CARNEGIE MELLON UNIVERSITY

CARNEGIE INSTITUTE OF TECHNOLOGY

THESIS

SUBMITTED IN PARTIAL FULFILLMENT OF THE
REQUIREMENTS FOR THE DEGREE OF DOCTOR OF
PHILOSOPHY

TITLE: The Risk Of Accidents And Spills At Offshore Production Platforms: A Statistical Analysis Of Risk Factors And The Development Of Predictive Models

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ABSTRACT

This dissertation develops two models: expert and logistic regression. The models are used to predict the likelihood of accidents and spills at offshore production platforms and rank the platforms in terms of risk. Two sources of information are used to construct the models 1) databases maintained by the Minerals Management Service, 2) a survey of platform inspectors that was conducted in June 1998. This study covers ten years of data (1986-1995).

Every platform that had an accident during the ten-year period also had a spill at some point during that same period. However, not every platform that had a spill also had an accident. Also, major complexes are over 12 times as likely as non-major complexes to experience either an accident or a spill over the ten-year period.

The logistic regression models routinely predict 50% of the accidents or spills that will occur in the top 15% of ranked platforms. In addition, platform complexity is the most important risk factor, inspection history is second, accident history is third and age of the platform, or experience of the operating company is fourth (out of four ranked risk factors). The models show that the relative merit of risk factors varies somewhat over time. However, there is no trend in model accuracy over time.

The expert models also routinely predict 50% of the accidents or spills in the top 15% of ranked platforms. The experts consider platform complexity as the most important risk factor, age of the platform or experience of the operating company is second, inspection history is third, and accident history is fourth (out of four ranked risk factors).

Both models (expert and logistic) are consistently good at ranking platforms, but the logistic regression model is significantly better (95% confidence level) than the expert model at predicting accidents. The logistic model is not significantly better than the expert model at predicting spills. Overall, a ranking based on an expert model risk index is much easier to calculate, and is only slightly less accurate than a ranking based on the logistic model.

ACKNOWLEDGMENTS

The Offshore Operations and Safety Management Office, Minerals Management Service, U.S. Department of Interior is supporting this research. I would like to thankfully acknowledge the encouragement and assistance provided by Doug Slitor and Greg Gould of the Inspection and Enforcement Branch of the Minerals Management Service, Herndon, VA. I would also like to thank Mitch Small, Mike DeKay, and Jim Garrett for serving on my Ph.D. committee. You have all offered valuable advice that has influenced my research.

I would like to especially thank my boss, Bill Ayers, at the Federal Energy Technology Center, Morgantown, WV. I could never have completed this work without your support. I would like to thank Patty Angus for encouraging me, and urging me to "keep going 'til you're finished." Your advice and support are much appreciated. In addition, I would like to thank Vicki, Patti, and Denise in the Department of Engineering and Public Policy for helping keep me on track toward graduation. I would also like to acknowledge the assistance, guidance, and encouragement of Professor Paul Fischbeck, Department of Social and Decision Sciences, and Engineering and Public Policy, Carnegie Mellon University. Without your advice, and suggestions, I would not have been able to complete this work. Thank you.

Thank you all.

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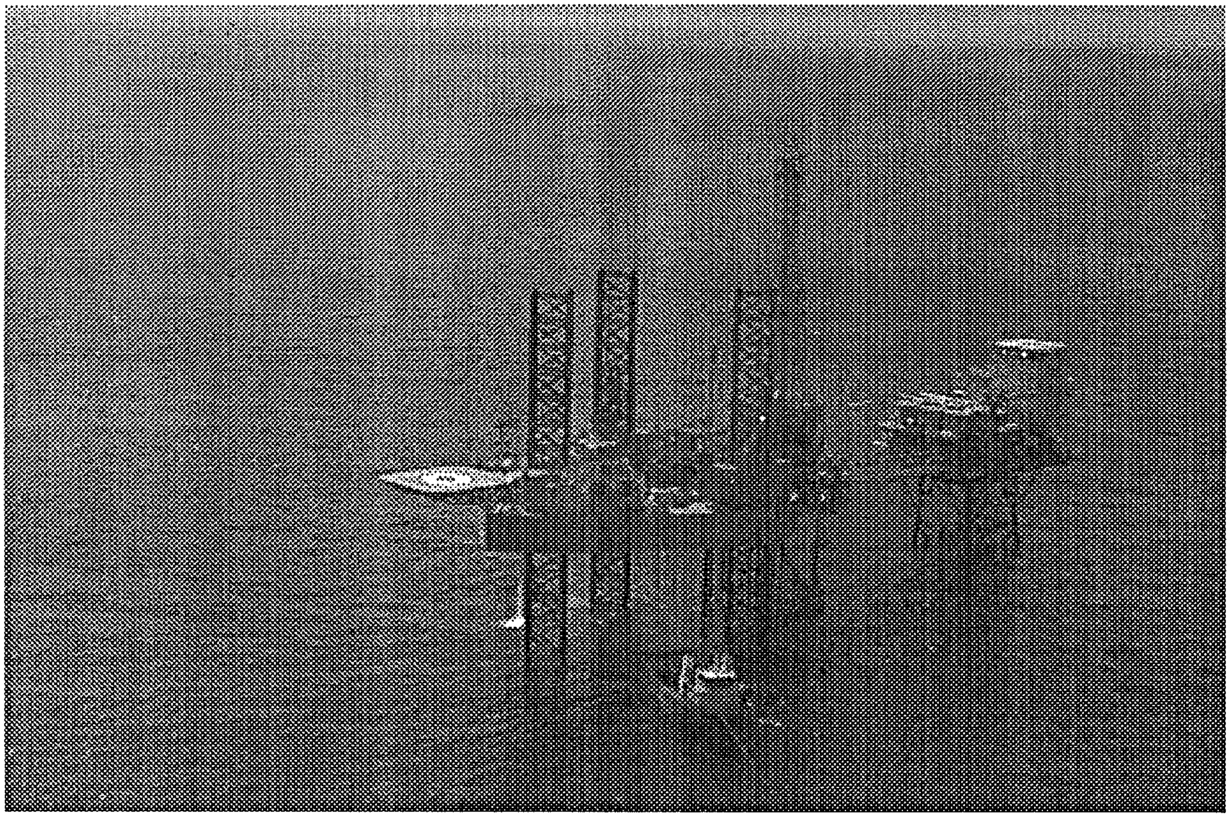

Figure 1-1 Lake Charles District – Platform on right has hydrocarbon separation, storage and crew quarters. It is connected by a walkway to a well platform on the left that has a workover unit (jack-up) in place drilling a new well. A supply boat is located in the bottom of the picture.

1.1 Introduction

Offshore platforms are often very large, expensive, and complicated structures. Dozens of workers live for weeks at a time up to 100 or more miles from shore. If an accident occurs it can be very difficult to evacuate people who are injured. If a spill occurs, it might take many hours for boats with repair equipment, or oil slick booms, to reach the platform. The difficulty in reaching the facility, the lack of easy egress, the potential cost to the owner, the danger to the environment, and the danger to health and safety of the workers make it important to minimize the likelihood of an accident or spill.

The primary government agency charged with maintaining safe operations on offshore platforms is the Minerals Management Service (MMS).[1] Though the MMS had acquired a large amount of information regarding the inspection and operational history of production platforms, no large-scale comprehensive analysis of the data had been completed. This study uses the MMS databases and extensive interviews of MMS platform inspectors to establish models that 1) determine the underlying factors associated with accidents and spills and 2) rank order platforms by accident or spill likelihood. The purpose of these models is 1) to inform operators so that they can improve their practices and 2) to enable inspectors to efficiently allocate limited resources. It is hoped that the model results, and platform ranking, will lead to safer platform operations. The following quote from the 28th Annual Offshore Technology Conference, May 1996, succinctly states the value of a predictive model:

> *"If technology is not used wisely, scarce resources and attention can be diverted from the true factors that determine the safety of an offshore platform, and less safe systems develop. The purpose of a risk management system should be to assist the front line operators to take the right (sensible) risks and to achieve acceptable safety."*[2]

1.2 Definition of accidents and spills

In this dissertation, the terms "accident" and "spill" are defined as binary events. Whether an accident or spill has occurred is determined strictly by entries in the MMS databases. For consistency, only one accident or spill is recorded for a platform for any 24-hour period. Multiple related events are coded as a single event. Note that accidents and spills can and do occur independently from each other.

Specifically, the following definitions are used throughout the dissertation:

- Accident – an event involving an injury, fire (not self-extinguishing), explosion, damage due to unspecified causes, vessel mishap, or unknown incident

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[1] The MMS is part of the US Department of the Interior. A more detailed description of the agency is given in Chapter 5.

[2] Bea, R.G. "*Quantitative and Qualitative Risk Analyses - The Safety of Offshore Platforms.*" Conference paper presented at the 28th Annual Offshore Technology Conference in Houston, Texas, 1996.

- Spill – an event involving the release of petroleum products (this includes fuel oil used for platform operations)

This analysis covers a ten-year period from 1986 to 1995. Using the above assumptions, the number of accidents and spills are as shown in Figure 1-2. The numbers of accidents and spills have averaged about 100 per year or approximately 2-3% of the platforms either has an accident or spill each year.

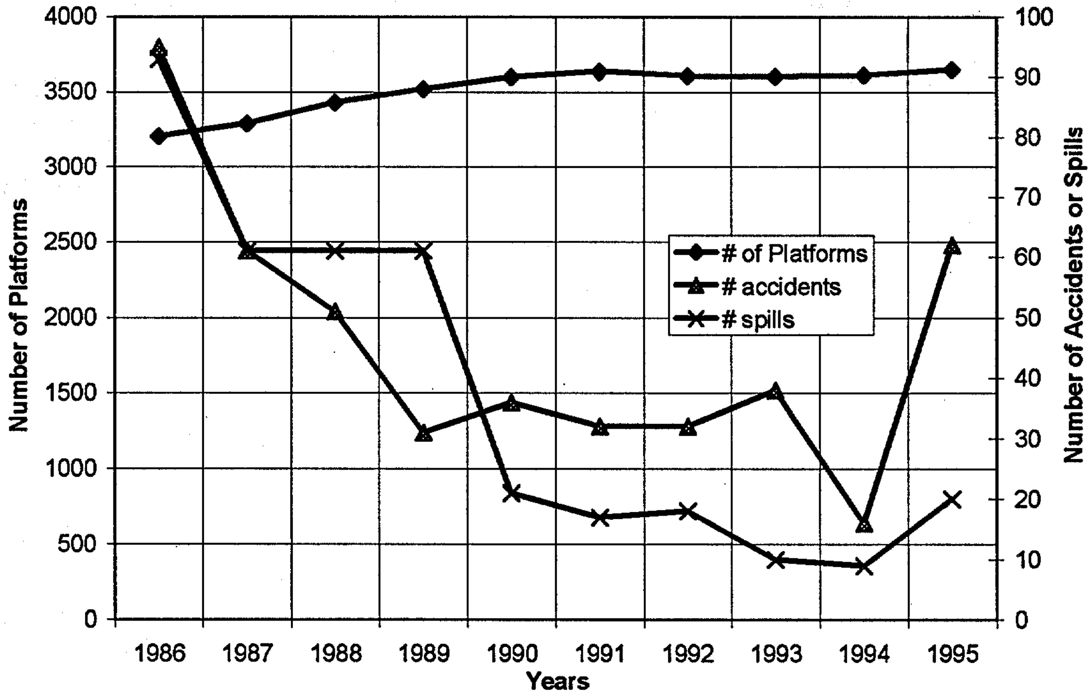

Figure 1-2 Number of platforms, accidents, and spills per year from 1986-1995

1.3 Motivation for study

The potential impact of a catastrophic offshore platform failure is quite serious in terms of both lives lost and environmental damage. As shown in Figure 1-2, over the ten-year period from 1986-1995, approximately 800 accidents or spills have occurred at the roughly 4,000 MMS-inspected platforms on the Outer Continental Shelf (OCS).[3] Fortunately, most of the accidents or spills were not of a serious nature. The worst incident in the United States, in terms of loss of life, resulted in

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[3] The term OCS is described more fully in later chapters. Basically, the OCS is 3 or more miles from shore.

seven deaths.[4] The rest of this section lists some of the major accidents that have occurred around the world, and the risks that platform's face.

1.4 Incidents at offshore facilities

The two events of greatest influence in terms of safety awareness were accidents that occurred in the North Atlantic. The fist incident was the capsizing and sinking of the Alexander L. Kielland, a Norwegian platform in 1980. The second incident was the fire and explosion on the Piper Alpha facility, a United Kingdom platform, in 1988. Several other total-loss events have occurred around the world, but these two events are the worst and they are responsible for the realization of the danger of working at these facilities and the need for better safety procedures.[5]

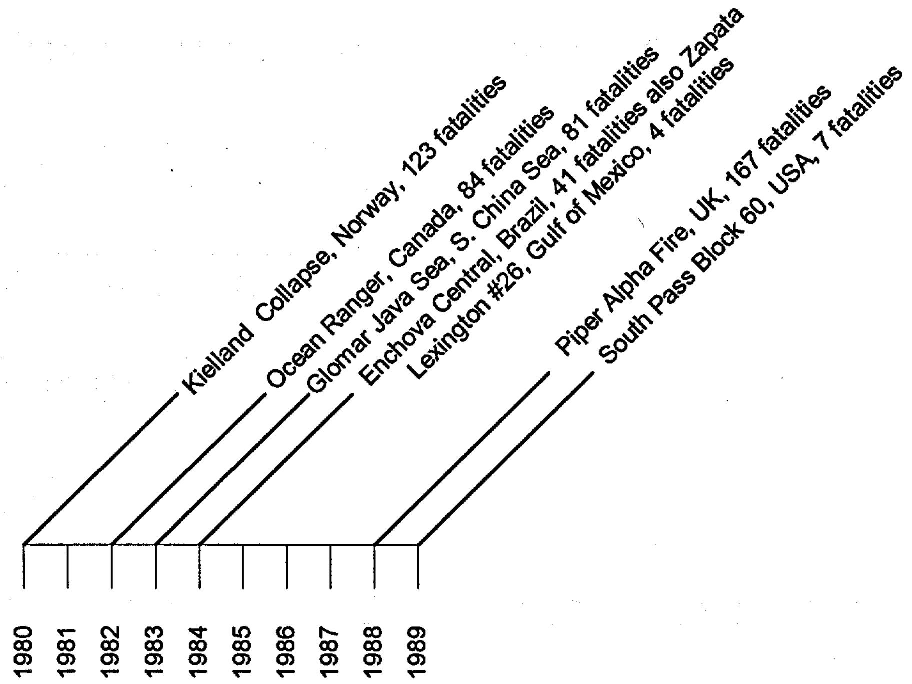

Figure 1-3 Selected platform disasters by number of fatalities[6]

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[4] OCS Report, MMS 90-0016. 1990. *"Investigation of March 19, 1989. Fire, South Pass Block 60, Platform B, Lease OCS-G 1608."* U.S. Department of the Interior.

[5] Pitblado, R. and Turney, R. editors, Risk Assessment in the Process Industries, published by the Institution of Chemical Engineers, 1996. p. 99.

[6] US Congress, Office of Technology Assessment, OTA-O-270, *"Oil and Gas Technologies for the Arctic and Deepwater,"* May 1985, p.103.

The Kielland disaster was caused by the collapse of one of the five legs of a floating accommodation platform, which resulted in the sinking and total loss of the platform.[7] The cause of the collapse was an error in design that did not anticipate an event of this type occurring. The platform sank in 20 minutes, which is a much shorter time than most people believed could happen. Additionally, many of the escape and evacuation systems did not work properly. The accident led to 123 fatalities, with only 89 people being rescued, and cost several hundred million dollars due to lost equipment and suspended hydrocarbon production. This accident caused a refocusing of concern for safety on Norwegian platforms and resulted in some of the early studies of risk attitudes and risk perception of offshore workers.

The next major incident was the destruction of the Piper Alpha platform, which resulted from a combination of human and system error. A catastrophic fire began when a pressure safety valve was removed and replaced with a blind flange,[8] which failed and allowed a combustible mixture to be released, ignite, and explode. The platform was destroyed, which resulted in over a billion dollars worth of damage,[9] the loss of 167 men, and the pouring of large quantities of oil into the North Atlantic.[10] This led to the push for greater safety oversight in the United Kingdom, and the creation of a systematic approach toward risk assessment of offshore facilities.[11] In addition, surveys of UK worker attitudes about risk and safety were conducted in a manner similar to surveys conducted by the Norwegians.

The worst incident in the United States, in terms of fatalities, was the South Pass Block 60 incident.[12] An anchor cable damaged a section of natural gas pipeline, causing a leak. The pipeline

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[7] An accommodation platform has crew quarters on it.

[8] A blind flange is a round, flat metal plate used to cap the end of a section of piping. Blind flanges are used to cap piping during maintenance procedures when a valve is removed for servicing, or when a section of pipe needs to be isolated from the process stream.

[9] Pate-Cornell, M.E. *"Risk Analysis and Risk Management for Offshore Platforms: Lessons from the Piper Alpha Accident."* Journal of Offshore Mechanics and Arctic Engineering, Vol. 115. 1993.

[10] Hughes, Harold W.D. *"UKOOA's Response in the Developing UK Safety Regime"*. Offshore Technical Conference, UK Offshore Operators Association. Date not known.

[11] The UK instituted what are called "safety cases" to determine the risk of offshore facilities. Safety cases are described and explained in later chapters.

[12] OCS Report, MMS 90-0016. 1990. *"Investigation of March 19, 1989. Fire, South Pass Block 60, Platform B, Lease OCS-G 1608."* U.S. Department of the Interior.

was shut down, which allowed water to enter. To complete repair of the pipeline, the water needed to be removed with what is called a "pig." See Figure 1-4. To prepare for cleaning the pipeline, a "pig trap" had to be installed on the South Pass Block 60 platform. It was decided that the trap would be installed on a riser (vertical section of pipe) and that to install the trap, a cold cutoff machine would first have to cut the pipe. During the operation to cut the pipe, pressure inside the pipe began to spew water and hydrocarbons onto the platform. The amount increased, causing the crew to abandon the cutting machine and try to escape from the area. The gas/oil/water mixture coming from the riser then exploded either killing the people instantly or blowing them off the platform or off the deck of a boat moored next to the platform. Seven people were killed and the subsequent fire destroyed the production and drilling decks of platform B. The check valves and shutdown valves worked, thereby isolating the platform from the pipeline. Therefore, oil spillage was relatively light, but several million dollars of property damage occurred.

1.5 The importance of inspection programs

To decrease the likelihood of accidents and spills, nations have instituted inspection programs of offshore facilities in the hope that problems will be caught during the inspection process before the

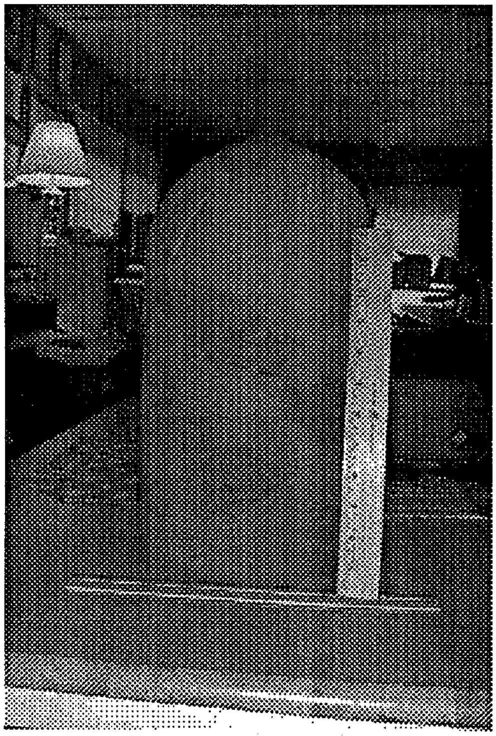

Figure 1-4

The item to the left is called a "pig." It is an oblong flexible foam plug that is inserted into one end of a pipeline, then pushed along (under high pressure) inside the pipeline in order to clean it. It is removed in what are called "pig traps." The attempt to install a "pig trap" caused the worst accident in the United States.

situation becomes a major incident. The inspection process serves the purpose of risk reduction in two ways: 1) operators must manage the platforms in a conscientious manner or face a platform shutdown, or civil or criminal penalties, 2) the inspection process gathers information about a platform's operational history that might be useful in predicting the likelihood of future problems.

Overall, the safety record for the US has been quite good. The reason for this good safety record has been attributed to the government's aggressive inspection program.[13] As the Panel on Evaluation of Case Studies of Risk Assessment of Offshore Platforms states: [14]

> *"The record of safety on the Outer Continental Shelf (OCS) has been good. In terms of injuries and fatalities, OCS drilling and production operations are comparable to other hazardous activities onshore, such as mining and construction. In terms of environmental impact, oil pollution from offshore operations contributes less than any other significant course to the release of hydrocarbons into the marine environment. US offshore industry spillage volumes and the amount spilled compared to total production has been reduced... Thus, MMS and the offshore industry are not faced with the problem of correcting a manifestly poor safety record. Th US has succeeded under its present inspection program in averting the kinds of catastrophic disasters that have befallen the offshore operations of many other nations. Although the evidence of a direct connection is lacking, certainly the activities and vigilance of the federal government have been a factor. However, an increase in the margin of safety on the OCS can be achieved by improving the link between the MMS inspection program and safety performance of the industry. The committee's recommendations are intended to accomplish that end."*

This dissertation builds on the Panel's recommendations.

1.6 Outline of the dissertation

The following is an outline of the remainder of the dissertation including a brief description of the items covered in each chapter.

Chapter 2 - discusses risk sources, and consequences of an accident or spill
Chapter 3 - discusses safety programs and risk assessment methods

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[13] The United States' inspection program has been used as a model for several other countries. Other countries routinely request information regarding how the MMS conducts the inspection program. In addition, in the United States, all of the inspectors are government employees. In some other countries, the oil companies pay the inspectors.

[14] Second Draft of Working Paper. *"Panel on Evaluation of Case Studies of Risk Assessment of Offshore Platforms."* Paragon Engineering Services Incorporated, Houston, Texas. September 30, 1996, p.8.

Chapter 4 - provides statistics on offshore production and describes the characteristics of offshore platforms

Chapter 5 - explains the role of the MMS in regulating platforms and discusses the role that other agencies play in inspecting offshore facilities

Chapter 6 - describes the risk factors used to develop the predictive models

Chapter 7 - describes the statistics of the risk factors and shows the results for single factor logistic regressions to predict accidents and spills

Chapter 8 - presents the results of multivariable logistic regression models that are used to predict which platforms are likely to have an accident or spill and then ranks the platforms

Chapter 9 - provides the results from an expert survey that was conducted in June 1998

Chapter 10 - uses the results from the survey discussed in Chapter 9 to develop expert models to predict accidents and spills and then ranks the platforms

Chapter 11 - compares the results from the logistic models in Chapter 8 to the results of the expert models in Chapter 10

Chapter 12 - discusses the policy implications of the results

1.7 Summary

Many people have been killed or severely injured due to accidents on offshore platforms. Fortunately, the U.S. has not experienced the number of fatalities that workers from many other countries have experienced. The reason for this has been attributed to the efforts of platform owners and government regulators. The goal of this research is to use historical data to rank the platforms in terms of risk in the hope that the identification of risky platforms will make offshore operation even safer.

Chapter 2 - Risk

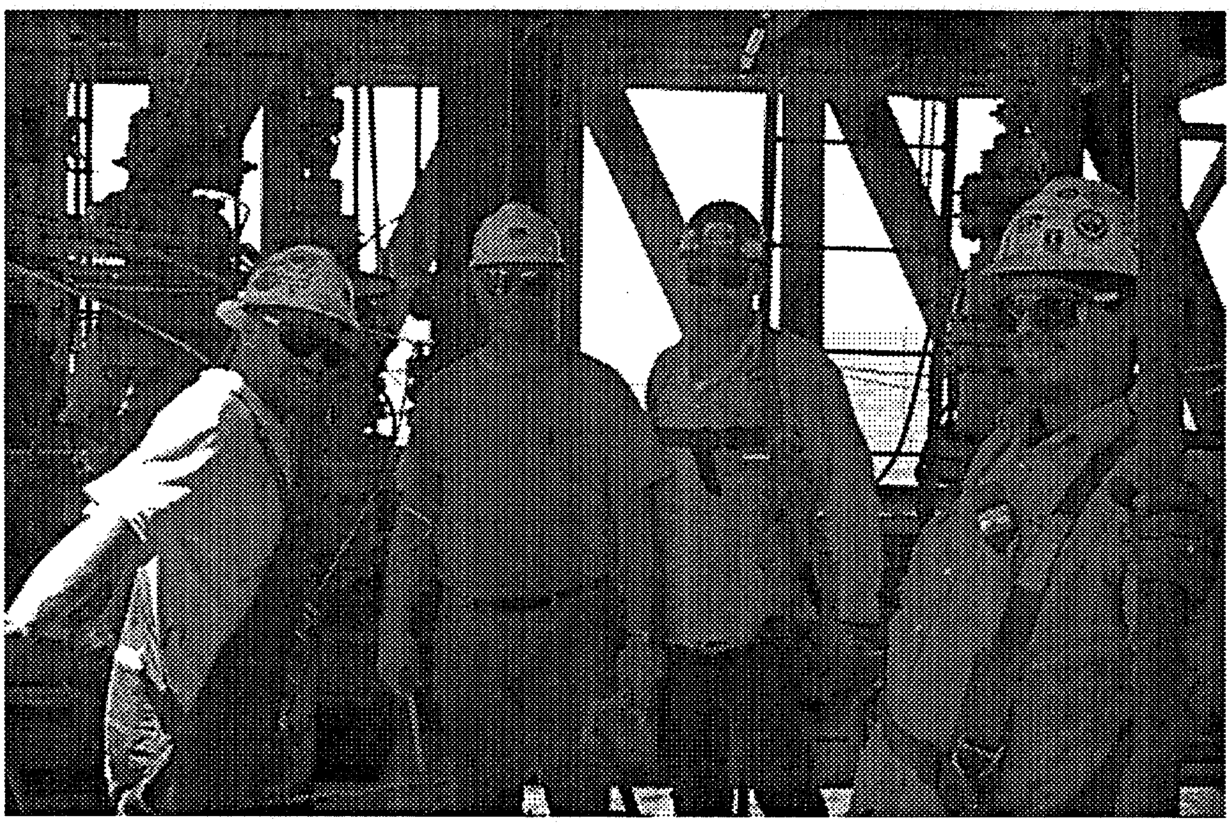

Figure 2-1 Lafayette District - Workers replacing structural steel that had suffered severe corrosion. Note welders wearing body harnesses and all workers with hardhats and safety glasses.

2.1 Sources of risk

Offshore facilities are impacted by natural (e.g., hurricanes, earthquakes, and tidal waves) and man-made (e.g., ship collisions, faulty maintenance, poor construction) sources of risks. These can easily lead to billion dollar losses, hundred of deaths and injuries, and irreversible environmental damage. See Figure 2-2.

In this dissertation, no attempt is made to address all risks associated with platform operation. Instead, the data are analyzed to look for trends that can be related to specific risk factors to find predictive relationships. Fault tree and event tree analyses are very specific detailed analyses of particular platforms or platform types. Though these techniques are often used in studying the risks associated with offshore facilities, they are in general quite complicated, time consuming, expensive to prepare, and platform specific. Our investigation uses historical data to identify risk factors and to determine a risk index that can be applied across all 4,000 platforms.

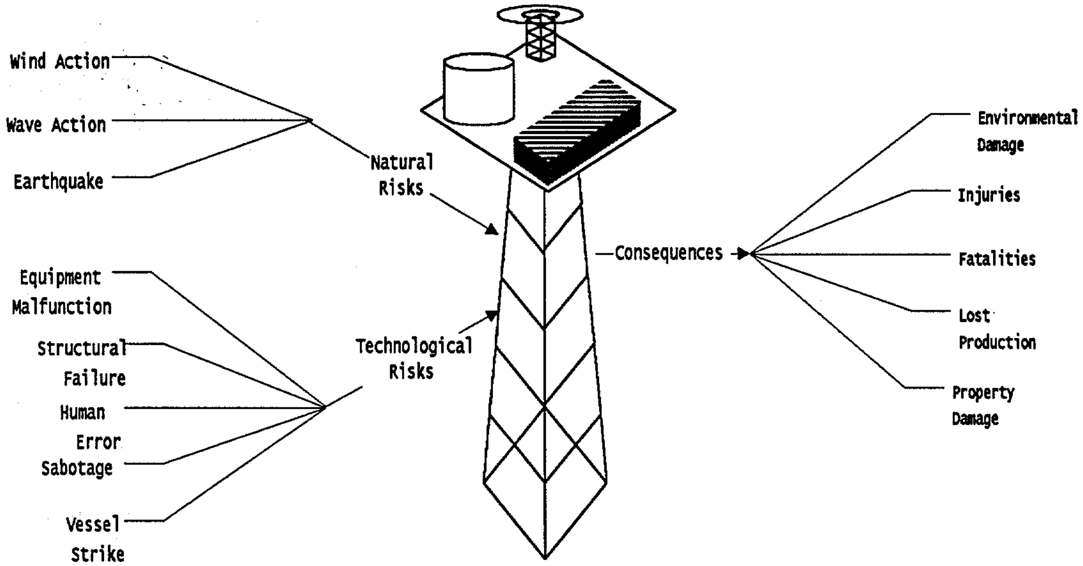

Figure 2-2 Natural versus technological risks and the consequences of an accident or spill

2.2 Regulatory risk

The loss of the Piper Alpha platform cost over $1 billion (US). Therefore, the direct financial impact of accidents can be severe. However, governments can and do require that operators meet other economic requirements. For example, substantial fines are imposed if the operating company is found negligent. See Figure 2-3.

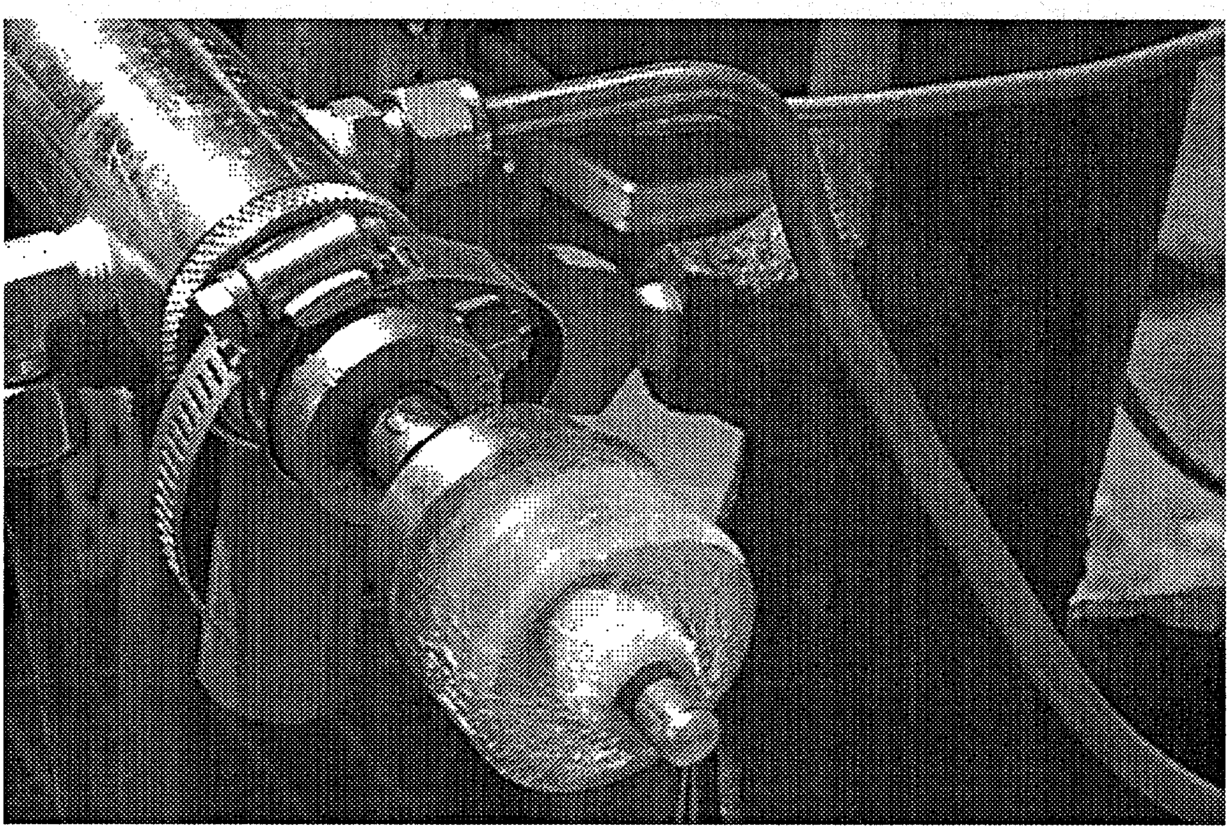

Figure 2-3 Lafayette District - Hose clamp illegally pinning out a safety device designed to shut down the facility if reservoir pressure fluctuates too much. Resulted in a facility shut-in. MMS has proposed the issuance of a civil penalty of approximately $40,000.[15]

To insure that responsible parties are able to satisfy their financial obligations for cleanup and damage caused by a spill, a new rule has been promulgated which can adversely affect operators of offshore facilities.[16] The rule has been revised to reflect provisions established in the US Coast Guard (USCG) Authorization Act of 1996. The rule requires financial responsibility ranging from $10 million to $150 million for facilities in State waters, and ranging from $35 million to $150 million for facilities on the Outer Continental Shelf (OCS). In addition, additional bonding requirements became effective on August 27, 1993, establishing three tiers of general and area-wide bonding requirements. The rule establishes a deadline for all leases to be brought into compliance

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[15] Personal conversation with Tom Basey, Inspector, Offshore Operations and Safety, Lafayette District, June 1998.

[16] Regg, J., *"Gulf of Mexico Activities and OCS Regulatory Trends,"* Excerpts from the Marine Safety Seminar, Texas A&M Sea Grant College, March 1998,p.5.

with new area-wide and general bonding requirements. The Final Rule was published in the Federal Register on May 22, 1997, with an effective date of August 22, 1997.[17]

2.3 Life cycle of risks

During the lifetime of a platform, there are several areas where the risk to platform personnel and equipment can be addressed.

- The design of the platform
- The manufacture of the platform
- The operation of the platform
- The maintenance of the platform
- The decommissioning of the platform

Interventions with inspection programs, the focus of this dissertation, are targeted at risks associated with the operation and maintenance phases.

2.4 Offshore facilities versus other industrial systems

In the US, the International Association of Drilling Contractors states that offshore-drilling injury rates are comparable to those in the mining sector and are less than onshore drilling injury rates (see Table 2-1). Production platform worker injury rates are not available, but they are believed to be lower than those experienced by drilling crews. Therefore, production operations on offshore platforms compare well, in terms of risk to heath and safety of the workers, to other industrial occupations.

Comparable Industry Injury Rates (1983)[18]	
Industry	**Injury rate per 200,000 man-hours**
Total private sector	3.4
Construction	6.2
Mining (other than oil and gas extraction)	4.4
Anthracite mining	6.1
Total oil and gas extraction	4.6
Onshore oil and gas drilling	10.4
Offshore oil and gas drilling	4.2

Table 2-1 Industrial sector injury rates

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[17] Regg, J., *"Gulf of Mexico Activities and OCS Regulatory Trends,"* Excerpts from the Marine Safety Seminar, Texas A&M Sea Grant College, March 1998, p.5.

[18] US Congress, Office of Technology Assessment, OTA-O-270, *"Oil and Gas Technologies for the Arctic and Deepwater,"* May 1985, p. 106.

2.5 Management options

A study to evaluate the impact that management could have on the likelihood of industrial incidents is summarized in Table 2-2 below. The table was derived from after-action analyses of industrial incidents. The table shows where intervention by management could have prevented the incident in the course of the facility's life. The category of "not known" and row "other" were added because this information was not present in the referenced table, but pertains to manufacturing, construction, or decommissioning phases during a facility's life cycle. [19] Table 2-2 shows that performing a HAZOP[20] analysis of the design of industrial facilities and the operation of the facilities would have avoided approximately 35% of all the accidents that occurred. Approximately 30% of the accidents could have been avoided if a study of human factors in the operation and maintenance of facilities was conducted. Four percent of accidents could have been avoided if prior to performing the task it was first reviewed for safety and 11% of the accidents could have been avoided if routine inspections were conducted of the industrial facility. Maintenance and operation activities account for 51% of accidents. It is hoped that the identification of "risky" platforms due to this research will improve the inspection process of offshore platforms and make them safer during routine operation and during maintenance procedures.

	Type of management intervention needed to avoid accident					
Point In Facility Life Cycle Where The Accidents Occurred	**Not known**	**Hazard Study (HAZOP)**	**Human Factors Review**[21]	**Task Checking**[22]	**Routine Inspections**[23]	**Totals**
Design		29%				**29%**
Operation		6%	24%			**30%**
Maintenance			6%	4%	11%	**21%**
Other	20%					**20%**
Total	**20%**	**35%**	**30%**	**4%**	**11%**	**100%**

Table 2-2 Incident matrix[24]

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[19] Pitblado, R. and Turney, R. editors, Risk Assessment in the Process Industries, published by the Institution of Chemical Engineers, 1996. p. 14. Original data in another paper.

[20] HAZOP – Hazard and Operability Analysis. In this method, questions like "What if there is more flow than the design limit" or "What if there is reverse flow" are asked. The goal is to determine the consequences of upset conditions.

[21] This refers to a review of human activities, human errors and the effect of systems on humans.

[22] This is a review of the tasks that people perform and the effects of changing the way people do things to avoid the incident.

[23] This is the effect that management could have had on the avoidance of an incident if inspection procedures had been properly followed.

Interviews of operators and managers are a major component of an industrial HAZOP study, and most of the other management strategies outlined in Table 2-2. Efforts in this area are discussed in the next section.

2.6 Risk perception

Following the Keiland and Piper Alpha accidents in the North Atlantic, Norway, and Great Britain began a systematic review of the safety of offshore platforms. This resulted in several new approaches to assessing the safety of platforms. In particular, the United Kingdom developed what are known as "Safety Cases" which attempt to both qualitatively and quantitatively assess platform risks. The "Safety Case" method of risk assessment is discussed in Chapter 3. The UK and Norway have also conducted surveys of the platform workers with the goal of capturing the general impressions or perceptions of safety on platforms. Below is a brief list of several of UK/Norway surveys.[25]

- **1980 – Norway -** Statfjord A platform, 238 employees including operator staff, drilling crew.
- **1990 – Norway -** eight platforms, five companies, 915 personnel.
- **1994 - Norway -**A follow-on to the 1990 survey, 12 platforms. ten companies, 1178 personnel,
- **1994 - United Kingdom -** Similar questions to the 1994 Norwegian survey, six platforms, 622 personnel.

The following are conclusions from the surveys regarding the attitude and perceptions of offshore oil and gas workers.

- It was found that the workers generally felt safe living and working offshore.
- Individuals were most concerned with major accidents and disasters because they feared the consequences of the incident, rather than the probability of it occurring.
- The activity feared most by the workers was flying to the platform in a helicopter.
- Maintenance and construction personnel and technical/mechanical personnel felt the least safe overall.
- Management and administrative personnel felt the safest overall.

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[24] Pitblado, R. and Turney, R. editors, Risk Assessment in the Process Industries, published by the Institution of Chemical Engineers, 1996. p. 14. Original data in another paper

[25] Mearns, K. and Flin, R.J. *"Risk perception and attitudes to safety by personnel in the offshore oil and gas industry: a review"*. Loss Prevention in the Process Industries. Vol. 8. No. 5. 1995, p. 300.

- Contractor staff feel less safe than operator staff.
- Lifting operations (particularly manual lifting) and repair work and maintenance led to the most injuries, and these tasks were considered the most risky on the platform.
- Personnel working on older installations and installations in the start-up phase felt less safe than personnel working on installation that had been in operation for four to eight years.
- The personnel who felt least safe were exposed to the highest risk and had had the most accidents.
- Good safety and emergency response measure were important for creating feeling of safety and had a direct effect on accident prevention.
- Approximately half of the respondents were dissatisfied with the emergency response training onboard the platforms.
- Those with managerial and supervisory responsibility appeared more reluctant to take risks and compromise safety than those without such responsibilities.

In terms of how workers feel about risk, when compared to other types of work, these surveys found that offshore platform workers felt significantly safer working on the platform than deep-sea fisherman, or coal miners, and their jobs were thought of as about as safe as working at a nuclear power plant.[26] The data show that working on offshore platforms was similar to other hazardous occupations, depending on how the exposure rate basis was calculated.[27]

These perceptions of risk reflect many of the concerns of platform inspectors in the U.S. In-depth interviews with inspectors conducted by the MMS (over the past three years) and as part of this research are summarized in Chapter 9.

2.7 Summary

Accidents and spills at offshore platforms have many sources. An accident or spill can severely affect the health and welfare of many people. The consequences of an accident or spill are not limited to those working on the facility. There are various points in a platform's life cycle where intervention strategies can be used to reduce risk. This research uses historical information to predict which platforms are more likely to have an accident or spill during routine operations. The platforms are then ranked by this prediction.

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[26] Flin, R., Mearns, K., Gordon, R. and Fleming, M. *"Risk Perception by Offshore Workers on UK Oil and Gas Platforms,"* Safety Science, Vol. 22, No. 1-3. pp. 131-145, 1996.

[27] Flin, R., Mearns, K., Gordon, R. and Fleming, M. *"Risk Perception by Offshore Workers on UK Oil and Gas Platforms,"* Safety Science, Vol. 22, No. 1-3. pp. 131-145, 1996

Chapter 3 - Offshore Risk Assessment and Safety Programs

Five risk assessment methods or safety programs are presented in this section:

1. **Safety Cases** - A risk assessment method developed in the UK that consists of a combination of a subjective analysis of risk perception of workers and safety systems and a detailed objective analysis of the probabilities of failure of devices or systems on platforms.[28]
2. **Design Standards** - Recommended design standards promulgated by the American Petroleum Institute. Platform owners in the US are required to comply with the standards by the Code of Federal Regulations.
3. **Safety and Environmental Management Program (SEMP)** - A voluntary program in the US designed to make sure management has proper safety procedures in place.
4. **Facility Maintenance and Enhancement (FAME)** – A study of accident data to determine if predictive relationships could be found.
5. **Fire and Life Safety Assessment and Indexing Methodology (FLAIM)©** - A platform risk ranking method that was based on platform traits or characteristics as well as management practices.

3.1 Safety case

The phrase "Safety Case" came into being after the Piper Alpha incident and the inquiry directed by Lord Cullen into the cause of the accident. The method consists of both a review of management procedures and assessment of items that could cause a "major" incident. There are actually several different types of safety cases, as listed below.[29]

- **Design Safety Case** – Covers the concept design and offshore construction and commissioning of fixed installations. It must be submitted early enough so that any issues raised by the Health and Safety Executive Offshore Safety Division can be taken into account in the detailed design.
- **Operational Safety Case** – Covers the detailed design and operation of fixed installations and is submitted 6 months before hydrocarbons are likely to be on the platform
- **Abandonment Safety Case** – Covers the method of decommissioning and is submitted 6 months prior to abandonment.

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[28] Hughes, Harold W.D. *"UKOOA's Response in the Developing UK Safety Regime"*. Offshore Technical Conference, UK Offshore Operators Association. Date not known.

[29] Second Draft of Working Paper. *"Panel on Evaluation of Case Studies of Risk Assessment of Offshore Platforms."* Paragon Engineering Services Incorporated, Houston, Texas. September 30, 1996, p.2.

- **Mobile Installation Safety Case** – Must be submitted three months prior to the operation of the vessel in UK waters.

Safety cases are very expensive, costing upwards of $1 million dollars each, and can take many months to prepare. As a minimum, the safety case has to demonstrate the following:[30]

- The management systems comply with health and safety law.
- A regular independent audit of the management system has been provided for.
- Potential hazards that can cause major accidents have been identified
- Risks of major accidents have been evaluated and demonstration, by the results of suitable and sufficient quantitative risk assessment, that the measures taken (in relation to the hazards) reduce the risks to personnel to "As Low As Reasonably Practical (ALARP)".

The United States Government does not require the preparation of safety cases for platforms. However, some of the same concepts as those listed in the safety cases are addressed in design standards and safety procedure reviews.

3.2 Design standards

The design of platforms in the U.S. is prescribed in the Code of Federal Regulation (30 CFR 250) and is based on the American Petroleum Institute (API) Recommended Practice 14J and 2A.[31] Inspection details and frequencies are mandated, as are rules for requalification due to inspection results. Since the adoption and use of the practices suggested by the API, there has been no loss of life due to loss of platform structural integrity. The only loss of a platform, designed to standards from the mid-1970, has been due to a ship collision.

3.3 Safety and Environmental Management Program (SEMP)[32]

A voluntary program in the US that provides a methodology for operators to systematically analyze their safety programs and address operational risks. The program contains the following elements:[33]

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[30] Mearns, K. and Flin, R., J. *"Risk perception and attitudes to safety by personnel in the offshore oil and gas industry: a review"*. Loss Prevention in the Process Industries. Vol. 8. No. 5. p. 300.

[31] API, *"Recommended Practice for Design and Hazards Analysis for Offshore Production Facilities,"* API Recommended Practice 14J (RP 14J). API *"Recommended Practice for Planning, Design and Construction Fixed Offshore Platforms – Working Stress Design"* ", API Recommended Practice 2A (RP 2A).

[32] SEMP is based on API Recommended Practice 75 (RP 75), *"Recommended Practice for Development of a Safety and Environmental Management Program for Outer Continental Shelf Operand and Facilities."*

- Safety and environmental data acquisition and reporting
- Hazards analysis
- Management of change procedures
- Operating procedures
- Safe work practices
- Training
- Assurance of quality and mechanical integrity of critical equipment
- Pre-startup review
- Emergency response and control
- Investigation of incidents procedures
- Audit timetable of safety and environmental management program elements

This procedure allows operators to exercise judgement and control over the risk management of their facilities and provides a framework for them to follow so that all operators can be consistent in their procedures. SEMP contains some of the information contained in the UK safety case studies, but is much less comprehensive and less costly to prepare. The MMS continues to work with the offshore industry to encourage voluntary adoption of American Petroleum Institute (API) recommendations by OCS leasors. A performance-measures workgroup has been established with industry to develop a methodology for determining the effectiveness of offshore safety-management systems. The group is working to establish an overall benchmark that can be used to compare all operators' Safety and Environmental Management Program (SEMP) efforts. Industry and the MMS have held several workshops to establish performance measures to be used in judging the adequacy of the SEMP initiative. A pilot project is planned to test the methodology being developed and, if successful, could lead to full-scale implementation as an audit tool for SEMP compliance. [34]

3.4 Facility Maintenance and Enhancement (FAME)

The FAME study was an analysis of fire and explosion data. The goal was to analyze the traits or characteristics of platforms that experience fires and explosions and determine if it is possible to predict which platforms were at greatest risk of a fire or explosion in the future. The study began

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[33] Second Draft of Working Paper. *"Panel on Evaluation of Case Studies of Risk Assessment of Offshore Platforms."* Paragon Engineering Services Incorporated, Houston, Texas. September 30, 1996, p.7.

[34] Regg, J., *"Gulf of Mexico Activities and OCS Regulatory Trends,"* Excerpts from the Marine Safety Seminar, Texas A&M Sea Grant College, March 1998.

in 1992, but unfortunately, it was cancelled before it was completed. However, the study did report that no relationship between the age of a platform and the likelihood of that platform having a fire or explosion.

3.5 Fire and Life Safety Assessment and Indexing Methodology (FLAIM)©

The "FLAIM"[35] study attempted to assign risk indexes to platforms based on their physical and operational characteristics. The project is described in the following quote:[36]

> *FLAIM can best be described as a quantitative risk assessment indexing methodology in which selected key factors relevant to fire safety and life safety are identified, assessed and assigned numerical (weighting values). Risk contributing factors are thereby indexed and ranked using a weighting system algorithm, keyed to relative (comparative) risk, to yield a set of risk indexes, and an overall risk index for the facilities."*

The "FLAIM" research was not entirely successful in this regard and the project was not completed.

3.6 Summary

The U.S., and most of the rest of the world, has focused on evaluating platform risk in the design or construction stage and on management procedures during operation. In the U.S., several attempts to rank platforms in terms of riskiness based on historical information have been made. None have been entirely successful. This dissertation successfully uses historical information to rank order platforms based on two methods: 1) multivariable logistic regression models 2) expert models.

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[35] Gale, W.E., Moore, W.H., Bea, R.G., Williamson, R.B., *"Fire and Life Safety Assessment and Indexing Methodology (FLAIM)©"* Proposal to the US Department of Interior, University of California at Berkeley, College of Engineering, Office of Research Services, August 15, 1994, Follow-up project to contract award number 14515.

[36] Second Draft of Working Paper. *"Panel on Evaluation of Case Studies of Risk Assessment of Offshore Platforms."* Paragon Engineering Services Incorporated, Houston, Texas. September 30, 1996, p.23.

Chapter 4 - Oil And Gas Production

Col. Edwin Drake completed the world's first oil well in August 27, 1859 in Titusville Pennsylvania. Total production for the year 1859 by this well and several others along Oil Creek was approximately 2,000 barrels. By 1870, US oil production increased to over 5,261,000 barrels and production in the rest of the world totaled 538,000 barrels.[37] The first offshore well appeared in 1897, near Summerland, CA. H.L. Williams extended an onshore oil field into the Santa Barbara Channel by drilling a submarine well from a pier. Five years later, more than 150 offshore wells were producing oil. Offshore construction remained quite simple and consisted of wooden or concrete piers that extend from land into the water. In the late 1920's, steel production piers appeared at Rincon and Elwood, CA that extended ¼ mile into the ocean. These wells were very high producers, and stimulated further interest in offshore platform development.

The first freestanding platform was built approximately ½ mile from shore in the open ocean in September 1932. The water depth was 38 feet, with a 25' air gap above the platform floor. In January 1940, a storm destroyed this structure and divers were used to remove the well casing and set abandonment plugs. WW II led to a halt in offshore exploration efforts. After the war, surplus navy ships were used to perform drilling operations and significantly lowered the cost of exploration. The first "out-of-site-of-land" platform was built off the coast of Louisiana in 1947 in 20 ft of water.[38]

4.1 Hydrocarbon production statistics

The following statistics are provided to give a sense of the activity levels offshore. [39]

- 3,900 active platforms, >95% of platforms are located in the Gulf of Mexico (GOM)
- 7,500 active hydrocarbon leases; (1,820 leases are producing)
- 3,300 producing oil wells; 3,450 producing gas wells
- 26,600 miles (total) of pipelines from platforms to shore.

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[37] US Department of the Interior stock number 024-000-00823-*1* *"Success at Oil Creek, Historical Vignettes, 1776-1976"*, published August 27, 1976.

[38] Bradley, H.B. editor in chief, Petroleum Engineering Handbook, Printed by the Society of Petroleum Engineers, 1987, p. 18-2.

[39] Regg, J., *"Gulf of Mexico Activities and OCS Regulatory Trends,"* Excerpts from the Marine Safety Seminar, Texas A&M Sea Grant College, March 1998.

- 33.7 million barrels of oil per month produced offshore (average - 1997)
  - Total US monthly usage is approx. 244 million barrels
- 433 billion cubic feet of gas per month produced offshore (average - 1997).
  - Total US monthly usage is approx. 1,711 billion cubic feet
- As of March 1998, 155 drilling rigs working in the GOM as compared to 154 in March 1997.

Additionally, each platform can have a number of well slots. That is, one platform may produce oil or gas from more than one well. In 1995, there were 80 exploratory wells in Alaska, and 50 exploratory wells on the Atlantic Coast, 1,125 production wells on the Pacific Coast and 32,750 production wells in the GOM.

The continued growth of deepwater (>1,000 feet of water) activity levels is illustrated by the following statistics:

- 27 rigs drilling in greater than 1,000 feet of water, several >4,000 feet with one in more than 7,000 feet (Shell, MC 739 - 7,082 feet), 70% are mobile rigs
- The percent of hydrocarbon production by platforms in deepwater is increasing
  - 1985 oil 1.8% gas .5%
  - 1990 oil 4.4% gas .6%
  - 1997 oil 24.9% gas 7.1%
- GOM deepwater production has increased at a rate of 28% per year since 1985

4.2 Drilling versus production

Offshore platforms do not all not serve the same function, nor are they all similar in size or complexity. Figures 4-1, 4-2, and 4-3 provide good examples of the varying complexity of production facilities. Also, production and drilling are not the same operation, and the structures associated with these two activities are not the same. Current deepwater drilling often uses a dynamically stabilized ship-mounted drill rig. The rig consists of a ship with an opening in the center through which the drilling pipe extends hundreds or thousands of feet to the ocean floor.[40] The drilling rigs are specialized pieces of equipment whose function is to drill the borehole, not produce the oil or gas from the wells.

Production activities consist of the following: separating water and other contaminants from the hydrocarbons, pumping the product into undersea pipelines that lead back to shore, storing the oil

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[40] Bradley, H.B. editor in chief, Petroleum Engineering Handbook, Printed by the Society of Petroleum Engineers, 1987, p. 18-2.

or gas on platform mounted storage tanks, or sending the hydrocarbons to surface moored pumping stations where tankers can be filled. On larger platforms, drilling and production activities often occur simultaneously. This is referred to as well "workover" or "simultaneous operations."[41] Drilling rigs are normally removed from these platforms once all scheduled wells have been drilled.

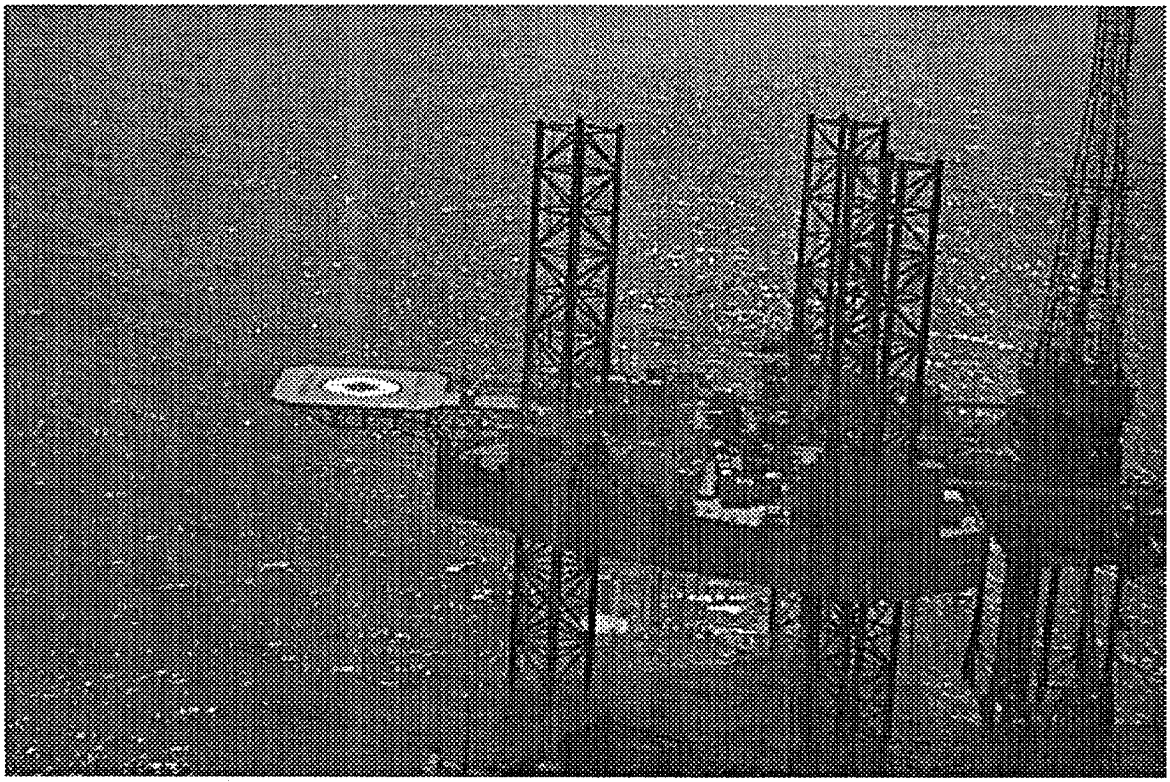

Figure 4-1 Lake Charles District- drilling workover unit and production platform. The area with the heliport is called a "jack-up" and is used to drill new wells. The legs retract through the hull of the barge and it is towed to the next site to drill more wells. The production platform is connected to the wells by a catwalk and is located to the right of the jack-up.

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[41] Bradley, H.B. editor in chief, Petroleum Engineering Handbook, Printed by the Society of Petroleum Engineers, 1987, p. 18-29.

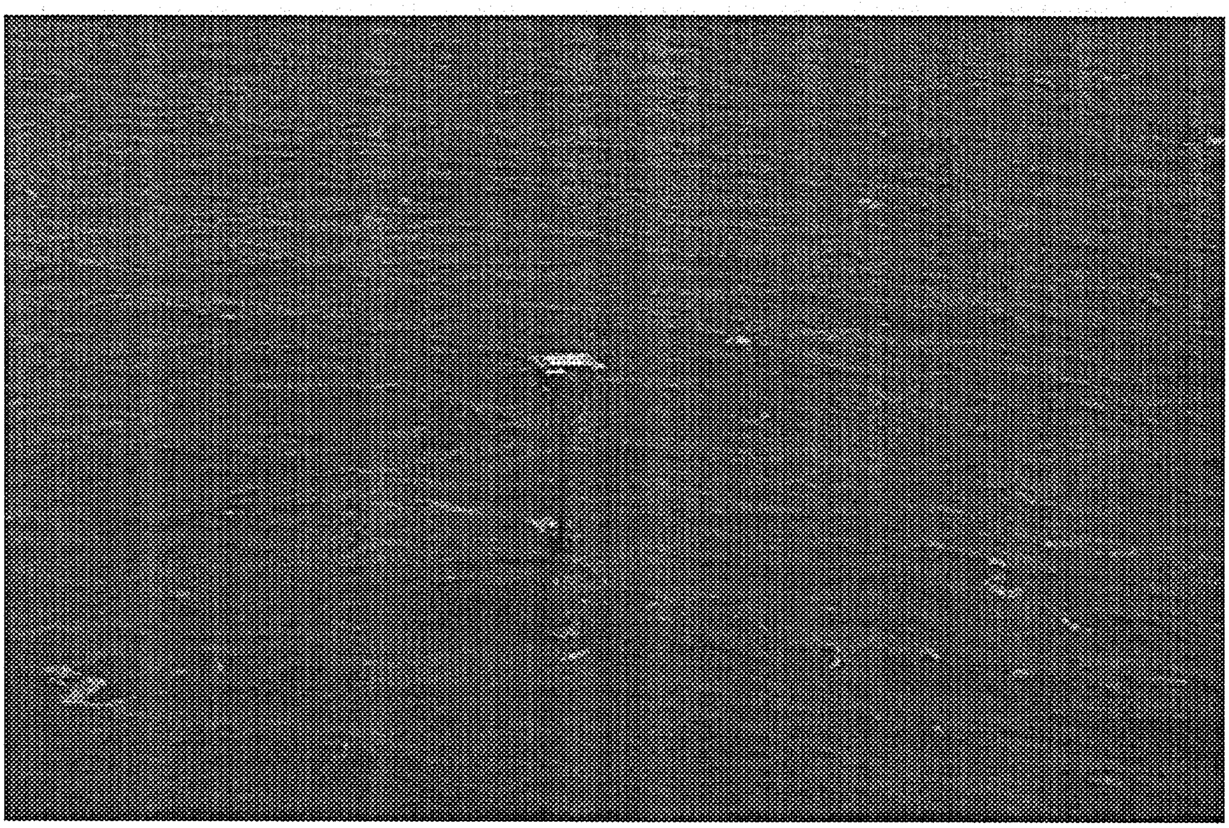

Figure 4-2 New Orleans District - Small single leg platform. The heliport is on top of the facility. This site has just one well, is unattended, and is operated by remote control.

4.3 Offshore production platforms

After oil or gas has been discovered, a number of further steps must be performed to enable the production of the fuel. Pumps may be needed, processing of the oil may occur, holding tanks may be used to store produced oil. Separators are often needed to separate oil, water, and gas from each other and provide storage of each separate fluid. The purpose of the production platform is to provide a location for this equipment during the oil and gas production process.[42]

In an offshore environment, there are three common ways to provide an area for the production processing equipment: man-made offshore islands; subsea installations; and freestanding or guyed production platforms.[43] There are a very small number of offshore facilities located on man-made islands and they are typically located in very shallow arctic water where the damage due to ice flows

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[42] Bradley, H.B. editor in chief, Petroleum Engineering Handbook, Printed by the Society of Petroleum Engineers, 1987, p. 18-28.

[43] By far, free standing production platforms are the most common form of production structure.

precludes freestanding platforms. Subsea facilities rest on the sea floor. The processing equipment on the subsea platform is specially designed to operate underwater at great depths. Therefore, the equipment is expensive and difficult to inspect and maintain. In addition, the equipment is subject to damage due to undersea mudslides and damage by ship anchors. As of 1998, subsea installations were not very popular. However, as experience is gained in their operation, and as exploration of deeper areas continues, interest in subsea installations will likely rise. In 1987, there were approximately 300 subsea processing facilities in use worldwide, compared to approximately 4,000 production platforms located just in the US. [44] Fully 99% of the crude oil and gas processing facilities are installed on above surface production platforms.[45]

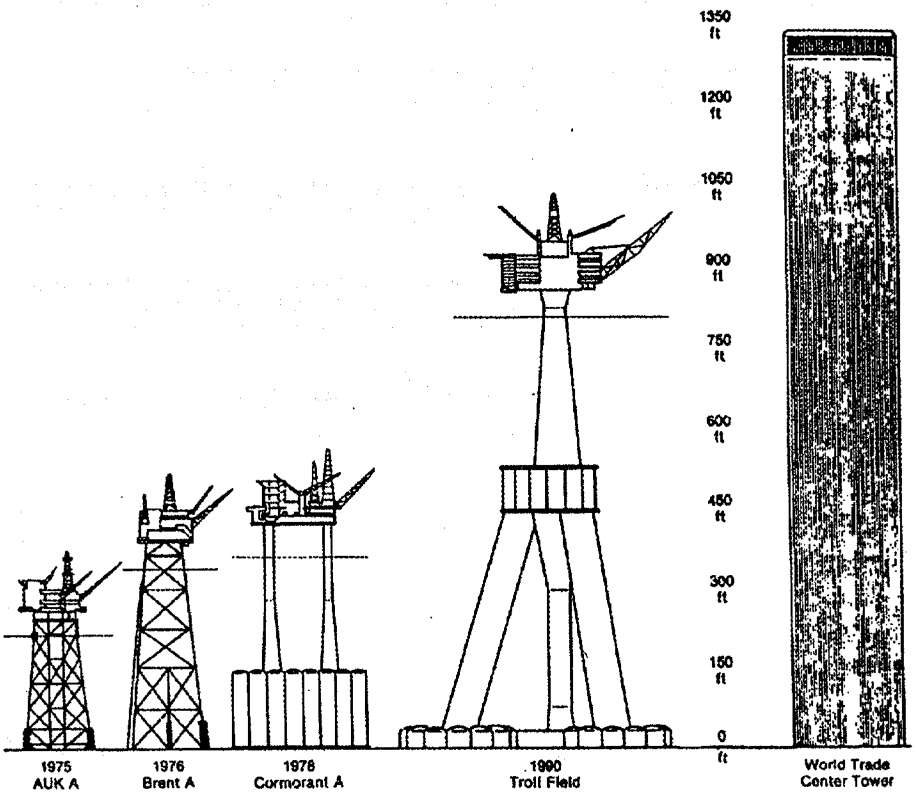

Figure 4-3 Relative sizes of selected production platforms. Many platforms are now in more than 2,000 feet of water.[46]

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[44] Bradley, H.B. editor in chief, Petroleum Engineering Handbook, Printed by the Society of Petroleum Engineers, 1987.

[45] Bradley, H.B. editor in chief, Petroleum Engineering Handbook, Printed by the Society of Petroleum Engineers, 1987, p. 18-29.

[46] US Congress, Office of Technology Assessment, OTA-O-270, *"Oil and Gas Technologies for the Arctic and Deepwater,"* May 1985, p. 48.

The major difference between onshore production and offshore production is the need for lightness and compactness of offshore production processing equipment. Often the equipment needed for a production platform is assembled into modules and towed to the offshore platform where it is then lifted into position. Most of the time, the production platform processes the oil and pumps it through subsea pipeline networks to shore for further processing in refineries. In rare instances, the oil may be stored subsurface, in tanks on the platform, or pumped directly into oil tankers.

4.4 Platform locations - The Outer Continental Shelf (OCS)[47]

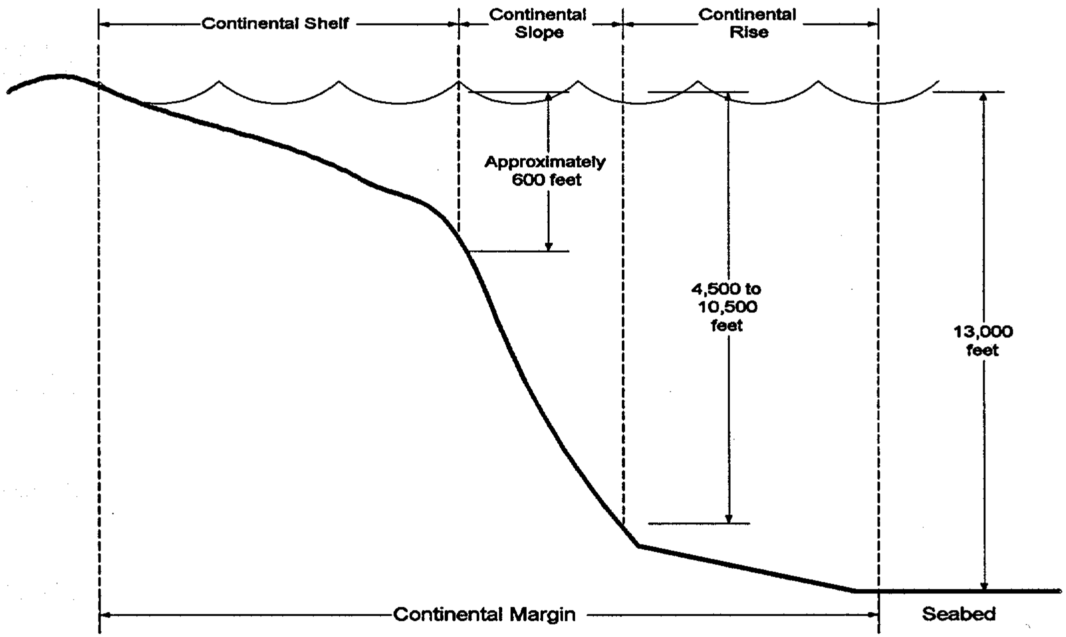

Figure 4-4 Continental Shelf - Note that the Federal OCS extends into much deeper water than the 600' contour described in Geneva as the "Continental Shelf."

Under the 1958 Geneva Convention on the "Continental Shelf," the shelf is described as:

> *"That submerged offshore area lying seaward of the territorial sea to a depth of 200 meters (656 feet) <u>and beyond that area to that depth which admits of mineral exploitation of natural resources."</u>*

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[47] The drawing is reproduced from a pamphlet provided by the U.S. Department of the Interior, stock number 024-000-00823-1 *"Success at Oil Creek, Historical Vignettes, 1776-1976"*, published August 27, 1976.

The term "Continental Shelf" is distinct from the term "Outer Continental Shelf." The term "Outer Continental Shelf" is a legal term created by Federal Statute – The OCS lands Act. The Federal jurisdiction is not limited to the 200-meter "Continental Shelf" contour restrictions described by the 1958 Geneva Convention. The extent of the OCS varies by statute along the US coastline. The shelf is narrow along the pacific coast, wider along the Atlantic coast and Gulf of Alaska, and widest in the Gulf of Mexico and around western and northwestern Alaska.

4.5 Leases

The government has broken up the OCS into "areas" and "blocks" (areas contain several blocks). Companies who wish to drill offshore must purchase "leases" which consists of either areas or blocks. The lease gives the lessee the right to remove minerals, but also specifies the duration of their exclusive right and provides for the payment of royalties to the government for extracting the resource. The government granted the first commercial leases immediately after the passage of the OCS Lands Act.[48] The majority of lease activity (exploration and development) has occurred in the GOM region.[49] There are three major planning areas in the GOM: Eastern, Central, and Western. The MMS holds a lease sale in each of the Central and Western GOM planning areas annually, granting exclusive mineral rights to the successful high bidder on a particular lease. Lease sales are area-wide, offering acreage throughout the planning area. The length of a primary lease term is dependent on water depth and is up to 10 years for deepwater development. A suspension of operations, a suspension of production, or the continuation of production beyond the primary term can extend the primary term. Utilization agreements can also extend the lease term.

Water Depth	**Length of Lease**
0 to 400 meters	5 years
400 to 900 meters	8 years
>900 meters	10 years

Table 4-1 OCS lease terms

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[48] Pamphlet from the U.S. Department of the Interior/Minerals Management Service. *"Managing Oil and Gas Operations on the Outer Continental Shelf."* 1986.

[49] The GOM Region also has responsibility for the Atlantic OCS.

4.6 Royalties

Lease owners are required to pay royalties to the U.S. Government based on the value of the extracted minerals. However, there are several different methods for calculating the proper royalty method and these are a subject of negotiation between the government and the leasee. In addition, the government provides incentives for companies to develop risky areas, e.g., for deepwater drilling, by offering to set aside royalty payments on some leases in exchange for their development. For example, the Royalty Free Final Rule of January 1998 provides for royalty relief under some circumstances. The water depths and royalty free production levels are as shown in Table 4-2.

Water Depth	**Royalty Free Production Level**
200 to 400 meters	17.5 mm BOE[50]
400 to 800 meters	52.5 mm BOE
> 800 meters	87.5 mm BOE

Table 4-2 Royalty free production at various water depths[51]

4.7 Summary

Offshore platforms vary widely in size and complexity. The platforms in the Gulf of Mexico account for 14% of all oil and 25% of all natural gas consumed in the U.S. They are a very important source of energy for the U.S. There are still areas in the Gulf of Mexico that have not yet been explored because of the great water depth, but this situation is slowly changing. The number of platforms installed in deep water is increasing. The consequences of an accident on these platforms could be more severe than on platforms located in shallower depths due to the deepwater platform's greater size, complexity, and isolation.

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[50] BOE means "Barrels of Oil Equivalent." BOE is a unit of energy. Gas production statistics are converted to "BOE" based on the amount of energy produced.

[51] Regg, J., *"Gulf of Mexico Activities and OCS Regulatory Trends,"* Excerpts from the Marine Safety Seminar, Texas A&M Sea Grant College, March 1998.

Chapter 5 - The MMS And Regulation Of Platform Operation

The Minerals Management Service is responsible for the following: oil and gas resource assessment, competitive leasing of development rights on government owned land, regulation and inspection of operations, royalty collection and land and resource conservation. In addition, The MMS has inspection responsibilities pursuant to the following regulations: Endangered Species Act, The Clean Water Act, the Oil Pollution Act, and others. The MMS has offices in Alaska, California Louisiana, Texas, Virginia, Colorado, and several other areas including a temporary office in Pensacola, Florida. The MMS is organized into two divisions: 1) Offshore Minerals Management and 2) Royalty Management.[52]

The MMS regularly inspects offshore facilities and archives the results of these inspections. The information consists of listings of violations, and the enforcement actions taken against platform operators. If a problem is noted during an inspection, the inspector issues a violation notice to the platform operator, called an "Incident of Non-Compliance" (commonly referred to as an "INC").[53] The types and number of INCs issued each year will be discussed later in this chapter.

The MMS is not the only agency concerned with the safe operation of offshore platforms. The following regulatory agencies are also involved in platform inspections.[54,55]

- **Coast Guard** - Life and safety code enforcement, including performing fire fighting and platform evacuation and assessing the safety of mobile drilling rigs.

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[52] Regg, J., *"Gulf of Mexico Activities and OCS Regulatory Trends,"* Excerpts from the Marine Safety Seminar, Texas A&M Sea Grant College, March 1998.

[53] A listing of the various types of INCs and a description of each is given in the *"National Potential Incident of Noncompliance (PINC) List and Guidelines,"* March 1995. Minerals Management Service, U.S. Department of the Interior.

[54] Regg, J., *"Gulf of Mexico Activities and OCS Regulatory Trends,"* Excerpts from the Marine Safety Seminar, Texas A&M Sea Grant College, March 1998.

[55] Pamphlet from the U.S. Department of the Interior/Minerals Management Service. *"Managing Oil and Gas Operations on the Outer Continental Shelf."* 1986.

- **Army Corps of Engineers** - Monitors construction of platforms and dredging and pipeline installation.
- **Environmental Protection Agency** - Monitors air and water discharge from production and drilling facilities.
- **Department of Transportation** - Responsible for regulation of oil and gas pipelines not regulated by the MMS.
- **National Marine Fisheries Service**- Responsible for clean water and safety of fish
- **Fish and Wildlife Service**- Responsible for clean water and safety of fish
- **Coastal states** - Responsible for inspection and safe operation of platforms within their jurisdiction. Most states have few regulations on platforms within their jurisdictions, and the regulations they do have generally focus on the safety of well design, not necessarily on safe platform design or operation.

5.1 Legal authority

Congress granted inspection authority to the MMS by the Outer Continental Shelf (OCS) Lands Act (1953 & Amendments) and the Code of Federal Regulations, Parts 250, 251, and 256.[56] The OCS lands Act requires: 1) scheduled inspections of offshore facilities at least once a year, 2) additional, unannounced on-site platform inspections at the discretion of the MMS. The OCS Lands Act was a compromise between the interests of the states to regulate platform operation and receive royalty payments for fossil fuel production off their coasts. The MMS has inspection and royalty receipt authority for the region three miles and greater from the shores of most states, with two exceptions. Texas and Florida have jurisdiction for offshore platforms within nine miles of their shores.[57]

5.2 Platform inspections: regions, personnel, and budget.

There are three inspection regions: Atlantic, Pacific, and Gulf of Mexico. By far, the most activity occurs in the Gulf of Mexico. In general, inspectors have worked several years on the OCS before they are hired as an inspector. There are 65 inspectors in the Gulf of Mexico and Pacific Regions.[58] Table 5-1 shows the FY 1995 budget for the four districts and two subdistrict offices in the Gulf of Mexico.[59]

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[56] Regg, J., *"Gulf of Mexico Activities and OCS Regulatory Trends,"* Excerpts from the Marine Safety Seminar, Texas A&M Sea Grant College, March 1998.

[57] Pamphlet from the U.S. Department of the Interior/Minerals Management Service. *"Managing Oil and Gas Operations on the Outer Continental Shelf".* 1986.

[58] Slitor, Doug. Electronic mail dated 6 January 1997. Minerals Management Service, Herndon, Virginia. The Pacific Region only has 9 inspectors, (6 in Camarillo, and 3 in Santa Maria). The Pacific region was not included in the inspector surveys nor were the platforms in the Pacific region used in this analysis.

Gulf of Mexico Inspection Districts	Number of Inspectors	District Budget	Number of Platforms
New Orleans	13	$ 2,626,823	960
Houma	14	$ 2,702,658	923
Lafayette	15	$ 2,964,565	707
Lake Jackson	7	$ 1,322,302	330
Lake Charles sub	4	$ 722,637	329
Corpus Christi sub	3	$ 741,664	127
Totals	**56**	**$11,070,649**	**3,376**

Table 5-1 Summary of Gulf of Mexico district budgets and number of inspectors

The budget for each district is for personnel associated with the inspection program and includes all costs associated with these districts including helicopter contracts. It is difficult to estimate the average cost of an inspection because there are many different types of inspections and the facilities are vastly different. For example, a single well caisson that has one device is much less complicated to inspect than is a 60-slot platform that has processing equipment, gathering lines, heaters, separators, treaters, etc.

5.3 Inspections and Incidents of Noncompliance (INC)

Inspections are conducted by petroleum engineering technicians 365 days a year, weather conditions permitting. Travel to and from the offshore facility is usually by helicopter, but at times, travel is by boat. Additionally, pipelines to shore from offshore facilities are also subject to inspection. Production platform inspections are usually announced and conducted on an annual basis. There are some other special inspections for production platforms, like the "pre-production" and "initial production" inspections. These occur as their titles suggest. Unannounced production platform inspections are normally conducted only when the MMS has reason to believe that a follow-up inspection is necessary, based on the presence of various risk factors, e.g., abnormal pressures, simultaneous operations, rigs new to district, unfamiliar operators, and proximity to sensitive areas.

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[59] Slitor, Doug. Electronic mail dated 6 January 1997. Minerals Management Service, Herndon, Virginia. This does not include regional or headquarters management costs associated with the inspection program.

An INC refers to a problem noted on a platform during an inspection. It is issued by one of the inspectors directly to the operator of the platform. An INC can be issued for a variety of reasons, however there are several broad categories under which all INCs fall.

- **G - General**: Refers to a violation of a general safety procedure.
- **E - Pollution**: Refers to the release of a pollutant into the environment.
- **D - Drilling:** Refers to a problem with the way drilling operations are conducted on the platform.
- **C - Well Completion:** Refers to violations during well completion operations.
- **W - Well Workover:** Refers to violations that occur when a workover rig is brought back onto a platform to conduct further work on an existing well.
- **A - Well Abandonment:** Refers to violations that occur when a well is not abandoned properly.
- **P - Production:** Refers to improper hydrocarbon removal procedures on a production platform.
- **L - Pipeline:** Refers to problems with pipelines that run from platforms to the shore.
- **M - Measurement:** Refers to problems with the hydrocarbon measurement system that is used to assess royalty payments to the government.
- **H - H2S:** Refers to the presence of hydrogen sulfide and the improper handling of the gas during operation of the platform.

Figure 5-1 shows that the ratio of number of INCs issued, to the number of platforms in existence, has varied somewhat over time. There is a noticeable increase in the number of INCs issued in 1989 and 1990. It should be noted that Piper Alpha occurred in 1988 and South Pass Block 60 occurred in 1989 and this could have influenced the number of INCs issued in 1989 and 1990. In addition, MMS policy changes or U.S. economic conditions can affect the way platforms are inspected or operated. Either of these additional sources of variation might account for spikes in the number of INCs in 1989 and 1990.

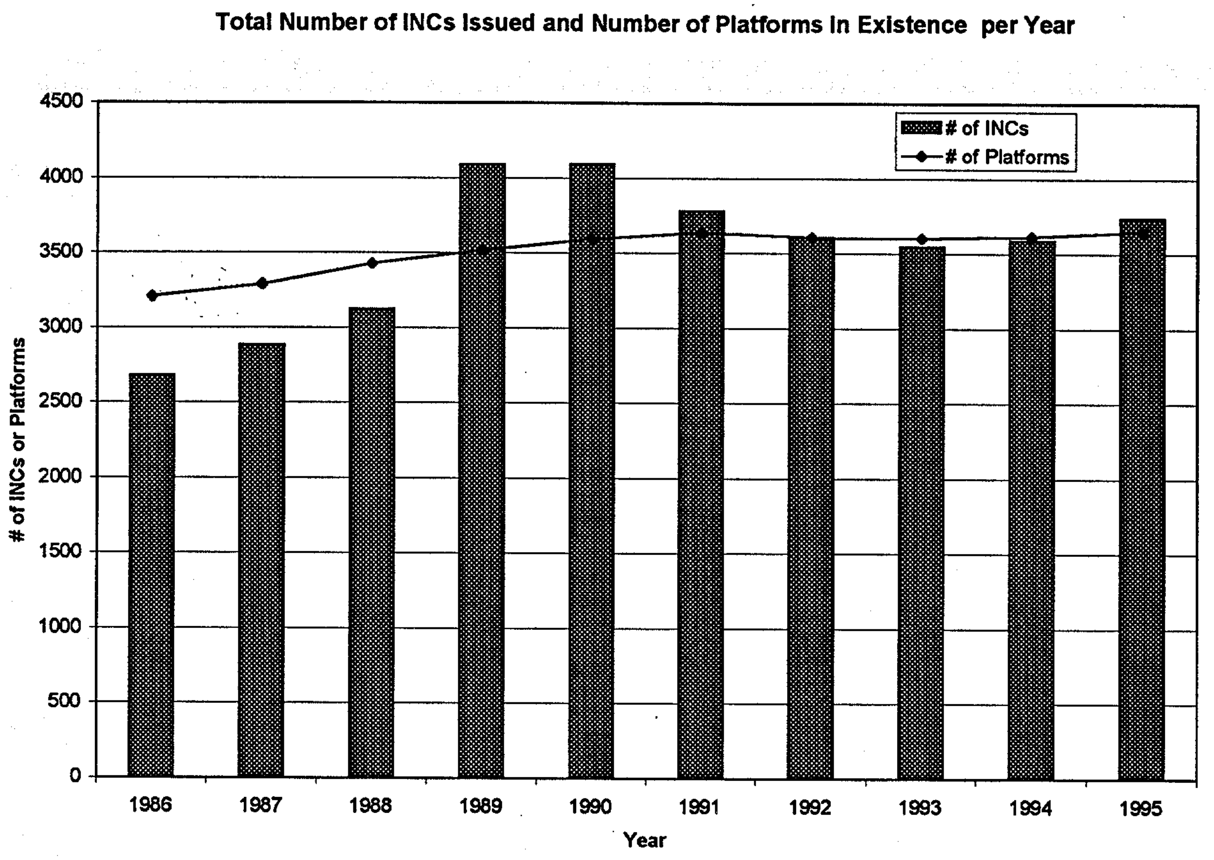

Figure 5-1 Number of platform INCs and number of platforms in existence from 1986-1995.

Also, within each broad category listed above, there are a number of individual sub-listings. For example, the most frequently issued INC is the G-110. G meaning "General" INC, and 110 referring to the following description:

> *"Does the lessee perform all operations in a safe and workmanlike manner, maintain all equipment in a safe condition, and take all necessary precautions to correct and remove any hazardous oil and gas accumulation or other health safety, or fire hazard?"*[60]

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[60] Minerals Management Service, U.S. Department of the Interior, "*National Potential Incident of Noncompliance (PINC) List and Guidelines,*" March 1995.

The following chart shows the variation in number of INCs issued by type over time. As can be seen from the chart, the increase in INCs in 1989 and 1990 can almost wholly be accounted for by an increase in the number of production INCs.

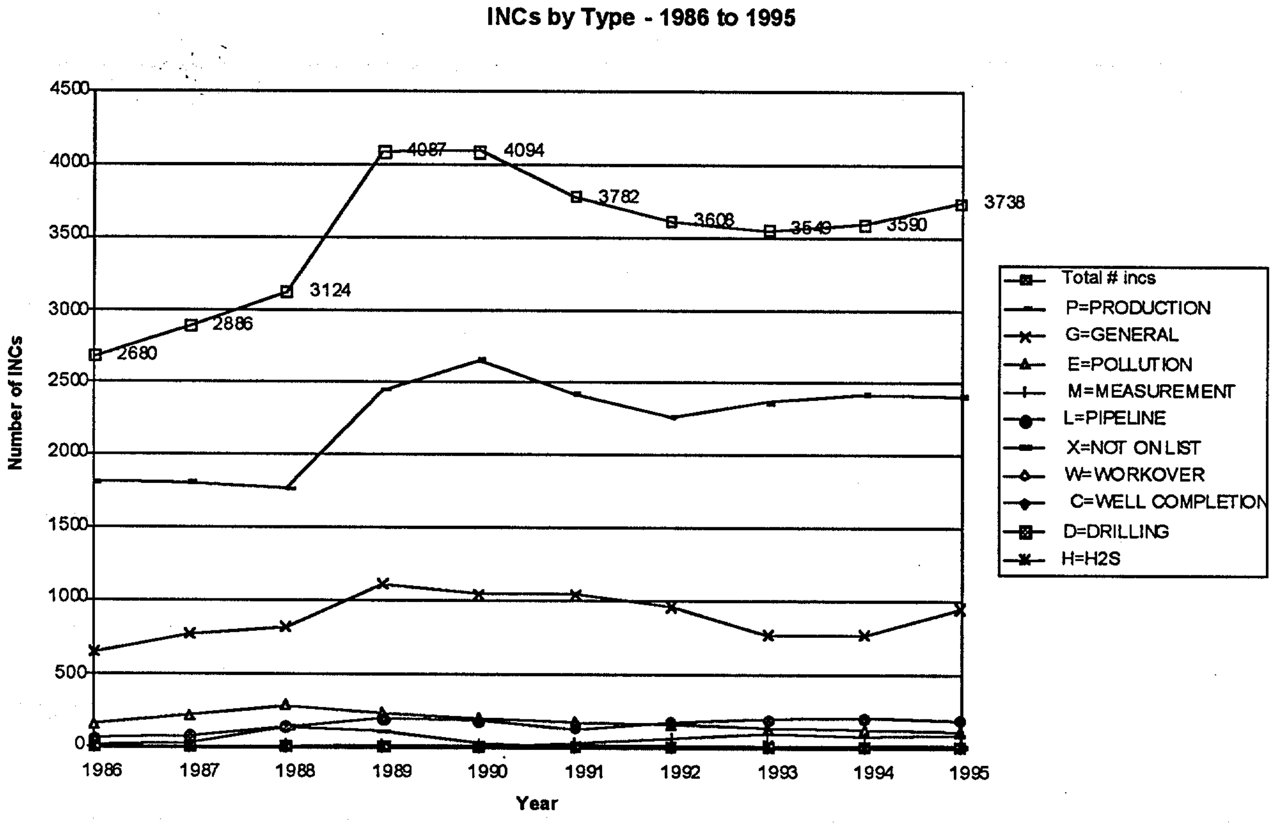

Figure 5-2 Number of INCs by type from 1986-1995.

5.4 Penalties and enforcement actions

If a platform operator receives an INC, there are three potential enforcement actions.[61] The codes for the enforcement actions are defined as follows:

- **W - Warning**: The operator is simply told to correct the problem.

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[61] Minerals Management Service, U.S. Department of the Interior, "*National Potential Incident of Noncompliance (PINC) List and Guidelines,*" March 1995.

- **C - Component shut-in**: the operator must shut down the piece of equipment that is in violation of the guidelines until the error is corrected. If the piece of equipment is vital to the operation of the facility, this could essentially shut down production.
- **S - Facility shut-in**: The entire platform is shut down until the problems noted during the inspection are corrected. This enforcement action is rarely used. From the perspective of the platform operator, the "S" can be a severe penalty.

Figure 5-3 shows a facility that was issued an “S” because a safety device had been illegally pinned out. The owner of this platform was well known to the inspectors because he had developed a reputation for poor maintenance and performance. As can be seen in the photo, platform rust is a significant problem, though it is not bad enough yet for the inspectors to shut the platform down entirely.

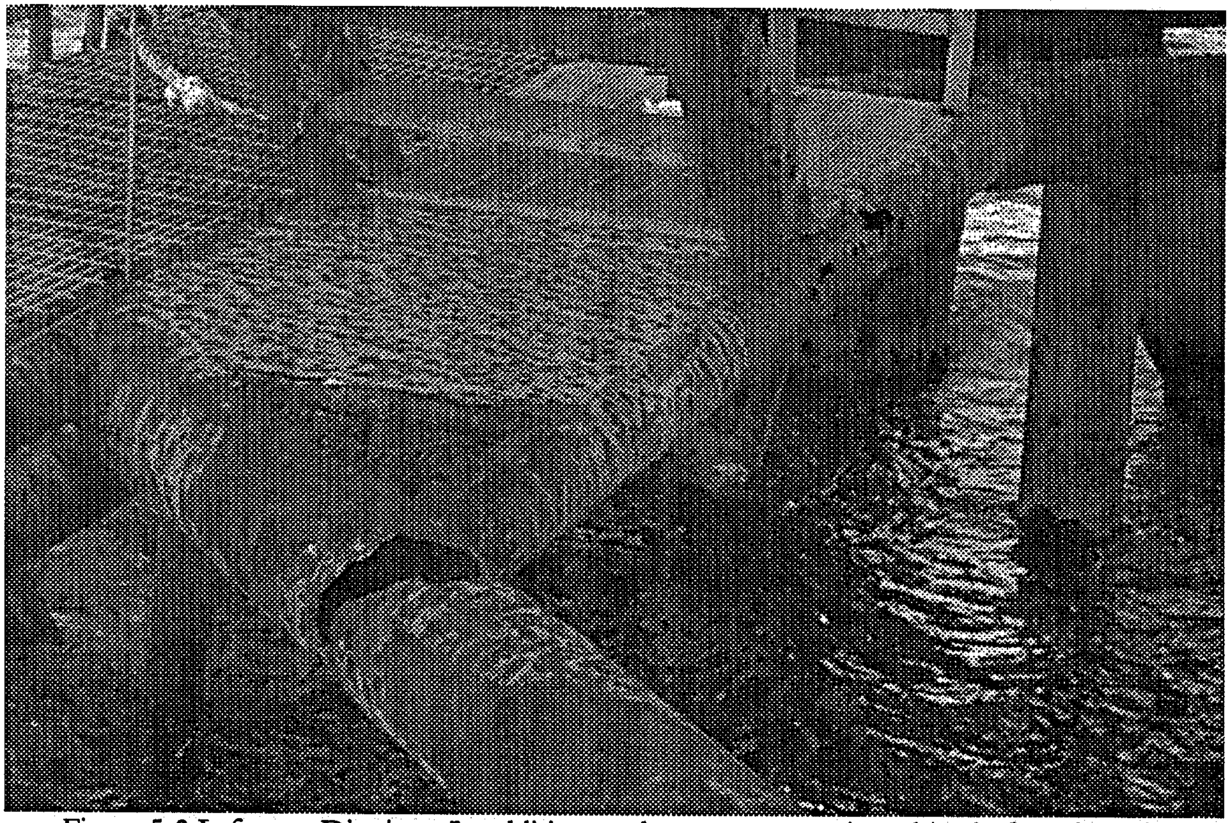

Figure 5-3 Lafayette District – In addition to the severe corrosion, this platform had an illegally pinned out safety device (See Figure 2-3). The corrosion did not cause a platform shut-in, but the pinned out safety device did.

5.5 Regulatory trends

Federal Law requires that the MMS inspect each production "facility" yearly. However, the MMS is facing an era of smaller budgets, fewer inspection personnel, and resources. In an effort to gain maximum advantage of the available resources, the MMS would like to redefine the term "facility" from an individual platform to include groups of structures connected by pipeline that send their production to a central processing facility. This is known as the mother-satellite-cluster concept. In practice, many of the platforms in the gulf are unmanned, and small, and send their production to larger manned platforms. A redefinition of what constitutes a "facility" could reduce the yearly number of required inspections by nearly 1,000. The MMS plans to implement a sampling program to determine which facilities in the cluster should receive an inspection.

In August 1997, OCS leassees and operators were informed that the MMS would conduct an Annual Performance Review (APR) of each operator. This annual review will examine: the operators history of compliance as it relates to the MMS Inspection Program; any action that MMS has forwarded for review or has resulted in a civil penalty; the operator's safety record as it relates to accidents and spills; and the operator's progress in implementing the SEMP. The APR does not require an operator to submit any additional information. By the end of 1998, 80 reviews occurred, were scheduled, or were pending.

5.6 Ongoing research[62]

Safety and pollution prevention research sponsored by MMS continues to focus on well control initiatives, as well as projects involving structural integrity issues, pipelines, produced fluids, safety devices (valves, blowout preventer equipment, etc.) and deepwater technological issues. Oil spill clean-up techniques have been another major focus for MMS research. Modeling of a deepwater release (e.g. a "blowout"), and the fates and effects of such a release have become high priority research as operations continue to move into deeper water. A joint effort by the MMS and industry is evaluating proposed research on deep plume modeling, surveillance, and remediation. Several of these studies are risk and reliability analyses.

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[62] Regg, J., *"Gulf of Mexico Activities and OCS Regulatory Trends,"* Excerpts from the Marine Safety Seminar, Texas A&M Sea Grant College, March 1998.

5.7 Summary

Many Federal Agencies have missions that could be impacted by an accident or spill at an offshore platform. However, the MMS is the agency responsible for inspecting platforms and ensuring that they are operated safely. There are many platforms to inspect, and each inspection can be very time consuming and complicated to perform. If a system is implemented whereby the "risky" platforms are inspected more frequently, a ranking of platforms based on historical accident and spill trends would be useful in prioritizing the inspections.

Chapter 6 - Data Sources, Risk Factor Descriptions and Sources of Error

Early efforts at risk assessment of platforms using operational or historic information were not successful. The primary cause for this was the lack of properly organized data. In 1985 the situation was as follows:

> *There is currently no single comprehensive source of statistics on US offshore accidents, and there are no reliable injury and fatality rate statistics for offshore operations beyond those compiled by the International Association of Drilling Contractors (IADC) for individual workplace accidents in offshore drilling. The lack of data makes it difficult to evaluate the level of safety achieved by oil and gas operators, safety-related equipment, and Federal regulation. It also makes it difficult to assess the effects on safety when changes are introduced (1985).*[63]

The situation today is improving, with respect to recordkeeping, over what existed in 1985. The MMS is now the lead organization for maintaining records of accidents and spills at offshore facilities and has published several good information papers.[64] Additionally, the information for accidents and spills and inspection reports is now kept in the same database instead of several separate locations.[65] However, there are still some very serious gaps in the reported information, and perhaps the most serious gap is that the platform or structure ID is not listed in the reports. This makes it very difficult to draw any conclusions regarding the operation of particular facilities, when those facilities are not clearly identified in the data.

There were two information sources for the models developed in this research: 1) databases maintained by the MMS that contained historical information on platform inspections and accidents and, 2) surveys of expert opinion of platform inspectors. The surveys will be discussed in

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[63] US Congress, Office of Technology Assessment, OTA-O-270, *"Oil and Gas Technologies for the Arctic and Deepwater"*, May, 1985

[64] *"Accidents Associated with Oil and Gas Operations, Outer Continental Shelf, 1956-1990"*, (OCS Report MMS 92-0058),*"Accidents Associated with Oil and Gas Operations, Outer Continental Shelf, 1991-1994"* (OCS Report 95-0052), *"Accidents Associated with Oil and Gas Operations, Outer Continental Shelf, 1995-1996"*, (OCS Report 98-0030)

[65] An Oracle database called TIMS "Technical Information Management System" is used to keep track of all information. In earlier years, accident and spill information was maintained separately from inspection records in a database called "OPAC" or "GOPAC."

Chapters 9 and 10. The risk factors in this research can broadly be defined as: 1) physical characteristics, e.g., the platform's distance to shore, age, etc.... 2) operational characteristics, e.g., how often it has been inspected and the platform's INC history, 3) accident and spill histories. Table 6-2 in Section 6.2, "Risk Factor Descriptions," is very important because in the remainder of the document, risk factor abbreviations or codes are often used in tables and figures. The reader will need to refer back to Table 6-2 for the definition of the abbreviations and codes.

6.1 Databases

Five distinct databases, covering the ten-year period from 1986 to 1995, were provided by the MMS. The databases contain physical characteristics, inspection histories, and accident histories of platforms. The common data element is the platform identification number (ID). [66] One database contained information on all platforms that were ever subject to inspection by the MMS,[67] two databases dealt only with information regarding platform inspections[68] and two dealt exclusively with accidents and spills.[69] Unfortunately, many of the columns were empty, or nearly so. The lack of consistent input of information made it necessary to delete some of the potential risk factors from the analysis.

Source[70]	Information
GOPAC-1	Accident and spills from 1986-1990
GOPAC-2	Accidents and spills from 1991-1995
TIMS - 1	Inspection histories from 1986-1995
TIMS - 2	All platforms that have ever existed
TIMS - 3	Platforms that have been inspected, but not received an INC from 1986-1995

Table 6-1 Description of databases used in research

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[66] There were well over 8,000,000 individual pieces of information (approximately 10,000 standard pages, at 800 entries per page) that were processed during the course of this analysis. The processing of all of this information was a non-trivial task given the way the information was stored. Unfortunately, some of the older databases did not maintain the platform ID number as an important data element. Much work was done to relate database information with a unique platform ID.

[67] Contained approximately 7,000 rows of information by 8 columns wide

[68] Contained approximately 45,000 rows by over 100 columns wide

[69] Contained approximately 1,000 rows by 100 columns.

[70] GOPAC refers to "Gulf of Mexico Offshore Pollution and Accidents." GOPAC was kept in Herndon, VA in D-Base format and in Excel spreadsheets. TIMS refers to "Technical Information Management System" and is an Oracle database that is primarily maintained by New Orleans District personnel.

Merging information from one database to another required a significant amount of data manipulation. The record headings on the accident and spill information were not the same as those used by the inspection database. The platform ID listed in the accident and spill databases was not the same format as that used in the inspection reports. Also, the two accident and spill databases were incomplete and there was often not a platform ID number associated with an accident or spill. Therefore, many of the accidents and spills that had partial information listed, i.e. lease number, block number, operator, etc. did not list the ID of the platform with which the spill or accident was associated. Of the 800 accidents and spills that occurred between 1986 to 1995, the following was found:

- Approximately 400 were associated with production platforms,
- 200 were associated with drilling, pipelines, or other activities
- 200 had no platform ID and it was not known what type of operation was occurring during the accident or spill.

The lack of information on the 200 accidents or spills which had no platform ID, but could have occurred on production platforms, necessitated a trip to the district office in New Orleans to physically go through each accident or spill paper form. Forty-three platforms were added to this analysis after the trip to New Orleans.

6.2 Risk factor descriptions

There were thousands of potential platform characteristics that could have been chosen as risk factors and used as inputs to the models. The TIMS data element dictionary contains over 2,600 data elements. The database fields were reviewed by employees of the MMS for the likelihood that the field is related to an increased risk of an accident or spill.[71] From this screening effort, a subset of approximately 100 risk factors was chosen. Table 6-2 lists the risk factor code names and the definition of the factors. This table does not show all of the data fields for the platforms, but shows only those data fields that were used in the risk analysis.[72] The underscore followed by an "l" (factor_l) refers to data for the lagged or previous year.

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[71] This review was in accordance with the three risk factor screening surveys that had been conducted in 1995 and 1996. The surveys are listed in Chapter 9 and in the Survey Appendix.

[72] I created what I call a "Grand Spreadsheet" which contains all of the information from the 5 databases. Not every data field in the "Grand Spreadsheet" was used in this analysis.

	Risk Factor Code	**Risk Factor Description**
1	#acc	Number of accidents in the prediction year.
2	#acc_l	Lagged number of accidents.
3	#EXP	Number of explosions
4	#EXP_l	Lagged number of explosions
5	#FAT	Number of fatalities:
6	#FAT_l	Lagged number of fatalities
7	#FIRE	Number of fires
8	#FIRE_l	Lagged number of fires
9	#INJ	Number of injuries
10	#INJ_l	Lagged number of injuries platform experienced
11	#ins_no_inc	Number of inspection without an inc. Thought to be an indication of conscientious platform operation.
12	#ins_no_inc_l	Lagged number of inspection without an inc. Thought to be an indication of conscientious platform operation.
13	#ins_w_inc	Number of inspection with an INC.
14	#ins_w_inc_l	Lagged number of inspection with an INC.
15	#MAJ	Number of major incidents
16	#MAJ_l	Lagged number of major incidents
17	#MIN	Number of minor incidents
18	#MIN_l	Lagged number of minor incidents
19	#SPLL	Number of spills in the prediction year.
20	#SPLL_l	Lagged number of spills:
21	#VESS	Number of vessel strikes
22	#VESS_l	Lagged number of vessel strikes
23	S_l	Lagged facility shut-ins. Thought to be an indication of severe equipment or operational problems.
24	AREA_CODE	Area code
25	BED_COUNT	Number of beds on the platform
26	BLOCK_NUMBER	Block code
27	C	Component shut-ins
28	C_l	Lagged component shut-ins. Thought to be an indication of faulty equipment on a platform.
29	Co_exp	Company experience on that particular platform. This is calculated by determining who the owner of record is on January 1 of the desired year and then searching backward in time to see when they first began operation on the OCS.
30	Co_exp_l	Lagged company experience
31	COMGL_PROD_FLAG	Commingling production flag. Does production from other platforms arrive at this platform?
32	COMPLEX_ID_NUM	Platform ID
33	COMPRESSOR_FLAG	Is a compressor present?
34	CRANE_COUNT	Number of cranes on the platform
35	DISTANCE_TO_SH	The distance the platform is to shore - miles
36	DISTRICT_CODE	District ID: 1= New Orleans, 2= Houma, 3= Lafayette, 4= Lake Jackson, 5= Lake Charles, 6= Corpus Christi
37	E	Pollution INCs
38	E_l	Lagged pollution INCs
39	FIRED_VESSEL_FL	An indicator of whether or not a platform has a fired (heated) vessel. Thought to perhaps be an indicator of increased fire risk.

40	G	General INCs
41	G_l	Lagged general INCs
42	GAS_FLARING_FLAG	Is gas being flared?
43	GAS_PROD_FLAG	Is gas being produced?
44	H	H2S INCs
45	H_l	Lagged H2S INCs
46	HELIPORT_FLAG	Is a heliport present?
47	INCS/COMP	Ratio of INCs/components
48	INST_YEAR_DATE	Year installed
49	L	Pipeline INCs
50	L_l	Lagged pipeline INCs
51	LATITUDE	Latitude
52	LEASE_NUMBER	Lease number
53	LONGITUDE	Longitude
54	M	Measurement INCs
55	M_l	Lagged INCs
56	MAJ_CMPLX_FLAG	Is the facility a "major complex" i.e. Does it have at least 6 completions and more than 2 pieces of production equipment.
57	NUM_COMP	Number of components. A component is a device such as a compressor, storage tank, isolation valve, production meter, or many other devices.
58	OIL_PROD_FLAG	Is oil produced?
59	Op_exp	Operator experience on that particular platform. This is calculated by determining who the operator of record is on January 1 of the desired year and then searching backward in time to see when they became the operator of record.
60	Op_exp_l	Op_exp_l refers to the operator's experience on that particular platform in the year before an accident or spill occurred.
61	P	Production INCs
62	P_l	Lagged production INCs
63	PLATFORM_AGE	Platform age: the age of the platform for the year in which a prediction is desired. Calculated by subtracting the installation year from the prediction year.
64	REMOVL_YEAR_DATE	Year removed
65	S	Facility shut-ins
66	SLOT_COUNT	The total number of drilling slots that a platform was designed to handle. Surrogate for platform size.
67	SLOT_DRILL_COUNT	The number of drilling slots on platforms that have been used. (Surrogate for platform activity).
68	STORE_TANK_FLAG	Is a storage tank present?
69	SUL_PROD_FLAG	Is sulfur produced?
70	tot_inc	Total number of INCs
71	tot_inc_l	Lagged total number of INCs: thought to be an indication of poor performance.
72	W	Warnings
73	W_l	Lagged warnings
74	WATER_DEPTH	The depth of the water in which the platform is located (feet).
75	YR	Data year

Table 6-2 Description of risk factors used in models

6.3 Sources of error

As stated earlier, about 157 instances of an accident or spill (20% of the 800 that occurred)[73] could not be included in this analysis because of a lack of a platform ID number. Therefore, the data in this analysis must be treated as a sample of the entire population. Additional error sources include:

- Lack of information
  - Data fields poorly populated in databases
  - Accidents and Spills not fully documented
- Information not tracked properly in databases
  - Wrong information
  - Data entry errors
  - Inconsistencies between districts and or inspectors
- Wrong assumptions in analysis
  - Interpreting causality when it does not exist
  - Not including information when it should have been included

An example of what is likely a data entry error is shown below in Figure 6-1. This error was caught when the platform locations were plotted and contour intervals were set up for water depth and distance to shore. The boxes with dots inside them are the locations of platforms in the Gulf of Mexico. The two platforms that have arrows pointing toward them are separated by approximately 10 miles yet have vastly different distances from shore listed in the databases. The true distance to shore for both platforms is a little over 100 miles. Therefore, the information for platform #23,766 is likely in error. Wherever possible, the information was checked for errors. An effort was made to fix errors on those platforms that had an accident or spill. It was necessary to take this extra step because a small number of errors on the platforms that have accidents and spills can have a great deal of leverage in the modeling effort because of the rarity of accidents and spills.

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[73] Three individuals went through a stack of papers about 4 1/2 feet high, for two days, in order to hand construct the information for 43 platforms. That is, 43 accidents or spills were associated with production platforms out of the 200 of unknown association. This left 157 accidents or spills that could not be included in this analysis. This lack of information is a substantial source of error that should be corrected in the future.

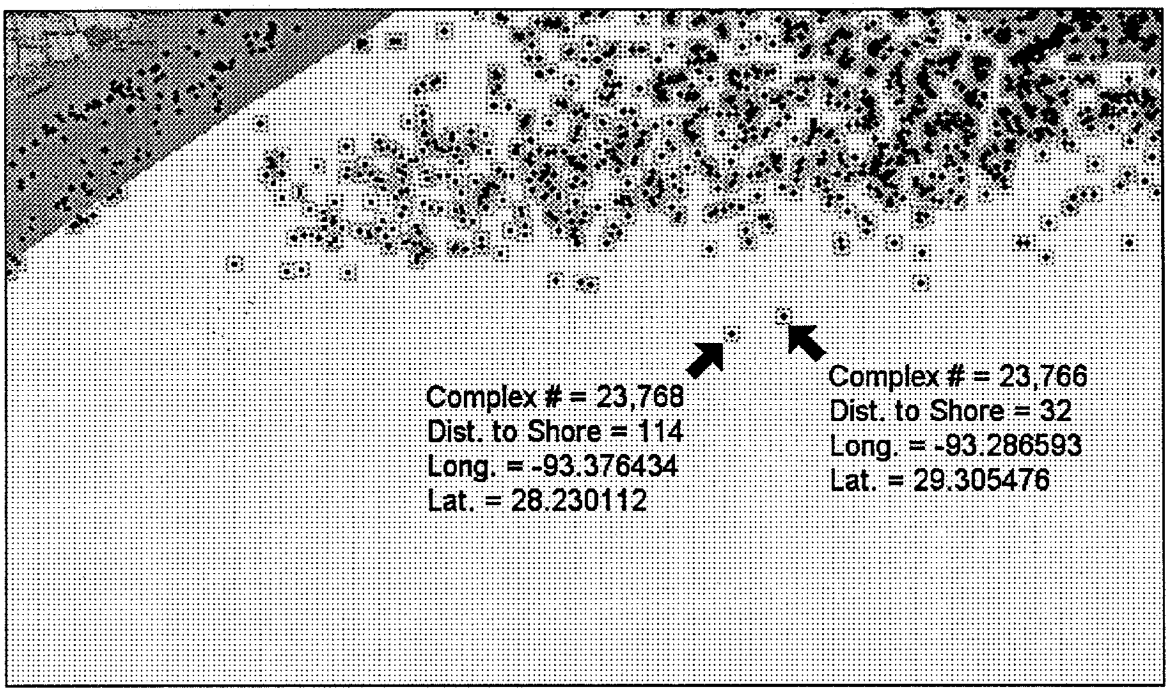

Figure 6-1 Example of data entry error. The small boxes with dots in them are the platforms. The shoreline is in the upper left corner. The distance separating the two platforms is approximately 10 miles. The actual distance to shore is a little over 100 miles.

6.4 Summary

The MMS should continue their efforts to improve both their data acquisition, data entry, and database management efforts. Improvements in the databases would greatly simplify the analysis of the data and allow many analyses to be performed on a routine basis, rather than as a one-time study. The MMS should go through the databases as least once and check all 4,000 platform records for errors. This would eliminate some of the sources of error and increase confidence in the conclusions drawn by this dissertation and subsequent analyses.

Chapter 7 - Data Statistics

When performing an analysis of a large data set, one of the first things the analyst should do is summarize the statistics of each risk factor individually, before constructing multi-variate regression models or performing other statistical analyses. The reason for this is pointed out in the quote below:[74]

> *"Data analysis should involve more than single-variable statistics. However, inspection of these statistics for each variable should be a routine part of any data analysis. This gives the researcher an extra chance to check for data errors that might escape detection in a multiple-variable analysis. Additionally, they help the researcher in understanding the variables to be used in further analysis."*

To illustrate what is meant by "single-variable statistics," two risk factors (platform age and number of INCs) are chosen and presented in Figures 7-1 and 7-2. Figure 7-1 shows a histogram of the platform ages for the ten-year period from 1986-1995. The histogram shows that the ages are not normally distributed over this period, i.e. there seem to be two peaks (bi-modal distribution). This may be due to fluctuations in the number of platforms installed or taken out of service due to market conditions. The average age of platforms during this period was 14 years.

In Figure 7-2, the distribution of INCs per platform in each year over the ten-year period from 1986-1995 is shown. Most platforms received few INCs, but there is a highly skewed distribution. On the very far tail of the distribution, some platforms received more than 60 INCs in a year, while the average number of INCs a platform received for any one year over this period was about one.

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[74] H.F. Weisber, J.A. Krosnick, and B.D. Bowen, *"An Introduction to Survey Research, Polling, and Data Analysis,"* SAGE Publications Inc., 1996, p. 216.

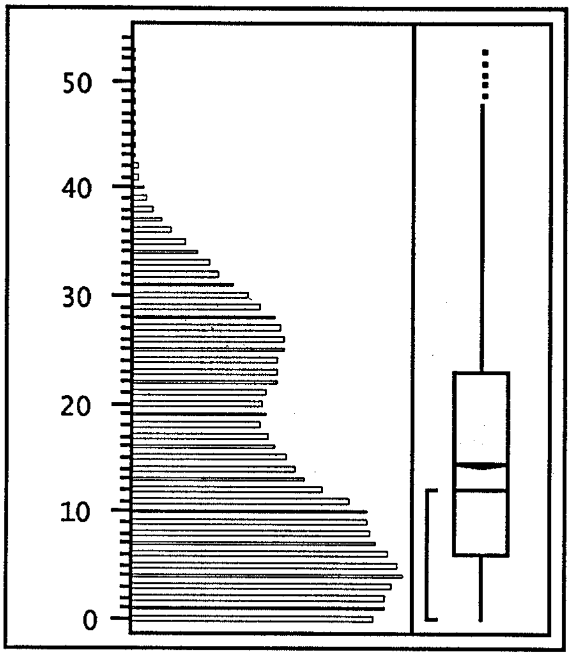

Figure 7-1 Platform ages from 1986 - 1995

Maximum	53
Median	12
Minimum	0
Mean	14.46
Std Dev	10.36
N	33402

Table 7-1 Age histogram statistics

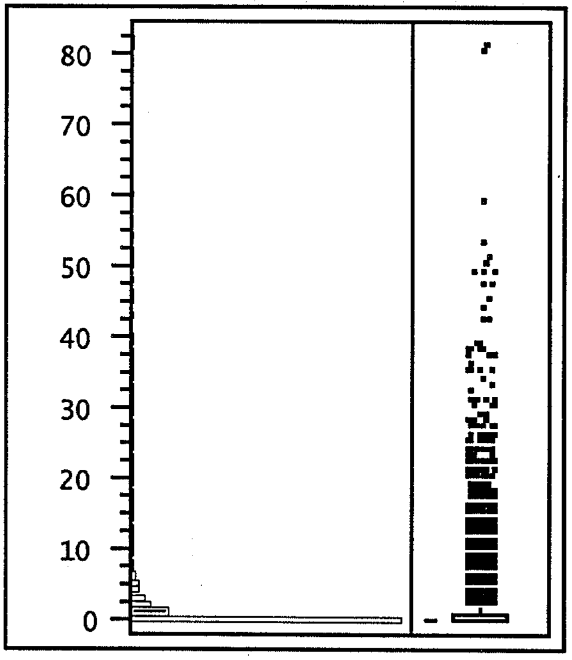

Figure 7-2 Number of INCs per year, 1986-1995

Maximum	82
Median	0
Minimum	0
Mean	1.04
Std Dev	3.00
N	33472

Table 7-2 INC histogram statistics

The highly skewed distribution of INCs noted in Figure 7-2 leads to several questions:

1. Do the platforms that have many INCs in a year have a disproportionate number of accidents and spills?
2. Is there a statistically significant difference in the average number of INCs received between platforms that have accidents and spills and those that do not?
3. If so, is it possible to build a predictive model based just on this one factor?
4. Are there other reasons that might cause a highly skewed distribution of INCs, other than simply poor performance? For example, a very large platform, that has a lot of components, drilling slots, etc… would be expected to have a larger total number of INCs simply because there is more to inspect.

The rest of Chapter 7 answers the four questions above and summarizes the risk factor statistics. The list that follows shows the sequence of calculations and analyses that are presented in the remainder of the chapter.

