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SURVEY OF RANGES OF COMPONENT RELIABILITY DATA FOR USE IN PROBABILISTIC SAFETY ASSESSMENT

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FOREWORD

Generic component reliability data are still widely used in probabilistic safety assessment (PSA), either to quantify component failure directly, or to serve as a prior in the updating process. In order to make generic component data widely available, the IAEA has compiled component reliability data from a number of literature sources in the IAEA Component Reliability Data Base. During compilation of the IAEA Data Base it was recognized that in some cases failure rates or probabilities for the same components and failure modes differ substantially, perhaps by up to two orders of magnitude. The component reliability data used in the PSA study could greatly influence the final result of the study. Comparison of the data from different sources could therefore yield some interesting insights. As the data have been derived from many sources, on the basis of differing assumptions, the clearest way of comparing data is to plot them on the same graph.

This document presents the ranges of rates or probabilities of component failure for selected components that are usually considered in PSA studies. It could also be used to compare particular data with the bulk of data found in the literature. No effort has been make to explain the differences in data. However, some of these differences can be explained by a knowledge of the source of the data. The sources are described in detail in the IAEA Data Base (see IAEA-TECDOC-478), and it is strongly suggested that this document be used together with the IAEA Data Base.

This document is intended to be used mainly by people who are knowledgeable in data analysis and the use of data in PSAs. The interpretation of data ranges withoug regard to the background information and assumptions from the original data source is strongly discouraged.

This report was prepared by the staff of the Reliability and Risk Assessment Section, Division of Nuclear Safety, under the programme on PSA. The principal investigator was Mr. Bojan Tomic. The entire report was reviewed by Mr. Luis Lederman.

EDITORIAL NOTE

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CONTENTS

1. INTRODUCTION

The Data Ranges Overview is a follow-up activity to the compilation of the IAEA Component Reliability Data Base (published as IAEA-TECDOC-478, Component Reliability Data for Use in Probabilistic Safety Assessment, IAEA, Vienna, 1988). The IAEA Component Reliability Data Base as of October 1988 contains more than 1000 records (data points) on 420 component types, categorized into 100 component groups and derived from 21 literature sources.

Most of the data sources used for the IAEA Data Base are either probabilistic safety analysis (PSA) studies or sources that provided input for PSA studies. As all sources deal with more or less similar components, it was considered interesting to compare reliability parameters for the important components and failure modes.

The clearest way to compare data points is to plot them on the same graph. For meaningful comparison, separate graphs with data from different sources were made for each component type, failure mode, operating mode or type of environment (when applicable).

The level of resolution in data comparison is governed by two competing elements: the availability and the comparability of data. A higher degree of resolution in component type, failure mode, operating mode and environment type would result in fewer data points being available. Conversely, the requirement for a higher quantity of data usually results in inferior resolution, leading to the comparison of 'non-comparable' items. Establishing a balance between these two elements was one of the objectives in the Data Ranges Overview.

After component types, failure modes and operating modes were selected for the Data Ranges Overview, the appropriate records from the IAEA Reliability Data Base were stored in separate files and each file was then plotted. Finally, about 70 charts were plotted. Each of the charts is accompanied by the data table (in the same format as in the IAEA Component Reliability Data Base), where for the user's convenience a complete record form for each of the data points is reproduced.

2. PURPOSE OF THE DATA RANGES OVERVIEW

The IAEA Data Ranges Overview graphs are intended for comparing reliability data from a variety of sources for use in PSA studies.

The purpose of the Data Ranges Overview is to present in an easy-to-understand graphical form ranges of component reliability data for components having similar characteristics in terms of type, failure mode and operating mode. These graphs can also be useful in comparing reliability data from a particular source with the data found in the literature.

Another purpose of these graphs is to facilitate the assessment of the centre points as well as of the higher and lower bounds of the data found in the literature. On comparing a data set used with the ranges of data presented in the graphs, tendencies towards lower or higher values are easily identifiable. Whenever a plant model is available, sensitivity analysis using the extreme values depicted in the graphs can also be performed.

It is recognized that changes in the failure rate or failure probability of certain critical components lead to significant changes in the core melt frequency in PSA studies. In particular, when PSA results are used to show compliance with probabilistic safety criteria, confidence in the numerical results of the PSA study is essential. The component reliability data used should therefore be carefully evaluated.

3. LIMITATIONS OF THE DATA RANGES OVERVIEW

The basic limitation of the Data Ranges Overview is the lack of precise and standard definitions which would allow more strict comparison of data. Lack of precise definition is the problem encountered when generic data are used for specific analyses. Loose definitions of component boundaries, operating mode and environment, demand interval and operating and maintenance policy could strongly influence the failure rate.

Another characteristic of the Data Ranges Overview graphs is that different types of data are plotted on the same graph. Some of the sources provide point estimates as the mean value of a distribution; others provide medians; while some others recommend values without a formal distribution, terming them either best estimates or recommended values. Owing to the limited number of available data points, it was not possible to plot separately means, medians or best estimates. All these data are therefore plotted on the same graph and termed 'centre points'. The rationale for having all of them on the same graph is that, irrespectively of definition, centre points are used in point estimate calculations, and therefore are to a certain extent comparable. The same applies to the upper and lower bounds, which are sometimes95% and 5% of log-normal distributions, sometimes 90% and 10%, and occasionally best estimate maximum and minimum values. The exact meaning of the centre point and upper and lower bounds for each of the sources plotted on one graph can be found in the data tables accompanying each graph.

For most of the sources there are also unique assumptions and limitations relating to the data provided. Sometimes these are not clearly stated. This is also a major obstacle to the formal combination of different data sources and it influences comparisons such as this one. More information about each of the sources may be found in the IAEA Component Reliability Data Base.

4. SELECTION OF DATA

4.1 Selection of component type and failure mode

The IAEA Component Reliability Data Base contains more than 420 component types sorted into 100 categories. The number of data points available for each component type is usually small, varying between one and three data points per component type and failure mode. There are, of course, components with fine resolutions (e.g. when the piping diameter is provided for valves), and components with coarse resolutions (e.g. batteries). As a rule, the number of data points is smaller when the resolution is finer, and larger when it is coarser.

The next level of resolution in the IAEA Data Base is the component category. The component category in principle corresponds to a generic component type as found in the literature, although sometimes the level of resolution is still more detailed than for the generic sources (e.g. in the IAEA Data Base transformers are divided in seven categories). At this level the amount of data in one category was adequate for meaningful plots. Out of 100 component categories in the IAEA Data Base, 20 generic component types were selected (e.g. all transformers were considered to be in one category.

The following component types were selected:

(1) Diesel driven pump
(2) Motor driven pump
(3) Turbine driven pump
(4) Air operated valve
(5) Motor operated valve
(6) Solenoid operated valve
(7) Manual valve
(8) Relief valve
(9) Safety valve
(10) Diesel generator
(11) Battery
(12) Battery charger
(13) Bus
(14) Motor
(15) Inverter

(16) Rectifier

(17) Transformer

(18) Relay

(19) Switch

(20) Transmitter.

The next step was the selection of the applicable failure mode. The general rule for all component types was that the failure modes that are most important and/or that are often addressed in PSAs have to be selected. As illustrated in Appendix 2 of the IAEA Data Base, failure modes given in the original sources vary substantially, even in descriptions of the same failure. In the compilation of the IAEA Data Base a set of generic failure modes was developed. The original failure modes from the sources were then put into one of the generic categories. These generic failure mode categories were used in the Data Ranges Overview. The limlitation in the failure mode selection was again data availability. Specific components and failure modes having very few data points were not considered.

Finally, between one and four failure modes per component type were selected. These were:

(1) Failure to start

(2) Failure to run

(3) Failure to change position

(4) Failure to open

(5) Failure to close

(6) Failure to remain in position

(7) Failure to function

(8) All modes

In a few cases, when it was found that two failure modes actually described the same failure (e.g. 'all modes' and 'failure to function'), they were combined. For some component types, two or more failure modes describing quite similar failures were plotted (e.g. 'fail to change position' and 'fail to open' for valves). The detail definition and possible applications for each failure mode is found in the Appendix 2 of the IAEA Component Reliability Data Base.

4.2 Data sources selection

All the sources in the IAEA Data Base were considered for inclusion in the Data Ranges Overview. The ultimate sources of data among all these are quite diverse, however. The same applies to the methods used to collect or generate the reliability data. In order to make a meaningful comparison, data sources had to be categorized.

The availability of data also plays a major role in source categorization. Defining a large number of categories would lead to few data points in each category. However, defining three categories seemed adequate in view of the constraints.

These three categories are:

(1) Generic sources
(2) Plant specific sources
(3) Updated sources

Each of these three exhibits some unique characteristics and in principle should be considered separately.

The plant specific and updated categories commonly have few data points which are, in addition, easily identifiable, thus they were plotted together. When only a few (three or four) data points were available in the three categories, only one graph was made. Each category was, however, plotted separately in the graph.

The plant specific category contains reliability data based on operating experience of a single plant or a group of similar plants with data collected in the same manner. Out of 21 sources included in the IAEA Data Base, two fully qualify as plant specific (referred to as PS) sources, and in two additional sources the majority of the data fit in this category.

These sources are (the complete title, table number, etc., are given in Chapter 6):

(1) NUREG/CR-4550, Vol. 3, Surry NPP
(2) Swedish Reliability Data Book, Ringhals 2 data

(3) HWR Data (some data are in generic category)

(4) EPRI-NP-2433 (diesel generators)

The updated category consists of sources obtained by updating generic data with the plant specific operating experience. Three sources qualify for this category (all are the PSA studies). Two of these sources (Oconee PSA and Zion PSA) used fairly similar generic priors (NUREG with LER Rates, IEEE 500/1977, WASH-1400. The third source used its own prior, which is not independent of the documents mentioned. To permit comparison, data tables give information about the prior and the operating experience (in terms of recorded number of failures and operating time or number of demands).

The updated sources are:

(1) Zion NPP PSS

(2) NASC 60, Oconee NPP PRA

(3) Old PWR reactor

The third category is termed generic and it contains all the remaining sources from the IAEA Data Base. This category includes the whole range of ultimate data sources from expert opinion (single or aggregate) to operating experience. The reason for placing all in one category is that all of these sources provide some kind of averaging of reliability data (because of the population involved) and therefore depict a smoother behaviour. The number of data points in this category is usually the largest of all three.

The generic sources are:

(1) German Risk Study

(2) IEEE Standard 500

(3) NUREG/CR-2728, IREP

(4) NUREG/CR-1205 pumps

(5) NUREG/CR-1363 valves

(6) NUREG/CR-1740 I & C equipment

(7) NUREG/CR-2815 PSA Procedure Guide

(8) NUREG/CR-2886 pumps

(9) NUREG/CR-3831 DG's, batteries

(10) NUREG/CR-4450 Vol. 1 Methodology

(11) Shoreham NPP PSA

(12) Sizewell B NPP Pre-construction Safety Report

(13) Swedish Reliability Data Book (Data from seven BWR plants)

(14) WASH-1400, RSS

(15) WWER Component Reliability Data Base

4.3 Operating mode selection

The operating mode of the component has a major influence on its failure rate. Separate graphs for every component operating mode in each failure mode category are therefore desirable. However, information on component operating modes is usually sparse and rarely found in the sources. Consequently, it was only possible in a few cases to have separate graphs for component operating modes.

The operating mode is more important for components that perform their function by continuously moving (e.g. by rotating, such as pumps) and less important for 'open-closed' components (such as valves) or for electrical and electronic components that do not change state on a macroscopic level. Owing to data availability, the only component for which separation into different operating modes was possible was the motor operating pump.

For the motor operating pumps, two failure modes were included in the Data Ranges Overview: failure to start and failure to run. The starting failures were considered in three operating modes: standby, alternating and all. (The operating mode 'all modes' is salso the default mode used in the IAEA Component Data Base whenever information on particular operating modes was not available). Running failures were regarded in four operating modes: standby, alternating, running and all modes. For all other components and failure modes, operating modes were considered to be 'all modes'.

5. INPUT DATA PREPARATION

One of the objectives of the IAEA Component Reliability Data Base was to reproduce the information found in original sources to the maximal extent possible. No changes or alterations of any kind were made in the data during the compilation of the IAEA Data Base. It is recognized, however, that the data for some of the components and failure modes originating from different sources are not compatible.

This situation did not cause any problems in compiling the IAEA Data Base, but to permit comparison the data should be made compatible. The problem of incompatibility is most severe in dealing with demand related failures.

The philosophy and mechanisms of demand related failures as well as the methods used to denote the time and demand related failures in common form are considered next.

5.1 Treatment of demand related failures

The majority of sources included in the IAEA Data Base define failures of components to change state or position (e.g. fail to start) as demand related failure. Some of the sources, however, define all or part of the failures of this kind as time dependent. To permit comparison of failure rates, all of these should be expressed in the same form.

In analysing the failure mechanism, in most cases the component failures are modelled as the sum of two contributions, one time dependent and the second demand related. The fractional contribution of each of these two depends on component type, failure mode, operating mode and demand interval, and varies significantly from case to case. If this approach is to be introduced in the modelling, unique data are needed for each contribution. Data of this type are sparse and usually not available, at lease for the components normally modelled in PSA studies. None of the sources in the IAEA Data Base provide data of this type. Instead it is assumed that both contributions are included in either demand related or time related failure data.

The demand related failure probabilities are always coupled with the specific test interval for periodically tested standby components, or with the demand interval for frequently demanded components or untested components. The use of the data is then limited to the components having (among other similarities) comparable demand rates. However, if the demand related failure probability is utilized for components which have significantly different demand intervals, this could result in either the underestimation or the overestimation of component reliability.

When the component failure rate is expressed as time dependent, differences in demand interval are considered. If the portion of the failure rate which is demand related is high and the demand interval is substantially different from the interval iriginally taken into account, it coudl again introduce errors in failure rate estimation. The use of the time related concept is preferable, because the potential error caused by neglecting the demand related contribution is generally smaller than that caused by neglecting differences in the demand interval.

For the purpose of the Data Ranges Overview, it was necessary to convert time related failure rates to demand related rates, or vice versa. As the majority of sources provided failure data for the failure modes in question as demand related, it was easier to convert the time related data to demand related data.

The simplest way to convert time related failure rates to demand related rates is to assess the test or demand interval and to assume failure to occur at half of this interval. The failure rate is then multiplied by the number of hours to obtain the probability of the component's failing when demanded.

This was the procedure followed in the Data Ranges Overview. As the exact test or demand intervals taken into account in the sources were not always known, some generally accepted intervals were used. Three demand intervals were chosen depending on the generic type of component:

(1) 1/month (720 h) used for components found in standby safety systems. It is a widely accepted test policy to test this category of components once per month.

(2) 1/quarter (2160 H) used for safety and relief valves which are tested during refuellings, and in addition demanded on average three times per year (in some of the transients).

(3) 1/day (24 hrs.) for components such as relays or switches located in the control/protection systems, which are demanded at a fairly high rate owing to continuous changes of process parameters.

Whenever a time related failure rate is converted to a demand related rate, this is indicated in the data tables together with the exact time interval used in the conversion.

6. USES OF THE DATA RANGES OVERVIEW

The plots provided in Appendix 2 can be used in a number of ways. One possible application is the establishment of failure rate (or failure probability) ranges for sensitivity analysis.

A useful application is to use the plots to compare data with those in the available literature. In this case the proper figure should be chosen on the basis of the component type and failure mode of interest and of whether the data to be compared are representative of a generic data source or the result of plant specific experience.

A more ambitious application is, however, the use of the plots to establish acceptable ranges for component failure rates or failure probabilities in PSA.

Appendix 1

DATA SOURCES AND RESPECTIVE CODING

SOURCE NAME	CODE
1. HWR assessment	F
2. EPRI-NP-2433, Diesel-Generator Reliability at Nuclear power Plants:Data and Preliminary Analysis, Science Application, Inc.,June, 1982.	R
3. German Risk Study (Deutsche Risikostudie Kernkraftwerke), GRS, FRG, 1979.	G
4. IEEE Standard 500, IEEE Guide to the Collection and Presentation of Electrical, Electronic, Sensing Component, and Mechanical Equipment Reliability Data for Nuclear-Power Generating Stations, Appendix D, Reliability Data for Nuclear-Power Generating Stations, IEEE 1984.	E
5. NUREG/CR-2728 Interim Reliability Evaluation Program Procedure Guide, Sandia National Laboratories, January 1983.	I
6. NUREG/CR-1205 Data Summaries of Licencee Events Reports of Pumps at U.S. Commercial Nuclear Power Plants EG& Idaho, Inc.,January 1982	P

7. NUREG/CR-1331 Data Summaries of Licencee Event Reports of Control Rods and Drive Mechanisms at US Commercial Nuclear Power Plants, EG&G Idaho, Feb, 1980.

C

8. NUREG/CR-1363 Data Summaries of Licencee Event Reports of Valves at US Commercial Nuclear Power Plants, EG&G Idaho,Inc.,October 1982.

V

9. NUREG/CR-1740 Data Summaries of Licencee Event Reports of Selected Instrumentation and Control Components at US Commercial Nuclear Power Plants, EG&G Idaho,Inc.,July,1984.

M

10. NUREG/CR-2815 Probabilistic Safety Analysis Procedure Guide, Brookhaeven National Laboratory, August 1985.

B

11. NUREG/CR-2886 In-Plant Reliability Data Base for Nuclear Plant Components: Interim Data Report, the Pump Component, Oak Ridge National Lab, December 1982.

D

12. NUREG/CR-3831 In-Plant Reliability Data Base for Nuclear Plant Components: Interim Data Report, Diesel Generators, Batteries, Chargers and Inverters. Oak Ridge National Lab, January 1985.

N

13.NUREG/CR 4550 Vol.1 Analysis of Core Damage Frequency From Internal Events: Methodology Guidelines September 1987.

J

14. NUREG/CR 4550 Vol.3, Analysis of Core Damage Frequency from Internal Events :Surry, Unit 1. Sandia National Laboratory, November 1986.

A

15. NASC 60, OCONEE PRA, A Probabilistic Risk Assessment of Oconne Unit 3, The Nuclear Safety Research Center, EPRI, and Duke Power Co..June, 1984.

O

16. Old PWR reactor

H

17. Shoreham Nuclear Power Station Probabilistic Safety Assessment, Science Application, Inc.,

S

18. PWR/RX 312 Sizewell 'B' PWR Pre-Construction Safety Report, Component Failure Data for PWR System Reliability Assessment, NNC, UK, June, 1982.

U

19. RKS 85-25 Reliability Data Book for Components in Swedish Nuclear Power Plants, RKS, SKI Sweden

T

20. WASH-1400, Reactor Safety Study, An Assessment of Accident in U.S. Commercial Nuclear Power Plants, US NRC, October 1975

W

21. Zion Nuclear Power Station, Probabilistic Safety Study, Commonwealth Edison Co., 1981.

Z

22. VVER Component Reliability Data Base, IAEA RER/9/005, June 1988.

X

In cases where for the same component type more than one record is available, a consecutive numbering system following the source ID was defined.

Appendix 2

DATA GRAPHS AND TABLES

This section presents the failure rates or failure probabilities for different component types and failure modes from the 21 data sources included in the IAEA Data Base. One additional source reproduced is the WWER Component Reliability Data Base.

Whenever this is available, the operating mode is indicated. Centre points and upper and lower estimates are plotted according to their availability in the sources.

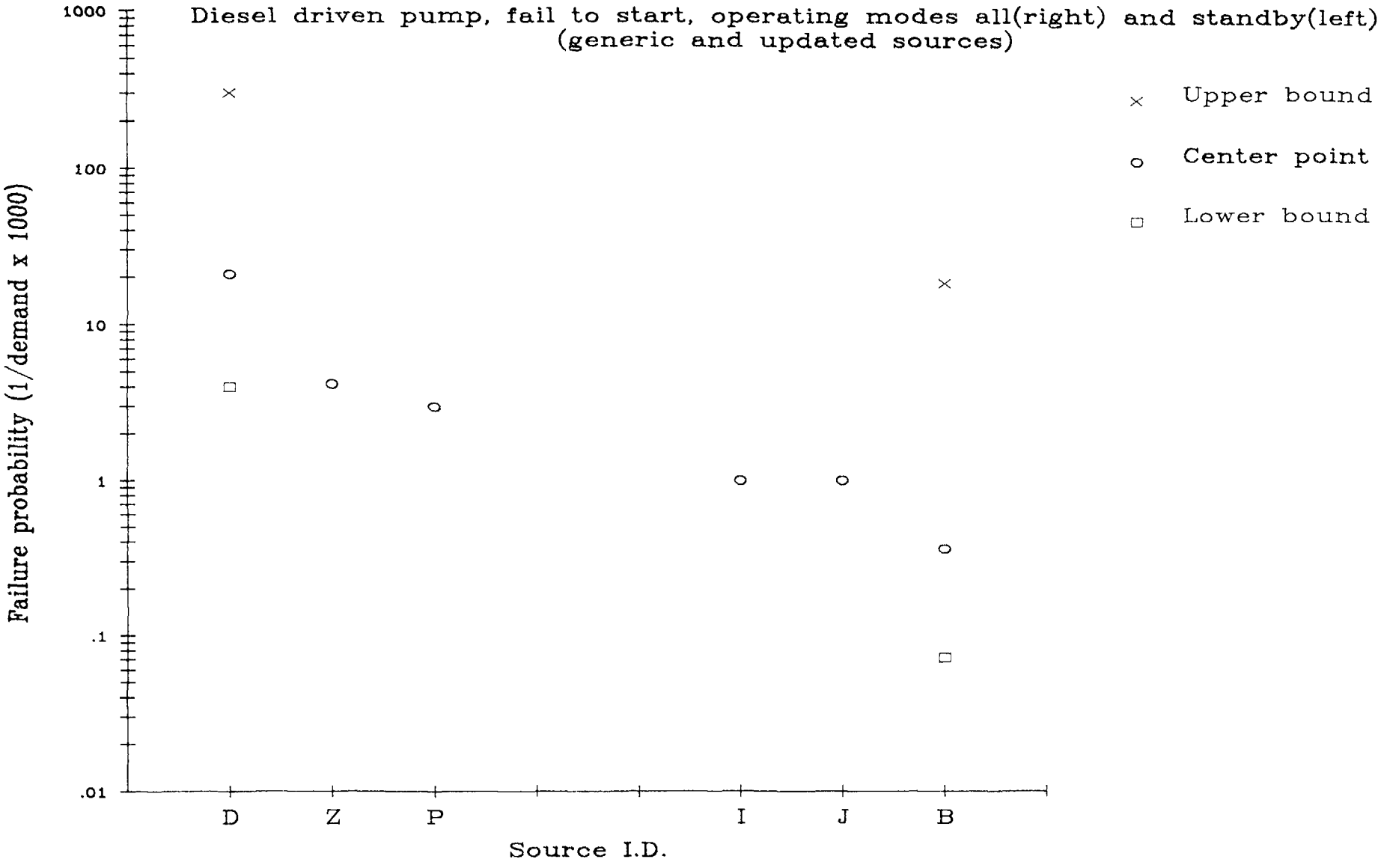
Each plot is accompanied by printouts of the specific record as stored in the IAEA Data Base. Inspection of the actual record is most useful for analysing each data point.

Graphs are plotted as described in Section 4.2 in two categories, namely:

- generic sources;
- plant specific and updated sources

The source identification used in the plots is the one defined in the IAEA Data Base and reproduced in the following:

IAEA RELIABILITY DATA BASE



D Source category: generic

PDASD pump diesel driven
Component boundary: pump,shaft,diesel,local instrumentation and control circutry Operating mode: standby Operating environment: normal
Generic failure mode: fail to start Original failure mode: fails to start
FAILURE RATE OR PROBABILITY mean : 2.1E-2/d · 3.0E-1/d : 4.0E-3/d
Source: NUREG 2886 (1982) (tbl.19) Ultimate source: plant operating experience-maintenance records(2PWR & 4BWR)
Comment: Pop.24. 9 catastrophic demand related failures of 427 demands. Upbound and lowbound are largest and smallest rate of the functional aggregates of selected pumps classified by dr ver

Z Source category: updated

PDCSZ pump diesel driven containment spray pump
Component boundary: detail n/a Operating mode: standby Operating environment: normal
Generic failure mode: fail to start Original failure mode: failure to start on demand
FAILURE RATE OR PROBABILITY mean : 4.2E-3/d
Source: ZION NPP PSS (tbl.1.5.1-5) Ultimate source: generic data upgraded with plant specific experience
Comment: Prior:NUREG 1205(diesel pump,stdby)(M),WASH 1400(diesel plant??). (D).Op.exp.183 demands,1 failure. N-1205 population of 4 include 2 ZION diesel pumps and only 1 failure occuring.Failrate too low?

P Source category· generic

PDASP pump diesel driven
Component boundary: incl.mech.control,governor,emergency tripping,blower,lube oil sys Operating mode. standby Operating environment: normal
Generic failure mode. fail to start Original failure mode· does not start
FAILURE RATE OR PROBABILITY mean : 3.0E-3/d
Source: NUREG 1205 (1982) (table 15) Ultimate source: US plant LER report evaluation
Comment: Pop.4 (PWR & BWR) 1 failure. W/o command faults.W command faults 3.0E 2/d Standby hourly rate with command faults 6.5E-5/hr

I Source category: generic

PDASI pump diesel driven
Component boundary: pump,diesel,lube oil system,fuel oil,suction and exhaust,starting Operating mode: all Operating environment: normal
Generic failure mode: fail to start Original failure mode: failure to start
FAILURE RATE OR PROBABILITY mean : 1.0E-3/d ERROR FACTOR: 3
Source: IREP NUREG 2728 (tb.5.1-1) Ultimate source: expert opinion
Comment:

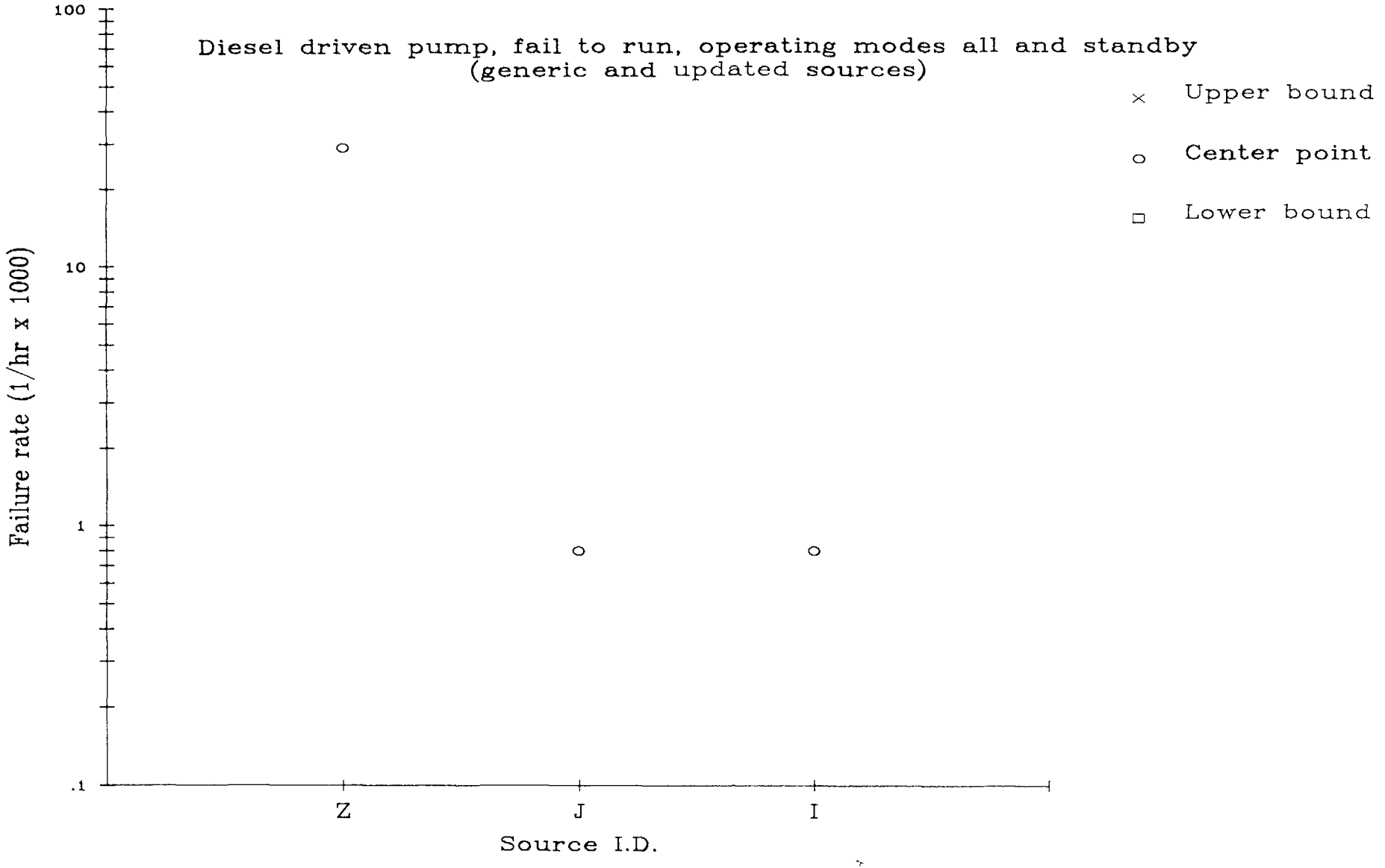
J Source category: generic

PDASJ pump diesel driven general
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to start Original failure mode: fails to start
FAILURE RATE OR PROBABILITY mean · 1.0E-3/d ERROR FACTOR: 3
Source: NUREG 4550, Vol.1,tbl.VIII.1-2 Ultimate source: assesed from several nuclear data sources
Comment: ASEP used the generic value from LERs. Failure to start incl.two types of failure:circut breaker command faults (3.0E-2) and pump hardware faults(3.0E-3).

B Source category: generic

PDASB pump diesel driven
Component boundary: Pump,diesel,lube oil system,fuel oil,suction and exhaust,starting Operating mode: all Operating environment: normal
Generic failure mode: fail to start Original failure mode: failure to start
FAILURE RATE OR PROBABILITY mean : 3.6E-4/d max: 1.8E-2/d min· 7 2E 5/d
Source: NUREG 2815 (table C.1.) Ultimate source: expert opinion agregation and IREP data
Comment: Original time related value changed to demand related assuming monthly test interval.

IAEA RELIABILITY DATA BASE



Z Source category:

PDCRZ pump diesel driven containment spray pump
Component boundary: detail n/a Operating mode: standby Operating environment: normal
Generic failure mode: fail to run Original failure mode: fail during operation
FAILURE RATE OR PROBABILITY mean : 2.9E-2/hr
Source: ZION NPP PSS (tbl.1.5.1-5) Ultimate source. generic data updated with plant experience
Comment: Prior:WASH 1400 pumps (w/o motor),failure to run, normal environ. WASH 1400, Diesel(engine only),failure to run.
Operating experience: 33 hours of operation, 2 failures.

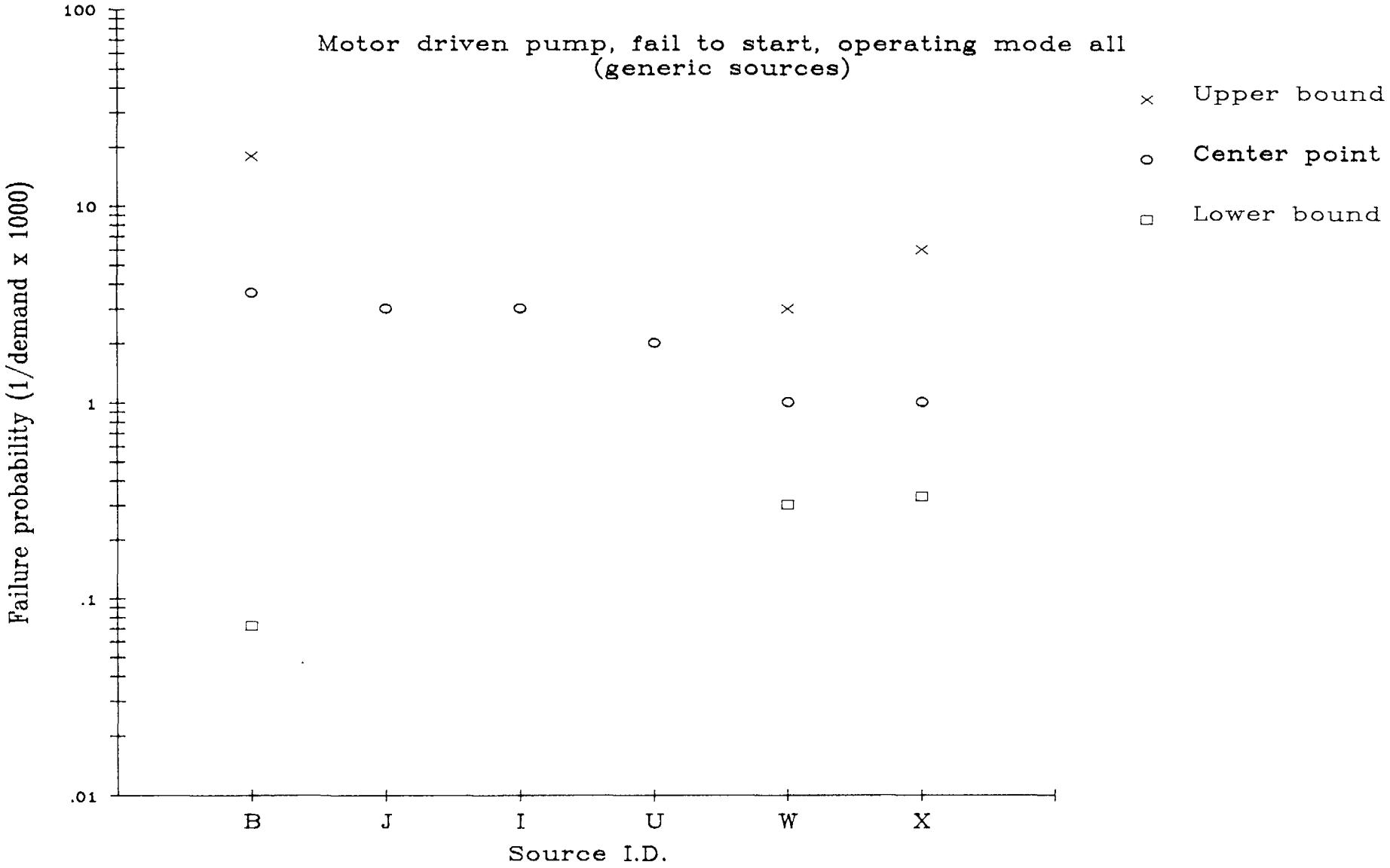
J Source category:

PDARJ pupm diesel driven general
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to run Original failure mode: fails to run
FAILURE RATE OR PROBABILITY mean : 8.0E-4/hr ERROR FACTOR: 10
Source: NUREG 4550, Vol.1,tbl.VIII.1-2 Ultimate source: assesed from several nuclear data sources
Comment: ASEP used generic values from LERs.

I Source category

PDARI pump diesel driven
Component boundary: pump,diesel,lube oil system,fuel oil,suction and exhaust,starting Operating mode: all Operating environment: normal
Generic failure mode: fail to run Original failure mode: failure to run given start
FAILURE RATE OR PROBABILITY mean : 8.0E-4/hr ERROR FACTOR: 30
Source: IREP NUREG 2728 (tb.5 1-1) Ultimate source: expert opinion
Comment:

IAEA RELIABILITY DATA BASE



B Source category: generic

PMYSB pump motor driven
Component boundary: including motor,excluding control circutry Operating mode: all Operating environment: normal
Generic failure mode: fail to start Original failure mode: failure to start
FAILURE RATE OR PROBABILITY mean : 1.0E-5/hr max: 5.0E-5/hr min: 2.0E-7/hr
Source: NUREG 2815 (table C.1.) Ultimate source: expert opinion agregation & IREP data
Comment: Original time related value changed to demand related assuming monthly test interval.

J Source category: generic

PMASJ pump motor driven general
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to start Original failure mode: fails to start
FAILURE RATE OR PROBABILITY mean : 3.0E-3/d ERROR FACTOR: 10
Source: NUREG 4550, Vol.1,tbl.VIII.1-2 Ultimate source: assesed from several nuclear data sources
Comment: ASEP used geenric values developed in Station Blackout Study (NUREG/CR-3226). Value for fails to start included two types of failures·Pump hardware (4.0E-4/d) and circut br.command(2.5E-3).

I Source category: generic

PMYSI pump motor driven
Component boundary: including motor, excluding control circutry Operating mode: all Operating environment: normal
Generic failure mode: fail to start Original failure mode: failure to start on demand
FAILURE RATE OR PROBABILITY mean : 3.0E-3/d ERROR FACTOR: 10
Source: IREP NUREG 2728 (tb.5.1-1) Ultimate source: expert opinion
Comment:

U Source category: generic

PULSU pump motor driven low pressure <20bar
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to start Original failure mode: failure to start
FAILURE RATE OR PROBABILITY mean : 2.0E-3/d
Source: Sizewell B (PWR/RX312 pg.11) Ultimate source: assesed from nuclear and industrial experience and data
Comment: Assesement based on W data,WASH 1400, EDF data item(1.8E-4/d out of 16800 demands) and two SRS data items (4.0E-3/d for HHSI,RHR and auxfeed) and (2.0E-3/d for CVCS and CCWS).

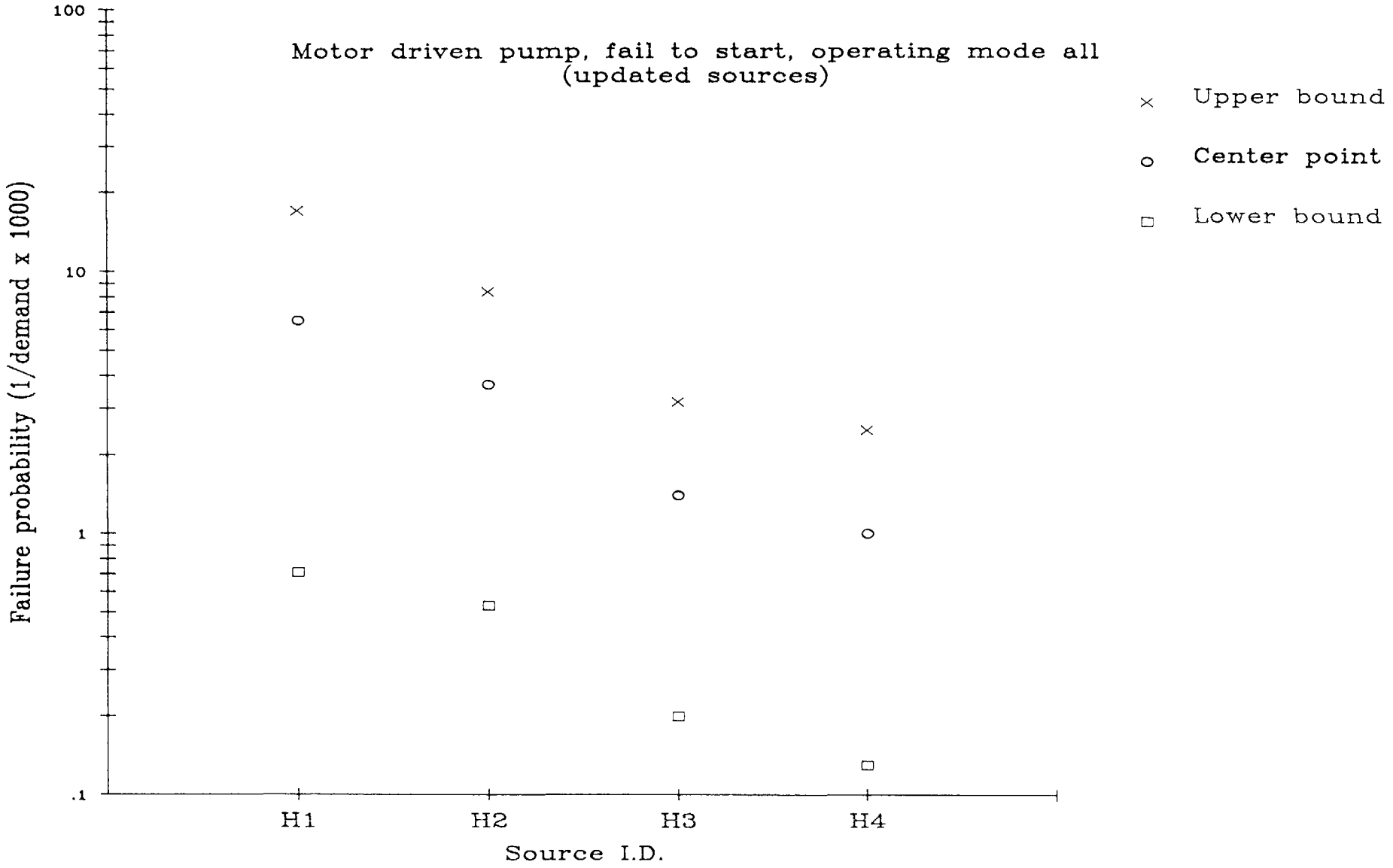
W Source category: generic

PMYSW pump motor driven
Component boundary: detail n/a, including motor Operating mode: all Operating environment: normal
Generic failure mode: fail to start Original failure mode: failure to start on demand
FAILURE RATE OR PROBABILITY median: 1.0E-3/d : 3.0E-3/d : 3.0E-4/d ERROR FACTOR: 3
Source: WASH 1400 (table III 4-1) Ultimate source: assesed from nuclear, industrial end military expereince and data
Comment:

X Source category:

PMASX pump motor driven general
Component boundary: detail n/a Operating mode· all Operating environment: normal
Generic failure mode: fail to start Original failure mode: fail to start
FAILURE RATE OR PROBABILITY mean · 1.0E-3/d 80%: 6.0E-3/d 20%· 3.3E-4/d
Source: VVER reliability data base Ultimate source: expert opinion, operating experience
Comment·

IAEA RELIABILITY DATA BASE



H1 Source category: updated

PUWSH pump motor driven residual heat removal pump
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to start Original failure mode: fail to start on demand
FAILURE RATE OR PROBABILITY mean : 6.5E-3/d 95%: 1.7E-2/d 5%: 7.1E-4/d
Source: Old PWR Ultimate source: generic data updated with plant specific operating experience
Comment: Generic mean 3.3E-3/d. Operating experience 58 demands, 1 failure

H2 Source category: updated

PUVSH pump motor driven well water pump
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to start Original failure mode: fail to start on demand
FAILURE RATE OR PROBABILITY mean : 3.7E-3/d 95%: 8.4E-3/d 5%: 5.3E-4/d
Source: Old PWR Ultimate source: generic data updated with plant operating experience
Comment: Generic mean 3.3E-3/d. Operating experience 192 demands, 1 failure.

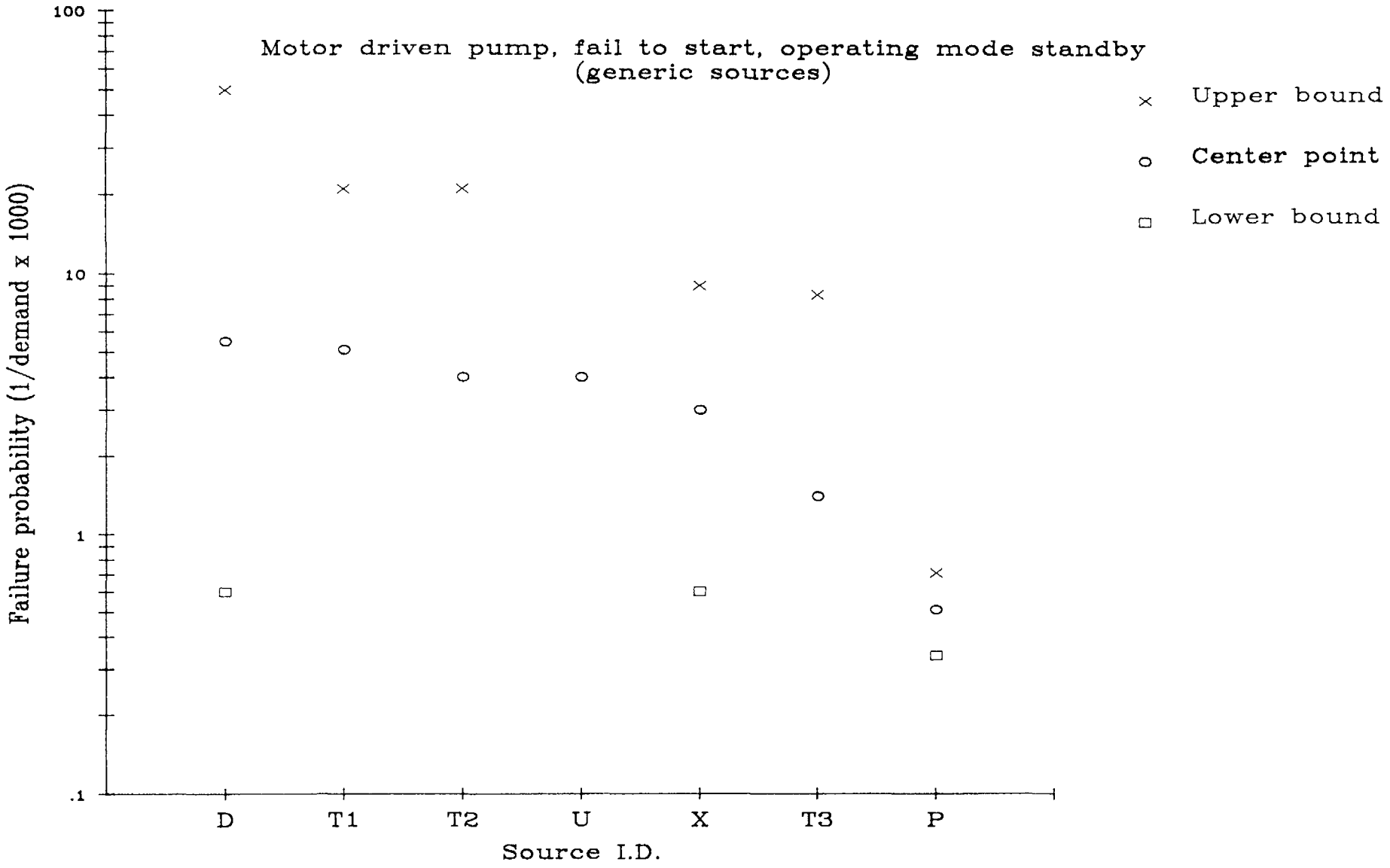
H3 Source category: updated

PMGSH pump motor driven electric equipment area ventilation cooling pump
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to start Original failure mode: fail to start on demand
FAILURE RATE OR PROBABILITY mean : 1.4E-3/d 95%: 3.2E-3/d 5%: 2.0E-4/d
Source: Old PWR Ultimate source: generic data updated with plant operating experience
Comment: Generic mean 2.4E-3/d. Operating experience 329 demands, no failures.

H4 Source category: updated

PUZSH pump motor driven recirculation pump
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to start Original failure mode: fail to start on demand
FAILURE RATE OR PROBABILITY mean : 1.0E-3/d 95%: 2.5E-3/d 5%: 1.3E-4/d
Source: Old PWR Ultimate source: generic data updated with plant operating experience
Comment: Generic mean 3.3E-3/d. Operating experience 684 demands, no failures.

IAEA RELIABILITY DATA BASE



D Source category: generic

PMTSD pump motor driven include containment spray,standby liquid control
Component boundary: pump,shaft,motor,swiches,local control and instrumentation Operating mode: standby Operating environment: normal
Generic failure mode: fail to start Original failure mode: failsre to start
FAILURE RATE OR PROBABILITY mean : 5.5E-3/d : 6.0E-4/d : 5.0E-2/d
Source: NUREG 2886 (1982)(tbl.18 & 19) Ultimate source: plant operating experience-maintenance records(2PWR & 4BWR)
Comment: Pop.95.31 catastrophic demand related failures of 5456 demands Up & lowbound derived from funct.aggregation.Failrate is based on 1 demand/month.(actual 2-3 times higher)very conservative

T1 Source category: generic

PMQST pump motor driven centrifugal,horisontal and vertical
Component boundary: pump,motor,transmission,swich,fuse,protection,controls Operating mode: standby Operating environment: normal
Generic failure mode: fail to start Original failure mode: failure to start
FAILURE RATE OR PROBABILITY mean : 5.1E-3/d 95%: 2.1E-2/d REPAIR TIME: 3 hr
Source: Swedish Rel.data book, tbl.8 Ultimate source: plant operating experience (7 BWR plants),ATV reports, LERs
Comment: Operating experience:total pop.18. No.of demands 784. 4 failures. a=0.387; b=75.4 Critical failures occured at 2 plants.

T2 Source category: generic

PUPST pump motor driven reciprocating(positive displacement)
Component boundary: pump,transmission,motor,swich,fuse,protection,control Operating mode: standby Operating environment: normal
Generic failure mode: fail to start Original failure mode: failure to start
FAILURE RATE OR PROBABILITY mean : 4.0E-3/d 95%: 2.1E-2/d REPAIR TIME: 7 hr
Source: Swedish Rel.data book, tbl.10 Ultimate source: plant operating exeperience (7 BWR plants)
Comment: Operating experience:total pop 22. No.of demands 1238. 5 failures a=0.186; b=46. Critical failures occured at 3 plants.

U Source category: generic

PMISU pump motor driven high pressure (>20 bar)
Component boundary: detail n/a Operating mode: standby Operating environment: normal
Generic failure mode: fail to start Original failure mode: failure to start on demand
FAILURE RATE OR PROBABILITY mean : 4.0E-3/d
Source: Sizewell B (PWR/RX312 pg.9) Ultimate source: assesed from nuclear and industrial experience and data
Comment: Assesment based on W data,WASH 1400,EDF data and 2 SRS data items one applies to HHSI,RHR and auxfeed(4.0E-3/d) and other to CVCS and CCWS (2.0E-3/d).

X Source category: generic

PMASX pump motor driven HPECCS
Component boundary: detail n/a Operating mode: standby Operating environment: all
Generic failure mode: fail to start Original failure mode: fail to start
FAILURE RATE OR PROBABILITY mean : 3.0E-3/d 80%: 9.0E-3/d 20%: 6.0E-4/d
Source: VVER reliability data base Ultimate source: Expert opinion, operating experience
Comment.

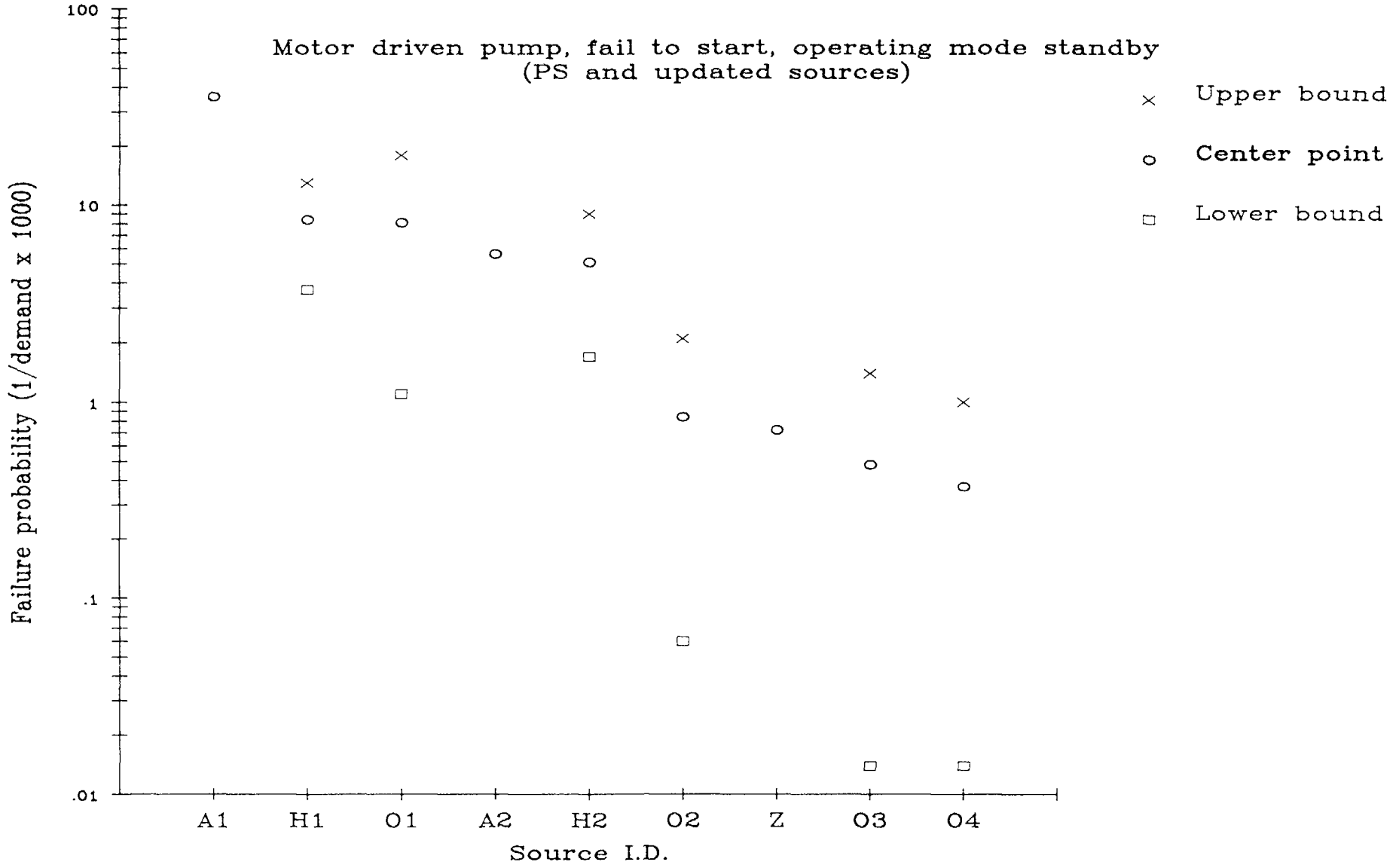
T3 Source category. generic

PMOST pump motor driven centrifugal horisontal and vertical
Component boundary: pump,transmission,motor,swich,fuses,protection,controls Operating mode: standby Operating environment: normal
Generic failure mode: fail to start Original failure mode: failure to start
FAILURE RATE OR PROBABILITY mean : 1.4E-3/d 95%: 8.3E-3/d REPAIR TIME: 2 hr
Source: Swedish Rel.data book, tbl.7 Ultimate source: operating experience (7 BWR plants),ATV reports,LERs,plant infor.
Comment: Data derived from observation of 12 components,696 demands(per op.time),1 failure occuring(critical)
Critical failures occured at one plant only. a=0.116;b=80.3

P Source category: generic

PMASP pump motor driven
Component boundary: pumping unit,motor,coupling,mech.controlExcl.MCC,breakers,ect Operating mode: standby Operating environment: normal
Generic failure mode: fail to start Original failure mode: does not start
FAILURE RATE OR PROBABILITY median: 5.1E-4/d 95%: 7.1E-4/d 5%: 3.4E-4/d
Source: NUREG 1205 (1982) (pg.362) Ultimate source: US plant LER report evaluation
Comment: Overall data, includes all types of reactors,LER-s from 1972 to 1980.Ttl.pop.596. No.of failures 91 W/o command faults.
W command faults 3.0E 3. Stdby hourly rate 1.0E-6

IAEA RELIABILITY DATA BASE



A1 Source category: plant specific

PMCSA pump motor driven inside spray recirculation
Component boundary: detail n/a Operating mode: standby Operating environment: normal
Generic failure mode: fail to start Original failure mode: fail to start/run
FAILURE RATE OR PROBABILITY median: 3.6E-2/d ERROR FACTOR: 1.8
Source: NUREG 4550/Vol.3,tbl.IV.8-1 Ultimate source: Surry NPP operating experience (test data)
Comment: It was not possible to identify failure mode in table. It seems to cover starting failure and initial running failure (during test)

H1 Source category: updated

PMSSH pump motor driven safety injection pump
Component boundary: detail n/a Operating mode: standby Operating environment: normal
Generic failure mode: fail to start Original failure mode: fail to start on demand
FAILURE RATE OR PROBABILITY mean : 8.4E-3/d 95%: 1.3E-2/d 5%: 3.7E-3/d
Source: Old PWR Ultimate source: generic data updated with plant operating experience
Comment: Generic mean 3.3E 3/d. Operating experience 719 demands,7 failures.

