APPENDIX A

DETAILED CONTENTS OF THE HAZARDOUS LIQUIDS PIPELINE DATABASE

4. Evaluating consistency between different data items. Some data items must follow certain rules which cannot be violated. For example, the nominal diameter of the pipe must be larger than its wall thickness or the amount of commodity spilled cannot be less than the amount of commodity which was recovered. The OPS databases were checked for existence of such inconsistencies. The results of the evaluation of the correctness of the data are presented in Chapter four.

5. Evaluating the adequacy of the existing data for risk assessment and risk management. The databases were evaluated to determine what additional data is needed to be collected in order to perform statistically significant assessment of what may cause accidents in hazardous liquid pipelines. Chapter five contains the results of this evaluation.

The report also includes conclusions and recommendations for improving the data that is being collected, quality control of data input, and the need for additional data for more valuable risk assessment/risk management programs.

Note: The findings in this report are based on copies of the databases as received from RSPA office in Washington, D.C. in October, 1994.

2.0 OVERVIEW OF RSPA'S DATA ON HAZARDOUS LIQUID ACCIDENTS

2.1 INTRODUCTION

RSPA has two sets of data on hazardous liquid accidents, LIQUID and LIQLCK. LIQUID contains accidents which were reported from **1968** to **1985.** From **1985** to the present, accident data is recorded in the LIQLCK database.

The content of both hazardous liquid databases will be described in two parts. The first part is a data dictionary (which is a list of field names and a short description of what they represent). If the input of a certain field is a numerical code (such as **1,2,** etc.), the codes will be explained as well. For example, the input of the field FIRE can be **1** or 2, where **1** means yes (there was fire) and 2 means no. This information will be provided as part of the data dictionary.

The second part of the database description is a technical description of the type of the data and the size of each field. The data is described in a table that has six columns. The first is the field name, the second is the data type. The third column provides information on the storage size (bytes or characters) that is used to store each field. The fourth column indicates the starting byte (or character) of a specific field in the record. The fifth and the sixth columns are similar to the previous two except that they specify the field size and location in **OPS's** *.DMO files (flat files that contain the data). One should note that the size and starting points of OPS's databases which are given here may differ from what OPS has in its *.ATR files (a text file with attribute descriptions). In order to be able to import the data from **OPS's** fixed length flat file (e.g. LIQLCK.DMO) one should use the information provided in columns five and six.

2.2 DATA DICTIONARY FOR DATABASE LIQLCK

NAME	DESCRIPTION	INPUT CODE EXPLANATION
YR	Year of Accident	
LOG	Log Number	
RPTID	Report ID	
OPID	Operator ID	
NAME	Name of Operator	
INTER	Interstate Pipeline?	1 Yes 2 No
IDATE	Date (Month, Day) of accident	
IYEAR	Date (Year) of accident	
DTHH	Hour of accident	24 hour clock
ACCST	Accident State	
ACCNT	Accident County	
ACCTY	Accident City	
COOR	Accident Coordinates (for offshore accidents)	
IFED	Federal Land?	
SPLOC0	Specific Location (description of)	
CSYS	Parts of system Involved	1 line pipe 2 tank farm 3 pump station
ORGLK	Item Involved	1 pipe 2 valve

1.0 INTRODUCTION TO APPENDIX A

The purpose of this study is to analyze the RSPA data for hazardous liquid pipelines. The databases that were studied are LIQUID and LIQLCK. Database LIQUID contains hazardous liquid accident information from 1968 to 1985. The other database (LIQLCK) contains accident data from 1985 to the present. These databases are a digital copy of accident reporting form "DOT form 7000-1" which must be filed by pipeline operators following a reportable hazardous liquid pipeline accident. The databases have some different data input because of modifications made in the reporting form in 1985. These differences will be discussed in this report. The transition from the old reporting form to the new one in 1985 resulted in some 1985 accidents to be reported in LIQUID while others are reported in LIQLCK.

The evaluation and the analysis of these databases was performed by pursuing the following process:

1. Converting the flat files LIQUID.DMO and LIQLCK.DMO (obtained from the OPS) into an ACCESS database using the field descriptions provided to us by the OPS. The conversion of the raw data into a database had two objectives. The first was to establish a database which was used for the analysis performed in this contract. The second objective was to verify the accuracy of the field descriptions provided to us by the OPS. In some cases the OPS field descriptions were inaccurate which meant that the conversion of the raw data into a database was erroneous. Chapter two of this report contains a corrected field description.

2. Comparing the OPS data with other data sources of the same accidents, NJIT utilized three additional accident data sources of information. The first was the description files of what happened at the time of the accident, which are part of 'DOT Form 7000.1." This is essentially a written report describing the circumstance of the accidents. The second source of accident data was the annual review of accidents which is performed by the the American Society of Mechanical Engineers (ASME) B31.4/B31.11 Committee. This committee performs an annual review of the accidents as reported to the OPS. The review includes compilation of accident statistics and some corrections of incorrect data values. The third source was the reports of the National Transportation Safety Board (NTSB) that investigates accidents which cause major damage or fatalities. Only a handful of hazardous liquid accidents were investigated by NTSB, thus, there was only very limited comparison possible from this source. The results of these comparisons are presented in Chapter three.

3. Evaluating the individual values of the reported items. Certain data items can have acceptable values only within a certain range. For example, the nominal diameter of a pipe cannot have a value of 12665 inches. If the database contains such a value one could assume that the probable value of the nominal diameter should be 12.665 inches. Thus, the database was checked for reasonable data values whenever it was possible to construct a range for acceptable values.

NAME	DESCRIPTION	INPUT CODE EXPLANATION
		4 pump 5 welding fitting 6 girth weld 7 tank 8 bolted fitting 9 long. weld 10 others
ORGLO	Item involved, other	
ITMYR	Year item installed	
CAUS	Cause of accident	1 corrosion
		2 failed weld
		3 incorrect operation by operator personnel
		4 failed pipe
		5 outside force damage
		6 malfunctioning of control or relief equipment.
		7 other
CAUSO	Cause of accident, other	
TFAT	Number of persons killed, Total	
EFAT	Number of persons killed, Employee	
NFAT	[Number of persons	
TINJ	Number of persons injured, Total	
EINJ	Number of persons injured, Employee	
NINJ	Number of persons injured, Non-employee	
PRPTY	Estimated total property damage	
COMM	Name of commodity spilled	
COMID	Commodity ID	
CLASS	Classification of commodity spilled	1 petroleum 2 petroleum product, HVL 3 petroleum product, non-HVL
LOSS	Estimated amount of barrels spilled	
RECOV	Estimated amount of barrels recovered	
FIRE	Was there a fire?	1 Yes 2 No
EXP	Was there an explosion?	1 Yes 2 No
NMDIA	Nominal Diameter	
		inches
SMYS	SMYS	psi
JNT	Type of Joint	1 welded 2 flanged 3 threaded 4 coupled 5 other
GRND	Pipe was	1 below ground 2 above ground
D		psi
AC		psi
PRTST	Has there been a pressure test on system?	1 Yes 2 No
DUR	Duration of test	hours
MXPRS	Maximum test pressure	psi
TSTMM	Date of test - month	
TSTYY	Date of test - year	
CORLC	Location of corrosion	1 internal 2 external 3 external 4 external
FACTD	Facility coated?	2 No
FACAT	Facility under cathodic protection?	1 Yes

