Guidelines for
Auditing Process Safety
Management Systems
Publications Available from the
CENTER FOR CHEMICAL PROCESS SAFETY
of the
AMERICAN INSTITUTE OF CHEMICAL ENGINEERS

Guidelines for Auditing Process Safety Management Systems
Guidelines for Investigating Chemical Process Incidents
Guidelines for Hazard Evaluation Procedures, Second Edition with Worked Examples
Plant Guidelines for Technical Management of Chemical Process Safety
Guidelines for Technical Management of Chemical Process Safety
Guidelines for Chemical Process Quantitative Risk Analysis
Guidelines for Process Equipment Reliability Data, with Data Tables
Guidelines for Vapor Release Mitigation
Guidelines for Safe Storage and Handling of High Toxic Hazard Materials
Guidelines for Use of Vapor Cloud Dispersion Models
Workbook of Test Cases for Vapor Cloud Source Dispersion Models
Proceedings of the International Conference on Vapor Cloud Modeling, 1987
1991 CCPS/AIChe Directory of Chemical Process Safety Services
Audiotapes and Materials from Workshops at the International Conference on Chemical Process Safety Management, 1991
Electronic Chemical Process Quantitative Risk Analysis Bibliography
Guidelines for Auditing Process Safety Management Systems
This book is available at a special discount when ordered in bulk quantities. For information, contact the Center for Chemical Process Safety at the address shown above.

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, neither the American Institute of Chemical Engineers, its consultants, CCPS and/or its sponsors, its subcommittee members, their employers, nor their employers' officers and directors warrant or represent, expressly or implied, the correctness or accuracy of the content of the information presented in this conference, nor can they accept liability or responsibility whatsoever for the consequences of its use or misuse by anyone.
## Contents

List of Figures and Tables xi
Acronyms xiii
Glossary xv
Preface xvii
Acknowledgments xx
Introduction xxii

### Chapter 1  Management of Process Safety Management Systems Audits

1.1 Overview 1
1.2 Audit Program Scope 3
1.3 Audit Frequency 5
  1.3.1 Degree of Risk 5
  1.3.2 Process Safety Management Program Maturity 5
  1.3.3 Results of Prior Audits 6
  1.3.4 Incident History 6
  1.3.5 Company Policies and Government Regulations 6
1.4 Audit Staffing 6
1.5 Audit Reporting 8
  1.5.1 Report Content 8
  1.5.2 Distribution of Reports 9
  1.5.3 Language of Reports 9
  1.5.4 Report Retention 10
1.6 Audit Follow-up 10
1.7 Quality Assurance 11
1.8 Summary 12

### Chapter 2  Audit Techniques

2.1 Overview 13
  2.1.1 Pre-Audit Activities 13
  2.1.2 Audit Activities 16
  2.1.3 Post-Audit Activities 19
2.2 Audit Guides 19
  2.2.1 Protocol 20
  2.2.2 Questionnaire 21
  2.2.3 Topical Outline 22
2.3 Gathering Data 22
  2.3.1 Data-Gathering Methods and Sources 22
  2.3.2 Interviewing Techniques 24
### Chapter 3 Accountability and Responsibility

#### 3.1 Overview

#### 3.2 Indicators of Accountability and Responsibility
- 3.2.1 Policy Statement
- 3.2.2 Management Commitment
- 3.2.3 Requirements for Procedures
- 3.2.4 Individual Performance Measurement

#### 3.3 Organizational Changes
- 3.3.1 Responsibilities
- 3.3.2 Performance Measurement
- 3.3.3 Resources
- 3.3.4 Procedures
- 3.3.5 Culture
- 3.3.6 Acquisitions

#### 3.4 Summary

### Chapter 4 Process Safety Knowledge

#### 4.1 Overview

#### 4.2 Audits of Process Safety Knowledge
- 4.2.1 Data Sources
- 4.2.2 Data Availability and Distribution
- 4.2.3 Maintaining Information

