Environmental Management System Implementation Study of UTC Facilities Final Report of Survey Results

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ACRONYMS AND ABBREVIATIONS

BMP	Best management practices
CAA	Clean Air Act
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CMA	Chemical Manufacturers Association
CWA	Clean Water Act
EH&S	Environmental health and safety
EMS	Environmental management system
EPA	U.S. Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
LDR	Land Disposal Restrictions
MSIP	Management Systems Improvement Plan
NESHAP	National Emissions Standards for Hazardous Air Pollutants
NO_x	Nitrogen oxides
NPDES	National Pollutant Discharge Elimination System
O&M	Operations and maintenance
P&W	Pratt and Whitney
P2	Pollution prevention
RCRA	Resource Conservation and Recovery Act
SPCC	Spill prevention, control, and countermeasures
Tetra Tech	Tetra Tech EM Inc.
UST	Underground storage tank
UTC	United Technologies Corporation
UTRC	United Technologies Research Center
VOC	Volatile organic compounds

DISCLAIMER

The information included in this document is a summary of the EPA/UTC Environmental Management System Implementation Study including survey responses and ideas that may help address environmental compliance issues identified in the survey responses. This document is intended solely to assist environmental managers, regulators, and other interested parties to better understand the causes of noncompliance and to consider recommendations and ideas that may help improve environmental compliance and performance. It should be emphasized that EPA has neither reached any conclusions nor made any decisions in response to the conclusions, recommendations, or ideas presented. This document is not a substitute for complying with the regulations themselves. Neither UTC nor EPA makes any guarantees nor assumes any liability with respect to use of any information, recommendations, conclusions or ideas contained in this document.

ABSTRACT

This Environmental Management System (EMS) Implementation Study (study) has been prepared by U.S. Environmental Protection Agency (EPA) - New England (Region 1), with assistance from its contractor, Tetra Tech EM Inc., in conjunction with representatives of United Technologies Corporation (UTC). This study builds upon the work performed under a similar project previously conducted by EPA and the Chemical Manufacturers Association (CMA) (the EPA/CMA Root Cause Analysis Pilot Project or RCA project). This study is designed to (1) determine the effect that implementation of an EMS has on compliance, (2) identify or evaluate differences in root causes of noncompliance before and after implementation of an EMS at a facility, and (3) identify or evaluate differences in pollution prevention (P2) practices before and after implementation of an EMS.

Between 1988 and 1990, EPA conducted inspections and file reviews of UTC facilities in New England to determine these facilities' compliance with requirements under the Resource Conservation and Recovery Act (RCRA) and the Clean Water Act (CWA). Based on the results of these inspections, EPA and UTC entered into a consent decree that required UTC to, among other things, (1) develop EMS for its facilities, and (2) conduct third-party audits to determine compliance at its facilities after the EMSs had been implemented.

EPA developed compliance profiles and surveys to meet the goals of this study. Based upon the information contained in the profiles and surveys, some of the conclusions are:

- Compliance at UTC facilities improved from the time the initial EPA inspections were conducted until the time the third-party audits were conducted. This assertion is based on (1) fewer total instances of noncompliance at individual facilities, and (2) less severe violations being identified in the third-party audits.

- The root cause of noncompliance generally shifted after implementation of EMSs at UTC facilities. The most common root causes of noncompliance before implementation of EMSs at UTC facilities were related to a lack of management controls to ensure compliance. After EMS implementation, the most common root cause of noncompliance was regulations and permits followed closely by human error and failure of individuals to comply with established policies and procedures.

- P2 activities typically were more sophisticated after implementation of EMSs at UTC facilities. UTC also had more systems in place to measure performance of P2 activities after EMSs were implemented.

- There were many similarities between the findings of the post-EMS portion of this study and the RCA project, supporting a number of recommendations of the RCA project.

EXECUTIVE SUMMARY

In the United States, despite growing interest in environmental management systems (EMS) and standards, some companies and regulatory agencies are uncertain about the benefits of developing an EMS. The U.S. Environmental Protection Agency (EPA) is interested in the benefits that implementation of an EMS might have in improving compliance with environmental regulations, as well as the benefits such implementation might have on pollution prevention. EPA - New England (Region 1), in conjunction with United Technologies Corporation (UTC), used the methodology developed by EPA's Chemical Industry Branch and the Chemical Manufacturers Association (CMA) in the Root Cause Analysis Pilot Project (the EPA/CMA Root Cause Analysis Pilot Project [EPA-305-R-99-301], herein referred to as the RCA project) to explore the effect of implementation of an EMS on compliance and pollution prevention. One of the goals of the project was to determine whether regulatory compliance improves as a result of implementation of an EMS. The survey used in the RCA project was modified to analyze the effect of implementing EMSs on compliance and pollution prevention at eight of UTC's facilities in New England.

The UTC project surveys were designed to obtain information to:

- Determine the effect that implementation of an EMS has on compliance
- Identify or evaluate differences in root causes of noncompliance before and after implementation of an EMS at a facility
- Identify or evaluate differences in pollution prevention (P2) practices before and after implementation of an EMS at a facility

From 1988 to 1990, the eight participating UTC facilities were subject to EPA inspections and records reviews under the authority of the Resource Conservation and Recovery Act (RCRA) and the Clean Water Act (CWA). As a result of issues of noncompliance identified during those inspections and records reviews, a consent decree was filed in the United States District Court for the District of Connecticut in 1993. The consent decree required UTC to perform a management systems analysis, develop and implement management systems improvement plans, and subsequently perform compliance audits. The follow-up audits, completed in 1998 by a third party, evaluated compliance with regulations under all applicable environmental statutes at all of UTC's facilities in New England. Despite the differences in scope of the two sets of compliance evaluations (pre- and post-EMS implementation), EPA and UTC had a rare opportunity to compare the compliance status of UTC facilities before and after implementation of an EMS.

This report summarizes the findings of that comparison by examining the compliance rates before and after implementation of an EMS and the changes in root (or underlying) causes and contributing causes of the noncompliance.

Types of Noncompliance

The types of noncompliance varied considerably between 1990 and 1998. In 1990, the most common types of noncompliance included (1) effluent violations and unauthorized discharges in violation of requirements under the CWA, and (2) failure to label and mark containers holding hazardous waste and prepare land disposal restrictions documentation, as required under RCRA. In 1998, the most common types of violations included violations of various stormwater regulations under the CWA and inadequacies found in self-inspections and contingency plan documentation required under RCRA.

Overall, the number of instances of noncompliance dropped substantially from 1990 to 1998. In addition, the 1998 instances of noncompliance tended to be more minor in nature than the 1990 violations.

Root Causes

UTC facilities were asked to identify the root causes of noncompliance from a list of 12 categories of root causes developed for this project. UTC was requested to identify a maximum of three root causes that applied to each instance of noncompliance. The general categories of root causes of noncompliance identified most frequently in the pre-EMS surveys included management (most often, specifically "*no formal management structure to address noncompliance and follow-through*"), procedures (most often, specifically "*no written operating procedures available*"), and human error (most often, specifically "*individual responsibility and professional judgment*").

The general categories of root causes of noncompliance identified most frequently in the post-EMS surveys were the same categories identified in the RCA project and included regulations and permits (most often, specifically *"facility unaware of applicability of a regulation"*), procedures (most often, specifically "*operating procedure not followed*"), and human error (most often, specifically *"individual responsibility or professional judgment*").

Contributing Causes

UTC personnel were free to identify as many contributing causes as were applicable to specific instances of noncompliance in both the pre- and the post-EMS surveys. The most frequently cited contributing causes of noncompliance in the pre-EMS surveys were policies, compliance monitoring, and management; in the post-EMS surveys, the most frequently cited contributing causes of noncompliance were procedures, human error, and compliance monitoring.

Pollution Prevention

Results of the survey indicate that, although UTC had begun implementing P2 activities in 1988, most of those activities were undertaken in response to environmental reporting requirements (for example, requirements for reporting releases to the Toxic Release Inventory).

Unfortunately, P2 efforts before 1992 were not documented at the individual facility level; therefore, data do not exist to evaluate links between the evolution of early P2 programs and implementation of an EMS at UTC facilities. However, the information that is available suggests that UTC has implemented many successful pollution prevention programs from the time of the 1990 inspections until the evaluation of P2 practices in 1998.

In follow-up discussions with EPA, environmental personnel of UTC indicated that they believe that many of the management systems that were adopted to ensure compliance — especially the elements of accountability, management review, and setting of goals, objectives, and targets — have led to improvements in P2.

EMSs and Compliance

Analysis of the survey responses indicate that there is a strong relationship between the implementation of the EMS and improvements in compliance. In general, the nature of noncompliance changed from noncompliance with broad program-wide elements of the regulatory programs before implementation of an EMS to more localized noncompliance with individual regulatory requirements after implementation of an EMS. For example, while some UTC facilities were not performing weekly inspections of hazardous waste container storage areas in 1990, by 1998, it appeared that such inspection requirements generally were being met, although occasionally specific obligations related to those self-inspections (for example, documentation of such inspections for certain weeks) were not being fulfilled. Likewise, the root causes of noncompliance changed from lack of management systems (that is, no procedures were in place) before implementation of an EMS to deficiencies in individual elements within the systems (that is, the procedure was not followed or required updating) after implementation.

Comparisons to the RCA Project

The survey results were generally consistent with those of the RCA project. In particular, the post-EMS survey results mirrored the RCA findings: the same four categories of noncompliance were observed most frequently, the same three categories of root cause predominated in the same order, and two of the three leading contributing causes were the same.

These findings suggest that in organizations that have implemented EMS (such as UTC in 1998 and CMA members covered by the RCA project), improvements in compliance are most likely to come from a combination of (1) improving and maintaining the EMS, (2) training and other

means of increasing awareness of EMS compliance elements, and (3) clearer rules and more compliance assistance.

As was recommended in the RCA project, improvements in compliance might also result from the development of a better understanding of the causes of human error and the identification of actions to address the human error root cause category for those noncompliance categories for which human error was frequently cited.

Conclusions

- The primary root cause of noncompliance identified in the pre-EMS surveys was the lack of a formal management structure for addressing regulatory compliance issues. Representatives of UTC who completed the surveys indicated that the primary root cause of noncompliance in the post-EMS period was individuals not following established procedures, differences in interpretations of regulations by UTC facilities and regulatory agencies, or facilities being unaware of the applicability of new regulations.

- Regulatory compliance improved at the UTC facilities that responded with respect to RCRA and CWA noncompliance identified in the 1993 complaint filed against UTC and its facilities. This conclusion is supported by: (1) comparatively few repeat instances of noncompliance occurred in the 1998 audits and (2), on average, the fewer instances of noncompliance at facilities in 1998.

- The severity of noncompliance also typically decreased. For example, in 1990, two-thirds of the facilities had been cited for storing hazardous waste for more than 90 days, and five of the six facilities reviewed under the CWA had been cited for unauthorized discharges to surface water without permits. In contrast, the post-EMS surveys indicate that only one UTC facility had an unauthorized or unpermitted activity (a pretreatment discharge).

- Overall, the usefulness of information about practices at facilities (for example, elements of an EMS present) and responses to noncompliance events related to violations identified in the 1993 complaint may be limited because fewer individuals at UTC have first-hand knowledge of practices in 1990. For example, responses in the pre-EMS surveys that are related to corrective actions are the same for several facilities, because it is only known in general how violations were addressed, (that is, by implementing the EMS), but current personnel of UTC have only vague recollection of specific corrective actions in 1990.

- The general category of root cause of noncompliance identified most frequently in the post-EMS surveys was **Regulations and Permits**. Further evaluation of the specific root causes reveals that disagreement over the interpretation of regulations often is cited as the root cause of noncompliance. UTC recommended UTC and the regulatory agencies should strive to improve communication (for example, through meetings or other

communication in addition to such activities as formal inspections) because a stronger establishment of informal dialogue may build greater understanding of facility operations on the part of regulators and greater understanding of the regulators' interpretations of regulations on the part of UTC.

- On the basis of responses to the post-EMS survey, UTC should review its programs for effectiveness on employees to maintain compliance. **Human Error** and **Communication** became more prominent as root causes of noncompliance (accounting for a greater percentage of instances of noncompliance) in the post-EMS profiles, compared with the pre-EMS profiles. Modification of training programs may be a logical step in addressing those root causes of noncompliance.

- Implementing an EMS appears to have moved the root causes of noncompliance from the category of management (lack of structure, control and oversight, guidance) toward the more intractable root causes of human error and communication.

- UTC should review its process for the evaluation and implementation of procedures for complying with new regulations. Many of the instances of noncompliance identified in the post-EMS profiles were related to regulations issued by EPA or the state during the period between 1990 and 1998 (for example, stormwater regulations under the CWA). Although the post-EMS surveys generally indicate that specific personnel are assigned to monitor new regulations, the results of the 1998 audits indicate that such monitoring may not have been sufficient to ensure compliance in all cases.

- **External Circumstances** played a more prominent role as a root cause of noncompliance in the post-EMS surveys than in the pre-EMS surveys. This provides an example of how more intractable root causes may become more prevalent after EMSs have been implemented. Several of the facilities do not include communication with external entities in their EMSs. Thus the root cause of **External Circumstances** could potentially be addressed by greater involvement with external entities (for example, suppliers, customers, contractors, and vendors) under the EMS in place at each facility.

- The results of both UTC and RCA projects support EPA and state agencies continued work on issuing straightforward, plain language regulations, and continued coordination within their organization and with each other to ensure clear and consistent interpretation of those regulations. The results also support continued or increased compliance assistance activities, particularly with respect to new regulations and important new interpretations.

- It appears that the implementation of EMSs may offer the advantage of helping a facility to focus on environmental compliance issues. This statement is based on improved compliance rates at participating UTC facilities, including both (1) fewer total instances of noncompliance at each facility, and (2) fewer facilities with individual instances of

noncompliance. In addition, instances of noncompliance identified during the 1998 audits typically were much less severe than those identified during the 1990 inspections.

- Results of the survey indicate that, although UTC had begun implementing P2 activities in 1988, most of those activities were undertaken in response to environmental reporting requirements (for example, requirements for reporting releases to the Toxic Release Inventory). P2 efforts at UTC have increased markedly since 1990, aided by the increased emphasis on reporting and accountability inherent in EMS.

- The findings of this analysis suggest that in organizations that have implemented EMS (such as UTC in 1998 and CMA members covered by the RCA project), improvements in compliance are most likely to come from a combination of (1) improving and maintaining the EMS, (2) training and other means of increasing awareness of EMS elements and regulatory requirements, and (3) clearer regulations and more compliance assistance.

- As was recommended in the RCA project, this study indicates that improvements in compliance might also result from the development of a better understanding of the causes of human error and the identification of actions to address the human error root cause category for those noncompliance categories for which human error was frequently cited.

1.0 INTRODUCTION

In 1993, the United States Environmental Protection Agency (EPA) - New England (Region 1) and United Technologies Corporation (UTC) lodged a consent decree with the United States District Court for the District of Connecticut, settling a multimedia enforcement action that involved 10 of UTC's facilities in New England. Under the terms of the settlement, UTC agreed to develop and implement environmental management systems (EMS) in all its facilities in New England (originally 26 facilities, currently 18, including facilities of Hamilton Sundstrand Division, Pratt & Whitney Division, Sikorsky Aircraft Division, and UT Research Division). The settlement required that UTC hire a management consulting firm to perform an EMS analysis and prepare a report of recommendations to correct practices that adversely affected the company's ability to achieve compliance. The settlement also required that UTC hire an audit firm to conduct independent, third-party compliance audits of UTC facilities once changes in the management systems had been implemented.

After a six-month period for implementing the recommendations in the Management Systems Improvement Plan that began in 1996, a work plan was developed for the performance of third party compliance audits. In 1997 and 1998, the third-party compliance audits required under the consent decree were performed and, as required, the results were reported to EPA New England. On the basis of the audit reports, EPA New England issued its Report of Violations in 1999. The existence of both information about noncompliance with requirements under the Resource Conservation and Recovery Act (RCRA) and the Clean Water Act (CWA) for eight of the existing facilities (from inspections) from the period before implementation of the EMSs, and compliance information from the period after implementation of the EMSs (from the third-party compliance audits) provided a rare opportunity to review the effect on compliance at UTC facilities of implementing the management systems analysis and improvements in the EMS.

Through this study, EPA and UTC seek to understand the causes of noncompliance and the relationship between environmental performance and the existence and level of implementation

of an EMS at the facility level. In support of that objective, EPA, with the assistance of its contractor, Tetra Tech EM Inc. (Tetra Tech), and in conjunction with UTC, developed three types of survey designed to obtain information that would allow them to:

- Determine the effect that implementation of an EMS has on compliance
- Identify or evaluate differences in root causes of noncompliance before and after implementation of an EMS at a facility
- Identify or evaluate differences in pollution prevention practices before and after implementation of an EMS at a facility

The three types of survey are: (1) facility-specific pre-EMS surveys, (2) facility-specific post-EMS surveys, and (3) a corporate EMS survey.

This EMS implementation study, conducted by EPA - New England and UTC, incorporated the concepts developed under a previous root cause analysis conducted by EPA and the Chemical Manufacturers Association (CMA) (the EPA/CMA Root Cause Analysis Pilot Project [EPA-305-R-99-301], herein referred to as the RCA project). EPA and CMA developed a root cause analysis survey designed to achieve the first two of the three objectives stated above. EPA and UTC modified the survey developed under the EPA/CMA project to make it more relevant to UTC policies and operations and to include an evaluation of pollution prevention (P2) practices at UTC facilities.

Of the facilities that were inspected or reviewed and included in the 1993 complaint, eight have continued in operation; UTC personnel representing those eight facilities participated in the pre- and post-EMS surveys. The surveys were designed to (1) obtain general information about each facility; (2) characterize instances of noncompliance into noncompliance categories, as defined by the survey; (3) identify root and contributing causes of noncompliance; (4) identify responses to the noncompliance; (5) identify the elements of an EMS (as defined by the pre- and post-EMS surveys) in place at each facility in 1990 and 1998; and (6) identify P2 practices in use at each facility before and after implementation of an EMS. In addition, UTC completed a corporate

EMS survey that requested information about EMS and P2 policies at the corporate level as of 1990 and solicited UTC's suggestions about approaches to compliance assistance or regulatory reforms that might improve compliance at UTC facilities. Before the surveys were completed, Tetra Tech developed regulatory compliance profiles for participating facilities. The information in these profiles is based on the results of inspections and records reviews conducted by EPA and state regulators before 1990 (pre-EMS profiles). UTC developed regulatory compliance profiles based on the results of third-party audits performed in 1997 and 1998 (post-EMS profiles).

Respondents characterized violations identified in the complaint as noncompliance events, classifying each under 1 of 15 noncompliance categories provided and according to the statute under which the noncompliance event occurred. The 15 noncompliance categories defined in the survey are listed below.

Noncompliance Categories	
• Corrective Action Activities • Equipment/Unit Design • Exceedance • Failure to Respond • Labeling • Legal Agreement • Monitoring/Detection/Control • Operations and Maintenance	• Record Keeping • Report Submissions and Reporting • Spills/Releases • Testing • Training/Certification • Unpermitted/Unauthorized Activity • Waste Identification

Survey respondents were provided the following definitions of the terms **root cause** and **contributing cause**.

- **Root cause**: A primary factor that led to the noncompliance event
- **Contributing cause**: A secondary factor that led to the noncompliance event

The survey identified 12 general **categories** of causes. Those categories are listed below.

Categories of Root and Contributing Causes	
• Human error	• Emergency procedures
• Policies	• Process upset or failure
• Procedures	• Compliance monitoring
• Management	• Regulations and permits
• Training	• External circumstances
• Communication	• Equipment problems

Each general **category** then was subdivided resulting in a total of 74 *specific* causes. An "Other" category also was provided for cases in which the predefined **categories** did not describe adequately the root or contributing cause(s) of a noncompliance event. Respondents were asked to select no more than three root causes from among the 74 *specific* causes and to select any number of contributing causes to characterize the noncompliance event. To facilitate completion of the survey, respondents were directed to address similar noncompliance events as a single event. For example, if a facility had a number of noncompliance events related to reporting requirements the facility would consider all those occurrences as a single event.

This report presents an analysis of (1) responses to the EMS surveys prepared by UTC facilities participating in the EPA New England EMS implementation study and (2) regulatory compliance profiles that Tetra Tech and UTC developed for participating UTC facilities. The remainder of this document consists of nine sections, as follows:

- Section 2.0, Overview of UTC Facilities Included in the Survey
- Section 3.0, Elements of the EMS at Each UTC Facility
- Section 4.0, Presentation of UTC's Compliance Status and the Root and Contributing Causes of Noncompliance in 1990 and in 1998
- Section 5.0, Effect of the Implementation of an EMS on the Root Causes of Noncompliance

- Section 6.0, Effect of the Implementation of an EMS on Compliance
- Section 7.0, P2 Practices at UTC Facilities
- Section 8.0, UTC's Recommendations for Compliance Assistance
- Section 9.0, Comparison to EPA/CMA Root Cause Project Results
- Section 10.0, Conclusions

2.0 OVERVIEW OF UTC FACILITIES INCLUDED IN THE SURVEY

The pre- and post-EMS surveys asked for general information about the operations conducted at each of the eight facilities, the number of employees at each facility, and other general information about each facility. Table 1 presents a summary of the information gathered through the post-EMS surveys (representing information about conditions at the facilities during 1998).