O1 Source category: updated

PMCSO pump motor driven reactor building spray
Component boundary: detail n/a Operating mode: standby Operating environment: normal
Generic failure mode: fail to start Original failure mode: failure to start
FAILURE RATE OR PROBABILITY mean : 8.1E-3/d 95%: 1.8E-2/d 5%: 1.1E-3/d REPAIR TIME: 28.6 hours
Source: Oconee NPP PRA (tbl.b-1.) Ultimate source: generic data updated with plant specific operating experience
Comment: Prior:Mean NUREG 1205(1980),80%/20% is based on RSS distribution. Same prior as for injecton pumps.Op.experience:140 dem.3 failures
Repair time is mean of plant spec.update of maintenance duration.

A2 Source category: plant specific

PMXSA pump motor driven auxiliary feedwater
Component boundary: detail n/a Operating mode: standby Operating environment: normal
Generic failure mode: fail to start Original failure mode: fail to start/run
FAILURE RATE OR PROBABILITY median: 5.6E-3/d ERROR FACTOR: 2.2
Source: NUREG 4550/Vol 3,tbl.IV.8-1 Ultimate source: Surry NPP operating experience (test data??)
Comment: It was not possible to identify failure mode as appear in table. It seems to cover starting failure and initial running failure.

H2 Source category. updated

PMCSH pump motor driven containment spray
Component boundary: detail n/a Operating mode: standby Operating environment: normal
Generic failure mode: fail to start Original failure mode: fail to start on demand
FAILURE RATE OR PROBABILITY mean : 5.1E-3/d 95%: 9.0E-3/d 5%: 1.7E-3/d
Source: Old PWR Ultimate source: generic data updated with plant operating experience
Comment: Generic mean 3 3E-3/d. Operating experience 634 demands, 4 failures.

O2 Source category: updated

PMVSO pump motor driven high pressure injection
Component boundary. detail n/a Operating mode: standby Operating environment: normal
Generic failure mode: fail to start Original failure mode: failure to start
FAILURE RATE OR PROBABILITY mean : 8.4E-4/d 95%: 2 1E-3/d 5%: 6.0E-5/d REPAIR TIME: 21.5 hours
Source: Oconee NPP PRA (tbl.b-1.) Ultimate source: generic data updated with plant specific operating experience
Comment: Prior:Mean NUREG 1205(1980),standby pump,80%/20% ratio based on RSS distribution.Operating experience: 530 demands,1 failure.
Repair t me is mean of updated component maintenance duration.

Z Source category. updated

PMASZ pump motor driven
Component boundary: detail n/a Operating mode: standby Operating environment: normal
Generic failure mode: fail to start Original failure mode: failure to start on demand
FAILURE RATE OR PROBABILITY mean : 7.2E-4/d
Source: ZION NPP PSS (tbl.1.5.1 5) Ultimate source: generic data upgraded with plant specific experience
Comment: Priors:NUREG 1205(tbl.14)standby system does not start,w/o comman (mean),and WASH 1400 table III 2-1,electric motor failure to strt for distribution. Experience:3138 demands,3 failures

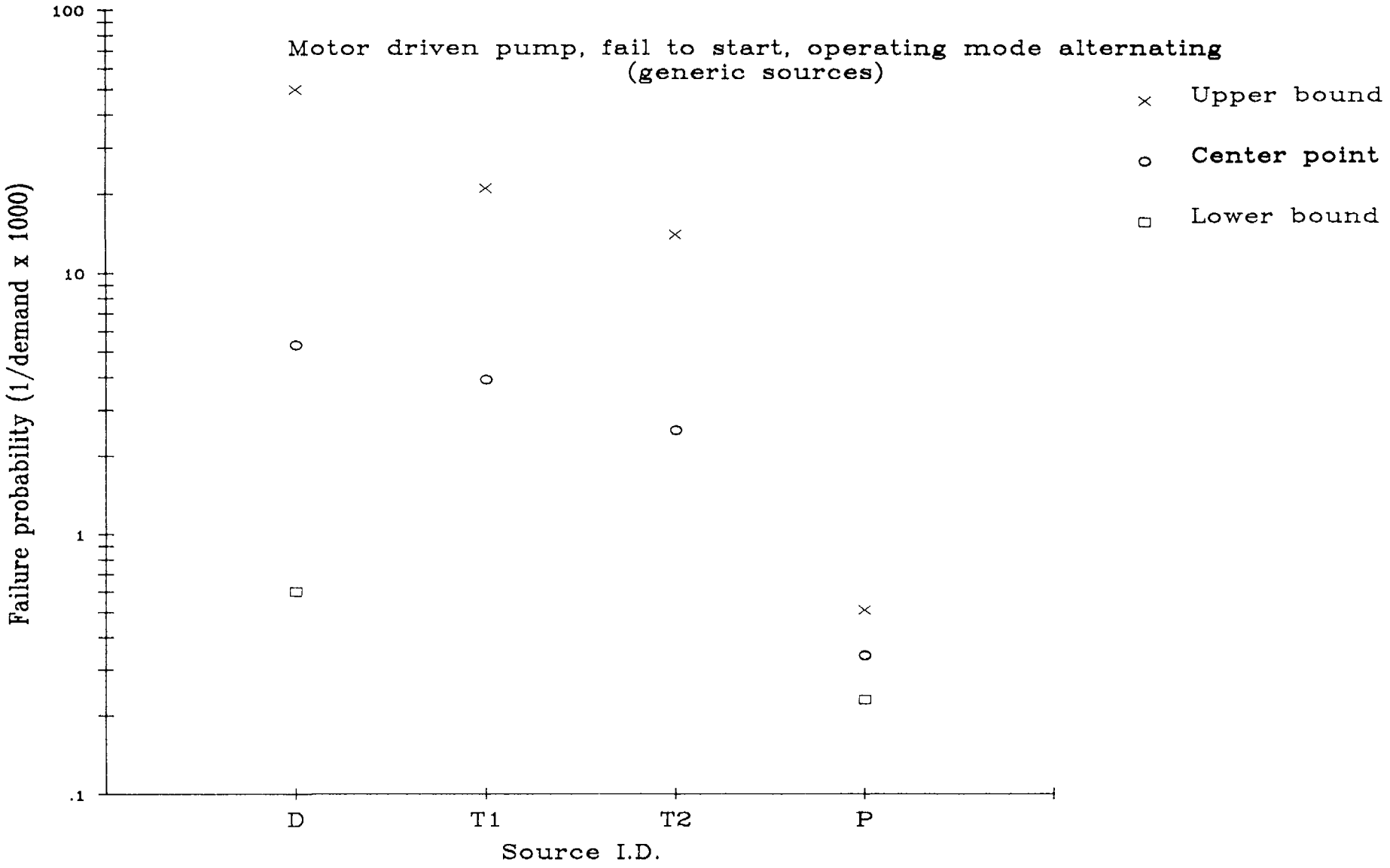
03 Source category: updated

PMFSO pump motor driven emergency feedwater pump
Component boundary: detail n/a Operating mode: standby Operating environment: normal
Generic failure mode: fail to start Original failure mode: failure to start
FAILURE RATE OR PROBABILITY mean : 4.8E-4/d 95%: 1.4E-3/d 5%: 1.4E-5/d REPAIR TIME: 20.9 hours
Source: Oconee NPP PRA (tbl.b-1.) Ultimate source: generic data updated with plant specific operating experience
Comment: Prior.mean NUREG 1205(1980),standby pump,80%/20% ratio based on RSS distrib.Op.expereince:18 demands, no failures. Repair time is mean generic component maintenance duration.

04 Source category: updated

PMLSO pump motor driven low pressure injection
Component boundary: detail n/a Operating mode: standby Operating environment: normal
Generic failure mode: fail to start Original failure mode: failure to start
FAILURE RATE OR PROBABILITY mean : 3.7E-4/d 95%: 1.0E-3/d 5%: 1.4E-5/d REPAIR TIME: 10.8 hours
Source: Oconee NPP PRA (tbl.b-1) Ultimate source: generic data updated with plant specific operational experience
Comment: Prior:mean NUREG 1205(1980),standby pump,80%/20% ratio based on RSS distrib.Same prior as for HPI pump.Op.exp.223 demands,no fail Repair time is mean generic component maintenance duration.

IAEA RELIABILITY DATA BASE



D Source category: generic

PMZSD pump motor driven include CCW,SW,RHR, boric acid transfer,boron injection recirc
Component boundary: pump,shaft,motor,swiches,local control & instrumentation Operating mode: alternating Operating environment: normal
Generic failure mode: fail to start Original failure mode: fails to start
FAILURE RATE OR PROBABILITY mean : 5.3E-3/d : 6.0E-4/d : 5.0E-2/d
Source: NUREG 2886 (1982) (tbl.19) Ultimate source: plant operating experience-maintenance records(2PWR & 4BWR)
Comment: Pop.102. 22 catastophic demand related failures of 4148 demand Upbound & lowbound are largest and smallest rate of func.aggreg. of the pumps class.by driver type.Include altern.and stdby pumps

T1 Source category: generic

PMMST pump motor driven centrifugal horisontal and vertical
Component boundary: pump,transmission,motor,breaker,fuse,protection,controls Operating mode: alternating Operating environment: normal
Generic failure mode: fail to start Original failure mode: failure to start
FAILURE RATE OR PROBABILITY mean : 3.9E-3/d 95%: 2.1E-2/d REPAIR TIME: 10 hr
Source: Swedish Rel.data book, tbl.5 Ultimate source: plant operating experience (7 BWR plants),ATV reports, LERs
Comment: Operating experience: total pop. 66.Other data not known. Critical failures occured at 6 plants.

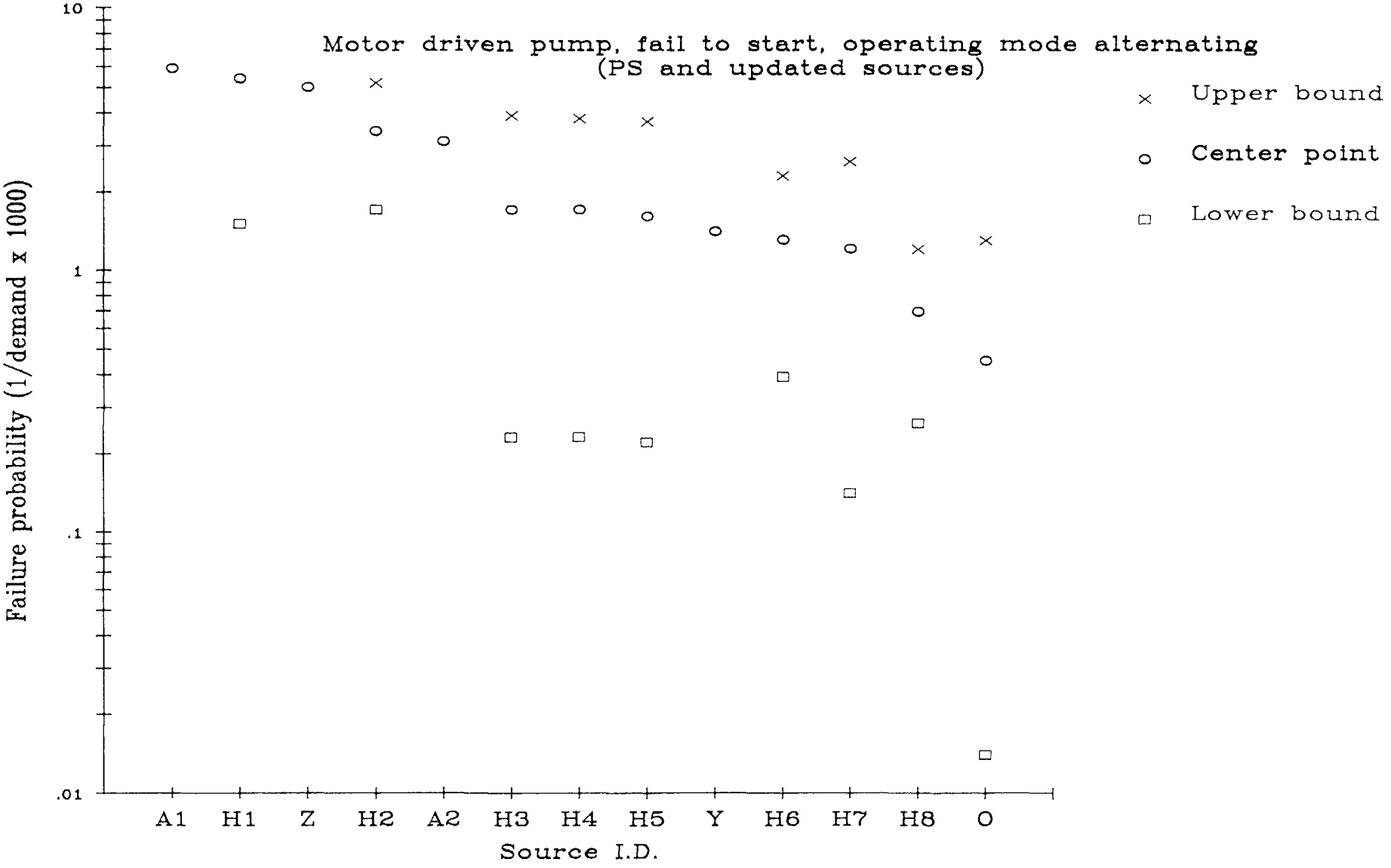
T2 Source category: generic

PUSST pump motor driven screw
Component boundary: pump,transmission,motor,swich,fuses,protection,controls Operating mode: alternating Operating environment: normal
Generic failure mode: fail to start Original failure mode: failure to start
FAILURE RATE OR PROBABILITY mean : 2.5E-3/d 95%: 1.4E-2/d REPAIR TIME: 8 hours
Source: Swedish Rel.data book, tbl.6 Ultimate source: plant operating experience (1 BWR plant), ATV reports, LERs
Comment: Operating experience: total pop.7. No.of demands 399. 1 failure. a=0.164; b=65.2

P Source category. generic

PMBSP pump motor driven
Component boundary: pumping unit,motor,coupling,mech.control.excl.MCC,breacker ect. Operating mode: alternating Operating environment: normal
Generic failure mode: fail to start Original failure mode: does not start
FAILURE RATE OR PROBABILITY median: 3.4E-4/d 95%: 5.1E-4/d 5%: 2.3E-4/d
Source: NUREG 1205 (1982) (pg.305) Ultimate source: US plant LER report evaluation
Comment: Overall data,include all types of reactors, LER-s from 1972 to 1980. Total pop.720 pumps.Total No.of failures 18.W/o command flt W.command faults 1.4E-3/d.Stdby hourly rate 1.4E-6/hr.

IAEA RELIABILITY DATA BASE



A1 Source category: plant specific

PUCSA pump motor driven service water pump used in charging pump cooling system
Component boundary: detail n/a Operating mode: alternating Operating environment: normal
Generic failure mode: fail to start Original failure mode: fail to start
FAILURE RATE OR PROBABILITY median: 5.9E-3/d ERROR FACTOR: 3.5
Source: NUREG 4550/Vol 3,tbl.IV.8-1 Ultimate source: Surry NPP operating expereince
Comment:

H1 Source category: updated

PMXSH pump motor driven auxiliary feedwater pump
Component boundary: detail n/a Operating mode: alternating Operating environment: normal
Generic failure mode: fail to start Original failure mode: fail to start on demand
FAILURE RATE OR PROBABILITY mean : 5.4E-3/d 95%: 1.1E-2/d 5%: 1.5E-3/d
Source: Old PWR Ultimate source: generic data updated with plant operating experience
Comment: Generic mean 3.3E-3/d. Operating experience 424 demands, 3 failures.

Z Source category. updated

PMXSZ pump motor driven auxiliary feedwater
Component boundary: DETAIL n/a Operating mode: alternating Operating environment: normal
Generic failure mode: fail to start Original failure mode: failure to start on demand
FAILURE RATE OR PROBABILITY mean : 5.0E-3/d
Source: ZION NPP PSS (tbl.1.5.1-5) Ultimate source: generic data updated with plant specific experience
Comment: Priors: NUREG 1205(tb.14) standby system,does not start, w/o comm (mean)and WASH 1400(tbl.III 2-1)electric motor failure to start (distribution)Experience: 462 demands,4 failures

H2 Source category· updated

PUESH pump motor driven primary component cooling water pump
Component boundary: detail n/a Operating mode: alternating Operating environment: normal
Generic failure mode: fail to start Original failure mode: fail to start on demand
FAILURE RATE OR PROBABILITY mean : 3.4E-3/d 95%: 5.2E-3/d 5%: 1.7E-3/d
Source: Old PWR Ultimate source: generic data updated with plant operating experience
Comment: Generic mean 2.4E-3/d. Operating experience 1840 demands, 7 failures.

A2 Source category· plant specific

PMHSA pump motor driven charging/high pressure injection
Component boundary: detail n/a Operating mode: alternating Operating environment: normal
Generic failure mode: fail to start Original failure mode: fail to start
FAILURE RATE OR PROBABILITY median: 3.1E-3/d ERROR FACTOR: 3.5
Source: NUREG 4550/Vol.3,tbl.IV.8-1 Ultimate source: Surry NPP operating experience
Comment: Charging pumps provide normal RCS makeup and RCP cooling flow in normal operation and serve as a high pressure injection recirculation following accident.

H3 Source category: updated

PMKSH pump motor driven secondary service water pump
Component boundary· detail n/a Operating mode: alternating Operating environment: normal
Generic failure mode: fail to start Original failure mode: fail to start on demand
FAILURE RATE OR PROBABILITY mean : 1.7E-3/d 95%: 3.8E-3/d 5%: 2.3E-4/d
Source: Old PWR Ultimate source: generic data updated with paint operating experience
Comment: Generic mean 2.4E-3/d. Operating experience 203 demands, no failures.

H4 Source category: updated

PUFSH pump motor driven secondary component cooling water
Component boundary: detail n/a Operating mode: alternating Operating environment: normal
Generic failure mode: fail to start Original failure mode: fail to start on demand
FAILURE RATE OR PROBABILITY mean : 1.7E-3/d 95%: 3.9E-3/d 5%: 2.3E-4/d
Source: Old PWR Ultimate source: generic data updated with plant operating experience
Comment: Generic mean 2.4E-3/d Operating experience 193 demands, no failures.

H5 Source category: updated

PUBSH pump motor driven primary service water booster pump
Component boundary: detail n/a Operating mode: alternating Operating environment: normal
Generic failure mode: fail to start Original failure mode: fail to start on demand
FAILURE RATE OR PROBABILITY mean : 1.6E-3/d 95%: 3.7E-3/d 5%: 2.2E-4/d
Source: Old PWR Ultimate source: generic data updated with plant operating experience
Comment: Generic mean 2.4E 3/d. Operating experience 222 demands,no failures.

Y Source category: plant specific

PMMSY pump motor driven centrifugal horizontal and vertical
Component boundary: pump,transmision,motor,breaker,fuses,protection,controls Operating mode: alternating Operating environment: normal
Generic failure mode: fail to start Original failure mode: failure to start
FAILURE RATE OR PROBABILITY mean : 1.4E-3/d REPAIR TIME: 24 hr
Source: Swedish Rel.data book, tbl.5 Ultimate source: plant operating experience (Ringhals 2 PWR)
Comment: 10 components observed, other information not available

H6 Source category. updated

PUKSH pump motor driven primary service water pump
Component boundary· detail n/a Operating mode: alternating Operating environment: normal
Generic failure mode: fail to start Original failure mode: fail to start on demand
FAILURE RATE OR PROBABILITY mean : 1.3E-3/d 95%: 2.3E-3/d 5%: 3.9E-4/d
Source: Old PWR Ultimate source: generic data updated with plant operating experience
Comment: Generic mean 2.4E-3/d. Operating experience 1909 demands, 2 failures.

H7 Source category· updated

PMHSH pump motor driven charging pump
Component boundary: detail n/a Operating mode: alternating Operating environment: normal
Generic failure mode: fail to start Original failure mode· fail to start on demand
FAILURE RATE OR PROBABILITY mean : 1.2E-3/d 95%· 2.6E-3/d 5%: 1.4E-4/d
Source: Old PWR Ultimate source: generic data updated with plant operating experience
Comment: Generic mean 2.4E-3/d Operating experience 559 demands, no failures.

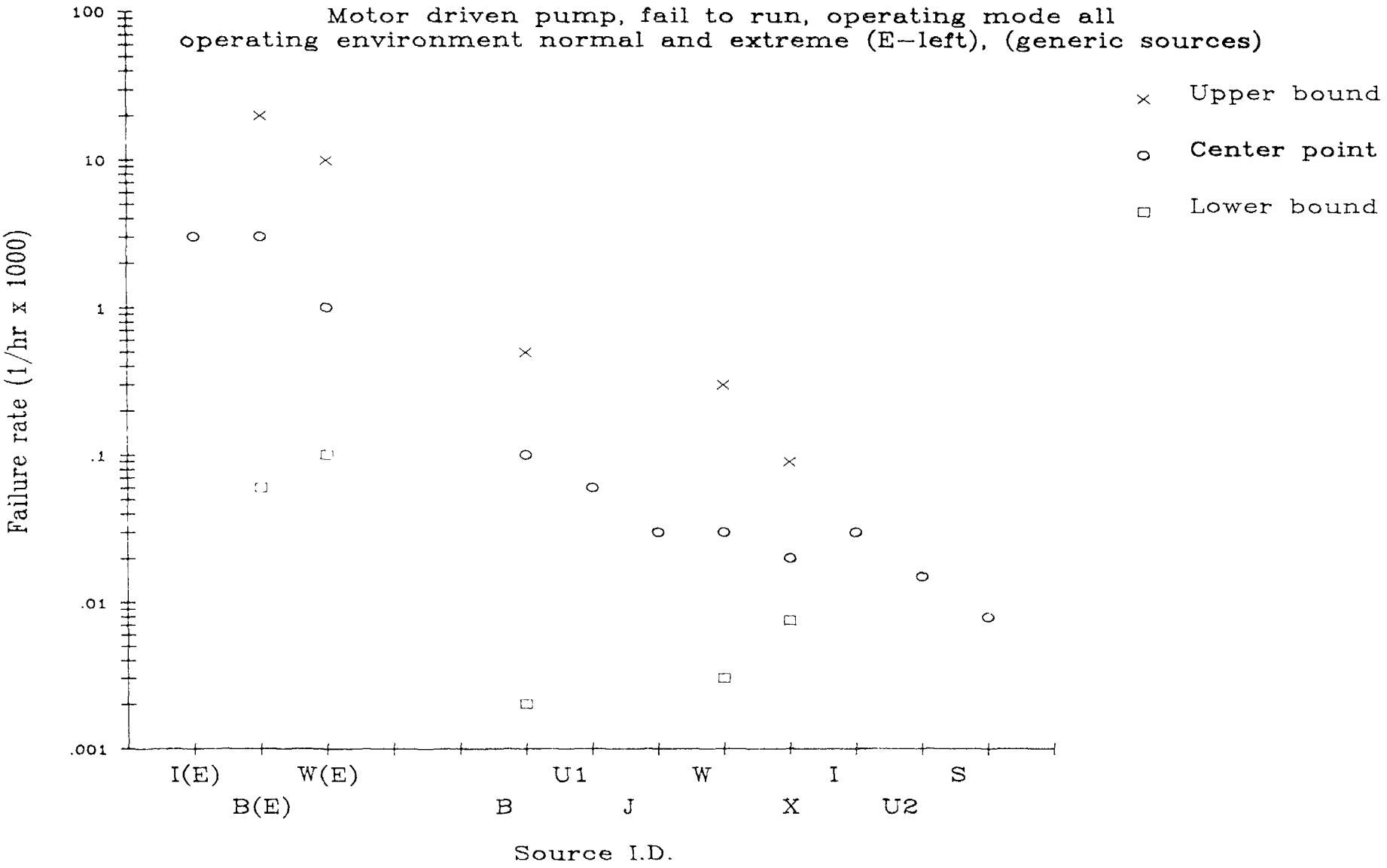
H8 Source category updated

PURSH pump motor driven main steam relief hydraulic pump
Component boundary. detail n/a Operating mode: alternating Operating environment. normal
Generic failure mode. fail to start Original failure mode: fail to start on demand
FAILURE RATE OR PROBABILITY mean : 6.9E-4/d 95%: 1.2E-3/d 5%: 2.6E-4/d
Source: Old PWR Ultimate source: generic data updated with plant operating experience
Comment: Generic mean 3.3E-3/d. Operating experience 5636 demands, 3 failures.

0 Source category. updated

PMKSO pump motor driven low pressure service water
Component boundary: detail n/a Operating mode: alternating Operating environment: normal
Generic failure mode: fail to start Original failure mode: failure to start
FAILURE RATE OR PROBABILITY mean : 4.5E-4/d 95%: 1.3E-3/d 5%: 1.4E-5/d REPAIR TIME: 10.5 hours
Source: Oconee NPP PRA (tbl.b-1.) Ultimate source: generic data updated with plant specific operating experience
Comment: Prior: mean NUREG 1205(1980), standby pump,80%/20%ratio based on RSS. Op.expereince: 61 demands, no failures.
Repair time is mean of plant spec.update of maintenance duration.

IAEA RELIABILITY DATA BASE



I(E) Source category: generic

PMURI pump motor driven
Component boundary: pump and motor excludes control circuts Operating mode: all Operating environment: extreme
Generic failure mode: fail to run Original failure mode: failure to run given start
FAILURE RATE OR PROBABILITY mean : 3.0E-3/hr ERROR FACTOR: 10
Source: IREP NUREG 2728 (tb.5.1-1) Ultimate source: expert opinion
Comment: Extreme operating environment is caracterised with interface with heavy chemical environment-boric acid.

B(E) Source category: generic

PMURB pump motor driven
Component boundary: pump and motor,exclusdes control circuts Operating mode: all Operating environment: extreme
Generic failure mode: fail to run Original failure mode: failure to run, given start
FAILURE RATE OR PROBABILITY mean : 3.0E-3/hr max: 2.0E-2/hr min: 6.0E-5/hr
Source: NUREG 2815 (table C.1.) Ultimate source: expert opinion agregation and IREP data
Comment: Extreme operating environment caracterise interface with heavy chemical environment-boric acid.

W(E) Source category: generic

PMURW pump motor driven
Component boundary: detail n/e, including motor Operating mode: all Operating environment: extreme, post accident inside containment
Generic failure mode: fail to run Original failure mode: failure to run given start
FAILURE RATE OR PROBABILITY median: 1.0E-3/hr 95%: 1.0E-2/hr 5%: 1.0E-4/hr ERROR FACTOR: 10
Source: WASH 1400 (table III 4-1) Ultimate source: assesed from test & resesarch reactors and military experience
Comment:

B Source category: generic

PMYRB pump motor driven
Component boundary: pump and motor, excludes control circuts Operating mode: all Operating environment: normal
Generic failure mode: fail to run Original failure mode: failure to run, given start
FAILURE RATE OR PROBABILITY mean : 1.0E-4/hr max: 5.0E-4/hr min: 2.0E-6/hr
Source: NUREG 2815 (table C.1.) Ultimate source: expert opinion agregation and IREP data
Comment:

U1 Source category: generic

PMIRU pump motor driven high pressure(> 20 bar)
Component boundary: detail n/a Operating mode: standby Operating environment: normal
Generic failure mode: fail to run Original failure mode: failure to continue operation
FAILURE RATE OR PROBABILITY mean : 6.0E-5/hr
Source: Sizewell B (PWR/RX312 pg.10) Ultimate source: assesed from nuclear and industrial experience and data
Comment: Assesement based on W data and 3 SRS data items. Two of them applies to RHR,HHSI and auxfeed (5.0E-5/hr and 1.0E-5/hr) and one to CVCS and CCWS (2.0E-5/hr).

J Source category: generic

PMARJ pump motor driven general
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to run Original failure mode: fails to run
FAILURE RATE OR PROBABILITY mean : 3.0E-5/hr ERROR FACTOR: 10
Source: NUREG 4550, Vol.1,tbl.VIII.1-2 Ultimate source: assesed from several nuclear data sources
Comment: ASEP used the generic values developed in the Station Blackout Study (NUREG/CR 3226).

W Source category: generic

PMYRW pump motor driven
Component boundary: detail n/a, include motor Operating mode: all Operating environment: normal
Generic failure mode: fail to run Original failure mode: failure to run given start
FAILURE RATE OR PROBABILITY median: 3.0E-5/hr 95%: 3.0E-4/hr 5%: 3.0E-6/hr ERROR FACTOR: 10
Source: WASH 1400 (table III 4-1) Ultimate source: assesed from nuclear, industrial and military experience and data
Comment:

X Source category: generic

PMARX pump motor driven general
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to run Original failure mode: fail to run
FAILURE RATE OR PROBABILITY mean : 3.0E-5/hr 80%: 9.0E-5/hr 20%: 7.5E-6/hr
Source: VVER reliability data base Ultimate source: expert opinion, operating experience
Comment:

I Source category: generic

PMYRI pump motor driven
Component boundary: pump and motor, exclude control circuts Operating mode: all Operating environment: normal
Generic failure mode: fail to run Original failure mode: failure to run given start
FAILURE RATE OR PROBABILITY mean . 3.0E-5/hr ERROR FACTOR: 10
Source: IREP NUREG 2728 (tb.5 1-1) Ultimate source. expert opinion
Comment:

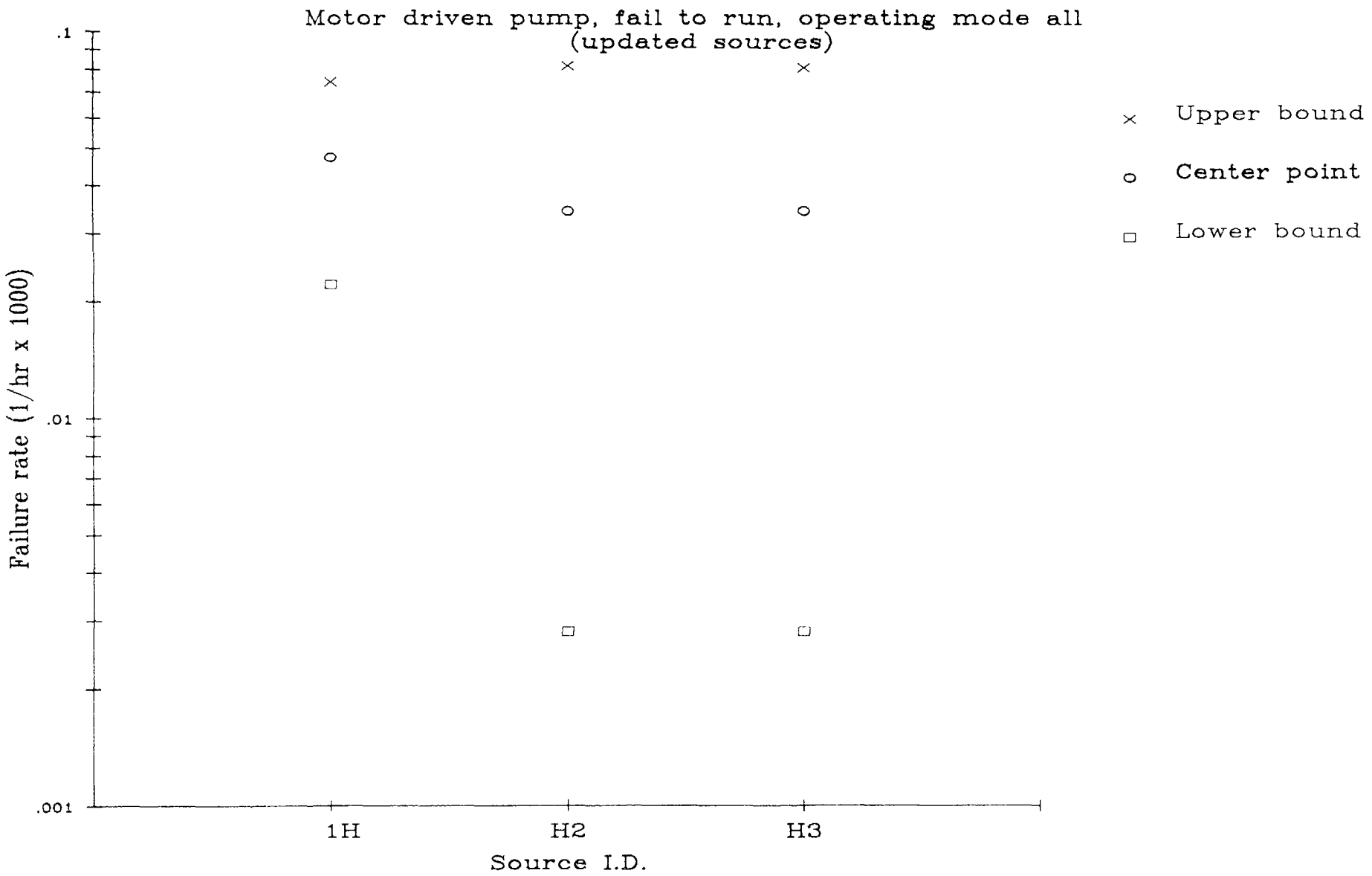
U2 Source category generic

PULRU pump motor driven low pressure <20 bar
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to run Original failure mode: failure to continue operation
FAILURE RATE OR PROBABILITY mean : 1.5E-5/hr
Source: Sizewell B (PWR/RX312 pg.11) Ultimate source: assesed from nuclear and industrial experience and data
Comment: Assesment based on W data,4 EDF data items(1.2E-4/hr ESW pumps) (6.8E-6/hr CCW),(5.6E-6/hr cond.extraction),(3.5E-6/hr cond.cool.
),2 SRS items(industrial use)(2.1E-4(1E5hrs) and 1.8E-5(5E5hrs)).

S Source category: generic

PMYRS pump motor driven
Component boundary: pump and motor Operating mode: all Operating environment: normal
Generic failure mode: fail to run Original failure mode: failure to run
FAILURE RATE OR PROBABILITY mean . 7.9E-6/hr
Source: Shoreham PRA,GE data(tb.A 2-1) Ultimate source: evaluation of BWR operating experience
Comment: From the data tables it is assumed that the given value include failure fot pump to start and to continue running.

IAEA RELIABILITY DATA BASE



H1 Source category: updated

PMGRH pump motor driven electrical equipment area ventilation cooling pump
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to run Original failure mode: fail during operation
FAILURE RATE OR PROBABILITY mean . 4.7E-5/hr 95%: 7.4E-5/hr 5%: 2.2E-5/hr
Source: Old PWR Ultimate source: generic data updated with plant operating experience
Comment: Generic mean 3.4E-5/hr. Operating experience 1.3E+5 hours of operation, 7 failures.

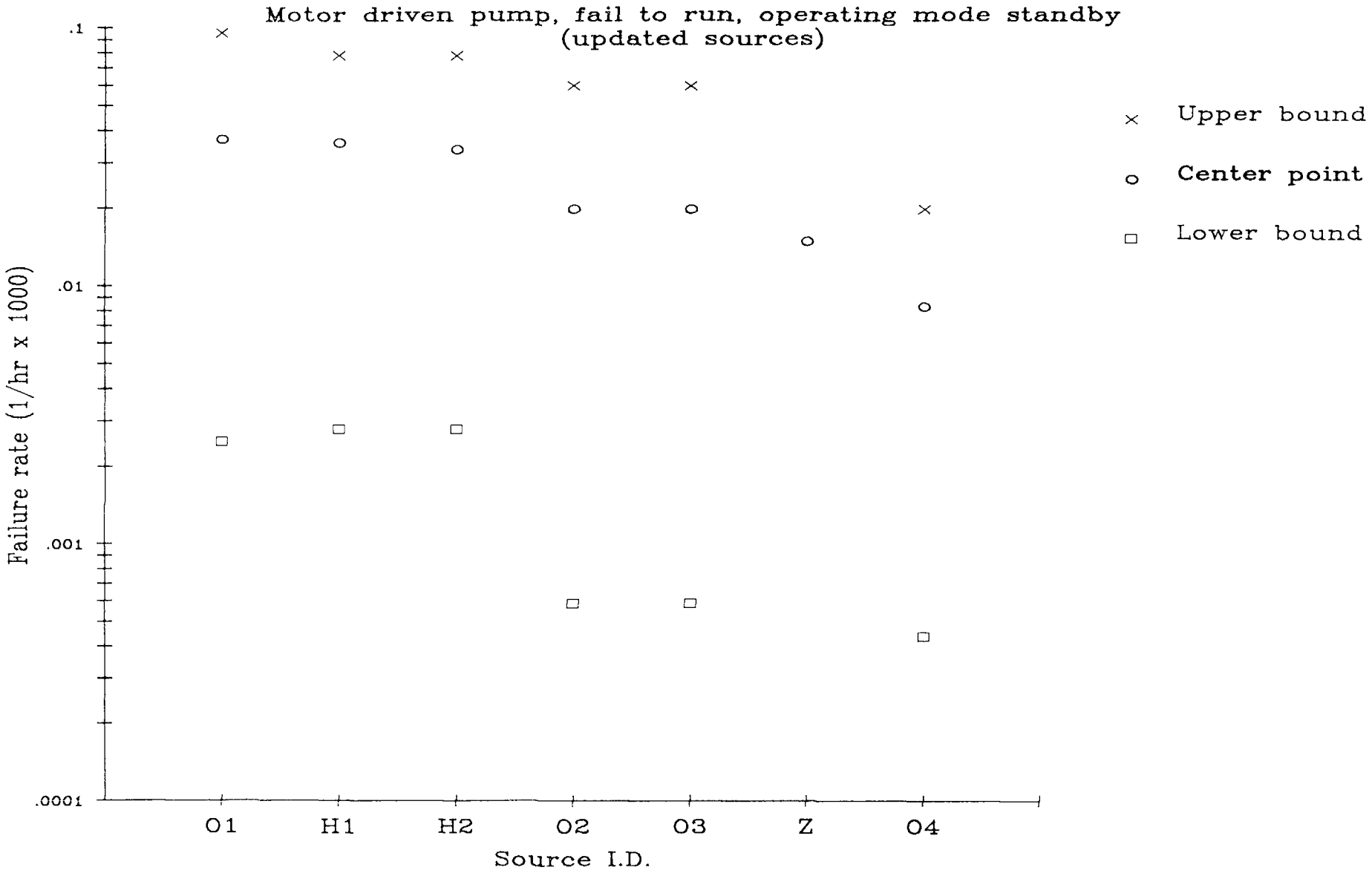
H2 Source category: updated

PJZRH pump motor driven recirculation pump
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to run Original failure mode: fail during operation
FAILURE RATE OR PROBABILITY mean : 3.4E-5/hr 95%: 8.1E-5/hr 5%: 2.8E-6/hr REPAIR TIME: 4.2 hours
Source: Old PWR Ultimate source: generic data updated with plant operating experience
Comment: Generic mean 3.4E-5/hr. Operating experience 56 hours of operation, no failures. Repair time is mean of 14 maintenance events.

H3 Source category: updated

PUVRH pump motor driven well water pump
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to run Original failure mode: fail during operation
FAILURE RATE OR PROBABILITY mean : 3.4E-5/hr 95%: 8.0E-5/hr 5%: 2.8E-6/hr
Source: Old PWR Ultimate source: generic data updated with plant operating experience
Comment: Generic mean 3.4E-5/hr. Operating experience 108 hours, no failures.

IAEA RELIABILITY DATA BASE



O1 Source category: updated

PMLRO pump motor driven low pressure injection
Component boundary: detail n/a Operating mode: standby Operating environment: normal
Generic failure mode: fail to run Original failure mode: operational failure
FAILURE RATE OR PROBABILITY mean : 3.7E-5/hr 95%: 9.5E-5/hr 5%: 2.5E-6/hr REPAIR TIME: 10.8 hours
Source: Oconee NPP PRA (tbl.b-1.) Ultimate source: generic data updated with plant specific operating experience
Comment: Prior:mean NUREG 1205(1980),alternating pump.80%/20% ratio based on RSS.Same prior as for HPI pump.Op.experience:11.287 op.hrs, 1 failure.Repair time is mean of generic maintenance duration.

H1 Source category: updated

PMSRH pump motor driven safety injection pump
Component boundary: detail n/a Operating mode: standby Operating environment: normal
Generic failure mode: fail to run Original failure mode: fail during operation
FAILURE RATE OR PROBABILITY mean : 3.6E-5/hr 95%: 7.8E-5/hr 5%: 2.8E-6/hr REPAIR TIME: 4.8 hours
Source: Old PWR Ultimate source: generic data updated with plant specific operating experience
Comment: Generic mean 3.4E-5/hr. Operating experience 272 hours of operation, no failures. Repair time is mean of 21 recorded maintenance events.

H2 Source category: updated

PMCRH pump motor driven containment spray
Component boundary: detail n/a Operating mode: standby Operating environment: normal
Generic failure mode: fail to run Original failure mode: fail during operation
FAILURE RATE OR PROBABILITY mean : 3.4E-5/hr 95%: 7.8E-5/hr 5%: 2.8E-6/hr REPAIR TIME: 6.6 hours
Source: Old PWR Ultimate source: generic data updated with plant operating experience
Comment: Generic mean 3.4E-5/hr. Operating experience 209 hours of operation, no failures. Repair time is mean of 16 maintenance events.

O2 Source category: updated

PMCRO pump motor driven reactor building spray
Component boundary: detail n/a Operating mode: standby Operating environment: normal
Generic failure mode: fail to run Original failure mode: operational failure
FAILURE RATE OR PROBABILITY mean : 2.0E-5/hr 95%: 6.0E-5/hr 5%: 5.9E-7/hr REPAIR TIME. 28 6 hours
Source: Oconee NPP PRA (tbl.b-1) Ultimate source: generic data updated with plant specific operating experience
Comment: Prior:mean NUREG 1205(1980),alternating pump,ratio of 80%/20% is based on RSS distrib.Same as for injection pumps.Op.exp.40 hrs of operation,no failures Repair time is mean maintenance duration

O3 Source category: updated

PMFRO pump motor driven emergency feedwater pump
Component boundary: detail n/a Operating mode: standby Operating environment: normal
Generic failure mode: fail to run Original failure mode: operational failure
FAILURE RATE OR PROBABILITY mean : 2 0E 5/hr 95%: 6.0E-5/hr 5%: 5 9E 7/hr REPAIR TIME. 20.9 hours
Source: Oconee NPP PRA (tbl b-1) Ultimate source. generic data updated with plant specific operating experience
Comment: Prior:mean NUREG 1205(1980),alternating pump,80%/20% based on RSS distribution Same prior as injection pumps.Op.exper:15 op.hrs, no failures.Repair time is mean generic maintenance duration.

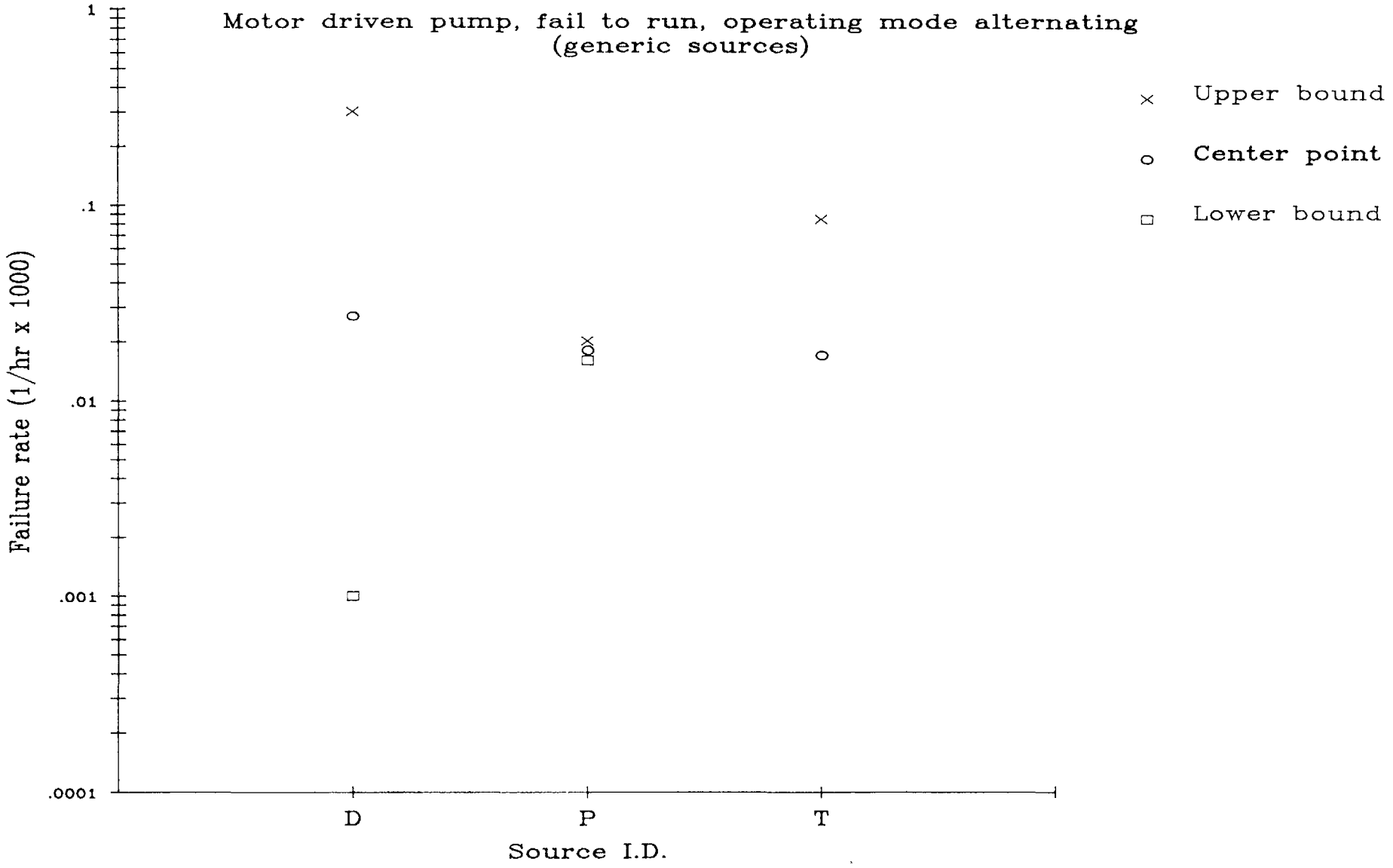
Z Source category: editted

PMCRZ pump motor driven containment spray
Component boundary: detail n/a Operating mode: standby Operating environment: normal
Generic failure mode: fail to run Original failure mode: fail during operation
FAILURE RATE OR PROBABILITY mean : 1.5E-5/hr
Source: ZION NPP PSS (tbl.1.5.1-5) Ultimate source: generic data updated with plant specific experience
Comment: Priors:NUREG 1205,alternating system,does not operate given start (mean) and WASH 1400, pump(w/o motor),failure to run(distrib.)
Operating expereince:66 hours of operation,no failures

04 Source category: updated

PMVRO pump motor driven high pressure injection
Component boundary: detail n/a Operating mode: standby Operating environment: normal
Generic failure mode: fail to run Original failure mode: operational failure
FAILURE RATE OR PROBABILITY mean : 8.4E-6/hr 95%: 2.0E-5/hr 5%: 4.4E-7/hr REPAIR TIME: 21.5 hours
Source: Oconee NPP PRA (tbl.b-1.) Ultimate source: generic data updated with plant specific operating experience
Comment: Prior:Mean NUREG 1205(1980),alteranting pump,80%/20% ratio based on RSS.Op.experience: 38.787 hours of operation, no failures.
Repair time is mean of updated component maintenance duration.

IAEA RELIABILITY DATA BASE



D Source category: generic

PMZRD pump motor driven include CCW,SW,RHR,boric acid transfer,boron injection recirc.
Component boundary: pump,shaft motor swiches,local control and instrumentation Operating mode: alternating Operating environment: normal
Generic failure mode: fail to run Original failure mode: fails while running
FAILURE RATE OR PROBABILITY mean : 2.7E-5/hr : 3.0E-4/hr : 1.0E-6/hr
Source: NUREG 2886 (1982)(tbl.18 & 19) Ultimate source: plant operating experience-maintenance records(2PWR & 4BWR)
Comment: Pop.102.33 catastrofic failures of 1.24E+6 population hours Upbound and lowbound identical as running pumps(see comment).

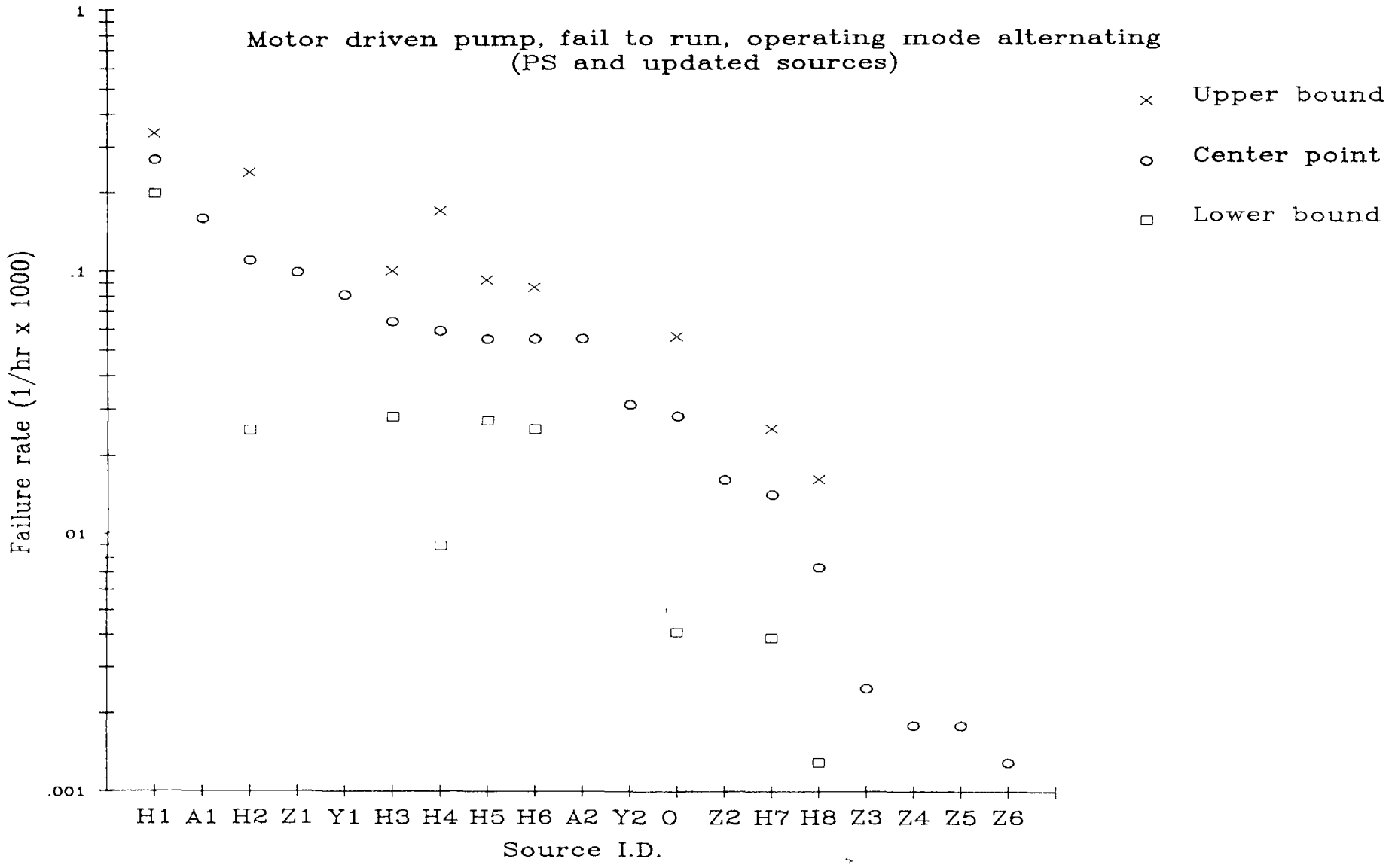
P Source category: generic

PMBRP pump motor driven
Component boundary: pumping unit,coupling,motor,mech.control.Excl.MCC,breakers Operating mode: alternating Operating environment: normal
Generic failure mode: fail to run Original failure mode: does not operate given start
FAILURE RATE OR PROBABILITY median: 1.8E-5/hr 95%: 2.0E-5/hr 5%: 1.6E-5/hr
Source: NUREG 1205 (1982) (pg.340) Ultimate source: US plant LER report evaluation
Comment: Overall data (PWR&BWR)LER from72 to 80.Ttl pop.720,no.of fail 110 W/o command faults(w.command faults 2.1E-5).F.mode does not operate incl:leakage/rupt.ls.of function,does not cont.to run

T Source category: generic

PMMRT pump motor driven centrifugal horisontal and vertical
Component boundary: pump,transmission,motor,breaker,fuse protection,controls Operating mode: alternating Operating environment: normal
Generic failure mode: fail to run Original failure mode: spourious stop
FAILURE RATE OR PROBABILITY mean : 1.7E-5/hr 95%: 8.4E-5/hr REPAIR TIME: 10 hr
Source: Swedish Rel.data book, tbl.5 Ultimate source: plant operating experience (7 BWR plants),ATV reports,LERs
Comment: Operating experience:Total pop.66. Operational time 78.6E+4 hours 13 faulures. a=0.21; b=12700. Critical failures occured at 6 plants.

IAEA RELIABILITY DATA BASE



H1 Source category: updated

PMHRH pump motor driven charging pump
Component boundary: detail n/a Operating mode: alternating Operating environment: normal
Generic failure mode: fail to run Original failure mode: fail during operation
FAILURE RATE OR PROBABILITY mean : 2.7E-4/hr 95%: 3.4E-4/hr 5%: 2.0E-4/hr REPAIR TIME: 16 hours
Source: Old PWR Ultimate source: generic data updated with plant operating experience
Comment: Generic mean 3.4E-5/hr.Operating experience 1.3E+5 hours of operation, 38 failures. Repair time is mean of 168 recorded maintenance events(short single pump outage).Long outage=667 hrs.

A1 Source category: plant specific

PUCRA pump motor driven service water pump used in charging pump cooling system
Component boundary: detail n/a Operating mode: alternating Operating environment: normal
Generic failure mode: fail to run Original failure mode: fail to run
FAILURE RATE OR PROBABILITY median: 1.6E-4/hr ERROR FACTOR: 1.6
Source: NUREG 4550/Vol 3,tbl.IV.8-1 Ultimate source: Surry NPP operating experience
Comment:

H2 Source category: updated

PUWRH pump motor driven residual heat removal pump
Component boundary: detail n/a Operating mode: alternating Operating environment: normal
Generic failure mode: fail to run Original failure mode: fail during operation
FAILURE RATE OR PROBABILITY mean : 1.1E-4/hr 95%: 2.4E-4/hr 5%: 2.5E-5/hr REPAIR TIME: 4.8 hours
Source: Old PWR Ultimate source: generic data updated with plant operating experience
Comment: Generic mean 3.4E-5/hr. Operating experience 1.4E+4 hours of operation, 3 failures. Repair time is mean of 2 maintenance event (short duration). Long duration maintenance 6.1E+3 hours??

Z1 Source category: updated

PMXRZ pump motor driven auxiliary feedwater
Component boundary: detail n/a Operating mode: alternating Operating environment: normal
Generic failure mode: fail to run Original failure mode: fail during operation
FAILURE RATE OR PROBABILITY mean . 9.9E-5/hr
Source: ZION NPP PSS (tbl.1.5.1-5) Ultimate source: generic data updated with plant specific operating experience
Comment: Priors:NUREG 1205 alternating system,does not operate given start (mean) and WASH 1400 pump(w/o motor)failure to run(distrib). Opearting experience:3800 hours of operation, 1 failure.

Y1 Source category: plant specific

PMMRY pump motor driven centrifugal, horisontal and vertical
Component boundary: pump,transmission,motor,breaker,fuses,protection,controls Operating mode: alternating Operating environment: normal
Generic failure mode: fail to run Original failure mode: spurious stop
FAILURE RATE OR PROBABILITY mean . 8.1E-5/hr REPAIR TIME: 24 hr
Source: Swedish Rel.data book, tbl.5 Ultimate source: plant operating experience (Ringhals 2 PWR)
Comment. Operating experience.total pop.10. Operating time 8.67E+4 hours 7 failures

H3 Source category: updated

PUBRH pump motor driven primary service water booster pump
Component boundary: detail n/a Operating mode: alternating Operating environment: normal
Generic failure mode: fail to run Original failure mode: fail during operation
FAILURE RATE OR PROBABILITY mean . 6 4E-5/hr 95%: 1.0E-4/hr 5%: 2.8E-5/hr REPAIR TIME: 12.1
Source: Old PWR Ultimate source generic data updated with plant operating experience
Comment: Generic mean 3.4E-5/hr. Operating experience 9.2E+4 hours of operation, 7 failures. Repair time is mean of 17 maintenance events.

