

A Brief Account of the Three-Day National Workshop on
FATIGUE, FRACTURE AND LIFE EXTENSION (FFLE-2014)
Hyderabad, 29-31 January 2014



A three day National Workshop on “Fatigue, Fracture and Life Extension (FFLE–2014)” was organised by the TR Anantharaman Education and Research Foundation (TRA-ERF) during 29th – 31st January, 2014 at Hyderabad jointly with the Defence Metallurgical Research Laboratory (DMRL- Hyderabad) and Regional Centre for Military Airworthiness (Materials) (RCMA-Hyderabad, a unit of CEMILAC, DRDO).

For the first time in India, the deliberations included Life Extension Methodologies and Life Extension Exercises for indigenously developed aero-engine and aircraft structural parts. The rationale for this coverage was the following: (i) the phenomena and micro-mechanisms of Fatigue and Fracture, though complex, are the principal sources of damage in aeronautical structures, (ii) an understanding of these micro-mechanisms is essential for the development of advanced new materials with improved fuel efficiency and (iii) most importantly, extended service life of aero-components and aero sub-systems can result in substantial savings in foreign exchange, which can only be accomplished by studying comprehensively the controlling fatigue and fracture phenomena and using well established life extension technologies. Detailed deliberations on these aspects were held through five structured technical sessions consisting of 17 invited lectures. The proceedings were flagged off with a keynote address on “DAMAGE TOLERANCE: A STRATEGY BASED ON MULTI-DISCIPLINARY SCIENCES AND TECHNOLOGY”, by the internationally recognised expert in the field of fatigue and fracture – Prof. B Dattaguru of Indian Institute of Science (IISc), Bangalore.



This was followed by 17 invited lectures in 5 structured technical sessions namely, (i) Fundamentals of Fatigue and Crack Growth (ii) Fatigue and Fatigue Crack Growth of Engineering Materials, (iii) Fracture and Fracture Based Design, (iv) Damage Evaluation and Life Prediction and

(v) Life Extension Technologies. The technical sessions were chaired by eminent aero-material scientists and outstanding structural aeroengineers – Prof. J L Strudel (of France), Dr. P Rama Rao, Prof. B Dattaguru, Prof. Vakil Singh and Dr. K Tamilmani respectively. In his closing remarks Dr Rama Rao traced the history of how Al-Li alloy research at DMRL started under his guidance during the 1980s, initially with Russian collaboration, but later developed completely in-house. The following speakers delivered invited talks during the technical sessions:



01. Prof. K Bhanu Sankar Rao, MGIT – ‘Introduction to Fatigue Deformation and Fracture’; 02. Dr. R Sunder, BISS – ‘Engineering Application of Threshold Stress Intensity’; 03. Prof. VV Kutumbarao, DMRL– ‘Fatigue & FCG of Al-Li Alloys’; 04. Prof. Vakil Singh, IIT-BHU (MET) – ‘Low Cycle Fatigue Behaviour of Aeronautical Materials’; 05. Dr. R Sandhya, IGCAR – ‘Low Cycle Fatigue Behaviour of Steels’; 06. Dr. M Manjunatha, NAL – ‘Fatigue Behaviour of Nano Composites’; 07. Dr. N Narasaiah, NIT-Warangal – ‘LEFM & LEFM Based Design’; 08. Dr. M Srinivas, DMRL – ‘EPFM & Application to Alloy Development’; 09. Dr. Samir V. Kamat, DMRL – ‘Fracture Toughness Evaluation of Thin Films using Nano Indentation’; 10. Dr. G Shasikala, IGCAR – ‘Application of Fracture

Mechanics in Nuclear Reactor Design’; 11. Dr. N Eswara Prasad, RCMA (Materials), CEMILAC – ‘Non-Linear Fracture Mechanics in CFCCs’; 12. Dr. T Jayakumar, IGCAR – ‘Role of NDE in Structural Integrity of Aerial Platforms’; 13. Dr. Vikas Kumar, DMRL – ‘Life Predication Technologies for Aero-engine Components’; 14. Dr. BVA Patnaik, GTRE – ‘Life Monitoring of Aero-engine Components’; 15. Dr. DV Vidyasagar, BHEL (R&D) – ‘Life Assessment of Power Plant Components’; 16. Shri RK Satpathy, RCMA (Kpt), CEMILAC – ‘Life Extension of Aero-engines’; 17. Gp. Cap BVN Siva, IAF MC, Nagpur – ‘Life Extension: An Air Force Experience’.



The technical sessions were well attended by over 200 participants that included working engineers of HAL, scientists of DRDO and DAE, Air Force personnel and 80 meritorious students of Metallurgy, Mechanical Engineering and Aero-engineering. A dedicated experimental session was conducted to demonstrate the practical methodologies for the evaluation of fatigue (low cycle, high cycle and fatigue crack growth), fracture toughness properties including elastic – plastic fracture mechanics based J_{IC} determination, and scanning electron microscopy to determine the fracture mode and quantification of fractographic features such as size and distribution of micro & macro dimples, cleavage facet size and mixed mode fracture features. The technical deliberations and practical demonstrations were aimed at imparting sufficient and essential knowledge to the Workshop participants so that all of them are acquainted with latest developments in the fields of fatigue, fracture and life extension.

In the **Valedictory Session** feedback was taken from the participants. The highlight was a detailed set of suggestions from the airport personnel, summarised and voiced by Group Capt. DV Murali, VSM, CO AFLE (Koraput). They were: (1) The need of the hour is to





translate the project studies and papers by the scientists to real time utility on IAF aircraft and aero-engines in terms of reliability improvement programs and life reviews; going beyond the OEM-fixed total life; (2) Establishment of NDT and Material Testing Centers for IAF drawing expertise from DRDO, CSIR, DAE (especially IGCAR, Kalpakkam); (3) Good Life Reviews based on appropriate FOH standards including refurbishment techniques, with IAF acting as the nodal agency with necessary help from CEMILAC, HAL, DRDO/ CSIR Laboratories, and if required, by incorporating

adequate private participation; and, (4) Conduct of a few theme oriented Workshops, similar to the present FFLE-2014 to finalize specific programmes on Life Extension.

The Workshop proceedings were finally summarised by Professor Kutumbarao of DMRL, Hyderabad, as: “the technical programme is excellent, the talks were genuinely helpful, informative and outstanding, the sessions were conducted smoothly and within the schedule, organisation was smooth and the logistics were well taken care of”.



The successful conduct of FFLE – 2014 encourages the TR Anantharaman Education and Research Foundation to look forward to arranging similar Workshops, National Seminars, Theme Lecture Series and Focused Research Initiatives in the coming years.

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