NAME	DESCRIPTION	INPUT CODE EXPLANATION
		2 No
CORR	Type of corrosion	1 galvanic 2 other
CORRO	Type of corrosion, other	
CAULK	Cause by outside force	1 Damage by operator or its contractor 2 Damage by others 3 Damage by natural forces 4 Landslide 5 Subsidence 6 Washout 7 Frostheave 8 Earthquake 9 Shipanchor 10 Mudslide 11 Fishing operations 12 Other
CAULO	Cause by outside force, other	
PREVT	Damage Prevention Program in Effect?	1 Yes 2 No
ONECL	Was the Program?	1 one-call 2 other
ONEOT	prevention program other than one-call	
EXCAL	Did excavator call?	1 Yes 2 No
TMPMK	Was Pipeline Location Temporarily Marked for Excavation?	1 Yes 2 No
RNAME	(Name and title of operator officer filing this report	
PHONE	Telephone No.	
NORPT	Non-reportable	
TELRN	(Telephone report number	
TELID	Telephonic report No.	
DOR	Date received at DOT (month, day)	
YOR	(Date received at DOT (year)	
DOE	Date of Entry (month, day)	
YOE	Date of Entry (year)	
DOC	Date of change (month, day)	
YOC	Date of change (year)	

2.3 TECHNICAL DESCRIPTION OF DATABASE LIQLCK

NAME	DATA TYPE	INJIT ACCESS SIZE	INJIT ACCESS START	OPS LIQLCK .DMO file SIZE	OPS LIQLCK .DMO file START
YR	Number (Integer)	2	1	2	1
LOG	Number (Integer)	2	3	4	3
RPTID	Number (Long)	4	5	6	7
OPID	Number (Long)	4	9	5	13
NAME	Text	50	13	50	18
INTER	Number Inte_er)	2	63	2	68
IDATE	Number Inte_er)	2	65	6	70
IYEAR	Number Inte_er)	2	67	4	76

NAME	DATA TYPE	NJIT ACCESS SIZE	NJIT ACCESS START	OPS LIQLCK .DMO file SIZE	OPS LIQLCK .DMO file START
DTHH	Number (Integer)	2	69	4	80
ACCST	Text	2	71	2	84
ACCNT	Text	25	73	25	86
ACCTY	Text	25	98	25	111
COOR	Text	25	123	25	136
IFED	Number (Integer)	2	148	2	161
SPLOC0	Text	160	150	160	163
CSYS	Number (Integer)	2	310	1	323
ORGLK	Number (Integer)	2	312	2	324
ORGLO	Text	25	314	25	326
ITMYR	Number	2	339	4	351

NAME	DATA TYPE	NJIT ACCESS SIZE	NJIT ACCESS START	OPS LIQLCK .DMO file SIZE	OPS LIQLCK .DMO file START
	(Integer)				
CAUS	Number (Integer)	2	341	1	355
CAUSO	Text	25	343	25	356
TFAT	Number (Integer)	2	368	3	381
EFAT	Number (Integer)	2	370	3	384
NFAT	Number (Integer)	2	372	3	387
TINJ	Number (Integer)	2	374	3	390
EINJ	Number (Integer)	2	376	3	393
NINJ	Number (Integer)	2	378	3	396
PRPTY	Number (Long)	4	380	8	399
COMM	Text	30	384	30	407
COMID	Number (Long)	4	414	7	437
CLASS	Number (Integer)	2	418	1	444
LOSS	Number (Long)	4	420	6	445
RECOV	Number (Long)	4	424	6	451
FIRE	Number (Integer)	2	428	2	457
EXP	Number (Integer)	2	430	2	459
NMDIA	Number (Double)	8	432	6	461
THK	Number (Double)	8	440	6	467
SMYS	Number (Long)	4	448	7	473
JNT	Number (Integer)	2	452	1	480
GRND	Number (Integer)	2	454	2	481
DSPRS	Number (Integer)	2	456	4	483
ACPRS	Number (Integer)	2	458	4	487
PRTST	Number (Integer)	2	460	2	491
DUR	Number (Integer)	2	462	3	493
MXPRS	Number	2	464	4	496

NAME	DATA TYPE	NJIT ACCESS SIZE	NJIT ACCESS START	OPS LIQLCK .DMO file SIZE	OPS LIQLCK .DMO file START
	(Integer)				
TSTMM	Number (Integer)	2	466	2	500
TSTYY	Number (Integer)	2	468	2	502
CORLC	Number (Integer)	2	470	2	504
FACTD	(Number (Integer)	2	472	2	506
FACAT	Number (Integer)	2	474	2	508
CORR	Number (Integer)	2	476	2	510
CORRO	Number (Integer)	25	478	25	512
CAULK	Number (Integer)	2	503	2	537
CAULO	Number (Integer)	25	505	25	539
PREVT	Number (Integer)	2	530	2	564
ONECL	Number (Integer)	2	532	2	566
ONEOT	Text	25	534	25	568
EXCAL	Number (Integer)	2	559	2	593
TMPMK	Number (Integer)	2	561	2	595
RNAME	Text	60	563	60	597
PHONE	Text	10	623	10	657
NORPT	Text	1	633	1	667
TELRN	Text	10	634	10	668
TELID	Number (Long)	4	644	5	678
DOR	Number (Integer)	2	648	6	683
YOR	Number (Integer)	2	650	4	689
DOE	Number (Integer)	2	652	6	693
YOE	Number (Integer)	2	654	4	699
DOC	Number (Integer)	2	656	6	703
YOC	Number (Integer)	2	658	4	709

2.4 DATA DICTIONARY FOR DATABASE LIQUID

NAME	DESCRIPTION	INPUT CODE EXPLANATION
YR	Year of Accident	
LOG	Log Number	

NAME	DESCRIPTION	INPUT CODE EXPLANATION
RPTID	Report ID	
OPID	Operator ID	
NAME	Name of Operator	
STOF	Principa 's business address - State	
RGOF	Pri ipa operator's business ldi - Region	
DATE	Date (Month, Day) of accident	
YEAR	Date (Year) of accident	
ACCHH	Hour of accident	1-12
ACCMN	Hour of accident	1 AM 2 PM
ACCST	Accident State	
ACCNT	Accident County	
ACCTY	Accident City	
SYS	Parts of system Involved	1 line Pipe 2 pumping Station 3 delivery Point 4 tank Farms 5 others
ORGN	Origin of liquid or vapor release	1 Pipe 2 Girth Weld 3 Long. Weld 4 Pump 5 Valve 6 Scraper Trap 7 Meter/Prover 8 Tank 9 Weld Fitting 10 Bolted Fitting 11 Sample House 13 Hay Tank 14 Others
CAUS	Cause of accident	1 corrosion 2 Defective Weld 3 Operation Error 4 Defective Pipe 5 Equipment Ruptured line 6 Others
FAT	Number of persons killed, Employee	
FAT	Number of persons killed, Non-employee	
INJ	Number of persons injured Employee	
INJ	Number of persons injured, Non-employee	
PPPT	Carrier property damage	
DMG	Items Damaged	
PRPT	Other Property Damaged	
DMG	Items Damaged	
COMM	Name of commodity spilled	
COMID	Commodity ID	
LOSS	Estimated Loss due to the Accident	barrels
ACYR	Year Facility Installed (excluding pipe)	
FIRE	Was there a fire?	1 Yes 2 No
EXP	Was there an explosion?	1 Yes 2 No
NMDIA	Nominal Diameter	inches
THK	Wall thickness	inches
GRD	Grade	
PIPYR	Year Installed	1 - before 1920 2 - 1920 to 30 3 - 1930 to 35 4 - After 1935