1. If possible, the risk factors were plotted geographically.[75]
2. Odds ratios were computed for binary information. The results were checked for significance with a chi-square test.
3. Means tests were conducted to determine if the average value of a risk factor differed on those platforms that experienced an accident or spill compared to those that did not. The results were tested for significance using the normal (z) table.
4. Logistic regressions were run for each risk factor. The results are both plotted and tabulated in the Data Appendix.
5. The risk factors were screened for correlation using simple linear correlations between risk factors. The results are tabulated in the Data Appendix.
6. The risk factors are ranked in importance based on the results of the individual risk factor analyses.

There are a very large number of tables, plots, graphs, etc… associated with the individual risk factors in this research. As much as possible, only summary information is presented in the body of the dissertation. Raw data is included in a separate document referred to as the "Data Appendix." In this separate document the raw correlation matrices, individual logistic regression tables, plots, etc… are printed. The reader is referred to this document if they wish the check the source of the summary tables presented here. Another separate document called the "Survey

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[75] Using "*MapInfo Professional - Version 4.12 for Windows 95.*" MapInfo Corporation, Troy, NY.

Appendix" includes summary information for the 3 surveys administered by the MMS in 1995 and 1996 and the survey administered in 1998 which was used to construct the expert model.

7.1 GIS display of accidents and spills

Geographic plots can often point out relationships, dependencies, or errors that numeric analysis alone might miss. Figure 6-1 showed that a geographic plot was very useful in checking whether errors are present in the data for some risk factors. Additionally, if a relationship is noted in a mathematical analysis, it can perhaps be confirmed graphically if the information is plotted based on location.

Figures 7-3 to 7-6 plot the location of accidents and spills in the Gulf of Mexico for the ten-year period from 1986 to 1995. The "pies" or "dots" in the plots are graduated in size according to the number of accidents or spills that occurred on that platform over the ten-year period. The gray squares are the platform locations. Figures 7-3 and 7-4 show that some platforms have experienced many accidents and spills, while most of the platforms have experienced no accidents or spills. Figure 7-5 shows that in general, the same platforms that have accidents also have spills. Figure 7-6 plots accidents and spill in relation to the location of "major complexes" (the diamonds are "major complexes," the pies are the number of accidents and spills). As the figure shows, there appears to be a relationship between the number of accidents and spills and whether or not a platform is a "major complex." This relationship is shown to be very strong and confirmed mathematically in the odds ratio section which follows.

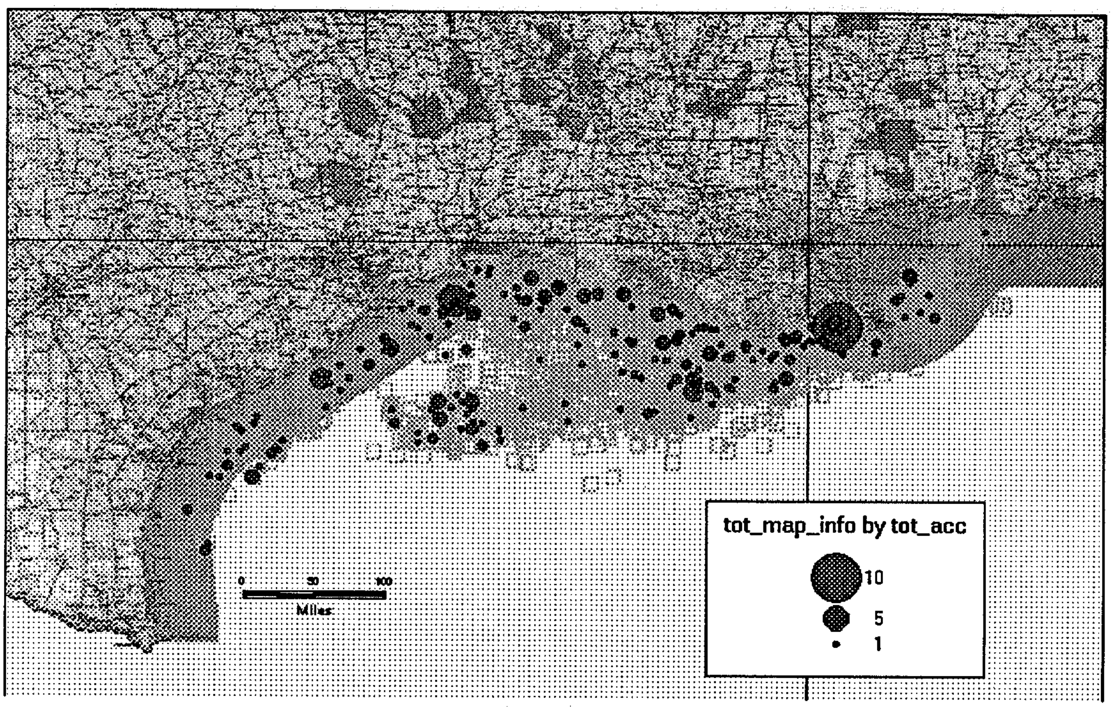

Figure 7-3 Accidents by location in the Gulf of Mexico - 1986 to 1995

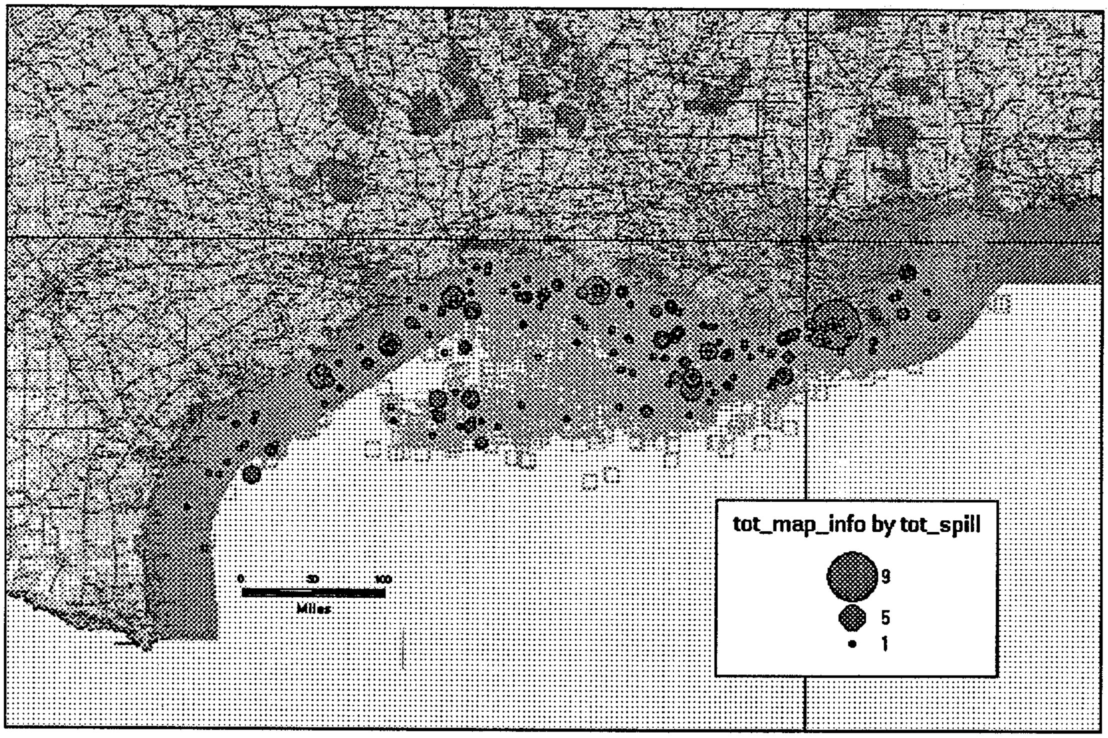

Figure 7-4 Spills by location in the Gulf of Mexico- 1986 to 1995

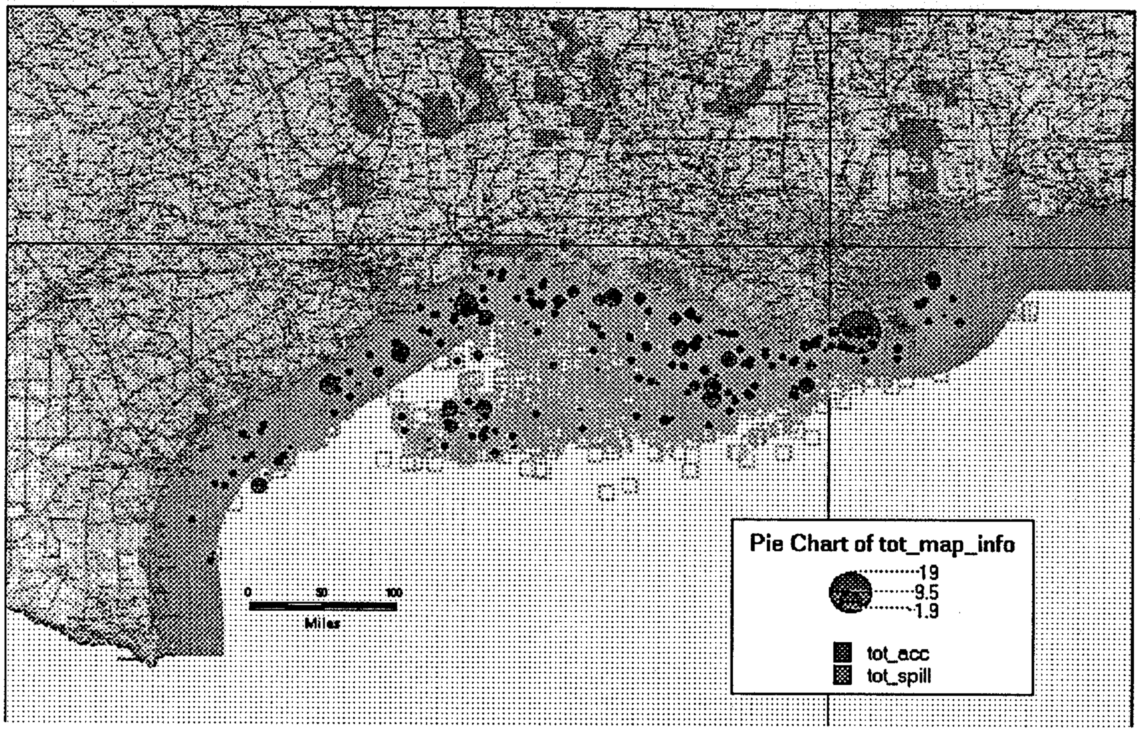

Figure 7-5 Both accidents and spills by location in the Gulf of Mexico - 1986 to 1995

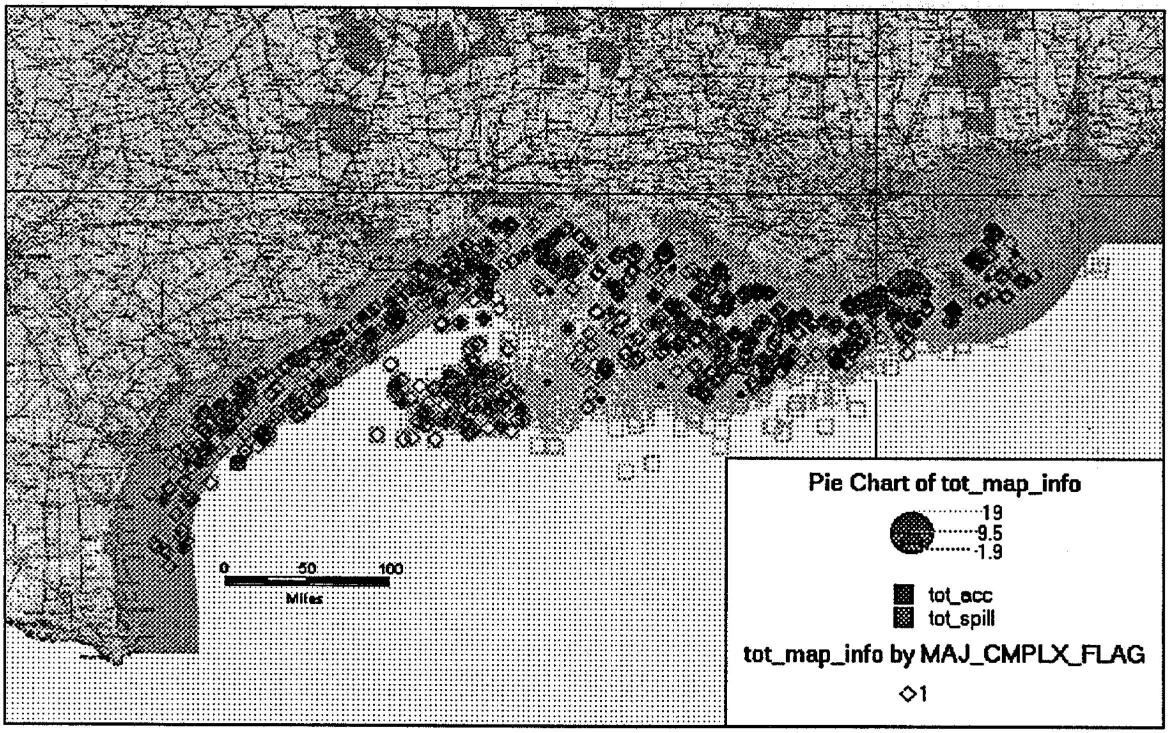

Figure 7-6 Accidents and spills versus major complexes- 1986 to 1995

7.2 Odds ratios

For non-monotonic data, e.g. binary data, one measure of association is developed using contingency tables and "odds ratios." Many of the risk factors are binary in nature, i.e. a "yes" or "no" is listed in the database for the presence of storage vessels, fired vessels, etc... The "odds" in this instance are actually the odds that an accident or spill occurred during the 10-year period from 1986-1995 if one of the binary risk factors is a "yes." These can be thought of as "bettin' odds." For example, major complexes are 12.6 times as likely as non-major complexes to have experienced an accident during this 10-year period. Major complexes are also 12.6 times as likely to have experienced a spill. In addition, if a platform has experienced a spill in one year, it is much more likely to experience an accident or spill in the next year (odds ratio of 7 or higher). The same holds true if a platform has experienced an accident, i.e. the odds are much greater that the platform will experience another accident or spill at some point during the ten years of 1986-1995. The odds ratio could not be calculated for accidents and spills in the same year because every platform that had an accident during the ten-year period also had a spill at some point during that ten-year period (the divisor would therefore be zero). However, not every platform that had a spill also had an accident. The "chi-square" value in Tables 7-4 and 7-5 indicates the likelihood of obtaining the same result by chance alone. For 1 degree of freedom, and a chi-sq. of 7.5 or higher, the probability is less than .005 (1/2 of 1%) that this result could happen by chance alone. All of the chi-square values are much higher than 7.5. Therefore, all of the results are statistically significant at least at the .005 level.

	#acc By COMPRESSOR_FLAG			
		COMPRESSOR_FLAG		
	Count	n	y	Odds Ratio
#acc	n	23703	6441	6.39
	y	122	212	

Table 7-3 Data for odds ratio calculation

$$\text{Odds\_Ratio} = \frac{212 \times 23703}{6441 \times 122} = 6.39$$

Equation 7-1 Example of odds ratio calculation

Degrees of Freedom = 1		
Significance: All are significant at the .005 level or better		
Factor	**Odds Ratio**	**chi-square**
#acc By MAJ_CMPLX_FLAG	12.59	80599.83
#acc By #SPLL_l	9.00	1956.64
#acc By #acc_l	7.47	1986.24
#acc By COMPRESSOR_FLAG	6.39	23402.82
#acc By HELIPORT_FLAG	6.31	33778.22
#acc By STORE_TANK_FLAG	4.77	9931.07
#acc By GAS_FLARING_FLAG	4.16	3109.71
#acc By FIRED_VESSEL_FL	3.46	8637.57
#acc By OIL_PROD_FLAG	3.18	8791.66
#acc By GAS_PROD_FLAG	3.17	11270.89
#acc By SUL_PROD_FLAG	1.92	21.24
#acc By co_ming_prod	1.40	123.72

Table 7-4 Odds ratios for accidents-data from 1986-1995

Degrees of Freedom = 1		
Significance: All are significant at the .005 level or better		
Factor	**Odds Ratio**	**chi-square**
#SPLL By #SPLL_l	12.86	3003.87
#SPLL By MAJ_CMPLX_FLAG	12.61	80964.25
#SPLL By #acc_l	10.28	2963.35
#SPLL By COMPRESSOR_FLAG	6.77	25396.38
#SPLL By HELIPORT_FLAG	6.74	36998.67
#SPLL By STORE_TANK_FLAG	5.68	12866.62
#SPLL By GAS_FLARING_FLAG	4.87	3984.70
#SPLL By OIL_PROD_FLAG	4.12	13850.95
#SPLL By GAS_PROD_FLAG	3.13	11043.06
#SPLL By SUL_PROD_FLAG	2.94	61.16
#SPLL By FIRED_VESSEL_FL	2.76	5560.95
#SPLL By co_ming_prod	2.05	583.52

Table 7-5 Odds ratios for spills-data from 1986-1995

7.3 Means tests

A means test using Equation 7-2 was conducted for all of the risk factors to see if there was a difference between those platforms that had an accident or spill and those that did not.

$$z = \frac{\overline{x_1} - \overline{x_2}}{\sqrt{\frac{\sigma_1^{\,2}}{n_1} + \frac{\sigma_2^{\,2}}{n_2}}}$$

Equation 7-2 Large sample test of hypothesis of means

Where:

$\overline{x_1}$ = The average value for the risk factor that had an accident or spill.
$\overline{x_2}$ = The average value for the risk factor that did not have an accident or spill.
σ_1 = The standard deviation for the factor that had an accident or spill.
σ_2 = The standard deviation for the factor that did not have an accident or spill.
n_1 = The number of observations for the factor that had an accident or spill
n_2 = The number of observations for the factor that did not have an accident or spill.

Strictly speaking, the more conservative small sample test could have been used for several of the years in this study. There were approximately 157 accidents or spills over the 10-year period (1986-1995) which could not be included in this analysis because of a lack of the platform ID number. If these accidents and spills were included in this analysis, then for every year, the true population variance is known, and the z table (large sample test) can be used.[76] However, since some of the platforms are missing from the analysis, the data is a sample of the total population of platforms. The normal (or "z") table was chosen because of the ease of computation given the large number of risk factors that were processed, and the fact that information was not uniform for each risk factor. This would necessitate a much more complicated data processing methodology incorporating varying degrees of freedom for numerous scenarios. However, the reader is cautioned that if the z value is close to the level of significance that the reader considers important, the t-table should be used because t-tests are more conservative. Equations 7-3 and 7-4 show how

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[76] H.F. Weisber, J.A. Krosnick, and B.D. Bowen, "*An Introduction to Survey Research, Polling, and Data Analysis*", SAGE Publications Inc., 1996, p. 242.

the z value was determined for the total number of INCs versus accidents and spills using data for 1986.

$$z_{\text{accident}} = \frac{1.78-.877}{\sqrt{\frac{2.798^2}{82}+\frac{2.389^2}{2866}}} = 2.902$$

Equation 7-3 z-value for accident, based on total number of INCs, for 1986

$$z_{\text{spill}} = \frac{1.766-.8791}{\sqrt{\frac{2.733^2}{77}+\frac{2.391^2}{2871}}} = 2.8191$$

Equation 7-4 z-value for spill, based on total number of INCs, for 1986

If the z value is greater than 1.96, you can say with 95% confidence that the means are different. As you can see above, the z values are much greater than 1.96. Therefore, you are relatively assured that there is a statistically significant difference in the number of INCs for platforms that have accidents and spills in 1986 (at least 95% confidence) compared to platforms that did not have an accident or spill. The same calculation is performed in Equations 7-5 and 7-6 to see if there is a relationship between platform age and accidents and spills.

$$z_{\text{accident}} = \frac{12.704-12.505}{\sqrt{\frac{6.644^2}{81}+\frac{9.212^2}{2860}}} = .262$$

Equation 7-5 z-value for accidents, based on platform age, for 1986

$$z_{\text{spill}} = \frac{12.737-12.505}{\sqrt{\frac{6.496^2}{76}+\frac{9.211^2}{2865}}} = .304$$

Equation 7-6 z-value for spill, based on platform age, for 1986

Equations 7-5 and 7-6 show that there is little discernible difference between the ages of platforms that have accidents and spill and platforms that do not have accidents and spills. A test of means was also conducted as in Equation 7-7 for lagged risk factors.

$$z_{accident\_1987} = \frac{\overline{x_1} - \overline{x_2}}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}}_{Using\_1986\_data}$$

Figure 7-7 Computation of lagged z values

For the 10 years from 1986 – 1995, there would be nine lagged z values, corresponding to the years for which lagged information could be computed.

Table 7-6 summarizes means tests that were conducted for all of the risk factors. The counts are the number of times over the ten-year period that the means were statistically different at the 95% confidence level. The following points should be noted about the information in Table 7-6.

1. Accidents and spills as risk factors are closely related. For the 10-year period 1986-1995, if a platform has an accident, 10 out of 10 times the average number of spills on those same platforms was different.
2. The reverse is also true. 10 out of 10 times, if a platform had a spill, the average number of accidents that it experienced was different.
3. The platform characteristics, e.g. whether the platform is a major complex, has a large number of components, large slot count, etc… are closely related to the likelihood of an accident or spill. 19 out of 20 times the number of components was larger on platforms that experienced accidents or spills.
4. 19 out of 20 times the slot counts were higher on platforms that had accidents or spills.
5. Only 4 out of 20 times was the platform age higher on platforms that had accidents and spills.
6. Zero times out of 20 were the number of explosions, fatalities and vessel strikes statistically different on platforms which had an accident or spill compared to those that did not. This seems to indicate that these risk factors will not be particularly helpful in the multivariable logistic regression models.
7. The lagged performance traits are less closely related with an accident or spill. The best "lagged" predictor is whether the platform had an accident or spill in the prior year.

95% confidence that means are different for each listed risk factor.						
10 points for performance traits in the current year, 9 for the lagged year.						
Risk Factor	**Accident occurred** **Count of means are different**		**Spill occurred** **Count of means are different**		**TOTAL**	
	NO	YES	NO	YES	NO	YES
#acc	0	10	0	10	0	20
#SPLL	0	10	0	10	0	20
COMPRESSOR_FLAG	0	10	0	10	0	20
MAJ_CMPLX_FLAG	0	10	0	10	0	20
#ins_w_inc	1	9	0	10	1	19
HELIPORT_FLAG	0	10	1	9	1	19
NUM_COMP	0	10	1	9	1	19
SLOT_COUNT	0	10	1	9	1	19
OIL_PROD_FLAG	1	9	1	9	2	18
SLOT_DRILL_COUNT	0	10	2	8	2	18
CRANE_COUNT	1	9	2	8	3	17
STORE_TANK_FLAG	1	9	2	8	3	17
C	2	8	2	8	4	16
DISTANCE_TO_SH	1	9	3	7	4	16
FIRED_VESSEL_FL	0	10	4	6	4	16
Tot_inc	2	8	2	8	4	16
GAS_PROD_FLAG	2	8	3	7	5	15
P	3	7	2	8	5	15
WATER_DEPTH	2	8	5	5	7	13
#MIN	5	5	4	6	9	11
#acc_1	4	5	4	5	8	10
#ins_w_inc_1	4	5	4	5	8	10
#SPLL_1	4	5	4	5	8	10
G	4	6	6	4	10	10
W	5	5	5	5	10	10
C_1	5	4	4	5	9	9
GAS_FLARING_FLAG	6	4	5	5	11	9
Tot_inc_1	4	5	5	4	9	9
SUL_PROD_FLAG	6	4	6	4	12	8
#FIRE	5	5	8	2	13	7
#FIRE_1	6	3	5	4	11	7
#INJ	6	4	7	3	13	7
P_1	5	4	6	3	11	7
S_1	7	2	4	5	11	7
E	7	3	7	3	14	6
S	7	3	7	3	14	6
co_exp	8	2	7	3	15	5
M	8	2	7	3	15	5
M_1	7	2	6	3	13	5
#INJ_1	7	2	7	2	14	4
#MIN_1	7	2	7	2	14	4
co_exp_1	7	2	7	2	14	4
COMGL_PROD_FLAG	7	3	9	1	16	4
PLATFORM_AGE	9	1	7	3	16	4
BED_COUNT	8	2	9	1	17	3
E_1	8	1	7	2	15	3

L_1	8	1	7	2	15	3
W_1	7	2	8	1	15	3
#ins_no_inc	9	1	9	1	18	2
G_1	8	1	8	1	16	2
H	9	1	9	1	18	2
#ins_no_inc_1	9	0	8	1	17	1
#MAJ	9	1	10	0	19	1
DISTRICT_CODE	9	1	10	0	19	1
op_exp	9	1	10	0	19	1
op_exp_1	8	1	9	0	17	1
#EXP	10	0	10	0	20	0
#EXP_1	9	0	9	0	18	0
#FAT	10	0	10	0	20	0
#FAT_1	9	0	9	0	18	0
#MAJ_1	9	0	9	0	18	0
#VESS	10	0	10	0	20	0
#VESS_1	9	0	9	0	18	0
H_1	9	0	9	0	18	0
INCS/COMP	10	0	10	0	20	0
L	10	0	10	0	20	0

Table 7-6 Summary of means tests for risk factors - 1986 to 1995

7.4 Individual risk factor logistic models

It appears from the means tests that some of the risk factors might be credible predictors of the likelihood of accidents or spills on their own. Therefore, logistic regression models were constructed using each single risk factor. In Chapter 8, multi-variable logistic regressions will be performed. However, single factor regressions can be very informative and interesting in their own right, which is why they are computed in this section. Tables 7-7 to 7-10 show the results of single factor logistic regressions for the risk factors "age" and "total number of INCs" versus the likelihood of an accident or spill. These tables follow the general format that will be used to display regression data in the rest of the dissertation. The tables are typical of the way most software packages present the results of logistic regressions.[77]

A note must be made regarding the results one obtains from running the regressions. For ordinal information (characterized by discrete ordered levels in the dependent variable) the software fits the logistic equation as shown in Equation 7-7. The ordinal logistic model fits one regression coefficient for each independent variable, with the intercepts corresponding to the different levels

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[77] The software used in this dissertation is called JMP. The description of the output tables is from: *JMP - Statistics and Graphics Guide Version 3,* from Statistics Discovery Software, SAS Institute, INC., Cary, NC.

of the dependent variable.[78] Tables 7-7 to 7-10 show the tests of significance of the regression coefficients, and the overall fit of the model. One should note that there is more than one intercept, and that this is not an error. The intercepts correspond to the number of accidents or spills that occur (ordinal levels) in a prediction year. Note that in any one 24-hour period, the number of accidents and spills are considered binary. However, over the course of a year, a platform may experience more than one accident or spill.

$$P(y_j) = F(\alpha_j + X\beta)$$

$$\text{for } j=1,\ldots,r$$

$$\text{Where: } F(X) = \frac{1}{1+e^{-X}}$$

Equation 7-7 Ordinal logistic regression

7.5 Description of regression output

In order to interpret Tables 7-7 to 7-10, the results of the regression table must be described.

1. Prob>Chi-sq.- is the observed significance probability, often called the p-value, for the chi-square test. It is the probability of getting, by chance alone, a chi-squares value greater than the one computed. Models are often judged significant if this probability is below .05.
2. R-sq. - is the proportion of the total uncertainty that is attributed to the model fit. The difference between the log likelihood from the fitted model and the log likelihood that uses horizontal lines is a test statistic to examine the hypothesis that the factor variable has no effect on the response. The ratio of this test statistic to the background log likelihood is subtracted from 1 to calculate R-sq. One should note that r-squared values for logistic regressions are seldom very large. They should not be interpreted the same way one would interpret an r-squared for a linear regression, where good fits are often characterized by r-squared values well over .5.
3. Parameter Estimate - is the parameter (also called the "beta") that will be multiplied by the independent variable in the logistic equation to generate the probability estimate. One note about the parameters listed in Tables 7-7 to 7-10. The software predicts the probability of NOT ACCIDENT or NOT SPILL.[79] Therefore, if one puts the listed parameters into the logistic equation, the probability OF ACCIDENT is 1-(P (not accident)).

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[78] *JMP - Statistics and Graphics Guide Version 3,* from Statistics Discovery Software, SAS Institute, INC., Cary, NC, p. 545.

[79] *JMP - Statistics and Graphics Guide Version 3,* from Statistics Discovery Software, SAS Institute, INC., Cary, NC, p. 216.

4. DF - is the degrees of freedom for each source of variation.
5. Observations (or Sum Wgts) - The number of observations in the sample. Note that in the following tables the number of observations is over 30,000. The tables are the regressions for all platforms in existence over the 10-year period for which data is available and a calculation could be made. There were actually about 3,500 platforms in existence each year, therefore with perfect information, the number of observations would be 35,000.
6. Response - The response variable. What you are trying to predict. Also referred to as the dependent variable, or prediction year variable.
7. Term - Refers to the intercept(s) in the regression and the risk factor used to predict the response. The risk factor is also referred to as the independent variable, or regressor variable depending on the context.

Converged by Objective Response accidents				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	59.0718	1	118.1436	<.0001
Full	1871.6544			
Reduced	1930.7263			
RSquare (U)		0.0306		
Observations (or Sum Wgts)		30524		
Term	Parameter Estimates	Std Error	ChiSquare	Prob>ChiSq
Intercept	4.66619443	0.0591415	6225	0.0000
Intercept	7.58280661	0.2318067	1070.1	<.0001
Intercept	10.528841	0.9709229	117.60	<.0001
tot_inc	-0.0907509	0.006785	178.90	<.0001

Table 7-7 Number of accidents by total number of INCs, 1986 - 1995

Converged by Objective Response spills				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	45.3571	1	90.71426	<.0001
Full	1331.0481			
Reduced	1376.4052			
RSquare (U)		0.0330		
Observations (or Sum Wgts)		30524		
Term	Parameter Estimate s	Std Error	ChiSquare	Prob>ChiSq
Intercept	5.09451832	0.0726889	4912.1	0.0000
Intercept	7.82388556	0.2611463	897.59	<.0001
Intercept	9.83805469	0.6916966	202.30	<.0001
Intercept	10.531049	0.9738249	116.94	<.0001
tot_inc	-0.0904318	0.0075195	144.63	<.0001

Table 7-8 Number of spills by total number of INCs, 1986 - 1995

```
Converged by Gradient Response accidents
Whole-Model Test
Model          -LogLikelihood   DF     ChiSquare       Prob>ChiSq
Difference     0.4549           1      0.909762        0.3402
Full      1911.3416
Reduced 1911.7965
RSquare (U)                     0.0002
Observations (or Sum Wgts)      30461
               Parameter
Term           Estimate s       Std Error     ChiSquare       Prob>ChiSq
Intercept      4.57955738       0.096509      2251.7          0.0000
Intercept      7.45365209       0.2427898     942.49          <.0001
Intercept      10.3986802       1.0031494     107.45          <.0001
AGE            -0.0049932       0.0052166     0.92            0.3385
```

Table 7-9 Number of accidents by platform age, 1986 - 1995

```
Converged by Objective Response spill
Whole-Model Test
Model          -LogLikelihood   DF     ChiSquare       Prob>ChiSq
Difference     1.3569           1      2.713824        0.0995
Full      1359.6135
Reduced 1360.9704
RSquare (U)                     0.0010
Observations (or Sum Wgts)      30461
               Parameter
Term           Estimates        Std Error     ChiSquare       Prob>ChiSq
Intercept      5.08831311       0.1211925     1762.8          0.0000
Intercept      7.77612757       0.2771212     787.39          <.0001
Intercept      9.79146291       0.7142228     187.94          <.0001
Intercept      10.4846445       1.0050358     108.83          <.0001
AGE            -0.0105367       0.0063535     2.75            0.0972
```

Table 7-10 Number of spills by platform age, 1986 - 1995

Risk Factor	**Accident R-sq.**	**Spill R-sq.**	**Parameter Estimate Prob > Chi-sq. (p-value)**	**Good predictor? (p-value <.05)**
INCs	.0306		<.0001	Yes
Platform Age	.0002		.3385	No
INCs		.0330	<.0001	Yes
Platform Age		.0010	.0972	Not quite

Table 7-11 Summary of Tables 7-7 to 7-10, single risk factor logistic regressions

Table 7-11 shows how well the risk factors "platform age" and "total number of INCs" predict accidents and spills. Age has almost no predictive ability for accidents, but a better (yet still not very good) predictability for spills.

A graphic method can also be used to screen single risk factors for significance. This method uses probability plots, based on regression model results, to allow the direct reading of the probability of the response variable for different values of the independent variable. Single factor probability plots are listed in the Data Appendix. Examples of the plots are shown in Figures 7-7 and 7-8. The logistic model probability plots can be interpreted as follows:

1. The left vertical axis is a probability scale, from zero to one.
2. The right vertical axis is the category of the risk factor of interest (dependent variable). For example, very few platforms have accidents or spills, so the category "0" is very large. The categories "1", "2", "3", are very small and bunched up at the top right hand corner.
3. The horizontal axis is the independent variable in the regression.
4. A horizontal line indicates no functional relationship between the risk factor and the likelihood of an accident or spill.
5. A curve that starts in the upper left-hand corner and proceeds to the lower right hand corner indicates that there is some functional relationship. This gives a quick graphic way to screen risk factors for their significance.

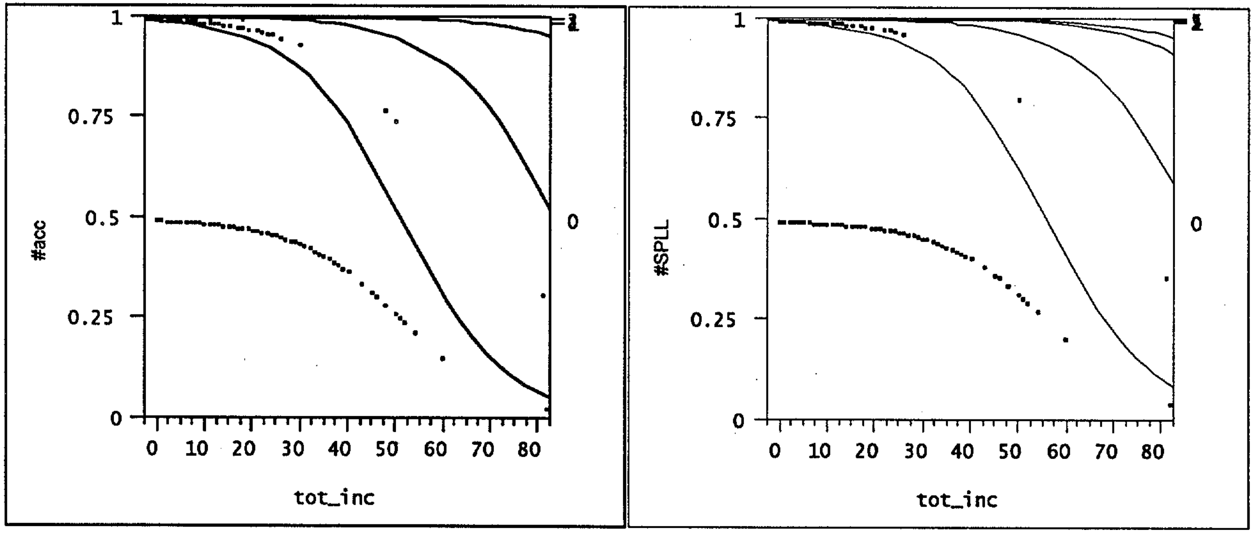

Figure -7-8 Probability plots –total # INCs, data from 1986-1995

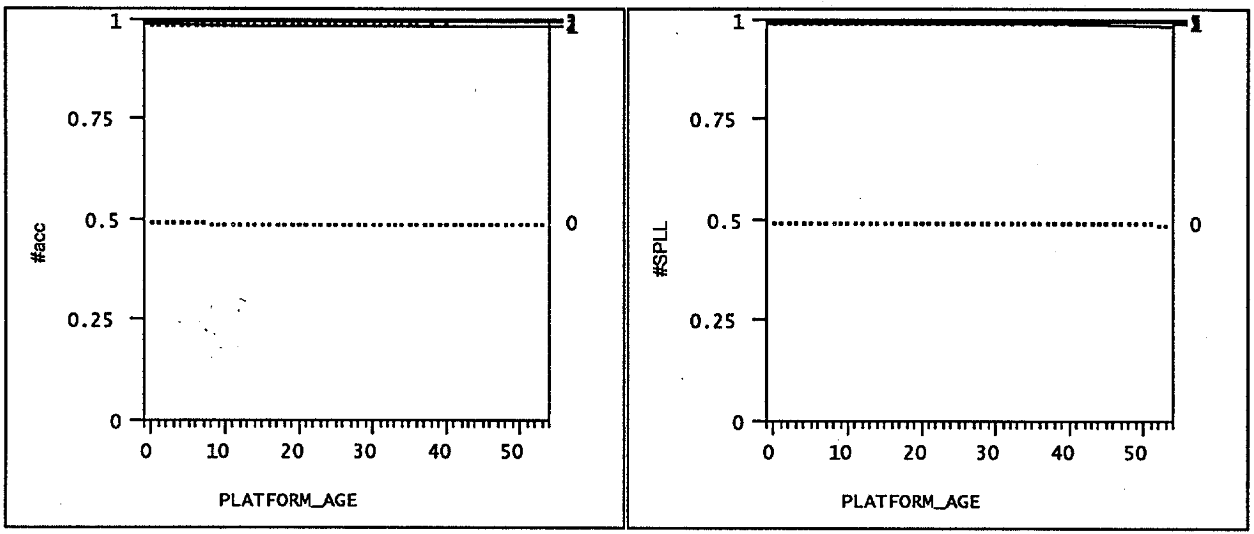

Figure -7-9 Probability plots – platform age, data from 1986-1995

Figures 7-8 and 7-9 show that there does not appear to be a functional relationship between platform age and the risk of having an accident or spill. The probability plots show that there is likely a functional relationship between the total number of INCs a platform has received in a year and the risk of an accident or spill. Table 7-12 summarizes individual logistic regression models for each risk factor. The goal of this table is to rank the risk factors by the model r-squared values and see which factors, acting by themselves, are the best predictors of accidents and spills. This ranking ignores the effects of multi-colinearity (which is described in the next section and in Chapter 8) but is useful as a starting point for evaluating the relative merit of risk factors.

	Response - Accidents				**Response - Spills**		
Rank	**Risk Factor**	**p-values**	**R-Square**	**Rank**	**Risk Factor**	**p-values**	**R-Square**
1	#acc	.0000	1.0000	1	#SPLL	.0000	1.0000
2	#SPLL	.0000	.5887	2	#acc	.0000	.8200
3	#MIN	.0001	.4707	3	#MIN	.0001	.2254
4	#FIRE	.0001	.1922	4	COMPRESSOR_FLAG	.0001	.0712
5	MAJ_CMPLX_FLAG	.0001	.0771	5	MAJ_CMPLX_FLAG	.0001	.0712
6	NUM_COMP	.0001	.0728	6	NUM_COMP	.0001	.0712
7	COMPRESSOR_FLAG	.0001	.0713	7	STORE_TANK_FLAG	.0001	.0516
8	#INJ	.0001	.0589	8	CRANE_COUNT	.0001	.0510
9	CRANE_COUNT	.0001	.0563	9	HELIPORT_FLAG	.0001	.0482
10	HELIPORT_FLAG	.0001	.0486	10	#ins_w_inc	.0001	.0439
11	SLOT_COUNT	.0001	.0462	11	SLOT_COUNT	.0001	.0415
12	STORE_TANK_FLAG	.0001	.0437	12	OIL_PROD_FLAG	.0001	.0398
13	#ins_w_inc	.0001	.0408	13	SLOT_DRILL_COUNT	.0001	.0365
14	SLOT_DRILL_COUNT	.0001	.0398	14	tot_inc	.0001	.0330

15	BED_COUNT	.0001	.0328	15	C	.0001	.0283
16	DISTANCE_TO_SH	.0001	.0323	16	BED_COUNT	.0001	.0280
17	FIRED_VESSEL_FL	.0001	.0319	17	#SPLL_l	.0001	.0271
18	tot_inc	.0001	.0306	18	#acc_l	.0001	.0258
19	C	.0001	.0287	19	P	.0001	.0251
20	OIL_PROD_FLAG	.0001	.0285	20	GAS_PROD_FLAG	.0001	.0232
21	GAS_PROD_FLAG	.0001	.0253	21	GAS_FLARING_FLAG	.0001	.0224
22	#VESS	.0001	.0253	22	W	.0001	.0218
23	P	.0001	.0241	23	DISTANCE_TO_SH	.0001	.0216
24	WATER_DEPTH	.0001	.0220	24	E	.0001	.0201
25	#ins_w_inc_l	.0001	.0204	25	FIRED_VESSEL_FL	.0001	.0189
26	W	.0001	.0179	26	WATER_DEPTH	.0001	.0177
27	GAS_FLARING_FLAG	.0001	.0173	27	#ins_w_inc_l	.0001	.0173
28	E	.0001	.0173	28	G	.0001	.0148
29	#MAJ	.0001	.0170	29	tot_inc_l	.0001	.0119
30	#SPLL_l	.0001	.0166	30	C_l	.0001	.0110
31	#acc_l	.0001	.0163	31	S	.0001	.0105
32	#FAT	.0001	.0149	32	P_l	.0001	.0103
33	G	.0001	.0142	33	DISTRICT_CODE	.3743	.0093
34	C_l	.0001	.0140	34	W_l	.0001	.0081
35	tot_inc_l	.0001	.0138	35	#FIRE	.0001	.0067
36	DISTRICT_CODE	.0001	.0125	36	#VESS	.0001	.0046
37	P_l	.0001	.0114	37	G_l	.0001	.0040
38	S	.0001	.0094	38	co_exp_l	.0017	.0040
39	#EXP	.0001	.0085	39	#MAJ	.0001	.0039
40	W_l	.0001	.0077	40	#MIN_l	.0001	.0038
41	G_l	.0001	.0060	41	L_l	.0002	.0033
42	L_l	.0001	.0035	42	co_exp	.0066	.0029
43	L	.0001	.0029	43	INCS/COMP	.0003	.0028
44	E_l	.0001	.0029	44	L	.0008	.0026
45	#ins_no_inc	.0014	.0025	45	COMGL_PROD_FLAG	.1618	.0024
46	#MIN_l	.0001	.0025	46	M_l	.0006	.0024
47	INCS/COMP	.0002	.0023	47	E_l	.0001	.0020
48	M_l	.0009	.0017	48	M	.0022	.0019
49	M	.0012	.0016	49	op_exp	.0624	.0014
50	S_l	.0052	.0014	50	op_exp_l	.0692	.0013
51	co_exp_l	.0372	.0012	51	PLATFORM_AGE	.0972	.0010
52	op_exp_l	.0515	.0011	52	#ins_no_inc_l	.1211	.0009
53	op_exp	.0578	.0010	53	#INJ	.1040	.0006
54	co_exp	.0704	.0009	54	SUL_PROD_FLAG	.9150	.0004
55	COMGL_PROD_FLAG	.2998	.0009	55	#FIRE_l	.3745	.0002
56	#FIRE_l	.1030	.0005	56	#INJ_l	.7982	.0001
57	PLATFORM_AGE	.3385	.0002	57	S_l	.5830	.0001
58	SUL_PROD_FLAG	.9276	.0001	58	#ins_no_inc	.8296	.0000
59	#INJ_l	.7525	.0001	59	H	.9082	.0000
60	H	.8642	.0000	60	#EXP	.8999	.0000
61	#EXP_l	.8766	.0000	61	#FAT	.8678	.0000
62	#FAT_l	.8766	.0000	62	#EXP_l	.8999	.0000
63	#VESS_l	.8373	.0000	63	#FAT_l	.8999	.0000
64	#MAJ_l	.8766	.0000	64	#VESS_l	.8678	.0000
65	H_l	.9310	.0000	65	#MAJ_l	.8999	.0000
66	#ins_no_inc_l	.7865	.0000	66	H_l	.9441	.0000

Table 7-12 Single risk factor logistic regression summary

Table 7-12 shows that physical characteristics of the platforms (number of components, presence of storage tanks, etc….) are very highly ranked as predictive risk factors. In addition, the highlighted risk factors have p-values greater than .05 which means that many of the risk factors are likely not significant for predicting accidents or spills.

7.6 Correlation

One of the problems with single factor regressions is that multicollinearity can drastically affect the interpretation of single factor models. The effect can be so severe that the true association between independent variables and dependent variables may not even have the proper sign. For example, what is actually a positive effect may occur in a single factor regression as a negative effect due to an opposite sign correlated variable. This can lead to very erroneous conclusions regarding causality and strength of association. The Data Appendix has the complete linear correlation matrix for all of the risk factors in this study. Table 7-13 lists the top 5 linear correlations for three different risk factors.

Risk	**Correlated With Platform Age**	**Risk**	**Correlated With Distance To Shore**	**Risk**	**Correlated With Accidents**
Distance To Shore	-.2	Slot Drill Count	.4	Vessel Strikes	.2
Company Experience	.2	Major Complex	.4	Injuries	.3
Operator Experience	.4	Slot Count	.5	Fires	.5
		Water Depth	.7	Minor Incidents	.7
				Spills	.8

Table 7-13 Risk factor correlations

Table 7-13 points out some interesting items:

1. Distance to shore is mildly negatively correlated with platform age. This is as one would expect. Newer platforms are probably located farther from shore. In addition, the experience levels of both the owner of the platform and the operating company are positively correlated with platform age. This points out what might be a confounding effect with respect to platform age as a predictor of accidents and spills. Evidently more experienced crews work on older platforms, which may tend to compensate for an increased risk as platforms age.

2. Distance to shore is highly correlated with water depth, as one would expect. However, another interesting fact is that major complexes and slot count are positively well correlated with distance to shore. This indicates that facilities are often larger farther from shore. Note that to be a major complex, you must have a large number of slots, so there is likely a strong correlation between these two risk factors.
3. The number of accidents is highly correlated with the number of spills, and is well correlated with several other risk factors. The correlation with number of minor incidents, number of fires, number of injuries and number of vessel strikes should be expected because these risk factors are a sub-set of all accidents.

7.7 Single risk factor data statistics

As pointed out above, multicollinearity can cause serious problems when trying to interpret the significance of an association between an independent and a dependent variable. The multi-variable regression techniques in Chapter 8 will attempt to sort through these problems and determine true independent variable influence on the response variables (accidents and spills). This section summarizes all of the single factor results and presents one way in which they can be used to evaluate the significance of individual risk factor significance. This is not the only approach that can be used to compare independent variables. The point of the following table is to rank the factors in a logical way and look for obvious groupings, associations, etc... based solely on individual merit, while ignoring possibly significant, confounding effects. The ranking is constructed as follows.

1. Rank the risk factors in accordance with their r-square values from the logistic regressions (see Table 7-12).
2. Assign 66 points to the highest ranked factor (there are 66 possible factors) and 65 to the next, and so on. This assigns a points value for each risk factor based on its model fit.
3. Do a ranking based on the number of times the means tests are different, i.e. count the number of times a "yes" is shown in table 7-6.
4. Divide this number by the number of possible responses. This gives a percent of the time that factor receives a "yes."
5. Multiply the percentage of times "Yes" by 66. This gives a point ranking based on the means comparisons.
6. Combine the points to form an individual risk factor score.

Table 7-14 shows how this point assignment is done.

Response - Accident								
Risk Factor	**Rank from R-Sq.**	**R-sq. points**	**Means test - # of times NO**	**Means test - # of times YES**	**% of time a "yes"**	**Means test points**	**Total points**	**Risk factor rank as a predictor of accidents**
#acc	1	66	0	10	100%	66	132	1
#SPLL	2	65	0	10	100%	66	131	2
MAJ_CMPLX_FLAG	5	62	0	10	100%	66	128	3
NUM_COMP	6	61	0	10	100%	66	127	4
COMPRESSOR_FLAG	7	60	0	10	100%	66	126	5
HELIPORT_FLAG	10	57	0	10	100%	66	123	6
SLOT_COUNT	11	56	0	10	100%	66	122	7
SLOT_DRILL_COUNT	14	53	0	10	100%	66	119	8
CRANE_COUNT	9	58	1	9	90%	59.4	117	9
FIRED_VESSEL_FL	17	50	0	10	100%	66	116	10

Table 7-14 Example of point assignment based on r-squared value and means tests

The following table shows a ranking of all of the risk factors. As stated earlier, this table ignores correlations and higher order effects between independent variables. It was designed as a qualitative check of independent variable importance. To evaluate true independent variable relevance in a multivariable regression, analysis of variance techniques (ANOVA) would be used, which are described in Chapter 8. The columns called "Relevance for predicting an accident or spill" refer to the percent of the time the risk factor is relevant in the means tests and the single factor regressions. It is based on the "Total Points" column of Table 7-14.

Risk Factor	**Relevance For Predicting An Accident**	**Relevance For Predicting A Spill**	**Overall Relevance**
#acc	100%	99%	100%
#SPLL	99%	100%	100%
MAJ_CMPLX_FLAG	97%	97%	97%
COMPRESSOR_FLAG	95%	98%	97%
NUM_COMP	96%	91%	94%
HELIPORT_FLAG	93%	89%	91%
SLOT_COUNT	92%	87%	90%
#ins_w_inc	86%	93%	90%
CRANE_COUNT	89%	85%	87%
STORE_TANK_FLAG	87%	85%	86%
SLOT_DRILL_COUNT	90%	81%	86%
OIL_PROD_FLAG	81%	87%	84%
tot_inc	77%	80%	79%
C	76%	79%	78%
DISTANCE_TO_SH	84%	68%	76%

#MIN	73%	78%	76%
FIRED_VESSEL_FL	88%	62%	75%
GAS_PROD_FLAG	74%	71%	72%
P	68%	76%	72%
WATER_DEPTH	73%	56%	64%
#SPLL_1	56%	66%	61%
#acc_1	55%	65%	60%
#ins_w_inc_1	60%	58%	59%
W	56%	59%	58%
GAS_FLARING_FLAG	50%	60%	55%
#FIRE	73%	34%	53%
G	56%	50%	53%
C_1	47%	56%	52%
tot_inc_1	52%	51%	52%
BED_COUNT	49%	44%	47%
E	45%	48%	46%
#INJ	65%	26%	45%
P_1	45%	43%	44%
S	37%	42%	40%
W_1	32%	31%	31%
S_1	24%	35%	30%
#MIN_1	27%	32%	29%
#VESS	35%	23%	29%
M_1	26%	33%	29%
co_exp_1	23%	34%	29%
#FIRE_1	25%	31%	28%
SUL_PROD_FLAG	26%	30%	28%
L_1	24%	31%	28%
#MAJ	34%	21%	28%
DISTRICT_CODE	28%	26%	27%
co_exp	20%	34%	27%
M	24%	29%	27%
G_1	25%	28%	26%
E_1	24%	26%	25%
COMGL_PROD_FLAG	24%	22%	23%
PLATFORM_AGE	13%	27%	20%
#INJ_1	18%	19%	19%
L	17%	17%	17%
INCS/COMP	15%	18%	17%
#FAT	27%	5%	16%
#ins_no_inc	22%	9%	15%
op_exp_1	17%	13%	15%
op_exp	16%	14%	15%
#EXP	21%	7%	14%
#ins_no_inc_1	4%	17%	10%
H	7%	7%	7%
#EXP_1	5%	6%	6%
#FAT_1	5%	5%	5%
#MAJ_1	3%	3%	3%
#VESS_1	2%	2%	2%
H_1	1%	1%	1%

Table 7-15 Overall risk factor ranking.

Figures 7-10, 7-11, and 7-12 show the results of the ranking in Table 7-15 graphically. As can be seen by the charts, some factors are better at predicting spills than they are at predicting accidents and vice versa.

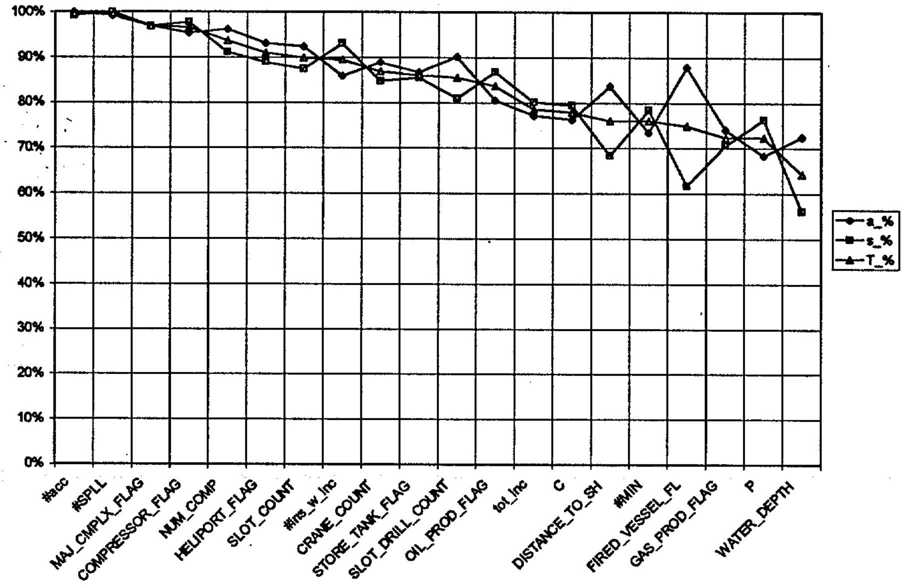

Figure 7-10 Rank of factors, chart one of three

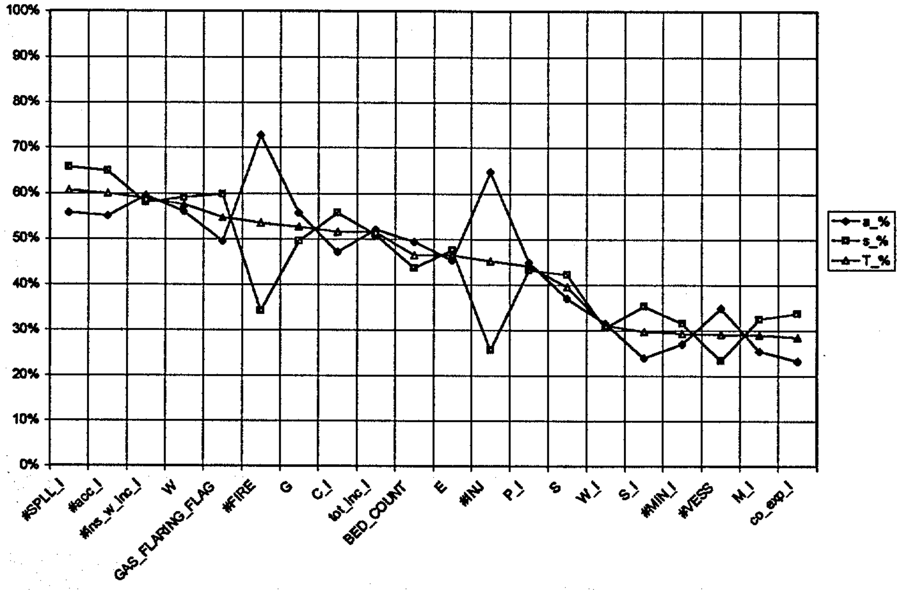

Figure 7-11 Rank of factors, chart two of three

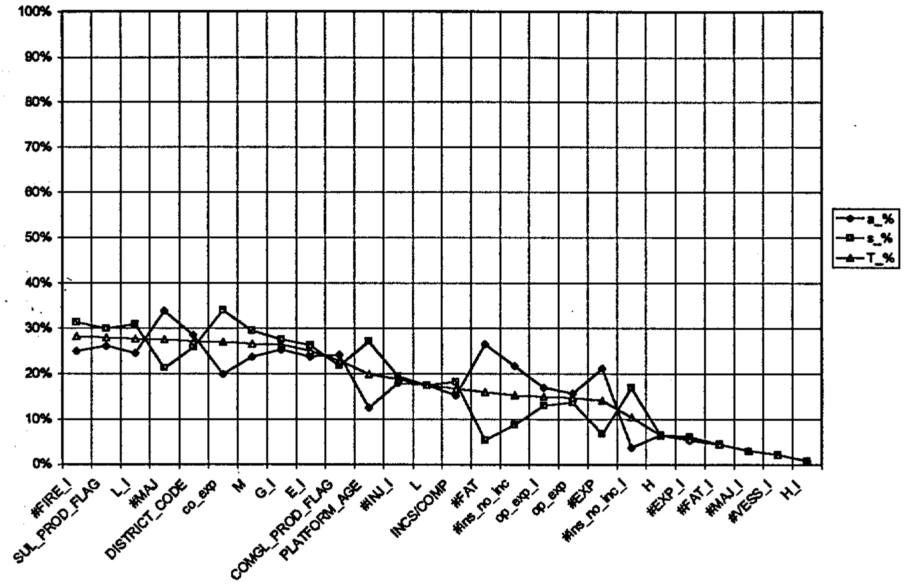

Figure 7-12 Rank of factors, chart three of three

7.8 Single factor results

One notices several important items in Table 7-15 and Figures 7-10 to 7-12 that will be investigated further in the multi-variable regressions in Chapter 8.

1. The number of accidents and spills a platform experiences during a year are highly related. Whether a platform has an accident is the best predictor of whether that platform will experience a spill that year, and vice-versa (but may not be a good predictor of future years).
2. The next most predictive risk factors can best be thought of as a group of risk factors reflecting "size" or "complexity." Whether a facility is a major complex or not (MAJ_CMPLX_FLAG) is highly correlated with the next four top independents variables. This suggests a natural grouping of individual risk factors based on principal components.
3. An INC rate measure is the eighth highest ranked independent risk factor. That is, whether an inspection resulted in an INC at all.
4. The lagged risk factors (one year prior to the prediction year) are in the top 1/3 of ranked risk factors with respect to level of association with the response variables (ranked 21 or higher out of 66). This suggests that a time series forecast will be successful in predicting accidents and spills.
5. The percentage relevance for some risk factors is different for accidents and spills. This seems to indicate that some factors are more important in predicting an accident versus predicting spills, and vice versa.

7.9 Summary

Many of the distributions of the risk factors are highly skewed and have large variances. This indicates that some platforms are significantly different from the "average" platform. The statistics show that there is a statistically significant difference in the characteristics of those platforms that have accidents and spills versus those that do not. The statistics show that some risk factors by themselves do not appear to be predictive of accidents and spills, but some risk factors do seem to be highly predictive (particularly measures of size and complexity). Most of the risk factors used in this research are correlated. Therefore, the multivariable models presented in Chapter 8 must address the issue of multicollinearity.

Chapter 8 - Multivariable Logistic Regression Models

As noted in Chapter 7, the first step in data analysis is to look at individual risk factors. However, data analysis does not stop there, and multiattribute models are used to give a more complete picture of the relationship between independent (risk factor) and dependent (response) variables. To reiterate some of the conclusions from Chapter 7:

- Many risk factors are correlated with each other. In addition, they seem to group together into natural categories such as: measures of complexity, age or experience, inspection history, and accident or spill history.
- Risk factors that can be considered as measures of "complexity" or "size" (e.g. major complex flag, number of components, etc....) appear to be important indicators of accidents and spills.
- Some risk factors, particularly those relating to age and experience, do not appear to be good predictors of accidents and spills.
- Some risk factors are likely better predictors of accidents versus spills, and vice versa.
- Some risk factors are likely not important at all in predicting accidents and spills.

The goal of Chapter 8 is to take the knowledge gained in Chapter 7 by analyzing the risk factors individually and use multivariable regression techniques to predict accidents or spills. Analysis of variance techniques (ANOVA) are used to evaluate the relevance of independent variables. The multivariable models in Chapter 8, (and later in Chapter 10 - Expert Models), use time series data to forecast (predict) the response of an independent variable at a particular time. Predictions will be performed for all platforms from 1992 to 1995. The platforms will be ranked by the model prediction, and the results will be displayed graphically. In addition, the accuracy of the models will be compared to each other using a signal detection theory procedure developed by Swets.[80] This method is described later in Chapter 8. The Swets method will also be used to compare the logistic models developed in this chapter to the expert models that are developed in Chapter 10.

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[80] The curve used to describe model accuracy is called an "isosensitivity curve." The original engineering nomenclature of the curve is "Receiver Operating Characteristic (ROC)." For a complete description of model accuracy measures, see: Macmillan, N. and Creelman, C., *"Detection theory: A user's guide"*, Cambridge University Press.

8.1 Statistical procedures[81]

The next section provides a brief discussion of the issues, techniques, and procedures used to develop the multiattribute logistic regression models. The topics covered are: analysis of variance, time series analysis, autocorrelation, problems with correlated variables in multivariable models, model over specification, and rotated principal components analysis.

8.1.1 Analysis of variance (ANOVA)

As the name implies, the analysis of variance procedure attempts to analyze the variation of a response and assign portions of this variation to each of a set of independent variables. The objective of the analysis of variance is to locate important independent variables in a study and determine how they interact and affect the response. The "whole model test" for logistic regression is analogous to ANOVA tables for continuous responses.[82]

8.1.2 Time series analysis using Arithmetic Moving Average (ARIMA)

A time series is a collection of data obtained by observing a response variable at periodic points in time. In this instance, both the response variables (accidents and spills) and the independent variables vary with time. The purpose of a time series analysis is to forecast what is likely to happen in the future based on what has occurred in the past.

In a time series analysis, the independent variables are generally lagged. However, not all risk factors in this research need to be lagged. Some should be evaluated in the desired prediction year because they are either constant for the life of the platform, or it does not make sense to consider them as lagged values in the regression. For example, water depth, distance to shore, crane count, etc… are constant, or nearly so, for the entire life of the platform.[83] These regressors are assumed constant or are assessed in the prediction year as follows:

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[81] The information in this section is from *"Mathematical Statistics with Applications - 4th edition,"* W. Mendenhall, D. Wackerly, R. Scheaffer, Duxbury Press, 1990, p. 588.

[82] See: *JMP - Statistics and Graphics Guide Version 3,* from Statistics Discovery Software, SAS Institute, INC., Cary, NC, p. 217.

[83] A note of caution. During downturns in business, wells are sometimes capped and the platforms removed from service. The platforms are towed to shore and placed in storage until the market rebounds. There is no guarantee that a platform will be returned to the same location from which it was removed if it is placed back into service. Also, wells are put into production and taken out of production in accordance with market and reservoir conditions. Therefore, there are very few truly non-time dependent regressor variables in this analysis. However, the effect of these slight variations is not believed to be significant for most platforms.

$$P(y_t)\Big|_{t=0} = \frac{1}{1+e^{-[\beta_0+\beta_1 x_{1,t}+\ldots+\beta_n x_{n,t}]}}$$

Equation 8-1 Multivariable logistic equation, no lagged risk factors

Where:

$t=0$ = The desired prediction year
$P(y_t)$ = Probability of response (y) at time t
y_t = Response at time t
β_0 = Constant in regression
β_n = Parameter estimate for risk factor "n"
$x_{n,t}$ = Risk factor "n" at time t

There are some good reasons for choosing different time lags for regressor variables. For example, it may only be relevant to think of the company experience or the operating company experience in the year immediately preceding the prediction year. It may make less sense to think of the "total" or "average" operator or company experience over a 5-year period as being important. However, it might be entirely relevant to think of the total number of INCs issued to a platform over the prior 5 years, and less relevant to look at simply the total number of INCs issued to that platform in the preceding year. Thus, for some lagged risk factors, it makes sense to think of them as being relevant on slightly different time scales. Therefore, three risk factors are evaluated with a 1-year lag: platform age, operator experience, and company experience. The remaining time-dependent risks use 5-year moving averages.

The following equation is for an "average summation" lagged risk factor regression model for predicting the future value of the response variable. It is based on 5-year cumulative lagged values of the risk factors.

$$P(y_t)\Big|_{t=0} = \frac{1}{1+e^{-[\beta_0+\beta_1 \overline{\sum_{t=1}^{\tau} x_{1,-t}}+\ldots+\beta_n \overline{\sum_{t=1}^{\tau} x_{n,-t}}+\lambda \overline{\sum_{t=1}^{\tau} y_{-t}}]}}$$

Equation 8-2 Time series equation - average for five lagged years

Where:

t = For $t<0$, the risk factor is lagged "t" time periods.
τ = Period over which the summation is averaged. For platforms newer than 5-years old, the averaging period will be less than 5 years (therefore the value of τ will be less than five as defined in the summation equation above).

$\overline{\beta_n \sum_{t=1}^{\tau} x_{n,-t}}$ = An "average" of "n" 5-year lagged risk factors.

$\overline{\lambda \sum_{t=1}^{\tau} y_{-t}}$ = An "average" of the 5-year lagged response variable.

Note that the 5-year summations are a compromise between the need to "smooth" or "even out" the performance measures of platforms and the need to make the analysis as simple as possible. Other summation periods could be used, e.g. 3 years, 8 years, etc.... One important thing to note is that for relatively new platforms, 5 years of information will not be available which is why the summation year is left as a variable (τ). If the platform is only 3 years old, $\tau=3$ and the regressor contains 3 years of information. Table 8-1 shows how the moving average is calculated.

Prediction year	**Risk factor used in time series regression**	**Description**
1993	Average number of INCs	(Sum of INCs for 1988 + 1989 + 1990 + 1991 + 1992)/ τ
......	......	......
......	......	......
1994	Average number of accidents	(Sum of accidents for 1989 + 1990 + 1991 + 1992 + 1993)/ τ

Table 8-1 5-year moving average example

The equation used in the regressions in this research is shown in Equation 8-3.

$$P(y_t)\Big|_{t=0} = \frac{1}{1+e^{-[\beta_0+\beta_1 x_{1,t}+\ldots+\beta_n x_{n,t}+\beta_{n+1}\overline{\sum_{t=1}^{\tau} x_{n+1,-t}}+\ldots+\beta_m\overline{\sum_{t=1}^{\tau} x_{m,-t}}+\lambda\overline{\sum_{t=1}^{\tau} y_{-t}}]}}$$

Equation 8-3 Full model logistic regression equation

Where:
n = number of risk factors evaluated at time t=0
m = total number of risk factors
m-n = number of risk factors that are summed and averaged over the prior 5 years

Equation 8-3 shows the underlying process that takes place during the regression analysis. However, the summations and betas, etc... listed in equation 8-3 will be simplified later in Chapter 8. Essentially, the summations will be combined by using a rotated principal component procedure. The components will then become the independent variables in the logistic regression equation.

Two processes occur before a prediction is made:

1. The regression parameters (betas) are calculated. An example of the matrix that was set up to calculate the betas is shown in Table 8-2. The rows are the risk factor values of the platforms you want to rank.
2. Use the moving average information for each platform and the betas to calculate a probability of an accident or spill for the next year. Once the betas are set (e.g. using only information from 1989 to 1994), the prediction matrix would be as shown in Table 8-2.

Platform data					**Prediction year 1995 - response variable**
Constants		**Moving average risk factors Average for years 1994, 1993, 1992, 1991 and 1990**			
Distance to shore (x_1)	Major Complex Flag (x_n)	Average number of INCs received (x_{n+1})	Average number of "P" INCs (x_m)	Average number of accidents (lagged y)	Number of accidents that occurred in 1995 (y)
100	1	10	3	1	1
....	....	....	....	....	....
....	....	....	....	....	....
10	0	1	0	0	0

Table 8-2 Example of matrix used to calculate logistic regression equation parameters.

8.1.3 Autocorrelation

One of the problems noted when performing regression with time series data is that the errors in the regression are generally correlated (called "autocorrelation"). The presence of autocorrelation causes difficulty in the estimation of error variance and, as a result, in tests of hypotheses and confidence interval estimation. The existence of positively correlated errors can result in an estimate of σ^2 that is a substantial underestimate. This tends to inflate t-statistics on coefficients and deflate the width of confidence intervals on coefficients.[84] One way of handling autocorrelation

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[84] *"Classical and Modern Regression with Applications - 2d edition,"* R.H. Myers, PWS-Kent Publishing Company, 1990, p. 288.

is to use lagged response variables.[85] Therefore, as indicated earlier, "lagged" response variables are included in this analysis.

8.1.4 Correlated variables

Correlated variables cause problems in multivariable regressions. As stated in Chapter 7, the cause and effect relationship between regressor and response variables can sometimes be very difficult to determine. The phrase correlation implies that there is a dependency or relationship between risk factors. Correlations can occur, for example, if one of the risk factors is a sub-set of the other risk factors. As pointed out in Chapter 7, some risk factors are highly correlated. For example, water depth and distance to shore have a correlation coefficient of around .6. Most of the platform physical characteristics are highly correlated. The following list some potential solutions to the problem of multicollinearity:[86]

- Drop one or more of the correlated independent variables from the final model. A screening procedure such as stepwise regression is helpful in determining which variable to drop.
- If you decide to keep all the independent variables in the model:
  - Avoid making inferences about the individual β parameters (such as establishing a cause-and-effect relationship between y and the predictor variables).
  - Restrict inference about E (y) and future y values to values of the independent variables that fall within the experimental region.
- If your ultimate objective is to establish a cause-and-effect relationship between y and the predictor variables use a designed experiment.
- To reduce rounding errors in polynomial regression models, code the independent variables so that first, second, and higher order terms for a particular x variables are not highly correlated.
- To reduce rounding errors and stabilize the regression coefficients, use "Ridge Regression" or "Principal Components Analysis" to estimate the β parameters.

Principal component analysis, based on a set of rotated principal components, is used in this research.

8.1.5 Model over specification

Another problem that can occur in multivariable models is over specification, or using too many independent variables in the analysis. There are 66 regressors that could be used in the multivariable regression. However, only nine spills occurred in 1994. Therefore, there is a good

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[85] *"Classical and Modern Regression with Applications - 2d edition,"* R.H. Myers, PWS-Kent Publishing Company, 1990, p. 292.

[86] *"A Second Course in Business Statistics: Regression Analysis - 4th edition"*, W. Mendenhall, T. Sincich, Dellen Publishing Co., 1993, p. 335.

possibility that if all of the available regressors are used, chance will result in some very good predictions simply because of model over specification (too many regressors). Principal component analysis helps to correct this problem by reducing the dimensionality of the data set.

8.1.6 Principal components

Multicollinearity will always exist in real data, because the independent variables cannot be chosen from the outset to be orthogonal (as in a designed experiment). This means that there will always be some confounding or not easily separated effects between independent variables. Principal components are related groupings of risk factors based on their degree of correlation. For "n" original variables, "n" principal components are formed as follows:

- The first principal component is the linear combination of the standardized original variables that has the greatest possible variance.
- Each subsequent principal component is the linear combination of the standardized original variables that has the greatest possible variance and is uncorrelated with all previously defined components.

Each principal component is calculated by taking a linear combination of an eigenvector of the correlation matrix with standardized original variables. The eigenvalues show the variance accounted for by each component. The set of principal components has the same total variation and structure as the original variables. It is important to note that the first component extracted in a principal component analysis accounts for a maximal amount of total variance in the observed variables.[87] Directions for variables that are opposite are considered close as well as those for directions that are the same.[88] To aid in interpretation of the components, they are rotated using a Varimax rotation, [89] a process that is used to find orthogonal groupings of correlated variables. Often, a Varimax rotation will result in logical and meaningful groupings of variables. The goal of principal component analysis is to combine correlated variables to address the effects of multicollinearity and model over specification.[90]

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[87] Hatcher, L., *"A Step-by-Step Approach to Using the SAS System of r Factor Analysis and Structural Equation Modeling"*

[88] See: *JMP - Statistics and Graphics Guide Version 3,* from Statistics Discovery Software, SAS Institute, INC., Cary, NC, p. 316.

[89] See: *JMP - Statistics and Graphics Guide Version 3,* from Statistics Discovery Software, SAS Institute, INC., Cary, NC, p. 316.

[90] Wadsworth, H.M., *'Handbook of Statistical Methods for Engineers and Scientists',* McGraw-Hill, 1990, p.156.

Table 8-3 provides is the definition of the rotated principal components used in the logistic regression models. Component one, Component two, Component three, and Component four are the independent variables used in a logistic regression to predict accidents and spills.

Component Name	Description	Code used in regression output tables
Component 1	**Inspection Performance** - This factor pertains to the number of INCs received, the type of INC received, and the type of enforcement action performed following an INC.	INCS
Component 2	**Complexity** - This factor pertains to measure of size, activity, and complexity. For example, major complexes, and numbers of components appear in this factor.	COMP
Component 3	**Age and Experience** - This factor pertains to the platform age and the operator and company experience levels.	AGE/EXP
Component 4	**Accident and Spill History** - This factor pertains to the number and types of accidents and spills	ACC/SPILL

Table 8-3 Definition of rotated principal components

Note that each component is actually a collection of time series information as described in Equations 8-1 to 8-3. The idea of principal component analysis is simply to reduce the dimensionality of Equation 8-3.

When a variable is given a great deal of importance in constructing a component, we say that the variable "loads" on that component. Table 8-4 shows the components that are used as independent variables in the logistic regression to predict the likelihood of accidents and spills for 1995 and the loading given to each risk factor. There are a number of methods for choosing the number of components.[91] The method chosen was the interpretability criteria. Rotated principal components with 1, 2, 3,4 and 5 components were constructed. The loading for each component was inspected to see if interpretable sets of factors consistently loaded onto components. A set of four rotated principal components had the most meaning, and was chosen as the set of independent variables in the regressions.

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[91] Hatcher, L., *"A Step-by-Step Approach to Using the SAS System of r Factor Analysis and Structural Equation Modeling"*. p.22.

Component 1 Inspection Performance (INCS)	**Component loading**	**Component 2 Complexity (COMP)**	**Component loading**	**Component 3 Age and Experience (AGE/EXP)**	**Component loading**	**Component 4 Accident and Spill History (ACC/SPILL)**	**Component loading**
#ins_w_inc_90_94	-0.84	DISTANCE_TO_SH	0.49	op_exp_90_94	0.85	#acc_90_94	-0.97
tot_inc_90_94	-0.95	SLOT_DRILL_COUNT	0.74	co_exp_90_94	0.78	#SPLL_90_94	-0.73
E_90_94	-0.63	SLOT_COUNT	0.80	age_94	0.55	#INJ_90_94	-0.50
G_90_94	-0.84	WATER_DEPTH	0.63	op_exp_94	0.87	#FIRE_90_94	-0.56
L_90_94	-0.50	FIRED_VESSEL_FL	0.46	co_exp_94	0.64	#MIN_90_94	-0.96
P_90_94	-0.88	GAS_PROD_FLAG	0.53				
C_90_94	-0.89	GAS_FLARING_FLAG	0.47				
W_90_94	-0.88	MAJ_CMPLX_FLAG	0.71				
S_90_94	-0.51	HELIPORT_FLAG	0.62				
		STORE_TANK_FLAG	0.59				
		OIL_PROD_FLAG	0.49				
		COMPRESSOR_FLAG	0.71				
		NUM_COMP	0.85				

Table 8-4 Components used in regression for predicting accidents and spills in 1995

The "loadings" for the components in Table 8-4 are determined by the Varimax rotation procedure and correspond to the level of agreement of the risk factor along the orthogonal rotated principal component axis. A level of +-(.4) was chosen as a cutoff point for determining whether an individual risk should be considered important in the definition of the component. Tables 8-5 to 8-9 show the rotated principal components for the risk factors from 1991 to 1994. One interesting result in Tables 8-5 to 8-9 is that almost all of the individual risks re-appear in the components (i.e. the loadings are consistently high for the same individual risks.) The only exception to this is Table 8-5 where the number of injuries does not appear highly related to the number of accidents (i.e., the loading is low). The recurrence of the same risks in the components increases the confidence level in the data. Once the components have been determined, it is necessary to assign scores for each platform to indicate where that platform stands on the retained components. These component scores can be used as predictor variables in logistic regression. A "component score" is a linear combination of the optimally weighted observed variables. The scores for each risk for each platform and the summation in each component are generated automatically in JMP.[92]

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[92] See: Hatcher, L., "*A Step-by-Step Approach to Using the SAS System for Factor Analysis and Structural Equation Modeling,*" *p.31.* for a further description of "component scores" and "component based scores."

Data from 1986-1990	Component 1	Component 2	Component 3	Component 4
(age/exp at end of year 1990)	INCS	COMPLEXITY	AGE/EXP	ACC/SPILL
DISTANCE_TO_SH	-0.13	0.48	0.23	0.15
SLOT_DRILL_COUNT	-0.15	0.77	-0.10	0.13
SLOT_COUNT	-0.15	0.80	-0.05	0.13
WATER_DEPTH	0.02	0.66	0.14	0.22
FIRED_VESSEL_FL	-0.19	0.49	0.18	0.03
GAS_PROD_FLAG	-0.01	0.60	0.02	-0.03
GAS_FLARING_FLAG	-0.03	0.44	-0.08	0.06
MAJ_CMPLX_FLAG	-0.25	0.69	0.06	0.09
HELIPORT_FLAG	-0.13	0.66	0.01	0.02
SUL_PROD_FLAG	0.03	0.05	0.02	-0.03
STORE_TANK_FLAG	-0.20	0.59	-0.02	0.05
OIL_PROD_FLAG	-0.04	0.55	-0.18	-0.01
DISTRICT_CODE	-0.05	-0.05	0.35	0.12
COMPRESSOR_FLAG	-0.21	0.74	0.04	0.08
NUM_COMP	-0.21	0.86	-0.05	0.12
op_exp_86_90	0.01	0.05	-0.87	-0.02
co_exp_86_90	0.04	-0.04	-0.83	-0.01
#ins_no_inc_86_90	0.09	-0.10	-0.18	0.05
#ins_w_inc_86_90	-0.84	0.26	0.05	0.05
tot_inc_86_90	-0.96	0.20	0.04	0.06
E_86_90	-0.70	0.09	-0.01	0.05
G_86_90	-0.85	0.10	0.03	0.05
H_86_90	0.00	0.00	0.00	0.00
L_86_90	-0.44	0.05	-0.01	0.04
M_86_90	0.00	0.00	0.00	0.00
P_86_90	-0.87	0.23	0.05	0.06
C_86_90	-0.87	0.22	0.04	0.06
W_86_90	-0.90	0.15	0.03	0.05
S_86_90	-0.53	0.03	0.00	0.05
#acc_86_90	-0.14	0.19	-0.05	0.80
#SPLL_86_90	-0.15	0.20	-0.06	0.63
#INJ_86_90	0.03	0.01	-0.03	0.23
#FAT_86_90	0.03	0.01	0.01	0.11
#FIRE_86_90	0.04	-0.04	0.02	0.65
#VESS_86_90	0.00	0.00	0.00	0.00
#EXP_86_90	-0.02	-0.05	0.01	0.19
#MIN_86_90	0.01	-0.01	-0.01	0.80
#MAJ_86_90	0.00	0.00	0.00	0.00
age_90	-0.12	-0.01	-0.49	-0.02
op_exp_90	0.01	0.05	-0.91	-0.01
co_exp_90	0.04	-0.02	-0.80	0.00

Table 8-5 Rotated component matrix - data from 1986 - 1990, loadings on selected risk factors are highlighted.

Data from 1987-1991	Component 1	Component 2	Component 3	Component 4
(age/exp at end of year 1991)	INCS	COMPLEXITY	AGE/EXP	ACC/SPILL
DISTANCE_TO_SH	-0.19	0.49	0.25	0.02
SLOT_DRILL_COUNT	-0.15	0.77	-0.12	0.07
SLOT_COUNT	-0.16	0.81	-0.06	0.06
WATER_DEPTH	-0.01	0.68	0.14	0.07
FIRED_VESSEL_FL	-0.22	0.48	0.18	0.02
GAS_PROD_FLAG	-0.01	0.58	0.00	-0.02
GAS_FLARING_FLAG	-0.02	0.43	-0.08	0.14
MAJ_CMPLX_FLAG	-0.26	0.70	0.06	0.04
HELIPORT_FLAG	-0.13	0.65	-0.02	0.02
SUL_PROD_FLAG	0.02	0.05	0.02	-0.01
STORE_TANK_FLAG	-0.19	0.58	-0.03	0.12
OIL_PROD_FLAG	-0.04	0.52	-0.21	0.05
DISTRICT_CODE	-0.07	-0.01	0.37	0.00
COMPRESSOR_FLAG	-0.22	0.73	0.04	0.10
NUM_COMP	-0.21	0.85	-0.06	0.13
op_exp_87_91	-0.01	0.04	-0.88	-0.04
co_exp_87_91	0.02	-0.03	-0.79	-0.05
#ins_no_inc_87_91	0.13	-0.01	-0.13	0.06
#ins_w_inc_87_91	-0.84	0.26	0.06	0.05
tot_inc_87_91	-0.96	0.20	0.05	0.07
E_87_91	-0.71	0.11	0.00	0.07
G_87_91	-0.85	0.10	0.05	0.05
H_87_91	0.00	0.00	0.00	0.00
L_87_91	-0.41	0.09	-0.01	0.03
M_87_91	-0.05	0.02	0.04	0.06
P_87_91	-0.87	0.22	0.06	0.06
C_87_91	-0.88	0.22	0.06	0.06
W_87_91	-0.90	0.14	0.04	0.06
S_87_91	-0.54	0.01	0.01	0.11
#acc_87_91	-0.13	0.15	-0.03	0.91
#SPLL_87_91	-0.13	0.15	-0.05	0.76
#INJ_87_91	0.02	0.02	-0.01	0.40
#FAT_87_91	0.03	0.02	0.01	0.07
#FIRE_87_91	-0.05	0.04	0.02	0.55
#VESS_87_91	0.04	0.04	-0.01	0.19
#EXP_87_91	-0.04	-0.05	0.01	0.17
#MIN_87_91	0.00	0.06	0.00	0.84
#MAJ_87_91	0.00	0.00	0.00	0.00
age_91	-0.10	-0.01	-0.51	0.03
op_exp_91	-0.01	0.04	-0.91	-0.04
co_exp_91	0.00	-0.03	-0.68	-0.05

Table 8-6 Rotated component matrix - data from 1987 - 1991, loadings on selected risk factors are highlighted.

Data from 1988-1992	Component 1	Component 2	Component 3	Component 4
(age/exp at end of year 1992)	INCS	COMPLEXITY	AGE/EXP	ACC/SPILL
DISTANCE_TO_SH	-0.19	0.50	0.24	0.03
SLOT_DRILL_COUNT	-0.15	0.77	-0.14	0.03
SLOT_COUNT	-0.15	0.81	-0.08	0.04
WATER_DEPTH	0.00	0.69	0.13	0.06
FIRED_VESSEL_FL	-0.23	0.47	0.16	0.06
GAS_PROD_FLAG	-0.03	0.56	0.00	0.01
GAS_FLARING_FLAG	-0.01	0.44	-0.08	0.09
MAJ_CMPLX_FLAG	-0.26	0.71	0.04	0.06
HELIPORT_FLAG	-0.13	0.64	-0.03	0.04
SUL_PROD_FLAG	0.03	0.06	0.03	-0.01
STORE_TANK_FLAG	-0.21	0.58	-0.05	0.06
OIL_PROD_FLAG	-0.07	0.50	-0.23	0.01
DISTRICT_CODE	-0.08	-0.02	0.36	0.07
COMPRESSOR_FLAG	-0.24	0.73	0.02	0.09
NUM_COMP	-0.22	0.85	-0.08	0.11
op_exp_88_92	0.01	0.03	-0.88	0.02
co_exp_88_92	0.03	-0.04	-0.80	-0.01
#ins_no_inc_88_92	0.12	-0.04	-0.18	0.16
#ins_w_inc_88_92	-0.85	0.26	0.03	-0.03
tot_inc_88_92	-0.96	0.20	0.01	0.03
E_88_92	-0.67	0.13	0.00	-0.01
G_88_92	-0.85	0.12	0.02	0.02
H_88_92	0.00	-0.01	0.02	0.00
L_88_92	-0.49	0.10	-0.03	0.01
M_88_92	-0.16	0.02	0.08	-0.01
P_88_92	-0.88	0.22	0.02	0.02
C_88_92	-0.88	0.21	0.01	0.04
W_88_92	-0.90	0.17	0.03	-0.02
S_88_92	-0.57	0.00	-0.05	0.18
#acc_88_92	-0.22	0.09	-0.09	0.88
#SPLL_88_92	-0.24	0.05	-0.13	0.68
#INJ_88_92	0.02	0.04	0.01	0.45
#FAT_88_92	0.02	0.04	0.03	0.14
#FIRE_88_92	-0.04	0.08	0.04	0.57
#VESS_88_92	0.05	0.04	0.01	0.26
#EXP_88_92	-0.05	-0.05	0.02	0.22
#MIN_88_92	-0.09	0.10	-0.01	0.78
#MAJ_88_92	0.03	0.01	0.04	0.22
age_92	-0.09	0.00	-0.52	-0.02
op_exp_92	0.03	0.04	-0.90	-0.02
co_exp_92	0.02	-0.04	-0.66	-0.04

Table 8-7 Rotated component matrix - data from 1988 - 1992, loadings on selected risk factors are highlighted.

Data from 1989-1993	Component 1	Component 2	Component 3	Component 4
(age/exp at end of year 1993)	INCS	COMPLEXITY	AGE/EXP	ACC/SPILL
DISTANCE_TO_SH	-0.19	0.48	0.27	0.09
SLOT_DRILL_COUNT	-0.17	0.76	-0.13	0.05
SLOT_COUNT	-0.16	0.81	-0.07	0.06
WATER_DEPTH	0.02	0.66	0.16	0.07
FIRED_VESSEL_FL	-0.25	0.45	0.16	0.08
GAS_PROD_FLAG	-0.03	0.53	0.03	0.02
GAS_FLARING_FLAG	0.01	0.48	-0.05	0.03
MAJ_CMPLX_FLAG	-0.26	0.70	0.05	0.09
HELIPORT_FLAG	-0.14	0.62	-0.01	0.06
SUL_PROD_FLAG	0.03	0.06	0.03	-0.02
STORE_TANK_FLAG	-0.21	0.59	-0.02	0.05
OIL_PROD_FLAG	-0.08	0.50	-0.20	0.01
DISTRICT_CODE	-0.07	-0.06	0.35	0.09
COMPRESSOR_FLAG	-0.26	0.71	0.04	0.08
NUM_COMP	-0.24	0.85	-0.06	0.10
op_exp_89_93	0.00	0.05	-0.85	-0.03
co_exp_89_93	0.02	-0.03	-0.80	-0.01
#ins_no_inc_89_93	0.09	-0.08	-0.18	0.05
#ins_w_inc_89_93	-0.86	0.24	0.05	0.04
tot_inc_89_93	-0.96	0.20	0.03	0.03
E_89_93	-0.67	0.08	0.01	0.11
G_89_93	-0.85	0.11	0.03	0.02
H_89_93	-0.02	0.01	0.02	-0.01
L_89_93	-0.52	0.11	0.01	-0.02
M_89_93	-0.31	0.07	0.05	0.00
P_89_93	-0.88	0.22	0.02	0.02
C_89_93	-0.89	0.22	0.02	0.03
W_89_93	-0.90	0.17	0.04	0.01
S_89_93	-0.58	0.00	-0.02	0.04
#acc_89_93	-0.11	0.09	-0.04	0.95
#SPLL_89_93	-0.12	0.08	-0.06	0.69
#INJ_89_93	0.01	0.03	0.00	0.49
#FAT_89_93	0.01	0.03	0.00	0.13
#FIRE_89_93	-0.05	0.06	-0.01	0.60
#VESS_89_93	0.04	0.01	0.01	0.22
#EXP_89_93	-0.08	-0.07	0.00	0.34
#MIN_89_93	-0.10	0.07	-0.03	0.93
#MAJ_89_93	0.03	0.03	0.03	0.15
age_93	-0.11	0.01	-0.53	-0.01
op_exp_93	0.02	0.06	-0.88	-0.02
co_exp_93	0.03	-0.04	-0.63	-0.01

Table 8-8 Rotated component matrix - data from 1989 - 1993, loadings on selected risk factors are highlighted.

Data from 1990-1994	Component 1	Component 2	Component 3	Component 4
(age/exp at end of year 1994)	INCS	COMPLEXITY	ACC/SPILL	AGE/EXP
DISTANCE_TO_SH	-0.20	0.49	-0.09	-0.25
SLOT_DRILL_COUNT	-0.19	0.74	-0.04	0.16
SLOT_COUNT	-0.19	0.80	-0.06	0.09
WATER_DEPTH	-0.08	0.63	-0.05	-0.15
FIRED_VESSEL_FL	-0.23	0.46	-0.09	-0.16
GAS_PROD_FLAG	-0.02	0.53	-0.02	-0.06
GAS_FLARING_FLAG	-0.01	0.47	-0.01	0.05
MAJ_CMPLX_FLAG	-0.25	0.71	-0.09	-0.03
HELIPORT_FLAG	-0.12	0.62	-0.08	0.01
SUL_PROD_FLAG	0.03	0.06	0.02	-0.04
STORE_TANK_FLAG	-0.22	0.59	-0.05	0.03
OIL_PROD_FLAG	-0.10	0.49	0.00	0.20
DISTRICT_CODE	-0.05	-0.03	-0.11	-0.36
COMPRESSOR_FLAG	-0.27	0.71	-0.08	-0.03
NUM_COMP	-0.25	0.85	-0.10	0.07
op_exp_90_94	0.03	0.05	0.03	0.85
co_exp_90_94	0.06	-0.03	-0.01	0.78
#ins_no_inc_90_94	0.11	-0.02	-0.06	0.09
#ins_w_inc_90_94	-0.84	0.27	-0.06	-0.02
tot_inc_90_94	-0.95	0.23	-0.03	-0.02
E_90_94	-0.63	0.09	-0.10	0.01
G_90_94	-0.84	0.14	-0.01	-0.03
H_90_94	-0.02	0.01	0.01	-0.02
L_90_94	-0.50	0.14	0.03	-0.01
M_90_94	-0.36	0.10	0.01	-0.03
P_90_94	-0.88	0.24	-0.03	-0.01
C_90_94	-0.89	0.24	-0.04	-0.01
W_90_94	-0.88	0.18	-0.02	-0.03
S_90_94	-0.51	0.03	-0.02	0.02
#acc_90_94	-0.09	0.07	-0.97	0.04
#SPLL_90_94	-0.12	0.03	-0.73	0.07
#INJ_90_94	0.03	0.02	-0.50	-0.01
#FAT_90_94	0.01	0.03	-0.12	0.00
#FIRE_90_94	-0.03	0.09	-0.56	0.01
#VESS_90_94	0.05	0.04	-0.18	-0.02
#EXP_90_94	-0.08	-0.07	-0.35	-0.02
#MIN_90_94	-0.09	0.06	-0.96	0.05
#MAJ_90_94	0.03	0.02	-0.20	-0.05
age_94	-0.11	0.01	0.03	0.55
op_exp_94	0.03	0.05	0.03	0.87
co_exp_94	0.05	-0.03	-0.02	0.64

Table 8-9 Rotated component matrix - data from 1990 - 1994, loadings on selected risk factors are highlighted.

8.2 Logistic regression model

As stated earlier, the goal of a time series analysis is to forecast what is likely to happen in the future, given what has happened in the past. When evaluating the t-test for the parameter estimates in the following regressions, one must keep in mind what the p-values tell us about the regressor variables. The p-value estimates allow conclusions concerning individual regressors *in the presence of the others.*[93]

$$P(\text{accident / spill}) = 1 - \frac{1}{1 + e^{-(\beta_0 + \beta_1 \text{INCs} + \ldots + \beta_4 \text{ACC/SPILL})}}$$

Equation 8-4 Equation used with components to predict probability of accident or spill

The process used to build the multivariable logistic regression model is as follows:

1. Use the component scores for each platform in the regression to set the betas and determine a probability of accident and spill for each platform as in Equation 8-4.
2. Evaluate the regression parameters (betas) and assess their significance.
3. Rank order the platforms in terms of their probability estimates
4. Graph the results.
5. Prepare a summary tables to compare the accuracy of the model prediction for each year.

It should be noted that the risk factors "bed count, co-mingling production, and crane count" could not be used in the regressions because the information in the databases was too sparse. Only about 500 platforms could be identified that had a value listed for these regressors. The following is an outline of the method used to generate the risk estimate.

USE		CALCULATE
(Components 1 to 4)$_{1986-1990}$	================➔	Regress to set parameters for 1991
(Components 1 to 4)$_{1987-1991}$ AND Parameters$_{1991}$	====➔	Predict accidents/spills for 1992
....		....
....		....
(Components 1 to 4)$_{1989-1993}$	================➔	Regress to set parameters for 1994
(Components 1 to 4)$_{1990-1994}$ AND Parameters$_{1994}$	====➔	Predict accidents/spills for 1995

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[93] *Classical and Modern Regression with Applications - 2d edition,*" R.H. Myers, PWS-Kent Publishing Company, 1990, p. 101.

One note about the parameters listed in Tables 8-10 to 8-17. As stated in Chapter 7, the software predicts the probability of NOT ACCIDENT or NOT SPILL.[94] Therefore, if one puts the listed parameters into the normal logistic equation, the probability OF ACCIDENT is 1-(P (not accident)). That is why Equation 8-4 has the added "1 - (exponential term)". Tables 8-18 and 8-19 in the next section summarize the regressions and evaluate the significance of the components in the regressions. Also, recall from Chapter 7 that more than one intercept in the regression output is not an error. It is simply a consequence of ordinal logistic regression with the software used in this analysis. The intercepts correspond to the different ordinal levels of the response.

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[94] *JMP - Statistics and Graphics Guide Version 3,* from Statistics Discovery Software, SAS Institute, INC., Cary, NC, p. 216.

Response: #acc_91				
Converged by Gradient				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	19.936	4	39.871	<.0001
Full	155.927			
Reduced	175.862			
RSquare (U)	0.113			
Observations (or Sum Wgts)	3333			
Term	Parameter Estimates	Std Error	ChiSquare	Prob>ChiSq
Intercept	5.216	0.259	406.59	<.0001
INCS_86_90	0.411	0.085	23.61	<.0001
COMP_86_90	-0.770	0.134	30.23	<.0001
AGE_86_90	-0.394	0.235	2.8	0.0943
ACC/SPILL_86_90	-0.072	0.126	0.32	0.5687

Table 8-10 Regression - accidents, 1991

Response: #acc_92				
Converged by Objective				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	16.637	4	33.274	<.0001
Full	163.567			
Reduced	180.204			
RSquare (U)	0.092			
Observations (or Sum Wgts)	3301			
Term	Parameter Estimates	Std Error	ChiSquare	Prob>ChiSq
Intercept	5.002	0.227	484.02	<.0001
INCS_87_91	0.288	0.095	9.24	0.0024
COMP_87_91	-0.634	0.136	21.90	<.0001
AGE_87_91	0.058	0.175	0.11	0.7411
ACC/SPILL_87_91	-0.245	0.063	15.21	<.0001

Table 8-11 Regression - accidents, 1992

Response: #acc_93				
Converged by Objective				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	19.582	4	39.164	<.0001
Full	186.566			
Reduced	206.148			
RSquare (U)	0.095			
Observations (or Sum Wgts)	3297			
Term	Parameter Estimates	Std Error	ChiSquare	Prob>ChiSq
Intercept	4.886	0.216	512.98	<.0001
Intercept	7.808	0.715	119.40	<.0001
INCS_88_92	0.244	0.102	5.66	0.0173
COMP_88_92	-0.543	0.129	17.66	<.0001
AGE_88_92	-0.374	0.190	3.87	0.0491
ACC/SPILL_88_92	-0.312	0.059	27.99	<.0001

Table 8-12 Regression - accidents, 1993

Response: #acc_94				
Converged by Objective				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	6.451	4	12.901	0.012
Full	93.021			
Reduced	99.471			
RSquare (U)	0.065			
Observations (or Sum Wgts)	3284			
Term	Parameter Estimates	Std Error	ChiSquare	Prob>ChiSq
Intercept	5.715	0.324	310.63	<.0001
Intercept	8.431	1.018	68.63	<.0001
INCS_89_93	0.385	0.116	10.99	0.0009
COMP_89_93	-0.546	0.199	7.49	0.0062
AGE_89_93	-0.197	0.296	0.44	0.5049
ACC/SPILL_89_93	-0.156	0.140	1.25	0.2638

Table 8-13 Regression - accidents, 1994

Response: #SPLL_91				
Converged by Gradient				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	9.334	4	18.668	0.0009
Full	97.355			
Reduced	106.689			
RSquare (U)	0.0875			
Observations (or Sum Wgts)	3333			
Term	Parameter Estimates	Std Error	ChiSquare	Prob>ChiSq
Intercept	5.728	0.328	304.56	<.0001
INCS_86_90	0.363	0.121	9.05	0.0026
COMP_86_90	-0.757	0.183	17.05	<.0001
AGE_86_90	-0.119	0.266	0.20	0.6552
ACC/SPILL_86_90	-0.002	0.209	0.00	0.9940

Table 8-14 Regression - spills, 1991

Response: #SPLL_92				
Converged by Gradient				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	10.881	4	21.761	0.0002
Full	100.879			
Reduced	111.760			
RSquare (U)	0.097			
Observations (or Sum Wgts)	3301			
Term	Parameter Estimates	Std Error	ChiSquare	Prob>ChiSq
Intercept	5.599	0.304	339.91	<.0001
INCS_87_91	0.338	0.102	11.04	0.0009
COMP_87_91	-0.516	0.189	7.41	0.0065
AGE_87_91	0.262	0.204	1.65	0.1995
ACC/SPILL_87_91	-0.267	0.073	13.27	0.0003

Table 8-15 Regression - spills, 1992

Response: #SPLL_93				
Converged by Objective				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	15.600	4	31.199	<.0001
Full	52.367			
Reduced	67.967			
RSquare (U)	0.230			
Observations (or Sum Wgts)	3292			
Term	Parameter Estimates	Std Error	ChiSquare	Prob>ChiSq
Intercept	6.701	0.518	167.39	<.0001
INCS_88_92	0.303	0.178	2.89	0.0892
COMP_88_92	-0.450	0.250	3.26	0.0711
AGE_88_92	-0.833	0.365	5.21	0.0224
ACC/SPILL_88_92	-0.488	0.081	36.72	<.0001

Table 8-16 Regression - spills, 1993

Response: #SPLL_94				
Converged by Gradient				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	7.190	4	14.379	0.006
Full	54.894			
Reduced	62.084			
RSquare (U)	0.116			
Observations (or Sum Wgts)	3284			
Term	Parameter Estimates	Std Error	ChiSquare	Prob>ChiSq
Intercept	6.470	0.473	186.93	<.0001
INCS_89_93	0.459	0.128	12.82	0.0003
COMP_89_93	-0.705	0.254	7.72	0.0054
AGE_89_93	0.166	0.304	0.30	0.5858
ACC/SPILL_89_93	-0.226	0.142	2.55	0.1104

Table 8-17 Regression - spills, 1994

8.3 Logistic regression parameter estimates summary

Tables 8-18 and 8-19 summarize the parameter estimates derived in the regressions. The levels of significance are as stated in the captions.

Component	Regression To Predict Accidents Parameter Significance Levels				Totals			
	1991	1992	1993	1994	#_***	#_**	#_*	#_n.s.
INC History (INCS)	***	***	**	***	3	1	0	0
Complexity (COMP)	***	***	***	***	4	0	0	0
Age or Experience Levels (AGE)	*	n.s.	**	n.s.	0	1	1	2
Accident/Spill History (ACC/SPILL)	n.s.	***	***	n.s.	2	0	0	2

Table 8-18 Parameter significance - accidents, ***=p<.01, **=p<.05, *=p<.10, n.s.=p>.10

Component	Regression To Predict Spills Parameter Significance Levels				Totals			
	1991	1992	1993	1994	#_***	#_**	#_*	#_n.s.
INC History (INCS)	***	***	*	***	3	0	1	0
Complexity (COMP)	***	***	*	***	3	0	1	0
Age or Experience Level (AGE)	n.s.	n.s.	**	n.s.	0	1	0	3
Accident/Spill History (ACC/SPILL)	n.s.	***	***	n.s.	2	0	0	2

Table 8-19 Parameter significance - spills, ***=p<.01,**=p<.05, *=p<.10, n.s.=p>.10

Table 8-20 ranks the components by the number of times their significance level in predicting either an accident or spill is greater than 90% (i.e. a p-value less than .01).

Component	Logistic Model Component Ranking		
	Number Of Times Significant	Number Of Times Not Significant	Rank[95]
Complexity (COMP)	8	0	1
INC History (INCS)	8	0	2
Accident/Spill History (ACC/SPILL)	4	4	3
Age or Experience Level (AGE)	3	5	4

Table 8-20 Ranking of components based on the number of times they are significant in the logistic regressions.

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[95] Note that the component "INCs" receives a lower significance for predicting accidents in 1993 than does the component "Complexity." That is the reason INCs is rated behind Complexity.

The following is a summary of the results shown in Tables 8-18 to 8-20 regarding the significance of each factor in the logistic regression models:

- The single most important component was platform complexity (COMP). However, the number of INCs received is also very important, and ranks nearly the same as complexity.
- Table 8-20 shows that for both accidents and spills, the COMP or "complexity" component is always significant (8 out of 8 times). This confirms the qualitative result presented in Chapter 7 that many of the complexity factors are good predictors of accidents and spills by themselves. Since the risks that make up the COMP component are highly correlated, one would expect that principal component analysis would also show that "complexity" is important in predicting accidents and spills.
- Note the prediction of spills for 1993 in Table 8-19. When complexity and INC history are slightly less important, age, and accident spill history, become very important.
- The "accident or spill history" (ACC/SPLL) is significant 2 out of 4 times for predicting accidents and 2 out of 4 times for predicting spills.
- The least significant component is "Age or Experience."

8.4 Logistic model results

To explain the results of the logistic regressions, the prediction of accidents in 1995 is chosen and used as an example in Table 8-21 and Figure 8-3. The platforms are ranked by prediction probability (PREDICT_ACC_95). The actual number of accidents that occurred in 1995 are listed in the "#acc_95" row. Note the following about Table 8-21.

- The top ranked platform has a prediction probability of .53 This platform actually did have an accident in 1995 (listed in #_acc_95).
- The top five ranked platforms account for four accidents in 1995, out of the 62 that did occur. Therefore, 6.5% of the accidents that did occur in 1995 are predicted in only .1% of the ranked platforms.
- Platform #23,692 probably has a data error. Major complexes are defined as platforms with six or more well completions, and two or more pieces of production equipment. Therefore, one of the data fields for this platform must be in error.
- The number of components is obviously different for the high ranked platforms versus the low ranked platforms.
- The average number of INCs issued over the prior 5 years (tot_inc_90_94) is obviously greater on high ranked platforms versus low ranked platforms.

Rank by model probability	**1**	**2**	**3**	**4**	**5**
PREDICT_ACC_95	**0.5353**	**0.0729**	**0.0729**	**0.0584**	**0.0551**
COMPLEX_ID_NUM	24080	20533	20744	22840	20622
DISTANCE_TO_SH	168	34	97	22	47
SLOT_COUNT	32	25	30	58	12
MAJ_CMPLX_FLAG	1	1	1	1	1
NUM_COMP	135	71	115	278	103
tot_inc_90_94	35	20.6	25.4	1.4	14
age_94	1	33	23	12	26
#acc_95	1	1	2	0	0
Rank by model probability	**1500**	**1501**	**1502**	**1503**	**1504**
PREDICT_ACC_95	**0.0030**	**0.0030**	**0.0030**	**0.0030**	**0.0030**
COMPLEX_ID_NUM	20601	10202	20579	23471	22266
DISTANCE_TO_SH	4	40	29	18	23
SLOT_COUNT	1	4	8	1	8
MAJ_CMPLX_FLAG	1	1	1	0	1
NUM_COMP	9	63	29	5	25
tot_inc_90_94	.4	.6	0	0.2	0
age_94	30	13	27	7	17
#acc_95	0	0	0	0	0
Rank by model probability	**3376**	**3377**	**3378**	**3379**	**3380**
PREDICT_ACC_95	**0.0005**	**0.0004**	**0.0003**	**0.0002**	**0.0001**
COMPLEX_ID_NUM	23209	10236	23692	26060	26067
DISTANCE_TO_SH	105	33	4	11	86
SLOT_COUNT	3	9	1	1	5
MAJ_CMPLX_FLAG	1	1	1	0	0
NUM_COMP	33	61	0	7	16
tot_inc_90_94	1.8	1.6	8.2	0	0
age_94	10	12	7	2	1
#acc_95	0	0	0	0	0

Table 8-21 Top 5, middle 5 and 5 lowest ranked platforms. Selected platform inspection, accident, and physical characteristics are shown for comparison purposes.

Figure 8-1 is a histogram showing the raw prediction probability for an accident for each platform in 1995. This histogram shows the number of platforms in each prediction range, i.e. number of platforms with a calculated probability >.5 (only platform #24,080, see Table 8-21). Figure 8-1 shows that relatively few platforms receive a high probability estimate.

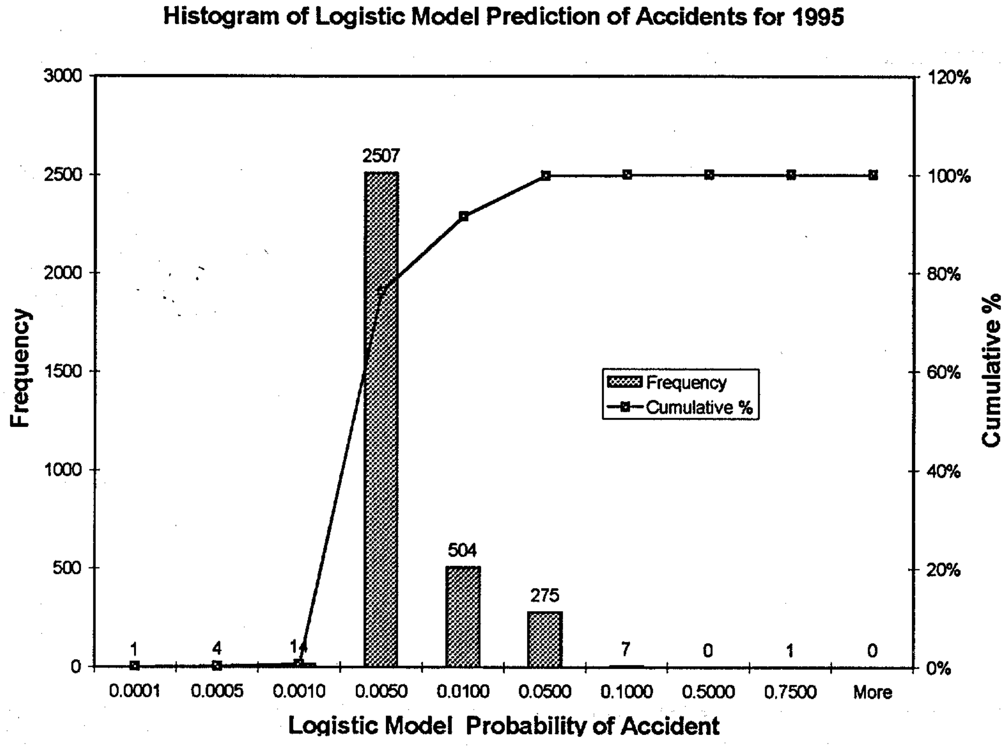


Figure 8-1 Histogram of accident probabilty estimates for 1995

In the next several pages, model predictions are graphed for accidents and spills for 1992, 1993, 1994, and 1995. To prepare the graphs, the platforms are sorted by the model prediction from largest to smallest. This provides the model's predicted risk ranking of platforms. The vertical axis of Figures 8-2 to 8-9 is the cumulative percent of accidents or spills that actually did occur in 1992, 1993, 1994, and 1995. The baseline rate is the cumulative number of platforms divided by the cumulative number of platforms, i.e., the slope is 1:1. This is the result you would expect if accidents and spills were randomly distributed across the model prediction, i.e. the model had no predictive value. You interpret Figures 8-2 to 8-9 as in the example that follows:

1. For the 1992 accident prediction, (Figure 8-2) find the 50% value on the vertical axis.
2. Move horizontally to the jagged line.
3. Read down to the horizontal axis. The value is 20%. This means that 50% of the accidents that happened in 1992 occurred in the top 20% of the ranked platforms. If the accidents were randomly distributed, i.e. a worthless model, you would get 50% of the accidents in 50% of the platforms.

Figures 8-2 to 8-9 are a visual screening method to see how well the models capture the true number of accidents or spills in accordance with their probability ranking. Figures 8-2 to 8-9 show that the models perform better than chance. If the models were not predictive, the regression results would fall along the diagonal (noted in the figures as the "Baseline"). In addition, in Chapter 11, a "pooled" model will be presented which combines all of the information in Figures 8-2 to 8-9.

