



A study of abnormal occurrence reports

Taylor, J.R.

Publication date:
1975

Document Version
Publisher's PDF, also known as Version of record

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Citation (APA):
Taylor, J. R. (1975). *A study of abnormal occurrence reports*. Risø National Laboratory. Risø-M No. 1837

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<p>Title and author(s)</p> <p>A STUDY OF ABNORMAL OCCURRENCE REPORTS</p> <p>J.R. Taylor</p>	<p>Date September 1975</p> <p>Department or group</p> <p>Electronics</p> <p>Group's own registration number(s)</p> <p>R-3-75</p>
<p>pages + tables + illustrations</p>	
<p>Abstract</p> <p>A detailed study of failure and occurrence reports from five U.S. nuclear reactors. Data concerning the frequency of failure causes and multifailure incidents are given.</p> <p>Methods of failure classification are discussed.</p>	<p>Copies to</p>

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Foreword

Reports are prepared by engineers in U.S. nuclear power plants for a wide range of component failures and similar occurrences. The precise reporting requirements are specified in the U.S. Nuclear Regulatory Commission's Regulatory Guide 1.16. Until 1974, such reports were termed Abnormal Occurrence reports, but since then the term "Abnormal Occurrence reports" has been reserved for those occurrences which have some safety significance. What were earlier termed "Abnormal Occurrences" are now as a general class, termed Reportable Occurrences.

The reports are published by the US NRC. The work here concerns a study of "Abnormal Occurrence Reports", using the pre 1974 definition and data up to and including spring 1974. The data cover a wide range of occurrence types. In particular they give component failure data mostly of relatively unimportant individual component failures, such as miscalibration of a single redundant instrument, but in some cases for failures of some engineering significance. The reports are much less formal than those required for reliability data banks. They give considerably more background information concerning the cause and nature of failures than do reliability data banks; and also much more information concerning consequences and interrelationships between separate failures.

For this reason, the reports provide very valuable information, which is relevant not only to the study of nuclear power plant reliability, but also provides insight into the way failures can occur in many different kinds of process plant.

A STUDY OF ABNORMAL OCCURRENCE REPORTS

Introduction

An earlier study (Rise-M-1742) attempted to evaluate the role of design errors in nuclear power plant reliability. The results of that study showed that design error plays a large role in power plant failures; and the surprising result that an unexpectedly large proportion of failure incidents involve several independent component failures.

Several questions arose as a result of that earlier work. One would expect that the role of design error diminishes for individual plants as they grow older. It was decided to investigate the sequence of abnormal occurrence reports from individual reactors over a number of years.

Another question is the extent to which separate failures in multi-failure incidents contribute significantly to the failure consequence. It is possible that several of the failures within an incident have no direct bearing on the extent of failure consequences. They may play an incidental rather than crucial part in the failure sequence.

The remaining area of interest for this study is the problem of common mode failure. The importance of common mode failure was established earlier, but the only datum obtained was a gross figure for the proportion of failures involving common mode effects. Results of the common mode failure study performed here are published separately (Rise-M-1826).

A major element in motivating this study, was the desire to discover the weak points in existing techniques of failure mode analysis of process plant, and to develop the background information for improving those techniques. There are some types of failure for which no systematic analysis technique exists, for example

- wiring errors involving incorrect interconnections
- "system design" errors in control systems
- mechanical blockage and jamming problems arising from loose parts
- errors in written procedures
- human errors due to confusion between procedures or misinterpretation of operating situation.

All of these problems involve complex common mode effects, and it is important to discover to what extent they are important in practice.

The procedure in this study has been to take individual incident reports, and to classify them according to fixed criteria. The nature of the data prevents one from obtaining good statistical data with known significance, but it is felt that qualitative, and "order of magnitude" conclusions can be drawn from the results.

Choice of data

The data used for this study is abnormal occurrence data submitted to the USNRC by operators of light water reactors. The reason for this choice is that the information is readily available, there are consistent criteria for reporting the data (reporting is required by law), and the quality of the reporting is generally excellent. The information differs from that usually available in reliability data banks, in that complete failure incidents are described, often involving several individual component failures.

The choice of reactors for this study was determined by the availability of records for a period of years. Records from the earliest years of reactor operation were however not available to the author. There has been a change in style of reporting over a number of years, and this has to some extent negated the value of the data as a record of "design error" evolution.

Classification of occurrences

For each occurrence report, the date, six month period number (from reactor start up), operating state at the time of occurrence, and method of failure discovery were recorded. Most failures are detected during surveillance testing, some via special inspections, but many are discovered as "actual" failure incidents which interfere with plant operation. In many cases a failed condition existed over a considerable period, but the plant state recorded was nevertheless the plant state at the time the failure was discovered. In virtually all cases it is true that a latent failure, discovered during surveillance or special tests, has existed while the plant was operating.

Each individual component failure was recorded separately for each incident, and in some cases there were several failures contributing to the incident.

- OP Plant operational, generating power.
- SU Plant was in start up phase.
- SD Plant was in shut down phase.
- CS Plant was in cold shut down state.
- RF Plant was shut down for refuelling.

Table 1. Classification of plant states at the time of failure discovery.

- ACT "Actual" incident - occurs during normal operation of component.
- SUR Failure discovered during surveillance testing.
- PM Failure discovered during post maintenance testing of the failed component.
- COM Failure discovered during commissioning tests.
- SI Failure discovered during special inspection, as a result of suspected incipient failure, or as a result of information from other plants.
- SU Failure discovered during start up testing.

Table 2. Classification of "mode of discovery" of failures.

In a study such as this, which is concerned with the cause of failure, it is important to define the term component failure carefully. A failure is deemed to have occurred, if a component is incapable of fulfilling its function, in spite of the fact that inputs such as power supplies, control signals, mechanical support, etc. are within the limits specified for the component. Failures due to incorrect input are judged to be consequent failures, and were recorded for interest, but were excluded from statistical analyses. Failures due to environmental changes were recorded as component failures, unless the environmental change was a result of some earlier component failure in which case they were classified as consequent failures, and again omitted from statistical analyses.

The degree to which a plant is divided into "components" also affects the number of component failures recorded. In this study, a standard level of div-

ision into components was used, as expressed by table 3. However, where a component was part of a larger component or subsystem, this fact was recorded by concatenating component and system names.

Amplifier	AM	Motor starter	MS
Annunciator	AN	Potentiometer	POT
Battery	BY	Recorder	REC
Battery charger	BC	Lightning arrester	LA
Cable	CAB	Ground switch	GS
Capacitor	CAP	Relay	RE
Circuit breaker	CB	Relay or switch contact	CN
Magnetic clutch	CL	Reset switch	RS
Control switch	CS	Resistor	RST
Coil	CO	Signal comparator	COMP
Diode	DI	Pressure switch	PS
Detector	DE	Torque switch	TQS
DC power supply	DC	Temperature switch	TS
Flow switch	FS	Fuse	FU
Heater	HG	Generator	GE
Input module	IM	Heat tracing	HT
Inverter (solidstate)	IN	Test button	SB
Level switch	LWL	Thermal overload	OL
Lamp	LMP	Transformer	TFMR
Limit switch	LMT	Transmitter	TMTR
Manual switch	SW	Wire	W
Meter, gauge	GG	Solenoid	SOL
Motor	MO		

Table 3A. Electrical component coding.

Accumulator	AC	Refrigeration unit	RF
Blower	BL	Sluice gate	SL
Control rod drive	CRD	Sump	SP
Control rod	CR	Tank	TK
Cover plate	COV	Tubing	TUB
Core	COR	Turbine	TURB
Damper	DM	Condenser	COND
Diesel	DIES	Vent	VT
Expansion joint	LJ	Well	WL
Filter, strainer	FL	Valve, check	CV
Flexible pipe, hose	FLEX	explosive	EV
Fuel	F	hydraulic	HV
Gas bottle	GB	motorised	MV
Gasket	GK	pneumatic	AV
Heat exchanger	HEX	relief	RV
Insulation (thermal)	TINS	manual	XV
Ion exchanger	IEX	safety	SV
Noggle	NZ	stop	DV
Orifice	OR	vacuum relief	VV
Pipe	PP	main steam isolation	MSIV
Pipe Cap	CP	solenoid	KV
Pipe Support	CUP	Seal	SL
Pressure vessel	PV	Actuating mechanism	ACT
Pump	PM		

Table 3B. Mechanical component coding.

Event sequence

The structure of event sequences has a direct bearing on the way in which failure records are interpreted and used in later failure mode analyses. Failures were classified as spontaneous, gradual, misoperation, latent or consequent.

A spontaneous failure is one which occurs at the time of the incident and serves to start the incident. The classification of "gradual" failures was introduced because it was difficult to describe some kinds of initial failures

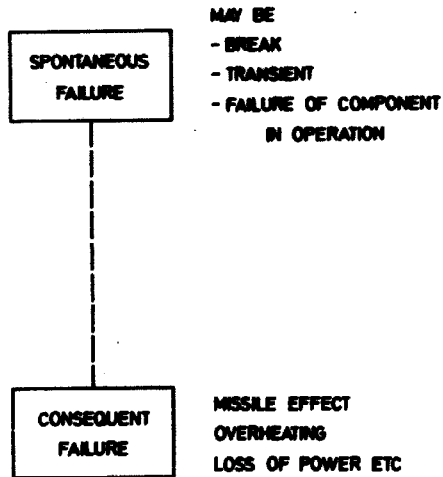


Fig. 1 Event sequence with spontaneous and consequent failures

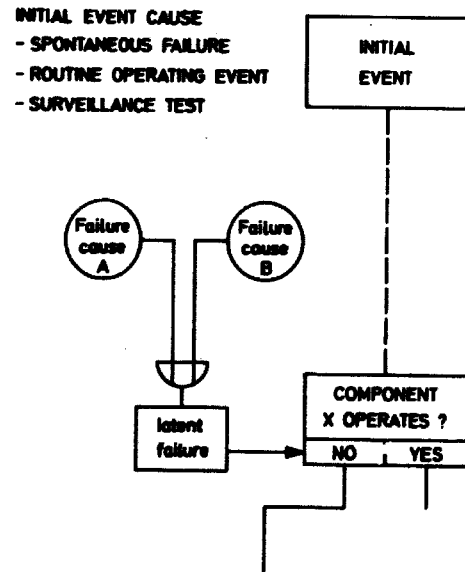


Fig. 2 Event sequence with latent failure

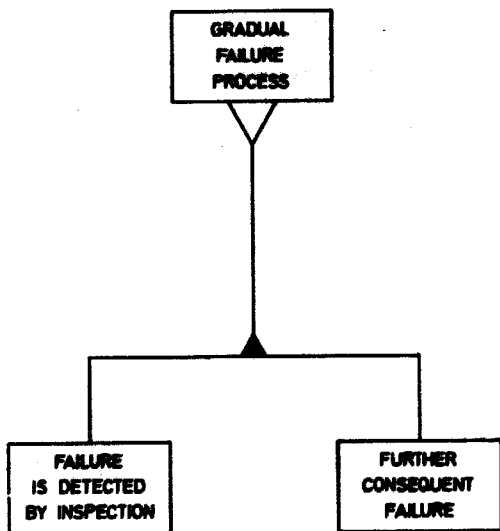


Fig. 3 Alternative failure sequences resulting from gradual failure.