H4 Source category: updated

PMXRH pump motor driven auxiliary feedwater pump
Component boundary: detail n/a Operating mode: alternating Operating environment: normal
Generic failure mode: fail to run Original failure mode: fail during operation
FAILURE RATE OR PROBABILITY mean : 5.9E-5/hr 95%: 1.7E-4/hr 5%: 8.9E-6/hr REPAIR TIME: 5.5 hours
Source: Old PWR Ultimate source: generic data updated with plant operating experience
Comment: Generic mean 3.4E-5/hr. Operating experience 5641 hour of operation, 1 failure. Repair time is mean of 27 maintenance events.

H5 Source category: updated

PUKRH pump motor driven primary service water pump
Component boundary: detail n/a Operating mode: alternating Operating environment: normal
Generic failure mode: fail to run Original failure mode: fails during operation
FAILURE RATE OR PROBABILITY mean : 5.5E-5/hr 95%: 9.2E-5/hr 5%: 2.7E-5/hr REPAIR TIME: 17.4 hours
Source: Old PWR Ultimate source: generic data updated with plant operating experience
Comment: Generic mean 3.4E-5/hr. Operating experience 1.6E+5 hours of operation,10 failures. Repair time is mean of 46 maintenance events.

H6 Source category: updated

PMKRH pump motor driven secondary service water
Component boundary: detail n/a Operating mode: alternating Operating environment: normal
Generic failure mode: fail to run Original failure mode: fail during operation
FAILURE RATE OR PROBABILITY mean : 5.5E 5/hr 95%: 8.6E-5/hr 5%: 2.5E-5/hr REPAIR TIME: 32.5 hours
Source: Old PWR Ultimate source: generic data updated with plant operating experience
Comment: Generic mean 3.4E-5/hr. Operating experience 1.4E+5 hours of operation, 9 failures. Repair time is mean of 17 maintenance evens.

A2 Source category: plant specific

PMHRA pump motor driven charging/high pressure injection
Component boundary: detail n/a Operating mode: alternating Operating environment. normal
Generic failure mode: fail to run Original failure mode: fail to run
FAILURE RATE OR PROBABILITY median. 5.5E-5/hr ERROR FACTOR: 2.9
Source· NUREG 4550/Vol 3,tbl.IV.8-1 Ultimate source: Surry NPP operating experience
Comment. Charging pump provide RCS makeup and RPS seal cooling flow in normal operation and serve as a high pressure injection/ recirculation pump following accident.

Y2 Source category: plant specific

PUSRY pump motor driven screw
Component boundary: pump,transmission,motor,breaker,fuse,protection,control Operating mode· alternating Operating environment: normal
Generic failure mode: fail to run Original failure mode: spourious stop
FAILURE RATE OR PROBABILITY mean : 3.1E-5/hr REPAIR TIME: 32 hr
Source· Swedish Rel.data book, tbl.6 Ultimate source: plant operating experience (Ringhals 2 PWR)
Comment: Operating experience: total pop. 6 Operating time 12.97E+4 hours 4 failures.
No failure to start recorded on this component.

O Source category: updated

PMKRO pump motor driven low pressure service water
Component boundary: detail n/a Operating mode: alternating Operating environment· normal
Generic failure mode: fail to run Original failure mode: operational failure
FAILURE RATE OR PROBABILITY mean : 2.8E-5/hr 95%: 5.6E-5/hr 5%: 4.1E-6/hr REPAIR TIME: 10.5 hours
Source: Oconee NPP PRA (tbl.b-1) Ultimate source: generic data updated with plant specific operating experience
Comment: Prior· mean NUREG 1205(1980),alternating pump,80%/20% ratio based on RSS Op experience:47.991 hours of operation,2 failures.
Repair time is mean of plant spec.update of maintenance duration.

Z2 Source category. updated

PMSRZ pump motor driven safety injection pump
Component boundary: detail n/a Operating mode: alternating Operating environment: normal
Generic failure mode: fail to run Original failure mode: fail during operation
FAILURE RATE OR PROBABILITY mean : 1.6E-5/hr
Source: ZION NPP PSS (tbl.1.5.1-5) Ultimate source: generic data updated with plant specific experience
Comment: Prior: NUREG 1205,alternating system,does not operate given start (M) and WASH 1400,pump (w/o motor),fail to run(distrib.)
Operating experience: 46 hours of operation, no failures.

H7 Source category: updated

PUERH pump motor driven primary component cooling water pump
Component boundary: detail n/a Operating mode: alternating Operating environment: normal
Generic failure mode: fail to run Original failure mode: fail during operation
FAILURE RATE OR PROBABILITY mean : 1.4E-5/hr 95%: 2.5E-5/hr 5%: 3.9E-6/hr REPAIR TIME: 8 hours
Source: Old PWR Ultimate source: generic data updated with plant operating experience
Comment: Generic mean 3.4E-5/hr. Operating experience 1.7E+5 hours of operation, 2 failures. Repair time is mean of 14 maintenance
events.

H8 Source category: updated

PUFRH pump motor driven secondary component cooling water
Component boundary: detail n/a Operating mode: alternating Operating environment: normal
Generic failure mode: fail to run Original failure mode: fail during operation
FAILURE RATE OR PROBABILITY mean : 7.3E-6/hr 95%: 1.6E-5/hr 5%: 1.3E-6/hr REPAIR TIME: 73.8 hours
Source: Old PWR Ultimate source: generic data updated with plant operating experience
Comment: Generic mean 3.4E-5/hr. Operating experience 1.4E+5 hours of operation, no failures. Repair time is mean of 7 maintenance
events.

Z3 Source category: updated

PUWRZ pump motor driven residual heat removal pump
Component boundary: detail n/a Operating mode: alternating Operating environment: normal
Generic failure mode: fail to run Original failure mode: fail during operation
FAILURE RATE OR PROBABILITY mean : 2.5E-6/hr
Source: ZION NPP PSS (tbl.1.5.1-5) Ultimate source: generic data updated with plant specific experience
Comment: Priors:NUREG 1205 alternating system,does not operate given start (mean) and WASH 1400,pump(w/o motor),failure to run(distrib.).
Operating experience:3.25E+4 hrs of operation, no failures.

Z4 Source category. updated

PMHRZ pump motor driven centrifugal charging pump
Component boundary: detail n/a Operating mode: alternating Operating environment: normal
Generic failure mode: fail to run Original failure mode: fail during operation
FAILURE RATE OR PROBABILITY mean : 1.8E-6/hr
Source: ZION NPP PSS (tbl.1.5.1-5) Ultimate source: generic data updated with plant specific experience
Comment: Priors:NUREG 1205,Alternating sys.,motor driven,does not operate given strt(M); WASH 1400,pumps,fail to run,extreme environment(D)
Operating experience:7.6E+4 hours of operation, no failures

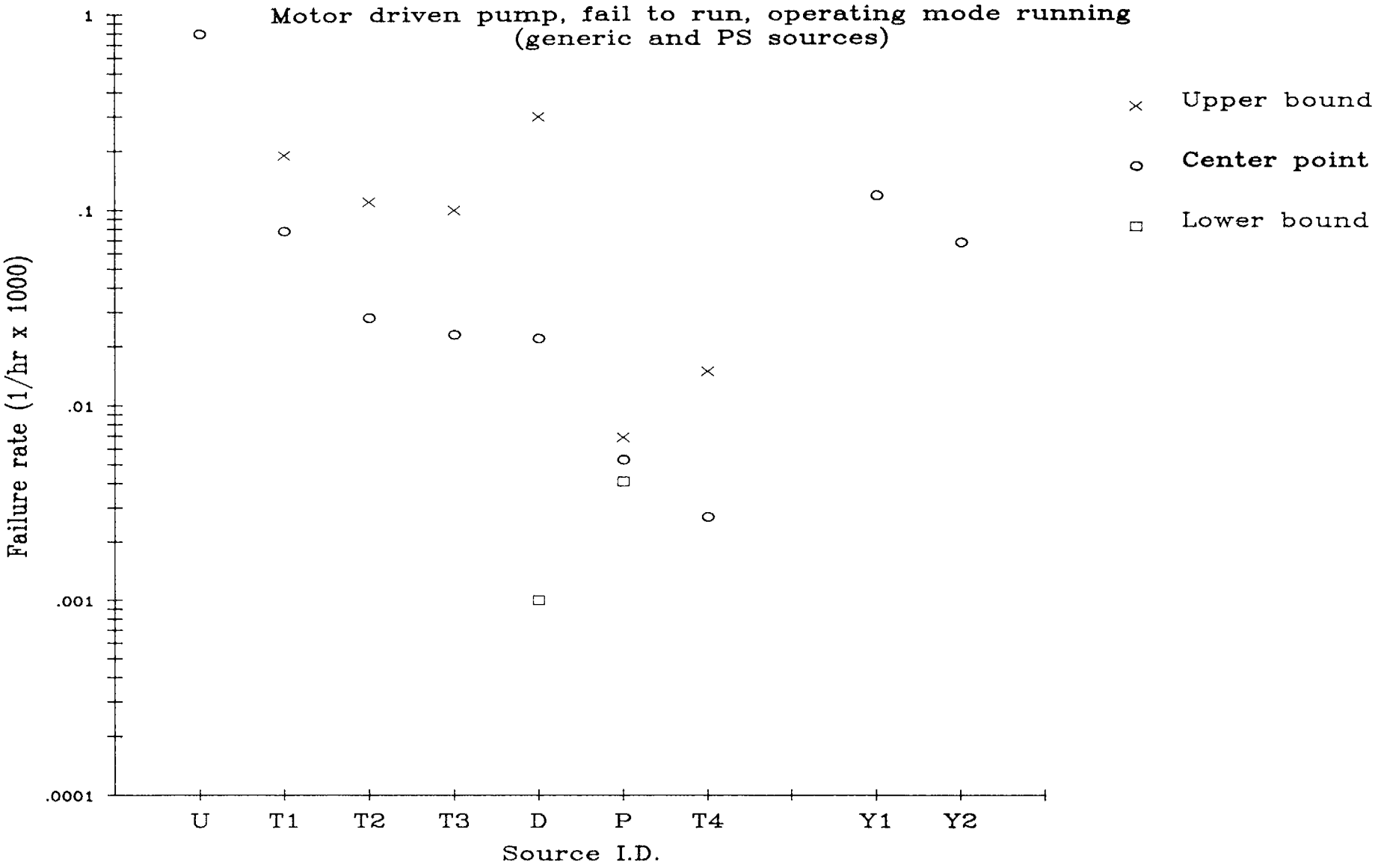
Z5 Source category: updated

PMERZ pump motor driven component cooling
Component boundary: detail n/a Operating mode: alternating Operating environment: normal
Generic failure mode: fail to run Original failure mode: fail during operation
FAILURE RATE OR PROBABILITY mean : 1.8E-6/hr
Source. ZION NPP PSS (tbl.1.5.1-5) Ultimate source: generic data upgraded with plant specific experience
Comment: Priors:NUREG 1205,alternaing system,does not operate given start, (Mean) and WASH 1400 pump(w/o motor) failure to run (Distrib).
Operating experience:7 6E+4 hrs of operation,no failures.

Z6 Source category: updated

PMKRZ pump motor driven service water
Component boundary: detail n/a Operating mode: alternating Operating environment: normal
Generic failure mode: fail to run Original failure mode: fail during operation
FAILURE RATE OR PROBABILITY mean : 1.3E-6/hr
Source: ZION NPP PSS (tbl 1.5.1-5) Ultimate source: generic data updated with plant specific experience
Comment: Priors:NUREG 1205,alternating system,does not operate given start (mean) and WASH 1400, pump(w/o motor),failure to run(distrib).
Operating expreince:1 52E+5 hours of operation,no failures

IAEA RELIABILITY DATA BASE



U Source category: generic

PUMRU pump motor driven main feed pumps
Component boundary: detail n/a Operating mode: running Operating environment: normal
Generic failure mode: fail to run Original failure mode: failure to continue operation
FAILURE RATE OR PROBABILITY mean : 8.0E-4/hr
Source: Sizewell B (PWR/RX312 pg.8) Ultimate source: assesed from nuclear and industrial experience and data
Comment: Assesment based on W data, CEGB data item,EDF PWRdata(3.1E-4/hr out of 4.2E+6 hrs) and 2 SRS data items(7.4E-4/hr)and(1.7E-3/hr based on operating experience 2.5E+5 hr).

T1 Source category: generic

PMWRT pump motor driven centrifugal wet
Component boundary: pump.trasmission,motor,breakers,fuses,protection,controls Operating mode: running Operating environment: normal
Generic failure mode: fail to run Original failure mode: spourious stop
FAILURE RATE OR PROBABILITY mean : 7.8E-5/hr 95%: 1.9E-4/hr REPAIR TIME: 18 hr
Source: Swedish Rel.data book, tbl.3 Ultimate source: plant operating experience (7 BWR plants), ATV reports, LERs
Comment: Operating experience: total pop 14. Operating time 27.2E+4 hours 19 failures. a=1.93; b=24900. Critical failures occured at 6 plants.

T2 Source category: generic

PMNRT pump motor driven centrifugal horizontal
Component boundary: pump,transmission,motor,breaker,fuses,protection,controls Operating mode: running Operating environment: normal
Generic failure mode. fail to run Original failure mode: spourious stop
FAILURE RATE OR PROBABILITY mean : 2.8E-5/hr 95%: 1.1E-4/hr REPAIR TIME: 11 hr
Source: Swedish Rel.data book, tbl.1 Ultimate source: plant operating experience (7 BWR plants), ATV reports, LERs
Comment: Operating experience:total pop.14. operating time 28,8E+4 hours 8 failures. a=0.0527; b=19000. Critical failures occured at 4 plants.

T3 Source category: generic

PMDRT pump motor driven centrifugal horisontal
Component boundary: pump,transmission,motor,breaker,fuse,protection,controls Operating mode: runing Operating environment: normal
Generic failure mode: fail to run Original failure mode: spourious stop
FAILURE RATE OR PROBABILITY mean : 2.3E-5/hr 95%: 1.0E-4/hr REPAIR TIME: 18 hr
Source: Swedish Rel.data book, tbl.2 Ultimate source: plant experience,(6 BWR plants), ATV reports, LERs, plant inform.
Comment: Operating expereince: total pop. 16. Operating time 18.1E+4 hours 5 failures. a=0.315; b=13800. Critical failures occured at 3 plan ts.

D Source category: generic

PMJRD pump motor driven includes reactor coolant,reactor recirculating,CW,feedwater,cond.
Component boundary: pump,shaft,motor,swiches,local control & instrumentation Operating mode: running Operating environment: normal
Generic failure mode: fail to run Original failure mode: fails while running
FAILURE RATE OR PROBABILITY mean : 2.2E-5/hr : 3.0E-4/hr : 1.0E-6/hr
Source: NUREG 2886 (1982)(tbl.18 & 19) Ultimate source: plant operating experience-maintenance records(2PWR & 48WR)
Comment: Pop.79. 35 catastrofic time related failures of 1.6E+6 operating hours.Upbound and lowbound are the largest and smallest rate of funct.aggregation by driver.

P Source category: generic

PMRRP pump motor driven
Component boundary: pumping unit,motor,coupling,mech,control.Excl.MCC,breakers ect Operating mode: running Operating environment: normal
Generic failure mode: fail to run Original failure mode. does not operate given start
FAILURE RATE OR PROBABILITY median: 5.3E-6/hr 95%: 6.9E-6/hr 5%: 4.1E-6/hr
Source. NUREG 1205 (1982) (pg.292) Ultimate source: US plant LER report evaluation
Comment: Overall data(PWR&BWR)LER from 72 to 80.Ttl.pop.209,no of fail.12 W/o command faults(w.command faults 1.4E-5).Fmode"does not operate"incl:leakage/rupt,ls of function,does not cont.to run

T4 Source category: generic

PMPRT pump motor driven centrifugal reactor coolant pump
Component boundary: pump,transmission,motor,breaker,fuses,protection,controls Operating mode: running Operating environment: normal
Generic failure mode: fail to run Original failure mode: spourious stop
FAILURE RATE OR PROBABILITY mean : 2.7E-6/hr 95%: 1.5E-5/hr REPAIR TIME: 5 hr
Source: Swedish Rel.data book, tbl.4 Ultimate source: plant operating experience (7 BWR plants), ATV reports, LERs
Comment: Operating experoence: total pop. 38.Operating time 112E+4 hours. No.of failures 3. a=0.0671; b=25100. Critical failures occured at 3 plants.

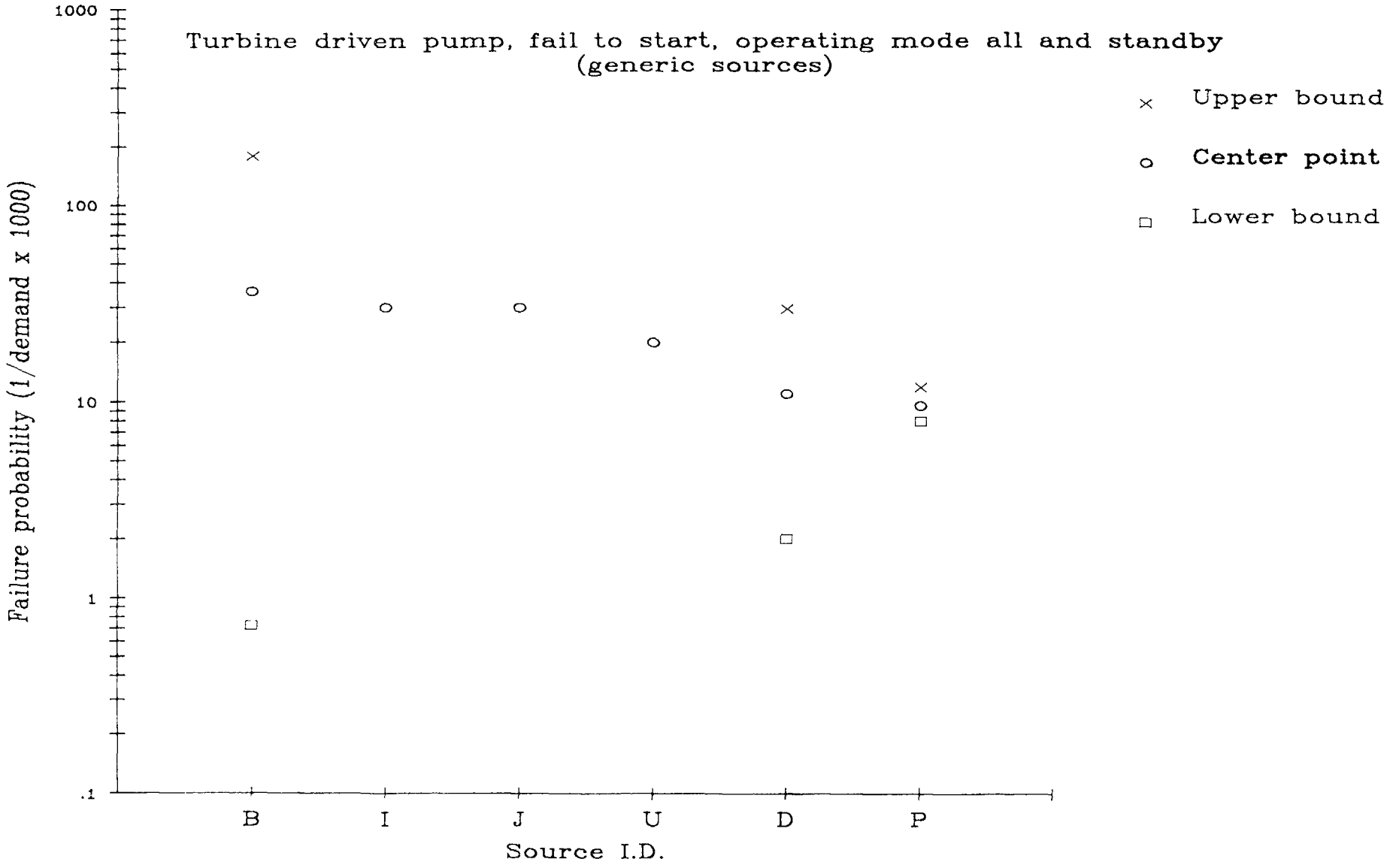
Y1 Source category: updated

PMWRY pump motor driven centrifugal wet
Component boundary: pump,transmission,motor,breaker,fuse,protection,controls Operating mode: running Operating environment: normal
Generic failure mode: fail to run Original failure mode: spurious stop
FAILURE RATE OR PROBABILITY mean : 1.2E-4/hr REPAIR TIME: 24 hr
Source: Swedish Rel.data book, tbl.3 Ultimate source: plant operating experience (Ringhals 2 PWR)
Comment: Operating experience: total pop 2. Operating time 2.56E+4 hours 3 failures.

Y2 Source category: updated

PMNRY pump motor driven centrifugal,horisontal
Component boundary: pump,transmission,motor,breaker,fuse,protection,controls Operating mode: running Operating environment: normal
Generic failure mode: fail to run Original failure mode: spourious stop
FAILURE RATE OR PROBABILITY mean . 6.9E-5/hr REPAIR TIME: 3 hr
Source: Swedish Rel.data book, tbl.1 Ultimate source: plant operating experience (Ringhals 2 PWR)
Comment: Operating experience: total pop.2 Operational time 4.32E+4 hours 3 failures.

IAEA RELIABILITY DATA BASE



B Source category: generic

PTYSB pump turbine driven
Component boundary: pump,turbine,steam and throttle valves, governor Operating mode: all Operating environment: normal
Generic failure mode: fail to start Original failure mode: failure to start
FAILURE RATE OR PROBABILITY mean : 3.6E-2/d max: 1.8E-1/d min: 7.2E-4/d
Source: NUREG 2815 (table C.1.) Ultimate source: expert opinion aggregation and IREP data
Comment: Failure mode includes under and over speed Org.time related value changed to demand related assuming monthly tests.

I Source category: generic

PTYSI pump turbine driven
Component boundary: pump,turbine,steam and throttle valves,governor Operating mode: all Operating environment: normal
Generic failure mode: fail to start Original failure mode: failure to start
FAILURE RATE OR PROBABILITY mean : 3.0E-2/d ERROR FACTOR: 10
Source: IREP NUREG 2728 (tb.5.1-1) Ultimate source: expert opinion
Comment: Failure mode includes under and overspeed

J Source category:

PTASJ pump turbine driven general
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to start Original failure mode: fails to start
FAILURE RATE OR PROBABILITY mean : 3.0E-2/d ERROR FACTOR: 10
Source: NUREG 4550, Vol.1,tbl.VIII.1-2 Ultimate source: assesed from several nuclear data sources
Comment: ASEP used generic value from IREP Procedure Guide.The value for fails to start incl.two types of failures:circut breaker command faults(2.0E-2) and pump hardware(1.0E-2).

U Source category· generic

PTSSU pump turbine driven high pressure > 20 bar
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to start Original failure mode: failure to start
FAILURE RATE OR PROBABILITY mean : 2.0E-2/d
Source: Sizewell B (PWR/RX312 pg.12) Ultimate source: assesed from nuclear and industrial experience and data
Comment: Assesment based on W data and SRS data item relevant for PWR (1.0E-2/d)

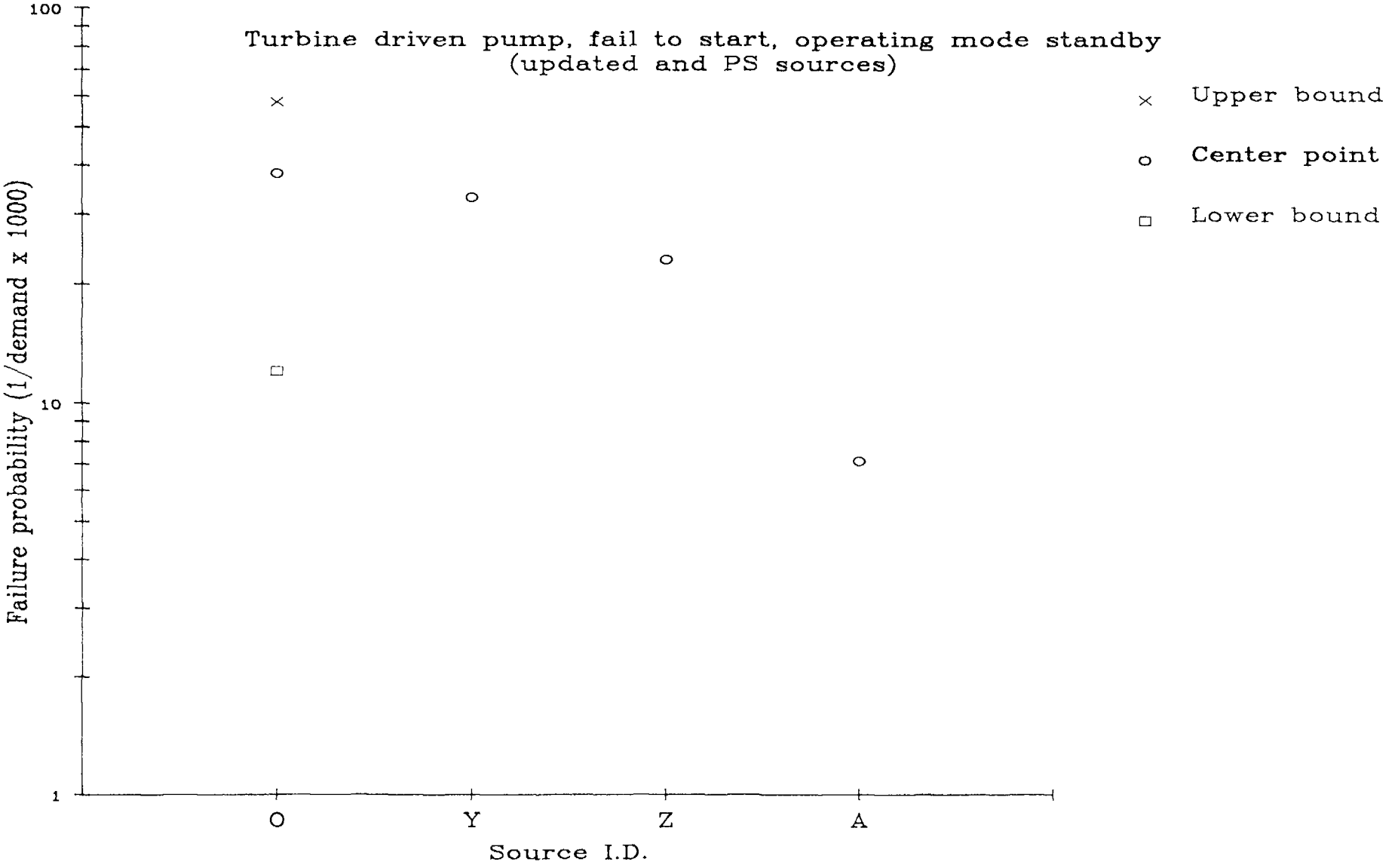
D Source category: generic

PTASD pump turbine driven
Component boundary: pump,shaft,turbine,local instrumentaion and control Operating mode: standby Operating environment: normal
Generic failure mode. fail to start Original failure mode: fails to start
FAILURE RATE OR PROBABILITY mean · 1 1E-2/d : 3.0E-2/d : 2.0E-3/d
Source: NUREG 2886 (1982) (tbl 19) Ultimate source: plant operating experience-maintenance records(2PWR & 4BWR)
Comment: Pop.11. 5 catastrofic demand related falures in 469 demands. Upbound and lowbound are the largest and smallest failure rate of the functional aggregate of selected pumps classified by driver

P Source category generic

PTASP pump turbine driven
Component boundary: Incl.mech.control,governor,trip-throt.vlv,lube oil sys,bearing lb Operating mode: standby Operating environment: normal
Generic failure mode: fail to start Original failure mode: does not start
FAILURE RATE OR PROBABILITY median: 9.6E-3/d 95%: 1 2E-2/d 5%: 8.0E-3/d
Source· NUREG 1205 (1982) (pg.372) Ultimate source· US plant LER report evaluation
Comment· Overall data,including all types of reactors,LER 72-80. Ttl.pop. 92. W/o command faults.With command faults 2.5E-2. Standby hour rate w/o command 1 9E 5/hr, with command faults 5.1E-5/hr.

IAEA RELIABILITY DATA BASE



O Source category: updated

PTXSO pump turbine driven emergency feedwater
Component boundary: detail n/a Operating mode: standby Operating environment: normal
Generic failure mode: fail to start Original failure mode: failure to start
FAILURE RATE OR PROBABILITY mean : 3.8E-2/d 95%: 5.8E-2/d 5%: 1.2E-2/d REPAIR TIME: 24.5 hours
Source: Oconee NPP PRA (tbl.b-1.) Ultimate source: generic data updated with plant specific operating experience
Comment: Prior:mean NUREG 1205(1980),standby pump.80%/20% ratio based on RSS distribution.Op.experience: 113 demands,6 failures.
Repair time is mean of plant spec.update of maintenance duration.

Y Source category: updated

PTCSY pump turbine driven centrifugal pump
Component boundary: auxiliary equipment not included Operating mode: standby Operating environment: normal
Generic failure mode: fail to start Original failure mode: failure to start
FAILURE RATE OR PROBABILITY mean : 3.3E-2/d REPAIR TIME: 8 hr
Source: Swedish Rel.data book, tbl.9 Ultimate source: plant operating experience (Ringhals 2 PWR)
Comment: One observed component, 30 demands per operational time, one failure recorded.

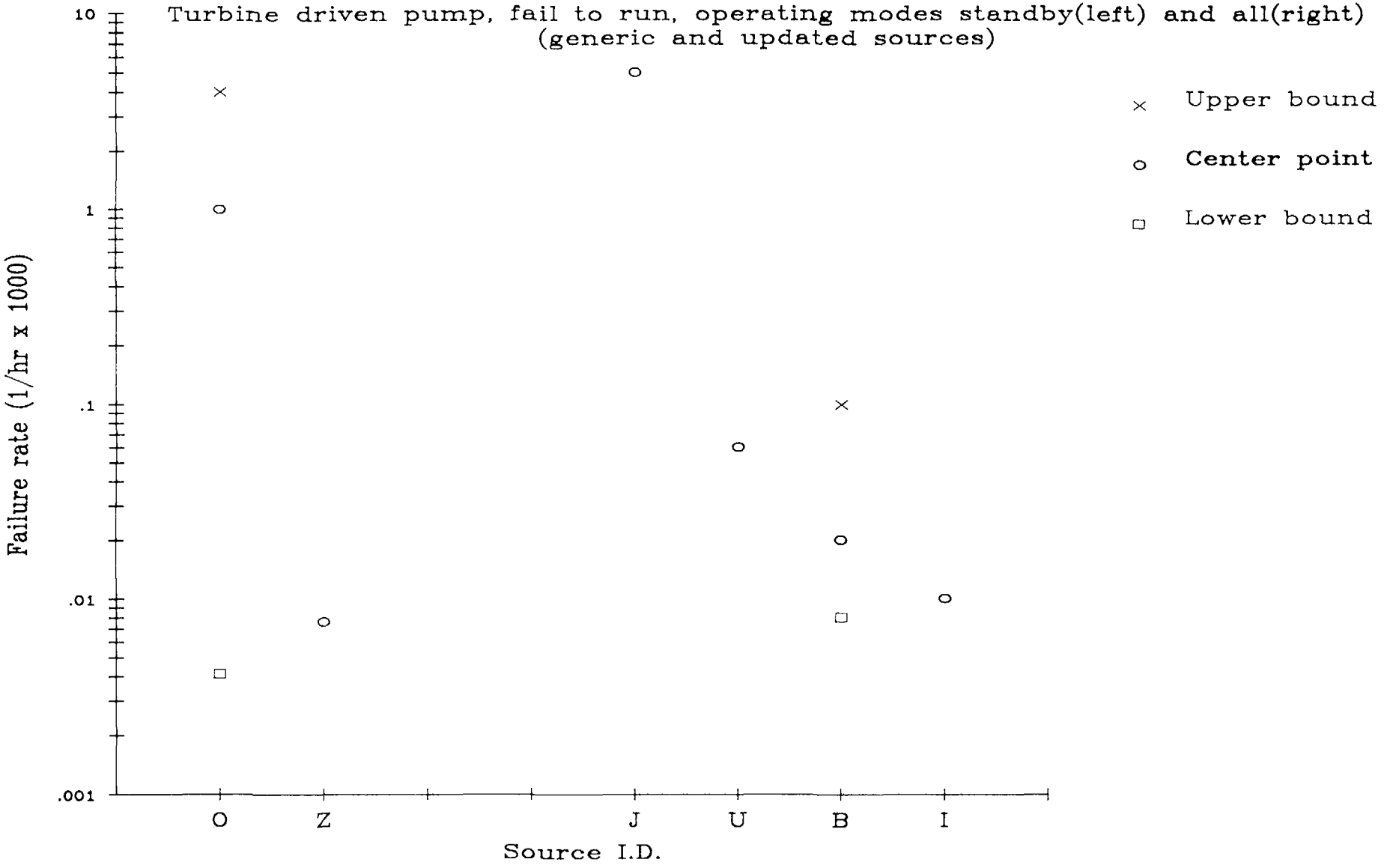
Z Source category: updated

PTFSZ pump turbine driven auxiliary feedwater
Component boundary: detail n/a Operating mode: standby Operating environment: normal
Generic failure mode: fail to start Original failure mode: faliure to start on demand
FAILURE RATE OR PROBABILITY mean : 2.3E-2/d
Source: ZION NPP PSS (tbl.1.5.1-5) Ultimate source: generic data updated with plant specific experience
Comment: Prior:NUREG 1205,standby system(w/o command) does not start(Mean) DIstribution based on engineering judgement.
Operating experience: 231 demands, 6 failures.

A Source category. plant specific

PTFSA pump turbine driven auxiliary feedwater
Component boundary: detail n/a Operating mode: standby Operating environment: normal
Generic failure mode: fail to start Original failure mode: fail to start/run
FAILURE RATE OR PROBABILITY median: 7.1E-3/d ERROR FACTOR: 4.6
Source: NUREG 4550/Vol.3,tbl.IV.8-1 Ultimate source: Surry NPP operating experience
Comment: It was not possible to identify failure mode as appear in table.

IAEA RELIABILITY DATA BASE



O Source category: updated

PTXRO pump turbine driven emergency feedwater pump
Component boundary: detail n/a Operating mode: standby Operating environment: normal
Generic failure mode: fail to run Original failure mode: operational failure
FAILURE RATE OR PROBABILITY mean : 9.9E-4/hr 95%: 4.0E-3/hr 5%: 4.1E-6/hr REPAIR TIME: 24.5 hours
Source: Oconee NPP PRA (tbl.b-1.) Ultimate source: generic data updated with plant specific operating expreience
Comment: Prior:mean NUREG 1205(1980),alternating pump.80%/20% ratio =100 Operating experience:94 hours of operation,1 failure.
Repair time is mean of plant spec.update of maintenance duration.

Z Source category: updated

PTFRZ pump turbine driven auxiliary feedwater
Component boundary: detail n/a Operating mode: standby Operating environment: normal
Generic failure mode: fail to run Original failure mode: fail during operation
FAILURE RATE OR PROBABILITY mean : 7 6E-6/hr
Source: ZION NPP PSS (tbl.1.5.1-5) Ultimate source: generic data updated with plant specific experience
Comment: Prior:NUREG 1205("turbine driven pump failure during operation is similar to motor driven).
Operating experience·1900 hours of operation, no failures.

J Source category· generic

PTARJ pump turbine driven general
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to run Original failure mode: fails to run
FAILURE RATE OR PROBABILITY mean : 5.0E-3/hr ERROR FACTOR: 10
Source: NUERG 4550, Vol.1,tbl.VIII.1-2 Ultimate source: assesed from several nuclear data sources
Comment: ASEP value is taken from IREP Procedure Guide.

U Source category: generic

PTSRU pump turbine driven high pressure > 20 bar
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to run Original failure mode: failure to continue operation
FAILURE RATE OR PROBABILITY mean : 6.0E-5/hr
Source: Sizewell B (PWR/RX312 pg.12) Ultimate source: assesed from nuclear and industrial experience
Comment: Assesment based on W data and SRS data item relevant for PWR (5.0E-5/hr).

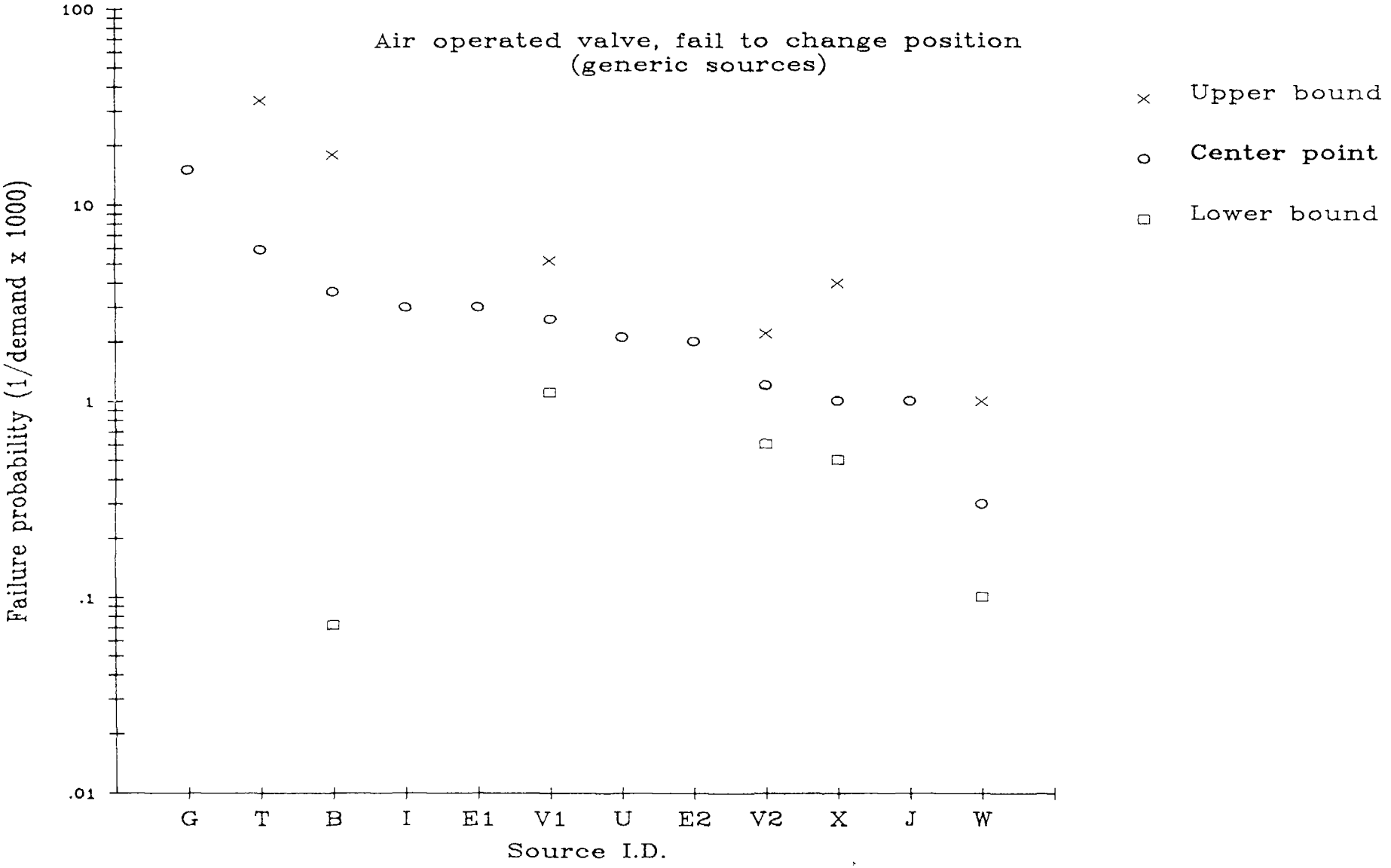
B Source category: generic

PTYRB pump turbine driven
Component boundary: pump, turbine,steam and throttle valve, governor Operating mode: all Operating environment: normal
Generic failure mode: fail to run Original failure mode: failure to run given start
FAILURE RATE OR PROBABILITY mean : 2.0E-5/hr max: 1.0E-4/hr min: 8.0E-6/hr
Source: NUREG 2815 (table C.1.) Ultimate source: expert opinion aggregation and IREP data
Comment:

I Source category: generic

PTYRI pump turbine driven
Component boundary: pump,turbine,steam and throttle valves, governor Operating mode: all Operating environment: normal
Generic failure mode: fail to run Original failure mode: failure to run given start
FAILURE RATE OR PROBABILITY mean : 1.0E-5/hr ERROR FACTOR: 3
Source: IREP NUREG 2728 (tb.5.1-1) Ultimate source: expert opinion
Comment:

IAEA RELIABILITY DATA BASE



G Source category: generic

VAACG valve air operated general
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to change position Original failure mode: fail to open or to close
FAILURE RATE OR PROBABILITY mean : 1.5E-2/d ERROR FACTOR: 23
Source: German Risk Study (pg.P3-76) Ultimate source: generic data
Comment: Failure rate is combination of several generic data sources. Compared with other valve types failure rate seems to be too high
Org.time related changed to demand related assuming monthly test.

T Source category: generic

VAHCT valve pneumatic operated isolation valve
Component boundary: valve,operator,control equipment,relays,logic and automation Operating mode: all Operating environment: normal
Generic failure mode: fail to change position Original failure mode: failure to change position
FAILURE RATE OR PROBABILITY mean : 5.9E-3/d 95%: 3.4E-2/d REPAIR TIME: 6 hours
Source: Swedish Rel.data book, tbl.16 Ultimate source: plant operating experience(7 BWR plants),ATV reports, LERs
Comment: Total pop.86.No.of demands per operational time 2366, 14 failures a=0.129; b=21.7 Critical failures occured at 4 plants.

B Source category: generic

VAACB valve air operated general
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to change position Original failure mode: failure to operate
FAILURE RATE OR PROBABILITY mean : 3.6E-3/d max: 1.8E-2/d min: 7.2E-5/d
Source: NUREG 2815 (table C.1.) Ultimate source: expert opinion and IREP data
Comment: Original time related value changed to demand related assuming monthly testing.

I Source category: generic

VAACI valve air operated general
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to change position Original failure mode: failure to operate
FAILURE RATE OR PROBABILITY mean : 3.0E-3/d ERROR FACTOR: 10
Source: IREP NUREG 2728 (tb.5.1-1) Ultimate source: expert opinion
Comment:

E1 Source category: generic

VABCE valve air operated general (BWR application)
Component boundary: detail n/a(generally excludes operator) Operating mode: all Operating environment. normal
Generic failure mode: fail to change position Original failure mode: fail to operate
FAILURE RATE OR PROBABILITY rec : 3.0E-3/cy
Source: IEEE 500 (1984) pg.1027 Ultimate source: expert judgement (delphi procedure) & experience
Comment: reference EGG-EA-5B16 1982.

V1 Source category: generic

VABCV valve air operated BWR (ESF systems valves only)
Component boundary: valve body & internals,operator,funct.accesories(limit,torque sw) Operating mode: all Operating environment: normal
Generic failure mode: fail to change position Original failure mode: fail to operate
FAILURE RATE OR PROBABILITY mean : 2.6E-3/d 95%: 5.2E-3/d 5%: 1.1E-3/d
Source: NUREG 1363 (1982) (pg 426) Ultimate source. US plants LER reports evaluation
Comment: With command faults. No failures recorded in w/o comand faults category, 95% confidence bound is 1 3E 3/d. Standby hourly rate
with command 1 2E-6/hr, w/o command (95%) 5 9E-7/hr.

U Source category: generic

VAACU valve air operated general
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to change position Original failure mode: failure to operate
FAILURE RATE OR PROBABILITY mean : 2.1E-3/d
Source: Sizewell B (PWR/RX312 pg.8) Ultimate source: assesed from nucelar experience and generic data
Comment: Assesment based on W data item and WASH 1400 data(failrate cited is not one which appears in WASH 1400).Time related value changed to demand related assuming monthly testing.

E2 Source category: generic

VAWCE valve air operated general (PWR application)
Component boundary: detail n/a (generally excludes driver) Operating mode: all Operating environment: normal
Generic failure mode: fail to change position Original failure mode: fail to operate
FAILURE RATE OR PROBABILITY rec : 2.0E-3/cy
Source: IEEE 500 (1984) pg.1026 Ultimate source: expert judgement (delphi procedure) & experience
Comment: Reference EGG-EA-5816 1984.

V2 Source category: generic

VAWCV valve air operated PWR (ESF systems valves only)
Component boundary: valve body & interiors,operator,functional accesories(eg.limit sw Operating mode: all Operating environment: normal
Generic failure mode: fail to change position Original failure mode: fail to operate
FAILURE RATE OR PROBABILITY mean : 1.2E-3/d 95%: 2.2E-3/d 5%: 6.0E-4/d
Source: NUREG 1363 (1982) (pg.422) Ultimate source: US plants LER reports evaluation
Comment: W/o command faults. With command faults 2.1E-3/d. Standby hourly failure rate w/o command 5.6E-7/hr, with command 9.8E-7/hr.

X Source category. generic

VAACX valve air operated general
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode· fail to change position Original failure mode: fail to change position
FAILURE RATE OR PROBABILITY mean . 1.0E-3/d 80%· 4.0E-3/d 20%: 5.0E-4/d
Source: VVER reliability data base Ultimate source: expert opinion, operating experience
Comment:

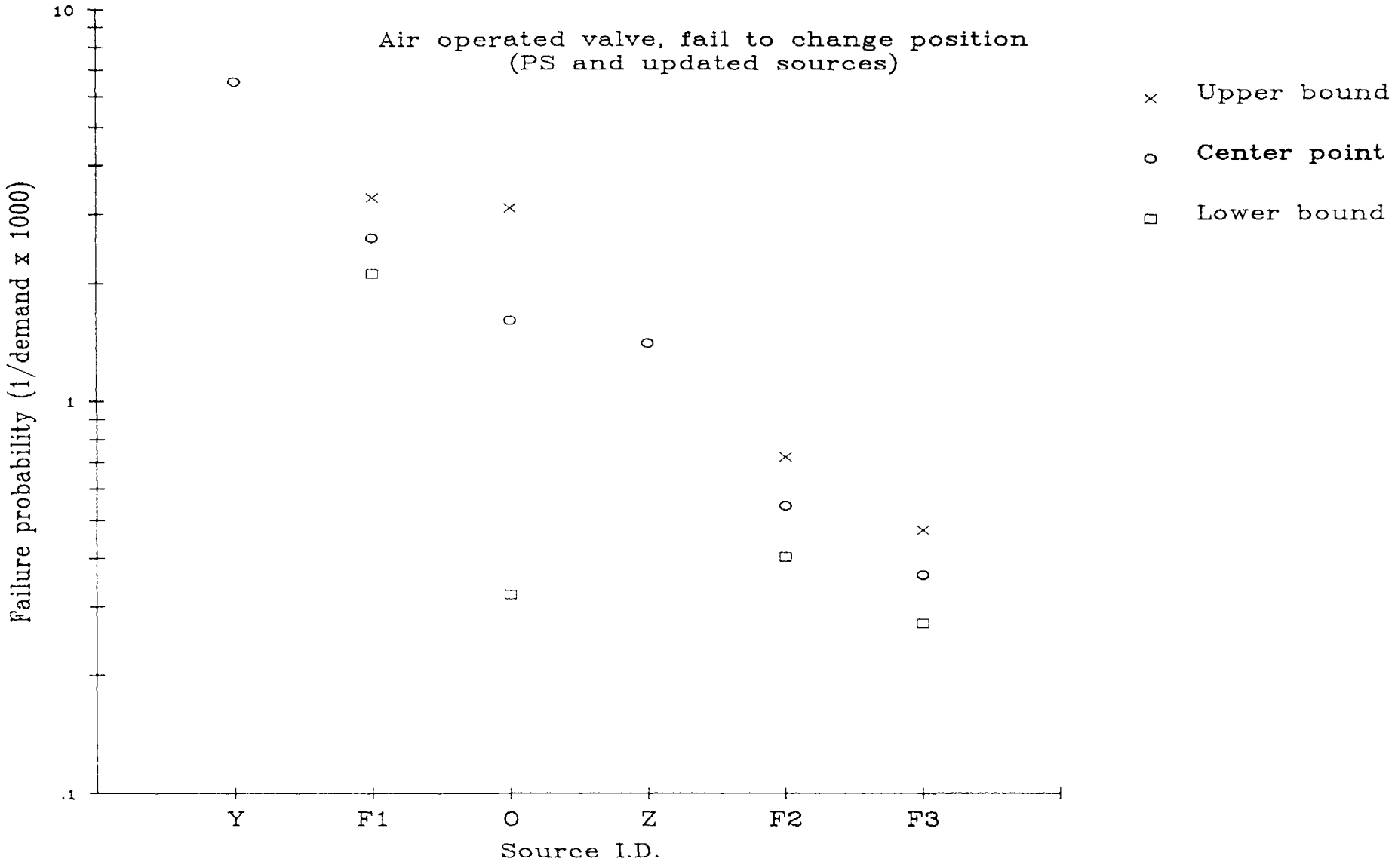
J Source category· generic

VAACJ valve air operated general
Component boundary· detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to change position Original failure mode· fails to operate
FAILURE RATE OR PROBABILITY mean 1.0E-3/d ERROR FACTOR· 3
Source: NUREG 4550,Vol 1,Tbl VIII 1-2 Ultimate source: assesed from several nuclear data sources
Comment: Generic value developed in Station Blackout Study(NUREG/CR-3226) Two types of failures are included in the failure rate: valve hardware faults(1.0E-3) and command circut fault(1 0E 4)

W Source category generic

VAACW valve air operated general
Component boundary detail n/a Operating mode· all Operating environment. normal
Generic failure mode. fail to change position Original failure mode· failure to operate
FAILURE RATE OR PROBABILITY median· 3 0E 4/d 95%· 1.0E-3/d 5%: 1.0E-4/d ERROR FACTOR: 3
Source· WASH 1400 (table III 4-1) Ultimate source· assesed from nuclear,industrial and military expereince and data
Comment· Failure to operate includes changing state from open to closed or closed to open.

IAEA RELIABILITY DATA BASE



Y Source category: plant specific

VAHCY valve pneumatic operated isolation valve
Component boundary: valve,operator,control equipment,relays,logic and automation Operating mode: all Operating environment: normal
Generic failure mode: fail to change position Original failure mode: failure to change position
FAILURE RATE OR PROBABILITY mean : 6.5E-3/d REPAIR TIME: 5 hours
Source: Swedish Rel.data book, tbl.16 Ultimate source: plant operating experience (Ringhals 2 PWR)
Comment: total pop.33.No.of demand per operational time 1236, no.of failures 8.

F1 Source category: plant specific

VATCF valve air operated butterfly
Component boundary. detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to change position Original failure mode: fail to operate
FAILURE RATE OR PROBABILITY mean : 2.6E-3/d 95%: 3.3E-3/d 5%: 2.1E-3/d ERROR FACTOR: 1.3 REPAIR TIME: 6 hours
Source: HWR data Ultimate source: HWR operating experience
Comment: Pop.70.Cum.operating time 623E+4 hours.No.of failures 45.No.of demands not known.Data based on expereince with control valves.
Org.time related changed to demand assuming monthly testing.

O Source category: updated

VAACO valve air operated general
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to change position Original failure mode: failure to operate
FAILURE RATE OR PROBABILITY mean : 1.6E-3/d 95%: 3.1E-3/d 5%: 3.2E-4/d
Source: Oconee NPP PRA (tbl.b-1.) Ultimate source: generic data updated with plant specific operating experience
Comment: Prior:NUREG 1363, PWR air-op valves,failure on demand,w/o command 80%/20% ratio=10.Operating experience; 1349 demands, 3 failures.

Z Source category: updated

VAACZ valve air operated general
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to change position Original failure mode: failure to operate on demand
FAILURE RATE OR PROBABILITY mean : 1.4E-3/d
Source: ZION NPP PSS (tbl.1.5.1-5) Ultimate source: generic data updated with plant operating experience
Comment. Priors: NUREG 1363 air operated valve(PWR),fail to operate(mean) and WASH 1400 air operated valve, fails to operate (distrib.)
Operating experience: 1540 demands, 3 failures.

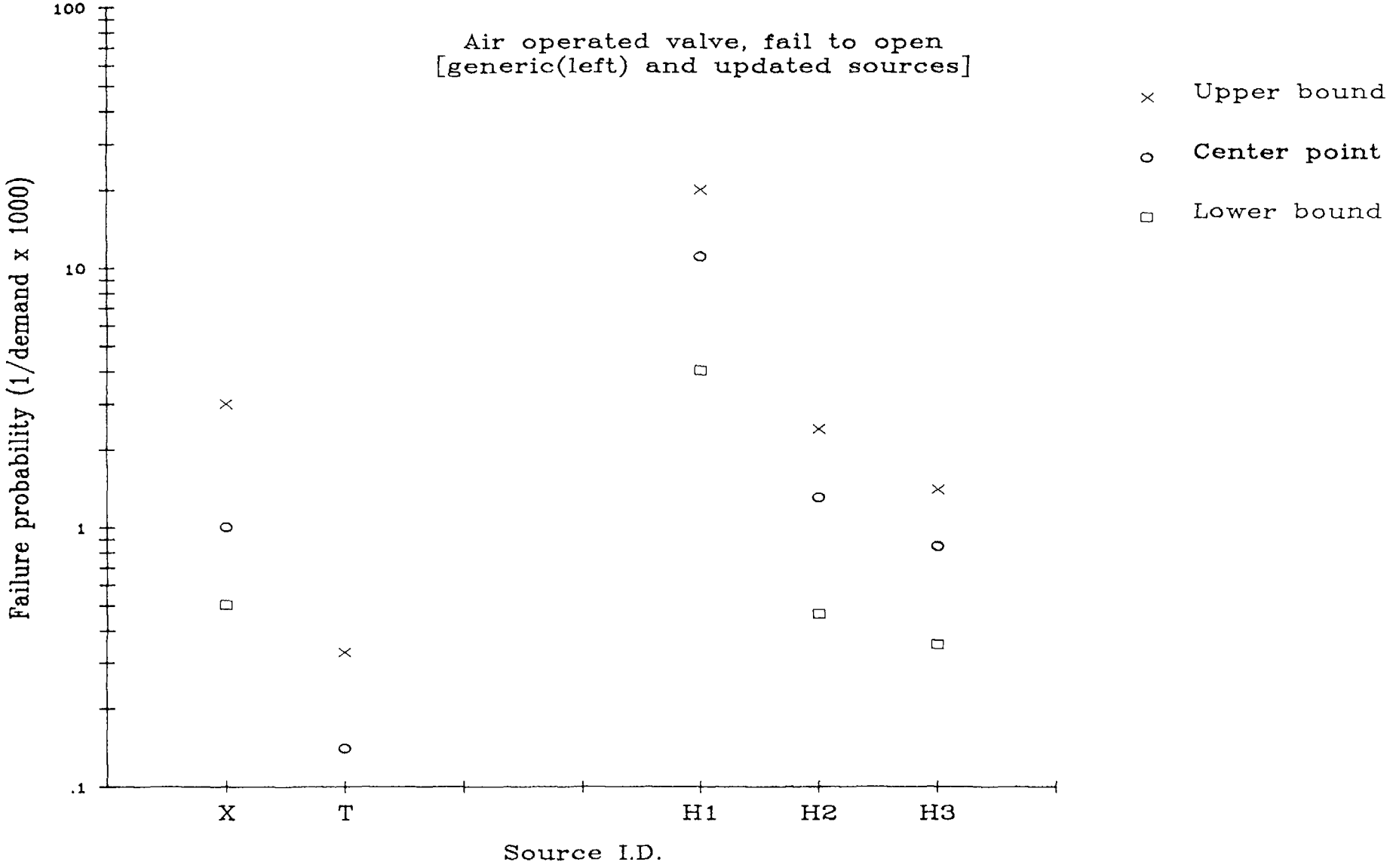
F2 Source category. plant specific

VAKCF valve air operated globe
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to change position Original failure mode: fail to operate
FAILURE RATE OR PROBABILITY mean : 5.4E-4/d 95%: 7.2E-4/d 5%: 4.0E-4/d ERROR FACTOR: 1.3 REPAIR TIME: 11 hours
Source: HWR data Ultimate source: HWR operating expereince
Comment. Pop.343. Cum.operating time 22.4E+6 hours. 34 failures.Number of demands in operational time is not known.Original time related
value changed to demand related assuming monthly testing.