TABLE 1
PROFILE OF UTC FACILITIES

	Hamilton Sundstrand Windsor Locks	**Pratt & Whitney Colt Street**	**Pratt & Whitney East Hartford**	**Pratt & Whitney Middletown**	**Pratt & Whitney North Haven**	**Pratt & Whitney Rocky Hill**	**Sikorsky Stratford**	**UT Research Center**
Primary SIC Code	3728	3724	3724	3724	3724	3724	3724	8731
Number of Employees								
- Full-time	>500	10-49	>500	>500	>500	50-100	>500	>500
- Contractors	101-500	0-9	>500	101-500	10-49	0-9	>500	10-49
Job Responsibility of Person Completing Survey	Compliance staff	Compliance staff	Compliance staff	Compliance staff/ environmental engineer/ plant management	Plant management/ environmental engineer	Compliance staff/ environmental engineer	Plant management/ environmental engineer	Compliance staff
Activities Currently Performed at the Facility	Aerospace manufacturing	Design, manufacture, testing, overhaul of jet engines	Design, manufacture, testing, overhaul of jet engines	Manufacture, assembly, testing of aircraft engines	Design, manufacture, testing, overhaul of jet engines	Production of composite aircraft engine parts	Manufacture and assembly of helicopters and helicopter parts	Research (unspecified)
Years in Operation	>10	>10	>10	>10	>10	>10	>10	>10

3.0 ELEMENTS OF AN EMS AT EACH UTC FACILITY

This section presents information about the elements of an EMS[1] at each facility, as indicated by responses to the pre- and post-EMS surveys, which provide information about conditions at UTC facilities in 1990 and in 1998, respectively. For the project, 12 general elements of an EMS were identified. Further, 90 specific elements were identified under the general elements. The blank survey documents included as Appendix B to this report contain all of the elements of an EMS used for this project.

Very few of the elements of an EMS (less than 10 percent of the elements, on average) were present at all eight participating UTC facilities in 1990. UTC initiated implementation of its Management Systems Improvement Plan (MSIP) in March 1996. In 1998, two years after implementation of the MSIP, a substantial majority of the elements of an EMS (more than 90 percent, on average) were present at all eight participating UTC facilities. Table 2 depicts the relative number of EMS elements present in 1990 and 1998 at participating UTC facilities. In parentheses in the first column of the table, the table shows the total number of specific elements under each general element. The table also shows the number of specific elements under each general element indicated in the pre-EMS surveys (represented by the first number in each two-number set, set forth as X/X, in the table) and in the post-EMS surveys (the second number in each two-number set). The following subsections describe the elements of an EMS present at UTC facilities in 1990 and in 1998.

The table is accompanied by a graph, Figure 1, showing changes in the number of elements present in terms of the percentage of EMS elements implemented, with the number of elements present in 1990 and the number present in 1998 averaged for the eight facilities.

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[1] The definition (required elements) of an EMS varies depending on the source of that definition. However, during the development of the survey, EPA and UTC made an effort to include (1) all relevant elements from a variety of available definitions; and (2) the elements specified in UTC's Standard Practice 001, which defines required elements of an EMS for that corporation.

TABLE 2
ELEMENTS OF AN EMS PRESENT AT PARTICIPATING UTC FACILITIES IN 1990 AND 1998

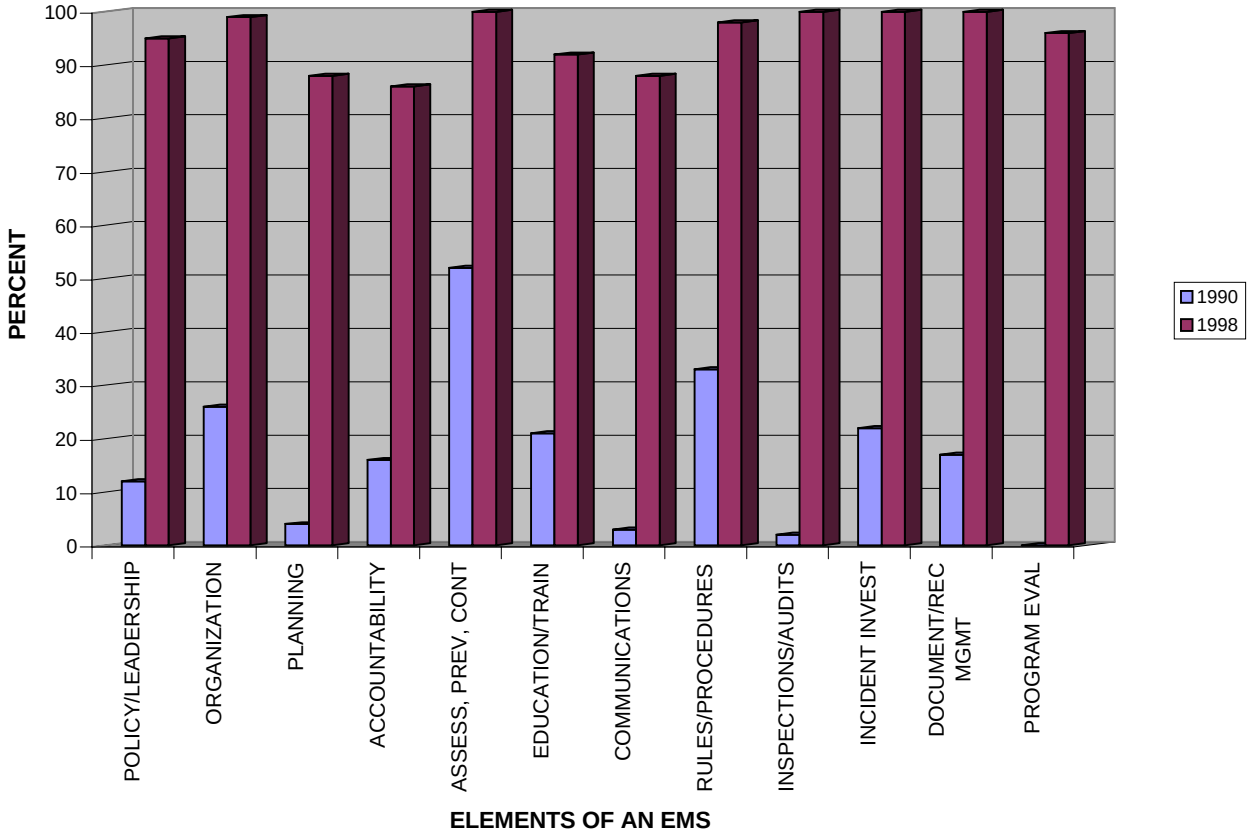
General Elements of an EMS	Hamilton Sundstrand	P&W Colt Street	P&W East Hartford	P&W Middletown	P&W North Haven	P&W Rocky Hill	Sikorsky Stratford	UTRC
Policy and Leadership (17)	0/17	4/17	4/16	1/16	1/15	0/16	2/16	4/16
Organization (17)	2/17	9/17	9/17	1/16	3/17	1/16	1/17	9/17
Planning (6)	0/6	0/5	0/5	0/5	0/5	0/5	0/6	2/5
Accountability (7)	0/7	3/7	3/7	0/4	0/7	0/4	0/6	3/7
Assessment, Prevention, and Control (7)	4/7	4/7	4/7	3/7	3/7	4/7	3/7	4/7
Education and Training (6)	3/6	2/5	2/5	0/5	0/6	0/5	1/6	2/6
Communication (5)	1/5	0/5	0/5	0/3	0/5	0/4	0/3	0/5
Rules and Procedures (5)	1/5	4/5	4/5	0/5	0/5	0/4	0/5	4/5
Inspections and Audits (7)	1/7	0/7	0/7	0/7	0/7	0/7	0/7	0/7
Incident Investigations (4)	1/4	2/4	2/4	0/4	0/4	0/4	0/4	2/4
Documents and Record Management (3)	1/3	1/3	1/3	0/3	0/3	0/3	0/3	1/3
Program Evaluation (6)	0/6	0/6	0/6	0/5	0/6	0/5	0/6	0/6

3.1 Elements of an EMS Present in 1990

The pre-EMS survey requested information about each facility's practices in 1990 related to specific elements of an EMS, as defined for this project and as set forth in section 1 of both the pre-EMS and the post-EMS survey (blank copies of the surveys are included in this report as Appendix B). All eight facilities had some elements of an EMS in place in 1990.

According to the pre-EMS surveys, the elements of an EMS that were present in 1990 often were required explicitly under existing environmental or health and safety regulations. Examples of such requirements include training regulations set forth under 40 Code of Federal Regulations (CFR) 265.16, which requires training for the management of hazardous waste and 29 CFR 1910.120, which requires health and safety training for persons who work at hazardous waste management and cleanup sites.

Figure 1. Average Percentage of Elements of An EMS Present



The elements of an EMS most commonly present in 1990 at the eight facilities that responded to the survey included (the number of facilities that had the element in place is shown in parentheses):

- Employee medical program (8)
- Emergency planning and response capability (8)
- Environmental, health, and safety (EH&S) technical staff available to provide technical consulting or advice (8)
- Written emergency action plan (7)
- Preventive maintenance program for pollution control equipment (6)
- Written EH&S policy or mission statement (6)

The corporate EMS survey also requested information from UTC's corporate office about the elements of an EMS that were present in 1990. According to UTC's responses in the corporate survey, elements of an EMS that should have been present (i.e., were required by corporate policy) at participating facilities in 1990 also included:

- An environmental policy statement
- Involvement of top management in setting goals and expectations for environmental performance
- A system in place for reviewing environmental procedures and updating them as necessary
- A system in place for tracking and interpreting new regulations and updating the policies and directives of the facility as necessary
- Emergency response procedures
- A preventive maintenance program for pollution control equipment
- A designated point of contact for records management
- Documented review to address possible need for changes in policy, objectives, and other elements of the EMS

It should be noted that the responses to the corporate survey were more broad (that is, included more elements of an EMS) than were the responses for the individual facilities. For example, in 1990, a designated point of contact for records management was identified as an element of an EMS in the corporate survey but was not indicated as an element of an EMS present in any of the pre-EMS surveys of individual facilities. This potential inconsistency may indicate that corporate policy was not being communicated effectively to or fully implemented at all participating UTC facilities in 1990.

3.2 Elements of an EMS Present in 1998

In the 1998 survey, all eight facilities that responded to the post-EMS survey indicated the presence of nearly all the elements of an EMS, as defined for this project. The following elements were not included in UTC's EMS as of 1998 (the number of facilities that did not have the specified element in place is shown in parentheses):

- Mandatory training program in place that includes EH&S policy and provides specific EH&S requirements that are conditions of employment (4)
- Documented communications plan in place for external communication of EH&S issues and information (3)
- Communication of EH&S policy to all customers (3)
- Written annual EH&S plan incorporated into the overall business plan of the operation (3)

The elements of an EMS most often missing in 1998, according to the surveys, can be grouped into two major categories: (1) incorporation of EMS policies and procedures into the overall "business plan" of the individual facility and (2) a communications plan in place for external communication of EH&S issues. Development of those elements may increase awareness of EH&S issues, both internally and externally, and may help bring about improvements in regulatory compliance and environmental performance.

4.0 PRESENTATION OF UTC'S COMPLIANCE STATUS AND THE ROOT AND CONTRIBUTING CAUSES OF NONCOMPLIANCE IN 1990 AND IN 1998

This section describes the types of noncompliance identified at UTC facilities before 1990 (as indicated by the 1993 complaint and summarized by Tetra Tech in the pre-EMS profiles) and in 1998 (as indicated by the results of third-party audits conducted in 1997 and 1998 [hereafter

referred to as the 1998 audits] and summarized in post-EMS profiles completed by UTC) and identifies the root and contributing causes of such instances of noncompliance[2].

The subsections that follow include information related to:

- Limitations and qualifications of the data analyzed
- Evaluation of facility compliance status for 1990 and for 1998
- Evaluation of noncompliance categories for instances of noncompliance for 1990 and for 1998
- Root and contributing causes for instances of noncompliance for 1990
- Root and contributing causes for instances of noncompliance for 1998

4.1 Limitations and Qualifications

The following limitations and qualifications apply to evaluation of noncompliance at UTC facilities and of the root causes of noncompliance:

- The analysis of the number and types of noncompliance is limited to the extent that the 1990-era inspections and the 1998 audits were conducted for different purposes. As such, these two groups of inspections are not directly comparable in scope or duration.

- The analysis of noncompliance must be qualified to the extent that the 1993 complaint addressed only instances of noncompliance with regulations under RCRA at six facilities (excluding noncompliance related to underground storage tank (UST) regulations) and the CWA at six facilities, while the 1998 audits included all eight facilities and also identified noncompliance with regulations under statutes that were not included in the inspections conducted before 1990, such as the Clean Air Act (CAA), the Emergency Planning and Community Right-to-Know Act (EPCRA), and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). However, identification of the root causes for those noncompliance events provides insight into the effect of the implementation of an EMS; therefore, the findings under the other statutes were included in the evaluation of root causes of noncompliance.

- The procedures used to determine compliance with CWA requirements differed between the 1990-era inspections and the 1998 audits. The 1990-era inspections included only a

[2] Throughout the remainder of this document, (1) categories of root cause of noncompliance are shown in bold, and (2) specific root causes of noncompliance are shown in italics.

file review at six facilities, while the 1998 audits included an on-site inspection at all eight facilities.

- The analysis of noncompliance categories before and after implementation of an EMS is limited because of the manner in which noncompliance is summarized in the 1993 complaint and in the pre- and post-EMS profiles. For example, in the 1993 complaint, multiple instances of noncompliance often were consolidated in the complaint as a single violation. Therefore, in the pre-EMS surveys, multiple instances of the same types of noncompliance often were assigned a single noncompliance category. The post-EMS profiles were arranged in a similar format for consistency. This consolidation may alter the distribution of noncompliance categories between the pre-EMS and post-EMS profiles. For example, in Section 4.3 of this document, the percentage of exceedances is reported as higher (17 percent) in the post-EMS profiles than in the pre-EMS profiles (8 percent) despite a much greater number of individual exceedances (due largely to effluent violations) identified in the pre-EMS profiles as compared to the post-EMS profiles.

4.2 Comparative Evaluation of the Compliance Status of UTC Facilities

This section provides an analysis of the information in the 1993 complaint and the 1999 Report of Violations, as summarized in Tetra Tech's pre-EMS profiles and UTC's post-EMS profiles. The following discussion presents a summary of the types of noncompliance identified at UTC facilities, by environmental statute. Table 3 depicts the instances of noncompliance for 1990; Table 4 shows instances of noncompliance from 1998 for RCRA and CWA, the two statutes for which there are data for both time frames. Instances of noncompliance identified in the 1993 complaint then are compared with those identified during the post-EMS compliance audits.

Table 3
Summary of Pre-EMS Noncompliance
(Page 1 of 2)

KEY: ❍ 1-5 counts ● 6-50 counts ■ >50 counts	Hamilton Sundstrand Windsor Locks	Pratt & Whitney Colt Street	Pratt & Whitney East Hartford	Pratt & Whitney Middletown	Pratt & Whitney North Haven	Pratt & Whitney Rocky Hill	Sikorsky Stratford	United Technologies Research Center
RCRA						X[3]		X[3]
Failure to label containers	●	■	●	❍	■		●	
Failure to mark containers with accumulation date	❍	❍	❍		■		●	
Failure to close containers during use	❍	❍	●	❍	●		●	
Inadequate contingency plan	❍		❍	❍	❍		❍	
Inadequate personnel training			❍	❍	❍		❍	
Failure to minimize possibility of fire/ explosion/sudden release of hazardous waste	❍	❍			❍			
Accumulation of hazardous waste for more than 90 days	❍		❍	●	❍		●	
Failure to make hazardous waste determination			❍	❍	❍		●	
Failure to maintain adequate security				❍	❍			
Failure to inspect hazardous waste storage tank				❍				
Failure to report spill incident	❍							
Failure to manage containers to prevent ruptures/leaks	❍				■			
Inadequate waste analysis plan		❍	❍	❍	❍			
Failure to maintain adequate aisle space	❍		❍		❍		❍	
Poor container condition	❍				❍			
Inadequate operating record					❍			
Inadequate groundwater monitoring					❍		❍	
Inadequate inspections			❍	❍	❍			

[3] Compliance with requirements under RCRA were not reviewed at the P&W Rocky Hill or UTRC facilities as part of the original action.

Table 3
Summary of Pre-EMS Noncompliance
(Page 2 of 2)

	Hamilton Sundstrand Windsor Locks	Pratt & Whitney Colt Street	Pratt & Whitney East Hartford	Pratt & Whitney Middletown	Pratt & Whitney North Haven	Pratt & Whitney Rocky Hill	Sikorsky Stratford	United Technologies Research Center
Failure to separate incompatible wastes			❍	❍	❍		●	
Improper storage of hazardous waste in waste piles			❍					
Closure plan violations			❍					
Land disposal restrictions (LDR) notices - failure to make determinations/send and retain notices	❍		●		●		●	
LDR - incorrect notices	●	❍		❍			■	
Violation of export requirements	●		❍				●	
CWA		X[4]					X[4]	
Unauthorized discharge	❍		●	●		❍		❍
Flow volume exceedances				■				
Effluent limitation violations	■		■	❍	●	●		
Violation of reporting requirements - direct discharges	■					❍		
Violations of national categorical standards for metal finishers	❍							
Violations of national pretreatment standards (pH)	❍							
Violation of reporting requirements-indirect discharges	■							

[4] Compliance with requirements of the CWA were not reviewed at the Pratt & Whitney, Colt Street, or Sikorsky Stratford facilities as part of the original action.

Table 4
Summary of Post-EMS Noncompliance
(Page 1 of 3)

KEY: ❍ 1-5 counts ● 6-50 counts ■ >50 counts	Hamilton Sundstrand Windsor Locks	Pratt & Whitney Colt Street	Pratt & Whitney East Hartford	Pratt & Whitney Middletown	Pratt & Whitney North Haven	Pratt & Whitney Rocky Hill	Sikorsky Stratford	United Technologies Research Center
RCRA[5]								
Failure to label containers	❍		❍	❍				
Failure to mark containers with accumulation date	❍							
Failure to close container during use								❍
Inadequate contingency plan								❍
Inadequate personnel training	❍							
Failure to provide access to internal alarm or communication device	❍							
Late annual report					❍			
Failure to notify of increase in waste quantity					❍			
Failure to include all required information on a manifest (export requirements and signature)			❍	❍				
Failure to maintain adequate aisle space		❍		❍				
Failure to submit accurate annual report on export activities		❍		❍				
Failure to file an exception report				❍				❍
Failure to submit a report on groundwater monitoring activities		❍						
Failure to inspect container accumulation areas weekly			●			●		
Failure to inspect containment building weekly			❍					
Failure to conduct daily inspections of loading/unloading areas					●			

[5] All facilities were audited under RCRA. These audits included evaluation of compliance with UST requirements.

Table 4
Summary of Post-EMS Noncompliance
(Page 2 of 3)

	Hamilton Sundstrand Windsor Locks	Pratt & Whitney Colt Street	Pratt & Whitney East Hartford	Pratt & Whitney Middletown	Pratt & Whitney North Haven	Pratt & Whitney Rocky Hill	Sikorsky Stratford	United Technologies Research Center
Failure to inspect evacuation alarm			❍					
Failure to amend contingency plan			❍	❍	❍			
Failure to conduct tank integrity assessments							❍	
CWA[6]								
Unauthorized discharge (photo processing wastewater)							❍	
Flow volume exceedance								❍
Effluent limitation violations	●			●	❍		●	●
Violation of reporting requirements-direct discharges				❍	❍			❍
NPDES permit excursion						●		
BMP does not address all that is required					❍			
Failure to identify and sample stormwater discharges			❍					
Aquatic toxicity violation for stormwater discharge		❍			●			
Incorrect flow rate					❍			
Failure to prevent avoidable by-pass			❍	❍				

[6] Note: All facilities were audited on site under the CWA in the 1998 audits, and the audits included the stormwater program, which did not exist at the time of the 1990-era inspections.