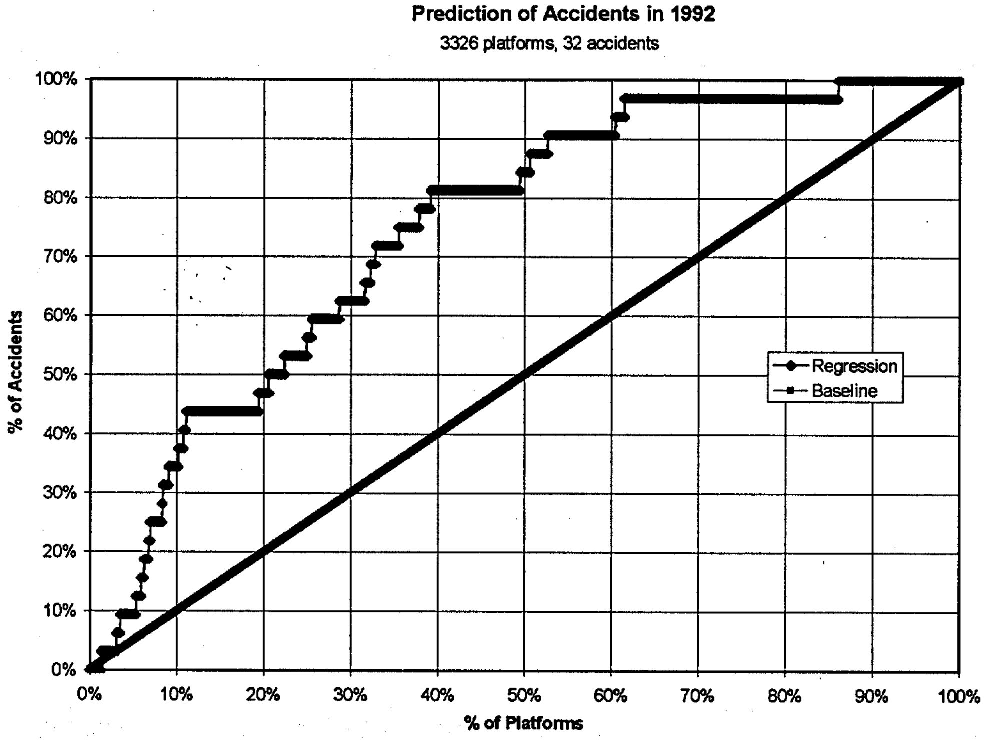


Figure 8-2 Prediction of accidents, Logistic regression, 1992

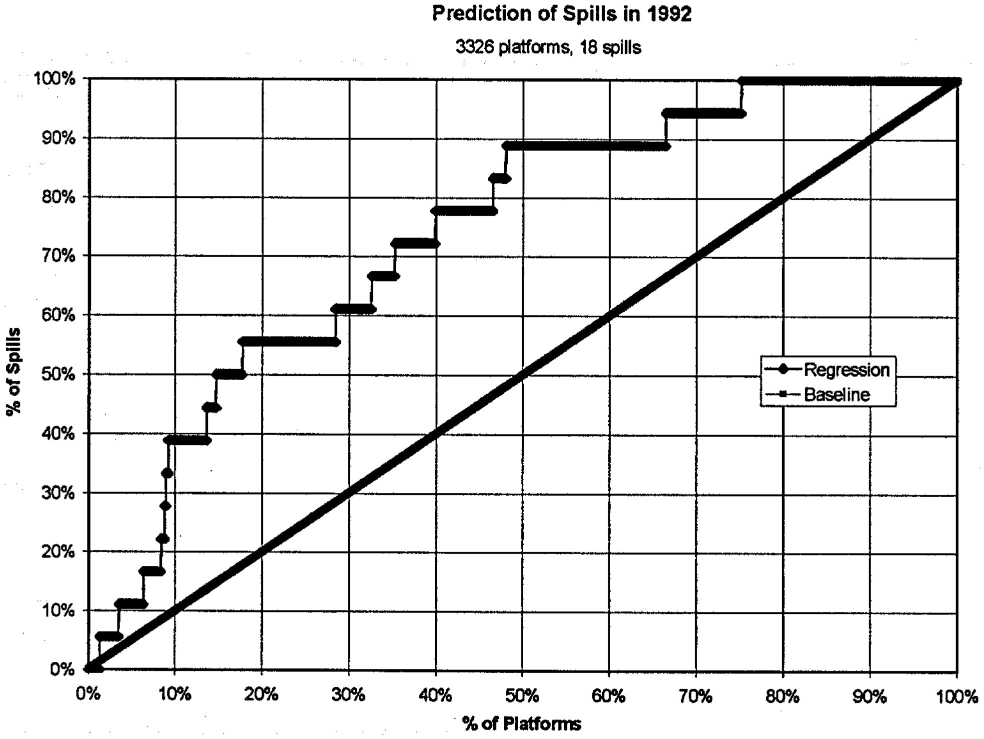


Figure 8-3 Prediction of spills, Logistic regression, 1992

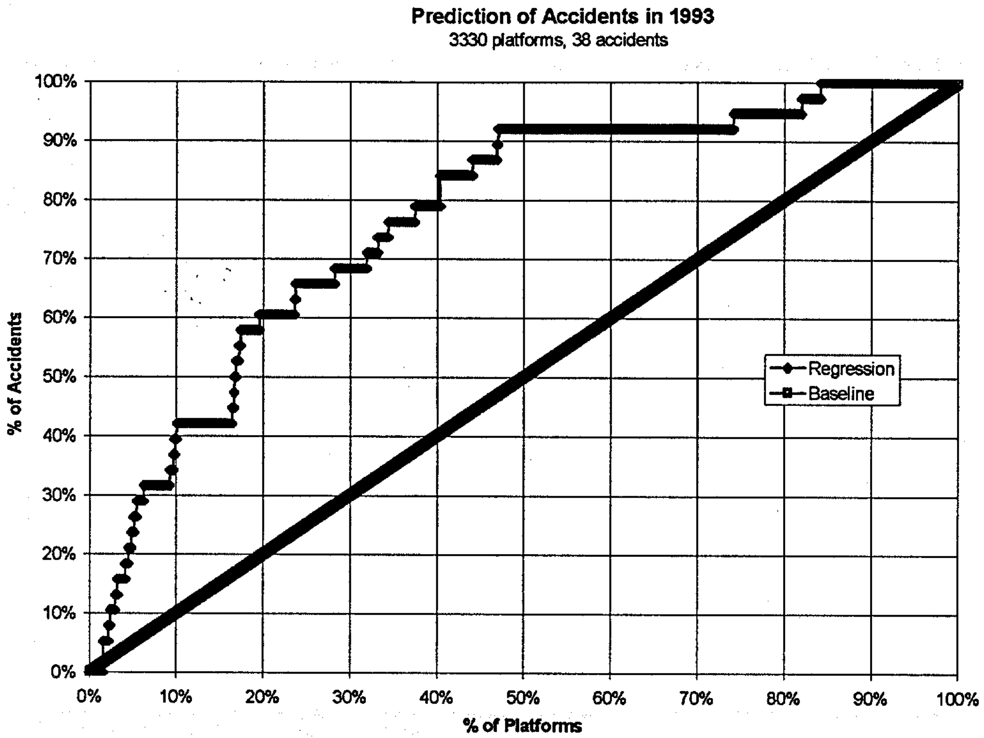


Figure 8-4 Prediction of accidents, Logistic regression, 1993

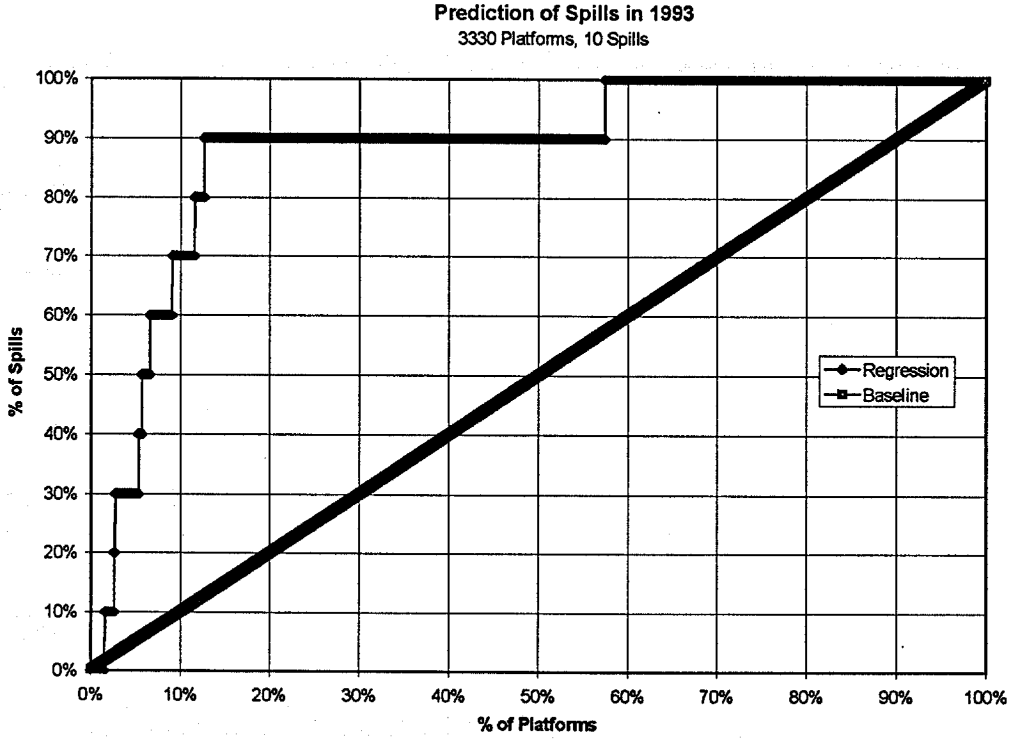
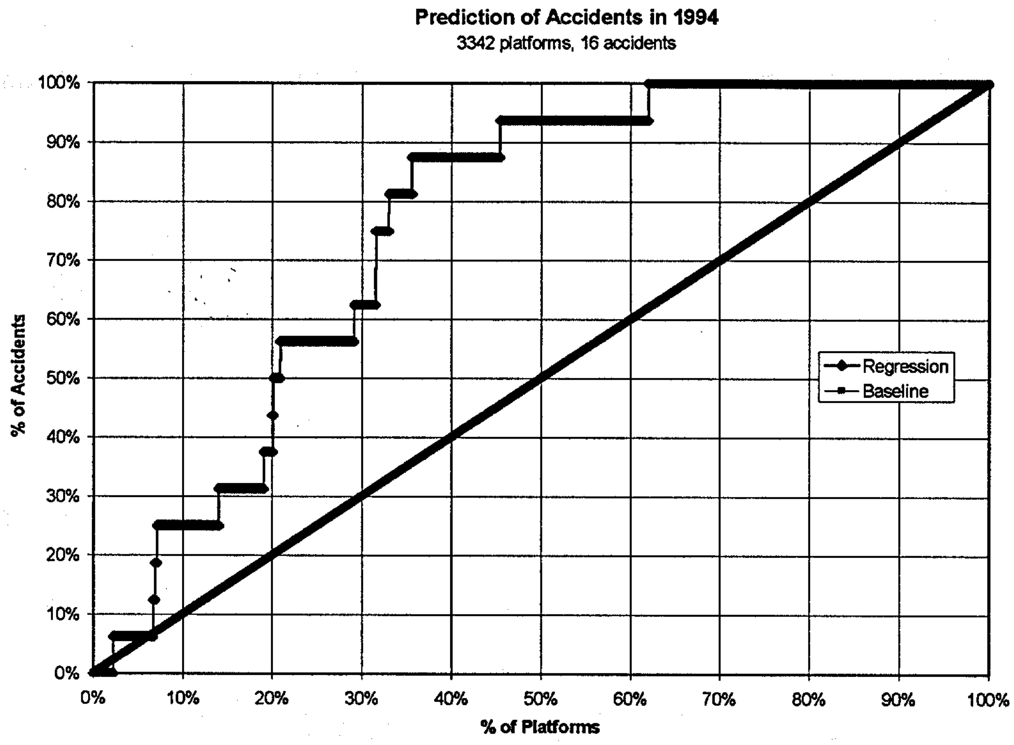
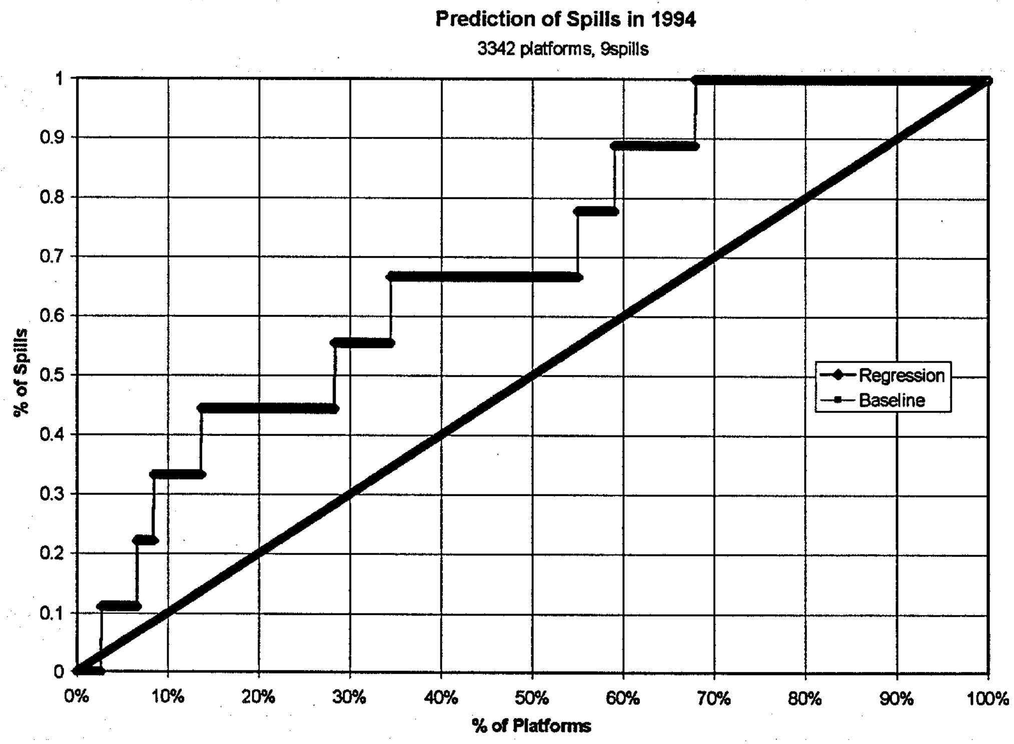


Figure 8-5 Prediction of spills, Logistic regression, 1993


Prediction of Accidents in 1994

3342 platforms, 16 accidents

Figure 8-7 Prediction of accidents, Logistic regression, 1994


Prediction of Spills in 1994

3342 platforms, 9spills

Figure 8-6 Prediction of spills, Logistic regression, 1994

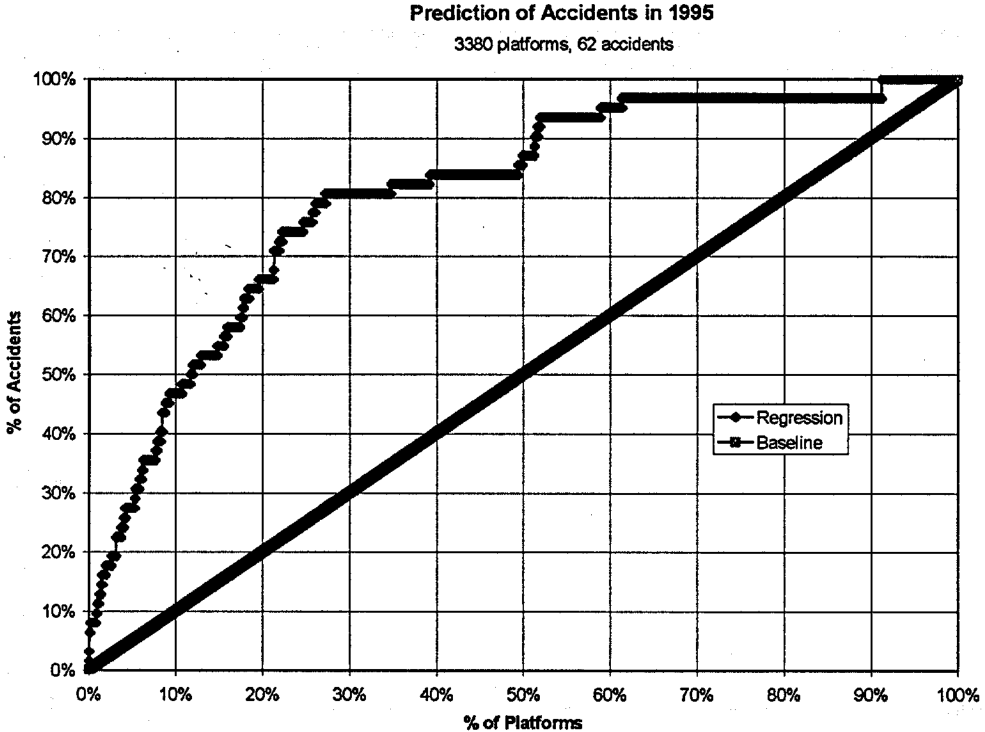


Figure 8-8 Prediction of accidents, Logistic regression, 1995

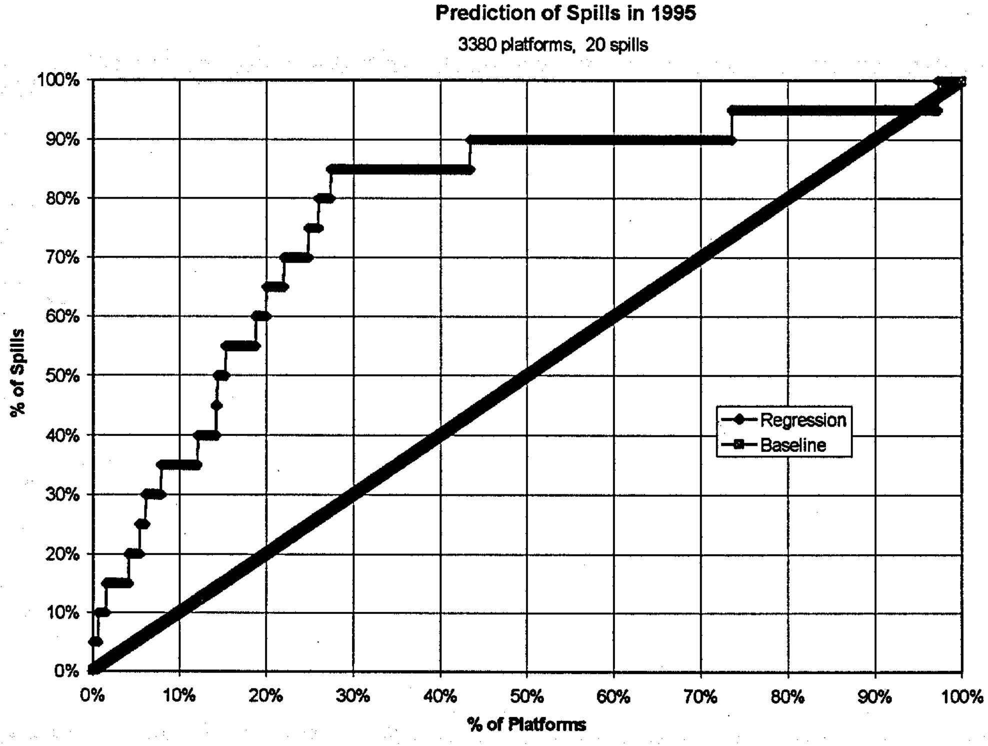


Figure 8-9 Prediction of spills, Logistic regression, 1995

8.5 Determining model accuracy

A very important step in evaluating models is comparing them to each other on a uniform and unbiased basis. A method for comparing the accuracy of different models is presented in a paper by John A. Swets.[96] Essentially, the true-positive proportion to false-positive proportion is plotted, with the area under the curve representing an unbiased estimator of the accuracy of the model.[97] This is done in Figure 8-10 for the logistic model prediction of accidents in 1995. The area under the curve in Figure 8-10 is calculated using the data presented in Table 8-22 and Equation 8-5.

$$A_{\text{total}} = \sum_{i=1}^{n} (FP\%_n - FP\%_{n-1}) * (TP\%_{n-1} + (TP\%_n - TP\%_{n-1}) / 2)$$

Equation 8-5 Model area calculation

Where:
$FP\%_n$ = A data point on the x axis
$FP\%_{n-1}$ = A data point on the x axis just to the left of $FP\%_n$
$TP\%_n$ = A data point on the y axis
$TP\%_{n-1}$ = A data point on the y axis just below $TP\%_n$

A synopsis of how the ratios used in the plot of true to false positives are calculated is as follows:

1. Rank the platforms in order of the model prediction.
2. Pick percentiles to evaluate the number of True and False positives in each percentile. The number of True Positives (TP) and the number of False Positives (FP) in each percentile are determined by simply counting them in the accident column of the spreadsheet.
3. From the number of TP and FP and the total number of platforms in the percentile, the number of False Negatives (FN) and True Negatives (TN) are determined as follows:
   FN = Total of Accidents that occurred - TP
   TN = Total number of platforms - (TN+FN+TP)
4. The data points for TP% and FP% are calculated as follows:
   TP % = TP / (TP + FN)
   FP% = FP/ (FP + TN)

---

[96] Swets, J., *"Measuring the Accuracy of Diagnostic Systems,"* Science, Vol. 240, June 1988.

[97] For a complete discussion regarding how the percentages and areas are calculated, the reader is directed to the Swets paper.

The x and y values in Figure 8-10 (in Table 8-22 on the lines TP% and FP%) are as follows:

Point 1 = (0%, 0%)	Point 2 = (5%, 27%)	Point 3 = (9%, 47%)
Point 4 = (24%, 76%)	Point 5 = (49%, 87%)	Point 6 = (100%, 100%)

Total # of accidents in 1995 is 62	Total # of platforms is 3,380	50th Percentile		75th Percentile		90th Percentile		95th Percentile	
# platforms in the listed percentile		1690		845		338		169	
		Positive	Negative	Positive	Negative	Positive	Negative	Positive	Negative
	Positive	TP = 54	FP= 1636	TP=47	FP=798	TP=29	FP=309	TP=17	FP=152
	Negative	FN = 8	TN= 1682	FN=15	TN=2520	FN=33	TN=3009	FN=45	TN=3166
FP%	100%	49%	24%	9%	5%	0%			
TP%	100%	87%	76%	47%	27%	0%			
Area	0.47	0.21	0.09	0.02	0.01	0.00			
Total_area	0.80								

Table 8-22 Data used to calculate logistic model accuracy for prediction of an accident in 1995

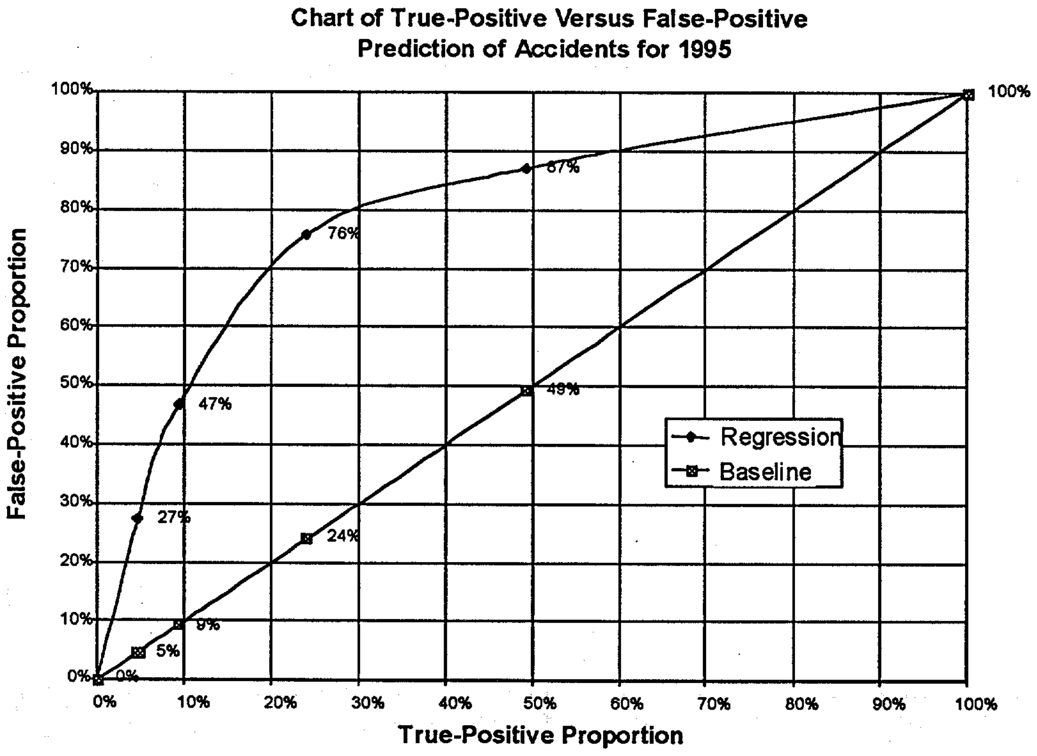


Figure 8-10 Model accuracy plot, Logistic regression, accidents, 1995

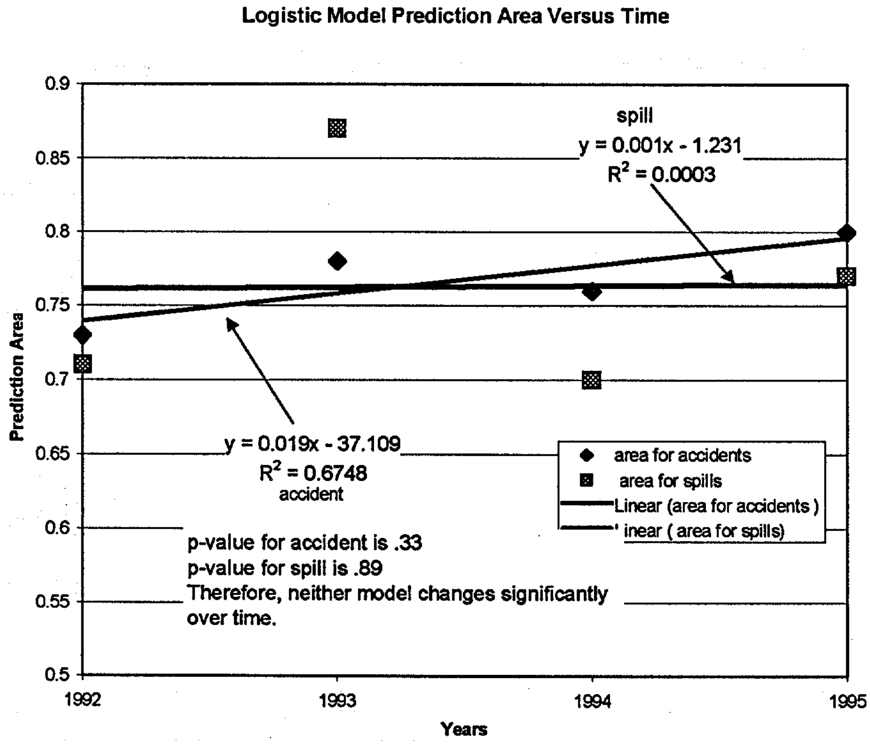
8.6 Logistic model results

Table 8-23 summarizes the logistic model prediction areas for each year. A perfect model would have an area of one. A model that is no better than chance would have an area of .5. As area increases, the model is a better predictor.

	Logistic Regression Model Areas	
Prediction Year	**Model area for predicting accidents**	**Model area for predicting spills**
1992	.73	.71
1993	.78	.87
1994	.76	.70
1995	.80	.77

Table 8-23 Accuracy of logistic models

- All of the logistic regression models are predictive. That is, all of the prediction areas are greater than chance (area of .5). The most accurate model is for predicting spills in 1993. The model area is .87.
- Figure 8-11 shows that there is no trend in model prediction ability from 1992 to 1995. Linear regressions are run for accident and spill areas for this 4-year period. The p-values for both regression coefficients are greater than .1 (.33 for accidents, .89 for spills).



p-value for accident is .33
p-value for spill is .89
Therefore, neither model changes significantly over time.

Figure 8-11 Logistic model prediction areas versus time.

8.7 Summary

The logistic regression models developed in Chapter 8 are predictive, i.e. they do offer a useful method of ranking platforms in terms of risk. The component "Complexity" is shown to always be important as an indicator of both accidents and spills. INC history is also shown to always be an important indicator of both accidents and spills. Age of the platform and experience level of the operator and owner of the platform do not appear to be important indicators of risk. The conclusion for the platform's accident and spill history is mixed. Sometimes this component is important, sometimes it is not.

Chapter 9 - Surveys

Prior to this research, the MMS had conducted three surveys of inspectors and MMS personnel. Building on this previous work, a fourth survey was constructed and administered to the inspectors in the Gulf of Mexico inspection districts in June 1998. Table 9-1 details all of the surveys and this section presents the results of the June 1998 survey. The results, questions and raw data from all four surveys are included in the '"Survey Appendix." The goal of the 1998 survey was to evaluate the risk perception of the inspectors and build an expert model (See Chapter 10) to rank the platforms in terms of perceived risk. In Chapter 11, the results of the expert model will be compared to the logistic regression model to see if any insights can be gained.

Year	Who and how many respondents	Questions asked
1995	Survey 1 - Many individuals, both in districts and in HQ.	Asked to give list of risk factors
1996	Survey 2 - District and HQ personnel – 9 respondents Survey 3 - District and HQ personnel – 13 respondents	Asked to categorize and eliminate redundant risk factors. Asked to further categorize and assign relative importance
1998	Survey 4 – District inspectors and engineers - 59 respondents	Asked to give numeric estimates of risk factors and asked to compare risk factors.

Table 9-1 Sequence of surveys

In their first three surveys, the MMS identified many potential risk factors. For example, three things that concerned the inspectors are as follows:

- The platform's INC history.
- The experience level of the workers.
- The age of a platform.

Unfortunately, the early MMS surveys did not quantify or compare the risks in a way that would allow the construction of expert risk prediction models. The risk factors were first put into categories, then compared to each other within those categories. This made it impossible to compare the relative importance of risk factors across categories. The survey that was administered in June 1998 directly compares and quantifies the risk factors. For example, the definition of the risk factor "age" was too ambiguous in the earlier surveys. The survey done in 1998 quantified what constituted a "risky age." The respondents were all involved with the inspection of offshore operations and were all government employees. There were three sections to the survey:

1. **Respondent data** – This section was designed to gather some descriptive data on the respondents to see if there is any relationship between their personal characteristics or experience and their perception of risk.
2. **Risk quantification** – In this section, respondents are asked to quantity their risk perceptions.
    - 2.1. **Categories** - There are 25 risk categories, e.g., age, distance to shore, slot count, etc...
    - 2.2. **Levels** - For platform age, there are six age levels, e.g. 0-5 years, 6-10 years, etc...
    - 2.3. **Scores** - The respondents are asked to assign a score for each level. The scores are coded on a 1 to 5 scale. 1 = "Much less than average risk," 3= "Average risk," 5= "Much more than average risk."
    - 2.4. **Confidence** - The respondents are asked to provide an estimate of how confident they are in their scores.
3. **Risk category comparisons** –In this section, the risk categories are compared and each category is assigned a "weight" on a zero to 100 scale. The respondent is asked to give a weight of 100 to the category they consider most important as to whether a platform will have an accident or spill, and decreasing weight on subsequent categories.

9.1 Risk category definitions

Table 9-2 lists the definitions of the risk categories used in the survey along with the units.

Risk Category Descriptions	Code	Units
Age of platform	age	Years
Distance from shipping lanes	dist_to_ship_lane	Miles
Distance to shore of a platform	dist_to_shore	Miles
Experience level of the "typical" worker on a platform	work_exp	Years
Experience level of the platform's operating company	op_comp_exp	Years
Number of accidents or spills a platform has experienced	numb_acc_5_yrs	Count
Number of components	num_comp	Count
Number of drill slots	num_drill_slots	Count
Number of INCs that a platform has received	num_inc	Count
Number of people working on a platform	num_on_plat	Count
Number of well completions on a platform	num_well_comp	Count
Percentage of operations contracted out	%_cont_out	Percentage
Presence of fired vessel	fired_vessel	Yes/no
Presence of H2S	pres_H2S	Yes/no
Presence of storage vessel	storage_vess	Yes/no
Simultaneous operations	number_sim_ops	Count
Type of accident or spill that a platform has previously experienced	type_acc_sp	Injury, fatality, etc...
Type of hydrocarbon a platform produces	type_prod	gas, oil or both
Type of INC enforcement that a platform receives	type_penalty	W,C, or S

Type of INCs that a platform has received	type_inc	G,P,H,L
Type of operations conducted	type_operation	Crane operation, etc…
Type of penalty a platform received	type_enf_code	No penalty, civil, or criminal
Volume of hydrocarbon produced on a platform per day	volume_prod	Barrels of oil equivalent
Water depth of a platform	water_depth	Feet
Well or reservoir pressure	well_press	Psia

Table 9-2 Survey risk category definitions

9.2 Respondent data

There were 59 respondents in all: 47 inspectors, 11 engineers, and 1 supervisor. There are 56 inspectors in the Gulf of Mexico. The following describes the "average" respondent.

- Years of experience as an inspector - **9.7 years**
- Years of offshore experience (other than as an inspector) – **15.2 years**
- Percentage of time spent as a production inspector – **56%**
- Percentage of time spent as a drilling inspector – **24% (20% in other activities)**
- Have you ever been injured on a platform – **19 yes, 27 no, 13 did not answer.**
- Have you ever seen anyone injured on a platform – **37 yes, 19 no, 3 did not answer.**

9.3 Risk quantification

The following italicized text is the directions for the risk quantification section. In addition, the example that was given in the survey on how to fill out this section is also reproduced below the italicized text. Following this introductory information, several summary tables and figures are presented.

Instructions for section one: Risk Quantification.

The purpose of this section is to obtain your opinion regarding how various risk factors affect the probability of an accident or spill on a platform in the next year. For example, if you believe that very old or very new platforms are more likely to have accidents or spills, then you might fill out the table as in the example below. (Note that you should put one and only one "X" in each ROW.)

In addition, for each table like the one below, we would like to know how confident you are in your answers. If you are very sure of your answers, then you might put an "X" in the box under "Very confident." However, if you were taking an "educated guess" and do not have a lot of specific information to support your answers, then you might place an "X" under "Not confident." You may find it difficult to give an answer to some of the questions. This is understood, and all that is asked is for you to provide your best guess, based on your experience as an inspector.

NOTE: You may believe that a factor has no relationship at all to a platform's probability of an accident or spill. If you feel that a risk factor has no impact on the probability of an accident or spill, then mark "average probability" for *all levels. You will be given an opportunity in section 2, Risk Factor Comparisons, to state your opinion regarding the importance of each factor as a predictor of an accident or spill.*

EXAMPLE

QUESTION: **A platform's age** may affect its probability of having an accident or spill in the future. For each age level, indicate how likely it would be for a platform to have an accident or spill in the next year.

Place X in box	**Probability of having an accident or spill**				
Platform age levels (years)	**Much less than average**	**Less than average**	**Average probability**	**More than average**	**Much more than average**
0-5				X	
6-10		X			
11-15		X			
16-20			X		
21-25				X	
>25					X
It is understood that some questions in the survey are relatively easy to answer, and some are quite difficult. The following boxes allow you to state how confident you are in your estimates.					
Place X in box	**Not confident**	**Fairly low confidence**	**Average confidence**	**Fairly high confidence**	**Very confident**
Confidence			X		

Table 9-3 Risk quantification example

The column "average probability" means that a risk level is perceived as an "average" risk. The "Much less than average," to "Much more than average" probabilities were coded to a 1 to 5 scale with 1 corresponding to a low risk, 5 a high risk. A "3" represents an average probability of having and accident or spill. Table 9-4 shows the risk levels sorted by highest average perceived risk to lowest average perceived risk. The inspectors ranked platforms over 25 years of age as the highest level. The lowest ranked level is a 50 component platform that has had 0 to 5 INCs in the prior 5 years. Figure 9-1 shows a plot of the top 25 risk levels.

Rank	**Category**	**Level**	**Average Score**	**St_dev**
1	age	>25	4.48	0.68
2	num_inc_5_comp	>25	4.42	0.83
3	number_sim_ops	>5	4.41	0.75
4	work_exp	0-3	4.41	0.62
5	num_inc_25_comp	>25	4.39	0.77
6	numb_acc_5_yrs	>10	4.34	1.05
7	op_comp_exp	0-3	4.31	0.65
8	%_cont_out	76-100	4.27	0.87
9	num_inc_5_comp	21-25	4.24	0.86

10	num_inc_50_comp	>25	4.22	0.91
11	numb_acc_5_yrs	9-10	4.14	0.96
12	num_inc_25_comp	21-25	4.10	0.79
13	number_sim_ops	5	4.10	0.79
14	number_sim_ops	4	4.05	2.62
15	age	21-25	4.03	0.67
16	numb_components	>50	4.02	0.82
17	type_inc	P-103	3.95	0.99
18	num_inc_50_comp	21-25	3.91	0.96
19	volume_oil_prod	>25	3.86	0.92
20	%_cont_out	51-75	3.83	0.72
21	num_well_comp	>25	3.81	0.97
22	dist_to_ship_lane	0-1/2	3.81	1.11
23	numb_acc_5_yrs	7-8	3.81	0.88
24	type_inc	E-100	3.81	0.98
25	numb_components	41-50	3.76	0.73
26	num_inc_5_comp	16-20	3.76	0.80
27	num_inc_25_comp	16-20	3.69	0.81
28	fired_vessel	fire_vess	3.69	0.65
29	age	16-20	3.63	0.64
30	dist_to_ship_lane	1/2-1	3.59	1.05
31	num_well_comp	21-25	3.59	0.85
32	work_exp	4-6	3.59	0.62
33	type_prod_spill	oil	3.59	0.77
34	storage_vess	storage_vess	3.59	0.79
35	type_operation	welding	3.59	0.83
36	volume_oil_prod	21-25	3.58	0.89
37	type_operation	construction	3.58	0.91
38	type_inc	G-110	3.58	0.83
39	type_operation	vess_cleanout	3.54	0.75
40	type_operation	well_work_over	3.54	0.70
41	volume_gas_prod	>40	3.53	1.03
42	numb_components	31-40	3.53	0.65
43	op_comp_exp	4-6	3.51	0.60
44	type_operation	clean_pig_trap	3.48	0.76
45	number_sim_ops	3	3.47	0.73
46	num_drill_slots	>35	3.44	1.12
47	well_press	>2000	3.42	0.95
48	num_inc_50_comp	16-20	3.41	0.95
49	numb_acc_5_yrs	5-6	3.38	0.79
50	volume_gas_prod	36-40	3.37	0.85
51	num_well_comp	16-20	3.36	0.78
52	type_operation	well_completion	3.36	0.74
53	num_drill_slots	31-35	3.32	1.01
54	num_inc_5_comp	11-15	3.31	0.80
55	type_enf_code	S	3.31	1.10
56	volume_oil_prod	16-20	3.29	0.64
57	type_inc	P-240	3.29	0.95
58	type_inc	W-100	3.29	0.85
59	type_prod_spill	both	3.27	0.67
60	type_operation	crane_op	3.27	0.78
61	type_operation	wire_ln_wk	3.27	0.69
62	volume_gas_prod	31-35	3.25	0.66
63	type_prod_acc	oil	3.25	0.78
64	dist_to_ship_lane	1-11/2	3.22	0.90

120	water_depth	51-100	2.68	0.80
121	num_well_comp	6-10	2.68	0.73
122	dist_to_shore	76-100	2.68	0.75
123	water_depth	0-50	2.66	0.92
124	type_prod_acc	gas	2.66	0.73
125	dist_to_shore	101-125	2.64	0.85
126	op_comp_exp	10-12	2.63	0.61
127	volume_gas_prod	11-15	2.61	0.67
128	num_inc_25_comp	6-10	2.61	0.95
129	type_acc_sp	vessel_strike	2.61	0.95
130	type_acc_sp	weather_dam	2.60	0.88
131	type_penalty	INC_no_pen	2.59	0.87
132	volume_oil_prod	6-10	2.58	0.72
133	type_inc	P-406	2.58	0.89
134	well_press	0-500	2.56	0.91
135	dist_to_ship_lane	>2	2.53	0.80
136	pres_H2S	H2S_not_pres	2.53	0.75
137	fired_vessel	no_fire_vess	2.53	0.75
138	age	6-10	2.52	0.63
139	%_cont_out	0-25	2.51	0.90
140	number_sim_ops	1	2.51	0.73
141	num_drill_slots	6-10	2.51	0.73
142	numb_components	0-10	2.46	0.70
143	storage_vess	no_storage_vess	2.44	0.70
144	numb_acc_5_yrs	1-2	2.42	0.79
145	age	0-5	2.41	1.22
146	work_exp	10-12	2.41	0.67
147	num_inc_50_comp	6-10	2.37	1.08
148	volume_gas_prod	6-10	2.37	0.72
149	volume_oil_prod	0-5	2.31	0.86
150	num_well_comp	0-5	2.31	0.86
151	num_drill_slots	0-5	2.24	0.88
152	op_comp_exp	13-15	2.24	0.60
153	work_exp	13-15	2.17	0.68
154	type_prod_spill	gas	2.17	0.75
155	volume_gas_prod	0-5	2.15	0.93
156	num_inc_5_comp	0-5	2.08	0.88
157	op_comp_exp	16-18	2.08	0.68
158	num_inc_25_comp	0-5	2.07	0.93
159	numb_acc_5_yrs	0	2.02	1.03
160	work_exp	16-18	1.98	0.73
161	op_comp_exp	>18	1.98	0.76
162	work_exp	>18	1.95	0.86
163	num_inc_50_comp	0-5	1.90	0.96

Table 9-4 Ranking of risk scores for various levels

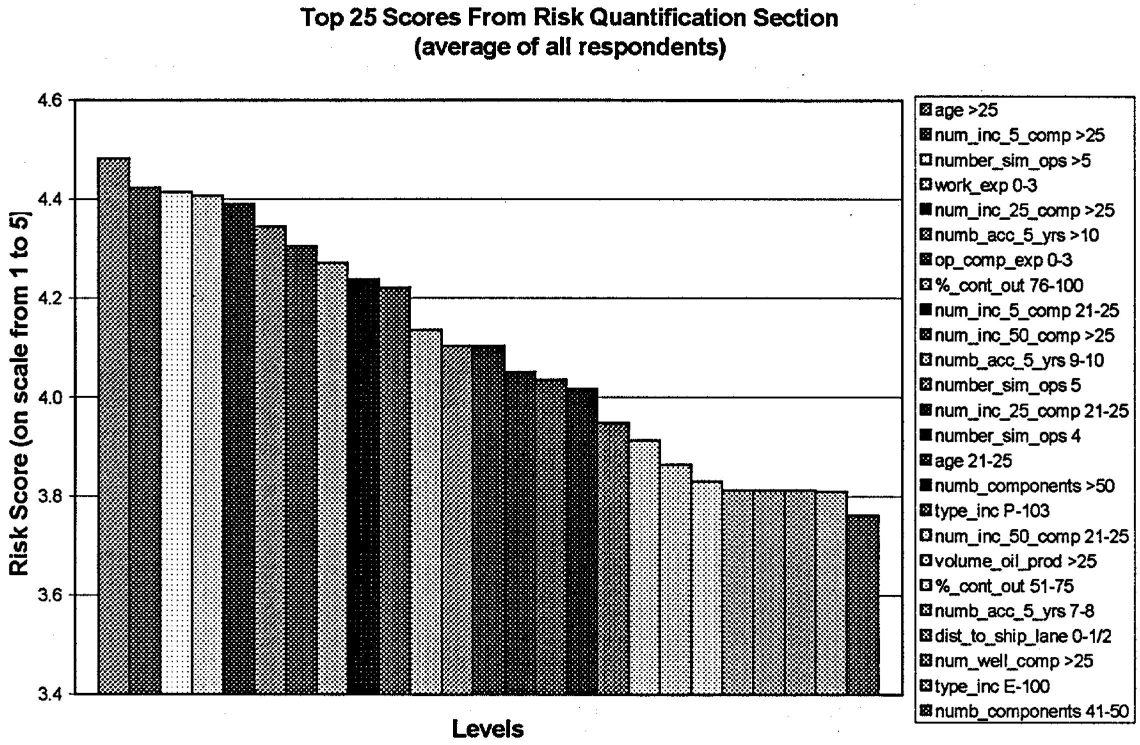


Figure 9-1 Top 25 risk scores in risk quantification section

Figures 9-2 and 9-3 on the following page show the risk scores for the category "age" for different levels of age and the category "INCs" for different levels of INCs. The bold line is a regression through the average value of the responses. The lighter lines above and below are regressions through the +- 1 standard deviation points for each level.

Figure 9-2 shows as the platform age increases, the perceived risk increases. However, there is less agreement between the experts regarding the perception of the risk of both new and old platforms. The variance is <u>not</u> uniform from category to category (exhibits heteroskedasticity). Another conclusion is platforms older than 15 years are perceived as greater than average risk.

Figure 9-3 shows that as the number of INCs increases, the perceived risk increases. In addition, the variance is constant, so there is generally agreement among the experts regarding this conclusion. If a five component platform receives more than 10 INCs in the prior 5 years, its risk perception is greater than average.

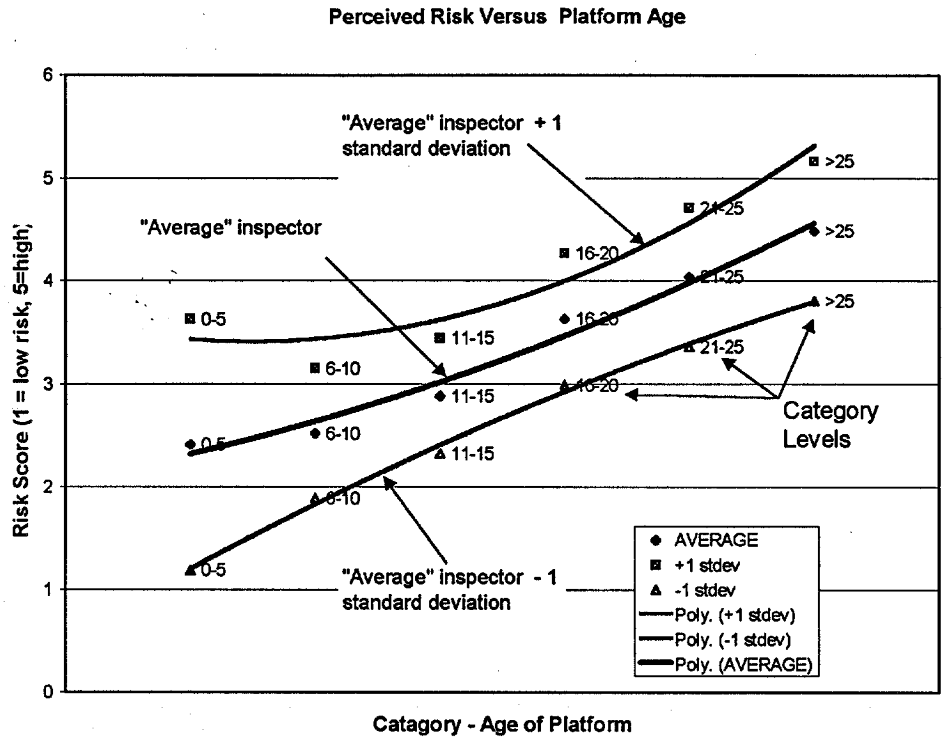


Figure 9-2 Expert perception of risk versus platform age

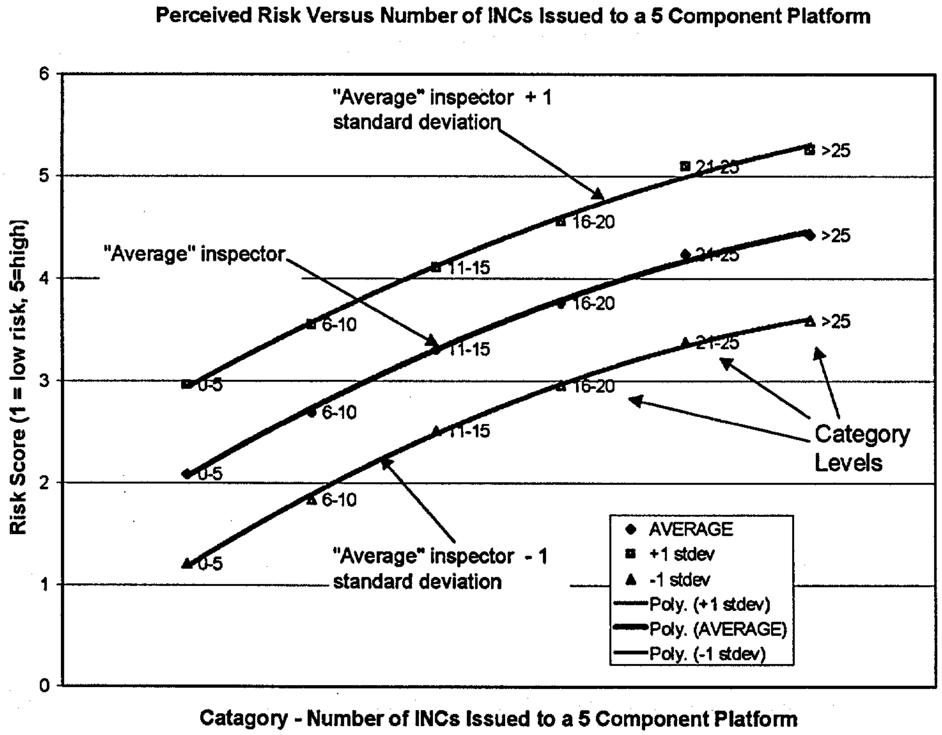


Figure 9-3 Expert perception of risk versus number of INCs

9.4 Confidence in risk estimates

Note that on the bottom of Table 9-3 the inspectors are asked to provide a "confidence level" in their probability estimates on a 5-point scale. There were two possible uses for this information: one use would be to assign uncertainty distributions to the estimates; another use would be to check if there was any relationship between a respondent's experience level and their level of confidence regarding their estimates. Table 9-5 shows the average level of confidence of the respondents for each risk category. The columns on the far right show how many times the inspectors responded at each possible degree of confidence, e.g. 29 responded with a confidence estimate of "3" for "type_operation", 19 responded with a "4". An "nr" means no response was given. It was decided that a confidence interval on the category estimates would not be used in building the expert model because the average confidence levels for all categories are very similar.

Rank	**Risk Category**	**Avg.**	**st_dev**	**nr**	**1**	**2**	**3**	**4**	**5**
1	type_operation	3.58	0.83	0	1	1	29	19	9
2	%_cont_out	3.47	0.75	0	1	2	28	24	4
3	type_prod_acc	3.47	0.75	0	1	2	28	24	4
4	type_prod_spill	3.46	0.75	0	1	2	29	23	4
5	num_inc_5_comp	3.45	0.73	1	1	1	31	21	4
6	number_sim_ops	3.44	0.84	0	1	3	31	17	7
7	age	3.41	0.84	1	1	4	29	18	6
8	numb_acc_5_yrs	3.41	0.81	0	1	4	29	20	5
9	storage_vess	3.41	0.75	0	1	1	35	17	5
10	work_exp	3.39	0.85	0	2	3	29	20	5
11	type_penalty	3.38	0.77	1	1	3	31	19	4
12	volume_oil_prod	3.38	0.75	1	1	2	33	18	4
13	fired_vessel	3.37	0.74	0	1	2	34	18	4
14	num_well_comp	3.36	0.79	1	1	4	30	19	4
15	num_inc_25_comp	3.36	0.74	0	1	2	35	17	4
16	num_inc_50_comp	3.36	0.69	0	1	1	36	18	3
17	op_comp_exp	3.36	0.76	0	1	3	33	18	4
18	well_press	3.36	0.76	0	1	4	30	21	3
19	type_enf_code	3.34	0.76	1	1	3	33	17	4
20	type_inc	3.31	0.79	0	2	3	32	19	3
21	type_acc_sp	3.29	0.75	1	1	5	30	20	2
22	volume_gas_prod	3.29	0.74	0	1	4	34	17	3
23	dist_to_shore	3.29	0.79	0	1	4	36	13	5
24	num_on_plat	3.27	0.72	0	1	3	37	15	3
25	water_depth	3.24	0.86	1	3	3	33	15	4
26	dist_to_ship_lane	3.24	0.84	0	2	5	33	15	4
27	num_drill_slots	3.22	0.84	1	1	7	33	12	5
28	pres_H2S	3.20	0.92	0	3	5	34	11	6

Table 9-5 Average respondent confidence in risk scores for each category in quantification section

A regression was run comparing the years of experience as an inspector versus confidence level. Figure 9-4 shows that the respondents' confidence does not depend on their experience as an inspector. No significant relationship was found.

Figure 9-4 Comparing average respondent confidence versus years of experience

9.5 Risk category comparison

The following italicized text is the directions given the respondents for the risk factor comparison section. In addition, the example that was given in the survey on how to fill out this section is also reproduced below the italicized text. Following this introductory information, several summary tables and figures are presented.

Instructions for section two: Risk Factor Comparisons

Listed on the following page are the 25 risk factors that you have just evaluated. Now that you have thought hard about the factors, we would like to get your estimates of their relative importance in predicting accidents or spills. We know that you have done similar ranking tasks before, but in this exercise, we want to capture the relative importance *between the risk factors. This is a somewhat difficult exercise, but is the only way to determine the relative importance of the risk factors.*

1) Go through the list and cross off any risk factor that you think is not important.

2) Take the remaining factors and rank them in order of importance in predicting an accident or a spill from most important (starting with 1) to least important. Do one ranking across all the remaining factors. Only one factor should be ranked "1": the most important.

3) We now want to find out how much less important you feel the second factor is than the first. Put 100 by the most important factor. Next to the second factor put a number that indicates how much less important it is. For example, if the second factor was half as important as the first, you would put 50; if it was almost the same importance, you might put 90 (see the example).

4) Continue down the list of risk factors in order of their ranks, indicating the relative importance of each. For example, if you put 90 by the second risk and the third risk is half as important as the second is, you would put 45 next to the third risk. These weights should never increase as you progress. If two consecutive factors are of equal importance, then you can give them the same weight.

5) At anytime you can go back and change either the rank or weight of an item. Just be sure that you are consistent throughout.

NOTE: *The following example is intended solely to show the process used to fill out the table. It* IS NOT *intended to influence your answers. The questions to be crossed out were picked at random, and the rankings and point values were randomly assigned.*

Please DO NOT *assign rankings based on political ramifications or consequences. Instead, base your ranking on your belief regarding the risk factors influence on the probability of a platform having an accident or spill.*

EXAMPLE

Category Weight	Ranking	Risk Category
		~~Number of drill slots~~
		~~Well or reservoir pressure~~
		Experience level of the "typical" worker on a platform
10	12	Number of people working on a platform
		~~Distance from shipping lanes~~
5	14	Number of well completions on a platform
20	10	Simultaneous operations
30	7	Distance to shore of a platform
20	9	Type of accident or spill that a platform has previously experienced
45	5	Experience level of the platform's operating company
5	15	Number of INCs that a platform has received
		~~Type of hydrocarbon a platform produces (gas, oil or both)~~
		~~Type of operations conducted~~
15	11	Water depth of a platform
5	13	Type of INC enforcement that a platform receives (W,C, or S)
90	2	Presence of fired vessel
30	6	Volume of hydrocarbon produced on a platform per day
45	4	Age of Platform
25	8	Number of accidents or spills a platform has experienced
		~~Type of penalty a platform received (no penalty, civil, or criminal)~~
		~~Presence of storage vessel~~
100	1	Percentage of operations contracted out
		~~Presence of H2S~~
45	3	Number of components
		~~Type of INCs that a platform has received~~

Table 9-6 Risk category comparison example

In Table 9-7, the weights are the sum of the weights given to that risk category by all of the inspectors. The categories are sorted by the amount of weight they received. Note that "experience" measures are ranked number one and number two. Age is ranked number six. Therefore, although "age >25 years" was listed in Table 9-5 as the most important risk level, age as a risk category is deemed less important than experience. Note that several risk categories in Table 9-7 are highlighted. Those risk categories could not be included in the expert model because enough information was not available in the MMS databases.

Risk Category	Total Weights	Scaled Weights
Experience level of the "typical" worker on a platform	5013	1.000
Experience level of the platform's operating company	4138	0.825
Percentage of operations contracted out	3367	0.672
Number of people working on a platform	3189	0.636
Number of accidents or spills a platform has experienced	3059	0.610
Age of Platform	3053	0.609
Simultaneous operations	2939	0.586
Type of operations conducted	2593	0.517
Type of accident or spill that a platform has previously experienced	2583	0.515
Type of hydrocarbon a platform produces (gas, oil or both)	2404	0.480
Number of INCs that a platform has received	2327	0.464
Presence of fired vessel	2297	0.458
Number of components	2236	0.446
Volume of hydrocarbon produced on a platform per day	2206	0.440
Type of INCs that a platform has received	2188	0.436
Type of INC enforcement that a platform receives (W,C, or S)	2016	0.402
Type of penalty a platform received (no penalty, civil, or criminal)	1912	0.381
Presence of H2S	1828	0.365
Presence of storage vessel	1781	0.355
Number of well completions on a platform	1518	0.303
Distance from shipping lanes	1422	0.284
Well or reservoir pressure	1410	0.281
Distance to shore of a platform	488	0.097
Water depth of a platform	365	0.073
Number of drill slots	227	0.045

Table 9-7 Risk category weights

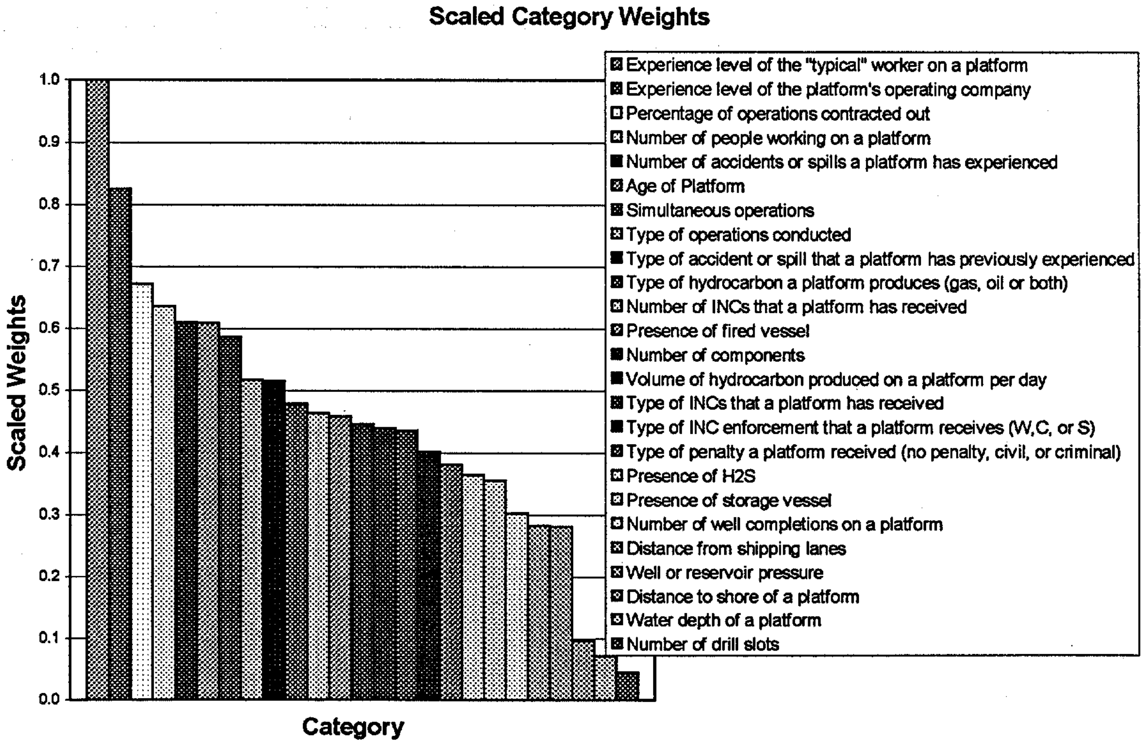


Figure 9-5 Scaled category weights

9.6 Survey results

In Chapter 8, the risk factors are combined into "components" based on a Varimax rotation of principal components. The components are then used in the regressions. In Table 8-20, the components are ranked according to the number of times they are significant in the logistic regressions. A similar grouping of risks is shown in Table 9-9 where the risks are placed into the same components as those used in Chapter 8. Table 9-8 summarizes Table 9-9 and shows the ranking for the expert and logistic regression

	Expert Model Components Ranking		
Component	Scaled Total Weights	Expert Rank	Logistic Model Rank
Complexity (COMP)	1.0	1	1
Age or Experience Levels (AGE)	.40	2	4
INC History (INCS)	.28	3	2
Accident/Spill History (ACC/SPILL)	.19	4	3

Table 9-8 Comparison of Components importance between experts and logistic models

Table 9-8 shows that the experts believe that some components are more important than the logistic model shows.

Complexity	**Weight**	**Age/Experience**	**Weight**	**Acc/Spill History**	**Weight**	**Inspection History**	**Weight**
Percentage of operations contracted out	3367	Experience level of the "typical" worker on a platform	5013	Number of accidents or spills a platform has experienced	3059	Number of INCs that a platform has received	2327
Number of people working on a platform	3189	Experience level of the platform's operating company	4138	Type of accident or spill that a platform has previously experienced	2583	Type of INCs that a platform has received	2188
Simultaneous operations	2939	Age of Platform	3053			Type of INC enforcement that a platform receives (W,C, or S)	2016
Type of operations conducted	2593					Type of penalty a platform received (no penalty, civil, or criminal)	1912
Type of hydrocarbon a platform produces (gas, oil or both)	2404						
Presence of fired vessel	2297						

Number of components	2236						
Volume of hydrocarbon produced on a platform per day	2206						
Presence of H2S	1828						
Presence of storage vessel	1781						
Number of well completions on a platform	1518						
Distance from shipping lanes	1422						
Well or reservoir pressure	1410						
Distance to shore of a platform	488						
Water depth of a platform	365						
Number of drill slots	227						
Total Weights Each Components	**30270**		**12204**		**5642**		**8443**
Scaled Weights For Each Component	**1**		**.40**		**.19**		**.28**

Table 9-9 Risks combined to form "components" as in Chapter 8.

Some more conclusions from the expert survey are as follows:

- The experience level of the experts did not affect their confidence in their estimates.
- The confidence level for all questions was relatively the same.
- The experts ranked platforms over 25 years of age as most likely to experience an accident or spill, based on their perception scores.
- Generally, experts thought other things were more important than age, until the platforms were quite old.
- There was a difference between the direct comparison of risk categories and the experts' belief in riskiness based on their perception scores. For example, "training and experience" is the number one category when comparing the "weights." However, when you evaluate the "risk levels," the rankings change and very old platforms are perceived as most likely to experience an accident or spill. This points out why the quantification exercise was necessary. Just comparing categories is not enough; you must compare various levels within each category.

9.7 Summary

The experts think that a platform's age, the experience level of the operating company, and the average worker's level of experience are very important, whereas the logistic models of Chapter 8 rank these risks the lowest, i.e. least predictive. The confidence the experts have in this belief does not depend on their experience level offshore, or their experience level as an inspector. Some of the risks that the experts think are important are not tracked in the databases and can not be included in the expert models presented in Chapter 10. The lack of information on risk factors that the expert's perceive to be important could be a significant source of error in the expert models.

Chapter 10 - Expert Model

The expert models are constructed using the data collected in the survey described in Chapter 9. Individual expert models are prepared for one year (1995) to evaluate whether some experts are good or bad at predicting accidents. In addition, models are prepared for an "average" expert to predict both accidents and spills for the years 1992 to 1995. An "average" expert ranks the platforms in terms of perceived risk in much the same manner as the platforms were ranked by the output of the logistic model in Chapter 8. The results are displayed graphically in Figures 10-6 to 10-13 in the same format as in Chapter 8, Section 8.4. In addition, a comparison of model accuracy is performed as outlined in Chapter 8, Section 8.5. The following hypothetical example illustrates the approach used in this research to construct the expert models.

10.1 Expert model example

This example uses a simplified model with only three risk factors: age, number of INCs, and distance to shore. Suppose that three experts provide the following information regarding their belief about the influence each risk category has on the probability of an accident or spill.

Category Age	**Risk Quantification, 1=small risk, 5=large risk**			
Years	**Expert 1**	**Expert 2**	**Expert 3**	**Average**
0-5	4	3	2	3
6-10	3	2	2	2.33
11-15	3	3	2	2.67
>15	5	5	5	5

Table 10-1 Expert model example – age category

Category INCs	**Risk Quantification, 1=small risk, 5=large risk**			
# in 5 years	**Expert 1**	**Expert 2**	**Expert 3**	**Average**
0-5	3	3	3	3
6-10	3	2	3	2.67
11-15	3	3	4	3.33
>15	5	5	5	5

Table 10-2 Expert model example – INCs category

Category Distance To Shore	**Risk Quantification, 1=small risk, 5=large risk**			
(miles)	**Expert 1**	**Expert 2**	**Expert 3**	**Average**
0-25	1	3	2	2
26-50	2	3	2	2.33
51-75	3	3	2	2.67
>75	3	3	3	3

Table 10-3 Expert model example – distance to shore category

Now, the experts are asked to rank the categories from 1 to 3 against each other, with 1 corresponding to the highest risk, 3 the lowest risk.

	Ranking Categories		
	Expert 1	**Expert 2**	**Expert 3**
Age	1	2	2
# INCs	2	1	1
Distance	3	3	3

Table 10-4 Expert model example – category ranking

Now the experts are asked to put a weight of 100 on category number one, and then compare category two to category one and assign either the same or a lesser amount of weight on category two. After doing this, compare category three to category two and assign either the same or a lesser weight.

Risk Category	**Assigning Weights To Categories**			**Total**	**Scaled Weights**
	Expert 1	**Expert 2**	**Expert 3**		
Age	100	70	60	230	.92
# INCs	50	100	100	250	1
Distance	10	20	15	45	.18

Table 10-5 Expert model example – category weights

This example shows that relatively speaking, the experts believe that the # of INCs a platform receives is a more important category than age, with distance to shore coming in third. The results from Tables 10-1 to 10-3 for the "average" expert are used as bins to determine what category score to give each platform.

Risk Scoring Matrix	Categories		
	Age	# INCs	Distance
Level 1	3	3	2
Level 2	2.33	2.67	2.33
Level 3	2.67	3.33	2.67
Level 4	5	5	3
Category Weights	.92	1	.18

Table 10-6 Expert model example – "average" scores

Now platforms can be ranked in terms of risk in accordance with the preferences of the experts. Suppose that you wish to rank the following three platforms:

	Data on Platform Age	"Average" Level Score	Data on Platform #INCs	"Average" Level Score	Data on Platform Distance To Shore	"Average" Level Score
Platform 1	2	3	5	3	5	2
Platform 2	8	2.33	10	2.67	50	2.33
Platform 3	15	2.67	15	3.33	100	3

Table 10-7 Expert model example – platform data

A risk index can be computed and the platforms ranked using Equation 10-1.

$$\text{Platform Risk Index} = \text{weight}_{\text{age}}\,(\text{level score}) + \text{weight}_{\#\text{INCs}}\,(\text{level score}) + \text{weight}_{\text{Distance}}\,(\text{level score})$$

Equation 10-1 Expert model example - risk index equation

Platform 1 Index = .92*(3)+1*(3)+.18*(2) = 5.8
Platform 2 Index = .92*(2.33)+1*(2.67)+.18*(2.33) = 5.2
Platform 3 Index = .92*(2.67)+1*(3.33)+.18*(3) = 6.3

Therefore, the platforms would be ranked as follows:

Platform 3 = most risky platform
Platform 1 = second
Platform 2 = third

The calculation of the risk index for one platform for accidents and spills in 1995 is given in Table 10-8 that follows. Later it will be shown that this platform ranks at number 338 out of 3,380 platforms in 1995. Therefore, it is at the edge of the top 10% of ranked platforms.

Platform Data		**Category**	**Level**	**"Average" Scores**	**"Average" Weight**	**Risk Index**
COMPLEX_ID_NUM	20874	age	>25	4.48	0.62	2.78
DISTANCE_TO_SH	7	num_on_plat	11-15	2.88	0.64	1.84
SLOT_DRILL_COUNT	11	num_inc_50_comp	6-10	2.37	0.46	1.09
SLOT_COUNT	12	type_inc	G	3.58	0.43	1.54
WATER_DEPTH	30	type_inc	P	3.24	0.43	1.39
FIRED_VESSEL_FL	0	type_enf_code	C	3.07	0.40	1.23
GAS_PROD_FLAG	1	pres_H2S	H2S_not_pres	2.53	0.36	0.91
GAS_FLARING_FLAG	0	op_comp_exp	0-3	4.31	0.82	3.53
MAJ_CMPLX_FLAG	1	work_exp	0-3	4.41	1.00	4.41
HELIPORT_FLAG	1	numb_acc_5_yrs	0	2.02	0.61	1.23
SUL_PROD_FLAG	0	type_prod	both	3.25	0.48	1.56
STORE_TANK_FLAG	0	num_well_comp	11-15	3.07	0.30	0.92
OIL_PROD_FLAG	1	num_drill_slots	11-15	2.69	0.04	0.11
DISTRICT_CODE	5	water_depth	0-50	2.66	0.07	0.19
CRANE_COUNT	B	dist_to_shore	0-25	2.71	0.10	0.27
COMPRESSOR_FLAG	0	fired_vessel	no_fire_vess	2.53	0.47	1.19
COMGL_PROD_FLAG	B	storage_vess	no_storage_vess	2.44	0.36	0.88
BED_COUNT	14	numb_components	41-50	3.76	0.45	1.69
NUM_COMP	45				**Total Index**	**26.75**
age_94	53					
op_exp_94	2.282					
co_exp_94	3.624					
#ins_no_inc_90_94	19					
#ins_w_inc_90_94	2					
tot_inc_90_94	8					
E_90_94	0					
G_90_94	6					
H_90_94	0					
L_90_94	0					
M_90_94	0					
P_90_94	2					
C_90_94	8					
W_90_94	0					
S_90_94	0					
#acc_90_94	0					
#SPLL_90_94	0					
#INJ_90_94	0					
#FAT_90_94	0					
#FIRE_90_94	0					
#VESS_90_94	0					
#EXP_90_94	0					
#MIN_90_94	0					
#MAJ_90_94	0					

Table 10-8 Platform Risk Index - platform ID #20,874 - for 1995

It may appear that simply using a linear summation model would be too simplistic. However, as pointed by Dr. Fischer:[98]

> *"In fact, psychological studies suggest that additive value models provide an extremely good approximation to almost all decision maker's preferences across a wide range of situations. Thus a very simple model is often appropriate because the structure of actual preferences is also quite simple."*

The weights shown in Table 9-7 were used to construct the expert models in this chapter, along with the category values shown in Table 9-4. Some potential risk factors could not be included because the databases did not contain the needed information. The highlighted rows in Table 9-7 correspond to information that experts felt was important, but could not be included in the expert model. In general, most of the important risk factors are included in the expert model. However, as noted in Chapter 9, the lack of database information, and the non-inclusion of some risk factors, is a source of error in the expert model.

10.2 Individual expert models

The "average" expert is presented in Section 10.4. Individual expert predictions of accidents in 1995 are presented in this section. To prepare the individual models, each survey respondent's risk probability estimates are used in the risk index equation. The best expert has a model area of .79, the worst .59. Figure 10-1 shows a plot of best and worst expert predictions for accidents in 1995. As can be seen from the figure, the worst expert does not predict much better than chance (the "baseline"). Figure 10-2 shows a histogram of model prediction areas for accidents in 1995 for all survey respondents. In general, the experts do a good job, and are clustered closely about the average. A check is done of the number correctly identified in the top 10% of ranked platforms and is shown in Figure 10-3. The "best" expert does not get as many correct in the top 10% as one would assume. In addition, a comparison of model accuracy based on the inspector districts is presented in Figure 10-4. There is no significant difference in accuracy based on district. A check of model accuracy to experience offshore is presented in Figure 10-5. There is no significant difference in model accuracy based on experience offshore.

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[98] Fischer, G., *"Multiattribute Preference Models: A Brief Overview"*, Department of Social and Decision Sciences, Carnegie Mellon University, spring, 1989. This is a handout prepared for a class in decision analysis.

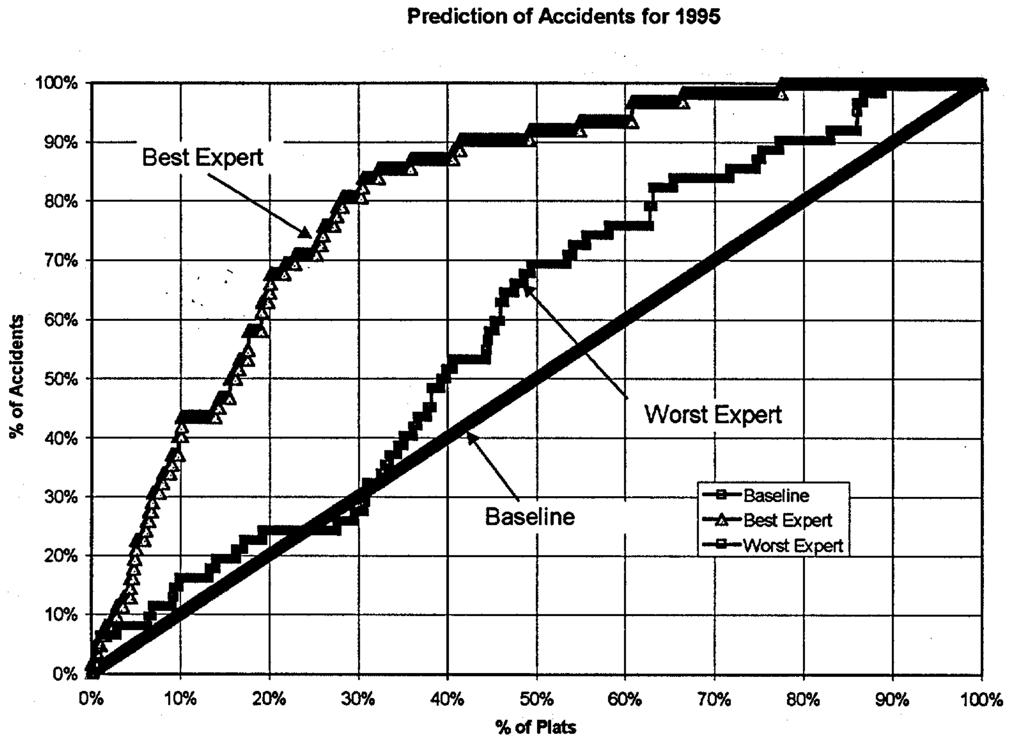

Figure 10-1 Plot of best and worst expert prediction of accidents in 1995.

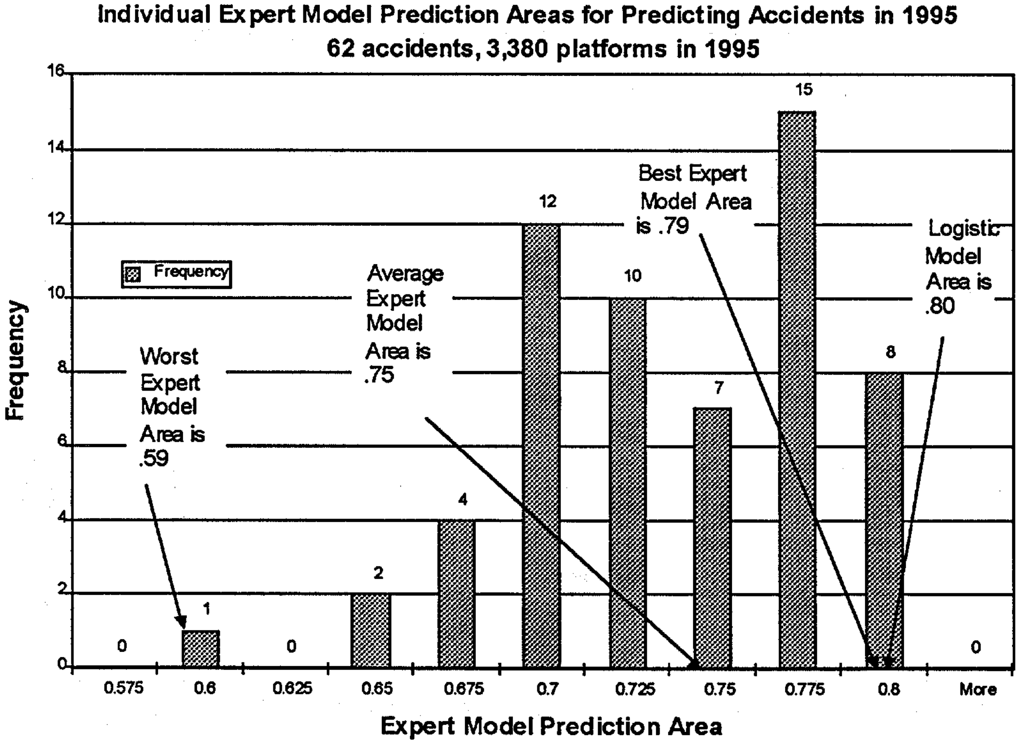

Figure 10-2 Histogram of expert prediction areas for accidents in 1995

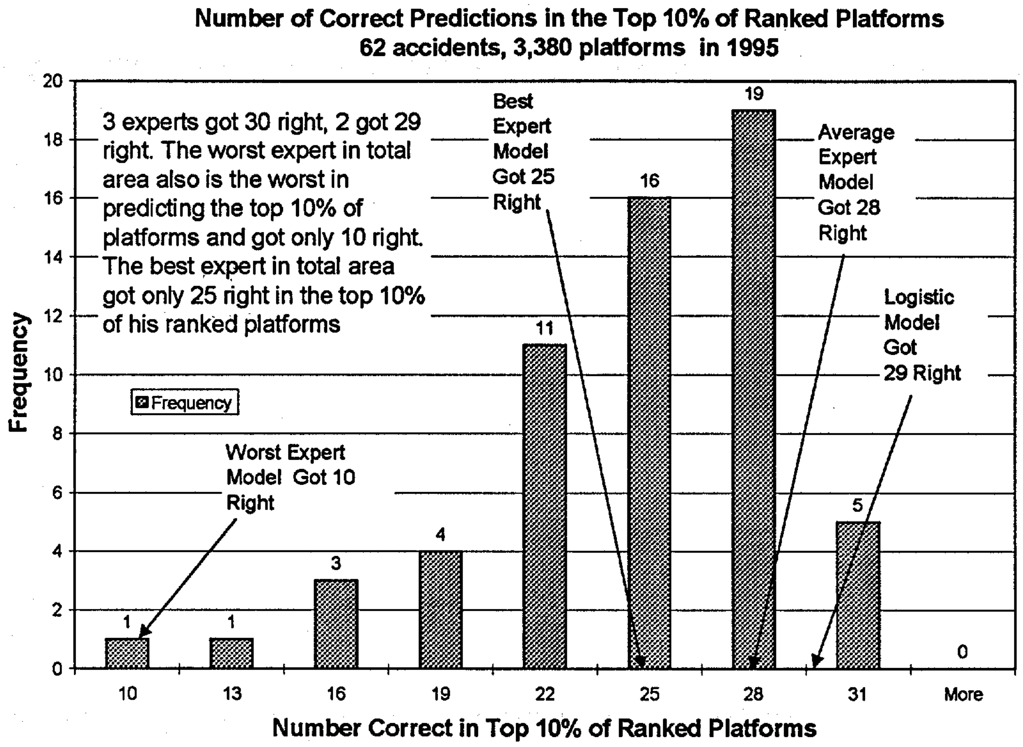

Figure 10-3 Histogram of number correct in top 10% of ranked platforms for predicting accidents in 1995

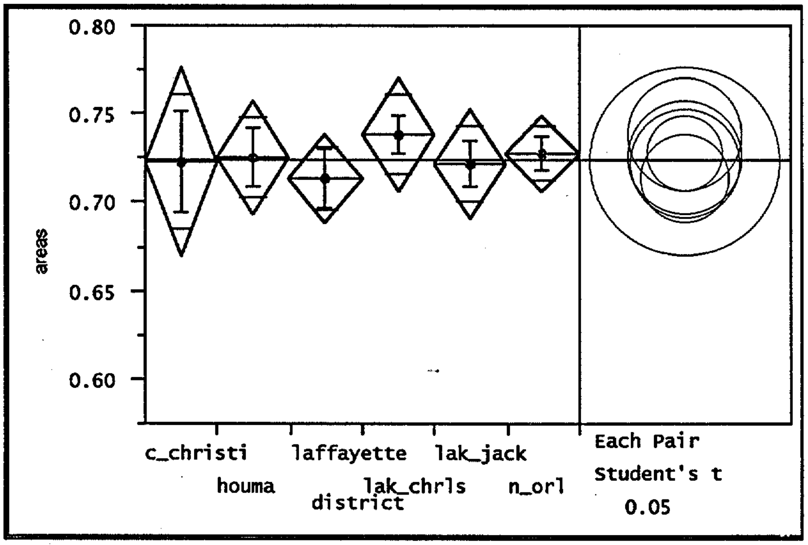

Figure 10-4 Graphic display of average model area by district. There is no statistically significant difference in model accuracy based on districts.

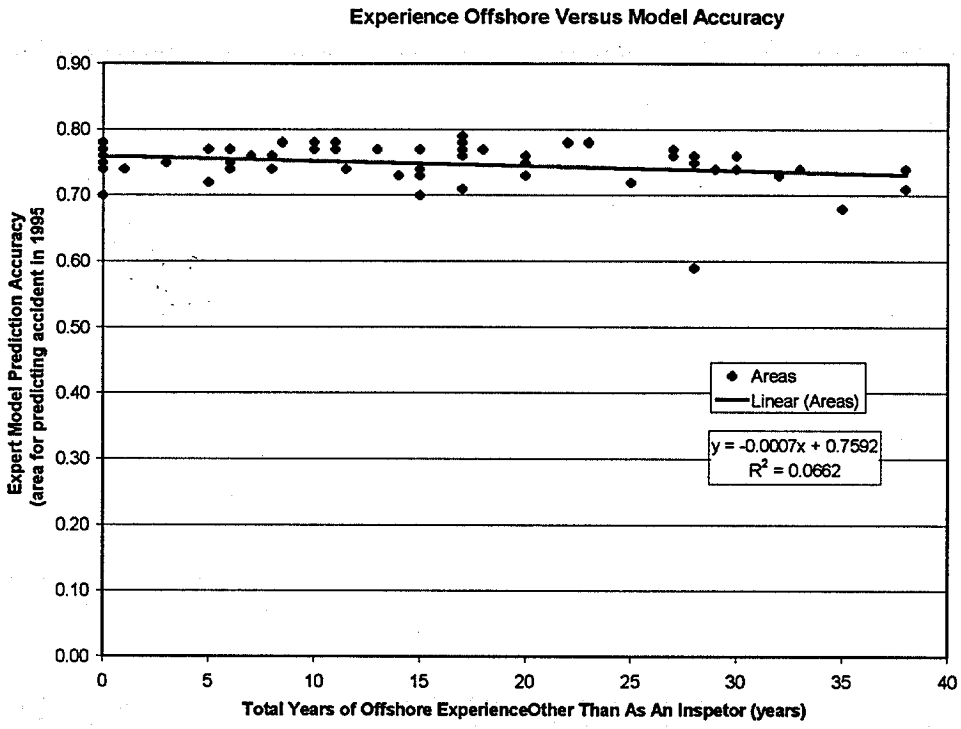

Figure 10-5 Model accuracy versus years of experience offshore. There is no improvement in model accuracy based on experience offshore.

Analysis of Variance				
Source	DF	Sum of Squares	Mean Square	F Ratio
Model	5	0.0036	0.0007	0.3348
Error	53	0.1153	0.0021	Prob>F
C Total	58	0.1190	0.0021	0.8897

Table 10-9 ANOVA test to see if model accuracy differs by district. No difference noted.

Some inspectors may be very good at predicting the worst platforms, but might not have the most accurate model overall. The inspectors were ranked based on their model accuracy and ranked based on the number of correct predictions in the top 10% of ranked platforms. The rank correlation is only about .56. This indicates that some inspectors are very good at getting the worst platforms, but their predictions are not so good for the remaining platforms.

	Rank by Total Area	**Rank by Number Correct in Top 10%**
Rank by Total Area	1	
Rank by Number Correct in Top 10%	0.56	1

Table 10-10 Correlation of accuracy rank versus most correct in top 10%

10.3 Individual expert model results

The following are some of the conclusions that can be drawn from the tables and figures in the previous section.

- The experience of the inspector and the number of years of offshore experience have no impact on the accuracy of their predictions.
- The experts are all surprisingly good at ranking platforms.
- There is less variation between experts than was expected at the outset of the research.
- There is no statistically significant difference in model accuracy between the districts.
- Some experts are very good at identifying the very worst platforms (top 10% of ranked platforms), but these same experts do not have the best model overall.
- The expert that had the best overall model was not as good as many other experts at picking the top 10% of platforms.
- Even the worst expert performed better than chance. Also, it might be that the worst expert is not really that bad, but simply chose not to whole-heartedly participate in the survey.
- The logistic model is better than the best expert.
- The average expert model is very good at predicting the very worst platforms (top 10% of ranked platforms).

10.4 Average expert model

Models for the "average" expert were constructed for all platforms from 1992 to 1995 using the average category weights and average level scores. Using a procedure similar to the one used in Chapter 8, the average expert model prediction is plotted. The vertical axis is the percent of accidents; the horizontal axis is the percent of platforms. The graphs are interpreted in the same manner as outlined in Chapter 8 for the logistic models. You interpret Figures 10-6 to 10-13 as in the example that follows:

1. For the 1992 accident prediction, (Figure 10-6) find the 50% value on the vertical axis.
2. Move horizontally to the jagged line.
3. Read down to the horizontal axis. The value is around 18%. This means that 50% of the accidents that occurred in 1992 were predicted in the top 18% of the ranked platforms. If the accidents were randomly distributed, i.e. a worthless model, you would get 50% of the accidents in 50% of the platforms.

The 8 charts that follow (Figures 10-6 to 10-13) are the "average" expert prediction of accidents and spills from 1992 to 1995.

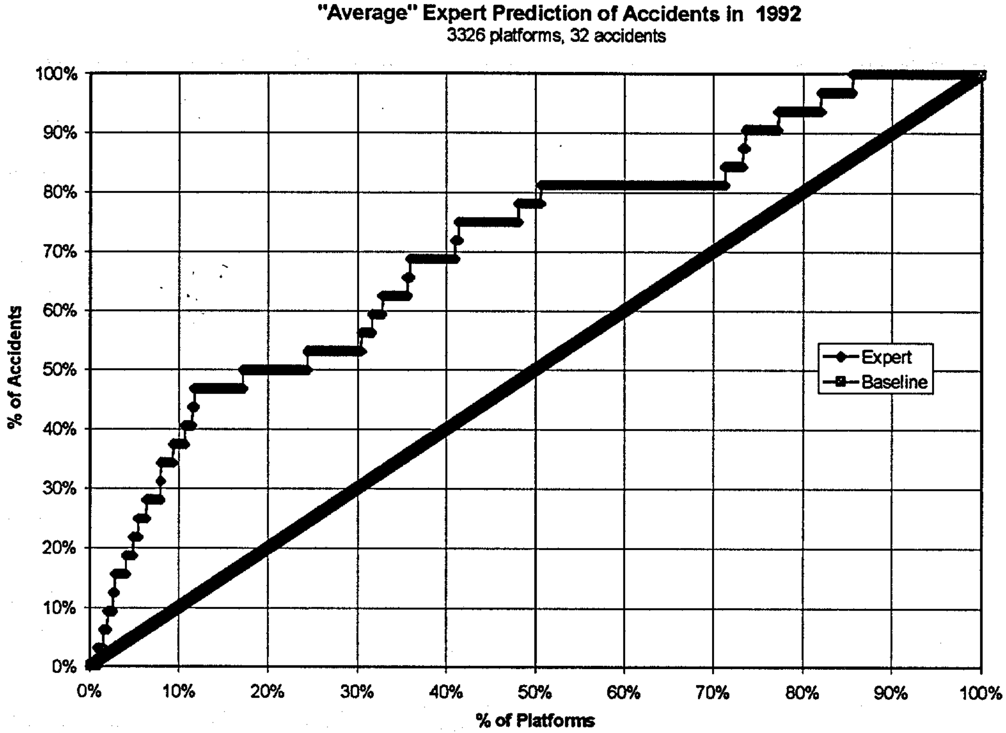

Figure 10-6 Average expert prediction of accidents in 1992

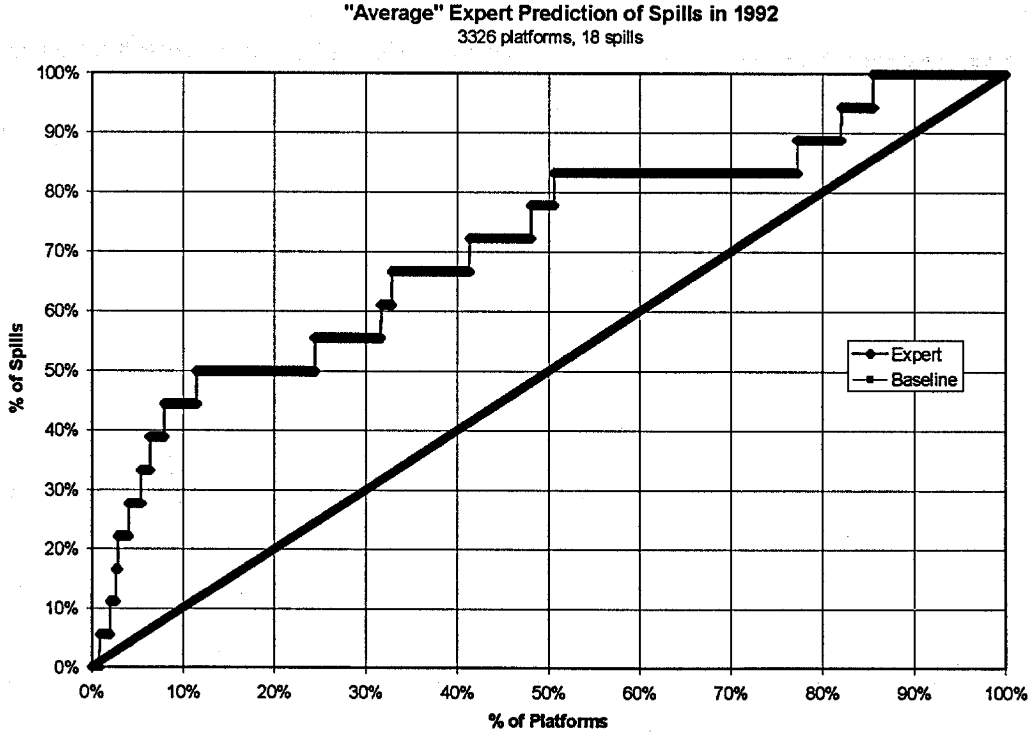

Figure 10-7 Average expert prediction of spills in 1992

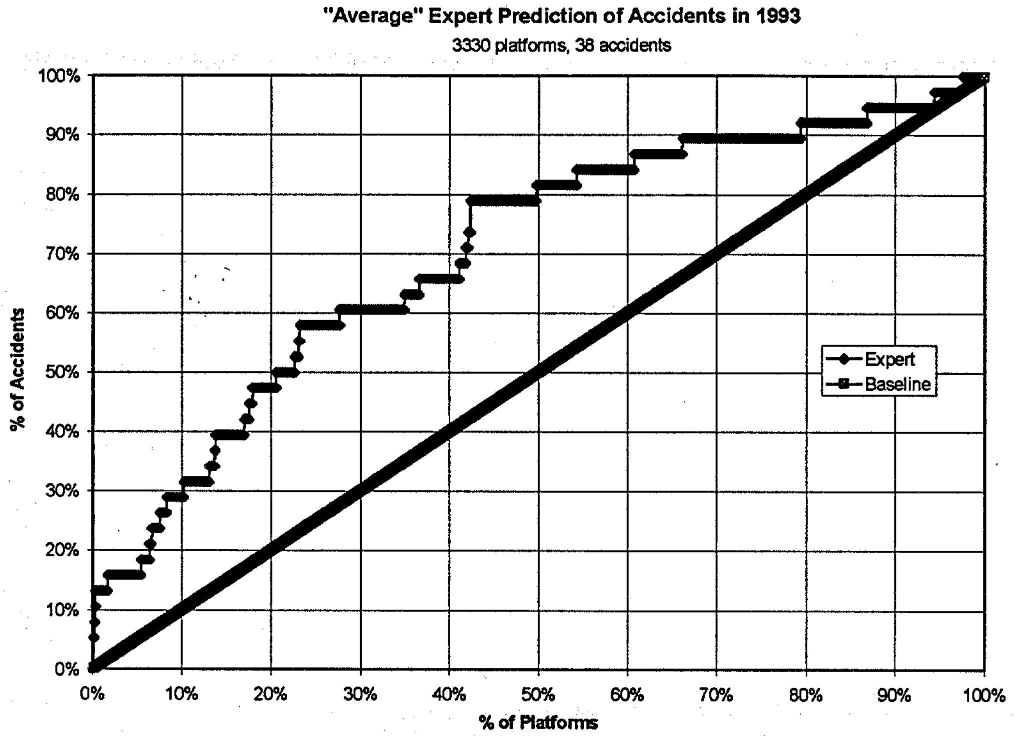

Figure 10-8 Average expert prediction of accidents in 1993

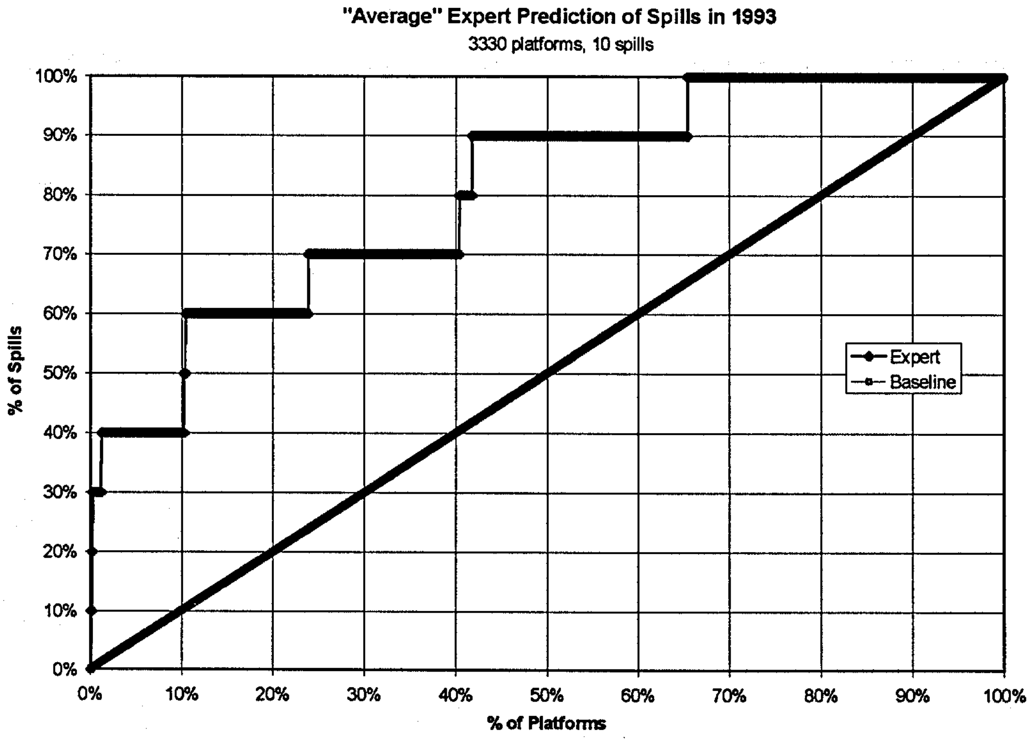

Figure 10-9 Average expert prediction of spills in 1993

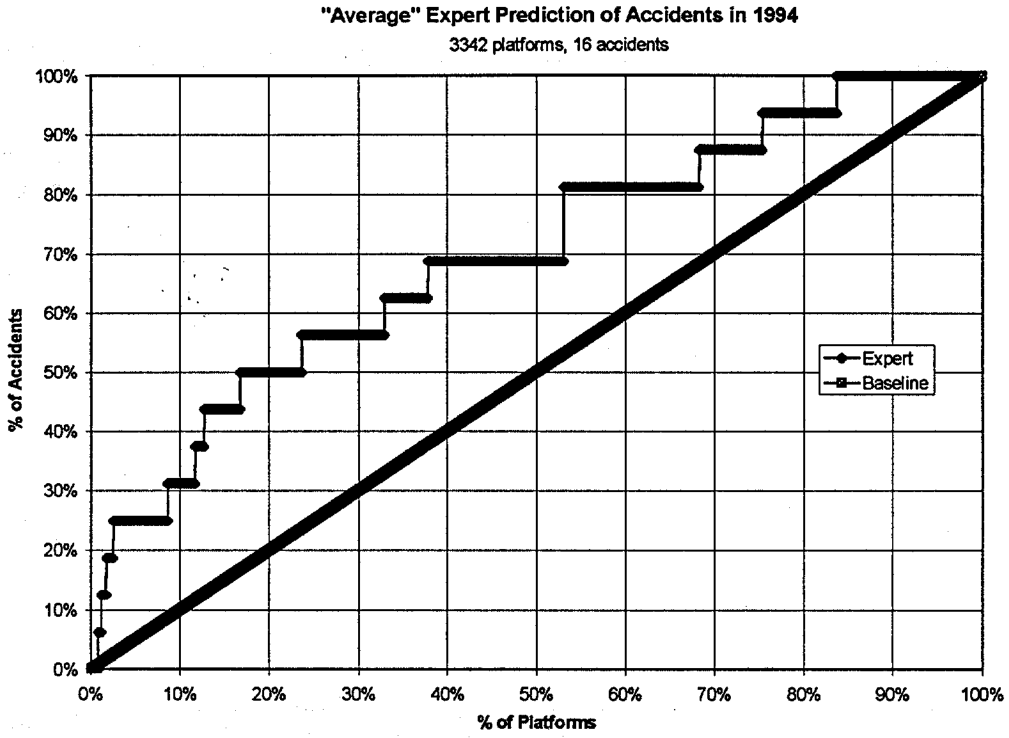

Figure 10-10 Average expert prediction of accidents in 1994

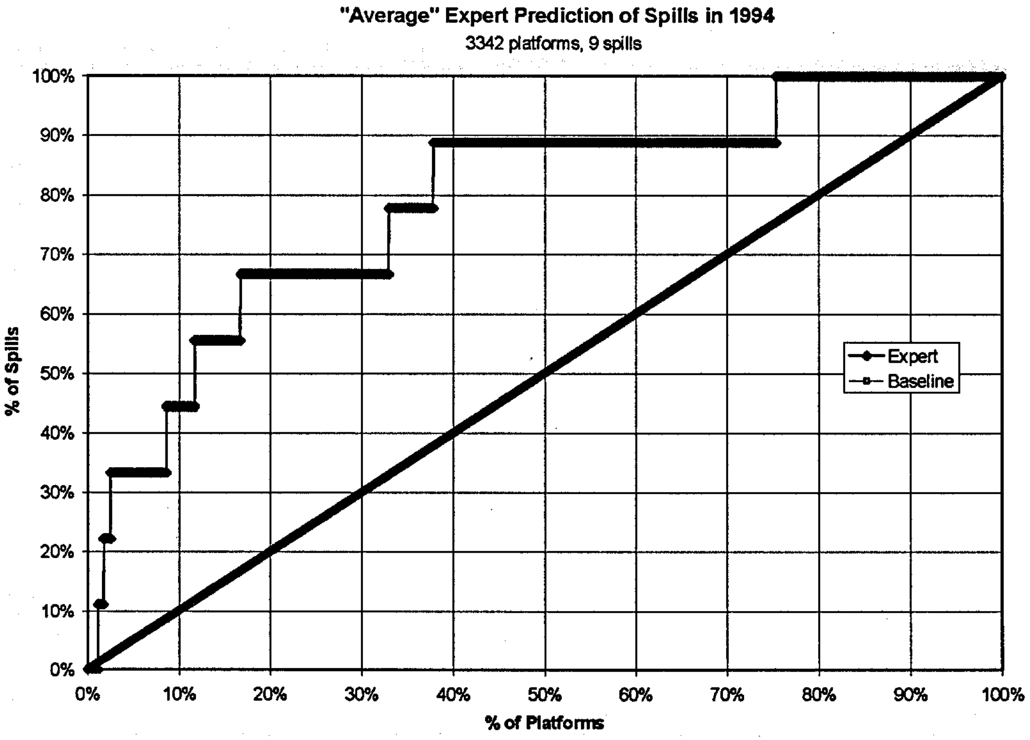

Figure 10-11 Average expert prediction of spills in 1994

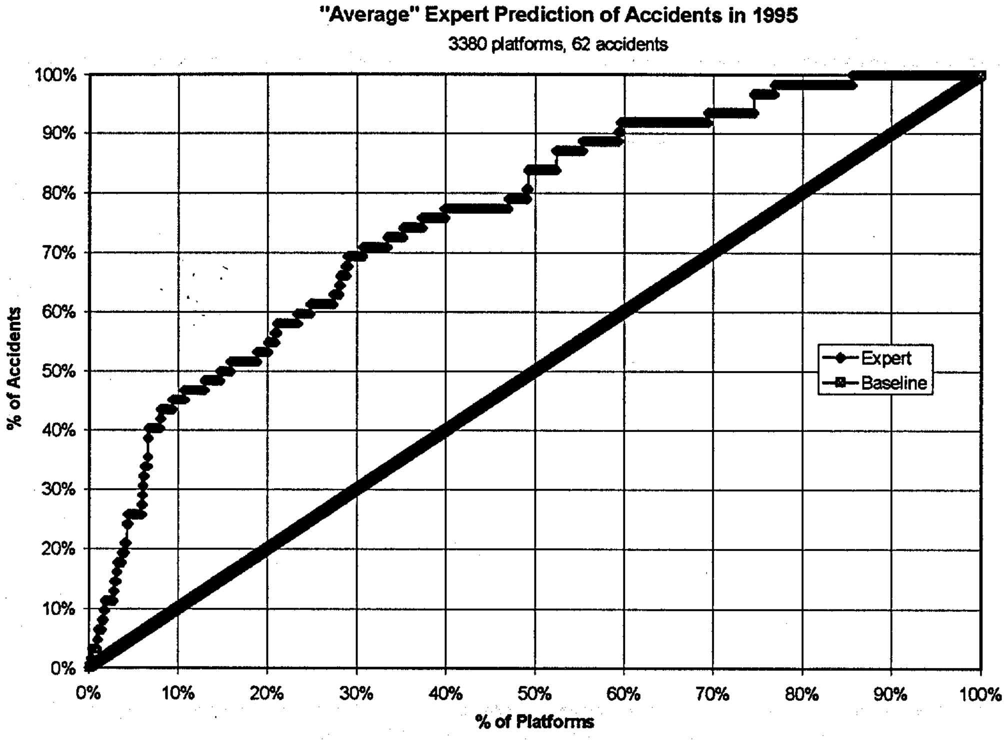

Figure 10-12 Average expert prediction of accidents in 1995

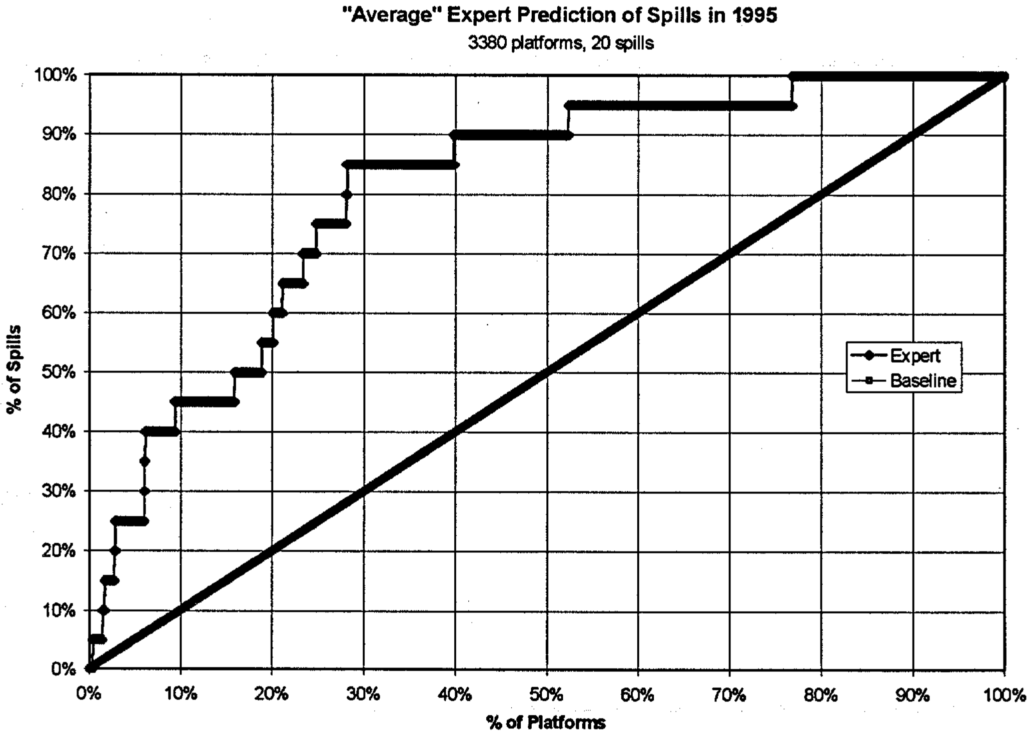

Figure 10-13 Average expert prediction of spills in 1995

10.5 Average expert model results

Table 10-11 summarizes the model accuracy (area) for the average expert models for predicting accidents and spills from 1992 to 1995. The areas are calculated using the same method presented in Chapter 8, Section 8.5 for the logistic model.

	Expert Model Areas	
Prediction Year	Model area for predicting accidents	Model area for predicting spills
1992	.70	.71
1993	.71	.79
1994	.66	.78
1995	.75	.80

Table 10-11 "Average" expert model prediction areas

- All of the expert models are predictive. That is, all of the prediction areas are greater than chance (area of .5). The most accurate model is for predicting spills in 1995. The model area is .80.
- 4 out of 4 times the expert model is better at predicting spills rather than accidents. Therefore, a paired t-test was done to see if the expert model is better at predicting spills versus accidents. Table 10-12 shows that the expert model is not better (95% confidence level) at predicting spills versus accidents, but it is fairly close. This can be seen graphically in Figure 10-14.
- Figure 10-14 on the following page shows that there is no trend in model prediction ability from 1992 to 1995. Linear regressions are run for accident and spill areas for this 4-year period. The p-values for both regression coefficients are greater than .1 (.65 for accidents, .18 for spills).

t-Test: Paired Two Sample for Means	expert area for accidents	expert area for spills
Mean	0.71	0.77
Variance	0.00	0.00
Observations	4.00	4.00
Pearson Correlation	0.29	
Hypothesized Mean Difference	0.00	
df	3.00	
t Stat	-2.79	
P(T<=t) one-tail	0.03	
t Critical one-tail	2.35	
P(T<=t) two-tail	0.07	
t Critical two-tail	3.18	

Table 10-12 Paired t-test of model areas for accidents and spills, average expert model

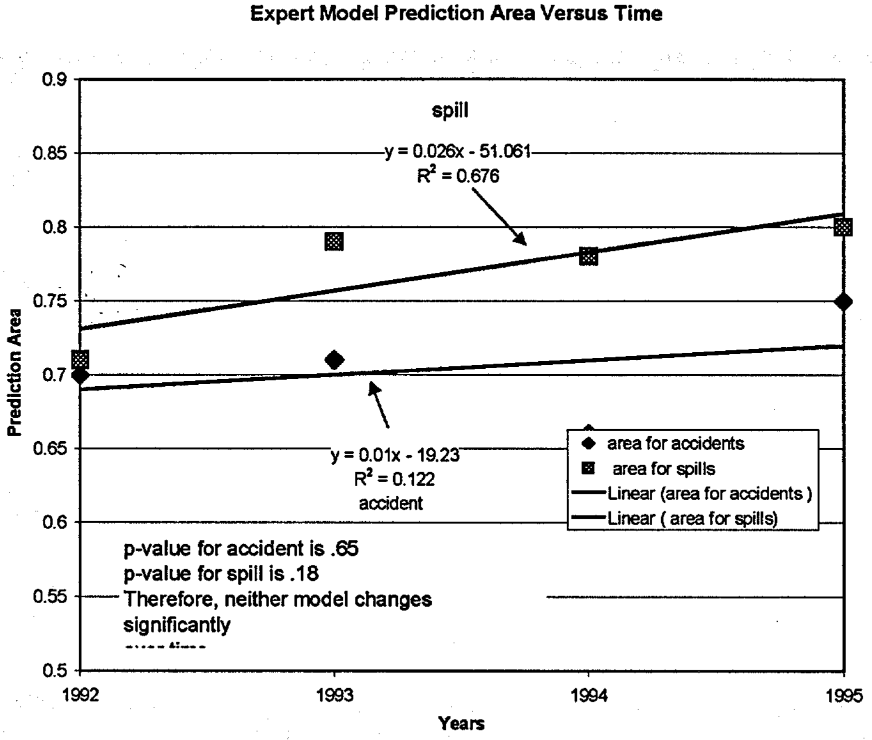

Figure 10-14 Average expert model predictions versus time

10.6 Summary

The expert models developed in Chapter 10 are predictive, that is the model prediction area is greater than .5 (even for the worst inspector). The expert models offer a method of ranking platforms in terms of perceived risk that compares very favorably with the logistic models presented in Chapter 8. The experience level of the inspectors does not affect the accuracy of their models, and there is no significant difference in the accuracy of models between inspection districts. The expert model is not more accurate at predicting spills versus accidents. The expert model prediction for spills does not change from 1992 - 1995 (no time effects). The same holds true for the model prediction of accidents.

Chapter 11 - Model Comparisons And Conclusions

It is important to note that no model is ever the "right" model under all situations. As Friedemen states:

> *"All models are wrong, but some are more useful than others. No method dominates all others over all situations, i.e.; there is usually no uniformly "best" method. Each model has a set of situations where it works best.*[99]

Therefore, two models were constructed in this research: 1) an expert model based on a survey conducted in June 1998, 2) a multivariable logistic regression model. In this chapter, the models are compared to each other using the ratio of true to false positives as outlined in Chapter 8.

11.1 Best, worst, average and logistic model

Table 11-1 and Figure 11-1 compares four models for predicting an accident in 1995. The best model is the logistic regression model. The next best is the "Best" expert, followed by the "Average" expert and the "Worst" expert.

Model Accuracy for Predicting an Accident in 1995			
Logistic regression model area	"Average" expert model area	"Best" expert model area	"Worst" expert model area
.80	.75	.79	.59

Table 11-1 Comparison of model accuracy for predicting accidents in 1995

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[99] Langaas, M., "*Discrimination and Classification*", Technical Report Statistics 1/1995, Department of Mathematical Sciences, The Norwegian Institute of Technology, The University of Trondheim, revised version, p.36.

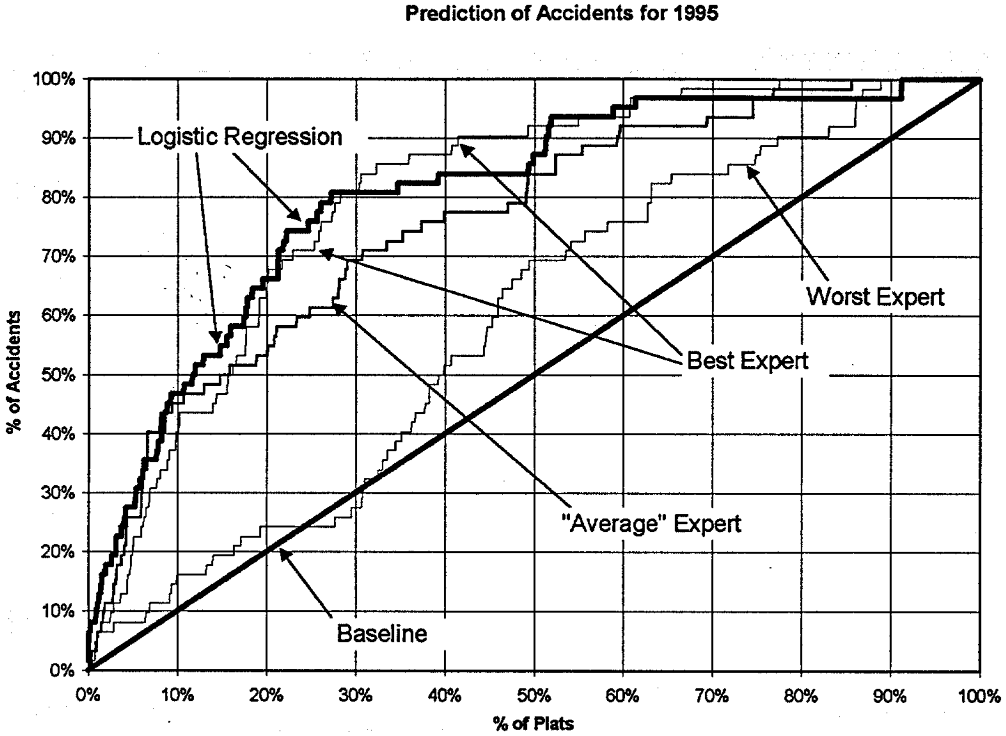

Figure 11-1 Comparison of logistic, best, worst, and average expert models

11.2 Pooled models

If the logistic regression model results are "pooled" together, a chart can be constructed to show where a platform probability estimate calculated today would have typically ranked that platform for the years 1992 to 1995. Figure 11-2 shows the results from "pooling" the logistic models to predict accidents from 1992 to 1995 (Figures 8-2, 8-4, 8-6 and 8-8). The objective of Figure 11-2 is to show how the logistic model probability estimate relates to platform rank and the prediction of accidents.

Note that the right-hand axis of figure 11-2 gives the logistic model's "probability of an accident" and is a logarithmic scale. The probability estimates go from zero to one, with higher estimates corresponding to an increased probability of an accident. This figure shows that very few platforms receive high probability estimates and the model probabilities drop off drastically after the first few hundred platforms. Figure 11-3 shows the results from "pooling" the logistic models to predict spills from 1992 to 1995 (Figures 8-3, 8-5, 8-7 and 8-9). Again, as with the pooled logistic model for accidents, the probability estimates drop off very quickly after the first few hundred platforms.

Figure 11-4 shows the "pooled" average expert model for accidents. This shows that the expert's rankings drop off rather gradually. There are some highly scored platforms, a number of platforms whose score decreases linearly, and a few platforms ranked near the bottom with very low scores. Figure 11-4 allows the direct computation of any platform's percentile rank and the percent of accidents that historically occurred on platforms in that percentile. This would be done as follows:

1. Determine the platforms risk index by using the risk perception scores and weights presented in Chapter 9 and the modeling method shown in Chapter 10. This will give that platform's risk index. For example, assume a platform index of "20". Find 20 on the right-hand axis of Figure 11-4.
2. Read along the "20" line to the left until you reach the "Expert Model Platform Indices" line.
3. Now read down to the horizontal axis. The value is "40%." This means that the platform is typically in the top 40% of ranked platforms.
4. Read up until you reach the jagged line. Then go left until you reach the left vertical axis. The value is 75%. This means that the top 40% of ranked platforms typically account for 75% of all accidents that will occur. You would therefore say that this platform is in a group of platforms that are likely to experience an accident in the next year.

The results for Figure 11-5, the pooled average expert model for predicting spills is similar to the accident results. The figure is also interpreted in the same manner. For a platform index of "20", the platform would be in the top 45% of platforms, and this corresponds to 85% of the spills that historically occurred in the next year. The pooled average expert models in Figures 11-4 and 11-5 provide an easy, straightforward way of evaluating where any platform would rank based on the expert model results for 1992 to 1995.

