WEIBULL DISTRIBUTION AVIONICS APPLICATION

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During the operation of aircraft, the events that determine the transition of the product to different technical states occur randomly. Intervals of time of stay of a product in this or that condition have casual values of duration; it is the time to failure, the time between failures, the time to critical failure, the resource, the service life, the shelf life, the recovery time. All random values of duration are continuous and are measured in units of time, usually in hours or in units proportional to time (number of cycles, starts, revolutions, etc.).

The criteria to be met by a variety of distribution models in the range, as time is determined resource or service life of components and systems. These criteria are also needed for a comparative analysis of different failure models to assess their feasibility in the calculation of reliability indicators. Following the recommendations of regulations as such criteria we choose:

– physicality;
– adequacy;
– practical suitability (possibility to perform calculations of system reliability);
– versatility.

In probability theory and statistics, the Weibull distribution is a continuous probability distribution. It is named after Swedish mathematician Waloddi Weibull, who described it in detail in 1951, although it was first identified by Fréchet (1927) and first applied by Rosin & Rammler (1933) to describe a particle size distribution.

The Weibull distribution (W-distribution) is obtained empirically as a result of studies of a wide class of resource allocations and corresponds to the situation of the destruction of the weakest link (element) from a certain set (system consisting of a group of elements).

The Weibull distribution is a fairly flexible function that can well align a variety of failure statistics and can be a model for the reliability of both electronic and mechanical products. The density of the distribution of operating time to failure in this model of reliability has the form:

$$f(t) = \frac{b}{a}\left(\frac{t}{a}\right)^{b-1} \exp\left[-\left(\frac{t}{a}\right)^{b}\right],$$

where a is a parameter of the scale of distribution with dimension [hours];

b is a dimensionless parameter of the distribution form.

The Weibull distribution density curve for different values of the parameter b of form b is shown in Fig. 1.

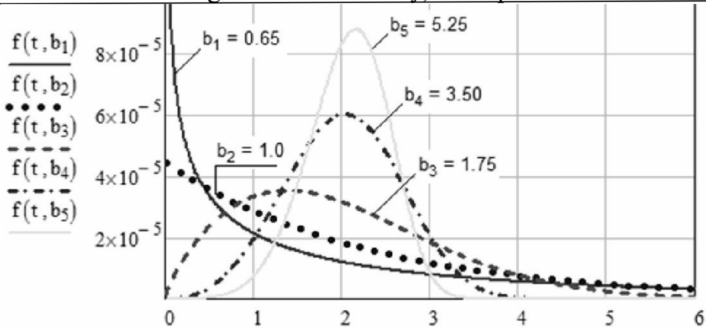

Fig. 1. Weibull distribution density

Consider the features of the Weibull distribution:

- Weibull's distribution has a single fashion for developments

$t_{мо} = a \cdot (1 - 1/b)^{1/b}$ for all b> 1;

- for b = 1 the Weibull distribution turns into an exponential distribution;
- according to the values of the form parameter b <3.5, the distribution has a positive asymmetry;
- for b = 3.5 the distribution density curve becomes symmetric;
- at the values of the parameter b> 3.5, the distribution is shifted along the t axis and acquires a negative asymmetry.

The Weibull distribution successfully can be used:

- in reliability engineering and failure analysis;
- in electrical engineering to represent overvoltage occurring in an electrical system;
- in industrial engineering to represent manufacturing and delivery times;
- in extreme value theory;
- in weather forecasting for aviation purposes to describe wind speed distributions, as the natural distribution often matches the Weibull shape;
- in communications systems engineering;
- in radar systems to model the dispersion of the level of the received signal produced by some types of clutters.

To model fading channels in wireless communications, as the Weibull fading model seems to exhibit a good fit to experimental fading channel measurements.

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