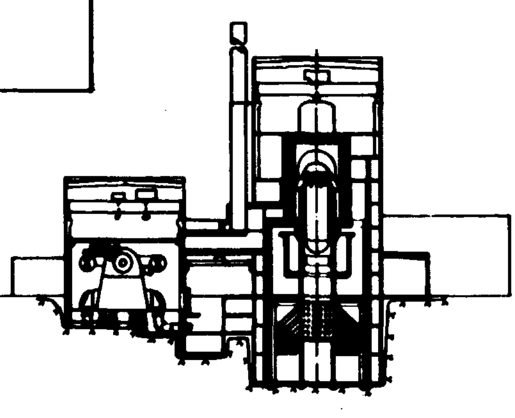
Studsvik Report

STUDSVIK/K2-81/479

QUANTITATIVE AND QUALITATIVE ANALYSIS OF THE ATV DATA BASE

Jean-Pierre Bento
Ecke Wendler

712 P1	RELA	78060214	78060216	1	1	ADBBCGDXFBFCGE	103929
		Feltyp	Pumpen startar ej pga att en kontakt i ett tidrelä ej sluter				
		Vt. Atg	Reläet utbytt				
712 P10	PUMP	76042016	76042016	1	8	A BLCIDIFZFCG	1105241
		Felobs	Doseringspump ur funktion/pumpen demonterad, backventiler rengjorda				
712 P10	PUMP	77030124	77030216	1	4	ABBKCFDVFZFBGB	101468
		Felobs	Pumpen startar ej				
		Feltyp	Fel inställning på pumpens reglerutrustning				
		Vt. Atg	Reglerutrustning injusterad				



Done under contract B59/78 for the Swedish Nuclear Power Inspectorate

STUDSVIK ENERGITEKNIK AB STUDSVIK/K2-81/479

1981-03-09

Jean-Pierre Bento
Ecke Wendler

QUANTITATIVE AND QUALITATIVE ANALYSIS OF THE ATV DATA BASE

ABSTRACT

The Swedish ATV data base has been analyzed with respect to the coverage of component failures in Swedish BWRs, and the correctness and quality of the ATV failure information. The main findings regarding the years 1974 - 1978 are:

- the coverage of occurred component failures is not greater than about 50 %, although the trend is upward
- the correctness of the failure coding and the quality of the plain-language remarks should be enhanced
- as the system is now, the coverage and description of common cause failures and human error is insufficient as far as the needs in probabilistic risk analyses are concerned.

Godkänd av

HUVUDINNEHÅLL

ATV-databasen har analyserats med avseende på täckningsgraden vad gäller inträffade komponentfel i svenska kokarreaktorer, samt på riktigheten och kvaliteten i databasens felinformation. Huvudkonklusionerna baserade på materialet 1974 - 1978 är:

- den kvantitativa täckningsgraden vad avser inträffade komponentfel är inte större än ca 50 %, även om trenden är stigande
- riktigheten i den kodade informationen och kvaliteten på klartexten behöver förbättras
- som systemet nu är utformat, blir täckningen och beskrivningen av beroende fel och mänskligt felhandlande otillräcklig för behoven i sannolikhetsbaserade riskanalyser.

CONTENTS

1. INTRODUCTION

Probabilistic risk assessment of nuclear power plants has, in recent years, become an increasingly used methodology to assess, in its first step, plant system reliability both under normal power operation and under postulated accidental conditions.

However, the well known WASH-1400 (1) is still the most comprehensive study of nuclear power plants, based on probabilistic risk assessment methods.

One of the most pertinent criticisms of (1) came in the so called Lewis report (2) which among other findings points out that

"Despite its shortcomings, WASH-1400 provides at this time the most complete single picture of accident probabilities associated with nuclear reactors. The fault-tree/event-tree approach coupled with an adequate data base is the best available tool with which to quantify these probabilities."

The above mentioned finding summarizes in a very concise manner one of the most crucial factors which affect the credibility of each probabilistic risk analysis: the quality and adequacy of the used data base. This is rightly reflected in (2) by the following finding:

"We are unable to determine whether the absolute probabilities of accident sequences in WASH-1400 are high or low, but we believe that the error bounds on those estimates are, in general, greatly understated. This is true in part because there is in many cases an inadequate data base, in part because of an inability to quantify common cause failures, and in part because of some questionable methodological and statistical procedures."

Translated and limited to Swedish conditions, the above findings are applicable in the respect that the data base remains the weakest point of probabilistic risk analyses.

Until 1979, most of the reliability and safety studies performed in Sweden (3, 4, 5) used the WASH-1400 data base.

For the present, on-going probabilistic studies base their results on Swedish operating experience which is best reflected in the Forsmark 3 availability study (6) and in the ATV-data base (7).

In (6) reliability data (failure rates, repair times and error factors) are listed for most of the component families which are present in a nuclear power plant.

In the ATV system, each component failure which occurs in a Swedish nuclear plant should be reported, coded and after examination of the failure report entered in the data base with the goal of being further processed to furnish "up to date" reliability data usable in reliability analysis of each plant.

Against this background and in order to increase the credibility of planned or on-going studies, it was judged wise to assess the quality or usefulness of the ATV-data base which is intended to constitute the most relevant Nordic data base - data from Finnish plants will hopefully be introduced - for the assessment of nuclear power plant reliability, availability and safety. The ATV data base contains engineering data and failure reports on components of the nuclear power plants in Sweden. ATV stands for "Arbets-grupp för Tillförlitlighetsteknik och -statistik för Värmekraft", ("Working group for reliability technology and statistics for thermal power").

The main purpose of the ATV data base is to provide statistics, needed for probabilistic calculations of system availability and reliability. It is therefore of great importance that the information, gathered in the data base, reflects operating experience as closely as possible. The statistical quality of the ATV-data base can be assessed by means of quantitative and qualitative analyses, answering the questions:

- how many of the occurred component failures are actually entered into the data base
- how accurately do these reports, mostly in coded form, describe the correspon-ding occurrences in the nuclear power plants?

The analysis was carried out manually. However, certain notes, put down during this work, were transferred to computer mass storage files, to provide means for further processing of the collected information (editing, counting, sort-ing, transfer to the ATV data base).

These files are stored at the Studsvik computer center. Copies in the form of 9-track magnetic tape, punched standard cards, or printouts can be made available on request.

2. QUANTITATIVE ANALYSIS OF THE ATV DATA BASE

The total amount of information in the data base is too large to be investigated manually in full. When the analysis was started in the beginning of 1979, the number of reported failure events was about 18 000. Therefore, it was deemed necessary to drastically reduce the number of component failures to be analyzed.

The systems, selected for this purpose, mostly safety related systems, are listed in

Table 1 for Oskarshamn 1 (O1),

Table 2 for Barsebäck 1 (B1) and

Table 3 for Ringhals 1 (R1).

The ATV failure reports concerning these systems were made available in the form of data printouts from the ATV computer system. Since the data base is subject to frequent updating, it would probably be difficult to analyze it at different points of time and get equal results.

In order to define an approximate point of time, for which the analysis is intended to be valid, the dates of production of the ATV printouts are indicated in the Tables 1 - 3.

The task of quantitative analysis was divided into two steps. In the first step, the ATV printouts were checked against the quarterly and semiannual reports, published by the Swedish Nuclear Power Inspectorate (SKI), and against the annual reports from the utilities.

Information on failure occurrences, which are described in these reports, but could not be found in the ATV printouts, was put together in a "list of missing items" for each of the reactor systems involved.

In the second step, the ATV printouts were compared to the corresponding work order sheets at the reactor sites. For each of the examined order sheets or failure reports it was determined whether or not the described occurence could be located in the ATV printouts.

If the component failure report could not be found there, the content of the sheet or report was added to the list of missing items.

Obviously, because of the great number of examined failure reports, there was a possibility that certain occurrences, found in the reports from the first analysis step and in the original papers from the second examination step, but not in the ATV printouts, were put twice into the list of missing items. After locating and deleting such duplicates, the number of items in the ATV printouts and in the list of missing items were determined.

The results, given per calendar year and per system, are listed in Tables A1, A2 and A3 in Appendix A.

A summary, given per calendar year and per reactor, is listed in Table 4. This table demonstrates a positive year-to-year trend of improvement for O1 and B1 during the years 76 - 78.

To make the results comparable and to provide means for observing year-to-year trends, a number QN, which express the quantitative coverage of experienced failures, is included in the tables. QN is defined as

$$QN = F_{ATV}/(F_{ATV} + F_{miss})$$

where

F_{ATV} = number of occurrences, reported in the ATV data base for a given system

F_{miss} = corresponding number of occurrences, reported elsewhere, but not in the ATV data base.