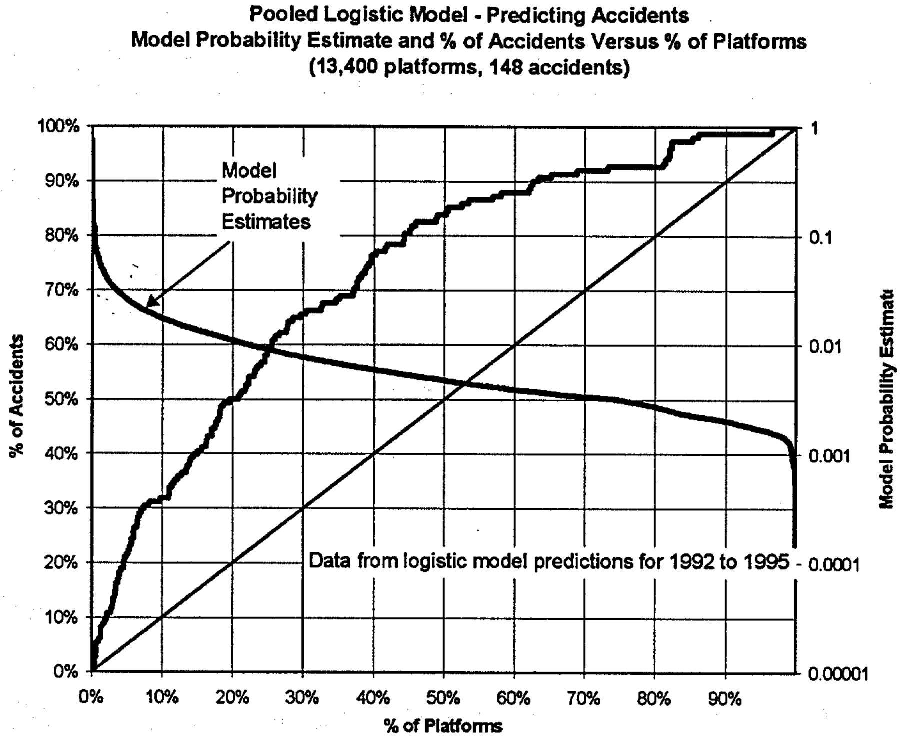

Figure 11-2 Pooled logistic regression model - Accidents - 1992 to 1995

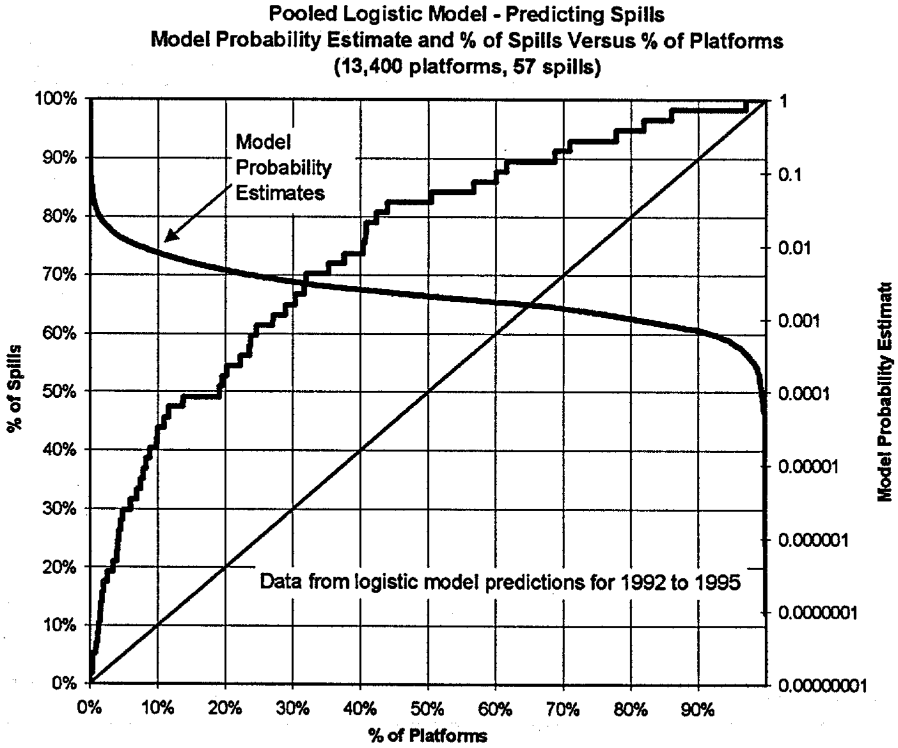

Figure 11-3 Pooled logistic regression model - Spills - 1992 to 1995

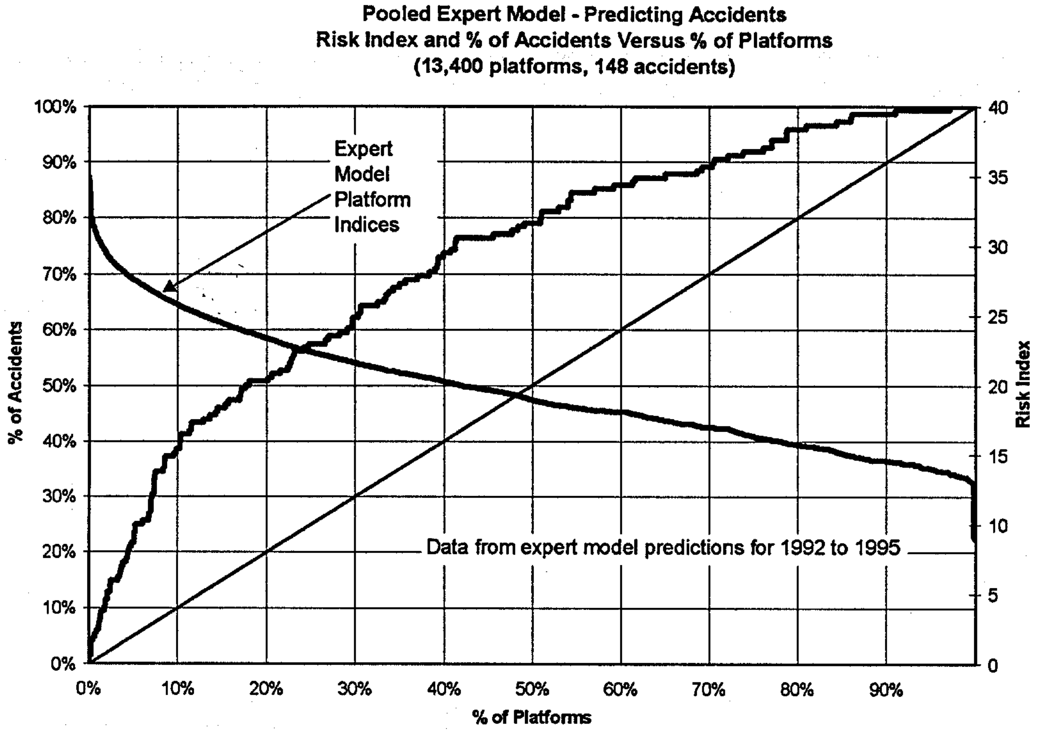

Figure 11-4 Pooled average expert model - Accidents - 1992 to 1995

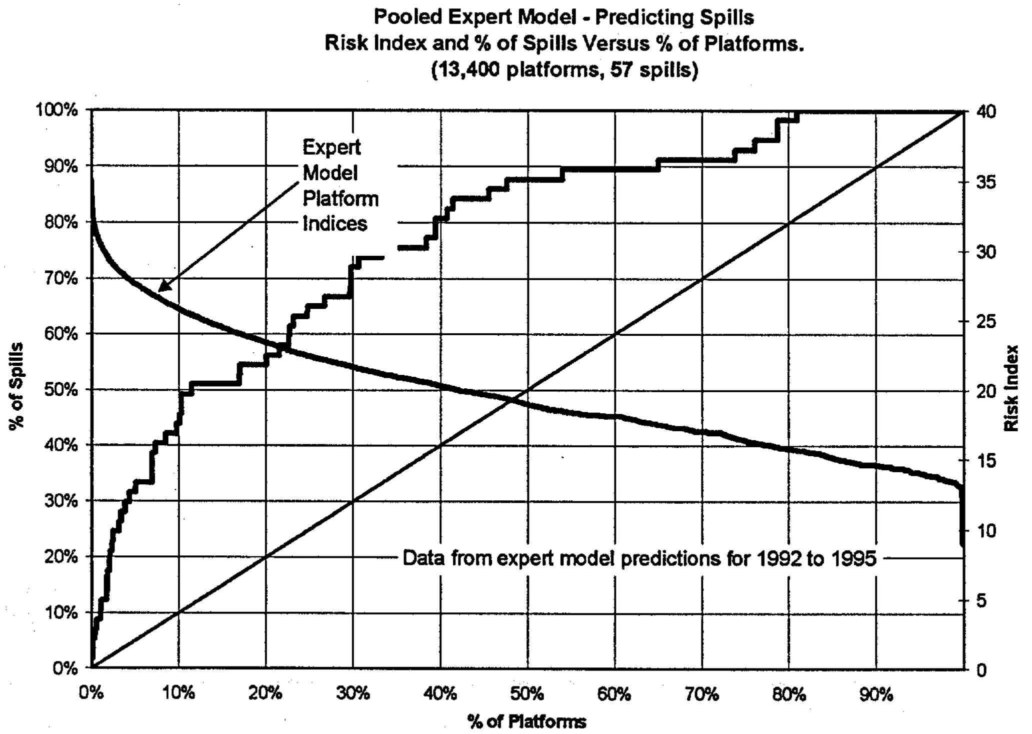

Figure 11-5 Pooled average expert model - Spills - 1992 to 1995

For a real world example of how to use the platform index, recall platform #20,874 presented in Table 10-8. This platform ranked on the border of the top 10% of ranked platforms for accidents in 1995. Figure 11-7 shows this platform's "typical" rank and how many accidents have "typically" occurred on platforms with a risk index of 26.75 or greater. Overall, platform #20,874 would rank slightly higher than in the top 10% (about top 8.5%). Also, platforms that have a risk index of 26.75 or higher will account for about 35% of the accidents that will occur.

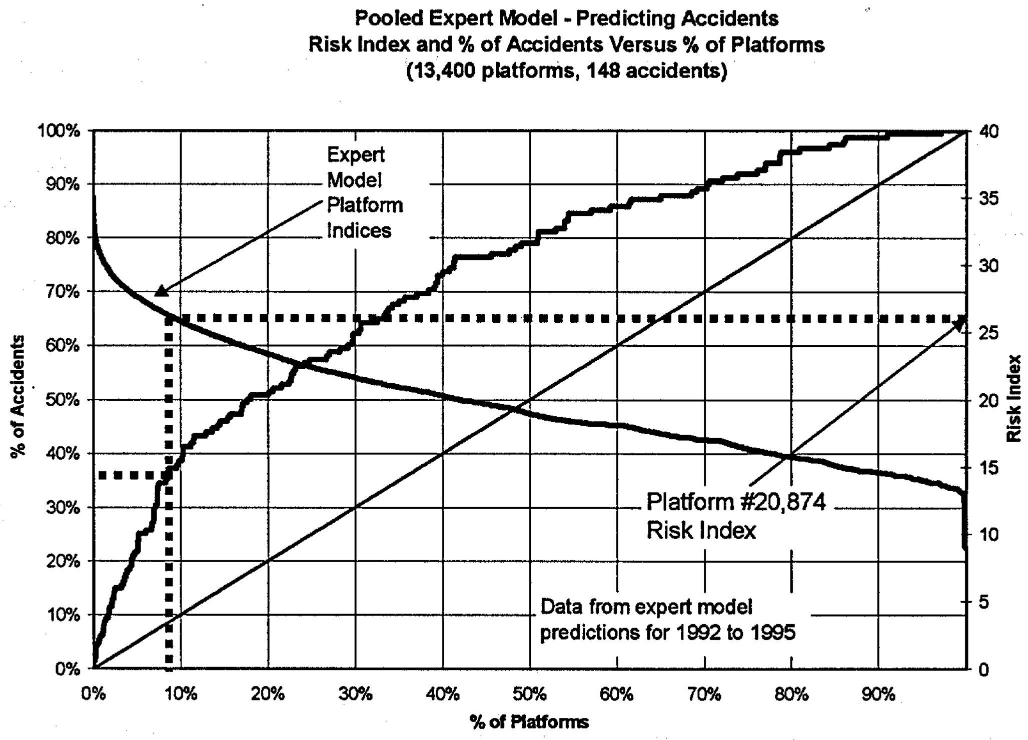

Figure 11-6 Evaluation of platform #20,874 using pooled expert model for predicting accidents

11.3 Comparison of platform ranks for predicting accidents in 1995

In addition to comparing the accuracy between the logistic and the average expert models, an interesting comparison is the rank of the platforms as determined by each method. Table 11-2 compares the top 5 riskiest platforms as determined by both the expert and logistic models for 1995. Although the models are similar in prediction area, the rank of the platforms is not as close as one might assume. Table 11-3 shows the correlation between the ranks. The correlation is about .5. This is less than one would expect and indicates that the ranks of the platforms are different.

COMPLEX _ID_NUM	Rank Expert	Rank Logistic	COMPLEX _ID_NUM	Rank Logistic	Rank Expert
21005	1	3301	24080	1	317
21972	2	122	20533	2	9
20706	3	139	20744	3	144
22473	4	168	22840	4	960
20604	5	634	20622	5	6

Table 11-2 Comparison of platform ranks for predicting accidents in 1995.

	Rank Expert	Rank Logistic
Rank Expert	1	
Rank Logistic	0.54	1

Table 11-3 Correlation of platform ranks for predicting accidents in 1995

11.4 Comparing significance of components - expert to logistic model

Table 8-20 ranks the risk components based on the number of times they are significant in the logistic regressions. Table 9-8 ranks the risk components based on the total weight given to each component by the experts. Table 11-4 shows that both the experts and the logistic regressions rank measures of complexity the highest. However, age/experience is ranked number two by the experts, but ranked last (4 out of 4) by the logistic regression. Therefore, the two models rely on different components to come up with the model predictions. This may explain why the correlation of platform ranks in Table 11-3 was not as close as was expected.

One reason that age and experience are not as important in the logistic model might be that there is not currently a good way to measure age, worker, and operator company experience. Platform age in the regressions is determined by subtracting the year the platform is installed from the prediction year. There might be errors in the data. In addition, there is no good measure of worker experience (which is what concerned the experts) so instead the experience of the platform owner was used as a surrogate. This is not a straightforward statistic and is calculated by evaluating who the owner of record is on December 31 immediately prior to the prediction year. It is assumed that worker experience is highly correlated with owner experience, but it is not known if this is true because the data are not available.

Components	Logistic Regression Rank of Component Importance	Expert's Rank of Component Importance
Complexity (COMP)	1	1
INC history (INCS)	2	3
Accident/Spill History (ACC/SPILL)	3	4
Age/Experience (AGE)	4	2

Table 11-4 Comparisons of component importance

11.5 Comparing average expert to logistic regression

Tables 11-5 summarizes all of the model results for predicting accidents and spills from 1992 to 1995. The logistic regression model is consistently better than the expert model for predicting accidents (4 out of 4 times). The logistic model is better 1 out of the 4 years for spills; the expert model is better for 2 years, and the two methods tie for 1 year. In general, the logistic model performs better than the average expert for predicting which platforms are likely to have an accident. However, the average expert performs about as good as or better than the logistic model for predicting spills. This may be because there appears to be a closer relationship between platform age and the likelihood of a spill. The experts emphasize age in their risk estimates, whereas in the logistic models, age and experience are generally not significant factors in the regressions.

Accidents Prediction Year	**Logistic Regression Model Area**	**"Average" Expert Model Area**	**Percent Difference[100]**
1992	.73 (best)	.70	4%
1993	.78 (best)	.71	9%
1994	.76 (best)	.66	13%
1995	.80(best)	.75	6%
SPILLS Prediction Year	**Logistic regression model area**	**"Average" expert model area**	**Percent difference**
1992	.71 (tie)	.71(tie)	0%
1993	.87 (best)	.79	9%
1994	.70	.78(best)	10%
1995	.77	.80(best)	4%

Table 11-5 Comparison of model areas

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[100] The percent difference is calculated as: 1 - (worst/best) = %

Tables 11-6 and 11-7 show paired t-tests to determine if there is a statistically significant difference in the accuracy of the two models. One t-test compares the expert and logistic model accident predictions. Another t-test compares the spill predictions. The logistic model is significantly better (95% level) than the expert model at predicting accidents. The logistic model is not significantly better than the expert model at predicting spills.

T-Test: Paired Two Sample For Means	**Logistic Area For Accidents**	**Expert Area For Accidents**
Mean	0.768	0.705
Variance	0.001	0.001
Observations	4.000	4.000
Pearson Correlation	0.619	
Hypothesized Mean Difference	0.000	
Df	3.000	
t Stat	4.186	
P(T<=t) one-tail	0.012	
t Critical one-tail	2.353	
P(T<=t) two-tail	0.025	
t Critical two-tail	3.182	

Table 11-6 Paired t-test for expert versus logistic models - predicting accidents. Logistic model is significantly different (95% confidence) from expert model (better predictor).

T-Test: Paired Two Sample For Means	**Logistic Area For Spills**	**Expert Area For Spills**
Mean	0.763	0.770
Variance	0.006	0.002
Observations	4.000	4.000
Pearson Correlation	0.513	
Hypothesized Mean Difference	0.000	
Df	3.000	
t Stat	-0.224	
P(T<=t) one-tail	0.419	
t Critical one-tail	2.353	
P(T<=t) two-tail	0.837	
t Critical two-tail	3.182	

Table 11-7 Paired t-test for expert versus logistic models - predicting spills. Logistic model is not significantly different (95% confidence) from expert model

11.6 Summary

Pareto found that in most processes, about 80% of the problems are caused by only around 20% of the actors. As the models and statistics in this research show, the likelihood of an accident or spill at an offshore platform is very nearly a textbook example of a Pareto process. A relatively small number of platforms are responsible for most accidents and spills. Further, all of the models are good at predicting which 20 % are most likely to have those accidents and spills.

Both the logistic model and the expert model are predictive, i.e. the model area is greater than .5. However, the logistic model is significantly better than the expert model at predicting accidents. There is no statistically significant difference between the two modeling methods for predicting spills. The two methods consider complexity as the most important indicator of an accident or spill. The experts consider platform age and worker/operator experience levels as much more important than does the logistic model.

Chapter 12 - Policy Implications

Many of the results presented in this research will come as no surprise to the people who work on platforms or inspect them. As the models show, the experts had a pretty good idea of what is important in determining which platforms are likely to experience accidents and spills. What was lacking, however, was the data to confirm the operator and inspector perceptions. In addition, though the operators, inspectors, and MMS had a good idea which risk factors were important, they did not have the data to show the relative importance of the risk factors. Nor could they assign a numeric "platform risk index" and rank platforms based on the likelihood of experiencing an accident or spill. This research answers many of the questions that have plagued government regulators. The debate should now shift from what factors are important, to how can the risks be reduced and platforms be made safer.

12.1 The platform rankings

The risk ranking developed in this research can be useful in a number of ways.

1. "At Risk" platforms can now be identified. The MMS can use the risk ranking to pick which platforms should be watched more closely, particularly if they proceed with the mother-cluster inspection regime whereby not all platforms are inspected every year.
2. The model results are generalizable to all 4,000 platforms in the Gulf of Mexico. This is in sharp contrast with "Safety Case" studies and Quantitative Risk Analyses that apply only to specific facilities.
3. Platforms can be ranked this year by either the logistic model, or the expert model. The expert model risk index is much easier to calculate, but the logistic model is in general more accurate.
4. Major complexes are 12 times more likely to experience an accident or spill than other platforms. This result is likely not surprising to operators or inspectors, but the data should make platform crew chiefs more conscious of the degree to which the workers are at risk of having an accident or the platform experiencing a spill.
5. INCs are a very good predictor of accidents and spills, which indicates that they should be included in the "Annual Performance Review" process discussed in Section 5.5. Operators who receive many INCs are likely to experience accidents or spills. This may be because they are not taking corrective action after an INC, or it may be because the numbers of INCs are correlated with platform complexity. The data show that INCs are important, and predictive of future problems, but that they are correlated with the complexity of the

platforms. This suggests the use of INC rates (i.e. number of INCs per component or number of INCs per slot count) as an appropriate means of assessing operator performance.

6. A history of accidents and spills is a predictor of future accidents and spills. This result backs up the use of the number of accidents and spills that have occurred on a platform as a performance measure in the Annual Performance Review.
7. The model results and methodology can likely be used for platforms in other countries, with a few caveats.
8. The approach developed in this research can be applied to many other areas, e.g., truck inspections, railroad inspections, ship inspections, and aircraft inspections.

12.2 Policy questions and answers

There a number of questions raised by the risk ranking. The questions are presented below in italics, followed by possible answers.

1. *A very important question is: How does this research and the ranking help management do its job better?*

First, management should feel assured that the inspectors are doing a good job of assessing which risks are likely to cause an accident or spill. The expert models are surprisingly good at ranking platforms. Nearly as good as the logistic regression model, which is an optimization method based solely on the mathematical relationships between risk factors. Second, the data and models provide a means of answering criticisms of how and why performance measures are picked. During the Annual Performance Review, if an operator wants to dispute why a certain factor is included, the MMS can point back to this research and show that measures like INCs and accidents are important predictors of future problems. Third, the "single-variable statistics" presented in Chapter 7 and listed in the Data Appendix can help the MMS decide which risk factors should be included in the calculation of a operator performance. Fourth, management now has some concrete examples of how an improved data acquisition and storage procedure can help them make decisions that are defensible to critics. The research shows the need for fixing the data acquisition and processing problems that the MMS has experienced.

2. *How can the MMS influence the likelihood of accidents and spills now that the platforms that are likely to experience an accident or spill can be identified? Is issuing more INCs a worthwhile approach?*

In general, simply issuing more INCs would not be a good strategy. The MMS should have the inspectors continue to issue INCs the way they are presently doing it. The inspectors are doing a good job of identifying the platforms that are likely to have problems in the future. However, the MMS would like to see the platform operators improve, and receive fewer INCs each year. Do not force the inspectors to issue more INCs. Expect the operators to do better each year. In order to improve safety on the OCS, the risk ranking must be used in a cooperative way with the inspectors and the platform's owners/operators. If inspectors change their method of issuing INCs, the platform risk profile will change. This may invalidate the models presented here and require construction of new models.

3. *If just issuing more INCs per inspection is not a good approach, would inspecting "at risk" platforms more frequently lower the likelihood of an accident?*

Greater attention at higher ranked facilities probably will result in fewer accidents. However, this result can only be confirmed with further analysis that would need to be conducted in the future.

4. *How can the MMS best utilize the control measures they have available to them to minimize the likelihood of an accident or spill?*

The models show that the most important characteristic for determining whether a platform will have an accident or spill is the platform's complexity level. This poses a problem to the MMS because the complexity of the facility is beyond the control of the inspectors or regulators. However, the fact that INCs and accidents are good predictors indicates that a poor performing major complex is worse that a non-poor performing major complex. Therefore, reducing the number of poor performers will reduce the number of accidents and spills.

5. *Who gets the risk ranking? Is there a legitimate reason for the government to keep this information confidential?*

The risk ranking should be considered an internal MMS management tool, and should not be made public, except perhaps in broad bands, i.e. "top 25%," "top 50%, etc... In addition, individual platform scores should not be made public. The methods for generating a risk index and probability estimate are given in this research. Outside agencies and other organizations can likely use the information presented here to generate their own rankings. However, the MMS should not be in the business of supplying these rankings to the outside world. As stated earlier, there is some uncertainty associated with the underlying data. The MMS should not put itself in a position where it is pinned down to a specific rating for a specific platform by an outside organization. If the ranking proves to be incorrect for any one particular platform, due to data errors, the MMS could be either embarrassed or dragged into legal procedures. For example, a mistake on the Major Complex Flag would erroneously place a platform in a group of platforms that are at higher than average risk of having an accident or spill. However, if the remaining risk factors are correct, and small, then the platform would receive a relatively low risk index for a major complex, thereby lowering the platform rank. The rank of the platform will be incorrect due to the data error, but it will likely remain in the proper broad "risk band "of structures.

6. *MMS inspectors - What affect will knowing that a platform is ranked highly or lowly have on how they inspect the platform?*

Hopefully, the inspectors will continue to inspect the same way they have been. However, the inspector should realize that if they note an uptick in the number of INCs for a particular platform, that this facility is becoming more dangerous and this should be brought to the attention of the crew chief and operating company.

7. *Insurers - Do insurance companies have a right to this information? If so, what can, or will, they do with it if they get it?*

No, they do not and no, they should not be given this information.

8. *Operating and owning companies – What will they do if they know that their platforms are ranked either high or low? Will they move personnel from low ranked to high ranked platforms? Will they give low ranked platforms less attention, thereby perhaps causing these platforms to become more risky? Will they try to sell the platform? Will they be able to if it is known that their facility is highly ranked? What impact will the ranking have on the value of the platform?*

The rankings should come as no surprise to the operators or platform owners. They likely already know how well they are doing, and how "risky" an operation they are running. Their insurance companies also probably have a good understanding of how well they are doing based on the number of claims they file. The ranking is primarily intended as an MMS management tool and will likely not have any severe financial consequences for the platform owners or operators.

9. *Other organizations - Environmental organizations, or lawyers working for injured clients, might be interested in the risk ranking. What might they do with the ranking? How might the actions of these other organizations impact the owners and operators?*

The MMS should not give out the individual platform scores or rankings. To do so would be to invite trouble. The MMS should be aware that some organizations might interpret a high ranking as an indication of poor performance. This is not necessarily so. A complicated structure can also receive a high score simply because of the close relationship between complexity and likelihood of experiencing an accident or spill. Also, simply because a platform is more likely to experience an accident or spill does not mean that it will experience a severe accident or spill.

10. *When should the ranking be updated? How long will the results of this study remain valid and when should new models be calculated?*

The data used in this research will become stale over time and will require the update of the models. This is particularly true if the MMS changes the inspection procedures. The old models will then require updating to reflect those changes.

12.3 Policy Recommendations

It was very surprising to realize that the databases were not targeting the platform ID as a key data element and were more concerned with the area or block within which the accident or spill occurred than on which platform the incident occurred. Therefore, many of the policy recommendations deal with data management issues.

- Geographic plots of accidents and spills should be included in the official MMS yearly accident reports.
- Database management is CRUCIAL with respect to later analysis. Good analysis of data cannot be performed without good data. It is imperative that work continues on TIMS so that later data analysis will be easier.
- It is IMPERATIVE that every structure be identified by a unique ID number and that this ID number remain with the facility until it is permanently removed from service or decommissioned.
- Technological fixes to data entry errors should be implemented. Every accident, spill, and INC MUST be recorded in the TIMS database consistently.
- The inspectors must be able to access operator performance information. As of now, there is no way for inspectors to know what problems have occurred with operators in other districts on the OCS.
- It is very important to note that the information on accidents and spills used in this analysis was incomplete. As pointed out in earlier chapters, about 20% of all of the accidents and spills that occurred could not be assigned the proper platform ID number. Accidents and spills are rare, when compared to the total number of platforms and inspections. Each accident and spill must be fully documented to ensure the models and risk factor comparisons are meaningful. A model is only as good as the information used to construct it.
- Every one of the 4,000 platforms should be reviewed to ensure that the data is correct.
- As a minimum, the 20 risk factors in Table 12-1 should be tracked in TIMS. The platform information in the TIMS database should be updated to include all of the historical information used in this study (1986-1995) for these 20 risk factors and data for each of the 20 factors MUST be included for each accident or spill and whenever an INC is issued. This will allow a comparison of this study with future studies to be based on a similar set of risk factors.

12.4 Further Research

A further investigation of the accuracy of each of the experts for predicting accidents and spills should be conducted. For example, the "best," "average" and "worst," expert models are presented for predicting accidents in 1995. This same analysis should be done for the remaining years (1992 – 1994), and for spills from 1992 to 1995

The first step in any improvement process is identifying the problems, which has been done here. However, going from problem identification to solution is not always straightforward and can have undesired and unintended consequences. The goal of the MMS is to make the offshore environment a safe place to work. It is very important to keep that goal in mind and when using the platform risk rankings as a basis for making policy changes.

	Minimum Set Of Risks That Should Be Tracked For Each Platform, In Addition To Platform ID.
1	Age of platform
2	Distance to shore of a platform
3	Experience level of the "typical" worker on a platform
4	Experience level of the platform's operating company
5	Number of accidents or spills a platform has experienced
6	Number of components
7	Number of drill slots
8	Number of INCs that a platform has received
9	Number of people working on a platform
10	Number of well completions on a platform
11	Percentage of operations contracted out
12	Presence of fired vessels
13	Presence of storage vessels
14	Whether simultaneous operations are being conducted
15	Type of accident or spill that a platform has previously experienced
16	Type of hydrocarbon a platform produces
17	Type of INC enforcement that a platform receives
18	Type of INCs that a platform has received
19	Water depth of a platform
20	Major complex flag

Table 12-1 Minimum set of risks that should be tracked for each platform.

Index

[redacted]

Data Appendix

CARNEGIE MELLON UNIVERSITY

CARNEGIE INSTITUTE OF TECHNOLOGY

THESIS

SUBMITTED IN PARTIAL FULFILLMENT OF THE
REQUIREMENTS FOR THE DEGREE OF DOCTOR OF
PHILOSOPHY

TITLE: The Risk Of Accidents And Spills At Offshore Production Platforms: A Statistical Analysis Of Risk Factors And The Development Of Predictive Models

PRESENTED BY: John Richard Shultz

ACCEPTED BY: The Department Of Engineering And Public Policy

MAJOR PROFESSOR: Dr. Paul Fischbeck - Associate Professor
The Department Of Social And Decision Sciences And The
Department Of Engineering And Public Policy

Table of Figures

1.1 INCs by Type and by Year

1986		1987		1988		1989		1990		1991		1992		1993		1994		1995	
Count of inc		Count of inc		Count of inc		Count of inc		Count of inc		Count of inc		Count of inc		Count of inc		Count of inc		Count of inc	
inc	Total	inc	Total	inc	Total	inc	Total	inc	Total	inc	Total	inc	Total	inc	Total	inc	Total	inc	Total
G110	480	G110	573	G110	536	G110	755	G110	751	G110	744	G110	689	G110	514	G110	543	G110	682
P406	215	P412	203	P406	195	P411	217	P406	185	P406	172	P240	181	P406	168	P406	158	P406	138
P412	191	P406	197	E105	102	P406	212	P100	174	P100	169	P406	167	P240	154	P412	144	P404	129
P404	107	P404	125	P411	96	P100	117	P240	151	P240	127	P100	127	P404	125	P240	138	P412	129
P280	100	P100	110	P240	95	P402	113	P412	140	P411	122	P431	106	P412	105	P404	121	P431	119
P402	100	P402	100	P412	91	P240	109	P411	138	P402	116	P404	101	P402	98	P431	104	P240	95
P240	95	P240	94	X409	82	P431	105	P402	133	P404	104	P402	99	P241	83	P402	95	P470	94
P470	65	E100	92	P402	81	P412	102	P431	128	P470	103	P412	94	P431	71	P241	93	P402	92
P241	63	P433	72	P404	78	P404	98	P404	107	P412	100	P433	79	P313	68	P433	88	P433	90
P431	62	G252	70	P431	77	P470	92	P470	87	P422	86	P422	71	P433	66	P100	75	P422	80
E103	58	P280	66	P100	74	X409	80	P433	78	P433	83	E100	65	P307	63	P470	68	P451	75
P100	53	P470	66	E100	72	G231	79	P522	78	E100	80	P411	65	P522	62	P422	66	P411	69
G252	49	P431	65	G231	70	P422	76	P241	76	P431	79	P574	62	P422	60	P522	63	P241	62
G231	48	E103	64	P470	67	G155	71	E100	73	P280	66	P451	57	P411	59	E100	56	P423	58
P451	48	P422	63	P422	62	E100	70	G231	61	G251	65	P470	54	P451	58	P302	53	P100	57
P341	45	P451	62	P451	48	E103	68	P422	56	P307	58	G251	52	E100	57	P103	52	P302	57
P424	45	G231	52	E102	46	P433	66	P280	53	G231	50	P307	50	P100	57	P411	49	G231	54
P433	45	P341	51	P280	46	P241	62	P283	50	P574	50	P280	48	P470	56	P574	48	P283	50
E102	43	P241	46	E103	45	L123	61	P320	49	P423	49	P522	48	P423	54	P576	48	P301	49
P422	43	P423	46	G251	44	G116	58	P307	47	P241	48	P341	47	P302	52	P451	47	G116	47
P340	39	E102	45	G152	43	P451	56	P423	45	P522	45	P423	45	L107	47	P301	46	P103	43
P103	35	L111	37	P423	43	P423	53	G116	43	P103	43	G231	43	P574	46	P313	44	E100	42
P423	30	P261	29	P433	40	P103	51	P451	43	P341	42	P241	40	P280	45	P423	41	P313	42
P104	29	P340	27	P574	40	P313	50	P574	43	E102	41	L109	39	G251	39	P424	39	G201	41
P313	29	G101	26	P241	36	E102	45	E103	39	P320	40	P576	39	P206	38	P280	38	P574	41
L111	28	P104	22	P261	35	P283	43	E102	34	G155	37	E103	38	P576	38	P308	38	P307	40
P170	26	G100	18	L123	34	P320	39	G155	34	E103	36	P103	34	G231	36	L107	37	P522	40
E100	25	L110	18	X450	32	P424	39	G251	33	P301	34	L107	33	L113	36	P341	37	L107	37
E200	25	P170	17	G252	28	P574	38	P341	33	P302	32	P424	32	P301	35	P364	35	P280	37
G101	22	P424	17	P424	28	P341	37	P474	32	G116	30	G101	31	G100	34	G116	34	P475	37
P320	21	P576	17	P103	26	E105	36	L123	31	P283	29	E102	29	E103	33	G231	34	G251	35
G100	19	L109	16	P576	25	G251	35	P576	30	P576	29	G100	29	P103	33	G201	33	P341	34
P261	19	P320	15	P101	23	P576	35	P103	28	P340	28	P283	29	P261	33	L113	33	P576	33
L110	18	P103	14	P472	22	P302	33	P308	28	P424	28	G116	28	P304	33	L112	32	E103	32
P302	18	P574	14	P313	21	P301	30	P408	28	G101	27	P313	28	P430	30	P175	32	P308	31
P562	18	G152	13	G101	20	P280	29	P424	28	P410	26	P302	27	G101	29	P304	32	P424	29
P576	18	P472	13	P283	20	L107	28	G152	27	L107	25	P320	26	G116	28	P307	31	L113	28
P301	16	P101	12	P320	19	P430	28	G100	26	P471	23	L113	25	G201	28	G100	30	L106	27
P574	16	P307	12	P341	19	G152	27	P301	26	G100	21	P301	23	P283	28	E103	29	L112	26
P101	12	E200	10	L113	18	P472	27	G101	23	L113	21	P308	22	P308	28	P303	29	P175	24
P239	12	P130	10	G100	17	P562	26	P303	23	P303	21	P340	22	P175	27	P283	28	E102	23
G152	11	P301	10	L109	15	G100	25	P562	23	P170	20	G155	20	P341	27	G251	27	P304	23
P471	11	P308	10	P104	15	L109	24	P573	23	L109	19	L112	20	P303	24	P562	26	P340	22
P303	10	P471	10	P340	15	P261	22	P261	21	P206	19	G152	19	E102	23	L106	24	P408	21
P105	9	P562	10	P408	15	P364	21	P313	21	P308	19	P170	19	P267	23	P471	22	G101	20

P150	9	P563	10	P562	15	P304	19	L113	20	P451	19	P206	19	L106	22	P475	21	P243	20
P203	9	P150	9	P105	14	X450	19	P472	20	G152	18	E120	17	P320	21	E102	20	P471	20
P304	9	P206	9	P151	14	P104	18	L106	19	P562	18	G115	17	P202	19	L109	20	P130	19
P364	9	P405	9	P170	14	G114	17	P101	19	L112	17	P304	17	L109	18	P206	20	P303	19
P563	9	P105	8	P563	14	P340	17	P471	19	P313	17	M129	16	P562	18	L123	19	P305	19
P307	8	P239	8	L111	13	G101	16	L107	18	P364	17	P303	16	L112	17	P563	19	L123	18
P472	8	P304	8	P150	13	L106	16	P130	18	L123	16	P261	15	P340	17	G101	18	P261	18
P520	8	P313	8	L107	12	P307	16	P170	18	P261	16	P474	15	M202	16	P320	16	P320	17
L109	7	P525	8	P302	11	P101	15	P176	18	P150	15	M202	14	P176	16	P340	16	P562	17
P202	7	G150	7	P202	10	P303	15	P410	18	P101	14	P176	14	G155	15	P305	15	G155	16
G115	6	P268	7	P260	10	P410	15	P150	17	P104	14	P430	14	P242	15	P104	14	P150	15
P206	6	P408	7	P301	10	L113	14	E106	16	P430	14	G201	13	M300	13	G155	13	L109	14
P233	6	P520	7	P471	10	P176	14	L109	16	G252	13	L123	13	P424	13	G115	12	M250	14
P308	6	G116	6	X105	10	P170	13	L112	16	P304	13	P104	13	P130	12	P261	12	P200	14
P380	6	P260	6	G116	9	P308	13	P302	16	P282	12	L106	12	P232	12	P408	12	P206	14
P525	6	P300	6	L106	9	P408	13	P304	16	P309	12	P305	12	P300	12	P430	12	P430	14
P130	5	P302	6	L110	9	P563	13	P430	16	P475	12	P471	12	G115	11	P202	11	G100	13
G116	4	P303	6	P303	9	L111	12	P475	15	P233	10	P475	12	L103	11	P405	11	M202	13
P232	4	P202	5	G250	8	P105	12	E105	14	P305	10	P233	11	P208	11	P170	10	P242	13
P263	4	P452	5	P364	8	P150	11	P104	14	P310	10	P562	11	P471	11	P472	10	P300	12
P305	4	P204	4	P405	8	P305	11	L121	13	P563	10	P563	11	P203	10	L102	9	G152	11
P452	4	P270	4	E106	7	P155	10	P340	13	G201	9	P260	10	P563	10	M202	9	P170	11
P260	3	P310	4	P430	7	P380	9	L122	12	P472	9	P267	10	L123	9	P300	9	P474	11
P475	3	G114	3	P525	7	L110	8	P563	12	M202	8	P101	9	P105	9	P520	9	P208	10
P521	3	P203	3	P527	7	L112	8	E120	11	P176	8	P105	9	P233	9	P101	8	P232	10
X175	3	P305	3	G114	6	P260	8	P309	10	P200	8	P155	9	P243	9	E105	7	P410	10
X608	3	P343	3	G115	6	P452	8	P520	10	P202	8	P203	9	P309	9	G152	7	L102	9
X752	3	P528	3	G150	6	P233	7	X266	10	P208	8	P472	9	P408	9	L103	7	P176	9
G312	2	X172	3	P206	6	P263	7	L102	9	P525	7	P520	9	E105	8	L114	7	P364	9
P200	2	X608	3	P270	6	P269	7	L111	9	L106	6	L111	8	M133	8	M304	7	P472	9
P201	2	X752	3	P282	6	P309	7	P311	9	L122	6	P208	8	M301	8	P200	7	P202	8
P243	2	E120	2	P310	6	P405	7	G115	8	P155	6	P242	8	P101	8	G153	6	P233	8
P310	2	G115	2	G304	5	P525	7	G156	8	P232	6	P408	8	P104	8	M250	6	G150	7
P343	2	G312	2	P208	5	P208	6	P155	8	P405	6	P150	7	P150	8	M305	6	M129	7
P381	2	P131	2	P304	5	P232	6	P208	8	P408	6	P405	7	P155	8	P155	6	M304	7
P474	2	P242	2	P344	5	P471	6	P300	8	P573	6	P410	7	P201	8	P176	6	P155	7
P567	2	P282	2	P475	5	P520	6	P364	8	G115	5	L121	6	P405	8	P242	6	P281	7
G114	1	P344	2	L102	4	G115	5	X409	8	G156	5	P200	6	M129	7	P243	6	P381	7
G150	1	P364	2	L103	4	L103	5	E101	6	P474	5	P202	6	P170	7	P310	6	P520	7
G309	1	P521	2	L112	4	P154	5	L110	6	P520	5	P525	6	P305	7	P525	6	G115	6
G311	1	X175	2	P201	4	P239	5	P260	6	E105	4	G250	5	E120	6	E120	5	G250	6
G313	1	X308	2	P205	4	P264	5	P268	6	E106	4	L110	5	G156	6	L111	5	L103	6
L108	1	X504	2	P232	4	P270	5	P525	6	G250	4	M131	5	G250	6	M300	5	P101	6
P131	1	X762	2	P263	4	P475	5	G114	5	G304	4	M302	5	L102	6	M302	5	P528	6
P133	1	L108	1	P307	4	X266	5	P105	5	L111	4	P133	5	L108	6	P208	5	P570	6
P207	1	L123	1	E120	3	E120	4	P133	5	P130	4	P232	5	M305	6	P233	5	E120	5
P231	1	P106	1	G151	3	G250	4	P171	5	P151	4	P243	5	P207	6	P282	5	M300	5
P234	1	P154	1	G153	3	L108	4	P200	5	P203	4	P300	5	P475	6	P452	5	M307	5
P237	1	P207	1	G300	3	P133	4	P202	5	P271	4	P364	5	L114	5	P474	5	P309	5

P242	1	P232	1	L108	3	P242	4	P231	5	P344	4	E105	4	P133	5	P573	5	P343	5
P269	1	P233	1	L121	3	P344	4	P233	5	P452	4	M111	4	P200	5	M129	4	P525	5
P270	1	P236	1	P130	3	E106	3	P310	5	P571	4	P309	4	P282	5	M306	4	P563	5
P282	1	P237	1	P200	3	G150	3	G252	4	E108	3	E106	3	P410	5	P105	4	M130	4
P300	1	P238	1	P204	3	G156	3	L108	4	L108	3	G114	3	P472	5	P130	4	M305	4
P344	1	P243	1	P235	3	G252	3	P107	4	M129	3	G156	3	P520	5	P201	4	M306	4
P361	1	P361	1	P236	3	G303	3	P206	4	M133	3	G252	3	P525	5	P232	4	P104	4
P362	1	P362	1	P308	3	G312	3	P305	4	P105	3	G304	3	P572	5	P281	4	P105	4
P405	1	P380	1	P309	3	L114	3	P405	4	P107	3	M133	3	P573	5	P311	4	P310	4
P426	1	P474	1	P452	3	L121	3	X450	4	P243	3	P107	3	G152	4	P381	4	P529	4
P522	1	P475	1	E200	2	P130	3	G150	3	P270	3	P204	3	L121	4	P410	4	G156	3
P569	1	P527	1	G303	2	P200	3	L103	3	P281	3	P231	3	M131	4	P551	4	G312	3
P571	1	P571	1	G312	2	P202	3	P132	3	W172	3	P264	3	M250	4	P572	4	L110	3
P572	1	X420	1	P133	2	P205	3	P175	3	E120	2	P310	3	M302	4	G114	3	L114	3
X109	1	X500	1	P154	2	P235	3	P232	3	G114	2	P311	3	M306	4	G250	3	L122	3
X201	1	(blank)	0	P176	2	P262	3	P242	3	G150	2	P452	3	P364	4	L121	3	M120	3
X504	1	Grand Total	2886	P203	2	P300	3	P263	3	L103	2	P573	3	P380	4	M120	3	M131	3
(blank)	0			P233	2	P527	3	P282	3	L110	2	L102	2	P452	4	M130	3	P106	3
Grand Total	2680			P237	2	P528	3	P426	3	M130	2	L108	2	P474	4	M200	3	P260	3
				P239	2	P573	3	X202	3	M134	2	M130	2	G252	3	M301	3	P311	3
				P242	2	L102	2	G111	2	P154	2	M132	2	P268	3	P150	3	P405	3
				P267	2	P177	2	G201	2	P171	2	M300	2	P281	3	P203	3	P572	3
				P268	2	P201	2	G303	2	P177	2	P130	2	E106	2	P260	3	E105	2
				P300	2	P203	2	G304	2	P201	2	P151	2	G151	2	P309	3	G153	2
				P305	2	P207	2	G306	2	P205	2	P175	2	G153	2	P362	3	H126	2
				P343	2	P243	2	P151	2	P207	2	P270	2	G300	2	P529	3	L111	2
				P571	2	P267	2	P235	2	P231	2	P281	2	G303	2	G150	2	M205	2
				P572	2	P268	2	P237	2	P242	2	P282	2	G304	2	G252	2	M301	2
				X266	2	P281	2	P344	2	P260	2	P344	2	G310	2	L110	2	M302	2
				E101	1	P282	2	P380	2	P264	2	P381	2	H118	2	M105	2	M303	2
				E108	1	P311	2	P381	2	P343	2	P524	2	H126	2	M131	2	P132	2
				G302	1	P343	2	P407	2	P521	2	G150	1	L111	2	M205	2	P177	2
				G305	1	P381	2	P427	2	P527	2	G303	1	M105	2	M206	2	P203	2
				G309	1	P474	2	P452	2	P528	2	G308	1	M116	2	P173	2	P205	2
				G310	1	C114	1	P528	2	G112	1	G310	1	M120	2	P231	2	P231	2
				G314	1	C116	1	P569	2	G151	1	H120	1	M132	2	P270	2	P239	2
				L122	1	D400	1	P571	2	G153	1	L103	1	M304	2	P312	2	P312	2
				P107	1	D401	1	W172	2	G308	1	L122	1	P106	2	P343	2	P362	2
				P153	1	E101	1	C112	1	G310	1	M128	1	P107	2	P407	2	P380	2
				P155	1	E108	1	E108	1	G311	1	M205	1	P231	2	P432	2	P421	2
				P171	1	G113	1	G113	1	G312	1	M301	1	P235	2	P524	2	P426	2
				P231	1	G153	1	G151	1	G313	1	M306	1	P239	2	P528	2	P452	2
				P234	1	G301	1	G250	1	L102	1	M309	1	P260	2	P531	2	P521	2
				P238	1	G304	1	G253	1	L121	1	P132	1	P311	2	P550	2	P524	2
				P269	1	G317	1	G311	1	M116	1	P154	1	P343	2	P571	2	P571	2
				P271	1	L104	1	G312	1	M205	1	P171	1	P381	2	W172	2	W107	2
				P380	1	P106	1	L114	1	M250	1	P177	1	P529	2	C110	1	C142	1
				P410	1	P107	1	P106	1	M302	1	P207	1	G313	1	D155	1	D273	1

				P426	1	P132	1	P154	1	P131	1	P237	1	G314	1	D261	1	E106	1
				P428	1	P171	1	P177	1	P234	1	P239	1	G316	1	E108	1	G114	1
				P474	1	P175	1	P201	1	P239	1	P268	1	H117	1	G156	1	G117	1
				P520	1	P204	1	P203	1	P263	1	P312	1	H120	1	G253	1	G252	1
				P524	1	P234	1	P204	1	P265	1	P343	1	H131	1	G301	1	G304	1
				P528	1	P284	1	P238	1	P300	1	P380	1	H133	1	G314	1	G313	1
				P542	1	P362	1	P281	1	P306	1	P526	1	H140	1	L108	1	H110	1
				X109	1	P521	1	P312	1	P311	1	P527	1	H141	1	L122	1	H118	1
				X175	1	P540	1	P343	1	P362	1	P528	1	L104	1	M133	1	L104	1
				X307	1	P541	1	P361	1	P380	1	P531	1	L110	1	M303	1	L108	1
				X608	1	P571	1	P362	1	P381	1	P542	1	L122	1	P106	1	M116	1
				X762	1	P572	1	P428	1	P420	1	P551	1	M104	1	P133	1	M128	1
				(blank)	0	X308	1	P521	1	P426	1	P569	1	M127	1	P151	1	M132	1
				Grand Total	3124	(blank)	0	P524	1	P506	1	P571	1	M130	1	P171	1	M138	1
						Grand Total	4087	P540	1	P524	1	W107	1	M205	1	P204	1	M200	1
								P542	1	P550	1	W170	1	M307	1	P238	1	M251	1
								P550	1	P569	1	W172	1	P151	1	P239	1	P107	1
								W171	1	P572	1	(blank)	0	P204	1	P264	1	P133	1
								(blank)	0	(blank)	0	Grand Total	3608	P205	1	P284	1	P153	1
								Grand Total	4094	Grand Total	3782			P236	1	P344	1	P171	1
														P262	1	P380	1	P173	1
														P263	1	P420	1	P201	1
														P269	1	P521	1	P234	1
														P310	1	P526	1	P237	1
														P361	1	P527	1	P267	1
														P362	1	P569	1	P268	1
														P407	1	W110	1	P270	1
														P426	1	W112	1	P344	1
														P521	1	W149	1	P407	1
														P526	1	W159	1	P420	1
														P528	1	(blank)	0	P428	1
														P540	1	Grand Total	3590	P527	1
														P541	1			P541	1
														(blank)	0			P551	1
														Grand Total	3549			P573	1
																		W172	1
																		(blank)	0
																		Grand Total	3738

Table -1 INCs by type, 1986 to 1995.

1.2 Accidents and Spills by Platform ID.

350 platforms listed out of a possible of approximately 4,000 platforms. All accidents or spills occurred on only 339 platforms during the ten year period from 1986 – 1995.

plat#	COMPLEX_ID_NUM	#acc	#SPLL	Total	c_acc	c_spll	c_%_tot	c_%_plat
1	20744	10	9	19	10	9	2.4%	0.0%
2	10066	6	4	10	16	13	3.7%	0.0%
3	20445	4	4	8	20	17	4.7%	0.1%
4	21760	4	4	8	24	21	5.7%	0.1%
5	21847	2	5	7	26	26	6.6%	0.1%
6	10088	3	3	6	29	29	7.4%	0.1%
7	10161	3	3	6	32	32	8.1%	0.2%
8	10186	3	3	6	35	35	8.9%	0.2%
9	20015	3	3	6	38	38	9.7%	0.2%
10	21037	4	2	6	42	40	10.4%	0.2%
11	21515	3	3	6	45	43	11.2%	0.2%
12	21875	3	3	6	48	46	12.0%	0.3%
13	21902	3	3	6	51	49	12.7%	0.3%
14	21930	3	3	6	54	52	13.5%	0.3%
15	22224	3	3	6	57	55	14.2%	0.3%
16	22431	3	3	6	60	58	15.0%	0.4%
17	10036	3	2	5	63	60	15.6%	0.4%
18	10225	3	2	5	66	62	16.3%	0.4%
19	20724	3	2	5	69	64	16.9%	0.4%
20	20999	3	2	5	72	66	17.6%	0.4%
21	21005	3	2	5	75	68	18.2%	0.5%
22	21757	3	2	5	78	70	18.8%	0.5%
23	23692	3	2	5	81	72	19.5%	0.5%
24	10128	2	2	4	83	74	20.0%	0.5%
25	10140	2	2	4	85	76	20.5%	0.6%
26	20084	2	2	4	87	78	21.0%	0.6%
27	20123	2	2	4	89	80	21.5%	0.6%
28	20195	2	2	4	91	82	22.0%	0.6%
29	20221	2	2	4	93	84	22.5%	0.6%
30	20446	2	2	4	95	86	23.0%	0.7%
31	20491	2	2	4	97	88	23.5%	0.7%
32	20536	1	3	4	98	91	24.0%	0.7%
33	20621	2	2	4	100	93	24.6%	0.7%
34	20642	2	2	4	102	95	25.1%	0.8%
35	20719	2	2	4	104	97	25.6%	0.8%
36	20878	2	2	4	106	99	26.1%	0.8%
37	20918	2	2	4	108	101	26.6%	0.8%
38	20940	2	2	4	110	103	27.1%	0.8%
39	21502	2	2	4	112	105	27.6%	0.9%
40	22033	2	2	4	114	107	28.1%	0.9%
41	22092	2	2	4	116	109	28.6%	0.9%
42	22181	2	2	4	118	111	29.1%	0.9%
43	22182	2	2	4	120	113	29.6%	1.0%
44	22289	2	2	4	122	115	30.2%	1.0%
45	22328	2	2	4	124	117	30.7%	1.0%
46	22372	2	2	4	126	119	31.2%	1.0%
47	22411	2	2	4	128	121	31.7%	1.0%
48	22564	2	2	4	130	123	32.2%	1.1%
49	22662	2	2	4	132	125	32.7%	1.1%
50	22707	2	2	4	134	127	33.2%	1.1%
51	22803	2	2	4	136	129	33.7%	1.1%
52	10023	2	1	3	138	130	34.1%	1.2%
53	10188	2	1	3	140	131	34.5%	1.2%
54	10222	2	1	3	142	132	34.9%	1.2%

55	10296	2	1	3	144	133	35.2%	1.2%
56	20003	2	1	3	146	134	35.6%	1.2%
57	20019	2	1	3	148	135	36.0%	1.3%
58	20045	2	1	3	150	136	36.4%	1.3%
59	20202	2	1	3	152	137	36.8%	1.3%
60	20249	1	2	3	153	139	37.2%	1.3%
61	20319	1	2	3	154	141	37.5%	1.4%
62	20558	2	1	3	156	142	37.9%	1.4%
63	20604	2	1	3	158	143	38.3%	1.4%
64	20863	1	2	3	159	145	38.7%	1.4%
65	20947	2	1	3	161	146	39.1%	1.4%
66	21032	2	1	3	163	147	39.4%	1.5%
67	21175	1	2	3	164	149	39.8%	1.5%
68	21468	2	1	3	166	150	40.2%	1.5%
69	21570	1	2	3	167	152	40.6%	1.5%
70	21972	2	1	3	169	153	41.0%	1.6%
71	22041	2	1	3	171	154	41.3%	1.6%
72	22113	1	2	3	172	156	41.7%	1.6%
73	22202	2	1	3	174	157	42.1%	1.6%
74	22533	2	1	3	176	158	42.5%	1.6%
75	22742	2	1	3	178	159	42.9%	1.7%
76	23209	3	0	3	181	159	43.3%	1.7%
77	23271	2	1	3	183	160	43.6%	1.7%
78	24098	2	1	3	185	161	44.0%	1.7%
79	10026	1	1	2	186	162	44.3%	1.8%
80	10058	1	1	2	187	163	44.5%	1.8%
81	10063	1	1	2	188	164	44.8%	1.8%
82	10065	1	1	2	189	165	45.0%	1.8%
83	10074	1	1	2	190	166	45.3%	1.8%
84	10077	1	1	2	191	167	45.5%	1.9%
85	10078	1	1	2	192	168	45.8%	1.9%
86	10083	1	1	2	193	169	46.1%	1.9%
87	10086	2	0	2	195	169	46.3%	1.9%
88	10100	2	0	2	197	169	46.6%	2.0%
89	10107	1	1	2	198	170	46.8%	2.0%
90	10116	1	1	2	199	171	47.1%	2.0%
91	10119	1	1	2	200	172	47.3%	2.0%
92	10123	1	1	2	201	173	47.6%	2.0%
93	10124	1	1	2	202	174	47.8%	2.1%
94	10131	1	1	2	203	175	48.1%	2.1%
95	10148	1	1	2	204	176	48.3%	2.1%
96	10175	2	0	2	206	176	48.6%	2.1%
97	10177	1	1	2	207	177	48.9%	2.2%
98	10198	1	1	2	208	178	49.1%	2.2%
99	10212	1	1	2	209	179	49.4%	2.2%
100	10284	1	1	2	210	180	49.6%	2.2%
101	10297	1	1	2	211	181	49.9%	2.2%
102	10300	1	1	2	212	182	50.1%	2.3%
103	10302	1	1	2	213	183	50.4%	2.3%
104	10303	1	1	2	214	184	50.6%	2.3%
105	10553	1	1	2	215	185	50.9%	2.3%
106	10566	1	1	2	216	186	51.1%	2.4%
107	20023	1	1	2	217	187	51.4%	2.4%
108	20025	1	1	2	218	188	51.7%	2.4%
109	20026	1	1	2	219	189	51.9%	2.4%
110	20036	1	1	2	220	190	52.2%	2.4%
111	20049	1	1	2	221	191	52.4%	2.5%
112	20054	1	1	2	222	192	52.7%	2.5%
113	20059	1	1	2	223	193	52.9%	2.5%
114	20074	1	1	2	224	194	53.2%	2.5%
115	20075	1	1	2	225	195	53.4%	2.6%
116	20088	1	1	2	226	196	53.7%	2.6%
117	20129	1	1	2	227	197	53.9%	2.6%
118	20147	1	1	2	228	198	54.2%	2.6%

119	20164	1	1	2	229	199	54.5%	2.6%
120	20200	1	1	2	230	200	54.7%	2.7%
121	20285	1	1	2	231	201	55.0%	2.7%
122	20302	1	1	2	232	202	55.2%	2.7%
123	20328	1	1	2	233	203	55.5%	2.7%
124	20376	1	1	2	234	204	55.7%	2.8%
125	20409	1	1	2	235	205	56.0%	2.8%
126	20447	1	1	2	236	206	56.2%	2.8%
127	20466	1	1	2	237	207	56.5%	2.8%
128	20478	1	1	2	238	208	56.7%	2.8%
129	20481	1	1	2	239	209	57.0%	2.9%
130	20510	1	1	2	240	210	57.3%	2.9%
131	20516	1	1	2	241	211	57.5%	2.9%
132	20524	1	1	2	242	212	57.8%	2.9%
133	20555	1	1	2	243	213	58.0%	3.0%
134	20575	1	1	2	244	214	58.3%	3.0%
135	20580	1	1	2	245	215	58.5%	3.0%
136	20582	1	1	2	246	216	58.8%	3.0%
137	20614	1	1	2	247	217	59.0%	3.0%
138	20618	1	1	2	248	218	59.3%	3.1%
139	20622	1	1	2	249	219	59.5%	3.1%
140	20631	1	1	2	250	220	59.8%	3.1%
141	20646	1	1	2	251	221	60.1%	3.1%
142	20669	1	1	2	252	222	60.3%	3.2%
143	20670	1	1	2	253	223	60.6%	3.2%
144	20675	1	1	2	254	224	60.8%	3.2%
145	20706	1	1	2	255	225	61.1%	3.2%
146	20715	1	1	2	256	226	61.3%	3.2%
147	20717	1	1	2	257	227	61.6%	3.3%
148	20732	1	1	2	258	228	61.8%	3.3%
149	20734	1	1	2	259	229	62.1%	3.3%
150	20736	1	1	2	260	230	62.3%	3.3%
151	20846	1	1	2	261	231	62.6%	3.4%
152	20939	1	1	2	262	232	62.8%	3.4%
153	21019	1	1	2	263	233	63.1%	3.4%
154	21035	1	1	2	264	234	63.4%	3.4%
155	21098	1	1	2	265	235	63.6%	3.4%
156	21138	1	1	2	266	236	63.9%	3.5%
157	21142	1	1	2	267	237	64.1%	3.5%
158	21187	1	1	2	268	238	64.4%	3.5%
159	21195	1	1	2	269	239	64.6%	3.5%
160	21220	1	1	2	270	240	64.9%	3.6%
161	21284	1	1	2	271	241	65.1%	3.6%
162	21285	1	1	2	272	242	65.4%	3.6%
163	21304	1	1	2	273	243	65.6%	3.6%
164	21360	1	1	2	274	244	65.9%	3.7%
165	21374	1	1	2	275	245	66.2%	3.7%
166	21391	1	1	2	276	246	66.4%	3.7%
167	21392	1	1	2	277	247	66.7%	3.7%
168	21428	1	1	2	278	248	66.9%	3.7%
169	21433	1	1	2	279	249	67.2%	3.8%
170	21437	1	1	2	280	250	67.4%	3.8%
171	21438	1	1	2	281	251	67.7%	3.8%
172	21444	1	1	2	282	252	67.9%	3.8%
173	21459	1	1	2	283	253	68.2%	3.9%
174	21467	1	1	2	284	254	68.4%	3.9%
175	21471	1	1	2	285	255	68.7%	3.9%
176	21501	1	1	2	286	256	69.0%	3.9%
177	21567	1	1	2	287	257	69.2%	3.9%
178	21582	1	1	2	288	258	69.5%	4.0%
179	21600	1	1	2	289	259	69.7%	4.0%
180	21700	1	1	2	290	260	70.0%	4.0%
181	21701	1	1	2	291	261	70.2%	4.0%
182	21728	1	1	2	292	262	70.5%	4.1%

183	21738	1	1	2	293	263	70.7%	4.1%
184	21782	1	1	2	294	264	71.0%	4.1%
185	21799	1	1	2	295	265	71.2%	4.1%
186	21805	1	1	2	296	266	71.5%	4.1%
187	21809	1	1	2	297	267	71.8%	4.2%
188	21812	1	1	2	298	268	72.0%	4.2%
189	21816	1	1	2	299	269	72.3%	4.2%
190	21864	1	1	2	300	270	72.5%	4.2%
191	21868	1	1	2	301	271	72.8%	4.3%
192	21916	1	1	2	302	272	73.0%	4.3%
193	21939	1	1	2	303	273	73.3%	4.3%
194	21940	1	1	2	304	274	73.5%	4.3%
195	21973	1	1	2	305	275	73.8%	4.3%
196	21997	1	1	2	306	276	74.0%	4.4%
197	21998	1	1	2	307	277	74.3%	4.4%
198	22001	1	1	2	308	278	74.6%	4.4%
199	22012	1	1	2	309	279	74.8%	4.4%
200	22019	1	1	2	310	280	75.1%	4.5%
201	22030	1	1	2	311	281	75.3%	4.5%
202	22052	1	1	2	312	282	75.6%	4.5%
203	22085	1	1	2	313	283	75.8%	4.5%
204	22094	1	1	2	314	284	76.1%	4.5%
205	22099	1	1	2	315	285	76.3%	4.6%
206	22101	1	1	2	316	286	76.6%	4.6%
207	22123	1	1	2	317	287	76.8%	4.6%
208	22165	1	1	2	318	288	77.1%	4.6%
209	22178	1	1	2	319	289	77.4%	4.7%
210	22219	1	1	2	320	290	77.6%	4.7%
211	22277	1	1	2	321	291	77.9%	4.7%
212	22279	1	1	2	322	292	78.1%	4.7%
213	22330	1	1	2	323	293	78.4%	4.7%
214	22384	1	1	2	324	294	78.6%	4.8%
215	22422	1	1	2	325	295	78.9%	4.8%
216	22473	1	1	2	326	296	79.1%	4.8%
217	22475	1	1	2	327	297	79.4%	4.8%
218	22488	1	1	2	328	298	79.6%	4.9%
219	22520	1	1	2	329	299	79.9%	4.9%
220	22562	1	1	2	330	300	80.2%	4.9%
221	22566	1	1	2	331	301	80.4%	4.9%
222	22616	1	1	2	332	302	80.7%	4.9%
223	22663	1	1	2	333	303	80.9%	5.0%
224	22674	1	1	2	334	304	81.2%	5.0%
225	22695	1	1	2	335	305	81.4%	5.0%
226	22696	1	1	2	336	306	81.7%	5.0%
227	22715	1	1	2	337	307	81.9%	5.1%
228	22734	1	1	2	338	308	82.2%	5.1%
229	22759	1	1	2	339	309	82.4%	5.1%
230	22795	1	1	2	340	310	82.7%	5.1%
231	22818	1	1	2	341	311	83.0%	5.1%
232	22840	1	1	2	342	312	83.2%	5.2%
233	22981	1	1	2	343	313	83.5%	5.2%
234	23001	1	1	2	344	314	83.7%	5.2%
235	23198	1	1	2	345	315	84.0%	5.2%
236	23305	1	1	2	346	316	84.2%	5.3%
237	23360	1	1	2	347	317	84.5%	5.3%
238	23370	1	1	2	348	318	84.7%	5.3%
239	23409	1	1	2	349	319	85.0%	5.3%
240	23537	1	1	2	350	320	85.2%	5.3%
241	23538	1	1	2	351	321	85.5%	5.4%
242	23560	1	1	2	352	322	85.8%	5.4%
243	23591	1	1	2	353	323	86.0%	5.4%
244	23608	1	1	2	354	324	86.3%	5.4%
245	23659	1	1	2	355	325	86.5%	5.5%
246	23801	1	1	2	356	326	86.8%	5.5%

247	23813	1	1	2	357	327	87.0%	5.5%
248	23831	1	1	2	358	328	87.3%	5.5%
249	23876	1	1	2	359	329	87.5%	5.5%
250	23881	1	1	2	360	330	87.8%	5.6%
251	23910	1	1	2	361	331	88.0%	5.6%
252	23922	2	0	2	363	331	88.3%	5.6%
253	24079	1	1	2	364	332	88.5%	5.6%
254	24080	1	1	2	365	333	88.8%	5.7%
255	26015	1	1	2	366	334	89.1%	5.7%
256	26067	1	1	2	367	335	89.3%	5.7%
257	29033	2	0	2	369	335	89.6%	5.7%
258	10057	1	0	1	370	335	89.7%	5.7%
259	10060	1	0	1	371	335	89.8%	5.8%
260	10080	1	0	1	372	335	89.9%	5.8%
261	10081	1	0	1	373	335	90.1%	5.8%
262	10082	1	0	1	374	335	90.2%	5.8%
263	10091	1	0	1	375	335	90.3%	5.9%
264	10093	1	0	1	376	335	90.5%	5.9%
265	10111	1	0	1	377	335	90.6%	5.9%
266	10121	1	0	1	378	335	90.7%	5.9%
267	10144	1	0	1	379	335	90.8%	5.9%
268	10150	1	0	1	380	335	91.0%	6.0%
269	10179	1	0	1	381	335	91.1%	6.0%
270	10193	1	0	1	382	335	91.2%	6.0%
271	10236	1	0	1	383	335	91.3%	6.0%
272	10255	1	0	1	384	335	91.5%	6.1%
273	10264	1	0	1	385	335	91.6%	6.1%
274	10273	1	0	1	386	335	91.7%	6.1%
275	10298	1	0	1	387	335	91.9%	6.1%
276	10331	1	0	1	388	335	92.0%	6.1%
277	10339	1	0	1	389	335	92.1%	6.2%
278	10341	1	0	1	390	335	92.2%	6.2%
279	10346	1	0	1	391	335	92.4%	6.2%
280	10400	1	0	1	392	335	92.5%	6.2%
281	10411	1	0	1	393	335	92.6%	6.3%
282	10450	1	0	1	394	335	92.7%	6.3%
283	10463	1	0	1	395	335	92.9%	6.3%
284	10521	1	0	1	396	335	93.0%	6.3%
285	10572	1	0	1	397	335	93.1%	6.3%
286	20032	1	0	1	398	335	93.3%	6.4%
287	20197	1	0	1	399	335	93.4%	6.4%
288	20449	1	0	1	400	335	93.5%	6.4%
289	20533	1	0	1	401	335	93.6%	6.4%
290	20608	1	0	1	402	335	93.8%	6.5%
291	20628	1	0	1	403	335	93.9%	6.5%
292	20708	1	0	1	404	335	94.0%	6.5%
293	20806	1	0	1	405	335	94.1%	6.5%
294	20906	1	0	1	406	335	94.3%	6.5%
295	20917	1	0	1	407	335	94.4%	6.6%
296	21469	1	0	1	408	335	94.5%	6.6%
297	21664	1	0	1	409	335	94.7%	6.6%
298	21713	1	0	1	410	335	94.8%	6.6%
299	21725	1	0	1	411	335	94.9%	6.7%
300	21763	1	0	1	412	335	95.0%	6.7%
301	21764	1	0	1	413	335	95.2%	6.7%
302	21776	1	0	1	414	335	95.3%	6.7%
303	21790	1	0	1	415	335	95.4%	6.7%
304	21830	1	0	1	416	335	95.5%	6.8%
305	21846	1	0	1	417	335	95.7%	6.8%
306	21888	1	0	1	418	335	95.8%	6.8%
307	21903	1	0	1	419	335	95.9%	6.8%
308	21960	1	0	1	420	335	96.1%	6.9%
309	22023	1	0	1	421	335	96.2%	6.9%
310	22087	1	0	1	422	335	96.3%	6.9%

311	22119	1	0	1	423	335	96.4%	6.9%
312	22217	1	0	1	424	335	96.6%	6.9%
313	22223	1	0	1	425	335	96.7%	7.0%
314	22248	1	0	1	426	335	96.8%	7.0%
315	22335	1	0	1	427	335	96.9%	7.0%
316	22499	1	0	1	428	335	97.1%	7.0%
317	22523	1	0	1	429	335	97.2%	7.1%
318	22692	1	0	1	430	335	97.3%	7.1%
319	22717	1	0	1	431	335	97.5%	7.1%
320	22864	1	0	1	432	335	97.6%	7.1%
321	23004	1	0	1	433	335	97.7%	7.1%
322	23156	1	0	1	434	335	97.8%	7.2%
323	23180	1	0	1	435	335	98.0%	7.2%
324	23200	1	0	1	436	335	98.1%	7.2%
325	23285	1	0	1	437	335	98.2%	7.2%
326	23321	1	0	1	438	335	98.3%	7.3%
327	23335	1	0	1	439	335	98.5%	7.3%
328	23353	1	0	1	440	335	98.6%	7.3%
329	23358	1	0	1	441	335	98.7%	7.3%
330	23552	1	0	1	442	335	98.9%	7.3%
331	23583	1	0	1	443	335	99.0%	7.4%
332	23695	1	0	1	444	335	99.1%	7.4%
333	23709	1	0	1	445	335	99.2%	7.4%
334	23738	1	0	1	446	335	99.4%	7.4%
335	24082	1	0	1	447	335	99.5%	7.5%
336	24085	1	0	1	448	335	99.6%	7.5%
337	26060	1	0	1	449	335	99.7%	7.5%
338	27008	1	0	1	450	335	99.9%	7.5%
339	28002	1	0	1	451	335	100.0%	7.5%
340	10001	0	0	0	451	335	100.0%	7.6%
341	10002	0	0	0	451	335	100.0%	7.6%
342	10003	0	0	0	451	335	100.0%	7.6%
343	10004	0	0	0	451	335	100.0%	7.6%
344	10005	0	0	0	451	335	100.0%	7.7%
345	10006	0	0	0	451	335	100.0%	7.7%
346	10007	0	0	0	451	335	100.0%	7.7%
347	10008	0	0	0	451	335	100.0%	7.7%
348	10010	0	0	0	451	335	100.0%	7.7%
349	10011	0	0	0	451	335	100.0%	7.8%
350	10012	0	0	0	451	335	100.0%	7.8%

Table 2 Cumulative number of accidents and spills by platform ID.

1.3 Means Comparisons by Year

The following two tables list means comparisons for the listed risk factors. The comparison used a large sample student's T-test with the desired significance at 95%. That is: Is the mean significantly different (95% level) for the indicated risk factors when the platform does have a spill or accident. A 1 indicates the location of the comparison test on the year –by-year matrix. The in the first column with a "p" (e.g. p_87) are for the prediction year, i.e. the current year. The data along the top row containing a "d" (e.g. d_86) indicate the year from which the data in the means comparisons is derived. For example, to check if a data value from the prior

1.3.1 By Spills

Spill																										
Count of means are diff.		means are diff.	data_yr																							
		NO											NO Total	YES											YES Total	Grand Total
Risk factor	pred_yr	cons	d_86	d_87	d_88	d_89	d_90	d_91	d_92	d_93	d_94	d_95		cons	d_86	d_87	d_88	d_89	d_90	d_91	d_92	d_93	d_94	d_95		
#acc	p_86														1										1	1
	p_87														1	1									2	2
	p_88															1	1								2	2
	p_89																1	1							2	2
	p_90					1							1						1						1	2
	p_91																		1	1					2	2
	p_92							1					1								1				1	2
	p_93								1				1									1			1	2
	p_94																					1	1		2	2
	p_95										1		1											1	1	2
#acc Total						1		1	1		1		4		2	2	2	1	2	1	1	2	1	1	15	19
#EXP	p_86		1										1													1
	p_87		1	1									2													2
	p_88			1	1								2													2
	p_89				1	1							2													2
	p_90					1	1						2													2
	p_91						1	1					2													2
	p_92							1	1				2													2
	p_93								1	1			2													2
	p_94									1	1		2													2
	p_95										1	1	2													2
#EXP Total			2	2	2	2	2	2	2	2	2	1	19													19
#FAT	p_86		1										1													1
	p_87		1	1									2													2

	p_88			1	1								2													2
	p_89				1	1							2													2
	p_90					1	1						2													2
	p_91						1	1					2													2
	p_92							1	1				2													2
	p_93								1	1			2													2
	p_94									1	1		2													2
	p_95										1	1	2													2
#FAT Total			2	2	2	2	2	2	2	2	2	1	19													19
#FIRE	p_86		1										1													1
	p_87		1	1									2													2
	p_88			1	1								2													2
	p_89				1	1							2													2
	p_90					1							1						1						1	2
	p_91							1					1						1						1	2
	p_92																			1	1				2	2
	p_93									1			1								1				1	2
	p_94										1		1									1			1	2
	p_95										1	1	2													2
#FIRE Total			2	2	2	2		1		1	2	1	13						2	1	2	1			6	19
#INJ	p_86		1										1													1
	p_87		1	1									2													2
	p_88			1	1								2													2
	p_89				1	1							2													2
	p_90					1	1						2													2
	p_91						1	1					2													2
	p_92								1				1							1					1	2
	p_93								1				1									1			1	2
	p_94																					1	1		2	2
	p_95										1		1											1	1	2
#INJ Total			2	2	2	2	2	1	2		1		14							1		2	1	1	5	19
#ins_no_inc	p_86		1										1													1
	p_87		1	1									2													2
	p_88			1	1								2													2
	p_89				1	1							2													2
	p_90					1	1						2													2
	p_91						1	1					2													2
	p_92							1	1				2													2

	p_93									1			1								1				1	2
	p_94									1	1		2													2
	p_95										1		1											1	1	2
#ins_no_inc Total			2	2	2	2	2	2	1	2	2		17								1			1	2	19
#ins_w_inc	p_86														1										1	1
	p_87														1	1									2	2
	p_88															1	1								2	2
	p_89																1	1							2	2
	p_90					1							1						1						1	2
	p_91						1						1							1					1	2
	p_92							1					1								1				1	2
	p_93								1				1									1			1	2
	p_94																					1	1		2	2
	p_95																						1	1	2	2
#ins_w_inc Total						1	1	1	1				4		2	2	2	1	1	1	1	2	2	1	15	19
#MAJ	p_86		1										1													1
	p_87		1	1									2													2
	p_88			1	1								2													2
	p_89				1	1							2													2
	p_90					1	1						2													2
	p_91						1	1					2													2
	p_92							1	1				2													2
	p_93								1	1			2													2
	p_94									1	1		2													2
	p_95										1	1	2													2
#MAJ Total			2	2	2	2	2	2	2	2	2	1	19													19
#MIN	p_86		1										1													1
	p_87		1	1									2													2
	p_88			1	1								2													2
	p_89				1	1							2													2
	p_90					1							1						1						1	2
	p_91																		1	1					2	2
	p_92							1					1								1				1	2
	p_93								1				1									1			1	2
	p_94																					1	1		2	2
	p_95										1		1											1	1	2
#MIN Total			2	2	2	2		1	1		1		11						2	1	1	2	1	1	8	19
#SPLL	p_86														1										1	1

	p_87														1	1								2	2
	p_88															1	1							2	2
	p_89																1	1						2	2
	p_90					1							1						1					1	2
	p_91																		1	1				2	2
	p_92							1					1								1			1	2
	p_93								1				1									1		1	2
	p_94																					1	1		2	2
	p_95										1		1											1	1	2
#SPLL Total						1		1	1		1		4		2	2	2	1	2	1	1	2	1	1	15	19
#VESS	p_86		1										1													1
	p_87		1	1									2													2
	p_88			1	1								2													2
	p_89				1	1							2													2
	p_90					1	1						2													2
	p_91						1	1					2													2
	p_92							1	1				2													2
	p_93								1	1			2													2
	p_94									1	1		2													2
	p_95										1	1	2													2
#VESS Total			2	2	2	2	2	2	2	2	2	1	19													19
BED_COUNT	p_86													1											1	1
	p_87	1											1													1
	p_88	1											1													1
	p_89	1											1													1
	p_90	1											1													1
	p_91	1											1													1
	p_92	1											1													1
	p_93	1											1													1
	p_94	1											1													1
	p_95	1											1													1
BED_COUNT Total		9											9	1											1	10
C	p_86														1										1	1
	p_87														1	1									2	2
	p_88															1	1								2	2
	p_89																1	1							2	2
	p_90					1	1						2													2
	p_91						1						1							1					1	2

	p_92								1				1							1					1	2
	p_93								1				1									1			1	2
	p_94									1			1										1		1	2
	p_95																						1	1	2	2
C Total						1	2		2	1			6		2	2	2	1		2		1	2	1	13	19
co_exp	p_86		1										1													1
	p_87		1	1									2													2
	p_88															1	1								2	2
	p_89																1	1							2	2
	p_90					1							1						1						1	2
	p_91						1	1					2													2
	p_92							1	1				2													2
	p_93								1	1			2													2
	p_94									1	1		2													2
	p_95										1	1	2													2
co_exp Total			2	1		1	1	2	2	2	2	1	14			1	2	1	1						5	19
COMGL_PROD_FLAG	p_86	1											1													1
	p_87	1											1													1
	p_88	1											1													1
	p_89													1											1	1
	p_90	1											1													1
	p_91	1											1													1
	p_92	1											1													1
	p_93	1											1													1
	p_94	1											1													1
	p_95	1											1													1
COMGL_PROD_FLAG Total		9											9	1											1	10
COMPRESSOR_FLAG	p_86													1											1	1
	p_87													1											1	1
	p_88													1											1	1
	p_89													1											1	1
	p_90													1											1	1
	p_91													1											1	1
	p_92													1											1	1
	p_93													1											1	1
	p_94													1											1	1
	p_95													1											1	1

COMPRESSOR_FLAG Total													10												10	10
CRANE_COUNT	p_86												1												1	1
	p_87												1												1	1
	p_88												1												1	1
	p_89												1												1	1
	p_90												1												1	1
	p_91												1												1	1
	p_92												1												1	1
	p_93	1										1														1
	p_94	1										1														1
	p_95												1												1	1
CRANE_COUNT Total		2										2	8												8	10
DISTANCE_TO_SH	p_86												1												1	1
	p_87												1												1	1
	p_88												1												1	1
	p_89												1												1	1
	p_90												1												1	1
	p_91												1												1	1
	p_92	1										1														1
	p_93	1										1														1
	p_94	1										1														1
	p_95												1												1	1
DISTANCE_TO_SH Total		3										3	7												7	10
DISTRICT_CODE	p_86	1										1														1
	p_87	1										1														1
	p_88	1										1														1
	p_89	1										1														1
	p_90	1										1														1
	p_91	1										1														1
	p_92	1										1														1
	p_93	1										1														1
	p_94	1										1														1
	p_95	1										1														1
DISTRICT_CODE Total		10										10														10
E	p_86		1									1														1
	p_87		1									1			1										1	2
	p_88			1	1							2														2

	p_89				1	1							2													2
	p_90					1	1						2													2
	p_91						1						1							1					1	2
	p_92							1	1				2													2
	p_93								1	1			2													2
	p_94										1		1									1			1	2
	p_95																						1	1	2	2
E Total			2	1	2	2	2	1	2	1	1		14			1				1		1	1	1	5	19
FIRED_VESSEL_FL	p_86													1											1	1
	p_87													1											1	1
	p_88													1											1	1
	p_89													1											1	1
	p_90	1											1													1
	p_91	1											1													1
	p_92	1											1													1
	p_93	1											1													1
	p_94													1											1	1
	p_95													1											1	1
FIRED_VESSEL_FL Total		4											4	6											6	10
G	p_86		1										1													1
	p_87		1										1			1									1	2
	p_88			1									1				1								1	2
	p_89				1								1					1							1	2
	p_90					1	1						2													2
	p_91						1	1					2													2
	p_92							1	1				2													2
	p_93								1	1			2													2
	p_94									1	1		2													2
	p_95																						1	1	2	2
G Total			2	1	1	1	2	2	2	2	1		14			1	1	1					1	1	5	19
GAS_FLARING_FLAG	p_86													1											1	1
	p_87													1											1	1
	p_88													1											1	1
	p_89													1											1	1
	p_90	1											1													1
	p_91	1											1													1
	p_92	1											1													1

	p_93													1											1	1
	p_94	1											1													1
	p_95	1											1													1
GAS_FLARING_FLAG Total		5											5	5											5	10
GAS_PROD_FLAG	p_86													1											1	1
	p_87													1											1	1
	p_88													1											1	1
	p_89													1											1	1
	p_90													1											1	1
	p_91	1											1													1
	p_92													1											1	1
	p_93	1											1													1
	p_94	1											1													1
	p_95													1											1	1
GAS_PROD_FLAG Total		3											3	7											7	10
H	p_86		1										1													1
	p_87		1	1									2													2
	p_88			1	1								2													2
	p_89				1	1							2													2
	p_90					1	1						2													2
	p_91						1	1					2													2
	p_92							1	1				2													2
	p_93								1	1			2													2
	p_94									1	1		2													2
	p_95										1		1											1	1	2
H Total			2	2	2	2	2	2	2	2	2		18											1	1	19
HELIPORT_FLAG	p_86													1											1	1
	p_87													1											1	1
	p_88													1											1	1
	p_89													1											1	1
	p_90													1											1	1
	p_91													1											1	1
	p_92	1											1													1
	p_93													1											1	1
	p_94													1											1	1
	p_95													1											1	1
HELIPORT_FLAG Total		1											1	9											9	10

INCS/COMP	p_86		1										1													1
	p_87			1									1													1
	p_88				1								1													1
	p_89					1							1													1
	p_90						1						1													1
	p_91							1					1													1
	p_92								1				1													1
	p_93									1			1													1
	p_94										1		1													1
	p_95											1	1													1
INCS/COMP Total			1	1	1	1	1	1	1	1	1	1	10													10
L	p_86		1										1													1
	p_87		1	1									2													2
	p_88			1	1								2													2
	p_89				1	1							2													2
	p_90					1	1						2													2
	p_91							1					1						1						1	2
	p_92							1	1				2													2
	p_93									1			1								1				1	2
	p_94									1	1		2													2
	p_95										1	1	2													2
L Total			2	2	2	2	1	2	1	2	2	1	17						1		1				2	19
M	p_86		1										1													1
	p_87		1	1									2													2
	p_88			1	1								2													2
	p_89				1	1							2													2
	p_90					1	1						2													2
	p_91						1						1							1					1	2
	p_92								1				1							1					1	2
	p_93								1				1									1			1	2
	p_94																					1	1		2	2
	p_95											1	1										1		1	2
M Total			2	2	2	2	2		2			1	13							2		2	2		6	19
MAJ_CMPLX_FLAG	p_86													1											1	1
	p_87													1											1	1
	p_88													1											1	1
	p_89													1											1	1
	p_90													1											1	1

	p_91													1											1	1
	p_92													1											1	1
	p_93													1											1	1
	p_94													1											1	1
	p_95													1											1	1
MAJ_CMPLX_FLAG Total														10											10	10
NUM_COMP	p_86													1											1	1
	p_87													1											1	1
	p_88													1											1	1
	p_89													1											1	1
	p_90													1											1	1
	p_91													1											1	1
	p_92													1											1	1
	p_93	1											1													1
	p_94													1											1	1
	p_95													1											1	1
NUM_COMP Total		1											1	9											9	10
OIL_PROD_FLAG	p_86													1											1	1
	p_87													1											1	1
	p_88													1											1	1
	p_89													1											1	1
	p_90													1											1	1
	p_91													1											1	1
	p_92													1											1	1
	p_93													1											1	1
	p_94	1											1													1
	p_95													1											1	1
OIL_PROD_FLAG Total		1											1	9											9	10
op_exp	p_86		1										1													1
	p_87		1	1									2													2
	p_88			1	1								2													2
	p_89				1	1							2													2
	p_90					1	1						2													2
	p_91						1	1					2													2
	p_92							1	1				2													2
	p_93								1	1			2													2
	p_94									1	1		2													2

	p_95										1	1	2													2
op_exp Total			2	2	2	2	2	2	2	2	2	1	19													19
P	p_86														1										1	1
	p_87														1	1									2	2
	p_88															1	1								2	2
	p_89																1	1							2	2
	p_90					1							1						1						1	2
	p_91						1						1							1					1	2
	p_92							1	1				2													2
	p_93								1				1									1			1	2
	p_94									1	1		2													2
	p_95										1		1											1	1	2
P Total						1	1	1	2	1	2		8		2	2	2	1	1	1		1		1	11	19
PLATFORM_AGE	p_86		1										1													1
	p_87			1									1													1
	p_88																1								1	1
	p_89					1							1													1
	p_90						1						1													1
	p_91							1					1													1
	p_92																				1				1	1
	p_93									1			1													1
	p_94										1		1													1
	p_95																							1	1	1
PLATFORM_AGE Total			1	1		1	1	1		1	1		7				1				1			1	3	10
S	p_86		1										1													1
	p_87		1	1									2													2
	p_88			1	1								2													2
	p_89																1	1							2	2
	p_90																	1	1						2	2
	p_91							1					1						1						1	2
	p_92								1				1							1					1	2
	p_93								1	1			2													2
	p_94																					1	1		2	2
	p_95										1	1	2													2
S Total			2	2	1			1	2	1	1	1	11				1	2	2	1		1	1		8	19
SLOT_COUNT	p_86													1											1	1
	p_87													1											1	1
	p_88													1											1	1

	p_89													1											1	1
	p_90													1											1	1
	p_91													1											1	1
	p_92													1											1	1
	p_93													1											1	1
	p_94	1											1													1
	p_95													1											1	1
SLOT_COUNT Total		1											1	9											9	10
SLOT_DRILL_COUNT	p_86													1											1	1
	p_87													1											1	1
	p_88													1											1	1
	p_89													1											1	1
	p_90													1											1	1
	p_91													1											1	1
	p_92													1											1	1
	p_93	1											1													1
	p_94	1											1													1
	p_95													1											1	1
SLOT_DRILL_COUNT Total		2											2	8											8	10
STORE_TANK_FLAG	p_86													1											1	1
	p_87													1											1	1
	p_88													1											1	1
	p_89													1											1	1
	p_90													1											1	1
	p_91													1											1	1
	p_92	1											1													1
	p_93	1											1													1
	p_94													1											1	1
	p_95													1											1	1
STORE_TANK_FLAG Total		2											2	8											8	10
SUL_PROD_FLAG	p_86	1											1													1
	p_87	1											1													1
	p_88	1											1													1
	p_89	1											1													1
	p_90	1											1													1
	p_91													1											1	1
	p_92													1											1	1

	p_93													1											1	1
	p_94													1											1	1
	p_95	1											1													1
SUL_PROD_FLAG Total		6											6	4											4	10
tot_inc	p_86														1										1	1
	p_87														1	1									2	2
	p_88															1	1								2	2
	p_89																1	1							2	2
	p_90					1							1						1						1	2
	p_91						1						1							1					1	2
	p_92							1	1				2													2
	p_93								1				1									1			1	2
	p_94									1	1		2													2
	p_95																						1	1	2	2
tot_inc Total						1	1	1	2	1	1		7		2	2	2	1	1	1		1	1	1	12	19
W	p_86		1										1													1
	p_87		1										1			1									1	2
	p_88			1	1								2													2
	p_89																1	1							2	2
	p_90					1							1						1						1	2
	p_91						1	1					2													2
	p_92							1	1				2													2
	p_93								1				1									1			1	2
	p_94									1	1		2													2
	p_95										1		1											1	1	2
W Total			2	1	1	1	1	2	2	1	2		13			1	1	1	1			1		1	6	19
WATER_DEPTH	p_86													1											1	1
	p_87													1											1	1
	p_88													1											1	1
	p_89													1											1	1
	p_90													1											1	1
	p_91	1											1													1
	p_92	1											1													1
	p_93	1											1													1
	p_94	1											1													1
	p_95	1											1													1
WATER_DEPTH Total		5											5	5											5	10

Grand Total		64	36	32	30	37	32	34	39	29	34	11	378	116	12	16	18	11	16	14	9	19	14	14	259	637

Table 3 Means Comparisons – Mean of Factor Given Spill did Occur

1.3.2 *By Accidents*

Accidents																										
Count of means are diff.		means are diff.	data _yr																							
		NO											NO Total	YES											YES Total	Grand Total
Risk factor	pred_yr	cons tant	d_86	d_87	d_88	d_89	d_90	d_91	d_92	d_93	d_94	d_95		cons tant	d_86	d_87	d_88	d_89	d_90	d_91	d_92	d_93	d_94	d_95		
#acc	p_86														1										1	1
	p_87														1	1									2	2
	p_88															1	1								2	2
	p_89																1	1							2	2
	p_90					1							1						1						1	2
	p_91																		1	1					2	2
	p_92							1					1								1				1	2
	p_93								1				1									1			1	2
	p_94																					1	1		2	2
	p_95										1		1											1	1	2
#acc Total						1		1	1		1		4		2	2	2	1	2	1	1	2	1	1	15	19
#EXP	p_86		1										1													1
	p_87		1	1									2													2
	p_88			1	1								2													2
	p_89				1	1							2													2
	p_90					1	1						2													2
	p_91						1	1					2													2
	p_92							1	1				2													2
	p_93								1	1			2													2
	p_94									1	1		2													2
	p_95										1	1	2													2
#EXP Total			2	2	2	2	2	2	2	2	2	1	19													19
#FAT	p_86		1										1													1
	p_87		1	1									2													2
	p_88			1	1								2													2
	p_89				1	1							2													2
	p_90					1	1						2													2
	p_91						1	1					2													2
	p_92							1	1				2													2
	p_93								1	1			2													2
	p_94									1	1		2													2
	p_95										1	1	2													2

#FAT Total			2	2	2	2	2	2	2	2	2	1	19													19
#FIRE	p_86		1										1													1
	p_87		1	1									2													2
	p_88			1	1								2													2
	p_89				1	1							2													2
	p_90					1							1						1						1	2
	p_91																		1	1					2	2
	p_92																			1	1				2	2
	p_93								1				1									1			1	2
	p_94										1		1									1			1	2
	p_95										1		1											1	1	2
#FIRE Total			2	2	2	2			1		2		11						2	2	1	2		1	8	19
#INJ	p_86		1										1													1
	p_87		1	1									2													2
	p_88			1	1								2													2
	p_89				1	1							2													2
	p_90					1	1						2													2
	p_91						1						1							1					1	2
	p_92								1				1							1					1	2
	p_93								1				1									1			1	2
	p_94																					1	1		2	2
	p_95										1		1											1	1	2
#INJ Total			2	2	2	2	2		2		1		13							2		2	1	1	6	19
#ins_no_inc	p_86		1										1													1
	p_87		1	1									2													2
	p_88			1	1								2													2
	p_89				1	1							2													2
	p_90					1	1						2													2
	p_91						1	1					2													2
	p_92							1	1				2													2
	p_93								1	1			2													2
	p_94									1	1		2													2
	p_95										1		1											1	1	2
#ins_no_inc Total			2	2	2	2	2	2	2	2	2		18											1	1	19
#ins_w_inc	p_86														1										1	1
	p_87														1	1									2	2
	p_88															1	1								2	2
	p_89																1	1							2	2
	p_90					1							1						1						1	2
	p_91						1						1							1					1	2
	p_92							1	1				2													2
	p_93																				1	1			2	2
	p_94									1			1										1		1	2
	p_95																						1	1	2	2
#ins_w_inc Total						1	1	1	1	1			5		2	2	2	1	1	1	1	1	2	1	14	19
#MAJ	p_86		1										1													1
	p_87		1	1									2													2
	p_88			1	1								2													2

	p_89				1	1							2													2
	p_90					1	1						2													2
	p_91						1	1					2													2
	p_92							1	1				2													2
	p_93								1	1			2													2
	p_94									1	1		2													2
	p_95										1		1											1	1	2
#MAJ Total			2	2	2	2	2	2	2	2	2		18											1	1	19
#MIN	p_86		1										1													1
	p_87		1	1									2													2
	p_88			1	1								2													2
	p_89				1	1							2													2
	p_90					1							1						1						1	2
	p_91							1					1						1						1	2
	p_92							1					1								1				1	2
	p_93								1				1									1			1	2
	p_94																					1	1		2	2
	p_95										1		1											1	1	2
#MIN Total			2	2	2	2		2	1		1		12						2		1	2	1	1	7	19
#SPLL	p_86														1										1	1
	p_87														1	1									2	2
	p_88															1	1								2	2
	p_89																1	1							2	2
	p_90					1							1						1						1	2
	p_91																		1	1					2	2
	p_92							1					1								1				1	2
	p_93								1				1									1			1	2
	p_94																					1	1		2	2
	p_95										1		1											1	1	2
#SPLL Total						1		1	1		1		4		2	2	2	1	2	1	1	2	1	1	15	19
#VESS	p_86		1										1													1
	p_87		1	1									2													2
	p_88			1	1								2													2
	p_89				1	1							2													2
	p_90					1	1						2													2
	p_91						1	1					2													2
	p_92							1	1				2													2
	p_93								1	1			2													2
	p_94									1	1		2													2
	p_95										1	1	2													2
#VESS Total			2	2	2	2	2	2	2	2	2	1	19													19
BED_COUNT	p_86													1											1	1
	p_87	1											1													1
	p_88	1											1													1
	p_89	1											1													1
	p_90	1											1													1
	p_91	1											1													1
	p_92	1											1													1

	p_93	1											1													1
	p_94	1											1													1
	p_95													1											1	1
BED_COUNT Total		8											8	2											2	10
C	p_86														1										1	1
	p_87														1	1									2	2
	p_88															1	1								2	2
	p_89																1	1							2	2
	p_90					1							1						1						1	2
	p_91						1						1							1					1	2
	p_92							1	1				2													2
	p_93								1				1									1			1	2
	p_94									1	1		2													2
	p_95																						1	1	2	2
C Total						1	1	1	2	1	1		7		2	2	2	1	1	1		1	1	1	12	19
co_exp	p_86		1										1													1
	p_87		1	1									2													2
	p_88															1	1								2	2
	p_89																1	1							2	2
	p_90					1	1						2													2
	p_91						1	1					2													2
	p_92							1	1				2													2
	p_93								1	1			2													2
	p_94									1	1		2													2
	p_95										1	1	2													2
co_exp Total			2	1		1	2	2	2	2	2	1	15			1	2	1							4	19
COMGL_PROD_FLAG	p_86	1											1													1
	p_87	1											1													1
	p_88	1											1													1
	p_89													1											1	1
	p_90	1											1													1
	p_91	1											1													1
	p_92	1											1													1
	p_93													1											1	1
	p_94													1											1	1
	p_95	1											1													1
COMGL_PROD_FLAG Total		7											7	3											3	10
COMPRESSOR_FLAG	p_86													1											1	1
	p_87													1											1	1
	p_88													1											1	1
	p_89													1											1	1
	p_90													1											1	1
	p_91													1											1	1
	p_92													1											1	1
	p_93													1											1	1

	p_94													1											1	1
	p_95													1											1	1
COMPRESSOR_FLAG Total														10											10	10
CRANE_COUNT	p_86													1											1	1
	p_87													1											1	1
	p_88													1											1	1
	p_89													1											1	1
	p_90													1											1	1
	p_91													1											1	1
	p_92													1											1	1
	p_93													1											1	1
	p_94	1											1													1
	p_95													1											1	1
CRANE_COUNT Total		1											1	9											9	10
DISTANCE_TO_SH	p_86													1											1	1
	p_87													1											1	1
	p_88													1											1	1
	p_89													1											1	1
	p_90													1											1	1
	p_91													1											1	1
	p_92													1											1	1
	p_93													1											1	1
	p_94	1											1													1
	p_95													1											1	1
DISTANCE_TO_SH Total		1											1	9											9	10
DISTRICT_CODE	p_86	1											1													1
	p_87	1											1													1
	p_88	1											1													1
	p_89	1											1													1
	p_90	1											1													1
	p_91	1											1													1
	p_92													1											1	1
	p_93	1											1													1
	p_94	1											1													1
	p_95	1											1													1
DISTRICT_CODE Total		9											9	1											1	10
E	p_86		1										1													1
	p_87		1										1			1									1	2
	p_88			1	1								2													2
	p_89				1	1							2													2
	p_90					1	1						2													2
	p_91						1						1							1					1	2
	p_92							1	1				2													2
	p_93								1	1			2													2
	p_94										1		1									1			1	2

	p_95										1		1											1	1	2
E Total			2	1	2	2	2	1	2	1	2		15			1				1		1		1	4	19
FIRED_VESSEL_FL	p_86													1											1	1
	p_87													1											1	1
	p_88													1											1	1
	p_89													1											1	1
	p_90													1											1	1
	p_91													1											1	1
	p_92													1											1	1
	p_93													1											1	1
	p_94													1											1	1
	p_95													1											1	1
FIRED_VESSEL_FL Total														10											10	10
G	p_86		1										1													1
	p_87		1										1			1									1	2
	p_88			1									1				1								1	2
	p_89				1								1					1							1	2
	p_90					1							1						1						1	2
	p_91						1	1					2													2
	p_92							1	1				2													2
	p_93								1				1									1			1	2
	p_94									1	1		2													2
	p_95																						1	1	2	2
G Total			2	1	1	1	1	2	2	1	1		12			1	1	1	1			1	1	1	7	19
GAS_FLARING_FLAG	p_86													1											1	1
	p_87													1											1	1
	p_88													1											1	1
	p_89													1											1	1
	p_90	1											1													1
	p_91	1											1													1
	p_92	1											1													1
	p_93	1											1													1
	p_94	1											1													1
	p_95	1											1													1
GAS_FLARING_FLAG Total		6											6	4											4	10
GAS_PROD_FLAG	p_86													1											1	1
	p_87													1											1	1
	p_88													1											1	1
	p_89													1											1	1
	p_90													1											1	1
	p_91	1											1													1
	p_92													1											1	1
	p_93													1											1	1
	p_94	1											1													1
	p_95													1											1	1

GAS_PROD_FLAG Total		2											2	8											8	10
H	p_86		1										1													1
	p_87		1	1									2													2
	p_88			1	1								2													2
	p_89				1	1							2													2
	p_90					1	1						2													2
	p_91						1	1					2													2
	p_92							1	1				2													2
	p_93								1	1			2													2
	p_94									1	1		2													2
	p_95										1		1											1	1	2
H Total			2	2	2	2	2	2	2	2	2		18											1	1	19
HELIPORT_FLAG	p_86													1											1	1
	p_87													1											1	1
	p_88													1											1	1
	p_89													1											1	1
	p_90													1											1	1
	p_91													1											1	1
	p_92													1											1	1
	p_93													1											1	1
	p_94													1											1	1
	p_95													1											1	1
HELIPORT_FLAG Total														10											10	10
incs/comp	p_86		1										1													1
	p_87			1									1													1
	p_88				1								1													1
	p_89					1							1													1
	p_90						1						1													1
	p_91							1					1													1
	p_92								1				1													1
	p_93									1			1													1
	p_94										1		1													1
	p_95											1	1													1
incs/comp Total			1	1	1	1	1	1	1	1	1	1	10													10
L	p_86		1										1													1
	p_87		1	1									2													2
	p_88			1	1								2													2
	p_89				1	1							2													2
	p_90					1	1						2													2
	p_91						1	1					2													2
	p_92							1	1				2													2
	p_93								1	1			2													2
	p_94									1	1		2													2
	p_95											1	1										1		1	2
L Total			2	2	2	2	2	2	2	2	1	1	18										1		1	19
M	p_86		1										1													1

	p_87		1	1									2													2
	p_88			1	1								2													2
	p_89				1	1							2													2
	p_90					1	1						2													2
	p_91						1						1							1					1	2
	p_92								1				1							1					1	2
	p_93								1	1			2													2
	p_94																					1	1		2	2
	p_95										1	1	2													2
M Total			2	2	2	2	2		2	1	1	1	15							2		1	1		4	19
MAJ_CMPLX_FLAG	p_86													1											1	1
	p_87													1											1	1
	p_88													1											1	1
	p_89													1											1	1
	p_90													1											1	1
	p_91													1											1	1
	p_92													1											1	1
	p_93													1											1	1
	p_94													1											1	1
	p_95													1											1	1
MAJ_CMPLX_FLAG Total														10											10	10
NUM_COMP	p_86													1											1	1
	p_87													1											1	1
	p_88													1											1	1
	p_89													1											1	1
	p_90													1											1	1
	p_91													1											1	1
	p_92													1											1	1
	p_93													1											1	1
	p_94													1											1	1
	p_95													1											1	1
NUM_COMP Total														10											10	10
OIL_PROD_FLAG	p_86													1											1	1
	p_87													1											1	1
	p_88													1											1	1
	p_89													1											1	1
	p_90													1											1	1
	p_91													1											1	1
	p_92													1											1	1
	p_93													1											1	1
	p_94	1											1													1
	p_95													1											1	1
OIL_PROD_FLAG Total		1											1	9											9	10
op_exp	p_86		1										1													1
	p_87		1	1									2													2
	p_88			1	1								2													2

	p_89				1	1							2													2
	p_90					1	1						2													2
	p_91						1	1					2													2
	p_92							1	1				2													2
	p_93								1	1			2													2
	p_94									1	1		2													2
	p_95																					1	1	2		2
op_exp Total			2	2	2	2	2	2	2	2	1		17									1	1	2		19
P	p_86														1									1		1
	p_87														1	1								2		2
	p_88															1	1							2		2
	p_89																1	1						2		2
	p_90					1							1						1					1		2
	p_91						1						1							1				1		2
	p_92							1	1				2													2
	p_93								1	1			2													2
	p_94									1	1		2													2
	p_95																					1	1	2		2
P Total						1	1	1	2	2	1		8		2	2	2	1	1	1			1	1	11	19
PLATFORM_AGE	p_86		1										1													1
	p_87			1									1													1
	p_88																1							1		1
	p_89					1							1													1
	p_90						1						1													1
	p_91							1					1													1
	p_92								1				1													1
	p_93									1			1													1
	p_94										1		1													1
	p_95											1	1													1
PLATFORM_AGE Total			1	1		1	1	1	1	1	1	1	9				1							1		10
S	p_86		1										1													1
	p_87		1	1									2													2
	p_88			1	1								2													2
	p_89																1	1						2		2
	p_90					1	1						2													2
	p_91						1	1					2													2
	p_92							1	1				2													2
	p_93								1	1			2													2
	p_94																				1	1		2		2
	p_95										1		1										1	1		2
S Total			2	2	1	1	2	2	2	1	1		14				1	1			1	1	1	5		19
SLOT_COUNT	p_86													1										1		1
	p_87													1										1		1
	p_88													1										1		1
	p_89													1										1		1
	p_90													1										1		1
	p_91													1										1		1

	p_92													1											1	1
	p_93													1											1	1
	p_94													1											1	1
	p_95													1											1	1
SLOT_COUNT Total														10											10	10
SLOT_DRILL_COUNT	p_86													1											1	1
	p_87													1											1	1
	p_88													1											1	1
	p_89													1											1	1
	p_90													1											1	1
	p_91													1											1	1
	p_92													1											1	1
	p_93													1											1	1
	p_94													1											1	1
	p_95													1											1	1
SLOT_DRILL_COUNT Total														10											10	10
STORE_TANK_FLAG	p_86													1											1	1
	p_87													1											1	1
	p_88													1											1	1
	p_89													1											1	1
	p_90													1											1	1
	p_91													1											1	1
	p_92	1											1													1
	p_93													1											1	1
	p_94													1											1	1
	p_95													1											1	1
STORE_TANK_FLAG Total		1											1	9											9	10
SUL_PROD_FLAG	p_86	1											1													1
	p_87	1											1													1
	p_88	1											1													1
	p_89	1											1													1
	p_90	1											1													1
	p_91													1											1	1
	p_92													1											1	1
	p_93													1											1	1
	p_94													1											1	1
	p_95	1											1													1
SUL_PROD_FLAG Total		6											6	4											4	10
tot_inc	p_86														1										1	1
	p_87														1	1									2	2
	p_88															1	1								2	2
	p_89																1	1							2	2
	p_90					1							1						1						1	2
	p_91						1						1							1					1	2

	p_92							1	1				2													2
	p_93																				1	1			2	2
	p_94									1	1		2													2
	p_95																						1	1	2	2
tot_inc Total						1	1	1	1	1	1		6		2	2	2	1	1	1	1	1	1	1	13	19
W	p_86		1										1													1
	p_87		1										1			1									1	2
	p_88			1	1								2													2
	p_89																1	1							2	2
	p_90					1							1						1						1	2
	p_91						1						1							1					1	2
	p_92							1	1				2													2
	p_93								1	1			2													2
	p_94									1	1		2													2
	p_95																						1	1	2	2
W Total			2	1	1	1	1	1	2	2	1		12			1	1	1	1	1			1	1	7	19
WATER_DEPTH	p_86													1											1	1
	p_87													1											1	1
	p_88													1											1	1
	p_89													1											1	1
	p_90													1											1	1
	p_91	1											1													1
	p_92													1											1	1
	p_93													1											1	1
	p_94	1											1													1
	p_95													1											1	1
WATER_DEPTH Total		2											2	8											8	10
Grand Total		44	36	32	30	38	34	34	42	31	33	8	362	136	12	16	18	10	14	14	6	17	15	17	275	637

Table 4 Means Comparisons – Mean of Factor Given Accident did Occur

1.4 Rotated Components

1.4.1 2 Rotated Components

Rotated Factor Pattern			
NUM_COMP	.9	#ins_no_inc	.2
SLOT_COUNT	.8	co_exp_I	.2
SLOT_DRILL_COUNT	.8	op_exp	.2
COMPRESSOR_FLAG	.8	co_exp	.2
crane_count	.7	op_exp_I	.2
MAJ_CMPLX_FLAG	.7	#ins_no_inc_I	.2
HELIPORT_FLAG	.7	co_ming_prod	.1
bed_count	.6	PLATFORM_AGE	.0
WATER_DEPTH	.6	SUL_PROD_FLAG	.0
STORE_TANK_FLAG	.6	#VESS_I	.0
GAS_PROD_FLAG	.6	#VESS	.0
OIL_PROD_FLAG	.5	#FAT_I	.0
FIRED_VESSEL_FL	.5	#MAJ_I	.0
DISTANCE_TO_SH	.5	#INJ_I	.0
GAS_FLARING_FLAG	.4	#FIRE_I	.0
#ins_w_inc_I	.3	H_I	.0
#ins_w_inc	.2	H	.0
co_ming_prod	.2	#EXP	.0
C_I	.2	#INJ	.0
P_I	.2	GAS_FLARING_FLAG	.0
tot_inc_I	.2	#FAT	.0
C	.2	#MAJ	.0
P	.2	GAS_PROD_FLAG	.0
#acc	.2	#EXP_I	.0
tot_inc	.2	WATER_DEPTH	.0
#acc_I	.2	#MIN_I	.0
#SPLL_I	.1	OIL_PROD_FLAG	.0
#MIN	.1	#FIRE	.0
#SPLL	.1	#MIN	-.1
W_I	.1	#SPLL	-.1
#MIN_I	.1	#acc_I	-.1
W	.1	#SPLL_I	-.1
#FIRE	.1	#acc	-.1
G_I	.1	HELIPORT_FLAG	-.1
L_I	.1	SLOT_DRILL_COUNT	-.1
G	.1	SLOT_COUNT	-.1
#FIRE_I	.1	M_I	-.1
L	.1	STORE_TANK_FLAG	-.2
E_I	.1	bed_count	-.2
op_exp_I	.1	FIRED_VESSEL_FL	-.2
op_exp	.1	NUM_COMP	-.2
E	.1	DISTANCE_TO_SH	-.2
M	.1	M	-.2
M_I	.1	MAJ_CMPLX_FLAG	-.2
#INJ	.1	crane_count	-.2
#INJ_I	.0	COMPRESSOR_FLAG	-.2
#ins_no_inc	.0	L_I	-.3
SUL_PROD_FLAG	.0	S_I	-.3
#FAT	.0	L	-.3
S_I	.0	S	-.3
#MAJ	.0	INCS/COMP	-.4
PLATFORM_AGE	.0	E_I	-.4
S	.0	E	-.4
#FAT_I	.0	G_I	-.6
#VESS	.0	#ins_w_inc_I	-.6
#VESS_I	.0	G	-.6
#ins_no_inc_I	.0	C_I	-.6
co_exp	.0	W_I	-.7
co_exp_I	.0	P_I	-.7
#MAJ_I	.0	#ins_w_inc	-.7
H_I	.0	W	-.7
#EXP	.0	C	-.7
H	.0	P	-.7
#EXP_I	.0	tot_inc_I	-.8
INCS/COMP	-.1	tot_inc	-.8