#### 4.3 Types of Process Safety Information
- 4.3.1 Chemical Data
- 4.3.2 Design Data
- 4.3.3 Design Basis
- 4.3.4 Process Flow Diagrams
- 4.3.5 Special Design Considerations
- 4.3.6 Piping and Instrumentation Drawings
- 4.3.7 Plot Plans
- 4.3.8 Electrical Classification Plot Plan
- 4.3.9 Plot Plan of Underground Services
- 4.3.10 Equipment Specification Sheets
- 4.3.11 Piping Specifications
- 4.3.12 Safety-Critical Instrument Index
- 4.3.13 Electrical One-line Diagrams
<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.3.14</td>
<td>Programmable Controllers and Computers</td>
<td>46</td>
</tr>
<tr>
<td>4.3.15</td>
<td>Vendor Data</td>
<td>48</td>
</tr>
<tr>
<td>4.3.16</td>
<td>Other Information</td>
<td>48</td>
</tr>
<tr>
<td>4.4</td>
<td>Procedures</td>
<td>48</td>
</tr>
<tr>
<td>4.4.1</td>
<td>Operating Procedures</td>
<td>48</td>
</tr>
<tr>
<td>4.4.2</td>
<td>Other Procedures</td>
<td>49</td>
</tr>
<tr>
<td>4.5</td>
<td>Enhancement of Process Safety Knowledge</td>
<td>49</td>
</tr>
<tr>
<td>4.6</td>
<td>Summary</td>
<td>50</td>
</tr>
</tbody>
</table>

**Chapter 5  Project Safety Reviews**

<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.1</td>
<td>Overview</td>
<td>51</td>
</tr>
<tr>
<td>5.2</td>
<td>Project Safety Review Procedures</td>
<td>52</td>
</tr>
<tr>
<td>5.3</td>
<td>Hazard Analysis</td>
<td>54</td>
</tr>
<tr>
<td>5.3.1</td>
<td>Hazard Analysis Techniques</td>
<td>55</td>
</tr>
<tr>
<td>5.3.2</td>
<td>Staffing</td>
<td>58</td>
</tr>
<tr>
<td>5.3.3</td>
<td>Roles/Responsibilities</td>
<td>58</td>
</tr>
<tr>
<td>5.4</td>
<td>Recommendations/Follow-up/Closure</td>
<td>58</td>
</tr>
<tr>
<td>5.4.1</td>
<td>Assigned Responsibility for Action Items</td>
<td>59</td>
</tr>
<tr>
<td>5.4.2</td>
<td>Tracking System on Status of Action Items</td>
<td>59</td>
</tr>
<tr>
<td>5.4.3</td>
<td>Resolution of Disagreements</td>
<td>60</td>
</tr>
<tr>
<td>5.4.4</td>
<td>Updating Process Safety Information</td>
<td>60</td>
</tr>
<tr>
<td>5.4.5</td>
<td>Report</td>
<td>60</td>
</tr>
<tr>
<td>5.4.6</td>
<td>Dissemination of Findings</td>
<td>60</td>
</tr>
<tr>
<td>5.4.7</td>
<td>Record Retention</td>
<td>60</td>
</tr>
<tr>
<td>5.5</td>
<td>Summary</td>
<td>61</td>
</tr>
</tbody>
</table>

**Chapter 6  Management of Change**

<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.1</td>
<td>Overview</td>
<td>63</td>
</tr>
<tr>
<td>6.2</td>
<td>Auditing Approach</td>
<td>64</td>
</tr>
<tr>
<td>6.3</td>
<td>Written Procedures</td>
<td>65</td>
</tr>
<tr>
<td>6.3.1</td>
<td>General Requirements</td>
<td>65</td>
</tr>
<tr>
<td>6.3.2</td>
<td>Definition of Change</td>
<td>66</td>
</tr>
<tr>
<td>6.3.3</td>
<td>Identification of Change</td>
<td>68</td>
</tr>
<tr>
<td>6.3.4</td>
<td>Description of Change</td>
<td>69</td>
</tr>
<tr>
<td>6.3.5</td>
<td>Temporary Changes</td>
<td>69</td>
</tr>
<tr>
<td>6.3.6</td>
<td>Authorization</td>
<td>69</td>
</tr>
<tr>
<td>6.3.7</td>
<td>Safety Review</td>
<td>70</td>
</tr>
<tr>
<td>6.3.8</td>
<td>Training</td>
<td>70</td>
</tr>
<tr>
<td>6.4</td>
<td>Documentation</td>
<td>71</td>
</tr>
<tr>
<td>6.5</td>
<td>Summary</td>
<td>71</td>
</tr>
</tbody>
</table>