QN can vary from 0 to 1, where QN = 1 indicates full coverage, and QN = 0 means no coverage at all.

The lists of missing items from the analyses of O1 and B1 exist in the form of manuscripts only.

In connection with the R1 analysis, which was carried out after the O1 and B1 analyses, it was decided that all notes, written during the analyses, from this point on, should be documented in a form, suitable for further processing by computers. This provides means for easy editing, sorting, counting and transfer to the ATV data base.

Therefore, the list of missing items from the Ringhals 1 analysis was written onto a data file, named R1QN, at the Studsvik computer center. A detailed description as well as a sample listing of this file is provided in Appendix B. Most of the text is in Swedish. Many linguistic errors and miss-spellings, found in the original reports, were intentionally copied to the file, to make it easier to recognize those texts in case of further analyses.

At Ringhals 1 the analysis was limited to the so-called T-cards, a T-shaped type of work order forms, which were used there until the end of the year 1977.

Carbon copies of these cards, sorted per system, were made available at the Ringhals technical maintenance departments I (instrumentation) and M (mechanics). The third department, E (electric power supply) was not able to provide the desired information. Unfortunately, the complete collection of order forms in the Ringhals archive are sorted by individual order numbers with no relation to the system numbering, and could therefore not be used for the analysis.

None of the lists of missing items was analyzed with regard to the type of failure reports.

3. QUALITATIVE ANALYSIS OF THE ATV DATA BASE

The component failure reports in the ATV data base originate from plain-language messages, written by the operators or maintenance personnel at the power plants. For the purpose of statistical evaluation of the contents of the data base, the messages are classified and catalogued according to a coding table. The corresponding codings, the plain-language messages and the appropriate timing information are put together in the data base. A copy of the coding table, which was in use when this analysis was carried out, is given in Appendix C.1. The coding includes the following characterization:

A	Failure detection
B	Effect of failure on item (Mode of failure I)
C	Effect of failure on system/unit
D	Type of failure (Mode of Failure II)
E	Action of failure
F G	Cause of failure

The objective of the qualitative analysis was to determine the completeness and clarity (reproducability) of the plain-language messages and how well they were transformed into the coded form. It is, of course, not feasible to perform such an analysis in an absolute and undisputable manner. It would require a completely clear and easy-to-use coding system and an immense amount of knowledge about the components and activities on the systems in question. Consequently, the individual comparisons cannot always yield "wrongs" or "rights". In order to overcome this problem, a method giving more gradations was introduced. A combination of "quality points" on the ATV codings and alternative codes was used whenever an ATV report was found to be more or less incorrect or unclear. Sometimes, the coded form did not match the plain-language message, which in turn was too poor to be used as a base for an alternative coding. In such cases, no alternative coding could be given.

The following set of quality points was applied

0	original coding is missing
1	original coding is wrong
2	original coding is probably wrong
3	original coding is questionable
4	original coding is maybe not quite correct
5	original coding is right, but could be replaced by an alternative coding

This list can also be found in Appendix C.2.

In several cases, a short plain-language remark was added to insufficient plain-language messages. The application of quality points and alternative codings is illustrated in Appendix C.3. All of the notes mentioned above, i.e. the identifiers and timing information from the ATV reports, the quality points, the alternative codings and the plain-language remarks, were transferred to mass storage files, one file for each reactor involved.

The files were named O1QLB, B1QLB and R1QLB, respectively, where QL indicates "Quality". A detailed description and sample listing of these files are provided in Appendix D.

The results from the qualitative analysis, given per calendar year and per system, are listed in the Tables E1, E2 and E3 in Appendix E.

A summary, given per calendar year and per reactor, is listed in Table 5.

In this table, the results are presented by the use of the following parameters:

F_{ATV} = number of analyzed ATV reports for a given system or reactor and calendar year

F_{rem} = corresponding number of ATV reports, which were subjected to at least one remark (quality points, alternative coding and/or plain-language remark)

$QL = (F_{ATV} - F_{rem})/F_{ATV}$

The value of QL can vary from 0 to 1, where QL = 1 reflects the best possible outcome from the analysis, i.e. no remarks.

It should be noted, however, that for example QL = 0.5 does not mean that half of the analyzed reports are completely wrong, since, as was pointed out before, a remark is not necessarily equal to a non-approval.

A different way of accounting for the qualitative analysis is to present the relative frequencies of combinations of quality points and alternative codings. However, to do this separately for every system and calendar year, would yield quite an extensive and confusing set of tables. Therefore, it was judged more useful to present the frequencies per reactor and per calendar year.

For the purpose of assessing year-to-year trends, and of reactor-to-reactor comparison, the frequencies are presented in relative form, i.e. as numbers of plain-language remarks and combinations of quality points and alternative codings per 100 analyzed reports.

The results are listed in the Tables E4 - E6 in Appendix E and, in a concentrated fashion, in the Tables 6 - 8 and Figure 1.

Figure 1 is a staple diagram, illustrating the totals of the relative frequencies, listed in Tables 6 - 8. It would of course have been more appropriate to give the relative frequencies different weights, depending on the corresponding quality points, before adding them up. This was not done, however, since it was not deemed particularly meaningful to apply arbitrarily chosen weight factors.

It should be taken into consideration, that the qualitative analysis was carried out by a human analyst. If the job were to be redone, the outcome would certainly not be the same again. There are many possibilities of making mistakes in writing the original ATV reports as well as in judging the quality of those reports. It was, therefore, deemed valuable to let the appropiate persons at the power utilities examine a selection of the original reports and the alternative

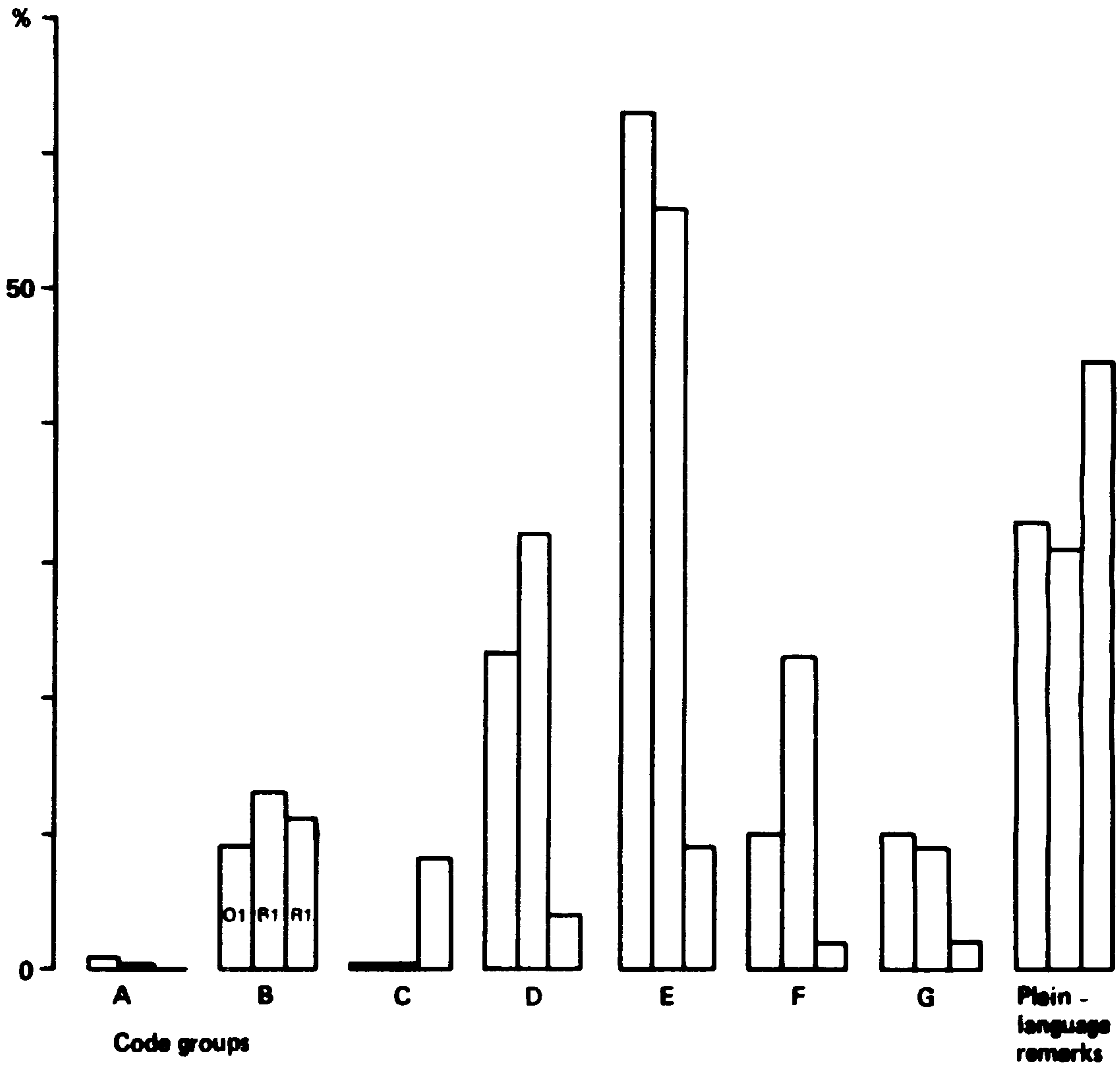


Figure 1

Relative frequencies of alternative codings and plain-language remarks, expressed in per cent of analyzed reports. The staples in each group refer to O1, B1, R1, from left to right respectively.