Table 52 Rotated Principal Components

1.4.2 3 Rotated Components

Rotated Factor Pattern					
NUM_COMP	.9	#ins_no_inc_I	.2	op_exp	.7
SLOT_COUNT	.8	#ins_no_inc	.2	op_exp_I	.7
COMPRESSOR_FLAG	.8	co_ming_prod	.0	co_exp_I	.7
SLOT_DRILL_COUNT	.7	SUL_PROD_FLAG	.0	co_exp	.7
crane_count	.7	#VESS	.0	PLATFORM_AGE	.4
MAJ_CMPLX_FLAG	.7	#VESS_I	.0	tot_inc_I	.1
HELIPORT_FLAG	.7	#FAT_I	.0	C_I	.1
bed_count	.6	#MAJ_I	.0	P_I	.1
WATER_DEPTH	.6	#INJ_I	.0	W_I	.1
STORE_TANK_FLAG	.6	#EXP	.0	#ins_no_inc	.1
GAS_PROD_FLAG	.6	#INJ	.0	G_I	.1
FIRED_VESSEL_FL	.5	H	.0	co_ming_prod	.1
OIL_PROD_FLAG	.5	H_I	.0	E_I	.1
DISTANCE_TO_SH	.5	WATER_DEPTH	.0	L_I	.1
GAS_FLARING_FLAG	.4	#MAJ	.0	OIL_PROD_FLAG	.1
#ins_w_inc	.2	#FIRE_I	.0	#ins_w_inc_I	.1
#ins_w_inc_I	.2	#FAT	.0	S_I	.1
co_ming_prod	.2	GAS_PROD_FLAG	.0	SLOT_DRILL_COUNT	.0
C	.2	#EXP_I	.0	M_I	.0
P	.2	GAS_FLARING_FLAG	.0	GAS_FLARING_FLAG	.0
#acc	.2	#FIRE	.0	#MIN_I	.0
tot_inc	.2	#SPLL	.0	#FIRE_I	.0
C_I	.2	#MIN	.0	#INJ_I	.0
P_I	.2	#MIN_I	-.1	SLOT_COUNT	.0
#acc_I	.2	co_exp	-.1	#VESS_I	.0
tot_inc_I	.2	#acc	-.1	#FAT_I	.0
#MIN	.1	co_exp_I	-.1	H_I	.0
#SPLL_I	.1	#acc_I	-.1	#MAJ_I	.0
#SPLL	.1	#SPLL_I	-.1	NUM_COMP	.0
W	.1	OIL_PROD_FLAG	-.1	#VESS	.0
#MIN_I	.1	op_exp_I	-.1	#FAT	.0
#FIRE	.1	op_exp	-.1	#EXP_I	.0
W_I	.1	HELIPORT_FLAG	-.1	#acc_I	.0
G	.1	DISTANCE_TO_SH	-.1	#ins_no_inc_I	.0
L	.1	PLATFORM_AGE	-.1	HELIPORT_FLAG	.0
#FIRE_I	.1	FIRED_VESSEL_FL	-.1	SUL_PROD_FLAG	.0
L_I	.1	SLOT_COUNT	-.1	H	.0
E	.1	M	-.1	#SPLL_I	.0
G_I	.1	SLOT_DRILL_COUNT	-.2	STORE_TANK_FLAG	.0
M	.1	M_I	-.2	#MAJ	.0
E_I	.1	STORE_TANK_FLAG	-.2	bed_count	.0
#INJ	.1	bed_count	-.2	#EXP	.0
M_I	.0	NUM_COMP	-.2	#FIRE	.0
#INJ_I	.0	MAJ_CMPLX_FLAG	-.2	#INJ	.0
#ins_no_inc	.0	crane_count	-.2	GAS_PROD_FLAG	.0
SUL_PROD_FLAG	.0	COMPRESSOR_FLAG	-.2	MAJ_CMPLX_FLAG	-.1
#FAT	.0	L	-.3	crane_count	-.1
#ins_no_inc_I	.0	S	-.3	#MIN	-.1
#MAJ	.0	INCS/COMP	-.3	COMPRESSOR_FLAG	-.1
S	.0	L_I	-.3	#SPLL	-.1
op_exp_I	.0	S_I	-.3	M	-.1
op_exp	.0	E	-.4	#acc	-.1
#VESS	.0	E_I	-.5	WATER_DEPTH	-.1
#FAT_I	.0	G	-.5	FIRED_VESSEL_FL	-.1
#VESS_I	.0	W	-.6	DISTANCE_TO_SH	-.2
#MAJ_I	.0	#ins_w_inc	-.6	L	-.2
S_I	.0	P	-.6	S	-.2
#EXP	.0	C	-.6	E	-.3
H	.0	G_I	-.7	INCS/COMP	-.3
H_I	.0	#ins_w_inc_I	-.7	#ins_w_inc	-.4
#EXP_I	.0	tot_inc	-.7	G	-.4
PLATFORM_AGE	.0	C_I	-.7	C	-.4
co_exp	.0	W_I	-.7	P	-.4

co_exp_l	.0	P_l	-.7	W	-.4
INCS/COMP	-.1	tot_inc_l	-.8	tot_inc	-.5

Table 6 3 Rotated Principle Components

1.4.3 4 Rotated Components

Rotated Factor Pattern							
INCS/COMP	.2	#ins_no_inc_l	.2	DISTANCE_TO_SH	.2	tot_inc	.9
co_exp_l	.0	co_exp	.1	FIRED_VESSEL_FL	.1	P	.8
co_exp	.0	#acc	.1	WATER_DEPTH	.1	W	.8
#EXP_l	.0	co_exp_l	.1	GAS_PROD_FLAG	.1	C	.8
PLATFORM_AGE	.0	op_exp	.0	COMPRESSOR_FLAG	.0	G	.7
H	.0	op_exp_l	.0	INCS/COMP	.0	#ins_w_inc	.7
#EXP	.0	co_ming_prod	.0	crane_count	.0	E	.5
S	.0	#MIN	.0	MAJ_CMPLX_FLAG	.0	INCS/COMP	.5
H_l	.0	#SPLL	.0	#ins_w_inc	.0	S	.4
#MAJ_l	.0	#INJ	.0	SUL_PROD_FLAG	.0	L	.4
S_l	.0	#VESS	.0	#ins_no_inc	.0	M	.2
#VESS	.0	#ins_no_inc	.0	G	.0	#acc	.2
#VESS_l	.0	#EXP	.0	W	.0	COMPRESSOR_FLAG	.2
#FAT_l	.0	#FIRE	.0	#ins_w_inc_l	.0	NUM_COMP	.2
#MAJ	.0	#MAJ	.0	tot_inc	.0	crane_count	.2
#ins_no_inc_l	.0	SUL_PROD_FLAG	.0	HELIPORT_FLAG	.0	MAJ_CMPLX_FLAG	.2
#FAT	.0	#FAT	.0	bed_count	.0	#MIN	.1
op_exp	.0	H	.0	P	.0	#ins_w_inc_l	.1
SUL_PROD_FLAG	.0	#VESS_l	.0	E	.0	#SPLL	.1
op_exp_l	.0	#FAT_l	.0	#MAJ_l	.0	STORE_TANK_FLAG	.1
E	.0	#MAJ_l	.0	C	.0	bed_count	.1
#INJ_l	.0	#INJ_l	.0	H_l	.0	SLOT_COUNT	.1
M_l	.0	GAS_FLARING_FLAG	.0	#EXP	.0	tot_inc_l	.1
#INJ	.0	WATER_DEPTH	.0	#SPLL_l	.0	SLOT_DRILL_COUNT	.1
G	-.1	#EXP_l	.0	#acc_l	.0	DISTANCE_TO_SH	.1
M	-.1	H_l	.0	H	.0	FIRED_VESSEL_FL	.1
#ins_no_inc	-.1	#FIRE_l	.0	#EXP_l	.0	W_l	.1
E_l	-.1	GAS_PROD_FLAG	.0	G_l	.0	P_l	.1
L	-.1	INCS/COMP	.0	#VESS_l	.0	C_l	.1
G_l	-.1	PLATFORM_AGE	.0	STORE_TANK_FLAG	.0	G_l	.1
W	-.1	OIL_PROD_FLAG	.0	W_l	.0	HELIPORT_FLAG	.1
L_l	-.1	#MIN_l	-.1	S	.0	#FIRE	.1
#FIRE_l	-.1	#SPLL_l	-.1	P_l	.0	OIL_PROD_FLAG	.1
W_l	-.1	M	-.1	#FAT_l	.0	#INJ	.1
#FIRE	-.1	#acc_l	-.1	E_l	.0	#SPLL_l	.1
#MIN_l	-.1	HELIPORT_FLAG	-.1	#MAJ	.0	WATER_DEPTH	.1
tot_inc	-.1	L	-.1	#INJ_l	.0	E_l	.1
#SPLL	-.1	S	-.1	#SPLL	.0	#acc_l	.1
#MIN	-.1	SLOT_COUNT	-.1	tot_inc_l	.0	GAS_PROD_FLAG	.1
P	-.1	SLOT_DRILL_COUNT	-.1	S_l	.0	#MAJ	.1
#SPLL_l	-.1	DISTANCE_TO_SH	-.1	C_l	.0	GAS_FLARING_FLAG	.0
C	-.1	E	-.1	#VESS	.0	#EXP	.0
#acc_l	-.2	STORE_TANK_FLAG	-.1	M	.0	#FAT	.0
tot_inc_l	-.2	FIRED_VESSEL_FL	-.1	#INJ	.0	S_l	.0
#acc	-.2	bed_count	-.1	#FIRE_l	.0	M_l	.0
P_l	-.2	NUM_COMP	-.1	#FAT	.0	L_l	.0
C_l	-.2	crane_count	-.1	L	.0	#EXP_l	.0
#ins_w_inc	-.2	COMPRESSOR_FLAG	-.1	#acc	.0	H	.0
co_ming_prod	-.2	MAJ_CMPLX_FLAG	-.1	M_l	.0	PLATFORM_AGE	.0
#ins_w_inc_l	-.2	M_l	-.2	NUM_COMP	.0	#VESS	.0
GAS_FLARING_FLAG	-.4	G	-.2	#MIN_l	.0	#MIN_l	.0
DISTANCE_TO_SH	-.5	W	-.2	L_l	.0	#FIRE_l	.0
OIL_PROD_FLAG	-.5	P	-.2	#ins_no_inc_l	.0	#INJ_l	.0
FIRED_VESSEL_FL	-.5	C	-.2	#FIRE	.0	#FAT_l	.0
GAS_PROD_FLAG	-.6	tot_inc	-.2	SLOT_COUNT	.0	H_l	.0
STORE_TANK_FLAG	-.6	#ins_w_inc	-.2	#MIN	.0	#MAJ_l	.0
WATER_DEPTH	-.6	L_l	-.4	GAS_FLARING_FLAG	.0	SUL_PROD_FLAG	.0
bed_count	-.6	S_l	-.4	SLOT_DRILL_COUNT	-.1	#VESS_l	.0
HELIPORT_FLAG	-.7	E_l	-.5	co_ming_prod	-.1	#ins_no_inc_l	.0
MAJ_CMPLX_FLAG	-.7	G_l	-.7	OIL_PROD_FLAG	-.1	co_ming_prod	.0
crane_count	-.7	#ins_w_inc_l	-.8	PLATFORM_AGE	-.5	op_exp_l	.0
COMPRESSOR_FLAG	-.7	W_l	-.8	co_exp	-.8	op_exp	.0
SLOT_DRILL_COUNT	-.7	C_l	-.8	co_exp_l	-.8	co_exp	.0

SLOT_COUNT	-.8	P_I	-.8	op_exp_I	-.9	co_exp_I	-.1
NUM_COMP	-.9	tot_inc_I	-1.0	op_exp	-.9	#ins_no_inc	-.2

Table 7 4 Rotated Principal Components

1.4.4 5 Rotated Components

Rotated Factor Pattern									
NUM_COMP	.9	tot_inc_I	1.0	op_exp	.9	#ins_no_inc	.2	#acc	.9
SLOT_COUNT	.8	P_I	.8	op_exp_I	.9	co_exp_I	.1	#MIN	.8
COMPRESSOR_FLAG	.7	C_I	.8	co_exp_I	.8	co_exp	.0	#FIRE	.6
SLOT_DRILL_COUNT	.7	W_I	.8	co_exp	.8	op_exp	.0	#SPLL	.6
crane_count	.7	#ins_w_inc_I	.8	PLATFORM_AGE	.5	op_exp_I	.0	#INJ	.4
MAJ_CMPLX_FLAG	.7	G_I	.7	OIL_PROD_FLAG	.1	co_ming_prod	.0	#acc_I	.3
HELIPORT_FLAG	.7	E_I	.5	co_ming_prod	.1	#ins_no_inc_I	.0	#VESS	.3
bed_count	.6	S_I	.4	SLOT_DRILL_COUNT	.1	#FIRE_I	.0	#MIN_I	.2
WATER_DEPTH	.6	L_I	.4	GAS_FLARING_FLAG	.1	#VESS_I	.0	#MAJ	.2
STORE_TANK_FLAG	.6	#ins_w_inc	.2	SLOT_COUNT	.0	#INJ_I	.0	#SPLL_I	.2
GAS_PROD_FLAG	.6	tot_inc	.2	NUM_COMP	.0	#MIN_I	.0	#FAT	.2
FIRED_VESSEL_FL	.5	C	.2	#ins_no_inc_I	.0	#MAJ_I	.0	#FIRE_I	.2
OIL_PROD_FLAG	.5	P	.2	L_I	.0	SUL_PROD_FLAG	.0	#EXP	.2
DISTANCE_TO_SH	.5	M_I	.2	#MIN	.0	#VESS	.0	#INJ_I	.1
GAS_FLARING_FLAG	.4	COMPRESSOR_FLAG	.1	#MIN_I	.0	#FAT_I	.0	NUM_COMP	.1
#ins_w_inc	.2	MAJ_CMPLX_FLAG	.1	#FIRE	.0	H_I	.0	COMPRESSOR_FLAG	.1
#ins_w_inc_I	.2	crane_count	.1	M_I	.0	#INJ	.0	bed_count	.1
co_ming_prod	.2	W	.1	L	.0	#FAT	.0	crane_count	.1
C	.2	G	.1	STORE_TANK_FLAG	.0	#FIRE	.0	WATER_DEPTH	.1
P	.2	NUM_COMP	.1	M	.0	#EXP	.0	SLOT_COUNT	.1
tot_inc	.2	bed_count	.1	C_I	.0	#MAJ	.0	STORE_TANK_FLAG	.1
C_I	.2	STORE_TANK_FLAG	.1	#FIRE_I	.0	#acc_I	.0	SLOT_DRILL_COUNT	.1
P_I	.2	FIRED_VESSEL_FL	.1	#FAT	.0	PLATFORM_AGE	.0	DISTANCE_TO_SH	.1
tot_inc_I	.2	DISTANCE_TO_SH	.1	S_I	.0	H	.0	MAJ_CMPLX_FLAG	.1
#acc_I	.1	SLOT_DRILL_COUNT	.1	tot_inc_I	.0	#EXP_I	.0	#ins_no_inc	.1
W	.1	SLOT_COUNT	.1	P_I	.0	GAS_FLARING_FLAG	.0	C_I	.1
#SPLL_I	.1	E	.1	E_I	.0	GAS_PROD_FLAG	.0	#ins_w_inc_I	.1
W_I	.1	HELIPORT_FLAG	.1	#VESS	.0	WATER_DEPTH	.0	tot_inc_I	.1
G	.1	#acc_I	.1	#INJ	.0	M_I	.0	#VESS_I	.1
L	.1	#MIN_I	.1	#INJ_I	.0	#SPLL_I	.0	FIRED_VESSEL_FL	.1
#MIN_I	.1	#SPLL_I	.1	#acc	.0	L_I	.0	HELIPORT_FLAG	.0
L_I	.1	S	.1	#FAT_I	.0	#MIN	.0	P_I	.0
E	.1	L	.1	S	.0	OIL_PROD_FLAG	-.1	#MAJ_I	.0
M	.1	OIL_PROD_FLAG	.0	W_I	.0	S_I	-.1	E	.0
G_I	.1	M	.0	HELIPORT_FLAG	.0	HELIPORT_FLAG	-.1	G_I	.0
#FIRE_I	.1	PLATFORM_AGE	.0	#MAJ	.0	#SPLL	-.1	#EXP_I	.0
E_I	.0	#FIRE_I	.0	bed_count	.0	E_I	-.1	#ins_w_inc	.0
M_I	.0	GAS_PROD_FLAG	.0	#VESS_I	.0	#acc	-.1	C	.0
SUL_PROD_FLAG	.0	#EXP_I	.0	G_I	.0	SLOT_DRILL_COUNT	-.1	GAS_FLARING_FLAG	.0
#SPLL	.0	WATER_DEPTH	.0	#SPLL	.0	SLOT_COUNT	-.1	OIL_PROD_FLAG	.0
#ins_no_inc	.0	H_I	.0	C	.0	FIRED_VESSEL_FL	-.1	tot_inc	.0
#INJ_I	.0	GAS_FLARING_FLAG	.0	#EXP_I	.0	DISTANCE_TO_SH	-.1	L_I	.0
#ins_no_inc_I	.0	#INJ_I	.0	H	.0	bed_count	-.1	W_I	.0
op_exp_I	.0	#FIRE	.0	#SPLL_I	.0	STORE_TANK_FLAG	-.1	S	.0
op_exp	.0	INCS/COMP	.0	#acc_I	.0	NUM_COMP	-.1	P	.0
#acc	.0	#MAJ_I	.0	H_I	.0	MAJ_CMPLX_FLAG	-.1	#FAT_I	.0
S	.0	#FAT	.0	P	.0	crane_count	-.1	GAS_PROD_FLAG	.0

#FAT_I	.0	#VESS_I	.0	#EXP	.0	C_I	-.1	E_I	.0
#VESS_I	.0	#FAT_I	.0	E	.0	G_I	-.1	S_I	.0
S_I	.0	#ins_no_inc	.0	#MAJ_I	.0	COMPRESSOR_FLAG	-.1	G	.0
H	.0	#MIN	.0	tot_inc	.0	P_I	-.1	M_I	.0
#MAJ_I	.0	#MAJ	.0	#ins_w_inc_I	.0	W_I	-.1	W	.0
H_I	.0	H	.0	W	.0	tot_inc_I	-.2	M	.0
#FAT	.0	SUL_PROD_FLAG	.0	G	.0	#ins_w_inc_I	-.2	#ins_no_inc_I	.0
#MIN	.0	#EXP	.0	#ins_no_inc	.0	M	-.2	L	.0
#FIRE	.0	#SPLL	.0	SUL_PROD_FLAG	.0	L	-.4	SUL_PROD_FLAG	.0
#EXP_I	.0	#acc	.0	#ins_w_inc	.0	S	-.4	co_exp	.0
PLATFORM_AGE	.0	#VESS	.0	MAJ_CMPLX_FLAG	.0	INCS/COMP	-.5	PLATFORM_AGE	.0
#MAJ	.0	#INJ	.0	crane_count	.0	E	-.5	H_I	.0
#EXP	.0	co_ming_prod	.0	COMPRESSOR_FLAG	.0	#ins_w_inc	-.7	co_exp_I	.0
#INJ	.0	op_exp_I	.0	GAS_PROD_FLAG	.0	G	-.7	H	.0
#VESS	.0	op_exp	.0	INCS/COMP	.0	C	-.8	INCS/COMP	.0
co_exp	.0	co_exp_I	.0	WATER_DEPTH	-.1	W	-.8	co_ming_prod	.0
co_exp_I	.0	co_exp	-.1	FIRED_VESSEL_FL	-.1	P	-.8	op_exp	.0
INCS/COMP	-.1	#ins_no_inc_I	-.2	DISTANCE_TO_SH	-.2	tot_inc	-.9	op_exp_I	.0

Table 8 5 Rotated Principal Components

1.5 Variable Correlation Matrix

Variable	DISTANCE_TO_SH	SLOT_DRILL_COUNT	SLOT_COUNT	WATER_DEPTH	FIRED_VESSEL_FL	GAS_PROD_FLAG	GAS_FLARING_FLAG	MAJ_CMPLX_FLAG	HELIPORT_FLAG	SUL_PROD_FLAG	STORE_TANK_FLAG	OIL_PROD_FLAG	COMPRESSOR_FLAG	NUM_COMP	crane_count	co_ming_prod	bed_count	op_exp_I	co_exp_I	#ins_no_inc_I	#ins_w_inc_I	tot_inc_I
DISTANCE_TO_SH	1.0																					
SLOT_DRILL_COUNT	.4	1.0																				
SLOT_COUNT	.5	.9	1.0																			
WATER_DEPTH	.7	.5	.6	1.0																		
FIRED_VESSEL_FL	.3	.2	.2	.2	1.0																	
GAS_PROD_FLAG	.2	.3	.4	.2	.3	1.0																
GAS_FLARING_FLAG	.1	.3	.3	.2	.2	.2	1.0															
MAJ_CMPLX_FLAG	.4	.5	.6	.4	.5	.4	.2	1.0														
HELIPORT_FLAG	.3	.4	.5	.3	.4	.5	.2	.6	1.0													
SUL_PROD_FLAG	.0	.0	.0	.0	.0	.0	.0	.0	.0	1.0												
STORE_TANK_FLAG	.2	.4	.4	.3	.3	.3	.4	.4	.4	.0	1.0											
OIL_PROD_FLAG	.0	.4	.4	.2	.1	.5	.3	.3	.3	.0	.4	1.0										
COMPRESSOR_FLAG	.3	.5	.5	.4	.5	.4	.4	.5	.5	.0	.5	.3	1.0									
NUM_COMP	.3	.7	.7	.5	.5	.4	.4	.6	.5	.0	.6	.5	.7	1.0								
crane_count	.3	.5	.5	.4	.5	.4	.3	.6	.6	.0	.5	.3	.6	.7	1.0							
co_ming_prod	-.1	.1	.1	.1	.0	.1	.2	.1	.1	.0	.2	.2	.1	.2	.1	1.0						
bed_count	.3	.5	.5	.4	.3	.3	.3	.4	.3	.0	.4	.2	.5	.6	.5	.1	1.0					
op_exp_I	-.1	.1	.0	-.1	-.1	.0	.0	.0	.0	.0	.0	.1	.0	.0	.0	.1	.0	1.0				
co_exp_I	-.1	.0	.0	-.1	-.1	.0	.0	-.1	.0	.0	.0	.0	-.1	.0	.0	.0	.0	.6	1.0			
#ins_no_inc_I	-.1	.0	.0	-.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	1.0		
#ins_w_inc_I	.2	.2	.3	.1	.2	.2	.1	.3	.2	.0	.2	.2	.3	.3	.3	.0	.3	-.1	-.1	-.3	1.0	
tot_inc_I	.2	.2	.2	.1	.2	.1	.1	.3	.2	.0	.2	.1	.3	.3	.3	.0	.2	.0	-.1	-.1	.7	1.0
E_I	.1	.1	.1	.0	.1	.1	.1	.1	.1	.0	.1	.1	.1	.1	.1	.0	.1	.0	.0	-.1	.4	.5
G_I	.1	.1	.1	.1	.1	.1	.1	.2	.1	.0	.2	.1	.2	.2	.2	.0	.2	.0	.0	-.1	.5	.7
H_I	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
L_I	.0	.1	.1	.0	.1	.1	.0	.1	.1	.0	.1	.1	.1	.1	.1	.0	.1	.0	.0	-.1	.3	.3
M_I	.0	.0	.0	.0	.1	.0	.0	.1	.0	.0	.1	.0	.1	.1	.1	.0	.0	.0	.0	.0	.1	.2
P_I	.2	.2	.2	.1	.2	.1	.1	.2	.2	.0	.2	.1	.3	.3	.3	.0	.2	.0	.0	-.1	.6	.9
C_I	.2	.2	.2	.1	.2	.1	.1	.2	.2	.0	.2	.1	.3	.3	.3	.0	.2	.0	.0	-.1	.6	.9
W_I	.2	.2	.2	.1	.2	.1	.1	.2	.1	.0	.2	.1	.2	.2	.2	.0	.2	.0	-.1	-.1	.6	.8
S_I	.1	.1	.1	.0	.1	.0	.0	.1	.1	.0	.1	.0	.1	.1	.1	.0	.1	.0	.0	.0	.3	.3
#acc_I	.1	.1	.1	.1	.1	.0	.1	.1	.1	.0	.1	.1	.1	.1	.1	.0	.1	.0	.0	.0	.1	.1
#SPLL_I	.1	.1	.1	.1	.0	.0	.1	.1	.1	.0	.1	.1	.1	.1	.1	.0	.1	.0	.0	.0	.1	.1
#INJ_I	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
#FAT_I	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
#FIRE_I	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0

#INJ_I	.0	.0	.0	.0	.0	.0	.0	.0	.0	.2	.0	1.0										
#FAT_I	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1	.0	.0	1.0									
#FIRE_I	.0	.0	.0	.0	.0	.0	.0	.0	.0	.4	.0	.3	.0	1.0								
#VESS_I	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1	.0	.1	.0	.1	1.0							
#EXP_I	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1	.0	.2	.0	.0	.0	1.0						
#MIN_I	.0	.0	.0	.0	.0	.0	.1	.0	.0	.6	.3	.3	.1	.6	.2	.1	1.0					
#MAJ_I	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1	.0	.2	.2	.1	.2	.2	.0	1.0				
PLATFORM_AGE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	1.0			
INCS/COMP	.0	.1	.0	.0	.0	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	1.0		
op_exp	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.4	-.1	1.0	
co_exp	.0	-.1	.0	.0	.0	.0	.0	-.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.2	.0	.5	1.0
#ins_no_inc	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	-.2	.0	.0
#ins_w_inc	.2	.3	.0	.1	.1	.3	.3	.3	.1	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0	.4	-.1	-.1
tot_inc	.2	.3	.0	.1	.1	.3	.3	.3	.1	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0	.4	.0	-.1
E	.1	.2	.0	.0	.0	.1	.1	.2	.1	.1	.0	.1	.0	.0	.0	.0	.0	.0	.0	.2	.0	.0
G	.1	.2	.0	.1	.0	.2	.2	.2	.1	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0	.3	.0	-.1
H	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
L	.1	.1	.0	.1	.0	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1	.0	.0
M	.0	.1	.0	.0	.1	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
P	.2	.2	.0	.1	.1	.3	.3	.3	.1	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0	.3	.0	-.1
C	.2	.2	.0	.1	.1	.3	.3	.3	.1	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0	.3	.0	-.1
W	.2	.2	.0	.1	.1	.2	.2	.3	.1	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0	.3	.0	-.1
S	.1	.1	.0	.0	.0	.1	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1	.0	.0
#INJ	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
#FAT	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
#FIRE	.0	.0	.0	.0	.0	.0	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
#VESS	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
#EXP	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
#MIN	.0	.0	.0	.0	.0	.0	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
#MAJ	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
#acc	.0	.0	.0	.0	.0	.1	.1	.0	.0	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
#SPLL	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0

Table -10 Correlation Matrix – Table 2 of 3

Variable	#ins_no_inc	#ins_w_inc	tot_inc	E	G	H	L	M	P	C	W	S	#INJ	#FAT	#FIRE	#VESS	#EXP	#MIN	#MAJ	#acc	#SPLL
DISTANCE_TO_SH																					
SLOT_DRILL_COUNT																					
SLOT_COUNT																					
WATER_DEPTH																					
FIRED_VESSEL_FL																					
GAS_PROD_FLAG																					
GAS_FLARING_FLAG																					
MAJ_CMPLX_FLAG																					
HELIPORT_FLAG																					
SUL_PROD_FLAG																					
STORE_TANK_FLAG																					
OIL_PROD_FLAG																					
COMPRESSOR_FLAG																					
NUM_COMP																					
crane_count																					
co_ming_prod																					
bed_count																					
op_exp_I																					
co_exp_I																					
#ins_no_inc_I																					
#ins_w_inc_I																					
tot_inc_I																					
E_I																					
G_I																					
H_I																					
L_I																					
M_I																					
P_I																					
C_I																					
W_I																					
S_I																					

#VESS_I	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
#EXP_I	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
#MIN_I	.0	.1	.1	.0	.0	.0	.0	.1	.0	.0	.0	.0	.1	.1	.1	.0	.1	.0	.0	.0	.1	.1
#MAJ_I	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
PLATFORM_AGE	-.2	.1	.1	-.2	-.1	-.1	.0	.0	.0	.0	.0	.1	.0	.0	.0	.0	.0	.4	.2	.0	.0	.0
INCS/COMP	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	-.1	.0	.0	.0	-.1	.0	.0	.1	.1
op_exp	-.1	.1	.0	-.1	-.1	.0	.0	.0	.0	.0	.0	.1	.0	.0	.0	.1	.0	1.0	.6	.0	-.1	.0
co_exp	.0	.0	.0	.0	.0	.0	.0	-.1	.0	.0	.0	.0	-.1	.0	.0	.0	.0	.5	.9	.0	-.1	-.1
#ins_no_inc	-.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.2	.0	.0
#ins_w_inc	.2	.3	.3	.1	.2	.2	.1	.3	.2	.0	.2	.2	.3	.3	.3	.0	.3	-.1	-.1	.0	.4	.4
tot_inc	.2	.2	.3	.2	.2	.1	.1	.3	.2	.0	.2	.1	.3	.3	.3	.0	.2	.0	-.1	.0	.3	.4
E	.1	.1	.1	.0	.1	.1	.1	.1	.1	.0	.1	.1	.1	.1	.1	.0	.1	.0	.0	.0	.2	.2
G	.2	.2	.2	.1	.1	.1	.1	.2	.1	.0	.2	.1	.2	.2	.2	.0	.2	.0	-.1	.0	.2	.3
H	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
L	.0	.1	.1	.0	.1	.1	.1	.1	.1	.0	.1	.1	.1	.1	.1	.0	.1	.0	.0	.0	.1	.1
M	.0	.0	.0	.0	.1	.0	.0	.1	.1	.0	.1	.0	.1	.1	.1	.0	.1	.0	.0	.0	.1	.1
P	.2	.2	.3	.2	.2	.1	.1	.2	.2	.0	.2	.1	.3	.3	.3	.0	.2	.0	-.1	.0	.3	.3
C	.2	.2	.2	.1	.2	.1	.1	.2	.2	.0	.2	.1	.3	.3	.3	.0	.2	.0	-.1	.0	.3	.3
W	.2	.2	.2	.1	.2	.1	.1	.2	.2	.0	.2	.1	.2	.2	.2	.0	.2	.0	-.1	-.1	.3	.3
S	.1	.1	.1	.0	.1	.0	.0	.1	.1	.0	.1	.0	.1	.1	.1	.0	.1	.0	.0	.0	.1	.1
#INJ	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
#FAT	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
#FIRE	.1	.1	.1	.0	.1	.0	.0	.0	.0	.0	.0	.0	.1	.1	.1	.0	.1	.0	.0	.0	.1	.0
#VESS	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
#EXP	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
#MIN	.1	.1	.1	.1	.1	.0	.0	.1	.1	.0	.1	.0	.1	.1	.1	.0	.1	.0	.0	.0	.1	.1
#MAJ	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
#acc	.1	.1	.1	.1	.1	.1	.1	.1	.1	.0	.1	.1	.1	.1	.1	.0	.1	.0	.0	.0	.1	.1
#SPLL	.1	.1	.1	.1	.0	.0	.1	.1	.1	.0	.1	.1	.1	.1	.1	.0	.1	.0	.0	.0	.0	.0
280.0	rows not used due to missing values.																					

Table -9 Correlation Matrix – Table 1 of 3

Variable	E_I	G_I	H_I	L_I	M_I	P_I	C_I	W_I	S_I	#acc_I	#SPLL_I	#INJ_I	#FAT_I	#FIRE_I	#VESS_I	#EXP_I	#MIN_I	#MAJ_I	PLATFORM_AGE	INCS/COMP	op_exp	co_exp
DISTANCE_TO_SH																						
SLOT_DRILL_COUNT																						
SLOT_COUNT																						
WATER_DEPTH																						
FIRED_VESSEL_FL																						
GAS_PROD_FLAG																						
GAS_FLARING_FLAG																						
MAJ_CMPLX_FLAG																						
HELIPORT_FLAG																						
SUL_PROD_FLAG																						
STORE_TANK_FLAG																						
OIL_PROD_FLAG																						
COMPRESSOR_FLAG																						
NUM_COMP																						
crane_count																						
co_ming_prod																						
bed_count																						
op_exp_I																						
co_exp_I																						
#ins_no_inc_I																						
#ins_w_inc_I																						
tot_inc_I																						
E_I	1.0																					
G_I	.4	1.0																				
H_I	.0	.0	1.0																			
L_I	.1	.2	.0	1.0																		
M_I	.0	.1	.0	.0	1.0																	
P_I	.3	.4	.0	.2	.1	1.0																
C_I	.4	.5	.0	.4	.1	.9	1.0															
W_I	.4	.8	.0	.2	.2	.7	.5	1.0														
S_I	.3	.3	.0	.1	.0	.2	.2	.2	1.0													
#acc_I	.1	.1	.0	.0	.0	.1	.1	.1	.0	1.0												
#SPLL_I	.0	.0	.0	.0	.0	.1	.1	.1	.0	.9	1.0											

#acc_I																					
#SPLL_I																					
#INJ_I																					
#FAT_I																					
#FIRE_I																					
#VESS_I																					
#EXP_I																					
#MIN_I																					
#MAJ_I																					
PLATFORM_AGE																					
INCS/COMP																					
op_exp																					
co_exp																					
#ins_no_inc	1.0																				
#ins_w_inc	-.3	1.0																			
tot_inc	-.2	.7	1.0																		
E	-.1	.4	.5	1.0																	
G	-.1	.5	.7	.4	1.0																
H	.0	.0	.0	.0	.0	1.0															
L	-.1	.3	.4	.1	.2	.0	1.0														
M	.0	.1	.2	.0	.1	.0	.1	1.0													
P	-.1	.6	.9	.3	.5	.0	.3	.1	1.0												
C	-.1	.6	.9	.4	.5	.0	.4	.2	.9	1.0											
W	-.1	.6	.8	.4	.8	.0	.3	.2	.7	.5	1.0										
S	.0	.3	.3	.3	.3	.0	.1	.0	.3	.3	.2	1.0									
#INJ	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	1.0								
#FAT	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1	1.0							
#FIRE	.0	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.3	.0	1.0						
#VESS	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1	.0	.1	1.0					
#EXP	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.2	.0	.0	.0	1.0				
#MIN	.0	.1	.1	.1	.0	.0	.0	.0	.1	.1	.0	.0	.3	.1	.7	.2	.1	1.0			
#MAJ	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.2	.5	.0	.1	.2	.0	1.0		
#acc	.0	.1	.1	.1	.1	.0	.0	.0	.1	.1	.1	.1	.3	.1	.5	.2	.1	.7	.1	1.0	
#SPLL	.0	.1	.1	.1	.1	.0	.0	.0	.1	.1	.1	.0	.0	.0	.0	.0	.0	.4	.0	.8	1.0

Table -11 Correlation Matrix – Table 3 of 3

1.6 Pairwise Correlations

Variable	by Variable	Correlation	Signif Prob	Variable	by Variable	Correlation	Signif Prob
op_exp	op_exp_I	1.00	0.00	E	#FIRE_I	0.02	0.00
co_exp	co_exp_I	0.93	0.00	H	tot_inc	0.02	0.00
P	tot_inc	0.92	0.00	H_I	tot_inc_I	0.02	0.00
P_I	tot_inc_I	0.92	0.00	#INJ	SLOT_DRILL_COUNT	0.02	0.00
C	tot_inc	0.90	0.00	#INJ	bed_count	0.02	0.00
C	P	0.90	0.00	#SPLL	INCS/COMP	0.02	0.00
C_I	P_I	0.89	0.00	#FIRE	W	0.02	0.00
C_I	tot_inc_I	0.89	0.00	#MAJ	SLOT_COUNT	0.02	0.00
SLOT_COUNT	SLOT_DRILL_COUNT	0.89	0.00	#SPLL	M_I	0.02	0.00
#SPLL_I	#acc_I	0.87	0.00	#EXP_I	G_I	0.02	0.00
W	tot_inc	0.84	0.00	#MAJ	C_I	0.02	0.00
W_I	tot_inc_I	0.84	0.00	#SPLL_I	L_I	0.02	0.00
#SPLL	#acc	0.79	0.00	#INJ	C_I	0.02	0.00
W	G	0.75	0.00	#acc	M_I	0.02	0.00
W_I	G_I	0.75	0.00	#INJ_I	GAS_FLARING_FLAG	0.02	0.00
NUM_COMP	COMPRESSOR_FLAG	0.74	0.00	#FAT_I	SLOT_COUNT	0.02	0.00
#acc	#MIN	0.73	0.00	#FAT	WATER_DEPTH	0.02	0.00
G	tot_inc	0.73	0.00	#FAT	P_I	0.02	0.00
G_I	tot_inc_I	0.73	0.00	#EXP	G	0.02	0.00
tot_inc_I	#ins_w_inc_I	0.71	0.00	#ins_no_inc	NUM_COMP	0.02	0.00
tot_inc	#ins_w_inc	0.71	0.00	#INJ_I	bed_count	0.02	0.00
W	P	0.71	0.00	M	#EXP_I	0.02	0.00
crane_count	NUM_COMP	0.70	0.00	#FIRE	L	0.02	0.00
W_I	P_I	0.70	0.00	#SPLL	E_I	0.02	0.00
NUM_COMP	SLOT_COUNT	0.68	0.00	#FAT	W	0.02	0.00

NUM_COMP	SLOT_DRILL_COUNT	0.68	0.00	#ins_no_inc_I	crane_count	0.02	0.00
#MIN	#FIRE	0.67	0.00	#FIRE_I	G_I	0.02	0.00
WATER_DEPTH	DISTANCE_TO_SH	0.65	0.00	#FAT	tot_inc_I	0.02	0.00
C	#ins_w_inc	0.65	0.00	H	NUM_COMP	0.02	0.00
C_I	#ins_w_inc_I	0.64	0.00	#FAT	L	0.02	0.00
P	#ins_w_inc	0.64	0.00	C	#FIRE_I	0.02	0.00
P_I	#ins_w_inc_I	0.64	0.00	#INJ	#ins_no_inc	0.02	0.00
bed_count	NUM_COMP	0.63	0.00	#MIN	S_I	0.02	0.00
#MIN_I	#FIRE_I	0.63	0.00	#acc	#ins_no_inc	0.02	0.00
NUM_COMP	MAJ_CMPLX_FLAG	0.62	0.00	#INJ_I	COMPRESSOR_FLAG	0.02	0.00
WATER_DEPTH	SLOT_COUNT	0.61	0.00	#MIN_I	#ins_no_inc_I	0.02	0.00
crane_count	HELIPORT_FLAG	0.60	0.00	#MAJ	#ins_w_inc	0.02	0.00
NUM_COMP	STORE_TANK_FLAG	0.59	0.00	#FIRE_I	GAS_PROD_FLAG	0.02	0.00
op_exp	co_exp_I	0.59	0.00	#EXP_I	#ins_w_inc_I	0.02	0.00
W_I	#ins_w_inc_I	0.59	0.00	#MAJ	NUM_COMP	0.02	0.00
crane_count	COMPRESSOR_FLAG	0.59	0.00	SUL_PROD_FLAG	WATER_DEPTH	0.02	0.00
W	#ins_w_inc	0.58	0.00	#EXP_I	tot_inc_I	0.02	0.00
MAJ_CMPLX_FLAG	SLOT_COUNT	0.57	0.00	#ins_no_inc	#MIN_I	0.02	0.00
#MIN_I	#acc_I	0.57	0.00	P	#FIRE_I	0.02	0.00
crane_count	MAJ_CMPLX_FLAG	0.57	0.00	E	PLATFORM_AGE	0.02	0.00
co_exp_I	op_exp_I	0.57	0.00	#FIRE_I	#ins_no_inc_I	0.02	0.00
HELIPORT_FLAG	MAJ_CMPLX_FLAG	0.56	0.00	#FIRE_I	C_I	0.02	0.00
OIL_PROD_FLAG	GAS_PROD_FLAG	0.55	0.00	#EXP_I	C_I	0.02	0.00
G	#ins_w_inc	0.54	0.00	#EXP	#ins_w_inc	0.02	0.00
co_exp	op_exp	0.54	0.00	#SPLL	M	0.02	0.00
NUM_COMP	HELIPORT_FLAG	0.54	0.00	#INJ_I	SLOT_COUNT	0.02	0.00
G_I	#ins_w_inc_I	0.54	0.00	#VESS	DISTANCE_TO_SH	0.02	0.00
COMPRESSOR_FLAG	STORE_TANK_FLAG	0.54	0.00	#FAT	G	0.02	0.00
C	G	0.54	0.00	#MIN	#SPLL_I	0.02	0.00
#MAJ	#FAT	0.53	0.00	SUL_PROD_FLAG	FIRED_VESSEL_FL	0.02	0.00
WATER_DEPTH	SLOT_DRILL_COUNT	0.53	0.00	#EXP	tot_inc	0.02	0.00
COMPRESSOR_FLAG	MAJ_CMPLX_FLAG	0.53	0.00	H_I	NUM_COMP	0.02	0.00
bed_count	crane_count	0.53	0.00	#FIRE_I	tot_inc_I	0.02	0.00
C_I	G_I	0.52	0.00	tot_inc	#FIRE_I	0.02	0.00
W	C	0.52	0.00	L	#MIN_I	0.02	0.00
bed_count	COMPRESSOR_FLAG	0.52	0.00	#MAJ	L	0.02	0.00
co_exp	op_exp_I	0.52	0.00	#EXP	C	0.02	0.00
COMPRESSOR_FLAG	SLOT_COUNT	0.52	0.00	E	#MIN_I	0.02	0.00
MAJ_CMPLX_FLAG	SLOT_DRILL_COUNT	0.52	0.00	#FAT	#ins_w_inc	0.02	0.00
W_I	C_I	0.51	0.00	#ins_w_inc	PLATFORM_AGE	0.02	0.01
NUM_COMP	WATER_DEPTH	0.51	0.00	#MAJ	#SPLL_I	0.02	0.01
HELIPORT_FLAG	GAS_PROD_FLAG	0.51	0.00	H	#ins_no_inc_I	0.02	0.01
#acc	#FIRE	0.50	0.00	S	H	0.02	0.01
NUM_COMP	FIRED_VESSEL_FL	0.50	0.00	#ins_no_inc	co_exp_I	0.02	0.01
COMPRESSOR_FLAG	SLOT_DRILL_COUNT	0.49	0.00	#FAT_I	crane_count	0.02	0.01
COMPRESSOR_FLAG	FIRED_VESSEL_FL	0.49	0.00	#INJ	GAS_PROD_FLAG	0.02	0.01
COMPRESSOR_FLAG	HELIPORT_FLAG	0.49	0.00	#INJ	P_I	0.02	0.01
bed_count	SLOT_COUNT	0.48	0.00	#INJ_I	FIRED_VESSEL_FL	0.02	0.01
crane_count	SLOT_COUNT	0.48	0.00	#FAT	MAJ_CMPLX_FLAG	0.02	0.01
MAJ_CMPLX_FLAG	FIRED_VESSEL_FL	0.48	0.00	H_I	G_I	0.02	0.01
crane_count	FIRED_VESSEL_FL	0.47	0.00	#ins_no_inc	#FIRE_I	0.02	0.01
NUM_COMP	OIL_PROD_FLAG	0.47	0.00	#MAJ	P_I	0.02	0.01
E_I	tot_inc_I	0.46	0.00	#INJ	FIRED_VESSEL_FL	0.01	0.01
P	G	0.46	0.00	#MAJ	#acc_I	0.01	0.01
crane_count	STORE_TANK_FLAG	0.46	0.00	#MAJ	WATER_DEPTH	0.01	0.01
bed_count	SLOT_DRILL_COUNT	0.46	0.00	#FAT	GAS_PROD_FLAG	0.01	0.01
crane_count	SLOT_DRILL_COUNT	0.46	0.00	#INJ_I	GAS_PROD_FLAG	0.01	0.01
E	tot_inc	0.45	0.00	#MIN_I	co_exp_I	0.01	0.01
NUM_COMP	GAS_PROD_FLAG	0.45	0.00	PLATFORM_AGE	C_I	0.01	0.01
SLOT_COUNT	DISTANCE_TO_SH	0.45	0.00	#MIN	#FIRE_I	0.01	0.01
HELIPORT_FLAG	SLOT_COUNT	0.45	0.00	#acc	S_I	0.01	0.01
P_I	G_I	0.44	0.00	#SPLL	co_ming_prod	0.01	0.01
OIL_PROD_FLAG	SLOT_DRILL_COUNT	0.44	0.00	H	G	0.01	0.01
NUM_COMP	GAS_FLARING_FLAG	0.44	0.00	tot_inc	PLATFORM_AGE	0.01	0.01
W_I	E_I	0.43	0.00	#EXP_I	P_I	0.01	0.01
HELIPORT_FLAG	FIRED_VESSEL_FL	0.43	0.00	#FAT	HELIPORT_FLAG	0.01	0.01
crane_count	GAS_PROD_FLAG	0.43	0.00	co_ming_prod	SUL_PROD_FLAG	0.01	0.01
MAJ_CMPLX_FLAG	DISTANCE_TO_SH	0.42	0.00	P	co_ming_prod	0.01	0.01
W	E	0.42	0.00	#MAJ	bed_count	0.01	0.01
STORE_TANK_FLAG	SLOT_COUNT	0.42	0.00	PLATFORM_AGE	bed_count	0.01	0.02

MAJ_CMPLX_FLAG	WATER_DEPTH	0.41	0.00	#EXP	P	0.01	0.02
PLATFORM_AGE	op_exp_I	0.41	0.00	INCS/COMP	#SPLL_I	0.01	0.02
op_exp	PLATFORM_AGE	0.41	0.00	#MAJ	crane_count	0.01	0.02
STORE_TANK_FLAG	SLOT_DRILL_COUNT	0.41	0.00	M_I	GAS_FLARING_FLAG	0.01	0.02
E_I	#ins_w_inc_I	0.41	0.00	S_I	H_I	0.01	0.02
HELIPORT_FLAG	SLOT_DRILL_COUNT	0.41	0.00	co_exp	#MIN_I	0.01	0.02
G_I	E_I	0.40	0.00	#FIRE	#MIN_I	0.01	0.02
E	#ins_w_inc	0.40	0.00	#INJ_I	SLOT_DRILL_COUNT	0.01	0.02
COMPRESSOR_FLAG	GAS_PROD_FLAG	0.40	0.00	H	STORE_TANK_FLAG	0.01	0.02
bed_count	STORE_TANK_FLAG	0.39	0.00	M	co_ming_prod	0.01	0.02
G	E	0.39	0.00	#FAT	#ins_w_inc_I	0.01	0.02
COMPRESSOR_FLAG	WATER_DEPTH	0.39	0.00	#ins_no_inc_I	NUM_COMP	0.01	0.02
OIL_PROD_FLAG	SLOT_COUNT	0.38	0.00	#INJ	DISTANCE_TO_SH	0.01	0.02
STORE_TANK_FLAG	MAJ_CMPLX_FLAG	0.38	0.00	#FAT	COMPRESSOR_FLAG	0.01	0.02
#SPLL	#MIN	0.38	0.00	INCS/COMP	#acc_I	0.01	0.02
C	L	0.37	0.00	#MIN	co_exp	0.01	0.02
crane_count	WATER_DEPTH	0.37	0.00	#MAJ	tot_inc_I	0.01	0.02
L	tot_inc	0.37	0.00	H_I	STORE_TANK_FLAG	0.01	0.03
bed_count	WATER_DEPTH	0.37	0.00	#EXP_I	S_I	0.01	0.03
COMPRESSOR_FLAG	GAS_FLARING_FLAG	0.37	0.00	#EXP	S_I	0.01	0.03
#ins_w_inc	#ins_w_inc_I	0.36	0.00	#ins_w_inc	H_I	0.01	0.03
#FIRE_I	#acc_I	0.36	0.00	#MAJ	MAJ_CMPLX_FLAG	0.01	0.03
MAJ_CMPLX_FLAG	GAS_PROD_FLAG	0.36	0.00	#ins_w_inc	#EXP_I	0.01	0.03
SLOT_DRILL_COUNT	DISTANCE_TO_SH	0.36	0.00	#INJ	G	0.01	0.03
bed_count	MAJ_CMPLX_FLAG	0.36	0.00	#FAT_I	SLOT_DRILL_COUNT	0.01	0.03
#ins_w_inc	INCS/COMP	0.36	0.00	#FAT	L_I	0.01	0.03
tot_inc	tot_inc_I	0.36	0.00	#EXP	S	0.01	0.03
tot_inc	INCS/COMP	0.36	0.00	#INJ	tot_inc_I	0.01	0.04
STORE_TANK_FLAG	GAS_FLARING_FLAG	0.36	0.00	#EXP_I	W_I	0.01	0.04
OIL_PROD_FLAG	STORE_TANK_FLAG	0.35	0.00	W	#FIRE_I	0.01	0.04
C	E	0.35	0.00	#INJ_I	DISTANCE_TO_SH	0.01	0.04
#ins_w_inc	tot_inc_I	0.35	0.00	#INJ_I	C_I	0.01	0.04
STORE_TANK_FLAG	HELIPORT_FLAG	0.35	0.00	L	co_ming_prod	0.01	0.04
C_I	L_I	0.35	0.00	M_I	co_ming_prod	0.01	0.04
C_I	E_I	0.35	0.00	#INJ_I	#ins_no_inc_I	0.01	0.04
GAS_PROD_FLAG	SLOT_COUNT	0.35	0.00	#FAT_I	MAJ_CMPLX_FLAG	0.01	0.04
L_I	tot_inc_I	0.35	0.00	#EXP_I	MAJ_CMPLX_FLAG	0.01	0.04
S	G	0.35	0.00	H	#ins_w_inc	0.01	0.04
#MIN_I	#INJ_I	0.35	0.00	#EXP	MAJ_CMPLX_FLAG	0.01	0.04
S	tot_inc	0.34	0.00	#EXP	W	0.01	0.04
crane_count	DISTANCE_TO_SH	0.34	0.00	#INJ_I	#ins_w_inc_I	0.01	0.04
bed_count	HELIPORT_FLAG	0.34	0.00	#FAT_I	NUM_COMP	0.01	0.04
S_I	E_I	0.34	0.00	PLATFORM_AGE	#SPLL_I	0.01	0.04
C	tot_inc_I	0.34	0.00	#FIRE	INCS/COMP	0.01	0.04
COMPRESSOR_FLAG	DISTANCE_TO_SH	0.34	0.00	#FAT_I	WATER_DEPTH	0.01	0.04
GAS_PROD_FLAG	SLOT_DRILL_COUNT	0.34	0.00	M	E_I	0.01	0.05
P	tot_inc_I	0.34	0.00	#ins_no_inc_I	FIRED_VESSEL_FL	0.01	0.05
#ins_w_inc	crane_count	0.33	0.00	#SPLL_I	co_ming_prod	0.01	0.05
NUM_COMP	DISTANCE_TO_SH	0.33	0.00	#INJ	#ins_w_inc_I	0.01	0.05
tot_inc	#ins_w_inc_I	0.33	0.00	#MAJ	HELIPORT_FLAG	0.01	0.05
W	INCS/COMP	0.33	0.00	#MAJ	#ins_w_inc_I	0.01	0.05
STORE_TANK_FLAG	FIRED_VESSEL_FL	0.33	0.00	#acc_I	#ins_no_inc_I	0.01	0.05
#ins_w_inc	NUM_COMP	0.33	0.00	#INJ_I	P_I	0.01	0.05
tot_inc	P_I	0.33	0.00	#FAT_I	GAS_PROD_FLAG	0.01	0.05
#MIN	#INJ	0.33	0.00	H	bed_count	0.01	0.05
P	INCS/COMP	0.33	0.00	M	#MIN_I	0.01	0.05
bed_count	FIRED_VESSEL_FL	0.33	0.00	#FAT_I	HELIPORT_FLAG	0.01	0.06
#ins_w_inc_I	crane_count	0.32	0.00	tot_inc	co_ming_prod	0.01	0.06
HELIPORT_FLAG	WATER_DEPTH	0.32	0.00	#INJ	WATER_DEPTH	0.01	0.06
S_I	tot_inc_I	0.32	0.00	#FAT	OIL_PROD_FLAG	0.01	0.06
C	P_I	0.32	0.00	H	FIRED_VESSEL_FL	0.01	0.06
S_I	G_I	0.32	0.00	H_I	bed_count	0.01	0.07
P	P_I	0.32	0.00	INCS/COMP	L_I	0.01	0.07
S	E	0.32	0.00	PLATFORM_AGE	P_I	0.01	0.08
#FIRE_I	#INJ_I	0.32	0.00	M	S_I	0.01	0.08
#ins_w_inc	P_I	0.32	0.00	#MAJ	DISTANCE_TO_SH	0.01	0.08
tot_inc	C_I	0.32	0.00	H	COMPRESSOR_FLAG	0.01	0.08
COMPRESSOR_FLAG	OIL_PROD_FLAG	0.32	0.00	INCS/COMP	#EXP_I	0.01	0.09
#ins_w_inc_I	NUM_COMP	0.32	0.00	C	co_ming_prod	0.01	0.09
#ins_w_inc	C_I	0.31	0.00	#VESS_I	DISTANCE_TO_SH	0.01	0.09

C	C_I	0.31	0.00	#FIRE	co_exp_I	0.01	0.09
#ins_w_inc	COMPRESSOR_FLAG	0.31	0.00	#VESS_I	COMPRESSOR_FLAG	0.01	0.09
tot_inc	W_I	0.31	0.00	PLATFORM_AGE	S_I	0.01	0.09
C	#ins_w_inc_I	0.31	0.00	#INJ_I	WATER_DEPTH	0.01	0.10
#ins_w_inc	MAJ_CMPLX_FLAG	0.31	0.00	#INJ_I	S_I	0.01	0.10
#MIN_I	#SPLL_I	0.31	0.00	#FIRE_I	P_I	0.01	0.10
P	C_I	0.31	0.00	#INJ	L	0.01	0.10
#ins_w_inc_I	MAJ_CMPLX_FLAG	0.31	0.00	#INJ	W	0.01	0.10
P	#ins_w_inc_I	0.30	0.00	#FAT	DISTANCE_TO_SH	0.01	0.10
tot_inc	NUM_COMP	0.30	0.00	#FIRE	#acc_I	0.01	0.11
#ins_w_inc	W_I	0.30	0.00	#VESS	co_exp	0.01	0.10
C	INCS/COMP	0.30	0.00	L_I	co_ming_prod	0.01	0.11
bed_count	GAS_FLARING_FLAG	0.30	0.00	C	#INJ_I	0.01	0.11
#ins_w_inc_I	COMPRESSOR_FLAG	0.30	0.00	#ins_no_inc_I	GAS_PROD_FLAG	0.01	0.11
crane_count	OIL_PROD_FLAG	0.30	0.00	H_I	#ins_w_inc_I	0.01	0.11
bed_count	DISTANCE_TO_SH	0.29	0.00	#ins_w_inc	#INJ_I	0.01	0.12
FIRED_VESSEL_FL	DISTANCE_TO_SH	0.29	0.00	#INJ_I	M_I	0.01	0.12
C	NUM_COMP	0.29	0.00	#ins_no_inc	co_exp	0.01	0.12
P	E	0.29	0.00	#FAT	G_I	0.01	0.12
tot_inc_I	NUM_COMP	0.29	0.00	#MIN	INCS/COMP	0.01	0.12
tot_inc	COMPRESSOR_FLAG	0.29	0.00	#acc	#FIRE_I	0.01	0.12
GAS_FLARING_FLAG	SLOT_DRILL_COUNT	0.29	0.00	#SPLL	PLATFORM_AGE	0.01	0.12
P_I	E_I	0.29	0.00	#SPLL	#INJ	0.01	0.12
C	W_I	0.28	0.00	H_I	FIRED_VESSEL_FL	0.01	0.13
P	NUM_COMP	0.28	0.00	#INJ_I	#SPLL_I	0.01	0.12
W	tot_inc_I	0.28	0.00	#VESS_I	SLOT_DRILL_COUNT	0.01	0.12
C	COMPRESSOR_FLAG	0.28	0.00	tot_inc	#INJ_I	0.01	0.13
S	#ins_w_inc	0.28	0.00	G	#FIRE_I	0.01	0.12
HELIPORT_FLAG	DISTANCE_TO_SH	0.28	0.00	P	#INJ_I	0.01	0.12
C_I	NUM_COMP	0.28	0.00	#FIRE_I	W_I	0.01	0.13
GAS_FLARING_FLAG	SLOT_COUNT	0.28	0.00	#EXP_I	#ins_no_inc_I	0.01	0.13
L	#ins_w_inc	0.28	0.00	#MAJ_I	#ins_no_inc_I	0.01	0.13
P	W_I	0.28	0.00	#MAJ_I	DISTANCE_TO_SH	0.01	0.13
tot_inc_I	COMPRESSOR_FLAG	0.28	0.00	#INJ_I	tot_inc_I	0.01	0.14
GAS_PROD_FLAG	FIRED_VESSEL_FL	0.28	0.00	#EXP	#ins_no_inc	0.01	0.14
P_I	NUM_COMP	0.27	0.00	#EXP_I	FIRED_VESSEL_FL	0.01	0.14
OIL_PROD_FLAG	HELIPORT_FLAG	0.27	0.00	#EXP	FIRED_VESSEL_FL	0.01	0.14
tot_inc	crane_count	0.27	0.00	H_I	COMPRESSOR_FLAG	0.01	0.15
P	COMPRESSOR_FLAG	0.27	0.00	#VESS_I	GAS_FLARING_FLAG	0.01	0.15
G	INCS/COMP	0.27	0.00	P_I	co_ming_prod	0.01	0.15
S_I	#ins_w_inc_I	0.27	0.00	E	#INJ_I	0.01	0.15
L_I	#ins_w_inc_I	0.27	0.00	#MIN	co_exp_I	0.01	0.15
tot_inc	G_I	0.27	0.00	PLATFORM_AGE	#MIN_I	0.01	0.16
C_I	COMPRESSOR_FLAG	0.27	0.00	PLATFORM_AGE	#acc_I	0.01	0.16
#acc	#INJ	0.27	0.00	#VESS_I	SLOT_COUNT	0.01	0.18
STORE_TANK_FLAG	GAS_PROD_FLAG	0.27	0.00	#MAJ_I	WATER_DEPTH	0.01	0.17
STORE_TANK_FLAG	WATER_DEPTH	0.27	0.00	#MAJ_I	COMPRESSOR_FLAG	0.01	0.17
tot_inc_I	crane_count	0.27	0.00	#VESS	SLOT_DRILL_COUNT	0.01	0.17
W	#ins_w_inc_I	0.27	0.00	co_exp	M_I	0.01	0.18
W	L	0.27	0.00	#FIRE	co_exp	0.01	0.19
P_I	COMPRESSOR_FLAG	0.26	0.00	#MAJ	GAS_PROD_FLAG	0.01	0.18
C	crane_count	0.26	0.00	#FIRE_I	co_exp_I	0.01	0.19
crane_count	GAS_FLARING_FLAG	0.26	0.00	E	#EXP_I	0.01	0.19
tot_inc	MAJ_CMPLX_FLAG	0.26	0.00	#VESS	GAS_PROD_FLAG	0.01	0.20
bed_count	GAS_PROD_FLAG	0.26	0.00	#EXP	E	0.01	0.19
P	L	0.26	0.00	#MIN_I	M_I	0.01	0.20
#ins_w_inc	G_I	0.26	0.00	S	PLATFORM_AGE	0.01	0.20
tot_inc_I	MAJ_CMPLX_FLAG	0.26	0.00	#EXP_I	E_I	0.01	0.21
S	C	0.26	0.00	#FAT	GAS_FLARING_FLAG	0.01	0.21
#ins_w_inc	SLOT_COUNT	0.26	0.00	#EXP	E_I	0.01	0.21
G	tot_inc_I	0.26	0.00	COMPRESSOR_FLAG	SUL_PROD_FLAG	0.01	0.22
S	P	0.26	0.00	#MAJ_I	bed_count	0.01	0.22
#ins_w_inc	bed_count	0.26	0.00	co_exp	#FIRE_I	0.01	0.22
C_I	crane_count	0.26	0.00	C_I	co_ming_prod	0.01	0.22
#FIRE	#INJ	0.26	0.00	#MAJ_I	SLOT_COUNT	0.01	0.22
OIL_PROD_FLAG	GAS_FLARING_FLAG	0.26	0.00	#acc_I	co_ming_prod	0.01	0.23
#ins_w_inc_I	bed_count	0.26	0.00	#FAT_I	DISTANCE_TO_SH	0.01	0.23
#ins_w_inc_I	SLOT_COUNT	0.26	0.00	#VESS	#ins_no_inc	0.01	0.23
P	crane_count	0.25	0.00	op_exp	#ins_no_inc_I	0.01	0.24
tot_inc	SLOT_COUNT	0.25	0.00	W	#INJ_I	0.01	0.23

OIL_PROD_FLAG	MAJ_CMPLX_FLAG	0.25	0.00	#MIN	SUL_PROD_FLAG	0.01	0.23
#ins_w_inc	SLOT_DRILL_COUNT	0.25	0.00	#MAJ	FIRED_VESSEL_FL	0.01	0.23
P	SLOT_COUNT	0.25	0.00	#FIRE_I	L_I	0.01	0.25
W	W_I	0.25	0.00	#MAJ_I	NUM_COMP	0.01	0.25
P_I	crane_count	0.25	0.00	W	co_ming_prod	0.01	0.25
#MAJ_I	#FAT_I	0.25	0.00	bed_count	SUL_PROD_FLAG	0.01	0.26
#MAJ_I	#EXP_I	0.25	0.00	#VESS	SLOT_COUNT	0.01	0.25
tot_inc	SLOT_DRILL_COUNT	0.25	0.00	#VESS_I	NUM_COMP	0.01	0.26
#ins_w_inc_I	SLOT_DRILL_COUNT	0.25	0.00	#FIRE	M_I	0.01	0.26
W_I	L_I	0.25	0.00	#MAJ	GAS_FLARING_FLAG	0.01	0.27
bed_count	OIL_PROD_FLAG	0.25	0.00	#FAT_I	OIL_PROD_FLAG	0.01	0.28
C	MAJ_CMPLX_FLAG	0.25	0.00	tot_inc_I	co_ming_prod	0.01	0.29
P_I	L_I	0.25	0.00	#FIRE_I	OIL_PROD_FLAG	0.01	0.29
P	SLOT_DRILL_COUNT	0.25	0.00	#VESS	COMPRESSOR_FLAG	0.01	0.28
G	G_I	0.25	0.00	#MAJ_I	SLOT_DRILL_COUNT	0.01	0.29
W	P_I	0.25	0.00	#MAJ_I	MAJ_CMPLX_FLAG	0.01	0.30
P	MAJ_CMPLX_FLAG	0.25	0.00	S	co_ming_prod	0.01	0.29
P_I	SLOT_COUNT	0.25	0.00	#acc	co_ming_prod	0.01	0.30
C	SLOT_COUNT	0.25	0.00	#VESS_I	#ins_no_inc_I	0.01	0.30
P_I	MAJ_CMPLX_FLAG	0.25	0.00	C	H_I	0.01	0.31
tot_inc_I	SLOT_COUNT	0.25	0.00	#VESS	WATER_DEPTH	0.01	0.30
#ins_w_inc	HELIPORT_FLAG	0.24	0.00	#VESS_I	WATER_DEPTH	0.01	0.31
C_I	MAJ_CMPLX_FLAG	0.24	0.00	#FAT	W_I	0.01	0.31
#ins_w_inc	STORE_TANK_FLAG	0.24	0.00	#MAJ	G_I	0.01	0.31
P_I	SLOT_DRILL_COUNT	0.24	0.00	G	#INJ_I	0.01	0.32
#ins_w_inc	FIRED_VESSEL_FL	0.24	0.00	#FIRE	#SPLL_I	0.01	0.32
tot_inc_I	SLOT_DRILL_COUNT	0.24	0.00	#FIRE	PLATFORM_AGE	0.01	0.33
C	G_I	0.24	0.00	op_exp_I	HELIPORT_FLAG	0.01	0.34
tot_inc	bed_count	0.24	0.00	#FAT_I	co_exp_I	0.01	0.34
C	SLOT_DRILL_COUNT	0.24	0.00	#MAJ_I	G_I	0.01	0.33
G	#ins_w_inc_I	0.24	0.00	S	#MIN_I	0.01	0.33
G	W_I	0.24	0.00	#INJ	M	0.01	0.35
FIRED_VESSEL_FL	WATER_DEPTH	0.24	0.00	#SPLL	SUL_PROD_FLAG	0.01	0.36
GAS_PROD_FLAG	WATER_DEPTH	0.24	0.00	op_exp	HELIPORT_FLAG	0.01	0.36
C_I	SLOT_COUNT	0.24	0.00	#INJ_I	OIL_PROD_FLAG	0.01	0.37
#ins_w_inc_I	STORE_TANK_FLAG	0.24	0.00	#EXP_I	HELIPORT_FLAG	0.01	0.37
W	C_I	0.24	0.00	#MAJ_I	HELIPORT_FLAG	0.01	0.37
FIRED_VESSEL_FL	SLOT_COUNT	0.24	0.00	H	W_I	0.01	0.37
tot_inc_I	bed_count	0.24	0.00	#EXP	HELIPORT_FLAG	0.01	0.37
C_I	SLOT_DRILL_COUNT	0.24	0.00	#VESS_I	MAJ_CMPLX_FLAG	0.01	0.39
S_I	P_I	0.24	0.00	#acc	PLATFORM_AGE	0.01	0.38
#MIN	#VESS	0.24	0.00	P	H_I	0.00	0.40
#ins_w_inc_I	FIRED_VESSEL_FL	0.23	0.00	#INJ	OIL_PROD_FLAG	0.00	0.40
S_I	C_I	0.23	0.00	#VESS	co_exp_I	0.00	0.41
tot_inc	STORE_TANK_FLAG	0.23	0.00	#ins_no_inc_I	op_exp_I	0.00	0.44
#ins_w_inc_I	HELIPORT_FLAG	0.23	0.00	#VESS_I	FIRED_VESSEL_FL	0.00	0.44
C	bed_count	0.23	0.00	#ins_w_inc	co_ming_prod	0.00	0.43
S	W	0.23	0.00	#FAT	E	0.00	0.43
W	G_I	0.23	0.00	#FAT_I	#ins_no_inc_I	0.00	0.44
C_I	bed_count	0.23	0.00	#MAJ_I	W_I	0.00	0.45
W	NUM_COMP	0.23	0.00	co_exp	#FAT_I	0.00	0.44
P	G_I	0.23	0.00	#INJ	G_I	0.00	0.44
P	bed_count	0.23	0.00	#MAJ	L_I	0.00	0.44
tot_inc_I	STORE_TANK_FLAG	0.23	0.00	#VESS_I	crane_count	0.00	0.45
P_I	bed_count	0.22	0.00	#EXP_I	STORE_TANK_FLAG	0.00	0.46
#EXP_I	#INJ_I	0.22	0.00	#FAT	E_I	0.00	0.45
#MAJ_I	#INJ_I	0.22	0.00	#EXP	STORE_TANK_FLAG	0.00	0.46
C	STORE_TANK_FLAG	0.22	0.00	#SPLL	#FIRE_I	0.00	0.45
#INJ_I	#acc_I	0.22	0.00	op_exp_I	MAJ_CMPLX_FLAG	0.00	0.46
S_I	W_I	0.22	0.00	#VESS_I	GAS_PROD_FLAG	0.00	0.46
W_I	NUM_COMP	0.22	0.00	E	SUL_PROD_FLAG	0.00	0.48
W	COMPRESSOR_FLAG	0.22	0.00	tot_inc	H_I	0.00	0.48
MAJ_CMPLX_FLAG	GAS_FLARING_FLAG	0.22	0.00	#VESS	OIL_PROD_FLAG	0.00	0.48
P	STORE_TANK_FLAG	0.21	0.00	#VESS	GAS_FLARING_FLAG	0.00	0.49
C_I	STORE_TANK_FLAG	0.21	0.00	#MAJ	E	0.00	0.50
W	crane_count	0.21	0.00	#INJ_I	E_I	0.00	0.50
G	C_I	0.21	0.00	#EXP_I	NUM_COMP	0.00	0.50
PLATFORM_AGE	co_exp_I	0.21	0.00	#MAJ_I	crane_count	0.00	0.51
G	P_I	0.21	0.00	#MAJ_I	tot_inc_I	0.00	0.51
P_I	STORE_TANK_FLAG	0.21	0.00	#ins_no_inc	SUL_PROD_FLAG	0.00	0.51

W_I	COMPRESSOR_FLAG	0.21	0.00	H	MAJ_CMPLX_FLAG	0.00	0.50
W	MAJ_CMPLX_FLAG	0.21	0.00	#EXP	NUM_COMP	0.00	0.50
GAS_FLARING_FLAG	WATER_DEPTH	0.21	0.00	H	#ins_w_inc_I	0.00	0.51
W_I	MAJ_CMPLX_FLAG	0.21	0.00	C	PLATFORM_AGE	0.00	0.52
OIL_PROD_FLAG	WATER_DEPTH	0.21	0.00	SUL_PROD_FLAG	SLOT_DRILL_COUNT	0.00	0.53
#ins_no_inc	#ins_no_inc_I	0.21	0.00	#ins_no_inc	COMPRESSOR_FLAG	0.00	0.53
#ins_w_inc	DISTANCE_TO_SH	0.21	0.00	#MIN	co_ming_prod	0.00	0.53
#MAJ	#INJ	0.20	0.00	#FIRE_I	M_I	0.00	0.54
W_I	crane_count	0.20	0.00	#VESS_I	bed_count	0.00	0.55
tot_inc	FIRED_VESSEL_FL	0.20	0.00	INCS/COMP	M_I	0.00	0.55
tot_inc	DISTANCE_TO_SH	0.20	0.00	#MAJ	PLATFORM_AGE	0.00	0.55
HELIPORT_FLAG	GAS_FLARING_FLAG	0.20	0.00	#INJ	#ins_no_inc_I	0.00	0.55
#acc	#VESS	0.20	0.00	#FAT	co_exp_I	0.00	0.56
tot_inc_I	FIRED_VESSEL_FL	0.20	0.00	#MIN	PLATFORM_AGE	0.00	0.55
#ins_w_inc_I	DISTANCE_TO_SH	0.20	0.00	#FAT_I	#ins_w_inc_I	0.00	0.56
tot_inc	HELIPORT_FLAG	0.20	0.00	#MAJ_I	#ins_w_inc_I	0.00	0.56
E	INCS/COMP	0.20	0.00	#MAJ_I	P_I	0.00	0.56
co_ming_prod	GAS_FLARING_FLAG	0.20	0.00	op_exp	#MIN_I	0.00	0.57
FIRED_VESSEL_FL	SLOT_DRILL_COUNT	0.20	0.00	#EXP	#ins_w_inc_I	0.00	0.56
C	FIRED_VESSEL_FL	0.20	0.00	PLATFORM_AGE	#FIRE_I	0.00	0.58
tot_inc_I	DISTANCE_TO_SH	0.19	0.00	op_exp	MAJ_CMPLX_FLAG	0.00	0.58
C_I	FIRED_VESSEL_FL	0.19	0.00	#ins_no_inc	M_I	0.00	0.58
G	NUM_COMP	0.19	0.00	#acc	SUL_PROD_FLAG	0.00	0.57
W	SLOT_COUNT	0.19	0.00	#ins_w_inc	#FAT_I	0.00	0.59
#EXP	#INJ	0.19	0.00	#ins_w_inc	#MAJ_I	0.00	0.59
C	HELIPORT_FLAG	0.19	0.00	#MAJ	#ins_no_inc	0.00	0.59
#ins_w_inc	E_I	0.19	0.00	M_I	co_exp_I	0.00	0.60
P	DISTANCE_TO_SH	0.19	0.00	#INJ_I	co_exp_I	0.00	0.60
M	tot_inc	0.19	0.00	#VESS_I	co_exp_I	0.00	0.60
tot_inc_I	HELIPORT_FLAG	0.19	0.00	H	HELIPORT_FLAG	0.00	0.60
#MAJ_I	#VESS_I	0.19	0.00	#FAT	FIRED_VESSEL_FL	0.00	0.60
G	COMPRESSOR_FLAG	0.19	0.00	G	H_I	0.00	0.61
#ins_w_inc	GAS_PROD_FLAG	0.19	0.00	#VESS	FIRED_VESSEL_FL	0.00	0.61
P	HELIPORT_FLAG	0.19	0.00	#MAJ_I	C_I	0.00	0.63
W	SLOT_DRILL_COUNT	0.19	0.00	M	SUL_PROD_FLAG	0.00	0.63
L	G	0.19	0.00	#MAJ	INCS/COMP	0.00	0.63
W	bed_count	0.19	0.00	#FAT	#ins_no_inc_I	0.00	0.64
C	DISTANCE_TO_SH	0.19	0.00	S_I	co_ming_prod	0.00	0.65
P_I	DISTANCE_TO_SH	0.18	0.00	G	#FAT_I	0.00	0.66
#MIN_I	#VESS_I	0.18	0.00	#VESS	NUM_COMP	0.00	0.65
GAS_FLARING_FLAG	GAS_PROD_FLAG	0.18	0.00	#ins_no_inc	#VESS_I	0.00	0.67
W_I	SLOT_COUNT	0.18	0.00	#FAT	#ins_no_inc	0.00	0.67
W	STORE_TANK_FLAG	0.18	0.00	H_I	MAJ_CMPLX_FLAG	0.00	0.67
C_I	HELIPORT_FLAG	0.18	0.00	#ins_no_inc	#acc_I	0.00	0.68
P	FIRED_VESSEL_FL	0.18	0.00	M	PLATFORM_AGE	0.00	0.67
W_I	bed_count	0.18	0.00	#FAT	PLATFORM_AGE	0.00	0.68
G	crane_count	0.18	0.00	#VESS_I	OIL_PROD_FLAG	0.00	0.69
P_I	HELIPORT_FLAG	0.18	0.00	#MIN_I	op_exp_I	0.00	0.69
E	tot_inc_I	0.18	0.00	M	#ins_no_inc_I	0.00	0.69
P_I	FIRED_VESSEL_FL	0.18	0.00	W	#FAT_I	0.00	0.69
W_I	SLOT_DRILL_COUNT	0.18	0.00	#FIRE	#ins_no_inc_I	0.00	0.69
G_I	NUM_COMP	0.18	0.00	H	G_I	0.00	0.70
tot_inc	E_I	0.18	0.00	#INJ	E	0.00	0.71
G	MAJ_CMPLX_FLAG	0.18	0.00	H_I	#ins_no_inc_I	0.00	0.72
STORE_TANK_FLAG	DISTANCE_TO_SH	0.18	0.00	co_exp	#VESS_I	0.00	0.71
G_I	COMPRESSOR_FLAG	0.18	0.00	#MAJ	W_I	0.00	0.71
C_I	DISTANCE_TO_SH	0.18	0.00	#MIN_I	co_ming_prod	0.00	0.73
#MAJ	#EXP	0.18	0.00	#VESS	MAJ_CMPLX_FLAG	0.00	0.73
co_ming_prod	OIL_PROD_FLAG	0.18	0.00	#SPLL	S_I	0.00	0.73
W_I	STORE_TANK_FLAG	0.17	0.00	#INJ	S_I	0.00	0.74
GAS_PROD_FLAG	DISTANCE_TO_SH	0.17	0.00	H_I	HELIPORT_FLAG	0.00	0.76
co_ming_prod	NUM_COMP	0.17	0.00	#INJ_I	co_ming_prod	0.00	0.75
co_exp	PLATFORM_AGE	0.17	0.00	#VESS	bed_count	0.00	0.76
G_I	MAJ_CMPLX_FLAG	0.17	0.00	#VESS_I	STORE_TANK_FLAG	0.00	0.77
#ins_w_inc	OIL_PROD_FLAG	0.17	0.00	H	co_ming_prod	0.00	0.76
C	M	0.17	0.00	M	#acc_I	0.00	0.76
G_I	crane_count	0.17	0.00	#FAT	co_exp	0.00	0.76
E	G_I	0.17	0.00	#FAT	INCS/COMP	0.00	0.80
#ins_w_inc_I	GAS_PROD_FLAG	0.17	0.00	#SPLL	#ins_no_inc	0.00	0.80
L_I	G_I	0.17	0.00	INCS/COMP	#INJ_I	0.00	0.81

W	M	0.17	0.00	co_exp	#INJ_I	0.00	0.81
G	bed_count	0.17	0.00	M	#SPLL_I	0.00	0.81
E	#ins_w_inc_I	0.16	0.00	E_I	co_ming_prod	0.00	0.82
W	DISTANCE_TO_SH	0.16	0.00	#FAT_I	FIRED_VESSEL_FL	0.00	0.82
E	W_I	0.16	0.00	#MAJ_I	FIRED_VESSEL_FL	0.00	0.82
M_I	tot_inc_I	0.16	0.00	C	H	0.00	0.82
#ins_w_inc_I	OIL_PROD_FLAG	0.16	0.00	#FIRE	op_exp	0.00	0.82
G	STORE_TANK_FLAG	0.16	0.00	#ins_no_inc_I	COMPRESSOR_FLAG	0.00	0.83
W_I	DISTANCE_TO_SH	0.16	0.00	#INJ_I	W_I	0.00	0.84
W	E_I	0.16	0.00	#SPLL_I	#ins_no_inc_I	0.00	0.85
G	SLOT_COUNT	0.16	0.00	#MIN	op_exp	0.00	0.85
GAS_FLARING_FLAG	FIRED_VESSEL_FL	0.16	0.00	W	H_I	0.00	0.86
G_I	bed_count	0.16	0.00	W_I	co_ming_prod	0.00	0.87
W	FIRED_VESSEL_FL	0.16	0.00	#FAT_I	COMPRESSOR_FLAG	0.00	0.88
P	E_I	0.15	0.00	#EXP_I	COMPRESSOR_FLAG	0.00	0.88
co_ming_prod	STORE_TANK_FLAG	0.15	0.00	PLATFORM_AGE	#MAJ_I	0.00	0.87
W_I	FIRED_VESSEL_FL	0.15	0.00	op_exp	M_I	0.00	0.87
G	SLOT_DRILL_COUNT	0.15	0.00	#EXP	COMPRESSOR_FLAG	0.00	0.88
W	HELIPORT_FLAG	0.15	0.00	#FAT	STORE_TANK_FLAG	0.00	0.90
P	WATER_DEPTH	0.15	0.00	#ins_w_inc_I	SUL_PROD_FLAG	0.00	0.91
tot_inc	WATER_DEPTH	0.15	0.00	#INJ_I	L_I	0.00	0.91
W_I	M_I	0.15	0.00	tot_inc	#FAT_I	0.00	0.90
G	DISTANCE_TO_SH	0.15	0.00	P	H	0.00	0.91
C	E_I	0.15	0.00	#INJ	PLATFORM_AGE	0.00	0.91
G_I	STORE_TANK_FLAG	0.15	0.00	#FAT	op_exp_I	0.00	0.91
G	FIRED_VESSEL_FL	0.15	0.00	#FAT	op_exp	0.00	0.91
co_ming_prod	crane_count	0.15	0.00	G_I	SUL_PROD_FLAG	0.00	0.92
tot_inc	OIL_PROD_FLAG	0.15	0.00	#FAT_I	W_I	0.00	0.93
G	E_I	0.15	0.00	E	co_ming_prod	0.00	0.92
E	crane_count	0.15	0.00	#INJ	co_exp_I	0.00	0.94
E	C_I	0.15	0.00	C_I	H_I	0.00	0.95
E	P_I	0.15	0.00	H	tot_inc_I	0.00	0.94
E	NUM_COMP	0.14	0.00	P	#FAT_I	0.00	0.94
C	WATER_DEPTH	0.14	0.00	#FIRE	op_exp_I	0.00	0.94
G_I	FIRED_VESSEL_FL	0.14	0.00	op_exp	#FIRE_I	0.00	0.95
C	OIL_PROD_FLAG	0.14	0.00	co_exp	HELIPORT_FLAG	0.00	0.96
W_I	HELIPORT_FLAG	0.14	0.00	L	#INJ_I	0.00	0.96
G_I	SLOT_COUNT	0.14	0.00	#INJ	W_I	0.00	0.96
co_ming_prod	GAS_PROD_FLAG	0.14	0.00	#EXP	#ins_no_inc_I	0.00	0.97
co_ming_prod	HELIPORT_FLAG	0.14	0.00	#ins_no_inc	#EXP_I	0.00	0.99
M	#ins_w_inc	0.14	0.00	H	P_I	0.00	0.99
C	GAS_PROD_FLAG	0.14	0.00	#INJ	co_ming_prod	0.00	0.99
#acc	#MAJ	0.14	0.00	#INJ	co_exp	0.00	0.99
P_I	WATER_DEPTH	0.14	0.00	#EXP	INCS/COMP	0.00	0.98
G_I	DISTANCE_TO_SH	0.14	0.00	#acc_I	M_I	0.00	1.00
E_I	crane_count	0.14	0.00	#ins_w_inc	SUL_PROD_FLAG	0.00	0.99
P	OIL_PROD_FLAG	0.14	0.00	P	PLATFORM_AGE	0.00	0.99
G_I	SLOT_DRILL_COUNT	0.14	0.00	P_I	H_I	0.00	0.99
C_I	M_I	0.14	0.00	#FAT_I	G_I	0.00	0.99
tot_inc_I	OIL_PROD_FLAG	0.14	0.00	#FAT_I	H_I	0.00	0.99
P	GAS_PROD_FLAG	0.14	0.00	#VESS_I	H_I	0.00	0.98
tot_inc	GAS_PROD_FLAG	0.14	0.00	#EXP_I	crane_count	0.00	0.98
E_I	NUM_COMP	0.14	0.00	#EXP_I	H_I	0.00	0.99
tot_inc_I	WATER_DEPTH	0.14	0.00	#EXP_I	#FAT_I	0.00	0.98
E	COMPRESSOR_FLAG	0.14	0.00	#MAJ_I	H_I	0.00	0.99
#ins_w_inc	WATER_DEPTH	0.14	0.00	H	H_I	0.00	0.99
E	MAJ_CMPLX_FLAG	0.14	0.00	H	#FAT_I	0.00	0.98
PLATFORM_AGE	SLOT_DRILL_COUNT	0.14	0.00	H	#EXP_I	0.00	0.98
E_I	MAJ_CMPLX_FLAG	0.14	0.00	H	#MAJ_I	0.00	0.98
C_I	OIL_PROD_FLAG	0.14	0.00	#FAT	H_I	0.00	0.98
L	NUM_COMP	0.13	0.00	#VESS	G_I	0.00	0.98
E_I	COMPRESSOR_FLAG	0.13	0.00	#EXP	crane_count	0.00	0.98
#ins_w_inc	L_I	0.13	0.00	#EXP	G_I	0.00	0.99
L	#ins_w_inc_I	0.13	0.00	#EXP	H_I	0.00	0.99
P	M	0.13	0.00	#EXP	#FAT_I	0.00	0.98
M_I	#ins_w_inc_I	0.13	0.00	#EXP	#EXP_I	0.00	0.98
PLATFORM_AGE	OIL_PROD_FLAG	0.13	0.00	#EXP	#MAJ_I	0.00	0.98
P_I	OIL_PROD_FLAG	0.13	0.00	#EXP	H	0.00	0.98
#acc	#FAT	0.13	0.00	#MIN	op_exp_I	0.00	0.99
C_I	WATER_DEPTH	0.13	0.00	#MAJ	STORE_TANK_FLAG	0.00	0.99

C_I	GAS_PROD_FLAG	0.13	0.00	#MAJ	H_I	0.00	0.98
L	tot_inc_I	0.13	0.00	#INJ_I	G_I	0.00	0.98
S	G_I	0.13	0.00	#INJ_I	H_I	0.00	0.97
G	HELIPORT_FLAG	0.13	0.00	#VESS_I	#FAT_I	0.00	0.98
co_ming_prod	SLOT_DRILL_COUNT	0.13	0.00	#EXP_I	#VESS_I	0.00	0.98
P_I	GAS_PROD_FLAG	0.13	0.00	PLATFORM_AGE	#FAT_I	0.00	0.98
S	tot_inc_I	0.13	0.00	H	#VESS_I	0.00	0.98
tot_inc_I	GAS_PROD_FLAG	0.13	0.00	#INJ	H_I	0.00	0.97
L	C_I	0.13	0.00	#FAT	#FAT_I	0.00	0.98
L_I	NUM_COMP	0.13	0.00	#FAT	#VESS_I	0.00	0.97
#acc_I	NUM_COMP	0.13	0.00	#FAT	#EXP_I	0.00	0.98
#ins_w_inc	S_I	0.13	0.00	#FAT	#MAJ_I	0.00	0.98
S	INCS/COMP	0.13	0.00	#FAT	H	0.00	0.98
#acc	NUM_COMP	0.12	0.00	#VESS	H_I	0.00	0.98
E	E_I	0.12	0.00	#VESS	#FAT_I	0.00	0.97
L	COMPRESSOR_FLAG	0.12	0.00	#VESS	#EXP_I	0.00	0.97
#ins_w_inc_I	WATER_DEPTH	0.12	0.00	#VESS	#MAJ_I	0.00	0.97
#VESS_I	#acc_I	0.12	0.00	#VESS	H	0.00	0.97
tot_inc	L_I	0.12	0.00	#EXP	#VESS_I	0.00	0.98
tot_inc	S_I	0.12	0.00	#EXP	#FAT	0.00	0.98
#MIN_I	#FAT_I	0.12	0.00	#EXP	#VESS	0.00	0.97
#MIN_I	#EXP_I	0.12	0.00	#MAJ	#FAT_I	0.00	0.97
C	L_I	0.12	0.00	#MAJ	#VESS_I	0.00	0.97
E	STORE_TANK_FLAG	0.12	0.00	#MAJ	#EXP_I	0.00	0.97
L	crane_count	0.12	0.00	#MAJ	#MAJ_I	0.00	0.97
L	INCS/COMP	0.12	0.00	#MAJ	H	0.00	0.98
G	S_I	0.12	0.00	H_I	SUL_PROD_FLAG	0.00	0.95
W	WATER_DEPTH	0.12	0.00	#FAT_I	#INJ_I	0.00	0.96
G_I	HELIPORT_FLAG	0.12	0.00	#FIRE_I	op_exp_I	0.00	0.96
L_I	crane_count	0.12	0.00	#FIRE_I	H_I	0.00	0.95
#SPLL_I	NUM_COMP	0.12	0.00	#EXP_I	OIL_PROD_FLAG	0.00	0.96
P_I	M_I	0.12	0.00	H	#INJ_I	0.00	0.96
S	W_I	0.12	0.00	#INJ	#FAT_I	0.00	0.95
L	P_I	0.12	0.00	#INJ	#EXP_I	0.00	0.95
#ins_w_inc	GAS_FLARING_FLAG	0.11	0.00	#INJ	#MAJ_I	0.00	0.95
P	L_I	0.11	0.00	#INJ	H	0.00	0.96
E_I	STORE_TANK_FLAG	0.11	0.00	#VESS	#VESS_I	0.00	0.96
co_ming_prod	SLOT_COUNT	0.11	0.00	#VESS	#FAT	0.00	0.96
L_I	COMPRESSOR_FLAG	0.11	0.00	#EXP	OIL_PROD_FLAG	0.00	0.96
E	FIRED_VESSEL_FL	0.11	0.00	#EXP	#INJ_I	0.00	0.96
L	bed_count	0.11	0.00	#MAJ_I	GAS_PROD_FLAG	0.00	0.95
S	#ins_w_inc_I	0.11	0.00	PLATFORM_AGE	M_I	0.00	0.95
co_ming_prod	MAJ_CMPLX_FLAG	0.11	0.00	H	SUL_PROD_FLAG	0.00	0.94
E_I	bed_count	0.11	0.00	H	#FIRE_I	0.00	0.94
tot_inc	GAS_FLARING_FLAG	0.11	0.00	#FAT	#INJ_I	0.00	0.95
W_I	WATER_DEPTH	0.11	0.00	#FIRE	H_I	0.00	0.94
OIL_PROD_FLAG	FIRED_VESSEL_FL	0.11	0.00	#MAJ	OIL_PROD_FLAG	0.00	0.94
W	OIL_PROD_FLAG	0.11	0.00	#MAJ	#INJ_I	0.00	0.94
W	S_I	0.11	0.00	M_I	H_I	0.00	0.93
M	G	0.11	0.00	#FAT_I	SUL_PROD_FLAG	0.00	0.94
E	bed_count	0.11	0.00	#FIRE_I	#FAT_I	0.00	0.93
#SPLL	NUM_COMP	0.11	0.00	#EXP_I	SUL_PROD_FLAG	0.00	0.94
E_I	FIRED_VESSEL_FL	0.11	0.00	#EXP_I	#FIRE_I	0.00	0.93
L_I	bed_count	0.11	0.00	#MIN_I	H_I	0.00	0.92
#acc	COMPRESSOR_FLAG	0.11	0.00	#MAJ_I	SUL_PROD_FLAG	0.00	0.94
L	MAJ_CMPLX_FLAG	0.10	0.00	PLATFORM_AGE	#INJ_I	0.00	0.93
L	STORE_TANK_FLAG	0.10	0.00	C	#FAT_I	0.00	0.93
C	S_I	0.10	0.00	C	#MAJ_I	0.00	0.93
S	C_I	0.10	0.00	#INJ	L_I	0.00	0.93
P	GAS_FLARING_FLAG	0.10	0.00	#INJ	#VESS_I	0.00	0.94
W_I	OIL_PROD_FLAG	0.10	0.00	#FIRE	H	0.00	0.92
E	HELIPORT_FLAG	0.10	0.00	#VESS	#INJ_I	0.00	0.93
#acc_I	SLOT_DRILL_COUNT	0.10	0.00	#EXP	SUL_PROD_FLAG	0.00	0.94
E	SLOT_DRILL_COUNT	0.10	0.00	#EXP	#FIRE_I	0.00	0.93
C	GAS_FLARING_FLAG	0.10	0.00	op_exp_I	bed_count	0.00	0.91
#acc_I	COMPRESSOR_FLAG	0.10	0.00	M_I	op_exp_I	0.00	0.91
E	SLOT_COUNT	0.10	0.00	#VESS_I	SUL_PROD_FLAG	0.00	0.92
#acc_I	SLOT_COUNT	0.10	0.00	INCS/COMP	#FAT_I	0.00	0.91
#MIN	#EXP	0.10	0.00	INCS/COMP	#MIN_I	0.00	0.91
L_I	E_I	0.10	0.00	M	H_I	0.00	0.92

#acc	crane_count	0.10	0.00	#FAT	SUL_PROD_FLAG	0.00	0.92
L_I	MAJ_CMPLX_FLAG	0.10	0.00	#FAT	#FIRE_I	0.00	0.91
#ins_w_inc_I	GAS_FLARING_FLAG	0.10	0.00	#FIRE	#FAT_I	0.00	0.92
#acc	#EXP	0.10	0.00	#FIRE	#EXP_I	0.00	0.92
E_I	HELIPORT_FLAG	0.10	0.00	#FIRE	#MAJ_I	0.00	0.92
L	E	0.10	0.00	#EXP	#FIRE	0.00	0.92
#acc	tot_inc	0.10	0.00	#MIN	H_I	0.00	0.91
co_ming_prod	COMPRESSOR_FLAG	0.10	0.00	#MAJ	SUL_PROD_FLAG	0.00	0.91
E_I	SLOT_DRILL_COUNT	0.10	0.00	#SPLL_I	H_I	0.00	0.90
#acc_I	crane_count	0.10	0.00	#FAT_I	M_I	0.00	0.90
tot_inc_I	GAS_FLARING_FLAG	0.10	0.00	#EXP_I	M_I	0.00	0.90
L	L_I	0.10	0.00	#MAJ_I	M_I	0.00	0.90
L	W_I	0.10	0.00	G	SUL_PROD_FLAG	0.00	0.91
E_I	SLOT_COUNT	0.10	0.00	H	M_I	0.00	0.90
L_I	STORE_TANK_FLAG	0.10	0.00	H	#MIN_I	0.00	0.90
S	L	0.10	0.00	#VESS	SUL_PROD_FLAG	0.00	0.90
W	GAS_PROD_FLAG	0.10	0.00	#EXP	M_I	0.00	0.90
G	WATER_DEPTH	0.10	0.00	#MAJ	#FIRE_I	0.00	0.91
E	S_I	0.10	0.00	#SPLL	H_I	0.00	0.91
P	S_I	0.10	0.00	#FAT_I	op_exp_I	0.00	0.89
M_I	G_I	0.10	0.00	#FAT_I	P_I	0.00	0.88
#SPLL_I	SLOT_DRILL_COUNT	0.10	0.00	#VESS_I	HELIPORT_FLAG	0.00	0.89
#acc	SLOT_COUNT	0.09	0.00	#MAJ_I	#MIN_I	0.00	0.89
#MAJ	#VESS	0.09	0.00	M	#FAT_I	0.00	0.89
#acc	SLOT_DRILL_COUNT	0.09	0.00	M	#MAJ_I	0.00	0.89
#acc	C	0.09	0.00	M	H	0.00	0.89
#SPLL_I	COMPRESSOR_FLAG	0.09	0.00	#INJ	#INJ_I	0.00	0.89
S	P_I	0.09	0.00	#FIRE	#VESS_I	0.00	0.89
L	SLOT_DRILL_COUNT	0.09	0.00	#FIRE	#FAT	0.00	0.89
#acc	#ins_w_inc	0.09	0.00	#VESS	#FIRE_I	0.00	0.90
C_I	GAS_FLARING_FLAG	0.09	0.00	#EXP	#MIN_I	0.00	0.89
#FAT_I	#acc_I	0.09	0.00	#EXP	M	0.00	0.89
#EXP_I	#acc_I	0.09	0.00	#MIN	H	0.00	0.88
#MAJ_I	#acc_I	0.09	0.00	#acc	H_I	0.00	0.88
L	SLOT_COUNT	0.09	0.00	#acc_I	H_I	0.00	0.88
P_I	GAS_FLARING_FLAG	0.09	0.00	P	#MAJ_I	0.00	0.87
#acc	bed_count	0.09	0.00	#INJ	INCS/COMP	0.00	0.88
#SPLL_I	SLOT_COUNT	0.09	0.00	#VESS	op_exp	0.00	0.88
M	NUM_COMP	0.09	0.00	#MIN	#FAT_I	0.00	0.88
L	G_I	0.09	0.00	#MIN	#EXP_I	0.00	0.88
#MIN	NUM_COMP	0.09	0.00	#MIN	#MAJ_I	0.00	0.88
M	P_I	0.09	0.00	#SPLL	#FAT_I	0.00	0.87
#SPLL_I	crane_count	0.09	0.00	#SPLL	#EXP_I	0.00	0.87
W	L_I	0.09	0.00	#SPLL	#MAJ_I	0.00	0.87
G	OIL_PROD_FLAG	0.09	0.00	#SPLL	H	0.00	0.88
L	FIRED_VESSEL_FL	0.09	0.00	#SPLL	#EXP	0.00	0.87
#acc_I	MAJ_CMPLX_FLAG	0.09	0.00	L_I	op_exp_I	0.00	0.86
#acc_I	STORE_TANK_FLAG	0.09	0.00	#SPLL_I	M_I	0.00	0.86
W	GAS_FLARING_FLAG	0.09	0.00	#INJ_I	SUL_PROD_FLAG	0.00	0.86
#acc	MAJ_CMPLX_FLAG	0.09	0.00	#FAT_I	tot_inc_I	0.00	0.85
M	tot_inc_I	0.09	0.00	#FAT_I	#SPLL_I	0.00	0.86
#acc	STORE_TANK_FLAG	0.09	0.00	#VESS_I	M_I	0.00	0.87
#acc	P	0.09	0.00	#EXP_I	#SPLL_I	0.00	0.86
#acc_I	bed_count	0.09	0.00	H	#SPLL_I	0.00	0.87
#SPLL	COMPRESSOR_FLAG	0.09	0.00	S	H_I	0.00	0.87
S	NUM_COMP	0.09	0.00	#FAT	M_I	0.00	0.87
L_I	SLOT_DRILL_COUNT	0.09	0.00	#FAT	#MIN_I	0.00	0.86
W_I	GAS_PROD_FLAG	0.09	0.00	#EXP	#SPLL_I	0.00	0.86
L_I	FIRED_VESSEL_FL	0.09	0.00	#MAJ	M_I	0.00	0.86
M	M_I	0.09	0.00	L_I	H_I	0.00	0.84
S	E_I	0.09	0.00	#VESS_I	C_I	0.00	0.85
E	DISTANCE_TO_SH	0.09	0.00	op_exp	bed_count	0.00	0.85
#SPLL	tot_inc	0.08	0.00	op_exp	L_I	0.00	0.85
M	L	0.08	0.00	op_exp	#INJ_I	0.00	0.85
#SPLL_I	STORE_TANK_FLAG	0.08	0.00	op_exp	#FAT_I	0.00	0.85
G_I	OIL_PROD_FLAG	0.08	0.00	H	#acc_I	0.00	0.84
#VESS_I	#INJ_I	0.08	0.00	M	#VESS_I	0.00	0.85
S	MAJ_CMPLX_FLAG	0.08	0.00	#FAT	M	0.00	0.85
M	C_I	0.08	0.00	#VESS	op_exp_I	0.00	0.85
G_I	WATER_DEPTH	0.08	0.00	#MIN	#ins_no_inc_I	0.00	0.85

L	HELIPORT_FLAG	0.08	0.00	#MAJ	M	0.00	0.84
L_I	SLOT_COUNT	0.08	0.00	#acc	H	0.00	0.85
S	crane_count	0.08	0.00	INCS/COMP	#FIRE_I	0.00	0.84
op_exp_I	co_ming_prod	0.08	0.00	L	H_I	0.00	0.84
G	L_I	0.08	0.00	#INJ	SUL_PROD_FLAG	0.00	0.84
op_exp	co_ming_prod	0.08	0.00	#INJ	#FIRE_I	0.00	0.83
M	FIRED_VESSEL_FL	0.08	0.00	#VESS	M_I	0.00	0.84
#acc	WATER_DEPTH	0.08	0.00	#VESS	#MIN_I	0.00	0.83
S	COMPRESSOR_FLAG	0.08	0.00	#EXP	#acc_I	0.00	0.83
C	M_I	0.08	0.00	#MIN	#VESS_I	0.00	0.84
#SPLL	crane_count	0.08	0.00	#acc	#FAT_I	0.00	0.84
op_exp_I	SLOT_DRILL_COUNT	0.08	0.00	#acc	#EXP_I	0.00	0.84
M	#ins_w_inc_I	0.08	0.00	#acc	#MAJ_I	0.00	0.84
tot_inc	#acc_I	0.08	0.00	#SPLL	#VESS_I	0.00	0.83
tot_inc	#SPLL_I	0.08	0.00	#SPLL	#FAT	0.00	0.83
#SPLL	STORE_TANK_FLAG	0.08	0.00	#INJ_I	op_exp_I	0.00	0.81
#SPLL	#SPLL_I	0.08	0.00	#FAT_I	S_I	0.00	0.81
E_I	DISTANCE_TO_SH	0.08	0.00	#MAJ_I	S_I	0.00	0.81
L	OIL_PROD_FLAG	0.08	0.00	INCS/COMP	H_I	0.00	0.82
op_exp	SLOT_DRILL_COUNT	0.08	0.00	H	S_I	0.00	0.82
#acc_I	#ins_w_inc_I	0.08	0.00	H	#ins_no_inc	0.00	0.82
#MIN	COMPRESSOR_FLAG	0.08	0.00	L	#FIRE_I	0.00	0.82
S_I	MAJ_CMPLX_FLAG	0.08	0.00	S	#FAT_I	0.00	0.81
INCS/COMP	tot_inc_I	0.08	0.00	S	#FIRE_I	0.00	0.82
L_I	HELIPORT_FLAG	0.08	0.00	S	#EXP_I	0.00	0.81
P	M_I	0.08	0.00	S	#MAJ_I	0.00	0.81
#SPLL	SLOT_DRILL_COUNT	0.08	0.00	#FAT	#SPLL_I	0.00	0.81
#SPLL	#ins_w_inc	0.08	0.00	#FIRE	#INJ_I	0.00	0.82
tot_inc	M_I	0.08	0.00	#VESS	M	0.00	0.82
#SPLL	#acc_I	0.08	0.00	#MAJ	#MIN	0.00	0.83
W	#acc_I	0.08	0.00	H_I	E_I	0.00	0.81
E	OIL_PROD_FLAG	0.08	0.00	E	H_I	0.00	0.81
M	crane_count	0.08	0.00	#EXP	W_I	0.00	0.81
#MIN	#FAT	0.08	0.00	#MAJ	op_exp_I	0.00	0.81
W	#SPLL_I	0.08	0.00	#MAJ	op_exp	0.00	0.81
G	GAS_PROD_FLAG	0.08	0.00	E_I	SUL_PROD_FLAG	0.00	0.80
S_I	NUM_COMP	0.08	0.00	#EXP_I	bed_count	0.00	0.79
#acc_I	tot_inc_I	0.08	0.00	PLATFORM_AGE	H_I	0.00	0.79
W_I	GAS_FLARING_FLAG	0.08	0.00	H	L_I	0.00	0.79
#SPLL_I	MAJ_CMPLX_FLAG	0.08	0.00	#INJ	E_I	0.00	0.79
op_exp_I	OIL_PROD_FLAG	0.08	0.00	#EXP	bed_count	0.00	0.79
S_I	COMPRESSOR_FLAG	0.08	0.00	H_I	co_ming_prod	0.00	0.78
S_I	L_I	0.08	0.00	#FAT_I	L_I	0.00	0.78
#SPLL_I	bed_count	0.08	0.00	#FIRE_I	SUL_PROD_FLAG	0.00	0.78
#SPLL	SLOT_COUNT	0.08	0.00	#VESS_I	P_I	0.00	0.78
#MIN	#ins_w_inc	0.08	0.00	#EXP_I	L_I	0.00	0.78
E_I	OIL_PROD_FLAG	0.07	0.00	#MAJ_I	L_I	0.00	0.78
op_exp	OIL_PROD_FLAG	0.07	0.00	L	#FAT_I	0.00	0.77
M	COMPRESSOR_FLAG	0.07	0.00	L	#EXP_I	0.00	0.77
#acc	W	0.07	0.00	L	#MAJ_I	0.00	0.77
#SPLL	P	0.07	0.00	L	H	0.00	0.79
#SPLL	C	0.07	0.00	#FAT	#acc_I	0.00	0.78
M	STORE_TANK_FLAG	0.07	0.00	#VESS	#SPLL_I	0.00	0.78
#MIN	crane_count	0.07	0.00	#EXP	L_I	0.00	0.78
#SPLL_I	tot_inc_I	0.07	0.00	#EXP	L	0.00	0.77
#acc	DISTANCE_TO_SH	0.07	0.00	#acc	#VESS_I	0.00	0.79
M_I	FIRED_VESSEL_FL	0.07	0.00	#EXP_I	SLOT_COUNT	0.00	0.76
M	W_I	0.07	0.00	#EXP	SLOT_COUNT	0.00	0.76
L_I	OIL_PROD_FLAG	0.07	0.00	#VESS_I	S_I	0.00	0.76
#acc_I	WATER_DEPTH	0.07	0.00	#ins_no_inc	#INJ_I	0.00	0.76
M_I	NUM_COMP	0.07	0.00	H	E_I	0.00	0.75
INCS/COMP	W_I	0.07	0.00	H	E	0.00	0.75
#FAT	#INJ	0.07	0.00	M	#INJ_I	0.00	0.75
#MIN	C	0.07	0.00	S	#VESS_I	0.00	0.76
#acc	E	0.07	0.00	#FAT	S_I	0.00	0.76
#acc	HELIPORT_FLAG	0.07	0.00	#FAT	S	0.00	0.76
#FIRE	NUM_COMP	0.07	0.00	#FAT_I	E_I	0.00	0.73
#MIN	bed_count	0.07	0.00	#FAT_I	C_I	0.00	0.74
#MIN	WATER_DEPTH	0.07	0.00	#MAJ_I	E_I	0.00	0.73
#MIN	tot_inc	0.07	0.00	E	#FAT_I	0.00	0.73

#ins_w_inc	M_I	0.07	0.00	E	#MAJ_I	0.00	0.73
#MIN_I	NUM_COMP	0.07	0.00	#INJ	M_I	0.00	0.74
INCS/COMP	P_I	0.07	0.00	#VESS	STORE_TANK_FLAG	0.00	0.75
#SPLL	W	0.07	0.00	#VESS	#acc_I	0.00	0.74
PLATFORM_AGE	SLOT_COUNT	0.07	0.00	#MAJ	S_I	0.00	0.74
S_I	crane_count	0.07	0.00	#MAJ	S	0.00	0.74
#SPLL	MAJ_CMPLX_FLAG	0.07	0.00	#INJ	#MIN_I	0.00	0.73
G	#SPLL_I	0.07	0.00	#FIRE	SUL_PROD_FLAG	0.00	0.72
#SPLL	bed_count	0.07	0.00	#EXP	tot_inc_I	0.00	0.73
#SPLL_I	#ins_w_inc_I	0.07	0.00	#MIN	#INJ_I	0.00	0.73
G	#acc_I	0.07	0.00	#VESS_I	L_I	0.00	0.71
#acc	G	0.07	0.00	#EXP_I	DISTANCE_TO_SH	0.00	0.71
#acc_I	P_I	0.07	0.00	#EXP_I	WATER_DEPTH	0.00	0.71
INCS/COMP	#ins_w_inc_I	0.07	0.00	tot_inc	#MAJ_I	0.00	0.71
#acc_I	C_I	0.07	0.00	#EXP	DISTANCE_TO_SH	0.00	0.71
S	STORE_TANK_FLAG	0.07	0.00	#EXP	WATER_DEPTH	0.00	0.71
#SPLL_I	P_I	0.07	0.00	#SPLL	#INJ_I	0.00	0.72
S	SLOT_COUNT	0.07	0.00	#FAT_I	co_ming_prod	0.00	0.70
#MIN	SLOT_COUNT	0.07	0.00	#EXP_I	co_ming_prod	0.00	0.70
#acc_I	HELIPORT_FLAG	0.07	0.00	#MAJ_I	co_ming_prod	0.00	0.70
M	MAJ_CMPLX_FLAG	0.07	0.00	INCS/COMP	#MAJ_I	0.00	0.70
#acc	#SPLL_I	0.07	0.00	H	op_exp	0.00	0.70
#MIN	MAJ_CMPLX_FLAG	0.07	0.00	L	#VESS_I	0.00	0.70
S_I	STORE_TANK_FLAG	0.07	0.00	#VESS	W_I	0.00	0.70
#acc	#acc_I	0.07	0.00	#VESS	S_I	0.00	0.71
G	GAS_FLARING_FLAG	0.07	0.00	#VESS	S	0.00	0.71
S	FIRED_VESSEL_FL	0.07	0.00	#EXP	co_ming_prod	0.00	0.70
G_I	GAS_PROD_FLAG	0.07	0.00	op_exp	#VESS_I	0.00	0.68
#SPLL_I	OIL_PROD_FLAG	0.07	0.00	#VESS	crane_count	0.00	0.69
#MIN	P	0.07	0.00	#VESS	C	0.00	0.67
#acc_I	DISTANCE_TO_SH	0.07	0.00	M_I	SUL_PROD_FLAG	0.00	0.66
#SPLL_I	C_I	0.07	0.00	#FAT_I	GAS_FLARING_FLAG	0.00	0.67
S	HELIPORT_FLAG	0.07	0.00	#EXP_I	GAS_FLARING_FLAG	0.00	0.67
M_I	STORE_TANK_FLAG	0.07	0.00	#MAJ_I	GAS_FLARING_FLAG	0.00	0.67
P	#acc_I	0.07	0.00	#VESS	L_I	0.00	0.66
S	DISTANCE_TO_SH	0.07	0.00	#EXP	GAS_FLARING_FLAG	0.00	0.67
S	S_I	0.07	0.00	#VESS_I	E_I	0.00	0.65
#MAJ_I	#FIRE_I	0.06	0.00	#MIN_I	SUL_PROD_FLAG	0.00	0.65
S	SLOT_DRILL_COUNT	0.06	0.00	E	#VESS_I	0.00	0.65
S	bed_count	0.06	0.00	#INJ	#SPLL_I	0.00	0.64
#acc	OIL_PROD_FLAG	0.06	0.00	#VESS	L	0.00	0.64
#MIN	SLOT_DRILL_COUNT	0.06	0.00	#acc	#ins_no_inc_I	0.00	0.65
#MIN	STORE_TANK_FLAG	0.06	0.00	#acc	#INJ_I	0.00	0.65
#MIN	DISTANCE_TO_SH	0.06	0.00	#VESS_I	op_exp_I	0.00	0.64
INCS/COMP	C_I	0.06	0.00	H	op_exp_I	0.00	0.64
S_I	bed_count	0.06	0.00	#MAJ	#ins_no_inc_I	0.00	0.64
M	bed_count	0.06	0.00	L_I	SUL_PROD_FLAG	0.00	0.63
#acc_I	OIL_PROD_FLAG	0.06	0.00	#MAJ	E_I	0.00	0.63
#SPLL	OIL_PROD_FLAG	0.06	0.00	G	#MAJ_I	0.00	0.61
C	#acc_I	0.06	0.00	M	#FIRE_I	0.00	0.61
#SPLL	WATER_DEPTH	0.06	0.00	#VESS	P	0.00	0.61
INCS/COMP	G_I	0.06	0.00	#VESS_I	co_ming_prod	0.00	0.61
P	#SPLL_I	0.06	0.00	#VESS_I	tot_inc_I	0.00	0.60
M_I	crane_count	0.06	0.00	C	SUL_PROD_FLAG	0.00	0.60
#acc	FIRED_VESSEL_FL	0.06	0.00	S	#INJ_I	0.00	0.60
#ins_w_inc	#acc_I	0.06	0.00	#FAT	co_ming_prod	0.00	0.61
#acc	#ins_w_inc_I	0.06	0.00	#INJ	#acc_I	0.00	0.59
E	GAS_PROD_FLAG	0.06	0.00	#VESS	E_I	0.00	0.58
#SPLL	E	0.06	0.00	#VESS	E	0.00	0.59
#acc	C_I	0.06	0.00	H_I	OIL_PROD_FLAG	0.00	0.58
#FIRE	COMPRESSOR_FLAG	0.06	0.00	W_I	SUL_PROD_FLAG	0.00	0.58
M_I	MAJ_CMPLX_FLAG	0.06	0.00	#EXP_I	SLOT_DRILL_COUNT	0.00	0.58
C	#SPLL_I	0.06	0.00	#EXP_I	co_exp_I	0.00	0.58
G_I	GAS_FLARING_FLAG	0.06	0.00	L	SUL_PROD_FLAG	0.00	0.58
M_I	COMPRESSOR_FLAG	0.06	0.00	#EXP	SLOT_DRILL_COUNT	0.00	0.58
#FIRE	crane_count	0.06	0.00	#MAJ	co_ming_prod	0.00	0.58
#ins_w_inc	#SPLL_I	0.06	0.00	H	C_I	0.00	0.56
L	E_I	0.06	0.00	M	co_exp	0.00	0.55
#acc	tot_inc_I	0.06	0.00	W	#MAJ_I	0.00	0.56
#SPLL	G	0.06	0.00	C_I	SUL_PROD_FLAG	0.00	0.54

#FIRE	bed_count	0.06	0.00	#SPLL_I	SUL_PROD_FLAG	0.00	0.54
S_I	SLOT_COUNT	0.06	0.00	INCS/COMP	#VESS_I	0.00	0.54
#MIN_I	#ins_w_inc_I	0.06	0.00	H	co_exp_I	0.00	0.54
#SPLL_I	HELIPORT_FLAG	0.06	0.00	#EXP	C_I	0.00	0.54
L	GAS_PROD_FLAG	0.06	0.00	co_exp_I	OIL_PROD_FLAG	0.00	0.53
#SPLL_I	WATER_DEPTH	0.06	0.00	co_exp	#EXP_I	0.00	0.53
#MIN_I	COMPRESSOR_FLAG	0.06	0.00	#VESS	co_ming_prod	0.00	0.53
E_I	GAS_PROD_FLAG	0.06	0.00	#EXP	P_I	0.00	0.53
bed_count	co_ming_prod	0.06	0.00	M	op_exp	0.00	0.52
#acc_I	W_I	0.06	0.00	#VESS_I	G_I	0.00	0.51
#MIN_I	crane_count	0.06	0.00	op_exp	H_I	0.00	0.51
#SPLL	HELIPORT_FLAG	0.06	0.00	co_exp	GAS_FLARING_FLAG	0.00	0.50
#SPLL_I	W_I	0.06	0.00	G	#VESS_I	0.00	0.50
co_ming_prod	WATER_DEPTH	0.06	0.00	H	co_exp	0.00	0.50
S_I	SLOT_DRILL_COUNT	0.06	0.00	#VESS	INCS/COMP	0.00	0.50
#MIN	FIRED_VESSEL_FL	0.06	0.00	W	SUL_PROD_FLAG	0.00	0.48
#SPLL	GAS_FLARING_FLAG	0.06	0.00	#acc_I	SUL_PROD_FLAG	0.00	0.47
L	GAS_FLARING_FLAG	0.06	0.00	H	WATER_DEPTH	0.00	0.48
S_I	FIRED_VESSEL_FL	0.06	0.00	tot_inc_I	SUL_PROD_FLAG	0.00	0.46
#MIN_I	MAJ_CMPLX_FLAG	0.06	0.00	#ins_no_inc	#FAT_I	0.00	0.46
S_I	HELIPORT_FLAG	0.06	0.00	#ins_no_inc	#MAJ_I	0.00	0.46
#SPLL_I	GAS_FLARING_FLAG	0.06	0.00	#MAJ	co_exp_I	0.00	0.46
#MIN	E	0.06	0.00	H_I	op_exp_I	0.00	0.46
#MIN	HELIPORT_FLAG	0.06	0.00	#ins_no_inc	GAS_FLARING_FLAG	0.00	0.46
S_I	DISTANCE_TO_SH	0.06	0.00	tot_inc	SUL_PROD_FLAG	0.00	0.45
#MIN	#ins_w_inc_I	0.06	0.00	#FAT_I	STORE_TANK_FLAG	0.00	0.45
#SPLL_I	DISTANCE_TO_SH	0.06	0.00	#VESS_I	W_I	0.00	0.45
M	HELIPORT_FLAG	0.05	0.00	#MAJ_I	STORE_TANK_FLAG	0.00	0.45
#FIRE	#ins_w_inc	0.05	0.00	W	#VESS_I	0.00	0.44
#acc	P_I	0.05	0.00	#VESS	tot_inc	0.00	0.45
#VESS	#FIRE	0.05	0.00	#ins_w_inc_I	co_ming_prod	0.00	0.44
#acc	GAS_PROD_FLAG	0.05	0.00	#VESS_I	#ins_w_inc_I	0.00	0.44
#MIN_I	tot_inc_I	0.05	0.00	op_exp	#EXP_I	0.00	0.43
#acc_I	GAS_FLARING_FLAG	0.05	0.00	#EXP	co_exp	0.00	0.44
#MIN	tot_inc_I	0.05	0.00	co_exp_I	GAS_FLARING_FLAG	0.00	0.41
#MIN	C_I	0.05	0.00	S_I	SUL_PROD_FLAG	0.00	0.42
#acc	GAS_FLARING_FLAG	0.05	0.00	C	#VESS_I	0.00	0.41
L_I	GAS_PROD_FLAG	0.05	0.00	S	SUL_PROD_FLAG	0.00	0.42
#MIN_I	SLOT_COUNT	0.05	0.00	#VESS	G	0.00	0.41
#acc_I	FIRED_VESSEL_FL	0.05	0.00	H_I	WATER_DEPTH	0.00	0.41
#FIRE	#ins_w_inc_I	0.05	0.00	PLATFORM_AGE	HELIPORT_FLAG	0.00	0.40
E_I	GAS_FLARING_FLAG	0.05	0.00	PLATFORM_AGE	#EXP_I	0.00	0.40
#acc	S	0.05	0.00	H	DISTANCE_TO_SH	0.00	0.40
#acc_I	E_I	0.05	0.00	H	OIL_PROD_FLAG	0.00	0.40
#FIRE	DISTANCE_TO_SH	0.05	0.00	P	#VESS_I	0.00	0.40
#FIRE	SLOT_DRILL_COUNT	0.05	0.00	#VESS	tot_inc_I	0.00	0.40
GAS_FLARING_FLAG	DISTANCE_TO_SH	0.05	0.00	#EXP_I	op_exp_I	0.00	0.39
W	M_I	0.05	0.00	H	PLATFORM_AGE	0.00	0.39
M	G_I	0.05	0.00	#INJ	op_exp	0.00	0.39
PLATFORM_AGE	NUM_COMP	0.05	0.00	#VESS	#ins_w_inc	0.00	0.39
E	GAS_FLARING_FLAG	0.05	0.00	M	op_exp_I	-0.01	0.39
#VESS	#INJ	0.05	0.00	P_I	SUL_PROD_FLAG	-0.01	0.36
#FIRE	C_I	0.05	0.00	#ins_no_inc	co_ming_prod	-0.01	0.35
#FIRE	SLOT_COUNT	0.05	0.00	tot_inc	#VESS_I	-0.01	0.36
#MIN_I	bed_count	0.05	0.00	#INJ	op_exp_I	-0.01	0.35
#MIN_I	SLOT_DRILL_COUNT	0.05	0.00	H_I	DISTANCE_TO_SH	-0.01	0.34
#FIRE	FIRED_VESSEL_FL	0.05	0.00	H	GAS_PROD_FLAG	-0.01	0.35
#SPLL	DISTANCE_TO_SH	0.05	0.00	#VESS	W	-0.01	0.35
#MIN_I	C_I	0.05	0.00	#VESS	C_I	-0.01	0.33
#acc_I	G_I	0.05	0.00	#MAJ_I	op_exp_I	-0.01	0.32
E	#SPLL_I	0.05	0.00	op_exp	#MAJ_I	-0.01	0.32
#FIRE	MAJ_CMPLX_FLAG	0.05	0.00	M	co_exp_I	-0.01	0.32
#FIRE	C	0.05	0.00	#MAJ	co_exp	-0.01	0.32
S	L_I	0.05	0.00	H_I	SLOT_DRILL_COUNT	-0.01	0.31
#acc_I	GAS_PROD_FLAG	0.05	0.00	PLATFORM_AGE	#VESS_I	-0.01	0.31
INCS/COMP	E_I	0.05	0.00	#VESS	HELIPORT_FLAG	-0.01	0.32
#FIRE_I	NUM_COMP	0.05	0.00	#VESS	P_I	-0.01	0.32
#MIN_I	P_I	0.05	0.00	#EXP	op_exp	-0.01	0.31
L	DISTANCE_TO_SH	0.05	0.00	#EXP	PLATFORM_AGE	-0.01	0.30
#MIN	W	0.05	0.00	PLATFORM_AGE	SUL_PROD_FLAG	-0.01	0.30

