Reliability Analysis Center
201 Mill Street
Rome, NY 13440-6916
(888) RAC-USER
or (315) 337-0900
Fax: (315) 337-9932

Reliability Prediction Environmental Conversion Matrix

Frequently, a Reliability Prediction needs to be revised or updated because the equipment is operated in an environment different than what the original prediction assumed. If the electrical stresses remain the same and only the environmental stresses changes, then a quick prediction update can easily be performed using a simple environmental conversion matrix as shown in Table 1. However, if both the environment and electrical stresses have changed then a complete new prediction is warranted. The environmental conversion factors include the combined effects of temperature, vibration, humidity and mechanical shock.

Table 1 is an update to Table 6.3.3-2 "Environmental Conversion Factors" in the RAC publication "Reliability Toolkit: Commercial Practices Edition".

Table 1. Environmental Conversion Factors

To From	**217 ⇒**	**GB**	**GF**	**GM**	**NS**	**NU**	**AIC**	**AIF**	**AUC**	**AUF**	**ARW**	**SF**
217 ⇓	**SD-18 ⇓⇒**	**Protected**	**-**	**-**	**Normal**	**Severe**	**Normal**	**-**	**Severe**	**Severe**	**Severe**	**-**
GB	Protected	X	0.5	0.2	0.3	0.1	0.3	0.2	0.1	0.1	0.1	1.1
GF	-	2.0	X	0.4	0.6	0.3	0.6	0.4	0.2	0.1	0.2	2.0
GM	-	5.0	2.5	X	1.4	0.7	1.4	0.9	0.6	0.3	0.5	5.0
NS	Normal	3.3	1.7	0.7	X	0.5	1.0	0.7	0.4	0.2	0.3	3.3
NU	Severe	10.0	3.3	1.4	2.0	X	2.0	1.4	0.9	0.5	0.7	10.0
AIC	Normal	3.3	1.7	0.7	1.0	0.5	X	0.7	0.4	0.2	0.3	3.3
AIF	-	5.0	2.5	1.1	1.4	0.7	1.4	X	0.6	0.4	0.5	5.0
AUC	Severe	10.0	5.0	1.7	2.5	1.1	2.5	1.7	X	0.6	0.8	10.0
AUF	Severe	10.0	10.0	3.3	5.0	2.0	5.0	2.5	1.7	X	1.4	10.0
ARW	Severe	10.0	5.0	2.0	3.3	1.4	3.3	2.0	1.3	0.7	X	10.0
SF	-	0.9	0.5	0.2	0.3	0.1	0.3	0.2	0.1	0.1	0.1	X

CAUTION: It is not valid to apply to these conversions to Mean Time Between Critical Failures (MTBCF) as reliability modeling must be performed.

The primary environmental symbols used in Table 1 represent the environments defined in MIL-HDBK-217F and they are shown in Table 2. The secondary terms in Table 1 represent the environments in the Navy document SD-18 "Part Requirement and Application Guide" these environments are described in Table 3.

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Reliability Prediction Environmental Conversion Matrix (Cont'd)

Table 2. MIL-HDBK-217 Environmental Definitions

Symbol	Name	Environmental Definition
GB	Ground, Benign	Nonmobile, temperature and humidity controlled environments readily accessible to maintenance; includes laboratory instruments and test equipment, medical electronic equipment, business and scientific computer complexes, and missiles and support equipment in ground silos.
GF	Ground, Fixed	Moderately controlled environments such as installation in permanent racks with adequate cooling air and possible installation in unheated buildings; includes permanent installations of air traffic control radars and communication facilities.
GM	Ground, Mobile	Equipment installed on wheeled or tracked vehicles and equipment manually transported; includes tactical missile ground support equipment, mobile communication equipment, tactical fire direction systems, handheld communications equipment, laser designations and range finders.
NS	Naval, Sheltered	Includes sheltered or below deck conditions on surface ships and equipment installed in submarines.
NU	Naval, Unsheltered	Unprotected surface shipborne equipment exposed to weather conditions and equipment immersed in salt water. Includes sonar equipment and equipment installed on hydrofoil vessels.
AIC	Airborne, Inhabited, Cargo	Typical conditions in cargo compartments which can be occupied by an aircrew. Environment extremes of pressure, temperature, shock and vibration are minimal. Examples include long mission aircraft such as the C130, C5, B52, and C141. This category also applies to inhabited areas in lower performance smaller aircraft such as the T38.
AIF	Airborne, Inhabited, Fighter	Same as AIC but installed on high performance aircraft such as fighters and interceptors. Examples include the F15, F16, F111, F/A 18, and A10 aircraft.
AUC	Airborne, Uninhabited, Cargo	Environmentally uncontrolled areas which cannot be inhabited by an aircrew during flight. Environment extremes of pressure, temperature and shock may be severe. Examples include uninhabited areas of long mission aircraft such as the C130, C5, B52, and C141. This category also applies to uninhabited area of lower performance smaller aircraft such as the T38.
AUF	Airborne, Uninhabited, Fighter	Same as AUC but installed on high performance aircraft such as fighters and interceptors. Examples include the F15, F16, F111, and A10 aircraft.
ARW	Airborne, Rotary Winged	Equipment installed on helicopters. Applies to both internally and externally mounted equipment such as laser designators, fire control systems, and communication equipment.
SF	Space, Flight - Earth Orbital	Approaches benign ground conditions. Vehicle neither under powered flight nor in atmospheric reentry; includes satellites and shuttles.

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Table 3. SD-18 "Part Requirement and Application Guide" Environmental Definitions

Protected Environment*
- readily accessible maintenance applications
- controlled environment
- temperature range of 0°C to 70°C
- application without shock, vibration, pressure or moisture
- not stored for later usage
- application life-span of up to 5 years

Normal Environment*
- inhabited applications
- applications usually accessible for maintenance or replacement
- uncontrolled, but not extreme, temperature environment with a temperature range of -40°C to +85°C
- application having a minimal to low-medium controlled shock, vibration, pressure or moisture environment
- can be stored for later usage (not > 10 years)
- application life span of 5 to 10 years

Severe Environment*
- uninhabited applications
- varying temperatures or temperature extremes
- temperature range of -55°C to 125°C
- application having a medium to high shock, pressure, vibration, or moisture environment
- can be stored for later usage (over 10 years)
- application life span of 10 to 20 years

*Parts employed according to the following provisions.

Source:
- Table 6.3.3-2 "Environmental Conversion Factors", page 176 in RAC "Reliability Toolkit: Commercial Practices Edition".
- MIL-HDBK-217 "Reliability Prediction for Electronic Equipment".
- SD-18 "Part Requirement and Application Guide", http://www.crane.navy.mil/sd18/default.htm.