codings and plain-language remarks. For this purpose, the information for the year 1978 was extracted from the files O1QLB, B1QLB, R1QLB and submitted for the examination by the power utilities technical personnel.

O1 and B1 responded by reanalyzing the ATV reports in question and applying the same set of quality points used in this study.

Out of 35 quality point settings, submitted to O1, 60 % were confirmed, 20 % were changed 1 step down and 20 % were changed 1, 2 or 3 steps up on the 0 - 5 scale. The plain-language remarks were not altered.

Out of 28 quality point settings, submitted to B1, 30 % were confirmed, 60 % were changed 1, 2 or 3 steps down and 10 % were changed 1 or 2 steps up. The plain-language remarks were not altered.

Out of 31 quality point settings, submitted to R1, only 8 were examined and given comments in plain-language. The outcome from the examination was not given in terms of new quality points.

From the O1 and B1 responses, the conclusion can be drawn, that the qualitative analysis was slightly less strict than the examination by the utility personnel. On the other hand, as suggested by the O1 expert, the quality points "5" should not be taken into account, since they don't indicate errors in the original codings.

The numbers in Table 5 indicate a positive year-to-year trend of improvement for B1 and R1 during the years 76 - 78. A similar conclusion for O1 is not obvious.

Some caution should be exercised when interpreting the staple diagram in Figure 1. It looks as though the code groups D, E, F are more difficult to use than the other groups, since there were significantly more alternative codings set for those groups. It is believed, however, that one additional reason for these peaks can be found in the fact that the code groups in question were easier to check against the plain-language messages.

4. ANALYSIS OF COMMON CAUSE FAILURES (CCF) AND HUMAN ERRORS (HE)

In order to be credible, a complete system reliability analysis must include the study of common cause failures. A common cause failure is any fault event or occurrence that increases the probability for, and in some cases results in, multiple component failure due to that single occurrence.

Common cause failures are often dominant contributors to failures of highly redundant systems.

Common cause failure analysis is not a new discipline. But the results of studies performed in this field still leave a lot to be desired. This is due to the nature of the problem itself and to the fact that the related data base is very poor. This in turn means that no experience has been available to confirm the results of those common cause failure analyses which have been performed.

An efficient way for improving the treatment of common cause failures is the development of an adequate data base which has the potential and capability of coding, classifying and retrieving such failures.

In the present analysis, an effort was made, to identify failure event reports, describing multiple component failures, which have been triggered by single primary causes. It was assumed, that those multiple failures do not necessarily have to occur simultaneously. The types of failure and the number of times they were reported are listed in Table 9.

For the systems analyzed, the most frequent failures were found in connection with valve position indicators and neutron detectors.

In an additional study, a selection of ATV failure reports was investigated in order to find failure events, which clearly could be related to human errors (HE), and in order to identify the types of errors that were reported. The reports were selected by means of the F-code. The actual analysis was based on the F and G codes and the plain-language messages in the reports. The types of human errors and the numbers of times they were reported, are listed in Table 10.

The most frequent errors were improper or omitted adjustment, calibration or alignment, and erroneous wiring or installation of components.

The information, to be analyzed with respect to CCF and HE, was extracted from the ATV data base and consists of 2500 failure event reports with the codings "FA" and "FB" (in the code position 6), from the reactors O1, O2, B1, B2, R1 and R2.

"FA" covers errors in design, material, manufacturing and installation.

"FB" covers operational errors, improper alignment, adjustment or calibration, insufficient maintenance, errors made in testing.

For the CCF analysis, additional 1600 failure event reports from O1, B1 and R1 were examined. These reports are the same as were studied for the qualitative analysis.

The associated codings in position 6 range all the way from "FA" to "FZ", so care was to be taken to avoid duplicates from the FA and FB reports, mentioned before.

The CCF and HE analyses were carried out manually. The findings were written down and transferred to two data files, named CCFC and HEE respectively. These files are described in detail and sample listed in Appendices F and G, respectively.

After sorting and counting, the findings are presented in concentrated form in the Tables 9 and 10.

5. IMPROVEMENTS OF THE ATV DATA BASE

Ideas regarding the possible improvements of the ATV failure report coding system have been presented in an earlier technical report from this study (8). Some of these ideas are revived below and presented together with some new ones.

Based on years 1974 - 1978, the quantitative and qualitative analysis of the ATV reveals deficiencies in the coverage and correctness of the ATV reporting and coding. It is of the utmost importance that improvements are made in these respects, if the ATV data base is to be used for obtaining statistical estimates of component failure rates, repair times etc.

Besides its apparent deficiencies, the ATV data base constitutes a formidable body of operating experience at component level. By analyzing the plain language of reported failures, ATV has been useful in on going probabilistic risk analyses.

In these analyses, reliability data were, however, extracted and assessed manually from the plain language information for given components, because the coding was judged not reliable enough to provide valuable computerized searches.

Feed-back of operating experience and probabilistic risk analysis have been allocated high priority by the nuclear power industry and regulatory bodies. In this respect, it is of primary importance that a dialogue is established between the safety staff and operating and maintenance teams at each plant in order to inform the teams about on going studies concerning "their plant". In this way one can expect a higher motivation for operating and maintenance people to help.

An additional feature that should make the ATV data base even more useful would be the indication of the mode of reactor operation at the time of

- discovery of the failure
- start of repair
- start of unavailability
- end of unavailability

This could be accomplished by using the adopted coding

O cold shutdown or reactor mode switch in the refuel position, reactor depressurized

X other mode of operation than O

y hot shutdown

Z power operation

in connection with the dates and times given in the printout.

A fairly unsophisticated analysis of the ATV data base did show that some 20 % of the reported occurrences could directly be tracked to human error, whereas the figure for common cause failure was about 7 %. This is a rather unexpected relationship, and there are strong reasons to believe that common cause failures are a much more important contributor. A more thorough analysis will probably also reveal a larger portion of human errors.

Additional coding options for CCF, HE and inter-relations between component failures is one alternative. However, this would perhaps make the code system too complex and difficult to use. Another way to achieve a better coverage of CCF and HE is to put more emphasis on identifying and classifying the primary causes behind the reported component failures. This could be accomplished by an improvement of the definitions in the F and G groups.

6. CONCLUSIONS

The study, reported in this paper, should be seen as a first effort to assess the usefulness of the ATV data base in an early stage of development. The results reveal a significant degree of incompleteness of the contents of the data base for the calendar years up to 1976. During this initial period, the degrees of coverage (QN) and correctness (QL) do not rise above the 50 % level. An exemption in this respect is the value of QN for O1, which reactor had an earlier start. After 1976, however, a noticeable trend of improvement can be observed. Even here is an exemption, this time for the value of QN for R1, which could not be investigated for 1978 due to the lack of material, suitable for this study.

Although it is believed, that the contents of the data base may show a higher degree of usefulness for the time after the start of this study, there are strong reasons to perform a similar investigation of selected portions of the data base for 1979 and 1980. The importance of a sufficient coverage and quality of the data base can hardly be overemphasized, since the data base is an invaluable tool for the work that is going on, in order to increase the reliability, availability and safety of the nuclear power plants. In this respect, the resources to be dedicated to the development of the ATV must be related to the extensive efforts already spent or planned in the fields feed-back of operating experience and probabilistic risk assessment.