#VESS_I	#FIRE_I	0.05	0.00	L	op_exp_I	-0.01	0.30
E	#acc_I	0.05	0.00	P	SUL_PROD_FLAG	-0.01	0.30
L	WATER_DEPTH	0.05	0.00	#EXP_I	GAS_PROD_FLAG	-0.01	0.29
#FIRE	STORE_TANK_FLAG	0.05	0.00	#ins_no_inc	#SPLL_I	-0.01	0.29
#FIRE	tot_inc_I	0.05	0.00	G	co_ming_prod	-0.01	0.29
M	SLOT_COUNT	0.05	0.00	#EXP	GAS_PROD_FLAG	-0.01	0.29
L_I	GAS_FLARING_FLAG	0.05	0.00	#EXP	op_exp_I	-0.01	0.29
M_I	bed_count	0.05	0.00	op_exp_I	STORE_TANK_FLAG	-0.01	0.28
#MIN_I	FIRED_VESSEL_FL	0.05	0.00	H_I	SLOT_COUNT	-0.01	0.28
co_ming_prod	FIRED_VESSEL_FL	0.05	0.00	H_I	co_exp_I	-0.01	0.28
#MIN_I	STORE_TANK_FLAG	0.05	0.00	#MAJ_I	co_exp_I	-0.01	0.26
M_I	L_I	0.05	0.00	co_exp	H_I	-0.01	0.26
#ins_no_inc_I	bed_count	0.05	0.00	#VESS	#ins_no_inc_I	-0.01	0.26
M_I	HELIPORT_FLAG	0.05	0.00	G_I	co_ming_prod	-0.01	0.24
#MIN_I	HELIPORT_FLAG	0.05	0.00	L	op_exp	-0.01	0.25
#MIN	G_I	0.05	0.00	#MAJ_I	OIL_PROD_FLAG	-0.01	0.23
#SPLL_I	G_I	0.05	0.00	#ins_no_inc	S_I	-0.01	0.23
#MIN	OIL_PROD_FLAG	0.05	0.00	H_I	GAS_PROD_FLAG	-0.01	0.22
op_exp_I	SLOT_COUNT	0.05	0.00	co_exp	#MAJ_I	-0.01	0.22
#FIRE	WATER_DEPTH	0.05	0.00	co_exp	OIL_PROD_FLAG	-0.01	0.21
#SPLL	#ins_w_inc_I	0.05	0.00	H	SLOT_DRILL_COUNT	-0.01	0.22
#SPLL	S	0.05	0.00	H	SLOT_COUNT	-0.01	0.22
op_exp	SLOT_COUNT	0.05	0.00	#VESS	#ins_w_inc_I	-0.01	0.21
#MIN_I	DISTANCE_TO_SH	0.05	0.00	op_exp	STORE_TANK_FLAG	-0.01	0.19
M	DISTANCE_TO_SH	0.05	0.00	#ins_no_inc_I	SUL_PROD_FLAG	-0.01	0.17
#SPLL	#VESS	0.05	0.00	#ins_no_inc	STORE_TANK_FLAG	-0.01	0.17
M_I	DISTANCE_TO_SH	0.05	0.00	#ins_no_inc_I	GAS_FLARING_FLAG	-0.01	0.16
#SPLL	tot_inc_I	0.05	0.00	#FIRE_I	co_ming_prod	-0.01	0.16
#ins_no_inc	bed_count	0.05	0.00	INCS/COMP	SUL_PROD_FLAG	-0.01	0.16
crane_count	SUL_PROD_FLAG	0.05	0.00	#ins_w_inc	#VESS_I	-0.01	0.16
#FIRE	G_I	0.05	0.00	PLATFORM_AGE	co_ming_prod	-0.01	0.14
M	SLOT_DRILL_COUNT	0.04	0.00	#SPLL	op_exp_I	-0.01	0.13
#SPLL_I	E_I	0.04	0.00	#SPLL	op_exp	-0.01	0.12
E	WATER_DEPTH	0.04	0.00	#EXP	co_exp_I	-0.01	0.11
S	OIL_PROD_FLAG	0.04	0.00	#SPLL	#ins_no_inc_I	-0.01	0.11
#SPLL_I	GAS_PROD_FLAG	0.04	0.00	#VESS	PLATFORM_AGE	-0.01	0.09
#MIN_I	WATER_DEPTH	0.04	0.00	#ins_no_inc_I	co_ming_prod	-0.01	0.09
#MIN_I	E_I	0.04	0.00	#ins_no_inc	L_I	-0.01	0.09
#ins_no_inc_I	co_exp_I	0.04	0.00	#FIRE	co_ming_prod	-0.01	0.08
G	M_I	0.04	0.00	#acc	co_exp	-0.01	0.08
#FIRE_I	bed_count	0.04	0.00	#SPLL_I	op_exp_I	-0.01	0.07
#FIRE_I	crane_count	0.04	0.00	#acc	op_exp	-0.01	0.07
#MIN	P_I	0.04	0.00	op_exp	#SPLL_I	-0.01	0.07
#SPLL	GAS_PROD_FLAG	0.04	0.00	#acc	op_exp_I	-0.01	0.06
#acc_I	S_I	0.04	0.00	#acc	co_exp_I	-0.01	0.05
#acc	G_I	0.04	0.00	INCS/COMP	MAJ_CMPLX_FLAG	-0.01	0.04
S_I	OIL_PROD_FLAG	0.04	0.00	SUL_PROD_FLAG	DISTANCE_TO_SH	-0.01	0.04
#acc	W_I	0.04	0.00	#acc_I	op_exp_I	-0.01	0.04
M	WATER_DEPTH	0.04	0.00	op_exp	#acc_I	-0.01	0.04
#MIN	GAS_PROD_FLAG	0.04	0.00	co_exp_I	HELIPORT_FLAG	-0.01	0.02
PLATFORM_AGE	#ins_no_inc_I	0.04	0.00	#ins_no_inc_I	STORE_TANK_FLAG	-0.01	0.01
#SPLL	C_I	0.04	0.00	#acc_I	co_exp_I	-0.01	0.01
#MIN_I	W_I	0.04	0.00	#ins_no_inc	OIL_PROD_FLAG	-0.01	0.01
#FIRE	tot_inc	0.04	0.00	op_exp	SUL_PROD_FLAG	-0.02	0.01
PLATFORM_AGE	STORE_TANK_FLAG	0.04	0.00	S_I	op_exp_I	-0.02	0.01
#SPLL	P_I	0.04	0.00	op_exp	S_I	-0.02	0.01
L_I	DISTANCE_TO_SH	0.04	0.00	PLATFORM_AGE	MAJ_CMPLX_FLAG	-0.02	0.01
#MIN	G	0.04	0.00	op_exp_I	SUL_PROD_FLAG	-0.02	0.01
E	L_I	0.04	0.00	#SPLL	co_exp	-0.02	0.00
M_I	SLOT_COUNT	0.04	0.00	#SPLL_I	co_exp_I	-0.02	0.00
S	GAS_PROD_FLAG	0.04	0.00	co_exp	#acc_I	-0.02	0.00
L	S_I	0.04	0.00	S	op_exp	-0.02	0.00
#SPLL	#MAJ	0.04	0.00	S	op_exp_I	-0.02	0.00
M_I	WATER_DEPTH	0.04	0.00	L	#ins_no_inc_I	-0.02	0.00
#FIRE	HELIPORT_FLAG	0.04	0.00	S_I	co_exp_I	-0.02	0.00
STORE_TANK_FLAG	SUL_PROD_FLAG	0.04	0.00	co_exp	S_I	-0.02	0.00
#FIRE_I	COMPRESSOR_FLAG	0.04	0.00	#SPLL	co_exp_I	-0.02	0.00
M_I	SLOT_DRILL_COUNT	0.04	0.00	PLATFORM_AGE	COMPRESSOR_FLAG	-0.02	0.00
#MIN	M	0.04	0.00	co_exp	#SPLL_I	-0.02	0.00
#SPLL_I	S_I	0.04	0.00	#ins_no_inc	MAJ_CMPLX_FLAG	-0.02	0.00

#FIRE	P_I	0.04	0.00	#ins_no_inc_I	OIL_PROD_FLAG	-0.02	0.00
#SPLL	FIRED_VESSEL_FL	0.04	0.00	PLATFORM_AGE	crane_count	-0.02	0.00
#FIRE_I	WATER_DEPTH	0.04	0.00	INCS/COMP	WATER_DEPTH	-0.02	0.00
#FIRE_I	MAJ_CMPLX_FLAG	0.04	0.00	INCS/COMP	FIRED_VESSEL_FL	-0.02	0.00
#FIRE	P	0.04	0.00	#ins_no_inc	C_I	-0.02	0.00
#MIN	W_I	0.04	0.00	INCS/COMP	bed_count	-0.02	0.00
PLATFORM_AGE	G_I	0.04	0.00	E_I	op_exp_I	-0.02	0.00
tot_inc	#MIN_I	0.04	0.00	L_I	co_exp_I	-0.02	0.00
#FIRE_I	FIRED_VESSEL_FL	0.04	0.00	co_exp	L_I	-0.02	0.00
#SPLL	#FIRE	0.04	0.00	#ins_no_inc	E_I	-0.02	0.00
#SPLL_I	FIRED_VESSEL_FL	0.04	0.00	op_exp_I	COMPRESSOR_FLAG	-0.02	0.00
E_I	WATER_DEPTH	0.04	0.00	#ins_no_inc	G_I	-0.02	0.00
NUM_COMP	SUL_PROD_FLAG	0.04	0.00	INCS/COMP	STORE_TANK_FLAG	-0.02	0.00
op_exp_I	NUM_COMP	0.04	0.00	op_exp	E_I	-0.02	0.00
L_I	WATER_DEPTH	0.04	0.00	#ins_no_inc	PLATFORM_AGE	-0.02	0.00
OIL_PROD_FLAG	DISTANCE_TO_SH	0.04	0.00	S	co_exp_I	-0.02	0.00
M	GAS_PROD_FLAG	0.04	0.00	S	co_exp	-0.02	0.00
#SPLL	W_I	0.04	0.00	INCS/COMP	crane_count	-0.02	0.00
W_I	H_I	0.04	0.00	INCS/COMP	GAS_FLARING_FLAG	-0.02	0.00
#ins_w_inc	#MIN_I	0.04	0.00	co_exp_I	SUL_PROD_FLAG	-0.02	0.00
#acc	L_I	0.04	0.00	co_exp	SUL_PROD_FLAG	-0.02	0.00
#FIRE_I	DISTANCE_TO_SH	0.04	0.00	op_exp_I	crane_count	-0.02	0.00
H	INCS/COMP	0.04	0.00	#ins_no_inc	op_exp	-0.02	0.00
L	#SPLL_I	0.04	0.00	op_exp	COMPRESSOR_FLAG	-0.02	0.00
op_exp	NUM_COMP	0.04	0.00	S	#ins_no_inc_I	-0.02	0.00
W	H	0.04	0.00	co_exp_I	SLOT_DRILL_COUNT	-0.02	0.00
S_I	GAS_PROD_FLAG	0.04	0.00	INCS/COMP	SLOT_COUNT	-0.03	0.00
#VESS_I	#SPLL_I	0.04	0.00	op_exp	crane_count	-0.03	0.00
#FIRE	E	0.04	0.00	#ins_no_inc	op_exp_I	-0.03	0.00
PLATFORM_AGE	#ins_w_inc_I	0.04	0.00	L	co_exp	-0.03	0.00
#FIRE_I	SLOT_DRILL_COUNT	0.04	0.00	M_I	#ins_no_inc_I	-0.03	0.00
#FIRE_I	#ins_w_inc_I	0.04	0.00	INCS/COMP	co_ming_prod	-0.03	0.00
#MAJ	#FIRE	0.04	0.00	#ins_no_inc_I	MAJ_CMPLX_FLAG	-0.03	0.00
#FIRE_I	SLOT_COUNT	0.04	0.00	co_exp	GAS_PROD_FLAG	-0.03	0.00
#MIN	L_I	0.04	0.00	INCS/COMP	SLOT_DRILL_COUNT	-0.03	0.00
P	#MIN_I	0.04	0.00	E	op_exp_I	-0.03	0.00
#MIN	S	0.04	0.00	E	#ins_no_inc_I	-0.03	0.00
S	#SPLL_I	0.04	0.00	co_exp_I	bed_count	-0.03	0.00
#MIN_I	G_I	0.04	0.00	#ins_no_inc	#ins_w_inc_I	-0.03	0.00
PLATFORM_AGE	W_I	0.04	0.00	co_exp	crane_count	-0.03	0.00
S	WATER_DEPTH	0.04	0.00	E	op_exp	-0.03	0.00
C	#MIN_I	0.03	0.00	INCS/COMP	#ins_no_inc_I	-0.03	0.00
#ins_no_inc	HELIPORT_FLAG	0.03	0.00	#ins_no_inc	WATER_DEPTH	-0.03	0.00
M	E	0.03	0.00	co_exp	bed_count	-0.03	0.00
W	#MIN_I	0.03	0.00	L	co_exp_I	-0.03	0.00
#MIN_I	OIL_PROD_FLAG	0.03	0.00	C	#ins_no_inc_I	-0.03	0.00
S	M_I	0.03	0.00	C_I	op_exp_I	-0.03	0.00
G	#EXP_I	0.03	0.00	S_I	#ins_no_inc_I	-0.03	0.00
S	GAS_FLARING_FLAG	0.03	0.00	S	#ins_no_inc	-0.03	0.00
PLATFORM_AGE	L_I	0.03	0.00	op_exp	C_I	-0.03	0.00
W	#EXP_I	0.03	0.00	INCS/COMP	COMPRESSOR_FLAG	-0.03	0.00
#MIN_I	GAS_PROD_FLAG	0.03	0.00	E_I	co_exp_I	-0.03	0.00
M_I	GAS_PROD_FLAG	0.03	0.00	M	#ins_no_inc	-0.03	0.00
tot_inc	#EXP_I	0.03	0.00	#ins_no_inc	P_I	-0.03	0.00
#FAT	SLOT_COUNT	0.03	0.00	co_exp_I	SLOT_COUNT	-0.03	0.00
SUL_PROD_FLAG	GAS_FLARING_FLAG	0.03	0.00	P_I	op_exp_I	-0.03	0.00
PLATFORM_AGE	E_I	0.03	0.00	co_exp	SLOT_DRILL_COUNT	-0.03	0.00
M_I	E_I	0.03	0.00	#ins_no_inc	tot_inc_I	-0.03	0.00
M	GAS_FLARING_FLAG	0.03	0.00	op_exp	P_I	-0.04	0.00
M	OIL_PROD_FLAG	0.03	0.00	#ins_no_inc	SLOT_COUNT	-0.04	0.00
M	INCS/COMP	0.03	0.00	INCS/COMP	OIL_PROD_FLAG	-0.04	0.00
#SPLL	L_I	0.03	0.00	W_I	op_exp_I	-0.04	0.00
#FAT	SLOT_DRILL_COUNT	0.03	0.00	#ins_no_inc_I	SLOT_COUNT	-0.04	0.00
#FIRE	W_I	0.03	0.00	co_exp	E_I	-0.04	0.00
#FIRE	S	0.03	0.00	G_I	op_exp_I	-0.04	0.00
INCS/COMP	S_I	0.03	0.00	op_exp	W_I	-0.04	0.00
M	L_I	0.03	0.00	op_exp	G_I	-0.04	0.00
#MIN	M_I	0.03	0.00	#ins_w_inc	#ins_no_inc_I	-0.04	0.00
#MIN	L	0.03	0.00	E	co_exp_I	-0.04	0.00
#ins_no_inc	GAS_PROD_FLAG	0.03	0.00	tot_inc_I	op_exp_I	-0.04	0.00

#INJ	NUM_COMP	0.03	0.00	op_exp	tot_inc_I	-0.04	0.00
S	M	0.03	0.00	co_exp_I	GAS_PROD_FLAG	-0.04	0.00
#FIRE_I	STORE_TANK_FLAG	0.03	0.00	P	#ins_no_inc_I	-0.04	0.00
G	#MIN_I	0.03	0.00	co_exp_I	NUM_COMP	-0.04	0.00
#INJ	C	0.03	0.00	#ins_no_inc_I	SLOT_DRILL_COUNT	-0.04	0.00
#acc	L	0.03	0.00	co_exp	SLOT_COUNT	-0.04	0.00
#FIRE_I	E_I	0.03	0.00	C	op_exp_I	-0.04	0.00
#FIRE_I	#SPLL_I	0.03	0.00	C	op_exp	-0.04	0.00
S	#acc_I	0.03	0.00	co_exp_I	crane_count	-0.04	0.00
#acc	E_I	0.03	0.00	co_exp	INCS/COMP	-0.04	0.00
L	#acc_I	0.03	0.00	INCS/COMP	GAS_PROD_FLAG	-0.04	0.00
#MIN	#MIN_I	0.03	0.00	co_exp_I	STORE_TANK_FLAG	-0.04	0.00
#FIRE_I	HELIPORT_FLAG	0.03	0.00	co_exp	STORE_TANK_FLAG	-0.04	0.00
#FIRE	GAS_PROD_FLAG	0.03	0.00	C_I	co_exp_I	-0.04	0.00
#FIRE_I	S_I	0.03	0.00	INCS/COMP	HELIPORT_FLAG	-0.04	0.00
#MAJ	#MIN_I	0.03	0.00	G	op_exp_I	-0.04	0.00
#SPLL	G_I	0.03	0.00	#ins_no_inc	W_I	-0.04	0.00
#ins_no_inc	crane_count	0.03	0.00	P	op_exp_I	-0.04	0.00
PLATFORM_AGE	tot_inc_I	0.03	0.00	INCS/COMP	PLATFORM_AGE	-0.04	0.00
P	#EXP_I	0.03	0.00	#ins_no_inc	SLOT_DRILL_COUNT	-0.04	0.00
#ins_no_inc	H_I	0.03	0.00	W	op_exp_I	-0.04	0.00
G	PLATFORM_AGE	0.03	0.00	E	co_exp	-0.04	0.00
#FIRE	E_I	0.03	0.00	P	op_exp	-0.04	0.00
#MIN	GAS_FLARING_FLAG	0.03	0.00	op_exp_I	GAS_PROD_FLAG	-0.04	0.00
op_exp_I	GAS_FLARING_FLAG	0.03	0.00	G	op_exp	-0.04	0.00
S_I	GAS_FLARING_FLAG	0.03	0.00	co_exp	NUM_COMP	-0.04	0.00
#MIN_I	S_I	0.03	0.00	co_exp	DISTANCE_TO_SH	-0.04	0.00
#INJ	P	0.03	0.00	INCS/COMP	co_exp_I	-0.04	0.00
L	PLATFORM_AGE	0.03	0.00	op_exp	GAS_PROD_FLAG	-0.04	0.00
#MAJ	tot_inc	0.03	0.00	W	op_exp	-0.04	0.00
H	crane_count	0.03	0.00	P_I	co_exp_I	-0.05	0.00
#INJ	MAJ_CMPLX_FLAG	0.03	0.00	G	#ins_no_inc_I	-0.05	0.00
#INJ	HELIPORT_FLAG	0.03	0.00	co_exp	C_I	-0.05	0.00
#acc	M	0.03	0.00	co_exp	WATER_DEPTH	-0.05	0.00
SUL_PROD_FLAG	MAJ_CMPLX_FLAG	0.03	0.00	G_I	co_exp_I	-0.05	0.00
op_exp	GAS_FLARING_FLAG	0.03	0.00	co_exp	P_I	-0.05	0.00
#FIRE	S_I	0.03	0.00	tot_inc	op_exp_I	-0.05	0.00
M_I	OIL_PROD_FLAG	0.03	0.00	tot_inc	#ins_no_inc_I	-0.05	0.00
#INJ_I	NUM_COMP	0.03	0.00	tot_inc	op_exp	-0.05	0.00
INCS/COMP	DISTANCE_TO_SH	0.03	0.00	#ins_w_inc_I	op_exp_I	-0.05	0.00
H	GAS_FLARING_FLAG	0.03	0.00	co_exp	FIRED_VESSEL_FL	-0.05	0.00
C	#EXP_I	0.03	0.00	op_exp	#ins_w_inc_I	-0.05	0.00
#FAT	bed_count	0.03	0.00	co_exp	MAJ_CMPLX_FLAG	-0.05	0.00
#MAJ	C	0.03	0.00	op_exp	INCS/COMP	-0.05	0.00
co_exp	co_ming_prod	0.03	0.00	INCS/COMP	op_exp_I	-0.05	0.00
OIL_PROD_FLAG	SUL_PROD_FLAG	0.03	0.00	C	co_exp	-0.05	0.00
#FAT	C_I	0.03	0.00	#ins_no_inc_I	WATER_DEPTH	-0.05	0.00
S_I	WATER_DEPTH	0.03	0.00	co_exp	G_I	-0.05	0.00
#INJ_I	STORE_TANK_FLAG	0.03	0.00	W_I	co_exp_I	-0.05	0.00
#INJ	#ins_w_inc	0.03	0.00	W	#ins_no_inc_I	-0.05	0.00
#FIRE	G	0.02	0.00	op_exp	WATER_DEPTH	-0.05	0.00
#FIRE	#FIRE_I	0.02	0.00	E_I	#ins_no_inc_I	-0.05	0.00
#MIN_I	L_I	0.02	0.00	co_exp	COMPRESSOR_FLAG	-0.05	0.00
co_exp_I	co_ming_prod	0.02	0.00	#ins_w_inc_I	co_exp_I	-0.05	0.00
#MIN_I	GAS_FLARING_FLAG	0.02	0.00	tot_inc_I	co_exp_I	-0.05	0.00
#FIRE	M	0.02	0.00	INCS/COMP	NUM_COMP	-0.05	0.00
#INJ_I	HELIPORT_FLAG	0.02	0.00	E	#ins_no_inc	-0.05	0.00
#INJ	tot_inc	0.02	0.00	co_exp	W_I	-0.05	0.00
co_exp	#ins_no_inc_I	0.02	0.00	co_exp_I	COMPRESSOR_FLAG	-0.06	0.00
#MAJ_I	#SPLL_I	0.02	0.00	co_exp_I	MAJ_CMPLX_FLAG	-0.06	0.00
H_I	GAS_FLARING_FLAG	0.02	0.00	P	co_exp	-0.06	0.00
#FIRE	OIL_PROD_FLAG	0.02	0.00	C	co_exp_I	-0.06	0.00
#MAJ	P	0.02	0.00	op_exp_I	WATER_DEPTH	-0.06	0.00
#FIRE	GAS_FLARING_FLAG	0.02	0.00	co_exp_I	WATER_DEPTH	-0.06	0.00
#MAJ	SLOT_DRILL_COUNT	0.02	0.00	L_I	#ins_no_inc_I	-0.06	0.00
#SPLL	#MIN_I	0.02	0.00	G	co_exp	-0.06	0.00
#INJ	crane_count	0.02	0.00	co_exp_I	DISTANCE_TO_SH	-0.06	0.00
#FAT	tot_inc	0.02	0.00	co_exp	tot_inc_I	-0.06	0.00
#FAT	C	0.02	0.00	#ins_w_inc	op_exp_I	-0.06	0.00
#MIN	#ins_no_inc	0.02	0.00	P	co_exp_I	-0.06	0.00

H_I	crane_count	0.02	0.00	co_exp_I	FIRED_VESSEL_FL	-0.06	0.00
W	PLATFORM_AGE	0.02	0.00	#ins_w_inc	op_exp	-0.06	0.00
#MAJ	G	0.02	0.00	co_exp	#ins_w_inc_I	-0.06	0.00
SUL_PROD_FLAG	SLOT_COUNT	0.02	0.00	G	co_exp_I	-0.06	0.00
SUL_PROD_FLAG	HELIPORT_FLAG	0.02	0.00	L	#ins_no_inc	-0.06	0.00
#ins_w_inc	#FIRE_I	0.02	0.00	W	co_exp	-0.06	0.00
#INJ	S	0.02	0.00	tot_inc	co_exp	-0.07	0.00
PLATFORM_AGE	GAS_FLARING_FLAG	0.02	0.00	W	co_exp_I	-0.07	0.00
L	M_I	0.02	0.00	PLATFORM_AGE	GAS_PROD_FLAG	-0.07	0.00
#FAT	crane_count	0.02	0.00	#ins_w_inc	co_exp	-0.07	0.00
#acc	INCS/COMP	0.02	0.00	tot_inc	co_exp_I	-0.07	0.00
#acc	#MIN_I	0.02	0.00	#ins_w_inc	co_exp_I	-0.07	0.00
SUL_PROD_FLAG	GAS_PROD_FLAG	0.02	0.00	co_ming_prod	DISTANCE_TO_SH	-0.08	0.00
#INJ	STORE_TANK_FLAG	0.02	0.00	#ins_no_inc	DISTANCE_TO_SH	-0.09	0.00
#MAJ	W	0.02	0.00	op_exp_I	FIRED_VESSEL_FL	-0.09	0.00
#FAT	NUM_COMP	0.02	0.00	op_exp	FIRED_VESSEL_FL	-0.09	0.00
#MIN	E_I	0.02	0.00	op_exp	DISTANCE_TO_SH	-0.10	0.00
#FAT	P	0.02	0.00	op_exp_I	DISTANCE_TO_SH	-0.10	0.00
#SPLL	L	0.02	0.00	#ins_no_inc_I	DISTANCE_TO_SH	-0.10	0.00
#INJ	COMPRESSOR_FLAG	0.02	0.00	G_I	#ins_no_inc_I	-0.11	0.00
#INJ	SLOT_COUNT	0.02	0.00	G	#ins_no_inc	-0.11	0.00
#INJ_I	MAJ_CMPLX_FLAG	0.02	0.00	C_I	#ins_no_inc_I	-0.12	0.00
#INJ_I	crane_count	0.02	0.00	PLATFORM_AGE	FIRED_VESSEL_FL	-0.12	0.00
#MAJ	COMPRESSOR_FLAG	0.02	0.00	C	#ins_no_inc	-0.12	0.00
#FIRE	#ins_no_inc	0.02	0.00	P_I	#ins_no_inc_I	-0.13	0.00
#MIN	#acc_I	0.02	0.00	W_I	#ins_no_inc_I	-0.13	0.00
#FAT_I	bed_count	0.02	0.00	P	#ins_no_inc	-0.14	0.00
#ins_no_inc	FIRED_VESSEL_FL	0.02	0.00	W	#ins_no_inc	-0.14	0.00
#INJ	GAS_FLARING_FLAG	0.02	0.00	tot_inc_I	#ins_no_inc_I	-0.14	0.00
#ins_no_inc_I	HELIPORT_FLAG	0.02	0.00	tot_inc	#ins_no_inc	-0.15	0.00
#acc_I	L_I	0.02	0.00	#ins_no_inc	INCS/COMP	-0.15	0.00
#FIRE	L_I	0.02	0.00	PLATFORM_AGE	WATER_DEPTH	-0.16	0.00
S_I	M_I	0.02	0.00	PLATFORM_AGE	DISTANCE_TO_SH	-0.21	0.00
#FIRE_I	GAS_FLARING_FLAG	0.02	0.00	#ins_w_inc_I	#ins_no_inc_I	-0.26	0.00
E	M_I	0.02	0.00	#ins_w_inc	#ins_no_inc	-0.28	0.00

Table 12 Pairwise Correlations

1.7 Logistic Regression Probability Plots

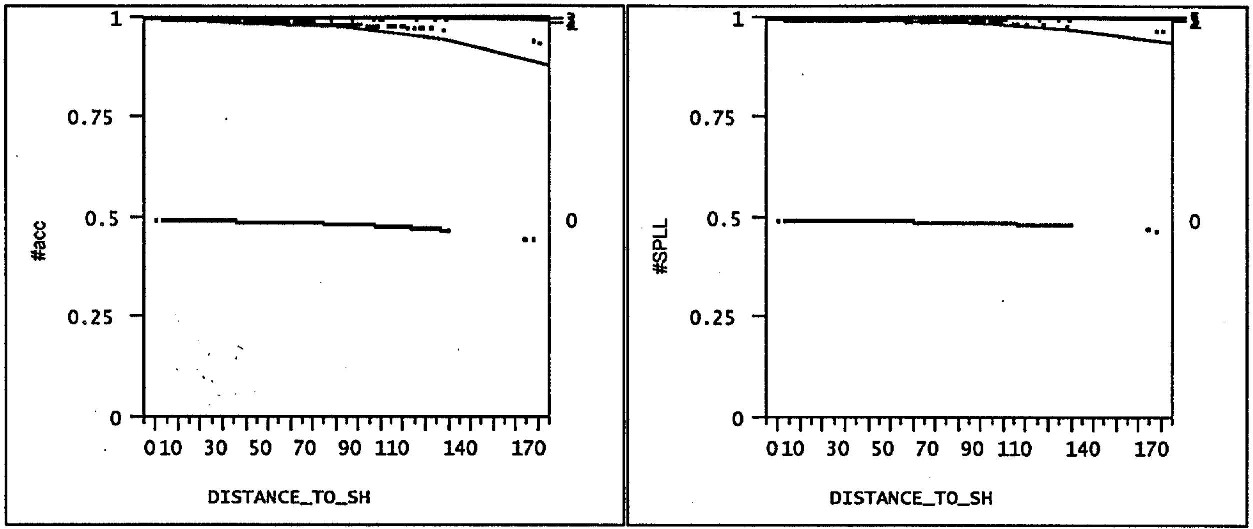


Figure -1 Logistic Regression Probability Plots – Distance to Shore

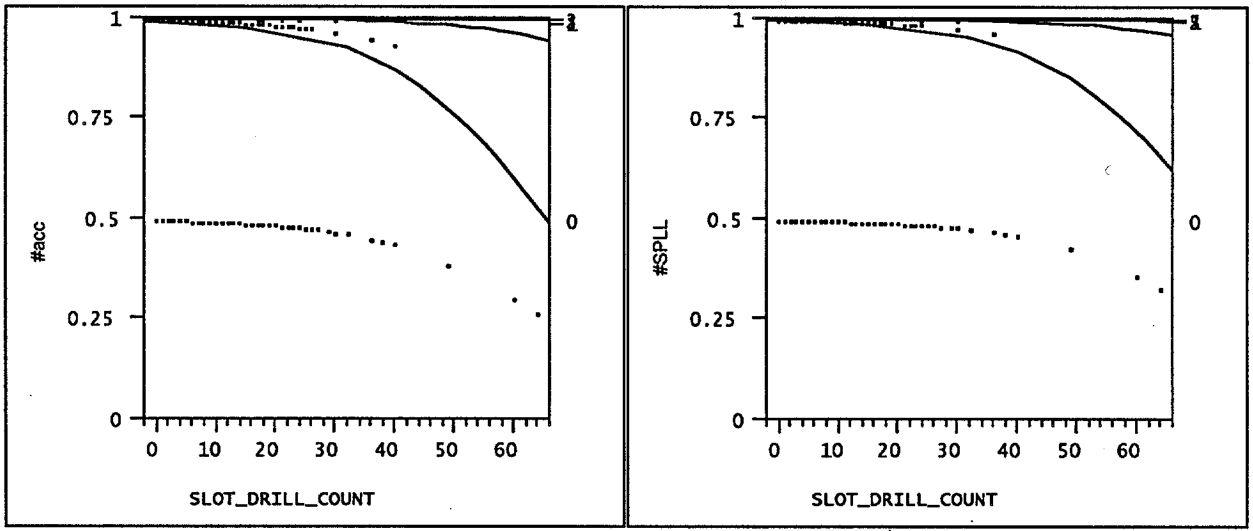


Figure -2 Logistic Regression Probability Plots – Slot Drill Count

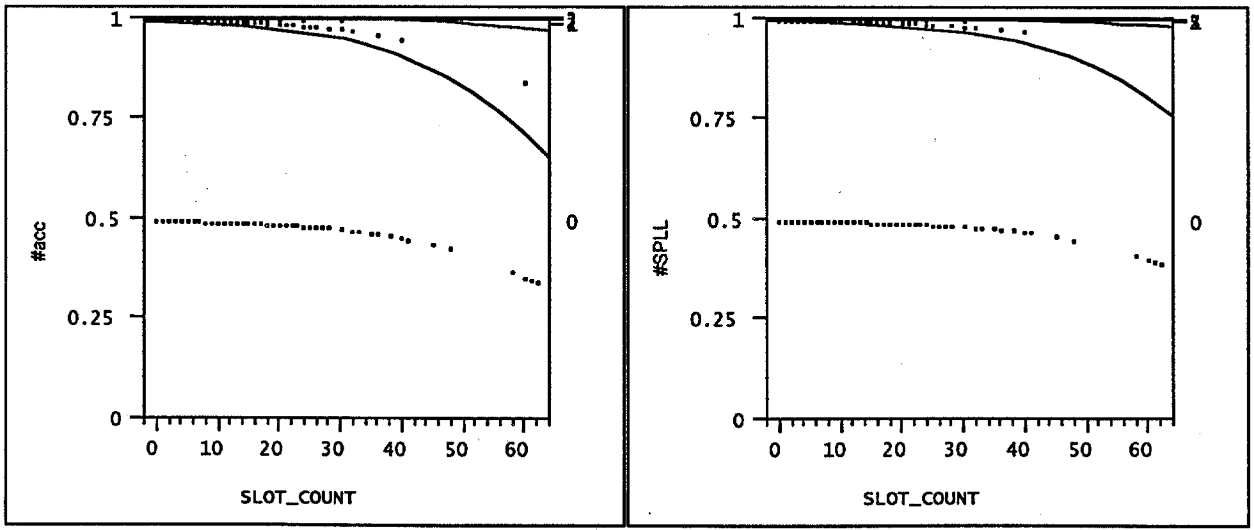


Figure -3 Logistic Regression Probability Plots – Slot Count

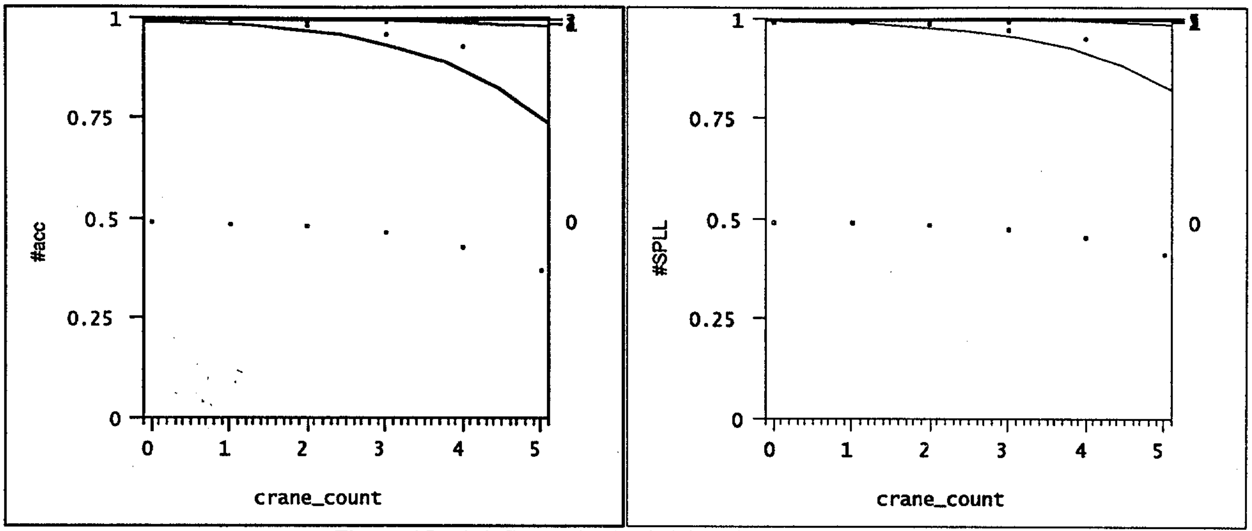


Figure -4 Logistic Regression Probability Plots – Crane Count

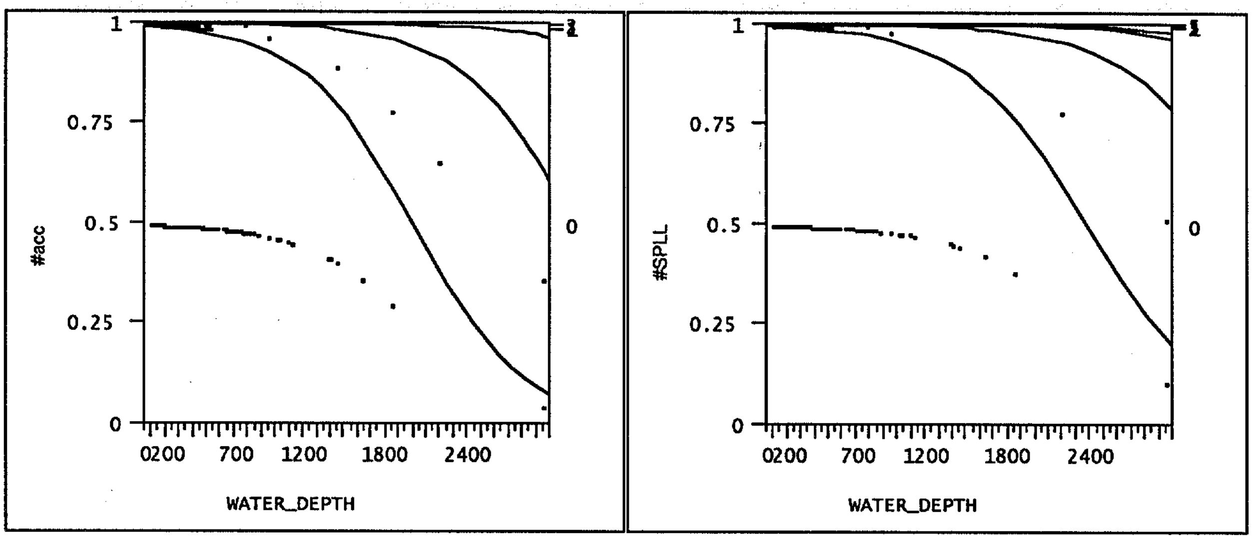


Figure -5 Logistic Regression Probability Plots – Water Depth

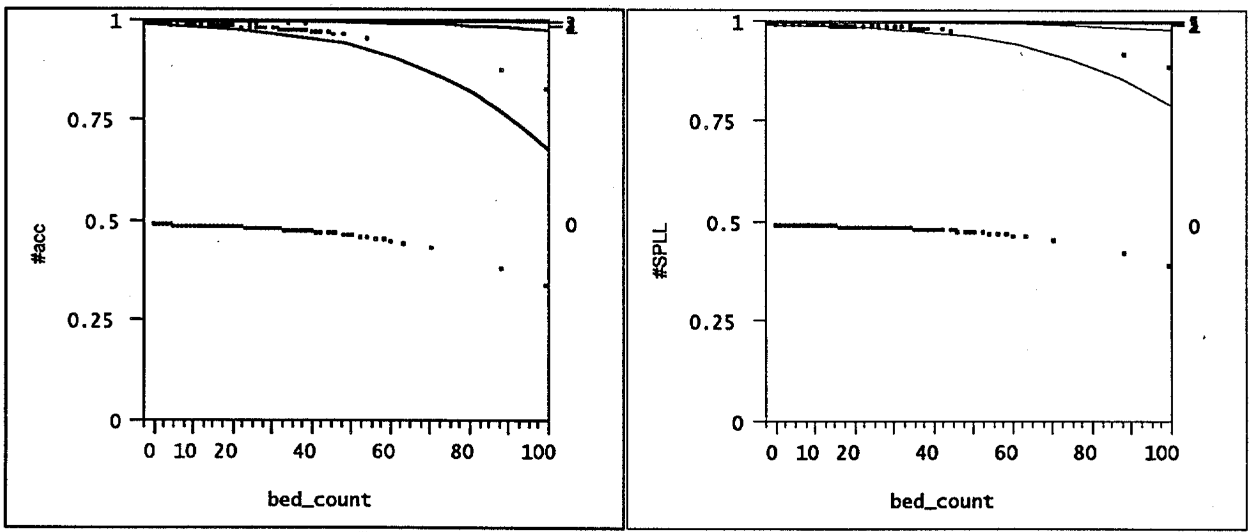


Figure -6 Logistic Regression Probability Plots – Bed Count

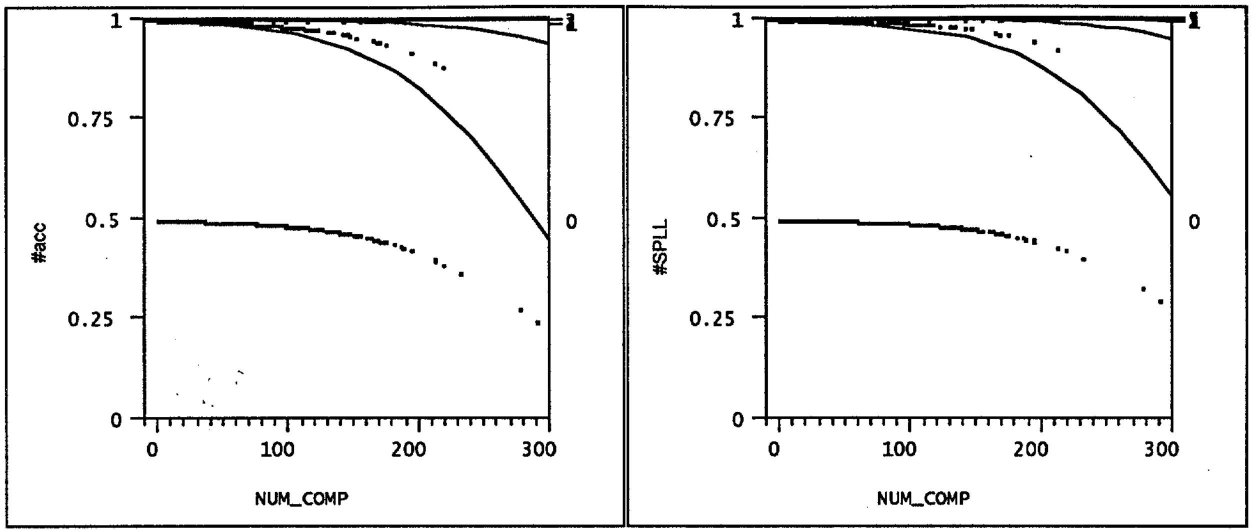


Figure -7 Logistic Regression Probability Plots – Number of Components

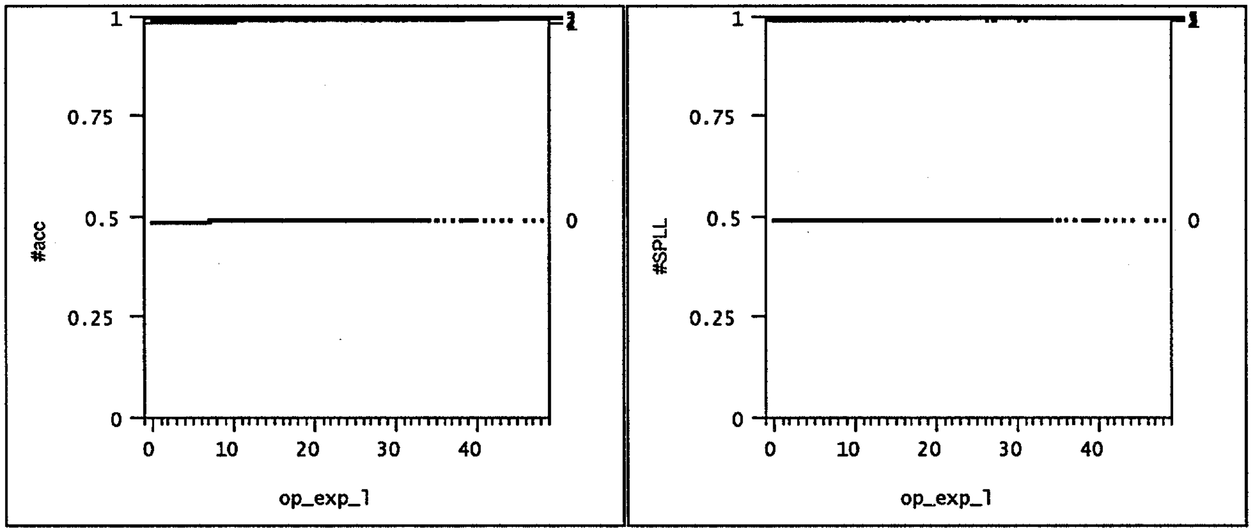


Figure -8 Logistic Regression Probability Plots – Lagged - Operator Experience Level

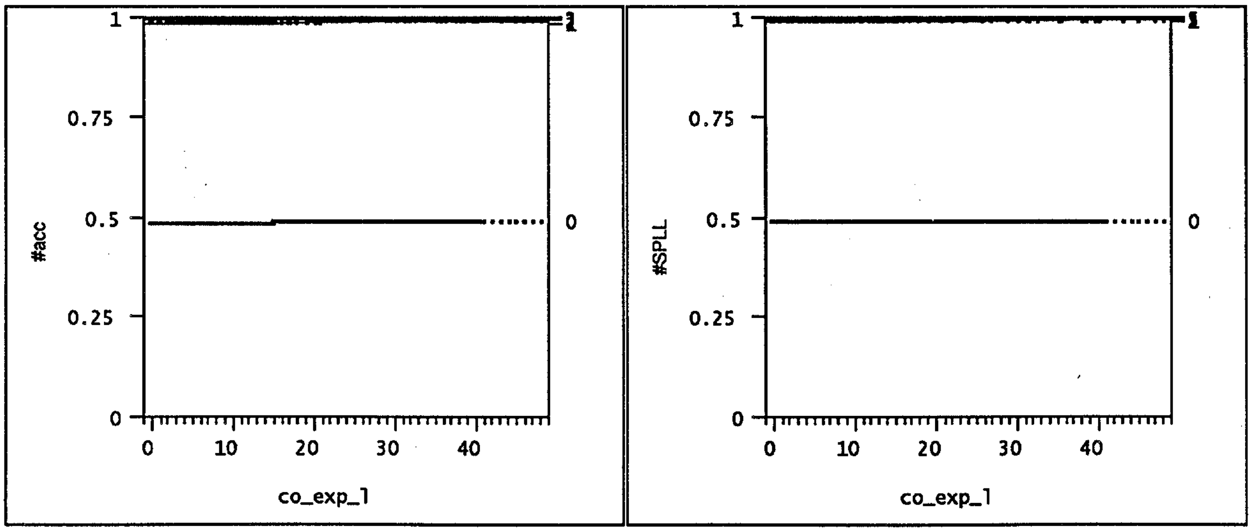


Figure -9 Logistic Regression Probability Plots – Lagged - Company Experience Level

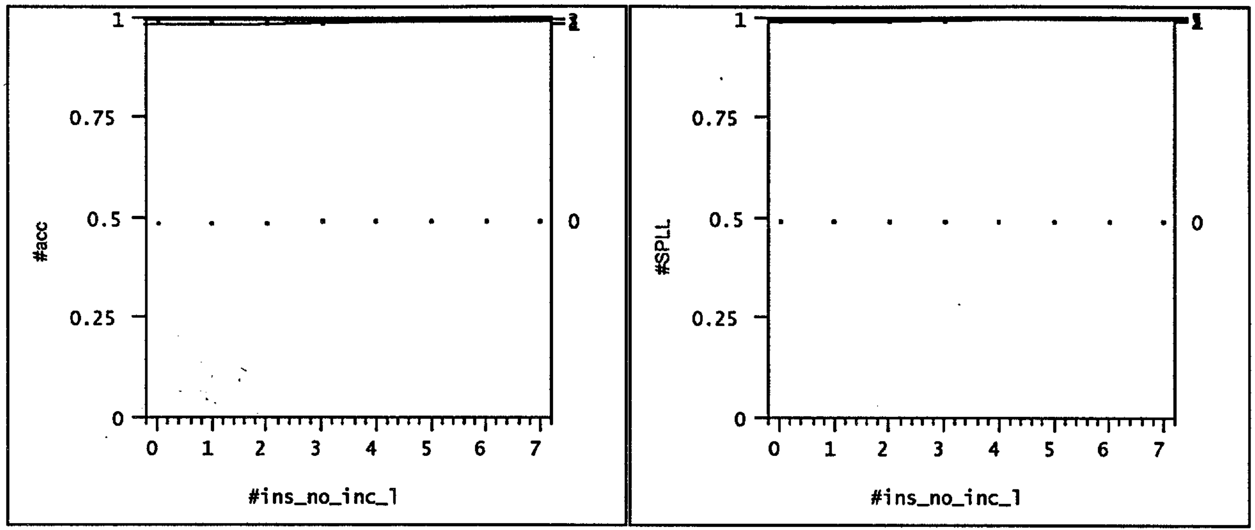


Figure -10 Logistic Regression Probability Plots – Lagged - # Inspections With no INC

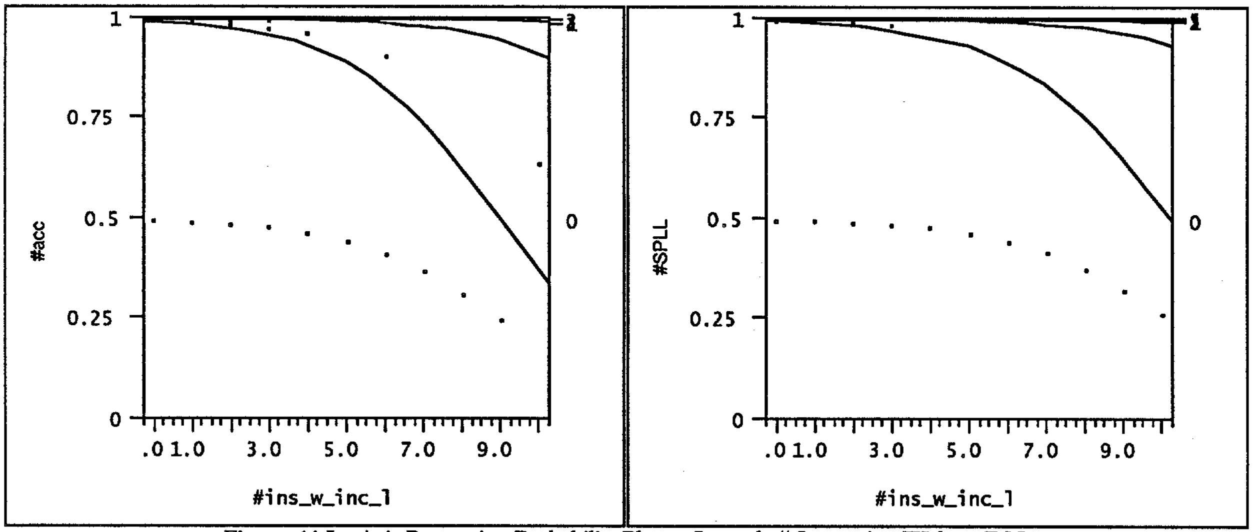


Figure -11 Logistic Regression Probability Plots – Lagged -# Inspection With an INC

