

**1998 CCPS Conference and Workshop Proceedings
Exxon's Worldwide Approach to Incident Investigation Training**

Copyright 1998

American Institute of Chemical Engineers
3 Park Avenue
New York, New York 10016-5991

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise without the prior permission of the copyright owner. AIChE and CCPS are trademarks owned by the American Institute of Chemical Engineers. These trademarks may not be used without the prior express written consent of the American Institute of Chemical Engineers. The use of this product in whole or in part for commercial use is prohibited without prior express written consent of the American Institute of Chemical Engineers. To obtain appropriate license and permission for such use contact Scott Berger, 212-591-7237, scotb@AIChE.org.

It is sincerely hoped that the information presented in this volume will lead to an even more impressive safety record for the entire industry; however, the American Institute of Chemical Engineers, its consultants, CCPS Subcommittee members, their employers, and their employers officers and directors disclaim making or giving any warranties or representations, express or implied, including with respect to fitness, intended purpose, use or merchantability and/or correctness or accuracy of the content of the information presented in this document. As between (1) American Institute of Chemical Engineers, its consultants, CCPS Subcommittee members, their employers, their employers officers and directors and (2) the user of this document, the user accepts any legal liability or responsibility whatsoever for the consequences of its use or misuse.

Exxon's Worldwide Approach to Incident Investigation Training

J. J. Thomas, Exxon Production Research Company (now ExxonMobil)

W. G. Bridges, Process Improvement Institute (formerly of JBF Associates, Inc.)

(this paper was originally published in *International Conference and Workshop on Reliability and Risk Management*, September 1998, Center for Chemical Process Safety/AIChE)

Exxon Company, International (ECI) stewards Upstream operating affiliates in many different countries around the world. Prior to development and delivery of the current incident investigation training, a number of different techniques were used in incident investigations. A need was identified to have a common methodology and structured tools for incident investigations including root cause analysis. Exxon Production Research (EPR), on behalf of ECI, conducted a survey of various available incident investigation techniques and training programs. The techniques chosen were causal factors charting and the Root Cause Map™ (similar to the current version of the Root Cause Chart™, which is from PII) from JBF Associates (JBFA). A two-day Exxon training program was developed using both internal material and material from JBFA. The training program addressed the entire process of incident investigation.

An extensive case study was also included in the training to reinforce key concepts and techniques. Training is conducted using an Exxon instructor and an instructor from JBFA. Over ten training sessions have been held world wide for most of the Upstream affiliates. Also a number of contractors and joint venture partners have attended the training. This paper discusses the background for developing the training, the content of the training and the results of the training.

BACKGROUND

As a large, integrated, multinational corporation, Exxon has several different regional operating companies as shown in Figure 1. Each petroleum operating company has both Upstream and Downstream functions. Also, two research and engineering organizations provide support for the Operating Companies. Exxon Production Research provides support for the Upstream (exploration and production) while Exxon Research and Engineering provides support for the Downstream and Chemicals. ECI – Upstream stewards operating affiliates in many countries, but the largest ones are located in Norway, Malaysia, Australia and the U.S.

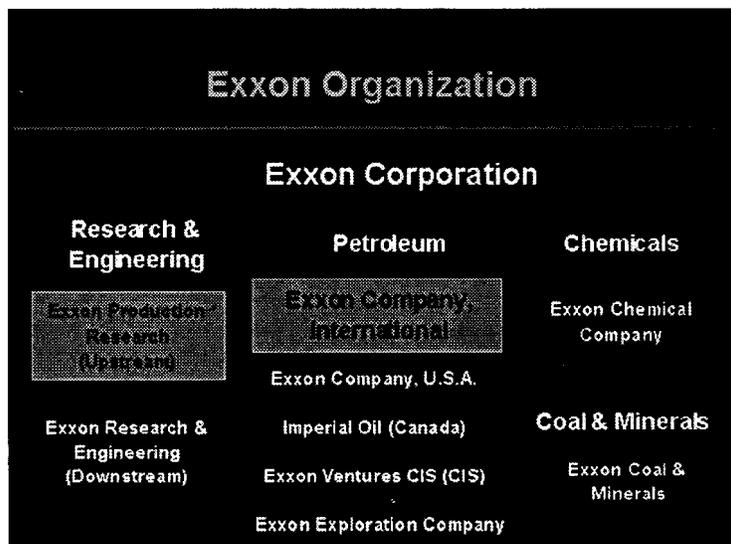


FIGURE 1. Exxon organization

ECI had several reasons for desiring incident investigation training:

- Consistent incident investigation methodology was desired across affiliates
- Exxon's Operations Integrity Management System (OIMS) required incidents to be investigated/analyzed by qualified personnel
- Management Systems could be improved by identifying root causes from incidents and near misses
- ECI Upstream affiliates requested/supported this type of training

Exxon's Operations Integrity Management System (OIMS) requires that incidents and near misses are investigated, root causes are identified, and persons conducting the investigations are qualified. Also, by conducting effective investigations and identifying root causes, management systems can be improved which may lower the likelihood of similar type incidents. A survey was conducted in 1995 of the major affiliates, with the majority supporting a common incident investigation training program.

