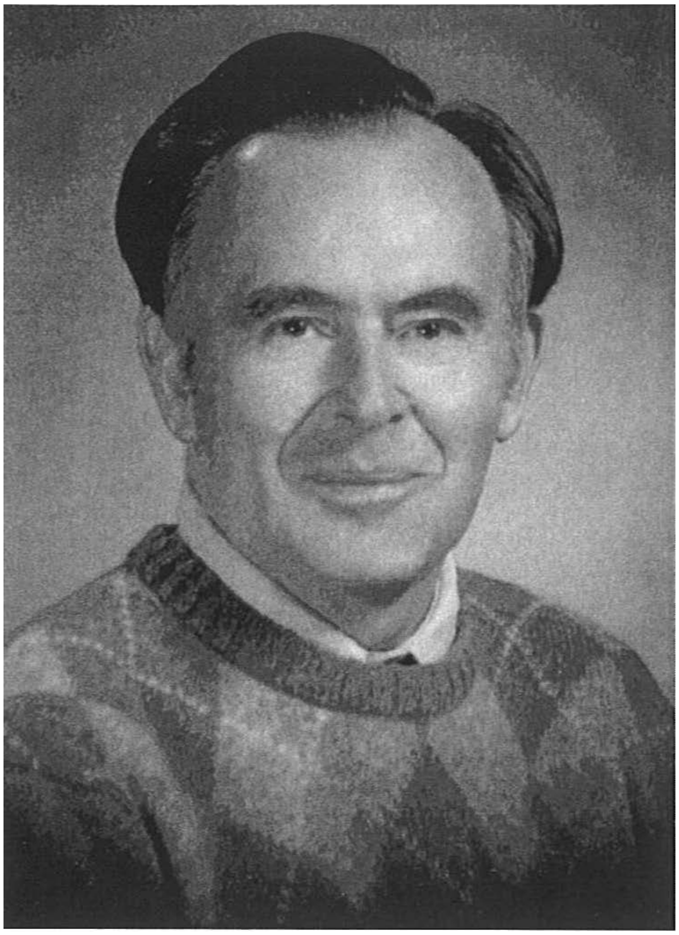

Dr. John A. "Kim" Bailie (1929–2008)

Configuration	Description	Application
Flatwise Tension	Skin/Stiffener Separation Due to Normal Pressure Loading	Wing Skin/Spar Flatwise Tension Due to Internal Fuel Pressure
Transverse Tension	Stiffener Web Splitting Due to Transverse Tension Loading	Wing Skin/Spar Transverse Tension Due to Chordwise Loads
Lateral Bending	Skin/Stiffener Separation Due to Lateral Stiffener Bending	Lateral Spar Bending Due to Asymmetrical Fuel Pressure
Postbuckling	Skin/Stiffener Separation Due to Post-buckling Deformation and Loads	Stiffened Panels Subjected to Compressive and/or Shear Buckling
Curved Panel Bending	Interlaminar Stresses Due to Panel "Beam-Column" Effects	Fuselage Skins and Frames Subjected to Bending Loads
Thickness Transitions	Interlaminar Stresses Due to Combined Loading and Local Bending	Ply Drop Offs, Build-Ups, and Doublers
Irregular Loading	Interlaminar Stresses and Local Bending Due to Axial Loading in the Presence of Eccentricity	Joggles and Kinks
Bonded Joints	Interlaminar Stresses Due to Local Bending Arising From Eccentricity	Single and Double Lap Bonded Joints

MS97-359

FIGURE 3-1. TYPICAL OUT-OF-PLANE LOADS IN COMPOSITE STRUCTURES [REF. 2]

From: J.A. Bailie, R.P. Ley and A. Pasricha, "A summary and review of composite laminate design guidelines", Task 22 NASA Contract NAS1-19347, Final Report, October 1997

Ph.D. from Stanford University

Formerly with:
Northrup Grumman Corporation, El Segundo, California
Lockheed Missiles & Space Co., Sunnyvale, California

From Kim Bailie's Obituary (written by Georgina Bailie):
Kim Bailie died at his home in Palo Alto on August 29, 2008, aged 79. He was a well-known authority on the structural dynamics of submarine-launched ballistic missiles. His outstanding achievements in this difficult field, after his emigration to the United States in the 1950s, included the structural design of the Polaris and Trident strategic nuclear weapons.