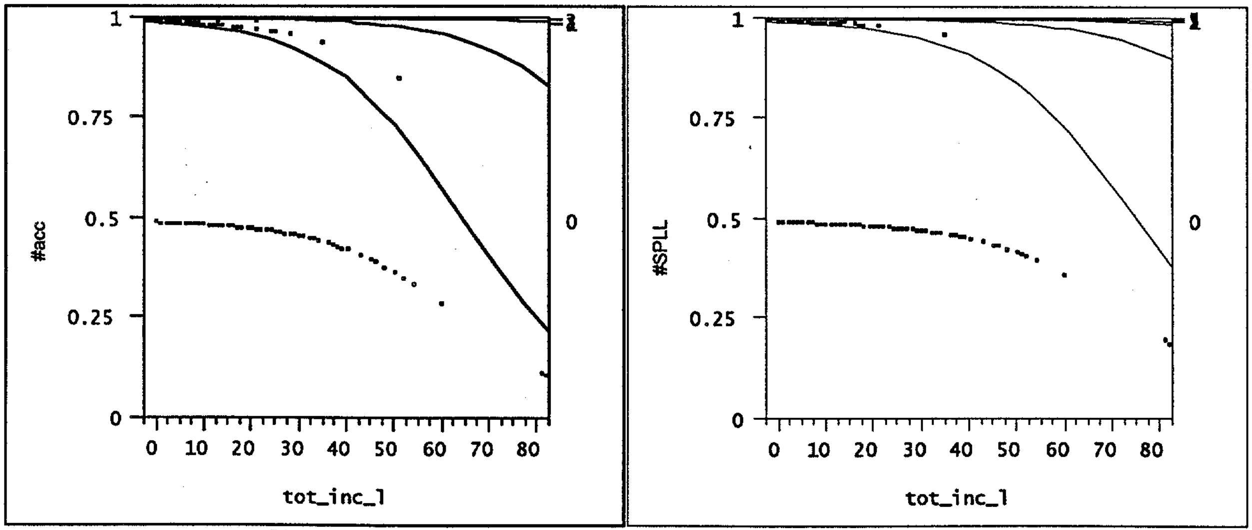


Figure -12 Logistic Regression Probability Plots – Lagged –Total # of INCs

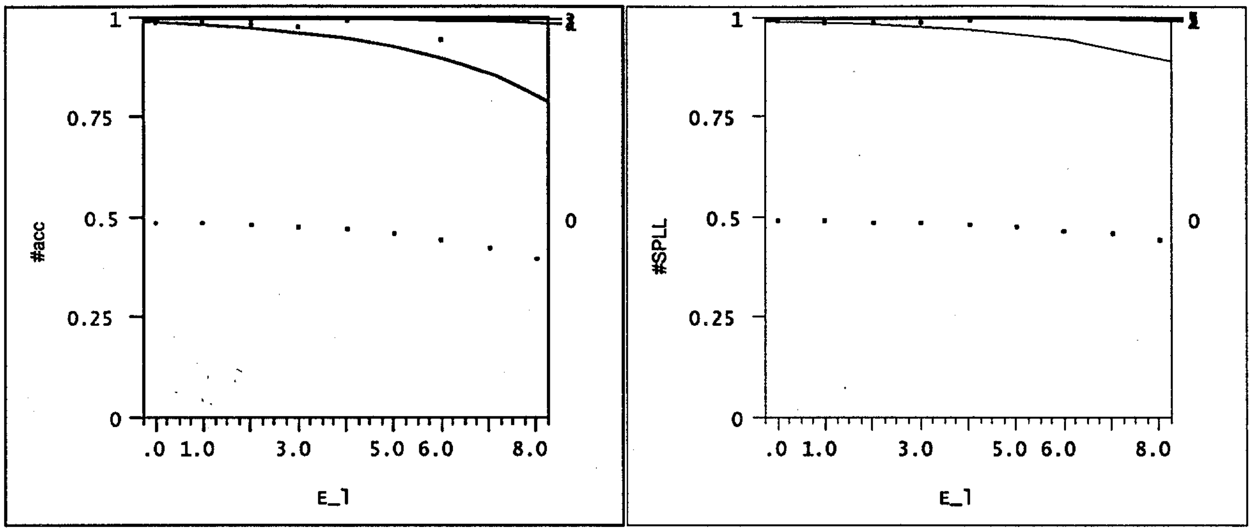


Figure -13 Logistic Regression Probability Plots – Lagged -# of E INCs

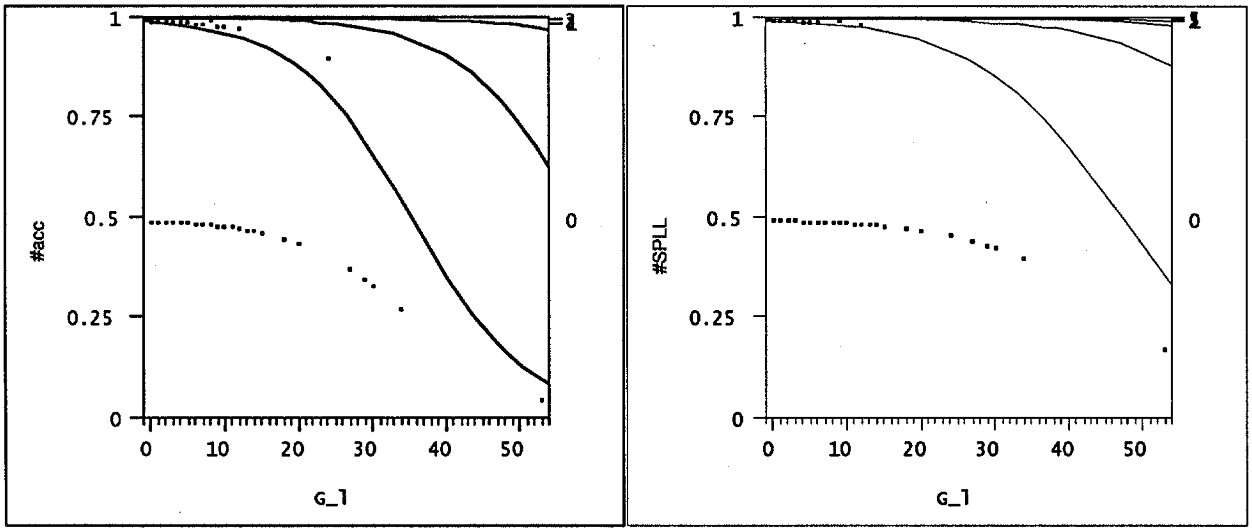


Figure -14 Logistic Regression Probability Plots – Lagged - # G INCs

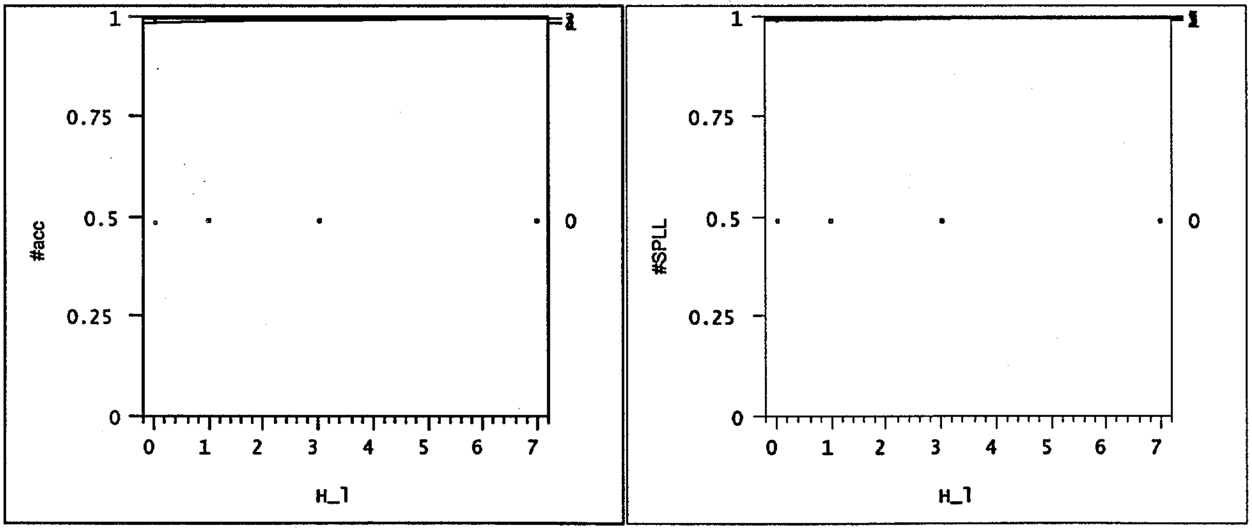


Figure -15 Logistic Regression Probability Plots – Lagged - # H INCs

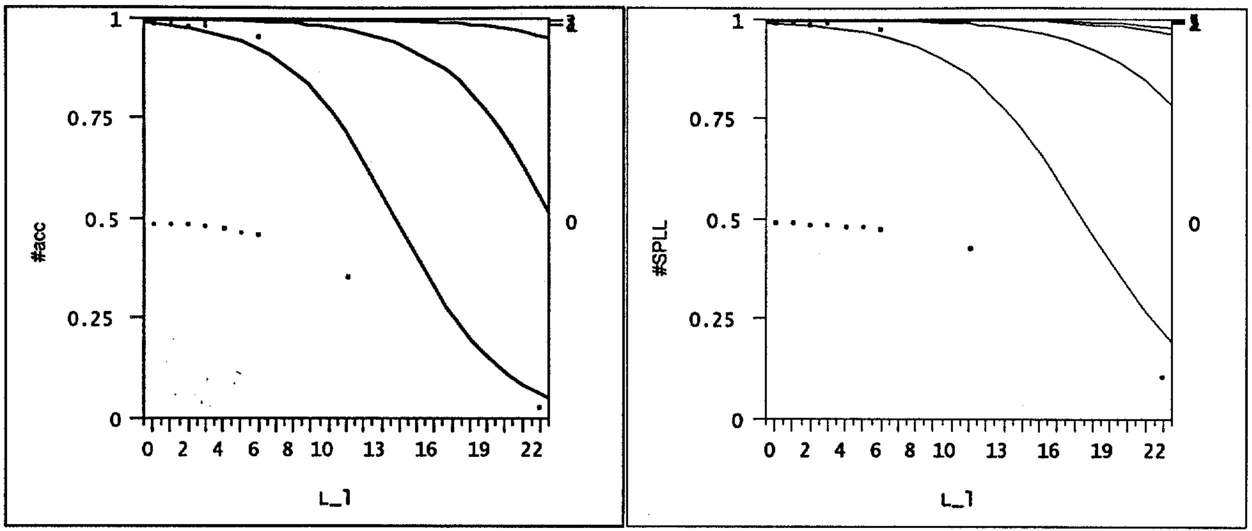


Figure -16 Logistic Regression Probability Plots – Lagged - # L INCs

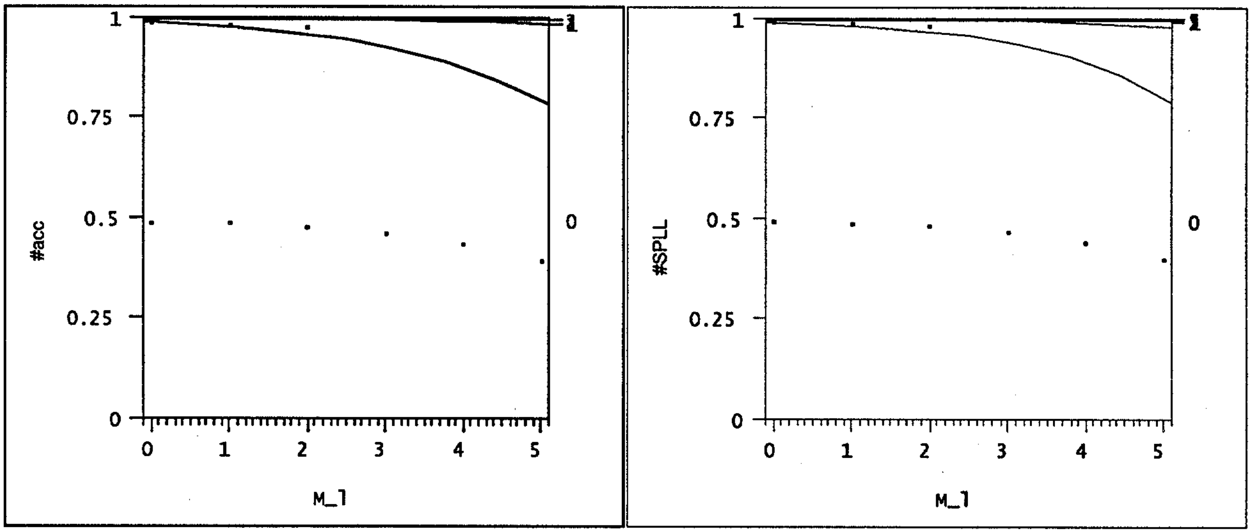


Figure -17 Logistic Regression Probability Plots – Lagged - # M INCs

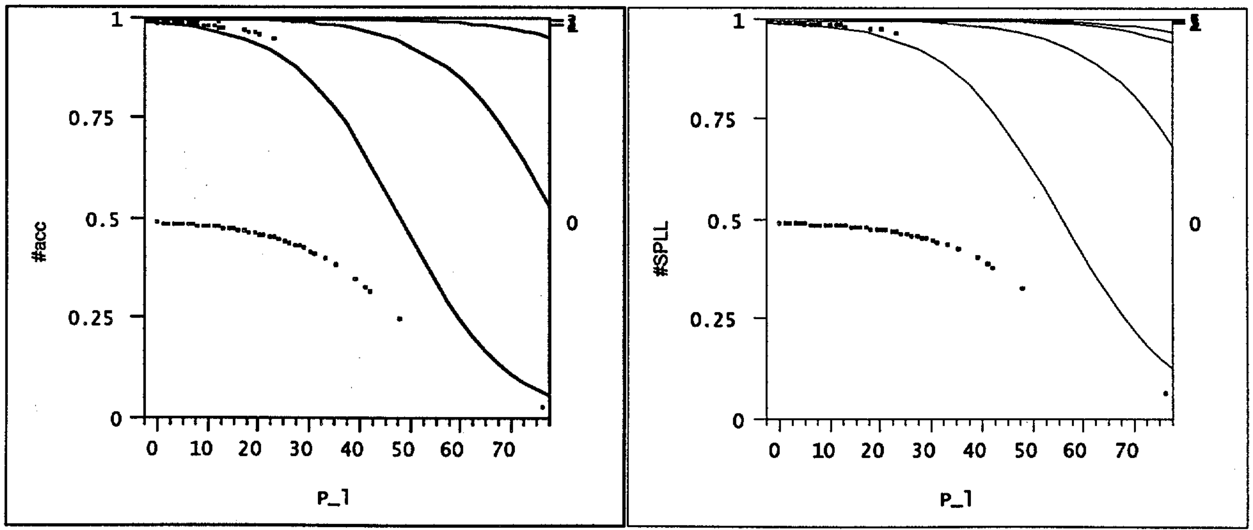


Figure -18 Logistic Regression Probability Plots – Lagged -# P INCs

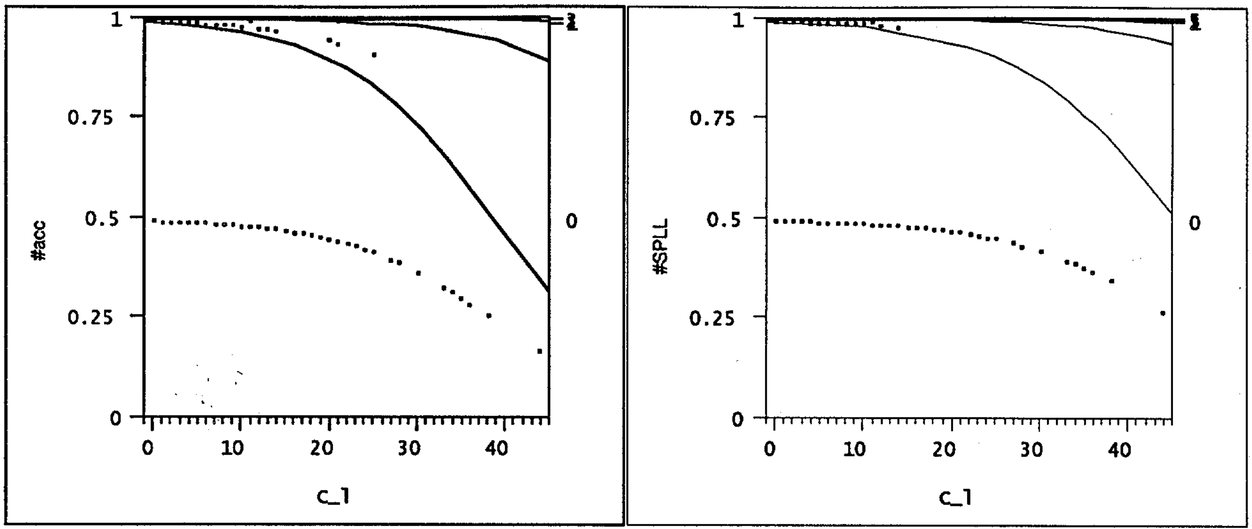


Figure -19 Logistic Regression Probability Plots – Lagged - # Component Shut-ins

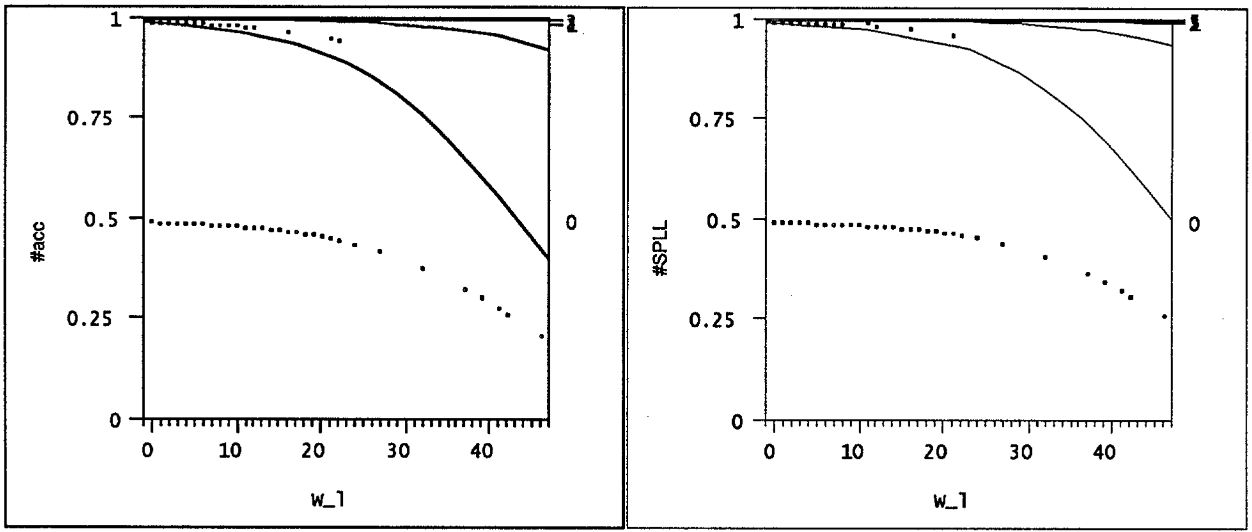


Figure -20 Logistic Regression Probability Plots – Lagged - # Warnings

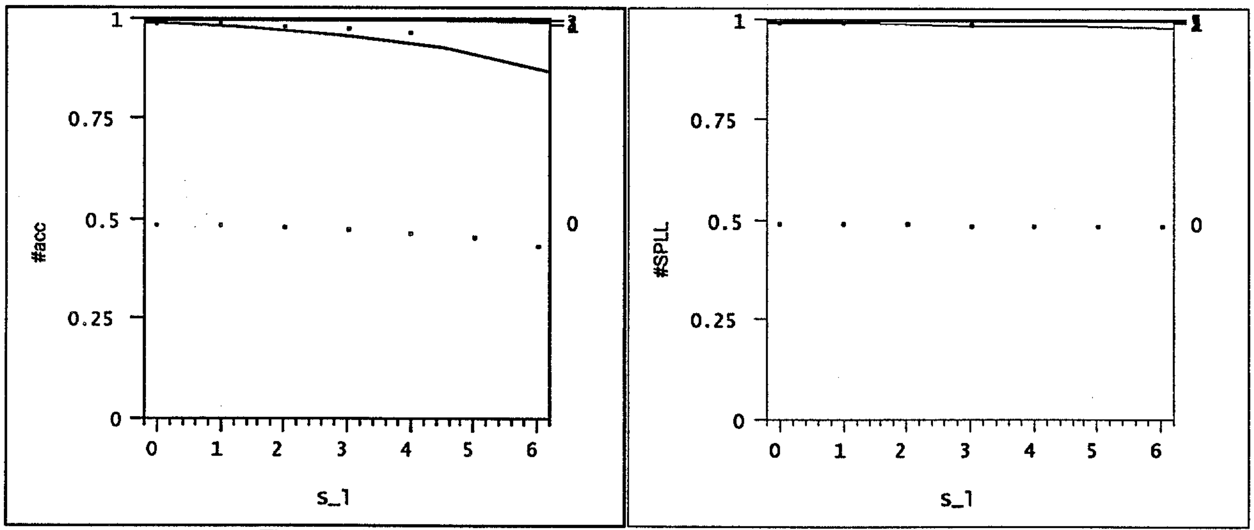


Figure -21 Logistic Regression Probability Plots – Lagged - # Facility Shut-ins

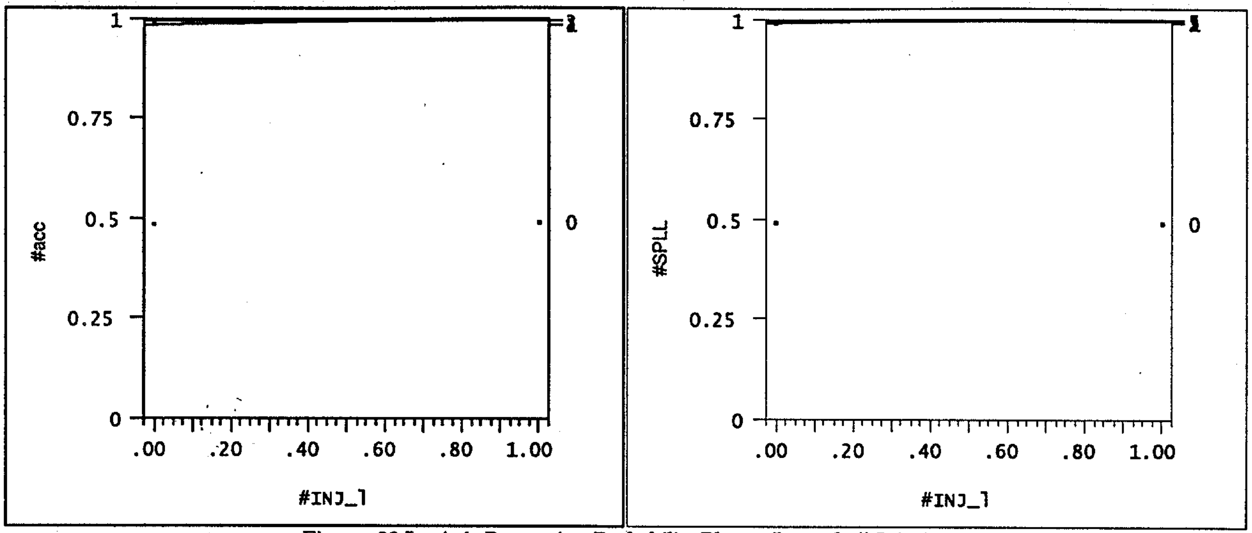


Figure -22 Logistic Regression Probability Plots – Lagged -# Injuries

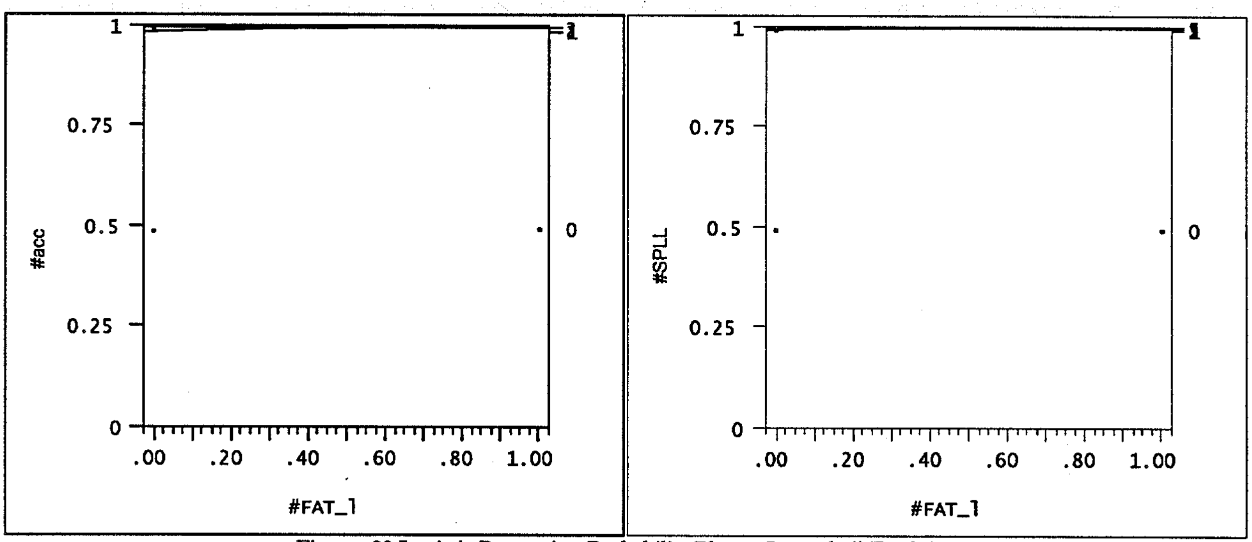


Figure -23 Logistic Regression Probability Plots – Lagged -# Fatalities

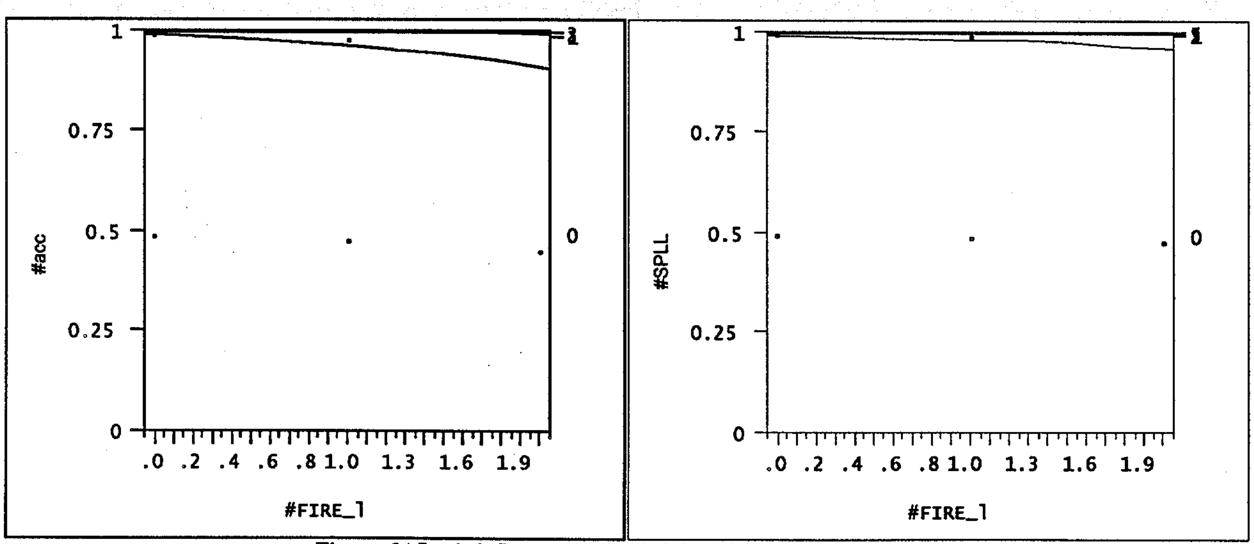


Figure -24 Logistic Regression Probability Plots – Lagged -# Fires

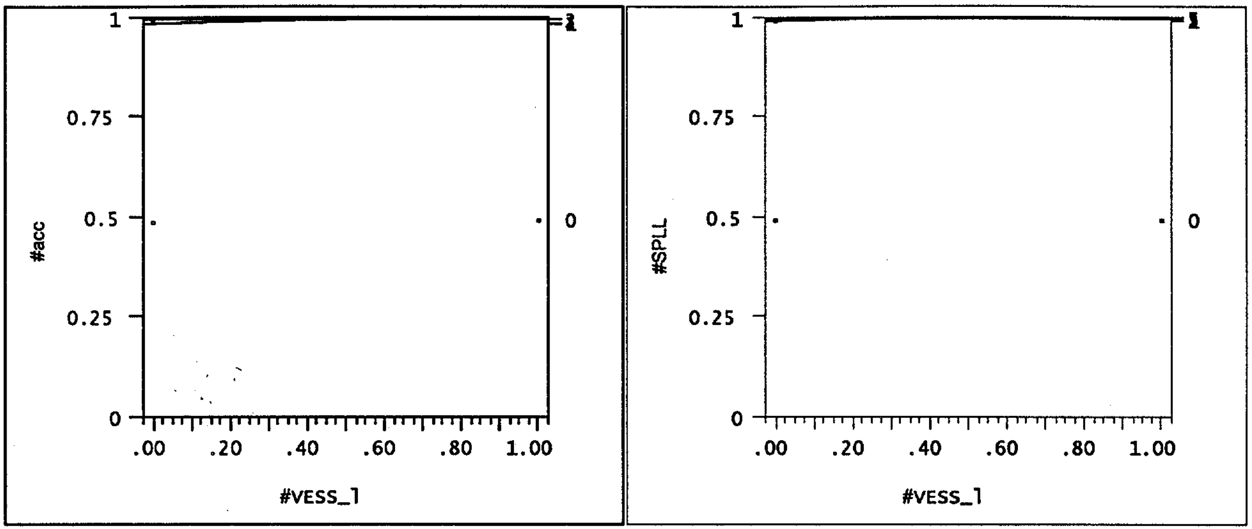


Figure -25 Logistic Regression Probability Plots – Lagged - # Vessel Strikes

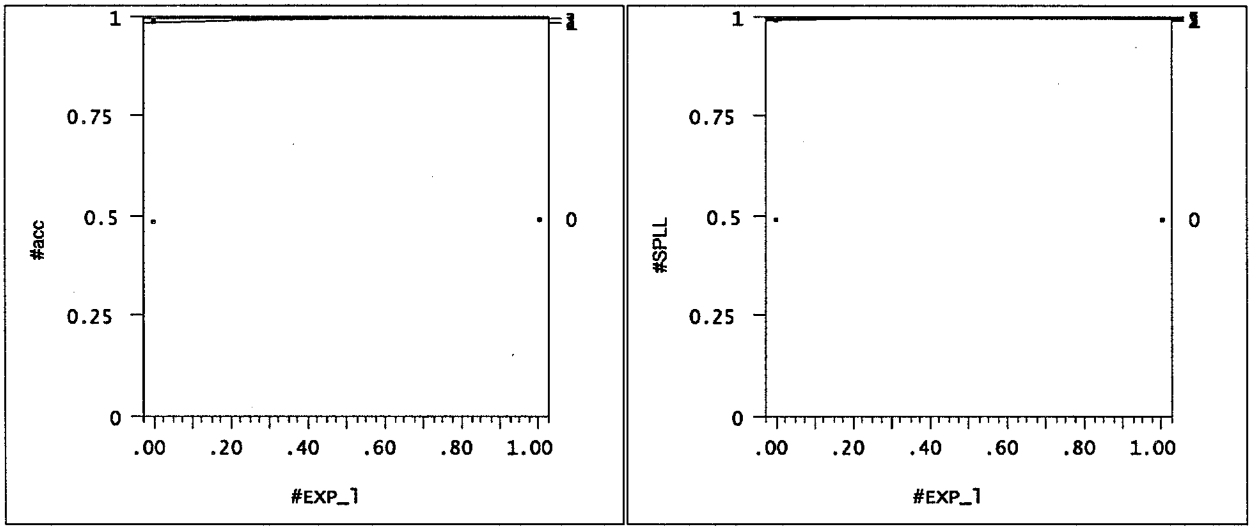


Figure -26 Logistic Regression Probability Plots – Lagged -# Explosions

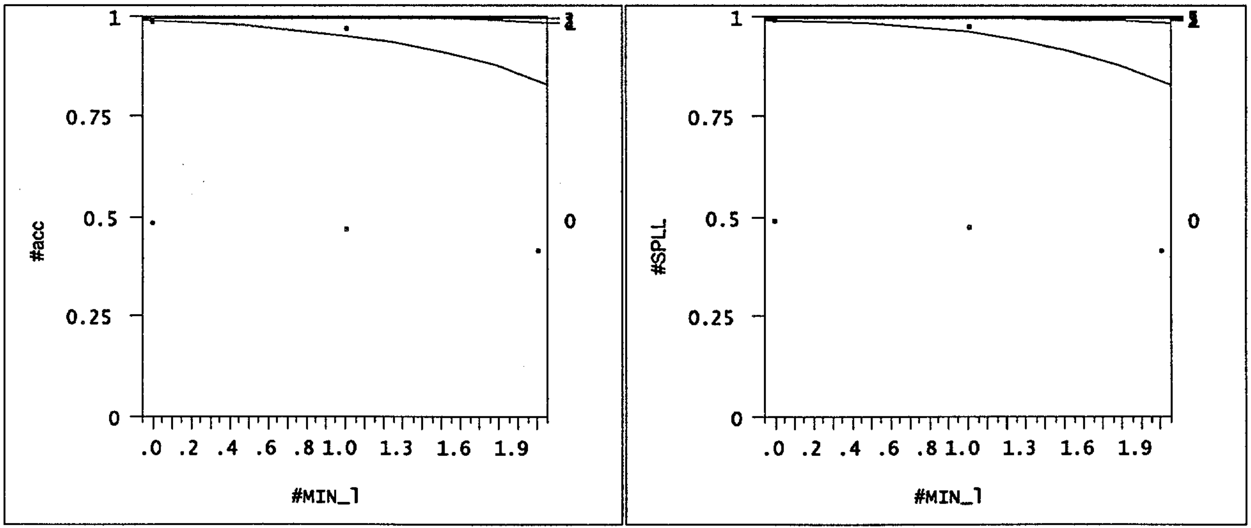


Figure -27 Logistic Regression Probability Plots – Lagged - # Minor Incidents

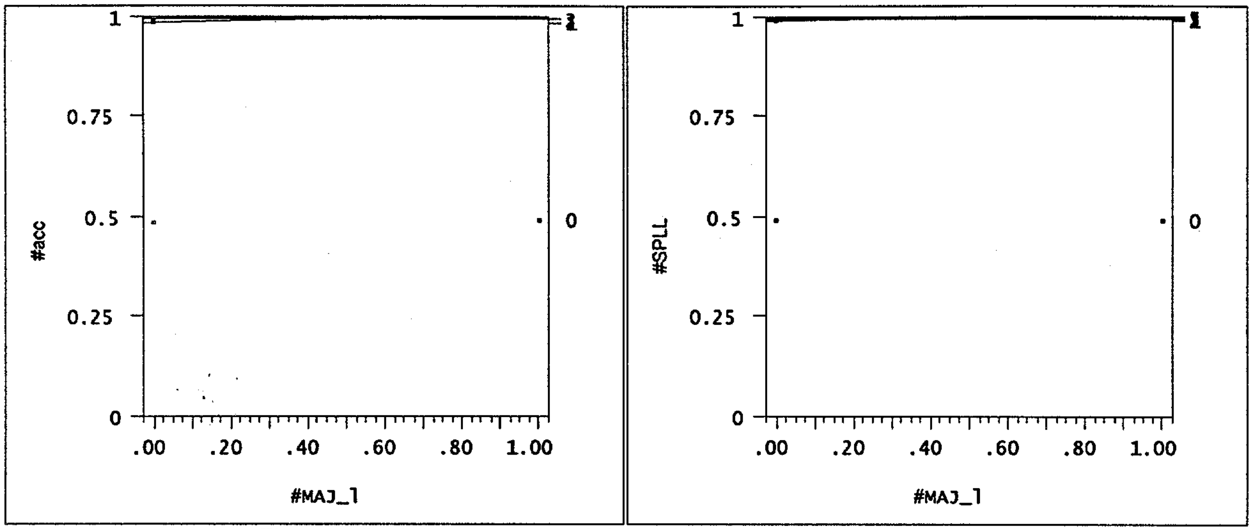


Figure -28 Logistic Regression Probability Plots – Lagged - # Major Incidents

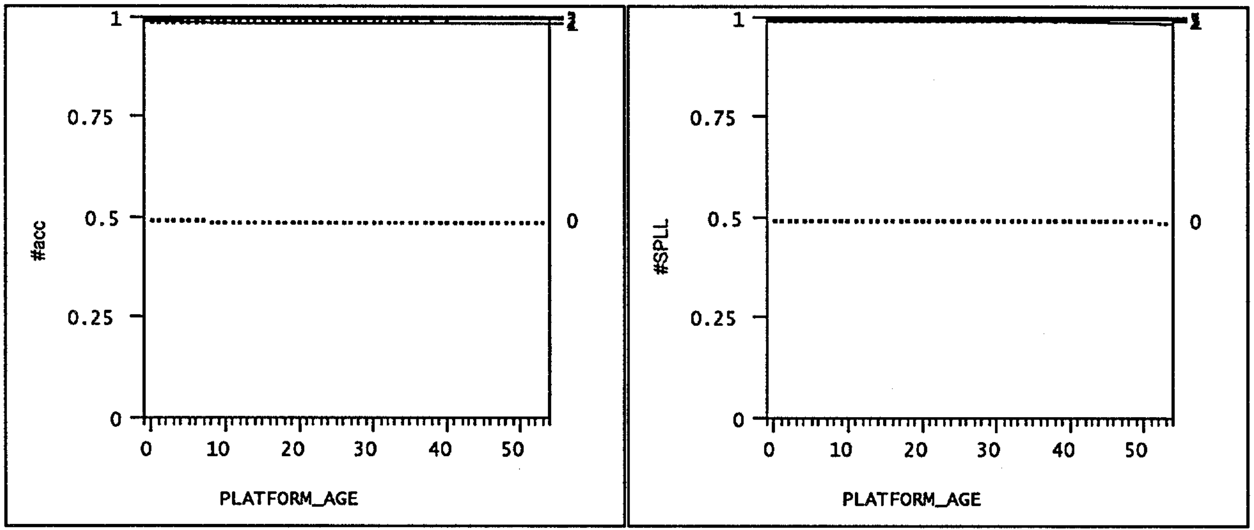


Figure -29 Logistic Regression Probability Plots – Platform Age

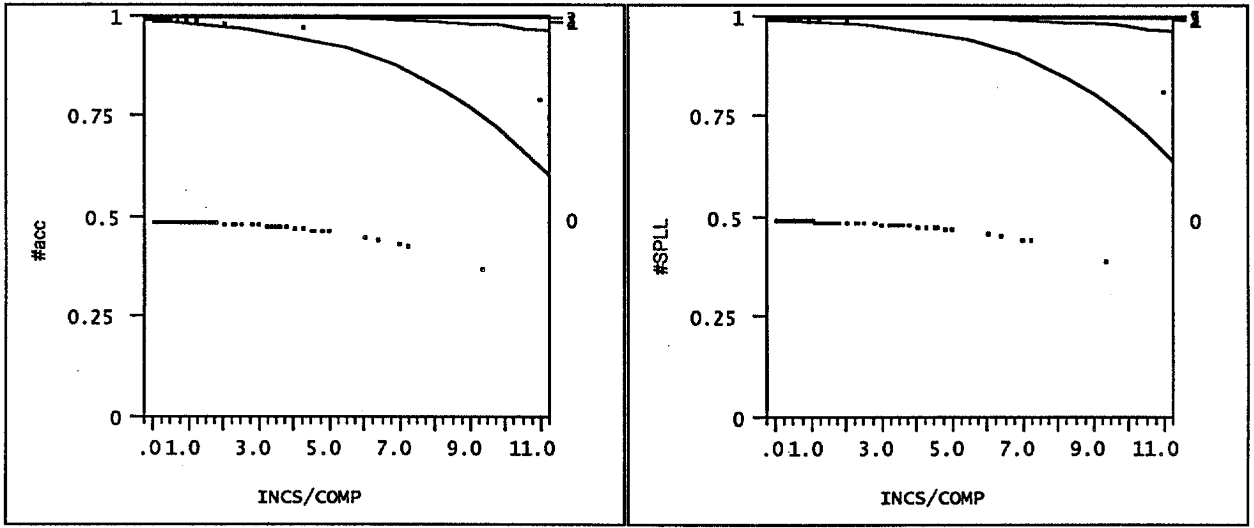


Figure -30 Logistic Regression Probability Plots – Number of INCs per Component

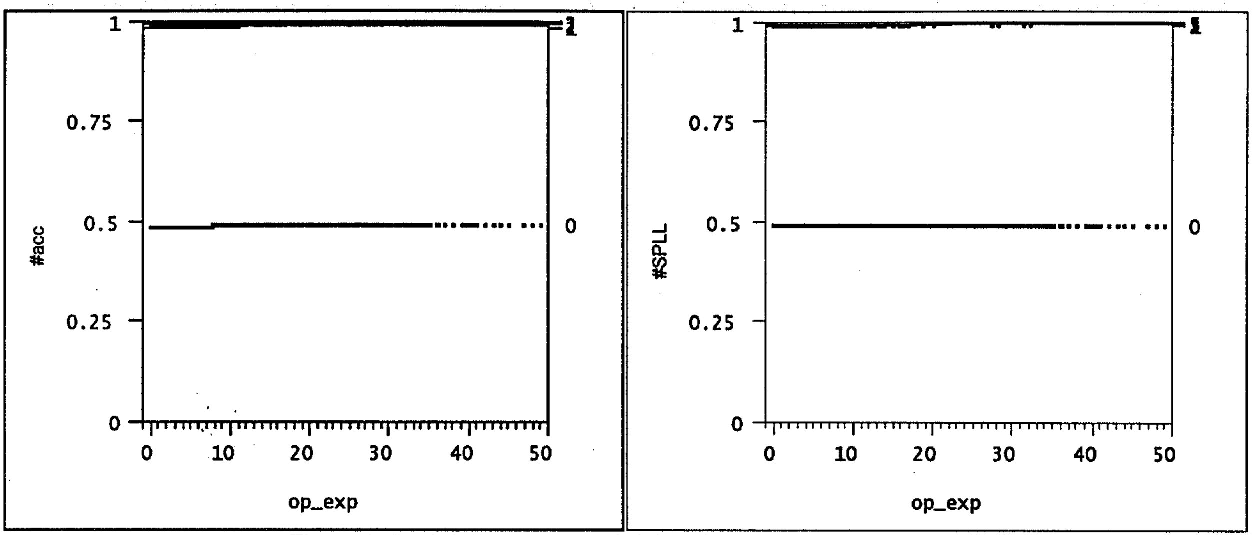


Figure -31 Logistic Regression Probability Plots – Operator Experience

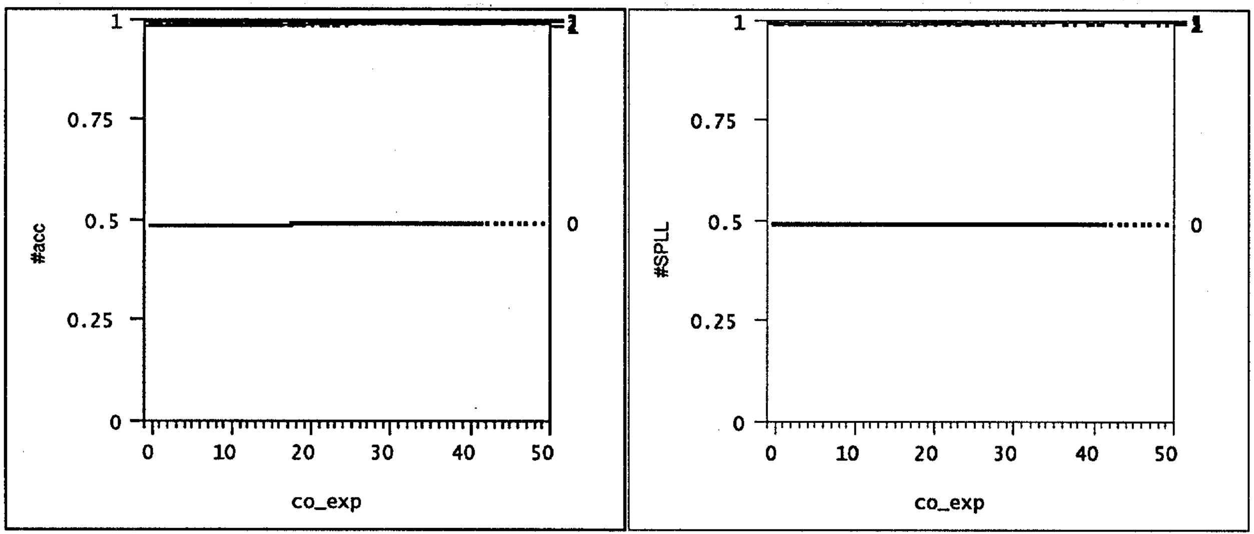


Figure -32 Logistic Regression Probability Plots – Company Experience

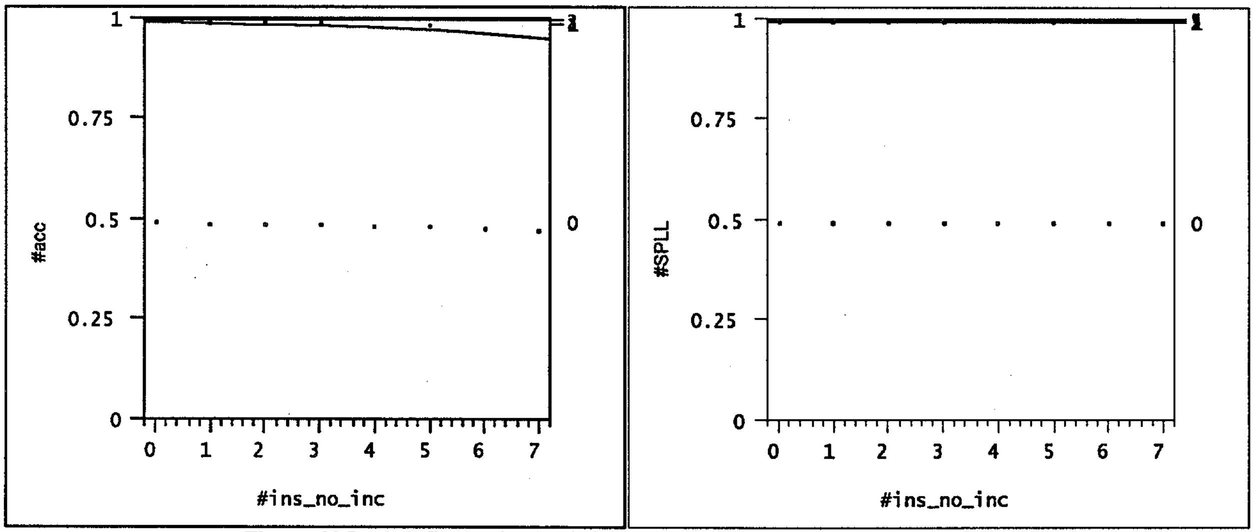


Figure -33 Logistic Regression Probability Plots – # Inspections Without an INC

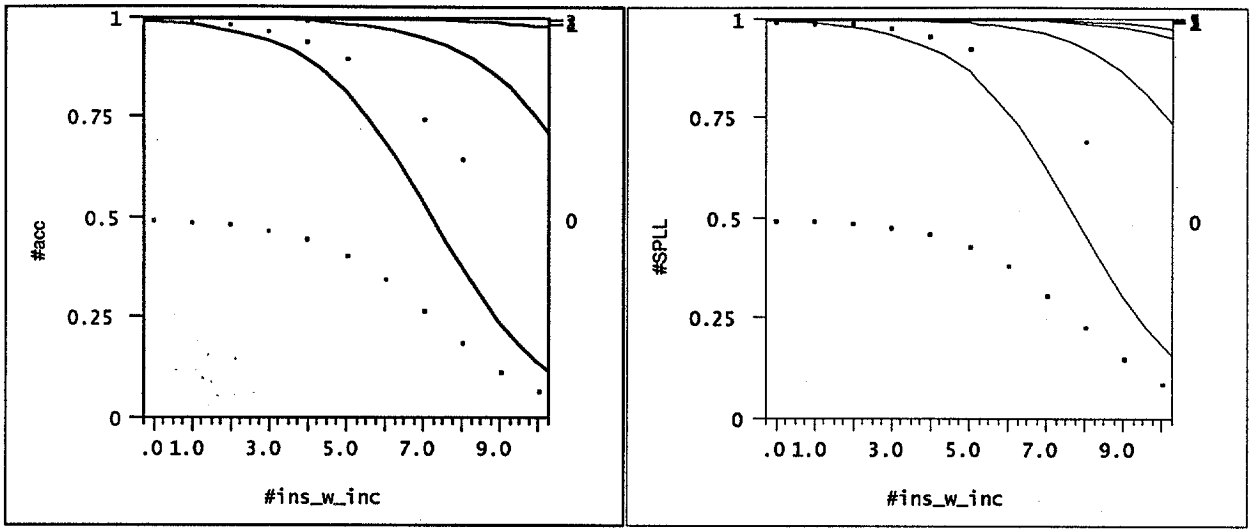


Figure -34 Logistic Regression Probability Plots – # Inspections With an INC

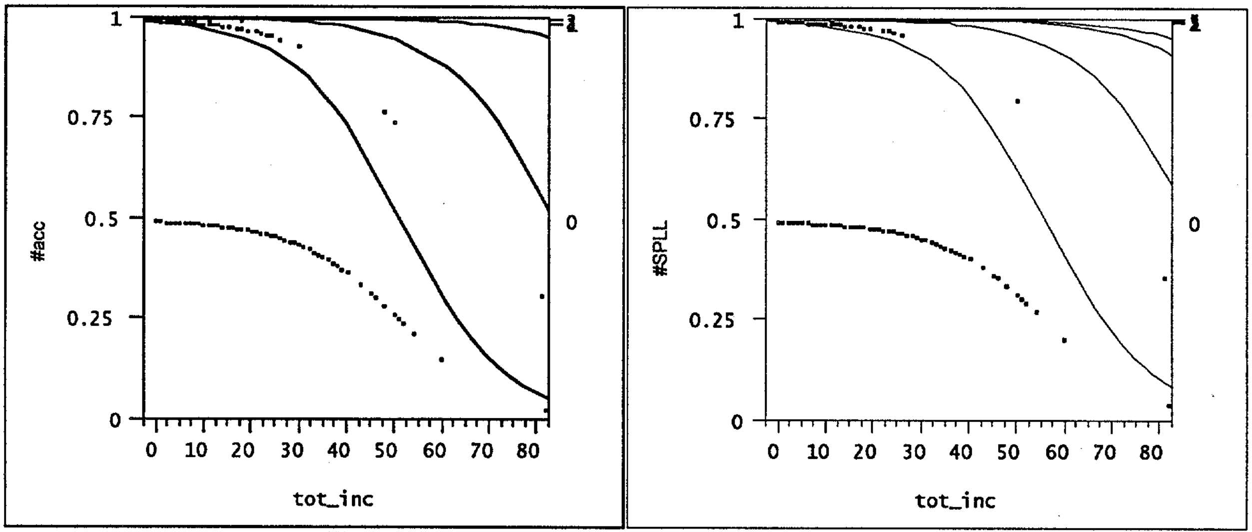


Figure -35 Logistic Regression Probability Plots –Total # INCs

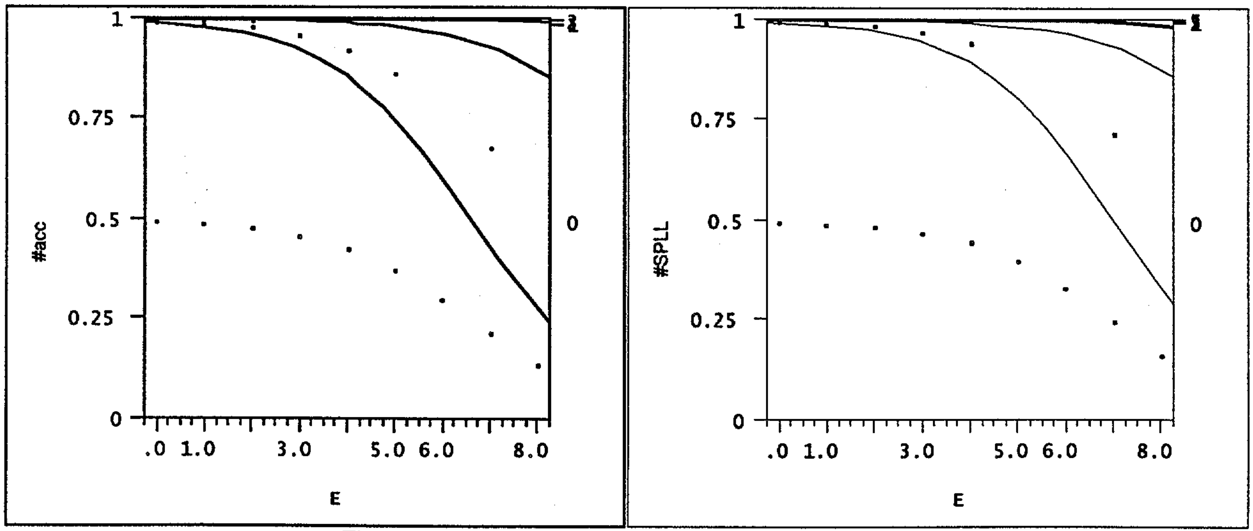


Figure -36 Logistic Regression Probability Plots – # E INCs

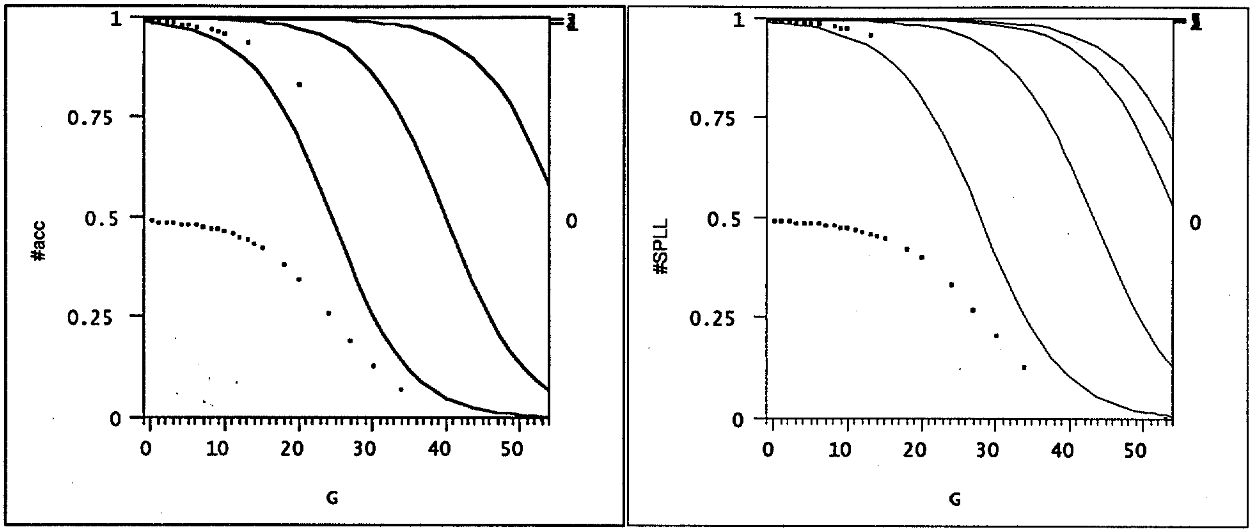


Figure -37 Logistic Regression Probability Plots – # G INCs

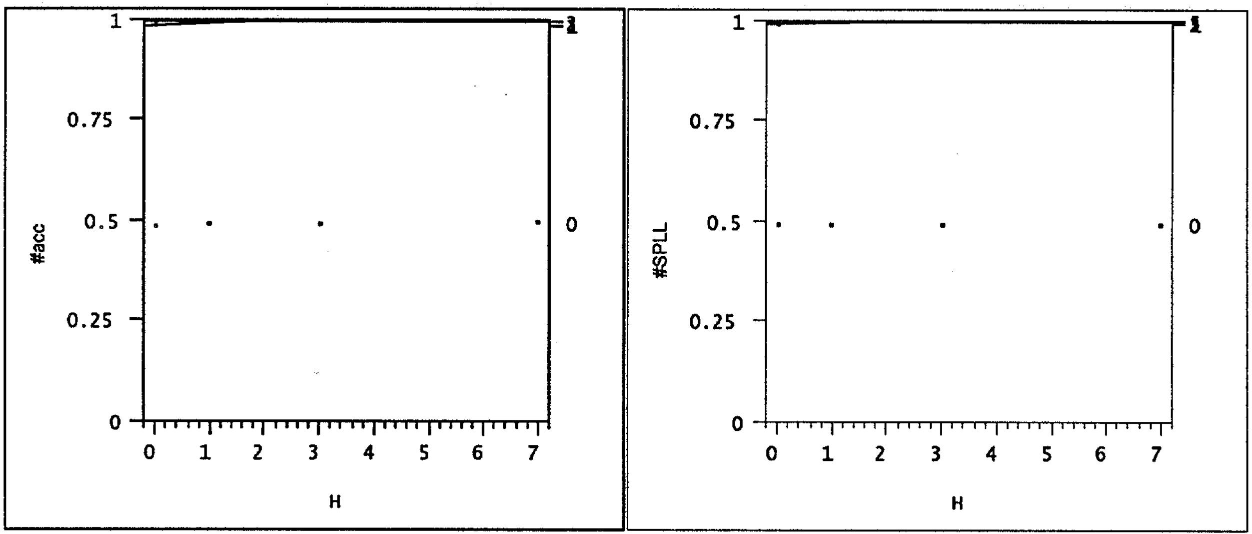


Figure -38 Logistic Regression Probability Plots – # H INCs

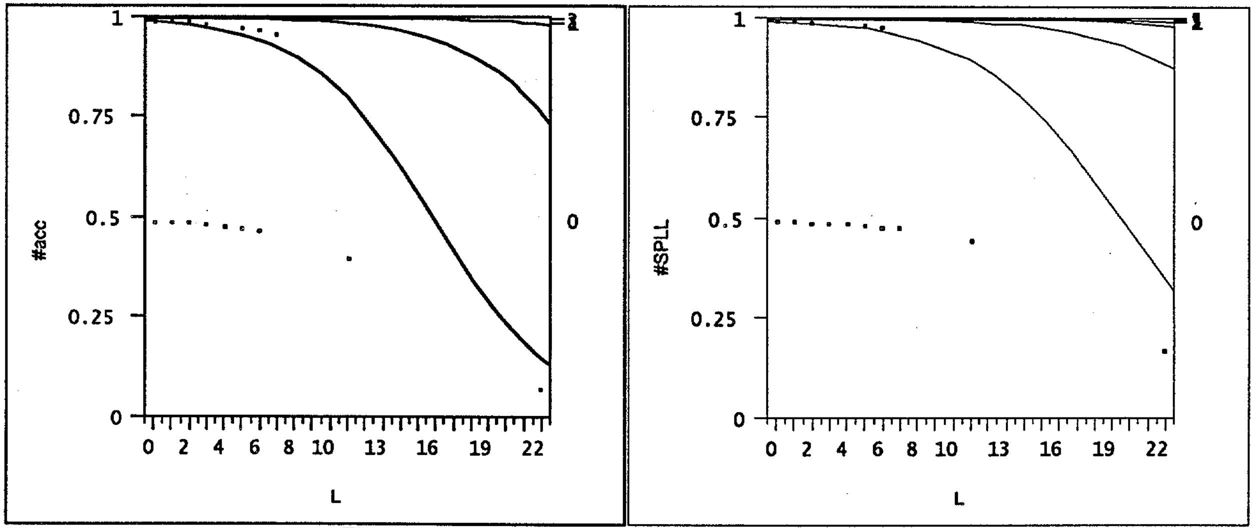


Figure -39 Logistic Regression Probability Plots -- # L INCs

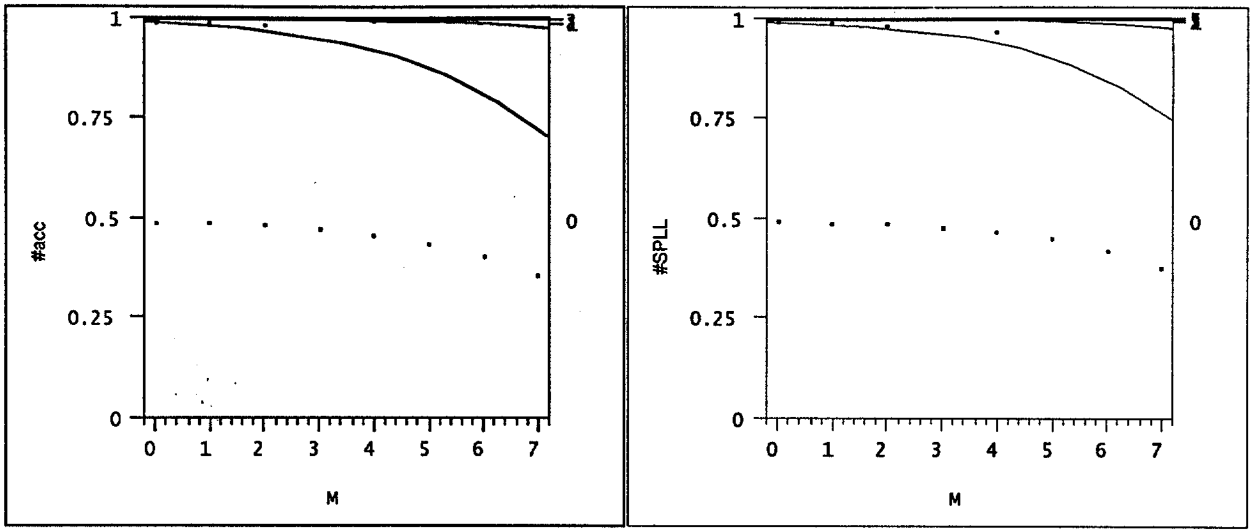


Figure -40 Logistic Regression Probability Plots – # M INCs

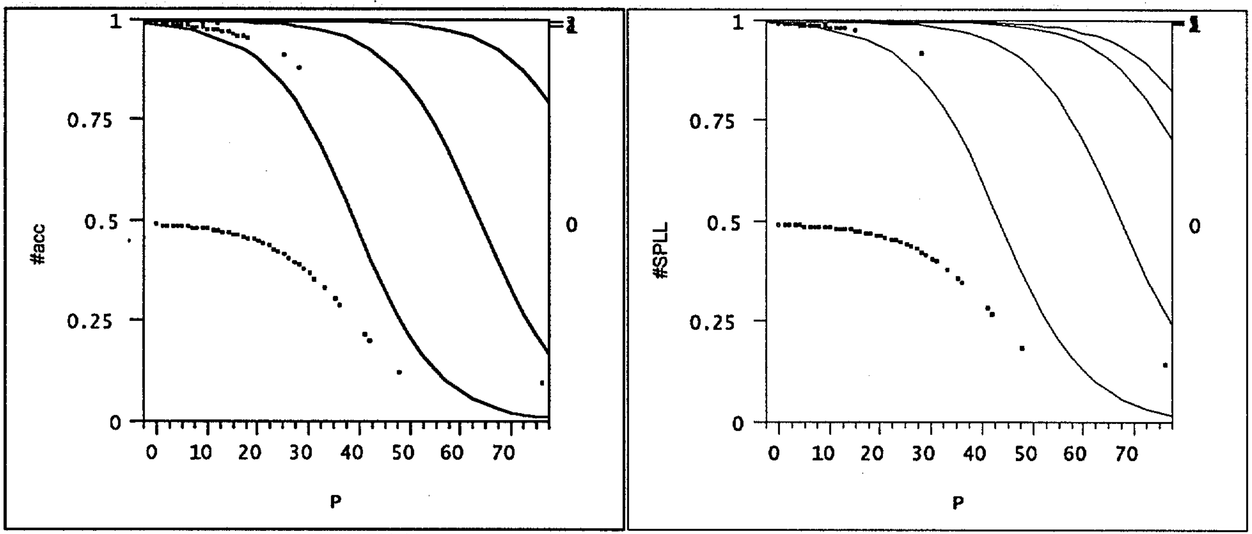


Figure -41 Logistic Regression Probability Plots – # P INCs

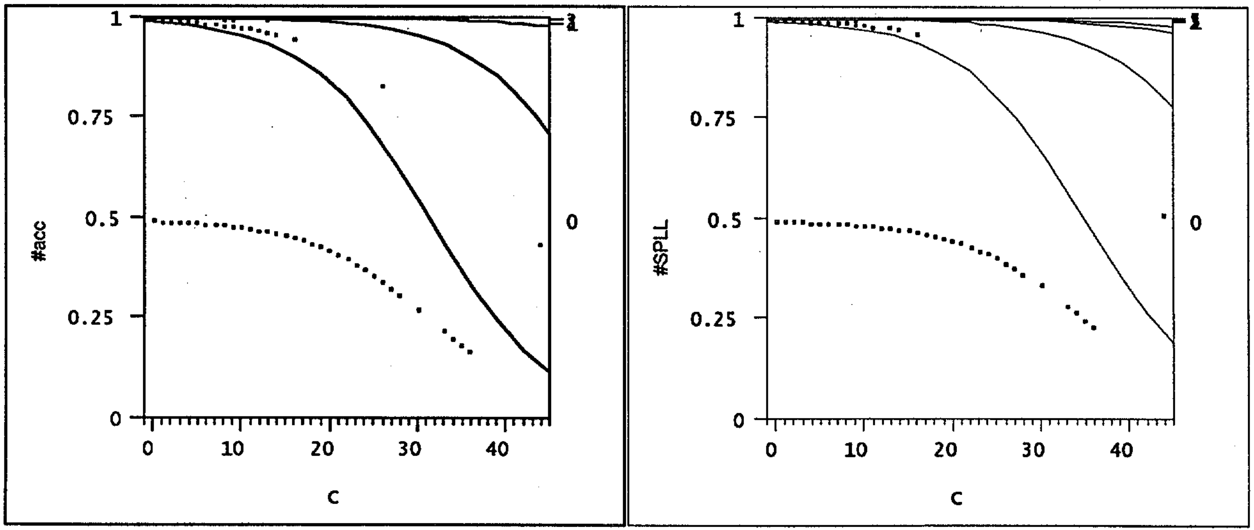


Figure -42 Logistic Regression Probability Plots – # Component Shut-ins

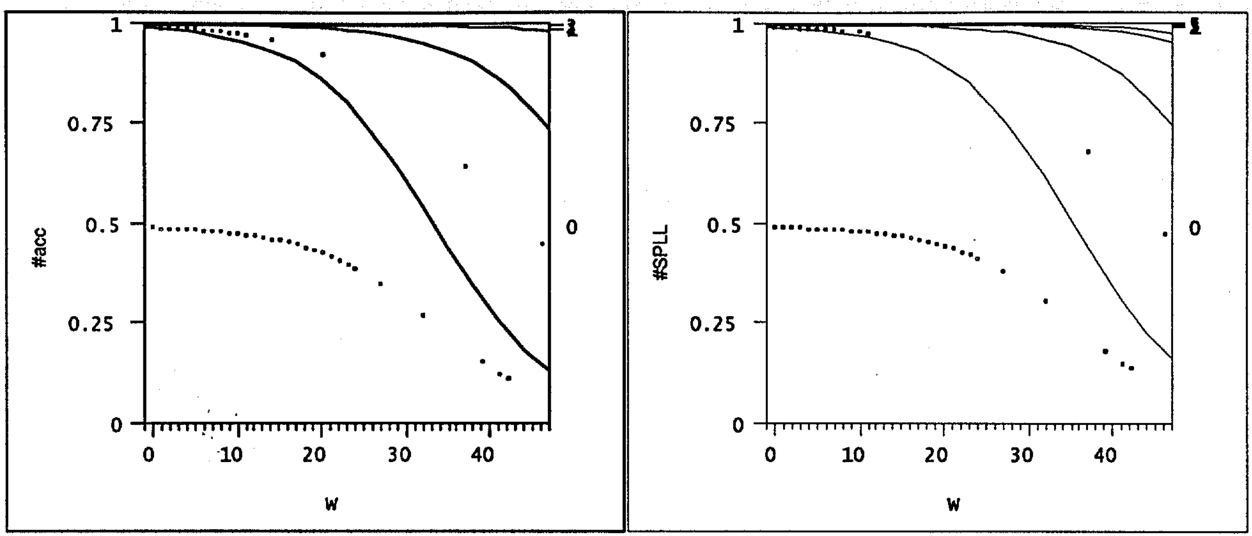


Figure -43 Logistic Regression Probability Plots – # Warnings

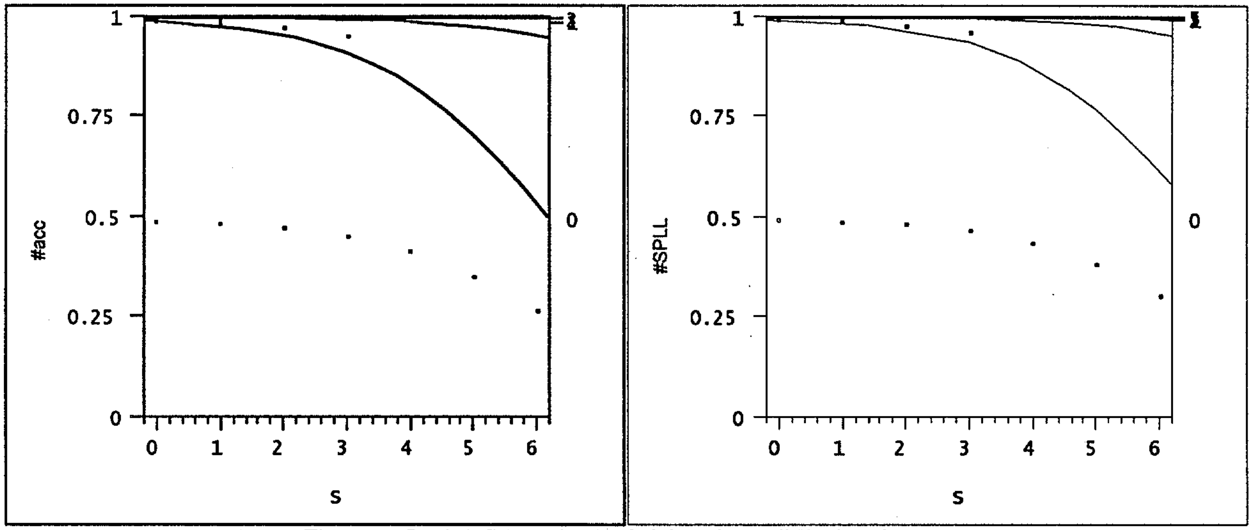


Figure -44 Logistic Regression Probability Plots – # Facility Shut-ins

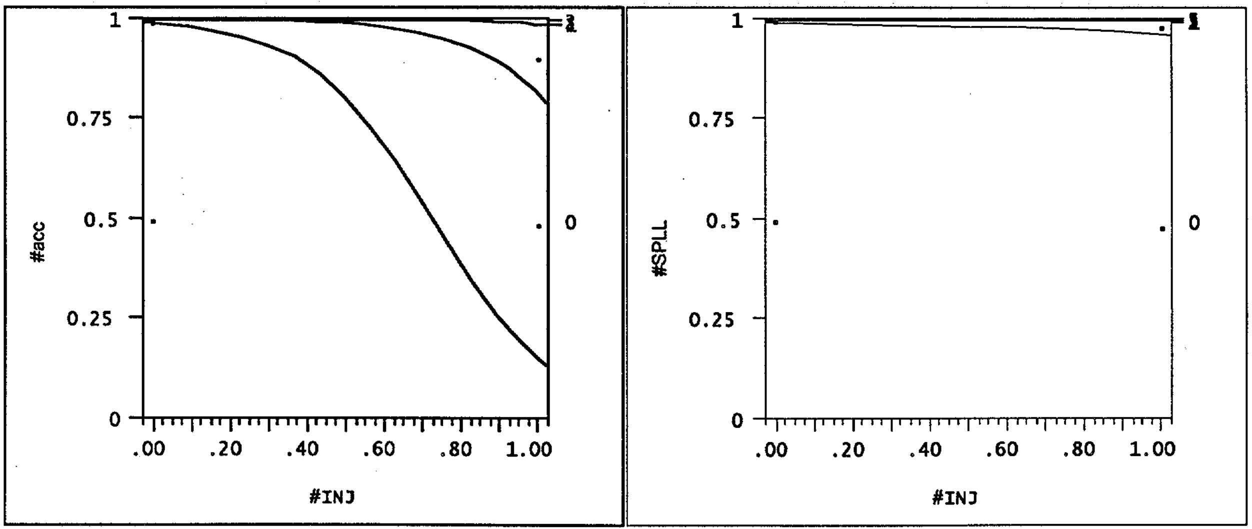


Figure -45 Logistic Regression Probability Plots – # Injuries

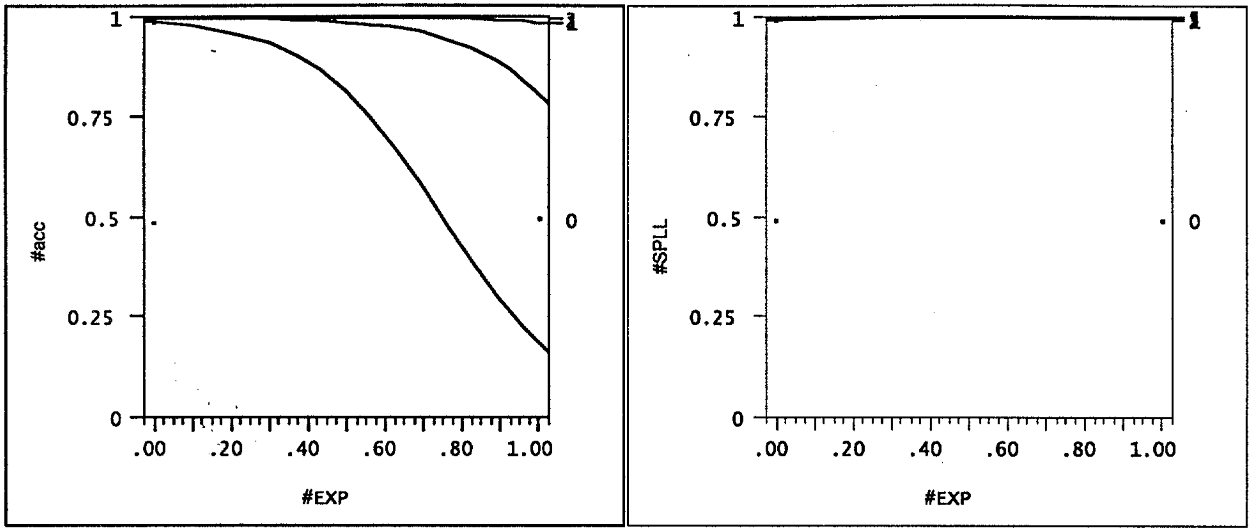


Figure -49 Logistic Regression Probability Plots – # Explosions

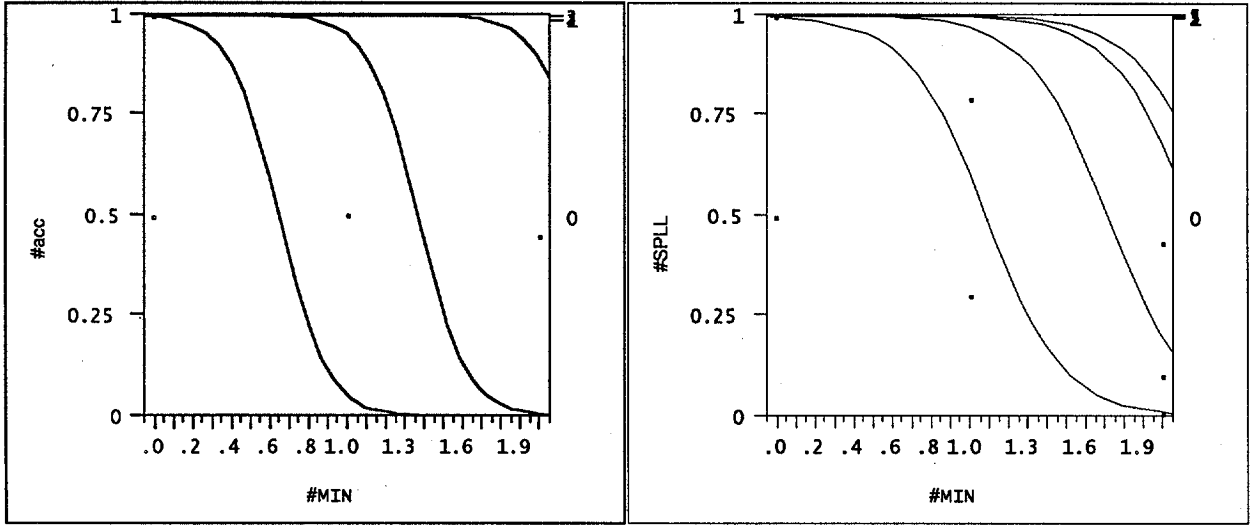


Figure -50 Logistic Regression Probability Plots – # Minor Incidents

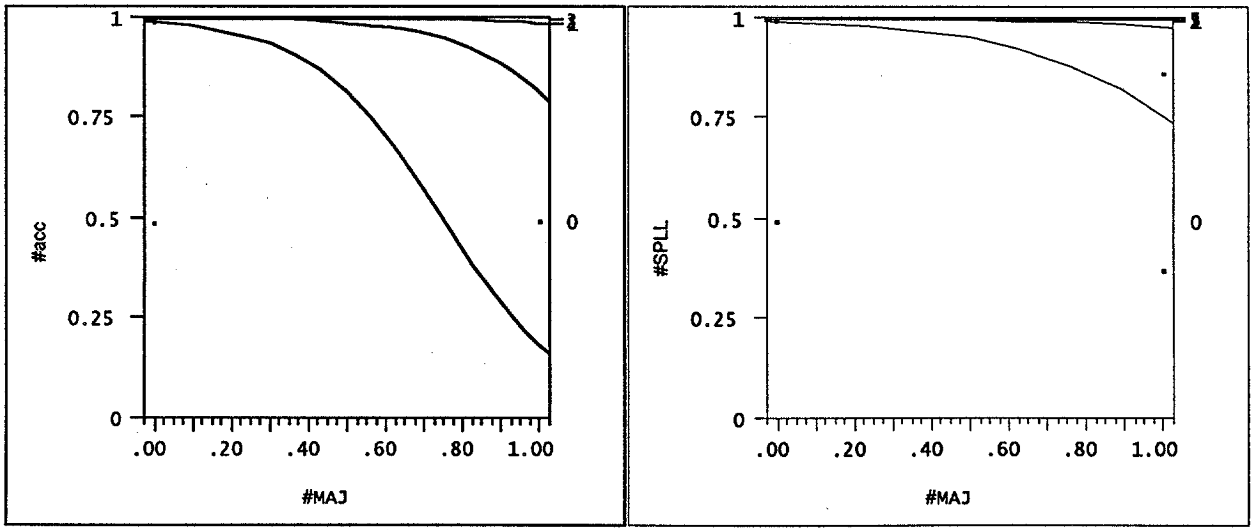


Figure -51 Logistic Regression Probability Plots – # Major Incidents

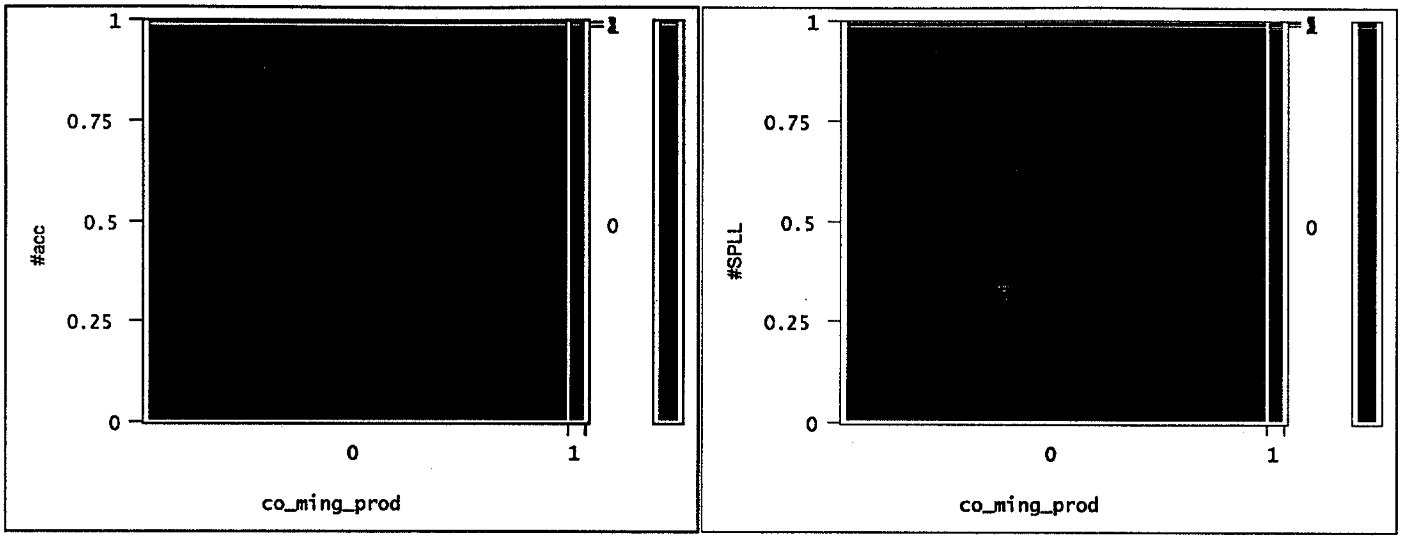


Figure -52 Logistic Regression Probability Plots – Commingling Production Flag

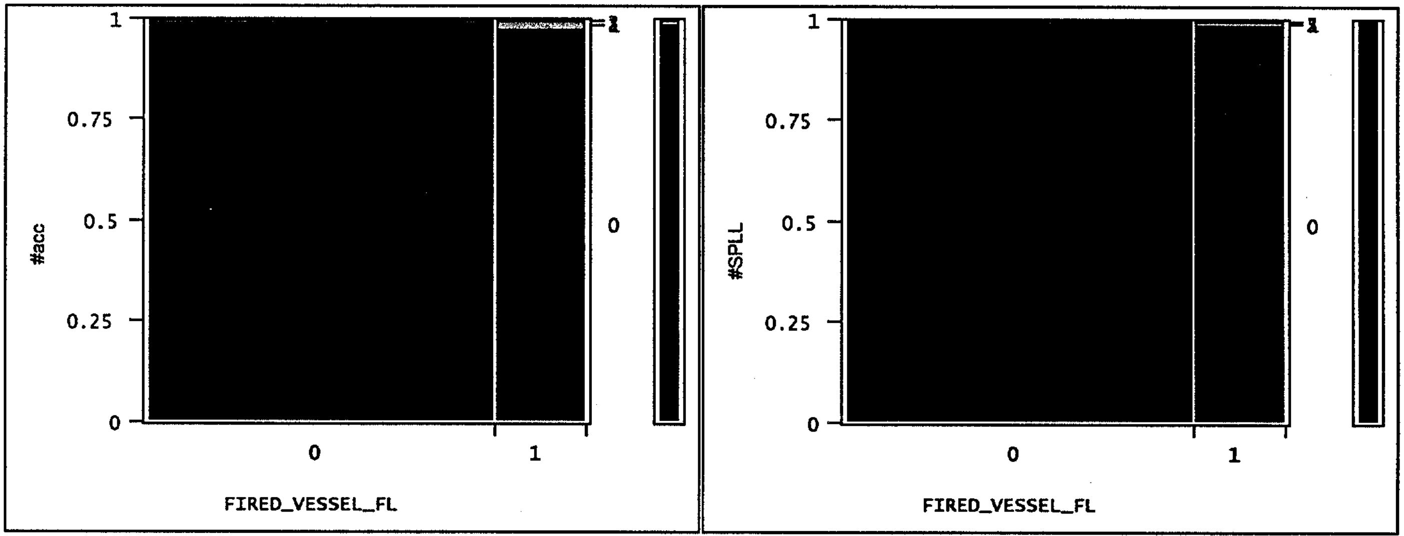


Figure -53 Logistic Regression Probability Plots – Fired Vessel Flag

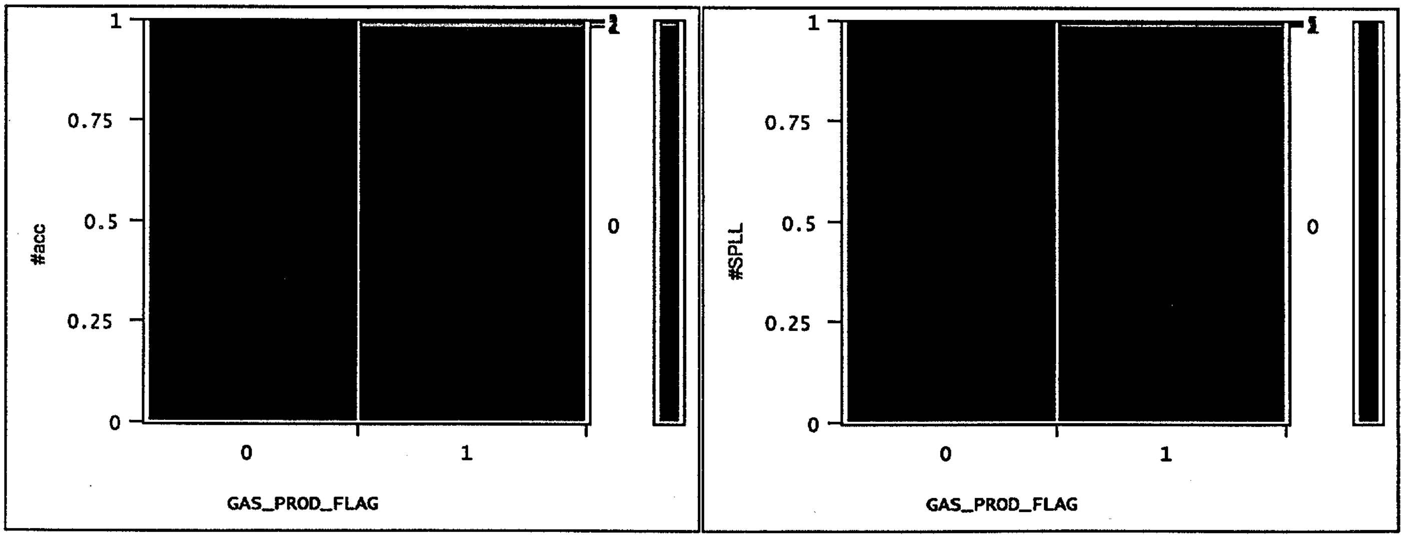


Figure -54 Logistic Regression Probability Plots – Gas Production Flag

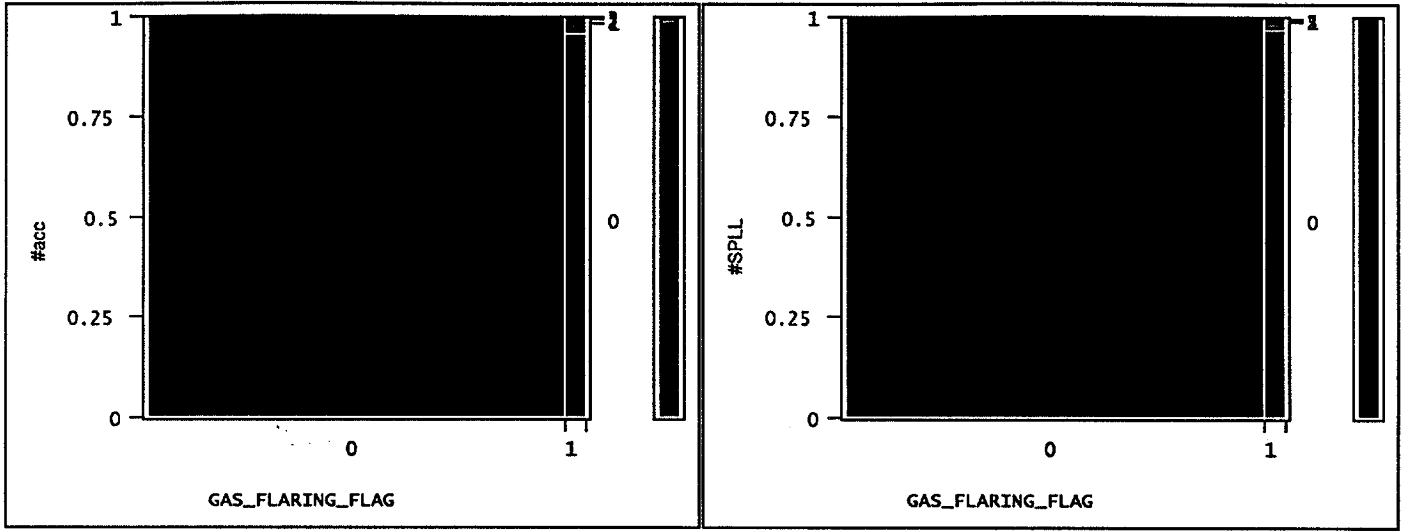


Figure -55 Logistic Regression Probability Plots – Gas Flaring Flag

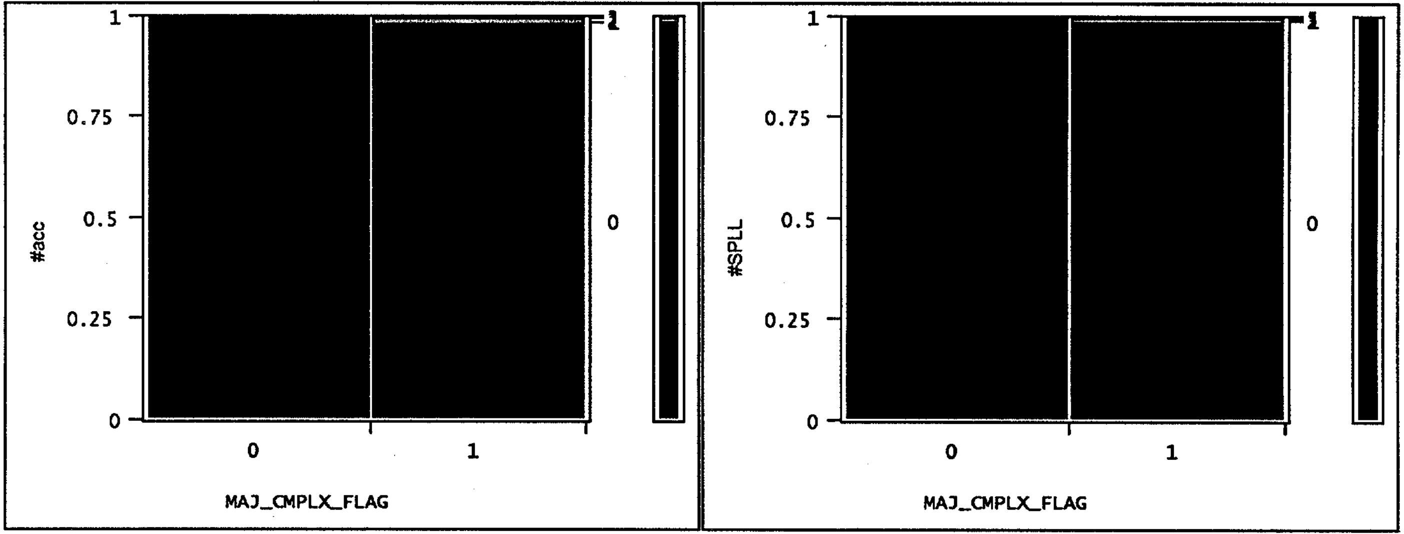


Figure -56 Logistic Regression Probability Plots – Major Complex Flag

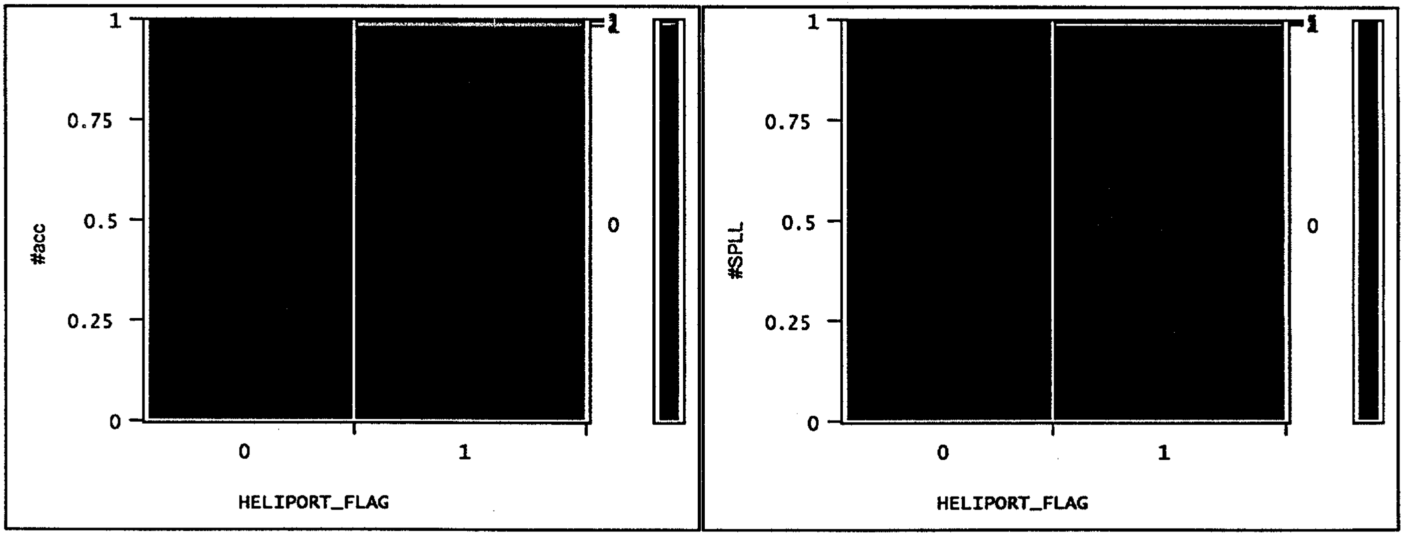


Figure -57 Logistic Regression Probability Plots – Heliport Flag

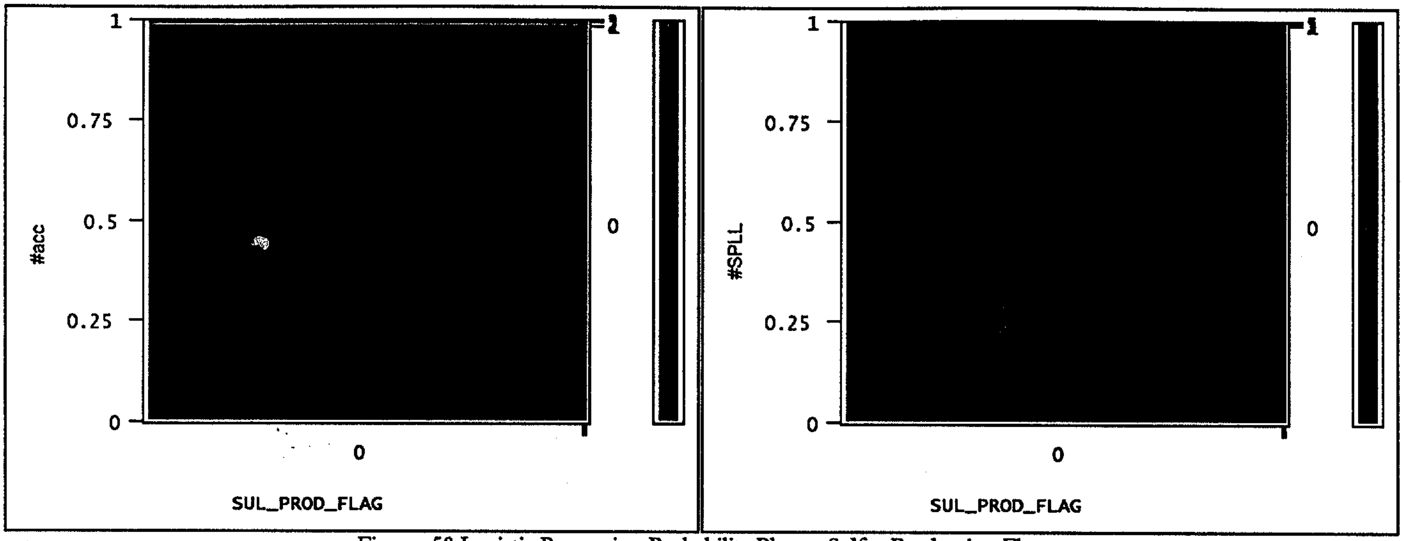


Figure -58 Logistic Regression Probability Plots – Sulfur Production Flag

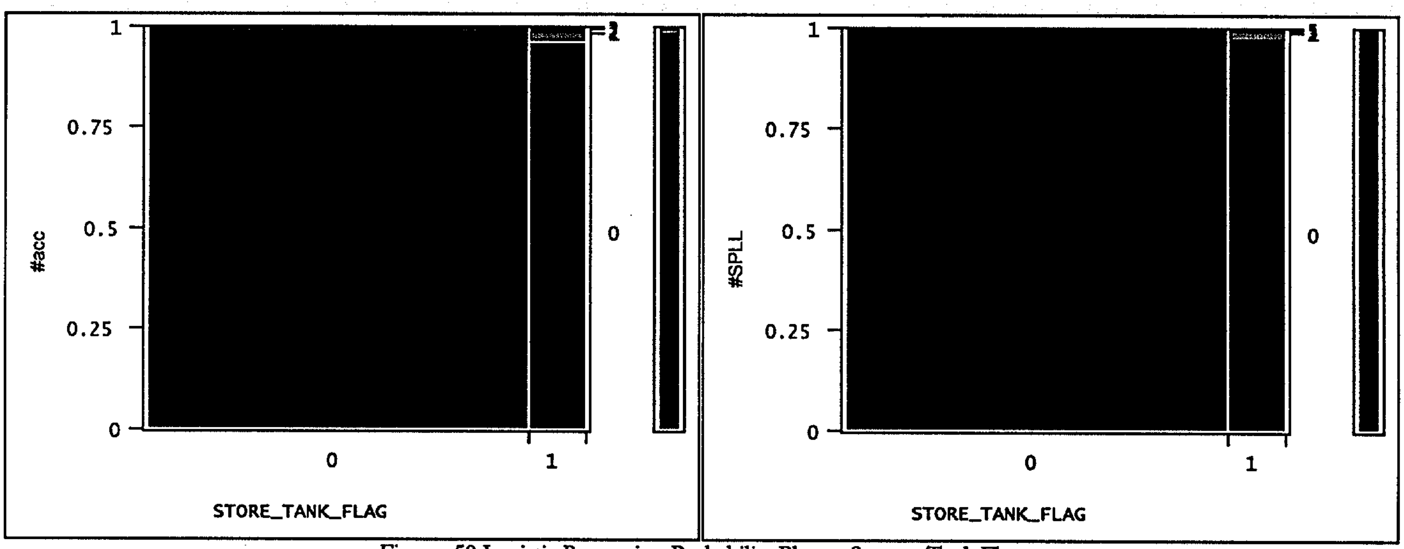


Figure -59 Logistic Regression Probability Plots – Storage Tank Flag

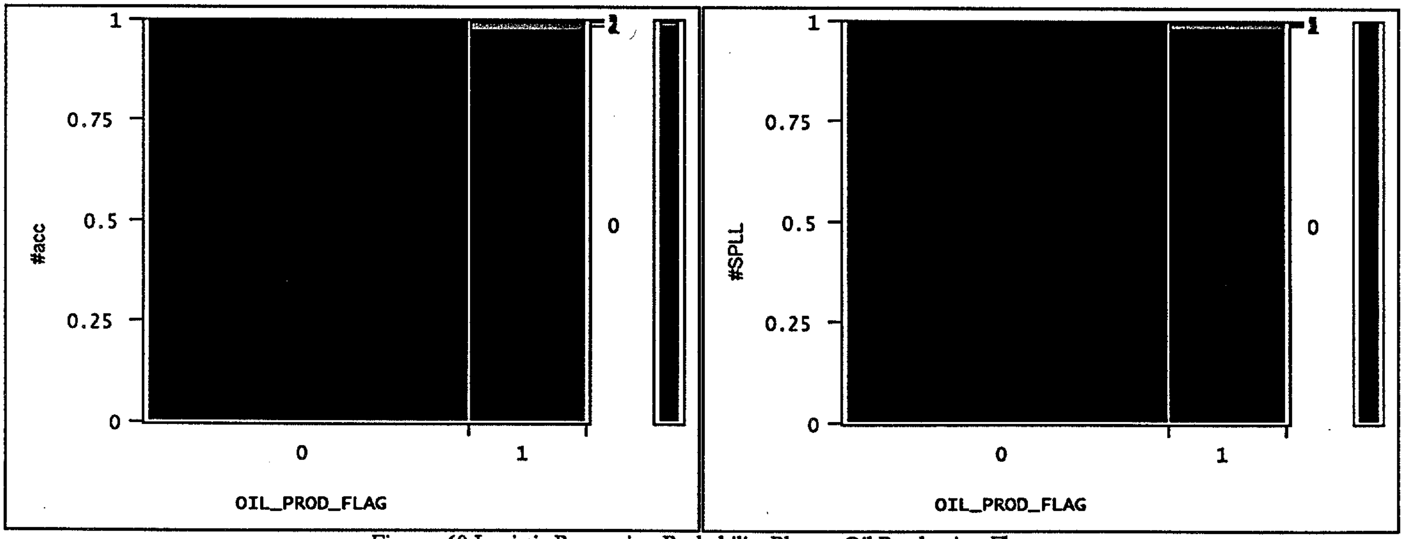


Figure -60 Logistic Regression Probability Plots – Oil Production Flag

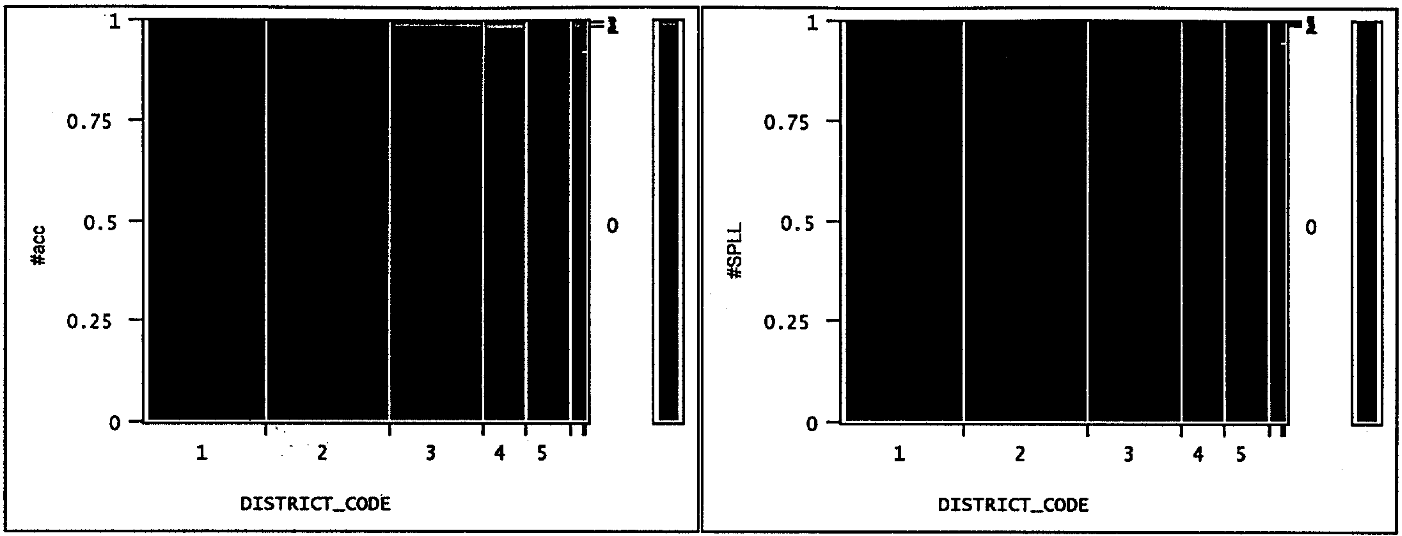


Figure -61 Logistic Regression Probability Plots – District Code

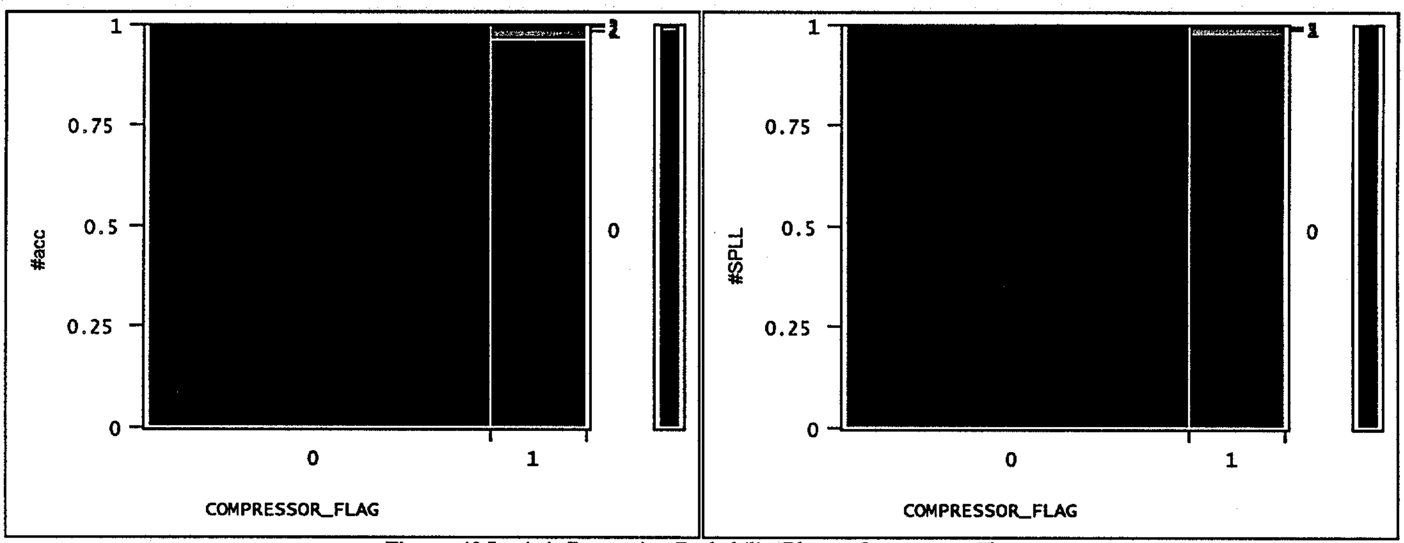


Figure -62 Logistic Regression Probability Plots – Compressor Flag

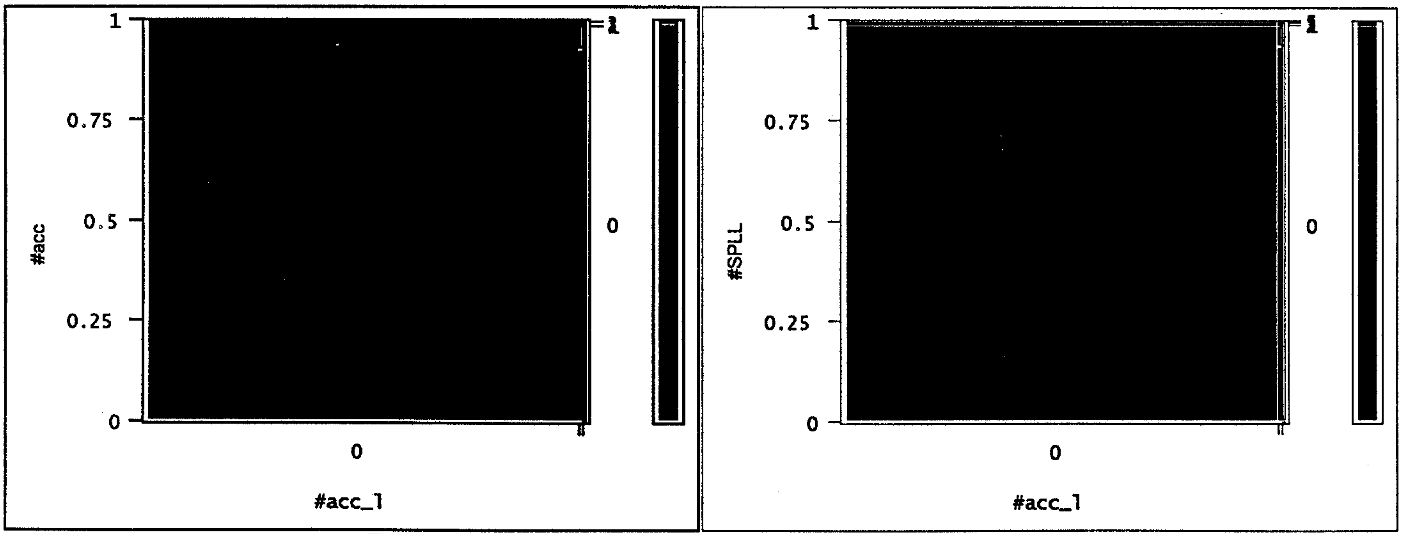


Figure -63 Logistic Regression Probability Plots – Lagged -# Accidents

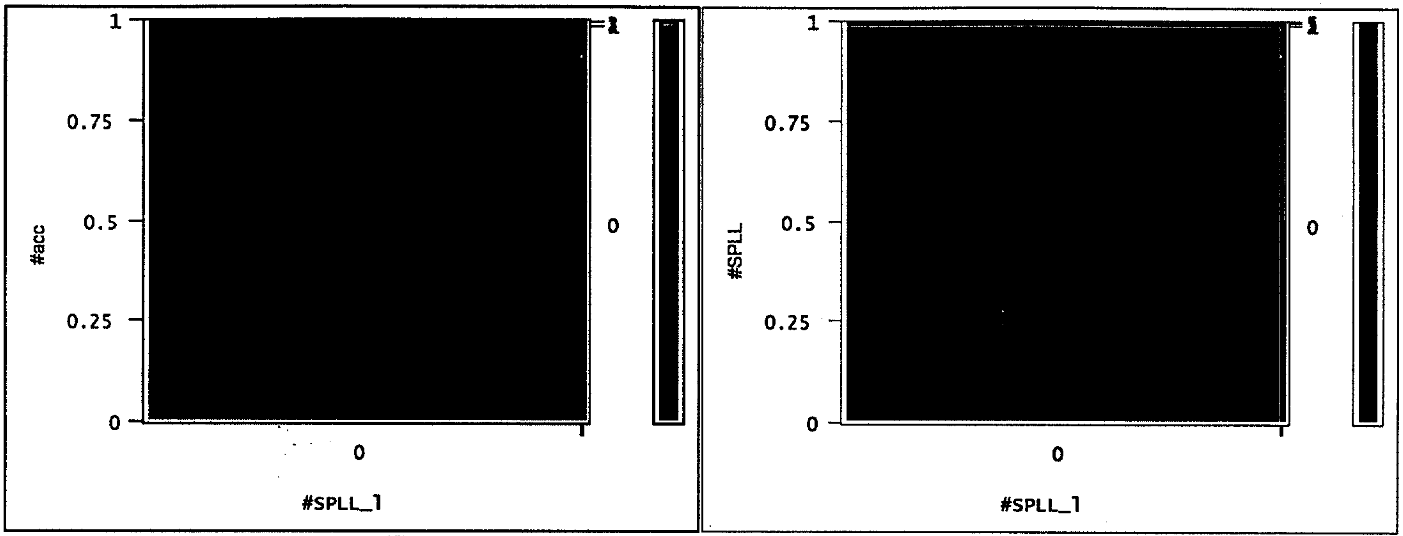


Figure -64 Logistic Regression Probability Plots – Lagged -# Spills

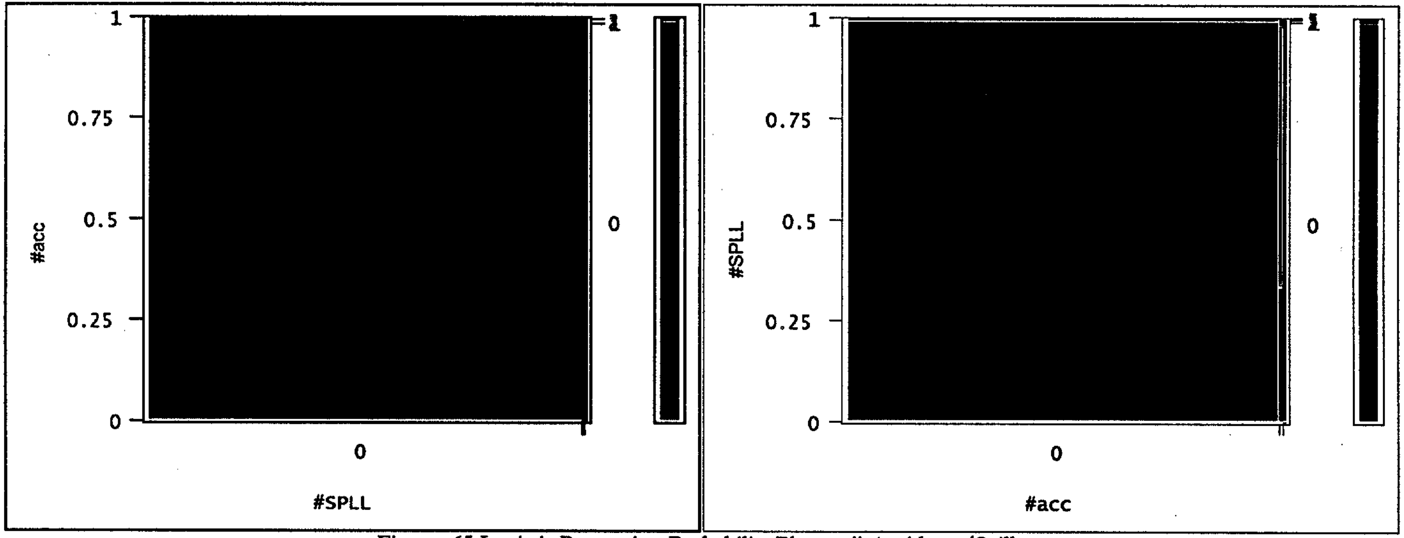


Figure -65 Logistic Regression Probability Plots – # Accidents/Spills

1.8 Logistic Regression Probability Tables

Crosstabs							
# of acc	# of SPLL						
	0	1	2	3	5	total	
0	30187	0	0	0	0	30187	Count
	98.90	0.00	0.00	0.00	0.00	98.90	Total %
	29966.462	204.71462	13.845433	0.9889595	0.9889595		Expected
1	108	205	5	0	0	318	Count
	0.35	0.67	0.02	0.00	0.00	1.04	Total %
	315.67678	2.1565326	0.1458524	0.010418	0.010418		Expected
2	6	2	9	0	1	18	Count
	0.02	0.01	0.03	0.00	0.00	0.06	Total %
	17.868497	0.1220679	0.0082558	0.0005897	0.0005897		Expected
3	0	0	0	1	0	1	Count
	0.00	0.00	0.00	0.00	0.00	0.00	Total %
	0.9926943	0.0067815	0.0004587	0.0000328	0.0000328		Expected
	30301	207	14	1	1	30524	Count
	99.27	0.68	0.05	0.00	0.00		Total %
Tests							
Source	DF	-LogLikelihood	RSquare (U)	Test	ChiSquare	Prob>ChiSq	
Model	12	1136.6090	0.5887	Likelihood Ratio	2273.218	0.0000	
Error	30509	794.1173		Pearson	61646.66	0.0000	
C Total	30521	1930.7263					
Total Count	30524						
Warning: 20% of cells have expected count less than 5, Chi-squares suspect							

Table 13Logistic Regression - # of Accidents by # of Spills

Crosstabs						
# of SPLL	# of acc					
	0	1	2	3	total	
0	30187	108	7	0	30302	Count
	98.90	0.35	0.02	0.00	99.27	Total %
	29967.451	315.6872	17.869087	0.992727		Expected
1	0	205	2	0	207	Count
	0.00	0.67	0.01	0.00	0.68	Total %
	204.71462	2.1565326	0.1220679	0.0067815		Expected
2	0	5	8	0	13	Count
	0.00	0.02	0.03	0.00	0.04	Total %
	12.856474	0.1354344	0.0076661	0.0004259		Expected
3	0	0	0	1	1	Count
	0.00	0.00	0.00	0.00	0.00	Total %
	0.9889595	0.010418	0.0005897	0.0000328		Expected
5	0	0	1	0	1	Count
	0.00	0.00	0.00	0.00	0.00	Total %
	0.9889595	0.010418	0.0005897	0.0000328		Expected
	30187	318	18	1	30524	Count
	98.90	1.04	0.06	0.00		Total %
Tests						
Source	DF	-LogLikelihood	RSquare (U)	Test	ChiSquare	Prob>ChiSq
Model	12	1128.6238	0.8200	Likelihood Ratio	2257.248	0.0000
Error	30508	247.7814		Pearson	60196.73	0.0000
C Total	30520	1376.4052				
Total Count	30524					
Warning: 20% of cells have expected count less than 5, Chi-squares suspect						

Table -14Logistic Regression - # of Spills by # of Accidents

Crosstabs				
# of acc	co_ming_prod			
	0	1	total	
0	29084	1103	30187	Count
	95.28	3.61	98.90	Total %
	29079.365	1107.6346		Expected
1	301	17	318	Count
	0.99	0.06	1.04	Total %
	306.3318	11.668196		Expected
2	18	0	18	Count
	0.06	0.00	0.06	Total %
	17.339536	0.6604639		Expected
3	1	0	1	Count
	0.00	0.00	0.00	Total %
	0.9633076	0.0366924		Expected
	29404	1120	30524	Count
	96.33	3.67		Total %
Tests				
Source	DF	-LogLikelihood	RSquare (U)	
Model	3	1.8331	0.0009	
Error	30518	1928.8932		
C Total	30521	1930.7263		
Total Count	30524			
Test	ChiSquare	Prob>ChiSq		
Likelihood Ratio	3.666	0.2998		
Pearson	3.273	0.3514		
Warning: 20% of cells have expected count less than 5, Chi-squares suspect				

Table 15Logistic Regression - # of Accidents by Commingling Production Flag

Crosstabs				
# of SPLL	co_ming_prod			
	0	1	total	
0	29198	1104	30302	Count
	95.66	3.62	99.27	Total %
	29190.146	1111.8543		Expected
1	192	15	207	Count
	0.63	0.05	0.68	Total %
	199.40467	7.5953348		Expected
2	12	1	13	Count
	0.04	0.00	0.04	Total %
	12.522998	0.4770017		Expected
3	1	0	1	Count
	0.00	0.00	0.00	Total %
	0.9633076	0.0366924		Expected
5	1	0	1	Count
	0.00	0.00	0.00	Total %
	0.9633076	0.0366924		Expected
	29404	1120	30524	Count
	96.33	3.67		Total %
Tests				
Source	DF	-LogLikelihood	RSquare (U)	
Model	4	3.2742	0.0024	
Error	30516	1373.1310		
C Total	30520	1376.4052		
Total Count	30524			
Test	ChiSquare	Prob>ChiSq		
Likelihood Ratio	6.548	0.1618		
Pearson	8.223	0.0837		
Warning: 20% of cells have expected count less than 5, Chi-squares suspect				

Table 16Logistic Regression - # of Spills by Commingling Production Flag

Crosstabs				
# of acc	FIRED_VESSEL_FL			
	0	1	total	
0	24054	6100	30154	Count
	78.90	20.01	98.90	Total %
	23966.535	6187.4647		Expected
1	163	152	315	Count
	0.53	0.50	1.03	Total %
	250.36342	64.636578		Expected
2	14	4	18	Count
	0.05	0.01	0.06	Total %
	14.306481	3.6935188		Expected
3	1	0	1	Count
	0.00	0.00	0.00	Total %
	0.7948045	0.2051955		Expected
	24232	6256	30488	Count
	79.48	20.52		
Tests				
Source	DF	-LogLikelihood	RSquare (U)	
Model	3	61.0475	0.0319	
Error	30482	1855.6088		
C Total	30485	1916.6562		
Total Count	30488			
Test	ChiSquare	Prob>ChiSq		
Likelihood Ratio	122.095	<.0001		
Pearson	150.412	<.0001		
Warning: 20% of cells have expected count less than 5, Chi-squares suspect				

Table 17Logistic Regression - # of Accidents by Fired Vessel Flag

Crosstabs				
# of SPLL	FIRED_VESSEL_FL			
	0	1	total	
0	24103	6165	30268	Count
	79.06	20.22	99.28	Total %
	24057.143	6210.857		Expected
1	119	86	205	Count
	0.39	0.28	0.67	Total %
	162.93493	42.065075		Expected
2	8	5	13	Count
	0.03	0.02	0.04	Total %
	10.332459	2.6675413		Expected
3	1	0	1	Count
	0.00	0.00	0.00	Total %
	0.7948045	0.2051955		Expected
5	1	0	1	Count
	0.00	0.00	0.00	Total %
	0.7948045	0.2051955		Expected
	24232	6256	30488	Count
	79.48	20.52		
Tests				
Source	DF	-LogLikelihood	RSquare (U)	
Model	4	25.8754	0.0189	
Error	30480	1340.2870		
C Total	30484	1366.1624		
Total Count	30488			
Test	ChiSquare	Prob>ChiSq		
Likelihood Ratio	51.751	<.0001		
Pearson	61.243	<.0001		
Warning: 20% of cells have expected count less than 5, Chi-squares suspect				

Table 18Logistic Regression - # of Spills by Fired Vessel Flag

Crosstabs				
# of acc	GAS_PROD_FLAG			
	0	1	total	
0	14683	15463	30146	Count
	48.17	50.73	98.90	Total %
	14598.26	15547.74		Expected
1	76	239	315	Count
	0.25	0.78	1.03	Total %
	152.53937	162.46063		Expected
2	1	17	18	Count
	0.00	0.06	0.06	Total %
	8.7165354	9.2834646		Expected
3	0	1	1	Count
	0.00	0.00	0.00	Total %
	0.484252	0.515748		Expected
	14760	15720	30480	Count
	48.43	51.57		
Tests				
Source	DF	-LogLikelihood	RSquare (U)	
Model	3	48.5706	0.0253	
Error	30474	1867.9975		
C Total	30477	1916.5681		
Total Count	30480			
Test	ChiSquare	Prob>ChiSq		
Likelihood Ratio	97.141	<.0001		
Pearson	89.603	<.0001		
Warning: 20% of cells have expected count less than 5, Chi-squares suspect				

Table 19Logistic Regression - # of Accidents by Gas Production Flag

Crosstabs				
#SPLL	GAS_PROD_FLAG			
	0	1	total	
0	14709	15551	30260	Count
	48.26	51.02	99.28	Total %
	14653.465	15606.535		Expected
1	50	155	205	Count
	0.16	0.51	0.67	Total %
	99.271654	105.72835		Expected
2	1	12	13	Count
	0.00	0.04	0.04	Total %
	6.2952756	6.7047244		Expected
3	0	1	1	Count
	0.00	0.00	0.00	Total %
	0.484252	0.515748		Expected
5	0	1	1	Count
	0.00	0.00	0.00	Total %
	0.484252	0.515748		Expected
	14760	15720	30480	Count
	48.43	51.57		
Tests				
Source	DF	-LogLikelihood	RSquare (U)	
Model	4	31.6774	0.0232	
Error	30472	1334.4271		
C Total	30476	1366.1045		
Total Count	30480			
Test	ChiSquare	Prob>ChiSq		
Likelihood Ratio	63.355	<.0001		
Pearson	58.339	<.0001		
Warning: 20% of cells have expected count less than 5, Chi-squares suspect				

Table 20 Logistic Regression - # of Spills by Gas Production Flag

Crosstabs				
# of acc	GAS_FLARING_FLAG			
	0	1	total	
0	28835	1307	30142	Count
	94.62	4.29	98.90	Total %
	28796.905	1345.0952		Expected
1	263	52	315	Count
	0.86	0.17	1.03	Total %
	300.94304	14.056963		Expected
2	17	1	18	Count
	0.06	0.00	0.06	Total %
	17.196745	0.803255		Expected
3	1	0	1	Count
	0.00	0.00	0.00	Total %
	0.9553747	0.0446253		Expected
	29116	1360	30476	Count
	95.54	4.46		
Tests				
Source	DF	-LogLikelihood	RSquare (U)	
Model	3	33.2178	0.0173	
Error	30470	1883.3063		
C Total	30473	1916.5240		
Total Count	30476			
Test	ChiSquare	Prob>ChiSq		
Likelihood Ratio	66.436	<.0001		
Pearson	108.427	<.0001		
Warning: 20% of cells have expected count less than 5, Chi-squares suspect				

Table -21 Logistic Regression - # of Accidents by Gas Flaring Flag

Crosstabs				
# of SPLL	GAS_FLARING_FLAG			
	0	1	total	
0	28936	1320	30256	Count
	94.95	4.33	99.28	Total %
	28905.818	1350.1824		Expected
1	168	37	205	Count
	0.55	0.12	0.67	Total %
	195.85182	9.1481822		Expected
2	11	2	13	Count
	0.04	0.01	0.04	Total %
	12.419871	0.5801286		Expected
3	1	0	1	Count
	0.00	0.00	0.00	Total %
	0.9553747	0.0446253		Expected
5	0	1	1	Count
	0.00	0.00	0.00	Total %
	0.9553747	0.0446253		Expected
	29116	1360	30476	Count
	95.54	4.46		
Tests				
Source	DF	-LogLikelihood	RSquare (U)	
Model	4	30.5828	0.0224	
Error	30468	1335.4927		
C Total	30472	1366.0755		
Total Count	30476			
Test	ChiSquare	Prob>ChiSq		
Likelihood Ratio	61.166	<.0001		
Pearson	114.555	<.0001		
Warning: 20% of cells have expected count less than 5, Chi-squares suspect				

Table 22Logistic Regression - # of Spills by Gas Flaring Flag

Crosstabs				
# of acc	MAJ_CMPLX_FLAG			
	0	1	total	
0	15534	14617	30151	Count
	50.96	47.95	98.90	Total %
	15389.521	14761.479		Expected
1	24	291	315	Count
	0.08	0.95	1.03	Total %
	160.78071	154.21929		Expected
2	2	16	18	Count
	0.01	0.05	0.06	Total %
	9.1874692	8.8125308		Expected
3	0	1	1	Count
	0.00	0.00	0.00	Total %
	0.510415	0.489585		Expected
	15560	14925	30485	Count
	51.04	48.96		
Tests				
Source	DF	-LogLikelihood	RSquare (U)	
Model	3	147.7150	0.0771	
Error	30479	1768.9082		
C Total	30482	1916.6232		
Total Count	30485			
Test	ChiSquare	Prob>ChiSq		
Likelihood Ratio	295.430	<.0001		
Pearson	252.975	<.0001		
Warning: 20% of cells have expected count less than 5, Chi-squares suspect				

Table -23 Logistic Regression - # of Accidents by Major Complex Flag

Crosstabs				
# of SPLL	MAJ_CMPLX_FLAG			
	0	1	total	
0	15543	14722	30265	Count
	50.99	48.29	99.28	Total %
	15447.709	14817.291		Expected
1	16	189	205	Count
	0.05	0.62	0.67	Total %
	104.63507	100.36493		Expected
2	1	12	13	Count
	0.00	0.04	0.04	Total %
	6.6353945	6.3646055		Expected
3	0	1	1	Count
	0.00	0.00	0.00	Total %
	0.510415	0.489585		Expected
5	0	1	1	Count
	0.00	0.00	0.00	Total %
	0.510415	0.489585		Expected
	15560	14925	30485	Count
	51.04	48.96		
Tests				
Source	DF	-LogLikelihood	RSquare (U)	
Model	4	97.3245	0.0712	
Error	30477	1268.8162		
C Total	30481	1366.1407		
Total Count	30485			
Test	ChiSquare	Prob>ChiSq		
Likelihood Ratio	194.649	<.0001		
Pearson	166.419	<.0001		
Warning: 20% of cells have expected count less than 5, Chi-squares suspect				

Table 24Logistic Regression - # of Spills by Major Complex Flag

Crosstabs				
# of acc	HELIPORT_FLAG			
	0	1	total	
0	14347	15804	30151	Count
	47.06	51.84	98.90	Total %
	14231.351	15919.649		Expected
1	41	274	315	Count
	0.13	0.90	1.03	Total %
	148.68083	166.31917		Expected
2	1	17	18	Count
	0.00	0.06	0.06	Total %
	8.4960472	9.5039528		Expected
3	0	1	1	Count
	0.00	0.00	0.00	Total %
	0.4720026	0.5279974		Expected
	14389	16096	30485	Count
	47.20	52.80		
Tests				
Source	DF	-LogLikelihood	RSquare (U)	
Model	3	93.2431	0.0486	
Error	30479	1823.3801		
C Total	30482	1916.6232		
Total Count	30485			
Test	ChiSquare	Prob>ChiSq		
Likelihood Ratio	186.486	<.0001		
Pearson	162.903	<.0001		
Warning: 20% of cells have expected count less than 5, Chi-squares suspect				

Table 25Logistic Regression - # of Accidents by Heliport Flag

Crosstabs				
#SPLL	HELIPORT_FLAG			
	0	1	total	
0	14363	15902	30265	Count
	47.11	52.16	99.28	Total %
	14285.159	15979.841		Expected
1	26	179	205	Count
	0.09	0.59	0.67	Total %
	96.760538	108.23946		Expected
2	0	13	13	Count
	0.00	0.04	0.04	Total %
	6.1360341	6.8639659		Expected
3	0	1	1	Count
	0.00	0.00	0.00	Total %
	0.4720026	0.5279974		Expected
5	0	1	1	Count
	0.00	0.00	0.00	Total %
	0.4720026	0.5279974		Expected
	14389	16096	30485	Count
	47.20	52.80		
Tests				
Source	DF	-LogLikelihood	RSquare (U)	
Model	4	65.8580	0.0482	
Error	30477	1300.2827		
C Total	30481	1366.1407		
Total Count	30485			
Test	ChiSquare	Prob>ChiSq		
Likelihood Ratio	131.716	<.0001		
Pearson	112.218	<.0001		
Warning: 20% of cells have expected count less than 5, Chi-squares suspect				

Table -26 Logistic Regression - # of Spills by Heliport Flag

Crosstabs				
# of acc	SUL_PROD_FLAG			
	0	1	total	
0	30101	47	30148	Count
	98.75	0.15	98.90	Total %
	30100.526	47.47405		Expected
1	314	1	315	Count
	1.03	0.00	1.03	Total %
	314.50397	0.4960304		Expected
2	18	0	18	Count
	0.06	0.00	0.06	Total %
	17.971655	0.0283446		Expected
3	1	0	1	Count
	0.00	0.00	0.00	Total %
	0.9984253	0.0015747		Expected
	30434	48	30482	Count
	99.84	0.16		
Tests				
Source	DF	-LogLikelihood	RSquare (U)	
Model	3	0.2299	0.0001	
Error	30476	1916.3603		
C Total	30479	1916.5901		
Total Count	30482			
Test	ChiSquare	Prob>ChiSq		
Likelihood Ratio	0.460	0.9276		
Pearson	0.548	0.9083		
Warning: 20% of cells have expected count less than 5, Chi-squares suspect				

Table 27Logistic Regression - # of Accidents by Sulfur Production Flag

Crosstabs				
# of SPLL	SUL_PROD_FLAG			
	0	1	total	
0	30215	47	30262	Count
	99.12	0.15	99.28	Total %
	30214.346	47.653566		Expected
1	204	1	205	Count
	0.67	0.00	0.67	Total %
	204.67719	0.3228135		Expected
2	13	0	13	Count
	0.04	0.00	0.04	Total %
	12.979529	0.0204711		Expected
3	1	0	1	Count
	0.00	0.00	0.00	Total %
	0.9984253	0.0015747		Expected
5	1	0	1	Count
	0.00	0.00	0.00	Total %
	0.9984253	0.0015747		Expected
	30434	48	30482	Count
	99.84	0.16		
Tests				
Source	DF	-LogLikelihood	RSquare (U)	
Model	4	0.4828	0.0004	
Error	30474	1365.6362		
C Total	30478	1366.1189		
Total Count	30482			
Test	ChiSquare	Prob>ChiSq		
Likelihood Ratio	0.966	0.9150		
Pearson	1.455	0.8345		
Warning: 20% of cells have expected count less than 5, Chi-squares suspect				

Table 28Logistic Regression - # of Spills by Sulfur Production Flag

Crosstabs				
# of acc	STORE_TANK_FLAG			
	0	1	total	
0	26423	3714	30137	Count
	86.72	12.19	98.90	Total %
	26331.179	3805.8211		Expected
1	193	122	315	Count
	0.63	0.40	1.03	Total %
	275.22054	39.779462		Expected
2	6	12	18	Count
	0.02	0.04	0.06	Total %
	15.726888	2.2731121		Expected
3	1	0	1	Count
	0.00	0.00	0.00	Total %
	0.873716	0.126284		Expected
	26623	3848	30471	Count
	87.37	12.63		
Tests				
Source	DF	-LogLikelihood	RSquare (U)	
Model	3	83.8244	0.0437	
Error	30465	1832.6445		
C Total	30468	1916.4689		
Total Count	30471			
Test	ChiSquare	Prob>ChiSq		
Likelihood Ratio	167.649	<.0001		
Pearson	244.824	<.0001		
Warning: 20% of cells have expected count less than 5, Chi-squares suspect				

Table 29Logistic Regression - # of Accidents by Storage Tank Flag

Crosstabs				
# of SPLL	STORE_TANK_FLAG			
	0	1	total	
0	26501	3750	30251	Count
	86.97	12.31	99.28	Total %
	26430.782	3820.2175		Expected
1	115	90	205	Count
	0.38	0.30	0.67	Total %
	179.11178	25.888222		Expected
2	6	7	13	Count
	0.02	0.02	0.04	Total %
	11.358308	1.6416921		Expected
3	1	0	1	Count
	0.00	0.00	0.00	Total %
	0.873716	0.126284		Expected
5	0	1	1	Count
	0.00	0.00	0.00	Total %
	0.873716	0.126284		Expected
	26623	3848	30471	Count
	87.37	12.63		
Tests				
Source	DF	-LogLikelihood	RSquare (U)	
Model	4	70.4568	0.0516	
Error	30463	1295.5824		
C Total	30467	1366.0392		
Total Count	30471			
Test	ChiSquare	Prob>ChiSq		
Likelihood Ratio	140.914	<.0001		
Pearson	210.277	<.0001		
Warning: 20% of cells have expected count less than 5, Chi-squares suspect				

Table 30Logistic Regression - # of Spills by Storage Tank Flag

Crosstabs				
# of acc	OIL_PROD_FLAG			
	0	1	total	
0	22334	7817	30151	Count
	73.26	25.64	98.90	Total %
	22245.573	7905.427		Expected
1	152	163	315	Count
	0.50	0.53	1.03	Total %
	232.40873	82.591274		Expected
2	6	12	18	Count
	0.02	0.04	0.06	Total %
	13.280499	4.7195014		Expected
3	0	1	1	Count
	0.00	0.00	0.00	Total %
	0.7378055	0.2621945		Expected
	22492	7993	30485	Count
	73.78	26.22		
Tests				
Source	DF	-LogLikelihood	RSquare (U)	
Model	3	54.7149	0.0285	
Error	30479	1861.9082		
C Total	30482	1916.6232		
Total Count	30485			
Test	ChiSquare	Prob>ChiSq		
Likelihood Ratio	109.430	<.0001		
Pearson	125.481	<.0001		
Warning: 20% of cells have expected count less than 5, Chi-squares suspect				

Table 31Logistic Regression - # of Accidents by Oil Production Flag

Crosstabs				
#SPLL	OIL_PROD_FLAG			
	0	1	total	
0	22402	7863	30265	Count
	73.49	25.79	99.28	Total %
	22329.683	7935.3172		Expected
1	86	119	205	Count
	0.28	0.39	0.67	Total %
	151.25012	53.749877		Expected
2	4	9	13	Count
	0.01	0.03	0.04	Total %
	9.5914712	3.4085288		Expected
3	0	1	1	Count
	0.00	0.00	0.00	Total %
	0.7378055	0.2621945		Expected
5	0	1	1	Count
	0.00	0.00	0.00	Total %
	0.7378055	0.2621945		Expected
	22492	7993	30485	Count
	73.78	26.22		
Tests				
Source	DF	-LogLikelihood	RSquare (U)	
Model	4	54.3896	0.0398	
Error	30477	1311.7511		
C Total	30481	1366.1407		
Total Count	30485			
Test	ChiSquare	Prob>ChiSq		
Likelihood Ratio	108.779	<.0001		
Pearson	126.313	<.0001		
Warning: 20% of cells have expected count less than 5, Chi-squares suspect				

Table -32 Logistic Regression - # of Spills by Oil Production Flag

Crosstabs									
# of acc	DISTRICT_ CODE								
Count	1	2	3	4	5	6	B	total	
0	8226	8576	6453	2833	3126	937	36	30187	Count
	26.95	28.10	21.14	9.28	10.24	3.07	0.12	98.90	Total %
	8208.3639	8549.5549	6472.74	2854.1371	3120.1672	943.46737	38.569421		Expected
1	71	66	86	48	27	17	3	318	Count
	0.23	0.22	0.28	0.16	0.09	0.06	0.01	1.04	Total %
	86.469663	90.063884	68.186018	30.06644	32.86889	9.9388023	0.4063032		Expected
2	2	3	6	5	2	0	0	18	Count
	0.01	0.01	0.02	0.02	0.01	0.00	0.00	0.06	Total %
	4.8945092	5.0979557	3.8595859	1.7018739	1.8605032	0.5625737	0.0229983		Expected
3	1	0	0	0	0	0	0	1	Count
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Total %
	0.2719172	0.2832198	0.2144214	0.0945486	0.1033613	0.0312541	0.0012777		Expected
	8300	8645	6545	2886	3155	954	39	30524	Count
	27.19	28.32	21.44	9.45	10.34	3.13	0.13		
Tests									
Source	DF	-LogLikelihood		RSquare (U)					
Model	18	24.1009		0.0125					
Error	30503	1906.6253							
C Total	30521	1930.7263							
Total Count	30524								
Test	ChiSquare	Prob>ChiSq							
Likelihood Ratio	48.202	0.0001							
Pearson	61.160	<.0001							
Warning: 20% of cells have expected count less than 5, Chi-squares suspect									

Table 33Logistic Regression - # of Accidents by District Code

Crosstabs									
# of SPLL	DISTRICT_ CODE								
	1	2	3	4	5	6	B	total	
0	8239	8599	6480	2862	3137	948	37	30302	Count
	26.99	28.17	21.23	9.38	10.28	3.11	0.12	99.27	Total %
	8239.6344	8582.1252	6497.3984	2865.0102	3132.0538	947.06159	38.716354		Expected
1	56	43	62	21	17	6	2	207	Count
	0.18	0.14	0.20	0.07	0.06	0.02	0.01	0.68	Total %
	56.286856	58.626491	44.385238	19.57155	21.395787	6.4695977	0.2644804		Expected
2	4	2	3	3	1	0	0	13	Count
	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.04	Total %
	3.5349233	3.6818569	2.7874787	1.2291312	1.3436968	0.4063032	0.0166099		Expected
3	1	0	0	0	0	0	0	1	Count
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Total %
	0.2719172	0.2832198	0.2144214	0.0945486	0.1033613	0.0312541	0.0012777		Expected
5	0	1	0	0	0	0	0	1	Count
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Total %
	0.2719172	0.2832198	0.2144214	0.0945486	0.1033613	0.0312541	0.0012777		Expected
	8300	8645	6545	2886	3155	954	39	30524	Count
	27.19	28.32	21.44	9.45	10.34	3.13	0.13		
Tests									
Source	DF	-LogLikelihood		RSquare (U)					
Model	24	12.7944		0.0093					
Error	30496	1363.6108							
C Total	30520	1376.4052							
Total Count	30524								
Test	ChiSquare	Prob>ChiSq							
Likelihood Ratio	25.589	0.3743							
Pearson	32.871	0.1068							
Warning: 20% of cells have expected count less than 5, Chi-squares suspect									

Table 34Logistic Regression - # of Spills by District Code

Crosstabs				
# of acc	COMPRESSOR_FLAG			
	0	1	total	
0	23703	6441	30144	Count
	77.77	21.13	98.90	Total %
	23563.908	6580.0916		Expected
1	118	197	315	Count
	0.39	0.65	1.03	Total %
	246.23909	68.76091		Expected
2	4	14	18	Count
	0.01	0.05	0.06	Total %
	14.070805	3.9291948		Expected
3	0	1	1	Count
	0.00	0.00	0.00	Total %
	0.7817114	0.2182886		Expected
	23825	6653	30478	Count
	78.17	21.83		
Tests				
Source	DF	-LogLikelihood	RSquare (U)	
Model	3	136.7227	0.0713	
Error	30472	1779.8234		
C Total	30475	1916.5461		
Total Count	30478			
Test	ChiSquare	Prob>ChiSq		
Likelihood Ratio	273.445	<.0001		
Pearson	346.314	<.0001		
Warning: 20% of cells have expected count less than 5, Chi-squares suspect				

Table 35Logistic Regression - # of Accidents by Compressor Flag

Crosstabs				
# of SPLL	COMPRESSOR_FLAG			
	0	1	total	
0	23748	6510	30258	Count
	77.92	21.36	99.28	Total %
	23653.023	6604.9765		Expected
1	75	130	205	Count
	0.25	0.43	0.67	Total %
	160.25084	44.749163		Expected
2	2	11	13	Count
	0.01	0.04	0.04	Total %
	10.162248	2.8377518		Expected
3	0	1	1	Count
	0.00	0.00	0.00	Total %
	0.7817114	0.2182886		Expected
5	0	1	1	Count
	0.00	0.00	0.00	Total %
	0.7817114	0.2182886		Expected
	23825	6653	30478	Count
	78.17	21.83		
Tests				
Source	DF	-LogLikelihood	RSquare (U)	
Model	4	97.2692	0.0712	
Error	30470	1268.8207		
C Total	30474	1366.0900		
Total Count	30478			
Test	ChiSquare	Prob>ChiSq		
Likelihood Ratio	194.538	<.0001		
Pearson	246.704	<.0001		
Warning: 20% of cells have expected count less than 5, Chi-squares suspect				

Table 36Logistic Regression - # of Spills by Compressor Flag

Crosstabs							
# of acc	# of acc_l						
	0	1	2	3	5	total	
0	29853	314	18	2	0	30187	Count
	97.80	1.03	0.06	0.01	0.00	98.90	Total %
	29830.975	334.26831	18.790231	1.977919	0.9889595		Expected
1	294	22	1	0	1	318	Count
	0.96	0.07	0.00	0.00	0.00	1.04	Total %
	314.24951	3.5212947	0.1979426	0.0208361	0.010418		Expected
2	16	2	0	0	0	18	Count
	0.05	0.01	0.00	0.00	0.00	0.06	Total %
	17.787708	0.1993186	0.0112043	0.0011794	0.0005897		Expected
3	1	0	0	0	0	1	Count
	0.00	0.00	0.00	0.00	0.00	0.00	Total %
	0.988206	0.0110733	0.0006225	0.0000655	0.0000328		Expected
	30164	338	19	2	1	30524	Count
	98.82	1.11	0.06	0.01	0.00		
Tests							
Source	DF	-LogLikelihood	RSquare (U)				
Model	12	31.4806	0.0163				
Error	30509	1899.2457					
C Total	30521	1930.7263					
Total Count	30524						
Test	ChiSquare	Prob>ChiSq					
Likelihood Ratio	62.961	<.0001					
Pearson	214.284	<.0001					
Warning: 20% of cells have expected count less than 5, Chi-squares suspect							

Table 37 Lagged - Logistic Regression - # of Accidents by # of Accidents

Crosstabs							
# of SPLL	# of acc_l						
	0	1	2	3	5	total	
0	29965	317	18	2	0	30302	Count
	98.17	1.04	0.06	0.01	0.00	99.27	Total %
	29944.618	335.54174	18.861814	1.9854541	0.992727		Expected
1	187	18	1	0	1	207	Count
	0.61	0.06	0.00	0.00	0.00	0.68	Total %
	204.55864	2.2921635	0.1288494	0.0135631	0.0067815		Expected
2	10	3	0	0	0	13	Count
	0.03	0.01	0.00	0.00	0.00	0.04	Total %
	12.846678	0.1439523	0.008092	0.0008518	0.0004259		Expected
3	1	0	0	0	0	1	Count
	0.00	0.00	0.00	0.00	0.00	0.00	Total %
	0.988206	0.0110733	0.0006225	0.0000655	0.0000328		Expected
5	1	0	0	0	0	1	Count
	0.00	0.00	0.00	0.00	0.00	0.00	Total %
	0.988206	0.0110733	0.0006225	0.0000655	0.0000328		Expected
	30164	338	19	2	1	30524	Count
	98.82	1.11	0.06	0.01	0.00		
Tests							
Source	DF	-LogLikelihood	RSquare (U)				
Model	16	35.5270	0.0258				
Error	30504	1340.8782					
C Total	30520	1376.4052					
Total Count	30524						
Test	ChiSquare	Prob>ChiSq					
Likelihood Ratio	71.054	<.0001					
Pearson	319.919	<.0001					
Warning: 20% of cells have expected count less than 5, Chi-squares suspect							
	Kappa	Std Err					
	0.062524	0.014275					
Kappa measures the degree of agreement.							

Table 38 Lagged - Logistic Regression - # of Spills by # of Accidents

Crosstabs							
# of acc	# of SPLL_l						
	0	1	2	3	5	total	
0	29932	230	22	2	1	30187	Count
	98.06	0.75	0.07	0.01	0.00	98.90	Total %
	29911.08	249.2178	22.746069	1.977919	1.977919		Expected
1	296	20	1	0	1	318	Count
	0.97	0.07	0.00	0.00	0.00	1.04	Total %
	315.09337	2.625344	0.2396147	0.0208361	0.0208361		Expected
2	16	2	0	0	0	18	Count
	0.05	0.01	0.00	0.00	0.00	0.06	Total %
	17.835474	0.1486044	0.0135631	0.0011794	0.0011794		Expected
3	1	0	0	0	0	1	Count
	0.00	0.00	0.00	0.00	0.00	0.00	Total %
	0.9908597	0.0082558	0.0007535	0.0000655	0.0000655		Expected
	30245	252	23	2	2	30524	Count
	99.09	0.83	0.08	0.01	0.01		
Tests							
Source	DF	-LogLikelihood	RSquare (U)				
Model	12	31.9546	0.0166				
Error	30509	1898.7716					
C Total	30521	1930.7263					
Total Count	30524						
Test	ChiSquare	Prob>ChiSq					
Likelihood Ratio	63.909	<.0001					
Pearson	189.876	<.0001					
Warning: 20% of cells have expected count less than 5, Chi-squares suspect							

Table 39 Lagged - Logistic Regression - # of Accidents by # of Spills

Crosstabs							
# of SPLL	# of SPLL_l						
	0	1	2	3	5	total	
0	30045	232	22	2	1	30302	Count
	98.43	0.76	0.07	0.01	0.00	99.27	Total %
	30025.029	250.16721	22.832722	1.9854541	1.9854541		Expected
1	188	17	1	0	1	207	Count
	0.62	0.06	0.00	0.00	0.00	0.68	Total %
	205.10795	1.7089503	0.1559756	0.0135631	0.0135631		Expected
2	10	3	0	0	0	13	Count
	0.03	0.01	0.00	0.00	0.00	0.04	Total %
	12.881175	0.1073254	0.0097956	0.0008518	0.0008518		Expected
3	1	0	0	0	0	1	Count
	0.00	0.00	0.00	0.00	0.00	0.00	Total %
	0.9908597	0.0082558	0.0007535	0.0000655	0.0000655		Expected
5	1	0	0	0	0	1	Count
	0.00	0.00	0.00	0.00	0.00	0.00	Total %
	0.9908597	0.0082558	0.0007535	0.0000655	0.0000655		Expected
	30245	252	23	2	2	30524	Count
	99.09	0.83	0.08	0.01	0.01		
Tests							
Source	DF	-LogLikelihood	RSquare (U)				
Model	16	37.3153	0.0271				
Error	30504	1339.0899					
C Total	30520	1376.4052					
Total Count	30524						
Test	ChiSquare	Prob>ChiSq					
Likelihood Ratio	74.631	<.0001					
Pearson	295.060	<.0001					
Warning: 20% of cells have expected count less than 5, Chi-squares suspect							
	Kappa	Std Err					
	0.070894	0.016044					
Kappa measures the degree of agreement.							

Table 40 Lagged - Logistic Regression - # of Spills by # of Spills

Converged by Gradient				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	62.3549	1	124.7098	<.0001
Full	1868.3713			
Reduced	1930.7263			
RSquare (U)		0.0323		
Observations (or Sum Wgts)		30524		
Parameter Estimates				
Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	5.18049779	0.0906357	3267	0.0000
Intercept	8.07224319	0.2407501	1124.2	<.0001
Intercept	11.0179245	1.0027237	120.74	<.0001
DISTANCE_TO_SH	-0.0180898	0.0015062	144.24	<.0001

Table -41 Logistic Regression - # of Accidents by Distance to Shore

Converged by Gradient				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	29.7876	1	59.57525	<.0001
Full	1346.6176			
Reduced	1376.4052			
RSquare (U)		0.0216		
Observations (or Sum Wgts)		30524		
Parameter Estimates				
Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	5.49145234	0.1087707	2548.9	0.0000
Intercept	8.19544816	0.2721281	906.98	<.0001
Intercept	10.2111338	0.7123474	205.48	<.0001
Intercept	10.9043254	1.003732	118.02	<.0001
DISTANCE_TO_SH	-0.0156807	0.0018913	68.74	<.0001

Table -42 Logistic Regression - # of Spills by Distance to Shore

Converged by Gradient				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	76.1233	1	152.2466	<.0001
Full	1834.3294			
Reduced	1910.4527			
RSquare (U)		0.0398		
Observations (or Sum Wgts)		30339		
Parameter Estimates				
Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	4.96244005	0.0708876	4900.6	0.0000
Intercept	7.84213187	0.232979	1133	<.0001
Intercept	10.78778	0.9921863	118.22	<.0001
SLOT_DRILL_COUNT	-0.0755972	0.005133	216.91	<.0001

Table -43 Logistic Regression - # of Accidents by Slot Drill Count

Converged by Gradient				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	49.6840	1	99.36797	<.0001
Full	1310.4043			
Reduced	1360.0883			
RSquare (U)		0.0365		
Observations (or Sum Wgts)		30339		
Parameter Estimates				
Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	5.37431647	0.0861775	3889.2	0.0000
Intercept	8.0654676	0.2631339	939.52	<.0001
Intercept	10.0812926	0.7053703	204.27	<.0001
Intercept	10.7745008	0.995838	117.06	<.0001
SLOT_DRILL_COUNT	-0.0736446	0.0059981	150.75	<.0001

Table -44 Logistic Regression - # of Spills by Slot Drill Count

Converged by Gradient				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	88.2338	1	176.4677	<.0001
Full	1823.5187			
Reduced	1911.7525			
RSquare (U)			0.0462	
Observations (or Sum Wgts)			30457	
Parameter Estimates				
Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	5.0856053	0.0764712	4422.7	0.0000
Intercept	7.96669309	0.235102	1148.3	<.0001
Intercept	10.9123014	0.9960945	120.01	<.0001
SLOT_COUNT	-0.0693714	0.0044776	240.03	<.0001

Table -45 Logistic Regression - # of Accidents by Slot Count

Converged by Gradient				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	56.4393	1	112.8786	<.0001
Full	1304.5022			
Reduced	1360.9415			
RSquare (U)			0.0415	
Observations (or Sum Wgts)			30457	
Parameter Estimates				
Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	5.49359527	0.0931932	3474.9	0.0000
Intercept	8.18511951	0.2657389	948.72	<.0001
Intercept	10.2008751	0.7076452	207.80	<.0001
Intercept	10.8940782	0.9985226	119.03	<.0001
SLOT_COUNT	-0.0676722	0.0053568	159.59	<.0001

Table -46 Logistic Regression - # of Spills by Slot Count

Converged by Gradient				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	63.2601	1	126.5203	<.0001
Full	1867.4661			
Reduced	1930.7263			
RSquare (U)			0.0328	
Observations (or Sum Wgts)			30524	
Parameter Estimates				
Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	4.72124205	0.0615095	5891.5	0.0000
Intercept	7.61386497	0.2305888	1090.3	<.0001
Intercept	10.5592056	0.9953937	112.53	<.0001
bed_count	-0.0395484	0.002826	195.84	<.0001

Table -47 Logistic Regression - # of Accidents by Bed Count

Converged by Gradient				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	38.4936	1	76.98724	<.0001
Full	1337.9116			
Reduced	1376.4052			
RSquare (U)			0.0280	
Observations (or Sum Wgts)			30524	
Parameter Estimates				
Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	5.13048763	0.0752384	4649.8	0.0000
Intercept	7.83626175	0.2601804	907.13	<.0001
Intercept	9.85180889	0.7063289	194.54	<.0001
Intercept	10.5449943	0.9982089	111.60	<.0001
bed_count	-0.0378506	0.0033921	124.51	<.0001

Table -48 Logistic Regression - # of Spills by Bed Count

Converged by Gradient				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	140.5905	1	281.1811	<.0001
Full	1790.1357			
Reduced	1930.7263			
RSquare (U)			0.0728	
Observations (or Sum Wgts)			30524	
Parameter Estimates				
Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	5.20230144	0.0779339	4455.9	0.0000
Intercept	8.1017019	0.2349699	1188.9	<.0001
Intercept	11.0479707	0.9889157	124.81	<.0001
NUM_COMP	-0.0179936	0.000927	376.79	<.0001

Table -53 Logistic Regression - # of Accidents by Number of Components

Converged by Gradient				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	97.9504	1	195.9009	<.0001
Full	1278.4548			
Reduced	1376.4052			
RSquare (U)			0.0712	
Observations (or Sum Wgts)			30524	
Parameter Estimates				
Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	5.63313772	0.0951891	3502.1	0.0000
Intercept	8.34361525	0.2659434	984.31	<.0001
Intercept	10.3604334	0.7039846	216.59	<.0001
Intercept	11.0536352	0.992802	123.96	<.0001
NUM_COMP	-0.0179834	0.0010819	276.31	<.0001

Table -54 Logistic Regression - # of Spills by Number of Components

Converged by Gradient				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	2.0709	1	4.141782	0.0418
Full	1914.1555			
Reduced	1916.2264			
RSquare (U)			0.0011	
Observations (or Sum Wgts)			30449	
Parameter Estimates				
Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	4.4247682	0.0659311	4504	0.0000
Intercept	7.3019869	0.2323356	987.76	<.0001
Intercept	10.2470211	1.0006693	104.86	<.0001
op_exp_l	0.01717485	0.0088209	3.79	0.0515

Table -55 Lagged - Logistic Regression - # of Accidents by Operator Experience

Converged by Gradient				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	1.8327	1	3.665426	0.0556
Full	1364.0471			
Reduced	1365.8798			
RSquare (U)			0.0013	
Observations (or Sum Wgts)			30449	
Parameter Estimates				
Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	4.8339197	0.0809448	3566.3	0.0000
Intercept	7.52636186	0.2620473	824.92	<.0001
Intercept	9.5417011	0.7085225	181.36	<.0001
Intercept	10.2348783	1.0010011	104.54	<.0001
op_exp_l	0.02017761	0.0111033	3.30	0.0692

Table -56 Lagged - Logistic Regression - # of Spills by Operator Experience

Converged by Objective				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	2.2698	1	4.539636	0.0331
Full	1913.9565			
Reduced	1916.2264			
RSquare (U)			0.0012	
Observations (or Sum Wgts)			30449	
Parameter Estimates				
Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	4.40052124	0.0712553	3813.9	0.0000
Intercept	7.277762	0.233895	968.17	<.0001
Intercept	10.2227965	1.0010158	104.29	<.0001
co_exp_l	0.00967736	0.0046435	4.34	0.0372

Table -57 Lagged - Logistic Regression - # of Accidents by Company Experience

Converged by Gradient				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	5.4381	1	10.87611	0.0010
Full	1360.4417			
Reduced	1365.8798			
RSquare (U)			0.0040	
Observations (or Sum Wgts)			30449	
Parameter Estimates				
Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	4.73470162	0.0853434	3077.8	0.0000
Intercept	7.42735731	0.2634278	794.96	<.0001
Intercept	9.4427309	0.7090351	177.36	<.0001
Intercept	10.1359102	1.0013647	102.46	<.0001
co_exp_l	0.01925056	0.0061175	9.90	0.0017

Table -58 Lagged - Logistic Regression - # of Spills by Company Experience

Converged by Gradient				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	0.0369	1	0.073732	0.7860
Full	1930.6894			
Reduced	1930.7263			
RSquare (U)			0.0000	
Observations (or Sum Wgts)			30524	
Parameter Estimates				
Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	4.47894462	0.080645	3084.6	0.0000
Intercept	7.36507147	0.2369946	965.78	<.0001
Intercept	10.3101031	1.0017665	105.92	<.0001
# of ins_no_inc_l	0.02204736	0.0814138	0.07	0.7865

Table -59 Lagged - Logistic Regression - # of Accidents by # of Inspections Without an INC

Converged by Objective				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	1.2418	1	2.483667	0.1150
Full	1375.1634			
Reduced	1376.4052			
RSquare (U)			0.0009	
Observations (or Sum Wgts)			30524	
Parameter Estimates				
Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	4.80257096	0.0969795	2452.4	0.0000
Intercept	7.50409375	0.2675059	786.92	<.0001
Intercept	9.51942744	0.7105522	179.49	<.0001
Intercept	10.2126063	1.002434	103.79	<.0001
# of ins_no_inc_l	0.16208959	0.1045738	2.40	0.1211

Table -60 Lagged - Logistic Regression - # of Spills by # of Inspections Without an INC

Converged by Objective				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	42.3876	1	84.77527	<.0001
Full	1888.3386			
Reduced	1930.7263			
RSquare (U)			0.0220	
Observations (or Sum Wgts)			30524	
Parameter Estimates				
Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	4.7767671	0.0638455	5597.7	0.0000
Intercept	7.68889587	0.2341945	1077.9	<.0001
Intercept	10.6264429	0.9799366	117.59	<.0001
WATER_DEPTH	-0.0024969	0.0002236	124.70	<.0001

Table -49 Logistic Regression - # of Accidents by Water Depth

Converged by Objective				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	24.4184	1	48.83673	<.0001
Full	1351.9869			
Reduced	1376.4052			
RSquare (U)			0.0177	
Observations (or Sum Wgts)			30524	
Parameter Estimates				
Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	5.16840034	0.0773789	4461.4	0.0000
Intercept	7.88521758	0.2627412	900.68	<.0001
Intercept	9.90023328	0.7049193	197.25	<.0001
Intercept	10.592383	0.9945162	113.44	<.0001
WATER_DEPTH	-0.0022567	0.0002616	74.39	<.0001

Table -50 Logistic Regression - # of Spills by Water Depth

Converged by Gradient				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	108.7707	1	217.5414	<.0001
Full	1821.9556			
Reduced	1930.7263			
RSquare (U)			0.0563	
Observations (or Sum Wgts)			30524	
Parameter Estimates				
Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	5.13092292	0.078523	4269.7	0.0000
Intercept	8.02828564	0.2363074	1154.2	<.0001
Intercept	10.9738803	0.9995049	120.55	<.0001
crane_count	-0.8003103	0.0477859	280.49	<.0001

Table -51 Logistic Regression - # of Accidents by Crane Count

Converged by Gradient				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	70.1880	1	140.3761	<.0001
Full	1306.2172			
Reduced	1376.4052			
RSquare (U)			0.0510	
Observations (or Sum Wgts)			30524	
Parameter Estimates				
Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	5.54111926	0.0960992	3324.7	0.0000
Intercept	8.24973644	0.2672875	952.63	<.0001
Intercept	10.2654813	0.709672	209.24	<.0001
Intercept	10.9586896	1.0011483	119.82	<.0001
crane_count	-0.7866171	0.0579607	184.19	<.0001

Table -52 Logistic Regression - # of Spills by Crane Count

Converged by Gradient

Whole-Model Test

Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	39.3635	1	78.72707	<.0001
Full	1891.3627			
Reduced	1930.7263			

RSquare (U)	0.0204
Observations (or Sum Wgts)	30524

Parameter Estimates

Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	4.73811276	0.063819	5512	0.0000
Intercept	7.63140128	0.2320307	1081.7	<.0001
Intercept	10.5765913	0.9989476	112.10	<.0001
# of ins_w_inc_l	-0.5272635	0.0501401	110.58	<.0001

Table -61 Lagged - Logistic Regression - # of Accidents by # of Inspections With an INC

Converged by Gradient

Whole-Model Test

Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	23.8327	1	47.66543	<.0001
Full	1352.5725			
Reduced	1376.4052			

RSquare (U)	0.0173
Observations (or Sum Wgts)	30524

Parameter Estimates

Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	5.14625455	0.0778136	4373.9	0.0000
Intercept	7.84908411	0.2610029	904.37	<.0001
Intercept	9.86445202	0.7066688	194.86	<.0001
Intercept	10.5576338	0.9984807	111.80	<.0001
# of ins_w_inc_l	-0.5034474	0.0598856	70.67	<.0001

Table -62 Lagged - Logistic Regression - # of Spills by # of Inspections With an INC

Converged by Objective

Whole-Model Test

Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	26.7040	1	53.40808	<.0001
Full	1904.0222			
Reduced	1930.7263			

RSquare (U)	0.0138
Observations (or Sum Wgts)	30524

Parameter Estimates

Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	4.60644773	0.0580317	6300.9	0.0000
Intercept	7.49411953	0.2295774	1065.6	<.0001
Intercept	10.4375387	0.9907641	110.98	<.0001
tot_inc_l	-0.0711723	0.0078727	81.73	<.0001

Table -63 Lagged - Logistic Regression - # of Accidents by Total # of INCs

Converged by Objective

Whole-Model Test

Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	16.3894	1	32.77886	<.0001
Full	1360.0158			
Reduced	1376.4052			

RSquare (U)	0.0119
Observations (or Sum Wgts)	30524

Parameter Estimates

Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	5.02002072	0.0709962	4999.7	0.0000
Intercept	7.72151911	0.2586652	891.11	<.0001
Intercept	9.73628209	0.7038778	191.33	<.0001
Intercept	10.4293326	0.9948664	109.90	<.0001
tot_inc_l	-0.0667765	0.0091542	53.21	<.0001

Table -64 Lagged - Logistic Regression - # of Spills by Total # of INCs

Converged by Gradient				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	5.5961	1	11.19217	0.0008
Full	1925.1302			
Reduced	1930.7263			
RSquare (U)			0.0029	
Observations (or Sum Wgts)			30524	
Parameter Estimates				
Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	4.52607709	0.0559703	6539.3	0.0000
Intercept	7.41278443	0.229763	1040.9	<.0001
Intercept	10.3579684	0.9999906	107.29	<.0001
E_I	-0.3850756	0.0944555	16.62	<.0001

Table -65 Lagged - Logistic Regression - # of Accidents by # of E INCs

Converged by Gradient				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	2.6842	1	5.368487	0.0205
Full	1373.7210			
Reduced	1376.4052			
RSquare (U)			0.0020	
Observations (or Sum Wgts)			30524	
Parameter Estimates				
Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	4.94263381	0.0687382	5170.4	0.0000
Intercept	7.64427844	0.2586144	873.71	<.0001
Intercept	9.65968949	0.7072245	186.56	<.0001
Intercept	10.3528685	1.0000516	107.17	<.0001
E_I	-0.3427747	0.1228442	7.79	0.0053

Table -66 Lagged - Logistic Regression - # of Spills by # of E INCs

Converged by Objective				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	11.5922	1	23.18436	<.0001
Full	1919.1341			
Reduced	1930.7263			
RSquare (U)			0.0060	
Observations (or Sum Wgts)			30524	
Parameter Estimates				
Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	4.54278138	0.0560374	6571.8	0.0000
Intercept	7.42887236	0.2293566	1049.1	<.0001
Intercept	10.371468	0.9866705	110.49	<.0001
G_I	-0.1276678	0.0210258	36.87	<.0001

Table -67 Lagged - Logistic Regression - # of Accidents by # of G INCs

Converged by Objective				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	5.4652	1	10.93042	0.0009
Full	1370.9400			
Reduced	1376.4052			
RSquare (U)			0.0040	
Observations (or Sum Wgts)			30524	
Parameter Estimates				
Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	4.9537609	0.0686318	5209.8	0.0000
Intercept	7.65534679	0.2583787	877.84	<.0001
Intercept	9.67067019	0.7054827	187.91	<.0001
Intercept	10.3638391	0.9974412	107.96	<.0001
G_I	-0.1046576	0.0250243	17.49	<.0001

Table 68 Lagged - Logistic Regression - # of Spills by # of G INCs

Converged by Objective				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	0.0148	1	0.029606	0.8634
Full	1930.7115			
Reduced	1930.7263			
RSquare (U)			0.0000	
Observations (or Sum Wgts)			30524	
Parameter Estimates				
Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	4.49501577	0.054777	6733.9	0.0000
Intercept	7.38113896	0.2294846	1034.5	<.0001
Intercept	10.3261678	1.0000044	106.63	<.0001
H_I	0.18853349	2.1783536	0.01	0.9310

Table -69 Lagged - Logistic Regression - # of Accidents by # of H INCs

Converged by Objective				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	0.0097	1	0.019436	0.8891
Full	1376.3955			
Reduced	1376.4052			
RSquare (U)			0.0000	
Observations (or Sum Wgts)			30524	
Parameter Estimates				
Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	4.91622393	0.0673614	5326.5	0.0000
Intercept	7.61765912	0.2582596	870.02	<.0001
Intercept	9.63298815	0.7071216	185.58	<.0001
Intercept	10.3261681	1.0000045	106.63	<.0001
H_I	0.18781858	2.6797793	0.00	0.9441

Table -70 Lagged - Logistic Regression - # of Spills by # of H INCs

Converged by Objective				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	6.7140	1	13.42793	0.0002
Full	1924.0123			
Reduced	1930.7263			
RSquare (U)			0.0035	
Observations (or Sum Wgts)			30524	
Parameter Estimates				
Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	4.51686504	0.0552761	6677.3	0.0000
Intercept	7.40163124	0.2293357	1041.6	<.0001
Intercept	10.3429417	0.9810285	111.15	<.0001
L_I	-0.3253793	0.0687377	22.41	<.0001

Table -71 Lagged - Logistic Regression - # of Accidents by # of L INCs

Converged by Objective				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	4.5540	1	9.107953	0.0025
Full	1371.8512			
Reduced	1376.4052			
RSquare (U)			0.0033	
Observations (or Sum Wgts)			30524	
Parameter Estimates				
Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	4.93543875	0.0678872	5285.4	0.0000
Intercept	7.63615596	0.2580128	875.93	<.0001
Intercept	9.65109565	0.7031259	188.40	<.0001
Intercept	10.3442321	0.9938528	108.33	<.0001
L_I	-0.2810489	0.075989	13.68	0.0002

Table -72 Lagged - Logistic Regression - # of Spills by # of L INCs

Converged by Gradient				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	3.3743	1	6.748605	0.0094
Full	1927.3520			
Reduced	1930.7263			
RSquare (U)			0.0017	
Observations (or Sum Wgts)			30524	
Parameter Estimates				
Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	4.50531516	0.0550889	6688.4	0.0000
Intercept	7.39169384	0.2295358	1037	<.0001
Intercept	10.3367162	0.9998403	106.88	<.0001
M_I	-0.6299576	0.18913	11.09	0.0009

Table -73 Lagged - Logistic Regression - # of Accidents by # of M INCs

Converged by Objective				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	3.3598	1	6.719568	0.0095
Full	1373.0454			
Reduced	1376.4052			
RSquare (U)			0.0024	
Observations (or Sum Wgts)			30524	
Parameter Estimates				
Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	4.92918805	0.0678164	5283	0.0000
Intercept	7.63086393	0.2583389	872.51	<.0001
Intercept	9.64618318	0.7069845	186.16	<.0001
Intercept	10.3393624	0.9997715	106.95	<.0001
M_I	-0.7012304	0.2035707	11.87	0.0006

Table -74 Lagged - Logistic Regression - # of Spills by # of M INCs

Converged by Objective				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	21.9882	1	43.97647	<.0001
Full	1908.7380			
Reduced	1930.7263			
RSquare (U)			0.0114	
Observations (or Sum Wgts)			30524	
Parameter Estimates				
Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	4.58919342	0.0575093	6367.9	0.0000
Intercept	7.47666366	0.2296917	1059.6	<.0001
Intercept	10.420902	0.9820568	112.60	<.0001
P_I	-0.0947272	0.0113662	69.46	<.0001

Table -75 Lagged - Logistic Regression - # of Accidents by # of P INCs

Converged by Objective				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	14.1741	1	28.34827	<.0001
Full	1362.2311			
Reduced	1376.4052			
RSquare (U)			0.0103	
Observations (or Sum Wgts)			30524	
Parameter Estimates				
Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	5.00476709	0.0704281	5049.8	0.0000
Intercept	7.70656511	0.2586616	887.68	<.0001
Intercept	9.72143666	0.7002203	192.75	<.0001
Intercept	10.4144406	0.9889322	110.90	<.0001
P_I	-0.0892156	0.0132713	45.19	<.0001

Table -76 Lagged - Logistic Regression - # of Spills by # of P INCs

Converged by Objective				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	27.1102	1	54.22035	<.0001
Full	1903.6161			
Reduced	1930.7263			
RSquare (U)			0.0140	
Observations (or Sum Wgts)			30524	
Parameter Estimates				
Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	4.60208115	0.0579246	6312.2	0.0000
Intercept	7.49069141	0.2297955	1062.6	<.0001
Intercept	10.4360427	0.9961181	109.76	<.0001
C_I	-0.1191213	0.0128791	85.55	<.0001

Table -77 Lagged - Logistic Regression - # of Accidents by # of Component Shut-ins

Converged by Gradient				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	15.1424	1	30.28481	<.0001
Full	1361.2628			
Reduced	1376.4052			
RSquare (U)			0.0110	
Observations (or Sum Wgts)			30524	
Parameter Estimates				
Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	5.01294133	0.0709012	4998.9	0.0000
Intercept	7.71520847	0.2589408	887.76	<.0001
Intercept	9.73059066	0.7060927	189.91	<.0001
Intercept	10.4237684	0.9982238	109.04	<.0001
C_I	-0.1101087	0.0155117	50.39	<.0001

Table -78 Lagged - Logistic Regression - # of Spills by # of Component Shut-ins

Converged by Objective				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	14.8813	1	29.7626	<.0001
Full	1915.8450			
Reduced	1930.7263			
RSquare (U)			0.0077	
Observations (or Sum Wgts)			30524	
Parameter Estimates				
Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	4.56201657	0.0567505	6462.1	0.0000
Intercept	7.44918217	0.2296642	1052	<.0001
Intercept	10.3941762	0.997345	108.61	<.0001
W_I	-0.1054437	0.0153893	46.95	<.0001

Table -79 Lagged - Logistic Regression - # of Accidents by # of Warnings

Converged by Objective				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	11.0820	1	22.16391	<.0001
Full	1365.3233			
Reduced	1376.4052			
RSquare (U)			0.0081	
Observations (or Sum Wgts)			30524	
Parameter Estimates				
Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	4.98521734	0.0696911	5117	0.0000
Intercept	7.68710713	0.258566	883.86	<.0001
Intercept	9.70232687	0.7057003	189.02	<.0001
Intercept	10.3954818	0.9977313	108.56	<.0001
W_I	-0.1059159	0.0171802	38.01	<.0001