ECI engaged EPR to develop a comprehensive incident investigation training program that could be conducted on-site at affiliate locations. The audience for the training included a wide-range of people from operations supervisors to engineers to safety coordinators.

PROGRAM DEVELOPMENT

The approach taken by EPR in developing a training program was to "not reinvent the wheel." In other words, it was desired to try and use existing outside methodologies and training to the extent possible while incorporating Exxon specific information.

EPR surveyed a number of outside investigation approaches and training. The key attributes desired included

- Practical approach that could be used by operations personnel (including wage personnel)
- Methodologies that would have repeatable results
- Techniques that had been tested and proven
- Training that was flexible to allow for inclusion of Exxon specific material

The approach selected for incident investigation was Casual Factors Charting and the JBFA Root Cause Map™. A two-day Exxon training program was developed using a combination of JBFA material, existing Exxon material and newly developed material and exercises.

To develop examples and exercises with the highest learning value, it was decided to use case studies based on actual incidents. Some of these case studies were used as instructor-led exercises; others were used as workshops for small breakout groups of five to six students. The key exercises, examples, and workshops developed included:

- What is an incident? A quiz and some side-by-side examples were developed to help students understand what constitutes incidents and near misses and which ones deserve investigation versus what is not worth the effort of an investigation.
- What is a management system? A quiz was developed to reinforce earlier training on Exxon's OIMS and management systems

- What is a root cause? A quiz was developed to help the students begin to dig deeper toward root causes.
- How do you effectively gather data? A mock interview situation was developed to teach basic interviewing skills. This involved role-playing, critiquing, and coaching in teams of three students, with oversight and synopsis by the instructors.
- What is causal factors charting? A simple example was developed to teach the students how to work backward in time (starting at the incident or near miss), and to test the event sequence forward to ensure there was sufficient information represented to describe the complete chain of events and conditions. Students were allowed to struggle with this example for a few minutes, before the instructors guided them through the thought process.
- What is root cause analysis? An example of a generator fire (based on an actual event) was used to teach students how to use the Root Cause Map™.
- What is a good report? Example incident reports were used to develop tests of the student's ability to recognize deficiencies in reports.
- How do you pull it all together? An extensive case study of an actual (minor) accident on an oil production platform was used to let the students experience the full scope of an investigation. All data had to be gathered and analyzed while working in small teams.

Two instructors are used to conduct the training (Jeff Thomas from Exxon and William Bridges from JBFA; now at PII). The two instructors split the lectures, serve as coaches, and also play roles during the exercises and case study.

TRAINING PROGRAM CONTENT

The training program was designed to cover the entire incident investigation process from securing the site to implementing follow-up actions. The main course topics included:

- Management Systems and Company Guidelines
- Securing the Site/Investigation
- Team Considerations
- Information Gathering (e.g. interviewing, reviewing documentation)
- Incident Causation Model
- Incident Analysis
 - Casual Factors Charting
 - JBFA Root Cause Map
- Legal Sensitivities
- Investigation Report
- Follow-up Activities
- Case Study
- Sharing of Incident Learnings

The main emphasis in the course is on information gathering (interviewing) and incident analysis. As mentioned earlier, a case study of an actual incident is worked in "teams" to simulate an actual incident investigation. The participants are given some background and basic incident information and have to gather additional information from the instructors who play roles as different operations personnel (e.g. crane operator, foreman, and mechanic). The investigation teams then analyze the information to determine events, conditions, gaps in data, causal factors, and ultimately root causes. Nine practical exercises, two videos and several discussion sessions also illustrate and reinforce key concepts covered in the training.

One of the main techniques covered in the training is Causal Factors (CF) Charting. This technique shows the events and conditions leading up to an incident. Causal Factors are negative events or hazardous conditions that contributed to the incident. CF Charting helps structure the analysis and data gathering processes to ensure necessary and sufficient information is collected. Once the chart is completed, causal factors are identified on the chart. An example of a simple Causal Factors Chart is shown in Figure 2.