NAME	DESCRIPTION	INPUT CODE EXPLANATION
SPYR	Year installed after 1935	
COND	Condition when installed	1 new 2 reconditioned
JNT	Type of Joint	1 Weld 2 Coupled 3 Threaded
CONF	Configuration at point of accident	1 Straight 2 Sag 3 Overbend 4 Sidebend
COAT	Pipe was	1 coated 2 not coated
GRND	Pipe was	1 belowground 2 above ground
COV	Cover if below ground	inches
DSPRS	Maximum operating pressure	psi
ACPRS	Pressure at time and location of accident	psi
PRTST	Has there been a pressure test on system?	1 Yes
		2 No
MED	If yes, Medium liquid	1 Water 2 Petroleum 3 Air
DUR	Duration of test	hours
MXPRS	Maximum test pressure	psi
TSTMM	Date of test - month	
TSTYY	Date of test - year	
CORR	Type of corrosion	1 internal 2 external
FACTD	Facility coated?	1 Yes 2 No
FACAT	Facility under cathodic protection?	1 Yes 2 No
COTST	COTST - Time Between Corrosion tests	months
TEST	Type of test used	
DSTLM	Distance to nearest line marker	
PTRLT	Length of time between patrol of section	days
VCODE		
DOE	Date of Entry (month, day)	
YOE	Date of Entry (year)	
DOC	Date of change (month, day)	
YOC	Date of change (year)	

2.5 TECHNICAL DESCRIPTION OF DATABASE LIQUID

NAME	DATA TYPE	NJIT ACCESS SIZE	NJIT ACCESS START	OPS LIQUID .DMO file SIZE	OPS LIQUID .DMO file START
YR	Number (Integer)	2	1	2	1
LOG	Number (Integer)	2	3	4	3
RPTID	Number (Long)	4	5	6	7
OPID	Number (Long)	4	9	5	13
NAME	Text	255	13	50	18
STOP	Number (Integer)	2	268	2	68
RGOP	Number (Integer)	2	270	1	70
IDATE	Number (Integer)	2	272	6	71
IYAER	Number (Integer)	2	274	4	77
ACCHH	Number (Integer)	2	276	2	81

NAME	DATA TYPE	NJIT ACCESS SIZE	NJIT ACCESS START	OPS LIQUID .DMO file SIZE	OPS LIQUID .DMO file START
ACCMN	Number (Integer)	2	278	2	83
ACCST	Text	2	280	2	85
ACCNT	Text	25	282	25	87
ACCTY	Text	25	307	25	112
CSYS	Number (Integer)	2	332	1	137
ORGN	Number (Integer)	2	334	2	138
CAUS	Number (Integer)	2	336	1	140
[illegible]	Number (Integer)	2	338	3	141
[illegible]	Number (Integer)	2	340	3	144
EINJ	Number (Integer)	2	342	3	147

NAME	DATA TYPE	NJIT ACCESS SIZE	NJIT ACCESS START	OPS LIQUID .DMO file SIZE	OPS LIQUID .DMO file START
NINJ	Number (Integer)	2	344	3	150
CPPPT	Number (Long)	4	346	7	153
CDMG	Text	20	350	20	160
OPRPT	Number (Long)	4	370	7	180
ODMG	Text	20	374	20	187
COMM	Text	25	394	25	207
COMID	Number (Long)	4	419	7	232
LOSS	Number (Long)	4	423	6	239
FACYR	Number (Integer)	2	427	4	245
FIRE	Number (Integer)	2	429	1	249
EXP	Number (Integer)	2	431	1	250
NMDIA	Number (Integer)	2	433	2	251
THK	Number (Integer)	8	435	7	253
GRD	Text	3	443	3	260
PIPYR	Number (Integer)	2	446	1	263
SPYR	Number (Integer)	2	448	2	264
COND	Number (Integer)	2	450	1	266
JNT	Number (Integer)	2	452	1	267
CONF	Number (Integer)	2	454	1	268
COAT	Number (Integer)	2	456	1	269
GRND	Number (Integer)	2	458	1	270
COV	Number (Integer)	2	460	3	271

NAME	DATA TYPE	NJIT ACCESS SIZE	NJIT ACCESS START	OPS LIQUID .DMO file SIZE	OPS LIQUID .DMO file START
DSPRS	Number (Integer)	2	462	4	274
ACPRS	Number (Integer)	2	464	4	278
PRTST	Number (Integer)	2	466	1	282
MED	Number (Integer)	2	468	1	283
DUR	Number (Integer)	2	470	3	284
MXPRS	Number (Integer)	2	472	4	287
TSTMM	Number (Integer)	2	474	2	291
TSTYY	Number (Integer)	2	476	2	293
CORR	Number (Integer)	2	478	1	295
FACTD	Number (Integer)	2	480	1	296
FACAT	Number (Integer)	2	482	1	297
COTST	Number (Integer)	2	484	2	298
TEST	Text	3	486	3	300
DSTLM	Number (Long)	4	489	7	303
PTRLT	Number (Integer)	2	493	3	310
VCODE	Text	1	495	1	313
DOE	Number (Integer)	2	496	6	314
YOE	Number (Integer)	2	498	4	320
DOC	Number (Integer)	2	500	6	324
YOC	Number (Integer)	2	502	4	330
ID	Number (Integer)	2	504	4	334

2.6 COMPARISON BETWEEN LIQLCK AND LIQUID

The following table is designed to show which data fields are the same in both databases (LIQUID and LIQLCK) and which fields appear in one database but not in the other. The description of each of these fields can be found in the previous sections.

LIQLCK	LIQUID	COMMENTS
YR	YR	
LOG	LOG	
RPTID	RPTID	
OPID	OPID	
NAME	NAME	
INTER		
	STOP	
	RGOP	
IDATE	IDATE	
IYEAR	IYEAR	
DTHH	ACCHH+ ACCMN	
ACCST	ACCST	
ACCNT	ACCNT	
ACCTY	ACCTY	
COOR		
IFED		
SPLOC0		
CSYS	CSYS	LIQUID has 5 categories. LIQLCK has 3
ORGLK	ORGN	LIQUID has 14 categories, LIQLCK has 10
ORGLO		
ITMYR		

LIQLCK	LIQUID	COMMENTS
CAUS	CAUS	LIQUID has 6 categories. (LIQLCK has 7
CAUSO		
TFAT		
EFAT	EFAT	
NFAT	NFAT	
TINJ		
EINJ	EINJ	
NINJ	NINJ	
PRPTY	CPPPT	Properly damage is more detailed in LIQUID
	CDMG	
	OPRPT	
	ODMG	
COMM	COMM	
COMID	COMID	
CLASS		
LOSS	LOSS	
RECOV		
	FACYR	Equivalent to ITMYR
FIRE	FIRE	
EXP	EXP	
NMDIA	NMDIA	

THK	THK	
SMYS		
	GRD	
	PIPYR	
	SPYR	
	COND	
JNT	JNT	
	CONF	
	COAT	
GRND	GRND	
	COV	
DSPRS	DSPRS	
ACPRS	ACPRS	
PRTST	PRTST	
	MED	
DUR	DUR	
MXPRS	MXPRS	
TSTMM	TSTMM	
TSTYY	TSTYY	
CORLC	CORR	
FACTD	FACTD	
FACAT	FACAT	
	COTST	
	TEST	
CORR		Detailed corrosion and damaged by outside

CORRO		Forces data available only in LIQLCK
CAULK		
CAULO		
PREVT		
ONECL		
ONEOT		
EXCAL		
TMPMK		
	DSTLM	
	PTRLT	
	VCODE	
RNAME		
PHONE		
NORPT		
TELRN		
TELID		
DOR		
YOR		
DOE	DOE	
YOE	YOE	
DOC	DOC	
YOC	YOC	

3.0 COMPARISON WITH OTHER DATA SOURCES

3.1 INTRODUCTION

This section presents some of the discrepancies that were found between data recorded in database LIQLCK and other sources of data on the same accidents. The other sources of data are the description files from the **OPS,** the annual review report on hazardous liquid accidents by the American Society of Mechanical Engineers (ASME) and National Transportation Safety Board investigation reports. The database LIQUID was not analyzed because additional data from other sources for this older database is not available.

The process of making the comparison and obtaining data discrepancies was a tedious manual one. Because of the manual process, the list below is not necessarily complete in the sense that some differences may have not been detected. Availability of this information in a digital form is desirable so that a more complete comparison could be achieved.