Table 4
Summary of Post-EMS Noncompliance
(Page 3 of 3)

	Hamilton Sundstrand Windsor Locks	Pratt & Whitney Colt Street	Pratt & Whitney East Hartford	Pratt & Whitney Middletown	Pratt & Whitney North Haven	Pratt & Whitney Rocky Hill	Sikorsky Stratford	United Technologies Research Center
Improper signature/no signature to NPDES permit application							❍	
Total chromium limit violation							❍	
Failed to include evaluation of roof emissions on site runoff/SWPPP	❍							
No pH records for discharges	●							
Failure to describe stormwater management controls (7,000 gallon H_2SO_4 tank)		❍						
Failure to conduct stormwater inspections			●	❍				
Failure to maintain records of stormwater inspections							●	
Good housekeeping practices for stormwater not followed				❍				
Failure to maintain adequate DMR records							❍	
Failure to cover equipment (dumpsters)				❍			❍	
Failure to perform evaluation for need for cover for stormwater control				❍				
Failure to conduct annual monitoring of stormwater outfall/missing element							❍	
SWPPP does not reflect actual conditions				❍				
UST records not available				❍				
Missed transformer and bulk tank inspections				●				

RCRA

The types of noncompliance with RCRA identified in the 1993 complaint generally were not identified in the post-EMS profiles. Exceptions include (the number of facilities for which specific instances of noncompliance were identified is listed in parentheses):

- Failure to label containers holding hazardous wastes (2)
- Failure to mark containers holding hazardous waste with the initial accumulation date (1)
- Failure to conduct weekly inspections of container accumulation areas (2)

Although most of the noncompliance in the 1993 complaint appears to have been addressed, as indicated by the 1998 compliance audits, several additional (new) instances of noncompliance were identified in the post-EMS compliance audits. The most common of those new instances of noncompliance include (the number of facilities at which the specific instance of noncompliance was identified is listed in parentheses):

- Inadequate aisle space (3)
- Failure to amend the contingency plan (3) (as compared to inadequate contingency plan in 1990)
- Noncompliance with requirements governing amounts of hazardous waste exported (2)

Overall, the total number of instances of noncompliance with RCRA regulations dropped substantially between the pre-EMS inspections and the post-EMS audits.

Figure 2 shows the total number of findings of noncompliance under RCRA per type of noncompliance. Figures 3 and 4 show similar information about RCRA violations for the P&W North Haven and P&W East Hartford facilities.[7] As the figures show, the 1990 findings of the RCRA inspections showed more instances of noncompliance with RCRA regulations that applied to the participating UTC facilities than did the 1998 audits. The 1998 audits performed

[7] In some instances, figures 2, 3, and 4 include similar violations that have been grouped together for ease of analysis and presentation. For example, the violation "failure to amend the contingency plan" is included in a broader category of "contingency plan," which also may include violations such as "inadequate contingency plan."

after implementation of EMSs at the facilities show a comparatively smaller number of violations, several of which are fairly minor in nature, such as missing signatures on a manifest.

Figure 2. RCRA Noncompliance: 1990 vs. 1998

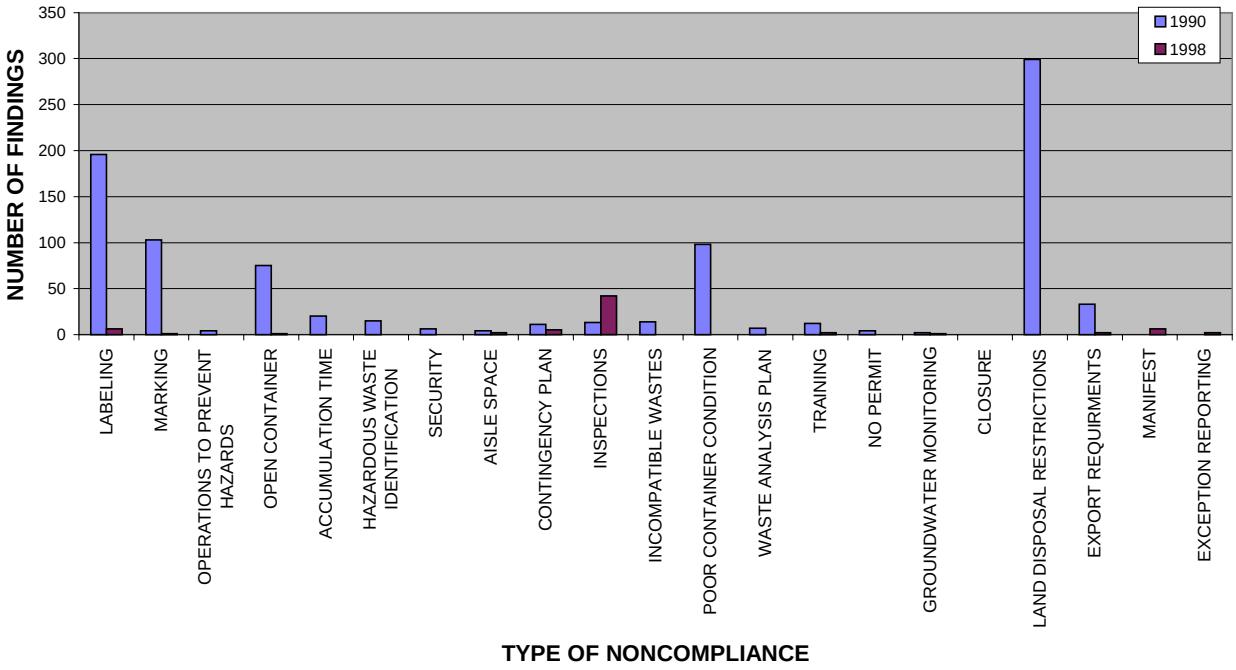


Figure 3. P&W North Haven - RCRA Noncompliance

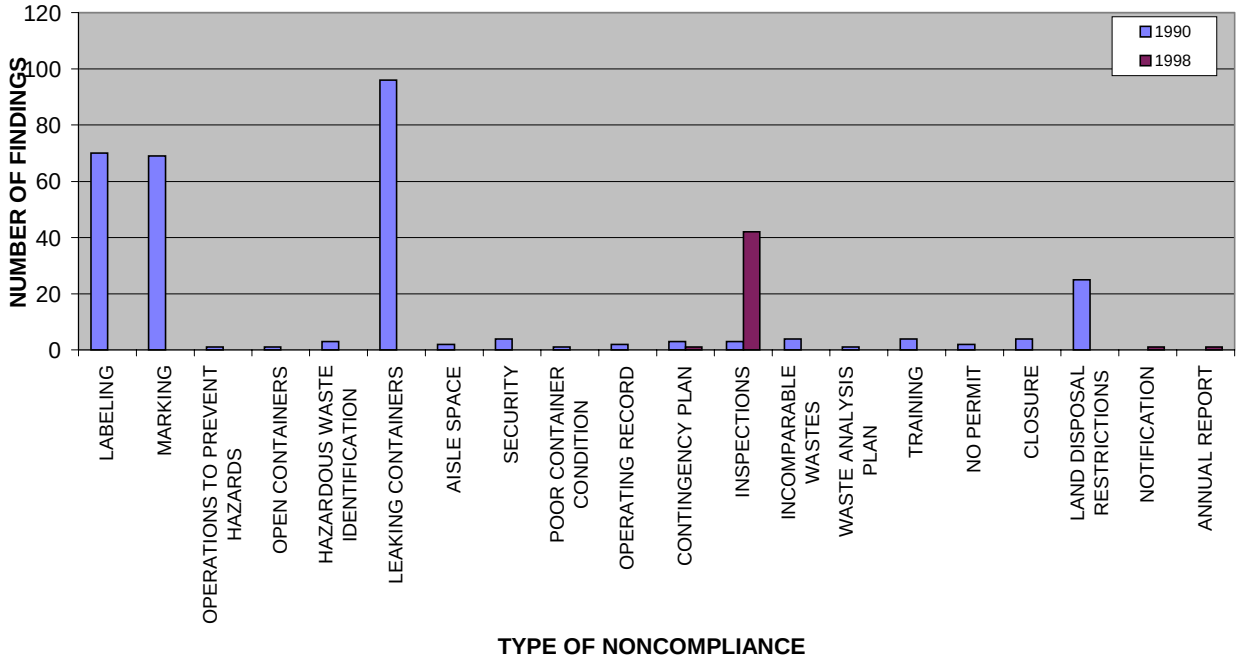
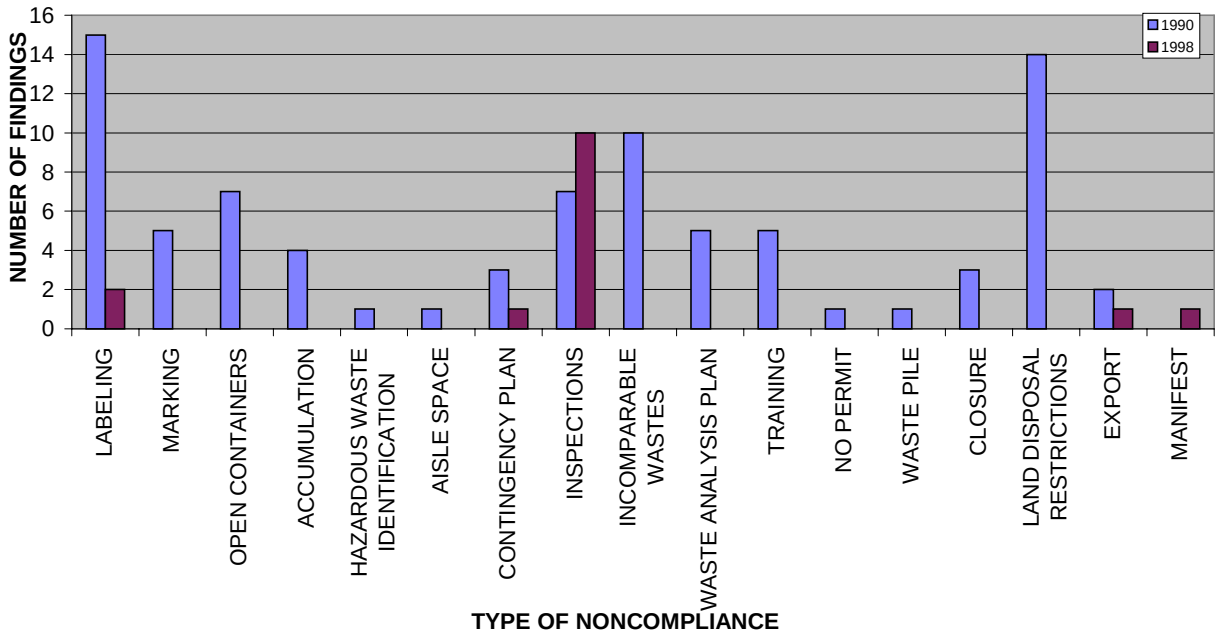


Figure 4. P&W East Hartford - RCRA Noncompliance



The audits in 1998 more commonly found less extensive problems within program areas, such as failure to inspect an alarm when performing weekly inspections at hazardous waste accumulation areas.

As the figures indicate, there generally has been significant improvement, based on the total numbers of instances of noncompliance, in the participating UTC facilities' ability to attain compliance with RCRA regulations. Post-EMS violations also tend to be more minor in nature than those that led to the complaint.

CWA

Instances of noncompliance with CWA regulations identified in the 1993 complaint generally are related to items identified through records reviews, mainly: (1) effluent violations (at five facilities) related to parameters specified in the National Pollutant Discharge Elimination System (NPDES) permits issued to the participating UTC facilities or (2) unauthorized discharges to surface water (at four facilities). Several types of noncompliance that had not appeared in the

complaint were identified in the audits which were performed on-site in 1998. Examples of common types of noncompliance identified in the complaint include (the number of facilities at which the violation was identified appears in parentheses):

- Violations of effluent limits on for pH (5), oil and grease (2), total suspended solids (TSS) (2), chlorine (1), fluoride (1), hexavalent chromium (1), and aquatic toxicity and metals (1)
- Failure to report effluent violations or permit exceedances (3)
- Failure to conduct inspections (3)
- Failure to prevent an avoidable by-pass (2)
- Unauthorized stormwater outfalls (2)
- Failure to cover equipment (2)
- Failure to maintain records of inspections (2)

Figure 5 shows the total number of instances of noncompliance with CWA requirements identified for 1990 and for 1998, sorted by the type of noncompliance. Figures 6 and 7 show similar information for the P&W East Hartford and the Hamilton Sundstrand facilities.[8]

[8] As with figures 2, 3, and 4 above (summarizing RCRA violations), figures 5, 6, and 7 include similar violations that have been grouped together for ease of analysis and presentation.

Figure 5. Comparison of Noncompliance with the CWA in 1990 vs. 1998

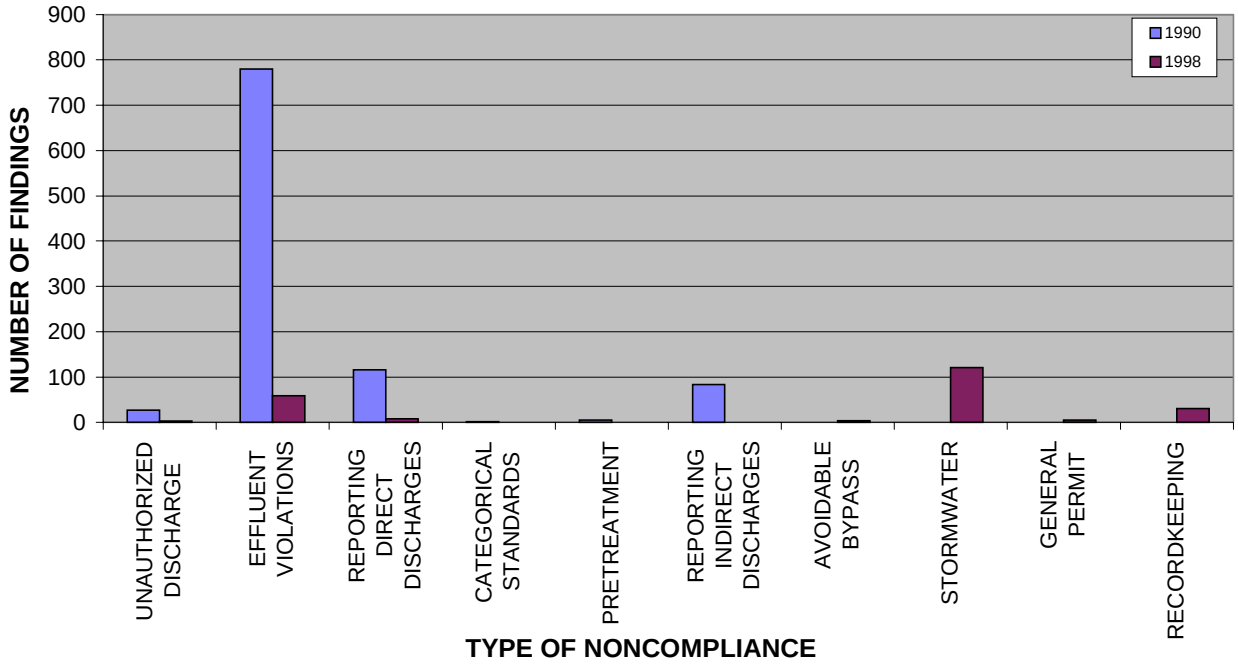


Figure 6. Noncompliance with the CWA at P&W East Hartford

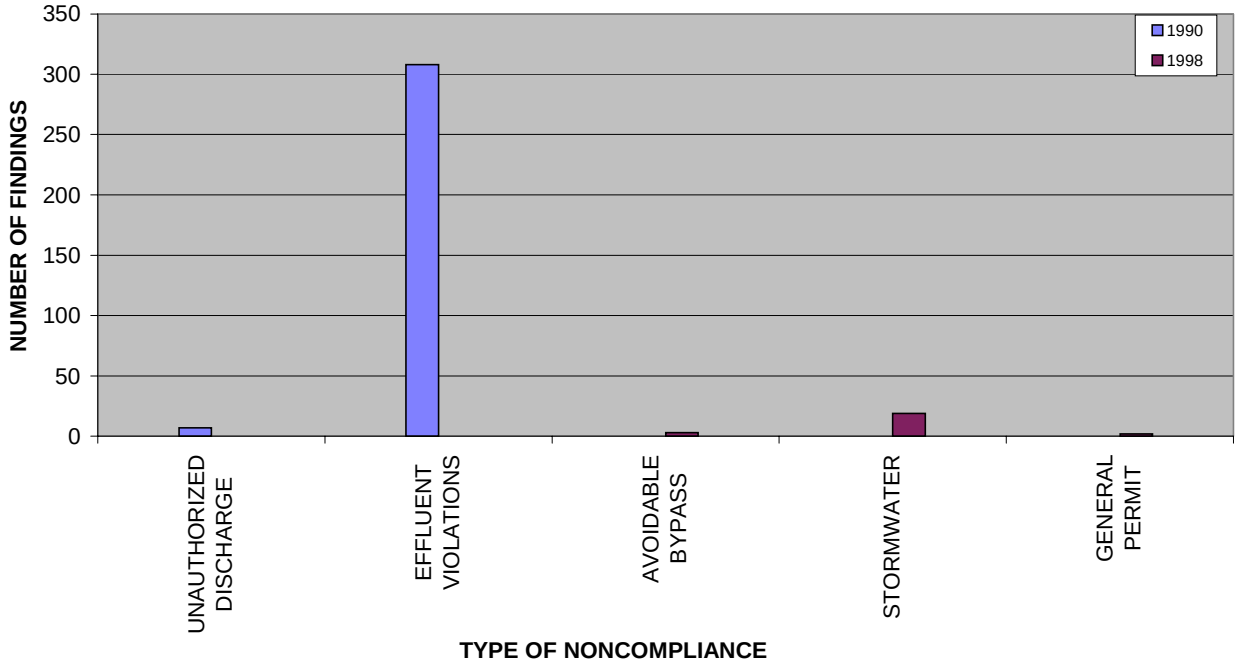
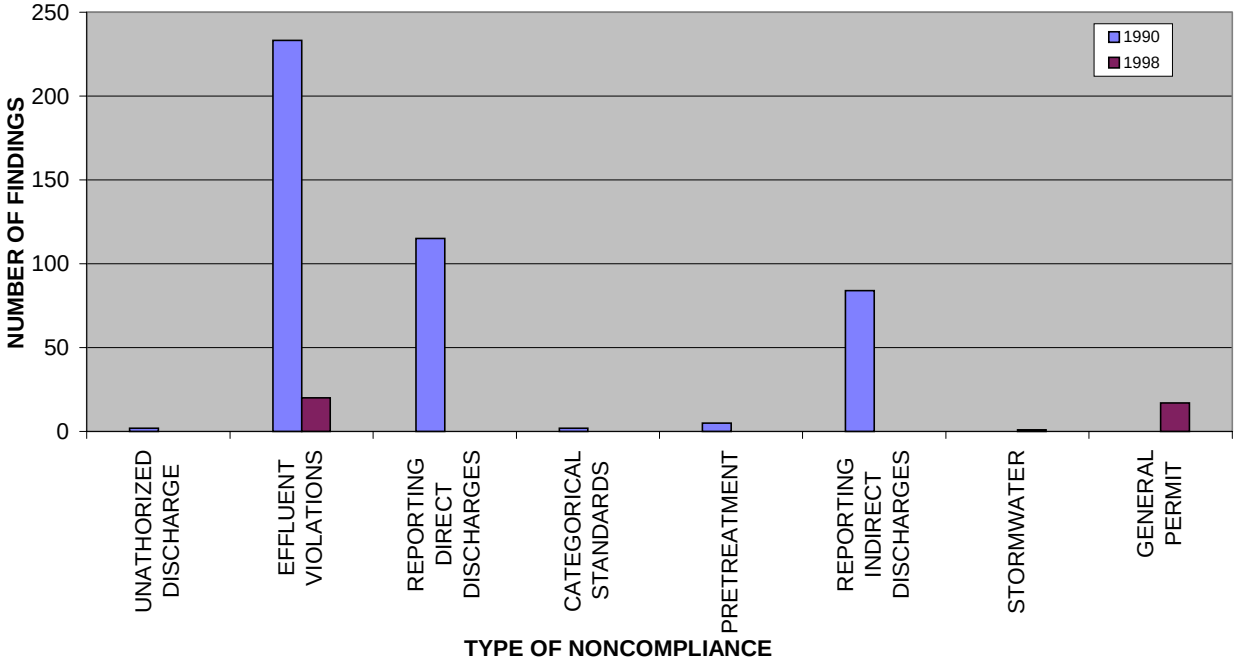


Figure 7. Noncompliance with the CWA at Hamilton Sundstrand



As can be seen in the figures, instances of noncompliance of regulations under the CWA in 1990 included over 700 effluent violations. The auditors who performed the 1998 follow-up audits after implementation of the EMSs found a much smaller number (fewer than 50) of similar violations. Similarly, more than 300 effluent limitation violations were identified at the P&W East Hartford facility in 1990, while none of those violations were noted in 1998.

As with the finding about noncompliance under the RCRA program, the overall number of instances of noncompliance with CWA requirements dropped substantially from the time of the pre-EMS inspections and that of the post-EMS audits and the post-EMS violations tended to be more minor in nature.

Under the CWA, the majority of the 1998 instances of noncompliance occurred under the stormwater program for which regulations were issued after UTC began implementing EMSs at their participating facilities. Thus it is not possible to compare compliance with the stormwater program's requirements before and after implementation of an EMS. The existence of the

noncompliance with stormwater regulations in 1998 does, however, highlight the need to update an EMS to keep pace with changing regulations.

