

Report VGB-TW803e
Centralized Reliability and Events Database
Reliability Data for Nuclear Power Plant Components
Analysis for 2002

Preface

The aim of this publication is to provide reliability data that can be used in ongoing and future probabilistic safety analyses (PSAs) conducted by the owners/operators of nuclear power plants contributing to the Centralized Reliability and Events Database (ZEDB¹).

As far as the preparation and use of plant-specific PSAs is concerned, there is a growing need for the generic data records used in the past to be replaced with reliability data based on current operating experience with the equipment concerned.

The Centralized Reliability and Events Database (ZEDB) was set up by the Technical Association of Power Generating Companies (VGB) to meet this need. This database gathers and analyzes operating experience gained at a large number of nuclear power plants. The first database analysis carried out in 1999 produced reliability data on pumps, emergency diesel generators and valves. The data corresponded to a cumulative total of more than 9000 operating years in the case of the valves, 3700 operating years in the case of the pumps and more than 900 operating years for the emergency diesels. This constituted an important initial step towards establishing a reliable set of data based on the operating experience of participating nuclear plants.

In the second analysis conducted in the year 2000, the calculations performed during the first analysis were updated according to the greater operating experience available by that time. At the same time, batteries, rotating inverters, static converters and transformers were added as new component prototypes. The analysis in the year 2000 covered around 22,000 operating years in the case of the valves, over 6900 years for the pumps and more than 1100 years in the case of the emergency diesel generators. The operating experience available for the new component prototypes included in the year 2000 analysis amounted to more than 2100 years for the batteries, approximately 350 years for the rotating inverters, around 2400 years for the static converters and approximately 1800 years for the transformers.

The third analysis, which is described in this publication, constitutes a further update of the previous analysis using the larger amount of operating experience now available, and once again expands its scope to include more components. The 2002 analysis, for example, additionally contains fans, busbars and circuit breakers. In other words, the operating experience available for the 2002 analysis corresponded to approximately 32,500 operating years for the valves, 13,400 years for the pumps, 3500 years for the fans, 1500 years for the emergency diesels, 3100 years for the batteries, 470 years for the rotating inverters, 3900 years for the static converters, 2800 years for the transformers, 6500 years for the busbars and 9600 years for the circuit breakers.



¹ ZEDB is the abbreviation for the German name of this database, *Zentrale Zuverlässigkeits- und Ereignisdatenbank*.

Report VGB-TW803e
Centralized Reliability and Events Database
Reliability Data for Nuclear Power Plant Components
Analysis for 2002

Contents

List of Abbreviations	3	5.2.6	Creation of "Battery" Populations	51
1 Introduction	4	5.2.7	Creation of "Rotating Inverter" Populations	52
2 General Description of ZEDB Database	5	5.2.8	Creation of "Static Converter" Populations	53
2.1 Background/Objectives	5	5.2.9	Creation of "Transformer" Populations	54
2.2 Organization	5	5.2.10	Creation of "Busbar" Populations	55
2.3 Terms and Definitions	7	5.2.11	Creation of "Circuit Breaker" Populations	56
2.4 Database Elements	8	6 Reliability Data	57	
2.5 Data Acquisition Using ZEDB 2000	8	6.1	Integration of Drive Control Interfaces and Priority Control Modules	57
2.6 Analytical Capabilities of ZEDB Database	9	6.1.1	Failure Rates of Drive Control Interfaces and Priority Control Modules	57
3 Data Content of ZEDB Database	10	6.1.2	Methodology to Account for Drive Control Interfaces and Priority Control Modules Inside ZEDB Component Boundaries	58
3.1 Data Acquisition and Quality Assurance	10	6.1.3	Simplified Procedure to Account for Drive Control Interfaces and Priority Control Modules Inside ZEDB Component Boundaries	60
3.2 Component Master Data	12	6.2	General Instructions for Use of Tables	62
3.3 Event Reports	13	6.3	Data Tables	64
3.4 Operating Reports	13	6.3.1	Valves	64
3.5 Component Boundaries	13	6.3.2	Pumps	134
4 Theoretical Principles	33	6.3.3	Fans	185
4.1 The Superpopulation Approach for Estimating Failure Data	33	6.3.4	Emergency Diesel Generators	194
4.2 Mathematical Principles of BAYES Program in ZEDB Database	34	6.3.5	Batteries	203
4.3 Utilization of Obtained Reliability Data	36	6.3.6	Rotating Inverters	207
5 Scope of Current Analysis	38	6.3.7	Static Converters	210
5.1 Selection of Component Prototypes	38	6.3.8	Transformers	219
5.2 Creation of Component Populations	38	6.3.9	Busbars	233
5.2.1 Basic Procedure	38	6.3.10	Circuit Breakers	243
5.2.2 Creation of "Valve" Populations	39	7 References	253	
5.2.3 Creation of "Pump" Populations	43			
5.2.4 Creation of "Fan" Populations	48			
5.2.5 Creation of "Emergency Diesel Generator" Populations	49			

Imprint

Published by: VGB PowerTech e.V.
- ISSN 1439-7498 -

Available from: VGB PowerTech Service GmbH
Verlag technisch-wissenschaftlicher Schriften
P.O. Box 10 39 32, D-45039 Essen

Price: 249,00 Euro (+ postage and VAT)

<u>Contact:</u>	André Seidel VGB PowerTech e. V. Kernkraftwerke Klinkenstr. 27 – 31 D-45136 Essen Phone: +49 (0) 2 01 81 28-291 Fax: +49 (0) 2 01 81 28-345 Email: andre.seidel@vgb.org Internet: http://www.vgb.org	Jürgen Zimander VGB PowerTech Service GmbH Verlag technisch-wissenschaftlicher Schriften P.O. Box 10 39 32 D-45039 Essen Phone: +49 (0) 2 01 81 28-200 Fax: +49 (0) 2 01 81 28-329 Email: mark@vgb.org
-----------------	--	---