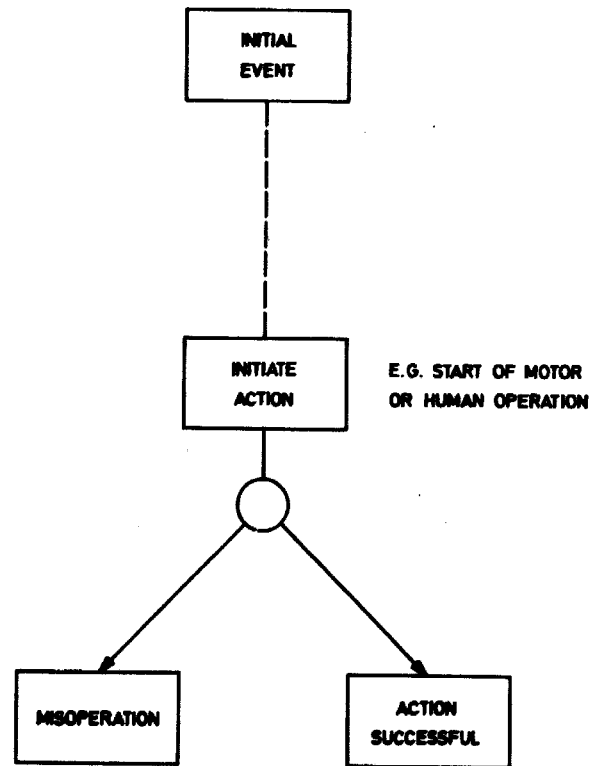


Fig. 4. Event sequences including misoperation

as spontaneous, for example slow leaks which are detected after they have caused further damage.

Latent failures occur in components which are called on to work intermittently. Such components may exist in a failed state, which is "revealed" when the component is tested or is called on to operate.

Misoperation failures are those which occur when a component or operator is called on to carry out such operation, and which occur while the component or operator is carrying out the operation.

Consequent failures are those which occur as a direct result of some earlier failure.

S	Spontaneous
G	Gradual
L	Latent
M	Misoperation
C	Consequent

Table 4. Classification of failures according to how they are triggered.

Further classification of "consequent" failures is possible - input failures (I) (command failures), overload or stress failures (secondary failures) (O), and direct effect failures (D). Such classification is often made in failure mode analysis studies. But such classification was made only for common mode failures, in this study.

Symbolic description of the different kinds of failure are shown in fig. 1 to 4 (see Rise Report Rise-M-1743). For each of the different kinds of failure, a different model is required to describe failure probability.

As a result of the study, some of the initial ideas on classification of failures were revised, and these ideas, which were not used in the study itself, are given in Appendix 1.

One of the important objectives of this study was to observe the number of failure events occurring in actual failure sequences. For this purpose, failures detected by testing were ignored. Also, several failures occurring within similar components due to a common mode effect, were treated as single failures. Consequent failures which were certain to occur, given earlier failures, in the sequence were ignored. But consequent failures which involved some probability factor, such as destruction of components by impinging steam jets, were counted as separate failures.

Common mode and coupled failures

As part of the study of multiple failures, a study was made of common mode and coupled failures in similar plant components. The results of this study are presented in a separate report.

Failure cause

The objective in this study has been to come as close as possible to the original cause of failure. Failure causes are classified at two levels, as shown in table 4. The second level of classification is much less certain than the first. In the case of operator and maintenance errors, the subclassification was completely experimental.

To maintain consistency of cause classification it is important to have clear criteria. An error was considered a design error if it was explicitly described as such in the abnormal occurrence report, if it was one of a long series of similar failures with very high failure rate, or if the design was modified as a result of the failure. A similar criterion was used for classifying procedural errors. Failures were classed as operator errors if this was explicitly stated in the abnormal occurrence report, and similarly for maintenance and installation errors. (This can lead to underestimation of operator errors).

Random component failures were recorded in those cases where a simple standard mechanism of component failure was involved e.g. bearing leakage, shorting of a relay coil etc., and in which no excessive grouping of failures of a similar kind occurred.

In some cases, more than one cause of component failure could be discovered. In other cases, it was difficult to judge between two alternative failure causes. In these cases, fractional contributions to failure classes were recorded, an equal fraction to each contributing cause.

In many cases, the same kind of failure occurred in the same component several times in the course of a few years. These cases were counted as single failures in determining relative importance of different failure causes (though all incidents were counted in determining common mode failure proportions). If one does not count failure causes in this way, then some frequently occurring failure types come to dominate the distribution of causes. The proportion of design error failures, in particular, becomes inflated.

<u>Cause</u>	<u>Cause subclass</u>
C Random component failure	M Mechanical
	E Electrical
D Design error	U Problem unknown at design time
	C Complex system interactions
	I Interdisciplinary problems
	O Oversight
	K Communication problems
	Z Calculation, sizing problems
	S Component selection problem
O Operator error	O Omission
	X Unnecessary extra operation
	W Wrong target of operation
	E Error in amount of operation
	S Error in operation sequence
	P Wrong procedure used
	J Judgement of quantity
	C Communication problem
	R Lack of recognition of danger situation
	M Misrecognition of danger situation

Table 4. Coding for causes of failure.

<u>Cause</u>	<u>Cause subclass</u>
M Maintenance error	A Adjustment (of instruments, switches)
I Installation error	O Omission of step in installation, repair
	P Positioning of component
	M Misuse of component, handling problem
	B activation of other equipment not under repair
	C Choice of component to install, repair
	I Interchange of two components, cables etc.
	Q Quality of join
P Procedure error	O Omission of subprocedure
	C Extra control, checking required
	M Procedure open to misinterpretation
	U Effect unknown before failure
	W Procedure wrong
F Fabrication fault	
? Cause unknown	

Table 4. Continued.

Data

Abnormal occurrence reports from five reactors were classified for reactors with start up dates in 1962, 1963, 1967, 1969, and 1970. Abnormal occurrence reports were generally available to the author only from the later years of reactor operation (from 1969 onward).

Both the number and character of abnormal occurrences varied greatly from reactor to reactor. The variation could have arisen from the different quantity and type of equipment at the reactor plant, as well as differences in reliability of components. However, it was hoped that by concentrating on the proportion of occurrences of different types, meaningful conclusions could be drawn.

As can be seen from fig. 7 not too much significance can be attached to the actual numbers of abnormal occurrence reports for successive years.

In addition to abnormal occurrence reports, some "unusual event" reports were included in the analysis, where the reports concern safety related or pressure boundary equipment (see USARMC safety guide 13.2. for definition of abnormal occurrence, unusual event).

There may be some omissions of abnormal occurrence reports for the reactors studied, though where possible records were checked against semiannual operating reports. On the assumption that omissions are randomly distributed, the effect on proportions of failure types should not be too important.

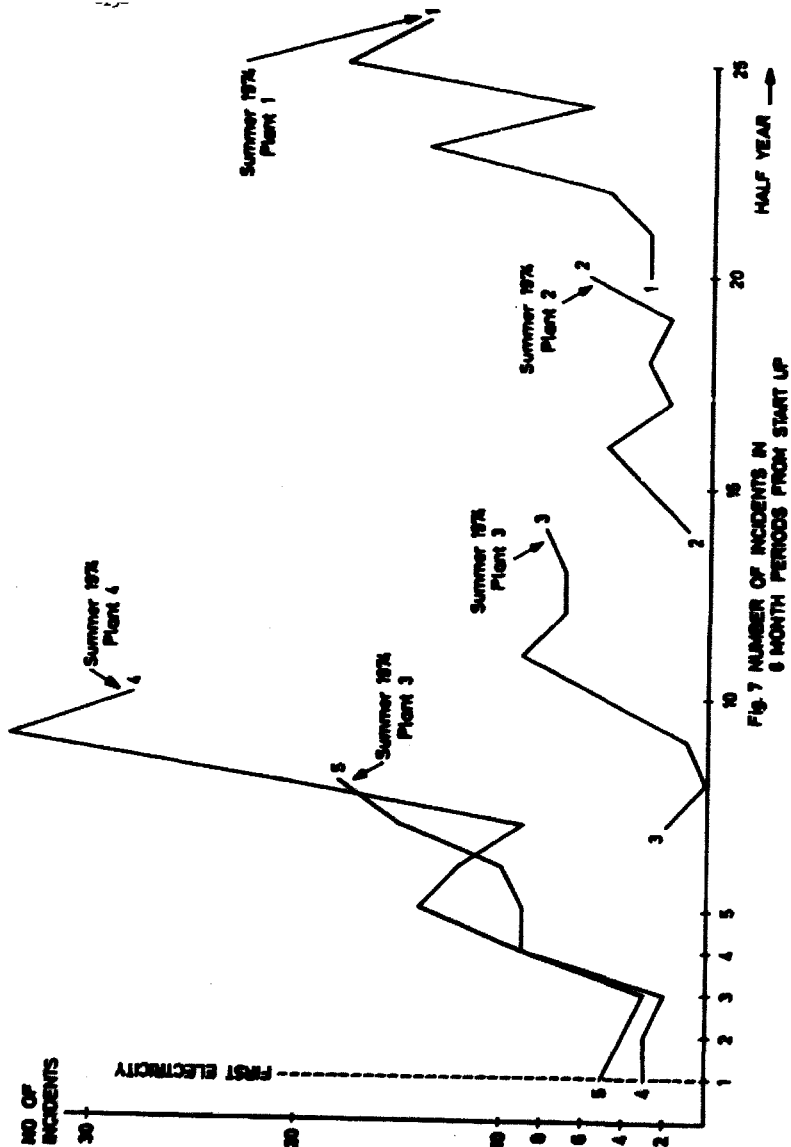
In all there were 67, 24, 33, 141, 75 abnormal occurrences for the respective reactors.