**Chapter 7  Process Equipment Integrity**

<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.1</td>
<td>Overview</td>
<td>73</td>
</tr>
<tr>
<td>7.2</td>
<td>New Equipment Design, Fabrication, and Installation</td>
<td>75</td>
</tr>
<tr>
<td>7.3</td>
<td>Preventive Maintenance</td>
<td>77</td>
</tr>
<tr>
<td>7.4</td>
<td>Maintenance Procedures</td>
<td>78</td>
</tr>
<tr>
<td>7.4.1</td>
<td>Work Authorization</td>
<td>78</td>
</tr>
</tbody>
</table>
Chapter 8  Process Risk Management

8.1  Overview  
8.2  Hazard Identification  
  8.2.1  Scope of the Study  
  8.2.2  Methodology Selection  
  8.2.3  Implementation Practices  
  8.2.4  Study Recommendations  
8.3  Risk Assessment of Operations  
  8.3.1  Scope of the Study  
  8.3.2  Methodology Selection  
  8.3.3  Implementation Practices  
  8.3.4  Study Recommendations  
8.4  Risk Reduction Activities  
8.5  Residual Risk Management  
8.6  Customer/Supplier Facilities and Practices  
8.7  New Businesses  
8.8  Summary  

Chapter 9  Incident Investigation

9.1  Overview  
9.2  Incident Investigation System  
9.3  Reporting Mechanism  
  9.3.1  Definition of Incidents  
  9.3.2  Initial Reporting  
  9.3.3  Responsibilities  
9.4  Investigation  
  9.4.1  Criteria for Investigation  
  9.4.2  Investigation Team  
  9.4.3  Investigation Process  
9.5  Investigation Reporting  
9.6  Dissemination of Findings  
  9.6.1  Internal Distribution  
  9.6.2  External Distribution  
9.7  Recommendation Implementation/Closure  
9.8  Incident Analysis  
9.9  Summary  

Chapter 10  Human Factors

10.1  Overview  
10.2  Organizational Issues  
10.3  Design Considerations  
10.3  Operating Culture
This page intentionally left blank
List of Figures and Tables

Figure 2-1  Typical Steps in the Process Safety Management Audit Process  14
Figure 2-2  Example Page from an Audit Protocol Format  21
Figure 2-3  Example Page from a Process Safety Management Topical Outline  23
Figure 4-1  Process Safety Knowledge Linkages  42
Figure 5-1  Project Safety Review Interfaces  52
Figure 5-2  Hazard Evaluation at Various Project Stages  56
Figure 6-1  Example of an Approach to Auditing Management of Change  65
Figure 6-2  Typical Management of Change Procedure  67
Figure 7-1  Process Equipment Integrity Chart  74
Figure 9-1  Incident Investigation Flowchart  95
Figure 11-1  Example Training Matrix for Site Organization  114
Figure 12-1  Emergency Response Planning Elements  123

Table 1-1  Twelve Elements of Chemical Process Safety Management  2
Table 1-2  Examples of Appropriate Report Phrasing  9
Table 1-3  Examples of Audit Reporting Language to Avoid  10
Table 2-1  Typical Background Information Gathered in Pre-Audit Process  15
Table 2-2  Examples of Systematic Sampling Methods  30
Table 4-1  Typical Chemical Data  43
Table 4-2  Selected U.S. Regulations for Chemicals  43
Table 4-3  Typical Process Design Data  44
Table 4-4  Examples of Special Design Considerations  45
Table 5-1  Evaluation of the Common Elements of Project Safety Reviews  55
Table 10-1  Examples of Items to Consider in a Human Factors Review  104
Table 11-1  Examples of OSHA Required Training  115
Table 12-1  Examples of U.S. Emergency Response Planning Regulations  122
Table 12-2  Typical Emergency Response Plan Considerations  125
This page intentionally left blank
Acronyms