The first comparison that is presented in this chapter is between LIQLCK and the description files. It is followed by the comparison with ASME and NTSB reports.

3.2 COMPARING LIQLCK AND DESCRIPTION FILES

The description files are narrative reports that are submitted to **OPS** by the operators as part of the accident reporting form. They contain written descriptions of the circumstances that existed before and at the time of the accident and its impact (damages and others). The reports were

read and searched for information on five items that are also reported in the database. These items were:

CAUS - Cause of the accident

LOSS - The amount of commodity lost

RECOV - The amount of commodity recovered

NMDIA - The nominal diameter of the pipe

THK - The pipe's wall thickness

These five items were selected because they were the only concrete pieces of information that could be found in the description files which had equivalent data in the database. Since both these items are submitted by the operator, they could provide an (sort of) independent check of data values to see if they are consistent.

The following is the list of discrepancies between data from LIQLCK database (DB) and the description files (Desc) that were found as a result of the comparison:

		CAUS		LOSS		RECOV		NMDIA		THK	
	RPTID	DB	DESC	DB	DESC	DB	DESC	DB	DESC	DB	DESC
	850143	4	6	894		379		11	10	0.219	
	850144	7	6	60		59		0	1	0	
	850154	3		100		60		0	8	0	
	850169	7		1926		1500		0	2	0	
	850172	5		3337		1300		6	8	0.188	.25
	860028	5		164		87		0	6	0	
	860033	5		970		820		7	10	0.188	
	860053	7	5	200		195		0		0	
	860068	1		60		0		6	6 5/8	0.188	
	860080	7		0				0	12	0	
	860095	5		350		330		9	8	0.322	
	860100	5		360		200		8	8 5/8	0.188	
	860108	4		1140		0		7	6	0.25	
	860140	3		250		225		0	10	0	
	860150	1		119		0		4	& 6 5/8	0.125	
	870046	7		90	?	0		8		0.375	
	870059	1		290		289		0	10	0	
	870086	7		300		295		0	6	0	
	870113	4		1647		325		13	12	0.203	
	870143	7		645		642		0	16		
	870247	7		76		65		0	26		
	870252	1		273		272		0	22		
	880152	7		25		0		0	12		
	880160	1		4		0		11	10	0.365	
	890027	5		500		385		10	10.75	0.25	
	890053	7		201		195			10		
	890084	5	4	2653		10		8		0.188	
	890106	7		75		35		0	8	0	
	900173	7		1		1		0	20	0	
	910052	7		100		60		20	16	0.375	
	910060	1		15		5		8.625	8	0.219	
	910062	2		1		0		0	18	0	
	910139	7		2	8	0	5	0		0	
	910166	5	1	290		255		8		0.322	

		CAUS		LOSS		RECOV		NMDIA		THK	
	RPTID	DB	DESC	DB	DESC	DB	DESC	DB	DESC	DB	DESC
	910172	5		602		0		0	20	0	
	910173	5		1650		1185		0	10	0	
	920048	7		8		4		0	24	0	
	920082	4		0		0		0	4	0	
	920103	7	6	1520		1500		0	16	0	
	920112	5		100		99		0	6	0	
	920133	7		7		5		0	30	0	
	920165	5		732		0		6.625	6	0.188	
	920190	7	6	5		1		0		0	
3	920196	7	6	8		8		0		0	
	930004	2	5	645		539		8		0.322	
	930074	6	5	813		230		8		0.322	
	930097	5		5277		0		0	6	0	
	940010	5		1260		443		8	8 5/8	0.188	
	940129	7	6	1		0		0		0	
	940197	7	5	20		18		0		0	

NOTE: ? MEANS THAT IT IS NOT CLEAR FROM THE DESCRIPTION WHETHER THE DATABASE VALUE IS CORRECT & MEANS THAT THERE IS MORE THAN ONE SINGLE VALUE IN THE DESCRIPTION FILE

It is appropriate to mention at this point that the description files contain information up to report ID (RPTID) **940258.** The last record in LIQLCK is **940235.** This means that LIQLCK is missing some 23 accidents that occurred in 1994.

3.3 COMPARISON WITH ASME REPORTS

The second comparison was between LIQLCK and the report on "Liquid Pipeline Accident Review" by the American Society of Mechanical Engineers (ASME) B31.4/B31.11 Committee.

As was the case of comparing the LIQLCK database to the description files, a selected number of fields were used for this comparison. The format of this report is that the information which is reported in LIQLCK is deleted (struck out) and replaced by the corrected one (as determined by the Committee). The cause field was not compared because the Committee used a much more detailed break down of causes. Instead of using only seven cause categories which are defined in LIQLCK, ASME's review uses **20.** These categories are:

DP	DEFECTIVE PIPE	IO	INCORRECT OPERATION BY CARRIER PERSONNEL
DPS	Defective pipe Seam	V	Vandalism
RPDP	Rupture of Previously Damaged Pipe	LIGHT	Lightning
DGW	Defective Girth Weld	CW	Cold Weather
DRW	Defective Repair Weld	HRF	Heavy Rain or Flood
DFW	Defective Fabrication Weld	MISC	Miscellaneous
RLG	Ruptured or Leaking Gasket or O-ring	IC	Internal Corrosion
RLSPP	Ruptured or Leaking Seal or Pump Packing	EC	External Corrosion
TSBPC	Threads Stripped, Broken Nipple, or Coupling Failure	TP	Third Party Inflicted Damage
MCRE	Malfunction of Control or Relief Equipment	O	Others

The cause categories in LIQLCK are:

	LIQLCK
1	Corrosion
2	Failed Weld
3	Incorrect Operation by Carrier Personnel (Operation Error)
4	Failed Pipe
5	Outside Force Damage
6	Malfunction of Control or Relief Equipment
7	Other

The items that were compared are:

NMDIA - Nominal diameter
THK - Wall thickness
DSPRS - Design pressure (MAOP)
ACPRS - Accident Pressure
GRND - Pipe was above or below ground

The following is a list of discrepancies between data values from the LIQLCK database and the values reported in the ASME review. The values crossed out are those reported in LIQLCK. These records of LIQLCK had the wrong report ID according to the ASME review.

RPTID	NMDIA	THK	DSPRS	ACPRS	GRND
910020 ~~900020~~	10.783	0.373	910	720	1
910042 ~~910047~~	6	.28	1000	720	1
910086	6	0.28	1200 ~~1826~~	1020	1
910109	8	0.322	600	275 ~~300~~	1
910166	8	0.322	900 ~~694~~	600	2
920002	10 ~~8.625~~	.188 ~~0.219~~	792 ~~1550~~	700 ~~1441~~	1
920013	8 ~~0~~	.219 ~~0~~	1550 ~~0~~	1441 ~~0~~	1 ~~e~~
920030	16	0.5	1440 ~~140~~	1200	0
920050	~~80~~	.219 ~~0~~	1550 ~~e~~	1441 ~~e~~	1 ~~e~~
920121	12 ~~12.75~~	0.25	1270	950	1
920211	1 ~~0~~	0	0	0	~~0~~
920083 ~~910083~~	8.625	0.25	1870	1760	1
920227	6.625	0.156	1100	0 ~~1480~~	1
930016	12	0.375	275	~~0~~ ~~50~~	
930068	6	0.28	0 ~~1620~~	0 ~~450~~	
930078	8	0	550	375 ~~400~~	
930079	8	0.188	870	200 ~~450~~	
930081	26	0.281	709	550 ~~500~~	
930101	12	0.25	0	0	

RPTID	NMDIA	THK	DSPRS	ACPRS	GRND
			~~1385~~	~~1050~~	
930102	4	0.237	75 ~~80~~	10	
930114	6	0.375	1440 ~~1450~~	476	
930186	4.5	0.156	1050	0 ~~1000~~	
930212	12	0.25	522	100 ~~430~~	
940005	10	0.365	900	790 ~~696~~	
940006	12.75	0.219	1286	45	

As mentioned earlier, the above table is an incomplete attempt to identify errors in the LIQLCK database. Only a rather limited portion of the hard copy ASME's reports was used and a manual comparison process was utilized to generate the above table. A more comprehensive way to perform this comparison is to establish a computerized database of these reports and use a database application program such as ACCESS to find the differences between these databases. **ASME** has a computerized database of its analysis but this was not available to NJIT at the time of this report.