F3 Source category. plant specific

VALCF valve air operated globe
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to change position Original failure mode: fail to operate
FAILURE RATE OR PROBABILITY mean : 3.6E-4/d 95%: 4.7E-4/d 5%: 2.7E-4/d ERROR FACTOR: 1.3 REPAIR TIME: 5 hours
Source: HWR data Ultimate source: HWR operating experience
Comment: Pop.420.Cum operating time 32.1E+6 hours. 31 failure.No.of demand in operational time is not known.Original time related value
changed to demand related assuming monthly testing.

IAEA RELIABILITY DATA BASE



X Source category: generic

VAAOX valve air operated general
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to open Original failure mode: fail to open
FAILURE RATE OR PROBABILITY mean : 1.0E-3/d 80%: 3.0E-3/d 20%: 5.0E-4/d
Source: VVER reliability data base Ultimate source. expert opinion, operating experience
Comment:

T Source category: generic

VAGOT valve pneumatic operated isolation valve (hydraulic scram system)
Component boundary: valve, operator,control equipment,relays,logic and automation Operating mode: all Operating environment: normal
Generic failure mode: fail to open Original failure mode: failure to open
FAILURE RATE OR PROBABILITY mean : 1.4E-4/d 95%: 3.3E-4/d REPAIR TIME: 4 hours
Source: Swedish Rel.data book, tbl.17 Ultimate source: plant operating experience(7 BWR plants), ATV reports, LERs
Comment: Total pop.278.No.of demands per operational time 27816. No.of failures 4. a=0.0203; b=141. Critical failures occured at one plant

H1 Source category: updated

VAIOH valve air operated vent isolation valve (annulus ventilation)
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to open Original failure mode: fail to open on demand
FAILURE RATE OR PROBABILITY mean : 1.1E-2/d 95%: 2.0E-2/d 5%: 4.0E-3/d
Source· Old PWR Ultimate source: generic data updated with plant operating experience
Comment: Generic mean 1.5E-3/d Operating experience 362 demands, 6 failures.

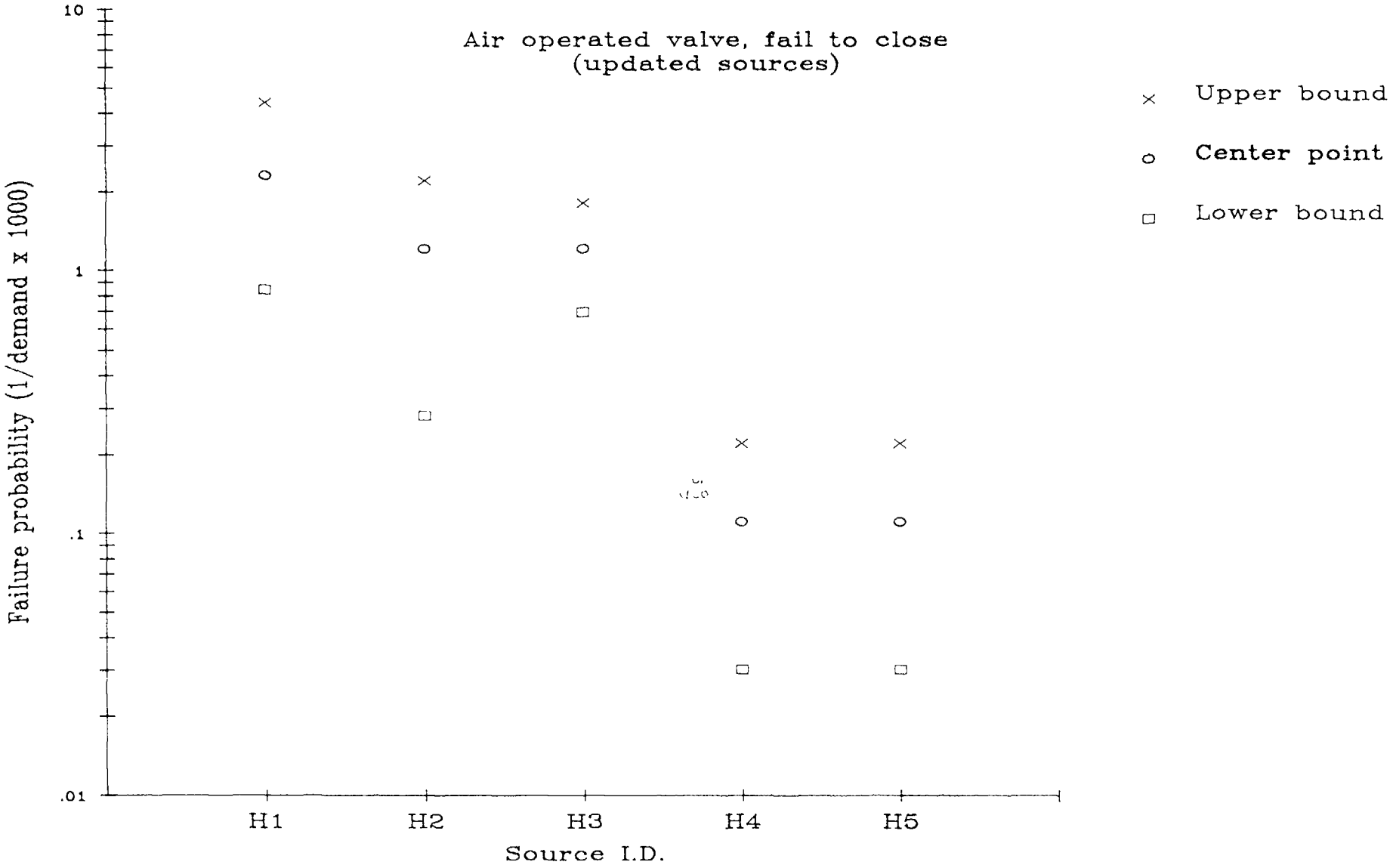
H2 Source category· updated

VAPOH valve air operated purge isolation
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to open Original failure mode: fail to open on demand
FAILURE RATE OR PROBABILITY mean : 1.3E-3/d 95%: 2.4E-3/d 5%: 4.6E-4/d
Source: Old PWR Ultimate source: generic data updated with plant operating experience
Comment: Generic mean 1.5E-3/d. Operating experience 756 demands, 1 failure

H3 Source category: updated

VAAOH valve air operated all systems
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to open Original failure mode: fail to open on demand
FAILURE RATE OR PROBABILITY mean : 8.4E-4/d 95%: 1.4E-3/d 5%: 3.5E-4/d
Source: Old PWR Ultimate source: generic data updated with plant operating expereince
Comment: Generic mean 1.5E-3/d. Operating experience 4970 demands, 3 failures.

IAEA RELIABILITY DATA BASE



H1 Source category: updated

VAPEH valve air operated purge isolation valve
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to close Original failure mode: fail to close on demand
FAILURE RATE OR PROBABILITY mean : 2.3E-3/d 95%: 4.4E-3/d 5%: 8.4E-4/d
Source: Old PWR Ultimate source: generic data updated with plant operating experience
Comment: Generic mean 1.5E-3/d. Operating experience 756 demands, 3 failures.

H2 Source category: updated

VAIEH valve air operated vent isolation valve
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to close Original failure mode: fail to close on demand
FAILURE RATE OR PROBABILITY mean : 1.2E-3/d 95%: 2.2E-3/d 5%: 2.8E-4/d
Source: Old PWR Ultimate source: generic data updated with plant operating experience
Comment: Generic mean 1.5E-3/d. Operating experience 362 demands, no failures

H3 Source category: updated

VAAEH valve air operated all systems
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to close Original failure mode: fail to close on demand
FAILURE RATE OR PROBABILITY mean : 1.2E-3/d 95%: 1.8E-3/d 5%: 6.9E-4/d
Source: Old PWR Ultimate source: generic data updated with plant specific operating experience
Comment: Generic mean 1.5E-3/d. Operating experience 4970 demands, 6 failures.

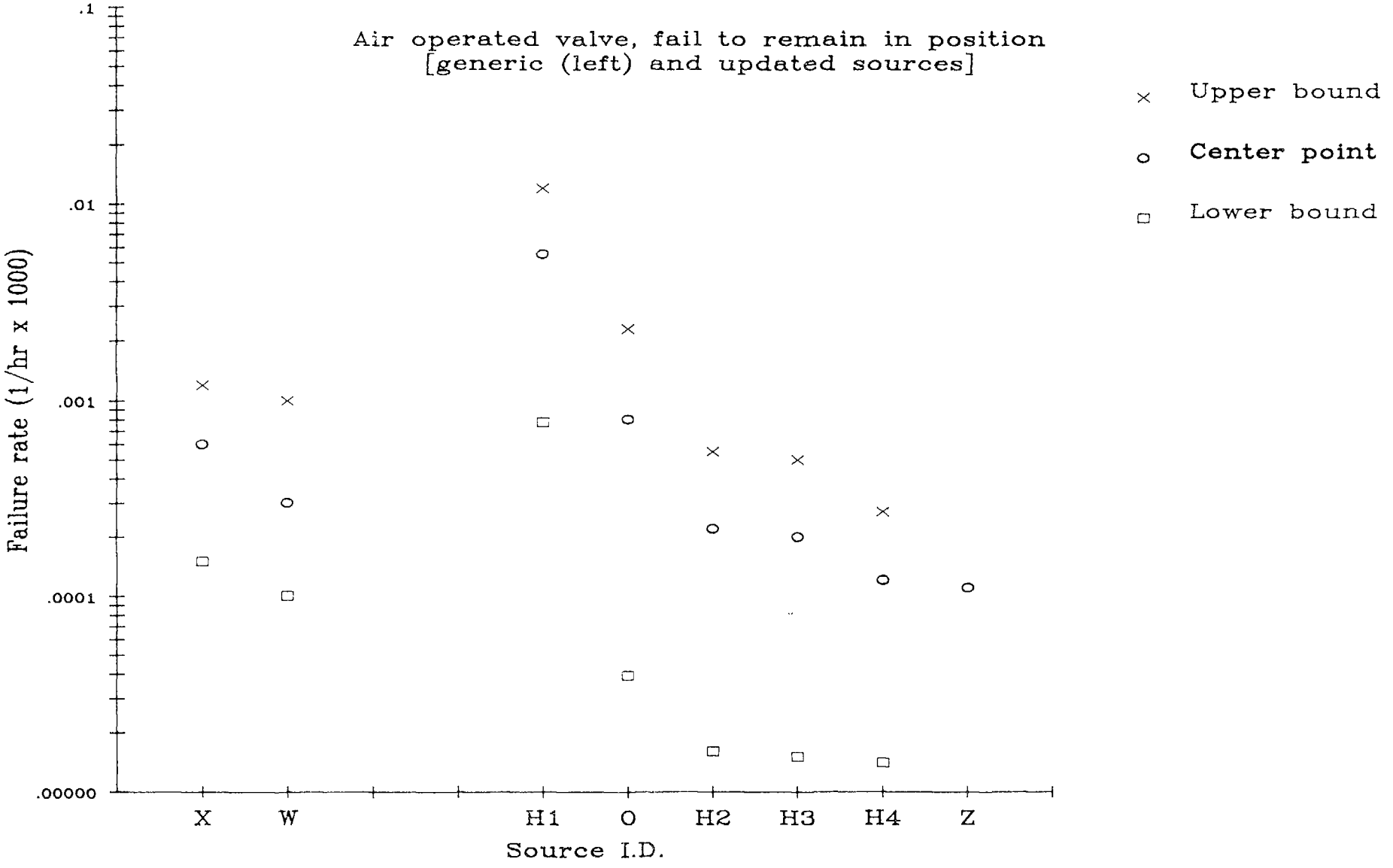
H4 Source category. updated

VAZEH valve air operated turbine stop valve
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to close Original failure mode: fail to close on demand
FAILURE RATE OR PROBABILITY mean : 1.1E-4/d 95%: 2.2E-4/d 5%: 3.0E-5/d
Source: Old PWR Ultimate source: generic data updated with plant operating experience
Comment: Generic mean 1 3E-4/d. Operating experience 1680 demands, no failures.

H5 Source category: updated

VAHEH valve air operated turbine governor valve
Component boundary. detail n/a Operating mode: all Operating environment: normal
Generic failure mode. fail to close Original failure mode: fail to close on demand
FAILURE RATE OR PROBABILITY mean : 1.1E-4/d 95%: 2.2E-4/d 5%: 3.0E-5/d
Source: Old PWR Ultimate source: generic data updated with plant operating experience
Comment: Generic mean 1.3E-4/d. Opearting experience 1680 demands, no failures.

IAEA RELIABILITY DATA BASE



X Source category. generic

VAADX valve air operated general
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to remain in position Original failure mode: fail to remain in position
FAILURE RATE OR PROBABILITY mean : 6.0E-7/hr 80%: 1.2E-6/hr 20%: 1.5E-7/hr
Source: VVER reliability data base Ultimate source: expert opinion, operating experience
Comment:

W Source category: generic

VA1DW valve air operated general
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to remain in position Original failure mode: failure to remain open(plug)
FAILURE RATE OR PROBABILITY median: 3.0E-7/hr 95%: 1.0E-6/hr 5%: 1.0E-7/hr ERROR FACTOR: 3
Source. WASH 1400 (table III 4-1) Ultimate source: ultimate source not known(sources presenting plug per demand)
Comment. Plug probabilities are given per demand and per hour since phenomena is generally time dependant,but plugged conditions may be discovered only upon demand. See FM comment air valve/demand.

H1 Source category· updated

VAQDH valve air operated raw water return line
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to remain in position Original failure mode: transfer closed
FAILURE RATE OR PROBABILITY mean : 5.5E-6/hr 95%: 1.2E-5/hr 5%: 7.7E-7/hr
Source. Old PWR Ultimate source: generic data updated with plant specific operating experience
Comment. Generic mean 2.7E-7/hr. Operating expereince 1.4E+5 hours of operation, 3 failures.

O Source category: updated

VAADO valve air operated general
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode. fail to remain in position Original failure mode: transfer closed
FAILURE RATE OR PROBABILITY mean : 8.0E-7/hr 95%: 2.3E-6/hr 5%: 3.9E-8/hr
Source: Oconee NPP PRA (tbl.b 1.) Ultimate source: generic data updated with plant specific operating experience
Comment: Prior:WASH 1400,air-op valves,f.to remain open.5%=20%;95%=80%. Per demand rate converted to hrly rate assuming 1 d.in 45 days. Operating experience.1.94E+5 hours of operation,1 failure.

H2 Source category updated

VAIDH valve air operated vent isolation valve (annulus ventilation)
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to remain in position Original failure mode: transfer open
FAILURE RATE OR PROBABILITY mean : 2.2E-7/hr 95%: 5.5E-7/hr 5%: 1.6E-8/hr
Source. Old PWR Ultimate source: generic data updated with plant operating experience
Comment: Generic mean 2.7E-7/hr. Operating experience 2.4E+5 hours of operation, no failures.

H3 Source category. updated

VAPDH valve air operated purge isolation valve
Component boundary· detail n/a Operating mode: all Operating environment: normal
Generic failure mode· fail to remain in position Original failure mode: transfer open
FAILURE RATE OR PROBABILITY mean : 2.0E-7/hr 95%: 5.0E-7/hr 5%: 1.5E-8/hr
Source: Old PWR Ultimate source: generic data updated with plant operating experience
Comment Generic mean 2 7E-7/hr Operating experience 4.7E+5 hours of operation, no failures.

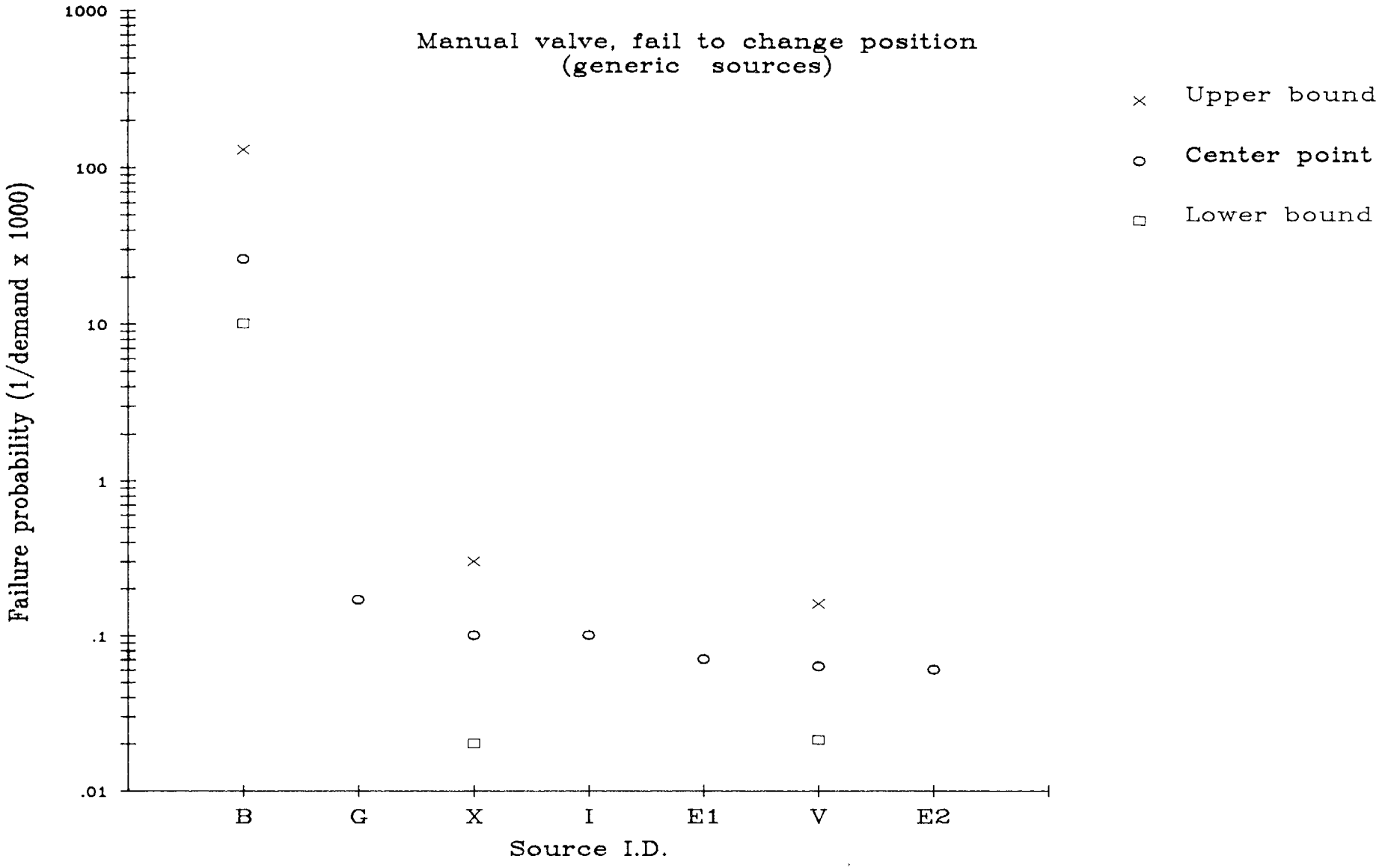
H4 Source category: updated

VARDH valve air operated all systems except raw water return line
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to remain in position Original failure mode: transfer closed
FAILURE RATE OR PROBABILITY mean : 1.2E-7/hr 95%: 2.7E-7/hr 5%: 1.4E-8/hr
Source: Old PWR Ultimate source: generic data updated with plant operating experience
Comment: Generic mean 2.7E-7/hr. Operating experience 3E+6 hours of operation,no failures.

Z Source category: updated

VAADZ valve air operated general
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to remain in position Original failure mode: transfer closed,plugged
FAILURE RATE OR PROBABILITY mean : 1.1E-7/hr
Source: ZION NPP PSS (tbl.1.5.1-5) Ultimate source: generic data updated with plant operating exprience
Comment. Prior:WASH 1400,air operated valve,failure to remain open(plug). 1 demand in 45 daysused to convert to hourly rate.
Operating experience: 2.13E+6 hours of operation, no failures.

IAEA RELIABILITY DATA BASE



B Source category: generic

VXACB valve manual general
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to change position Original failure mode: failure to operate
FAILURE RATE OR PROBABILITY mean : 2.6E-2/d max: 1.3E-1/d min: 1.0E-2/d
Source: NUREG 2815 (table C.1.) Ultimate source: expert opinion and IREP data
Comment: Failure to operate is dominated by human error. Rate is based on one actuaton per month. Original time related value changed to demand related assuming monthly testing.

G Source category: generic

VXACG valve manual general
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to change position Original failure mode: fail to open or to close
FAILURE RATE OR PROBABILITY mean : 1.7E-4/d ERROR FACTOR: 12
Source: German Risk Study (pg.F3-79) Ultimate source: generic data and operating experience
Comment: Both generic and specific sources were combined for this failure rate. Original time related value changed to demand related assuming monthly testing.

X Source category: generic

VXACX valve manual general
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to change position Original failure mode: fail to change position
FAILURE RATE OR PROBABILITY mean : 1.0E-4/d 80%. 3.0E-4/d 20%: 2.0E-5/d
Source: VVER reliability data base Ultimate source: expert opinion, operating experence
Comment:

I Source category: generic

VXACI valve manual general
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to change position Original failure mode: failure to operate
FAILURE RATE OR PROBABILITY mean : 1.0E-4/d ERROR FACTOR: 3
Source: IREP NUREG 2728 (tb.5.1-1) Ultimate source: expert opinion
Comment: Failure to operate is dominated by human error Hourly rate 3.0E-7 (EF 10) is based on one actuation per month

E1 Source category: generic

VXPCE valve manual general (PWR application)
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to change position Original failure mode: failed to operate
FAILURE RATE OR PROBABILITY rec : 7.0E-5/cy
Source: IEEE 500 (1984) pg.1018 Ultimate source: expert judgement aggregation (delphi method)
Comment:

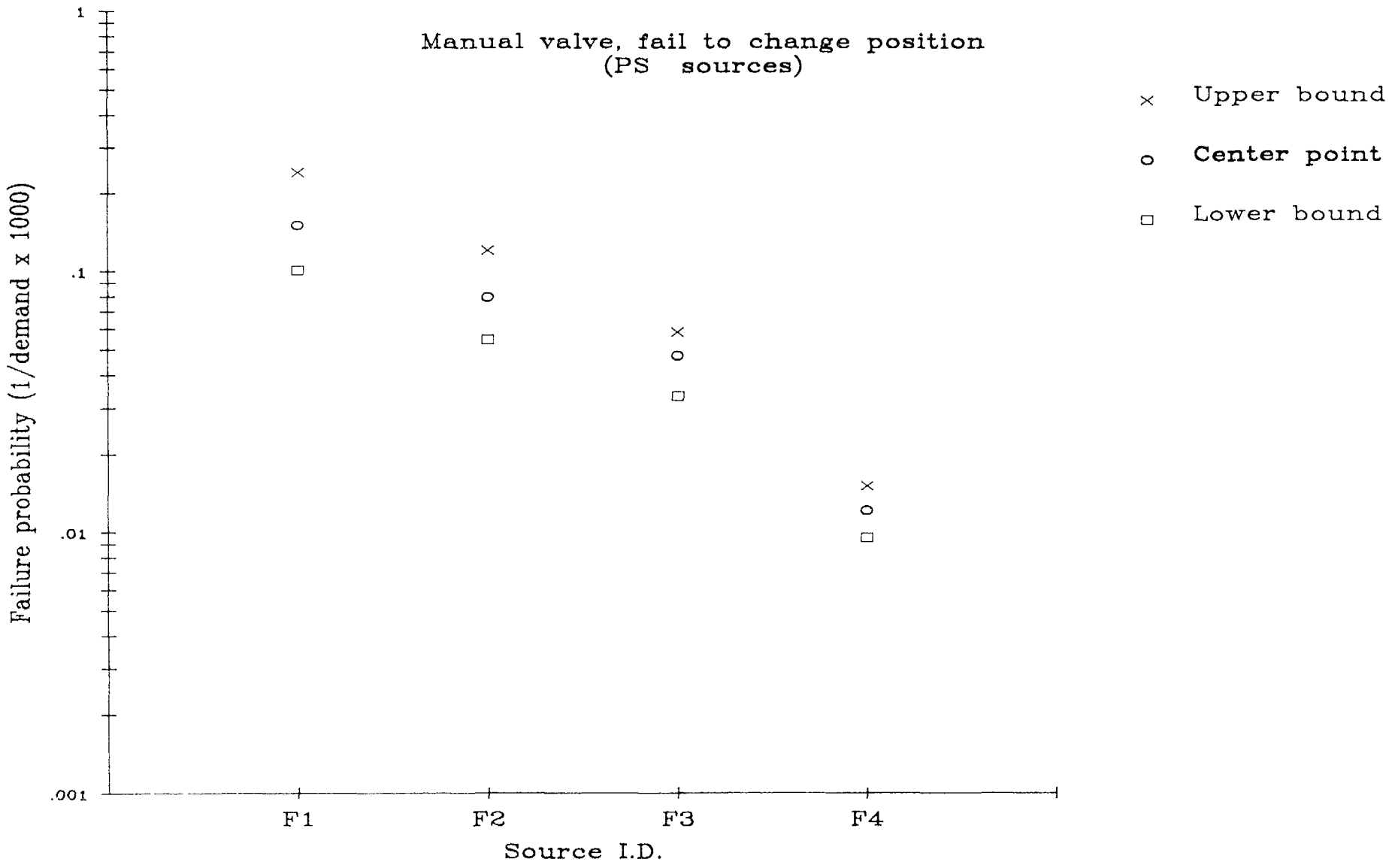
V Source category: generic

VXECV valve manual PWR + BWR (ESF systems valves only)
Component boundary: valve body and interiors, operating mechanism Operating mode: all Operating environment: normal
Generic failure mode: fail to change position Original failure mode: fail to operate
FAILURE RATE OR PROBABILITY mean : 6.3E-5/d 95%: 1.6E-4/d 5%: 2.1E-5/d
Source: NUREG 1363 (1982) (pg.454) Ultimate source: US plants LER reports evaluation
Comment: Overall data PWr and BWR about equal. Standby hourly rate 2.9E-8/hr.

E2 Source category: generic

VXBCE valve manual general (BWR application)
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to change position Original failure mode: failed to operate
FAILURE RATE OR PROBABILITY rec : 6.0E-5/cy
Source: IEEE 500 (1984) pg.1019 Ultimate source: expert opinion aggregation (delphi method) & operating exeprience
Comment: Reference EGG-EA-5816 82.Data Summaries of LER of Valves at US Commercial NPP

IAEA RELIABILITY DATA BASE



F1 Source category: plant specific

VXGCF valve manual gate
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to change position Original failure mode: fail to operate
FAILURE RATE OR PROBABILITY mean : 1.5E-4/d 95%: 2.4E-4/d 5%: 1.0E-4/d ERROR FACTOR: 1.5 REPAIR TIME: 14 hours
Source: HWR data Ultimate source: HWR operating experience
Comment: Pop.520. Cumulative operating time 34.6E+6 hours.15 failures. Number of demand per operational time is not known.Original time related value changed to demand related assuming monthly testing.

F2 Source category: plant specific

VXICF valve manual gate
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to change position Original failure mode: fail to operate
FAILURE RATE OR PROBABILITY mean : 7.9E-5/d 95%: 1.2E-4/d 5%: 5.4E-5/d ERROR FACTOR: 1.4 REPAIR TIME: 9 hours
Source: HWR data Ultimate source: HWR operating expereince
Comment: Pop.1179. Cum.operating time 84.2E+6 hours.18 failures. Number of demands per operational time in not known.Original time related value changed to demand related assuming monthly testing.

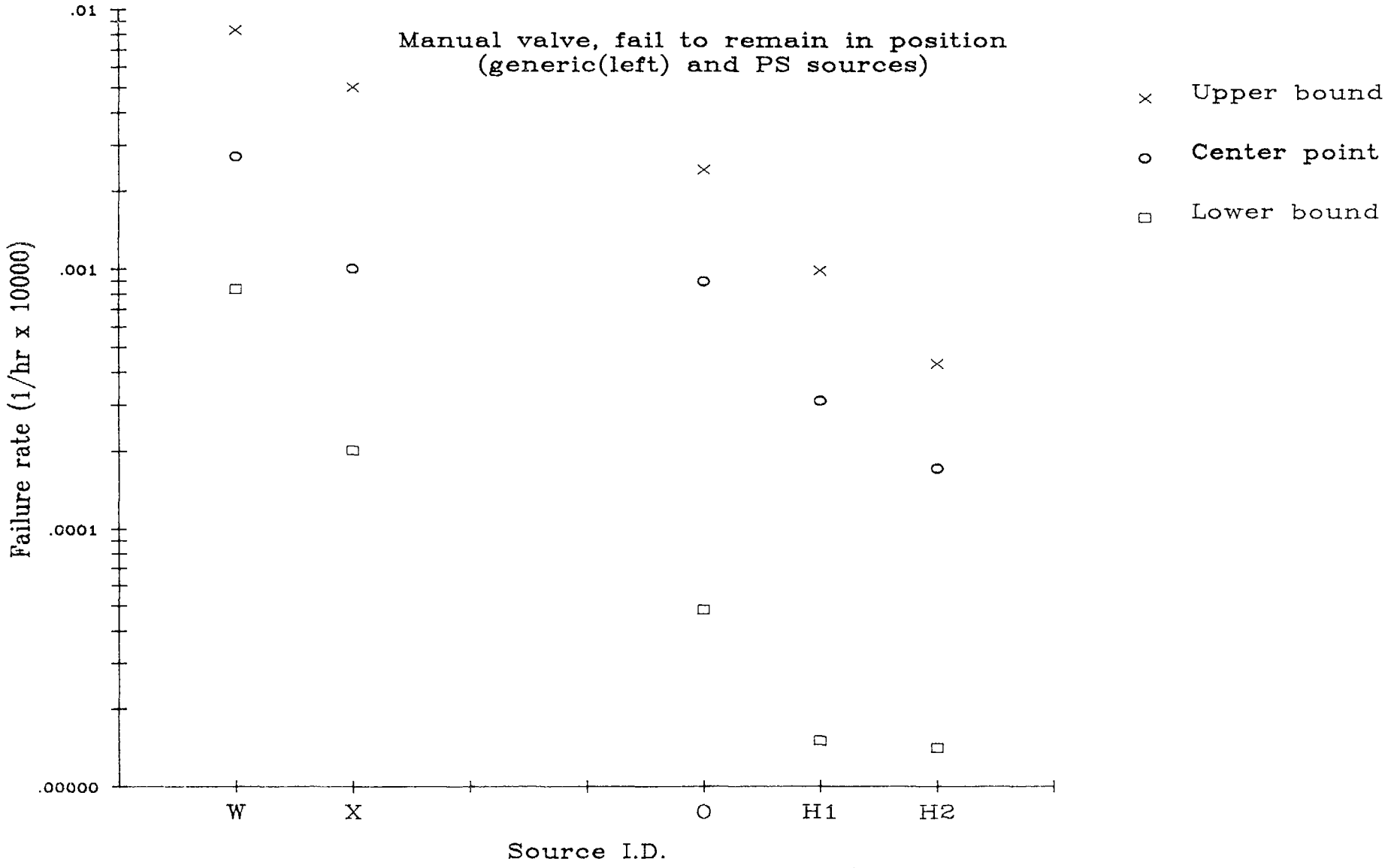
F3 Source category: plant specific

VXHCF valve manual gate
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to change position Original failure mode: fail to operate
FAILURE RATE OR PROBABILITY mean : 4.7E-5/d 95%: 5.8E-5/d 5%: 3.3E-5/d ERROR FACTOR: 1.3 REPAIR TIME: 4 hours
Source: HWR data Ultimate source: HWR operating experience
Comment: Pop.3546. Cum.operating time 2.5E+8 hours. 30 failures. Number of demands per operating time is not known.Original time related value changed to demand related assuming monthly testing.

F4 Source category: plant specific

VXSCF valve manual gate
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to change position Original failure mode: fail to operate
FAILURE RATE OR PROBABILITY mean : 1.2E-5/d 95%: 1.5E-5/d 5%: 9.4E-6/d ERROR FACTOR: 1.3 REPAIR TIME: 2 hours
Source: HWR data Ultimate source: HWR operating experience
Comment: Pop.19351. Cum.operating time 1.3E+9 hours. 43 failures. Number of demands per operating time is not known.Original time related value changed to demand related assuming monthly testing.

IAEA RELIABILITY DATA BASE



W Source category: generic

VXADW valve manual general
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to remain in position Original failure mode: failure to remain open(plug)
FAILURE RATE OR PROBABILITY median: 2.7E-7/hr 95%: 8.3E-7/hr 5%: 8.3E-8/hr ERROR FACTOR: 3
Source: WASH 1400 (table III 4-1) Ultimate source: assesed from US nuclear expereince (including test & research R)
Comment: failure to remain open refers to reduction of flow to unusable level due to foreign material or gate failure.
Demand value changed to time related assuming 1 demand per month.

X Source category: generic

VXADX valve manual general
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to reamin in position Original failure mode: fail to remain in position
FAILURE RATE OR PROBABILITY mean : 1.0E-7/hr 80%: 5.0E-7/hr 20%: 2.0E-8/hr
Source: VVER reliability data base Ultimate source: expert opinion, operating experience
Comment:

O Source category: updated

VXADO valve manual general
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to remain in position Original failure mode: transfer closed
FAILURE RATE OR PROBABILITY mean : 8.9E-8/hr 95%: 2.4E-7/hr 5%: 4.8E-9/hr
Source: Oconee NPP PRA (tbl.b-1.) Ultimate source: generic data updated with plant specific operating experience
Comment: Prior: NUREG 1363,failure of internals of manual valves. Operating experience: 3.09E+6 hours of operation, 1 failure.
95%/5% ratio is 100, indicating high degree of uncertanty.

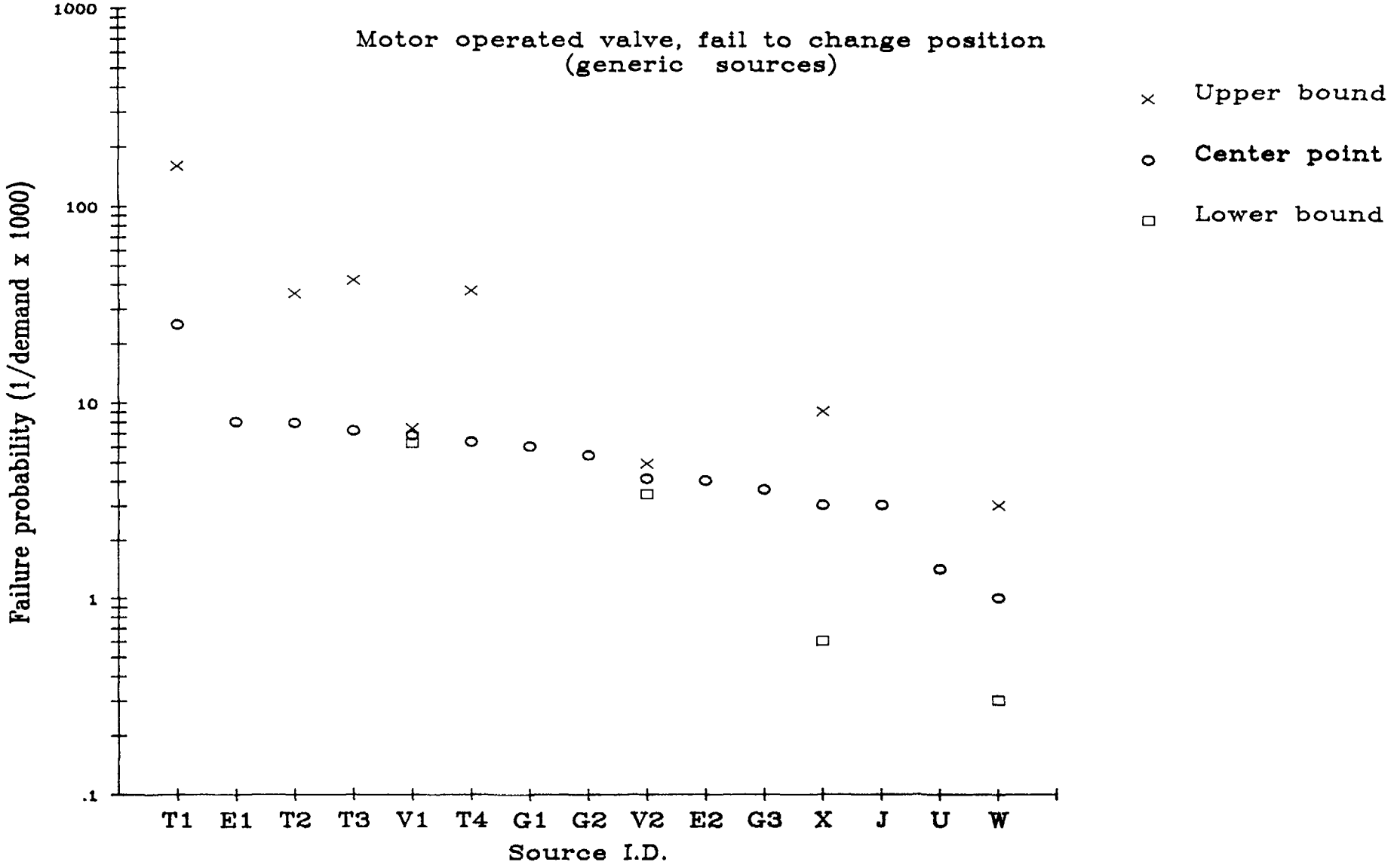
H1 Source category: updated

VXTDH valve manual butterfly
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to remain in position Original failure mode: transfer closed
FAILURE RATE OR PROBABILITY mean : 3.1E-8/hr 95%: 9.8E-8/hr 5%: 1.5E-9/hr
Source: Old PWR Ultimate source: generic data updated with plant operating experience
Comment: Generic mean 4.2E-8/hr. Opearting experience 2.2E+6 hours, no failures.

H2 Source category: updated

VXADH valve manual
Component boundary: deatil n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to remain in position Original failure mode: transfer closed
FAILURE RATE OR PROBABILITY mean 1.7E-8/hr 95%: 4.3E-8/hr 5%: 1 4E-9/hr
Source: Old PWR Ultimate source generic data updated with plant operating experience
Comment: Generic mean 4 2E-8/hr Operating experience 1 8E+7 hours of operation, no failures.

IAEA RELIABILITY DATA BASE



T1 Source category: generic

VMFCT valve motor operated control valve
Component boundary: valve,motor,protection,controls,relays,logic and automation Operating mode: all Operating environment: normal
Generic failure mode: fail to change position Original failure mode: failure to change position
FAILURE RATE OR PROBABILITY mean : 2.5E-2/d 95%: 1.6E-1/d REPAIR TIME: 4 hours
Source: Swedish Rel.data book, tbl.20 Ultimate source: plant operating experience(7 BWR plants), ATV reports
Comment: Total pop.69.No.of demands per operational time 2012.No of failures 22. a=0.0971; b=3.75 Critical failures reported at 5 plants.

E1 Source category: generic

VMQCE valve motor operated general (BWR application)
Component boundary: detail n/a(generaly exclude driver) Operating mode: all Operating environment: normal
Generic failure mode: fail to change position Original failure mode: fail to operate
FAILURE RATE OR PROBABILITY rec : 8.0E-3/cy
Source: IEEE 500 (1984) pg.1023 Ultimate source: expert judgement aggregation (delphi procedure) & experience
Comment: Reference EGG-EA 5816 1982.

T2 Source category: generic

VMKCT valve motor operated isolation valve =<100 mm
Component boundary: valve,motor,protection,controls,switch,fuse,indications Operating mode: all Operating environment: normal
Generic failure mode: fail to change position Original failure mode: failure to change position
FAILURE RATE OR PROBABILITY mean : 7.9E-3/d 95%: 3.6E-2/d REPAIR TIME: 4 hours
Source: Swedish Rel.data book, tbl.11 Ultimate source: plant operating experience (7 BWR plants), ATV reports, LERs
Comment: Total pop.71.Number of demands per operational time 2512.Number of failures observed: 18. a=0.307; b=38.5. Critical failures occured at 6 plants.

T3 Source category: generic

VMNCT valve motor operated isolation valve (>200mm)
Component boundary: valve,motor,protection,controls,switch,fuse,indications Operating mode: all Operating environment: normal
Generic failure mode: fail to change position Original failure mode: failure to change position
FAILURE RATE OR PROBABILITY mean : 7.2E-3/d 95%: 4.2E-2/d REPAIR TIME: 5 hours
Source: Swedish Rel.data book, tbl.13 Ultimate source: plant operating experience (7 BWR plants), ATV reports, LERs
Comment: Total pop.95.Number of demands per operational time 3059.Number of failures 22. a= 0.11; b=15.2 Critical failures occured at 4 plants.

V1 Source category: generic

VM1CV valve motor operated BWR (ESF systems valves only)
Component boundary: valve body and its internal parts,motor,functional accesories Operating mode: all Operating environment: normal
Generic failure mode: fail to change position Original failure mode: fail to operate
FAILURE RATE OR PROBABILITY mean : 6.8E-3/d 95%: 7.4E-3/d 5%: 6.2E-3/d
Source: NUREG 1363 (1982) (pg.398) Ultimate source: US plants LER reports evaluation
Comment: W/o command faults. With command 9.6E-3/d.Standby hourly failure rate:w/o 3.1E-6/hr; with 4.4E-6/hr.LEr rates from 'unknovn remote and MOV' what better represent MOV population.

T4 Source category: generic

VMOCT valve motor operated isolation valve (100< DN < 200 mm)
Component boundary: valve,motor,protection,controls,switch,fuse,indications Operating mode: all Operating environment: normal
Generic failure mode: fail to change position Original failure mode: failure to change position
FAILURE RATE OR PROBABILITY mean : 6.3E-3/d 95%: 3.7E-2/d REPAIR TIME: 4 hours
Source: Swedish Rel.data book, tbl.12 Ultimate source: plant operating experience(7 BWR plants), ATV reports, LERs
Comment: Total pop.180.Number of demads per operational time 6181.Number of failures:30. a=0.114; b=18 Critical failures occured at 6 plants.

G1 Source category: generic

VMMCG valve motor operated MSIV (FD-Schnellschlusschieber)
Component boundary: main valve without pilot valve Operating mode: all Operating environment: normal
Generic failure mode: fail to change position Original failure mode: fail to open or to close
FAILURE RATE OR PROBABILITY median: 6.0E-3/d ERROR FACTOR: 4
Source: German Risk Study (tb.F3,7-1) Ultimate source: operating experience
Comment: Bases for failure rate is 112 operating demands without failure.

G2 Source category: generic

VMACG valve motor operated general
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to change position Original failure mode: fail to open or to close
FAILURE RATE OR PROBABILITY mean : 5.4E-3/d ERROR FACTOR: 3
Source: German Risk Study (pg.F3-74) Ultimate source: generic data and operating expereince
Comment: The same value is used in FTs for fail to open or close mode. For the standby operating mode,assuming montly test interval failure per demand is 5.4E-3.(Value changed from hr to demand)

V2 Source category: generic

VMHCV valve motor operated PWR (ESF system valves only)
Component boundary: valve body & internals,motor,functional assecories(limit swich) Operating mode: all Operating environment: normal
Generic failure mode: fail to change position Original failure mode: fail to operate
FAILURE RATE OR PROBABILITY mean : 4.1E-3/d 95%: 4.9E-3/d 5%: 3.4E-3/d
Source: NUREG 1363 (1982) (pg.398) Ultimate source: US plants LER reports evaluation
Comment: W/o command faults. With command faults 6.2E-3/d.Standby rate 1.9E-6/hr. LER rate from 'unknown remote and motor operated' what better represent MOV population.

E2 Source category: generic

VMPCE valve motor operated general (PWR application)
Component boundary: detail n/a(generally excludes operator) Operating mode: all Operating environment: normal
Generic failure mode: fail to change position Original failure mode: fail to operate
FAILURE RATE OR PROBABILITY rec : 4.0E-3/cy
Source: IEEE 500 (1984) pg.1022 Ultimate source: expert opinion aggregation (delphi procedure) & plant experiexce
Comment: Reference EGG-EA-5816 1982.

G3 Source category generic

VMRCG valve motor operated regualting
Component boundary: valve with operator Operating mode: all Operating environment: normal
Generic failure mode: fail to change position Original failure mode: fail to close (in terms of regulating)
FAILURE RATE OR PROBABILITY mean : 3.6E-3/d ERROR FACTOR: 7
Source: German Risk Study (pg.F3-79) Ultimate source: generic data
Comment: Failure rate is combination of generic data sources Original time related value changed to demand related assumingst monthly testing.

X Source category: generic

VMACX valve motor operated general
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to change position Original failure mode: fail to change position
FAILURE RATE OR PROBABILITY mean : 3.0E-3/d 80%: 9.0E 3/d 20%: 6.0E-4/d
Source: VVER reliability data base Ultimate source: expert opinion, operating experience
Comment:

J Source category: generic

VMACJ valve motor operated general
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to change position Original failure mode: fails to operate
FAILURE RATE OR PROBABILITY mean : 3.0E-3/d ERROR FACTOR: 10
Source: NUREG 4550, Vol.1,tbl VIII.1-2 Ultimate source: assesed from several nuclear data sources
Comment: Valuse used is from Station Blachout Study (NUREG/CR-3226). Two types of failures are included: valve hardware faults(5.0E-4) and command circut faults (2.5E-4)

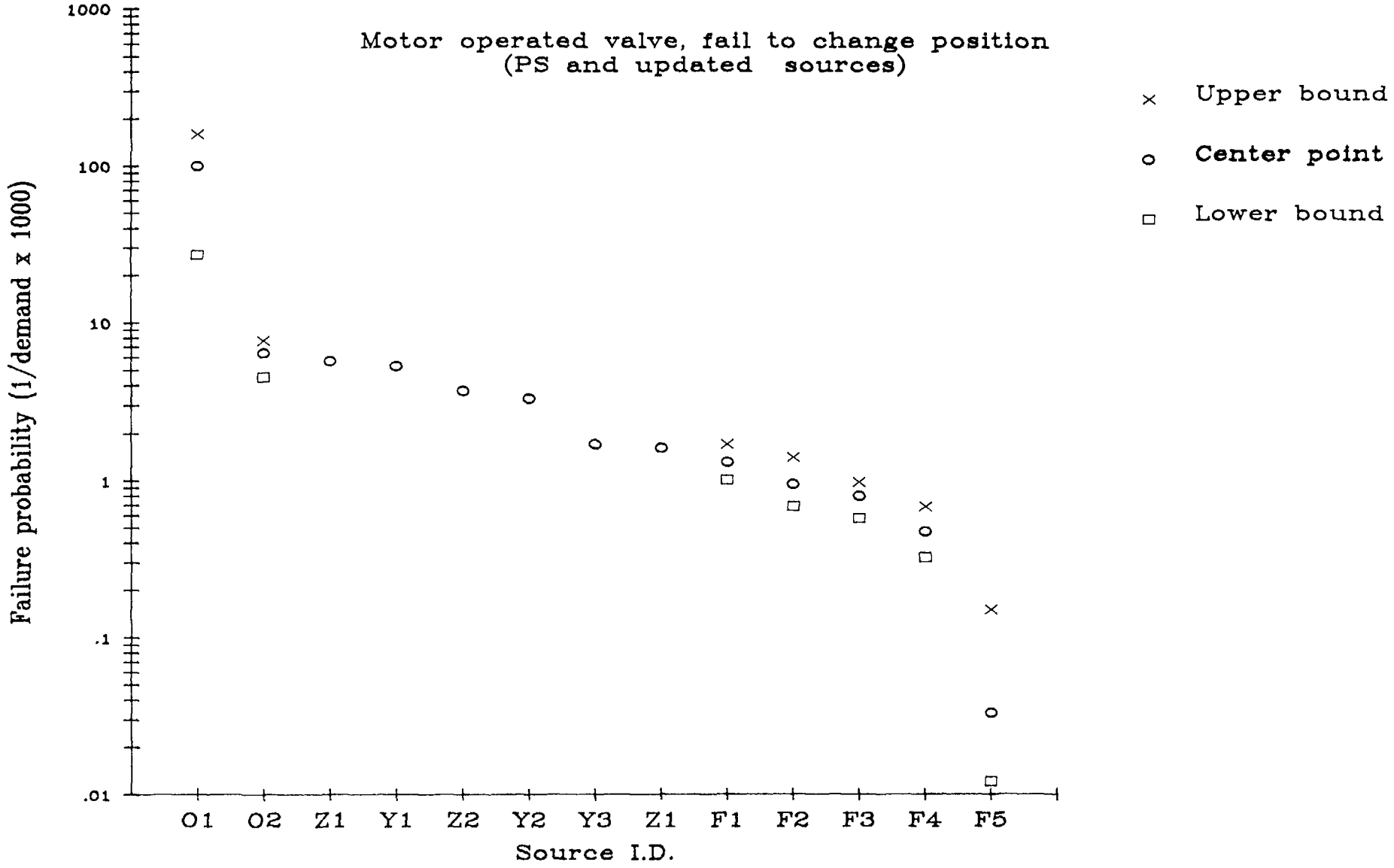
U Source category: generic

VMACU valve motor oprated general
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to change position Original failure mode: failure to operate
FAILURE RATE OR PROBABILITY mean : 1.4E-3/d
Source: Sizewell B (PWR/RX312 pg.6) Ultimate source: asesed from nuclear experience and generic sources
Comment: Assesment based on W data item and WASH 1400 data.If valves are tested montly,given failure rate gives the peak probability of 1.4E-3/d, what is in agreement with WASH 1400.(Hr changed to dem)

W Source category: generic

VMACW valve motor operated general
Component boundary: detail n/a, include driver. Operating mode: all Operating environment: normal
Generic failure mode: fail to change position Original failure mode: failure to operate
FAILURE RATE OR PROBABILITY median: 1.0E-3/d 95%: 3.0E-3/d 5%: 3.0E-4/d ERROR FACTOR: 3
Source: WASH 1400 (table III 4-1) Ultimate source: assesed from nuclear,industrial and military experience and data
Comment: Demand probabilities are based on presence of proper input signal Failure to operate include changing state from closed to open or from open to closed position.

IAEA RELIABILITY DATA BASE



01 Source category: updated

VMDCO valve motor operated
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to change position Original failure mode: failure to operate
FAILURE RATE OR PROBABILITY mean : 1.0E-1/d 95%: 1.6E-1/d 5%: 2.7E-2/d
Source: Oconee NPP PRA (tbl.b 1.) Ultimate source: generic data updated with plant specific operating experience
Comment: Prior: NUREG 1363,failure of MOV and remote operated on demand. Operating experience: 30 demands, 5 failures.

02 Source category: updated

VMBCO valve motor operated
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to change position Original failure mode: failure to operate
FAILURE RATE OR PROBABILITY mean : 6.4E-3/d 95%: 7.7E-3/d 5%: 4.5E-3/d
Source: Oconee NPP PRA (tbl.b-1.) Ultimate source: generic data updated with plant specific operating experince
Comment: Prior: NUREG 1363, failure of MOV and remote operated on demand. Operating experience: 6725 demands, 42 failures.

Z1 Source category: updated

VMECZ valve motor operated
Component boundary: detail n/a Operating mode: standby Operating environment: normal
Generic failure mode: fail to change position Original failure mode: failure to operate on demand
FAILURE RATE OR PROBABILITY mean : 5.7E-3/d
Source: ZION NPP PSS (tbl.1.5.1-5) Ultimate source: generic data updated with plant operating experience
Comment: Priors:NUREG 1363 MOV+remote (PWR)(w/o command),fail to operate (M) and WASH 1400 MOV, fails to operate (distrib.).
Operating experience. 1647 deamnds, 10 failures.

Y1 Source category. plant specific

VMKCY valve motor operated isolation valve =<100 mm
Component boundary: valve,motor,protection,controls,switch,fuse,indications Operating mode: all Operating environment: normal
Generic failure mode: fail to change position Original failure mode: failure to change position
FAILURE RATE OR PROBABILITY mean : 5.3E-3/d REPAIR TIME: 3 hours
Source: Swedish Rel.data book, tbl.11 Ultimate source: plant operating experience (Ringhals 2 PWR)
Comment: Total pop.22.Number of demands per operational time 983.Number of failures:5.

Z2 Source category: updated

VMCCZ valve motor operated
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to change position Original failure mode: failure to operate on demand
FAILURE RATE OR PROBABILITY mean : 3.7E-3/d
Source. ZION NPP PSS (tbl.1.5.1-5) Ultimate source. generic data updated with plant operating experience
Comment: Priors: NUREG 1363,MOV+remote(PWR)(w/o command)fail to operate(M) and WASH 1400 MOV, fails to operate (distrib).
Operating experience:1720 demands, 7 failures

Y2 Source category: plant specific

VMNCY valve motor operated isolation valve (>200 mm)
Component boundary: valve,motor,protection,controls,switch,fuse,indications Operating mode: all Operating environment: normal
Generic failure mode: fail to change position Original failure mode: failure to change position
FAILURE RATE OR PROBABILITY mean : 3.3E-3/d REPAIR TIME: 8 hours
Source: Swedish Rel.data book, tbl.13 Ultimate source: plant operating experience (Ringhals 2 PWR) ATV reports
Comment Total pop. 23.Number of demands per operational time 1486.Number of failures 5.

Y3 Source category: plant specific

VMOCY valve motor operated isolation valve (100mm< DN< 200 mm)
Component boundary: valve,motor,protection,control,switch,fuse,indications Operating mode: all Operating environment: normal
Generic failure mode: fail to change position Original failure mode: failure to change position
FAILURE RATE OR PROBABILITY mean : 1.7E-3/d
Source: Swedish Rel.data book, tbl.12 Ultimate source: plant operating experience (Ringhals 2 PWR),ATV reports
Comment: Total pop. 12.Number of demands per operational time 600.Number of failures 1.FAILMODE regarded open/close operation as one demand

Z3 Source category: updated

VMJCZ valve motor operated
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to change position Original failure mode: failure to operate on demand
FAILURE RATE OR PROBABILITY mean : 1.6E-3/d
Source: ZION NPP PSS (tbl.1.5.1-5) Ultimate source: generic data updated with plant operating experience
Comment: Priors:NUREG 1363 MOV+ remote(PWR)(w/o command)fail to operate(M) and WASH 1400 failed to operate (distrib.). Operating experience: 11310 demands, 14 failures.

F1 Source category: plant specific

VMTCF valve motor operated butterfly (6-12")
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to change position Original failure mode: fail to operate
FAILURE RATE OR PROBABILITY mean : 1.3E-3/d 95%: 1.7E-3/d 5%: 1.0E-3/d ERROR FACTOR: 1.3 REPAIR TIME: 3 hours
Source: HWR data Ultimate source: HWR operating experience
Comment: Pop.165.Cum.opearting time 12.95E+6 hours.No.of failures 47. No.of demands not known.Failure mode include actuator failure,but not loss of power.Data based on experience with isolation valves.

F2 Source category: plant specific

VMSCF valve motor operated butterfly (12-24")
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to change position Original failure mode: fail to operate
FAILURE RATE OR PROBABILITY mean : 9.4E-4/d 95%: 1.4E-3/d 5%: 6.8E-4/d ERROR FACTOR: 1.4 REPAIR TIME: 10 hours
Source: HWR data Ultimate source: WRU operating experience
Comment: Pop.95.Cum.operating time 8E+6 hours.No.of failures 21.No.of demands not known.Failure mode "fail to operate" include actuator failure but not loss of power.Data from isolation valves.

F3 Source category: plant specific

VMGCF valve motor operated gate (12-24")
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to change position Original failure mode: fail to operate
FAILURE RATE OR PROBABILITY mean : 7.9E-4/d 95%· 9.7E-4/d 5%: 5.7E-4/d ERROR FACTOR: 1.2 REPAIR TIME: 21 hour
Source. HWR data Ultimate source. HWR operating expereince
Comment: Pop.356. Cum operating time 29.1E+6 hours.63 failures. Number of demands in operational time is not known "Fail to operate" incl. actuator failure,but not power supply to actuator.