The technical challenge confronting Lockheed, the prime contractor, and the U.S. Navy was particularly daunting in the area of structural dynamics. No precedents existed for calculating the stresses, distortions and drag imposed on a big missile launched from under the sea, which then had to emerge into the atmosphere, sustain rocket ignition, and eventually hit a target several thousand miles away with pin-point accuracy.

While working at Lockheed Missiles and Space Company, Kim completed his Ph.D. degree at Stanford University in structural dynamics, and thus was a natural for taking on the extremely difficult task in parallel of solving the required analysis for the Polaris program. Having done an outstanding job in this area, he then turned his attention to the Trident series of missiles, which had the additional complication of being made predominantly of composite materials, a very new field in those days.

Kim became an expert in this area and edited the *Design Guide for Fleet Ballistic Missile Composites* (1978-81), writing several of the chapters, a seminal work in this field. He also lectured at Santa Clara University, California, on the theory of elasticity and composite structures and at the University of California, Berkeley, on these and allied subjects.

John Alexander Hope Bailie, always known as Kim, was born in Johannesburg on February 2, 1929. His parents, Sydney and Marjorie, were born in South Africa, and forbears included John Bailie, one of the leaders of the 1820 English settlers' group, and Alexander Bailie, who worked as a surveyor for Cecil Rhodes.

Kim grew up in Bathurst, Eastern Cape, and was educated at St. Andrew's College School, Grahamstown. In 1947 he left for England to join the de Havilland Aeronautical Technical School at Hatfield, Hertfordshire, for a four-year apprenticeship in aeronautical engineering. He met his future wife, Georgina Gardner, when they were working in the aircraft design office of Vickers Armstrong. They were married in 1956 and emigrated to the United States to join the Lockheed Aircraft Company in Burbank. Uniquely, they were the first husband-and-wife engineering team to join that company. The couple moved to Palo Alto in 1958 to join the newly formed Lockheed Missiles and Space Company, later becoming American citizens.

Later in his career, he worked on composite structures back at the Lockheed Aircraft Company and at Northrop-Grumman in Los Angeles. In addition to his Ph.D., about which he was extremely modest, he held masters' degrees from Cranfield University in England and Stanford University, and was elected an Associate Fellow of the American Institute of Aeronautics and Astronautics and a Member of the Royal Aeronautical Society in the United Kingdom.

In retirement he helped to restore vintage aircraft at the Hiller Aviation Museum in San Carlos and built houses for Habitat for Humanity. He also joined the team of volunteers that built a full-size replica of the Wright brothers' famous airplane, known as the *Wright Flyer*.

Selected Publications:

MacNeal, R.H., Winemiller, A.F. and Bailie J.A., Elastic Stability of Cylindrical Shells Reinforced by One or Two Frames and Subjected to External Radial Pressure, AIAA Journal, Vol. 4, No.8, 1431-1433, August 1966.

J.A. Bailie and J.E. McFeely, "Panel flutter in hypersonic flow", Proceedings of the AIAA/ASME 8th Structures, Structural Dynamics & Material Conference, March 29-31, 1967

W.C. Mace, C.L. Snipe and J.A. Bailie, "Fabrication of reinforced PMR 15 graphite cloth cylinder assembly", 23rd National SAMPE Symposium, Convina, California, 2-4 May 1978, pp 208-217

J.A. Bailie, M.F. Duggan, L.M. Fisher and J.N. Dickson, “The influence of holes on the compression strength of graphite epoxy cloth and tape laminate at temperatures up to 430 K”, pp 198-211 of Advances in Composite Materials: Proceedings of the Third International Conference on Composite Materials, Paris 26-29 August, 1980, edited by A.R. Bunsell