3.4 COMPARISON WITH NTSB REPORTS

There are very few NTSB reports on hazardous liquid accidents. Thus, only a limited comparison can be made between LIQLCK and the information found in NTSB reports. The following reports have been reviewed by NJIT:

REPORT	COMPANY	LOCATION	DATA
NTSB-PAR-81-3	Williams Pipeline Co.	Roseville, MN	4/14/81
NTSB-PAR-86/01	Continental Pipeline Co.	Kaycee, WY	7/23/85
NTSB-PAR-80-1	Texas Pipeline Co.	Brewick, LA	1/2/80

No significant differences that merit questioning the LIQLCK database have been found in these reports.

4.0 DATA ANALYSIS

4.1 INTRODUCTION

In this chapter the hazardous liquid databases (LIQUID and LIQLCK) are analyzed to determine the integrity and the internal accuracy of the reported information. The first phase of the analysis was to check whether the databases contain duplicate records. The second phase was to review the consistency between the various fields (of a single record) on which the cause of the accident is reported. The last phase of the analysis was to examine the relationship between various fields that must exhibit a logical consistency. In this phase one can assume, for example, that the wall thickness of the pipeline must be smaller than its diameter. If this rule is vio-

lated in a specific record, it means that there exists an error in the data. Finally, the chapter concludes with some remarks on data correction.

4.2 DUPLICATION OF RECORDS

Databases LIQUID and LIQLCK were checked for the presence of duplicate records by utilizing a built-in feature of the ACCESS database program. Database LIQLCK did not appear to have any duplicate records. On the other hand, database LIQUID (as obtained from **OPS**) has over 3000 of them. It seems as if all the records from 1968 up to report number 120 in 1977 have been duplicated. It appears to us that the duplication is a result of a "cut" and double "paste" action performed by a computer operator. One should examine what has actually happened to this database. (Following these findings, **OPS** reported that this duplication does not exist in this database.) For the purpose of the analysis carried out by this study, the duplications have been removed. A complete list of duplicate records with the five first fields of data is enclosed in Appendix **B-1** of this report.

Another form of duplication that was found in LIQUID were records with the same report ID (RPTID) but with different data in the various fields. The first five fields of these records are presented in the following table:

RPTID	YR	LOG	OPID	NAME
800007	80	7	15490	PHILLIPS PIPELINE CO
800007	80	7	3370	DIAMOND SHAMROCK CORPORATION
810075	81	75	809	ARCO PIPELINE CO
810075	81	75	4906	EXXON PIPELINE CO
810126	81	126	2330	CHEVRON PIPELINE CO
810126	81	126	395	AMOCO OIL CO
810128	81	128	443	AMOCO PIPELINE CO
810128	81	128	12452	MID-AMERICA PIPELINE CO (MAPCO)
810129	81	129	443	AMOCO PIPELINE CO
810129	81	129	6855	GULF CENTRAL PIPELINE CO

For the analysis performed under this study these records were unchanged. The assumption that was made was that the data is correct and that the only error is in the report ID. This decision is not unreasonable since these are only 10 records out of a total of 4739 records that exist in LIQUID.

4.3 ANALYSIS OF CAUSE AS REPORTED IN DATABASE LIQLCK

The reporting form for hazardous liquid accidents (DOT Form 7000-1 (4-85)) has three different parts where the cause of an accident can be specified. In part D of the form the categories of cause are:

CAUSE	DESCRIPTION
1	CORROSION
2	FAILED WELD
3	INCORRECT OPERATION BY OPERATOR PERSONNEL

0	FAILED PIPE
5	OUTSIDE FORCE DAMAGE
6	MALFUNCTIONING OF CONTROL OR RELIEF EQUIPMENT
	OTHER

If the operator selects "Other" as the cause, he or she is asked to specify the actual cause (based on his/her judgment) of the accident in a data field called "CAUSO". "CAUSO" is a text field in which an explanation or a description can be written. In some cases operators use this field to explain or clarify the cause of the accident although the cause was not categorized as "other" (7). For example, if the accident was caused by outside force, the operator may add a comment such as "backhoe dug into line". Reviewing this field can shed some light on the specific cause of the accident and on the accuracy of the categorization of the cause. Inaccurate information can be deduced if, for example, the cause was reported as 4 (failed pipe) but the description was "corrosion". In the above example, the investigation of the accident could have revealed that the pipe failed but the more probable reason (or the real cause) was failure due to corrosion.

The following tables present the analysis of the cause information as reported in database LIQLCK. The tables also include a suggested correct definition for the cause (i.e. NEW def). A new category, eight (8), was added (but not used in our analysis) in order to indicate that there is a need for a separate category for accidents caused by failure of the pipeline system components such as O-ring, seals, valves and nipples.

The first table summarizes the content of the CAUSO field which contained information although the cause was not categorized as "other" (cause code 7). In the database there were 121 descriptions for causes in which the cause was categorized as other than 7. Records in which the descriptions and the categorization of the cause were consistent (i.e., cause code is 5 (damage by outside forces) and the description is: "Backhoe dug into line"), are not listed in the following table. The reason for not listing consistent records is because the objective of this analysis is to find inconsistencies and errors.

INFORMATION IN "OTHER" BUT 0<CAUSE<7

RPTID	CAUSE	CAUSO	NEW def
860191	1	CAUSED BY SHORTED CASING	8
870025	1	CLOSED VALVE GATE LEAKAGE	8
920082	4	CORROSION	1
860037	3	CRAKED PUMP CASE	8
920207	6	FAILED GASKET	8
890149	5	FAILED PIPE NIPPLE	8
920043	6	FAILED STAINLESS STEEL TU	8
930058	5	FAILED WELD	2
930221	1	FAILURE OF FILTER HOUSING	6
930179	6	FAILURE OF TANK ROOF	8
930056	6	FAILURE OF TANK ROOF DRAI	8
920007	5	FAILURE OF WELDED FITTING	2
900113	6	GASKET FAILED AT BOLT	8
930211	6	GASKET FAILURE	8
930010	5	IMPROPER INSTALLATION BY	3

RPTID	CAUSE	CAUSO	NEW def
890113	5	INCORRECT OPERATION	3
940196	2	INCORRECT OPERATION	3
890114	5	INCORRECT OPERATIONS	3
920006	6	LEAKING GASKET	8
940159	3	MALFUCTION OF RELIEF EQUP	6
920227	5	MALFUNCTION OF CONTROL OR	6
940033	5	MECH BREAKDOWN COUPLER	6
910003	6	O-RING FAILURE	8
920139	1	OUTSIDE FORCE DAMAGE	5
910009	6	PACKING GLAND BOLTS BROKE	8
930030	6	PIN HOLE IN WELD	2
890104	5	PIPE FAILED FROM EXT.GOUG	4
930042	5	PIPE FAILED/PIN HOLE INVE	4
910089	2	SEAM SPLIT ACCEL BY CORR	1

As one can see from the above table, some of the reports have ambiguous data. For example, the last item of the table has cause code "damage by outside forces", but the description says failed pipe due to a pin hole. A pin hole could develop from corrosion or it could be there because the pipe was defective. It is not necessarily correct that a pin hole will develop from outside forces. However, unless there is more information available on what exactly was found at the site of the accident, a definite change of cause in the database would be premature. This is the reason why **NJIT** chose to indicate potential data problems and not make the corrections.