REFERENCES

1. WASH-1400, Reactor Safety Study. NUREG-75/014, October 1975.

2. Risk assessment review group report to the US NRC. NUREG/CR-400, September 1978.

3. Accident analysis of the Barsebäck 2 nuclear power plant. Prepared by Studsvik Energiteknik AB for the Swedish Nuclear Power Inspectorate.

4. BENTO, J-P and MANKAMO, T
Safety evaluation of the SECURE nuclear district heating plant.
Nuclear Technology, V 38, April 1978.

5. Safety Study Forsmark 3.
Ds 1 1978:3.

6. ROSEN, Y et al
Availability analysis of the Forsmark 3 nuclear power plant.
Asea-Atom, November 1978.

7. KAUSEN, L, ANDERSSON and KARLEN, G
The Swedish thermal power reliability data system.
Swedish Power Board, June 1978.

8. WENDLER, E
Riskbedömning av kärnkraftverk. Synpunkter på ATV-feldatakoderna.
Studsvik Technical Report K2-79/222, November 1979.

TABLES

Table 1

Oskarshamn 1 systems, the ATV reporting of which was assessed in the quantitative analysis

System No	System	ATV printout date
221	Control rod drives	790201
314	Pressure relief system	"
414	Lubricating system	"
416	Governing and safety oil system	"
516	Trip and interlock system	"
532	Rod control system	"

Table 2

Barsebäck 1 systems, the ATV reporting of which was assessed in the quantitative analysis

System No	System	ATV printout date
221	Control rod drives	790220
314	Pressure relief system	"
321	Residual heat removal system	"
323	Safety injection system	"
354	Hydraulic system for control rod drives	"
441	Lubricating system	"
443	Governing and safety oil system	"
516	Trip and interlock system	"
532	Rod control system	"
533	Rod position indication system	"
536	Incore intrumentation system	"
661	Standby diesel system dieselset	"

Table 3

Ringhals 1 systems, the ATV reporting of which was assessed in the quantitative analysis

System No	System	ATV printout date
221	Control rod drives	790226
314	Pressure relief system	"
321	Residual heat removal system	"
323	Safety injection system	790227
354	Hydraulic system for control rod drives	" 790226
441	Lubricating system	"
442	Governing and safety oil system	790305
516	Trip and interlock system	790226
532	Rod control system	"
533	Rod position indication system	"
651	Standby diesel system diesel set	"
660	Auxiliary power system DC net, general	"
661	Heavy duty system, charging equipment and batteries	"
662	Heavy duty system, distribution system	"
663	Trip circuit supply, charging equipment and batteries	"
664	Trip circuit supply, distribution system	"
665	Indication and alarm system supply	"

Table 4

Summary of quantitative analysis. The numbers represent the quantitative coverage

$$QN = F_{ATV}/(F_{ATV} + F_{miss})$$

where

F_{ATV} = number of occurrences, reported in the ATV data base for a given system,

F_{miss} = corresponding number of occurrences, reported elsewhere, but not in the ATV data base.

Year	1974	1975	1976	1977	1978
Reactor					
O1	0.54	0.70	0.40	0.68	0.90
B1		0.50	0.35	0.47	0.50
R1		0.0	0.32	0.33*	

* See page 7.

Table 5

Summary of qualitative analysis. The numbers represent

$$QL = (F_{ATV} - F_{rem})/F_{ATV}$$

where

F_{ATV} = number of analyzed ATV reports for a given reactor and calendar year

F_{rem} = corresponding number of ATV reports, which were subjected to at least one remark (quality points, alternative coding and/or plain-language remark).

Year	1974	1975	1976	1977	1978
Reactor					
O1	0.0	0.0	0.13	0.60	0.47
B1		0.0	0.15	0.53	0.69
R1			0.44	0.51	0.56

Table 6

01
Relative frequencies of combinations of quality points and alternative codings. The numbers represent per cent of analyzed reports. Zeros actually mean rounded values > 0. Blanks mean real zeros.

Code group	A	B	C	D	E	F	G	Plain-language remarks
Quality point								33
0								
1	0	1		3	48			
2	0	8		14	11	0	0	
3	1	0	0	5	3	10	10	
4				1	1	0	0	
5				0				

A total of 489 reports were analyzed.

Table 7

B1
Relative frequencies of combinations of quality points and alternative codings. The numbers represent per cent of analyzed reports. Zeros actually mean rounded values > 0. Blanks mean real zeros.

Code group	A	B	C	D	E	F	G	Plain-language remarks
Quality points								31
0		0	0					
1	0	5		18	41	0	0	
2		7		10	9	1	0	
3		1		4	6	21	8	
4				0		1	1	
5								

A total of 267 reports were analyzed.

Table 8

R1
Relative frequencies of combinations of quality points and alternative codings. The numbers represent per cent of analyzed reports. Zeros actually mean rounded values > 0. Blanks mean real zeros.

Code group	A	B	C	D	E	F	G	Plain-language remarks
Quality points								45
0								
1				1	2			
2		8	1	2	2			
3		2	7	0	5	1	1	
4		1		0		1	1	
5				1	0			

A total of 299 reports were analyzed.

Table 9

Common cause failures found in ATV reports

No of occurrences	Failure mode
68	Faulty indication of valve position
59	Detector drifting
34	Detector gas leakage
16	Pulse generator erroneously calibrated
11	Moisture in PRM contact
9	Spark-over in detector
9	Valve seat/cone deformation
5	Fuel hose leakage
5	Leakage in pilot unit caused by unfit type of diaphragm
4	Oxidized contacts
4	Adjustment of skidding protection incorrect
4	Poor insulation in detector
4	Pulse monitor cable broken
4	Valve failure-on-demand caused by erroneous connection
4	Transmitter erroneously adjusted
4	Fuel and coolant hose leakage caused by vibrations
3	Boiling off of reference column
3	Stop button stuck
3	Leaking condensator
3	Faulty isolation affects two pumps
3	Failure of valve to open caused by transmitter drifting
3	Pipe clamps shaken apart by vibrations
3	Valve opening causes movement of loose spindle head
2	Ball stuck in check valve at scram
2	Drain pipe break caused by wrong gasket in packing box
2	Earth fault in two redundant 1 % control rod indicators
2	Bad contact in junction box
2	Valve not manoeuverable from the control room (CKR)
1	Micro breakers released by incorrectly installed light bulb
1	Light bulbs of wrong type installed in display of several alarms
1	Failure of eight alarm bulbs caused by broken printed circuit
1	Failure of two agitators caused by incorrect setting of overload protector
1	Failure of two pumps to start caused by bad contact
1	Failures of strainers 1 - 5 on lamp testing

Table 9 continued

No of occurrences	Failure mode
1	Failure of "auto" switch-over of P2 and P3 feedwater pumps
1	P1 and P2 trip caused by wrongly adjusted K-point when testing
1	Failure of two pumps to stop caused by one erroneous shackling
1	Two valves affected by confounded cables
1	Spurious valve actuations caused by air in transmitters
1	Failure of several control rod indicators caused by earth fault
1	Monitors disconnected
288	

Table 10

Human errors according to ATV reports

No of occurrences	Error mode
234	Adjustment incorrect or omitted
116	Erroneous electrical connection
68	Erroneous installation
49	Poor fastening or tightening
35	Improper choice of component
31	Component or part missing
26	Component disconnected
25	Mechanical damage
23	Inadequate design
23	Component or part not restored after having been taken out of service
21	Incorrect manoeuver action taken
18	End of cable hanging loose
18	Calibration incorrect or omitted
16	Tightening too hard
13	Valve left in wrong position
11	Taking system, component or part out of service unjustified
11	Misjudgement of fault (fault unexistent)
9	Improper choice of material
9	Inappropriate location of piping or wiring
8	Improper choice of wiring material
8	Poor soldering
4	Poor welding
3	Erroneous labeling
2	Replacement erroneous or omitted
2	Inadequate repair
2	Insufficient maintenance
2	Strange object
1	Component or part not reinstalled after having been removed
1	Improper placement
1	Instruction misleading or deficient
1	Component or part left in wrong place
1	Damage caused by water cleaning
792	

Appendices

Table A1

O1, statistics from the quantitative analysis of a selection of failure reports. The quantitative coverage is

$$QN = F_{ATV}/(F_{ATV} + F_{miss})$$

where

F_{ATV} = number of occurrences, reported in the ATV data base for a given system

F_{miss} = corresponding number of occurrences, reported elsewhere, but not in the ATV data base.

