

# Making a Viable Electron Device into a Reliable Product: Brief Review

**Suhir E\***

Department of Physical Sciences and Engineering Division, Portland State University, Portland

ISSN: 2640-9739



**\*1Corresponding author:** Suhir E, Bell Laboratories, Basic Research, Physical Sciences and Engineering Division, Murray Hill, NJ, USA (ret); Portland State University, Portland, OR, USA; Vienna Institute of Technology, Vienna, Austria; James Cook University, Queensland, Australia, and ERS Co., Los Altos, CA, 727 Alvina Ct., Los Altos, CA, 94024, USA

**Submission:** 📅 October 04, 2020

**Published:** 📅 October 16, 2020

Volume 1 - Issue 5

**How to cite this article:** Suhir E. Making a Viable Electron Device into a Reliable Product: Brief Review. COJ Elec Communicat. 1(5).COJEC.000525.2020. DOI: [10.31031/COJEC.2020.01.000525](https://doi.org/10.31031/COJEC.2020.01.000525)

**Copyright@** Suhir E, This article is distributed under the terms of the Creative Commons Attribution 4.0 International License, which permits unrestricted use and redistribution provided that the original author and source are credited.

## Editorial

To assure high operational reliability of an electronic or a photonic product [1-5] one has to understand the underlying reliability physics and, to an extent possible, predict and quantify its performance in the field. In the areas of commercial or agricultural electronics, as long as the customer comes back, not the product, cost-effectiveness and time-to-market are much more important than reliability. The situation is different in aerospace, military, long-haul communication and, in many cases, also in medical electronics engineering, where understanding the physics of possible failures and ability to assure reliability is paramount. Because of the inevitable uncertainties, such an assurance should be done on the probabilistic basis. In effect, the difference between a highly reliable and insufficiently reliable products is “merely” the difference between the levels of their never-zero probabilities of failure. The desirable reliability level cannot be low, of course, but it does not have to be higher than necessary either: it has to be adequate for a particular product and application. Too high level of reliability, when the products “never fail”, might be an indication that these products are “over-engineered” and are more expensive than they could and should be. Thus, the ability to predict/quantify reliability of an electronic or photonic product intended for an application, where high level reliability is required, is a must.

The recently suggested, mostly in application to avionics and automotive electronics and photonics, probabilistic design for reliability (PDR) concept [6-11] is based on the highly focused and highly cost-effective failure-oriented-accelerated-testing (FOAT) [12-17] aimed, first of all, at understanding and confirming the anticipated physics of failure. This type of testing should be conducted, when developing a new technology, in addition to the widely used today, in different modifications, highly-accelerated-life-testing (HALT). In many cases, especially for new products, when suitable HALT have not been developed yet, and “best practices” do not yet exist, FOAT could be designed and conducted, for the most vulnerable material(s) and structural element(s) of the product, even instead of HALT. FOAT should be geared to a flexible, easy-to-use and physically meaningful predictive model that would be able to assess the probability of failure and the corresponding lifetime of the product from the FOAT data. It is shown that the multi-parametric Boltzmann-Arrhenius-Zhurkov (BAZ) equation [18-25] can be employed in this capacity. FOAT, being a “transparent box” that is able, using BAZ equation, to predict the probability of operational failure and the corresponding lifetime of the product, could be viewed as an extension of HALT, a “black box” that has a number of merits, but is unable to quantify reliability.

FOAT could be designed and conducted within the framework of HALT, when “fine tuning” of the design of importance is necessary, while HALT, if exists, could be employed for “rough tuning”. No matter how good the design and the manufacturing efforts are, the manufactured products always contain, in addition to robust and healthy products, also weak products, s.c. “freaks” that should be eliminated using burn-in-testing (BIT), before the healthy population of the manufactured product is shipped to the customer(s). Useful guidelines on whether “to BIT or not to BIT” and if “to BIT”, how to conduct and interpret the BIT process could be found in [26-29]. All the above predictions were made using analytical modeling [30-35].