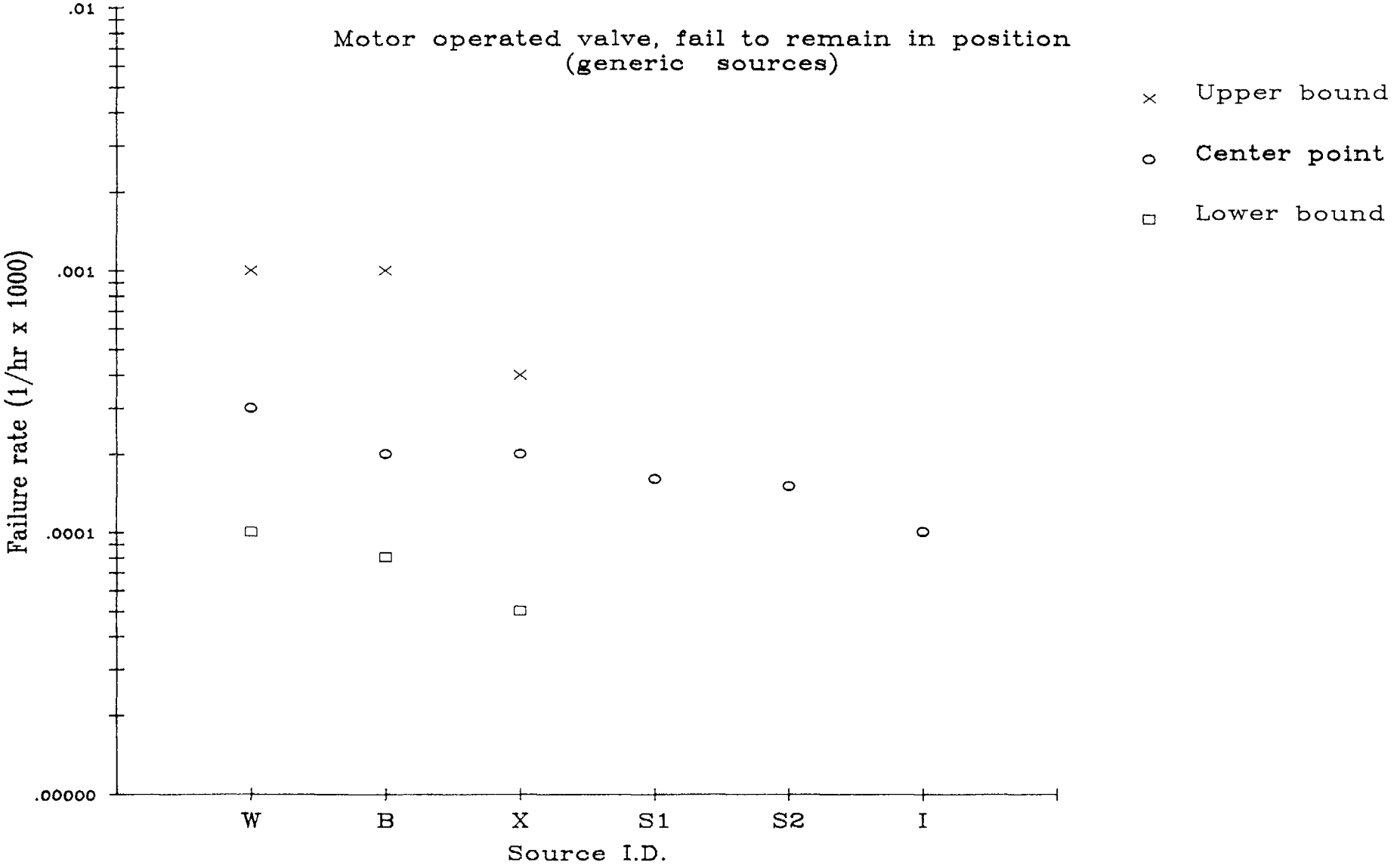
F4 Source category: plant specific

VMLCF valve motor operated globe (2-6")
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to change position Original failure mode: fail to operate
FAILURE RATE OR PROBABILITY mean : 4.7E-4/d 95%: 6.8E-4/d 5%: 3.2E-4/d ERROR FACTOR: 1.1 REPAIR TIME: 5 hours
Source: HWR data Ultimate source: HWR operating experience
Comment: Pop.220.Cum.operating time 14E+6 hours.18 failures.No.of demands in operational time is not known. Data based on experience with isolating valves.FM incl.actuator failure,but not power supply.

F5 Source category: plant specific

VMUCF valve motor operated butterfly (2-6")
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to change position Original failure mode: fail to operate
FAILURE RATE OR PROBABILITY mean : 3.3E-5/d 95%: 1.5E-4/d 5%: 1.2E-5/d ERROR FACTOR: 2.7 REPAIR TIME: 1 hour
Source: HWR data Ultimate source: HWR operating experience
Comment: Pop.157.Cum.operating time 1080E+4 hours.1 failure.No.of demands in time not known.Data based on expereince with isolating valves (electr.or pneum.operator).FM.incl.failure of actuator, w/o comm.

IAEA RELIABILITY DATA BASE



W Source category: generic

VMADW valve motor operated general
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to remain in position Original failure mode: failure to remain open (plug)
FAILURE RATE OR PROBABILITY median: 3.0E-7/hr 95%: 1.0E-6/hr 5%: 1.0E-7/hr ERROR FACTOR: 3
Source: WASH 1400 (table III 4-1) Ultimate source: ultimate data source not known(sources presents plug per demand)
Comment: Failure to remain open refers to reduction of flow to unusable level due to foreign particles or gate failure. Not included in value inadvertant or false signal driving valve closed.

B Source category: generic

VMADB valve motor operated general
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to remain in position Original failure mode: failure to remain open
FAILURE RATE OR PROBABILITY mean : 2.0E-7/hr max: 1.0E-6/hr min: 8.0E-8/hr
Source: NUREG 2815 (table C.1.) Ultimate source: expert opinion and IREP data
Comment:

X Source category: generic

VMADX valve motor operated general
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to remain in position Original failure mode: fail to remain in position
FAILURE RATE OR PROBABILITY mean : 2.0E-7/hr 80%: 4.0E-7/hr 20%: 5.0E-8/hr
Source: VVER reliability data base Ultimate source: expert opinion, operating experience
Comment:

S1 Source category: generic

VMYDS valve motor operated general
Component boundary: detail n/a Operating mode: normally closed Operating environment: normal
Generic failure mode: fail to remain in position* Original failure mode: failed open
FAILURE RATE OR PROBABILITY mean : 1.6E-7/hr
Source: Shoreham PRA,GE data(tb.A.2-1) Ultimate source: evaluation of BWR operating experience
Comment:

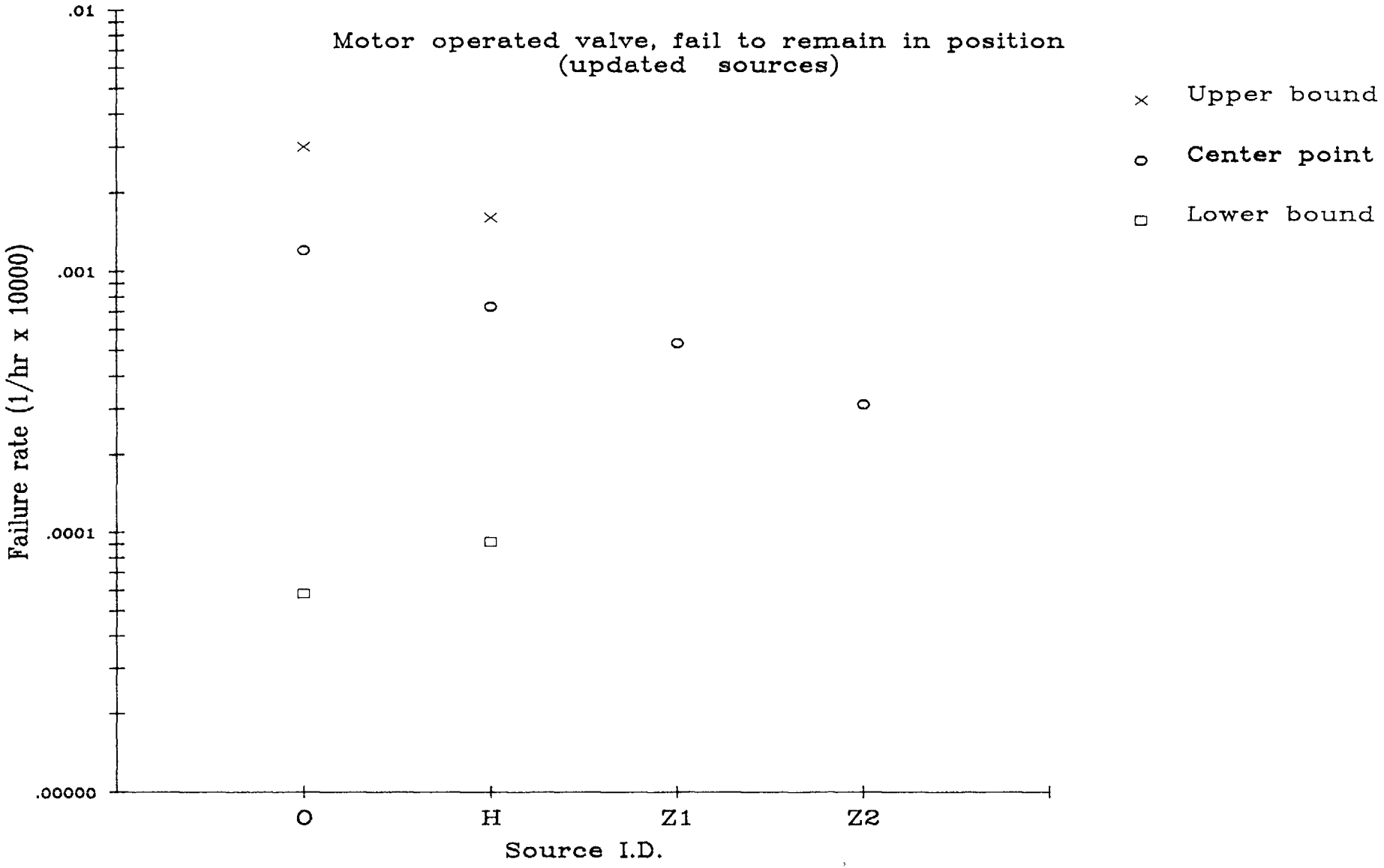
S2 Source category: generic

VMXDS valve motor operated general
Component boundary: detail n/a Operating mode: normally open Operating environment: normal
Generic failure mode: fail to remain in position* Original failure mode: failed closed
FAILURE RATE OR PROBABILITY mean : 1.5E-7/hr
Source: Shoreham PRA,GE data(tb.A.2-1) Ultimate source: evaluatiopn of BWR operating experience
Comment:

I Source category: generic

VMADI valve motor operated general
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to remain in position Original failure mode: failure to remain open
FAILURE RATE OR PROBABILITY mean : 1.0E-7/hr ERROR FACTOR: 3
Source: IREP NUREG 2728 (tb.5.1-1) Ultimate source: expert opinion
Comment:

IAEA RELIABILITY DATA BASE



O Source category: updated

VMADO valve motor operated general
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to remain in position Original failure mode: transfer closed
FAILURE RATE OR PROBABILITY mean : 1.2E-7/hr 95%: 3.0E-7/hr 5%: 5.8E-9/hr
Source: Oconee NPP PRA (tbl.b-1.) Ultimate source: generic data updated with plant specific operating experience
Comment: Prior: WASH 1400,MOV fail to remain open. 5%=20%; 95%=80%. Per demand rate converted to hrly rate assuming 1 demand in 45 days.
Operating experience: 1.89E+6 hours of operation, no failures.

H Source category: updated

VMADH valve motor operated general
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to remain in position Original failure mode: transfer closed
FAILURE RATE OR PROBABILITY mean : 7.3E-8/hr 95%: 1.6E-7/hr 5%: 9.1E-9/hr
Source: Old PWR Ultimate source: generic data updated with plant operating experience
Comment: Generic mean 9.3E-8/hr. Operating experience 1.6E+6 hours of operation, no failures.

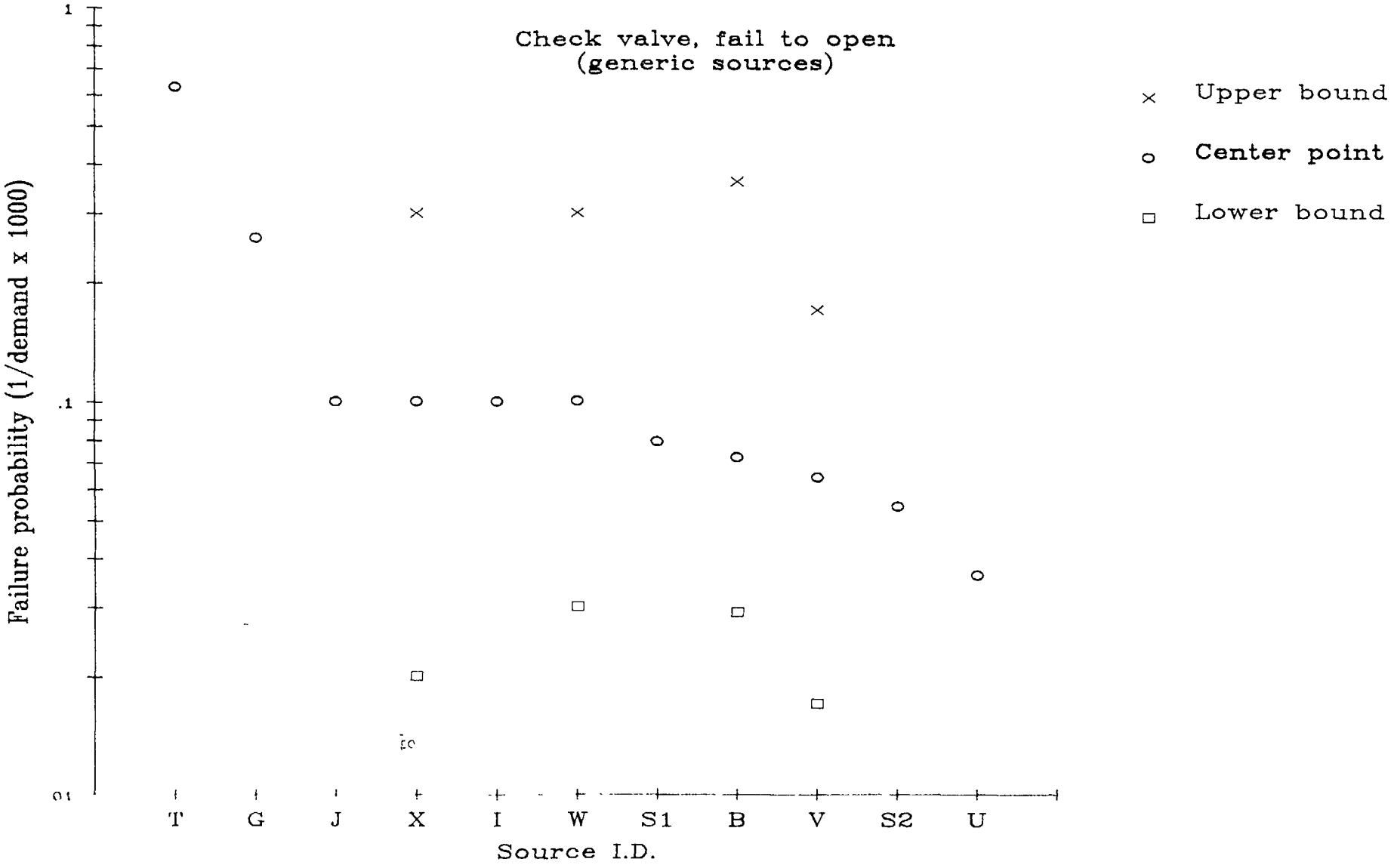
Z1 Source category: updated

VMADZ valve motor operated general
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to remain in position Original failure mode: transfer closed
FAILURE RATE OR PROBABILITY mean : 5.3E-8/hr
Source: ZION NPP PSS (tbl.1.5.1-5) Ultimate source: generic data updated with plant specific experience
Comment: Also applicable to manual valves. Prior:WASH 1400, fail to remain open,plugged. 1 demand in 45 days used to convert to hourly rate.
Operating experience:1.11E+7 hours of operation, no failures.

Z2 Source category: updated

VMADZ valve motor operated general
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to remain in position Original failure mode: transfer open /excessive leakage through valve
FAILURE RATE OR PROBABILITY mean : 3.1E-8/hr
Source: ZION NPP PSS (tbl.1.5.1-5) Ultimate source: generic data updated with plant operating experience
Comment: Priors:NUREG 1363 MOV+remote(PWR),external leakage (mean)and WASH 1400, MOV, external elakage/rupture (distribution).
Opearting experience:6.95E+5 hours of operation, no failures.

IAEA RELIABILITY DATA BASE



T Source category: generic

VCJOT valve self operated check >100 mm
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to open Original failure mode: failure to open
FAILURE RATE OR PROBABILITY mean : 6.3E-4/d REPAIR TIME: 9 hours
Source: Swedish Rel.data book, tbl.19 Ultimate source: plant operating experience (7 BWR plants), ATV reports, LERs
Comment: Total pop.168. No.of demands per operational time 3211. No of failures 1.a=0.071; b=11.2 Critical failure at one plant only. Ringhals 2 PWR- no failure to open out of 1844 demands.

G Source category: generic

VCEOG valve self operated check (ECCS and RHR systems)
Component boundary: detail n/a Per hour value changed to per demand (360 hrs) Operating mode: standby Operating environment: normal
Generic failure mode: fail to open Original failure mode: fail to open
FAILURE RATE OR PROBABILITY mean : 2.6E-4/d ERROR FACTOR: 4
Source: German Risk Study (pg.P3-76) Ultimate source: operating experience
Comment: Operating experience: 1.5E+6 operating hours, no failures. For other check valves combination of generic data sources with failure rate of 2.1E-6/hr (EF 10) was used in FTs.

J Source category: generic

VCAOJ valve self operated check
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to open Original failure mode: fails to open
FAILURE RATE OR PROBABILITY mean : 1.0E-4/d ERROR FACTOR: 3
Source: NUREG 4550, Vol.1,tbl.VIII.1-2 Ultimate source: assesed from several nuclear data sources
Comment: Generic value developed in Station Blackout Study was used.

X Source category: generic

VCAOX valve self operated check
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to open Original failure mode: fail to open
FAILURE RATE OR PROBABILITY mean : 1.0E-4/d 80%: 3.0E-4/d 20%: 2.0E-5/d
Source: VVER relaibility data base Ultimate source: expert opinion, operating experience
Comment:

I Source category: generic

VCAOI valve self operated check
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to open Original failure mode: failure to open
FAILURE RATE OR PROBABILITY mean : 1.0E-4/d ERROR FACTOR: 3
Source: IREP NUREG 2728 (tb.5.1-1) Ultimate source: expert opinion
Comment: Hourly rate is 3.0E-7 (EF 10), based on one actuation per month

W Source category: generic

VCAOW valve self operated check
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to open Original failure mode: failure to open
FAILURE RATE OR PROBABILITY median: 1.0E-4/d 95%: 3.0E-4/d 5%: 3.0E-5/d ERROR FACTOR: 3
Source: WASH 1400 (table III 4-1) Ultimate source: assesed from nuclear, industrial and military expereince and data
Comment:

S1 Source category: generic

VCNOS valve self operated check valve testable check valve
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to open Original failure mode: fails to permit flow
FAILURE RATE OR PROBABILITY mean : 7.9E-5/d
Source: Shoreham PRA,GE data(tb.A.2-1) Ultimate source: evaluation of BWR operating experience
Comment: Original time related value changed to demand related assuming monthly testing.

B Source category: generic

VCAOB valve self operated check
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to open Original failure mode: failure to open
FAILURE RATE OR PROBABILITY mean : 7.2E-5/d max: 3.6E-4/d min: 2.9E-5/d
Source: NUREG 2815 (table C.1.) Ultimate source: expert opinion and IREP data
Comment: Original time related value changed to demand related assuming monthly testing.

V Source category: generic

VCFOV valve self operated check
Component boundary: valve, body and interiors Operating mode: all Operating environment: normal
Generic failure mode: fail to open Original failure mode: failure to open
FAILURE RATE OR PROBABILITY mean : 6.4E-5/d 95%: 1.7E-4/d 5%: 1.7E-5/d
Source: NUREG 1363 (1982) (pg.438) Ultimate source: US plants LER reports
Comment: Overall standy hourly failure rate 3.0E-8/hr.

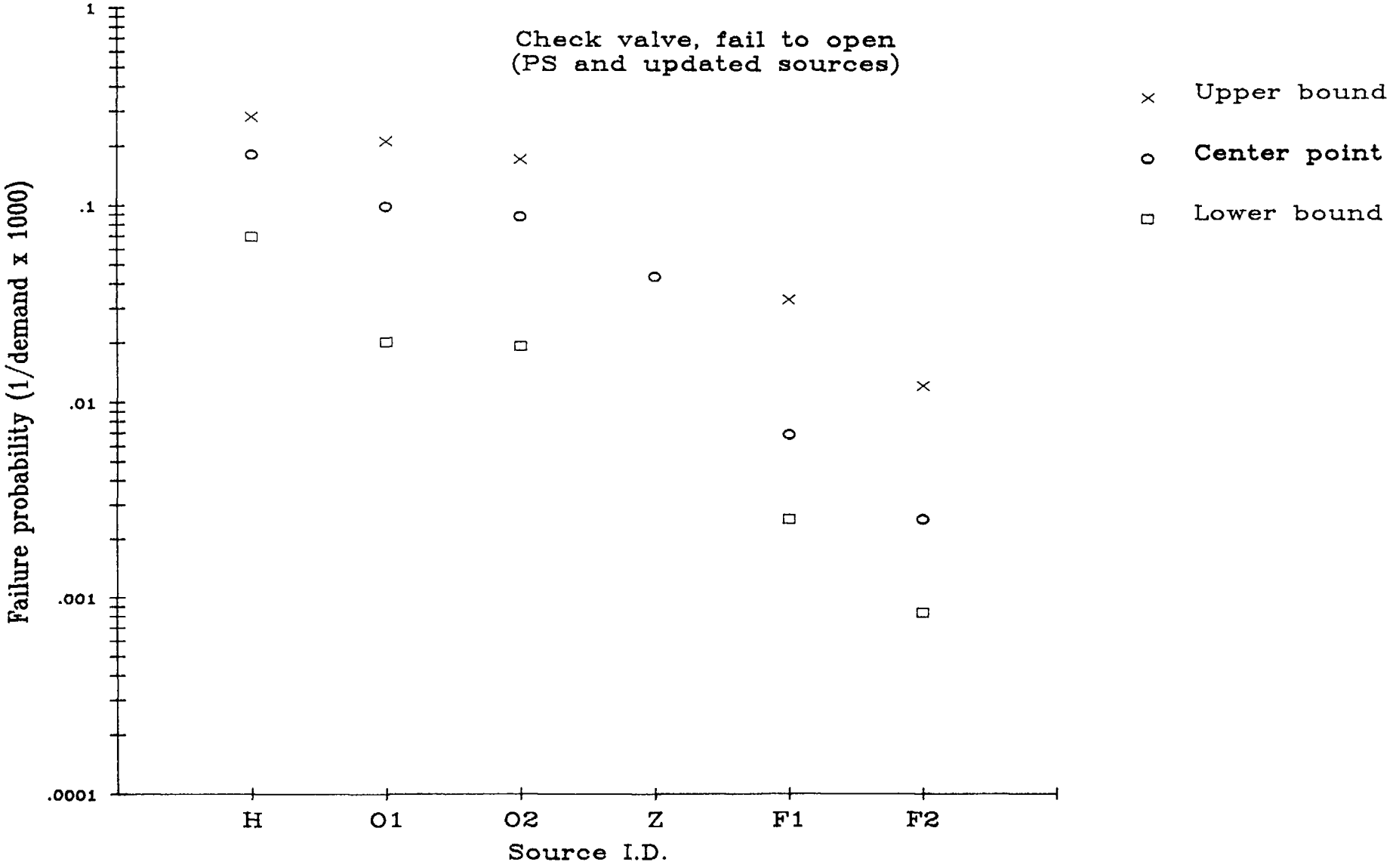
S2 Source category: generic

VCAOS valve self operated check
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to open Original failure mode: fails to permit flow
FAILURE RATE OR PROBABILITY mean : 5.4E-5/d
Source: Shoreham PRA,GE data(tb.A.2-1) Ultimate source: evaluation of BWR operating experience
Comment: Original time related value changed to demand related assuming monthly testing.

U Source category: generic

VCAOU valve self operated check
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to open Original failure mode: failure to open
FAILURE RATE OR PROBABILITY mean : 3.6E-5/d
Source: Sizewell B (PWR/RX312 pg.4) Ultimate source: assesed from nuclear expereince and data
Comment: Assesment based on 2 W data item,WASH 1400,and SRS data item(PWR) (5.0E-5/d).For monthly tested valves stdby failrate of 1.0E-7/hr gives average failure rate of 3.6E-5/d.

IAEA RELIABILITY DATA BASE



H Source category: updated

VCAOH valve self operated check
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to open Original failure mode: fail to open on demand
FAILURE RATE OR PROBABILITY mean : 1.8E-4/d 95%: 2.8E-4/d 5%: 6.9E-5/d
Source: Old PWR Ultimate source: generic data updater with plant operating expereince
Comment: Generic mean 2.7E-4/d. Operating experience 14262 demands, 2 failures.

01 Source category: updated

VCWOO valve self operated check swing
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to open Original failure mode: failure to open
FAILURE RATE OR PROBABILITY mean : 9.8E-5/d 95%: 2.1E-4/d 5%: 2.0E-5/d
Source: Oconee NPP PRA (tbl.b-1.) Ultimate source: generic data updated with plant specific operating experience
Comment: Prior:NUREG 1363, check valve failure to open on demand. Operating experience: 427 demands, no failures.
95%/5% ratio is 10 indicating moderate degree of unceratnty.

02 Source category: updated

VCZOO valve self operated check tilting disc check valve
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to open Original failure mode: failure to open
FAILURE RATE OR PROBABILITY mean : 8.7E-5/d 95%: 1.7E-4/d 5%: 1.9E-5/d
Source: Oconee NPP PRA (tbl.b-1.) Ultimate source: generic data updated with plant specific operating experience
Comment: Prior: NUREG 1363,check valve failure to open on demand Operating experience: 2707 demands, no failures.
95%/5% ratio is 10 indicating moderate degree of uncertanty.

Z Source category: updated

VCAOZ valve self operated check
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to open Original failure mode: failure to open on demand
FAILURE RATE OR PROBABILITY mean : 4.3E-5/d
Source: ZION NPP PSS (tbl.1.5.1-5) Ultimate source: generic data updated with plant operating experience
Comment: Prior:NUREG 1363 check valves(PWR),fail to open (mean) and WASH 1400 check valves, fail to oepn (distrib.).
Operating experience:6968 demands, no failures.

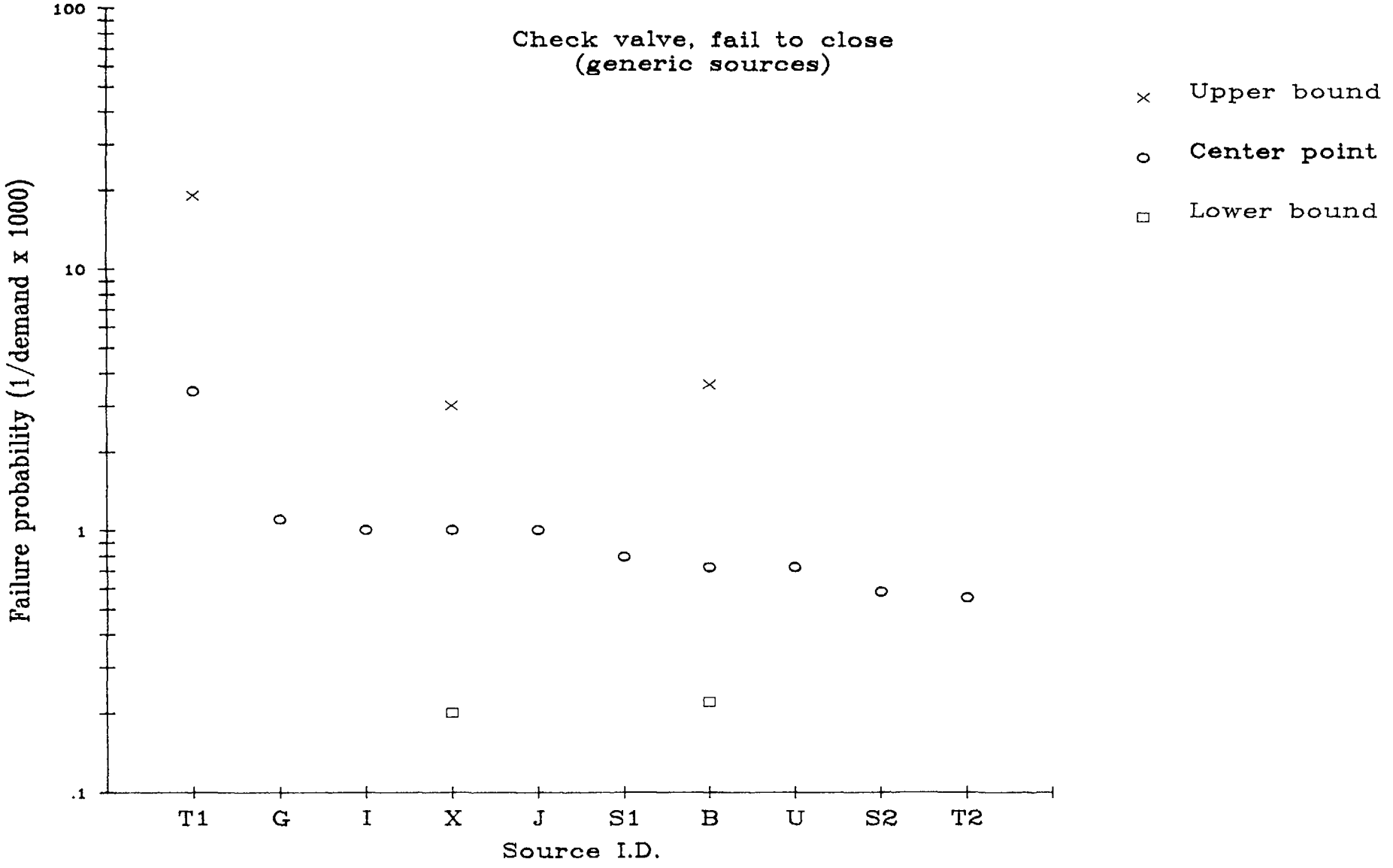
F1 Source category: plant specific

VCSOF valve self operated check (2-6")
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to open Original failure mode: fail to open
FAILURE RATE OR PROBABILITY mean : 6.8E-6/d 95%: 3.3E-5/d 5%: 2.5E-6/d ERROR FACTOR: 2.8 **REPAIR TIME:** 6 hours
Source: HWR data Ultimate source: HWR operating experience
Comment: Pop.662.Cum.operating time 51E+6 hours. 1 failure. No.of demands in cumulative operational time not known.Original time related
value changed to demand related assuming monthly testing.

F2 Source category: plant specific

VCBOF valve self operated check (<2")
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to open Original failure mode: fail to open
FAILURE RATE OR PROBABILITY mean : 2.5E-6/d 95%: 1.2E-5/d 5%: 8.3E-7/d ERROR FACTOR: 3.0 **REPAIR TIME:** 4 hours
Source: HWR data Ultimate source: HWR operating experience
Comment: Pop.1907.Cum.operating time 1.4E+8 hours.No.of failure 1. No.of demands not known.Original time related value changed to demand
related assuming monthly testing.

IAEA RELIABILITY DATA BASE



T1 Source category: generic

VCJET valve self operated check (>100 mm)
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to close Original failure mode: failure to close
FAILURE RATE OR PROBABILITY mean : 3 4E-3/d 95%: 1.9E-2/d REPAIR TIME: 9 hours
Source: Swedish Rel.data book, tbl.19 Ultimate source: plant operating experience(7 BWR plants), ATV reports, LERs
Comment: Total pop.168.No.of demands per operational time 3211.No.of failures 11. a=0.0568; b=16.5 Critical falures reportd at 5 plants.

G Source category· generic

VCAEG valve self operated check
Component boundary· detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to close Original failure mode: fail to close
FAILURE RATE OR PROBABILITY mean · 1.1E-3/d ERROR FACTOR: 3
Source: German Risk Study (pg.P3-77) Ultimate source: generic data
Comment: Failure rate used is combination of several generic data sources. Regarding operating experience, there was 1 recorded failure in 2.6E+6 hours.Time rel.changed to demand assuming monthly testing.

I Source category: generic

VCAEI valve self operated check
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to close Original failure mode: failure to close
FAILURE RATE OR PROBABILITY mean : 1.0E-3/d ERROR FACTOR: 3
Source: IREP NUREG 2728 (tb.5.1-1) Ultimate source: expert opinion
Comment: Hourly rate 3.0E 6(EF 10) based on one actuation per month

X Source category: generic

VCAEX valve self operated check
Component boundary: detail n/a Operating mode· all Operating environment: normal
Generic failure mode: fail to close Original failure mode: fail to close
FAILURE RATE OR PROBABILITY mean : 1.0E-3/d 80%: 3.0E-3/d 20%: 2.0E-4/d
Source: VVER reliability data base Ultimate source. expert opinion, operating experience
Comment:

J Source category· generic

VCAEJ valve self operated check
Component boundary. detail n/a Operating mode all Operating environment: normal
Generic failure mode: fail to close Original failure mode· fails to close (causing back leakage)
FAILURE RATE OR PROBABILITY mean · 1.0E 3/d ERROR FACTOR: 3
Source: NUREG 4550, Vol.1,tbl.VIII.1 2 Ultimate source: assesed from several nuclear data sources
Comment: Value used is from IREP Procedure Guide.

S1 Source category: generic

VCNES valve self operated check testable
Component boundary. detail n/a Operating mode: all Operating environment: normal
Generic failure mode fail to close Original failure mode fails to prevent flow
FAILURE RATE OR PROBABILITY mean 7.9E 4/d
Source: Shoreham PRA,GE data(tb A.2-1) Ultimate source: evaluation of BWR operating experience
Comment: Original time related value changed to demand related assuming monthly testing.

B Source category: generic

VCAEB valve self operated check
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to close Original failure mode: failure to close
FAILURE RATE OR PROBABILITY mean : 7.2E-4/d max: 3.6E-3/d min: 2.2E-4/d
Source: NUREG 2815 (table C.1.) Ultimate source: expert opinion and IREP datda
Comment: Original time related value changed to demand related assuming monthly testing.

U Source category: generic

VCAEU valve self operated check
Component boundary: detail n/a Per hr changed to per demand (360 hrs) Operating mode: all Operating environment: normal
Generic failure mode: fail to close Original failure mode: failure to close
FAILURE RATE OR PROBABILITY mean : 7.2E-4/d
Source: Sizewell B (PWR/RX312 pg.4) Ultimate source: assesed from nuclear experience and data
Comment: Assesment based on W data item,literature data, and SRS data item (2.0E-4/d).For monthly tested valves stdby prob. of 2.0E-6/hr gives average failure prob.of7.2E-4/d.

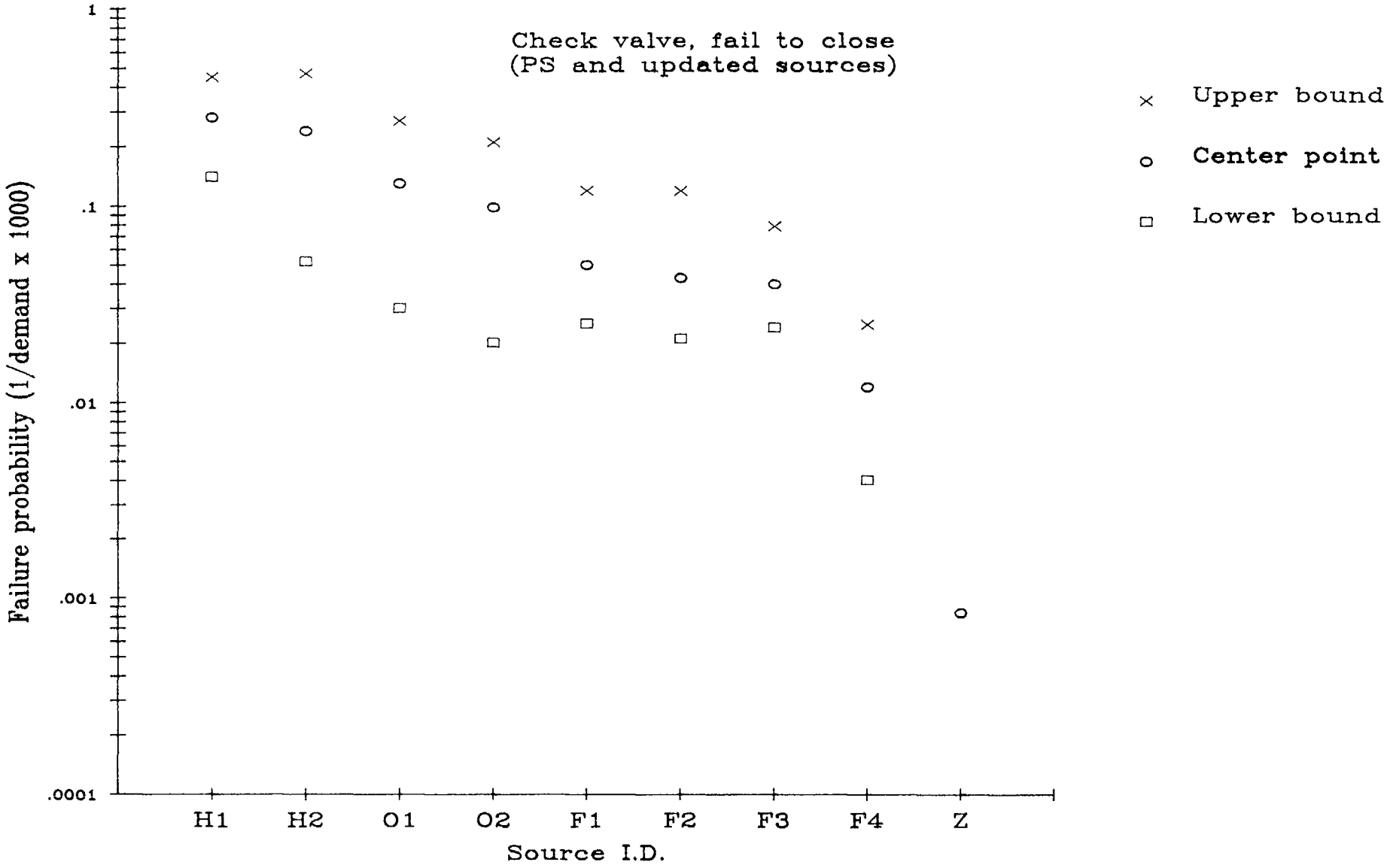
S2 Source category: generic

VCAES valve self operated check
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to close Original failure mode: fails to prevent flow
FAILURE RATE OR PROBABILITY mean : 5.8E-4/d
Source: Shoreham PRA,GE data(tb.A.2.1) Ultimate source: evaluation ofBWR operating experience
Comment: Original time related value changed to demand related assuming monthly testing.

T2 Source category: generic

VCIET valve self operated check <100 mm
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to close Original failure mode: failure to close
FAILURE RATE OR PROBABILITY mean : 5.5E-4/d REPAIR TIME: 12 hours
Source: Swedish Rel.data book, tbl.18 Ultimate source: plant operating experience (7 BWR plants), ATV reports, LERs
Comment: Total pop.417.No.of demands per operational time 3628.No of failures 2.a=0.0129; b=23.3 Critical failures at one plant only. No failure to open observed out of 3628 demands.

IAEA RELIABILITY DATA BASE



H1 Source category: updated

VCMEH valve self operated check (main steam)
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to close Original failure mode: fail to close on demand
FAILURE RATE OR PROBABILITY mean : 2.4E-4/d 95%: 4.7E-4/d 5%: 5.2E-5/d
Source: Old PWR Ultimate source: generic data updated with plant operating experience
Comment: Generic mean 2.7E-4/d. Operating experience 378 demands, no failures.

H2 Source category: updated

VCAEH valve self operated check
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to close Original failure mode: fail to close on demand
FAILURE RATE OR PROBABILITY mean : 2.8E-4/d 95%: 4.5E-4/d 5%: 1.4E-4/d
Source: Old PWR Ultimate source: generic data updated with plant operating experince
Comment: Generic mean 2.7E-4/d. Operating experience 14262 demands, 5 failures.

O1 Source category: updated

VCZEO valve self operated check tilting disc
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to close Original failure mode: failure to close
FAILURE RATE OR PROBABILITY mean : 1.3E-4/d 95%: 2.7E-4/d 5%: 3.0E-5/d
Source: Oconee NPP PRA (tbl.b-1.) Ultimate source: generic data updated with plant specific operating experience
Comment: Prior: NUREG 1363, check valve failure to close on demand. Operating experience: 2719 demands, 1 failure.
95%/5% ratio is 10 indicating moderate degree of unceratnty.

O2 Source category: updated

VCWEO valve self operated check swing
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to close Original failure mode: failure to close
FAILURE RATE OR PROBABILITY mean : 9.8E-5/d 95%: 2.1E-4/d 5%: 2.0E-5/d
Source: Oconee NPP PRA (tbl.b-1.) Ultimate source: generic data updated with plant specific operating experience
Comment: Prior:NUREG 1363, check valve failure to close on demand. Operating experience: 426 demands, no failures
95%/5% ratio is 10 indicating moderate degree of uncertanty.

F1 Source category: plant specific

VCTEF valve self operated check (6-12")
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to close Original failure mode: fail to close
FAILURE RATE OR PROBABILITY mean : 5.0E-5/d 95%: 1.2E-4/d 5%: 2.5E-5/d ERROR FACTOR: 2 REPAIR TIME: 6 hours
Source: HWR data Ultimate source: HWR operating experience
Comment: Pop.390. Cumulative component operating time 29E+6 hours. No.of failures 4.Number of demands per operational time is not known.
Org.time rel.value changed to demand rel.assuming monthly testing

F2 Source category: plant specific

VCLEF valve self operated check (12-24")
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to close Original failure mode: fail to close
FAILURE RATE OR PROBABILITY mean : 4.3E-5/d 95%: 1.2E-4/d 5%: 2.1E-5/d ERROR FACTOR. 2.1 REPAIR TIME: 19 hours
Source: HWR data Ultimate source. HHW operating experiece
Comment: Pop.343.Cum.operating time 24.4E+6 hours.No.of failures 3.No.of demands in cumulative component operating time is not known.
Org.time rel.value changed to demand rel.assuming monthly testing

F3 Source category: plant specific

VCSEF valve self operated check (2-6")
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to close Original failure mode: fail to close
FAILURE RATE OR PROBABILITY mean : 4.0E-5/d 95%: 7.9E-5/d 5%: 2.4E-5/d ERROR FACTOR: 1.8 REPAIR TIME: 6 hours
Source: HWR data Ultimate source: HWR operating experience
Comment: Pop.662.Cum.operating time 51E+6 hours.6 failures. No.of demands in cumulative opearting time is not known.
Org.time rel.value changed to demand rel.assuming monthly testing

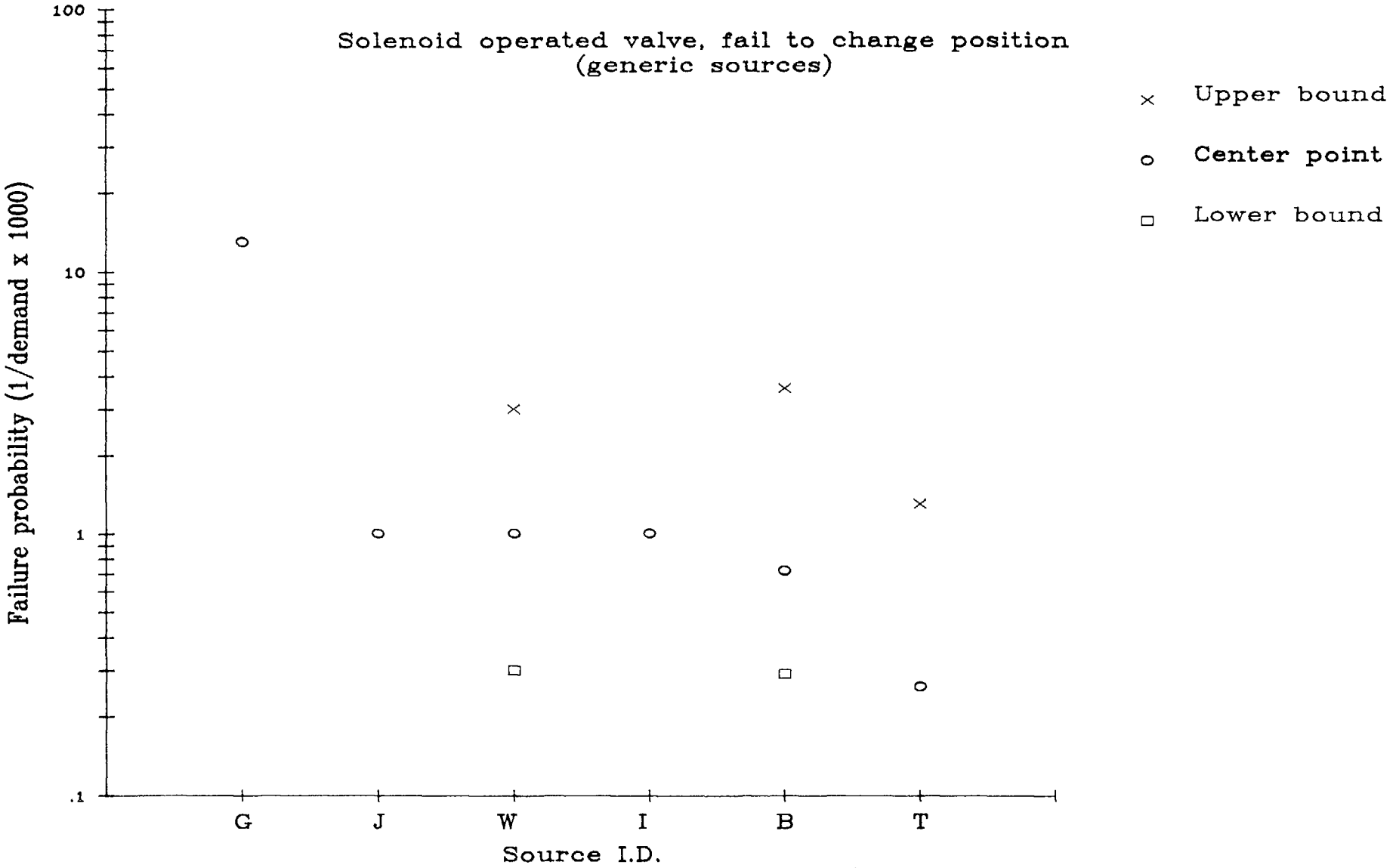
F4 Source category: plant specific

VCBEF valve self operated check (>2")
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to close Original failure mode: fail to close
FAILURE RATE OR PROBABILITY mean : 1.2E-5/d 95%: 2.5E-5/d 5%: 4.0E-6/d ERROR FACTOR: 2 REPAIR TIME: 4 hours
Source: HWR data Ultimate source: HWR operating experience
Comment: Pop.1907.Cum.operating time 1.4E+8 hours. No.of failures 4. No.of demands not known.
Org.time rel.value changed to demand rel.assuming monthly testing

Z Source category: updated

VCAEZ valve self operated check
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to close Original failure mode: failure to seat/excessive leakage
FAILURE RATE OR PROBABILITY mean : 8.4E-7/d
Source: ZION NPP PSS (tbl.1.5.1-5) Ultimate source: generic data updated with plant operating experience
Comment: Priors:NUREG 1363 check valve(PWR),internal leakage (mean) and WASH 1400, check valves, reverse leakage (distrib).
Operating experience:6.08E+5 hours of operation, no failures.

IAEA RELIABILITY DATA BASE



G Source category: generic

VDACG valve solenoid operated general
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to change position Original failure mode: fail to open or to close
FAILURE RATE OR PROBABILITY mean : 1.3E-2/d ERROR FACTOR: 20
Source: German Risk Study (pg.P3-75) Ultimate source: generic data
Comment: There is no specific operating experience data for this component and failure rate is combination of several generic data sources (6).Org.time rel.value changed to demand assuming monthly testing

J Source category: generic

VDACJ valve solenoid operated general
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to change position Original failure mode: fails to operate
FAILURE RATE OR PROBABILITY mean : 1.0E-3/d ERROR FACTOR: 3
Source: NUREG 4550, Vol.1,tbl.VIII.1-2 Ultimate source: assesed from several nuclear data sources
Comment: Same value as for air operated valve. Two types of failures included in the failure rate: valve hardware fault (1.0E-3) and command circut faults (1.0E-4).

W Source category: generic

VDACW valve solenoid operated general
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to change position Original failure mode: failure to operate
FAILURE RATE OR PROBABILITY median: 1.0E-3/d 95%: 3.0E-3/d 5%: 3.0E-4/d ERROR FACTOR: 3
Source: WASH 1400 (table III 4-1) Ultimate source: assesed from nuclear,industrial and military experience and data
Comment: Based on presence of proper input signal Failure of a valve to operate include changing state from closed to open or fron open to closed position.

I Source category: generic

VDACI valve solenoid operated general
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to change position Original failure mode: failure to operate
FAILURE RATE OR PROBABILITY mean : 1.0E-3/d ERROR FACTOR: 3
Source: IREP NUREG 2728 (tb.5.1-1) Ultimate source: expert opinion
Comment:

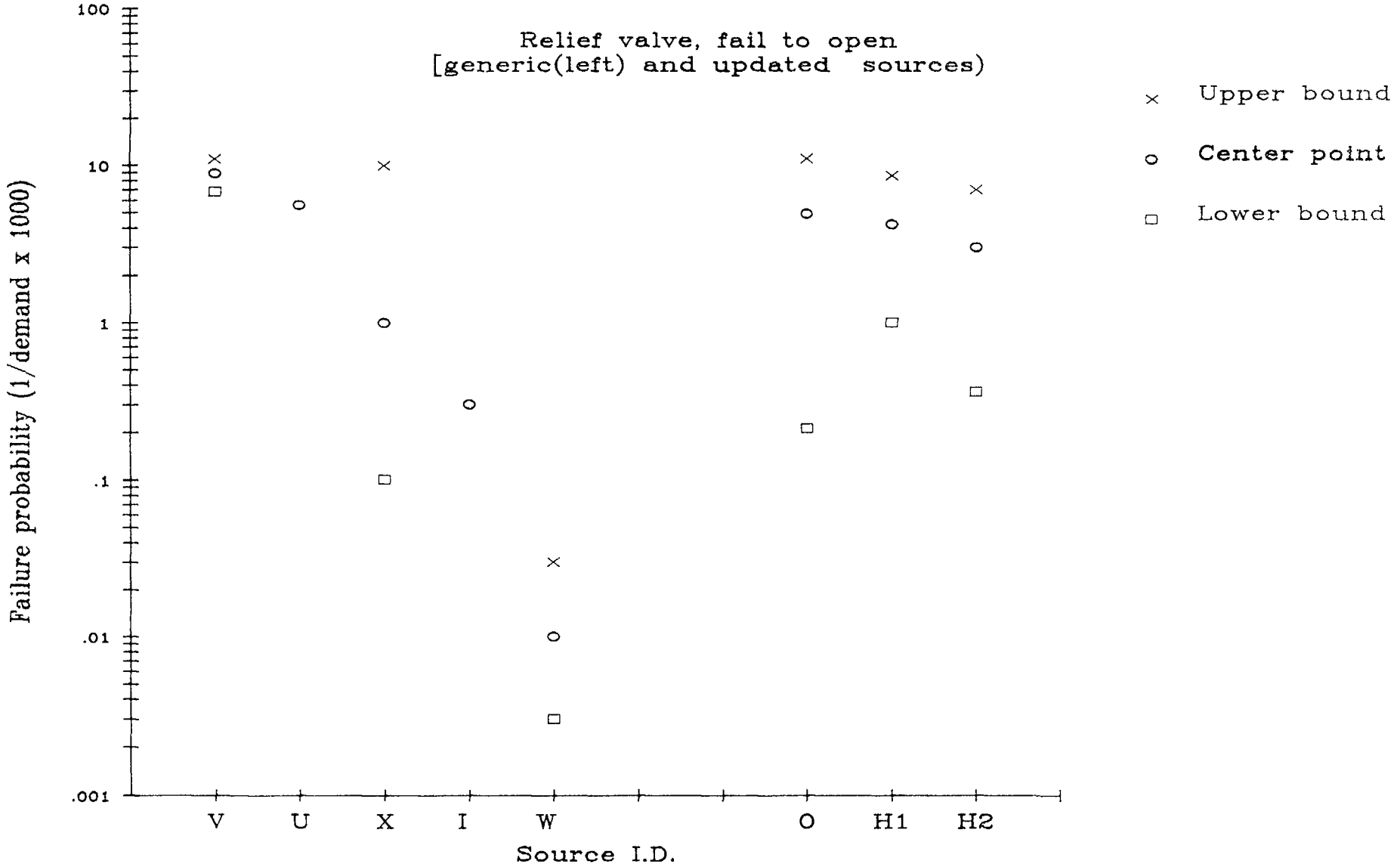
B Source category: generic

VDACB valve solenoid operated general
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to change position Original failure mode: failure to operate
FAILURE RATE OR PROBABILITY mean : 7.2E-4/d max: 3.6E-3/d min: 2.9E-4/d
Source: NUREG 2815 (table C.1.) Ultimate source: expert opinion and IREP data
Comment: Original time related value changed to demand related assuming monthly testing

T Source category: generic

VDNCT valve solenoid operated general (normally activated)
Component boundary: detail n/a Operating mode: normally activated Operating environment: normal
Generic failure mode: fail to change position Original failure mode: failure to function
FAILURE RATE OR PROBABILITY mean : 2.6E-4/d 95%: 1.3E-3/d REPAIR TIME: 3 hours
Source: Swedish Rel.data book, tbl.23 Ultimate source: plant operating experience (7 BWR plants), ATV reports, LERs
Comment: Total pop.513.Operating time 2260E+4 hours. No.of failures 16. Critical failures reported on 2 plants. a=0.0487; b=68600.Time rel.changed to demand assuming month.tests

IAEA RELIABILITY DATA BASE



V Source category: generic

VRBOV valve primary relief valve BWR
Component boundary: valve body and internals,operating mechanism Operating mode: all Operating environment: normal
Generic failure mode: fail to open Original failure mode: failure to open
FAILURE RATE OR PROBABILITY mean : 8.9E-3/d 95%: 1.1E-2/d 5%: 6.8E-3/d
Source: NUREG 1363 (1982) (pg.474) Ultimate source: US plants LER reports evaluation
Comment: Incl.all BWR safety-relief v\v(ADS and ordinary relief).W/o comm. W command 1.1E-2/d.No.of demands is 1 test and operational demand equal to tot.no.of forced and manual scrams.Rate 8.7E-6/hr stdby.

U Source category: generic

VRPOU valve power operated relief (PORV)
Component boundary: detail n/a Per hour changed to per demand with 2160 hrs Operating mode: standby Operating environment: normal
Generic failure mode: fail to open Original failure mode: failure to open
FAILURE RATE OR PROBABILITY mean : 5.6E-3/d
Source: Sizewell B (PWR/RX312 pg.5) Ultimate source: assesed from nuclear expereince and data
Comment: The same failure rate applicable for safety valves.Assesment bsd on W data,WASH 1400 adn SRS data item(7.0E-3/d).For yearly testin stdby failrate(2.6E-6/hr)gives peak rate 2.3E-2/d(pessimistic).