CAA, CERCLA and EPCRA

During the 1990 inspections, participating UTC facilities were not evaluated for compliance with requirements of the CAA, CERCLA or EPCRA. Therefore, no violations of those requirements are represented in the pre-EMS profiles. During the 1998 audits, the facilities were evaluated for compliance with regulations under all environmental statutes. At some of the facilities, some violations of the requirements of the CAA, CERCLA and EPCRA were identified in the post-EMS profiles. At two facilities, third-party auditors identified noncompliance issues under the National Emissions Standards for Hazardous Air Pollutants (NESHAP) regulations related to the disposal of asbestos. At one facility a monitoring and recordkeeping NESHAP violation was identified. Noncompliance with requirements under the CAA Title 5 permitting program was identified at another facility. The post-EMS profile indicated a failure to report continuous releases of nitrogen oxides (NO_x) at one facility. Under EPCRA, three facilities were found to have failed to submit Tier II forms, and one facility failed to identify all storage locations on a Tier II form and to report all uses of a toxic chemical (methanol) on a Form R.

4.3 Evaluation of Noncompliance Categories for 1990 and 1998

Tetra Tech analyzed the pre- and post-EMS profiles by examining the relative number of types of noncompliance categories as defined in the survey. As mentioned in Section 4.1, it should be noted that the individual findings of similar types of noncompliance were consolidated in the pre- and post-EMS profiles. For example, multiple findings of noncompliance with RCRA labeling requirements for hazardous waste containers, CWA exceedences under NPDES permits, and similar multiple violations were assigned a single noncompliance category for purposes of analysis. For a more detailed discussion of the relative numbers of instances of noncompliance at participating UTC facilities for the pre-EMS and post-EMS timeframes, the reader should refer to Section 4.2 of this document.

The noncompliance categories identified most frequently in the pre-EMS profiles were (the percentage of times cited is listed in parentheses):

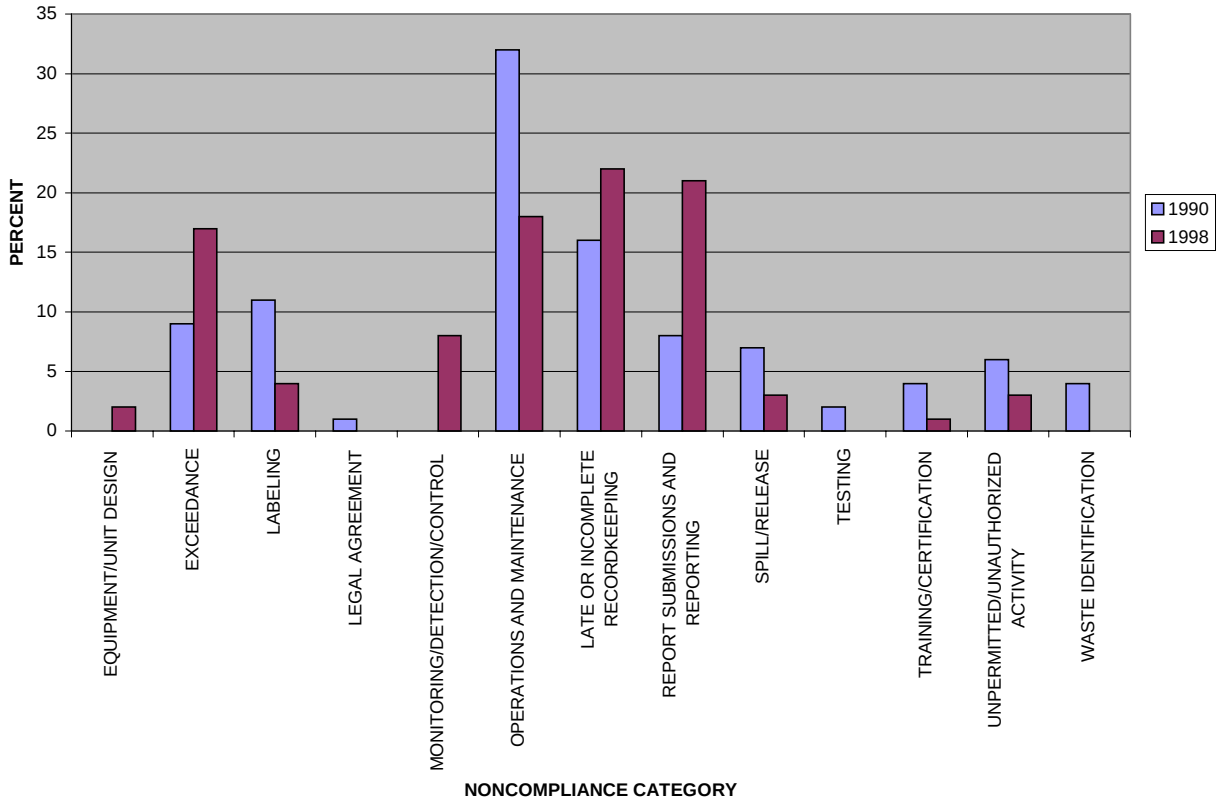
- Operations and maintenance (32 percent)
- Late or incomplete recordkeeping (16 percent)
- Labeling (11 percent)

The noncompliance categories most frequently identified in the post-EMS profiles were:

- Late or incomplete recordkeeping (23 percent)
- Report submissions and reporting (21 percent)
- Operations and maintenance (18 percent)
- Exceedances (17 percent)

Figure 8 is a bar graph that allows comparison of the distribution of the noncompliance categories in 1990 and in 1998. The root and contributing causes of noncompliance related to each of the noncompliance categories are discussed in greater detail below.

Figure 8. Distribution of Noncompliance by Category - 1990 and 1998



Operations and Maintenance

For the pre-EMS profiles, operations and maintenance (O&M) was identified as a noncompliance category twice as often as any other category, accounting for 32 percent of the instances of noncompliance identified, while the category accounted for only 18 percent of the instances of noncompliances identified after implementation of the EMS.

Root Cause: The category of root cause of noncompliance related to O&M most frequently identified in pre-EMS surveys (34 percent) was **Management**, while **Procedures** was the second most frequently cited root cause (24 percent). The root cause category cited most frequently in the post-EMS surveys was **Human Error** (45 percent), a significant change from the citations in pre-EMS surveys, in which **Human Error** was identified as a root cause category only 6 percent of the time.

Although **Procedures** was the second most frequently cited root cause category for noncompliance related to O&M in both the pre- and post-EMS surveys the two sets of surveys differ in the specific root causes identified in the **Procedures** category. In general, before the implementation of an EMS, the specific root cause cited in the **Procedures** category was most often "*no written operating procedures available*." After implementation of an EMS the specific root cause most frequently was identified as *"operating procedure not followed."*

This demonstrates a shift in root causes after implementation of the EMS, from large gaps in EMS (no operating procedures) to more focused areas in which improvement is needed, such as the implementation of existing procedures.

The remaining 42 percent of the categories of root causes of noncompliance identified in the pre-EMS surveys by UTC facilities included (in descending frequency of citation): **Policy, Training**, **Human Error**, **Compliance Monitoring**, **Regulations and Permits**, and **Equipment Problems**. In the post-EMS surveys, the remaining categories are **Compliance Monitoring**, **Emergency Preparedness**, **Communications**, and **Management**. **Management** was a leading

category of root cause cited in the pre-EMS surveys, while it played a only minor role as a root cause category after implementation of an EMS. However, **Management** was cited as a major contributing cause category in the post-EMS surveys. The pre- and post-EMS surveys differed in the specific cause within the category of **Management** each set of surveys identified. In the pre-EMS surveys, specific root cause was identified as *"no formal management structure to address noncompliance and follow-through,"* while in the post-EMS surveys, the specific contributing cause under the **Management** category was identified as "*staffing at an inappropriate level or expertise."*

Contributing Cause: The most frequently cited categories of contributing causes of noncompliance for violations related to O&M (percentage of time cited shown in parenthesis) were:

Pre-EMS Contributing Cause

- **Compliance Monitoring** (28 percent)
- **Management** (24 percent)
- **Human Error** (17 percent)
- **Training** (13 percent)

Post-EMS Contributing Cause

- **Management** (24 percent)
- **Procedures** (24 percent)
- **Compliance Monitoring** (14 percent)
- **Regulations and Permits** (10 percent)
- **Communications** (10 percent)

Other categories of contributing causes of noncompliance for O&M violations related to O&M before implementation of an EMS included **Communication**, **Procedures**, **Regulations and Permits**, **Policies**, and **Equipment Problems**. Similar **categories** for the post-EMS period included **Human Error**, **Emergency Preparedness**, **Equipment**, and **Training**.

Keeping in mind that respondents could cite as many contributing causes as they felt applied, the second most frequently cited contributing cause for the O&M category in the pre-EMS surveys (after **Compliance Monitoring** where the specific cause most commonly was "*audit program insufficient*") is **Management**, which is tied with **Procedures** for the most frequently cited contributing cause in the post-EMS surveys. The specific contributing cause most often cited was *"staffing-inappropriate level or expertise"* (cited 9 times in the pre-EMS survey and 5 times

in the post EMS survey) whereas the specific contributing cause of "*management support or guidance not provided*" was cited 9 times in the pre-EMS survey and not at all in the post-EMS survey. This may demonstrate that lack of management support and guidance may have contributed substantially to noncompliance in the pre-EMS timeframe.

Late or Incomplete Recordkeeping

Late or incomplete recordkeeping was the major category of noncompliance cited in the post-EMS profiles, accounting for 23 percent of the incidents of noncompliance identified. In the pre-EMS profiles, late or incomplete recordkeeping accounted for 16 percent of the incidents of noncompliances identified. The categories of root causes of noncompliance related to late or incomplete recordkeeping that were cited in the two sets of surveys were (the percentage of times each category of root cause was identified is listed in parentheses):

Pre-EMS Root Cause

- **Procedures** (28 percent)
- **Management** (24 percent)
- Other (48 percent), including **Compliance Monitoring, Communication, Human Error, Emergency Preparedness,** and **Regulations and Permits**

Post-EMS Root Cause

- **Regulations and Permits** (41 percent)
- **Procedures** (25 percent)
- **Human Error** (16 percent)
- Other (18 percent), including **Management, Communication** and **Compliance Monitoring**

The principal root cause category for noncompliance in the category of late or incomplete recordkeeping has changed since implementation of EMSs at participating UTC facilities from **Procedures** to **Regulations and Permits**. In general, in the post-EMS surveys, the specific root cause was identified as "*ambiguous federal regulations*" and "*ambiguous state regulations.*" As in the case of noncompliance related to O&M, **Procedures** was cited as a root cause category in both the pre-EMS and post-EMS surveys. However, again, the specific root cause in the **Procedures** category has changed from "*no written operating procedures*" (pre-EMS) to "*operating procedures were not followed*" (post-EMS). This demonstrates a shift from more

widespread root causes (lack of procedures) to more intractable root causes attributable to the actions of individuals.

The categories of contributing causes of noncompliance related to late or incomplete recordkeeping are (percentage of times cited in parenthesis):

Pre-EMS Contributing Cause

- **Compliance Monitoring** (33 percent)
- **Management** (30 percent)
- **Regulations and Permits** (22 percent)

Post-EMS Contributing Cause

- **Procedures** (30 percent)
- **Human Error** (26 percent)
- **Compliance Monitoring** (16 percent)

There is little similarity in contributing causes between pre and post-EMS survey results for incomplete recordkeeping. Other categories of contributing cause of noncompliance that were identified in the pre-EMS surveys include **Human Error**, **Training**, and **Procedures**. Less frequently cited contributing categories of noncompliance in the post-EMS surveys were **Management**, **Communication**, and **Regulations and Permits**.

Report Submissions and Reporting

Report submissions and reporting accounted for 21 percent of the incidents of noncompliance cited in the post-EMS profiles, in contrast to only eight percent of such citations in the pre-EMS profiles. The categories of root causes of noncompliance related to report submissions and reporting identified in the two sets of surveys include (the percentage of times each category of root cause was identified is listed in parentheses):

Pre-EMS Root Cause

- **Management** (38 percent)
- **Compliance Monitoring** (25 percent)
- **Procedures** (19 percent)
- **Human Error** (13 percent)
- **Regulations and Permits** (6 percent)

Post-EMS Root Cause

- **Human Error** (31 percent)
- **Procedures** (23 percent)
- **External Circumstances** (15 percent)
- **Regulations and Permits** (15 percent)
- Other (15 percent), including **Compliance Monitoring** and **Communication**

As in the cases of O&M and the late or incomplete recordkeeping, **Management** was the most frequently identified category of causes of noncompliance attributed to Report Submissions and Reporting identified in the pre-EMS surveys. An evaluation of specific root causes of noncompliance related to report submissions and reporting in the pre-EMS surveys indicates that noncompliance resulted primarily from *"no formal management structure to address noncompliance and follow-through"* and *"staffing - inappropriate level or expertise."*

Unlike the O&M and recordkeeping categories, **Human Error** was the most frequently cited root cause category for noncompliance related to Report Submissions and Reporting identified in the post-EMS surveys. The specific root cause of noncompliance most frequently identified was "*individual responsibility or professional judgment*." The next most common specific root causes of noncompliance identified included "*operating procedures not followed*" and "*contracted services, such as haulers and handlers.*"

In general, the findings are consistent with findings about the categories of noncompliance discussed earlier: noncompliance in the post-EMS period seems to primarily be associated with failure to implement established procedures correctly.

The categories of contributing causes of noncompliance related to Report Submissions and Reporting identified in the two sets of surveys include:

Pre-EMS Contributing Cause

- **Compliance Monitoring** (20 percent)
- **Management** (20 percent)
- **Human Error** (15 percent)
- **Training** (15 percent)
- **Procedures** (15 percent)

Post-EMS Contributing Cause

- **Compliance Monitoring** (24 percent)
- **Human Error** (18 percent)
- **Procedures** (18 percent)
- **External Circumstances** (12 percent)
- **Communications** (12 percent)

The specific contributing causes under **Compliance Monitoring** for both pre-EMS and post-EMS surveys included "*routine site and equipment compliance checks not conducted"*, however *"audit program insufficient"* was cited as a specific cause only in the pre-EMS surveys.

Other contributing causes identified in the pre-EMS surveys include **Regulations and Permits** and **Management**. The category of **Regulations and Permits** also was identified as a contributing cause of noncompliance in the post-EMS surveys.

Exceedances

Exceedances accounted for a greater proportion of the noncompliances identified in the post-EMS profiles (17 percent) than in the pre-EMS profiles (8 percent). The categories of root causes of noncompliance related to exceedances that were identified in the two sets of surveys include (the percentage of times each category of root cause was identified is listed in parentheses):

Pre-EMS Surveys Root Cause

- **Management** (35 percent)
- **Human Error** (24 percent)

Post-EMS Surveys Root Cause

- **Equipment/Problems** (30 percent)
- **Management** (17 percent)
- **Process Upset or Failure** (13 percent)
- **Regulations and Permits** (13 percent)

For noncompliance related to exceedances, **Management** plays a key role, as indicated by the responses to both the pre-EMS and the post-EMS survey, ranking as the number one and number two most frequently cited root cause category, respectively. A review of the specific root causes, however, shows a change between the pre- and post-EMS surveys. In the pre-EMS surveys, the specific cause *"no formal management structure to address noncompliance and follow-through"* accounted for a total of 29 percent of all root causes. Identification of this specific root cause may indicate a lack of attention on the part of management to environmental compliance obligations before implementation of an EMS. By contrast, the specific root causes in the general root cause category of management for exceedances cited most frequently in the post-EMS survey was *"environmental aspects of facility process and operations not identified."* Identification of the specific root cause, *"no formal management structure to address noncompliance and follow-through"* fell to four percent of the responses.

There were other specific root causes that were identified frequently in the pre-EMS surveys such as *"employee not trained"* (**Training** root cause category) and *"audit program insufficient"* (**Compliance Monitoring** root cause category) each accounting for 12 percent of the root causes, that might also be associated with lack of structured management systems.

In contrast to the pre-EMS results for the exceedance noncompliance category, root causes associated with facility processes (**Equipment Problems** and **Process Upset or Failure**) together account for 43 percent of the noncompliance related to exceedances identfied in the post-EMS surveys. Some specific root causes included in these results included: *"design or installation," "equipment maintenance"* and *"other."*

Root cause categories other than those described above that were identified for exceedances in the pre-EMS surveys included **External Circumstances** and **Regulations and Permits.** Other root cause categories identified in the post-EMS surveys included **Human Error, Communications, Procedures, and Policies.**

The categories of contributing causes of noncompliance related to exceedances that were identified in the two sets of surveys included:

Pre-EMS Contributing Cause

- **Compliance Monitoring** (35 percent)
- **Management** (30 percent)
- **Equipment Problems** (15 percent)
- **Procedures** (10 percent)

Post-EMS Contributing Cause

- **Management** (27 percent)
- **Policies** (27 percent)
- **Regulations and Permits** (13 percent)
- **Procedures** (13 percent)

Other categories of contributing causes of noncompliance identified in the pre-EMS surveys included **Communication** and **External Circumstances**.

In findings similar to those related to the **Management** root cause category, the specific causes in the **Management** contributing cause category identified in the pre-EMS surveys varied widely

and included *"no formal management structure to address noncompliance and follow-through,"* "*environmental aspects of facility process and operations not identified*", "*control and oversight not provided or not adequate", "management support or guidance not provided",* and *"management organization not defined,"* while the *specific* contributing cause cited most frequently in the general category of **Management** for exceedances in the post-EMS surveys was, as noted, *"environmental aspects of facility process and operations not identified*."

Labeling

More than 10 percent of instances of noncompliance identified in the pre-EMS profiles involved labeling, while fewer than five percent of the incidents identified in the post-EMS profiles fall into that category. The categories of root causes of noncompliance related to labeling that were identified in the pre-EMS and post-EMS surveys include (the percentage of times each category of root cause was identified is listed in parentheses):

Pre-EMS Root Causes

- **Management** (41 percent)
- **Procedures** (33 percent)
- **Training** (15 percent)
- Other (11 percent), including **Human Error** and **Regulations** and **Permits**

Post-EMS Root Causes

- **Procedures** (75 percent)
- **Human Error** (25 percent)

Again, **Management** is the predominant root cause category in the pre-EMS surveys, specifically, *"no formal management structure to address noncompliance and follow-through."* Although **Procedures** accounts for a high percentage of responses in both pre- and post-EMS surveys, as the general root cause category applicable to noncompliance related to labeling, a more thorough evaluation of the specific root causes of noncompliance shows a distinct difference between the two sets of surveys in the types of specific root causes identified.

- In the pre-EMS surveys, the most frequently cited specific root causes were as follows (percentages of the times cited are shown in parentheses)*: "definition of roles and responsibilities unclear"* (15 percent), *"difficulty in relating operating procedures to actual facility operations and products"* (7 percent), *"operating procedures not followed"* (7 percent), and *"no written operating procedures available"* (4 percent).

- In the post-EMS surveys, the only specific root cause related to **Procedures** was *"operating procedures not followed"* (75 percent of responses). In the remaining 25 percent of responses, which fell into the general category of **Human Error**, the specific root cause of noncompliance related to labeling was *"individual responsibility or professional judgment."*

The information presented above suggests that noncompliance associated with labeling during the period covered by the pre-EMS surveys was primarily the result of the lack of operating procedures or the inadequacy of such procedures. In contrast, evaluation of the specific root cause identified in the post-EMS surveys indicates that noncompliance associated with labeling is the result of human error and the failure to adhere to existing procedures.

The categories of contributing causes of noncompliance related to labeling that were identified in the two sets of surveys include:

Pre-EMS Contributing Causes

- **Management** (35 percent)
- **Compliance Monitoring** (32 percent)
- **Human Error** (10 percent)
- Other (23 percent), including **Training, Communications, and Procedures**

Post-EMS Contributing Causes

- **Training** (50 percent)
- **Human Error** (25 percent)
- **Procedures** (25 percent)

Management was identified as the leading category of both root and contributing cause for noncompliance related to labeling in the pre-EMS surveys, but was not identified as such in the post-EMS surveys. Generally, the specific root cause was *"no formal*

The change in the distribution of the **Management** cause category between the pre-EMS and post-EMS surveys may indicate that the involvement of management in the implementation of an EMS at UTC facilities may have been a major contributing factor in the reduction of noncompliance events related to the labeling noncompliance category.

management structure to address noncompliance and follow-through," while the specific contributing causes varied widely.

4.4 Observations

Analysis of the noncompliance categories used for the pre- and post-EMS surveys reveals that O&M was the category of noncompliance most frequently identified (32 percent) in the pre-EMS profiles, while late or incomplete recordkeeping was the second most frequently identified category of noncompliance (16 percent). In the post-EMS profiles, late or incomplete recordkeeping (23 percent) was the most frequently cited category of noncompliance, followed closely by report submissions and reporting (21 percent), O&M (18 percent), and exceedances (17 percent).