## References

- Suhir E, Mahajan R (2011) Are current qualification practices adequate? Circuit Assembly.
- JEDEC standard JESD-47(2016) Stress-test-driven qualification of integrated circuits.
- Suhir E (2019) Making a viable medical electron device package into a reliable product. IMAPS Advancing Microelectronics 46(2).
- Suhir E (2020) The outcome of an engineering undertaking of importance must be quantified to assure its success and safety: Review. Journal of Aerospace Engineering and Mechanics JAEM 4(2).
- Suhir E (2020) Quantifying the unquantifiable in electronics and aerospace engineering: review. Journal of Aerospace Engineering and Mechanics, 2020, in print.
- Suhir E, Poborets B (1990) Solder glass attachment in cerdip/cerquad packages: Thermally induced stresses and mechanical reliability. ASME Journal of Electronic Packaging 112(2).
- Suhir E (2010) Probabilistic design for reliability. Chip Scale Reviews 14(6).
- Suhir E, Mahajan R, Lucero A, Bechou L (2012) Probabilistic design for reliability (PDR) and a novel approach to qualification testing (QT). IEEE/AIAA Aerospace Conf, Big Sky, Montana, USA.
- Suhir E (2013) Could electronics reliability be predicted, quantified and assured? Microelectronics Reliability 53.
- Suhir E, Ghaffarian R (2017) Solder material experiencing low temperature inelastic thermal stress and random vibration loading: predicted remaining useful lifetime. Journal of Materials Science: Materials in Electronics 28(4).
- Suhir E, Yi S (2017) Probabilistic design for reliability (PDR) of medical electronic devices (MEDs): when reliability is imperative, ability to quantify it is a must. Journal of SMT 30(1).
- Suhir E (2013) Failure-oriented-accelerated-testing (FOAT) and its role in making a viable IC package into a reliable product. Circuit Assembly.
- Suhir E (2018) What could and should be done differently: failure-oriented-accelerated-testing (FOAT) and its role in making an aerospace electronics device into a product. Journal of Materials Science: Materials in Electronics 29(4).
- Suhir E (2019) Failure-oriented-accelerated-testing (FOAT), Boltzmann-arrhenius-zhurkov equation (BAZ) and their application in microelectronics and photonics reliability engineering. Int J of Aeronautical Sci and Aerospace Research (IJASAR) 6(3).
- Suhir E, Ghaffarian R (2019) Electron device subjected to temperature cycling: predicted time-to-failure. Journal of Electronic Materials 48(2): 778.
- Suhir E (2019) Failure-oriented-accelerated-testing (FOAT), Boltzmann-arrhenius-zhurkov equation (BAZ) and their application in microelectronics and photonics reliability engineering. Int J of Aeronautical Sci and Aerospace Research (IJASAR) 6(3).
- Suhir E (2019) Failure-oriented-accelerated-testing and its possible application in ergonomics. Ergonomics Int J 3(2).
- Zhurkov SN (1965) Kinetic concept of the strength of solids. Int J of Fracture Mechanics 1(4).
- Suhir E, Kang S (2013) Boltzmann-arrhenius-zhurkov (BAZ) model in physics-of-materials problems. Modern Physics Letters B (MPLB) 27.
- Suhir E (2017) Static fatigue lifetime of optical fibers assessed using boltzmann-arrhenius-zhurkov (BAZ) model. Journal of Materials Science: Materials in Electronics 28(16).
- Suhir E, Ghaffarian R (2018) Constitutive equation for the prediction of an aerospace electron device performance-brief review. Aerospace 5(74).
- Ponomarev A, Suhir E (2019) Predicted useful lifetime of aerospace electronics experiencing ionizing radiation: Application of BAZ model. Journal of Aerospace Engineering and Mechanics (JAEM) 3(1).
- Suhir E, Ghaffarian R (2019) Electron device subjected to temperature cycling: predicted time-to-failure. Journal of Electronic Materials 48(2).
- Suhir E, Stamenkovic Z (2020) Using yield to predict long-term reliability of integrated circuit (IC) devices: application of boltzmann-arrhenius-zhurkov (BAZ) model. Solid-State Electronics 164.
- Suhir E (2020) Boltzmann-arrhenius-zhurkov equation and its applications in electronic-and-photonics aerospace materials reliability-physics problems. Int Journal of Aeronautical Science and Aerospace Research (IJASAR).
- Suhir E (2019) To burn-in, or not to burn-in: that's the question. Aerospace 6(3): 29.
- Suhir E (2019) Burn-in: when, for how long and at what level. Chip Scale Review.
- Suhir E (2019) For how long should burn-in testing last? J Electr Electron Syst 8(2): 305.
- Suhir E (2020) Is burn-in always needed? Int J of Advanced Research in Electrical, Electronics and Instrumentation Engineering 9(1): 2751-2757.
- Suhir E (2016) Analytical modeling occupies a special place in the modeling effort. Short Comm J Phys Math 7(1).
- Suhir E (2017) Analytical modeling enables explanation of paradoxical behaviors of electronic and optical materials and assemblies. Advances in Materials Research 6(2).
- Suhir E, Yi S, Hwang JS, Ghaffarian R (2019) Elevated stand-off heights of solder joint interconnections can result in appreciable stress and warpage relief. IMAPS J of Microelectronics and Electronic Packaging 16(1):
- Suhir E (2019) Analytical thermal stress modeling in electronics and photonics engineering: application of the concept of interfacial compliance. Journal of Thermal Stresses, special issue dedicated to 90<sup>th</sup> birthday of Prof. Richard Hetnarski, published online.
- Suhir E, Salotti JM, Nicolics J (2020) Required repair time to assure the specified availability. Universal Journal of Lasers, Optics, Photonics and Sensors 1(1).
- Suhir E (2020) Predicted accelerations of surface-mounted electron devices during spacecraft launch. Journal of Aerospace and Mechanics, 2020, in print.

For possible submissions Click below:

Submit Article