Important

When performing re-ageing operation of units keep in mind the operator is exposed to live voltage if unit is not properly insulated from surrounding. When operator is handling units he must wear insulating glooves and glasses to prevent any body damage due to possible and sudden unit explosion

Reliability

Technical data given for capacitors of different ITELCOND types agree with CECC norms (where applicable and/or available) following Table 6.

Series	CECC
Screw terminal type	30301-802/807/810
Solder pin type	30301-805/808/809/811

Table 6

The relative failure rate given in DIN specifications and fully met by ITELCOND capacitors of different series are reported here below in Table 7.

General Specification Requirements		
Working Voltage	Failure Rate	Series
<25Vdc	0.5%	Long life
30<Vdc<450	0.2%	Long life
6.3<Vdc<450	2.0%	General use

Table 7

In the following paragraphs there are the main terms occurring when considering problems concerned with reliability.
It should be considered that the values each parameter assumes in reliability are statistical figures and so they are valid only if great numbers or lots are considered.

Operational Life

The Operational Life is the period of time in which a capacitor reaches the maximum accepted values of modification of its electrical parameters.
To forecast the predictable operational life, MIL-STD-690 specifications with a "confidence level" of 60% (see next paragraph) are considered.
The following Figure 3 and Figure 4 based on before said specifications, indicate both the "failure rate" versus the testing time and the way to forecast the likely “failure rate" versus the number of "unit-hour", the "confidence level" and number of faulty ones.

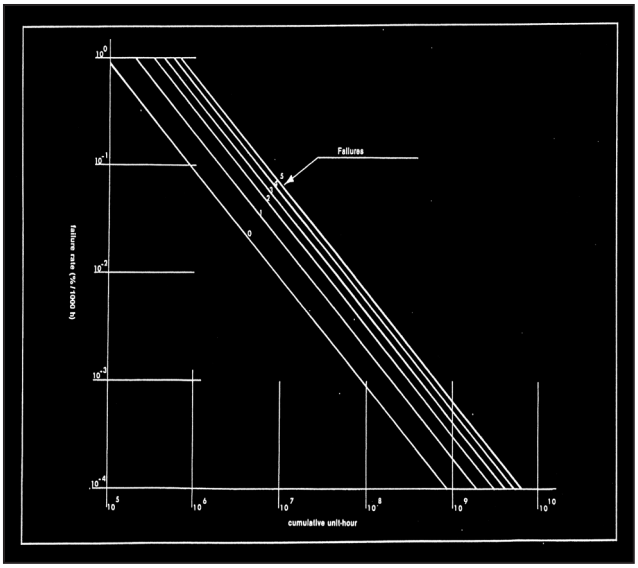

Figure 3

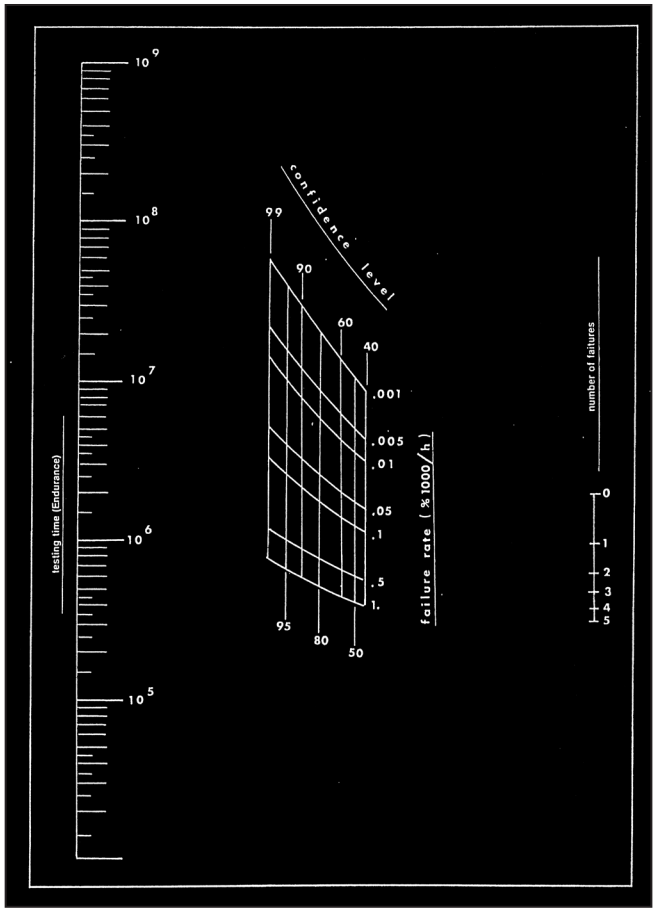

Figure 4

Figure 4 shows the relation among the various factors already considered:

- Unit-hours
- Confidence level
- Failure rate
- Number of defective units

Example: it may be considered, for example, a test period of 10^8 unit-hours, in which only a defective unit has been found on all the samples tested. If a line between the scale of the component-hours (10^8) and the scale of the faulty ones is drawn, the different combinations between "failure rate" and "confidence level" can be obtained, as per Table 8:

Failure Rate	0.005	0.004	0.002
Confidence Level	95%	90%	60%

Table 8

Clearly the same nomogram (based on MIL-STD) can be used to obtain the lowest number of "component-hour" to predict the maximum number of defectives with a certain confidence level etc.