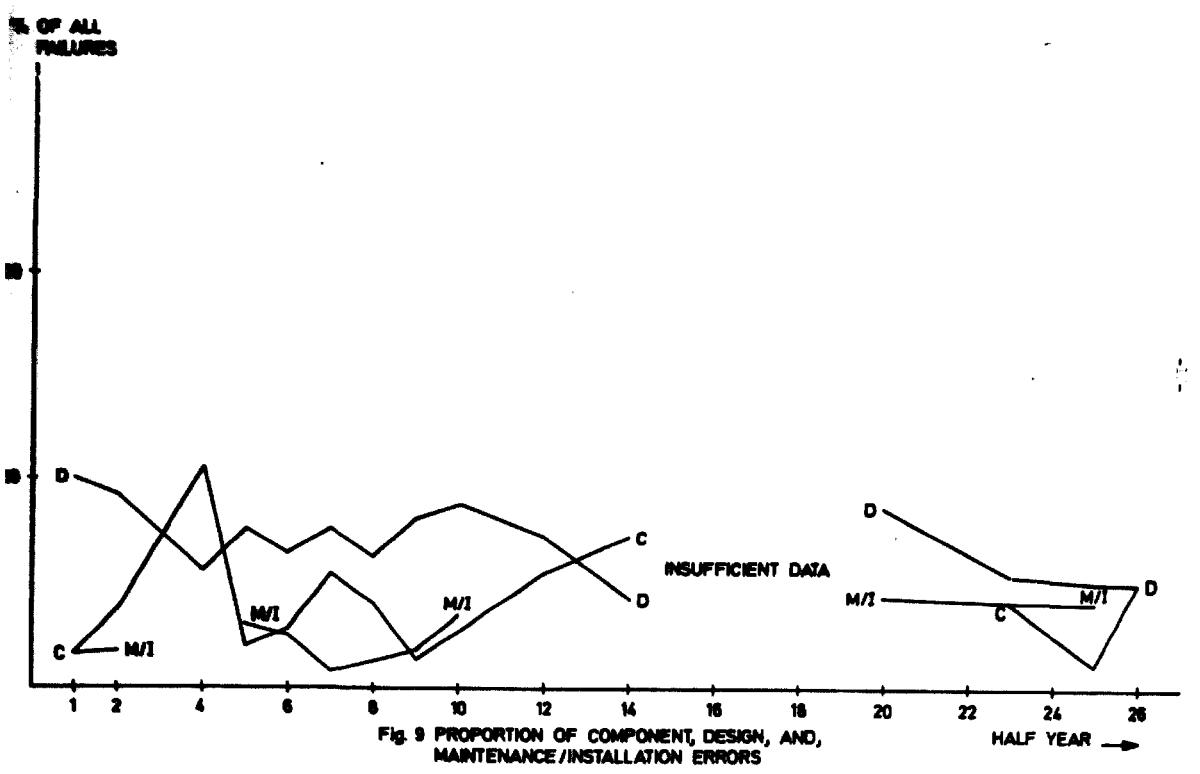
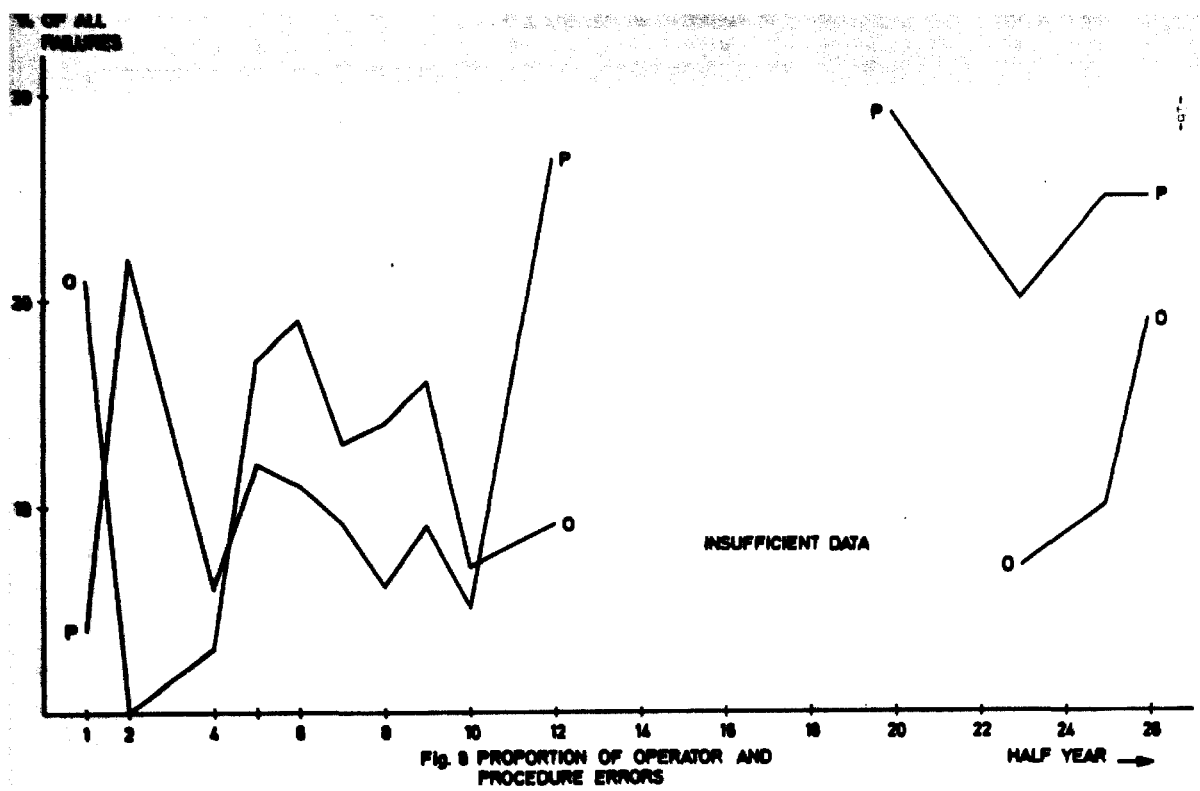
Causes of failure

Fig. 8 and 9 show how the various causes of failure behave as plants grow older. No significant trends can be detected, the proportion of failures due to respective causes seem if anything more or less constant. But much more data would be required, before trends could be detected beneath the random variations in the data. As has been observed in earlier studies, design error seems to be the dominant cause of failure, followed by random component failure.

Table 5 gives the numbers of failures attributed to particular cause classes, for each of the reactors studied. The pattern is more or less constant, apart from an unusually high proportion of failures attributed to maintenance errors, for one of the older reactors, and a complete lack of reported operator errors for one reactor.

The classification of secondary causes for design, operator, procedure, and maintenance errors are shown in tables 6 to 9. The classifications here are experimental, and should be regarded as indicative rather than definite. Such classifications can be used as a guide to qualitative studies of failure causes.





Reactor	Design error	Random component failure	Operator error	Error in procedure	Maintenance or installation error	Fabrication error	Cause of failure unknown or unrecorded	Number of individual failures reported
1	37 %	11 %	10 %	18 %	16 %	1 %	7 %	82
2	14	11	11	11	<u>36</u>	0	18	28
3	48	<u>31</u>	<u>0</u>	7	5	0	10	42
4	34	17	12	9	10	0	17	174
5	34	23	19	7	6	3	7	96
ALL	35 %	18 %	12 %	10 %	12 %	1 %	12 %	422

Table 5. Cause classes for component failures.

	%
S Component selection	14
O Oversight	17
U Error due to effect unknown at design time	25
Z Sizing, dimensioning error	13
C Error due to lack of recognition of complex system interactions	7
K Error due to communication problems	1
? Error with cause unknown or unrecorded	22

Table 6. Design error secondary causes
(Based on 147 occurrences)

	% of error
O Omission of a step, operation or procedure (reason for omission unknown)	49
P Wrong procedure used	16
R Lack of recognition of situation	7
M Misrecognition of situation	2
S Error in operation sequence	4
W Operation applied to wrong target component	4
J Error of judgement of amount	2
C Error due to communications problems, lack of communication	4
E Error in amount of adjustment	2
? Error due to unknown cause	9

Table 7. Secondary causes of operator errors.
(Based on 77 occurrences)

	%
O Error due to omission of step or procedure	56
U Error due to omission, because effect was unknown at the time the procedure was defined	16
M Procedure was open to misinterpretation, unclear	7
F Wrong test frequency specified	2
W Wrong procedure specified	2
C Extra control required - procedure does not contain sufficient cross checks	6
? Error with unknown cause	14

Table 8. Secondary causes of errors in procedures.
(Based on 44 occurrences)

		%
A	Problems with adjustment of instruments, limit, torque switches etc.	22
W	Wrong operation carried out, or right operation carried out wrongly, due to lack of knowledge or expertise	16
B	Spurious activation of other equipment while carrying out tests or repair	9
I	Interchange of two cables	6
U ₀	Omission of operation, due either to oversight or to ignorance of requirement	6
P	Error positioning component	3
Q	Problems of quality in soldering, welding	3
R	Error due to lack of recognition of situation	3
C	Error in choice of which component to repair	3
S	Breach of safety regulations	3
?	Error due to unidentified causes	25

Table 9. Secondary causes of installation and maintenance errors.

(Based on 49 occurrences)

It is possible to make some qualitative comments on the results.

A large proportion of design errors involve effects which were unknown before failure occurred. Many failures of this type occur repeatedly, the same component sometimes being repaired several times before the failure is correctly diagnosed. Such incidents underline the value of abnormal occurrence reporting.

Another large group of design errors involve inappropriate choice, of materials, or especially, of instruments. Problems of this kind can be reduced by qualification testing and standardisation, activities which are receiving a great deal of attention from nuclear engineers.

By far the largest proportion of operator errors involve omission or oversight, involving just a single type of plant operations. By their nature, such errors are relatively easy to foresee, and analyse, even in the cases where several components are affected in a common mode fashion. More serious are the errors due to lack of recognition of dangerous situations, misrecognition, application of inappropriate procedures or application of correct procedures to the wrong component. Among installation and maintenance errors, difficulties in adjusting limit switches and torque switches are outstanding.

Some types of failure are difficult to account for in failure analysis. It is difficult to identify all of the failures of this kind, but the following provides a list of errors which occurred, but for which no systematic failure analysis procedure exists (as yet).

Loose parts jamming	5
electrical circuit omissions or miswiring	5
omission of essential procedural steps, or incorrect steps	3
human decision errors with wide ranging effects	3
established trip levels inappropriate	6
water hammer effects	3

Also, there were some instances of problems present special difficulties in failure mode analysis.

common dependences of several components on one service supply or environment	7
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Multifailure incidents

In this study, as in the previous one, the number of multiple failure incidents was high when compared with expectation. At the level of consequence represented by abnormal occurrence reports, there are still a significant number of 4, 5, 6, and 7 fold failure incidents (fig. 8).