X Source category: generic

VRAOX valve power or pilot operated relief valve
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to open Original failure mode: fail to open
FAILURE RATE OR PROBABILITY mean : 1.0E-3/d 80%: 1.0E-2/d 20%: 1.0E-4/d
Source: VVER reliability data base Ultimate source: expert opinion, operating experience
Comment:

I Source category: generic

VRAOI valve relief valve
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to open Original failure mode: failure to open
FAILURE RATE OR PROBABILITY mean : 3.0E-4/d ERROR FACTOR: 10
Source: IREP NUREG 2728 (tb.5.1-1) Ultimate source: expert opinion
Comment:

W Source category: generic

VRAOW valve relief
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to open Original failure mode: failure to open
FAILURE RATE OR PROBABILITY median: 1.0E-5/d 95%: 3.0E-5/d 5%: 3.0E-6/d ERROR FACTOR: 3
Source: WASH 1400 (table III 4-1) Ultimate source: assesed from nuclear,industrial(SRS) and mil.experience and data
Comment:

O Source category: updated

VRPOO valve power operated relief PORV
Component boundary: detail n/a Operating mode: standby Operating environment: normal
Generic failure mode: fail to open Original failure mode: failure to open
FAILURE RATE OR PROBABILITY mean : 4.9E-3/d 95%: 1.1E-2/d 5%: 2.1E-4/d
Source: Oconee NPP PRA (tbl.b-1.) Ultimate source: generic data updated with plant specific operating experience
Comment: Prior: NUREG 1363 (1980),BWR relief open on demand. BWR used because lack of PWR PORV data, and similarities between PORV and AD function.Op.experience 31 demand, no failures.

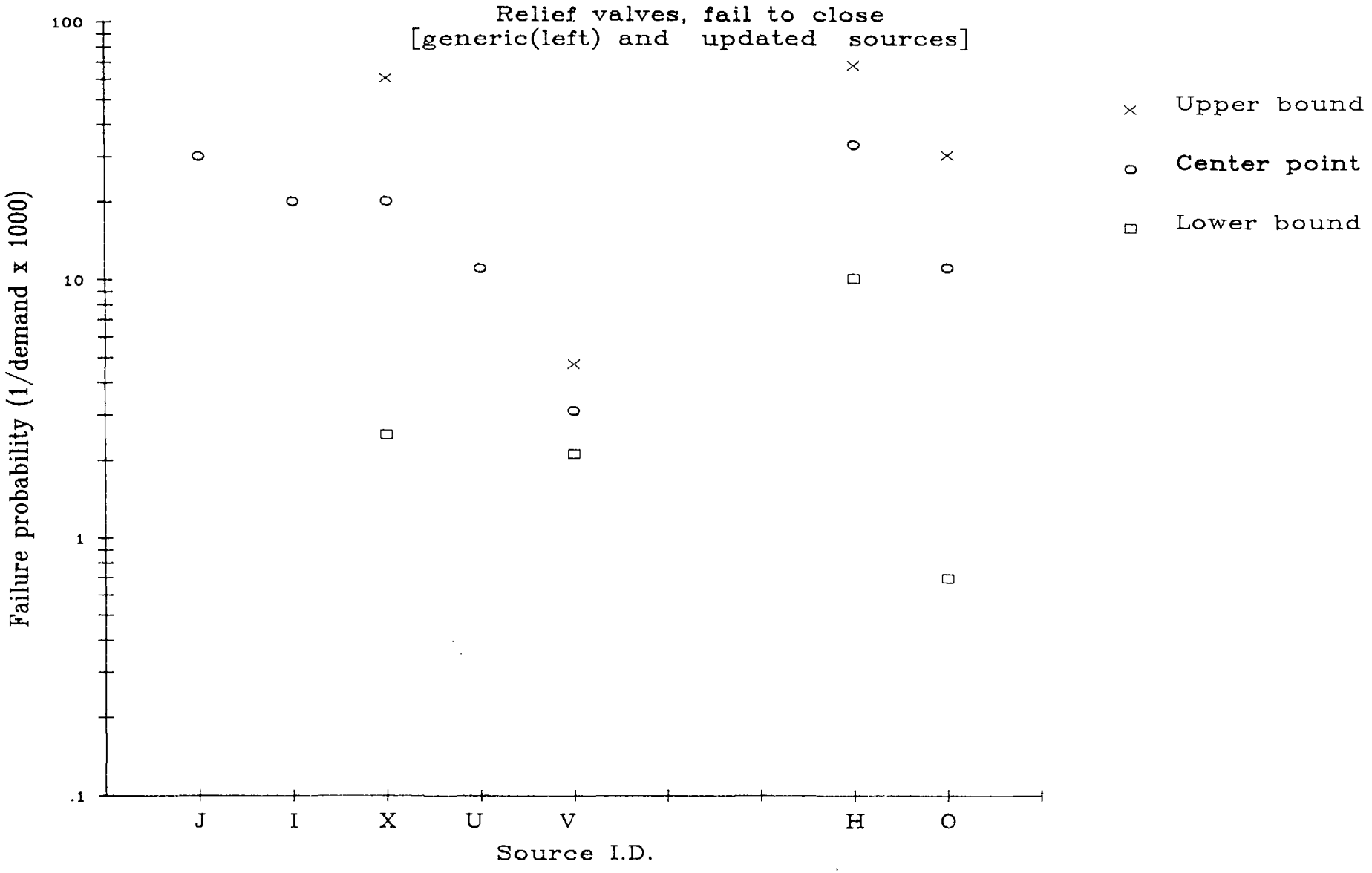
H1 Source category: updated

VRPOH valve power operated relief PORV
Component boundary: detail n/a Operating mode: closed Operating environment: normal
Generic failure mode: fail to open Original failure mode: fail to open on demand
FAILURE RATE OR PROBABILITY mean : 4.2E-3/d 95%: 8.6E-3/d 5%: 1.0E-3/d
Source: Old PWR Ultimate source: generic data updated with plant operatng experience
Comment: Generic mean 4.3E-3/d . Operating expereince 8 demands, no failures.

H2 Source category: updated

VRMOH valve relief (main steam atmosferic relief)
Component boundary: detail n/a Operating mode: closed Operating environment: normal
Generic failure mode: fail to open Original failure mode: fail to open on demand
FAILURE RATE OR PROBABILITY mean : 3.0E-3/d 95%: 7.0E-3/d 5%: 3.6E-4/d
Source: Old PWR Ultimate source: genric data updated with palnt opearting experience
Comment: Generic mean 2.4E-3/d. Operating experience 199 demands, 1 failure.

IAEA RELIABILITY DATA BASE



J Source category: generic

VRPEJ valve power operated relief valve PORV
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to close Original failure mode: fails to reclose
FAILURE RATE OR PROBABILITY mean : 3.0E-2/d ERROR FACTOR: 10
Source: NUREG 4550, Vol.1,tbl.VIII.1-2 Ultimate source: assesed from several nuclear data sources
Comment: This value is also applicable to Safety Relief Valves. ASEP used generic value from IREP procedure guide, but it also falls into the range indicated by LERs.

I Source category: generic

VRAEI valve relief valve
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to close Original failure mode: failure to close, given open
FAILURE RATE OR PROBABILITY mean : 2.0E-2/d ERROR FACTOR: 3
Source: IREP NUREG 2728 (tb.5.1-1) Ultimate source: expert opinion
Comment:

X Source category: generic

VRAEX valve power or pilot operated relief valve
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to close Original failure mode: fail to close
FAILURE RATE OR PROBABILITY mean : 2.0E-2/d 80%: 4.0E-2/d 20%: 2.5E-3/d
Source: VVER reliablity data base Ultimate source: expert opinion
Comment:

U Source category: generic

VRPEU valve power operated relief valve PORV
Component boundary: detail n/a Per hour changed to per demand with 2160 hrs. Operating mode: all Operating environment: normal
Generic failure mode: fail to close Original failure mode: failure to close
FAILURE RATE OR PROBABILITY mean : 1.1E-2/d
Source: Sizewell B (PWR/RX312 pg.5) Ultimate source: assesed from nuclear experience and data
Comment: Assesment based on W data item and SRS data item applicable to PORV's(4.0E-2/d). Original time related value changed to demand related assuming 1 demand/1/2 year.

V Source category: generic

VRBEV valve primary relief valve BWR
Component boundary valve body and internals, operating mechanism Operating mode: all Operating environment: normal
Generic failure mode: fail to close Original failure mode: fail to reseat
FAILURE RATE OR PROBABILITY mean . 3.1E-3/d 95%. 4.7E-3/d 5%: 2.1E 3/d
Source. NUREG 1363 (1982) (pg.482) Ultimate source: US plants LER reports evaluation
Comment: See comment relief failure to open.Standby hourly rate 3.0E-6/hr. W/o command faults. With command faults 3.2E-3/d.Standby hourly rate with command faults 3.2E-6/hr.

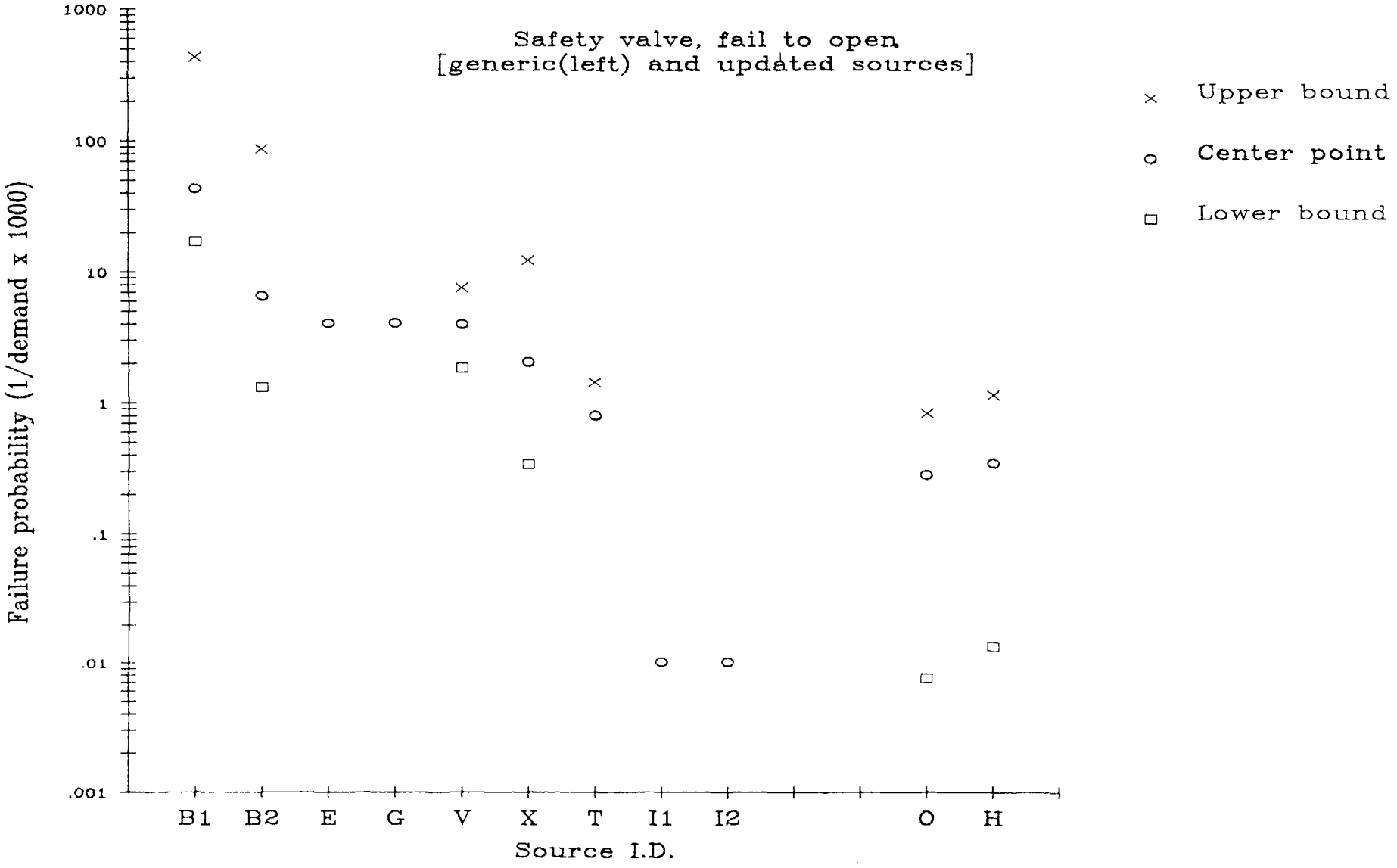
H Source category: updated

VRPEH valve power operated relief PORV
Component boundary: detail n/a Operating mode: standby Operating environment: normal
Generic failure mode: fail to close Original failure mode: fail to close on demand
FAILURE RATE OR PROBABILITY mean : 3.3E-2/d 95%: 6.7E-2/d 5%: 1.0E-2/d
Source: Old PWR Ultimate source: generic data updated with plant operating experience
Comment: Generic mean 2.5E-2/d. Operating experience 8 demands, 1 failure.

O Source category: updated

VRPEO valve power operated relief PORV
Component boundary: detail n/a Operating mode: standby Operating environment: normal
Generic failure mode: fail to close Original failure mode: failure to close
FAILURE RATE OR PROBABILITY mean : 1.1E-2/d 95%: 3.0E-2/d 5%: 6.9E-4/d
Source: Oconee NPP PRA (tbl.b-1.) Ultimate source: generic data updated with plant specific operating experience
Comment: Prior: NUREG 1363. Failure to reclose after water or steam relief has the same distribution, based on EPRI valve test program.
Operating experience:31 demands. 1 failure.

IAEA RELIABILITY DATA BASE



B1 Source category: generic

VSCOB valve self operated code safety valve
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to open Original failure mode: failure to open
FAILURE RATE OR PROBABILITY mean : 6.5E-3/d max: 8.6E-2/d min: 1.3E-3/d
Source: NUREG 2815 (table C.1.) Ultimate source: expert opinion and IREP data
Comment: Applies to PWR only. Premature opening covered under initiating events. Original time related value changed to demand related assuming demand occuring every 1/2 year.

B2 Source category: generic

VSBOB valve self operated primary safety valve
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to open Original failure mode: failure to open
FAILURE RATE OR PROBABILITY mean : 4.3E-2/d max: 4.3E 1/d min: 1.7E-2/d
Source: NUREG 2815 (table C.1.) Ultimate source: expert opinion and IREP data
Comment: applies to BWR only Original time related value changed to demand related assuming demand occuring every 1/2 year.

E Source category: generic

VSAOE valve safety
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to open Original failure mode: fail to open
FAILURE RATE OR PROBABILITY rec : 4.0E-3/cy
Source: IEEE 500 (1984) pg.1040 Ultimate source: expert judgement(delphi procedure) & experience
Comment: reference EGG-EA -5816 1982

G Source category: generic

VSTOG valve pilot valve operated safety valve (pressurizer or main steam line)(with 2 or 3 pilots)
Component boundary: detail n/a Operating mode: closed Operating environment: normal
Generic failure mode: fail to open Original failure mode: fail to open
FAILURE RATE OR PROBABILITY median: 4.0E-3/d ERROR FACTOR: 6
Source: German Risk Study (tb.F3,7-1) Ultimate source: operating experience
Comment: Operating experience: 20 test and 80 operational demands, no failures reported. It is assumed that having more than one pilot valve lower actual valve opening failure rate.N/a to water relief

V Source category: generic

VSPOV valve self operated safety valves PWR
Component boundary: valve body and internals, operating mechanism Operating mode: all Operating environment: normal
Generic failure mode: fail to open Original failure mode: fail to open
FAILURE RATE OR PROBABILITY mean : 3.9E-3/d 95%: 7.4E-3/d 5%: 1.8E-3/d
Source: NUREG 1363 (1982) (pg.465) Ultimate source: US plants LER reports evaluation
Comment: Overall data.Standby hourly rate is 1.7E-6/hr. Demand rate is taking into account 5 years test interval,and operational demands in observed period (demand=1/2 of all forced scrams,PWR)

X Source category: generic

VSAOX valve safety
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to open Original failure mode: fail to open
FAILURE RATE OR PROBABILITY mean 2.0E-3/d 80%: 1.2E-2/d 20% 3.3E-4/d
Source VVER reliability data base Ultimate source: expert opinion
Comment:

T Source category: generic

VSROT valve pilot valve operated safety valve
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to open Original failure mode: failure to open
FAILURE RATE OR PROBABILITY mean : 7.8E-4/d 95%: 1.4E-3/d REPAIR TIME: 9 hours
Source: Swedish Rel.data book, tbl.22 Ultimate source: plant operating experience(7 BWR plants),ATV reports,LERs
Comment: Total pop.126.No.of demands 1281.No of failures 1.a=0.0167;b=21.4 Pilot valve see "vwkot". Safety valve+pilot valve=pressure relief system.Critical failure on one plant only.

I1 Source category: generic

VSCOI valve self operated code safety valve
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to open Original failure mode: failure to open
FAILURE RATE OR PROBABILITY mean : 1.0E-5/d ERROR FACTOR: 3
Source: IREP NUREG 2728 (tb.5.1-1) Ultimate source: expert opinion
Comment: Applies to PWR only. Premature opening is treated as an initiating event.

I2 Source category: generic

VSBOI valve self operated primary safety valves
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to open Original failure mode: failure to open
FAILURE RATE OR PROBABILITY mean : 1.0E-5/d ERROR FACTOR: 3
Source: IREP NUREG 2728 (tb.5.1-1) Ultimate source: expert opinion
Comment: applies to BWR only

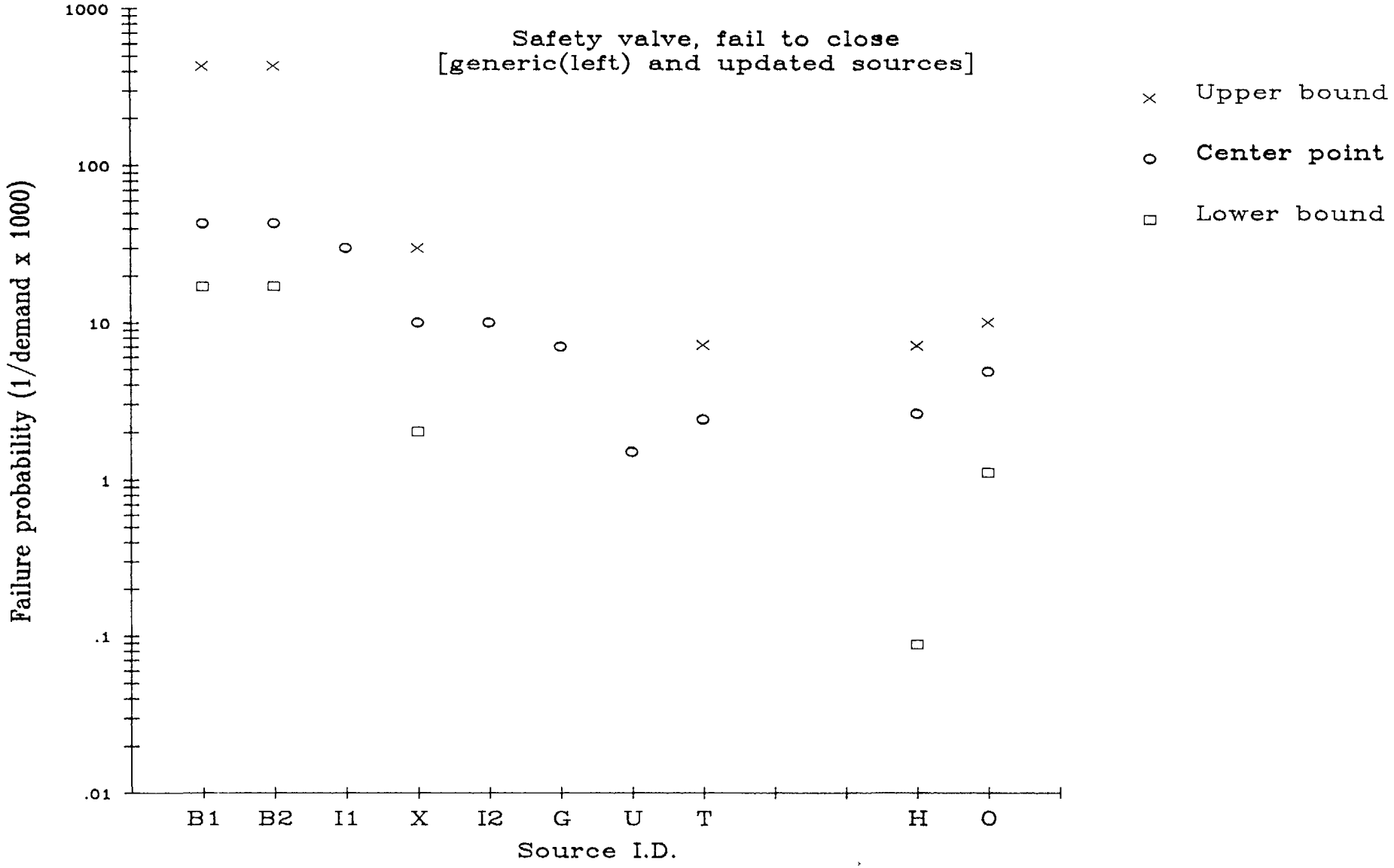
O Source category: updated

VSDOO valve self operated pressurizer safety valve
Component boundary: detail n/a Operating mode: standby Operating environment: normal
Generic failure mode: fail to open Original failure mode: failure to open
FAILURE RATE OR PROBABILITY mean : 2.7E-4/d 95%: 8.0E-4/d 5%: 7.4E-6/d
Source: Oconee NPP PRA (tbl.b-1.) Ultimate source: generic data updated with plant specific operating experience
Comment: Prior:Median of General Atomic data base (GCR) for primary relief valves, range factor 10.
Operating experience: 10 demands, no falures.

H Source category: updated

VSMOH valve self operated safety(main steam)
Component boundary: detail n/a Operating mode: closed Operating environment: normal
Generic failure mode: fail to open Original failure mode: fail to open on demand
FAILURE RATE OR PROBABILITY mean : 3.3E-4/d 95%: 1.1E-3/d 5%: 1.3E-5/d
Source: Old PWR Ultimate source: generic data updated with plant operating experience
Comment: Generic mean 3.3E-4/d. Operating experience 10 demands, no failures.

IAEA RELIABILITY DATA BASE



B1 Source category: generic

VSBEB valve self operated primary safety valve
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to close Original failure mode: failure to close,given open
FAILURE RATE OR PROBABILITY mean : 4.3E-2/d max: 4.3E-1/d min: 1.7E-2/d
Source: NUREG 2815 (table C.1.) Ultimate source: expert opinion and IREP data
Comment: applies to BWR only Original time related value changed to demand related assuming demand occuring every 1/2 year.

B2 Source category: generic

VSCEB valve self operated code safety valve
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to close Original failure mode: failure to close, given open
FAILURE RATE OR PROBABILITY mean : 4.3E-2/d max: 4.3E-1/d min: 1.7E-2/d
Source: NUREG 2815 (table C.1.) Ultimate source: expert opinion and IREP data
Comment: Aplies to PWR only Original time related value changed to demand related assuming demand occuring everu 1/2 year.

I1 Source category: generic

VSBEI valve self operated primary safety valve
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to close Original failure mode: failure to close,given open
FAILURE RATE OR PROBABILITY mean : 3.0E-2/d ERROR FACTOR: 10
Source: IREP NUREG 2728 (tb.5.1-1) Ultimate source: expert opinion
Comment: aplies to BWR only

X Source category: generic

VSAEX valve safety
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to close Original failure mode: fail to close
FAILURE RATE OR PROBABILITY mean : 1.0E-2/d 80%: 3.0E-2/d 20%: 2.3E-3/d
Source: VVER reliability data base Ultimate source: expert opinion
Comment:

I2 Source category: generic

VSCEI valve self operated code safety valve
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to close Original failure mode: failure to close, given open
FAILURE RATE OR PROBABILITY mean : 1.0E-2/d ERROR FACTOR: 3
Source: IREP NUREG 2728 (tb.5.1-1) Ultimate source: expert opinion
Comment: applies to PWR only

G Source category: generic

VSTEG valve pilot valve operated safety valve (pressurizer or main steam line)(with 2 or 3 pilot)
Component boundary: detail n/a Operating mode: closed Operating environment: normal
Generic failure mode: fail to close Original failure mode: fail to close
FAILURE RATE OR PROBABILITY median: 7.0E-3/d ERROR FACTOR: 4
Source: German Risk Study (tb.F3,7-1) Ultimate source: operating expereince
Comment: Operating experience: 20 test and 80 operational demands, no failures. Failure rate is not influenced by number of pilot valves. Not applicable to water relief safety valves.

U Source category: generic

VSAEU valve self operated safety relief valve
Component boundary: detail n/a Per hour changed to per demand using 2160hrs. Operating mode: all Operating environment: normal
Generic failure mode: fail to close Original failure mode: failure to close
FAILURE RATE OR PROBABILITY mean : 1.5E-3/d
Source: Sizewell B (PWR/RX312 pg.5) Ultimate source: assesed from nuclear experience and data
Comment: Assesment based on W data item and SRS data applicable to SRVs, (6.0E-3/d).Original time related value changed to demand related assuming demand occuring every 1/2 year.

T Source category: generic

VSRET valve self operated (pilot operated) safety valve (pressure relief system)
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to close Original failure mode: failure to reclose
FAILURE RATE OR PROBABILITY mean : 2.4E-3/d 95%: 7.2E-3/d REPAIR TIME: 9 hours
Source: Swedish Rel.data book, tbl.22 Ultimate source: plant operating experience (BWR plants), ATV reports, LERs
Comment: Total pop.126.No.of demands 1281.No.of failures 2. Pilot valve see "vwket". a=0.0232; b=9.67
Critical failures reported on 2 plants.

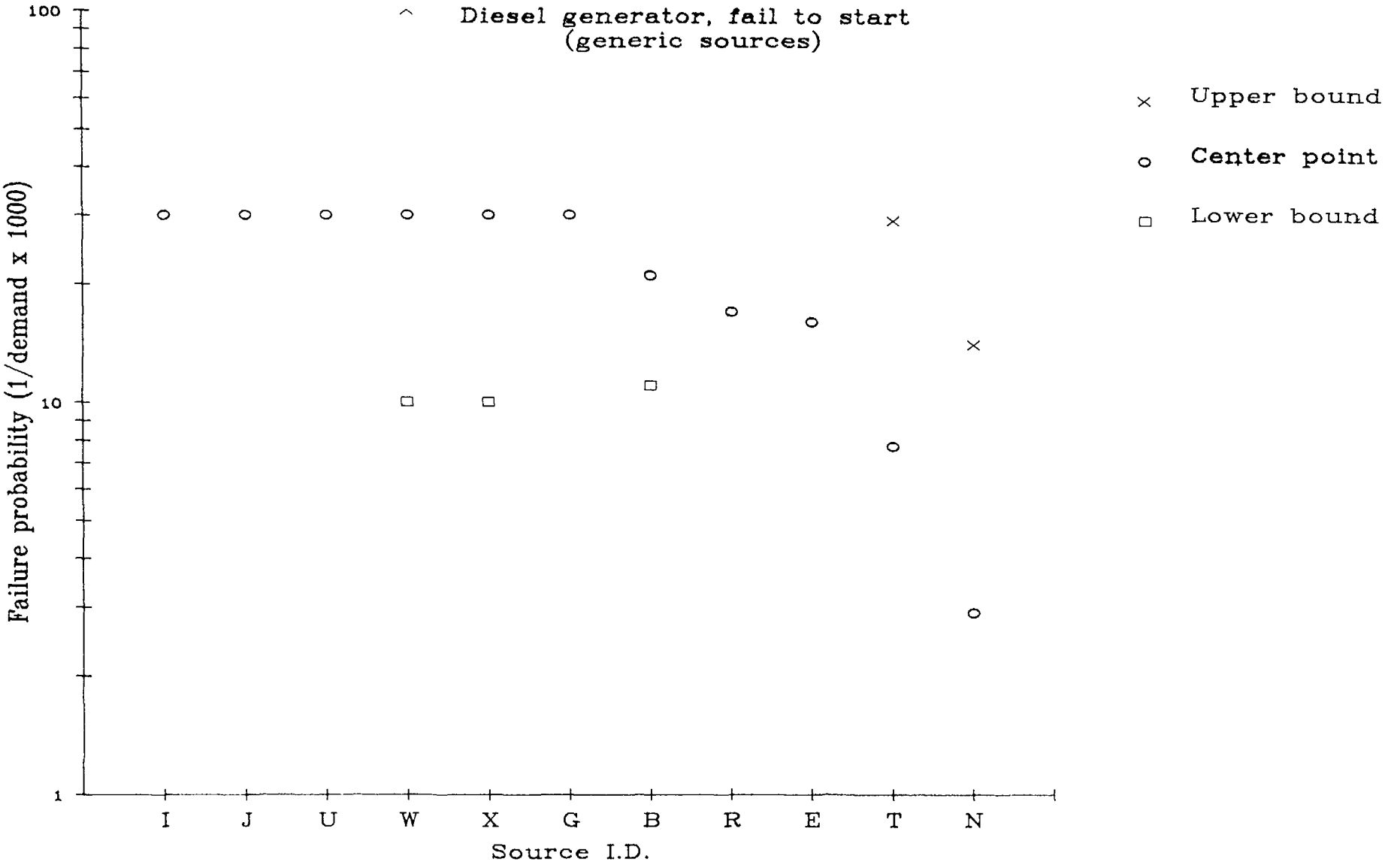
H Source category: updated

VSMEH valve self operated safety (main steam)
Component boundary: detail n/a Operating mode: closed Operating environment: normal
Generic failure mode: fail to close Original failure mode: fail to close on demand
FAILURE RATE OR PROBABILITY mean : 2.6E-3/d 95%: 7.1E-3/d 5%: 8.8E-5/d
Source: Old PWR Ultimate source: generic data updated with plant operating experience
Comment: Generic mean 2.9E-3/d.Operating experience 10 demands, no failures.

O Source category: updated

VSDEO valve self operated pressurizer safety valve
Component boundary: detail n/a Operating mode: standby Operating environment: normal
Generic failure mode: fail to close Original failure mode: failure to close
FAILURE RATE OR PROBABILITY mean : 4.8E-3/d 95%: 1.0E-2/d 5%: 1.1E-3/d
Source: Oconee NPP PRA (tbl.b-1.) Ultimate source: generic data updated with plant specific operating experience
Comment: Prior:Median,failure to reclose(steam relief) Babcock&Wilcox Co. Distribution based on EPRI test.
Operating experience: 10 deamnds, no failure. ONLY STEAM RELIEF

IAEA RELIABILITY DATA BASE



I Source category: generic

DGASI diesel generator emergency AC
Component boundary: engine,gen.coupling,governor,out.breaker,exciter,lube & fuel oil Operating mode: standby Operating environment: normal
Generic failure mode: fail to start Original failure mode. failure to start
FAILURE RATE OR PROBABILITY mean : 3.0E-2/d ERROR FACTOR: 3
Source: IREP NUREG 2728 (tb.5.1-1) Ultimate source: expert opinion
Comment: BOUNDARY contd.starting system,intake and exaust air. Excluded: starting air compressor and accumulator,fuel storage & transfer load sequencer & synchroiser.Failmode incl. running for 1/2 hour.

J Source category: generic

DGASJ diesel generator emergency AC
Component boundary: detail n/a Operating mode: standby Operating environment: normal
Generic failure mode· fail to start Original failure mode: failure to start
FAILURE RATE OR PROBABILITY mean : 3.0E-2/d ERROR FACTOR: 3
Source: NUREG 4550, Vol.1,tbl.VIII.1-2 Ultimate source: assesed from several nuclear data sources
Comment: ASEP used generic value from the Reliability of AC Power System Study (NUREG/CR-2989) which contain industry wide data.

U Source category: generic

DGASU diesel generator emergency AC
Component boundary: detail n/a Operating mode: standby Operating environment: normal
Generic failure mode: fail to start Original failure mode: failure to start
FAILURE RATE OR PROBABILITY mean : 3.0E-2/d
Source: Sizewell B (PWR/RX312 pg.13) Ultimate source: assesed from nuclear and industrial expereince and data
Comment: Assesment based on W data, WASH 1400,and SRS data,2.6E-2/d out of 1567 demands and 1.3E-2/d out of 5500 demands.

W Source category: generic

DGASW diesel generator emergency AC
Component boundary: complete plant,including starters,pumps and fueling system Operating mode: standby Operating environment: normal
Generic failure mode: fail to start Original failure mode: failure to start
FAILURE RATE OR PROBABILITY median: 3.0E-2/d 95%: 1.0E-1/d 5%: 1.0E-2/d ERROR FACTOR: 3
Source: WASH 1400 (table III 4-2) Ultimate source: assesed from nuclear and industrial experience and data
Comment:

X Source category· generic

DGASX diesel generator emergency AC
Component boundary. detail n/a Operating mode· standby Operating environment: normal
Generic failure mode· fail to start Original failure mode: fail to start
FAILURE RATE OR PROBABILITY mean · 3.0E-2/d 80%· 9.0E-2/d 20%. 1.0E-2/d
Source: VVER reliability data book Ultimate source· expert opinion
Comment:

G Source category. generic

DGASG diesel generator emergency AC
Component boundary: DG,governor,fuel system,starting system,cooling, controls Operating mode: standby Operating environment: normal
Generic failure mode. fail to start Original failure mode: failure to start
FAILURE RATE OR PROBABILITY mean : 3.0E-2/d ERROR FACTOR: 3
Source: German Risk Study (pg F3-86) Ultimate source: German plants operating experience
Comment: Starting failure include failures which happed during initial running time.
Operating expereince ca.810 demands, 24 failures.

B Source category: generic

DGASB diesel generator emergency AC
Component boundary: SEE IREP DG failure to start Operating mode: standby Operating environment: normal
Generic failure mode: fail to start Original failure mode: failure to start
FAILURE RATE OR PROBABILITY mean : 2.1E-2/d max: 1.4E-1/d min: 1.1E-2/d
Source: NUREG 2815 (table C.1.) Ultimate source: expert opinion aggregation and IREP data
Comment: Failure to start is failure to start, accept load and run for 1/2 hour. Original time related value changed to demand related assuming monthly testing.

R Source category: generic

DGASR diesel generator emergency AC
Component boundary: detail n/a Operating mode: standby Operating environment: normal
Generic failure mode: fail to start Original failure mode: failure to start
FAILURE RATE OR PROBABILITY pt.est: 1.7E-2/d
Source: EPRI NP-2433(1982) (table S-1) Ultimate source: operating experience (plant or utility supplied data,13 plants)
Comment: Failure per demand is based on 123.5 years of experience and 6910 diesel demands.

E Source category: generic

DGASE diesel generator emergency AC
Component boundary: detail n/a Operating mode: standby Operating environment: normal
Generic failure mode: fail to start Original failure mode: fails to start
FAILURE RATE OR PROBABILITY rec : 1.6E-2/cy high: 4.0E-1/cy low: 3.0E-4/hr REPAIR TIME: 11.5 hours
Source: IEEE 500 (1984) pg.1218 Ultimate source: expert opinion aggregation and operating experience
Comment: Failure rate is composite value of IEEE 500 (1977) and several nuclear sources including NUREG 1362 (1980).

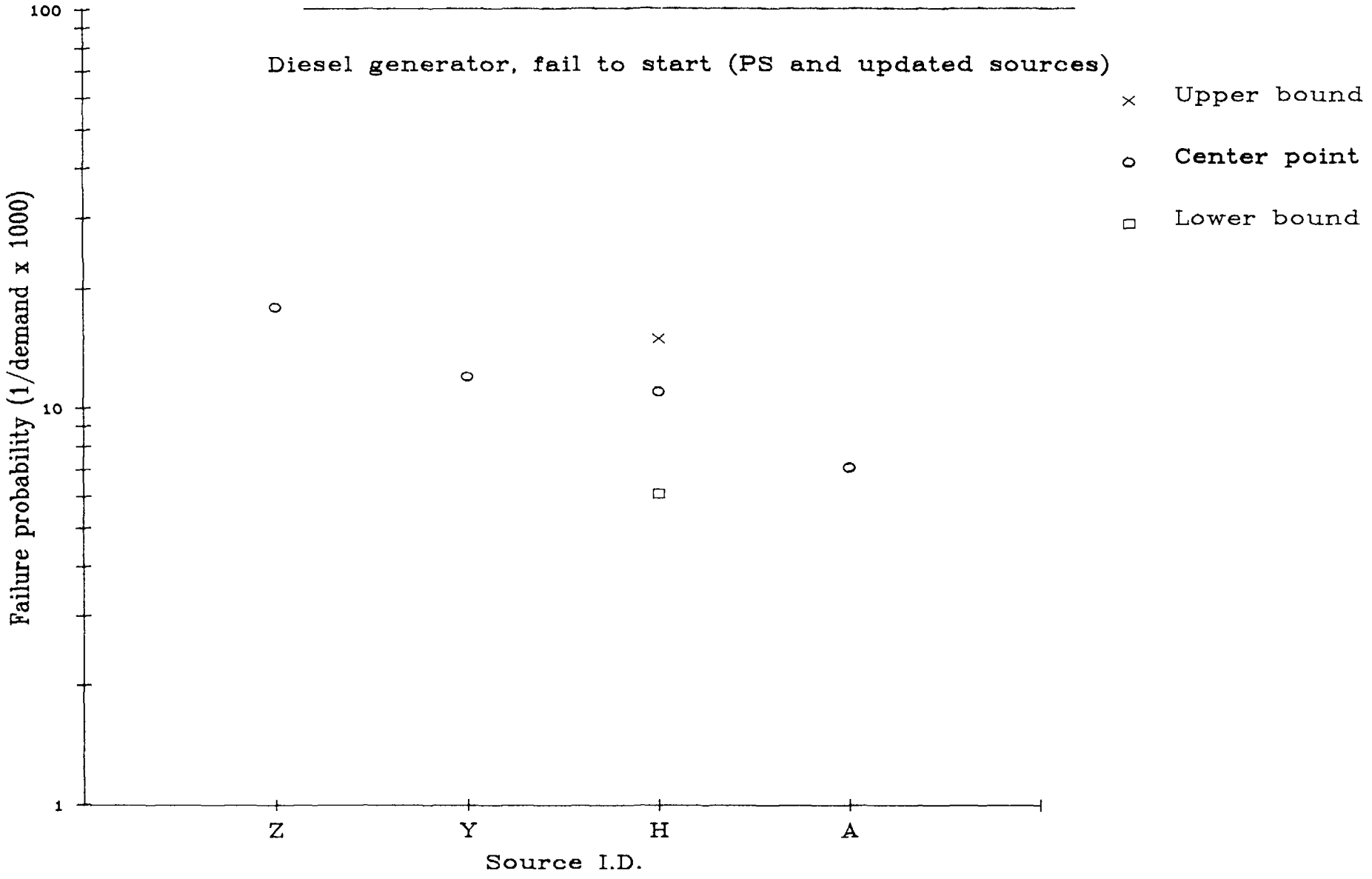
T Source category: generic

DGAST diesel generator emergency AC
Component boundary: DG,protection & control equipment,service systems Operating mode: standby Operating environment: normal
Generic failure mode: fail to start Original failure mode: failure to start
FAILURE RATE OR PROBABILITY mean : 7.7E-3/d 95%: 2.9E-2/d REPAIR TIME: 20 hours
Source: Swedish Rel.data book, tbl.40 Ultimate source: plant operating experience (7 BWR plants),ATV reports, LERs
Comment: Operating experence:total pop.20. No.of demands 2090. No.of failures 16. a=0.552; b=67.7
Critical failures reported on 6 plants.

N Source category: generic

DG4SN diesel generator emergency AC 4160 VAC
Component boundary: DG,all local systems and components needed for start & operation Operating mode: standby Operating environment: normal
Generic failure mode: fail to start Original failure mode: failure to start
FAILURE RATE OR PROBABILITY rec : 2.9E-3/d high: 1.4E-2/d low: 4.0E-4/d REPAIR TIME: 3-8 hours
Source: NUREG 3831 (1985) (tbl.A1) Ultimate source: operating experience (plant records)
Comment: Operating experience:total pop.14. No.of 2801. No.of failures 8.
Repair time is range of medians.

IAEA RELIABILITY DATA BASE



Z Source category: updated

DGASZ diesel generator emergency AC
Component boundary: detail n/a Operating mode: standby Operating environment: normal
Generic failure mode: fail to start Original failure mode: failure to start on demand
FAILURE RATE OR PROBABILITY mean : 1.8E-2/d
Source: ZION NPP PSS (tbl.1.5.1-5) Ultimate source: generic data upgraded with plant operatig expereince
Comment: Prior:mean NUREG 1362,DG fails to start, w/o command. montly test Distribution WASH 1400,DG fail to start.
Operating expereince 1693 deamnds, 30 failures.

Y Source category: plant specific

DGASY diesel generator emergency AC
Component boundary: DG,control & protection equipment, service systems Operating mode: standby Operating environment: normal
Generic failure mode: fail to start Original failure mode: failure to start
FAILURE RATE OR PROBABILITY mean : 1.2E-2/d REPAIR TIME: 8 hours
Source: Swedish Rel.data book, tbl.40 Ultimate source: plant operating experience (Ringhals 2),ATV reports
Comment: Operating experience:total pop.4. No.of demands 492. No.of failures 6.
No failures recorded out of 164 operating hours.

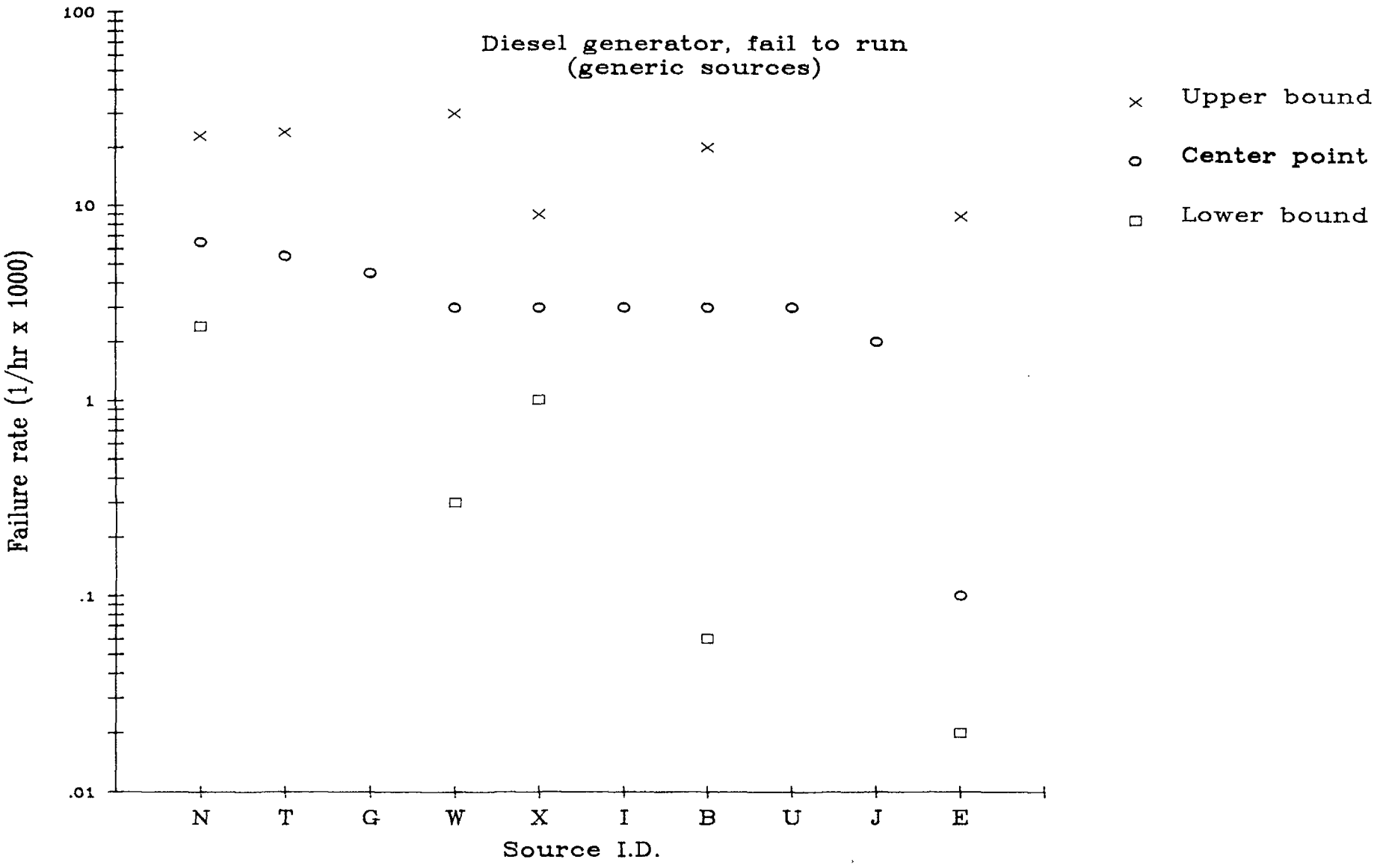
H Source category: updated

DGASH diesel generator emergency AC
Component boundary: detail n/a Operating mode: standby Operating environment: normal
Generic failure mode: fail to start Original failure mode: fail to start on demand
FAILURE RATE OR PROBABILITY mean : 1.1E-2/d 95%: 1.5E-2/d 5%: 6.1E-3/d
Source: Old PWR Ultimate source: generic data updated with plant specific operating experience
Comment: Generic mean 2.1E-2/d. Operating experience 1068 demands, 11 failures.

A Source category: plant specific

DGASA diesel generator emergency AC
Component boundary: detail n/a Operating mode: standby Operating environment: normal
Generic failure mode: fail to start Original failure mode: fail to start
FAILURE RATE OR PROBABILITY median: 7.1E-3/d ERROR FACTOR: 4.1
Source: NUREG 4550/Vol.3,tbl.IV.8-1 Ultimate source: Surry NPP operating expreince
Comment:

IAEA RELIABILITY DATA BASE



N Source category: generic

DG4RN diesel generator emergency AC 4160 V AC
Component boundary: DG,all local systems and components needed for start & operation Operating mode: standby Operating environment: normal
Generic failure mode: fail to run Original failure mode: fail to run
FAILURE RATE OR PROBABILITY rec : 6.5E-3/hr high: 2.3E-2/hr low: 2.4E-3/hr REPAIR TIME: 3-8 hours
Source: NUREG 3831 (1985) (tbl.12) Ultimate source: operating experience (plant records)
Comment: Failure rate is combined failure modes "fail to run" and"inproper operation" because that way it is comparable with other data sources.

T Source category: generic

DGART diesel generator emergency AC
Component boundary: DG,control & protection equipment,service systems Operating mode: standby Operating environment: normal
Generic failure mode: fail to run Original failure mode: spourious stop
FAILURE RATE OR PROBABILITY mean : 5.5E-3/hr 95%: 2.4E-2/hr REPAIR TIME: 20 hours
Source: Swedish Rel.data book, tbl.40 Ultimate source: plant operating experience (7 BWR plants),ATV reports,LERs,
Comment: Operating experience:total pop.20. Operational time 1440 hours No.of failures 8. a=0.338; b=60.8
Critical failures reported on 5 plants.

G Source category: generic

DGARG diesel generator emergency AC
Component boundary: DG,governor,fuel system,starting system,cooling,controls Operating mode: standby Operating environment: normal
Generic failure mode: fail to run Original failure mode: failure to run
FAILURE RATE OR PROBABILITY mean : 4.5E-3/hr ERROR FACTOR: 2
Source: German Risk Study (pg.F3-86) Ultimate source: German plants operating experience
Comment: Operating experience:35 units observed for 2.5 years.Exact time known for 11 units(avr.76 hr/y),50 hr/y considered for the rest.
Tot.op.time:3740 hr.No.of failures 17.SHORT OPERATING TIME RATE.

W Source category: generic

DGARW diesel generator emergency AC
Component boundary: complete diesel generator plant Operating mode: standby Operating environment: normal
Generic failure mode: fail to run Original failure mode: failure to run given start
FAILURE RATE OR PROBABILITY median: 3.0E-3/hr 95%: 3.0E-2/hr 5%: 3.0E-4/hr ERROR FACTOR: 10 REPAIR TIME: 21 hours
Source: WASH 1400 (table III 4-2) Ultimate source: nuclear and non-nuclear experience
Comment: Repair time is mean maintenance duration. For plant with specific ation which limits the outage time to 24 hours, mean maintenance duration is 13 hours.

X Source category: generic

DGARX diesel generator emergency AC
Component boundary: detail n/a Operating mode: standby Operating environment: normal
Generic failure mode: fail to run Original failure mode: fail to run
FAILURE RATE OR PROBABILITY mean : 3.0E-3/hr 80%: 9.0E-3/hr 20%: 1.0E-3/hr
Source: VVER reliability data base Ultimate source: expert opinion
Comment:

I Source category: generic

DGARI diesel generator emergency AC
Component boundary: SEE failure to start, same source Operating mode: standby Operating environment: normal
Generic failure mode: fail to run Original failure mode: failure to run given start
FAILURE RATE OR PROBABILITY mean : 3.0E-3/hr ERROR FACTOR: 10
Source: IREP NUREG 2728 (tb.5.1-1) Ultimate source: expert opinion
Comment: Failure to run is failure to run more than 1/2 hour,given start.

B Source category: generic

DGARB diesel generator emergency AC
Component boundary: SEE IREP DG failure to start Operating mode: standby Operating environment: normal
Generic failure mode: fail to run Original failure mode: failure to run, given start
FAILURE RATE OR PROBABILITY mean : 3.0E-3/hr max: 2.0E-2/hr min: 6.0E-5/hr
Source: NUREG 2815 (table C.1.) Ultimate source: expert opnion aggregation and IREP data
Comment: Failure to run is failure to run for more than 1/2 hour, given start.
Failure rate is applicable to emergency condition.

U Source category: generic

DGARU diesel generator emergency AC
Component boundary: detail n/a Operating mode: standby Operating environment: normal
Generic failure mode: fail to run Original failure mode: failure to continue operation
FAILURE RATE OR PROBABILITY mean : 3.0E-3/hr
Source: Sizewell B (PWR/RX312 pg.13) Ultimate source: assesed from nuclear and industrial expereince and data
Comment: Assesment based on W data item,WASH 1400 and 3 SRS data items, (3.0E-3/hr)(1.3E-3/hr op.exp.8.7E+6hours) (1.4E-3/hr applicable to average industrial use).

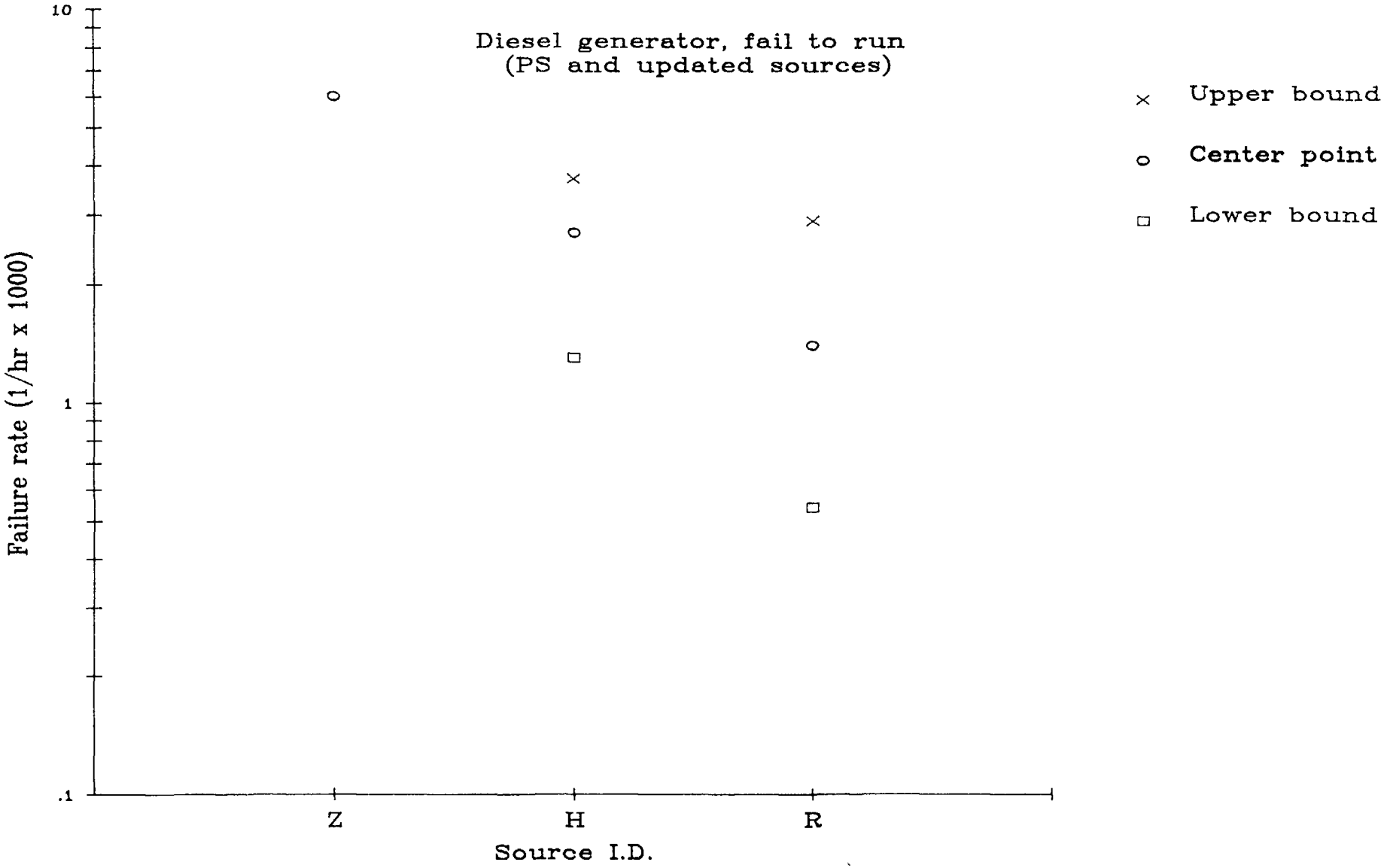
J Source category: generic

DGARJ diesel generator emergency AC
Component boundary: detail n/a Operating mode: standby Operating environment: normal
Generic failure mode: fail to run Original failure mode: failure to run
FAILURE RATE OR PROBABILITY mean : 2.0E-3/hr ERROR FACTOR: 10
Source: NUREG 4550, Vol.1,tbl.VIII.1-2 Ultimate source: assesed from several nuclear data sources
Comment: ASEP used generic value from the Reliability of AC Power System Study (NUREG/CR-2989) which contain industry wide analysis.

E Source category: generic

DGARE diesel generator emergency AC
Component boundary: detail n/a Operating mode: standby Operating environment: normal
Generic failure mode: fail to run Original failure mode: fails while running
FAILURE RATE OR PROBABILITY rec : 1.0E-4/hr high: 8.8E-3/hr low: 2.0E-5/hr REPAIR TIME: 11.5 hours
Source: IEEE 500 (1984) pg 1218 Ultimate source: expert opinion aggregation and operating experience
Comment: Failure rate is composite value of IEEE 500 (1977) and several nuclear sources including NUREG 1362 (1980).

IAEA RELIABILITY DATA BASE



Z Source category: updated

DGARZ diesel generator emergency AC
Component boundary: detail n/a Operating mode: standby Operating environment: normal
Generic failure mode: fail to run Original failure mode: fail during operation
FAILURE RATE OR PROBABILITY mean : 6.0E-3/hr
Source: ZION NPP PSS (tbl.1.5.1-5) Ultimate source: generic data updated with plant specific operating experience
Comment: Prior: mean NUREG 1362, DG does not continue to run,w/o command, montly testing.Distribution WASH 1400, DG failure to run
Operating experience: operating time 1340 hours, 6 failures.