In the pre-EMS surveys, **Management** was identified as the leading root cause of noncompliance for two of the top five noncompliance categories (O&M and labeling); for late or incomplete recordkeeping it was identified as the second most common category after **Procedures**. In the post-EMS surveys, the distribution of categories of root causes of noncompliance was more variable. The most-commonly cited root cause categories in those surveys were **Human Error** and **Procedures**.

> Aspects of **Management** (specific causes such as "*management support or guidance not provided*", "*no formal management structure to address noncompliance and follow-through*") appear to play a large role as a root cause of noncompliance prior to implementation of an EMS.

Section 5 below provides a more detailed comparison of the root and contributing causes of noncompliance identified in the pre- and post-EMS surveys. The next section also outlines the findings regarding the effect of the implementation of an EMS on the root cause of noncompliance.

5.0 COMPARISON OF ROOT AND CONTRIBUTING CAUSES OF NONCOMPLIANCE IN 1990 AND IN 1998 AND EFFECT OF THE IMPLEMENTATION OF AN EMS ON THE ROOT CAUSES OF NONCOMPLIANCE

This section (1) summarizes the root and contributing causes of noncompliance, as identified by UTC, for noncompliance listed in the 1993 complaint and the 1998 third-party audits and (2) describes the effect that implementation of an EMS may have had on the root and contributing causes of noncompliance at the participating UTC facilities. This section begins with a description of limitations and qualifications for the data and ends with general observations related to the potential effect of the implementation of an EMS on the root and contributing causes of noncompliance**.**

5.1 Limitations and Qualifications

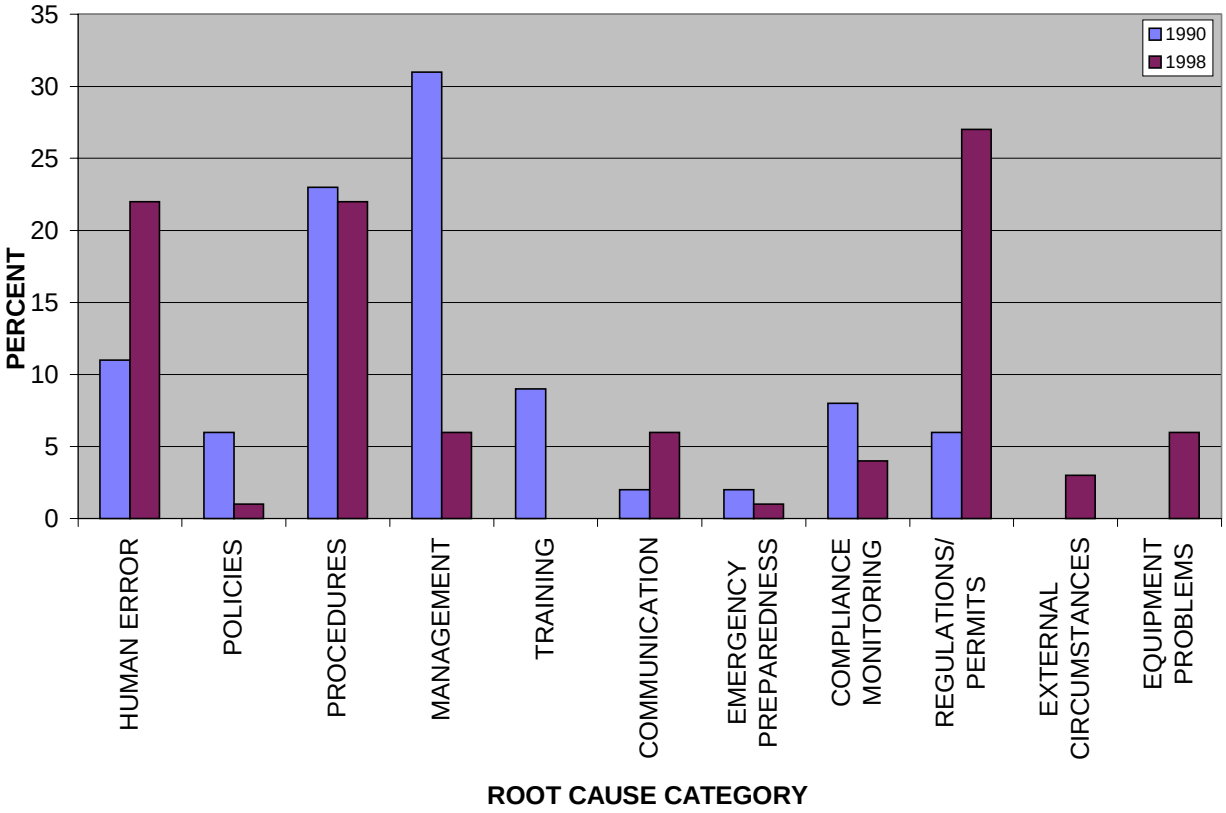
The conclusions that can be made are limited by the lack of availability of some personnel who have first-hand knowledge of practices at UTC facilities in 1990. The conclusions that can be drawn also may be limited by the limitations and qualifications presented in Section 4.1 of this document.

5.2 Root Causes

Figure 9 allows comparison of the distribution of categories of root causes of noncompliance in 1990 with that in 1998. The most common categories of root causes of noncompliance identified by UTC for 1990 were (the number of times each root cause was identified is listed in parentheses):

- **Management** (69)
- **Procedures** (51)
- **Human Error** (23)

Figure 9. Distribution of Root Causes of Noncompliance - 1990 vs. 1998



The specific root causes of noncompliance identified most frequently in the pre-EMS surveys are (the number of times each root cause was identified is listed in parentheses):

- *No formal management structure to address noncompliance and follow-through* (57)
- *No written operating procedures available* (19)
- *Unavailable policy* (12)
- *Facility unaware of applicability of a regulation* (10)
- *Staffing - inappropriate level or expertise* (7)

Figure 9 shows that there were some major changes in root causes of noncompliance between 1990 and 1998. The lack of a formal management structure contributed greatly to the noncompliance events spelled out in the 1993 complaint. The figure shows the trend from the overall **Management** root cause to other possibly more intractable causes such as **Human Error**

and **Regulations and Permits**. In addition, the second and third most frequently cited specific root causes of noncompliance for 1990, *("no written operating procedures available*" and *"unavailable policy"*) indicates the extent of absence of a systematic approach to complying with environmental requirements.

The categories of root causes of noncompliance most frequently identified by UTC in the post-EMS surveys are (the number of times each root cause category was identified is listed in parentheses):

- **Regulations and Permits** (38)
- **Human Error** (31)
- **Procedures** (31)

The specific root causes of noncompliance identified most frequently in the post-EMS surveys are (the number of times each root cause was identified is listed in parentheses):

- *Individual responsibility or professional judgment* (27)
- *Operating procedure not followed* (20)
- *Facility unaware of applicability of a regulation* (12)
- *Ambiguous state regulations* (7)
- *Inconsistent or contradictory interpretation of state regulations* (6)
- *Regulation deemed not applicable based on conversation with regulatory agency or facility interpretation*; or *position differs from regulatory agency or interpretation of requirement differs* (6)
- *Unavailable policy* (5)

The specific root cause indicating disagreements over interpretation of regulations within the prominent **Regulations and Permits** root cause category in the post-EMS surveys, indicates an awareness of the regulations on the part of UTC, but a potential lack of knowledge about how government

The factor that appears to play the most significant role with respect to noncompliance at UTC facilities in 1998 has to do with regulations and permits. That is, UTC staff were unaware of the applicability of a regulation, or there was disagreement between UTC personnel and EPA and state regulators about the interpretation of regulations.

officials apply or interpret and subsequently enforce such regulations. The number of times (12) that the root cause of noncompliance was the result of lack of knowledge of the applicability of a regulation may indicate the existence of a gap in the EMS, or it may reflect the time that it takes to implement all or a portion of an EMS.

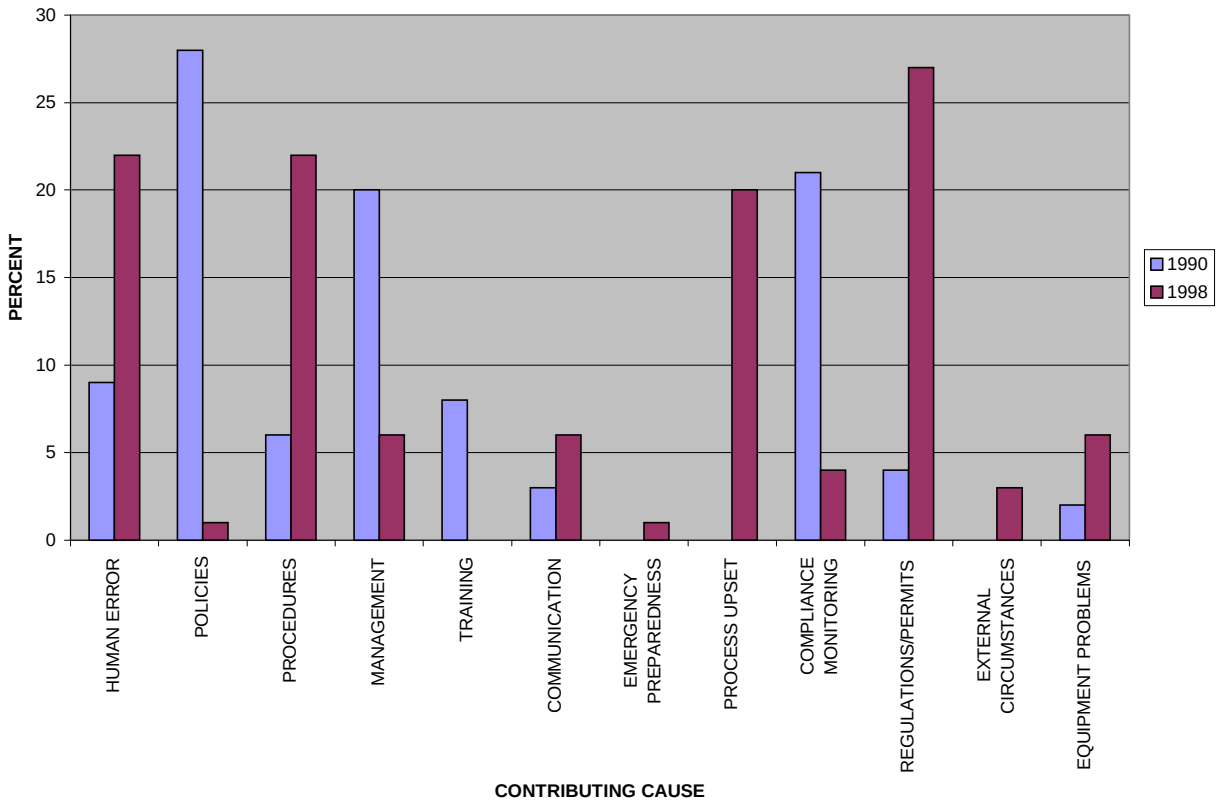
Analysis of the information presented above also indicates that the root cause of noncompliance in general has shifted from a lack of management systems toward other, possibly more intractable, factors, such as professional judgment and a failure to follow established procedures. When management is cited as the root cause of noncompliance reported in the post-EMS surveys, it appears more frequently to be the result of a lack of management oversight of individual employees than of the total absence of policies and procedures.

5.3 Contributing Causes

Figure 10 allows comparison of contributing causes of noncompliance in 1990 and in 1998. The most common categories of contributing causes of noncompliance identified by UTC in the pre-EMS surveys are:

- **Policies** (132)
- **Compliance Monitoring** (98)
- **Management** (92)
- **Human Error** (42)

Figure 10. Distribution of Contributing Causes of Noncompliance - 1990 vs. 1998



The specific contributing causes of noncompliance most frequently identified in the pre-EMS surveys are (the number of times each contributing cause was identified is listed in parentheses):

- *Audit program insufficient* (56)
- *Routine site and equipment compliance checks not conducted* (40)
- *Inexperience, lack of knowledge, lack of technical expertise* (29)
- *Management support or guidance not provided* (26)
- *Staffing - inappropriate level or expertise* (24)
- *No written operating procedures available* (17)
- *Employee not trained* (17)
- *Management organization undefined* (15)
- *Training not available* (14)
- *Communication difficulties between management and employee* (13)
- *Environmental aspects of facility processes not identified* (13)

The most common categories of contributing causes of noncompliance identified by UTC in the post-EMS surveys include (the number of times each contributing cause was identified is listed in parentheses):

- **Procedures** (24)
- **Human Error** (20)
- **Compliance Monitoring** (15)

The specific contributing causes of noncompliance identified most frequently in the post-EMS surveys are (the number of times each contributing cause was identified is listed in parentheses):

- *Individual responsibility or professional judgment* (13)
- *Routine site and equipment compliance checks not conducted* (13)
- *Difficulty in relating operating procedures to actual facility operations and products* (11)
- *Staffing - inappropriate level or expertise* (7)
- *Environmental aspects of facility process and operations not identified* (7)
- *Operating procedure not followed* (5)

Based on the data presented above, it appears that two years after EMSs had been implemented at participating UTC facilities, contributing causes of noncompliance generally reflect issues of human error (professional judgment) and following and relating operating procedures to actual operations, rather than such issues as complete lack of management systems or oversight.

5.4 Observations

The implementation of an EMS appears to have resulted in a general change in the types of root causes identified for noncompliance. In 1990, many of the root causes of noncompliance were related to **Management**: specifically, for example, "*no formal management structure to address noncompliance and follow-through*" existed to monitor and track compliance. Issues related to **Management** accounted for 31 percent of root causes of noncompliance in 1990; that number fell to 15 percent in 1998. Because all the participating facilities had implemented the vast majority of elements of an EMS by 1998, it appears that the implementation of an EMS helped to

bring about a decrease of the number of instances of noncompliance that result from a lack of management controls and, in smaller and more focused areas in which corrective action was necessary to achieve compliance.

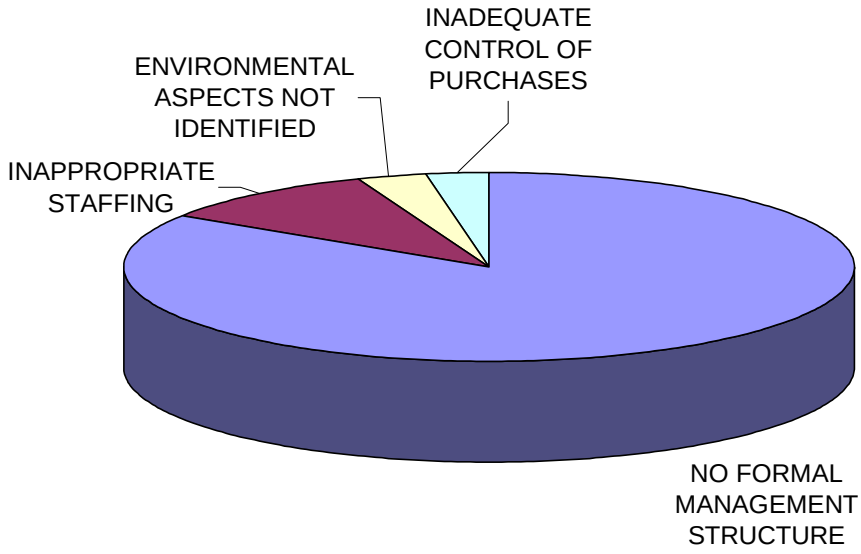
In the post-EMS surveys, the distribution of root causes identified had moved toward **Human Error** and failure to adhere to established **Policies** and **Procedures**. The responses to the post-EMS surveys indicate that, in most cases, a management structure had been established to communicate responsibilities related to environmental obligations, but that personnel assigned those responsibilities were not meeting them in all cases. That assertion is supported by the following data:

- Percentage of instances of noncompliance for which the root cause was **Human Error** climbed from 11 percent in 1990 to 19 percent in 1998.
- Although the percentage of instances of noncompliance attributed to **Procedures** remained nearly unchanged (23 percent in 1990 to 22 percent in 1998), examination of the specific causes of noncompliance shows that in the pre-EMS surveys the majority of the procedure-related incidents of noncompliance were the result of lack of procedures, and in the post-EMS surveys the majority of procedure-related incidents of noncompliance were the result of failure of personnel to comply with established procedures.

The change in root causes of noncompliance described above demonstrates that implementation of systems may be able to change the specific causes of noncompliance. Figures 11 and 12 show examples of the shift in distribution of root causes of noncompliance related to **Management** and **Procedures.**

Figure 11. Distribution of Specific Management Root Causes - 1990 and 1998

1990:



1998:

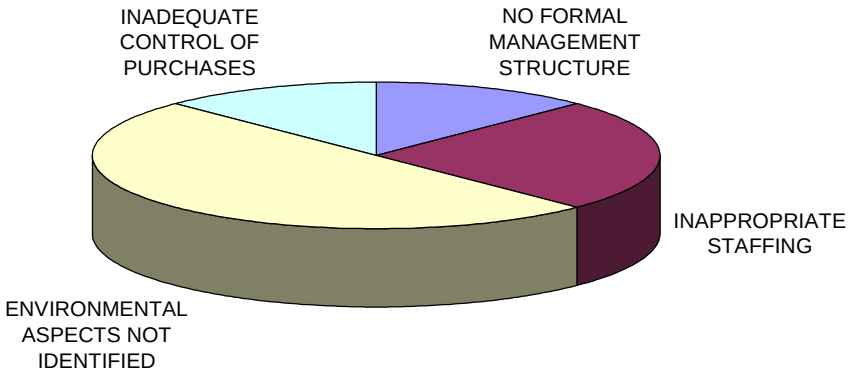
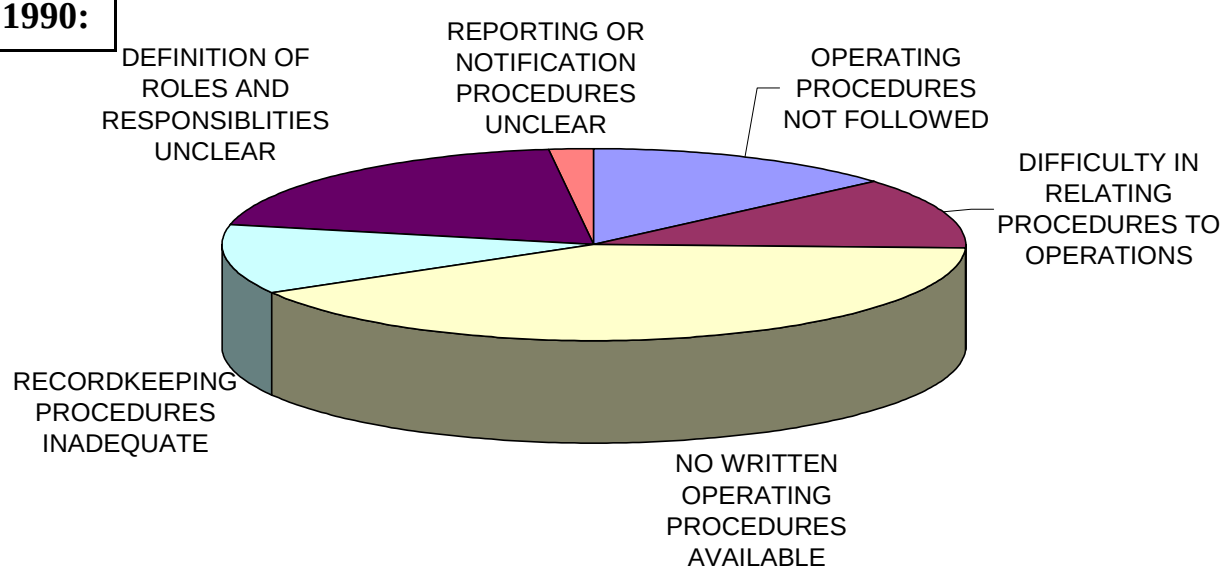
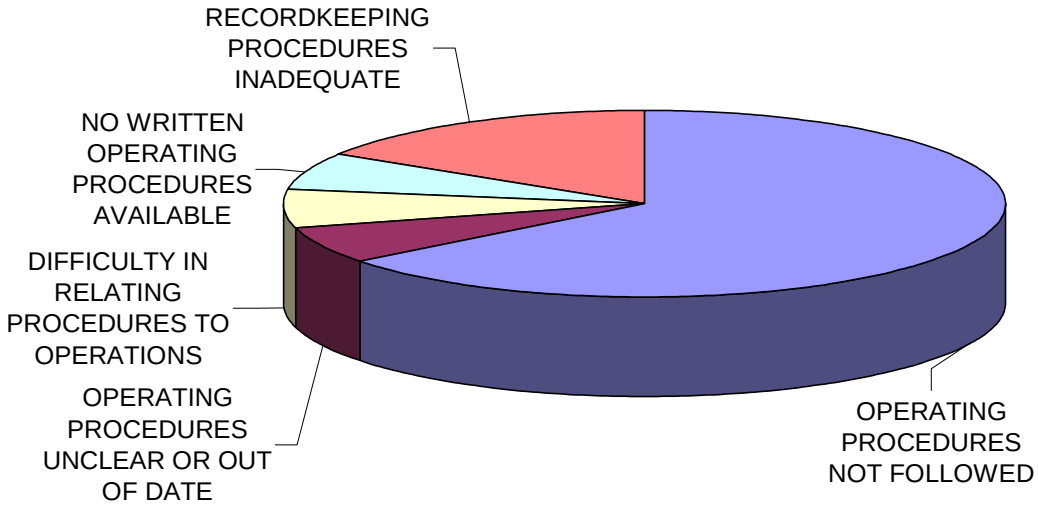


Figure 12. Distribution of Specific Procedures Root Causes - 1990 and 1998

1990:



1998:



6.0 EFFECT OF THE IMPLEMENTATION OF AN EMS ON COMPLIANCE

This section describes the potential effect of the implementation of an EMS on compliance. The subsections below include (1) a discussion of limitations and qualifications related to the analysis of the effect an EMS has on compliance and (2) observations related to the potential effect of the implementation of an EMS on compliance.

