

## ZEDB

# Centralized Reliability and Events Database

As far as the preparation and use of probabilistic safety analyses (PSAs) is concerned, plant-specific reliability data should be used according to the German PSA guide lines.

Therefore, the VGB PowerTech (Technical Association of power and heat generation) has set up a Centralized Reliability and Events Database (ZEDB - Zentrale Zuverlässigkeits- und Ereignisdatenbank) to gather and analyse operating experience gained at all German nuclear power plants, the Dutch unit Borssele and the Swiss unit Goesgen. The ZEDB is operated by Areva NP GmbH using software developed by RISA GmbH.

The analysis is performed using a two-stage Bayesian model to calculate plant-specific and generic reliability data. Using this model, the so-called super-population model, the reliability parameter for any component in a particular plant can be assessed with reference to the operating experience from all others.



Components	Analysis Reports (bound edition)				Analysis Reports (loose-leaf system)			
					basis edition	1 <sup>st</sup> up- grading	2 <sup>nd</sup> up- grading	3 <sup>rd</sup> up- grading
	1999	2000	2002	2004	2006	2007	2008	2010
Valves	27	32	31	37	(37)+30	38+2	33+13	36+10
Pumps	8	18	18	24	(23)+14	23+0	19+0	8+0
Emergency diesel generators	2	2	2	2	(2)	2+0	-	2+0
Batteries	-	2	2	2	(2)	2+0	-	2+0
Rotating inverters	-	1	1	1	(1)	1+0	-	1+0
Static inverters	-	4	4	4	(4)	4+0	-	4+0
Transformers	-	8	8	8	(8)	8+0	-	8+0
Fan/ Compressors	-	-	3	3	(3)	3+0	-	3+0
Busbars	-	-	5	5	(5)	5+0	-	5+0
Circuit breakers	-	-	5	6	(6)	6+0	6+0	-
Vessels/ Tanks	-	-	-	-	5	5+0	-	5+0
Heat exchanger	-	-	-	-	2	2+0	-	2+0
Control rods	-	-	-	-	2	2+0	-	2+0



Remarks: „(a) + b“ - Results for “a” populations are implemented from analysis report 2004 and data for “b” populations are updated or analysed for the first time  
 „(c)“ - Results for “c” populations are implemented from analysis report 2004  
 „d + e“ - Results for “d” populations are updated and data for “e” populations are analysed for the first time

The first database analysis was carried out in 1999. The collection of operating experience and the generation of reliability data for safety-related nuclear power plant components are continued and expanded (see also Table 1).

The results of the analyses are published in the VGB’s technical reports. These reports contain:



- An overview of the ZEDB and the method of analysis;
- Tables of results, including:
  - characterization of components population;
  - generic and plant-specific values (5% quantile, 50% quantile (median) and 95% quantile, k factor, mean value).

The results of current ZEDB analysis were published in the form of a loose-leaf system, in such a way as to allow the replacement of or addition to selected chapters.

-  **"Zentrale Zuverlässigkeits- und Ereignisdatenbank - Zuverlässigkeitskenngrößen für Kernkraftwerkskomponenten"**; German; ISSN 1439-7498; ord.no. **TW805**
-  **"Centralized Reliability and Events Database - Reliability Data for Nuclear Power Plant Components"**; English; ISSN 2191-9534; ord.no. **TW805e**

These bundles of several reports (TW805 and TW805e) already include the basis edition (December 2006), the 1<sup>st</sup> upgrading (December 2007), and the 2<sup>nd</sup> upgrading (December 2008).

In addition of the published bundles the 3<sup>rd</sup> upgrading is available:

-  **"Zentrale Zuverlässigkeits- und Ereignisdatenbank, Zuverlässigkeitskenngrößen für Kernkraftwerkskomponenten - Juni 2010"**; German; ISSN 1439-7498; ord.no. **TW805-11**
-  **"Centralized Reliability and Events Database, Reliability Data for Nuclear Power Plant Components - June 2010"**; English; ISSN 2191-9534; ord.no. **TW805e-11**

The two-stage Bayesian models are standard practice nowadays, for example also in the Swedish T-Book, although they may differ in their mathematical models and software implementation.

The ZEDB Steering Committee appointed by VGB therefore commissioned an independent mathematical review of the two-stage Bayesian model and the software implementation in the ZEDB. This review was performed by Professor Cooke and his staff at the Institute of Applied Mathematics at Delft University of Technology (Netherlands). The publication presents the final report to the users of the ZEDB and all other parties interested in two-stage Bayesian models:

-  Report **"Mathematical Review of ZEDB Two-Stage Bayesian Model"**; English; ord.no. **TW802e**

Generally speaking, different assumptions can be made for the hyper distribution and hyper priors for the parameters of the hyper distribution, and these may influence the calculated reliability data. Evaluating the same data sets using the T-Book and the ZEDB approaches, provides an opportunity for the comparison of the methodologies. Therefore TUD (responsible for the T-Book) and VGB (responsible for the ZEDB) agreed on a benchmark, the subject of which was to apply the T-Book/ZEDB statistical tools to real data in order to observe the outcome with regard to the estimated failure rates. For this purpose T-Book-data sets are evaluated using the ZEDB approach and ZEDB-data sets using the T-Book approach. The final report presents the results of this benchmark:

-  Report **"Calculation of Reliability Data using Two-Stage Bayesian Models - T-Book/ZEDB-Benchmark"**; English; ord.no. **TW820e**

The VGB publications on the ZEDB analyses, review and benchmark are available from the Shop of VGB PowerTech Service GmbH (<http://www.vgb.org/shop/>).

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