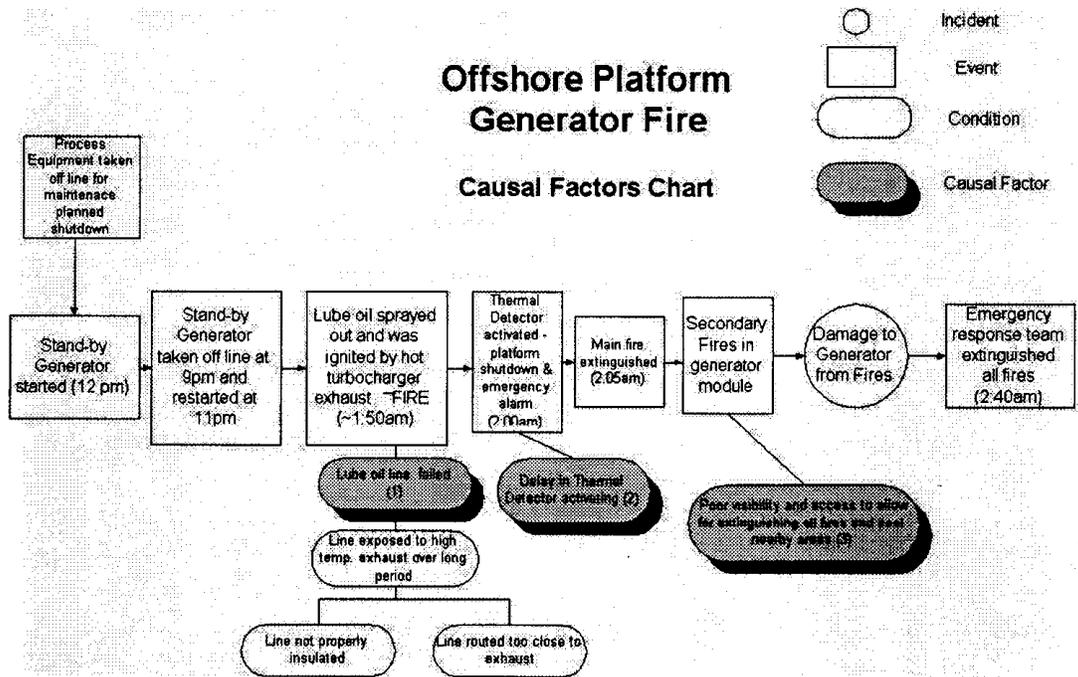


FIGURE 2. Example causal factors chart.

Once the causal factors are identified, each one is analyzed using the Root Cause Map™. The Root Cause Map™ consists of thirteen root cause categories (Figure 3) which branch into 170 root or near root causes.

- | | |
|-------------------------------------|-----------------------------|
| • Design Input/Output | • Human Factors Engineering |
| • Design Review/Verification | • Procedures |
| • Equipment Records | • Training |
| • Calibration Program | • Immediate Supervision |
| • Preventive Maintenance Program | • Communications |
| • Inspection/Testing Program | • Personal Performance |
| • Administrative Management Systems | |

FIGURE 3. Major Root Cause Categories in the Root Cause Map™

The overall structure of the map is shown in Figure 4.