System/year		1974	1975	1976	1977	1978
221	F_{ATV}	6	11	5	3	2
	F_{miss}	4	5	2	9	2
	QN	0.6	0.7	0.7	0.2	0.5
314	F_{ATV}	2	5	5	8	2
	F_{miss}	8	6	8	8	2
	QN	0.2	0.5	0.4	0.5	0.5
354	etc	36	112	88	91	66
		26	23	156	33	5
		0.6	0.8	0.4	0.7	0.9
414		7	4	9	8	8
		6	2	4	2	0
		0.5	0.7	0.7	0.8	1.0
416		0	5	8	13	11
		3	6	12	10	1
		0.0	0.5	0.4	0.6	0.9
516		1	0	2	1	0
		0	17	17	6	0
		1.0	0.0	0.1	0.1	-
532		0	0	14	41	0
		0	0	0	7	0
		-	-	1.0	0.9	-
660		4	8	3	10	3
		0	2	2	9	0
		1.0	0.8	0.6	0.5	1.0
Total		56	145	134	175	92
		47	61	201	84	10
		0.54	0.70	0.40	0.68	0.90

Table A2

B1, statistics from the quantitative analysis of a selection of failure reports. The quantitative coverage is

$$QN = F_{ATV}/(F_{ATV} + F_{miss})$$

where

F_{ATV} = number of occurrences, reported in the ATV data base for a given system

F_{miss} = corresponding number of occurrences, reported elsewhere, but not in the ATV data base.

System/year		1975	1976	1977	1978
221	F_{ATV}	0	1	2	4
	F_{miss}	0	1	1	4
	QN	-	0.5	0.7	0.5
314	F_{ATV}	8	17	34	15
	F_{miss}	16	64	22	9
	QN	0.3	0.2	0.6	0.6
321	etc	11	12	13	4
		6	14	15	3
		0.6	0.5	0.5	0.6
323		4	3	3	2
		4	0	0	1
		0.5	1.0	1.0	0.7
354		14	19	10	18
		28	22	26	12
		0.3	0.5	0.3	0.6
441		5	2	4	1
		4	11	5	5
		0.6	0.2	0.4	0.2
443		2	2	3	2
		3	2	8	2
		0.4	0.5	0.3	0.5
516		1	1	0	0
		1	5	0	0
		0.5	0.2	-	-
532		5	2	1	0
		1	5	2	10
		0.8	0.3	0.3	0.0

(continued)

Table A2 continued

System/year		1975	1976	1977	1978
533	F_{ATV}	15	15	6	5
	F_{miss}	2	14	8	5
	QL	0.9	0.5	0.4	0.5
536		1	0	1	0
		0	0	0	1
		1.0	-	1.0	0.0
661		5	8	3	3
		6	11	5	1
		0.5	0.4	0.4	0.8
Total		71	82	80	54
		71	149	92	53
		0.50	0.35	0.47	0.50

Table A3

R1, statistics from the quantitative analysis of a selection of failure reports. The quantitative coverage is

$$QN = F_{ATV}/(F_{ATV} + F_{miss})$$

where

F_{ATV} = number of occurrences, reported in the ATV data base for a given system

F_{miss} = corresponding number of occurrences, reported elsewhere, but not in the ATV data base.

System/year		1975	1976	1977
221	F_{ATV}	0	3	1
	F_{miss}	2	29	13
	QN	0.0	0.1	0.1
314	F_{ATV}	0	8	0
	F_{miss}	9	42	54
	QN	0.0	0.2	0.0
321	etc	0	1	5
		7	28	16
		0.0	0.0	0.2
323		0	10	9
		13	42	26
		0.0	0.2	0.3
354		0	35	23
		5	51	41
		0.0	0.4	0.4
441		0	21	21
		4	7	3
		0.0	0.8	0.9
442		0	6	7
		2	4	1
		0.0	0.6	0.9
516		0	3	4
		1	4	3
		0.0	0.4	0.6
532		0	0	3
		7	1	1
		0.0	0.0	0.8

(continued)

Table A3 continued

System/year		1975	1976	1977
533	F_{ATV}	0	11	1
	F_{miss}	8	17	14
	Q_N	0.0	0.4	0.1
651		0	7	16
		1	6	8
		0.0	0.5	0.7
660		0	0	0
		0	0	0
		-	-	-
661		0	C	1
		0	0	0
		-	-	1.0
662		0	0	0
		0	0	0
		-	-	-
663		0	3	1
		0	0	0
		-	1.0	1.0
664		0	0	0
		2	1	9
		0.0	0.0	0.0
665		0	3	2
		0	0	0
		-	1.0	1.0
Total		0	111	94
		61	232	189
		0.0	0.32	0.33

Datafilen R1QN

Denna fil innehåller felhändelserapporter, som ej fanns i ATV vid kvantitativ granskning.
4 typer av kortbilder förekommer:

Kort typ 1

Kol	1	En asterisk identifierar kortet som titelkort
	4-10	Filnamn
	11-16	Datum för generering eller senaste ändring av filen

Kort typ 2

Kol	1-2	Blockbeteckning
	6-7	Aggregatnummer
	11-13	Systemnummer
	15-19	*****
	21-	Uppgift om var rapporten hittats

Kortet gäller som rubrikkort för samtliga efterföljande kort av typ 3 och 4, tills nytt kort av typ 2 uppträder. Kortet kan lokaliseras genom test på kolumn 1, som alltid är en bokstav.

Kort typ 3

Kol	1-8	Tid (datum och ev timme) för feluppträckt
	11-19	Funktionell anläggningsdel
	21-26	Rapportnummer
	27	Ett plustecken, om ytterligare kort av typ 3 med samma rapportnummer kommer längre ner
	31-36	datum för tillgänglighet efter åtgärd

Kort typ 3 (forts)

Kol	41-45	Mantid i h (flyttal med högst 1 decimal)
	48-50	Antal man (heltal)

Kortet kan lokaliseras genom test på kolumn 1, som alltid är en siffra.

Kort typ 4

Kol	2-80	Klartextmeddelande. Vidtagen åtgärd beskrivs i regel efter ett bråkstreck.

Antalet sådana här kort per funktionell anläggningsdel eller dylikt varierar. Kortet kan lokaliseras genom test på kolumn 1, som alltid är blank.

FELDATAKODER

Klassificering för karakterisering av felhändelser

A FELUPPTÄCKT

- A Alarm
- B Driftövervakning
- C Förebyggande underhåll (FU)
- D Provning
- E Besiktning
- F Tillfällighet

B FELFUNKTION

- A Stänger/Stoppar/Bryter ej (på order)
- B Öppnar/Startar/Sluter ej (på order)
- C Stänger/Stoppar/Bryter obefogat
- D Öppnar/Startar/Sluter obefogat
- E Utebliven signal (mätvärde)
- F Obefogad signal
- G Felaktigt mätvärde
- H Felaktig reglering
- I Uppfyller ej spec prestanda
- K Övriga funktionshindrande fel
- L Ej/eller obetydligt funktionshindrande fel

C KONSEKVENS

- A Snabbstopp
- B Turbinutlösning
- C Huvudagg. ur funktion
- D Reducerad last
- E System ur funktion
- F Systemfunktion reducerad/felaktig
- G Redundant systemdel ur funktion
- H Skada på annan anl. del (apparat/system)
- I Utan konsekvens

D FELTYP

- A Brott
- B Spricka
- C Spricka (motsv) med externt läckage
- D Internt tubläckage (godsläckage), eller motsv i t ex värmeväxl)
- E Externt tätningsläckage (läckage i packningar, packbox o dyl till omgivn eller dränagesystem)
- F Internt tätningsläckage (sätesläckage, interna packningar etc där läckaget ej kommer till omgivningen) II)
- G Deformation, förskjutning
- H Vibrationer, oljud
- I Igensättning, avlagring, beläggn.
- J Kärvning, iskärning
- K Varmgång, elektrisk
- L Glappkontakt
- M Elavbrott
- N Jordfel, isolationsfel
- O Kortslutning
- P Gränslägesförskjutning, mekanisk
- R Gränslägesförskjutning, elektrisk
- S Felaktig indikering, visning
- T Elektronikdrift
- U Korrosion, erosion, slitage
- V Mekaniskt övrigt 1)
- X Elkraft övrigt 1)
- Y Kontrollutrustning övrigt 1)
- Z Övrigt 1) t ex felaktig inställning/montering/koppling/skyltning

II) Således ej sätesläckage i en säkerhetsventil (med öppen sek.sida)

E VIDTAGEN ÅTGÄRD

- A Utbyte av objekt
- B Utbyte av apparat
- C Reparation/utbyte av komponent
- D Justering, rengöring, smörjning
- E Modifiering av apparat
- F Ingen åtgärd
- Z Övrigt 1)

F o G FELORSAK 2)

- A Utrustning och material
  - A Konstruktion
  - B Material
  - C Tillverkning
  - D Montage
- B Drift o underh: personal
  - A Manöverfel
  - B Felaktig inställning, justering (mekanisk)
  - C Felaktig inställning, justering (el, teleteknik)
  - D Fel vid prov eller arbeten, egen personal
  - E Brist i underhåll
  - F Arbete av främmande personal
- C Följd av drift
  - A Överskridande av gränsvärden
  - B Oppåräknad påkänning
  - C Avsättningar, avlagringar
  - D Främmande föremål
  - E Normal utnyttjning av livslängd/normal företeelse
- D Diverse orsaker
  - A Följdfel
  - B Yttre påverkan
  - C Brist i instruktion eller anvisning
  - D Orsak oklar
- Z Övrigt 1)

1) Förklaring ges i klartext på blanketten.
2) Fastställd verklig felorsak
— Kodgrupp F: Huvudgrupp, grovklassning i 1:a steg
— Kodgrupp G: Detalj, finklassning i 2:a steg
Om huvudgruppering kan ske på det första steget kodgrupp F, men andra steget kodgrupp G är oklart, ifylls den första kodbokstaven medan den andra rutan tills vidare lämnas tom.