This pattern holds true in spite of the fact that

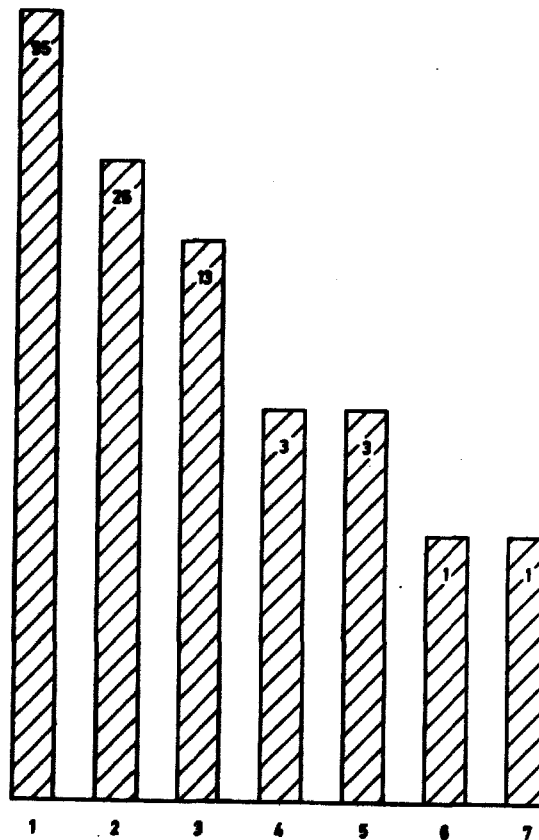
- a) failures to several components of the same type, due to the same cause, have been treated as single failures.
- b) failures which are a direct consequence of earlier failures, are not counted in arriving at the number of independent failures.
- c) failures which do not contribute significantly to the consequences of the incident have been ignored.

Examining the nature of the multiple failure incidents reveals several distinct types,

- blowdown incidents, in which steam is released, causing defects in surrounding components to be revealed, in some cases, and causing a large variety of safety components to be activated.
- multiple human errors. It is clear that in some of these incidents there is coupling between the errors. Once one human being has made an error, others tend to perpetuate it. However, the nature and degree of interdependence of these errors is difficult to determine.
- because of the way that these data are classified, if single component fails to work because its design is inappropriate and its operating procedure is incorrect, the result is counted as a double failure. This "classification effect" is significant in raising the number of 2 and 3 fold failures. It does not contribute significantly to the number of 4, 5, 6 fold failures etc.

By far the largest proportion of failure types in the multiple failure incidents are latent failures revealed during special incident conditions, or revealed when safety equipment is activated.

NO. OF INCIDENTS



NO. OF FAILURES PER INCIDENT

Fig. 8 HISTOGRAM OF MULTIPLE FAILURE INCIDENTS

Conclusions

Conclusions as to the meaning and importance of the kind of results given here have been presented before (Riss-M-1742). The additional data collected here serve merely to reinforce those conclusions which are

- 1) That design and other human errors are responsible for a significant number of failures and abnormal occurrences.
- 2) Some "design error" type failures cannot be accounted for in traditional types of reliability analysis.
- 3) Improvement in particular component reliability performance, in testing, and in standardisation, should be valuable in improving plant reliability, because a small number of component types are responsible for a large proportion of failures.
- 4) Multiple failure incidents play an unexpectedly large role in abnormal occurrences. Records of interrelationships between failures would be a useful addition to failure statistics data bases.

In addition to these remarks, some conclusions can be offered concerning the type of classification study attempted here.

It would be useful to obtain some standardization of the terms used in classifying different types of failure, according to the way in which failures reveal themselves, the plant state at the time of occurrence and/or discovery, and the triggering mechanism of the failure. The classification used here is self consistent, but is different from schemes used elsewhere.

The classification of primary causes of failure seems acceptable, and is similar to that use by the USAEC (e.g. OOE-OS-001, 1974). However the method of classification used here, attributing a failure to a single class, or using fractions to represent degree of responsibility for a particular cause, is messy. Accepting that a failure may have several causes, and that the percentages of failures due to different causes may total to more than 100%, seems preferable. But if this method of classification is accepted, some definition must be made of how important and unusual an effect must be, before it is accepted as a contributing cause of failure.

The classification of different failure causes into secondary categories was not particularly successful. Often there was insufficient information in the abnormal occurrence reports to make classification precise. And the cat-

egories used here often overlapped. The information in such classification should not be used to derive percentages to which different causes are responsible for failures. The information might be used to perform clustering studies, with the hope of finding more clearly identifiable types of failure.

Uncertainty as to cause of failure should not be used as an excuse for assigning two causes to a particular failure. Instead, if there are several clearly alternative causes, this fact should be recorded explicitly (e.g. A/B means either cause A or cause B is involved, C & D/E means either cause C and E are together responsible, or cause E is responsible). Failure for which causes are unknown, should be recorded separately. Only in this way is it possible to interpret the meaning of failure cause data.

A revised system of classifying different failures according to event sequences, is given in appendix 1.

Appendix 1. Classification of failure events

Classification of the different kind of failure events which can enter into event sequences is useful and important, because it indicates the relevance of particular pieces of failure data to different reliability calculation models. In fact, as reliability models become more complex, more complex failure classifications are required. The scheme introduced here is therefore just a particular example of a range of possible schemes which differ in level of detail.

The first distinction is made between failures which are caused by some external event or process, and those which arise with no apparent cause or for which the failure cause is an inherent property of the component. This second group is the one which has been called "random component failure" earlier in this note. These are called spontaneous failures here. Examples are the normal forms of bearing failure, relay contact failure etc., for which no specific cause can be described, or which cannot be prevented in normal engineering practice. Examples of typical causes in the first group of failures are design and installation errors, extreme environmental conditions, misoperation by an operator etc.

A distinction which is equally important for obtaining a reliability model of failure consequences is whether the effects follow instantaneously from the failure, or whether the effects are gradual (e.g. slow leakage of some valuable material).

When components operate intermittently or only occasionally (such as safety systems) or with intermittent load (such as many pneumatic or hydraulic systems) a third distinction becomes important - whether the effects of the failure remain latent, or whether the consequences show themselves immediately. In the case of a latent failure, a failure event occurs at some time. The component is reduced to a state in which it cannot operate according to specifications. When the component is called upon to operate (the failure is triggered), a "failure to operate" occurs.

The definitions of the various failure types are illustrated in fig. 7.

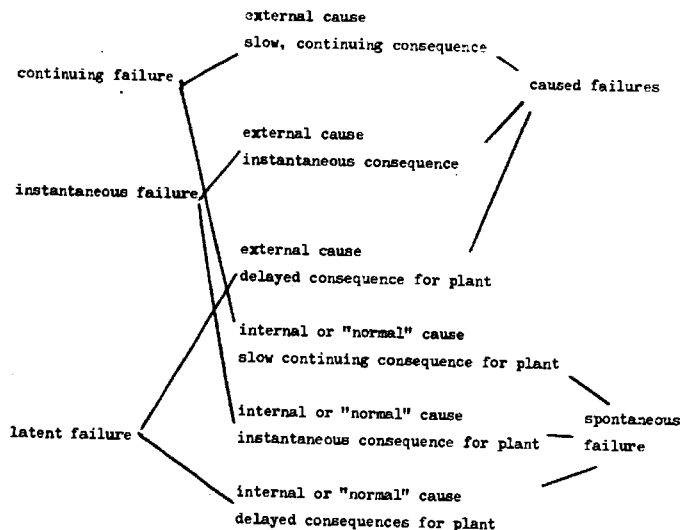


Fig. 7. Definitions of failure classes.

For latent failures, the stage at which the failure is discovered becomes important, especially for systems in which automatic continuous testing and periodic testing is performed.

A latent failure may remain hidden due to the fact that the particular type of error is not exercised or triggered by the test inputs applied. These failures are called "untriggered". Equally, a failure may be triggered, but its effects may not be indicated because the failure alarm outputs and test measurements performed, are inadequate. These failures are called unmonitored. (See fig. 8).

kind of failure involved	Stage at which failure phenomenon occurs		
	continuous operation	during stand-by	on activation
latent	—	latent failure	failure to operate failure on demand
immediate	failure in operation	active failure	misoperation

Table 10. Terms used in describing latent and immediate failure sequences.

A useful distinction in judging the effectiveness of testing, is that between actual failures and failures found under test. For actual failures consequences occur which affect the operation of the plant. The following relation is true.

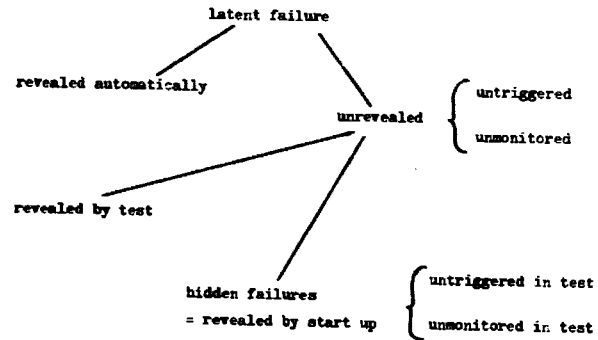


Fig. 8. Types of latent failure.

Actual failures = hidden failures
 + failures in operation
 + active failures
 + misoperations, not under test

Finally, it is useful, in classifying multiple failure sequences, to indicate whether a failure was initial (initiated the sequence), contributory (independent, but triggered as a result of the initial failure, or increasing the consequences of the initial failure), or consequent (caused by the initial failure).

DOCKET NUMBER	ULCERWORK NUMBER	DATE	SIX MONTH PERIOD TO	OPERATIONAL STATE OF PLANT	DISCOVERY TYPE	ALERT?	CAUSE	CAUSE SUBCLASS	COMPONENT TYPE	FAILURE MODE	FAILURE MECHANISM	RECOVERY MECHANISM	CONSEQ. RISK EFFECT	COMPONENTS AFFECTED	CONSEQ. RISK CONSEQUENCE	LATENT/SPOONTANEOUS	IMMEDIATE/REVERSIBLE/PROLONGED	INITIAL SOURCE	DESCRIPTION
57	40	Apr 28 -70	2	SC	IC	SI	D	D	IC	IS	IS	4	2	1	0	0	0	0	Defective flow from reactor circuit.
48	40	Dec 4 -70	1	IC	SI	SI	D	D	IC	IS	IS	4	2	1	0	0	0	0	Pressure signal not transmitted - cold pipe/break oil.
49	40	Nov 26 -70	1	OP	ACT	C	C	M	OP	ACT	IS	4	2	1	0	0	0	0	Pressure Starter call thru close-ANNOD failure to occur.
51	40	Feb 1 -71	1	OP	ACT	O/P	O	O	OP	ACT	IS	4	2	1	0	0	0	0	Monitor removed during release of water.
57	40	Mar 14 -71	1	OP	ACT	O/P	O	O	OP	ACT	IS	4	2	1	0	0	0	0	Failed to stop DC pump test.