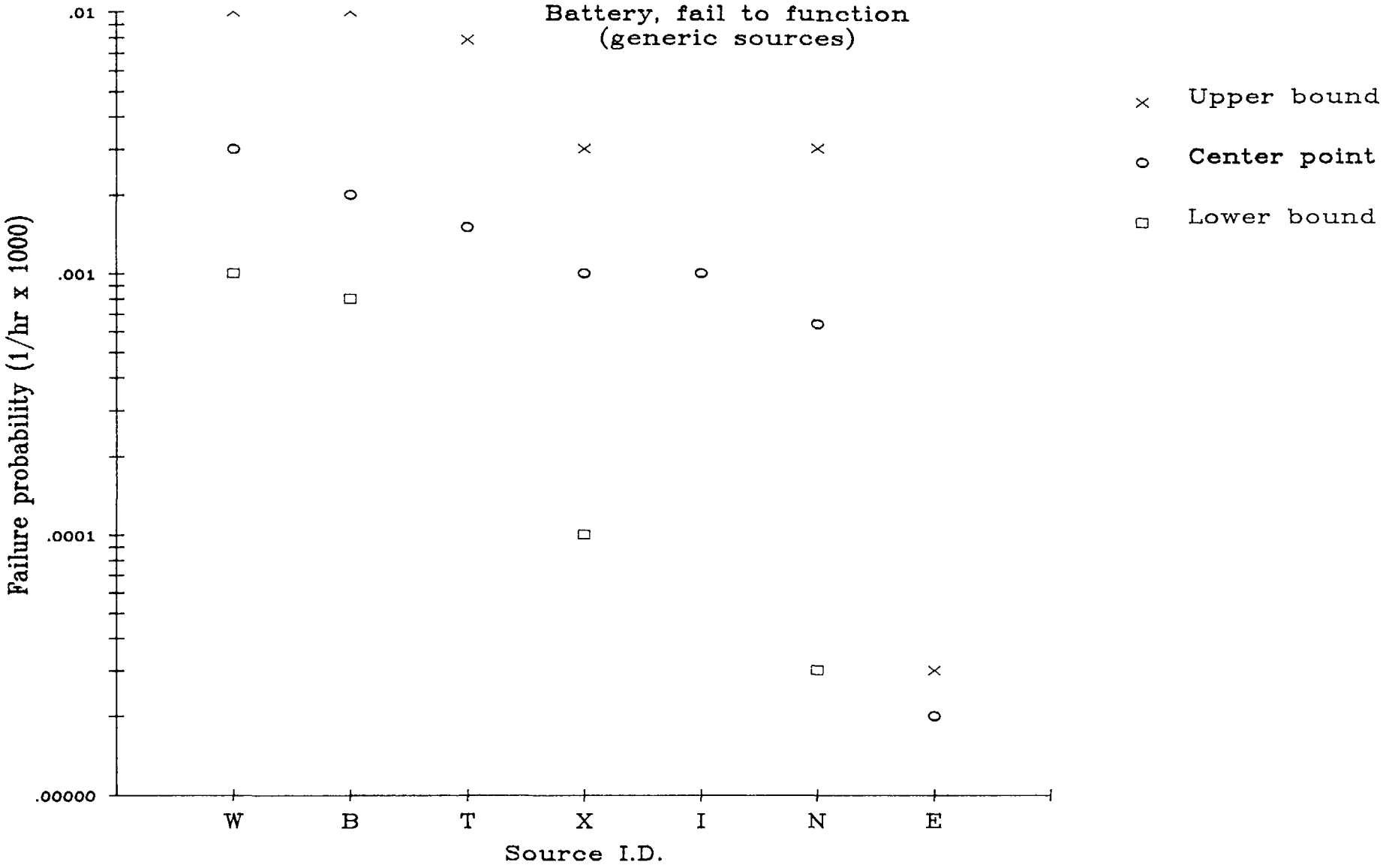
H Source category: updated

DGARH diesel generator emergency AC
Component boundary: detail n/a Operating mode: standby Operating environment: normal
Generic failure mode: fail to run Original failure mode: fail during first hour of operation
FAILURE RATE OR PROBABILITY mean : 2.7E-3/hr 95%: 3.7E-3/hr 5%: 1.3E-3/hr REPAIR TIME: 6.8 hours
Source: Old PWR Ultimate source: generic data updated with plant operating experience
Comment: Generic mean 1.7E-2/hr. Operating experience 1177 hours of operation, 2 failures.

R Source category: plant specific

DGARR diesel generator emergency AC
Component boundary: detail n/a Operating mode: standby Operating environment: normal
Generic failure mode: fail to run Original failure mode: failure to continue to run
FAILURE RATE OR PROBABILITY mean : 1.4E-3/hr 95%: 2.9E-3/hr 5%: 5.4E-4/hr
Source: EPRI NP-2433(1982) (table 3-1) Ultimate source: operating experience(utility supplied data) Peach Bottom 2 & 3
Comment: Failure rate is calculated for Peach Bottom 2 & 3 plants only. Total expereince 32.9 years. No.of failures 5.

IAEA RELIABILITY DATA BASE



W Source category: generic

BTWFW battery (power system) wet cell
Component boundary: detail n/a Operating mode: emergency load condition Operating environment: normal
Generic failure mode: fail to function Original failure mode: failure to provide proper output
FAILURE RATE OR PROBABILITY median: 3.0E-6/hr 95%: 1.0E-5/hr 5%: 1.0E-6/hr ERROR FACTOR: 3
Source: WASH 1400 (table III 4-2) Ultimate source: assesed from industrial,nuclear experience,expert opinion
Comment: Batteries are constantly charged and their open circut output vol tage is monitored, so failures like shorts to ground or internaly are detected quickly. Only significant failure mode is one listed

B Source category: generic

BTWFB battery (power system) wet cell
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: failure to provide proper output
FAILURE RATE OR PROBABILITY mean : 2.0E-6/hr max: 1.0E-5/hr min: 8.0E-7/hr
Source: NUREG 2815 (table C.1.) Ultimate source: expert judgement and IREP data
Comment: Assumes out-of-specification cell replacement

T Source category: generic

BTAFT battery
Component boundary: battery only Per demand value changed to per hour(1 year test) Operating mode: standby Operating environment: normal
Generic failure mode: fail to function Original failure mode: failed effective output
FAILURE RATE OR PROBABILITY mean : 1.5E-6/hr 95%: 7.8E-6/hr REPAIR TIME: 2 hours
Source: Swedish Rel.data book, tbl.41 Ultimate source: plant operating experience (7 BWR plants), ATV reports, LERs
Comment: Demand failure rate is based on refueling outage testing interval Operating experience: Total pop.129.No of demands 531.Number of failures 7. a=0.0346; b=2.59

X Source category: generic

BTAFX battery geberal
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: fail to function
FAILURE RATE OR PROBABILITY mean : 1.0E-6/hr 80%: 3.0E-6/hr 20%: 1.0E-7/hr
Source: VVER reliability data base Ultimate source: expert opinion
Comment:

I Source category: generic

BTWFI battery (power system) wet cell
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: failure to provide proper output
FAILURE RATE OR PROBABILITY mean : 1.0E-6/hr ERROR FACTOR: 3
Source: IREP NUREG 2728 (tb.5.1-1) Ultimate source: expert opinion
Comment: Assumes out-of-specification cell replacement

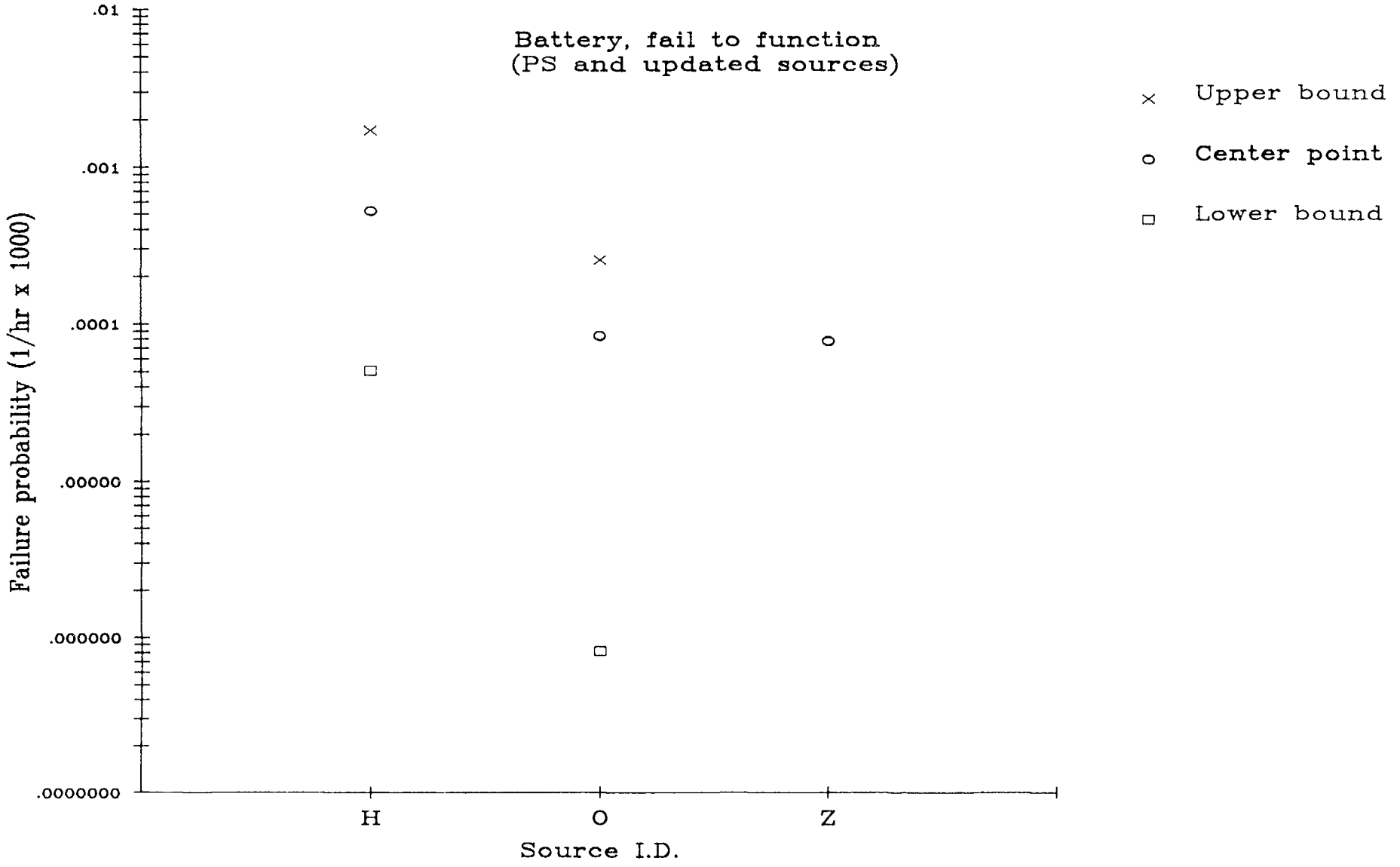
N Source category: generic

BTAFN battery
Component boundary: battery,container,terminal connections incl.1st breaker connect. Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: no output
FAILURE RATE OR PROBABILITY rec : 6.4E-7/hr high: 3.0E-6/hr low: 3.0E-8/hr REPAIR TIME: 4-7 hours
Source: NUREG 3831 (1985) (tbl.A6) Ultimate source: operating experience (plant records)
Comment: Operating experience: total pop. 51.Operating time 1.564.315hours No of failures 1. High and low chi-square estimates.
Repair times range of median

E Source category: generic

BTLFE battery lead acid
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: catastrophic (no output given challenge)
FAILURE RATE OR PROBABILITY rec : 2.0E-8/hr high: 3.0E-8/hr low: 0.0E-0/hr
Source: IEEE 500 (1984) pg.85 Ultimate source: expert opinion aggregation and operating experience
Comment: Failure rate is composite of several sources. Tot.failure rate of batteries is estimated to be 1.6E-6/oper.hr,but 99.6% of failures were discovered through testing,what gives 6E-9/hr emergency oper

IAEA RELIABILITY DATA BASE



H Source category: updated

BTVFH battery 125 V
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: fail during opeartion
FAILURE RATE OR PROBABILITY mean : 5.2E-7/hr 95%: 1.7E-6/hr 5%: 5.0E-8/hr REPAIR TIME: 5 hours
Source: Old PWR Ultimate source: Generic data updated with plant operating experience
Comment: Generic mean 7.5E-7/hr. Operating experience 4.1E+5 hours of operation, no failures.

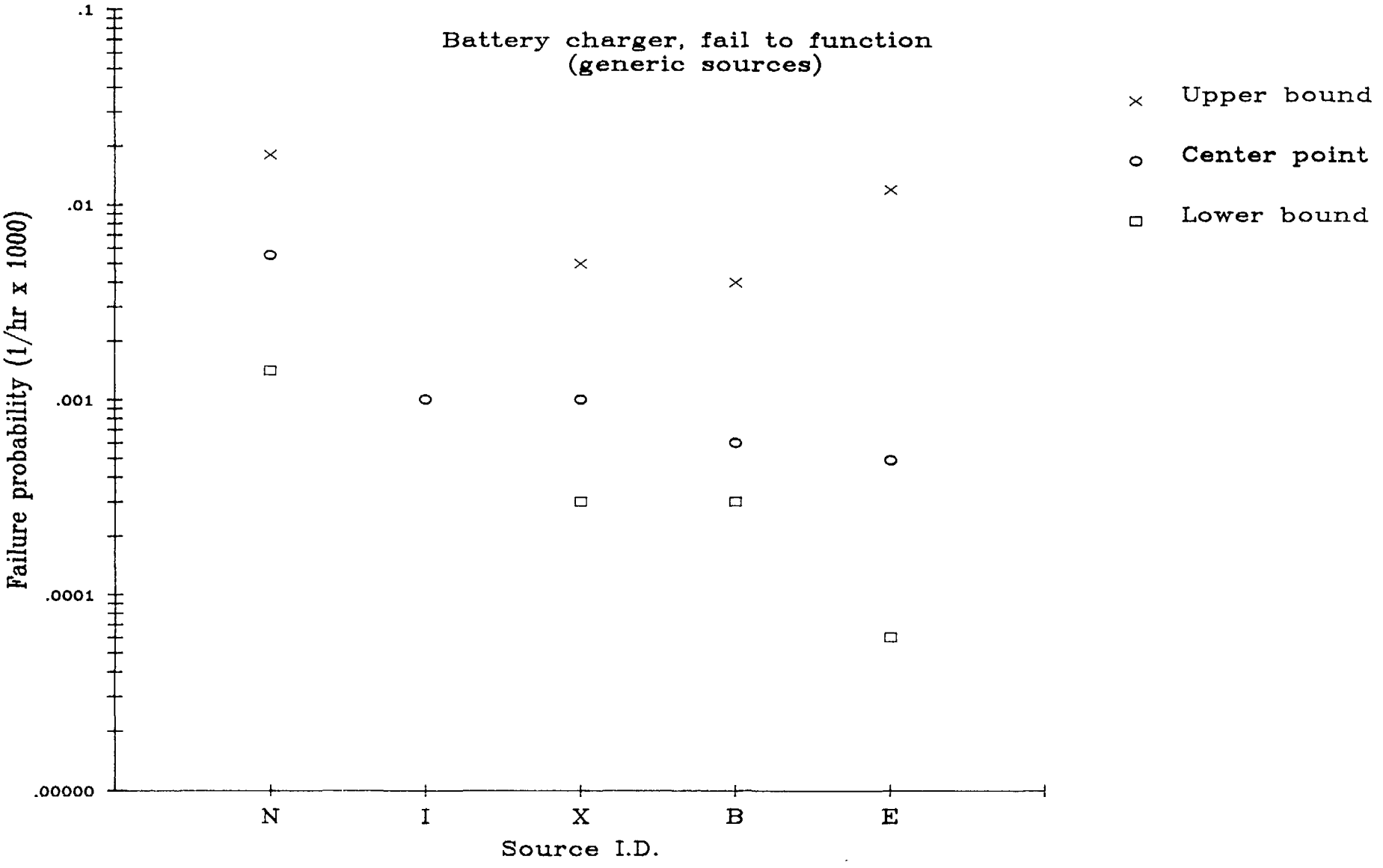
O Source category: updated

BTAFO battery
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: operational failure
FAILURE RATE OR PROBABILITY mean : 8.2E-8/hr 95%: 2.5E-7/hr 5%: 8.E-10/hr REPAIR TIME: 11.2 hours
Source: Oconee NPP PRA (tbl.b-1.) Ultimate source: generic data updated with plant specific operating experience
Comment: Prior:IEEE 500(1977)(pg104),rec=median; max=80% of distribution. Operating experience: 96.426 hours of operation, no failures.
Repair time is mean of updated component maintenance duration.

Z Source category: updated

BTAFZ battery
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: fail during operation
FAILURE RATE OR PROBABILITY mean : 7.6E-8/hr
Source: ZION NPP PSS (tbl.1.5.1-5) Ultimate source: generic data updated with plant specific experience
Comment: Prior:IEEE 500(1977)(pg.104) lead-acid batteries,stationary type failure mode "catastrophic". Operating experience:2.0E+5 hours,
no failures.

IAEA RELIABILITY DATA BASE



N Source category: generic

BCSFN battery charger solid state general
Component boundary: charger, connecting breakers(feeder & output),protect.& controls Operating mode: operating Operating environment: normal
Generic failure mode: fail to function Original failure mode: no output
FAILURE RATE OR PROBABILITY rec : 5.5E-6/hr high: 1.8E-5/hr low: 1.4E-6/hr REPAIR TIME: 5-10 hours
Source: NUREG 3831 (1985) (tbl.A12) Ultimate source: operating experience (plant records)
Comment: Operating experience:total pop.70. Operating time 2.183.975 hours No.of failures 12.
Repair time is range of medians.

I Source category: generic

BCAFI battery charger
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: failure to operate
FAILURE RATE OR PROBABILITY mean : 1.0E-6/hr ERROR FACTOR: 3
Source: IREP NUREG 2728 (tb.5.1-1) Ultimate source: expert opinion
Comment:

X Source category: generic

BCAFX battery charger
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: fail to function
FAILURE RATE OR PROBABILITY mean : 1.0E-6/hr 80%: 5.0E-6/hr 20%: 3.3E-7/hr
Source: VVER reliability data base Ultimate source: expert opinion
Comment:

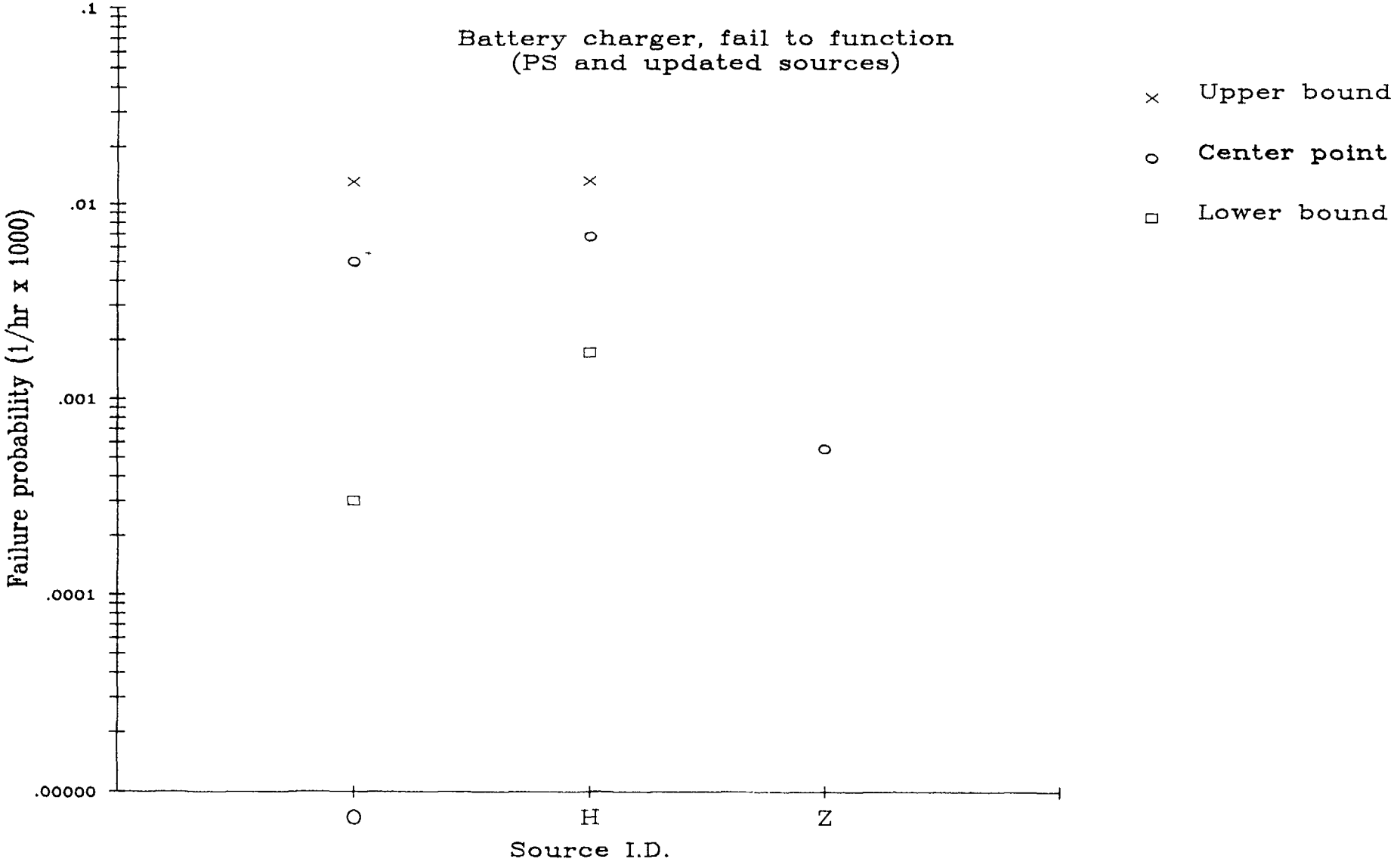
B Source category: generic

BCAFB battery charger
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: failure to operate
FAILURE RATE OR PROBABILITY mean : 6.0E-7/hr max: 4.0E-6/hr min: 3.0E-7/hr
Source: NUREG 2815 (table C.1.) Ultimate source: expert judgement and IREP data
Comment:

E Source category: generic

BCRFE battery charger rectifier
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: no output
FAILURE RATE OR PROBABILITY rec : 4.9E-7/hr high: 1.2E-5/hr low: 6.0E-8/hr
Source: IEEE 500 (1984) pg.66 Ultimate source: expert opinion aggregation and operating experience
Comment: Failure rate is composite of different types and voltage levels.

IAEA RELIABILITY DATA BASE



O Source category: updated

BCSFO battery charger SCR type
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: operational failure
FAILURE RATE OR PROBABILITY mean : 5.0E-6/hr 95%: 1.3E-5/hr 5%: 3.0E-7/hr REPAIR TIME: 10.1 hours
Source: Oconee NPP PRA (tbl.b-1.) Ultimate source: generic data updated with plant specific operating experience
Comment: Prior:IEEE 500 (1977)(pg93), rec=median; max=95% of distribution. Operating experience: 96.426 hours of operation, 1 failure.
Repair time is mean of updated component maintenance duration.

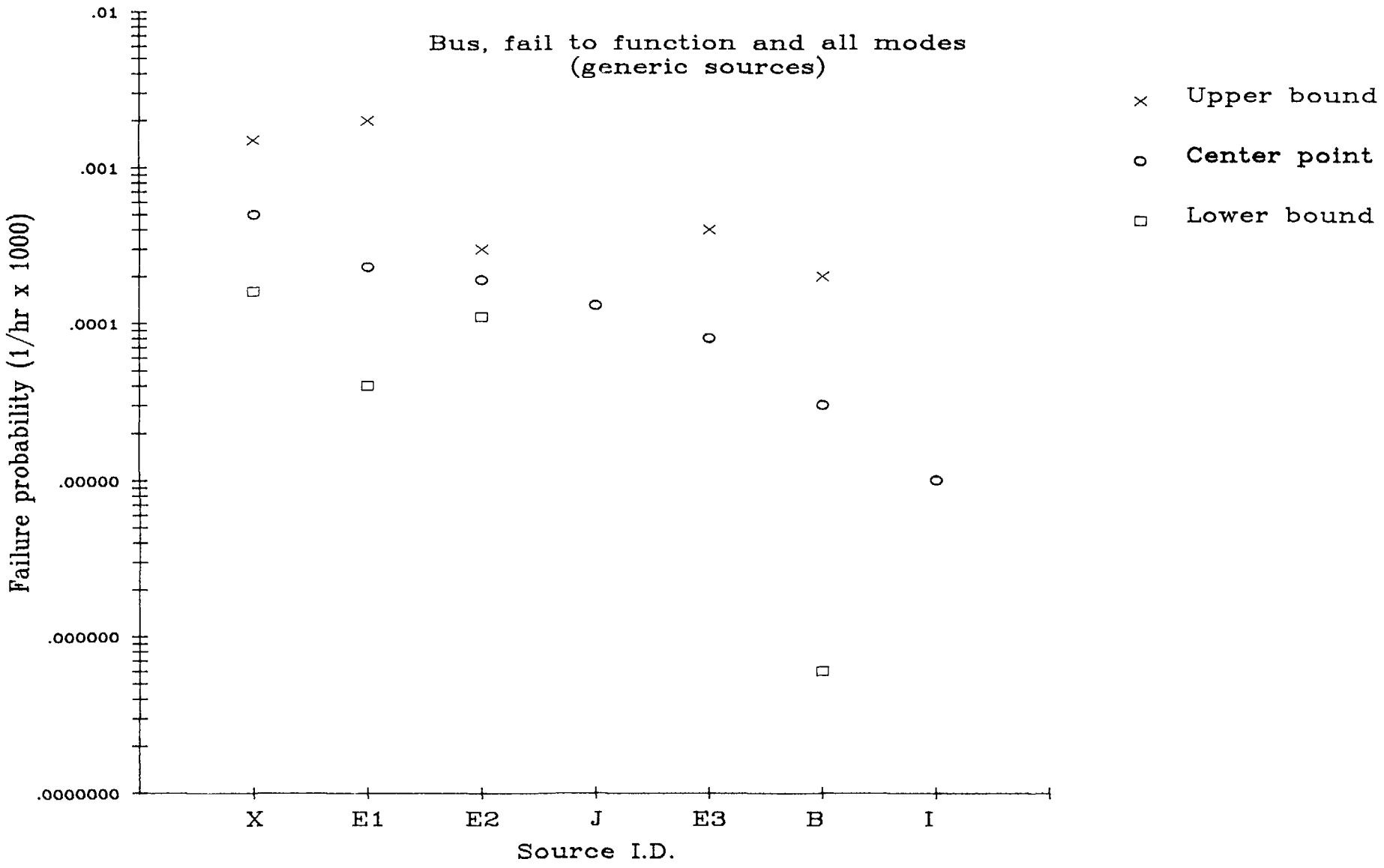
H Source category: updated

BC1FH battery charger 120 V
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: fail during operation
FAILURE RATE OR PROBABILITY mean : 6.7E-6/hr 95%: 1.3E-5/hr 5%: 1.7E-6/hr REPAIR TIME: 5.6 hours
Source: Old PWR Ultimate source: Generic data updated with plant operating experience
Comment: Generic mean 1.9E-5/hr. Operating experience 2E+5 hours of operation, 1 failure.

Z Source category: updated

BCAFZ battery charger
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: fail during operation
FAILURE RATE OR PROBABILITY mean : 5.5E-7/hr
Source: ZION NPP PSS (tbl.1.5.1-5) Ultimate source: generic data updated with plant specific experience
Comment: Prior:IEEE 500(1977)(pg90) rectifiers,stationary type. Prior failure mode "all modes"
Operating experience: 2.0E+5 hours of operation,no failures

IAEA RELIABILITY DATA BASE



X Source category: generic

CBAFX bus
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: fail to function
FAILURE RATE OR PROBABILITY mean : 5.0E-7/hr 80%: 1.5E-6/hr 20%: 1.6E-7/hr
Source: VVER reliability data base Ultimate source: expert opinion
Comment:

E1 Source category: generic

CBBFE bus bare outdoor switchgear
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: catastrophic
FAILURE RATE OR PROBABILITY rec : 2.3E-7/hr high: 2.0E-6/hr low: 4.0E-8/hr
Source: IEEE 500 (1984) pg.804 Ultimate source: expert opinion aggregation
Comment: Reference : IEEE 500 (1977) Failure mode "catastrophic" include open circut, short line to line and short to ground.

E2 Source category: generic

CBIAE bus insulated switchgear bus 601-15 kV
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: all modes Original failure mode: all modes
FAILURE RATE OR PROBABILITY rec : 1.9E-7/hr high: 3.0E-7/hr low: 1.1E-7/hr
Source: IEEE 500 (1984) pg.810 Ultimate source: expert opinion aggregation
Comment: Reference IEEE 493 (1980)

J Source category: generic

CBAAJ bus general
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: all modes Original failure mode: hardware failure
FAILURE RATE OR PROBABILITY mean : 9.0E-5/d ERROR FACTOR: 5
Source: NUREG 4550,Vol.1. tbl.VIII.1-2 Ultimate source: assesed from several nuclear data sources
Comment: There is no specific failure mode assigned for this component in the source. ASEP used IEEE value of 1.3E-7/hr assuming monthly system test.

E3 Source category: generic

CBMFE bus metal entclosed
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: catastrophic
FAILURE RATE OR PROBABILITY rec : 8.0E-8/hr high: 4.0E-7/hr low: 0.0E-0/hr
Source: IEEE 500 (1984) pg.811 Ultimate source: expert opinion aggreagtion
Comment: Reference: IEEE 500 (1977) Failure mode "catastrophic" include open circut,short line to line and short to ground.

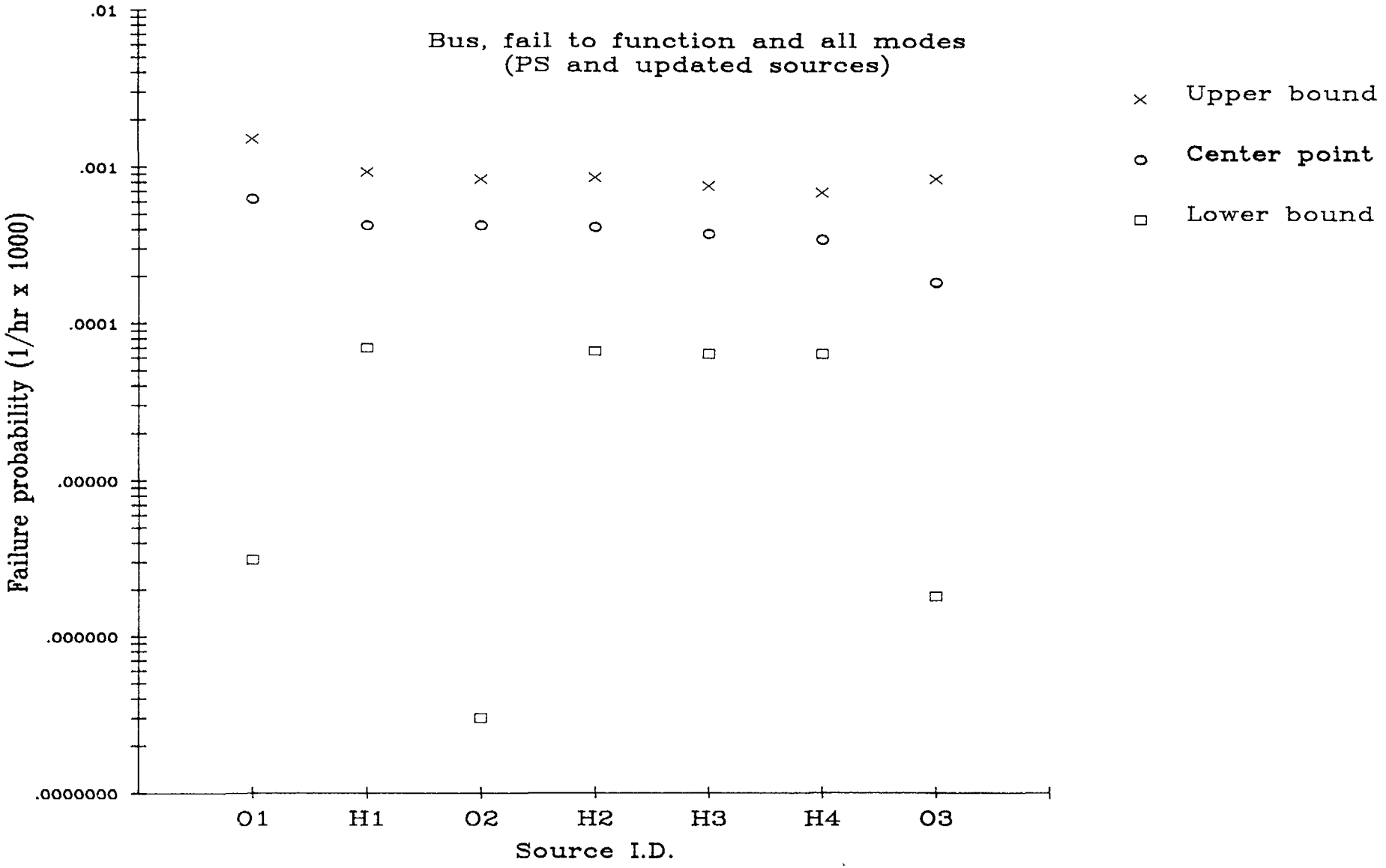
B Source category: generic

CBAAB bus
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: all modes Original failure mode: all modes
FAILURE RATE OR PROBABILITY mean : 3.0E-8/hr max: 2.0E-7/hr min: 6.E-10/hr
Source: NUREG 2815 (table C.1.) Ultimate source: expert judgement and IREP data
Comment:

I Source category: generic

CBAAI bus
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: all modes Original failure mode: all modes
FAILURE RATE OR PROBABILITY mean : 1.0E-8/hr ERROR FACTOR: 3
Source: IREP NUREG 2728 (tb.5.1-1) Ultimate source: expert opinion
Comment:

IAEA RELIABILITY DATA BASE



O1 Source category: updated

CBHFO bus high voltage,indoor voltage >= 4 kV
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: operational failure
FAILURE RATE OR PROBABILITY mean : 6.2E-7/hr 95%: 1.5E-6/hr 5%: 3.1E-9/hr REPAIR TIME: 10.8 hours
Source: Oconee NPP PRA (tbl.b-1.) Ultimate source: generic data updated with plant specific operating experience
Comment: Prior:IEEE 500(1977)(pg.188),rec=median;max=80% of distribution Operating experience:4.34E+5 hours of operation, no failures.
Repair time is mean of updated maintenance duration (4kV bus).

H1 Source category: updated

CB1FH bus 120 V DC
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: fail during operation
FAILURE RATE OR PROBABILITY mean : 4.2E-7/hr 95%: 9.2E-7/hr 5%: 6.9E-8/hr
Source: Old PWR Ultimate source: Generic data updated with plant operating experience
Comment: Generic mean 5.0E-7/hr. Operating experience 4.1E+5 hours of operation, no failures.

O2 Source category: updated

CBDFO bus DC
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: operational failure
FAILURE RATE OR PROBABILITY mean : 4.2E-7/hr 95%: 8.3E-7/hr 5%: 3.E-10/hr REPAIR TIME: 10.8 hours
Source: Oconee NPP PRA (tbl.b-1.) Ultimate source: generic data updated with plant specific operating experience
Comment: Prior:IEEE 500(1977)(pg.185),rec=median;max=80%distribution Operating experince: 2.89E+5 hours of operation, no failures.
Repair time is mean of updated maintenance duration(bus or panel)

H2 Source category: updated

CB6FH bus 6 kV
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: fail during operation
FAILURE RATE OR PROBABILITY mean : 4.1E-7/hr 95%: 8.5E-7/hr 5%: 6.6E-8/hr
Source: Old PWR Ultimate source: Generic data updated with plant operating experience
Comment: Generic mean 5.0E-7/hr. Operating experience 5.4E+5 hours of operation, no failures.

H3 Source category: updated

CB3FH bus 380 V
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: fail during operation
FAILURE RATE OR PROBABILITY mean : 3.7E-7/hr 95%: 7.5E-7/hr 5%: 6.3E-8/hr
Source: Old PWR Ultimate source: Generic data updated with plant specific operating experience
Comment: Generic mean 5.0E-7/hr. Operating experience 9.5E+5 hours of operation, no failures.

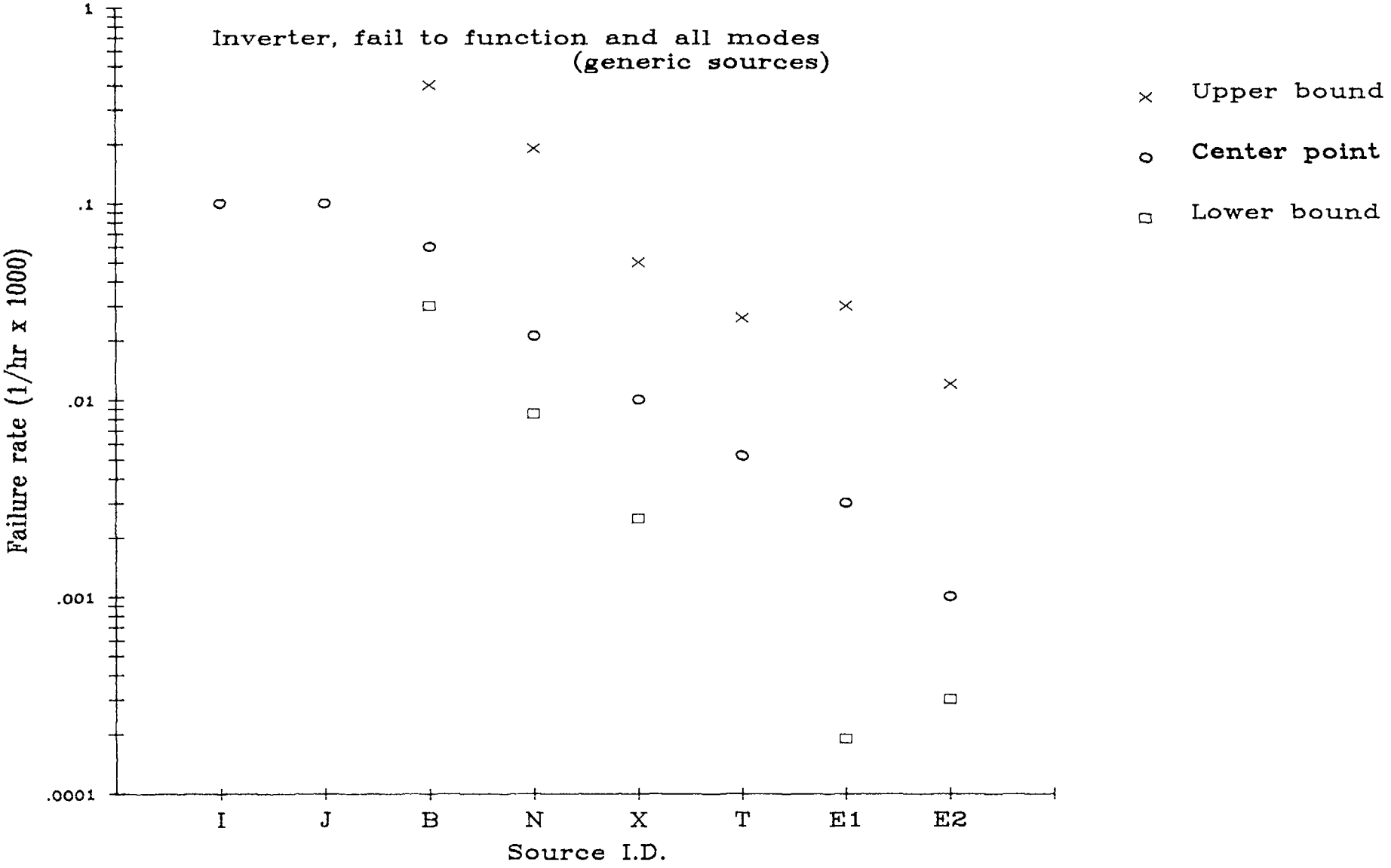
H4 Source category: updated

CB2FH bus 120 V AC , 220 V AC
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: fail during operation
FAILURE RATE OR PROBABILITY mean : 3.4E-7/hr 95%: 6.8E-7/hr 5%: 6.3E-8/hr
Source: Old PWR Ultimate source: Generic data updated with plant operating experiecne
Comment: Generic mean 5.0E-7/hr. Operating experience 1.4E+6 hours of opeartion, no failures.

O3 Source category: updated

CBLFO bus low voltage indoor voltage <= 600 V
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: operational failure
FAILURE RATE OR PROBABILITY mean : 1.8E-7/hr 95%: 8.3E-7/hr 5%: 1.8E-9/hr
Source: Oconee NPP PRA (tbl.b-1.) Ultimate source: generic data updated with plant specific operating experience
Comment: Prior:IEEE 500 (1977)(pg.188),rec=median;max=80% of distribution Operating experience:2.17E+6 hours of operation, no failures.

IAEA RELIABILITY DATA BASE



1 Source category: generic

EIAFI inverter general
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: failure to operate
FAILURE RATE OR PROBABILITY mean : 1.0E-4/hr ERROR FACTOR: 3
Source: IREP NUREG 2728 (tb.5.1-1) Ultimate source: expert opinion
Comment:

J Source category: generic

EIAAJ inverter general
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: all modes Original failure mode: hardware failure
FAILURE RATE OR PROBABILITY mean : 1.0E-4/hr ERROR FACTOR: 3
Source: NUREG 4550, Vol.1,tbl.VIII.1-2 Ultimate source: assesed from several nuclear data sources
Comment: There is no specific failure mode assigned for this component in the source. ASEP used IPRD (NUREG 3831) value of 1.0E-4/hr assuming montly system test.

B Source category: generic

EIAFB inverter general
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: failure to operate
FAILURE RATE OR PROBABILITY mean : 6.0E-5/hr max: 4.0E-4/hr min: 3.0E-5/hr
Source: NUREG 2815 (table C.1.) Ultimate source: expert judgement and IREP data
Comment:

N Source category: generic

EISFN inverter solid state 120 volts AC
Component boundary: inverter,transfer switch,rectifier,feeder breaker,prot.& control Operating mode: operating Operating environment: normal
Generic failure mode: fail to function Original failure mode: no output
FAILURE RATE OR PROBABILITY rec : 2.1E-5/hr high: 1.9E-4/hr low: 8.5E-6/hr REPAIR TIME: 4-8 hours
Source: NUREG 3831 (1985) (tbl.A18) Ultimate source: operating experience (plant records)
Comment: Operating experience:total pop.31. Operating time 985.505 hours No.of failures 21.
Repair time is range of medians.

X Source category: generic

EIAFX inverter
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: fail to function
FAILURE RATE OR PROBABILITY mean : 1.0E-5/hr 80%: 8.0E-5/hr 20%: 2.5E-6/hr
Source: VVER reliability data base Ultimate source: expert opinion
Comment:

T Source category: generic

EISFT inverter static
Component boundary: inverter,reversing switch,associated cables, transformer,breaker Operating mode: operating Operating environment: normal
Generic failure mode: fail to function Original failure mode: loss of effective output
FAILURE RATE OR PROBABILITY mean : 5.2E-6/hr 95%: 2.6E-5/hr REPAIR TIME: 13 hours
Source: Swedish Rel.data book, tbl.43 Ultimate source: plant operating experience (4 BWR plants), ATV reports, LERs
Comment: Operating experience: Total pop.10. Operational time 38.5E+4. No.of failures 2. Only one critical failure; a=0.224; b=43100

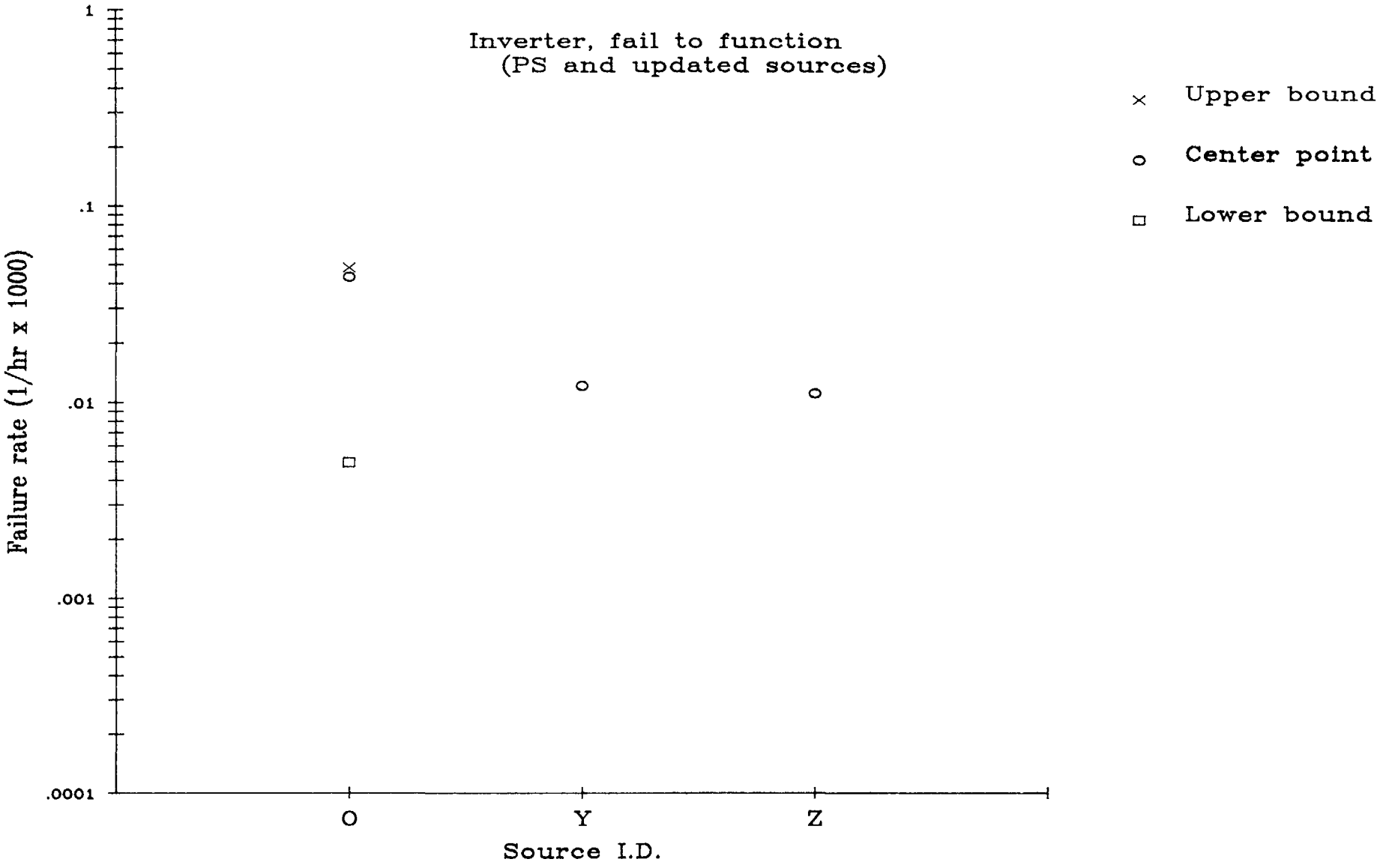
E1 Source category: generic

EIXFE inverter static three phase
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: no output
FAILURE RATE OR PROBABILITY rec : 3.0E-6/hr high: 3.0E-5/hr low: 1.9E-7/hr
Source: IEEE 500 (1984) pg.277 Ultimate source: expert opinion aggregation and operating experience
Comment: Reference IEEE 500 (1977)

E2 Source category: generic

EI2FE inverter static single phase
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: no output
FAILURE RATE OR PROBABILITY rec : 1.0E-6/hr high: 1.2E-5/hr low: 3.0E-7/hr
Source: IEEE 500 (1984) pg.276 Ultimate source: expert opinion aggregation and operating experience
Comment: Reference IEEE 500(1977)

IAEA RELIABILITY DATA BASE



O Source category: updated

EIIFO inverter instrument inverter
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: operational failure
FAILURE RATE OR PROBABILITY mean : 4.3E-5/hr 95%: 4.8E-5/hr 5%: 4.9E-6/hr REPAIR TIME:
Source: Oconee NPP PRA (tbl.b-1.) Ultimate source: generic data updated with plant specific operating experience
Comment: Not possible to identify prior source. Prior mean 1.3E-4/hr. Oper exp:3.37E+5 hours of operation,9 failures.

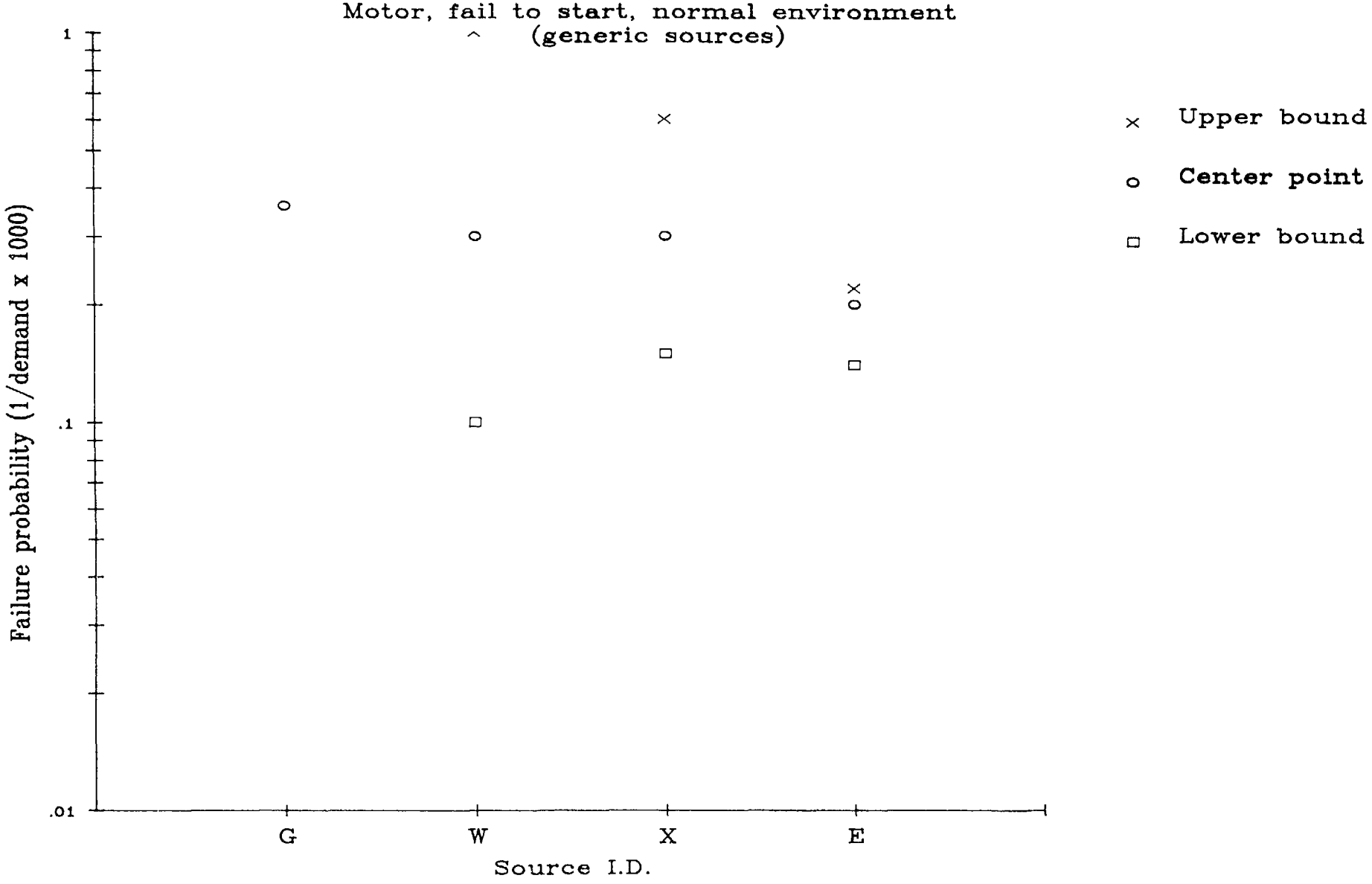
Y Source category: plant specific

EISFY inverter static
Component boundary: inverter, reversing switch, associated cables,transformer,breaker Operating mode: operating Operating environment: normal
Generic failure mode: fail to function Original failure mode: loss of effective output
FAILURE RATE OR PROBABILITY mean : 1.2E-5/hr REPAIR TIME: 11 hours
Source: Swedish Rel.data book, tbl.43 Ultimate source: plant operating experience (Ringhals 2 PWR)
Comment: operating experience: Total pop. 4. Total operational time 17.29E+4 hours.No.of failures 2.

Z Source category: updated

EIAFZ inverter general
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: fail during operation
FAILURE RATE OR PROBABILITY mean : 1.1E-5/hr
Source: ZION NPP PSS (tbl.1.5.1-5) Ultimate source: generic data updated with plant operating experience
Comment: Prior: WASH 1400, solid state devices, high power application failure mode "fails to function".Operating experience:
3.04E+5 hours of operation, 3 failures.

IAEA RELIABILITY DATA BASE



G Source category: generic

MAASG motor general
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to start Original failure mode: fail to start
FAILURE RATE OR PROBABILITY median: 3.6E-4/d ERROR FACTOR: 8
Source: German Risk Study (tb.F3,7-1) Ultimate source: generic data
Comment: Failure rate is combination of number of generic data sources, including non nuclear. Original time related value changed to demand related assuming monthly testing.

W Source category: generic

MAASW motor general
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to start Original failure mode: failure to start
FAILURE RATE OR PROBABILITY median: 3.0E-4/d 95%: 1.0E-3/d 5%: 1.0E-4/d ERROR FACTOR: 3
Source: WASH 1400 (table 111 4-2) Ultimate source: assesed from nuclear, industrial and military expereince and data
Comment: Demand probability is based on presence of proper input signal Applicable only to motors that function independently of pumps and valves

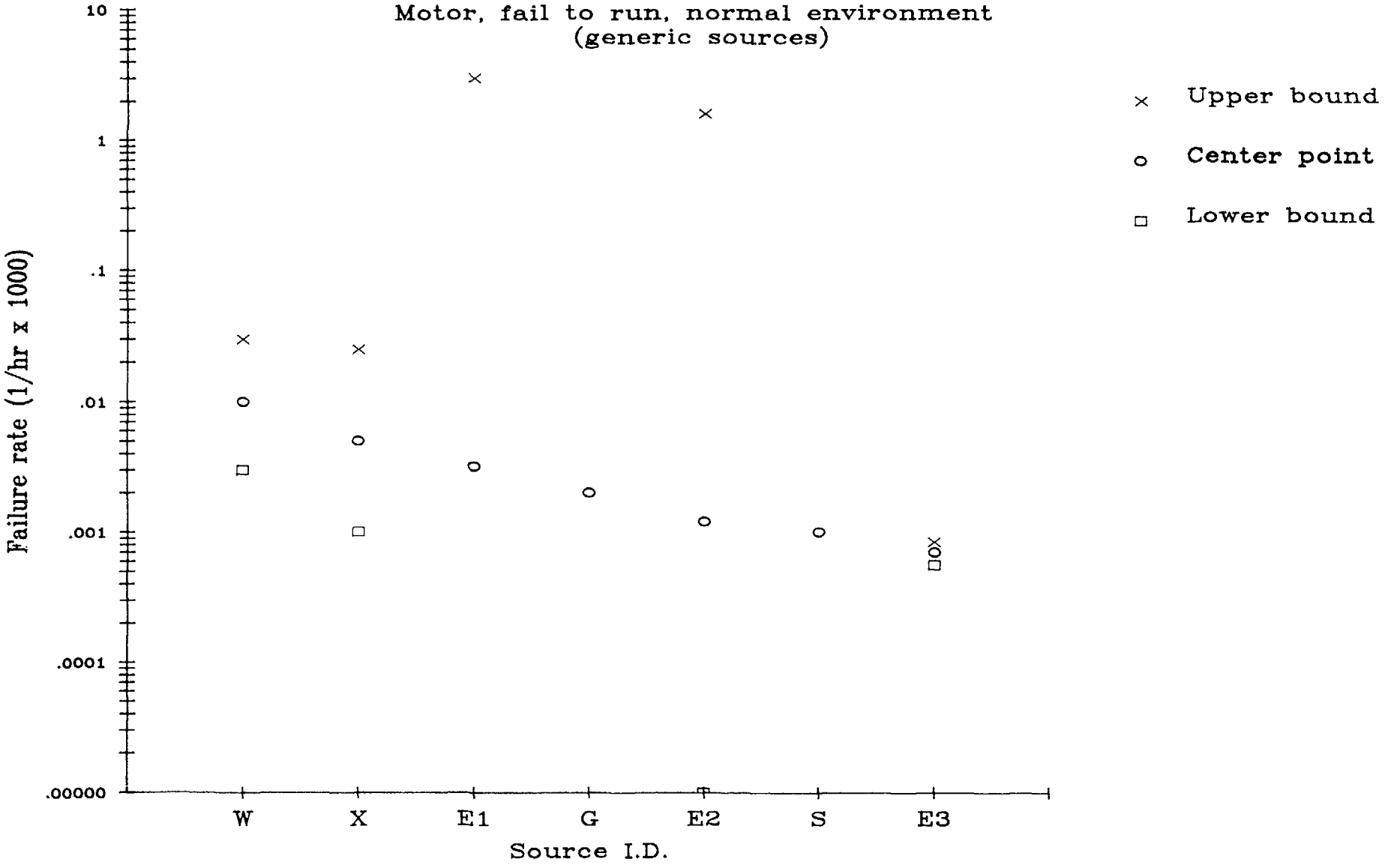
X Source category: generic

MAASX motor general
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to start Original failure mode: fail to start
FAILURE RATE OR PROBABILITY mean : 3.0E-4/d 80%: 6.0E-4/d 20%: 1.5E-4/d
Source: VVER reliability data base Ultimate source: expert opinion
Comment:

E Source category: generic

MAWSE motor AC synchronous
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to start Original failure mode: fail to start
FAILURE RATE OR PROBABILITY rec : 2.0E-4/d high: 2.2E-4/d low: 1.4E-4/d
Source: IEEE 500 (1984) pg.241 Ultimate source: expert opinion aggregation and operating experience
Comment: Number of starts in time not known. Original time related value changed to demand related assuming monthly testing.