Quality point scale for qualitative analysis of ATV failure reports

0	original coding is missing
1	original coding is wrong
2	original coding is probably wrong
3	original coding is questionable
4	original coding is maybe not quite correct
5	original coding is right, but could be replaced by an alternative coding

Funkt anl del	Objekttyp	T-F-F-uppt	Start-i-tillg	Start-av -rep	Tillg-E-åtgärd	Arb tid	ins man	Feldatakoder A B C D E F G	Rappnr
314V18	Givare	7808280220	78083016	78083015	78083016	2	2	AB BH CI DP EZ FDGD	003278

Felobs: Ventilen går förbi stängaindikering.
Feltyp: Gränsläget för stängd ventil påverkas ej.
Vt åtg: Gränsläget justerat.

Example on alternative coding and quality point setting:

In the above ATV component failure report, the codings DP and EZ were found to be "probably wrong" and "wrong", respectively. Therefore, it received the notes:

78 003278 DS2 ED1 V18

which means that

DP was given the quality point 2 ("probably wrong") and should be replaced by the alternative code DS

EZ was given the quality point 1 ("wrong") and should be replaced by the alternative code ED

Note:

The first character of each two-character group always indicates the code position (A-G) and points to the appropriate code group (column) in the code table.

Datafilerna O1QLB, B1QLB and R1QLB

Dessa filer innehåller poängtal, alternativa kodningar och klartextanmärkningar från kvalitativ granskning av ATV-data. 3 olika korttyper förekommer:

Kort typ 1

Kol	1	En asterisk identifierar kortet som titelkort
	4-10	Filnamn
	11-16	Datum för generering eller senaste ändring av filen

Kort typ 2

Kol	1-2	Blockbeteckning
	6-7	Aggregatnummer
	11-13	Systemnummer

Kortet gäller som rubrikkort för samtliga efterföljande kort av typ 3, tills nytt kort av typ 2 uppträder. Kortet kan lokaliseras genom test på kolumn 1, som alltid är en bokstav.

Kort typ 3

Kol	1-2	Årtal för felupptäckt
	4-9	Rapportnummer
	10	Ett plustecken, om ytterligare kort av typ 3 med samma rapportnummer kommer längre ner
Kol	12	Kodgruppbeteckning
	16	"
	20	"
	24	"
	28	"
	32	"
	36	"

Kort typ 3 (forts)

Kol	13	Alternativ kodning
	17	"
	21	"
	25	"
	29	"
	33	"
	37	"
Kol	14	Poängtal
	18	"
	22	"
	26	"
	30	"
	34	"
	38	"
Kol	41-74	Anmärkningar i klartext
	75-80	Funktionell anläggningsdel

Kortet kan lokaliseras genom test på kolumn 1, som alltid är en siffra.

* B10LB 791030

81	221								
76	000278				EB2				A10
77	000723				EB2				A12
77	000317				EB2				A12
73	003003	BK3			EB2			BORDE VARA 2 RAPPORTER	A20
78	003101			DY4	EB2				A22
78	003024				EB2				C22
78	002396							VT ÅTG EJ DEF	D05
81	314								
76	103585			DS2	EC1	FC3		FUNKT ANL-DEL EJ DEF	
76	104488+	BM2		DY2	E 3	FC3	GE3	FUNKT ANL-DEL EJ DEF	
76	104488							VT ÅTG EJ DEF	
76	104166			DS2	EB1	FC3	GE3	FUNKT ANL-DEL TROLIGEN FEL	4004
75	103291			DS2	EB1	FC3	GE3		K520
76	104165			DS2	EB1	FC3	GE3		V001
76	104167			DS2	EB1	FC3	GE3		V005
	104168			DS2	EB1	FC3	GE3	BORDE VARA 2 RAPPORTER	V006
76	104169			DS2	EB1	FC3	GE3		V008
76	104414			DN1	EC2	FC3	GE3		V011
76	104153			DS2	ED1	FC3	GE3		V017
76	103823			DS2	EB2	FC3	GE3		V019
	102612	BL1		DS1	E 2	FC3	GE3		V042
76	104369			DS1	EC1	FC3	GE3		V043
76	103568			DS2	EB1	FD3	GD3		V044
76	104370			DS1	EC1	FC3	GE3		V044
75	172612	BL1		DS1	E 3			VT ÅTG EJ DEF	V045
75	182612	BL1		DS1	E 3			VT ÅTG EJ DEF	V046
75	192612	BL1		DS1	E 3			VT ÅTG EJ DEF	V047
75	102294							VT ÅTG EJ DEF	V048
75	102483			DS3					V049
75	102600			DS3	ED1				V049
76	104314	BK1			EC1	FD3	GD3		V049
76	103818			DE3	E 3	F 3	G 3	VT ÅTG EJ DEF	V058
76	193818			DE3	E 3	F 3	G 3	VT ÅTG EJ DEF	V059
77	001371				EC2				V12
78	002568					FA4	GD4		V137
78	002672	BL2		DS3		FA4	GD4		V137
78	003278			DS2	ED1				V18
	000733							VT ÅTG EJ DEF	V42
77	002988				EB2				V46
77	001148+			DM2				OBJEKTTYP TROLIGEN FEL	V48
77	001148							VT ÅTG EJ DEF	V48
77	001080			DS1				VT ÅTG EJ DEF	V48
	000506	BB1							V49
77	000850							VT ÅTG FELRUBRICERAD	V49
77	001391							VT ÅTG FELRUBRICERAD	V49
78	002673	BK2		DS2					V5
77	001336				EC2				V50
77	001486	BL2		DS2					V50
77	001337				EC2			VT ÅTG FELRUBRICERAD	V51
77	001382							VT ÅTG FELRUBRICERAD	V6
77	001373							VT ÅTG FELRUBRICERAD	V7
77	001370				EC1			VT ÅTG FELRUBRICERAD	V70
77	001785	BB1						VT ÅTG FELRUBRICERAD	V82
77	001786				EB1			VT ÅTG FELRUBRICERAD	V82
77	001951			DY1	EB1			VT ÅTG FELRUBRICERAD	V83
77	001952				EC2			VT ÅTG FELRUBRICERAD	V85
77	001504	BA1						VT ÅTG FELRUBRICERAD	V86
77	000732							VT ÅTG EJ DEF	V89
81	321								
75	100872				ED2			FELOBS OFULLSTÄNDIG	E001
75	190872				ED2			FELOBS OFULLSTÄNDIG	E002
76	104131			DI1	ED1	FC3	GE3		K351
75	102607			DS1	ED1	FC3	GE3		K506
75	102552				EB1			FELOBS OFULLSTÄNDIG	K507

Table E1

O1, statistics from the qualitative analysis of a selection of failure reports.

QL = $(F_{ATV} - F_{rem})/F_{ATV}$

where

F_{ATV} = number of analyzed ATV reports for a given system

F_{rem} = corresponding number of ATV reports, which were subjected to at least one remark (quality points, alternative coding and/or plain-language remarks)

System/year		1973	1974	1975	1976	1977	1978
354	F_{ATV}	95	36	113	88	91	66
	Frem	95	36	112	77	36	35
	QL	0.0	0.0	0.0	0.1	0.6	0.5

Note: The O1 analysis was limited to the 354-system, because of the large number of reports.