6.1 Limitations and Qualifications

The following limitations and qualifications restrict the types of findings this study can support with respect to the effect of implementation of an EMS on compliance:

- The analysis is limited because it is difficult to determine what caused a change in compliance rates: compliance with the terms of the consent decree or implementation of an EMS. For example, many corrective actions that involved modifications of wastewater treatment systems to achieve compliance with requirements of the CWA were mandated under the consent decree to which UTC was a signatory and the consent decree mandated the follow-up audits; thus it is difficult to assess the percentage of improvements in the compliance that could be attributed directly to implementation of an EMS.

- The analysis also must be qualified by the fact that the inspections conducted in the 1990 time frame were conducted for different purposes than the 1998 audits. Therefore, the two sets of inspections were not equivalent in terms of scope or duration.

- The information related to compliance during the 1998 time frame identifies instances of noncompliance with several statutes; however, only noncompliance with RCRA and the CWA were addressed in the 1993 complaint and subsequent profiles and pre-EMS surveys. Therefore, it is not meaningful to evaluate effects on compliance for statutes other than RCRA and the CWA.

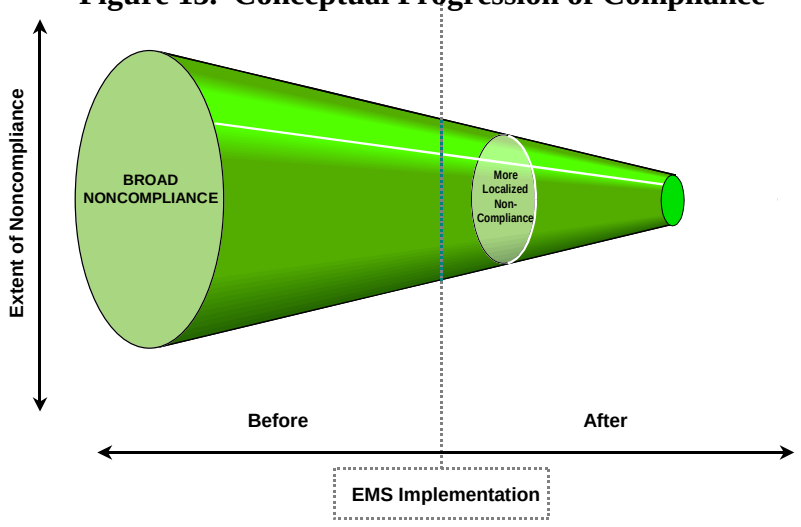
6.2 Observations

In general, both the number of instances of noncompliance identified at each facility and the number of facilities having particular violations decreased between 1990 and 1998. For example, although all six facilities inspected under RCRA were cited in 1990 for failure to mark containers accumulating hazardous wastes with an initial accumulation date, only one of the eight facilities evaluated in this study was found in 1998 to be in violation of that requirement.

> Based on the number of instances of noncompliance identified in 1990 and 1998, compliance at participating UTC facilities improved significantly with respect to noncompliance with specific requirements under RCRA and the CWA identified in the 1993 complaint.

Similarly, in the case of requirements for weekly inspections of hazardous waste accumulation areas, the complaint indicates that prior to EMS implementation, for many weeks there were no records of the facilities' performance of required self-inspections; indicating that the facilities routinely either failed to perform the inspections or failed to record their performance. However, in 1998, noncompliance associated with self-inspections generally included occasional failures to record some data on weekly inspection logs. Such improvements may be associated with the implementation of EMSs at UTC's participating facilities. Figure 13 provides a conceptual view of this progression.

Figure 13. Conceptual Progression of Compliance



Previous sections have outlined the trend shown in root causes of noncompliance, from (1) lack of management structure and oversight, and lack of operating procedures prior to EMS implementation to (2) human error and failure to follow established procedures after EMS implementation. The results of this study indicate that the implementation of EMSs and its associated structure and procedures may offer the advantage of helping a facility to focus on environmental compliance issues. This statement is based on a combination of the analysis of the root and contributing causes of noncompliance as well as improved compliance rates at participating UTC facilities, including both (1) fewer total instances of noncompliance at each facility, and (2) fewer facilities with individual instances of noncompliance. In addition, noncompliance that was identified during the 1998 audits typically was much less severe than that identified during the 1990 inspections. For example, the 1990 inspections found widespread noncompliance resulting in a consent decree and a multi-million dollar penalty. By contrast, a number of the instances of noncompliance identified during the 1998 audit were deemed sufficiently minor that no penalty was associated with them in the Report of Violations.

7.0 POLLUTION PREVENTION PRACTICES AT UTC FACILITIES

This section describes the elements of a P2 program that were present at UTC facilities in 1990 and in 1998, as expressed by personnel of UTC facilities in response to the pre- and post-EMS surveys. In general, the use of the surveys was not effective in eliciting specific details about P2 projects implemented at participating UTC facilities. The elements of a P2 program agreed upon for this project are listed in Section 5 of the pre-EMS survey and Section 4 of the post-EMS survey (see Appendix B).

7.1 Limitations and Qualifications

The responses presented in this section may be limited in their accuracy by the fact that the personnel completing the pre-EMS survey may not have had access to personnel who have first-hand knowledge of P2 practices in place at a facility in 1990. In addition, as discussed in greater

detail below, the responses are limited by the way in which UTC records and tracks P2 information.

7.2 Elements of a P2 Program in 1990

Six of the eight facilities that responded to the survey indicated that they had been engaged in P2 activities in 1990. All eight of the responding facilities indicated that, in 1990, they had not been required to have in place a formal P2 plan, and each reported that it did not have such a plan. The P2 activities at UTC facilities implemented in 1990 typically consisted of spill prevention and other "housekeeping" measures. In conversations between UTC personnel and Tetra Tech personnel, the P2 efforts in place in 1990 were characterized as "informal." However, beginning in 1988, all participating UTC facilities had measurement and reporting mechanisms in place for hazardous waste and toxic air emissions to meet the requirements of EPA. These mechanisms provided a baseline for setting P2 goals and promoting future P2 efforts.

7.3 Progress in Pollution Prevention During Implementation of an EMS

In the period from 1990 to 1998, various P2 initiatives related to an EMS were implemented at the corporate level at UTC to promote P2 activity at the divisions and at individual facilities. Specifically, senior management of UTC began setting P2 goals during that time period. In UTC's first EH&S annual report, prepared in 1992, progress in the reduction of hazardous waste and toxic air emissions is reported against a 1988 baseline. A goal of 50 percent reduction by 1995 was established. After 1995, UTC established reduction goals for the year 2000 of 80 percent for hazardous waste and 95 percent for toxic air emissions (compared with the 1988 baseline).

Since 1992, UTC has prepared a public report on its progress against P2 goals. In addition,

> Increased emphasis on reporting and management review has contributed to the significant focus on accountability and innovation for P2.

progress has been tracked continuously at all levels of management, from factory operations to the board of directors.

7.4 Elements of a Pollution Prevention Program in 1998

Information in the post-EMS surveys indicates that the P2 activities reported generally were more sophisticated than activities reported in the pre-EMS surveys. For example, the post-EMS surveys cited specific examples of material substitution and source reduction that had been implemented between 1990 and 1998. As the information presented in Appendix B shows, the surveys were designed to provide very specific information about P2 practices; however, specific information about P2 practices before 1990 generally was not available. Subsequent to the surveys being completed, business unit-level examples of P2 practices were provided by UTC to EPA from available P2 reports. In the post-EMS surveys, all the facilities reported that they maintained a formal P2 plan. Notably, only three of those eight facilities stated that they were required under state law to have P2 plans.

7.5 Comparison of Pollution Prevention Elements in 1990 and 1998

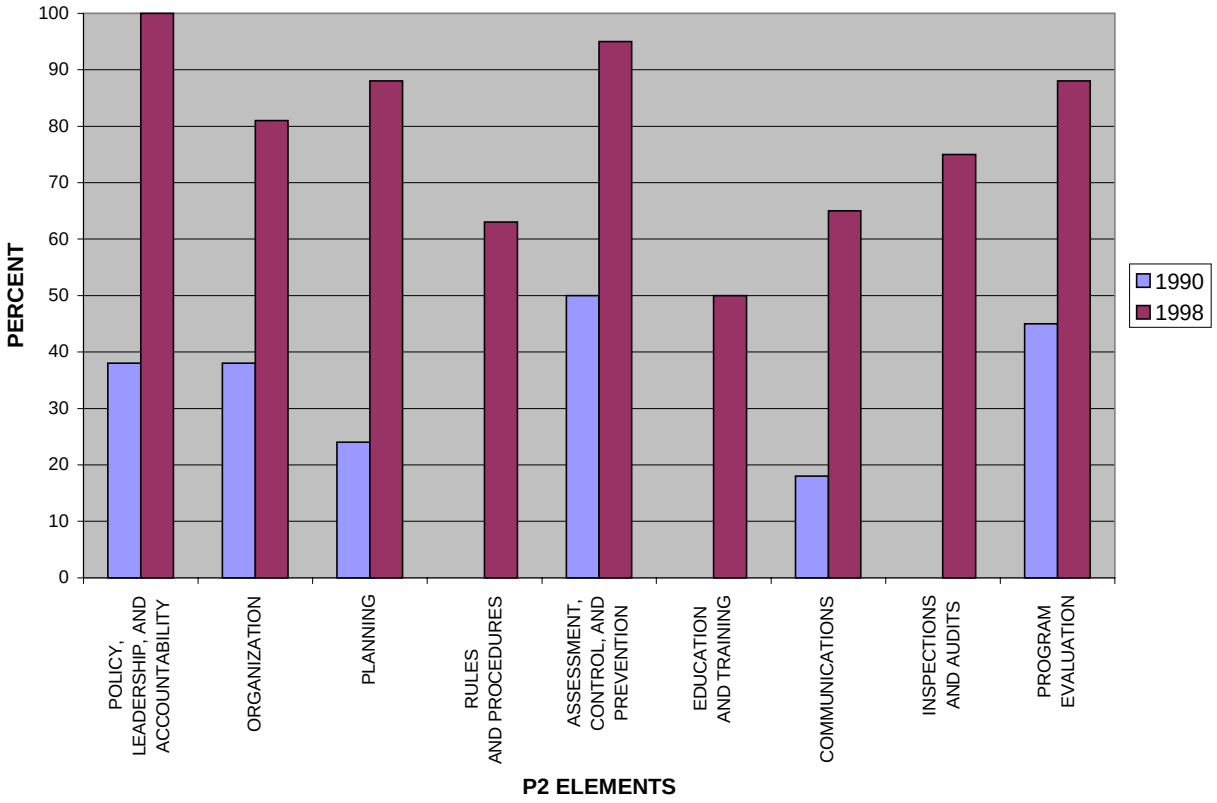
Table 5 shows the elements of a P2 program that were present in 1990 and 1998, as indicated by UTC's responses to the pre- and post-EMS surveys. The table shows the total number of specific elements of a P2 program at each facility, before and after implementation of an EMS. The numbers of specific P2 elements under each general element are shown in parentheses in the first column of the table. The table also shows the number of specific P2 elements for each facility reported in the pre-EMS survey (represented by the first of two numbers presented in an X/X format) and in the post-EMS surveys (reported by the second of two numbers).

Table 5
COMPARISON OF P2 ELEMENTS AT PARTICIPATING UTC FACILITIES: 1990 vs. 1998

General Element of a P2 Program	Hamilton Sundstrand	P&W Colt Street	P&W East Hartford	P&W Middletown	P&W North Haven	Rocky Hill	Sikorsky Stratford	UTRC
Policy, Leadership, and Accountability (2)	1/2	1/2	1/2	0/2	2/2	0/2	0/2	1/2
Organization (4)	2/4	2/3	2/3	1/4	3/2	1/4	0/3	1/3
Planning (18)	5/16	6/15	6/15	2/18	6/16	1/18	0/14	9/15
Rules and Procedures (3)	0/2	0/2	0/2	0/1	0/3	0/2	0/1	0/2
Assessment, Control, and Prevention (7)	4/7	4/7	3/7	3/6	3/6	3/7	3/7	5/7
Education and Training (2)	0/1	0/1	0/1	0/0	0/1	0/2	0/2	0/0
Communications (5)	5/5	0/3	0/3	1/0	0/5	1/5	0/2	0/3
Inspections and Audits (1)	0/1	0/1	0/1	0/0	0/1	0/1	0/0	0/1
Program Evaluation and Results (5)	3/5	3/5	3/5	1/0	0/5	1/5	5/5	3/5

In general, the responses to the pre- and post-EMS surveys indicate that many more elements of a P2 program were in place in 1998 than were in place in 1990. Figure 14 shows the average number of P2 elements as a percentage present at the participating UTC facilities in 1990 and in 1998.

Figure 14. Percent of P2 Elements Present



Information about P2 efforts received by EPA from UTC included:

- Several issues of *Waste Lessons*, a quarterly publication that highlights waste minimization and P2 activities throughout UTC
- Various examples of P2 activities implemented at the eight participating UTC facilities

Specifically, examples of P2 activities implemented at the eight participating UTC facilities between 1990 and 1998 include:

- UTC has reduced toxic air emissions by 92 percent corporate wide by eliminating ozone-depleting substances formerly used in vapor degreasers. Specifically, Sikorsky replaced numerous vapor degreasers with mechanical washers and immersion tanks, thereby reducing the use of perchloroethylene by 200,000 pounds annually.

- Hamilton Sundstrand reduced volatile organic compound (VOC) emissions and saved $1 million in capital and operating costs by inventing its own water-based coolant to replace a more toxic solvent-based coolant.

- In 1992, Sikorsky began to use a central filtration system to recover and reuse machine coolant. The new process reduced the volume of hazardous waste that was produced by 13,000 gallons per year.

- By applying a flocculation process and a closed-loop recycling system to wastewater from its vibratory bowls, P&W North Haven reduced metal hydroxide sludge generated by 60 percent and water use by more than 50 percent.

- In 1996, P&W North Haven began to use a vacuum distillation unit for nitric acid that has eliminated the use of nitric acid and will save the company more than $700,000 over five years.

- In 1998, Sikorsky introduced the use of plastic media blasting (PMB) to reduce the amount of waste generated by traditional paint-stripping operations. Use of the process has eliminated the average annual generation of 350,000 pounds of wastewater previously managed as hazardous waste, as well as reduced the amount of solid waste by 200 pounds per aircraft.

- Compared with the 1988 baseline, the amount of hazardous waste generated has been reduced 83 percent.

A review of the information provided by UTC indicates that more elements of a P2 program were in place in 1998 than in 1990, as reported in the pre- and post-EMS surveys. It also is apparent that more P2 activities were being documented (or documented more thoroughly) in 1998 than in 1990. However, a definitive statement about the effect of the implementation of an EMS on P2 efforts at individual facilities is difficult because:

- Much of the information compiled by UTC (for example, hazardous waste generation rates and use of toxic chemicals as identified under EPCRA) does not appear to be maintained permanently by UTC at the facility level, making comparisons of circumstances at individual facilities difficult.

- Information about individual production rates is not available for many of the participating facilities, so it was not possible to normalize P2 results for production. UTC uses sales as the basis on which to normalize P2 activities.

- It appears that many early (that is, pre-1992) P2 efforts were not recorded formally. Therefore, establishment of a "baseline" description of P2 efforts is extremely difficult.

8.0 UTC's RECOMMENDATIONS FOR COMPLIANCE ASSISTANCE

The corporate EMS survey solicited recommendations from UTC about possible approaches to compliance assistance. Those recommendations are set forth below.

- UTC suggested that EPA and the states replace their current (administrative) systems with performance-based systems.
- UTC indicated a desire for more consistency on the part of EPA and the states in interpreting environmental regulations.
- UTC indicated that priorities should be established for the use of federal and state government and industry resources related to compliance, according to the risk that particular operations pose to human health and the environment.
- UTC suggested that more detail accompany notices of violation (NOV) to aid a facility in taking corrective actions; UTC stated that recommendations from the regulatory agencies (that is, examples of compliant approaches at other facilities) would be helpful.
- UTC encouraged more familiarity among EPA and state regulators with facility operations and more communication between facilities and EPA and state regulators.

9.0 COMPARISONS TO THE RCA PROJECT

This section provides a comparison of the findings of this project with the EPA/CMA Root Cause Analysis Pilot Project (RCA project). As was previously noted, this project used a methodology very similar to that developed for the RCA Project. Particularly as this is the first effort to build on the work of that study, it is useful to evaluate how the findings of this effort compare with those of the RCA project. The subsections below include (1) a comparison of the RCA Project noncompliance and root cause categories with the UTC 1998 survey results and (2)

a comparison of the corrective actions as reported in the RCA Project and the UTC 1998 survey results.

This report compares the RCA project findings with the 1998, post-EMS UTC findings for two reasons. First, the RCA project covered six statutes – the same five with findings in the 1998 UTC audit plus TSCA findings – so the 1998 UTC data, which also covered six statutes, are a closer match. Second, the RCA project report found "widespread implementation of EMS elements at the time of noncompliance" among covered CMA member companies (RCA project page 29). Therefore, in terms of EMS implementation, the data from the UTC study in 1998 are more comparable to the CMA project than the 1990 data from the UTC study.

9.1 Comparison of Noncompliance and Root Cause Categories for the CMA RCA Project and the UTC EMS Study

In terms of noncompliance categories, the same four categories dominated in both the 1998 UTC survey and in the RCA project:

UTC 1998		**CMA RCA** (from page 11 of the report)	
Recordkeeping	(27%)	Reporting	(29%)
Reporting	(21%)	Exceedence	(10%)
Operations & Maintenance	(18%)	Operations & Maintenance	(10%)
Exceedences	(17%)	Recordkeeping	(10%)

Even more striking, the same three root causes were observed, in the same order, in both studies: **Regulations and Permits**, followed by **Human Error**, followed by **Procedures**. Two of three leading contributing causes were the same in both studies: **Regulations and Permits** and **Management** (see pages 22-23 of the RCA report).

The degree of concordance between these findings tends to increase the likelihood that both are relatively accurate reflections of reality. It also suggests that these noncompliance categories,

and cause categories, are worthy of particular attention by companies that have already implemented EMS. The RCA report recommends that companies ensure that all EMS elements are in place, establish accurate, standard operating procedures, and conduct employee training and other activities to increase awareness of and commitment to the EMS and operating procedures (see RCA report page 42). This report generally echoes and supplements the recommendations of the RCA project, and refines them by focusing on the need to ensure that environmental aspects are identified, that operating procedures are followed, that appropriate staff are assigned to jobs, and that EMS are updated to reflect newly arising requirements such as stormwater rules.

Importantly, the fact that **Regulations and Permits** was the dominant root cause in both studies reinforces the RCA report's recommendations (from page 42) that federal and state regulators articulate new regulations more clearly, work with each other to coordinate interpretations of those rules, and increase their compliance assistance and outreach activities. Both UTC and the CMA recommended in the surveys that EPA work with state agencies to ensure that regulations are interpreted consistently.

9.2 Comparison of Corrective Actions for CMA RCA Project and UTC EMS Study

Further similarities are found between the 1998 UTC survey and the CMA RCA project in the area of corrective actions that were taken as a result of the noncompliance found. The surveys completed by participants in both projects included information on corrective actions taken, however, data provided from UTC facilities on corrective actions taken in the 1990 timeframe provided insufficient particulars to do a detailed comparison using earlier data. However, detailed information was available for corrective actions in the post-EMS surveys and it is helpful to compare the results with those from the RCA Project.

The corrective actions for the post-EMS surveys in the UTC EMS Study were grouped into categories similar to those used in the RCA project to allow for comparison of the data, as shown

below. In the RCA project, the types of corrective actions were divided into those that are viewed almost universally as integral parts of an EMS and those that are not. In the information presented below, the corrective action categories not deemed to be fundamental parts of an EMS are shown in italics.

UTC 1998

Changes in Procedures/Polices (36%)
Additional Training (20%)
Changes to Equipment (19%)
Communications (8%)
Management Aspects (7%)
Change Compliance Monitoring/Auditing (6%)
Regulations/Permits (3%)

CMA RCA Project (from pages 31 and 32)

Changes in Procedures/Policies (44%)
Changes to Equipment (22%)
Additional Training (12%)
Change Compliance Monitoring/Auditing (9%)
Regulations/Permits (7%)
Management Aspects (4%)
Communications (2%)

The modification of Procedures and Policies was the most frequently cited type of corrective action for both UTC and the CMA members and the top three changes made were the same for both studies. Modifications of procedures or policies along with changes to equipment and additional training, accounted for a significant majority of corrective actions, totaling 75 percent and 78 percent in the 1998-UTC and CMA studies, respectively.