DOCKET NUMBER	ULCERWORK NUMBER	DATE	SIX MONTH PERIOD TO	OPERATIONAL STATE OF PLANT	DISCOVERY TYPE	ALERT?	CAUSE	CAUSE SUBCLASS	COMPONENT TYPE	FAILURE MODE	FAILURE MECHANISM	RECOVERY MECHANISM	CONSEQ. RISK EFFECT	COMPONENTS AFFECTED	CONSEQ. RISK CONSEQUENCE	LATENT/SPOONTANEOUS	IMMEDIATE/REVERSIBLE/PROLONGED	INITIAL SOURCE	DESCRIPTION
63	40	Jun 28 -71	2	OP	ACT	SI	D	U	OP	ACT	IS	4	2	1	0	0	0	0	Indequator red water
64	40	Jun 28 -71	2	OP	ACT	SI	D	U	OP	ACT	IS	4	2	1	0	0	0	0	Component of steam generator
76	40	May 14 -72	2	OP	ACT	SI	D	D	OP	ACT	IS	4	2	1	0	0	0	0	Spacer stripping
72	40	Aug 12 -72	2	OP	ACT	SI	D	D	OP	ACT	IS	4	2	1	0	0	0	0	Leak in sample heat exchanger
85	40	Jan 17 -71	3	OP	ACT	SI	D	D	OP	ACT	IS	4	2	1	0	0	0	0	High pressure trip - see later
89	40	Jan 7 -72	3	OP	ACT	SI	D	D	OP	ACT	IS	4	2	1	0	0	0	0	High pressure trip - see later
87	40	Feb 15 -72	3	OP	ACT	SI	D	D	OP	ACT	IS	4	2	1	0	0	0	0	High pressure trip - see later
91	40	May 8 -72	4	OP	ACT	SI	D	D	OP	ACT	IS	4	2	1	0	0	0	0	High pressure trip - see later
97	40	June 7 -72	4	OP	ACT	SI	D	D	OP	ACT	IS	4	2	1	0	0	0	0	High check cover pressure

Pump binding

DOCKET NUMBER	OCCURRENCE NUMBER	DATE	SIX MONTH PERIOD	DISCOVERY TIME	SERIOUS	CAUSE	CAUSE STRAIN	COMPONENT TYPE	FAILURE MODE	FAILURE MECHANISM	RECOVERY MECHANISM	TURBINE TRIP EFFECT	CONSEQUENCE AFFECTED	CONSEQUENCE MONITORED	LAFFIN/ SIGNATURE	IMPACT OF REPAIR/ CORRECTION	INITIAL CONTROL	REMARKS
143	AO	Jan 20 1973		ACT														...
146				ACT														...
166	AO	April 10 1973	6	ACT														...
167	AO	Mar 20 1973		ACT														...
172	AO	Apr 23 1973	6	ACT														...

DOCKET NUMBER	OCCURRENCE NUMBER	DATE	SIX MONTH PERIOD	DISCOVERY TIME	SERIOUS	CAUSE	CAUSE STRAIN	COMPONENT TYPE	FAILURE MODE	FAILURE MECHANISM	RECOVERY MECHANISM	TURBINE TRIP EFFECT	CONSEQUENCE AFFECTED	CONSEQUENCE MONITORED	LAFFIN/ SIGNATURE	IMPACT OF REPAIR/ CORRECTION	INITIAL CONTROL	REMARKS	
186	AO	Jun 6 - 73	6	ACT				XV. C.ECC XV. PS. C.ECC				Y	X	4	M	MP			Vent valves open on contain vent pressure measurement Valves were not on drawing
197	AO	Jun 73	6	ACT				LS. RFS											Turbine trip did not lead to reactor trip immediately, but from high pressure 7 sec. later.
212	AO	Aug 13	6	SIR				AC											Set point calculation error - too low -> release 1.75 WT
	AO	Aug 23	6	ACT				confusion											
225	AO	July 10	6	ACT				CS. BL				Y	all ?	4	M				Spring alignment in over current protector
226	AO	July 10	6	ACT				CB. PM. ECC				Y	all ? or 4	N	L	M	CMF		All circuit breakers type westinghouse DB-80 replaced omitted testing of S-by S O testing after replacement. Overcurrent setting not adjusted -> spurious trips.

DOCKET NUMBER	OPERATION NUMBER	DATE	STATUS	DIAGNOSIS	REMARKS	CAUSE	MODE	COMPONENT	FAILURE MODE	FAILURE MECHANISM	RE OPER. MECHANISM	START TIME	STOP TIME	OPERATOR	DESCRIPTION
285	AO	Aug - 72													Breaker on 2400 volt bus - 2400 - 2400 - 2400
286	AO	Oct - 72													Trip wire on 2400 volt bus - 2400 - 2400
287	AO	Oct - 72													Major fault on 2400 volt bus - 2400 - 2400
288	AO	Oct - 72													Breaker on 2400
289	AO75	Dec - 72													
291	AO	Aug 25 - Dec - 72													Tripped
294	AO														Several components on generator - fuel system
	AOB	Dec - 72													all four trip breakers resulting in friction problems - failure of trip, intermittently

DOCKET NUMBER	OPERATION NUMBER	DATE	STATUS	DIAGNOSIS	REMARKS	CAUSE	MODE	COMPONENT	FAILURE MODE	FAILURE MECHANISM	RE OPER. MECHANISM	START TIME	STOP TIME	OPERATOR	DESCRIPTION
300		Dec - 74	OP	ACT		D	G	PH		BRK					Jamming of seismic restraint shoe - breakage of restraint grouting
302	74-1	Jan 3 - 74	OP	SUR		O	M	PP		NOK					Boiling acid situation
304		Jan 16 - 74	OP	ACT				NH							Computer data value error
305	AO	Nov 22	OP	ACT		F		TUB HE		COR					Tube leak due to corrosion around are strike
308	AO	Jan 25 74	OP	ACT				PP PS		BRK					Instrument air line broken
								MV TURB							Failure to close -- trip
								FV CRD		CIR					down - refusal to restart
318	AO	Feb 6 74	OP	ACT		C/I		M. FAN		CIR					
321															
319	AO	Feb 6	OP	ACT		O	O								Door to outlock not latched

ROCKET NUMBER	OCURRENCE NUMBER	DATE	SIX MONTH PERIOD	OPERATIONAL MODE	DISRUPTIVE TIME	SEVERITY	AID	CAUSE CATEGORY	COMPONENT TYPE	FAILURE MODE	CAUSED WEAR/LOSS	RE-OPERATION STATUS	NUMBER OF SAFETY	NON-ACCIDENT RELATED	CAUSED LOSS OF LIFE	CAUSED PROPERTY DAMAGE	CAUSED ENVIRONMENTAL DAMAGE	REMARKS
200	AO																	Same as AO 71-3
208	73-4	Feb 73	11	OP	ACT	D	M	KV	K	LK, CI								
								C		LAM								
220	AO 73-5		12		ACT	C		MV	L	CPY FI								Sampling line isolation valve 270° crack around seat
224	AO 73-7		12			D		MV		FIM								Let down valve opened too slowly - causing relief valve to blow, then leaked, due to
								P	U									- procedural error minor LOCA, radioactivity release
225	AO 73-6	June 73	12	OP	ACT	D		AV.		BRL CI								purification line torn - overtorquing - fit torque switch - Minor
										CCD LANTLY CLEAN								LOCA, release radioactivity
	AO		12	OP	ACT	D	O	bolts		BRM CI		Y	13	Y	B	I	I	Overstressed hold down bolts on steam gen
										CCP								4 steam generators

ROCKET NUMBER	OCCURRENCE NUMBER	DATE	SIX MONTH PERIOD	OPERATING MODE OF PLANT	DISCOVERY TYPE	SERIOUS	CAUSE	CAUSE SPECIFIC	COMPONENT TYPE	FAILURE MODE	FAILURE MECHANISM	RECOVERY MECHANISM	CONTROL SYSTEM EFFECT	COM-GRAND AVAILABLE	TOP-LEVEL FAILURE MODE	CAUSE SPECIFIC	IMPACT NUCLEAR	STATUS	DESCRIPTION
239	AO 73-10	12	OP	ACT			D												Motor control center power supply failure
240	AO Oct 73 73-9	13	OP	SUP			M, P, D, U												Voltage sensing relay covers too tight The low contact pressure Post maintenance test did not detect incident
245	AO Nov 73 73-1	13	OP	ACT			D	S	MV.										Radiative waste tank valve leaked
253	AO Dec 73 73-17	13																	Same as AD-733
257	AO 73-1	13	OP	SUR			C	M	MIXIN		JAM	OT							
260	AO Jan 74 74-2	13	OP	ACT			C, U, M, P, D, U												Two unit heaters failed
261	AO Jan 74 74-1	13					C, U, M, P, D, U												Two flow sensor lines froze- Same as AD-733

Several components/several causes

ROCKET NUMBER	OCCURRENCE NUMBER	DATE	SIX MONTH PERIOD	OPERATING MODE OF PLANT	DISCOVERY TYPE	SERIOUS	CAUSE	CAUSE SPECIFIC	COMPONENT TYPE	FAILURE MODE	FAILURE MECHANISM	RECOVERY MECHANISM	CONTROL SYSTEM EFFECT	COM-GRAND AVAILABLE	TOP-LEVEL FAILURE MODE	CAUSE SPECIFIC	IMPACT NUCLEAR	STATUS	DESCRIPTION
283	AO 74-3	Jan 74 13	OP	ACT			ET												Total loss of external power- rice, relay problem Service water pumps failed on automatic, worked on manual
284	AO 74-4	Mar 74 14	OP	ACT			?		PM, RHR, SV, FL, GAS		LK								Filter fire spray valve leaked
291	AO 74-5	Mar 74 14		ACT			M, C	M	MV.		JAM								Overtightened letdown valve packing
292	AO 74-6	Apr 74 14	HS				C	M	V		BLK								Check valve
312	AO 74-8	May 74 14	OP	ACT			D	O	GEN		CIR FIRE		Y	6	2	S	I	C	Transformer winding short + fire Both generators affected by design error.
313	AO 74-4	Apr 74 14	OP	ACT			c	M	SV		CRC LK								Leaking seal on vol.control hydrogen regulator
320	AO 74-9	May 74 14	OP	SUR			C, D	M, O	SL, PS		Drift		Y	4	2	L	R	C	Power switch set points drift 'set points too near limit'

DOC/CI NUMBER	DOCUMENT NUMBER	DATE	SIX MONTHS PERIOD	DISPOSITION OF UNIT	DISPOSITION	STATUS	AUXILIARY	COMPONENTS	FAULTS/REPAIRS	REMARKS	REMARKS	REMARKS	REMARKS	REMARKS	REMARKS	REMARKS	REMARKS	REMARKS	REMARKS	
324	AO 74-1	June 74	14	OP	SUR	C														See trip unit
	AO 74-1	June 74	14	OP	SUR	C	M	MSIV	VAM											Dried out packing