J.A. Bailie, W.C. Mace, A. Wereta, Jr. and G.D. Menke, “Development and fabrication of graphite polyimide launch vehicle structures”, Chapter in Fibrous Composites in Structural Design, edited by Edward M. Lence, Plenum Press 1980

Duggan, M.F. and Bailie, J.A., “A new test specimen geometry for achieving uniform biaxial stress distribution in laminated composite cylinders, Proc. 3rd ICCM, Paris-1, pp. 900-913, 1980

J.A. Bailie, M.F. Duggan, N.C. Bradshaw and T.G. McKenzie, “Design data for graphite cloth epoxy bolted joints at temperatures up to 450 K”, Chapter in Joining of Composite Materials, edited by K.T. Kedward, ASTM International, 1981, pp 165-180

Bailie, J.A., Fisher, L.M., Howard, S.A. and Perry, K. G., “Some environmental and geometric effects on the static strength of graphite cloth epoxy bolted joints”, Chapter in Composite Structures, edited by I.H. Marshall, Applied Science Publishers, Englewood, New Jersey, 1981, pp 63-78

A. Wereta, J.A. Bailie, R.J. Boeddiker and R.L. Colhern, paper (title unknown) presented at the 13th National SAMPE Technical Conference, pp. 310-?, 1981

J.A. Bailie, “Application of composites to missile structure – a review”, SAMPE Quarterly, Vol. 12, No. 2, p1, 1981

J.A. Bailie, M.F. Duggan, L.M. Fisher and R.C. Yee, “Effects of holes on graphite cloth epoxy laminates tension strength, Journal of Aircraft, Vol. 19, No. 7, pp 559-566, 1982

J.A. Bailie, “Woven fabric aerospace structures”, Chapter in Handbook of Composites, Elsevier Science, pp 353-391, 1989

J.A. Bailie, Woven Composite Structures”, Chapter in Handbook of Composite Reinforcements, edited by Stuart M. Lee, John Wiley & Sons, 1992

Bailie, J.A., et al, “A summary and review of composite laminate design guidelines, NASA Langley Research Center, 1997

J.A. Bailie, R.P. Ley and A. Pasricha (Military Aircraft Systems Division, Northrop Grumman Corporation). “A summary and review of composite laminate design guidelines”, Task 22 NASA Contract NAS1-19347, Final Report, October 1997
ABSTRACT and OBJECTIVES: The purpose of this study is to review many of the available design guidelines for unidirectional tape, laminated aerospace composite panels. Guidelines for bonded and bolted joints, cutouts, and durability and damage tolerance are also presented, as they strongly influence designs for production aircraft. These guidelines are accompanied by explanations of why each one was generated and the influence each one has on the structural performance of various aircraft components. Most of these guidelines were

developed during actual construction of relatively simple aircraft components in the late 1960s and early 1970s. Unfortunately, generally available literature detailing the derivation of these guidelines is scarce; hence, it was made necessary to obtain information directly from various aerospace engineering organizations and notes presented in lectures. The scarcity of formal documentation may also be due, in part, to the fact that many lessons were learned when unpredicted failures occurred during early development programs that are only now being declassified.

The present review is focused on composite laminates made of graphite fibers embedded in a polymer matrix since use of such laminates is increasing in highly loaded aerospace primary structures. Simple analyses and data are presented to illustrate the basis for many of the guidelines.

The objective of this review is to (1) gather the design guidelines currently used for structural design and analysis of unidirectional tape laminates, (2) review their derivation, and (3) explain their ranges of application. Many of these guidelines have served the aerospace industry for close to three decades as they were developed for fighter/attack aircraft structural components being designed in the late 1960s. Attention was directed towards production aircraft that were to be certified for operating lives on the order of 6,000 flight hours.

By gathering together these guidelines and critically evaluating their derivation, it is feasible to assess situations under which they can be safely relaxed or even ignored. Such an assessment is performed for a spar cap composed entirely of unidirectional plies proposed for unmanned air vehicles under development for NASA's ERAST program.