The data show that in both studies, the majority of the corrective actions taken were relevant to an EMS (78 percent for the UTC study and 71 percent for the CMA RCA Project) such as commitment on the part of management clearly communicated procedures, auditing, and training. This finding supports the conclusion that an EMS can provide approaches to address noncompliance and that as an EMS matures, facilities may need to focus on the more intractable categories of root causes by ensuring both that policies and procedures reflect actual operational needs and that procedures and training keep pace with changing requirements and regulations.

10.0 CONCLUSIONS

The following conclusions are based on the analysis of the pre-EMS and post-EMS surveys; the corporate EMS survey; the pre-EMS and post-EMS profiles; and a response to an additional information request that Tetra Tech submitted to UTC facilities.

- The primary root cause of noncompliance identified in the pre-EMS surveys was the lack of a formal management structure for addressing regulatory compliance issues. Representatives of UTC who completed the surveys indicated that the primary root cause of noncompliance identified in the pre-EMS surveys was the lack of a formal management structure for addressing regulatory compliance issues and that the primary root cause of noncompliance in the post-EMS period was individuals not following established procedures, differences in interpretations of regulations by UTC facilities and regulatory agencies, or facilities being unaware of the applicability of new regulations.

- Regulatory compliance improved at the UTC facilities that responded with respect to RCRA and CWA noncompliance identified in the 1993 complaint filed against UTC and its facilities. This conclusion is supported by: (1) comparatively few repeat instances of noncompliance occurred in the 1998 audits and (2), on average, the fewer instances of noncompliance at facilities in 1998.

- The severity of noncompliance also typically decreased. For example, in 1990, two-thirds of the facilities had been cited for storing hazardous waste for more than 90 days, and five of the six facilities reviewed under the CWA had been cited for unauthorized discharges to surface water without permits. In contrast, the post-EMS surveys indicate that only one UTC facility had an unauthorized or unpermitted activity (a pretreatment discharge).

- Overall, the usefulness of information about practices at facilities (for example, elements of an EMS present) and responses to noncompliance events related to violations identified in the 1993 complaint may be limited because fewer individuals at UTC have first-hand knowledge of practices in 1990. For example, responses in the pre-EMS surveys that are related to corrective actions are the same for several facilities, because it is only known in general how violations were addressed, (that is, by implementing the EMS), but current personnel of UTC have only vague recollection of specific corrective actions in 1990.

- The general category of root cause of noncompliance identified most frequently in the post-EMS surveys was **Regulations and Permits**. Further evaluation of the specific root causes reveals that disagreement over the interpretation of regulations often is cited as the root cause of noncompliance. UTC recommended UTC and the regulatory agencies

should strive to improve communication (for example, through meetings or other communication in addition to such activities as formal inspections) because establishment of informal dialogue may build greater understanding of facility operations on the part of regulators and greater understanding of the regulators' interpretations of regulations on the part of UTC.

- On the basis of responses to the post-EMS survey, UTC should review its programs for effectiveness on employees to maintain compliance. **Human Error** and **Communication** became more prominent as root causes of noncompliance (accounting for a greater percentage of instances of noncompliance) in the post-EMS profiles, compared with the pre-EMS profiles. Modification of training programs may be a logical step in addressing those root causes of noncompliance.

- Implementing an EMS appears to have moved the root causes of noncompliance from the category of management (lack of structure, control and oversight, guidance) toward the more intractable root causes of human error and communication.

- UTC should review its process for the evaluation and implementation of procedures for complying with new regulations. Many of the instances of noncompliance identified in the post-EMS profiles were related to regulations issued by EPA or the state during the period between 1990 and 1998 (for example, stormwater regulations under the CWA). Although the post-EMS surveys generally indicate that specific personnel are assigned to monitor new regulations, the results of the 1998 audits indicate that such monitoring may not have been sufficient to ensure compliance in all cases.

- **External Circumstances** played a more prominent role as a root cause of noncompliance in the post-EMS surveys than in the pre-EMS surveys. This provides an example of how more intractable root causes may become more prevalent after EMSs have been implemented. Several of the facilities do not include communication with external entities in their EMSs. Thus the root cause of **External Circumstances** could potentially be addressed by greater involvement with external entities (for example, suppliers, customers, contractors, and vendors) under the EMS in place at each facility.

- The results of both UTC and RCA projects support EPA and state agencies continued work on issuing straightforward, plain language regulations, and continued coordination within their organization and with each other to ensure clear and consistent interpretation of those regulations. The results also support continued or increased compliance assistance activities, particularly with respect to new regulations and important new interpretations.

- It appears that the implementation of EMSs may offer the advantage of helping a facility to focus on environmental compliance issues. This statement is based on improved compliance rates at participating UTC facilities, including both (1) fewer total instances

of noncompliance at each facility, and (2) fewer facilities with individual instances of noncompliance. In addition, instances of noncompliance identified during the 1998 audits typically were much less severe than those identified during the 1990 inspections.

- Results of the survey indicate that, although UTC had begun implementing P2 activities in 1988, most of those activities were undertaken in response to environmental reporting requirements (for example, requirements for reporting releases to the Toxic Release Inventory). P2 efforts at UTC have increased markedly since 1990, aided by the increased emphasis on reporting and accountability inherent in EMS.

- The findings of this analysis suggest that in organizations that have implemented EMS (such as UTC in 1998 and CMA members covered by the RCA project), improvements in compliance are most likely to come from a combination of (1) improving and maintaining the EMS, (2) training and other means of increasing awareness of EMS elements and regulatory requirements, and (3) clearer regulations and more compliance assistance.

- As was recommended in the RCA project, this study indicates that improvements in compliance might also result from the development of a better understanding of the causes of human error and the identification of actions to address **Human Error**.

APPENDIX A

DATA TABLES

Distribution of Noncompliance by Noncompliance Category in 1990

Noncompliance Category	Count of Category
Exceedance	9
Labeling	11
Legal Agreement	1
Operations and Maintenance	32
Late or Incomplete Recordkeeping	16
Report Submissions and Reporting	8
Spill/Release	7
Testing	2
Training and Certification	4
Unpermitted/Unauthorized Activity	6
Waste Identification	4

Distribution of Root Causes of Noncompliance in 1990

Root Cause	Count of Root Cause
Human Error	23
Policies	13
Procedures	51
Management	69
Training and Certification	19
Communications	4
Emergency Preparedness	4
Compliance Monitoring	18
Regulations and Permits	12
Equipment Problems	4

Breakdown of Root Causes of Noncompliance in 1990

Root Cause	Question Number	Count of Root Cause
Human Error	1	11
Human Error	2	3
Human Error	3	9
Policies	5	12
Policies	6	1
Procedures	11	7
Procedures	13	6
Procedures	14	21
Procedures	15	6
Procedures	16	10
Procedures	17	1
Management	20	58
Management	23	7
Management	24	2
Management	25	2
Training and Certification	29	14
Training and Certification	31	4
Training and Certification	32	1
Communications	36	4
Emergency Preparedness	39	4
Compliance Monitoring	47	14
Compliance Monitoring	49	2
Compliance Monitoring	50	2
Regulations and Permits	57	1
Regulations and Permits	62	10
Regulations and Permits	64	1
Equipment Problems	69	3
Equipment Problems	72	1

Distribution of Root Causes of Noncompliance by Noncompliance Category in 1990

Category	Question Number	Counts
Exceedance	20	5
Exceedance	2	2
Exceedance	29	2
Exceedance	47	2
Exceedance	69	2
Exceedance	3	1
Exceedance	24	1
Exceedance	62	1
Exceedance	1	1
Labeling	20	9
Labeling	29	4
Labeling	16	4
Labeling	13	2
Labeling	11	2
Labeling	23	2
Labeling	1	2
Labeling	62	1
Labeling	14	1
Legal Agreement	47	1
Legal Agreement	20	1
Operations and Maintenance	20	22
Operations and Maintenance	14	8
Operations and Maintenance	5	7
Operations and Maintenance	29	6
Operations and Maintenance	1	5
Operations and Maintenance	11	4
Operations and Maintenance	3	4
Operations and Maintenance	47	3
Operations and Maintenance	13	3

Distribution of Root Causes of Noncompliance by Noncompliance Category in 1990 (continued)

Category	Question Number	Counts
Operations and Maintenance	16	3
Operations and Maintenance	25	2
Operations and Maintenance	49	2
Operations and Maintenance	62	2
Operations and Maintenance	69	1
Operations and Maintenance	72	1
Operations and Maintenance	23	1
Late or Incomplete Recordkeeping	20	6
Late or Incomplete Recordkeeping	14	5
Late or Incomplete Recordkeeping	47	3
Late or Incomplete Recordkeeping	36	3
Late or Incomplete Recordkeeping	15	2
Late or Incomplete Recordkeeping	1	2
Late or Incomplete Recordkeeping	39	2
Late or Incomplete Recordkeeping	3	1
Late or Incomplete Recordkeeping	62	1
Report Submissions and Reporting	20	4
Report Submissions and Reporting	15	3
Report Submissions and Reporting	47	2
Report Submissions and Reporting	23	2
Report Submissions and Reporting	50	2
Report Submissions and Reporting	1	1
Report Submissions and Reporting	62	1
Report Submissions and Reporting	3	1
Spill/Release	20	3
Spill/Release	31	2
Spill/Release	39	2
Spill/Release	17	1
Spill/Release	23	1

Distribution of Root Causes of Noncompliance by Noncompliance Category in 1990 (continued)

Category	Question Number	Counts
Spill/Release	24	1
Spill/Release	16	1
Spill/Release	14	1
Spill/Release	47	1
Spill/Release	62	1
Spill/Release	64	1
Spill/Release	36	1
Testing	2	1
Testing	3	1
Testing	5	1
Testing	20	1
Training and Certification	14	4
Training and Certification	31	2
Training and Certification	5	2
Training and Certification	20	2
Training and Certification	15	1
Training and Certification	32	1
Unpermitted/Unauthorized Activity	20	4
Unpermitted/Unauthorized Activity	47	2
Unpermitted/Unauthorized Activity	62	2
Unpermitted/Unauthorized Activity	23	1
Unpermitted/Unauthorized Activity	29	1
Unpermitted/Unauthorized Activity	16	1
Unpermitted/Unauthorized Activity	11	1
Unpermitted/Unauthorized Activity	57	1
Waste Identification	5	2
Waste Identification	14	2
Waste Identification	62	1
Waste Identification	3	1

Distribution of Root Causes of Noncompliance by Noncompliance Category in 1990 (continued)

Category	Question Number	Counts
Waste Identification	6	1
Waste Identification	13	1
Waste Identification	16	1
Waste Identification	20	1
Waste Identification	29	1

Distribution of Contributing Causes of Noncompliance by Noncompliance Category in 1990

Category	Question Number	Counts
Exceedance	49	5
Exceedance	70	3
Exceedance	14	2
Exceedance	47	2
Exceedance	20	2
Exceedance	24	1
Exceedance	25	1
Exceedance	34	1
Exceedance	22	1
Exceedance	21	1
Exceedance	66	1
Labeling	47	11
Labeling	49	8
Labeling	22	6
Labeling	21	6
Labeling	3	5
Labeling	35	4
Labeling	23	4
Labeling	14	4
Labeling	29	3
Labeling	24	2
Labeling	32	2
Labeling	20	2
Labeling	1	1
Labeling	25	1
Labeling	31	1
Legal Agreement	24	1
Legal Agreement	49	1

Distribution of Contributing Causes of Noncompliance by Noncompliance Category in 1990 (continued)

Category	Question Number	Counts
Operations and Maintenance	47	24
Operations and Maintenance	3	15
Operations and Maintenance	49	13
Operations and Maintenance	23	9
Operations and Maintenance	22	9
Operations and Maintenance	29	7
Operations and Maintenance	35	7
Operations and Maintenance	1	7
Operations and Maintenance	14	7
Operations and Maintenance	31	6
Operations and Maintenance	20	5
Operations and Maintenance	24	5
Operations and Maintenance	32	4
Operations and Maintenance	21	3
Operations and Maintenance	12	2
Operations and Maintenance	54	1
Operations and Maintenance	69	1
Operations and Maintenance	62	1
Operations and Maintenance	39	1
Operations and Maintenance	13	1
Operations and Maintenance	8	1
Operations and Maintenance	11	1
Late or Incomplete Recordkeeping	47	9
Late or Incomplete Recordkeeping	62	7
Late or Incomplete Recordkeeping	23	6
Late or Incomplete Recordkeeping	49	6
Late or Incomplete Recordkeeping	22	3
Late or Incomplete Recordkeeping	24	3
Late or Incomplete Recordkeeping	60	2

Distribution of Contributing Causes of Noncompliance by Noncompliance Category in 1990 (continued)

Category	Question Number	Counts
Late or Incomplete Recordkeeping	3	2
Late or Incomplete Recordkeeping	21	2
Late or Incomplete Recordkeeping	31	2
Late or Incomplete Recordkeeping	1	1
Late or Incomplete Recordkeeping	55	1
Late or Incomplete Recordkeeping	15	1
Late or Incomplete Recordkeeping	29	1
Report Submissions and Reporting	3	2
Report Submissions and Reporting	47	2
Report Submissions and Reporting	29	2
Report Submissions and Reporting	11	2
Report Submissions and Reporting	49	2
Report Submissions and Reporting	22	2
Report Submissions and Reporting	54	1
Report Submissions and Reporting	1	1
Report Submissions and Reporting	62	1
Report Submissions and Reporting	14	1
Report Submissions and Reporting	36	1
Report Submissions and Reporting	31	1
Report Submissions and Reporting	20	1
Report Submissions and Reporting	23	1
Report Submissions and Reporting	21	1
Spill/Release	47	3
Spill/Release	29	2
Spill/Release	55	1
Spill/Release	49	1
Spill/Release	62	1
Spill/Release	35	1
Spill/Release	31	1

Distribution of Contributing Causes of Noncompliance by Noncompliance Category in 1990 (continued)

Category	Question Number	Counts
Spill/Release	2	1
Spill/Release	3	1
Testing	14	2
Testing	22	1
Testing	23	1
Testing	17	1
Testing	16	1
Testing	21	1
Testing	31	1
Training and Certification	29	2
Training and Certification	47	2
Training and Certification	22	2
Training and Certification	20	2
Training and Certification	21	1
Training and Certification	3	1
Training and Certification	31	1
Unpermitted/Unauthorized Activity	49	3
Unpermitted/Unauthorized Activity	23	2
Unpermitted/Unauthorized Activity	3	2
Unpermitted/Unauthorized Activity	54	1
Unpermitted/Unauthorized Activity	50	1
Unpermitted/Unauthorized Activity	47	1
Unpermitted/Unauthorized Activity	67	1
Unpermitted/Unauthorized Activity	22	1
Unpermitted/Unauthorized Activity	14	1
Unpermitted/Unauthorized Activity	5	1
Unpermitted/Unauthorized Activity	1	1
Unpermitted/Unauthorized Activity	24	1
Unpermitted/Unauthorized Activity	30	1

Distribution of Contributing Causes of Noncompliance by Noncompliance Category in 1990 (continued)

Category	Question Number	Counts
Waste Identification	47	2
Waste Identification	3	1
Waste Identification	54	1
Waste Identification	51	1
Waste Identification	49	1
Waste Identification	35	1
Waste Identification	31	1
Waste Identification	22	1
Waste Identification	1	1
Waste Identification	55	1
Waste Identification	23	1

Distribution of Contributing Causes of Noncompliance in 1990

Contributing Cause	Count of Contributing Cause
Human Error	42
Policies	132
Procedures	26
Management	92
Training and Certification	38
Communications	15
Emergency Preparedness	1
Compliance Monitoring	98
Regulations and Permits	19
External Circumstances	2
Equipment Problems	4

Breakdown of Contributing Causes of Noncompliance in 1990

Contributing Cause	Question Number	Count of Contributing Cause
Human Error	1	12
Human Error	2	1
Human Error	3	29
Policies	5	1
Policies	8	1
Procedures	11	3
Procedures	12	2
Procedures	13	1
Procedures	14	17
Procedures	15	1
Procedures	16	1
Procedures	17	1
Management	20	12
Management	21	15
Management	22	26
Management	23	24
Management	24	13
Management	25	2
Training and Certification	29	17
Training and Certification	30	1
Training and Certification	31	14
Training and Certification	32	6
Communications	34	1
Communications	35	13
Communications	36	1
Emergency Preparedness	39	1
Compliance Monitoring	47	56
Compliance Monitoring	49	40
Compliance Monitoring	50	1

Breakdown of Contributing Causes of Noncompliance in 1990 (continued)

Contributing Cause	Question Number	Count of Contributing Cause
Compliance Monitoring	51	1
Regulations and Permits	54	4
Regulations and Permits	55	3
Regulations and Permits	60	2
Regulations and Permits	62	10
External Circumstances	66	1
External Circumstances	67	1
Equipment Problems	69	1
Equipment Problems	70	3

Distribution of Noncompliance by Noncompliance Category in 1998

Noncompliance Category	Count of Category
Equipment/Unit Design	2
Exceedance	16
Labeling	4
Monitoring	8
Operations and Maintenance	17
Record Keeping	21
Report Submissions and Reporting	20
Spill/Release	3
Training and Certification	1
Unpermitted/Unauthorized Activity	3

Distribution of Root Causes of Noncompliance in 1998

Root Cause	1998 Count Of Root Cause
Human Error	31
Policies	2
Procedures	31
Management	8
Communications	8
Emergency Preparedness	1
Process Upset or Failure	3
Compliance Monitoring	6
Regulations and Permits	38
External Circumstances	4
Equipment Problems	9

Breakdown of Root Causes of Noncompliance in 1998

Root Cause	Question Number	Count of Root Cause
Human Error	1	27
Human Error	2	2
Human Error	3	2
Policies	9	2
Procedures	11	20
Procedures	12	2
Procedures	13	2
Procedures	14	2
Procedures	15	5
Management	20	1
Management	23	2
Management	24	4
Management	25	1
Communications	34	2
Communications	36	3
Communications	37	3
Emergency Preparedness	39	1
Process Upset or Failure	45	1
Process Upset or Failure	46	2
Compliance Monitoring	47	1
Compliance Monitoring	49	2
Compliance Monitoring	50	3
Regulations and Permits	54	4
Regulations and Permits	55	7
Regulations and Permits	58	1
Regulations and Permits	60	2
Regulations and Permits	61	6

Breakdown of Root Causes of Noncompliance in 1998 (continued)

Root Cause	Question Number	Count of Root Cause
Regulations and Permits	62	12
Regulations and Permits	64	6
External Circumstances	67	4
Equipment Problems	69	4
Equipment Problems	70	2
Equipment Problems	71	2
Equipment Problems	72	1

Distribution of Root Causes of Noncompliance by Noncompliance Category in 1998

Category	Question Number	Counts
Equipment/Unit Design	12	1
Equipment/Unit Design	55	1
Equipment/Unit Design	11	1
Exceedance	69	4
Exceedance	61	3
Exceedance	24	3
Exceedance	70	2
Exceedance	46	2
Exceedance	1	2
Exceedance	36	1
Exceedance	37	1
Exceedance	20	1
Exceedance	12	1
Exceedance	9	1
Exceedance	71	1
Exceedance	45	1
Labeling	11	3
Labeling	1	1
Monitoring	62	3
Monitoring	11	2
Monitoring	49	2
Monitoring	64	1
Monitoring	60	1
Monitoring	14	1
Monitoring	13	1
Monitoring	1	1
Monitoring	24	1

Distribution of Root Causes of Noncompliance by Noncompliance Category in 1998 (continued)

Category	Question Number	Counts
Monitoring	9	1
Operations and Maintenance	1	8
Operations and Maintenance	11	3
Operations and Maintenance	62	2
Operations and Maintenance	47	1
Operations and Maintenance	39	1
Operations and Maintenance	34	1
Operations and Maintenance	25	1
Operations and Maintenance	3	1
Operations and Maintenance	2	1
Operations and Maintenance	61	1
Operations and Maintenance	15	1
Operations and Maintenance	60	1
Late or Incomplete Recordkeeping	55	5
Late or Incomplete Recordkeeping	1	5
Late or Incomplete Recordkeeping	11	5
Late or Incomplete Recordkeeping	54	4
Late or Incomplete Recordkeeping	15	3
Late or Incomplete Recordkeeping	23	2
Late or Incomplete Recordkeeping	62	2
Late or Incomplete Recordkeeping	64	2
Late or Incomplete Recordkeeping	34	1
Late or Incomplete Recordkeeping	37	1
Late or Incomplete Recordkeeping	2	1
Late or Incomplete Recordkeeping	50	1
Report Submissions and Reporting	1	7
Report Submissions and Reporting	67	4
Report Submissions and Reporting	11	4

