

Mixing Reliability Prediction Models Maximizes Accuracy

Overcome Component Limitations, Better Reflect Past Experiences, and Achieve Superior Predictions

Although many models are available for performing reliability prediction analyses, each of these models was originally created with a particular application in mind. This document describes the most widely used reliability prediction models in terms of their intended applications, noting both their advantages and disadvantages. It then explains how mixing models in your reliability analyses yields more accurate predictions.

Widely Used Reliability Prediction Models

In any system, you have a mixture of electronic and mechanical parts. The selection of a reliability prediction model is driven by the critical parts in the system to be modeled and your system requirements. The following table lists the most widely used reliability prediction models and their intended applications, originating country, advantages, and disadvantages.

Reliability Prediction Model	Application & Originating Country	Advantages	Disadvantages
<p>MIL-HDBK-217 The Military Handbook for the Reliability Prediction of Electronic Equipment</p>	<p>Military and Commercial, United States</p>	<p>Provides for both Parts Stress and Parts Count analysis of electronic parts. Can easily move from preliminary design stage to complete design stage by progressing from Parts Count to Parts Stress.</p> <p>Includes models for a broad range of part types.</p> <p>Provides many choices for environment types.</p> <p>Well-known and widely accepted.</p>	<p>Is based on pessimistic failure rate assumptions.</p> <p>Does not consider other factors that can contribute to failure rate such as burn-in data, lab testing data, field test data, designer experience, wear-out, etc.</p> <p>NOTE: <i>The Relex Reliability Prediction module overcomes these limitations by allowing you to use Telcordia calculation methods and PRISM process grades with MIL-HDBK-217.</i></p>

<p>Telcordia (Bellcore) Reliability Prediction Procedure for Electronic Equipment (Technical Reference # TR-332 or Telcordia Technologies Special Report SR-332)</p>	<p>Commercial, United States</p>	<p>Offers analysis ranging from Parts Count to full Parts Stress through the use of Calculation Methods.</p> <p>Considers burn-in data, lab testing data, and field test data.</p> <p>Well-known and accepted.</p>	<p>Considers only electronic parts.</p> <p>Supports only a limited number of Ground Environments.</p> <p>Fewer part models compared to MIL-HDBK-217.</p> <p>Does not account for other factors such as designer experience, wear-out, etc.</p> <p>NOTE: <i>The Relex Reliability Prediction module overcomes these limitations by allowing you to use PRISM process grades with Telcordia.</i></p>
<p>Mechanical The Handbook of Reliability Prediction Procedures for Mechanical Equipment (NSWC-98/LE1)</p>	<p>Military and Commercial, United States</p>	<p>Provides for analyzing a broad range of mechanical parts (seals, springs, solenoids, bearings, gears, etc.)</p>	<p>Limited to mechanical parts.</p>
<p>CNET 93 Recueil de Donnes de Fiabilite des Composants Electroniques RDF 93 (UTE C 80-819)</p>	<p>Telecommunications, France</p>	<p>Fairly broad range of part types modeled.</p> <p>Provides unique handling of PCBs.</p>	<p>Considers only electronic parts.</p> <p>Only available in French.</p>
<p>RDF 2000 Recueil de Donnes de Fiabilite RDF 2000 (UTE C 80-810)</p> <p>IEC-62380 Reliability data handbook - Universal model for reliability prediction of electronic components,</p>	<p>Telecommunications, France</p> <p>International Electrotechnical Commission, Europe</p>	<p>Introduces a new approach to failure rate modeling.</p> <p>Considers cycling profiles and their applicable phases when determining failure rate.</p>	<p>Considers only electronic parts.</p> <p>Cannot be mixed with other models because of the unique way in which failure rates are calculated.</p>

PCBs and equipment		Provides unique handling of PCBs.	Very new, still gaining acceptance.
HRD5 The Handbook for Reliability Data for Electronic Components used in Telecommunication Systems	Telecommunications, United Kingdom	Similar to Telcordia. Fairly broad range of part types modeled.	Considers only electronic parts. Not widely used.
299B Chinese Military Standard GJB/z 299B	Military, China	Provides for both parts stress and parts count analysis.	Considers only electronic parts. Currently used primarily in China. Based on an older version of MIL-HDBK-217. Cannot model hybrids.
PRISM System Reliability Assessment Methodology developed by the Reliability Analysis Center (RAC)	Military and Commercial, United States	Incorporates NPRD/EPRD database of failure rates. Enables the use of process grading factors, predecessor data, and test or field data.	Small, limited set of part types modeled. Newer standard, still gaining acceptance. Considers only electronic parts. Cannot model hybrids. No reference standard available.
217Plus The RIAC-HDBK-217Plus, Handbook of 217Plus Reliability Prediction Model published by the Reliability Information Analysis Center (RIAC), a Department of Defense Information Analysis Center sponsored by the Defense Technical Information Center.	Military and Commercial, United States	Incorporates NPRD/EPRD database of failure rates. Enables the use of process grading factors, predecessor data, and test or field data. Includes a model	Newer standard, still gaining acceptance. Considers only electronic parts. Cannot model hybrids.

		for software reliability.	
NPRD/EPRD Nonelectronic Parts Reliability (NPRD) and Electronic Parts Reliability (EPRD) databases by RAC	Military and Commercial, United States	Broad array of electronic and non-electronic parts. Based completely on field data.	Consists entirely of databases of failure rates, not mathematical models.