Table E2

B1, statistics from the qualitative analysis of a selection of failure reports.

QL = $(F_{ATV} - F_{rem})/F_{ATV}$

where

F_{ATV} = number of analyzed ATV reports for a given system

F_{rem} = corresponding number of ATV reports , which were subjected to at least one remark (quality points, alternative coding and/or plain-language remarks)

System/year		1975	1976	1977	1978
221	F_{ATV}	0	1	2	4
	F_{rem}	0	1	2	4
	QL	-	0.0	0.0	0.0
314	F_{ATV}	8	17	34	15
	F_{rem}	8	16	21	4
	QL	0.0	0.1	0.4	0.7
321	etc	11	12	13	4
		11	9	5	1
		0.0	0.2	0.6	0.8
354		14	19	10	18
		14	17	1	3
		0.0	0.1	0.9	0.8
441		5	2	4	1
		5	1	3	1
		0.0	0.5	0.2	0.0
443		2	2	3	2
		2	2	1	2
		0.0	0.0	0.7	0.0
516		1	1	1	0
		1	1	0	0
		0.0	0.0	1.0	-
532		5	2	1	0
		4	0	0	0
		0.2	1.0	1.0	-

(continued)

Table E2 continued

System/year		1975	1976	1977	1978
533	F_{ATV}	15	8	6	5
	F_{rem}	14	8	3	0
	QL	0.1	0.0	0.5	1.0
661		5	8	3	3
		5	6	0	1
		0.0	0.2	1.0	0.7
Total		66	72	77	52
		64	61	36	16
		0.0	0.15	0.53	0.69

Table E3

R1, statistics from the qualitative analysis of a selection of failure reports.

$QL = (F_{ATV} - F_{rem})/F_{ATV}$

where

F_{ATV} = number of analyzed ATV reports for a given system

F_{rem} = corresponding number of ATV reports, which were subjected to at least one remark (quality points, alternative coding and/or plain-language remarks)

System/year		1976	1977	1978
221	F_{ATV}	3	1	0
	F_{rem}	3	1	0
	QL	0.0	0.0	-
314	F_{ATV}	8	0	10
	F_{rem}	1	0	3
	QL	0.9	-	0.7
321	etc	1	5	0
		1	2	0
		0.0	0.6	-
323		10	9	7
		5	3	4
		0.5	0.7	0.4
354		35	23	26
		14	10	11
		0.6	0.6	0.6
441		21	21	20
		12	10	7
		0.4	0.5	0.6
442		6	7	5
		5	2	3
		0.2	0.7	0.4
516		3	4	0
		0	4	0
		1.0	0.0	-

(continued)

Table E3 continued

System/year		1976	1977	1978
532	F_{ATV}	0	3	0
	F_{rem}	0	3	0
	QL	-	0.0	-
533		11	1	3
		11	1	3
		0.0	0.0	0.0
651		7	16	13
		6	7	7
		0.1	0.6	0.5
661		0	1	3
		0	1	2
		-	0.0	0.3
663		4	1	5
		3	1	1
		0.2	0.0	0.8
664		0	0	1
		0	0	0
		-	-	1.0
665		3	2	0
		2	1	0
		0.3	0.5	-
Total		112	94	93
		63	46	41
		0.44	0.51	0.56

Table E4

O1, relative frequencies of combinations of quality points and alternative codings. The numbers to the right of the quality point column represent per cent of analyzed reports. Zeros actually mean rounded values > 0. Blanks mean real zeros.

Year	Number of anal reports	Code group	A	B	C	D	E	F	G	Plain-language remarks
73	95	Quality points								57
		0								
		1		1		4	56			
		2		6		10	26			
		3			1	6	2	10	10	
		4								
		5								
74	36									17
		0								
		1					83			
		2		3		47	3			
		3				14	3	22	22	
		4				6	3			
		5								
75	113									42
		0								
		1		1		9	76			
		2		19		29	10			
		3				4	4	22	22	
		4				1	2			
		5								
76	88									35
		0								
		1				1	47			
		2	1	5		3	12	1	1	
		3	1	1		5	3	3	5	
		4				1	1	1	1	
		5								
77	91									14
		0								
		1		4		1	16			
		2	1	3		4				
		3				2	1	2	2	
		4								
		5								

(continued)

Table E4 continued

Year	Number of anal reports	Code group	A	B	C	D	E	F	G	Plain-language remarks
78	66									15
		0								
		1	2			2	17			
		2		6		3	6			
		3	3	2	2	6	2			
		4				3				
		5				2				

Table E5

B1, relative frequencies of combinations of quality points and alternative codings. The numbers to the right of the quality point column represent per cent of analyzed reports. Zeros actually mean rounded values > 0. Blanks mean real zeros.

Year	Number of anal reports	Code group	A	B	C	D	E	F	G	Plain-language remarks
75	66	Quality								39
		0								
		1		11		17	67	2	2	
		2		3		3	8			
		3				8	9	11	6	
		4								
		5								
76	72									26
		0								
		1		3		43	61			
		2		8		26	8	3		
		3				6	10	69	24	
		4								
		5								
77	77									36
		0								
		1		5		3	5			
		2		4		4	12			
		3		1						
		4								
		5								
78	52									4
		0		2	2					
		1	2			2	10			
		2		8		6	6	2	2	
		3		2		2				
		4				2		4	4	
		5								

Table E6

R1, relative frequencies of combinations of quality points and alternative codings. The numbers to the right of the quality point column represent per cent of analyzed reports. Zeros actually mean rounded values > 0. Blanks mean real zeros.

Year	Number of anal reports	Code group	A	B	C	D	E	F	G	Plain-language remarks
76	112	Quality points								48
		0								
		1					1			
		2		12	1		3			
		3		1	9		3		1	
		4		2				2	2	
		5				1				
77	94									52
		0								
		1				1	2			
		2		4	1	2	1			
		3		4	5	1	7		1	
		4							2	
		5					1			
78	93									29
		0								
		1				1	3			
		2		6		4	2			
		3			5		4	2	1	
		4		1		1				
		5					1			

Data File CCFC

This file contains the notes, made during the analysis of selected ATV-failure reports for events, considered common cause failures (CCF).

The line printer, used to produce the sample listings, cannot print the non-Enligsh characters Å, Ä and Ö. Instead, it prints $, ≡ and [, respectively.

There are 4 different types of card images (text lines) in the file:

Card_typ_1

This card appears only once, as the first card of the file.

Column	
1 - 4	File name, where the character in column 4 indicates the current file version.

Card_type_2

This card appears only once, as the second card of the file.

Column	
1 - 6	Date of last significant modification
8 - 11	Hour "-

Card_type_3

This card may appear several times within the file. It is a header card, valid for all subsequent cards of type 4, until a new card of type 3 appears.

Column	
1	Asterisk
4 - 5	Reactor
6 - 8	"CCF"
21 - 25	ATV-F-codes in the analyzed ATV-failure reports

Card_type_4

This card carries an individual note from the analysis of the ATV-failure report, denoted by the corresponding identifiers on the same card

Column	
1 - 3	System
4 - 15	Apparatus (pump, valve, instrument, etc)
16 - 17	Year of failure discovery
21 - 26	ATV report number
27	A plus sign, if the same ATV report number is repeated further down the file
28 - 29	Subdivision of reactor unit
31 - 32	Note-reference number
36 - 80	Concentrated description of reported failure