DOCKET NUMBER	DISCOVERY NUMBER	DATE	SIX MONTH PERIOD	DISCOVERY TYPE	SERIOUS?	CAUSE	CAUSE CLASS	COMPONENT TYPE	FAILURE MODE	FAILURE MECHANISM	RECOVERY MECHANISM	COMMON MODE EFFECT	COMPONENTS AFFECTED	FUNCTION MODE	CAUSE/SPONTANEOUS	IMMEDIATE REVERSAL/CONTINGENCY	REPAIR/REPLACEMENT	DESCRIPTION
50-13-97		April 17/77	14	OP ACT		M			COND									External transient caused trip of normal power Condenser failed Safety valve opened early Operator failed to recognise SV open. - This caused condenser failure condensate return valve thermal overhead trip - Jammed wedge, high dosing torque switch. Lack of procedure for this kind of incident Lack of power to Reactor Press water level instruments Off/gas isolation valve instruments fuse. Lack of monitor light Stainless steel control rod follower rivets. Followers removed. Overdose to investigating engineer. Condensate return valve again
53		Apr 71	16	OP SUR		C	E	Fuse	DC									
61			16	MT ACT		D	G	CP			Y	ALL	N					
67		Sept	16			C			JAM									

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DOCKET NUMBER	DISCOVERY NUMBER	DATE	SIX MONTH PERIOD	DISCOVERY TYPE	SERIOUS?	CAUSE	CAUSE CLASS	COMPONENT TYPE	FAILURE MODE	FAILURE MECHANISM	RECOVERY MECHANISM	COMMON MODE EFFECT	COMPONENTS AFFECTED	FUNCTION MODE	CAUSE/SPONTANEOUS	IMMEDIATE REVERSAL/CONTINGENCY	REPAIR/REPLACEMENT	DESCRIPTION
76		22 Jan 72	14	MT SUR		M			Drift	Water		N						Low vacuum sensor - water accumulation
78		10 July 71	16	OP SUR		?		GEN										Generator voltage drop -
81		29 Mar 72	17	OP SUR		MT		GEN										Oil in distributor of propane generator
84		17 Apr 72	19	OP SUR		M		GEN										Solenoid fuel stop valve short
		13 Apr	18			?		GEN		JAM								Oil in solenoid
115		26 Jan 73	19	OP ACT		OP	O											Radwaste concentrator valve left open - oversight
121		2 Oct 72	19			?												Baffle damage
		14 Aug 72	18			?												Loss of power to emergency condenser condensate return valve.
123		20 May 73	20	OP ACT		M		Seal.							M			Shaft seals leaked when demineraliser pump was stopped + motor failure due to arcing.
130		July 73	20	OP PM		?		GEN										Failed to start
136		11 Aug 73	20	MT SUR		M		TS	D	Drift		N						
142		26 Nov 73	21	OP SUR		E	E	MT	B									Cranking limiter control resistor open circuit prevented generator start.

BUCKET NUMBER	DISCOVERY DATE	DISCOVERY TYPE	IDENTIFICATION	STATUS	LOCATION	DESCRIPTION	REMARKS
50-155	Dec 62	OP	ACT	21	D	R	
77	Mar 71	19	OP	SUR	D	R	
76	Mar 71	19	OP	SUR	D	R	
80	Oct 71	20	OP	SUR	D	R	
82	May 71	19	OP	SUR	D	R	
83	Mar 71	19	OP	SUR	D	R	
89	Aug 71	20	OP	SUR	D	R	
	July 71	20	OP	SUR	D	R	
92	Sept 71	20	OP	SUR	D	R	

Improved detection of small leaks - low level base up water alarm adjusted
 More rapid depressurization after loss

BUCKET NUMBER	DISCOVERY DATE	DISCOVERY TYPE	IDENTIFICATION	STATUS	LOCATION	DESCRIPTION	REMARKS
105	Jan 72	21	OP	ACT	21	D	R
109	Feb 71	19	OP	SUR	D	R	
111	Mar 72	21	OP	SUR	D	R	
115	May 72	21	OP	SUR	D	R	
116	June 72	22	OP	SUR	D	R	
123	Aug 72	22	OP	SUR	D	R	
124	July 72	22	OP	SUR	D	R	

Change in activation of core spray
 Extra feed water supply
 Storm caused 12 short circuits
 Oil circuit breaker overheated
 Stuck contact, overcurrent relay
 Longue switch set wrongly - over-seating valve motor
 Fuel pool siphon
 Back fire, failure to shear - clear p.A.
 Oil pressure switch
 Off Gas isolation valve failed to close completely
 Off gas hold up pipe rising
 Overheating 2 cables due to ventilation failure

DOCKET NUMBER	INCIDENT NUMBER	DATE	TYPE	STATUS	DESCRIPTION	CAUSE	EFFECT	REASON	REPAIR	STATUS	REMARKS
156	156	Apr 21 73	OP	SUR							Control room alarm failure
157	157	Apr 22 73	OP	SUR							Warning of radiation failure
158	158	Apr 23 73	OP	SUR							Unexplained radiation alarm in control room
159	159	Apr 24 73	OP	SUR							Loss of main charge rods
160	160	Apr 25 73	OP	SUR							High parking jam
161	161	Apr 26 73	OP	SUR							High seal leak - loss of prime
162	162	Apr 27 73	OP	SUR							Loss of generator
163	163	Apr 28 73	OP	SUR							Insufficient spray
164	164	Apr 29 73	OP	SUR							Reactor pressure switches
165	165	Apr 30 73	OP	SUR							Control room alarm failure
166	166	Apr 31 73	OP	SUR							Adjustment of
167	167	May 1 73	OP	SUR							Calibration, interchange
168	168	May 2 73	OP	SUR							Large error in pressure switch - change temperature

DOCKET NUMBER	INCIDENT NUMBER	DATE	TYPE	STATUS	DESCRIPTION	CAUSE	EFFECT	REASON	REPAIR	STATUS	REMARKS
173	173	Jan 23 73	OP	SUR							Off gas isolation valve left open - procedures altered
174	174	Jan 23 73	OP	SUR							Large error in pressure switch reading
175	175	Jan 23 73	OP	SUR							Incorrect connection - power supply reversed
176	176	Jan 24 73	OP	SUR							New procedure top
177	177	Jan 24 73	OP	SUR							Neutron monitor not checked S during test preliminaries - procedures altered
178	178	Jan 24 73	OP	SUR							Omission of recalibration after rod withdrawal - cured by adding alarm circuit SMP
179	179	Jan 24 73	OP	SUR							Emergency condenser leak - radiation
180	180	Jan 24 73	OP	ACT							Loss of nitrogen due to loose fittings
181	181	Jan 24 73	OP	ACT							Valve open timings not in accordance with safety spec.
182	182	Jan 25 73	OP	PK							Stack gas monitor filter displaced
183	183	Jan 25 73	OP	PK							Test made possible

ROCKET NUMBER	OCURRENCE NUMBER	DATE	DAY	TIME	STATUS	LOCATION	DESCRIPTION	CAUSE	EFFECT	REPAIR	STATUS	REMARKS	REPAIR	STATUS	REMARKS
270	A019	Jun 74	26	SE	ACT		IM								Degradation of oil-water leak. Piston pump assembly flooded
285	IE 7	July 74	26	SE	ACT		RP	JAN	RE						Could not withdraw drives
	IE 8	July 74	26	HS	ACT		RP	JAN	SC						Seven loose parts in all retrieved
	IE 9	June 74	26	SE	ACT		M	BRK							Neutron sources broke up - Beryllium oxide scattered through plant
290	A020	July 74	26	RF	ACT		Post								Post incident system valved out of service
291	B010	July 74	26	RF	ACT		BOLT								Baffle bolts broke DMF
	A021		26												Failure to report IE 10
	A022	July 74	26	RF	ACT		AV								Unable to test valves - subsystem after repair
304	B111	July 74	26	RF	ACT		REL	GIP							Lifetime problem with relay coil - isolation valve trip.
311	A023	Sept 74	26	RF	SUP		ENL								Emergency lock test equipment

DOCKET NUMBER	OCURRENCE NUMBER	DATE	SIX MONTH PERIOD TO	DISCOVERY TYPE	SERIOUS	CAUSE	CAUSE SURFACE	COMPONENT TYPE	FAILURE MODE	FAILURE MECHANISM	RECOVERY MECHANISM	DIAGNOSIS	CONSEQUENT ACTIONS	PREVENTIVE ACTIONS	STATUS	REMARKS		
50-2	19																	
				Oyster Creek unit 1														
58	A0	Oct. 69	1	SU	SU	D	M	FL. CR. RPS		BLK. TIM		Y	26	Y	D	R	C	First of a series of problems with control rod filter mesh
59	A0	Sep. 69	0	SU	SU	?		AM. TURB.										Major transient, MSIV shut etc.
60		Jan. 70	1	SU	SU	I		MSIV		LK		Y	3	Y	L	R	C	MSIV valves linking across seat due to excessive hanger strain
66	A0	Mar. 70	1		SUR	C	M	PS RPS		LK	SI							Swage lock fitting leak
						O												Operator tightening fitting + scram
						D	C	W. ECC				Y	2	Y	L	R	C	Both condensers disabled
80		Jul. 70	2	OP	SUR	D		FS. RAC										Reset level of trip
						P												New operating procedure
110	A0	Sep. 27 70	2	OP	ACT	D	C	CTRL. CAM. FDRR		OSC								Turbine control cam design problem - trip
						C	M	MV. TURB		BLK								Dirt in valve
						C	M	FLHV		MIS								Leakage
						P	O											New procedure implemented

DOCKET NUMBER	OCURRENCE NUMBER	DATE	SIX MONTH PERIOD TO	DISCOVERY TYPE	SERIOUS	CAUSE	CAUSE SURFACE	COMPONENT TYPE	FAILURE MODE	FAILURE MECHANISM	RECOVERY MECHANISM	DIAGNOSIS	CONSEQUENT ACTIONS	PREVENTIVE ACTIONS	STATUS	REMARKS			
		Sep. 27 70	2	OP	BCR	M	M	MV		BRK								Bypass valve linkage rod broken - someone stood on it	
114	A0	Nov. 70	3	SD	SUR	?		KV		LK		Y	2	?	L	R	C	Torn Oxygen sample valve leak	
117	A0	Dec. 70	3		SUR	I	A	AV		ADJ JAM		Y	2	Y	L	R	C	Vacuum breaker block valves jamming	
135	UE	May 71	4		SUR	C	E	RT. RE		CIR								Resistor overheated + burn + broke + jammed timer relay	
138	A0	Jun. 71			SUR	C	M	PS. CS		LOOS + JAM									
139	UE	Jan. 71	4		ACT	?		PP										Collapse of package boiler flue	
140	A0	Jun. 71	4		SUR	D	C	PM. CS				Y	2	Y	L	R	C	Water hammer/vibration in core spray	
148	A0	Aug. 71	4	OP	ACT	D		TK. RD		OVP								Excess demand for rod waste storage while tank maintenance in progress	
		Aug. 2	4	OP	SUR	C	M	XV. RS RPS		LK									
		July 6	4	OP	SUR	C, D	M, S	KV .095		JAM									
		Aug. 17	4	OP	SUR	C	M	RE. CR. RPS		JAM									Dump tank (CR. water hold up) level alarm relay binding