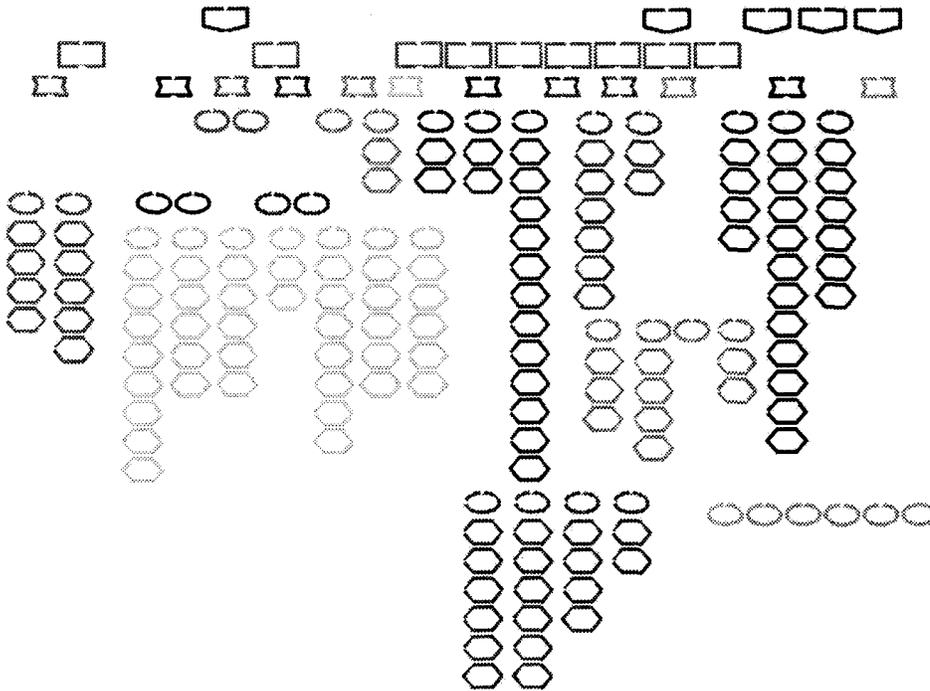


FIGURE 4. Overall structure of JBFA Root Cause Map

In addition to the course notebook and exercises, there is also a Handbook that accompanies the Root Cause Map', which describes each cause (node) in more detail, along with examples. This Handbook helps improve the consistency in use of the Root Cause Map.

TRENDING INCIDENT ANALYSIS RESULTS

Exxon has a computer program, IRAS (Incident Reporting and Analysis System), that is used to capture incident information and do trending analysis on groups of incidents. A recent release of this program has added the Root Cause Map causes to IRAS. This will allow an analysis to be conducted on groups of incidents at various levels in Exxon (e.g., site, affiliate, region and company-wide). Having a set of common root causes will help to facilitate this type of analysis and identify common issues to focus on.

TRAINING LOCATIONS

Training has been held in a number of Exxon worldwide locations. Figure 5 shows the locations where training has been held.



FIGURE 5. Locations of incident investigation training.

To date 12 sessions have been held and approximately 200 people have attended the training. The types of people trained have included operations/drilling supervisors, engineers, safety coordinators, and even a few managers. Also, some Exxon contractors and joint venture partners have attended.

FEEDBACK ON TRAINING

Evaluations from the training have been very positive. Students like having a structured approach to incident investigation. The case study and exercises in particular are highlights of the course.

Also, we have already begun to see improvement in the consistency and quality of incident reports. Root causes are now being better identified and management systems are being continually improved. The number of near miss reports is also increasing.

FUTURE PLANS

Other Exxon Regions and functions are evaluating this training program as a way to improve and standardize their incident investigations. It is planned to develop a one-day refresher training program later this year. This refresher training will reinforce the techniques, and give additional practice using case studies. The plan is to select a number of actual industry incidents to use in the refresher training.

As previously mentioned, the causes from the Root Cause Map' are being integrated into the IRAS database program so affiliates can enter root causes and conduct analysis at various levels in the organization. This global analysis should help identify common issues and system related problems.

CONCLUSIONS

Based on our experience in developing and conducting this incident investigation training for ECI Upstream affiliates, we have the following conclusions:

- Having common tools and training for incident investigation helps improve the quality and consistency of incident investigations.
- An effective way of developing training is to use existing outside material combined with existing in-house material and newly developed material and case studies.
- The approach of Casual Factor Charting and a structured set of root causes has proven practical for a wide range of people (from operations supervisors to engineers to safety coordinators) in world-wide locations.
- Case Studies and exercises are critical in training people on incident investigation techniques.

REFERENCES

AICHe/CCPS. Guidelines for Investigating Chemical Process Incidents, Center for Chemical Process Safety, New York, 1992.

Department of Energy. Events and Causal Factors Charting, DOE/SSDC 76-45/14, 1985.

Department of Energy. Root Cause Analysis Handbook, WSRC-1M-91-3, 1991.

Ferry, Ted S. Modern Accident Investigation and Analysis, 2nd ed., John Wiley and Sons, New York, 1988.

JBFA Root Cause Analysis Handbook, Version 1.1. JBF Associates, Inc., 1000 Technology Drive, Knoxville, TN 37932

JBFA Root Cause Map™, Rev. 4, July, 1997, JBF Associates, Inc., 1000 Technology Drive, Knoxville, TN 37932

Kletz, Trevor, Mat Went Wrong: Case Histories of Process Plant Disasters, Gulf Publishing Co., Houston, 1994.

Pennycook, W. A., & Danz-Reece, M. E. Practical Examples of Human Error Analysis in Operations. Proceedings of the 1994 Society of Petroleum Engineer's Conference on Health, Safety & Environment in Oil and Gas Exploration and Production, paper #SPE27262, 1994.

TapRooT™ Incident Investigation System, System Improvements, Inc., Suite 301, 238 Peters Road, Knoxville, TN 37920