IAEA RELIABILITY DATA BASE



W Source category: generic

MAARW motor general
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to run Original failure mode: failure to run, given start
FAILURE RATE OR PROBABILITY median: 1.0E-5/hr 95%: 3.0E-5/hr 5%: 3.0E-6/hr ERROR FACTOR: 3
Source: WASH 1400 (table III 4-2) Ultimate source: assesed from nuclear, industrial and military expereince and data
Comment: Applicable only to motors that function independently of pumps and valves.

X Source category: generic

MAARX motor general
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to run Original failure mode: fail to run
FAILURE RATE OR PROBABILITY mean : 5.0E-6/hr 80%: 2.5E-5/hr 20%: 1.0E-6/hr
Source: VVER reliability data base Ultimate source: expert opinion
Comment:

E1 Source category: generic

MACRE motor AC general
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to run Original failure mode: fail to run once started
FAILURE RATE OR PROBABILITY rec : 3.2E-6/hr high: 3.0E-3/hr low: 0.0E-0/hr REPAIR TIME: 1.8 hours
Source: IEEE 500 (1984) pg.220 Ultimate source: expert opinion aggregation and operating experience
Comment: Failure rate is composite of different types and voltage levels.

G Source category: generic

MAARG motor general
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to run Original failure mode: fail to run
FAILURE RATE OR PROBABILITY median: 2.0E-6/hr ERROR FACTOR: 8
Source: German Risk Study (tb.F3,7-1) Ultimate source: generic data
Comment: Failure rate is combination of number of generic data sources including non-nuclear.

E2 Source category: generic

MAIRE motor AC induction
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to run Original failure mode: fail to run once started
FAILURE RATE OR PROBABILITY rec : 1.2E-6/hr high: 1.6E-3/hr low: 1.0E-8/hr
Source: IEEE 500 (1984) pg.229 Ultimate source: expert opinion aggregation and operating experience
Comment: Failure rate is composite of different voltage and power levels.

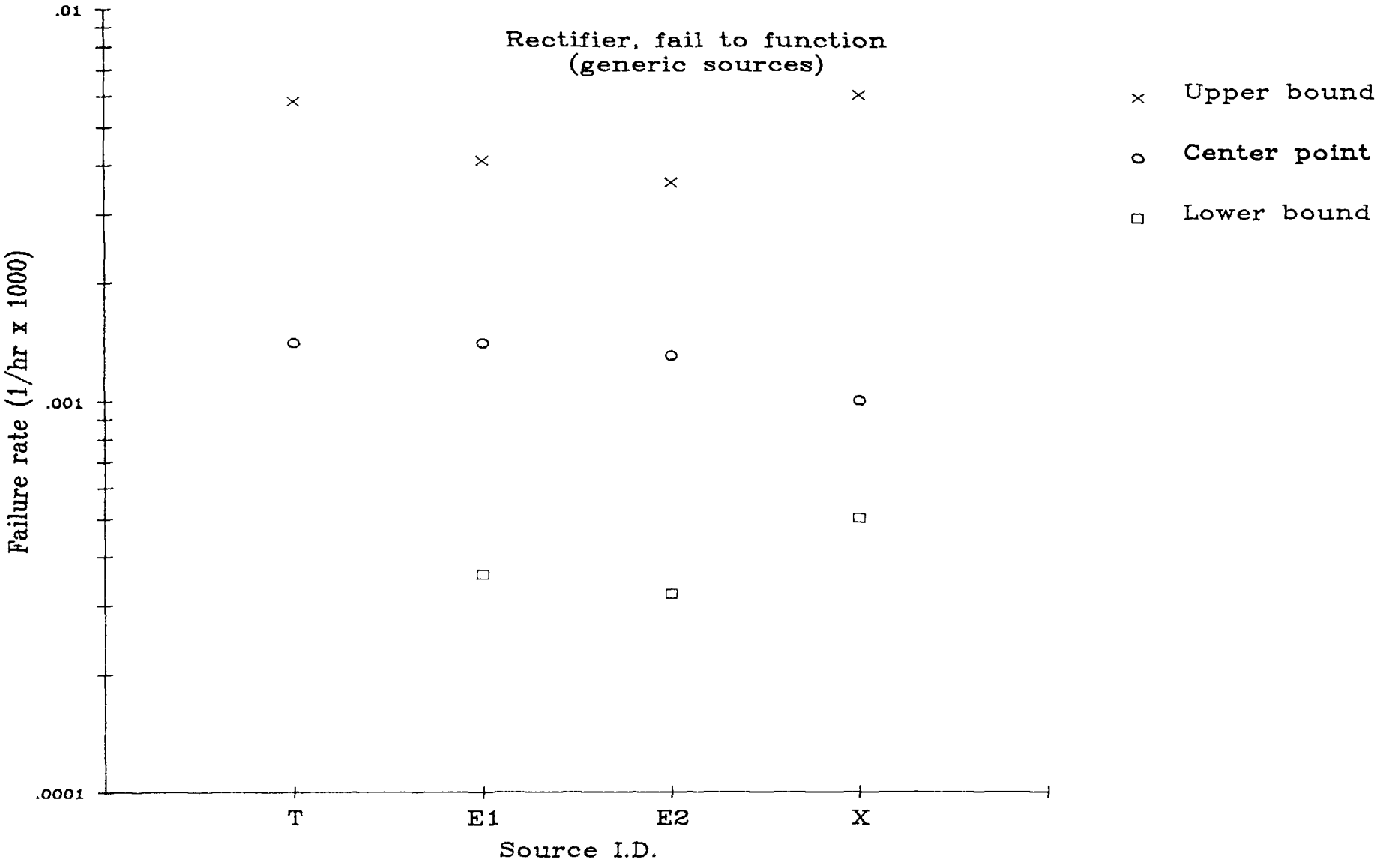
S Source category: generic

MAARS motor general
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to run Original failure mode: fails to run given start
FAILURE RATE OR PROBABILITY mean : 1.0E-6/hr
Source: Shoreham PRA,GE data(tb.A.2-1) Ultimate source: evaluation of BWR operating experience
Comment:

E3 Source category: generic

MAWAE motor AC synchronous
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to run Original failure mode: fail to run once started
FAILURE RATE OR PROBABILITY rec : 7.0E-7/hr high: 8.4E-7/hr low: 5.6E-7/hr
Source: IEEE 500 (1984) pg.241 Ultimate source: expert opinion aggregation and operating experience
Comment:

IAEA RELIABILITY DATA BASE



T Source category: generic

ERSFT rectifier static
Component boundary: rectifier, fuse(380V side), tap. Operating mode: operating Operating environment: normal
Generic failure mode: fail to function Original failure mode: loss of effective output
FAILURE RATE OR PROBABILITY mean : 1.4E-6/hr 95%: 5.8E-6/hr REPAIR TIME: 16 hours
Source: Swedish Rel.data book, tbl.42 Ultimate source: plant operating experience (7 BWR plants), ATV reports, LERs
Comment: Critical failures are: burned connections,failed fans,unstable electronics.Op.experience: total pop.140.Op.time 427E+4 hours.
No.of failures 6. a=0.0324; b=23000 Critical failures at 3 plants

E1 Source category: generic

ERPFE rectifier precipitator rectifier
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: no output(catastrophic)
FAILURE RATE OR PROBABILITY rec : 1.4E-6/hr high: 4.1E-6/hr low: 3.6E-7/hr
Source: IEEE 500 (1984) pg.422 Ultimate source: expert opinion aggregation and operating experience
Comment: Falure mode "no output" consist of:1)automatic removal by protective circutry; 2)manual removal; 3)open circut.

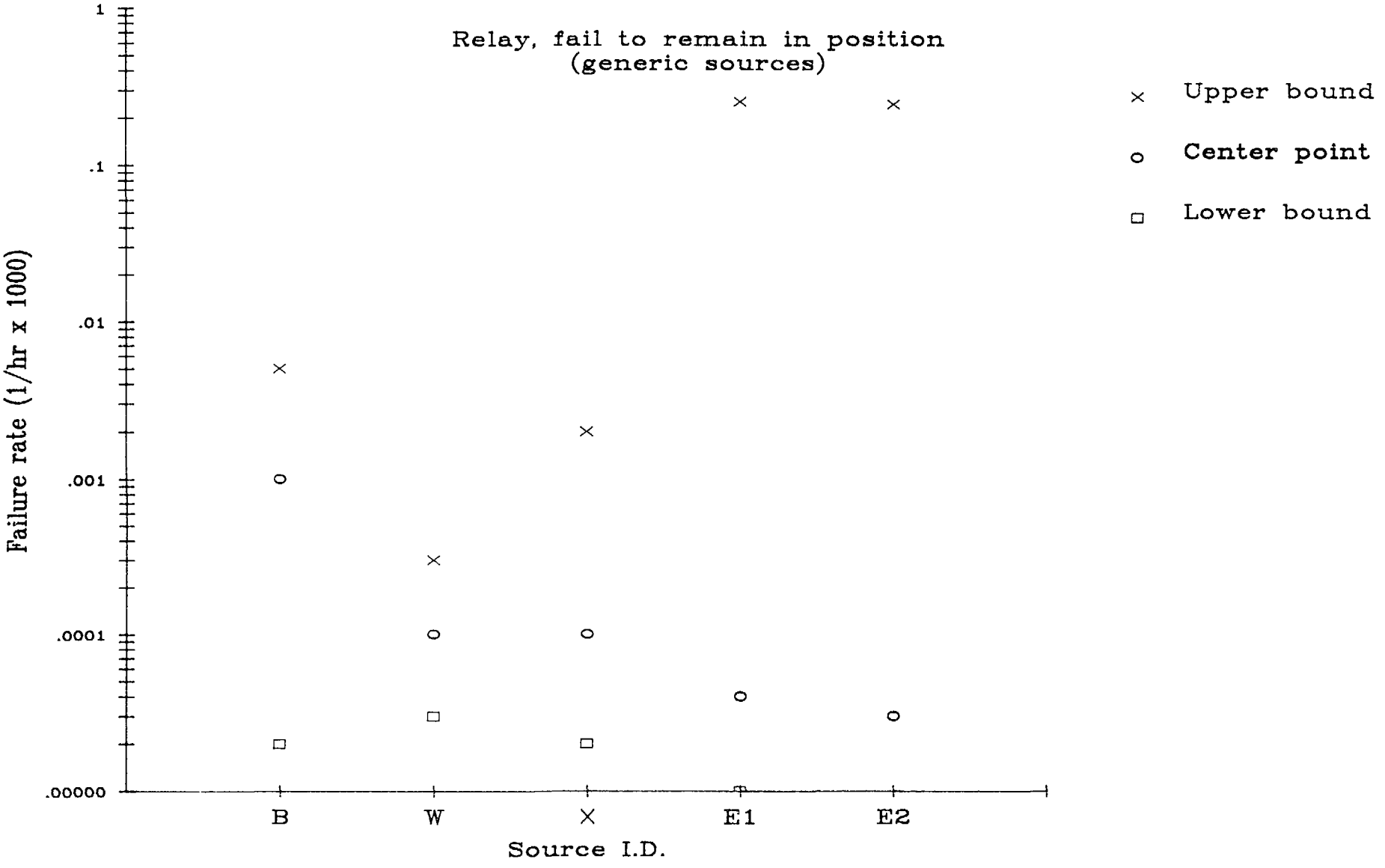
E2 Source category: generic

EREFE rectifier excitation rectifier
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: no output(catastrophic)
FAILURE RATE OR PROBABILITY rec : 1.3E-6/hr high: 3.6E-6/hr low: 3.2E-7/hr
Source: IEEE 500 (1984) pg.421 Ultimate source: expert opinion aggregation and operating experience
Comment: Failure node "no output" consist of:1)automatic removal by protective circutry; 2)manual removal; 3)open circut

X Source category: generic

ERAFX rectifier
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: fail to function
FAILURE RATE OR PROBABILITY mean : 1.0E-6/hr 80%: 6.0E-6/hr 20%: 5.0E-7/hr
Source: VVER reliability data base Ultimate source: expert opinion
Comment:

IAEA RELIABILITY DATA BASE



B Source category: generic

RTADB relay time delay general
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to remain in position Original failure mode: premature transfer
FAILURE RATE OR PROBABILITY mean : 1.0E-6/hr max: 5.0E-6/hr min: 2.0E-8/hr
Source: NUREG 2815 (table C.1.) Ultimate source: expert judgement and IREP data
Comment:

W Source category: generic

RWCDW relay general
Component boundary: detail n/a Operating mode: normally closed Operating environment: normal
Generic failure mode: fail to remain in position Original failure mode: failure of NC cnts by opening,given not energised
FAILURE RATE OR PROBABILITY median: 1.0E-7/hr 95%: 3.0E-7/hr 5%: 3.0E-8/hr ERROR FACTOR: 3
Source: WASH 1400 (table III 4-2) Ultimate source: assesed from nuclear expereince
Comment:

X Source category: generic

RWCDX relay general
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to remain in position Original failure mode: fail to remain in position
FAILURE RATE OR PROBABILITY mean : 1.0E-7/hr 80%: 2.0E-6/hr 20%: 2.0E-8/hr
Source: VVER reliability data base Ultimate source: expert opinion
Comment:

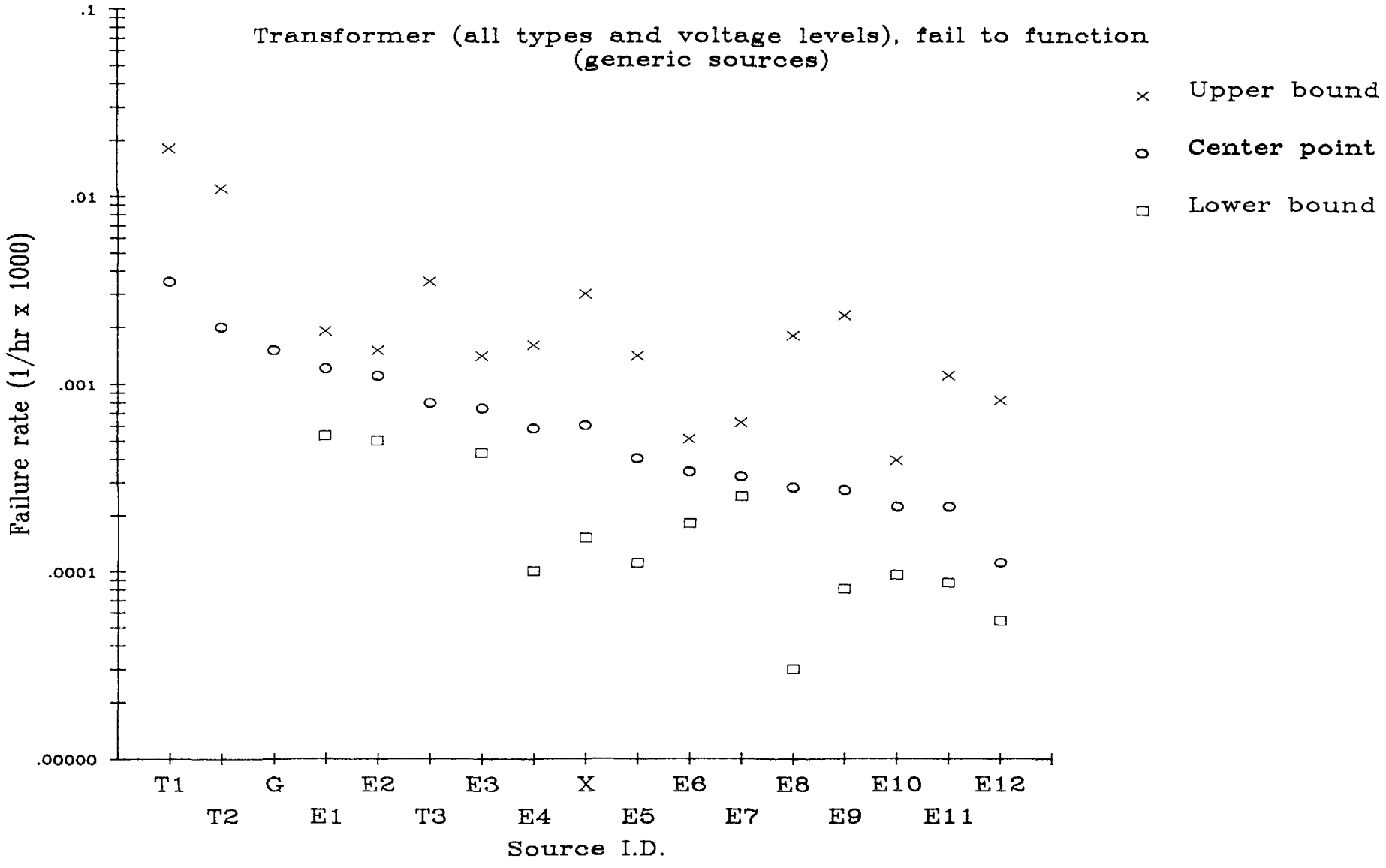
E1 Source category: generic

RRADE relay protective all types
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to remain in position Original failure mode: spourious operation
FAILURE RATE OR PROBABILITY rec : 3.0E-8/hr high: 2.4E-4/hr low: 0.0 REPAIR TIME: .55 hours
Source: IEEE 500 (1984) pg.164 Ultimate source: expert opinion aggregation and operating experience
Comment: Given value is composite of all types and voltage levels of protective relays.References IEEE 500 (1977) and IEEE 493 (1980)

E2 Source category: generic

RCLDE relay control all types
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to remain in position Original failure mode: spourious operation
FAILURE RATE OR PROBABILITY rec : 4.0E-8/hr high: 2.5E-4/hr low: 1.0E-8/hr
Source: IEEE 500 (1984) pg.183 Ultimate source: expert opinion aggregation and operating experience
Comment: Given value is composite of AC and DC control relays and diffrerent voltage leves in both groups.Reference IEEE 500(1977)

IAEA RELIABILITY DATA BASE



T1 Source category: generic

TM5FT transformer main transformer Voltage= 400kV,130kV
Component boundary: transformer,coolers,relay protection,supervision,monitors Operating mode: operating Operating environment: normal
Generic failure mode: fail to function Original failure mode: interruption
FAILURE RATE OR PROBABILITY mean : 3.5E-6/hr 95%: 1.8E-5/hr REPAIR TIME: 38 hours
Source: Swedish Rel.data book, tbl.45 Ultimate source: plant operating experience (7 BWR plants), ATV reports, LERs
Comment: Operating experience:total pop. 10.Operating time 28.8E+4 hours. No.of failures 1. Most frequent failures are cooling fan failures which are not critical failures of the transform.a=0.195;b=56200

T2 Source category: generic

TXAFT transformer station start and auxiliary transformer Voltage levels: 130/6 kV, 70/6 kV, 20/6 kV
Component boundary: tramsformer,coolers,relay protection,supervisions, monitors Operating mode: operating Operating environment: normal
Generic failure mode: fail to function Original failure mode: interruption
FAILURE RATE OR PROBABILITY mean : 2.0E-6/hr 95%: 1.1E-5/hr REPAIR TIME: 5 hours
Source: Swedish Rel.data book, tbl.46 Ultimate source: plant operating experience (7 BWR plants), ATV reports, LERs
Comment: Operating experience:total pop. 17.Operational time 51.2E+4 hours No.of failures 1.
a=0.101; b=51800

G Source category: generic

TAAFG transformer general
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: failure to operate
FAILURE RATE OR PROBABILITY median: 1.5E-6/hr ERROR FACTOR: 5
Source: German Risk Study (tb.F3,7-1) Ultimate source: generic data
Comment: In the table F3,7-1 failure mode is missing. Failure mode "failure to operate" was assumed on the bases of generic sources included."Failure to operate" include "open" and "short" circut.

E1 Source category: generic

TS5FE transformer main power generator or unit transformer liquid filled, single phase (347-550 kV)
Component boundary: detil n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: no output(catastrophic)
FAILURE RATE OR PROBABILITY rec : 1.2E-6/hr high: 1.9E-6/hr low: 5.3E-7/hr
Source: IEEE 500 (1984) pg.352 Ultimate source: expert opinion aggregation and operating experience
Comment: Failure mode "no output" include: 1) automatic removal by protec. circutry; 2)manual removal; 3)open circut.
#1) is order of magnitude higher than #2) and #3).

E2 Source category: generic

TM4FE transformer main power generator or unit transformer liquid filled, three phase (146-242 kV)
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: no output(catastrophic)
FAILURE RATE OR PROBABILITY rec : 1.1E-6/hr high: 1.5E-6/hr low: 5.0E-7/hr
Source: IEEE 500 (1984) pg.358 Ultimate source: expert opinion aggregation and operating experience
Comment: Failure mode "no output" include: 1) automatic removal; 2)manual removal; 3) open circut.
Dominant contributor is #1) (more than order-of-magnitude)

T3 Source category: generic

TA6FT transformer general Voltage <= 6 kV
Component boundary: transformer,relay protection,coolers,supervision,monitors Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: interruption
FAILURE RATE OR PROBABILITY mean : 7.9E-7/hr 95%: 3.5E-6/hr REPAIR TIME: 10 hours
Source: Swedish Rel.data book, tbl.47 Ultimate source: plant operating experience (7 BWR plants),ATV reports, LERs
Comment: Operating experience: total pop. 129.Opertional time 379E+4 hours No.of failures 3. Critical failures occured at two plants only.
a=0.0345; b=43600

E3 Source category: generic

TM5FE transformer main power generator or unit transformer liquid filled, three phase (347-550 kV)
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: no output(catastrophic)
FAILURE RATE OR PROBABILITY rec : 7.4E-7/hr high: 1.4E-6/hr low: 4.3E-7/hr
Source: IEEE 500 (1984) pg.360 Ultimate source: expert opinion aggregation and operating experience
Comment: Failure mode "no output" include: 1) automatic removal; 2) manual removal; 3) open circut.
#1) is order of magnitude higher than #2) and #3).

E4 Source category: generic

TMAFE transformer main power generator or unit transformer liquid filled, three phase all voltage levels
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: no output(catastrophic)
FAILURE RATE OR PROBABILITY rec : 5.8E-7/hr high: 1.6E-6/hr low: 1.0E-7/hr
Source: IEEE 500 (1984) pg.354 Ultimate source: expert opinion aggregation and operating experience
Comment: Given value is composite of all voltage levels. Failure mode include:1)automatic; 2)manual removal; 3)open circut
#1) is order of magnitude higher than #2) and #3).

X Source category: generic

TAAFX transformer general
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: fail to function
FAILURE RATE OR PROBABILITY mean : 6.0E-7/hr 80%: 3.0E-6/hr 20%: 1.5E-7/hr
Source: VVER reliability data base Ultimate source: expert opinion
Comment:

E5 Source category: generic

TETFE transformer station service including excitation dry type, three phase (all voltage levels)
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: no output(catastrophic)
FAILURE RATE OR PROBABILITY rec : 4.0E-7/hr high: 1.4E-6/hr low: 1.1E-7/hr
Source: IEEE 500 (1984) pg.330 Ultimate source: expert opinion aggregation and operating experience
Comment: Given value is composite of three different voltage levels Failure mode include: 1) automatic removal; 2) manual
removal; 3) open circut. Dominant contributor is #1).

E6 Source category: generic

TM2FE transformer main power generator or unit transformer liquid filled, three phase (2-30 kV)
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: no output(catastrophic)
FAILURE RATE OR PROBABILITY rec : 3.4E-7/hr high: 5.1E-7/hr low: 1.8E-7/hr
Source: IEEE 500 (1984) pg.355 Ultimate source: expert opinion aggregation and operating experience
Comment: Failure mode "no output" include: 1)automatic removal; 2)manual removal, 3) open circut.
Dominalnt contributor is #1).

E7 Source category: generic

TS4FE transformer main power generator or unit transformer liquid filled, single phase (146-242 kV)
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: no output(catastrophic)
FAILURE RATE OR PROBABILITY rec : 3.2E-7/hr high: 6.2E-7/hr low: 2.5E-7/hr
Source: IEEE 500 (1984) pg.350 Ultimate source: expert opinion aggregation and operating experience
Comment: Failure mode "no output" include: 1)automatic removal by protect. circutry 2)manual removal; 3)open circut.
4) is order of magnitude higher than #2) and #3).

E8 Source category: generic

TSAFE transformer main power generator or unit transformer liquid filled, single phase (all voltage levels)
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: no output(catastrophic)
FAILURE RATE OR PROBABILITY rec : 2.8E-7/hr high: 1.8E-6/hr low: 3.0E-8/hr
Source: IEEE 500 (1984) pg.348 Ultimate source: expert opinion aggregation and operating experience
Comment: This is a composite value of all voltage levels of main, liquid filled single phase transformers. Failure mode include:1)autom. removal; 2)manual removal; 3)open circut. #1) is dominant.

E9 Source category: generic

TESFE transformer station service including excitation dry type,single phase (all voltage levels)
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: no output(catastrophic)
FAILURE RATE OR PROBABILITY rec : 2.7E-7/hr high: 2.3E-6/hr low: 8.0E-8/hr
Source: IEEE 500 (1984) pg.326 Ultimate source: expert opinion aggregation and operating experience
Comment: Given value is composite of three diffrerent voltage levels. Failure mode include: 1)automatic removal; 2) manual removal; 3)open circut. Dominant contributor is #1).

E10 Source category: generic

TS2FE transformer main power generator or unit transformer liquid filled, single phase (2-30 kV)
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: no output(catastrofic)
FAILURE RATE OR PROBABILITY rec : 2.2E-7/hr high: 3.9E-7/hr low: 9.5E-8/hr
Source: IEEE 500 (1984) pg.347 Ultimate source: expert opinion aggregation and operating experience
Comment: Failure mode includes no output due to:1) automatic removal by protective circutry; 2)manual removal; 3) open circut.

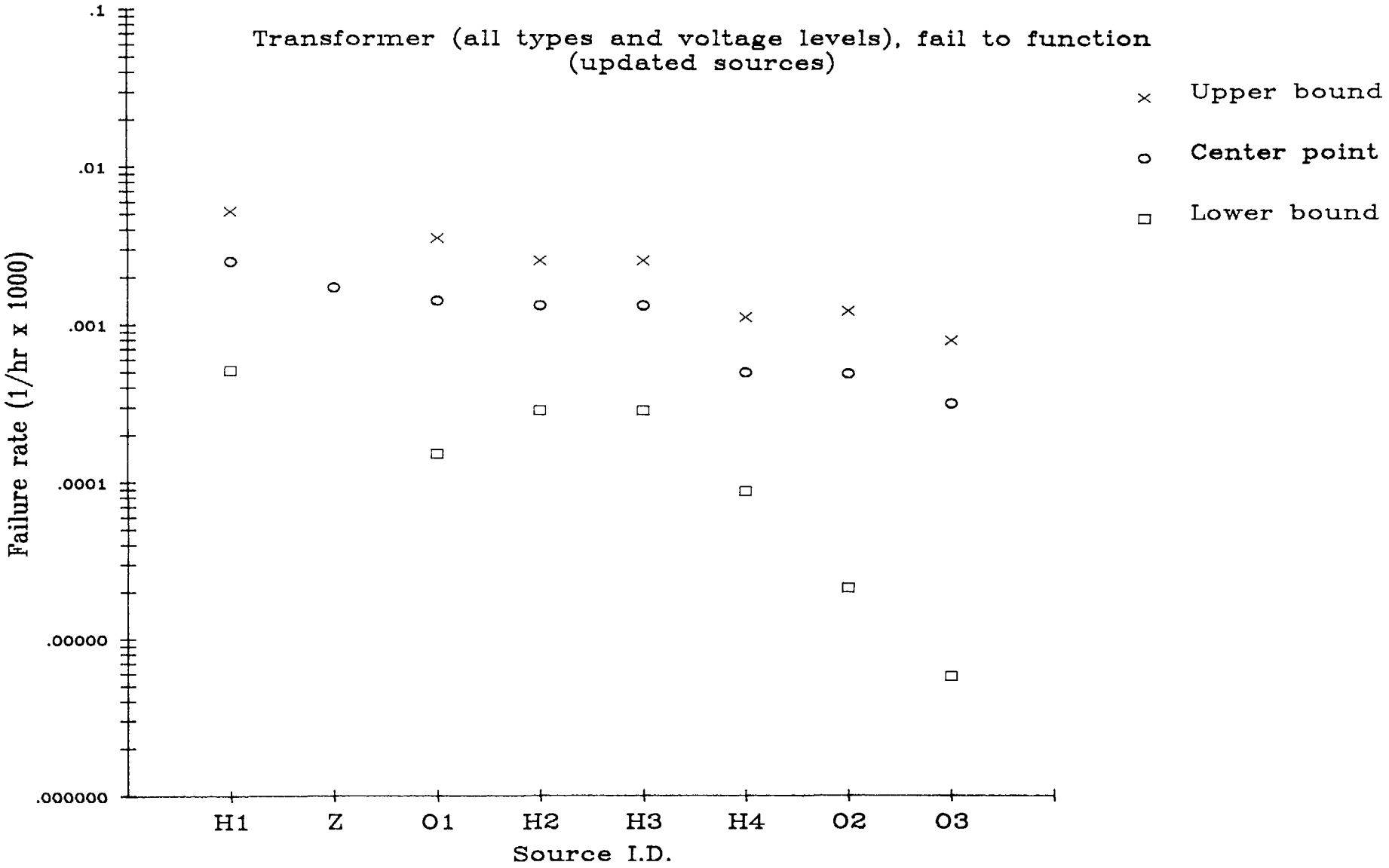
E11 Source category: generic

TEGFE transformer station service including excitation liquid filled, single phase (0-40 kV)
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: no output(catastrophic)
FAILURE RATE OR PROBABILITY rec : 2.2E-7/hr high: 1.1E-6/hr low: 8.6E-8/hr
Source: IEEE 500 (1984) pg.318 Ultimate source: expert opinion aggregation and operating experience
Comment: Given value is composite of three diffrerent voltage levels. Falure mode include: 1)automatic removal; 2)manual removal 3)open circut. dominant contributor is #1).

E12 Source category: generic

TEHFE transformer station service including excitation liquid filled, three phase (0-40 kV)
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: no output(catastrophic)
FAILURE RATE OR PROBABILITY rec : 1.1E-7/hr high: 8.1E-7/hr low: 5.4E-8/hr
Source: IEEE 500 (1984) pg.322 Ultimate source: expert opinion aggregation and operating experience
Comment: Given value is composite of threr diffrerent voltage levels. Failure mode include: 1)automatic removal; 2)manual removal: 3)open circut. Dominant contributor is #1).

IAEA RELIABILITY DATA BASE



H1 Source category: updated

TA2FH transformer 220/120 V
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: fail during operation
FAILURE RATE OR PROBABILITY mean : 2.5E-6/hr 95%: 5.2E-6/hr 5%: 5.1E-7/hr
Source: Old PWR Ultimate source: generic data updated with plant operating experience
Comment: Generic mean 1.6E-6/hr. Operating experience 5.4E+5 hours of operation, 2 failures.

Z Source category: updated

TABFZ transformer general
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: fail during operation
FAILURE RATE OR PROBABILITY mean : 1.7E-6/hr
Source: ZION NPP PSS (tbl.1.5.1-5) Ultimate source: generic data updated with plant specific experience
Comment: Prior:IEEE 500(1977)(pg.300) transformer 601V-15kV, prior failure mode="all modes"
Operating experience:3.0E+5 hours of operation,1 failure.

01 Source category: updated

TM2FO transformer high voltage outdoor
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: operational failure
FAILURE RATE OR PROBABILITY mean : 1.4E-6/hr 95%: 3.5E-6/hr 5%: 1.5E-7/hr REPAIR TIME: 10.8 hours
Source: Oconee NPP PRA (tbl.b-1.) Ultimate source: generic data upgraded with plant operating experience
Comment: Prior:IEEE 500 (1977)(pg.315),rec=median;max=80%.FM"catastrophic' "seems to include load side protection).Op.exp. 81.900 hours
of operation,no failures. Repair time is generic maintn.duration.

H2 Source category: updated

TA5FH transformer 50/6 kV
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: fail during operation
FAILURE RATE OR PROBABILITY mean : 1.3E-6/hr 95%: 2.5E-6/hr 5%: 2.8E-7/hr
Source: Old PWR Ultimate source: generic data updated with plant operating experience
Comment: Generic mean 1.6E-6/hr. Operating experience 1.4E+5 hours of operation, no failures.

H3 Source category: updated

TA8FH transformer 8 kV / 6 kV
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: fail during operation
FAILURE RATE OR PROBABILITY mean : 1.3E-6/hr 95%: 2.5E-6/hr 5%: 2.8E-7/hr
Source: Old PWR Ultimate source: generic data updated with plant operating experience
Comment: Generic mean 1.6E-6/hr. Operating experience 1.4E+5 hours of operation, no failures.

H4 Source category: updated

TA6FH transformer 6kV/380 V
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: fail during operation
FAILURE RATE OR PROBABILITY mean : 4.9E-7/hr 95%: 1.1E-6/hr 5%: 8.6E-8/hr
Source: Old PWR Ultimate source: generic data updated with plant specific operating experience
Comment: Generic mean 6.9E-7/hr. Operating expereince 8.2E+5 hours of operation, no failures.

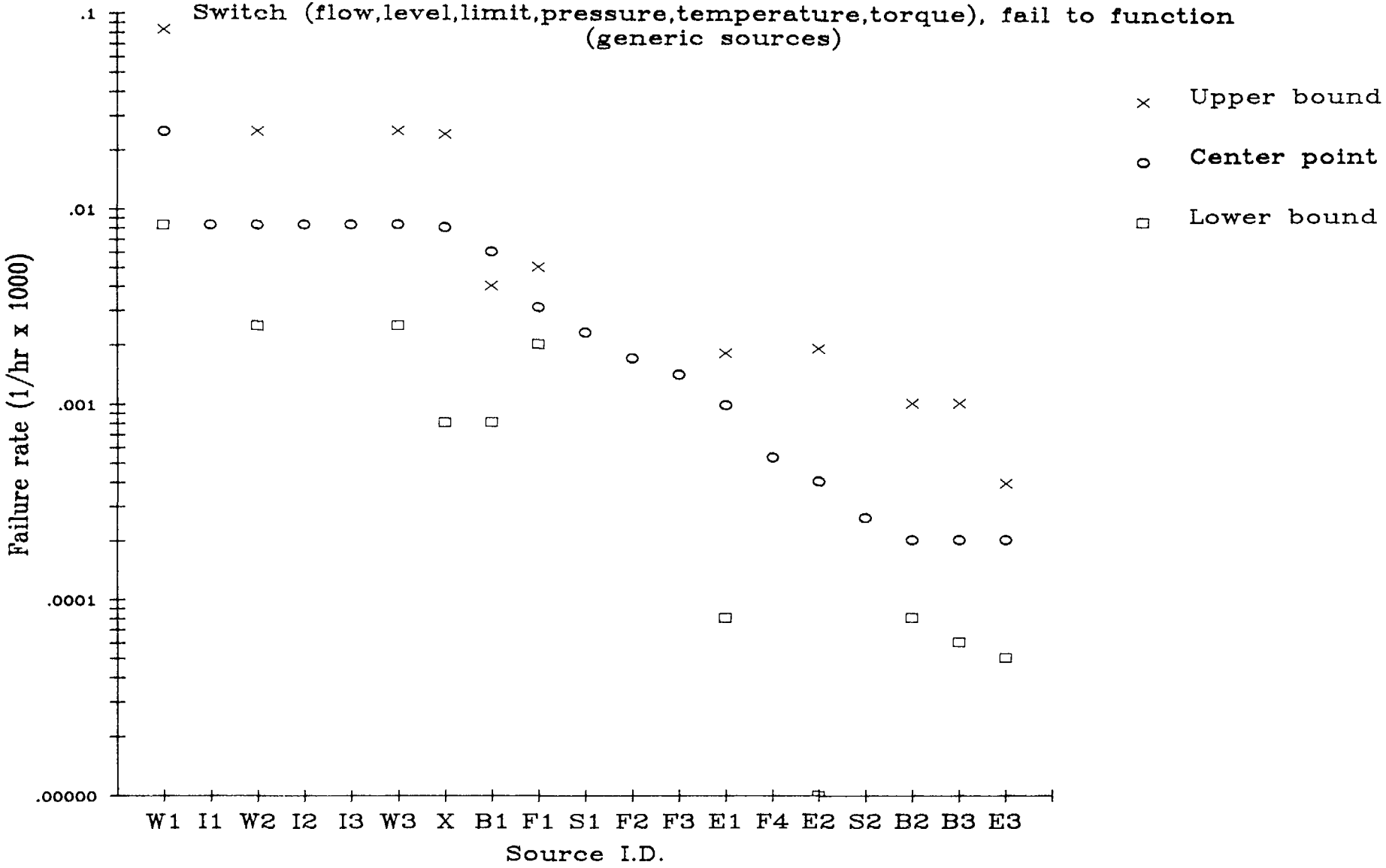
02 Source category: updated

TADFO transformer dry (4 kV/600V)
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: operational failure
FAILURE RATE OR PROBABILITY mean : 4.8E-7/hr 95%: 1.2E-6/hr 5%: 2.1E-8/hr REPAIR TIME: 10.8 hours
Source: Oconee NPP PRA (tbl.b-1.) Ultimate source: generic data updated with plant specific operating experience
Comment: Prior:IEEE 500(1977)(pg.300), rec=median;max=80% of distribution Operating experience: 4.34E+5 hours of operation, no failures.
Repair time is mean generic maintenance duration.

03 Source category: updated

TAEFO transformer dry (600 V/208 V)
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: operational failure
FAILURE RATE OR PROBABILITY mean : 3.1E-7/hr 95%: 7.8E-7/hr 5%: 5.7E-9/hr REPAIR TIME: 10.8 hours
Source: Oconee NPP PRA (tbl.b-1.) Ultimate source: generic data updated with plant specific operational experience
Comment: Prior:IEEE 500 (1977) pg.299.rec=median; max=80% of distribution. Operating experience:8.2E+5 hours of operation, no failures.
Repair time is mean generic maintenance duration.

IAEA RELIABILITY DATA BASE



W1 Source category: generic

SIAFW switch limit general
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: failure to operate
FAILURE RATE OR PROBABILITY median: 2.5E-5/hr 95%: 8.3E-5/hr 5%: 8.3E-6/hr ERROR FACTOR: 3
Source: WASH 1400 (table III 4-2) Ultimate source: assesed from nuclear, industrial and military experience and data
Comment: The data do not uniquely separate the causes of failure, hence failure modes are not necessary independent. Failure to operate includes failures of contacts.Org.demand rel.Assumen 1 demand/day

I1 Source category: generic

SQAFI switch torque general
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: failure to operate
FAILURE RATE OR PROBABILITY mean : 8.3E-6/hr ERROR FACTOR: 3
Source: IREP NUREG 2728 (tb.5.1-1) Ultimate source: expert opinion
Comment: Where torque switch is used as part of pump/valve, switch failure rate is included in pump/valve failure rate. Original demand related value changed to time related assuming 1 demand/day.

W2 Source category: generic

SQAFW switch torque general
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: failure to operate
FAILURE RATE OR PROBABILITY meidan: 8.3E-6/hr 95%: 2.5E-5/hr 5%: 2.5E-6/hr ERROR FACTOR: 3
Source: WASH 1400 (table III 4-2) Ultimate source: assesed from nuclear and military experience and data sources
Comment: Data do not uniquely separate the causes of failure,hence failure modes are not necessary independent. Failure to operate include failures of contacts.Org.value per demand.Assumed 1 demand/day.

I2 Source category: generic

SPAFI switch pressure general
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: failure to operate
FAILURE RATE OR PROBABILITY mean : 8.3E-6/hr : n/s ERROR FACTOR: 3
Source: IREP NUREG 2728 (tb.5.1-1) Ultimate source: expert opinion
Comment: Original demand related value changed to time related assuming one demand per day.

I3 Source category: generic

SIAFI switch limit general
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: failure to operate
FAILURE RATE OR PROBABILITY mean : 8.3E-6/hr ERROR FACTOR: 3
Source: IREP NUREG 2728 (tb.5.1-1) Ultimate source: expert opinion
Comment: Where limit switch is used as part of pump/valve,switch failure rate is included in pump/valve failure rate. Original demand related value changed to time related assuming 1 demand per day.

W3 Source category: generic

SPAFW switch pressure general
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: failure to operate
FAILURE RATE OR PROBABILITY median: 8.3E-6/hr 95%: 2.5E-5/hr 5%: 2.5E-6/hr ERROR FACTOR: 3
Source: WASH 1400 (table III 4-2) Ultimate source: assesed from nuclear, industrial and military experience and data
Comment: Data do not uniquely separate causes of failures, hence failure modes are not necessary independent. Failure to operate includes failure of contacts.Org.value demand.Assumed 1 dem./day.

X Source category: generic

SGAFX switch all types
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: fail to function
FAILURE RATE OR PROBABILITY mean : 8.0E-6/hr 80%: 2.4E-5/hr 20%: 8.0E-7/hr
Source: VVER reliability data base Ultimate source: expert opinion
Comment:

B1 Source category: generic

SIAFB switch limit general
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: failure to operate
FAILURE RATE OR PROBABILITY mean : 6.0E-6/hr max: 4.0E-6/hr min: 8.0E-7/hr
Source: NUREG 2815 (table C.1.) Ultimate source: expert judgement and IREP data
Comment: Where limit switch is uses as a part of pump/valve, switch failure rate is included in pump/valve rate

F1 Source category: generic

SPAFF switch pressure
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: failure to operate
FAILURE RATE OR PROBABILITY mean : 3.1E-6/hr 95%: 5.0E-6/hr 5%: 2.0E-6/hr ERROR FACTOR: 1.5
Source: HWR data Ultimate source: HWR operating experience
Comment: Operational data for this failure mode are not given, but probbably included in "all modes".
(data source IEEE 500??)

S1 Source category: generic

STAFS switch temperature general
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: fails to operate
FAILURE RATE OR PROBABILITY mean : 2.3E-6/hr
Source: Shoreham PRA,GE data(tb.A.2-1) Ultimate source: evaluation of BWR operating experience
Comment:

F2 Source category generic

SFAFF switch flow
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: fail to operate
FAILURE RATE OR PROBABILITY mean : 1.7E-6/hr REPAIR TIME: 4 hours
Source: HWR data Ultimate source: HWR assesment
Comment: Ultimate source of data is not clear. (IEEE data ??)

F3 Source category. generic

SLAFF switch level
Component boundary. detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: fail to operate
FAILURE RATE OR PROBABILITY mean 1 4E-6/hr REPAIR TIME: 4 hours
Source: HWR data Ultimate source: HWR assesment
Comment: Ultimate data source is not known. (IEEE data??)

E1 Source category: generic

SFAFE switch flow general
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: no function with signal
FAILURE RATE OR PROBABILITY rec : 9.8E-7/hr high: 1.8E-6/hr low: 8.0E-8/hr REPAIR TIME: .6 hours
Source: IEEE 500 (1984) pg.578 Ultimate source: expert opinion aggreagtion and operating experience
Comment: Failure rate is composite and include some non-nuclear suorces

F4 Source category: generic

STAFF switch temperature
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: failure to operate
FAILURE RATE OR PROBABILITY mean : 5.3E-7/hr
Source: HWR data Ultimate source: HWR assesment
Comment: Ultimate data source is not known. (data source IEEE 500 ??)

E2 Source category: generic

SPAFE switch pressure general
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: no function with signal
FAILURE RATE OR PROBABILITY rec : 4.0E-7/hr high: 1.9E-6/hr low: 1.0E-8/hr REPAIR TIME: .6 hours
Source: IEEE 500 (1984) pg.556 Ultimate source: expert opinion aggregation and operating experience
Comment: Value is composite and include some non-nuclear sources For this component failure rate per hour and per cycle is given.

S2 Source category: generic

SFAFS switch flow general
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: fails to operate
FAILURE RATE OR PROBABILITY mean : 2.6E-7/hr
Source: Shoreham PRA,GE data(tb.A.2-1) Ultimate source: evaluation of BWR operating experience
Comment:

B2 Source category: generic

SPAFB switch pressure
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: failure to operate
FAILURE RATE OR PROBABILITY mean : 2.0E-7/hr max: 1.0E-6/hr min: 8.0E-8/hr
Source: NUREG 2815 (table C.1.) Ultimate source: expert judgement and IREP data
Comment:

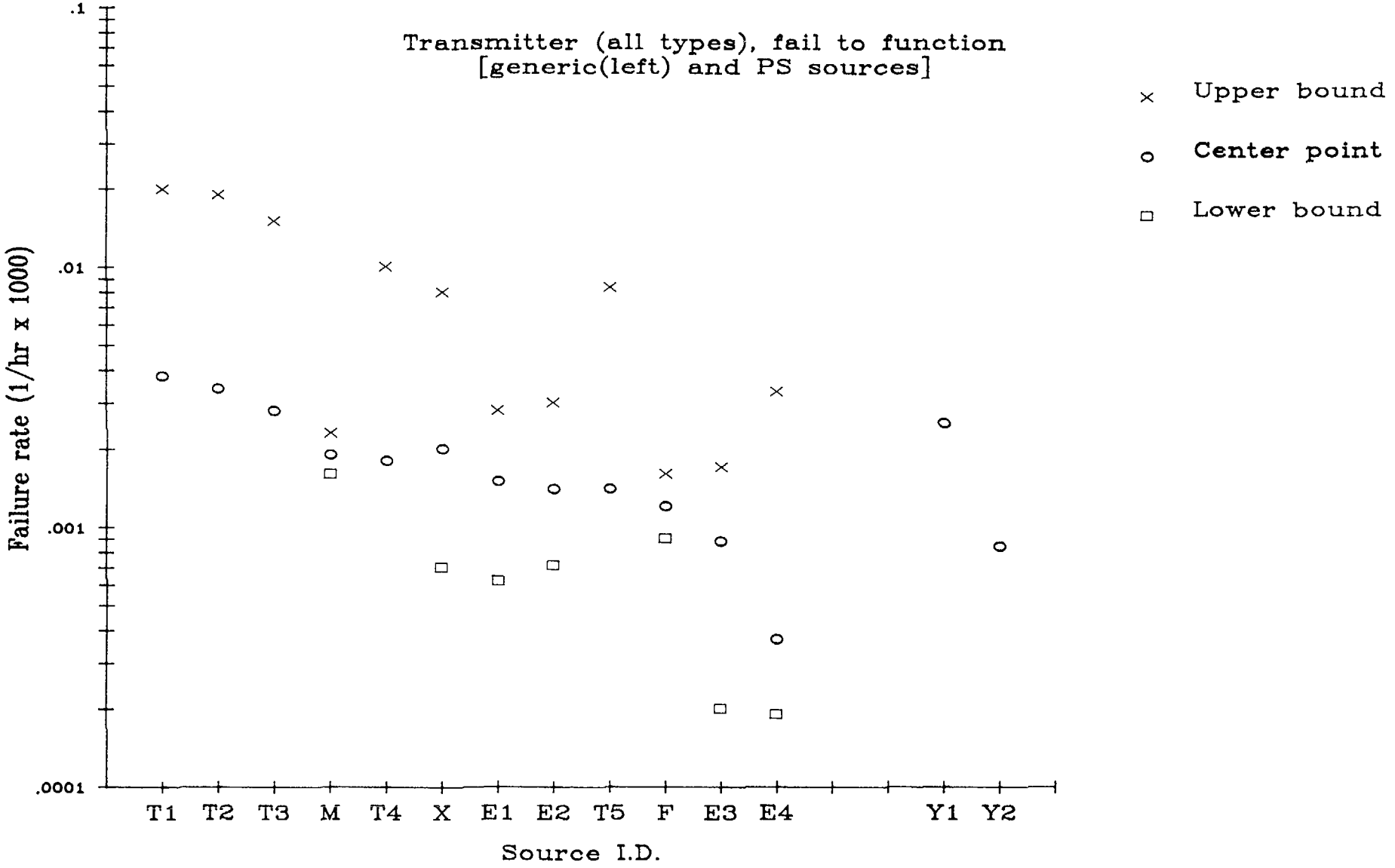
B3 Source category: generic

SQAFB switch torque general
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: failure to operate
FAILURE RATE OR PROBABILITY mean : 2.0E-7/hr max: 1.0E-6/hr min: 6.0E-8/hr
Source: NUREG 2815 (table C.1.) Ultimate source: expert judgement and IREP data
Comment: Where torque switch is used as a part of pump/valve, switch failure rate is included in pump/valve rate

E3 Source category: generic

STAFE switch temperature general
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: no function with signal
FAILURE RATE OR PROBABILITY rec : 2.0E-7/hr high: 3.9E-7/hr low: 5.0E-8/hr REPAIR TIME: .5 hours
Source: IEEE 500 (1984) pg.534 Ultimate source: expert opinion aggregation and operating experience
Comment: Given value is composite. For this component failure rate per hour and per cycle is given.

IAEA RELIABILITY DATA BASE



T1 Source category: generic

LLLFT transmitter level general
Component boundary: level transmitter only Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: signal failure
FAILURE RATE OR PROBABILITY mean : 3.8E-6/hr 95%: 2.0E-5/hr REPAIR TIME: 2 hours
Source: Swedish Rel.data book, tbl.35 Ultimate source: plant operating experience(5 BWR plants), ATV reports, LERs
Comment: Operating experience:total pop.72. Operational time 289E+4 hours No.of failures 11.
a=0.188; b=49500

T3 Source category: generic

LFFFT transmitter flow general
Component boundary: transmitter only Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: signal failure
FAILURE RATE OR PROBABILITY mean : 3.4E-6/hr 95%: 1.9E-5/hr REPAIR TIME: 3 hours
Source: Swedish Rel.data book, tbl.33 Ultimate source: plant operating experience (5 BWR plants),ATV reports, LERs
Comment: Operating experience: total pop.97. Operational time 358E+4 hours. No.of failures 12. a=0.101; b=30200
Critical failures reported on 5 plants.

T3 Source category: generic

LTTFT transmitter temperature general
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: signal failure
FAILURE RATE OR PROBABILITY mean : 2.8E-6/hr 95%: 1.5E-5/hr REPAIR TIME: 3 hours
Source: Swedish Rel.data book, tbl.37 Ultimate source: plant operating experience(6 BWR plants), ATV reports, LERs
Comment: Operating experience: total pop. 132. Operational time 289E+4 hours. No.of failures 8. a=0.0579; b=20900
Critical failures reported on 5 plants.

M Source category: generic

LADFM transmitter flow, level, pressure general
Component boundary: transmitter only Operating mode: operating Operating environment: normal
Generic failure mode: fail to function Original failure mode: inoperable
FAILURE RATE OR PROBABILITY mean : 1.9E-6/hr 95%: 2.3E-6/hr 5%: 1.6E-6/hr
Source: NUREG 1740 (1984) (table 18) Ultimate source: US plants LER reports evaluation
Comment: Overall rate, with command faults. W/o command faults 1.7E-6/hr. Only the flow transmitter for BWR.
PWR rate is almost two orders of magnitude higher than BWR.

T4 Source category: generic

LPPFT transmitter pressure general
Component boundary: pressure transmitter only Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: signal failure
FAILURE RATE OR PROBABILITY mean : 1.8E-6/hr 95%: 1.0E-5/hr REPAIR TIME: 2 hours
Source: Swedish Rel.data book, tbl.29 Ultimate source: plant operating experience (5 BWR plants), ATV reports, LERs
Comment: Operating experience:total pop.203.Operational time 820E+4 hours no.of failures 15.
a=0.0558; b=30500

X Source category: generic

LGAFX transmitter all types
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: fail to function
FAILURE RATE OR PROBABILITY mean : 2.0E-6/hr 80%: 8.0E-6/hr 20%: 7.0E-7/hr
Source: VVER reliability data base Ultimate source: expert opinion
Comment:

E1 Source category: generic

LFFFE transmitter flow general
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: catastrophic
FAILURE RATE OR PROBABILITY rec : 1.5E-6/hr high: 2.8E-6/hr low: 6.2E-7/hr
Source: IEEE 500 (1984) pg.577 Ultimate source: expert opinion aggregation
Comment: Reference IEEE 500 (1977) Failure mode "catastrophic" include:1) zero or maximum output; 2)no change in output whit change in input. Dominant #1).

E2 Source category: generic

LLLFE transmitter level general
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: catastrophic
FAILURE RATE OR PROBABILITY rec : 1.4E-6/hr high: 3.0E-6/hr low: 7.1E-7/hr
Source: IEEE 500 (1984) pg.588 Ultimate source: expert opinion aggregation
Comment: Reference IEEE 500 (1977) Failure mode"catastrophic" include: 1)zero or max.output; 2)no change in output whit change in input. Both about equal.

T5 Source category: generic

LXRFT transmitter presure difference general
Component boundary: pressure differernce transmitter only Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: signal failure
FAILURE RATE OR PROBABILITY mean : 1.4E-6/hr 95%: 8.3E-6/hr REPAIR TIME: 3 hours
Source: Swedish Rel.data book, tbl.31 Ultimate source: plant operating experience(7 BWR plants), ATV reports, LERs
Comment: Operating experience:total pop 132. Operational time 558E+4 hours No.of failures 8. a=0.0942; b=66200
Critical failures reported on 4 plants

F Source category: generic

LADFF transmitter flow, level, pressure (DP cells)
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: no output
FAILURE RATE OR PROBABILITY mean : 1.2E-6/hr 95%: 1.6E-6/hr 5%: 9.0E-7/hr ERROR FACTOR: 1.3 REPAIR TIME: 3 hours
Source: HWR data Ultimate source: HWR operating experience
Comment: Operational data for this failure mode are not given,but probbably included in "all modes".Catastrophic failures are this and "no chng in output with ch.." summed together mean=1.9E-6/hr.

E3 Source category: generic

LPPFE transmitter pressure general
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: catastrophic
FAILURE RATE OR PROBABILITY rec : 8.8E-7/hr high: 1.7E-6/hr low: 2.0E-7/hr
Source: IEEE 500 (1984) pg 552 Ultimate source: expert opinion aggregation
Comment: Reference IEEE 500 (1977) Faliure mode "catastrophic" include: 1)zero or max output; 2)no change in output with change in input. About equal contribution.

E4 Source category: generic

LTTFE transmitter temperature general
Component boundary: detail n/a Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: catastrophic
FAILURE RATE OR PROBABILITY rec : 3.7E-7/hr high: 3.3E-6/hr low: 1.9E-7/hr
Source: IEEE 500 (1984) pg.531 Ultimate source: expert opinion aggregation
Comment: Reference IEEE 500 (1977) Failure mode include: 1)zero or max.output 2)no change of output with change of input. Dominant contributor is #1).

Y1 Source category: plant specific

LPPFY transmitter pressure general
Component boundary: pressure transmitter only Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: signal failure
FAILURE RATE OR PROBABILITY mean : 2.5E-6/hr REPAIR TIME: 5 hours
Source: Swedish Rel.data book, tbl.29 Ultimate source: plant operating experience (Ringhals 2 PWR)
Comment: Operating experience:total pop.12.Operational time 39.91E+4 hours 1 failure

Y2 Source category: plant specific

LXRFY transmitter pressure difference general
Component boundary: pressure difference transmitter only Operating mode: all Operating environment: normal
Generic failure mode: fail to function Original failure mode: signal failure
FAILURE RATE OR PROBABILITY mean : 8.4E-7/hr REPAIR TIME: 2 hours
Source: Swedish Rel.data book, tbl.31 Ultimate source: plant operating experience (Ringhals 2 PWR), ATV reports
Comment: Operating experience:total pop.72.Operational time 239.5E+4 hours No.of failure 2.