DOCKET NUMBER	INCIDENT NUMBER	DATE	EX POSURE	TYPE OF PLANT	DISCOVERY TYPE	SERIOUS?	CAUSE	CAUSE SURCLASS	COMPONENT TYPE	FAILURE MODE	FAILURE MECHANISM	RECOVERY MECHANISM	CONCURRENT EFFECT	DOMINANT ASSESSED CONSEQUENCE	IDENTIFIED SPONSORING AGENCY/ORGANIZATION	STATUS	REMARKS		
149	A0	Sep. 71	4	OP	SUR		D	S	RT. RE. RHR		CIR		Y	M	N	L	R	C	Same as earlier relay failure - see 50-210-135
152	A0	Dec. 71	5	SD	SUR		D	H	MSIV LK		LK		Y	4	N	L	R	C	Same as earlier MSIV leakage
153	A0	Nov. 71	5	OP	ACT		O	O	MSIV		JAM BRK					L	P	C	Failure to equalise pressure across valves + breakage - linkage break + failure to close oil leak to motor + burn out
154	A0	Nov. 71	5	SD	ACT		D, P	O	MV. RHR		LK-FIRE		Y	3	N	L	G	C	Led to water hammer
156	A0	Nov. 71	5	OP	ACT		I, D		PP. AS		BRK					S	I	I	Air supply pipe rupture + loss of air + scrams - manual scram Other compressor could take over only after manual valve closed
157	A0	Dec. 71	5				?		CO RW TK. RW		BLK					S	G	I	Blockage of concentrator + plant outage + Excess activity in tank
159	A0	Dec. 71	5	OP	SUR ACT		D		SW PM TK. GEN				Y	4	2	L	R	C	Lack of spare concentrator Empty fuel oil tank due to pump switch problem
							C												Added to check list
							P												New annunciator added
							D												

DOCKET NUMBER	INCIDENT NUMBER	DATE	EX POSURE	TYPE OF PLANT	DISCOVERY TYPE	SERIOUS?	CAUSE	CAUSE SURCLASS	COMPONENT TYPE	FAILURE MODE	FAILURE MECHANISM	RECOVERY MECHANISM	CONCURRENT EFFECT	DOMINANT ASSESSED CONSEQUENCE	IDENTIFIED SPONSORING AGENCY/ORGANIZATION	STATUS	REMARKS		
160	A0	Jan. 72	5				I	A	PA		LOOP				L	R	C	Failure 3/4" vent line - orderly shut down	
							D	O	PH PP						L	R	C	Due to poor pipe hanger installation, pipe hanger extra needed	
164	A0	Dec. 71	5	OP	ACT		D	U	SL CR	I			Y	2	Y	L	R	C	LOCA Failure to insert fully- seal leakage
167	A0	Jan. 72	5	OP	ACT		O	P							S	I	C	Shut down generator 1 & core spray 2	
							P	C					Y						2 dissimilar systems
168	A0	Jan. 72	5	OP	ACT		P	O	S						L	S	I	I	New procedure Loss of buss power
							D	C							L				Extra circuitry to prevent problem
							P	O							L				Extra tagging procedure Many plant subway terms but power
169		Feb. 72	5	OP	ACT		O	W, P					Y	several dissimilar systems trip					Operator removed 125 V S DC power + load drop Feedwater pump scoop tube jammed
							D7		PM PW		OBC								

DOCKET NUMBER	OCURRENCE NUMBER	DATE	SLK NO. & PERIOD	STATUS OF PLANT	DISCOVERY TIME	SERIOUS	CAUSE	CAUSE SUB CAUSE	COMPONENT IN V.	FAILURE MODE	FAILURE MECHANISM	RECOVERY MECHANISM	CAUTIONS	REPAIRS MADE	UNEXPECTED ASSESS	TURBINE OIL SAMPLES	LABORATORY INVESTIGATION	MICRO ANALYSIS	REPAIRS / WORK	STATUS	REMARKS
173		Mar. 72	5	OP	SUR		H		ES PP PPS		DIRT JAM										Screw pump valve level switch again off. 110
176		Mar. 72	5				?		TK RW												Red waste outside tank activity again
177		Mar. 72	5	OP	SUR		?		BY GEN		E		Y	2	Y	L	R				Two batteries had bad cells
180 266		Apr. 72	6	OP	ACT		C	E	NO W		CIR										
							D	C	DM C		CIR		Y	4	Y	L	R				
182		May 72	6		SUR		I	W	SV		CRF		Y	4	Y	L	R				Cracking in two seat bushings
184 205											STR COR DIRT										out of 16
189	A0	May 72	6	OP	ACT		O	O	Fuel												Fuel bundle misoriented - four people checked
							O	O													
							O	O													
							P	O													New procedure
190				OP	SI		P	Z	RAFFLE												Raffles removed after Monticello incident

DOCKET NUMBER	OCURRENCE NUMBER	DATE	SLK NO. & PERIOD	STATUS OF PLANT	DISCOVERY TIME	SERIOUS	CAUSE	CAUSE SUB CAUSE	COMPONENT IN V.	FAILURE MODE	FAILURE MECHANISM	RECOVERY MECHANISM	CAUTIONS	REPAIRS MADE	UNEXPECTED ASSESS	TURBINE OIL SAMPLES	LABORATORY INVESTIGATION	MICRO ANALYSIS	REPAIRS / WORK	STATUS	REMARKS	
196		Jun. 72	6	SD	ACT		C	E	RE. C		CIR DH											Relay overheating
		Jun. 72	6	SD	ACT				PP. ESWS		BRK LK HYD?											Rubber expansion joint broke on pump start
					SUR		?		MSIV		LK											MSIV leakage again
198		Jun. 72	6	OP	ACT		D	S	TS.		LK											Turbine cooling water tower temp. switch lost its gas charge
201	A0	Jul. 72	6	OP	ACT		D		TK. RW													Outside waste tank again - high activity
203	A0	Aug. 72	6	OP	SUR		C	H	PS.		LOOS											Loose nut - loss of torque in torque tube of PS
204	A0	Aug. 72	6	OP	ACT		C	E	RE. TS		DIRT											Containment spray pump circuit breaker open circuit ? dirt
							P	O														Added to check procedures
207	A0	Aug. 72	6	SD	ACT		C	H	EG RHR		STK											Failure of containment isolation condensers
							I, D	O	SNUBBER EG		MISS											Missing snubber - full scale reading - sticking
							P		TV		DAM											+ motor valve too tight on seat

INCIDENT NUMBER	DESCRIPTION NUMBER	DATE	SIX MONTH PERIOD	OPERATOR	DISCOVERY	CAUSE	CAUSE SURTAGE	COMPONENT TYPE	FAILURE MODE	FAILURE MECHANISM	REASON FOR OCCURRENCE	CORRECTIVE EFFECT	CONTOUR OF ASSESS	CONSEQUENCE	STATUS	REMARKS	7 of 20
215	AB	Sep. 72	6	OP	ACT	I	M RE AC	LOSS SCRAM								Scram due to loose wire - multiple leakage in isolation valves	
218	AB	Sep. 72	6			D	S SL. RV	LF	Y	7	7					Liquid control system pump packing leak - maintenance	
						D	O W. PH	CIR								Packing on circuit breaker preventing other pump starting	
221	AB	Nov. 72	7			P	O W. PS	CIR	Y	2	2					Interchange of isolation condenser pressure switch lines	
222	AB	Dec. 72	7	OP	SUR	D	S SO		Y	4	2						
224	AB	Dec. 72	7	OP	ACT	C	M PP. RW	DOR								Release of rad waste	

INCIDENT NUMBER	DESCRIPTION NUMBER	DATE	SIX MONTH PERIOD	OPERATOR	DISCOVERY	CAUSE	CAUSE SURTAGE	COMPONENT TYPE	FAILURE MODE	FAILURE MECHANISM	REASON FOR OCCURRENCE	CORRECTIVE EFFECT	CONTOUR OF ASSESS	CONSEQUENCE	STATUS	REMARKS	8 of 20
227	AB	Dec. 72	7	OP	ACT	D/O		P								Operator opened door of relay cabinet - scram	
						D	H RV	BLK BLK								Electromatic relief valve failed to reset (?why did it open) see below	
						D		RV	BRR	Y	4	Y				LOCA Broken parts on 4 relief valves	
						C	H RV. PC	LOOS, BLK								Missing parts problem	
						C	H SW	BRR								Mode switch broken, prevented switch to start up mode - NSIV closure	
						C	H NSIV	DIRT, BLK								NSIV failed to close	
						D	C RV. BRR	JAM								Failure of isolation condenser, condensate return valve to open	
235	AB	Feb. 73	7	OP	ACT	D	O PP. DGS	BLK								Stock gas sample line froze	
236	AB	Feb. 73	7	CS	ACT	P	7									Personnel overexposure in clean up after blow-down	
237		Feb. 73	7	SU	ACT	C	5 SW. CR	CIR								Failed open circuit	

DOCKET NUMBER	OCCURRENCE NUMBER	DATE	SLX NUMBER PERIOD NO.	OPERATING MODE OF PLANT	DISCOVERY TYPE	SERIOUS?	CAUSE	CAUSE SEVERAL	COMPONENT TYPE	FAILURE MODE	FAILURE MECHANISM	RECOVERY MECHANISM	COMMON MODE EFFECT	CONSEQUENCE AVOIDED	CONTROL ROLE CONSEQUENCE	LATENCY/SPONTANEITY	INITIALLY REVEALED/OPERATOR	INITIALLY REVEALED/OPERATOR	INITIALLY REVEALED/OPERATOR
320	73-20		8	SD	ACT	?			RE. MV. RHR	-						L	R	C	New condensate return valve
321	73-21		8	SD	SUR	D	S		SL. SH	LK			Y	21	Y	L	R	C	Snubber seals again
322	73-22		8	CS	SUR	?			MSIV	LK						L	R	C	
330	A0	Oct. 73	9		SUR	C	M		PS. ADS	STK						L	R	C	
350	73-23																		
331	A0	Sep. 73	8		SUR	?			MSIV	W LK						L	R	C	See above
332	73-24		8		SUR	?			RE. RHR							L	R	C	
335	73-25		8		SUR	D			MSIV, SL	LK			Y	2	Y	L	R	C	2 more MSIV's leaking - but this time through stem packing
337	A0	Oct. 73	9	OP	ACT	O	P									S	I	I	
349	73-26					O	O				Adjustment of power trips - calculation incorrect					S	S	S	S