CCFC
800215 0908

* 01CCF		FA-FB		
313K505	76	101098	1	FELVALD KABELTYP
313K512	77	102267	1	FELVALD KABELTYP
313K514	77	102221	1	FELVALD KABELTYP
313K517	77	102243	1	FELVALD KABELTYP
313K518	77	102244	1	FELVALD KABELTYP
313K522	77	102035	1	FELVALD KABELTYP
435P1	79	106216	5	FELVALT MATERIAL
435P2	79	106115	5	FELVALT MATERIAL
442P1	76	100179	46	STOPPKNAPP SITTER FAST
442P2	76	100022	46	STOPPKNAPP SITTER FAST
442P3	76	100023	46	STOPPKNAPP SITTER FAST
314V51	79	105484	48	FELINSATT LAMPA LISTE UT OVERGBRYTARE
531	76	100273	47	LECKAGE I KONDENSATOR
531	76	100274	47	LECKAGE I KONDENSATOR
531	76	100275	47	LECKAGE I KONDENSATOR
531	77	101380	8	GASLECKAGE I DETEKTOR
531	77	101379	8	GASLECKAGE I DETEKTOR
531	77	101394	8	GASLECKAGE I DETEKTOR
531	77	101395	8	GASLECKAGE I DETEKTOR
531	77	101470	8	GASLECKAGE I DETEKTOR
531	77	101534	8	GASLECKAGE I DETEKTOR
531	77	101812	8	GASLECKAGE I DETEKTOR
531	77	102044	8	GASLECKAGE I DETEKTOR
531	77	100788	9	DETEKTORDRIFT
531	77	103278	9	DETEKTORDRIFT
531	77	103279	9	DETEKTORDRIFT
531	77	103281	9	DETEKTORDRIFT
531	77	103280	9	DETEKTORDRIFT
531	77	103282	9	DETEKTORDRIFT
531	78	103387	9	DETEKTORDRIFT
531	78	103511	9	DETEKTORDRIFT
531	78	103576	9	DETEKTORDRIFT
531	78	103579	9	DETEKTORDRIFT
531K807	77	101416	8	GASLECKAGE I DETEKTOR
531K807	77	101434	8	GASLECKAGE I DETEKTOR
531K813	78	104609	9	DETEKTORDRIFT
531K814	78	105032	9	DETEKTORDRIFT
531K814	78	104616	9	DETEKTORDRIFT
531K814	78	105736	9	DETEKTORDRIFT
531K814	78	106002	9	DETEKTORDRIFT
531K816	78	104563	9	DETEKTORDRIFT
531K816	78	104566	9	DETEKTORDRIFT
531K817	77	101230	9	DETEKTORDRIFT
531K817	77	101512*	8	GASLECKAGE I DETEKTOR
531K818	77	101512	8	GASLECKAGE I DETEKTOR
531K818	77	101481	8	GASLECKAGE I DETEKTOR
531K819	77	101171	8	GASLECKAGE I DETEKTOR
531K819	77	101183	8	GASLECKAGE I DETEKTOR
531K819	78	104610	9	DETEKTORDRIFT
531K820	78	104615	9	DETEKTORDRIFT
531K823	77	101417	8	GASLECKAGE I DETEKTOR
531K823	77	101435	8	GASLECKAGE I DETEKTOR
531K823	78	103351	9	DETEKTORDRIFT
531K824	77	101482	9	DETEKTORDRIFT
531K829	78	103824	9	DETEKTORDRIFT
531K830	78	103313	9	DETEKTORDRIFT
531K831	78	103306	9	DETEKTORDRIFT
531K832	78	104564	9	DETEKTORDRIFT
531K833	76	101284	8	GASLECKAGE I DETEKTOR
531K834	78	103360	9	DETEKTORDRIFT
531K834	78	103492	8	GASLECKAGE I DETEKTOR
531K835	77	101177	8	GASLECKAGE I DETEKTOR
531K836	77	101912	9	DETEKTORDRIFT

Data File HEE

This file contains the notes, made during the analysis of selected ATV-failure reports for events, considered human errors (HE).

The line printer, used to produce the sample listings, cannot print the non-English characters Å, Ä and Ö. Instead, it prints $, ≡ and [, respectively.

There are 4 different types of card images (text lines) in the file:

Card_typ_1

This card appears only once, as the first card of the file.

Column

1 - 3 File name, where the character in column 3 indicates the current file version.

Card_type_2

This card appears only once, as the second card of the file.

Column

1 - 6 Date of last significant modification

8 - 11 Hour "-

Card_type_3

This card may appear several times within the file. It is a header card, valid for all subsequent cards of type 4, until a new card of type 3 appears.

Column	
1	Asterisk
4 - 5	Reactor
6 - 7	"HE"
21 - 25	ATV-F-codes in the analyzed ATV failure reports

Card type 4

This card carries an individual note from the analysis of the ATV-failure report, denoted by the corresponding identifiers on the same card.

Column	
1 - 3	System
4 - 15	Apparatus (pump, valve, instrument, etc)
16 - 17	Year of failure discovery
21 - 26	ATV report number
27	A plus sign, if the same ATV report number is repeated further down the file
28 - 29	Subdivision of reactor unit
31 - 32	Note-reference number
36 - 80	concentrated discription of reported failure

HEE
800208 0954
* 01HE

211K517	77	109297	4	KABELPART L(S
211H16	76	100645	22	D$LIG FASTS=TTNING ELLER $TDRAGNING
243K502	73	102309	22	D$LIG FASTS=TTNING ELLER $TDRAGNING
311SE18	76	100412	4	KABELPART L(S
312K005	74	103370	11	FELMONTERING
312K405	72	100841	11	FELMONTERING
312K526	77	100427	4	KABELPART L(S
312V6	78	104962	15	FELVALD ANL=GGNINGSDETALJ
313K505	76	101098	1	FELVALD KABELTYP
313K512	77	102267	1	FELVALD KABELTYP
313K514	77	102221	1	FELVALD KABELTYP
313K517	77	102243	1	FELVALD KABELTYP
313K518	77	102244	1	FELVALD KABELTYP
313K522	77	102035	1	FELVALD KABELTYP
314V061	76	105278	2	FELKOPPLING
314V19	77	102720	22	D$LIG FASTS=TTNING ELLER $TDRAGNING
315K502	76	100206	2	FELKOPPLING
321	77	101419	22	D$LIG FASTS=TTNING ELLER $TDRAGNING
322V22	78	104540	25	DETALJ SAKNAS
324T6	76	101088	11	FELMONTERING
325K504	76	106882	17	ICKE $TERST=LLD URDRIFTTAGNING
325P5	79	106661	2	FELKOPPLING
331K502	76	100207	2	FELKOPPLING
332	77	102089	22	D$LIG FASTSETTNING ELLER $TDRAGNING
332J2	76	100224	7	FELKONSTRUKTION
332V109	77	101382	2	FELKOPPLING
332V112	77	101996	3	FELAKTIG ELLER UTEBLIVEN JUSTERING
332V212	77	102087	3	FELAKTIG ELLER UTEBLIVEN JUSTERING
342	77	101042	2	FELKOPPLING
342	77	101210	4	KABELPART L(S
342K410	75	104668	7	FELKONSTRUKTION
342P28	79	106495	4	KABELPART L(S
343V023	74	102218	2	FELKOPPLING
351K503	76	100652	25	DETALJ SAKNAS
351V015	73	100061	22	D$LIG FASTS=TTNING ELLER $TDRAGNING
352V012	73	101612	22	D$LIG FASTS=TTNING ELLER $TDRAGNING
352V12	77	102748	11	FELMONTERING
352V159	78	104188	22	D$LIG FASTS=TTNING ELLER $TDRAGNING
354K501	76	106403	2	FELKOPPLING
354K571	76	106389	14	EJ ANSLUTEN, EJ INKOPPLAD
354P3	77	102241	15	FELVALD ANL=GGNINGSDETALJ
354V98	77	102225	42	OL=MPLIG PLACERING
411K502	73	100717	2	FELKOPPLING
411V045	76	106801	2	FELKOPPLING
411V46	76	101255	29	$VERKAN
422G1	77	103051	26	OL=MPLIG LEDNINGSF(RL=GGNING (EL ELLER R(R
423V001	76	104958	11	FELMONTERING
423V10	77	103261	5	FELVALT MATERIAL
431	77	101613	22	D$LIG FASTS=TTNING ELLER $TDRAGNING
433K103	78	103879	26	OL=MPLIG LEDNINGSF(RL=GGNING (EL ELLER R(R
433V10	78	104447	15	FELVALD ANL=GGNINGSDETALJ
435P1	79	106216	5	FELVALT MATERIAL
435P2	79	106115	5	FELVALT MATERIAL
441K508	75	101939	14	EJ ANSLUTEN, EJ INKOPPLAD
441K806	78	104581	2	FELKOPPLING
517	75	103663	2	FELKOPPLING
517	76	106386	14	EJ ANSLUTEN, EJ INKOPPLAD
517	77	101458	4	KABELPART L(S
517	77	102837	22	D$LIG FASTSETTNING ELLER $TDRAGNING
517D2	78	103864	7	FELKONSTRUKTION
519	76	105438	22	D$LIG FASTS=TTNING ELLER $TDRAGNING
522	78	103352	7	FELKONSTRUKTION
523	77	102274	22	D$LIG FASTS=TTNING ELLER $TDRAGNING

STUDSVIK/K2-81/479

QUANTITATIVE AND QUALITATIVE ANALYSIS OF THE ATV DATA BASE

Jean-Pierre Bento and Ecke Wendler

Studsvik

Studsvik Energiteknik AB S-611 82 NYKÖPING
SWEDEN Telefon 0155-800 00 Telex 64013 studss