The next table lists the content of the field "CAUSO" when it was filled out appropriately (e.g., cause code was *7)*. Since many of these descriptions point towards a cause that could be categorized with an existing code for cause (i.e., a description of "operating error" can be categorized as cause code 3), a suggested change of the cause code is provided.

INFORMATION IN "OTHER" AND CAUSE=7

RPTID	CAUSE	CAUSO	NEW def
920142	7	FATIGUE CRACK NEAR WELD	4
870076	7	"D" RING SEAL FAILED	8
860119	7	"O" RING IN SCRAPER TRAP	8
900119	7	0-RING FAILED	8
880009	7	0-RING SEAL FAILURE	8
940128	7	1 INCH DEFECT ON L. WELD	2
880186	7	1" LINE ON PUMP BROKE	8
850162	7	1" VALVE UNSCREWED	3
930127	7	1/2 INCH COOLING LINE	6
890058	7	1/2" LONG HAIRLINE CRACK	4
910104	7	1/2" PIPE NIPPLE CRACKED	8
930146	7	1/2"LINE ON A GRAVITOMETE	7
930036	7	1/4" DEEP FLAT SPOT IN PI	7
930024	7	1/4" HOLE BURNED TANK FLO	7
860048	7	10" TANK VALVE FAILURE	6
920216	7	16" CHECK VALVE O-RING LE	8
850169	7	2" PLUG NOT INSTALLED	3
890134	7	2" THREADED CONN. LOOSEN	3
920164	7	3/4 INCH DRAIN LINE VALVE	6
870143	7	3/4" PIPE NIPPLE, ON MAIN	8
870254	7	4" GASKET FAILED BETWEEN	8
930210	7	5/8" S S TUBING BROKE AT	6
930014	7	8" PIPE COLLAR COUPLING	8
920218	7	A BELL & PICKET JOINT PUL	8
920019	7	APPARENT CRACK IN VALVE M	6
920054	7	APPARENTLY A COW BUMPED A	5
920023	7	BACK PRESSURE VALVE FAILU	6
860194	7	BACKHOE DUG INTO LINE	5
910097	7	BALL CHECK ASSEMPLY LEAK	8
940127	7	BLK VALVE GASKET SWEATLEA	8
910234	7	BONNET GASKET LEAK	8
890135	7	BOOSTER PUMP MOTOR FAILED	6
860169	7	BOOSTER PUMP SEAL FAILURE	6
880027	7	BREAK IN STEEL PIPE	4
860135	7	BROKEN 3/4" NIPPLE IN THR	8
880111	7	BROKEN GLAND BOLT	8
910137	7	BROKEN ROOF DRAIN	6
900105	7	BROKING INSTRU. TUBING	8
870225	7	BULL PLUG WAS REMOVED.	3
870030	7	BULLDOZER OPERATED BY OTH	5
880087	7	BULLET HOLE IN PIPE.	5
870117	7	CHECK VALVE	6
930207	7	CHECK VALVE SEAL FAILURE	6
930190	7	CHECK VALVE SEAL FAILURE	6
880116	7	CHECK VALVES FAILED	6
910204	7	CHK VALVE SHAFT GLND FAIL	6
900026	7	CLAPPER SHAFT SEAL FAIL	8
900005	7	COLD WEATHER	5
930182	7	COLLAR COUPLING BROKE OUT	6
870066	7	COLLAR FAILURE, THREADS	6
930019	7	COLLAR SEEP	6
890007	7	COLLAR SEPARATED	6
880195	7	CONT. HIT FR. END TEETH	5
870135	7	CONTRACTOR INSTALLING CAB	3
860155	7	CONTRCOR FAIL TO TIGHTRN	3
910037	7	CORROSION PIT	1
930196	7	CRACK CAUSED BY CORROSION	1
930081	7	CRACK DEVELOPED IN BOTTOM	4
940110	7	CRACK IN 6 INCH CHECK VAL	6
910023	7	CRACK IN BODY OF VALVE	6
870118	7	CRACK IN CHECK VALVE	6
870237	7	CRACK IN FIBERGLASS TANK	6
920060	7	CRACK IN NIPPLE	8
930011	7	CRACK IN TANK FLOOR	6
930159	7	CRACK IN THE FLOOR TO	6
890153	7	CRACK IN THE SUMP	6
860176	7	CRACK IN THREADED SECTION	6
880088	7	CRACK IN VALVE BODY	6
880181	7	DAMAGE TO PIPE	5
870167	7	DEFECT IN SEAM	4
900110	7	DIAMETER TUBING FAILED	8
930171	7	DIAPHRAGM ON LEVEL GAUGE	6
900166	7	DRAIN VALVE LEAK	6
930068	7	DRIP LEAK ON SUBSEA MANIF	6
910019	7	DRIVER SHAFT TORQUE TWIST	3
920213	7	EQMT FAIL & INT CORR	1
850153	7	EQUIP RUPT LINE	5
870229	7	EQUIP.MALFUNCTIONED	6

RPTID	CAUSE	CAUSO	NEW def
870101	7	EQUIPMENT FAILURE	6
860077	7	EQUIPMENT MALFUNCTION	6
880026	7	EQUIPMENT RUPTURING LINE	5
880164	7	ERROR BY CONTRACTOR PERS.	3
880020	7	EXTENDED LOW TEMP. NEAR 0	5
880209	7	FAIL PIPLN CLAMP	8
870095	7	FAILED "ASBESTOS-TYPE" GA	8
890046	7	FAILED CAST IRON VALVE	6
920223	7	FAILED CHECK VALVE SEAL	6
920202	7	FAILED CHECK VALVE SHAFT	6
920136	7	FAILED CHECK VALVE STEM S	6
940116	7	FAILED DENSITOMETER PUMP	6
900088	7	FAILED DOCK HOSE	6
920189	7	FAILED DRAIN HOSE	6
920056	7	FAILED FLANGE GASKET	6
880019	7	FAILED FORGED FITTING	8
920173	7	FAILED GASKET	8
910095	7	FAILED GASKET IN FLANGES	8
[illegible]	7	IN TRAP	8
910212	7	FAILED INSUL. FLANGE GASK	8
920196	7	FAILED O-RING IN CHECK VA	8
940039	7	FAILED O-RING IN GRAVITOM	8
920190	7	FAILED O-RING IN SCRAPER	8
900132	7	FAILED PACKING ON VALVE	8
910154	7	FAILED PIN IN VALVE SHAFT	8
890038	7	FAILED PLUG	6
860187	7	FAILED PUMP	6
940114	7	FAILED ROOF DRAIN VALVE	6
890060	7	FAILED TANK MIXER SHAFT	6
920184	7	FAILED THREADED COUPLING	6
890053	7	FAILUE OF GARLOCK GASKET	8
910116	7	FAILURE AT SIGLE CORR PIT	6
920105	7	FAILURE IN BOTTOM PLATE O	6
940158	7	FAILURE IN FITTING	3
910113	7	FAILURE IN TANK BOTTOM	6
870086	7	FAILURE OF 1.5" FORGED ST	6
930104	7	FAILURE OF 2" 90 ELL	6
870247	7	FAILURE OF A 20" GASKET A	8
930041	7	FAILURE OF A TANK ROOF DR	6
930075	7	FAILURE OF BOLTED INSULAT	6
920188	7	FAILURE OF FLANGE GASKET	8
870136	7	FAILURE OF FLEXITALLIC	6
920228	7	FAILURE OF FOUR LINER CAP	6
930001	7	FAILURE OF LINER CAP BOLT	6
870214	7	FAILURE OF METER	3
850144	7	FAILURE OF NIPPLE AT THRE	8
860075	7	FAILURE OF PACKING GLAND	8
930116	7	FAILURE OF PRESSURE HOSE	6
920047	7	FAILURE OF PUMP MOTOR THR	6
880147	7	FAILURE OF TANK ROOF	6
930070	7	FAILURE OF TANK ROOF DRAI	6
930202	7	FAILURE OF TEMPORARY CONN	3
850160	7	FAILURE OF VICTAULIC	6
860171	7	FAILURE/THREADED NIPPLE	8
860060	7	FARMER HIT WITH PLOW	5
910076	7	FATIGUE CRACK IN TANK FL	6
890034	7	FATIGUE FAILURE	4