For every ITELCOND type for which a rated operational life is given at rated temperature the figures in the detail section show the variation of the operational life according to a certain decrease of the ambient temperature on a load of full category voltage; obviously a decrease of the ambient temperature and a reduced voltage improve the given data.

As a further guarantee it should be mentioned that:

- Every series of capacitors undergoes regularly operational life test for a period of time longer than that in catalogue
- The variations of the electrical parameters found at the end of the before said ITELCOND tests, are well within the limits given for the individual types at the end of standard internal tests.

Confidence Level

The term "confidence level" indicates a probability that a component will fail the homologation when its assessed failure rate is equal to the failure rate required for the homologation.

Assessed Failure Rate

The term indicates the failure that should be found if all the units produced in a process "under control" would actually be tested.

NOTE: a "under control process" is a process in which there are random variations of the average failure rate

Failure Rate (λ)

The failure rate is the number of failed units indicated in percent for every 1000hrs test: this definition is valid only for a well-defined confidence level. The failure rate values depends on ambient temperature and on ratio of applied voltage to rated voltage.

Reference conditions are given in Table 9.

T [°C]	Vapplied/Vrated
40	0,50

Table 9

Figure 5 shows the variation of λ (or fit, see next paragraph) versus applied voltage (in %).

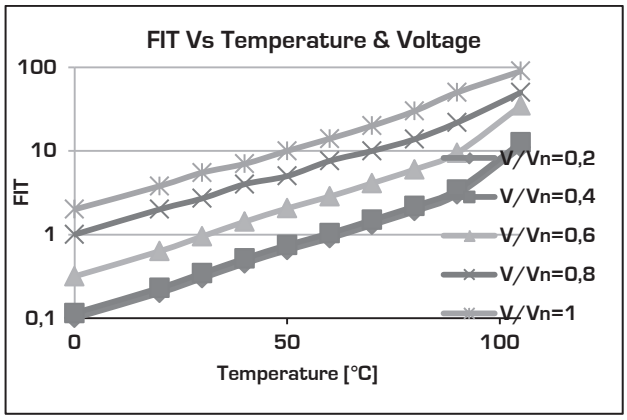

Figure 5

Failure in time (FIT)

FIT is the general expression of the failure rate with a confidence level of 60 % (MIL-STD-690) as per Equation 10 and Equation 11, a sample of calculation is reported in Equation 12.

It's a calculation from field observation and results of periodical tests in our laboratory.

The failure rate mainly depends from failure criteria and the operating and ambient conditions.

$$FIT = \frac{\text{number of failures (confidence level 60\%)}}{(\text{tested components} \bullet \text{test duration})}$$

Equation 10

$$1FIT = 1 \bullet 10^{-9} hrs$$

Equation 11

Example:

$$100FIT = 1 \bullet 10^{-7} hrs = 0{,}01\% \bullet 10^{-3} hrs = {}^{0{,}01\%}/_{1000hrs}$$

Equation 12

Typical FIT Values

Years of experience have shown that values in Table 10 can be considered, during the intrinsic failure period of a typical bathtub statistical curve.

ITELCOND series	Voltage	FIT	ITELCOND series	Voltage	FIT
AR,AY	<150 Vdc	40	AZK	<150 Vdc	50
	≥150 Vdc	70		≥150 Vdc	80
AS	<150 Vdc	45	ATK	<150 Vdc	40
	≥150 Vdc	45		≥150 Vdc	70
AP	ALL VOLTAGES	45	ACC	ALL VOLTAGES	50
AF	ALL VOLTAGES	45	AZC	<150 Vdc	50
AT	ALL VOLTAGES	20		≥150 Vdc	80
			ATC	<150 Vdc	40
AKS	<150 Vdc	50		≥150 Vdc	70

Table 10

Mean Time Between Failure (MTBF)

The MTBF is given in Equation 13.

$$MTBF = 1/\lambda$$

Equation 13

where λ is the failure rate.

Mean Time To The First Failed Component (MTTF)

The value of MTTF is given in

Equation 14

$$MTTF = {}^{100'000}/_{(\%/1000hrs)} = {}^{100'000}/_{\lambda}$$