\textbf{AIChe} \quad \text{American Institute of Chemical Engineers}

\textbf{AIChe-DIERS} \quad \text{American Institute of Chemical Engineers—Design Institute for Emergency Relief Systems}

\textbf{ANSI} \quad \text{American National Standards Institute}

\textbf{API} \quad \text{American Petroleum Institute}

\textbf{ASME} \quad \text{American Society of Mechanical Engineers}

\textbf{CAD} \quad \text{Computer Aided Design}

\textbf{CCPS} \quad \text{Center for Chemical Process Safety}

\textbf{CMA} \quad \text{Chemical Manufacturers Association}

\textbf{EHSRMA} \quad \text{Extremely Hazardous Substances Risk Management Act (DE)}

\textbf{EPA} \quad \text{Environmental Protection Agency}

\textbf{FMEA} \quad \text{Failure Modes and Effects Analysis}

\textbf{HAZOP} \quad \text{Hazard and Operability Analysis}

\textbf{HVAC} \quad \text{Heating, Ventilating and Air Conditioning}

\textbf{MSDS} \quad \text{Material Safety Data Sheet}

\textbf{NDE} \quad \text{Non-Destructive Examination}

\textbf{OSHA} \quad \text{Occupational Safety and Health Administration}

\textbf{PFD} \quad \text{Process Flow Diagram}

\textbf{P&ID} \quad \text{Piping and Instrument Diagram}

\textbf{RCRA} \quad \text{Resource Conservation and Recovery Act}

\textbf{RMPP} \quad \text{Risk Management and Prevention Program (California)}

\textbf{SARA} \quad \text{Superfund Amendments and Reauthorization Act}

\textbf{SOP} \quad \text{Standard Operating Procedure}

\textbf{TCP} \quad \text{Toxic Catastrophe Prevention Act (New Jersey)}

\textbf{UPS} \quad \text{Uninterruptable Power Supply}
This page intentionally left blank
Glossary

**Accident:** An incident limited to a single injury and/or minor property damage.

**Accountability:** The obligation to explain and answer for one's actions that are related to expectations, objectives, and goals. Because it is associated with positive and negative rewards for actions taken, accountability gives "teeth" to the roles and responsibilities assigned through the management system. Accordingly, it is a powerful element of an effective process safety management system.

**Action plan:** A project schedule for the follow-up activity, and a management control document which can be used to monitor the status of corrective action.

**Administrative control:** Procedures that will hold human and/or equipment performance within established limits.

**Audit:** A systematic, independent review to verify conformance with established guidelines or standards. It employs a well-defined review process to ensure consistency, and to allow the auditor to reach defensible conclusions.

**Checklist (traditional):** A detailed list of desired system attributes or steps for a system or operator to perform. Usually written from experience and used to assess the acceptability or status of the system or operation compared to established norms.

**Confirmation:** A special audit term referring to the substantiation of the existence or condition of something. A confirmation often takes the form of a written request and acknowledgement from independent third parties, but it may also be obtained orally or through observation.

**Consequence:** The direct, undesirable result of an accident sequence usually involving a fire, explosion, or release of toxic material. Consequence descriptions may be qualitative or quantitative estimates of the effects of an accident in terms of factors such as health impacts, economic loss, and environmental damage.

**Consistency:** Continued uniformity, during a period or from one period to another.

**Determine:** To conclude; to reach an opinion consequent to the observation of the fit of sample data within the limit, range, or area associated with substantial conformance, accuracy, or other predetermined standard; to obtain firsthand knowledge of.

**Evaluate:** To reach a conclusion as to significance, worth, effectiveness or usefulness.

**Exception:** A finding which is a deviation from a standard.

**Failure Modes and Effects Analysis (FMEA):** A systematic, tabular method for evaluating and documenting the causes and effects of known types of component failures.