RPTID	CAUSE	CAUSO	NEW def
910026	7	FAULTY "O" RING SEAL	8
910139	7	FAULTY CAST ON CHECK VALV	6
880070	7	FIBER GASKET FAILURE	8
910162	7	FIRE CAUSED BY LIGHTNING	5
940211	7	FIRE CAUSED FROM AUTO	5
930040	7	FIVE CRACKS IN THE FLOOR	6
920214	7	FLANGE BOLTS MAY BE LOOSE	3
860057	7	FLANGE GASKET FAILED	8
900001	7	FLANGE GASKET FAILURE	8
860073	7	FLANGE GASKET ON 8" VALVE	6
900036	7	FLOATING ROOF DRAIN FAIL	6
880049	7	FLOW SWITCH FAILED	6
870272	7	FOUR-FOUR CONSTRUCTION CO	5
870173	7	FRACTURE OF .5 X 2" NIPPL	8
940060	7	FREEZING TEMP CAUSED	5
920211	7	FROZEN 1-INCH PRESSURE RE	5
870141	7	GASKET FAILED	8
900049	7	GASKET FAILED	8
900106	7	GASKET FAILED	8
870044	7	GASKET FAILURE	8
870069	7	GASKET FAILURE	8
870246	7	GASKET FAILURE	8
880011	7	GASKET FAILURE	8
900109	7	GASKETFAILURE	8
910049	7	GASKETFAILURE	8
910053	7	GASKET FAILURE	8
930077	7	GASKET FAILURE	8
940082	7	GASKET FAILURE	8
870055	7	GASKET FAILURE IN SWIVEL	8
920103	7	GASKET FAILURE-UNKNOWN RE	8
860013	7	GASKET FITTING	8
930192	7	GASKET LEAK	8
870083	7	GASKET MISALIGNMENT	8
920125	7	GASKET ON DISCHARGE SIDE	8
890108	7	GASKET ON LEAK FAILED.	8
900143	7	GAUGE LINE CRACK	8
940099	7	GUN SHOT	5
920166	7	HASKET FAILURE	6
910220	7	HEAVY RAINS	5
920094	7	HEAVY RAINS(12"-14") CAUS	5
880102	7	HIGH LEVEL SHUT DOWN SWIT	3
870273	7	HIGH PRESSURE NIPPLE BROK	8
870267	7	HIT BY ROAD GRADER	5
870216	7	HIT PIPELINE	5
920199	7	HOSE SEPARATED FROM ITS C	6
940190	7	HOSE TO PIPELINE FAILED	6
870257	7	HUMAN ERROR, EMPLOYEE CLO	3
880190	7	HYDROGEN STRESS	3
920046	7	ICE FREEZING IN WATER DRA	5
900053	7	ILLEGAL TAP	5
880051	7	IMPRO.TIGHTING OF VALVE	3
940175	7	IMPROPER DRAIN PIPING	3
920030	7	IMPROPERLY TORQUED FLANGE	3
930017	7	INBOARD PUMP SEAL FAILED	3
870140	7	INCORRECT MAINTENANCE PRO	3
940049	7	INCORRECT OPERATION BY	3
900172	7	INCORRECT PROCEDURE	3

RPTID	CAUSE	CAUSO	NEW def
940067	7	INJECTION PUMP SEAL FAIL	8
920008	7	INSUFFICIENT SEALING OF V	3
870032	7	INSUFFICIENT SURFACE AREA	3
920048	7	INSUFFICIENTLY TIGHTENED	3
880207	7	INSUL. FLANGE GASK. FAIL	8
920009	7	INSULATING GASKET FAILED	8
900083	7	INT. CORROSION (UNKNOWN)	1
860031	7	(IT APPEARS PIPE WAS DAMGD	5
900155	7	LAND OWNER HIT LINE	5
910138	7	LEAK FLANGE,CORR. ELBOW	1
940173	7	LEAKING 1" NEEDLE VALVE	6
930126	7	LEAKING DRAIN VALVE	6
940231	7	LEAKING SEAL SURGE PUMP	8
900063	7	LEV. MONITOR. SYS. FAILED	6
860111	7	LIGHTNING	5
880158	7	LIGHTNING	5
940229	7	LIGHTNING	5
930067	7	LIGHTNING STRIKE	5
940195	7	LIGHTNING STRIKE	5
910164	7	LIGHTNING STRUCK TANK	5
850171	7	LINE DAMAGED BY 3RD PARTY	5
870230	7	LINE DAMAGED BY 3RD PARTY	5
870008	7	LINE WAS SHOT BY A RIFLE	5
880021	7	LIQUID RELEASED FROM VENT	3
940070	7	LOADING VALVE REMAINED	3
910208	7	LOOSE CONN. TO HEAT EXCH	3
900076	7	LOOSE FLANGE BOLT	3
930112	7	LOOSE GREASE FITTING CAP	3
940094	7	LOOSE SEGMENT BOLT	3
860173	7	LOST PACKING/CHECK VALVE	8
890059	7	MAINTANER HIT 2" VALVE	3
920137	7	MALFUNCTION OF HIGH LEVEL	6
860041	7	MALFUNCTION OF SWIVEL	6
890106	7	MALFUNCTION OF VALVE	6
920106	7	MALFUNCTION OF VALVE OPER	6
940150	7	MALFUNCTION PUMP SLEEVE	6
910025	7	MANIFOLD VALVE MALFUNC.	6
880022	7	MANUFACTURING DEFECT PIPE	6
930183	7	MECHANICAL DAMAGE	5
870159	7	MECHANICAL FAILURE	6
930073	7	MECHANICAL FAILURE	6
930129	7	MECHANICAL FAILURE OF BOL	6
930034	7	MECHANICAL FAILURE OF RUP	6
940167	7	MECHANICAL FAILURE VALVE	6
870249	7	MECHANICAL SEAL FAILURE	6
910028	7	MECHANICAL SEAL FAILURE	6
880010	7	MECHANICAL SEAL FAILURE.	6
910132	7	METAL FATIGUE (VIBRATION)	4
910229	7	METAL FATIGUE OF NIPPLE	8
940139	7	MISCALCULATED VOLUMES	3
870271	7	MOTOR GRADER	5
880094	7	MOTOR GRADER	5
940197	7	NATURAL CAUSE RAINFALL	5
890122	7	NATURAL WEAR AND TEAR	3
930031	7	NIPPLE FAILED	8
940164	7	NIPPLE ON VOL.BOT. BROKE	8
940201	7	NIPPLE VOL BOTTLE BROKE	8