Table -80 Lagged - Logistic Regression - # of Spills by # of Warnings

Converged by Gradient				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	2.7055	1	5.411069	0.0200
Full	1928.0207			
Reduced	1930.7263			
RSquare (U)			0.0014	
Observations (or Sum Wgts)			30524	
Parameter Estimates				
Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	4.51039374	0.0553912	6630.5	0.0000
Intercept	7.39677781	0.2296389	1037.5	<.0001
Intercept	10.3417974	1.0000198	106.95	<.0001
S_I	-0.4169331	0.1492027	7.81	0.0052

Table -81 Lagged - Logistic Regression - # of Accidents by # of Facility Shut-ins

Converged by Objective				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	0.1297	1	0.25943	0.6105
Full	1376.2755			
Reduced	1376.4052			
RSquare (U)			0.0001	
Observations (or Sum Wgts)			30524	
Parameter Estimates				
Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	4.92035294	0.067897	5251.6	0.0000
Intercept	7.62179576	0.2583999	870.02	<.0001
Intercept	9.63712242	0.7071704	185.71	<.0001
Intercept	10.3303022	1.000037	106.71	<.0001
S_I	-0.1484225	0.2703333	0.30	0.5830

Table -82 Lagged - Logistic Regression - # of Spills by # of Facility Shut-ins

Converged by Objective				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	0.2112	1	0.422364	0.5158
Full	1930.5151			
Reduced	1930.7263			
RSquare (U)			0.0001	
Observations (or Sum Wgts)			30524	
Parameter Estimates				
Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	4.49442096	0.0547769	6732.1	0.0000
Intercept	7.38055094	0.2294837	1034.4	<.0001
Intercept	10.3255802	1.0000003	106.62	<.0001
# of INJ_I	3.01736826	9.569599	0.10	0.7525

Table -83 Lagged - Logistic Regression - # of Accidents by # of Injuries

Converged by Objective				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	0.1388	1	0.27765	0.5982
Full	1376.2664			
Reduced	1376.4052			
RSquare (U)			0.0001	
Observations (or Sum Wgts)			30524	
Parameter Estimates				
Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	4.91563137	0.0673612	5325.2	0.0000
Intercept	7.61707096	0.2582585	869.89	<.0001
Intercept	9.63240027	0.7071186	185.56	<.0001
Intercept	10.3255802	1.0000003	106.62	<.0001
# of INJ_I	3.01163974	11.776976	0.07	0.7982

Table -84 Lagged - Logistic Regression - # of Spills by # of Injuries

Converged by Objective

Whole-Model Test

Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	0.0385	1	0.076926	0.7815
Full	1930.6878			
Reduced	1930.7263			

RSquare (U)	0.0000
Observations (or Sum Wgts)	30524

Parameter Estimates

Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	4.4949512	0.0547767	6733.8	0.0000
Intercept	7.38107559	0.2294853	1034.5	<.0001
Intercept	10.3261045	1.0000076	106.63	<.0001
# of FAT_I	2.0153501	12.981162	0.02	0.8766

Table -85 Lagged - Logistic Regression - # of Accidents by # of Fatalities

Converged by Objective

Whole-Model Test

Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	0.0253	1	0.050551	0.8221
Full	1376.3799			
Reduced	1376.4052			

RSquare (U)	0.0000
Observations (or Sum Wgts)	30524

Parameter Estimates

Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	4.9161596	0.067361	5326.4	0.0000
Intercept	7.61759556	0.2582602	870.00	<.0001
Intercept	9.63292464	0.7071238	185.58	<.0001
Intercept	10.3261046	1.0000076	106.63	<.0001
# of FAT_I	2.01012994	15.974403	0.02	0.8999

Table -86 Lagged - Logistic Regression - # of Spills by # of Fatalities

Converged by Gradient

Whole-Model Test

Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	0.9140	1	1.827952	0.1764
Full	1929.8123			
Reduced	1930.7263			

RSquare (U)	0.0005
Observations (or Sum Wgts)	30524

Parameter Estimates

Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	4.49879713	0.0549143	6711.5	0.0000
Intercept	7.38500401	0.2295204	1035.3	<.0001
Intercept	10.3300308	1.0000125	106.71	<.0001
# of FIRE_I	-1.0922456	0.6698852	2.66	0.1030

Table -87 Lagged - Logistic Regression - # of Accidents by # of Fires

Converged by Objective

Whole-Model Test

Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	0.2916	1	0.583118	0.4451
Full	1376.1137			
Reduced	1376.4052			

RSquare (U)	0.0002
Observations (or Sum Wgts)	30524

Parameter Estimates

Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	4.91874327	0.0674928	5311.2	0.0000
Intercept	7.62020167	0.2582974	870.35	<.0001
Intercept	9.63552957	0.7071412	185.67	<.0001
Intercept	10.3287094	1.0000231	106.68	<.0001
# of FIRE_I	-0.8391525	0.9449576	0.79	0.3745

Table -88 Lagged - Logistic Regression - # of Spills by # of Fires

		Converged by Objective		
		Whole-Model Test		
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	0.0673	1	0.134627	0.7137
Full	1930.6589			
Reduced	1930.7263			
RSquare (U)			0.0000	
Observations (or Sum Wgts)			30524	
		Parameter Estimates		
Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	4.4948518	0.0547768	6733.5	0.0000
Intercept	7.38097709	0.2294838	1034.5	<.0001
Intercept	10.3260061	1.000001	106.63	<.0001
# of VESS_I	2.0154495	9.8129018	0.04	0.8373

Table -89 Lagged - Logistic Regression - # of Accidents by # of Vessel Strikes

		Converged by Objective		
		Whole-Model Test		
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	0.0442	1	0.088469	0.7661
Full	1376.3610			
Reduced	1376.4052			
RSquare (U)			0.0000	
Observations (or Sum Wgts)			30524	
		Parameter Estimates		
Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	4.91606058	0.0673611	5326.2	0.0000
Intercept	7.61749712	0.2582586	869.99	<.0001
Intercept	9.63282624	0.7071191	185.58	<.0001
Intercept	10.3260062	1.000001	106.63	<.0001
# of VESS_I	2.01022896	12.075594	0.03	0.8678

Table -90 Lagged - Logistic Regression - # of Spills by # of Vessel Strikes

		Converged by Objective		
		Whole-Model Test		
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	0.0385	1	0.076926	0.7815
Full	1930.6878			
Reduced	1930.7263			
RSquare (U)			0.0000	
Observations (or Sum Wgts)			30524	
		Parameter Estimates		
Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	4.4949512	0.0547767	6733.8	0.0000
Intercept	7.38107559	0.2294853	1034.5	<.0001
Intercept	10.3261045	1.0000076	106.63	<.0001
# of EXP_I	2.0153501	12.981162	0.02	0.8766

Table -91 Lagged - Logistic Regression - # of Accidents by # of Explosions

		Converged by Objective		
		Whole-Model Test		
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	0.0253	1	0.050551	0.8221
Full	1376.3799			
Reduced	1376.4052			
RSquare (U)			0.0000	
Observations (or Sum Wgts)			30524	
		Parameter Estimates		
Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	4.9161596	0.067361	5326.4	0.0000
Intercept	7.61759556	0.2582602	870.00	<.0001
Intercept	9.63292464	0.7071238	185.58	<.0001
Intercept	10.3261046	1.0000076	106.63	<.0001
# of EXP_I	2.01012994	15.974403	0.02	0.8999

Table -92 Lagged - Logistic Regression - # of Spills by # of Explosions

Converged by Objective

Whole-Model Test

Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	4.7475	1	9.495037	0.0021
Full	1925.9787			
Reduced	1930.7263			

RSquare (U)	0.0025
Observations (or Sum Wgts)	30524

Parameter Estimates

Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	4.50982223	0.055266	6658.9	0.0000
Intercept	7.39642998	0.2295992	1037.8	<.0001
Intercept	10.3414471	0.9999391	106.96	<.0001
# of MIN_I	-1.4050435	0.3659135	14.74	0.0001

Table -93 Lagged - Logistic Regression - # of Accidents by # of Minor Incidents

Converged by Gradient

Whole-Model Test

Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	5.2024	1	10.40483	0.0013
Full	1371.2028			
Reduced	1376.4052			

RSquare (U)	0.0038
Observations (or Sum Wgts)	30524

Parameter Estimates

Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	4.93638607	0.0681283	5250	0.0000
Intercept	7.63840976	0.2584523	873.46	<.0001
Intercept	9.65372842	0.7070921	186.40	<.0001
Intercept	10.3469076	0.9999015	107.08	<.0001
# of MIN_I	-1.628196	0.3909713	17.34	<.0001

Table -94 Lagged - Logistic Regression - # of Spills by # of Minor Incidents

Converged by Objective

Whole-Model Test

Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	0.0385	1	0.076926	0.7815
Full	1930.6878			
Reduced	1930.7263			

RSquare (U)	0.0000
Observations (or Sum Wgts)	30524

Parameter Estimates

Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	4.4949512	0.0547767	6733.8	0.0000
Intercept	7.38107559	0.2294853	1034.5	<.0001
Intercept	10.3261045	1.0000076	106.63	<.0001
# of MAJ_I	2.0153501	12.981162	0.02	0.8766

Table -95 Lagged - Logistic Regression - # of Accidents by # of Major Incidents

Converged by Objective

Whole-Model Test

Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	0.0253	1	0.050551	0.8221
Full	1376.3799			
Reduced	1376.4052			

RSquare (U)	0.0000
Observations (or Sum Wgts)	30524

Parameter Estimates

Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	4.9161596	0.067361	5326.4	0.0000
Intercept	7.61759556	0.2582602	870.00	<.0001
Intercept	9.63292464	0.7071238	185.58	<.0001
Intercept	10.3261046	1.0000076	106.63	<.0001
# of MAJ_I	2.01012994	15.974403	0.02	0.8999

Table -96 Lagged - Logistic Regression - # of Spills by # of Major Incidents

Converged by Gradient				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	0.4549	1	0.909762	0.3402
Full	1911.3416			
Reduced	1911.7965			
RSquare (U)			0.0002	
Observations (or Sum Wgts)			30461	
Parameter Estimates				
Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	4.57955738	0.096509	2251.7	0.0000
Intercept	7.45365209	0.2427898	942.49	<.0001
Intercept	10.3986802	1.0031494	107.45	<.0001
PLATFORM_AGE	-0.0049932	0.0052166	0.92	0.3385

Table -97Logistic Regression - # of Accidents by Platform Age

Converged by Objective				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	1.3569	1	2.713824	0.0995
Full	1359.6135			
Reduced	1360.9704			
RSquare (U)			0.0010	
Observations (or Sum Wgts)			30461	
Parameter Estimates				
Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	5.08831311	0.1211925	1762.8	0.0000
Intercept	7.77612757	0.2771212	787.39	<.0001
Intercept	9.79146291	0.7142228	187.94	<.0001
Intercept	10.4846445	1.0050358	108.83	<.0001
PLATFORM_AGE	-0.0105367	0.0063535	2.75	0.0972

Table -98 Logistic Regression - # of Spills by Platform Age

Converged by Objective				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	4.4198	1	8.839584	0.0029
Full	1926.3065			
Reduced	1930.7263			
RSquare (U)			0.0023	
Observations (or Sum Wgts)			30524	
Parameter Estimates				
Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	4.52297516	0.0557522	6581.5	0.0000
Intercept	7.41081906	0.2298497	1039.5	<.0001
Intercept	10.3558319	1.0003759	107.16	<.0001
INCS/COMP	-0.3634171	0.097263	13.96	0.0002

Table -99 Logistic Regression - # of Accidents by # of INCs/Component

Converged by Gradient				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	3.8581	1	7.716227	0.0055
Full	1372.5471			
Reduced	1376.4052			
RSquare (U)			0.0028	
Observations (or Sum Wgts)			30524	
Parameter Estimates				
Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	4.94714715	0.0685327	5210.9	0.0000
Intercept	7.65057708	0.2587563	874.19	<.0001
Intercept	9.66589723	0.7075728	186.61	<.0001
Intercept	10.3590761	1.0005417	107.19	<.0001
INCS/COMP	-0.3862165	0.1070685	13.01	0.0003

Table -100 Logistic Regression - # of Spills by Number of INCs/Component

Converged by Gradient

Whole-Model Test

Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	1.9494	1	3.898708	0.0483
Full	1914.2770			
Reduced	1916.2264			

RSquare (U)	0.0010
Observations (or Sum Wgts)	30449

Parameter Estimates

Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	4.41887328	0.0683633	4178.1	0.0000
Intercept	7.29608611	0.2330366	980.24	<.0001
Intercept	10.2411196	1.0008325	104.71	<.0001
op_exp	0.01602208	0.0084441	3.60	0.0578

Table -101 Logistic Regression - # of Accidents by Operator Experience

Converged by Gradient

Whole-Model Test

Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	1.9173	1	3.834656	0.0502
Full	1363.9624			
Reduced	1365.8798			

RSquare (U)	0.0014
Observations (or Sum Wgts)	30449

Parameter Estimates

Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	4.82181361	0.0839047	3302.5	0.0000
Intercept	7.5142618	0.2629755	816.47	<.0001
Intercept	9.52960174	0.7088665	180.73	<.0001
Intercept	10.2227788	1.0012447	104.25	<.0001
op_exp	0.01991811	0.0106885	3.47	0.0624

Table -102 Logistic Regression - # of Spills by Operator Experience

Converged by Objective

Whole-Model Test

Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	1.6898	1	3.379517	0.0660
Full	1914.5366			
Reduced	1916.2264			

RSquare (U)	0.0009
Observations (or Sum Wgts)	30449

Parameter Estimates

Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	4.40428652	0.0750459	3444.3	0.0000
Intercept	7.28149302	0.2350796	959.43	<.0001
Intercept	10.226527	1.0013029	104.31	<.0001
co_exp	0.00804323	0.0044458	3.27	0.0704

Table -103 Logistic Regression - # of Accidents by Company Experience

Converged by Gradient

Whole-Model Test

Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	3.9455	1	7.890986	0.0050
Full	1361.9343			
Reduced	1365.8798			

RSquare (U)	0.0029
Observations (or Sum Wgts)	30449

Parameter Estimates

Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	4.74327769	0.0901368	2769.2	0.0000
Intercept	7.43584857	0.2650181	787.25	<.0001
Intercept	9.45122189	0.7096264	177.38	<.0001
Intercept	10.1444017	1.0017828	102.54	<.0001
co_exp	0.01558379	0.0057349	7.38	0.0066

Table -104 Logistic Regression - # of Spills by Company Experience

Converged by Gradient				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	4.7436	1	9.48714	0.0021
Full	1925.9827			
Reduced	1930.7263			
RSquare (U)			0.0025	
Observations (or Sum Wgts)			30524	
Parameter Estimates				
Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	4.68253204	0.0834339	3149.8	0.0000
Intercept	7.5690549	0.2380014	1011.4	<.0001
Intercept	10.5140982	1.0020383	110.10	<.0001
# of ins_no_inc	-0.2335842	0.0730284	10.23	0.0014

Table -105 Logistic Regression - # of Accidents by # of Inspections Without an INC

Converged by Gradient				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	0.0230	1	0.046086	0.8300
Full	1376.3822			
Reduced	1376.4052			
RSquare (U)			0.0000	
Observations (or Sum Wgts)			30524	
Parameter Estimates				
Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	4.93229492	0.1006883	2399.6	0.0000
Intercept	7.6337315	0.2688886	805.99	<.0001
Intercept	9.64906041	0.7110798	184.13	<.0001
Intercept	10.3422405	1.0028134	106.36	<.0001
# of ins_no_inc	-0.0212854	0.0989032	0.05	0.8296

Table -106 Logistic Regression - # of Spills by # of Inspections Without an INC

Converged by Gradient				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	78.7927	1	157.5854	<.0001
Full	1851.9335			
Reduced	1930.7263			
RSquare (U)			0.0408	
Observations (or Sum Wgts)			30524	
Parameter Estimates				
Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	4.84745445	0.0657085	5442.3	0.0000
Intercept	7.74659527	0.2318149	1116.7	<.0001
Intercept	10.6917569	0.9852957	117.75	<.0001
# of ins_w_inc	-0.6670471	0.0446267	223.42	<.0001

Table -107 Logistic Regression - # of Accidents by # of Inspections with an INC

Converged by Objective				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	60.3592	1	120.7185	<.0001
Full	1316.0460			
Reduced	1376.4052			
RSquare (U)			0.0439	
Observations (or Sum Wgts)			30524	
Parameter Estimates				
Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	5.2864844	0.0805272	4309.7	0.0000
Intercept	7.99660473	0.2612718	936.76	<.0001
Intercept	10.010991	0.6979218	205.75	<.0001
Intercept	10.7039994	0.9847798	118.14	<.0001
# of ins_w_inc	-0.6786102	0.0504071	181.24	<.0001

Table -108 Logistic Regression - # of Spills by # of Inspections with and INC

Converged by Objective

Whole-Model Test

Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	59.0718	1	118.1436	<.0001
Full	1871.6544			
Reduced	1930.7263			

RSquare (U)	0.0306
Observations (or Sum Wgts)	30524

Parameter Estimates

Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	4.66619443	0.0591415	6225	0.0000
Intercept	7.58280661	0.2318067	1070.1	<.0001
Intercept	10.528841	0.9709229	117.60	<.0001
tot_inc	-0.0907509	0.006785	178.90	<.0001

Table -109 Logistic Regression - # of Accidents by Total Number of INCs

Converged by Objective

Whole-Model Test

Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	45.3571	1	90.71426	<.0001
Full	1331.0481			
Reduced	1376.4052			

RSquare (U)	0.0330
Observations (or Sum Wgts)	30524

Parameter Estimates

Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	5.09451832	0.0726889	4912.1	0.0000
Intercept	7.82388556	0.2611463	897.59	<.0001
Intercept	9.83805469	0.6916966	202.30	<.0001
Intercept	10.531049	0.9738249	116.94	<.0001
tot_inc	-0.0904318	0.0075195	144.63	<.0001

Table -110 Logistic Regression - # of Spills by Total Number of INCs

Converged by Objective

Whole-Model Test

Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	33.3967	1	66.79343	<.0001
Full	1897.3295			
Reduced	1930.7263			

RSquare (U)	0.0173
Observations (or Sum Wgts)	30524

Parameter Estimates

Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	4.57553246	0.0569301	6459.5	0.0000
Intercept	7.46844654	0.2295748	1058.3	<.0001
Intercept	10.4134683	0.9946861	109.60	<.0001
E	-0.6911332	0.0672972	105.47	<.0001

Table -111 Logistic Regression - # of Accidents by # of E INCs

Converged by Gradient

Whole-Model Test

Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	27.6718	1	55.34353	<.0001
Full	1348.7335			
Reduced	1376.4052			

RSquare (U)	0.0201
Observations (or Sum Wgts)	30524

Parameter Estimates

Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	5.00629286	0.0702096	5084.4	0.0000
Intercept	7.71426224	0.2586057	889.84	<.0001
Intercept	9.72955571	0.7038631	191.08	<.0001
Intercept	10.422733	0.9948974	109.75	<.0001
E	-0.7138178	0.073905	93.29	<.0001

Table -112 Logistic Regression - # of Spills by # of E INCs

		Converged by Objective		
		Whole-Model Test		
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	27.4341	1	54.86815	<.0001
Full	1903.2922			
Reduced	1930.7263			
RSquare (U)			0.0142	
Observations (or Sum Wgts)			30524	
		Parameter Estimates		
Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	4.57864942	0.0567204	6516.2	0.0000
Intercept	7.46493621	0.2291567	1061.2	<.0001
Intercept	10.3700423	0.8950749	134.23	<.0001
G	-0.1858675	0.019414	91.66	<.0001

Table -113 Logistic Regression - # of Accidents by # of G INCs

		Converged by Objective		
		Whole-Model Test		
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	20.3057	1	40.61145	<.0001
Full	1356.0995			
Reduced	1376.4052			
RSquare (U)			0.0148	
Observations (or Sum Wgts)			30524	
		Parameter Estimates		
Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	4.99846227	0.0695134	5170.5	0.0000
Intercept	7.69913412	0.2581177	889.71	<.0001
Intercept	9.70357514	0.6684594	210.72	<.0001
Intercept	10.3900011	0.9124139	129.67	<.0001
G	-0.177146	0.0205548	74.27	<.0001

Table -114 Logistic Regression - # of Spills by # of G INCs

		Converged by Objective		
		Whole-Model Test		
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	0.0626	1	0.125193	0.7235
Full	1930.6637			
Reduced	1930.7263			
RSquare (U)			0.0000	
Observations (or Sum Wgts)			30524	
		Parameter Estimates		
Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	4.49487244	0.0547772	6733.4	0.0000
Intercept	7.38099747	0.2294847	1034.5	<.0001
Intercept	10.3260264	1.0000042	106.63	<.0001
H	1.3187306	7.7106811	0.03	0.8642

Table -115 Logistic Regression - # of Accidents by # of H INCs

		Converged by Objective		
		Whole-Model Test		
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	0.0303	1	0.060593	0.8056
Full	1376.3749			
Reduced	1376.4052			
RSquare (U)			0.0000	
Observations (or Sum Wgts)			30524	
		Parameter Estimates		
Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	4.91612807	0.0673626	5326.1	0.0000
Intercept	7.61756402	0.2582596	870.00	<.0001
Intercept	9.6328931	0.7071208	185.58	<.0001
Intercept	10.3260731	1.0000033	106.63	<.0001
H	0.62423577	5.4131865	0.01	0.9082

Table -116 Logistic Regression - # of Spills by # of H INCs

Converged by Objective				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	5.6905	1	11.3809	0.0007
Full	1925.0358			
Reduced	1930.7263			
RSquare (U)			0.0029	
Observations (or Sum Wgts)			30524	
Parameter Estimates				
Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	4.51530452	0.0552972	6667.6	0.0000
Intercept	7.40118222	0.2293709	1041.2	<.0001
Intercept	10.3457731	0.9932232	108.50	<.0001
L	-0.2832128	0.0700896	16.33	<.0001

Table -117 Logistic Regression - # of Accidents by # of L INCs

Converged by Objective				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	3.6298	1	7.259564	0.0071
Full	1372.7754			
Reduced	1376.4052			
RSquare (U)			0.0026	
Observations (or Sum Wgts)			30524	
Parameter Estimates				
Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	4.93437721	0.0678946	5282	0.0000
Intercept	7.63474282	0.2580294	875.49	<.0001
Intercept	9.64953173	0.7048963	187.40	<.0001
Intercept	10.3424057	0.9965251	107.71	<.0001
L	-0.252033	0.0750224	11.29	0.0008

Table -118 Logistic Regression - # of Spills by # of L INCs

Converged by Objective				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	3.0599	1	6.119731	0.0134
Full	1927.6664			
Reduced	1930.7263			
RSquare (U)			0.0016	
Observations (or Sum Wgts)			30524	
Parameter Estimates				
Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	4.50507618	0.0550779	6690.4	0.0000
Intercept	7.3914217	0.2295006	1037.3	<.0001
Intercept	10.3366597	0.9997854	106.89	<.0001
M	-0.5042969	0.1559208	10.46	0.0012

Table -119 Logistic Regression - # of Accidents by # of M INCs

Converged by Objective				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	2.6821	1	5.364254	0.0206
Full	1373.7231			
Reduced	1376.4052			
RSquare (U)			0.0019	
Observations (or Sum Wgts)			30524	
Parameter Estimates				
Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	4.92792044	0.0677714	5287.3	0.0000
Intercept	7.62964242	0.2583484	872.16	<.0001
Intercept	9.6449644	0.7070458	186.08	<.0001
Intercept	10.3381438	0.9998621	106.91	<.0001
M	-0.5335974	0.174483	9.35	0.0022

Table -120 Logistic Regression - # of Spills by # of M INCs

Converged by Objective				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	46.6095	1	93.21899	<.0001
Full	1884.1168			
Reduced	1930.7263			
RSquare (U)			0.0241	
Observations (or Sum Wgts)			30524	
Parameter Estimates				
Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	4.6334876	0.0584239	6289.8	0.0000
Intercept	7.56378667	0.2344667	1040.7	<.0001
Intercept	10.5029846	0.9491574	122.45	<.0001
P	-0.1180022	0.010242	132.74	<.0001

Table -121 Logistic Regression - # of Accidents by # of P INCs

Converged by Objective				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	34.5370	1	69.07398	<.0001
Full	1341.8682			
Reduced	1376.4052			
RSquare (U)			0.0251	
Observations (or Sum Wgts)			30524	
Parameter Estimates				
Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	5.05586026	0.0716001	4986.1	0.0000
Intercept	7.80557751	0.2650077	867.55	<.0001
Intercept	9.81993389	0.6923429	201.18	<.0001
Intercept	10.5127481	0.9632977	119.10	<.0001
P	-0.1154412	0.011379	102.92	<.0001

Table -122 Logistic Regression - # of Spills by # of P INCs

Converged by Objective				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	55.4180	1	110.836	<.0001
Full	1875.3082			
Reduced	1930.7263			
RSquare (U)			0.0287	
Observations (or Sum Wgts)			30524	
Parameter Estimates				
Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	4.65456779	0.0590273	6218	0.0000
Intercept	7.55846561	0.2305647	1074.7	<.0001
Intercept	10.4938576	0.9859481	113.28	<.0001
C	-0.1476541	0.0113361	169.66	<.0001

Table -123 Logistic Regression - # of Accidents by # of Component Shut-ins

Converged by Gradient				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	38.9422	1	77.8844	<.0001
Full	1337.4630			
Reduced	1376.4052			
RSquare (U)			0.0283	
Observations (or Sum Wgts)			30524	
Parameter Estimates				
Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	5.0767295	0.0724569	4909.2	0.0000
Intercept	7.79266595	0.2599118	898.92	<.0001
Intercept	9.80796612	0.7038902	194.15	<.0001
Intercept	10.5011345	0.9944643	111.50	<.0001
C	-0.1447517	0.0128577	126.74	<.0001

Table -124 Logistic Regression - # of Spills by # of Component Shut-ins

Converged by Gradient				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	34.5896	1	69.17919	<.0001
Full	1896.1367			
Reduced	1930.7263			
RSquare (U)			0.0179	
Observations (or Sum Wgts)			30524	
Parameter Estimates				
Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	4.59927848	0.0574547	6408.1	0.0000
Intercept	7.50317233	0.2306631	1058.1	<.0001
Intercept	10.4482069	0.9909704	111.16	<.0001
W	-0.137616	0.0138299	99.02	<.0001

Table -125 Logistic Regression - # of Accidents by # of Warnings

Converged by Objective				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	30.0583	1	60.11651	<.0001
Full	1346.3470			
Reduced	1376.4052			
RSquare (U)			0.0218	
Observations (or Sum Wgts)			30524	
Parameter Estimates				
Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	5.03130638	0.0707272	5060.4	0.0000
Intercept	7.75205691	0.2599331	889.43	<.0001
Intercept	9.76663754	0.7013878	193.90	<.0001
Intercept	10.4597252	0.9904754	111.52	<.0001
W	-0.1417607	0.0148455	91.19	<.0001

Table -126 Logistic Regression - # of Spills by # of Warnings

Converged by Objective				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	18.2250	1	36.45	<.0001
Full	1912.5013			
Reduced	1930.7263			
RSquare (U)			0.0094	
Observations (or Sum Wgts)			30524	
Parameter Estimates				
Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	4.53756215	0.055919	6584.6	0.0000
Intercept	7.42533257	0.2294007	1047.7	<.0001
Intercept	10.370341	0.9974813	108.09	<.0001
S	-0.7298748	0.0932857	61.22	<.0001

Table -127 Logistic Regression - # of Accidents by # of Facility Shut-ins

Converged by Gradient				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	14.4753	1	28.95054	<.0001
Full	1361.9300			
Reduced	1376.4052			
RSquare (U)			0.0105	
Observations (or Sum Wgts)			30524	
Parameter Estimates				
Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	4.96262209	0.0688535	5194.8	0.0000
Intercept	7.66576781	0.2583061	880.73	<.0001
Intercept	9.68114278	0.7057103	188.19	<.0001
Intercept	10.3743241	0.9978341	108.09	<.0001
S	-0.7488593	0.1036952	52.15	<.0001

Table -128 Logistic Regression - # of Spills by # of Facility Shut-ins

Converged by Gradient				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	113.7709	1	227.5417	<.0001
Full	1816.9554			
Reduced	1930.7263			
RSquare (U)			0.0589	
Observations (or Sum Wgts)			30524	
Parameter Estimates				
Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	4.57843062	0.0570825	6433.2	0.0000
Intercept	7.75521381	0.2562964	915.59	<.0001
Intercept	10.7111637	1.0089986	112.69	<.0001
# of INJ	-6.2763999	0.4239806	219.14	<.0001

Table -129 Logistic Regression - # of Accidents by # of Injuries

Converged by Objective				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	0.8357	1	1.671352	0.1961
Full	1375.5695			
Reduced	1376.4052			
RSquare (U)			0.0006	
Observations (or Sum Wgts)			30524	
Parameter Estimates				
Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	4.9199456	0.0675123	5310.7	0.0000
Intercept	7.62148461	0.2583043	870.59	<.0001
Intercept	9.63681131	0.7071424	185.72	<.0001
Intercept	10.3299911	1.0000228	106.70	<.0001
# of INJ	-1.6609183	1.0216748	2.64	0.1040

Table -130 Logistic Regression - # of Spills by # of Injuries

Converged by Objective				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	28.6950	1	57.39007	<.0001
Full	1902.0312			
Reduced	1930.7263			
RSquare (U)			0.0149	
Observations (or Sum Wgts)			30524	
Parameter Estimates				
Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	4.51602109	0.0553468	6657.7	0.0000
Intercept	7.46881938	0.235645	1004.6	<.0001
Intercept	10.3985715	0.9944542	109.34	<.0001
# of FAT	-5.9927149	0.7713566	60.36	<.0001

Table -131 Logistic Regression - # of Accidents by # of Fatalities

Converged by Objective				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	0.0442	1	0.088469	0.7661
Full	1376.3610			
Reduced	1376.4052			
RSquare (U)			0.0000	
Observations (or Sum Wgts)			30524	
Parameter Estimates				
Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	4.91606058	0.0673611	5326.2	0.0000
Intercept	7.61749712	0.2582586	869.99	<.0001
Intercept	9.63282624	0.7071191	185.58	<.0001
Intercept	10.3260062	1.000001	106.63	<.0001
# of FAT	2.01022896	12.075594	0.03	0.8678

Table -132 Logistic Regression - # of Spills by # of Fatalities

Converged by Gradient				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	371.1185	1	742.237	<.0001
Full	1559.6078			
Reduced	1930.7263			
RSquare (U)			0.1922	
Observations (or Sum Wgts)			30524	
Parameter Estimates				
Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	4.76998231	0.0627577	5777	0.0000
Intercept	8.93991812	0.3501203	651.98	<.0001
Intercept	14.9761429	1.3085742	130.98	<.0001
# of FIRE	-6.9088902	0.3291578	440.56	<.0001

Table -133 Logistic Regression - # of Accidents by # of Fires

Converged by Objective				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	9.2102	1	18.42034	<.0001
Full	1367.1950			
Reduced	1376.4052			
RSquare (U)			0.0067	
Observations (or Sum Wgts)			30524	
Parameter Estimates				
Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	4.93971618	0.068159	5252.4	0.0000
Intercept	7.64238812	0.2583142	875.31	<.0001
Intercept	9.65769094	0.7064345	186.90	<.0001
Intercept	10.3508688	0.9989387	107.37	<.0001
# of FIRE	-2.1109746	0.3645103	33.54	<.0001

Table -134 Logistic Regression - # of Spills by # of Fires

Converged by Gradient				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	48.9202	1	97.84044	<.0001
Full	1881.8060			
Reduced	1930.7263			
RSquare (U)			0.0253	
Observations (or Sum Wgts)			30524	
Parameter Estimates				
Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	4.52639092	0.0556215	6622.5	0.0000
Intercept	7.58638831	0.2476572	938.36	<.0001
Intercept	11.4337341	1.3637047	70.30	<.0001
# of VESS	-5.9261252	0.588986	101.24	<.0001

Table -135 Logistic Regression - # of Accidents by # of Vessel Strikes

Converged by Objective				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	6.3245	1	12.64906	0.0004
Full	1370.0807			
Reduced	1376.4052			
RSquare (U)			0.0046	
Observations (or Sum Wgts)			30524	
Parameter Estimates				
Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	4.92603835	0.0676757	5298.2	0.0000
Intercept	7.62895511	0.2579116	874.96	<.0001
Intercept	9.6441162	0.7033921	187.99	<.0001
Intercept	10.3372792	0.9943134	108.09	<.0001
# of VESS	-3.1142563	0.669134	21.66	<.0001

Table -136 Logistic Regression - # of Spills by # of Vessel Strikes

Converged by Objective				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	16.3687	1	32.73747	<.0001
Full	1914.3575			
Reduced	1930.7263			
RSquare (U)			0.0085	
Observations (or Sum Wgts)			30524	
Parameter Estimates				
Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	4.50699346	0.0551003	6690.6	0.0000
Intercept	7.4310833	0.233008	1017.1	<.0001
Intercept	10.3742303	1.0002786	107.56	<.0001
# of EXP	-5.9686613	1.0110856	34.85	<.0001

Table -137 Logistic Regression - # of Accidents by # of Explosions

Converged by Objective				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	0.0253	1	0.050551	0.8221
Full	1376.3799			
Reduced	1376.4052			
RSquare (U)			0.0000	
Observations (or Sum Wgts)			30524	
Parameter Estimates				
Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	4.9161596	0.067361	5326.4	0.0000
Intercept	7.61759556	0.2582602	870.00	<.0001
Intercept	9.63292464	0.7071238	185.58	<.0001
Intercept	10.3261046	1.0000076	106.63	<.0001
# of EXP	2.01012994	15.974403	0.02	0.8999

Table -138 Logistic Regression - # of Spills by # of Explosions

Converged by Objective				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	908.7115	1	1817.423	0.0000
Full	1022.0147			
Reduced	1930.7263			
RSquare (U)			0.4707	
Observations (or Sum Wgts)			30524	
Parameter Estimates				
Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	5.31133104	0.0821143	4183.8	0.0000
Intercept	11.1876524	0.4575311	597.91	<.0001
Intercept	18.3743769	1.2452331	217.73	<.0001
# of MIN	-8.141018	0.3280713	615.77	<.0001

Table -139 Logistic Regression - # of Accidents by # of Minor Incidents

Converged by Objective				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	310.3051	1	620.6102	<.0001
Full	1066.1001			
Reduced	1376.4052			
RSquare (U)			0.2254	
Observations (or Sum Wgts)			30524	
Parameter Estimates				
Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	5.38378097	0.0846841	4041.8	0.0000
Intercept	8.4785056	0.291853	843.94	<.0001
Intercept	10.612512	0.5705473	345.98	<.0001
Intercept	11.26875	0.7058413	254.88	<.0001
# of MIN	-4.940101	0.1637187	910.49	<.0001

Table -140 Logistic Regression - # of Spills by # of Minor Incidents

Converged by Gradient				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	32.8135	1	65.62701	<.0001
Full	1897.9128			
Reduced	1930.7263			
RSquare (U)			0.0170	
Observations (or Sum Wgts)			30524	
Parameter Estimates				
Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	4.51904865	0.0554298	6646.7	0.0000
Intercept	7.48156049	0.2365346	1000.4	<.0001
Intercept	10.426392	1.0022782	108.22	<.0001
# of MAJ	-6.0004365	0.7237878	68.73	<.0001

Table -141 Logistic Regression - # of Accidents by # of Major Incidents

Converged by Objective				
Whole-Model Test				
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	5.3583	1	10.71657	0.0011
Full	1371.0469			
Reduced	1376.4052			
RSquare (U)			0.0039	
Observations (or Sum Wgts)			30524	
Parameter Estimates				
Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	4.9251377	0.0676641	5298.1	0.0000
Intercept	7.62909597	0.2584297	871.49	<.0001
Intercept	9.64441408	0.7071919	185.98	<.0001
Intercept	10.3375932	1.0000592	106.85	<.0001
# of MAJ	-3.7976378	0.8227222	21.31	<.0001

Table -142 Logistic Regression - # of Spills by # of Major Incidents

Survey Appendix

CARNEGIE MELLON UNIVERSITY

CARNEGIE INSTITUTE OF TECHNOLOGY

THESIS

SUBMITTED IN PARTIAL FULFILLMENT OF THE
REQUIREMENTS FOR THE DEGREE OF DOCTOR OF
PHILOSOPHY

TITLE: The Risk Of Accidents And Spills At Offshore Production Platforms: A Statistical Analysis Of Risk Factors And The Development Of Predictive Models

PRESENTED BY: John Richard Shultz

ACCEPTED BY: The Department Of Engineering And Public Policy

MAJOR PROFESSOR: Dr. Paul Fischbeck - Associate Professor
The Department Of Social And Decision Sciences And The
Department Of Engineering And Public Policy

3	Unqualified personnel
4	Recurring violations
5	Civil penalties assessed
6	Safety devices not being maintained
7	New operators
8	Operator history of noncompliance
9	Knowing and willful violations
10	Facility housekeeping and maintenance
11	Boiler house reports (falsified reports)
12	Operator noncompliance with lease stipulations
13	Inadequate maintenance of gas detection systems
14	Manned facilities
15	Unmanned facilities
16	Third party personnel
17	Operator personnel
18	Oil production
19	Gas production
20	H2S production
21	Operators known as "problem operators"
22	Calls from disgruntled employees
23	Anonymous reports of bad practices of operators.
24	Operator attitude concerning regulations
25	EPA violations
26	Production volume (MCF and BOPD)
27	Waiver for other than daily pollution or monthly production inspections
28	Equipment in use with a history of known failures
29	Platforms equipped with fired components
30	INCs addressing safety systems or devices found in bypass
31	High pressure production
32	Low pressure production
33	High technology operation (automated operation)
34	Low technology operation (partially automated operation RTU)
35	Operations with conditions conducive to potential fires
36	Approved plan violations (including burning and welding)
37	Proximity to shipping lanes
38	Use of new or unproven technology
39	Barge shipping/oil storage
40	Amount of production coming into or crossing platform via pipelines
41	Competitive reservoir (one operator vs. Another)
42	Contractors known as "problem contractors"
43	Complex structures
44	Satellite structures
45	Manpower shortage
46	Drilling exploration vs. Development (deepwater)
47	Drilling in environmentally sensitive areas
48	Use of oil base mud

49	Age of facility
50	Inexperience of operator
51	Lack of knowledge of equipment/operation
52	Rigs new to the Gulf
53	Rigs new to the District
54	Hurricane season
55	Annual crane maintenance
56	Operator compliance with component shut-in
57	Change from oil company to contractor
58	Operator switching contractors and location of records
59	Shallow hazards
60	Wildcat drilling
61	Turnkey drilling operators
62	High pressure workovers
63	Reverse circulation with coil tubing
64	Wellbore equipment uncertainty in workovers
65	Testing of fire loop system to initiate surface and sub-surface shut-in

Table -2 Survey 1 – identification of risk factors

1.3 Survey two

The goal of survey two was to eliminate factors from the original list of 65 and try to broadly categorize the factors. The three broad categories were:

- Operator performance
- Technology
- Current operations

These three categories were ranked against each other with the following results.

Category	Mean Score	Risk Rank
Operator performance	1.11	1
Current operations	2.00	2
Technology	2.89	3

Table -3 Survey 2 – category ranking

The respondents were then asked to rank the individual risk factors within each category. The results of this ranking are shown in Table 4 below.

	Distribution of responses on risk factors for offshore operations											
		Respondent districts										
#	Risk categories	H	H	H	L	L	NO	CC	HQ	HQ	aver.	st_dev
A	Operator performance	2	1	1	1	1	1	1	1	1	1.11	0.33

1	Accidents	8	3	6	1	1	4	6	10	1	4.44	3.28
2	Knowing and willful violations	10	4	2	2	2	1	11	3	5	4.44	3.64
3	History of noncompliance	4	2	1	4	4	10	10	2	13	5.56	4.30
4	Safety systems INCs or devices found bypassed	3	6	5	5	5	2	17	9	3	6.11	4.57
5	Safety devices not maintained	5	5	4	6	6	6	15	6	2	6.11	3.59
6	Pollution incidents	9	9	13	3	3	5	3	8	4	6.33	3.57
7	Lack of knowledge of equipment or operation	1	7	10	7	11	14	5	5	7	7.44	3.81
8	Operator attitude regarding regulations	2	1	11	x	15	16	16	1	10	9.00	6.72
9	Falsified reports	11	13	3	11	7	3	9	4	12	8.11	3.98
10	Contractor know as "problem contractors"	7	15	7	x	14	8	4	13	8	9.50	3.96
11	Inadequate maintenance of gas detection systems	12	8	12	10	16	7	14	6	11	10.67	3.28
12	Noncompliance w/ lease stipulations	14	10	9	x	8	9	7	11	17	10.63	3.34
13	New operators	6	16	14	x	17	17	1	17	6	11.75	6.41
14	Poor facility maintenance	17	11	16	8	9	11	2	7	15	10.67	4.82
15	Personnel in violation of training requirements	13	17	18	12	18	13	8	12	14	13.89	3.30
16	Poor facility housekeeping	16	12	15	9	10	12	18	15	16	13.67	3.04
17	EPA violations	15	14	17	x	19	15	13	14	9	14.50	2.93
18	Anonymous reports on operators	x	18	8	x	12	18	12	16	18	14.57	3.95
19	Call from disgruntled employees	x	19	19	x	13	19	19	x	19	18.00	2.45
B	**Technology**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**2.89**	**0.33**
1	Equipment with history of known failures	2	1	2	2	3	1	4	1	1	1.89	1.05
2	Complex structures	3	4	3	3	2	3	5	3	2	3.11	0.93
3	Use of new or unproven Technology	5	2	5	4	4	4	6	2	4	4.00	1.32
4	Platforms equipped with fired components	1	7	4	1	1	x	8	7	6	4.38	3.02
5	Low technology operation)(partial automated RTU)	4	3	6	7	7	5	1	5	5	4.78	1.92
6	Age of facility	8	6	1	5	5	2	7	6	3	4.78	2.33
7	Satellite structure	7	5	7	6	8	6	2	8	7	6.22	1.86
8	High technology operation (automated)	6	8	8	8	6	7	3	4	8	6.44	1.88
C	**Current operations**	**1**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**3**	**2.00**	**0.50**
1	H2S production	1	5	4	x	21	6	3	6	1	5.88	6.42
2	Conditions conducive to potential fires	12	2	5	2	3	16	4	7	2	5.89	4.99
3	Manned facilities	15	1	3	1	1	8	17	4	4	6.00	6.10
4	Simultaneous operations	7	9	10	6	2	7	20	5	3	7.67	5.29
5	Third party personnel	5	4	2	x	12	15	1	17	11	8.38	6.14
6	Manpower shortage	3	3	1	5	6	20	16	9	16	8.78	6.89
7	Production volume (MCF/BOPD)	10	13	8	9	5	5	21	2	7	8.89	5.56
8	Proximity to environmentally sensitive areas	2	22	13	13	14	1	18	8	6	10.78	7.08
9	Drilling in environmentally sensitive areas	4	17	16	12	16	2	19	8	14	12.00	6.02
10	High pressure production	21	6	11	10	8	13	12	3	8	10.22	5.09
11	Deepwater operations	13	18	17	3	4	26	2	14	5	11.33	8.31

12	Exploration drilling vs. Development drilling	8	16	18	x	17	11	5	15	19	13.63	5.07
13	Oil production	11	12	7	x	22	4	23	16	12	13.38	6.67
14	Unmanned facilities	9	15	23	4	11	23	6	23	10	13.78	7.56
15	Use of oil bas mud	6	10	19	17	18	9	8	20	22	14.33	6.02
16	Gas production	16	11	12	x	23	14	13	10	9	13.50	4.44
17	Barge shipping/oil storage	14	14	9	14	9	12	11	18	24	13.89	4.73
18	Approve plan violations (including burning/welding)	19	24	22	7	7	17	7	1	17	13.44	8.06
19	Sustained high casing pressures	20	8	6	15	19	10	22	19	15	14.89	5.71
20	Proximity to shipping lanes	17	23	14	8	15	19	24	11	13	16.00	5.32
21	Low pressure production	22	7	21	11	10	22	10	21	20	16.00	6.28
22	Presence of gather lines	X	20	15	16	20	21	9	13	21	16.88	4.39
23	Proximity to shore	18	19	24	x	23	3	14	12	25	17.25	7.40
24	Waivers	X	25	20	x	x	25	15	22	18	20.83	3.97
25	Competitive reservoirs	X	21	25	x	x	24	25	x	23	23.60	1.67

Table -4 Survey 2 – results for all factors

1.4 Survey three

There were some problems with survey number two.

- Survey 2 only had 9 respondents. More respondents were desired.
- The categories in survey two were too broad. That is, the survey did not provide enough information to compare risks.

To address these problems, another survey administered. This time there were 13 respondents, and the questions were re-categorized so that direct comparisons could be made.

The broad categories in survey 3 were as follows:

- Performance Risk
  - History of noncompliance
  - History of incidents
  - Operator traits
- Production risk
  - Production Characteristics
  - Simulations operations
  - Location of facility
  - Type of facility

The results are as follows:

Performance risk		Mean score	Risk rank
	History of noncompliance	1.33	1
	History of incidents	1.93	2
	Operator traits	2.73	3
Production risk			
	Production characteristics	1.29	1
	Simultaneous operations	2.21	2
	Location of facility	3.21	3
	Type of facility	3.36	4

Table -5 Survey 3 – category ranking

In addition, within these broad categories, individual risk factors were ranked and compared to each other. The results of these comparisons are listed in Table 6 below.

Risk Category 1 - Performance risk																		
District	H	H	H	L	L	L	NO	NO	LJ	LJ	LJ	LC	CC	HQ	HQ	tot.	aver.	st_dev
History of noncompliance	1	1	1	2	1	1	1	2	2	2	1	1	1	1	2	20	1.33	0.49
Violations (INCs)	1	1	1	3	1	3	2	1	1	1	3	1	1	3	3	26	1.73	0.96
Civil penalties	2	2	2	2	2	1	1	3	3	2	2	3	3	2	2	32	2.13	0.64
Criminal penalties	3	3	3	1	3	2	3	2	2	3	1	2	2	1	1	32	2.13	0.83
History of incidents	2	2	2	1	3	2	2	1	1	1	3	2	3	3	1	29	1.93	0.80
Injury/fatality	1	1	1	1	1	2	1	1	1	1	3	2	1	1	2	20	1.33	0.62
Fire/explosion	3	2	2	2	2	1	2	2	2	3	2	1	2	2	3	31	2.07	0.59
Pollution/event	2	3	3	3	3	3	3	3	5	2	3	3	3	3	4	46	3.07	0.70
Operator traits	3	3	3	3	2	3	3	3	3	3	2	3	2	2	3	41	2.73	0.46
Lack of onsite personnel	1	2	2	1	4	3	1	3	1	1	2	5	4	1	1	32	2.13	1.36
New operator	3	1	1	2	1	1	2	1	5	3	5	4	2	4	2	37	2.47	1.46
Contractors involved	4	3	4	4	2	2	3	2	3	4	3	3	1	2	5	45	3.00	1.07
Turnkey operators	2	4	3	5	3	4	4	5	2	2	4	1	3	3	4	49	3.27	1.16
Service companies	5	5	5	3	5	5	5	4	4	5	1	2	5	5	3	62	4.13	1.30
Risk category 2 - Production risk																		
	H	H	H	L	L	L	NO	NO	LJ	LJ	LJ	LC	CC	HQ	HQ	tot.	aver.	st_dev
Production characteristics	1	1	X	1	2	2	1	1	1	1	3	1	1	1	1	18	1.29	0.61
H2s	1	1	1	1	1	1	2	1	3	1	1	1	1	1	1	18	1.20	0.56
High pressure	6	3	4	4	2	2	5	2	4	2	3	2	2	2	2	45	3.00	1.31
Oil	2	2	5	3	3	3	1	3	1	4	2	6	4	4	6	49	3.27	1.58
Volume	4	4	3	2	4	4	3	6	5	3	4	4	3	5	3	57	3.80	1.01
Storage facilities	3	5	2	5	5	6	4	5	2	6	6	3	5	6	4	67	4.47	1.41
Gas	5	6	6	6	6	5	6	4	6	5	5	5	5	3	5	78	5.20	0.86

Simultaneous operations	2	2	X	3	1	1	4	2	3	2	2	2	3	2	2	31	2.21	0.80
Type of operation	2	1	1	1	2	2	1	1	1	1	1	1	2	2	1	20	1.33	0.49
Number of operations	1	2	2	2	1	1	2	2	2	2	2	2	1	1	2	25	1.67	0.49
Location of facility	4	3	X	4	3	3	2	3	2	4	4	3	2	4	4	45	3.21	0.80
Proximity to sensitive areas	1	1	4	2	1	1	1	1	1	3	2	4	1	2	4	29	1.93	1.22
Complex structures	4	4	2	1	4	4	3	2	4	5	3	1	3	4	2	46	3.07	1.22
Proximity to shore	2	2	3	4	2	5	2	3	2	4	4	3	2	5	5	48	3.20	1.21
Proximity to shipping lanes	3	3	5	3	3	2	4	5	3	2	1	5	5	1	3	48	3.20	1.37
Technology(auto./unproved)	5	5	1	5	5	3	5	4	5	1	5	2	4	3	1	54	3.60	1.64
Type of facility	4	4	X	2	4	4	3	4	4	3	1	4	4	3	3	47	3.36	0.93
Major facility	1	1	1	1	1	1	1	1	1	1	2	1	1	1	2	17	1.13	0.35
Onboard personnel	2	3	2	2	2	3	2	2	2	2	1	2	3	2	1	31	2.07	0.59
Minor facility	3	2	3	3	3	2	3	3	3	3	3	3	2	3	3	42	2.80	0.41

Table -6 Survey 3 – further categorizing

1.5 Survey four

In the third survey, two items were considered by the experts to be very important indicators of a platforms' future problems: 1) a prior history of poor inspections and 2) a prior history of accidents and spills. Unfortunately, this survey did not allow the development of survey based risk prediction models. The risk factors were first put into categories, then compared to each other within those categories. This made it difficult to compare the relative importance of risk factors.

For example, under the category **"History of noncompliance,"** the factor "criminal penalties" is tied for the third position with "civil penalties." Note that under **"History of incidents,"** the factor "having experienced a fire or explosion" was the second ranked risk factor in this category. The important question is: How do you compare the relative merit of "criminal penalties" versus "having experienced a fire or explosion?" To address this question, a fourth survey was conducted.

In addition to directly comparing risk factors, the fourth survey was designed to quantify the risk factors determined through the three earlier surveys. For example, the definition of the risk factor "age" was too ambiguous. The fourth survey sought to quantify what constituted a "risky age." Did the respondent mean old platforms? New platforms? How old, or how new?

The subjects in the fourth survey were all involved in the inspection of offshore operations and were all government employees. There were 59 respondents in all: 47 inspectors, 11 engineers, and one supervisor. There were three sections to the fourth survey.

1. Respondent data – this section is designed to gather some descriptive data on the respondents to see if there is any relationship between a respondents personal traits or experience and their perception of risk
2. Risk quantification – in this section, respondents are asked to quantity their risk estimates by assessing different levels for each risk factor. For example, for platform age, the ages are broken up into 5-year increments and the respondents are asked to assign a perceived riskiness for each 5-year increment.
3. Risk comparisons – in this section, direct comparisons are made between the risk factors and an attempt is made to determine their relative importance.

The following three sections list summary information, graphs, and tables for the fourth survey administered in June 1998.

1.5.1 Respondent data

The respondents were asked the following questions:

1. What is your job title?
2. In which district do you currently work?
3. Years of experience as an inspector?
4. Years of offshore experience (other than as an inspector)?
5. As an inspector, what percentage of your time has been spent as a production inspector?
6. As an inspector, what percentage of your time has been spent as a drilling inspector?
7. Have you ever been injured on a platform?
8. Have you ever seen anyone injured on a platform?
9. Any comments?

The results from some of these questions are summarized in the tables below.

	Count Of Years as an Inspector			
Years Inspector	**Engineer**	**Inspector**	**supervisor**	**Grand Total**
0	7	4	1	12
0.5		1		1
1	1	4		5
3		1		1
3.5		1		1
7		7		7
8		3		3
9	1	2		3
10		3		3
12		1		1
14		4		4
14.5		1		1
16		1		1
17		1		1
18.5		1		1
19		2		2
20		4		4
21		1		1
23		1		1
24		2		2
25	1	1		2
27	1			1
X		1		1
Grand Total	11	47	1	59

Table -7 Survey 4 – years of experience as an inspector

	Count Of Times You Have Been Injured			
Times You	**Engineer**	**Inspector**	**Supervisor**	**Grand Total**
0	9	30	1	40
1	2	9		11
2		6		6
3		2		2
Grand Total	11	47	1	59

Table-8 Survey 4 – number of times the respondent has been injured on a platform

	Count Of Times You Have See Others Injured			
Times Otheres	**Engineer**	**Inspector**	**Supervisor**	**Grand Total**
0	7	14	1	22

1	2	5		7
2		2		2
3		3		3
4		3		3
5	1	6		7
6		1		1
7		2		2
8		1		1
10	1	2		3
12		1		1
25		1		1
30		1		1
150		1		1
many		2		2
X		2		2
Grand Total	11	47	1	59

Table -9 Survey 4 – number of times the respondent has seen a person injured on a platform

1.5.2 *Quantification data*

The results from the risk quantification section are summarized in the tables and figures that follow. The last 6 columns contain the count of the number of times the respondents picked that particular level of risk. The "x" means that the respondent did not answer that question.

Questions	**Category**	**aver.**	**st_dev**	**X**	**1**	**2**	**3**	**4**	**5**
age	>25	4.48	0.68	1	0	0	6	18	34
num_inc_5_comp	>25	4.42	0.83	0	0	3	4	17	35
number_sim_ops	>5	4.41	0.75	1	0	1	6	19	32
work_exp	0-3	4.41	0.62	0	0	0	4	27	28
num_inc_25_comp	>25	4.39	0.77	0	0	2	4	22	31
numb_acc_5_yrs	>10	4.34	1.05	1	2	2	7	10	37
op_comp_exp	0-3	4.31	0.65	0	0	0	6	29	24
%_cont_out	76-100	4.27	0.87	0	0	4	4	23	28
num_inc_5_comp	21-25	4.24	0.86	0	0	3	7	22	27
num_inc_50_comp	>25	4.22	0.91	0	0	4	7	20	28
numb_acc_5_yrs	9-10	4.14	0.96	0	1	3	8	22	25
number_sim_ops	5	4.10	0.79	1	0	1	12	25	20
num_inc_25_comp	21-25	4.10	0.79	1	0	3	6	31	18
number_sim_ops	4	4.05	2.62	0	0	2	20	28	8
age	21-25	4.03	0.67	1	0	0	12	32	14
numb_components	>50	4.02	0.82	0	0	2	13	26	18
type_inc	P-103	3.95	0.99	0	2	1	15	21	20
num_inc_50_comp	21-25	3.91	0.96	1	1	3	14	22	18

volume_oil_prod	>25	3.86	0.92	0	1	1	20	20	17
%_cont_out	51-75	3.83	0.72	0	0	4	9	39	7
numb_acc_5_yrs	7-8	3.81	0.88	0	0	6	11	30	12
dist_to_ship_lane	0-1/2	3.81	1.11	0	5	1	9	29	15
num_well_comp	>25	3.81	0.97	0	1	4	16	22	16
type_inc	E-100	3.81	0.98	1	1	4	16	21	16
numb_components	41-50	3.76	0.73	0	0	3	15	34	7
num_inc_5_comp	16-20	3.76	0.80	1	0	2	21	24	11
fired_vessel	fire_vess	3.69	0.65	0	0	0	24	29	6
num_inc_25_comp	16-20	3.69	0.81	0	1	2	19	29	8
age	16-20	3.63	0.64	0	0	1	24	30	4
type_operation	welding	3.59	0.83	0	1	3	22	26	7
storage_vess	storage_vess	3.59	0.79	0	1	3	20	30	5
type_prod_spill	oil	3.59	0.77	0	1	1	25	26	6
work_exp	4-6	3.59	0.62	0	0	2	22	33	2
num_well_comp	21-25	3.59	0.85	0	1	3	23	24	8
dist_to_ship_lane	1/2-1	3.59	1.05	0	5	1	16	28	9
type_inc	G-110	3.58	0.83	0	1	3	23	25	7
type_operation	construction	3.58	0.91	0	1	5	21	23	9
volume_oil_prod	21-25	3.58	0.89	0	1	4	23	22	9
type_operation	well_work_over	3.54	0.70	0	0	3	25	27	4
type_operation	vess_cleanout	3.54	0.75	0	1	2	24	28	4
volume_gas_prod	>40	3.53	1.03	1	2	4	26	13	13
numb_components	31-40	3.53	0.65	0	0	2	27	27	3
op_comp_exp	4-6	3.51	0.60	0	0	2	26	30	1
type_operation	clean_pig_trap	3.48	0.76	3	0	4	26	21	5
number_sim_ops	3	3.47	0.73	0	0	5	24	27	3
num_drill_slots	>35	3.44	1.12	0	5	3	23	17	11
well_press	>2000	3.42	0.95	0	3	3	26	20	7
num_inc_50_comp	16-20	3.41	0.95	0	2	6	24	20	7
numb_acc_5_yrs	5-6	3.38	0.79	1	0	7	26	21	4
volume_gas_prod	36-40	3.37	0.85	0	1	5	30	17	6
type_operation	well_completion	3.36	0.74	0	1	3	32	20	3
numb_components	confidence	3.36	0.76	0	1	3	33	18	4
num_well_comp	16-20	3.36	0.78	0	1	5	28	22	3
num_drill_slots	31-35	3.32	1.01	0	5	2	27	19	6
num_inc_5_comp	11-15	3.31	0.80	1	0	8	28	18	4
type_enf_code	S	3.31	1.10	0	5	7	19	21	7
type_inc	W-100	3.29	0.85	0	1	7	30	16	5
type_inc	P-240	3.29	0.95	0	4	3	29	18	5
volume_oil_prod	16-20	3.29	0.64	0	0	6	30	23	0
type_operation	wire_ln_wk	3.27	0.69	0	2	2	33	22	0
type_operation	crane_op	3.27	0.78	0	1	6	31	18	3
type_prod_spill	both	3.27	0.67	0	1	1	41	13	3
type_prod_acc	oil	3.25	0.78	0	2	4	32	19	2
volume_gas_prod	31-35	3.25	0.66	0	0	5	36	16	2
dist_to_ship_lane	1-11/2	3.22	0.90	1	4	3	30	18	3
type_prod_acc	both	3.22	0.62	0	1	1	43	12	2

%_cont_out	26-50	3.22	0.70	0	1	5	34	18	1
num_on_plat	>20	3.21	1.33	3	7	11	13	13	12
type_operation	fabrication	3.21	0.95	1	3	10	19	24	2
type_inc	H-126	3.19	1.11	0	6	6	25	15	7
numb_components	21-30	3.17	0.57	1	0	3	44	9	2
num_inc_25_comp	11-15	3.17	0.75	1	1	7	33	15	2
num_drill_slots	26-30	3.17	0.89	0	5	2	32	18	2
pres_H2S	H2S_pres	3.15	1.05	0	2	15	21	14	7
well_press	1500-2000	3.15	0.71	0	1	6	37	13	2
type_inc	P-412	3.14	1.09	0	5	11	19	19	5
type_acc_sp	fire	3.08	0.92	0	3	10	28	15	3
type_enf_code	C	3.07	0.72	0	1	8	38	10	2
volume_gas_prod	26-30	3.07	0.58	0	0	8	39	12	0
num_well_comp	11-15	3.07	0.69	0	1	8	37	12	1
num_on_plat	0	3.05	1.49	3	15	4	11	15	11
numb_acc_5_yrs	3-4	3.03	0.67	0	0	12	33	14	0
type_penalty	INC_crim_pen	3.02	1.32	0	9	13	15	12	10
num_drill_slots	21-25	2.98	0.75	0	5	2	41	11	0
volume_oil_prod	11-15	2.98	0.54	0	0	9	42	8	0
num_on_plat	16-20	2.98	1.11	2	6	13	18	16	4
well_press	1000-1500	2.97	0.56	0	1	7	44	7	0
num_inc_50_comp	11-15	2.97	0.99	1	3	17	20	15	3
type_acc_sp	minor_spill	2.95	0.68	0	0	14	35	9	1
type_penalty	INC_civ_pen	2.95	0.97	0	4	15	22	16	2
type_acc_sp	explosion	2.95	1.06	0	6	12	24	13	4
op_comp_exp	7-9	2.95	0.51	0	0	9	44	6	0
work_exp	7-9	2.95	0.51	0	0	9	44	6	0
volume_gas_prod	21-25	2.95	0.54	0	1	7	45	6	0
num_drill_slots	16-20	2.92	0.73	0	4	6	40	9	0
type_acc_sp	major_spill	2.91	1.17	1	10	8	21	15	4
type_operation	painting	2.90	0.92	0	5	11	30	11	2
dist_to_ship_lane	11/2-2	2.90	0.89	1	6	6	36	8	2
age	11-15	2.88	0.56	0	0	13	40	6	0
num_on_plat	11-15	2.88	0.90	3	5	10	29	11	1
number_sim_ops	2	2.85	0.74	0	3	11	38	6	1
water_depth	>400	2.85	1.00	0	9	4	36	7	3
numb_components	11-20	2.83	0.53	0	0	14	41	4	0
type_acc_sp	fatality	2.80	1.06	0	9	11	24	13	2
num_on_plat	6-10	2.80	0.83	0	4	14	32	8	1
water_depth	301-350	2.80	0.91	0	7	7	39	3	3
well_press	500-1000	2.78	0.65	0	3	11	41	4	0
volume_gas_prod	16-20	2.76	0.65	0	4	9	43	3	0
water_depth	251-300	2.75	0.80	0	7	6	42	3	1
num_on_plat	1-5	2.73	0.74	0	4	14	35	6	0
water_depth	151-200	2.71	0.67	0	6	6	46	1	0
dist_to_shore	0-25	2.71	0.95	0	10	5	38	4	2
type_enf_code	W	2.69	0.73	0	4	15	35	5	0
num_inc_5_comp	6-10	2.69	0.86	0	3	23	23	9	1

dist_to_shore	51-75	2.69	0.77	0	8	5	43	3	0
water_depth	201-250	2.69	0.68	0	6	7	45	1	0
num_drill_slots	11-15	2.69	0.70	0	5	11	40	3	0
dist_to_shore	>125	2.69	0.99	0	10	8	33	6	2
dist_to_shore	76-100	2.68	0.75	0	7	8	41	3	0
num_well_comp	6-10	2.68	0.73	0	5	13	37	4	0
water_depth	51-100	2.68	0.80	0	8	7	40	4	0
dist_to_shore	26-50	2.68	0.78	0	9	3	45	2	0
water_depth	101-150	2.68	0.75	0	7	8	41	3	0
type_prod_acc	gas	2.66	0.73	0	3	20	30	6	0
water_depth	0-50	2.66	0.92	0	10	6	39	2	2
dist_to_shore	101-125	2.64	0.85	0	9	8	37	5	0
op_comp_exp	10-12	2.63	0.61	0	0	25	32	1	1
type_acc_sp	vessel_strike	2.61	0.95	0	10	11	31	6	1
num_inc_25_comp	6-10	2.61	0.95	0	7	20	22	9	1
volume_gas_prod	11-15	2.61	0.67	0	5	14	39	1	0
type_acc_sp	weather_dam	2.60	0.88	1	8	13	32	4	1
type_penalty	INC_no_pen	2.59	0.87	0	9	12	32	6	0
type_inc	P-406	2.58	0.89	0	6	22	23	7	1
volume_oil_prod	6-10	2.58	0.72	0	5	18	33	3	0
well_press	0-500	2.56	0.91	0	10	12	32	4	1
fired_vessel	no_fire_vess	2.53	0.75	0	8	13	37	1	0
pres_H2S	H2S_not_pres	2.53	0.75	0	7	16	34	2	0
dist_to_ship_lane	>2	2.53	0.80	0	7	18	30	4	0
age	6-10	2.52	0.63	1	3	23	31	1	0
num_drill_slots	6-10	2.51	0.73	0	7	16	35	1	0
number_sim_ops	1	2.51	0.73	0	7	16	35	1	0
%_cont_out	0-25	2.51	0.90	0	8	20	25	5	1
numb_components	0-10	2.46	0.70	0	6	21	31	1	0
storage_vess	no_storage_vess	2.44	0.70	0	6	22	30	1	0
numb_acc_5_yrs	1-2	2.42	0.79	0	6	27	21	5	0
work_exp	10-12	2.41	0.67	0	6	23	30	0	0
age	0-5	2.41	1.22	0	16	18	15	5	5
num_inc_50_comp	6-10	2.37	1.08	0	16	15	19	8	1
volume_gas_prod	6-10	2.37	0.72	0	7	24	27	1	0
volume_oil_prod	0-5	2.31	0.86	0	13	17	27	2	0
num_well_comp	0-5	2.31	0.86	0	13	17	27	2	0
op_comp_exp	13-15	2.24	0.60	0	4	38	16	1	0
num_drill_slots	0-5	2.24	0.88	0	16	14	28	1	0
work_exp	13-15	2.17	0.68	1	9	30	19	0	0
type_prod_spill	gas	2.17	0.75	0	10	31	16	2	0
volume_gas_prod	0-5	2.15	0.93	0	18	17	21	3	0
op_comp_exp	16-18	2.08	0.68	0	10	35	13	1	0
num_inc_5_comp	0-5	2.08	0.88	0	18	20	19	2	0
num_inc_25_comp	0-5	2.07	0.93	0	19	21	15	4	0
numb_acc_5_yrs	0	2.02	1.03	0	21	23	10	3	2
work_exp	16-18	1.98	0.73	0	15	31	12	1	0
op_comp_exp	>18	1.98	0.76	1	16	28	13	1	0

work_exp	>18	1.95	0.86	0	20	25	11	3	0
num_inc_50_comp	0-5	1.90	0.96	0	27	14	15	3	0

Table -10 Survey 4 – all risk factors from risk quantification section

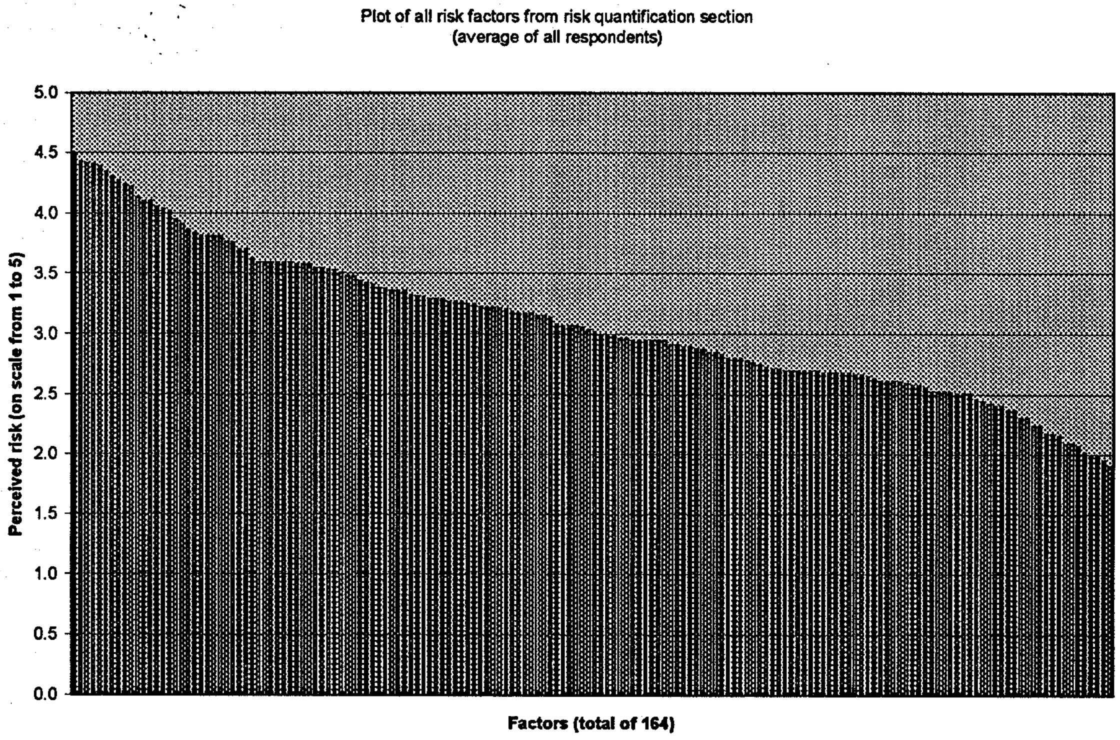


Figure -1 Survey 4 - plot of all risk factors in risk quantification section

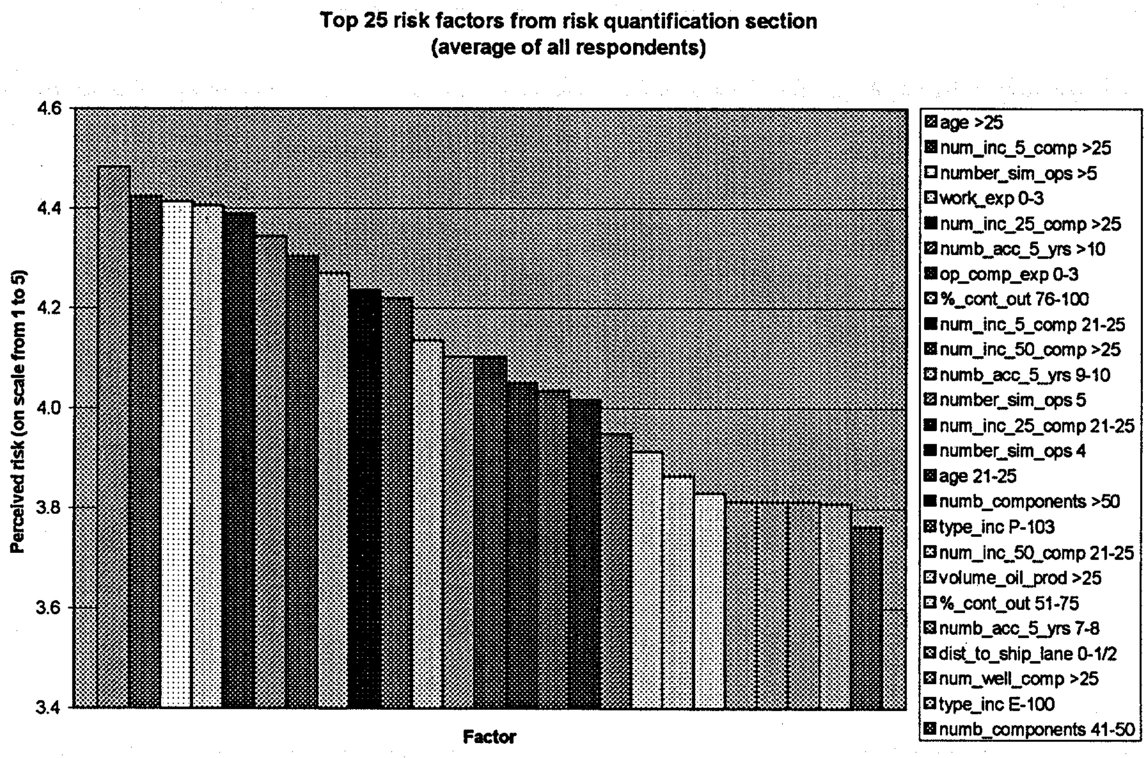


Figure -2 Survey 4 - top 25 risk factors in risk quantification section

The following table show the average level of confidence of the respondents for each question in section one.

q. num	Questions	Category	avg.	st_dev	X	1	2	3	4	5
178	type_operation	Confidence	3.58	0.83	0	1	1	29	19	9
12	%_cont_out	Confidence	3.47	0.75	0	1	2	28	24	4
96	type_prod_acc	Confidence	3.47	0.75	0	1	2	28	24	4
100	type_prod_spill	Confidence	3.46	0.75	0	1	2	29	23	4
26	num_inc_5_comp	Confidence	3.45	0.73	1	1	1	31	21	4
185	number_sim_ops	Confidence	3.44	0.84	0	1	3	31	17	7
7	age	Confidence	3.41	0.84	1	1	4	29	18	6
92	numb_acc_5_yrs	Confidence	3.41	0.81	0	1	4	29	20	5
167	storage_vess	Confidence	3.41	0.75	0	1	1	35	17	5
76	work_exp	Confidence	3.39	0.85	0	2	3	29	20	5
53	type_penalty	Confidence	3.38	0.77	1	1	3	31	19	4
113	volume_oil_prod	Confidence	3.38	0.75	1	1	2	33	18	4
164	fired_vessel	Confidence	3.37	0.74	0	1	2	34	18	4
130	num_well_comp	Confidence	3.36	0.79	1	1	4	30	19	4

33	num_inc_25_comp	Confidence	3.36	0.74	0	1	2	35	17	4
40	num_inc_50_comp	Confidence	3.36	0.69	0	1	1	36	18	3
68	op_comp_exp	Confidence	3.36	0.76	0	1	3	33	18	4
106	well_press	Confidence	3.36	0.76	0	1	4	30	21	3
57	type_enf_code	Confidence	3.34	0.76	1	1	3	33	17	4
49	type_inc	Confidence	3.31	0.79	0	2	3	32	19	3
84	type_acc_sp	Confidence	3.29	0.75	1	1	5	30	20	2
123	volume_gas_prod	Confidence	3.29	0.74	0	1	4	34	17	3
155	dist_to_shore	Confidence	3.29	0.79	0	1	4	36	13	5
19	num_on_plat	Confidence	3.27	0.72	0	1	3	37	15	3
148	water_depth	Confidence	3.24	0.86	1	3	3	33	15	4
161	dist_to_ship_lane	Confidence	3.24	0.84	0	2	5	33	15	4
139	num_drill_slots	Confidence	3.22	0.84	1	1	7	33	12	5
60	pres_H2S	Confidence	3.20	0.92	0	3	5	34	11	6

Table -11 Survey 4 - average respondent confidence

The Figure 3 shows that the respondents' confidence does not depend on their experience.

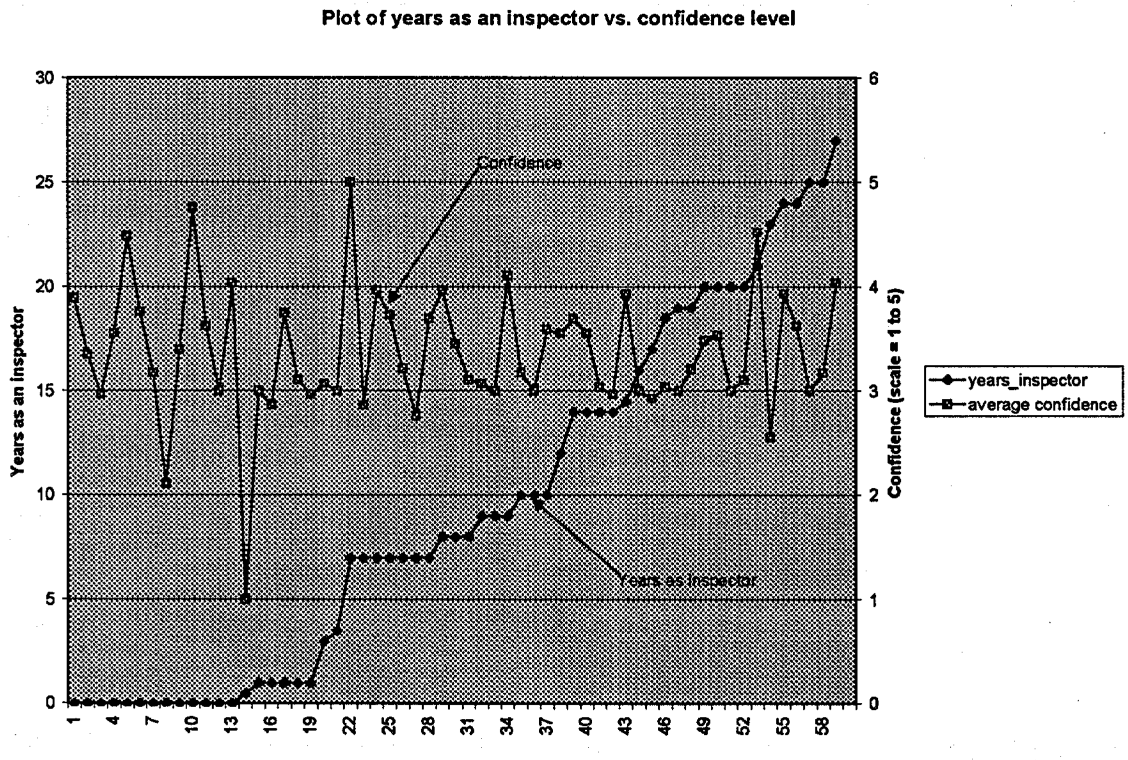
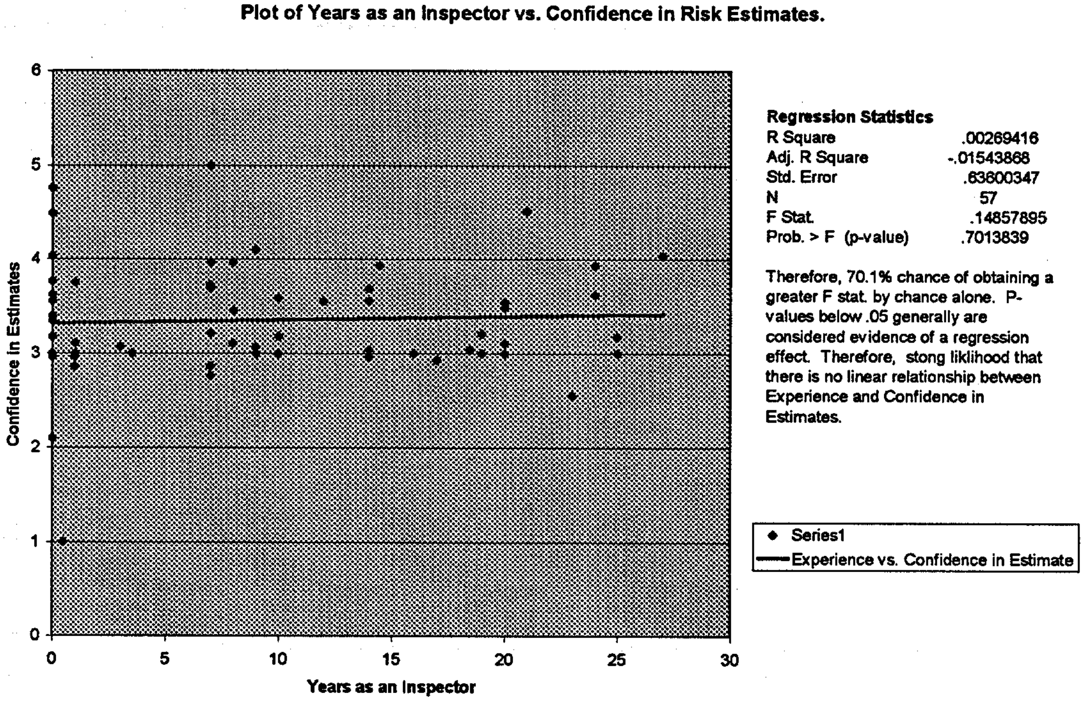


Figure -3 Survey 4 - comparing average respondent confidence versus respondent experience in risk quantification section



Regression Statistics

R Square	.00269416
Adj. R Square	-.01543868
Std. Error	.63600347
N	57
F Stat	.14857895
Prob. > F (p-value)	.7013839

Therefore, 70.1% chance of obtaining a greater F stat. by chance alone. P-values below .05 generally are considered evidence of a regression effect. Therefore, stong liklihood that there is no linear relationship between Experience and Confidence in Estimates.

Figure -4 Survey 4 - Regression of Confidence in Risk Estimates versus Years as an Inspector

1.5.3 Comparison data

The following information is from the risk factor comparison section of Survey 4. In the table below, the "p_value" refers to the total number of points the factor received from all respondents. The "c_value" is simply a linear ranking based on the number of times a factor was ranked number "1", number "2", and so on. The results are essentially the same for both ranking methods.

Risk Factor	p_value	p_rank	c_value	c_rank
Experience level of the "typical" worker on a platform	5013	1	1335	1
Experience level of the platform's operating company	4138	2	1175	2
Percentage of operations contracted out	3367	3	978	4

Number of people working on a platform	3189	4	992	3
Number of accidents or spills a platform has experienced	3059	5	942	6
Age of Platform	3053	6	966	5
Simultaneous operations	2939	7	941	7
Type of operations conducted	2593	8	841	9
Type of accident or spill that a platform has previously experienced	2583	9	862	8
Type of hydrocarbon a platform produces (gas, oil or both)	2404	10	824	10
Number of INCs that a platform has received	2327	11	793	11
Presence of fired vessel	2297	12	754	13
Number of components	2236	13	759	12
Volume of hydrocarbon produced on a platform per day	2206	14	713	14
Type of INCs that a platform has received	2188	15	691	15
Type of INC enforcement that a platform receives (W,C, or S)	2016	16	645	16
Type of penalty a platform received (no penalty, civil, or criminal)	1912	17	595	19
Presence of H2S	1828	18	602	18
Presence of storage vessel	1781	19	613	17
Number of well completions on a platform	1518	20	492	20
Distance from shipping lanes	1422	21	445	22
Well or reservoir pressure	1410	22	472	21
Distance to shore of a platform	488	23	114	23
Water depth of a platform	365	24	99	24
Number of drill slots	227	25	88	25

Table -12 Survey 4 - comparison of risk factor relative importance

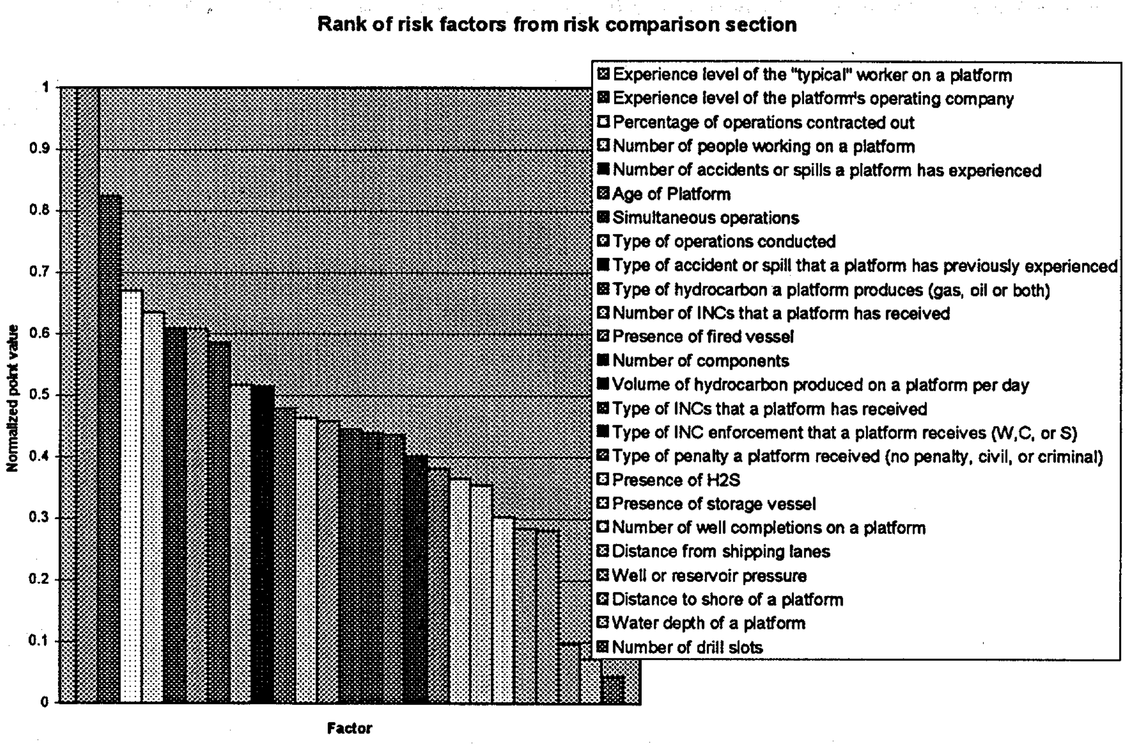


Figure -5 Survey 4 - normalized ranking by number of points given to factor in each position.

1.6 Copy of survey four

The following is a copy of survey four. It was administered in June 1998.

Assessment of Production Platform Risk Factors

Opinion Survey

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Reason for Opinion Survey

The MMS is moving toward a statistical method to assign the inspection frequency of platforms based on the probability of the platform having an accident or spill. To do this, the information in the TIMS database has been analyzed and some mathematical models have been developed. However, some of the information we would like to include in the models is not currently tracked by the MMS in TIMS, or was not available in the old OPAC accident and spill information. Therefore, we would like to get your opinion regarding some of the risk factors so that we can include this information in our models.

The following is a continuation of the surveys conducted in 1996 in which general risk factors were identified. In this survey, you are asked questions regarding how you think various platform traits or characteristics will affect the probability of a production platform having an accident or spill in the future. The questions in this survey pertain to production platforms only, not to drilling platforms. Please keep this in mind when you respond.

The survey has two sections: Risk Quantification and Risk Factor Comparisons. It was designed to be completed in about 30 minutes. The questions generally have either yes or no responses, or boxes in which you may place an "X" to indicate your response.

Personal data

What is your job title ____?

In which district do you currently work ______________________________?

Years of experience as an inspector ________________________________?

Years of offshore experience ______________________________________?
(other than as an inspector)

As an inspector, what percentage of your time has been spent as a production inspector ___________%?
What percentage of your time has been spent as a drilling inspector ___________%?

Personal experiences

Have you ever been injured on a platform? Yes____ No ____ How many times ________?
Have you ever seen anyone injured on a platform? Yes____ No ____ How many times ________?

Any comments?
____
____
____
____

Instructions for section one: Risk Quantification

The purpose of this section is to obtain your opinion regarding how various risk factors affect the probability of an accident or spill on a platform in the next year. For example, if you believe that very old or very new platforms are more likely to have accidents or spills, then you might fill out the table as in the example below. (Note that you should put one and only one "X" in each ROW.)

In addition, for each table like the one below, we would like to know how confident you are in your answers. If you are very sure of your answers, then you might put an "X" in the box under "Very confident." However, if you were taking an "educated guess" and do not have a lot of specific information to support your answers, then you might place an "X" under "Not confident." You may find it difficult to give an answer to some of the questions. This is understood, and all that is asked is for you to provide your best guess, based on your experience as an inspector.

NOTE: You may believe that a factor has no relationship at all to a platform's probability of an accident or spill. If you feel that a risk factor has no impact on the probability of an accident or spill, then mark "average probability" for <u>all levels</u>. You will be given an opportunity in section 2, Risk Factor Comparisons, to state your opinion regarding the importance of each factor as a predictor of an accident or spill.

EXAMPLE

QUESTION: **A platform's age** may affect its probability of having an accident or spill in the future. For each age category, indicate how likely it would be for a platform to have an accident or spill in the next year.

Place X in box	**Probability of having an accident or spill**				
Platform age (years)	**Much less than average**	**Less than average**	**Average probability**	**More than average**	**Much more than average**
0-5				**X**	
6-10		**X**			
11-15		**X**			
16-20			**X**		
21-25				**X**	
>25					**X**
It is understood that some questions in the survey are relatively easy to answer, and some are quite difficult. The following boxes allow you to state how confident you are in your estimates.					
Place X in box	**Not confident**	**Fairly low confidence**	**Average confidence**	**Fairly high confidence**	**Very confident**
Confidence level			**X**		

Section one: Risk Quantification

For each row in the tables below, please place an "X" in the box that best represents your estimate for the probability of an accident or spill. Make sure to put one and only one "X" in each row.

QUESTION: **A platform's age** may affect its probability of having an accident or spill in the future. For each age category, indicate how likely it would be for a platform to have an accident or spill in the next year.

Place X in box	Probability of having an accident or spill				
Platform age (years)	Much less than average	Less than average	Average probability	More than average	Much more than average
0-5					
6-10					
11-15					
16-20					
21-25					
>25					
It is understood that some questions in the survey are relatively easy to answer, and some are quite difficult. The following boxes allow you to state how confident you are in your estimates.					
Place X in box	Not confident	Fairly low confidence	Average confidence	Fairly high confidence	Very confident
Confidence level					

QUESTION: The percentage of operations contracted out **on a platform may affect its probability of having an accident or spill in the future. For each percentage of outside contracting, indicate how likely it would be for a platform to have an accident or spill in the next year.**

Place X in box	Probability of having an accident or spill				
% of operations contracted out	Much less than average	Less than average	Average probability	More than average	Much more than average
0-25					
26-50					
51-75					
76-100					
It is understood that some questions in the survey are relatively easy to answer, and some are quite difficult. The following boxes allow you to state how confident you are in your estimates.					
Place X in box	Not confident	Fairly low confidence	Average confidence	Fairly high confidence	Very confident
Confidence level					

QUESTION: The **number of people working on a platform** may affect its probability of having an accident or spill in the next year. For each number category, indicate how likely it would be for a platform to have an accident or spill in the next year.

Place X in box	**Probability of having an accident or spill**				
Number of people on platform	**Much less than average**	**Less than average**	**Average probability**	**More than average**	**Much more than average**
0					
1-5					
6-10					
11-15					
16-20					
>20					
It is understood that some questions in the survey are relatively easy to answer, and some are quite difficult. The following boxes allow you to state how confident you are in your estimates.					
Place X in box	**Not confident**	**Fairly low confidence**	**Average confidence**	**Fairly high confidence**	**Very confident**
Confidence level					

The following 3 questions pertain to 3 different size facilities:
5 components, 25 components, and 50 components.

QUESTION: The **number of INCs that a platform has received** in the past may affect its probability of having an accident or spill in the future. Consider a platform with **5 components**. For each INC category below (number of INCs received in the past five years), indicate how likely it would be for a platform to have an accident or spill in the next year.

Place X in box	**Probability of having an accident or spill**				
Number of INCs in 5 years	**Much less than average**	**Less than average**	**Average probability**	**More than average**	**Much more than average**
0-5					
6-10					
11-15					
16-20					
21-25					
>25					
It is understood that some questions in the survey are relatively easy to answer, and some are quite difficult. The following boxes allow you to state how confident you are in your estimates.					
Place X in box	**Not confident**	**Fairly low confidence**	**Average confidence**	**Fairly high confidence**	**Very confident**
Confidence level					

QUESTION: The **number of INCs that a platform has received** in the past may affect its probability of having an accident or spill in the future. Consider a platform with **25 components**. For each INC category below (number of INCs received in the past five years), indicate how likely it would be for a platform to have an accident or spill in the next year.

Place X in box	**Probability of having an accident or spill**				
Number of INCs in 5 years	**Much less than average**	**Less than average**	**Average probability**	**More than average**	**Much more than average**
0-5					
6-10					
11-15					
16-20					
21-25					
>25					
It is understood that some questions in the survey are relatively easy to answer, and some are quite difficult. The following boxes allow you to state how confident you are in your estimates.					
Place X in box	**Not confident**	**Fairly low confidence**	**Average confidence**	**Fairly high confidence**	**Very confident**
Confidence level					

QUESTION: The **number of INCs that a platform has received** in the past may affect its probability of having an accident or spill in the future. Consider a platform with **50 components**. For each INC category below (number of INCs received in the past five years), indicate how likely it would be for a platform to have an accident or spill in the next year.

Place X in box	**Probability of having an accident or spill**				
Number of INCs in 5 years	**Much less than average**	**Less than average**	**Average probability**	**More than average**	**Much more than average**
0-5					
6-10					
11-15					
16-20					
21-25					
>25					
It is understood that some questions in the survey are relatively easy to answer, and some are quite difficult. The following boxes allow you to state how confident you are in your estimates.					
Place X in box	**Not confident**	**Fairly low confidence**	**Average confidence**	**Fairly high confidence**	**Very confident**
Confidence level					

The INC descriptions below are provided to help you answer the next question

Type of INC	Description
G-110	Does the lessee perform all operations in a safe and workmanlike manner, maintain all equipment in a safe condition, and take all necessary precautions to correct and remove any hazardous oil and gas accumulation or other health, safety, or fire hazard?
P-406	Is an operable FSV installed in the final flowline segment?
P-412	Is each wellhead completion equipped with an operable SSV or USV located above the master valve in the vertical run of the tree?
P-240	Does the SSV close within 45 seconds after automatic detection if an abnormal condition or actuation of an ESD?
P-103	Is each surface or subsurface safety device, which is bypassed or blocked out of service, out of service due to start-up, testing, or maintenance and is it flagged and monitored by personnel?
E-100	Is the lessee preventing pollution of offshore waters?
H-126	Is the H2S-detection and H2S-monitoring equipment calibrated?
W-100	Have all wells in the same well-bay which are capable of production hydrocarbons been shut in below the surface with a pump-through-type tubing plug or SSV at the surface with a closed master valve prior to moving well-workover rigs and related equipment (or as otherwise approved by the District Supervisor)?

QUESTION: The **type of INCs that a platform has received** in the past may affect its probability of having an accident or spill in the future. A **platform has received an "average"* number of the following types of INCs in the prior 5 years.** For each INC category, indicate how likely it would be for a platform to have an accident or spill in the next year. If there are other INCs that you feel are important predictors of accidents or spills list them in the blank lines provided.

Place X in box	**Probability of having an accident or spill**				
Type of INC	**Much less than average**	**Less than average**	**Average probability**	**More than average**	**Much more than average**
G-110					
P-406					
P-412					
P-240					
P-103					
E-100					
H-126					
W-100					

It is understood that some questions in the survey are relatively easy to answer, and some are quite difficult. The following boxes allow you to state how confident you are in your estimates.

Place X in box	**Not confident**	**Fairly low confidence**	**Average confidence**	**Fairly high confidence**	**Very confident**
Confidence level					

*** Note: "average" means typical for a particular platform's size or complexity. What we are trying to measure in this question is your concern for particular <u>types</u> of INCs, not your concern for the <u>rate</u> at which INCs are issued.**

QUESTION: The **type of penalty a platform receives (no penalty, civil, or criminal)** after getting an INC may affect its probability of having an accident or spill in the future. For each penalty category, indicate how likely it would be for a platform to have an accident or spill in the next year.

Place X in box	**Probability of having an accident or spill**				
Penalty type	**Much less than average**	**Less than average**	**Average probability**	**More than average**	**Much more than average**
INC-no penalty					
INC - civil penalty					
INC - criminal penalty					
It is understood that some questions in the survey are relatively easy to answer, and some are quite difficult. The following boxes allow you to state how confident you are in your estimates.					
Place X in box	**Not confident**	**Fairly low confidence**	**Average confidence**	**Fairly high confidence**	**Very confident**
Confidence level					

QUESTION: The **type of INC enforcement code that a platform receives (W, C, or S)** after getting an INC may affect its probability of having an accident or spill in the future. For each enforcement code category, indicate how likely it would be for a platform to have an accident or spill in the next year.

Place X in box	**Probability of having an accident or spill**				
Enforcement code	**Much less than average**	**Less than average**	**Average probability**	**More than average**	**Much more than average**
W					
C					
S					
It is understood that some questions in the survey are relatively easy to answer, and some are quite difficult. The following boxes allow you to state how confident you are in your estimates.					
Place X in box	**Not confident**	**Fairly low confidence**	**Average confidence**	**Fairly high confidence**	**Very confident**
Confidence level					

QUESTION: The **presence of H2S** on a platform may affect its probability of having an accident or spill in the future. For each category, indicate how likely it would be for a platform to have an accident or spill in the next year.

Place X in box	**Probability of having an accident or spill**				
Presence of H2S	**Much less than average**	**Less than average**	**Average probability**	**More than average**	**Much more than average**
H2S is present					
H2S is not present					
It is understood that some questions in the survey are relatively easy to answer, and some are quite difficult. The following boxes allow you to state how confident you are in your estimates.					
Place X in box	**Not confident**	**Fairly low confidence**	**Average confidence**	**Fairly high confidence**	**Very confident**
Confidence level					

QUESTION: The **experience level of the platform's operating company** may affect its probability of having an accident or spill in the future. For each experience category (in years), indicate how likely it would be for a platform to have an accident or spill in the next year.

Place X in box	**Probability of having an accident or spill**				
<u>Operating company</u> experience level (years)	**Much less than average**	**Less than average**	**Average probability**	**More than average**	**Much more than average**
0-3					
4-6					
7-9					
10-12					
13-15					
16-18					
>18					
It is understood that some questions in the survey are relatively easy to answer, and some are quite difficult. The following boxes allow you to state how confident you are in your estimates.					
Place X in box	**Not confident**	**Fairly low confidence**	**Average confidence**	**Fairly high confidence**	**Very confident**
Confidence level					

QUESTION: The **experience level of the "typical" worker on a platform** may affect its probability of having an accident or spill in the future. For each experience category (in years), indicate how likely it would be for a platform to have an accident or spill in the next year.

Place X in box	**Probability of having an accident or spill**				
<u>Worker</u> experience level (years)	**Much less than average**	**Less than average**	**Average probability**	**More than average**	**Much more than average**
0-3					
4-6					
7-9					
10-12					
13-15					
16-18					
>18					
It is understood that some questions in the survey are relatively easy to answer, and some are quite difficult. The following boxes allow you to state how confident you are in your estimates.					
Place X in box	**Not confident**	**Fairly low confidence**	**Average confidence**	**Fairly high confidence**	**Very confident**
Confidence level					

QUESTION: The **type of accident or spill that a platform has experienced in the prior 5 years** may affect its probability of having an accident or spill in the future. For each accident and spill category, indicate how likely it would be for a platform to have an accident or spill in the next year.

Place X in box	**Probability of having an accident or spill**				
Type of accident or spill	**Much less than average**	**Less than average**	**Average probability**	**More than average**	**Much more than average**
Explosion					
Fire*					
Fatality					
Major spill					
Minor spill					
Vessel strike					
Weather damage					

It is understood that some questions in the survey are relatively easy to answer, and some are quite difficult. The following boxes allow you to state how confident you are in your estimates.

Place X in box	**Not confident**	**Fairly low confidence**	**Average confidence**	**Fairly high confidence**	**Very confident**
Confidence level					

***NOTE: Do not consider galley fires or those that self-extinguish.**

QUESTION: The **number of accidents or spills that a platform has experienced** in the past may affect its probability of having an accident or spill in the future. For each category below (number of accidents or spills in the past five years), indicate how likely it would be for a platform to have an accident or spill in the next year.

Place X in box	**Probability of having an accident or spill**				
Number of Accidents or spills in last 5 years	**Much less than average**	**Less than average**	**Average probability**	**More than average**	**Much more than average**
0					
1-2					
3-4					
5-6					
7-8					
9-10					
>10					

It is understood that some questions in the survey are relatively easy to answer, and some are quite difficult. The following boxes allow you to state how confident you are in your estimates.

Place X in box	**Not confident**	**Fairly low confidence**	**Average confidence**	**Fairly high confidence**	**Very confident**
Confidence level					

QUESTION: The **type of hydrocarbon a platform produces (gas, oil or both in equal amounts-BOE)** may affect its probability of having an accident or spill in the future. For each production type, indicate how likely it would be for a platform to have an **accident** in the next year.

Place X in box	**Probability of having an accident**				
Production Type	**Much less than average**	**Less than average**	**Average probability**	**More than average**	**Much more than average**
Oil					
Gas					
Oil and Gas equally (BOE)					

It is understood that some questions in the survey are relatively easy to answer, and some are quite difficult. The following boxes allow you to state how confident you are in your estimates.

Place X in box	**Not confident**	**Fairly low confidence**	**Average confidence**	**Fairly high confidence**	**Very confident**
Confidence level					

QUESTION: The **type of hydrocarbon a platform produces (gas, oil or both in equal amounts-BOE)** may affect its probability of having an accident or spill in the future. For each production type, indicate how likely it would be for a platform to have a **spill** in the next year.

Place X in box	**Probability of having a spill**				
Production Type	**Much less than average**	**Less than average**	**Average probability**	**More than average**	**Much more than average**
Oil					
Gas					
Oil and Gas equally (BOE)					

It is understood that some questions in the survey are relatively easy to answer, and some are quite difficult. The following boxes allow you to state how confident you are in your estimates.

Place X in box	**Not confident**	**Fairly low confidence**	**Average confidence**	**Fairly high confidence**	**Very confident**
Confidence level					

QUESTION: The **well or reservoir pressure** on a platform may affect its probability of having an accident or spill in the future. For pressure category, indicate how likely it would be for a platform to have an accident or spill in the next year.

Place X in box	**Probability of having an accident or spill**				
Reservoir pressure (psig)	**Much less than average**	**Less than average**	**Average probability**	**More than average**	**Much more than average**
0-500					
500-1000					
1000-1500					
1500-2000					
>2000					

It is understood that some questions in the survey are relatively easy to answer, and some are quite difficult. The following boxes allow you to state how confident you are in your estimates.

Place X in box	**Not confident**	**Fairly low confidence**	**Average confidence**	**Fairly high confidence**	**Very confident**
Confidence level					

QUESTION: The **volume of hydrocarbon produced on a platform per day** may affect its probability of having an accident or spill in the future. For each **oil production volume** category, indicate how likely it would be for a platform to have an accident or spill in the next year.

Place X in box	Probability of having an accident or spill				
Production volume, BO/day (thousand)	Much less than average	Less than average	Average probability	More than average	Much more than average
0-5					
6-10					
11-15					
16-20					
21-25					
>25					
It is understood that some questions in the survey are relatively easy to answer, and some are quite difficult. The following boxes allow you to state how confident you are in your estimates.					
Place X in box	Not confident	Fairly low confidence	Average confidence	Fairly high confidence	Very confident
Confidence level					

QUESTION: The **volume of hydrocarbon produced on a platform per day** may affect its probability of having an accident or spill in the future. For each **gas production volume** category, indicate how likely it would be for a platform to have an accident or spill in the next year.

Place X in box	Probability of having an accident or spill				
Production volume, c.f. /day (million)	Much less than average	Less than average	Average probability	More than average	Much more than average
0-5					
6-10					
11-15					
16-20					
21-25					
26-30					
31-35					
36-40					
>40					
It is understood that some questions in the survey are relatively easy to answer, and some are quite difficult. The following boxes allow you to state how confident you are in your estimates.					
Place X in box	Not confident	Fairly low confidence	Average confidence	Fairly high confidence	Very confident
Confidence level					

QUESTION: The **number of well completions on a platform** may affect its probability of having an accident or spill in the future. For each well completion category, indicate how likely it would be for a platform to have an accident or spill in the next year.

Place X in box	**Probability of having an accident or spill**				
Number of well completions	**Much less than average**	**Less than average**	**Average probability**	**More than average**	**Much more than average**
0-5 (minor)					
6-10 (major)					
11-15 (major)					
16-20 (major)					
21-25 (major)					
>25 (major)					
It is understood that some questions in the survey are relatively easy to answer, and some are quite difficult. The following boxes allow you to state how confident you are in your estimates.					
Place X in box	**Not confident**	**Fairly low confidence**	**Average confidence**	**Fairly high confidence**	**Very confident**
Confidence level					

QUESTION: The **number of drill slots on a platform** may affect its probability of having an accident or spill in the future. For each number of drill slots category, indicate how likely it would be for a platform to have an accident or spill in the next year.

Place X in box	**Probability of having an accident or spill**				
Number of drill slots	**Much less than average**	**Less than average**	**Average probability**	**More than average**	**Much more than average**
0-5					
6-10					
11-15					
16-20					
21-25					
26-30					
31-35					
>35					
It is understood that some questions in the survey are relatively easy to answer, and some are quite difficult. The following boxes allow you to state how confident you are in your estimates.					
Place X in box	**Not confident**	**Fairly low confidence**	**Average confidence**	**Fairly high confidence**	**Very confident**
Confidence level					

QUESTION: **A platform's water depth** may affect its probability of having an accident or spill in the future. For each water depth category, indicate how likely it would be for a platform to have an accident or spill in the next year.

Place X in box	**Probability of having an accident or spill**				
Water depth (meters)	**Much less than average**	**Less than average**	**Average probability**	**More than average**	**Much more than average**
0-50					
51-100					
101-150					
151-200					
201-250					
251-300					
301-350					
>400					

It is understood that some questions in the survey are relatively easy to answer, and some are quite difficult. The following boxes allow you to state how confident you are in your estimates.

Place X in box	**Not confident**	**Fairly low confidence**	**Average confidence**	**Fairly high confidence**	**Very confident**
Confidence level					

QUESTION: **A platform's distance to shore** may affect its probability of having an accident or spill in the future. For each distance category, indicate how likely it would be for a platform to have an accident or spill in the next year.

Place X in box	**Probability of having an accident or spill**				
Distance to shore (std. miles)	**Much less than average**	**Less than average**	**Average probability**	**More than average**	**Much more than average**
0-25					
26-50					
51-75					
76-100					
101-125					
>125					

It is understood that some questions in the survey are relatively easy to answer, and some are quite difficult. The following boxes allow you to state how confident you are in your estimates.

Place X in box	**Not confident**	**Fairly low confidence**	**Average confidence**	**Fairly high confidence**	**Very confident**
Confidence level					

QUESTION: A **platform's distance from shipping lanes** may affect its probability of having an accident or spill in the future. For each distance category, indicate how likely it would be for a platform to have an accident or spill in the next year.

Place X in box	Probability of having an accident or spill				
Distance to shipping lanes (std. miles)	Much less than average	Less than average	Average probability	More than average	Much more than average
0-½					
½-1					
1-1½					
1½-2					
>2					
It is understood that some questions in the survey are relatively easy to answer, and some are quite difficult. The following boxes allow you to state how confident you are in your estimates.					
Place X in box	Not confident	Fairly low confidence	Average confidence	Fairly high confidence	Very confident
Confidence level					

QUESTION: The **presence of a fired vessel** on a platform may affect its probability of having an accident or spill in the future. For each category, indicate how likely it would be for a platform to have an accident or spill in the next year.

Place X in box	Probability of having an accident or spill				
Presence of a fired vessel	Much less than average	Less than average	Average probability	More than average	Much more than average
Fired vessel					
No fired vessel					
It is understood that some questions in the survey are relatively easy to answer, and some are quite difficult. The following boxes allow you to state how confident you are in your estimates.					
Place X in box	Not confident	Fairly low confidence	Average confidence	Fairly high confidence	Very confident
Confidence level					

QUESTION: The **presence of a storage vessel** on a platform may affect its probability of having an accident or spill in the future. For each category, indicate how likely it would be for a platform to have an accident or spill in the next year.

Place X in box	Probability of having an accident or spill				
Presence of storage facilities	Much less than average	Less than average	Average probability	More than average	Much more than average
Storage facilities					
No storage facilities					
It is understood that some questions in the survey are relatively easy to answer, and some are quite difficult. The following boxes allow you to state how confident you are in your estimates.					
Place X in box	Not confident	Fairly low confidence	Average confidence	Fairly high confidence	Very confident
Confidence level					

QUESTION: The **type of operation conducted** on a platform may affect its probability of having an accident or spill in the future. For each operation category, indicate how likely it would be for a platform to have an accident or spill in the next year. If there are other operations that you feel are important predictors of accidents or spills list them in the blank lines provided.

Place X in box	**Probability of having an accident or spill**				
Operation type	**Much less than average**	**Less than average**	**Average probability**	**More than average**	**Much more than average**
Vessel clean out					
Wire line work					
Crane operation					
Construction					
Painting					
Well work over					
Cleaning pig trap					
Fabricating					
Welding					
Well completion					

It is understood that some questions in the survey are relatively easy to answer, and some are quite difficult. The following boxes allow you to state how confident you are in your estimates.

Place X in box	**Not confident**	**Fairly low confidence**	**Average confidence**	**Fairly high confidence**	**Very confident**
Confidence level					

QUESTION: **The number of simultaneous operations conducted on a platform** may affect its probability of having an accident or spill in the future. For each number category, indicate how likely it would be for a platform to have an accident or spill in the next year.

place X in box	**Probability of having an accident or spill**				
number of operations occurring simultaneously	**Much less than average**	**Less than average**	**Average probability**	**More than average**	**Much more than average**
1					
2					
3					
4					
5					
>5					

It is understood that some questions in the survey are relatively easy to answer, and some are quite difficult. The following boxes allow you to state how confident you are in your estimates.

place X in box	**Not confident**	**Fairly low confidence**	**Average confidence**	**Fairly high confidence**	**Very confident**
Confidence level					

QUESTION: The **number of components on a platform** may affect its probability of having an accident or spill in the future. For each category, indicate how likely it would be for a platform to have an accident or spill in the next year.

place X in box	**Probability of having an accident or spill**				
Number of components on a platform	**Much less than average**	**Less than average**	**Average probability**	**More than average**	**Much more than average**
0-10					
11-20					
21-30					
31-40					
41-50					
>50					

It is understood that some questions in the survey are relatively easy to answer, and some are quite difficult. The following boxes allow you to state how confident you are in your estimates.

place X in box	**Not confident**	**Fairly low confidence**	**Average confidence**	**Fairly high confidence**	**Very confident**
Confidence level					

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Instructions for section two: Risk Factor Comparisons

Listed on the following page are the 25 risk factors that you have just evaluated. Now that you have thought hard about the factors, we would like to get your estimates of their relative importance in predicting accidents or spills. We know that you have done similar ranking tasks before, but in this exercise we want to capture the relative importance between the risk factors. This is a somewhat difficult exercise, but is the only way to determine the relative importance of the risk factors.

1) Go through the list and cross off any risk factor that you think is not important.

2) Take the remaining factors and rank them in order of importance in predicting an accident or a spill from most important (starting with 1) to least important. Do one ranking across all the remaining factors. Only one factor should be ranked "1": the most important.

3) We now want to find out how much less important you feel the second factor is than the first. Put 100 by the most important factor. Next to the second factor put a number that indicates how much less important it is. For example, if the second factor was half as important as the first, you would put 50; if it was almost the same importance, you might put 90 (see the example).

4) Continue down the list of risk factors in order of their ranks, indicating the relative importance of each. For example, if you put 90 by the second risk and the third risks was half as important as the second, you would put 45 next to the third risk. These weights should never increase as you progress. If two consecutive factors are of equal importance, then you can give them the same weight.

5) At anytime you can go back and change either the rank or weight of an item. Just be sure that you are consistent throughout.

EXAMPLE

NOTE: The following example is intended solely to show the process used to fill out the table. It IS NOT intended to influence your answers. The questions to be crossed out were picked at random, and the rankings and point values were randomly assigned.

Please DO NOT assign rankings based on political ramifications or consequences. Instead, base your ranking on your belief regarding the risk factors influence on the probability of a platform having an accident or spill.

Point Value	Ranking	Risk Factor
		~~Number of drill slots~~
		~~Well or reservoir pressure~~
		Experience level of the "typical" worker on a platform
10	12	Number of people working on a platform
		~~Distance from shipping lanes~~
5	14	Number of well completions on a platform
20	10	Simultaneous operations
30	7	Distance to shore of a platform
20	9	Type of accident or spill that a platform has previously experienced
45	5	Experience level of the platform's operating company
5	15	Number of INCs that a platform has received
		~~Type of hydrocarbon a platform produces (gas, oil or both)~~
		~~Type of operations conducted~~
15	11	Water depth of a platform
5	13	Type of INC enforcement that a platform receives (W,C, or S)
90	2	Presence of fired vessel
30	6	Volume of hydrocarbon produced on a platform per day
45	4	Age of Platform
25	8	Number of accidents or spills a platform has experienced
		~~Type of penalty a platform received (no penalty, civil, or criminal)~~
		~~Presence of storage vessel~~
100	1	Percentage of operations contracted out
		~~Presence of H2S~~
45	3	Number of components
		~~Type of INCs that a platform has received~~

Section two: Risk Factor Comparison

Please DO NOT assign rankings based on political ramifications or consequences. Instead, base your ranking on your belief regarding the risk factors influence on the probability of a platform having an accident or spill.

Point Value	Ranking	Risk Factor
		Number of drill slots
		Well or reservoir pressure
		Experience level of the "typical" worker on a platform
		Number of people working on a platform
		Distance from shipping lanes
		Number of well completions on a platform
		Simultaneous operations
		Distance to shore of a platform
		Type of accident or spill that a platform has previously experienced
		Experience level of the platform's operating company
		Number of INCs that a platform has received
		Type of hydrocarbon a platform produces (gas, oil or both)
		Type of operations conducted
		Water depth of a platform
		Type of INC enforcement that a platform receives (W,C, or S)
		Presence of fired vessel
		Volume of hydrocarbon produced on a platform per day
		Age of Platform
		Number of accidents or spills a platform has experienced
		Type of penalty a platform received (no penalty, civil, or criminal)
		Presence of storage vessel
		Percentage of operations contracted out
		Presence of H2S
		Number of components
		Type of INCs that a platform has received