Mixing Models to Overcome Component Limitations

Each reliability prediction model has its own set of advantages and disadvantages. By mixing the models used in your reliability analyses, you can greatly improve the accuracy of your predictions. For example, even very simple systems often have both electronic and mechanical components. To accurately predict the failure rates of both electronic and mechanical components, you would select a reliability model for electronic components, such as MIL-HDBK-217 or Telcordia, and also refer to *The Handbook of Reliability Prediction Procedures for Mechanical Equipment* from NSWC. By using both electronic and mechanical component models in your reliability analyses, you would obviously obtain more accurate predictions for the system and its components than by using either model alone.

The need to mix reliability prediction models for the electronic components in a system stems from limitations on the component types that these models support. For instance, suppose you select Telcordia as the basis for analyzing the reliability of your electronic components; then, during your analysis, you realize that Telcordia does not support some of the switches and relays used in your system. By adding MIL-HDBK-217 to your modeling mix, you would gain comprehensive coverage for switches, relays, and several other components not supported by Telcordia.

Similarly, if you selected PRISM as the basis for your analysis, coverage for switching devices, connectors, rotary devices, and inductors would be missing. To accurately assess system MTBF (Mean Time Between Failure) for systems with these components, you would have to add reliability models that covered these components to your modeling mix. Having multiple models available for your reliability analyses makes it much more likely that the failure rates predicted for the system and its component are accurate.

Mixing Models to Better Reflect Past Experiences

In addition to mixing reliability prediction models because of part type limitations, you may want to mix models because certain ones more accurately predict the failure rates your system components have experienced in the past. For example, perhaps the failure rates calculated by PRISM best reflect those for the integrated circuits in your system, and the failure rates calculated by Telcordia best reflect those for the resistors in your system. In such cases, you would want to be able to choose the model that calculates the failure rates closest to those experienced in the past for each type of system component. The ability to choose completely different models for various components in the same system empowers you to generate the most accurate predictions possible.

Mixing Techniques for Superior Predictions

NOTE: *The following paragraphs describe features that are applicable only to specific reliability prediction models. However, none of these limitations apply to the Relx Reliability Prediction module. Providing that you have licensed a model described in this document, the Relx Reliability Prediction module supports the use of that model's features with all other licensed models.*

Although PRISM has models for calculating the failure rates of only a limited number of components, it provides many techniques for enhancing reliability predictions. For example, you can use PRISM process grades, which explicitly

account for factors contributing to system reliability by grading the process for each system failure cause. If you think the reliability of a component is affected by process-related variability during the design and manufacturing process, you can use process grades to adjust the failure rates calculated for those components.

PRISM also provides summary data from RAC's Nonelectronics Parts Reliability (NPRD) and Electronic Parts Reliability (EPRD) databases for estimating failure rates of components that do not have models. If some of your components are operating within a specific set of environmental conditions and quality levels, you can retrieve the actual life-based failure rate values for components in very similar operating conditions from the NPRD and EPRD databases and then use these values in conjunction with reliability prediction models.

PRISM also allows you to include empirical data on a predecessor system and test data or field data to update the predicted reliability values. Similarly, Telcordia offers Calculation Methods to take advantage of burn-in-data, lab testing data, or field test data that has been collected. If you have such data for certain components, you will want to take advantage of it in the modeling of these components.

In most cases, you would need to use PRISM to factor in process grades, empirical data on a predecessor system, and test data or field data to update predicted reliability values. Likewise, you would need to use Telcordia to have its Calculation Methods factor in burn-in, lab testing, and field test data. However, if you use the Relex Reliability Prediction module to perform your reliability analyses, such limitations do not exist. The Relex Reliability Prediction module extends the advantages and features unique to individual models to all models. Therefore, you can apply the process grade factors defined in PRISM to any licensed model to adjust the failure rates according to design and manufacturing factors. Or, the Calculation Methods defined in Telcordia for adjusting failure rates based on burn-in, lab testing, and field test data can be applied to any other licensed models.

In conclusion, having many reliability prediction models available for your use will help to accurately assess your system MTBF. You can select the model best suited to your specific system parameters and your individual needs.

Relex Reliability Prediction supports all of the models mentioned in this brief. If you would like additional information about how the Relex Reliability Prediction module provides for mixing models and techniques for superior results, please e-mail info@relex.com.