RPTID	CAUSE	CAUSO	NEW def
910001	7	NUT ON PUMP BACKED OFF	8
870105	7	O RING FAILURE	8
940199	7	O RING FAILURE METER CASE	8
910052	7	O RING FAILURE/DOOR CLOSE	8
940129	7	O-RING FAILURE	8
920085	7	O-RING GASKET FAILED ON S	8
910024	7	O-RING ON CHECK VALVE LID	8
940112	7	O-RING SEAL FAILURE	8
940210	7	O-RING SPLIT	8
880001	7	O-RING STOPPLE FITTING	8
920171	7	O-RING/BONNET SEAL FAILUR	8
900061	7	OIL BACKED UP FROM PUMP	3
920062	7	OLD BOLTED CLAMP BEGAN LE	6
870171	7	OPENNED VALVE	3
930227	7	OPERATIONAL ERROR	3
910039	7	OPERATOR ERROR	3
940091	7	OUTBOARD PUMP SEAL FAILUR	8
930003	7	OVERFILLED TANK	3
910190	7	OVERPRESSURE OF STEAM TRP	3
940098	7	OVERPRESSURED PIPE	3
890028	7	PACK. NUT ON PUMP CAME OF	8
920237	7	PACKING FAILED	8
880065	7	PACKING GLAND BLOT BROKE	8
940068	7	PACKING GLAND BOLTS BROKE	8
920198	7	PACKING GLAND FAILED.	8
930029	7	PACKING GLAND FAILURE ON	8
940134	7	PACKING GLAND FAILURE ON	8
910182	7	PACKING GLAND LEAK ON PMP	8
870274	7	PACKING NUT BACKED OFF ON	8
860121	7	PACKING ON PD PUMP FAILED	8
860061	7	PINHOLE LEAK IN A WELD	2
900084	7	PINHOLE LEAK IN SEAM.	8
940168	7	PINHOLE LEAK IN WELD	2
940170	7	PINHOLE LEAK IN WELD	2
870155	7	PIPE BROKEN BY FLOOD	5
900138	7	PIPE FAILED AT PREV DENT	4
870023	7	PIPE IN DRESSER COUPLING	8
920215	7	PIPE RESTING ON ROCK/CRAC	3
870007	7	PIPE SEAM FAILURE	8
940177	7	PRESSURE FROM PIPELINE	3
910074	7	PRESSURE SENSING LINE	3
900091	7	PROBE FAILURE	6
930094	7	PROVER LOOP VENT VALVE NO	6
900094	7	PUMP CASE BROKE	6
900144	7	PUMP CASE CRACKED	6
890042	7	PUMP CASE SPLIT	6
880193	7	PUMP COOLING LINE SEP.	6
870116	7	PUMP PACKING & PLUNGER FA	6
920036	7	PUMP PACKINGS	6
940165	7	PUMP ROD BROKE	6
940200	7	PUMP ROD BROKE	6
860005	7	PUMP SEAL	8
870003	7	PUMP SEAL FAILED	8
900016	7	PUMP SEAL FAILED	8
860192	7	PUMP SEAL FAILURE	8
940002	7	PUMP SEAL FAILURE	8
940015	7	PUMP SEAL FAILURE	8

RPTID	CAUSE	CAUSO	NEW def
860152	7	PUMP SEAL LEAK	8
870097	7	PUMP VIBRATION	8
940161	7	PUMP/MOTOR MALFUNCTION	6
880068	7	RELIEF LINE REMOVED	3
890083	7	ROAD GRADER	5
860096	7	ROD PULLED OUT PACKING	6
940065	7	ROOF DRAIN FAILURE	6
870042	7	ROOF DRAIN HOSE BROKE APA	6
920080	7	ROOF DRAIN LINE RUPTURE	6
860085	7	ROOF LEG PUNCTURED TANK	3
940230	7	ROOF TANK TO DEFLECT	6
880089	7	ROTATE ELEM.OF PUMP SEIZE	6
920195	7	RUPTURED GASKET ON SURGE	8
920133	7	SCRAPER TRAP DOOR FAILURE	6
880126	7	SCRATCH DEVELOPED CRACK	4
880041	7	SEAL FAILURE	8
880048	7	SEAL FAILURE	8
890145	7	SEAL FAILURE	8
900120	7	SEAL FAILURE	8
940203	7	SEAL FAILURE	8
910203	7	SLOP TANK OVERFLOW	3
890064	7	SMALL CRACK IN DENT	4
870162	7	SMALL PINHOLE IN PLIDCO	6
910057	7	SPLIT IN HEAT AFFECT ZONE	3
880036	7	(SPRING IN PUMP BROKE	8
930099	7	STOPPLE SEALING ELEMENT F	6
880082	7	STRAINER NIPPLE FAILED	8
920147	7	STREE CRACKING AT UNKNOWN	4
920111	7	STRESS CRACK	4
930200	7	STRESS CRACK IN THE COLUM	4
870064	7	STRUCK BY LIGHTENING	5
880047	7	SUDDEN UNEXPEC. PRESSURE	3
920131	7	SUMP OVERFLOWED	3
870102	7	SUN PRESSURE	5
880097	7	TANDEM PUMP SEAL	6
930018	7	TANK BOTTOM FAILURE	6
930113	7	TANK BOTTOM FAILURE	6
880205	7	TANK BOTTOMS SEAL LEAK.	6
940232	7	TANK C-9 CRACK IN WELD	2
910202	7	TANK DRAIN VALV FAILURE	6
870154	7	TANK EQUIP MALFUNCTIONED	6
860197	7	TANK MIXER VIBRATION	6
930047	7	TANK OVER RUN CAUSED BY	3
900007	7	TANK OVERFLOW	3
890029	7	TANK ROOF DRAIN HOSE FAIL	6
930046	7	TANK ROOF DRAIN LINE HOSE	6
870239	7	TANK TGGAUGING EQUIPMENT	6

RPTID	CAUSE	CAUSO	NEW def
880187	7	TANK VALVE CRACKED	6
900018	7	TEMP. RESTRAINT FAILED	6
920204	7	TEMPORARY PLUGGING DEVICE	6
870111	7	THE COATING HAD APPARENTL	1
940072	7	THIRD PARTY DAMAGE	5
940089	7	THIRD PARTY DAMAGE	5
920130	7	THREAD LEAK (DRIP)	6
890095	7	THREADS ED ON 2" NIPI	8
	7	TOP/THERMAL VALVE UNSCREW	3
870204	7	TRANSFER HOSE RUI	6
880057	7	TUBE STRING FAILURE.	6
930145	7	TUBE TURN CLOSURE 'O-RING	8
940154	7	TUBING WORN THIN RUPTURED	6
920135	7	UNAUTHORIZEDTAMPERINGNA	5
930218	7	INEL OPEN VALVE	3
920067	7	UNIT CHECK VALVE SHAFT SE	6
920127	7	UNKNOWN-VACUUM TRUCK HOSE	6
	7	UNKNOWN;CRACK AT BOTTOM	4
1910020	7	VALVE BODY CRACKED	6
900030	7	VALVE FAILED	6
900078	7	VALVE FAILED/METAL FATIGU	6
920229	7	JRE	6
900033	7	VALVE LANGE FAILURE	6
880152	7	VALVE KNOCKED OFF BY CREW	3
890052	7	VALVE LEAK	6
860144	7	VALVE MALFUNCTION	6
910134	7	VALVE OPEN RELEASE OIL	6
910055	7	VALVE PACKING BLEW OUT	6
890031	7	VALVE SEAL FAILURE.	6
940038	7	VALVE SEAL LEAKED	6
920026	7	VALVE STEM SEAL LEAK	6
880192	7	VANDALISM	5
900069	7	VANDALISM	5
930026	7	VANDALISM	5
930108	7	VENTED PLUG ON VALVE STEM	6
880053	7	VIBRA.ON PUMP BROKE LINE	6
880075	7	VIBRATION/WEAR	3
930083	7	VISIBLE THIRD PARTY DAMAG	5
870071	7	WATER DRAIN LINE FAILED	6
880050	7	WATER FROZE & CR. HOUSE	3
900017	7	WATER IN VALVE FROZEN	3
940028	7	WATER LINE FROZE	5
890157	7	WATER SEAL IN WELL LOST	3
930005	7	WEATHER CONDITIONS- FROZ	5
880109	7	WEEPER IN LONG. SEAM	4
860099	7	WELD FAILURE	2
860067	7	WELDERS WORKING	3