DOCKET NUMBER	OCCURRENCE NUMBER	DATE	SLX NUMBER PERIOD NO.	OPERATING MODE OF PLANT	DISCOVERY TYPE	SERIOUS?	CAUSE	CAUSE SEVERAL	COMPONENT TYPE	FAILURE MODE	FAILURE MECHANISM	RECOVERY MECHANISM	COMMON MODE EFFECT	CONSEQUENCE AVOIDED	CONTROL ROLE CONSEQUENCE	LATENCY/SPONTANEITY	INITIALLY REVEALED/OPERATOR	INITIALLY REVEALED/OPERATOR	INITIALLY REVEALED/OPERATOR
339	A0	Oct. 73	9	OP	SUR		C, D	M	RV. SW	COR LK						S	I	I	
342	A0	Oct. 73	9	OP	ACT		C	M	HE. FW	LK						G			Radiation release, closed cooling water system leak 14,500 gal.
							D, P	U								L			
346	A0		9	OP	SUR		D	S	SH.	LK				1		L			Bergen Patterson arrestor again
363	73-30	Dec. 73	9		SUR	?			PS. RPS	Drift			Y	4	Y	L	R	C	
365	74-2	Jan. 8	9	OP	SUR	?			PS. C	Drift			Y	2	Y	L	R	C	
366	74-1	Jan. 4	9	OP	SUR		C, D, P	O	PS.	Drift ADJ			Y	4	Y	L	R	C	
367	74-3	Jan. 13	9	CS	SUR		D	S	SH							L	R	C	Bergen Patterson snubber again
368	74-5		9	CS	SUR		C	M	MSIV	LK						L	R	C	Valve packing back again as Sep. 73
369	74-6	Jan. 22	9	SD	ACT		O	J	INERT NO2							L	R	C	Operator used too much NO2 - misjudged amount left - delivery date
370	74-7		9	SU	ACT	?			PS. RPS	Drift						L	R	C	

DOCKET NUMBER	OCCURRENCE NUMBER	DATE	SIX MONTH PERIOD	DISCOVERY TYPE	SERIOUS	CAUSE	CAUSE CATEGORY	COMPONENT TYPE	FAILURE MODE	FAILURE MECHANISM	RECOVERY MECHANISM	COMMON MODE EFFECT	COMPONENT AFFECTED	CONSEQUENCE	AGENT/STORAGE	IMMEDIATE RELEASE/CONTAIN	STATUS	DESCRIPTION
378	73-01		9	OP ACT		H I		W. DC				Y	2	Y	S	I	I	Loss of DC power
379	73-02		9		SUR	D U		KV. MSIV		STK DIRT					L	R	C	Overtravel - pr. transient
380	73-03	Nov. 21 73	9		ACT	?		REL. ADS.		OH					S	G	I	
385	73-04	Dec. 73	9	OP SUR		I Q		NH.							L	R	C	Poor soldered contact
388	73-05	Nov. 73	9	OP ACT		D C		FI. HE. RHR		TIM					L	R	C	
390	73-06	Dec. 73	9	OP ACT		D O		PP. RW		BRK					S	G	C	Radioactivity release after pipe freeze - than
400	74-01	Jan. 17	9	HS SUR		?		FI. RHR		Drift TIM		Y	3	Y	L	R	C	
403	74-02	Jan. 22	9	HS SUR		D, S		KV. MSIV		STK					L	R	C	
407	74-03	Jan. 31	9	OP SUR		D S		PS.		Drift		Y	2	Y	L	R	C	As 73-30
408	74-04	Feb. 8 10	9	OP SUR		D		PS.				Y	2	Y	L	R	C	As 73-30 - these are Barkdale PS's

DOCKET NUMBER	OCCURRENCE NUMBER	DATE	SIX MONTH PERIOD	DISCOVERY TYPE	SERIOUS	CAUSE	CAUSE CATEGORY	COMPONENT TYPE	FAILURE MODE	FAILURE MECHANISM	RECOVERY MECHANISM	COMMON MODE EFFECT	COMPONENT AFFECTED	CONSEQUENCE	AGENT/STORAGE	IMMEDIATE RELEASE/CONTAIN	STATUS	DESCRIPTION
415	74-11	Feb. 15	9	OP SUR		D S		VV		STK		Y	4	Y	L	R	C	
419	74-15	Feb. 28	9	OP SUR								Y	4	Y				As 74-11 & 74-14
420	74-16		9	As	74-11							Y	4	Y				As 74-11
425	74-13	Feb. 18	9	OP ACT		H B									L			Cleanup system isolation valve inoperatable - Manual trip 'blunder' failed to close
428	74-17	Mar. 7	9	SD ACT		?		SW. CB. EP							L	R	C	Loss of electrical power on two buses
129	74-18	Mar. 8	9			D S		SH				Y	7	Y	L	R	C	As 74-3
130	74-19	Mar. 9	9	CS ACT		D ?		CG.		STK					L	R	C	Gauge sticking -
						O O									S	I	C	Omitted to check recorder

DOCKET NUMBER	OCCURRENCE NUMBER	DATE	SIX MONTH PERIOD NO.	DISCOVERY TYPE	SERIOUS	CAUSE	CAUSE SURCHASE	COMPONENT TYPE	FAILURE MODE	FAILURE MECHANISM	RECOVERY MECHANISM	SCRAM NO. EFFECT	SCRAM ON THE APPROP.	SCRAM FOUR SOURCE/URGE	LA TERN/ STOPPAGE	IMMEDIATE REVERSAL / CORRECT.	REMARKS	
431	74-20	Mar. 10	9	RS SUR		I, P	M	SL. MSIV	LK			Y	4	Y	L	R	C	Leaking because seal was cut to install, instead of dismantling
438	74-21	Mar. 11	9	OP ACT		?		XV. PG							S	I	I	Bypass valve open
446	74-22	Mar. 15	9	OP SUR		D		DS. C	Drift			Y		N	L	R	C	As 74-1
449	74-23	Mar. 15	9	OP SUR		D	S	FS. RHR	Drift			Y	2	Y	L	R	C	
456	74-25	Apr. 9	10	OP SUR		?		W. C	LK			Y	2	Y	L	R	C	
457, 460	74-24	Apr. 10	10	OP ACT		O	O	FL. OGS							S	I	I	Omitted to measure off gas filter activity
460	74-26	10				C		PH. ESW							L			Emergency service water pump failed to operate
469	74-29	Apr. 17	10							Bergen Patterson shock absorbers again		Y	3	Y				
476	74-28	Apr. 19	10	RS SUR		H	A	LS MV. CS							L	R	C	
484	74-29	10		RS SUR		E	S	PS. ADS	Drift			Y	2	Y	L	R	C	

DOCKET NUMBER	OCCURRENCE NUMBER	DATE	SIX MONTH PERIOD NO.	DISCOVERY TYPE	SERIOUS	CAUSE	CAUSE SURCHASE	COMPONENT TYPE	FAILURE MODE	FAILURE MECHANISM	RECOVERY MECHANISM	SCRAM NO. EFFECT	SCRAM ON THE APPROP.	SCRAM FOUR SOURCE/URGE	LA TERN/ STOPPAGE	IMMEDIATE REVERSAL / CORRECT.	REMARKS	
486		Apr. 24	10	RS SUR		C	M	MV. ADS, C		CRK					L	R	C	Crack in butterfly valve disc
500	74-30	May 14	10	RF SUR		H	H	PS. TURB	Drift						L	R	C	
505	74-33	May 21	10	RF SUR		P	L	TI. ADS		TIM		Y	2	Y	L	R	C	7 seconds extra delay on ADS
508	74-52	May 21	10	RF SUR		?		PS. CS		CIR					L	R	C	Mercoid pressure switch failed open
511	74-31		10							Bergen Patterson		Y	2	Y	L	R	C	
512	74-54	May 28	10	RF		C		PEN		LK					S	I	I	Leakage in instrument penetration (LOCA-minor) (0.02 gal/hr.)
520		May 25	10	SU ACT		D	Mod, O	PS. CS				Y	2	Y	L	R	C	Reset trip point
529	74-35	Jul. 5	10	SU SUR		D	S	PS. MSIV				Y	4	Y	L	R	C	Several switches on one alarm Operator did not reset Barksdale switches, As 74-1
530	74-36	July	10	OP SUR		D	S	PS. RPS							L	R	C	Another Barksdale switch
545	74-74	July	10	SUR		D	O	W. C				Y	2	Y	L	R	C	Activation of main line drain isolation valves omitted

DOCKET NUMBER	OCURRENCE NUMBER	DATE	JULY MONTH REPORT NO.	DISCOVERY TYPE	SERIOUS?	CAUSE	CAUSE SURPLASS	NONMOVING PART	FAILURE MODE	FAILURE MECHANISM	RECOVERY MEASURE ILM	CONVICTED BY REPORT	CONVICTED BY ASSESSOR	CONVICTED BY INVESTIGATOR	LABORATORY APPROVED	INVESTIGATED/REPEATED/OTHER	STATUS	REMARKS	
546	74-37		10									Y	4	Y					Barksdale switches again. As 74-1
552	74-40		10																Bergen Patterson again
557	74-38	July 74	10			D	S	HV MSIV		TIM					L	R	C		New activation design on these valves
558	74-39	July 14	10	RF	SUR	D	Z	PS. ADS	Drift			Y	4	Y	L	R	C		
559	74-41	July 19	10	OP	SUR	D	S					Y	2	Y	L	R	C		Barksdale switches again as 74-1
560	74-42	July 25	10									Y	4	Y					Ditto
564		Aug. 8	10		ACT	?		PM. RPS											
566	74-44	Aug. 9	10	As	74-1				Barksdale switches										
568	74-43	Aug. 2	10																
582	74-46	Aug. 26	10	OP	SUR	D	S, U	WV. C		JAM		Y		N	L	R	C		Teflon 'growth' in hinge
588	74-47		10						Bergen Patterson shock absorbers										
596	74-48	Sep. 25	10	OP	ACT	1									S	I	I		Scram - load rejection
						D	Z	RHR				Y	2	Y	L	R	C		Both heat removal systems out

DOCKET NUMBER	OCURRENCE NUMBER	DATE	SLX DGRH SERIAL NO.	DISCOVERY TYPE	SERIOUS?	CAUSE	CAUSE SURPLASS	NONMOVING PART	FAILURE MODE	FAILURE MECHANISM	RECOVERY MEASURE ILM	CONVICTED BY REPORT	CONVICTED BY ASSESSOR	CONVICTED BY INVESTIGATOR	LABORATORY APPROVED	INVESTIGATED/REPEATED/OTHER	STATUS	REMARKS	
597	74-49		11																Barksdale switch again
599	74-50	Oct. 4	11	OP	ACT	H	H	CB MV. C		BLK					L	P	C		
602	74-52		11																Barksdale switch again
603	74-55	Oct. 18	11	OP	SUR	?		PM. CS							L	R	C		