Distribution of Root Causes of Noncompliance by Noncompliance Category in 1998 (continued)

Category	Question Number	Counts
Report Submissions and Reporting	62	3
Report Submissions and Reporting	50	2
Report Submissions and Reporting	58	1
Report Submissions and Reporting	15	1
Report Submissions and Reporting	14	1
Report Submissions and Reporting	3	1
Report Submissions and Reporting	37	1
Report Submissions and Reporting	36	1
Spill/Release	62	1
Spill/Release	72	1
Spill/Release	64	1
Spill/Release	61	1
Spill/Release	55	1
Spill/Release	11	1
Spill/Release	1	1
Spill/Release	71	1
Training and Certification	11	1
Unpermitted/Unauthorized Activity	64	2
Unpermitted/Unauthorized Activity	1	2
Unpermitted/Unauthorized Activity	13	1
Unpermitted/Unauthorized Activity	36	1
Unpermitted/Unauthorized Activity	61	1
Unpermitted/Unauthorized Activity	62	1

Distribution of Contributing Causes of Noncompliance in 1998

Contributing Cause	Count of Contributing Cause
Human Error	20
Policies	4
Procedures	24
Training	4
Management	16
Communications	8
Emergency Preparedness	2
Compliance Monitoring	15
Regulations and Permits	9
External Circumstances	3
Equipment Problems	2

Breakdown of Contributing Causes of Noncompliance in 1998

Category	Question Number	Count
Human Error	1	13
Human Error	2	4
Human Error	3	3
Policies	9	4
Procedures	11	5
Procedures	12	1
Procedures	13	11
Procedures	15	1
Procedures	16	3
Procedures	17	2
Procedures	19	1
Management	23	7
Management	24	7
Management	26	1
Management	27	1
Training	30	1
Training	32	1
Training	33	2
Communication	34	4
Communication	35	2
Communication	36	1
Communication	37	1
Emergency Preparedness	40	2
Compliance Monitoring	47	1
Compliance Monitoring	49	13
Compliance Monitoring	52	1
Regulations and Permits	54	1
Regulations and Permits	55	3
Regulations and Permits	60	2
Regulations and Permits	62	2
Regulations and Permits	64	1
External Circumstances	65	1

Breakdown of Contributing Causes of Noncompliance in 1998 (continued)

Category	Question Number	Count
External Circumstances	66	1
External Circumstances	67	1
Equipment problems	70	1
Equipment problems	72	1

Distribution of Contributing Causes by Noncompliance Category in 1998

Category	Question Number	Counts
Equipment/Unit Design	40	1
Equipment/Unit Design	49	1
Equipment/Unit Design	1	1
Exceedance	24	4
Exceedance	9	4
Exceedance	62	2
Exceedance	13	1
Exceedance	11	1
Exceedance	66	1
Exceedance	2	1
Exceedance	27	1
Labeling	33	2
Labeling	3	1
Labeling	13	1
Monitoring	1	3
Monitoring	13	1
Monitoring	49	1
Monitoring	2	1
Monitoring	16	1
Monitoring	24	1
Operations and Maintenance	23	5
Operations and Maintenance	13	4
Operations and Maintenance	49	4
Operations and Maintenance	60	2
Operations and Maintenance	1	2
Operations and Maintenance	11	2
Operations and Maintenance	35	2

Distribution of Contributing Causes by Noncompliance Category in 1998 (continued)

Category	Question Number	Counts
Operations and Maintenance	24	1
Operations and Maintenance	55	1
Operations and Maintenance	40	1
Operations and Maintenance	34	1
Operations and Maintenance	26	1
Operations and Maintenance	72	1
Operations and Maintenance	32	1
Operations and Maintenance	70	1
Late or Incomplete Recordkeeping	49	4
Late or Incomplete Recordkeeping	1	3
Late or Incomplete Recordkeeping	13	3
Late or Incomplete Recordkeeping	34	2
Late or Incomplete Recordkeeping	23	2
Late or Incomplete Recordkeeping	16	2
Late or Incomplete Recordkeeping	3	2
Late or Incomplete Recordkeeping	17	1
Late or Incomplete Recordkeeping	12	1
Late or Incomplete Recordkeeping	55	1
Late or Incomplete Recordkeeping	2	1
Late or Incomplete Recordkeeping	47	1
Report Submissions and Reporting	49	3
Report Submissions and Reporting	1	3
Report Submissions and Reporting	19	1
Report Submissions and Reporting	67	1
Report Submissions and Reporting	65	1
Report Submissions and Reporting	64	1
Report Submissions and Reporting	52	1
Report Submissions and Reporting	37	1

Distribution of Contributing Causes by Noncompliance Category in 1998 (continued)

Category	Question Number	Counts
Report Submissions and Reporting	34	1
Report Submissions and Reporting	24	1
Report Submissions and Reporting	13	1
Report Submissions and Reporting	11	1
Report Submissions and Reporting	30	1
Spill/Release	1	1
Spill/Release	11	1
Spill/Release	36	1
Spill/Release	55	1
Training and Certification	15	1
Training and Certification	17	1
Unpermitted/Unauthorized Activity	54	1
Unpermitted/Unauthorized Activity	2	1

APPENDIX B

BLANK PRE-EMS, POST-EMS, AND CORPORATE SURVEYS

Pre-Environmental Management System (EMS) Survey for the EMS Implementation Study

A joint study by

United States Environmental Protection Agency Region 1

and

United Technologies Corporation

June 29, 1999

If you have any questions about this survey, please contact:

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Overview and Introduction

In 1993, the United States Environmental Protection Agency (EPA) and United Technologies Corporation (UTC) filed a consent decree in the United States District Court for the District of Connecticut settling a multimedia enforcement action. Under the settlement, UTC agreed to develop and implement environmental management systems (EMS) in all of its facilities in New England (currently 19, including Hamilton Standard Division, Pratt & Whitney Division, Sikorsky Aircraft Division, and UT Research Division). EPA and UTC seek to understand the causes of noncompliance and specifically the relationship between environmental performance and the existence and level of implementation of EMSs at the facility level.

Included with this survey is a facility-specific profile that presents the findings of violation as noted in the second amended and supplemental complaint filed by EPA in 1990.

The objectives of this project are to:

- Quantify the effect the implementation of an EMS has on compliance
- Quantify the changes in root causes of noncompliance before and after implementation of an EMS at a facility
- Determine whether the level of implementation and acceptance of an EMS has a measurable effect on compliance or on the root causes of noncompliance

For this project, root cause analysis is the process of: (1) identifying factors that caused or contributed to a noncompliance event, (2) evaluating what can be done to prevent such incidents from recurring, and (3) identifying opportunities to improve compliance practices and EMSs.

Overview and Introduction

The survey contains six sections. Only Sections 1 through 5 require responses. **Section 6 is for reference only.** Please complete all the items in sections 1 through 5. Thank you for your cooperation and support.

Section	Title	Purpose
1	Facility Information	Establish a profile of the facilities completing the survey
2	Root and Contributing Causes	Determine the root and contributing causes of noncompliance
3	Response to the Noncompliance	Identify the actions taken to address noncompliance events; evaluate how a facility verified the effectiveness of the actions; and describe lessons learned
4	Elements of an Environmental Management System	Evaluate the status of EMS elements
5	Pollution Prevention and Waste Minimization	Evaluate the status of pollution prevention and waste minimization activities
6	Definitions of Noncompliance Categories	Provide definitions for completing Section 2

The following definitions apply to terms used in this survey.

Environmental impact - any change in the environment, whether adverse or beneficial, wholly or partially resulting from an organization's activities, products, and services.

Environmental management system - the part of the overall management system of a facility that includes organizational structure, planning activities, responsibilities, practices, procedures, processes, and resources for developing, implementing, achieving, reviewing, and maintaining the environmental policy.

Environmental performance - measurable results of the environmental management system, related to an organization's control of its environmental aspects, based on its environmental policy, objectives, and targets.

Pollution prevention - use of processes, practices, or products that avoid or reduce the generation of pollutants before recycling, treatment, or disposal, which may include source reduction and closed-loop (within-process) recycling, as well as conserving such resources as energy and water.

Product stewardship - incorporation of health, safety, and environmental protection as an integral part of a product's life cycle, from manufacture, marketing, and distribution to use, recycling, and disposal.

SECTION 1

The purpose of this section is to collect facility information that is important in supporting the analysis of responses. Please respond NA, or not applicable, to items that are not applicable to the facility.

---

1. Please provide the **primary** four-digit Standard Industrial Classification (SIC) code of the facility in 1990.

2. How many employees worked at the facility in 1990?
(Please check one box each for A and B.)

   A. Full-time employees

   ☐ 0-9 ☐ 10-49 ☐ 50-100 ☐ 101-500 ☐ More than 500

   B. Full-time contractors

   ☐ 0-9 ☐ 10-49 ☐ 50-100 ☐ 101-500 ☐ More than 500

3. What are the job responsibilities of the person(s) completing this survey?
(Check all that apply.)

   ☐ Compliance staff ☐ Operator ☐ Environmental engineer

   ☐ Corporate management ☐ Plant management ☐ Engineer (other than environmental)

   ☐ Other (specify) _____

4. Identify the activities performed at the facility in 1990 (for example, production, packaging, storage, and research and development).

   _____

   _____

5. What were the total standard hours for the facility in 1990? _____

SECTION 1 — Facility Information

6. Did the facility employ the following essential elements of a management system in 1990?

   Circle Y (Yes) or N (No).

Essential Elements of a Environmental Management System		Present Today	
A.	**Policy and Leadership**		
1.	Written environmental policy or mission statement	**Y**	**N**
2.	Written environment, health, and safety (EH&S) policy defined by top management that sets forth management's philosophy, commitment, and goals and expectations	**Y**	**N**
3.	Written EH&S policy includes explicit commitment to regulatory compliance	**Y**	**N**
4.	Written EH&S policy includes explicit commitment to pollution prevention	**Y**	**N**
5.	Philosophy of continuous improvement is integrated into environmental policy	**Y**	**N**
6.	Written EH&S policy available to employees	**Y**	**N**
7.	Written EH&S policy available to customers	**Y**	**N**
8.	Written EH&S policy available to suppliers	**Y**	**N**
9.	Written EH&S policy available to the public	**Y**	**N**
10.	Communication of EH&S policy to all employees	**Y**	**N**
11.	Communication of EH&S policy to all customers	**Y**	**N**
12.	Communication of EH&S policy to all suppliers	**Y**	**N**
13.	Annual review of EH&S policy	**Y**	**N**
14.	Senior operations managers demonstrate commitment and leadership by ensuring EH&S is incorporated into the business decision-making process (for example, purchasing, engineering, and manufacturing)	**Y**	**N**
15.	Senior operations managers demonstrate commitment and leadership by participating in EH&S activities with employees (for example, meetings, inspections, and audits)	**Y**	**N**
16.	Senior operations managers demonstrate commitment and leadership by fostering participation in external groups	**Y**	**N**
17.	Written procedures define how the operation implements the EH&S policy	**Y**	**N**
B.	**Organization**		
1.	Formal lines of authority and responsibility and accountability for environmental management established	**Y**	**N**
2.	Committee established to direct and coordinate the overall EH&S program	**Y**	**N**
3.	Scheduled meetings of the EH&S committee	**Y**	**N**
4.	Environmental managers have organizational stature, independence, and authority to implement environmental programs and to make decisions about environmental protection	**Y**	**N**
5.	EH&S technical staff available to provide technical consulting or advice	**Y**	**N**
6.	Written EH&S implementation plan for all tenants sharing the site	**Y**	**N**
7.	System in place to ensure that appropriate procedures, programs, and activities exist	**Y**	**N**
8.	System in place to ensure that personnel who have environmental responsibilities have relevant background and training	**Y**	**N**
9.	System in place to ensure that adequate technical skills are available to the operation	**Y**	**N**
10.	System in place to ensure employee participation in the development and implementation of EH&S programs and activities	**Y**	**N**

SECTION 1 — Facility Information

Essential Elements of a Environmental Management System		Present Today	
B.	**Organization (continued)**		
11.	System in place to review and approve operation-wide policies, plans, programs, and other initiatives	**Y**	**N**
12.	System in place to provide direction to line and functional staff	**Y**	**N**
13.	System in place for tracking and interpreting new federal, state, and local regulations and changes in such regulations and updating facility policies and directives for the organization's response	**Y**	**N**
14.	System in place to ensure that environmental reports required by federal and state regulations are prepared routinely and submitted on a timely basis	**Y**	**N**
15.	EH&S technical coordinator (senior level) in place for each operation	**Y**	**N**
16.	EH&S technical coordinator in place to assess EH&S conditions and advise management of appropriate prevention and control strategies	**Y**	**N**
17.	Staff participation in EH&S management system throughout all functional areas (for example, finance, marketing, purchasing, and engineering)	**Y**	**N**
C.	**Planning**		
1.	Written annual EH&S plan incorporated into the overall operation's business plan	**Y**	**N**
2.	Annual plan includes numerical targets and goals	**Y**	**N**
3.	Annual plan includes objectives and activities to achieve targets and goals	**Y**	**N**
4.	Annual plan addresses risk reduction	**Y**	**N**
5.	Annual plan addresses compliance with legal and company or corporate policies and standards	**Y**	**N**
6.	Annual plan specifies timing and responsibility for completion	**Y**	**N**
D.	**Accountability**		
1.	Written accountability system includes the achievement of EH&S goals	**Y**	**N**
2.	Accountability system holds all employees accountable for assigned responsibilities and activities to attain EH&S goals and objectives	**Y**	**N**
3.	Accountability system holds all employees accountable for complying with EH&S policies, rules, procedures, regulations, and environmental performance	**Y**	**N**
4.	Accountability system holds operations and functional management accountable for management practices in the area of responsibility of each	**Y**	**N**
5.	Accountability system addresses recognition of superior performance	**Y**	**N**
6.	Accountability system addresses incorporation of EH&S performance into the operation's pay-for-performance program	**Y**	**N**
7.	Accountability system addresses incorporation of EH&S into job descriptions and performance appraisals, as a key element of each	**Y**	**N**
E.	**Assessment, Prevention, and Control**		
1.	Process in place to continually identify, assess, and set priorities among EH&S hazards and risks	**Y**	**N**
2.	Preventive maintenance program developed and implemented to ensure proper operation of pollution control equipment	**Y**	**N**
3.	Strategy in place to effectively manage risks; strategy defines prevention methods and controls that would eliminate or minimize inherent risks	**Y**	**N**

Essential Elements of a Environmental Management System		Present Today	
E.	**Assessment, Prevention, and Control (continued)**		
4.	Employee medical program in place that complies with local laws, promotes health, and provides treatment for and management of occupational injury or illness	**Y**	**N**
5.	Emergency planning and response capability in place that includes measures to protect people, the environment, and property from fire and explosion, chemical spills or releases, natural disasters, or any other major risk to people or the environment	**Y**	**N**
6.	Written emergency action plan in place	**Y**	**N**
7.	Integration of EH&S into the product development and procurement process	**Y**	**N**
F.	**Education and Training**		
1.	Initial training curriculum in place that includes EH&S policy	**Y**	**N**
2.	For a new job responsibility or a change in process, initial training curriculum in place specific to that job responsibility	**Y**	**N**
3.	Refresher training program in place	**Y**	**N**
4.	Mandatory training program in place that includes EH&S policy (and other management policy) that provides specific EH&S requirements that are conditions of employment	**Y**	**N**
5.	Job-specific training curriculum in place that addresses hazards, risks, and prevention and control practices	**Y**	**N**
6.	Documented training program and tracking system in place	**Y**	**N**
G.	**Communications**		
1.	Documented communication plan in place for internal communication of EH&S issues and information	**Y**	**N**
2.	Documented communication plan in place for external communication of EH&S issues and information	**Y**	**N**
3.	Documented communication plan for discussing EH&S performance, including progress toward goals and activities and accomplishments, as well as incidents and rules, procedures, and general awareness	**Y**	**N**
4.	Process in place to collect and analyze comments as a component of EH&S program evaluation	**Y**	**N**
5.	Process in place to provide technology transfer to other parts of the operation and to external entities about EH&S lessons learned	**Y**	**N**
H.	**Rules and Procedures**		
1.	Written EH&S rules and procedures in place and integrated into work instructions	**Y**	**N**
2.	EH&S rules and procedures based on hazards, risks, applicable regulatory requirements, and company standards	**Y**	**N**
3.	EH&S rules and procedures reviewed with affected employees	**Y**	**N**
4.	Compliance with EH&S rules and procedures enforced by operations management	**Y**	**N**
5.	Violation of EH&S rules and procedures treated in same fashion as violation of other company rules and procedures	**Y**	**N**

SECTION 1 — Facility Information

Essential Elements of a Environmental Management System		Present Today	
I.	**Inspections and Audits**		
1.	Inspection and audit programs in place (evaluate implementation of programs, procedures, and policies; evaluate relevant physical conditions; evaluate action of employees)	**Y**	**N**
2.	Corrective action program in place (findings and deficiencies identified during inspections and audits reviewed to identify appropriate corrective action, including timely and effective implementation)	**Y**	**N**
3.	Environmental compliance audits conducted at least every three years	**Y**	**N**
4.	Audits conducted by persons independent of the unit subject to the compliance audit	**Y**	**N**
5.	Results of compliance audits reported directly to facility management	**Y**	**N**
6.	Periodic audits of the environmental management system conducted	**Y**	**N**
7.	Independent assurance reviews conducted periodically by corporate EH&S staff	**Y**	**N**
J.	**Incident Investigations**		
1.	Written procedure in place for reporting and investigation of incidents	**Y**	**N**
2.	Incident investigation tracking system in place	**Y**	**N**
3.	Routine root cause analysis completed for incidents	**Y**	**N**
4.	Corrective action program in place (findings and deficiencies identified during incidents reviewed to identify appropriate corrective action, including timely and effective implementation)	**Y**	**N**
K.	**Documents and Records Management**		
1.	System in place to create, distribute, control, and manage documents and records prepared in support of the EH&S program	**Y**	**N**
2.	Designated point of contact in place for records related to the environmental management system.	**Y**	**N**
3.	Written description of the environmental management system in place that describes its organizational and functional structure and elements.	**Y**	**N**
L.	**Program Evaluation**		
1.	Annual evaluation of EH&S management system's implementation and effectiveness	**Y**	**N**
2.	Annual assessment of facility's overall regulatory compliance	**Y**	**N**
3.	Regular review of environmental management system by top management to ensure adequacy and effectiveness	**Y**	**N**
4.	Tracking system in place to measure progress toward attainment of goals of the EH&S program	**Y**	**N**
5.	Periodic reviews to ensure integrity and efficacy of environmental management system and revisions made as necessary	**Y**	**N**
6.	Corrective action program in place (findings and deficiencies identified during program evaluation reviewed to identify appropriate corrective actions and incorporate appropriate corrective actions in the annual EH&S plan)	**Y**	**N**

SECTION 1 — Facility Information

7. In 1990, had the facility made an inventory of current or potential environmental impacts associated with its operations, services, and products?

☐ NO ☐ YES If YES, which? ☐ Current ☐ Potential

If yes, did an inventory of environmental impacts affect the facility's ability to manage compliance with environmental regulations?

Explain briefly the level of detail contained in the inventory of environmental impacts and how the inventory has been used.

8. What indicators (for example, environmental indicators such as fines, or pollution prevention indicators such as wastewater discharge) were **in use** in 1990? Please list them in the table below, indicating how they were used and any associated goals or targets established. Please indicate as well whether each item was selected in response to a regulatory requirement.

Indicator	How Used	Goal/Target	Regulatory Requirement?
a.			**Y** **N**
b.			**Y** **N**
c.			**Y** **N**
d.			**Y** **N**
e.			**Y** **N**
f.			**Y** **N**
g.			**Y** **N**

SECTION 1 — Facility Information

Please provide the 1990 values for the indicators listed above (following the example provided).

Indicator	Non-normalized Value	Normalization Factor	Normalized Value
Wastewater discharge	100,000 gal/day	1,000,000 pounds product	0.1 gal/day/pound
a.			
b.			
c.			
d.			
e.			
f.			
g.			

9. In 1990, had the facility participated in community outreach activities (for example, reporting of environmental performance, involvement in conservation activities, or marketing energy use)?

☐ NO ☐ YES

If yes, briefly describe the activities and the motivation for participating.

SECTION 2

Several factors can cause or contribute to an incident of noncompliance. The purpose of this section is to determine the **root** and **contributing causes** of the violation(s) listed in the facility profile provided with this survey.

A **root cause** is a primary factor in an incident of noncompliance. For this survey, please identify no more than three root causes for each noncompliance code.

A **contributing cause** is a secondary factor in an incident of noncompliance.

Please follow these instructions for completing the table in this section:

Step 1: Root Cause. In the following table, enter each noncompliance code from the facility profile in the **Root Cause** column next to items that were primary factors in the noncompliance. **For the Root Cause column, enter each noncompliance code no more than three times.**

Step 2: Contributing Cause. On the same table, enter the appropriate noncompliance code from the facility profile in the **Contributing Cause** column next to each item that was a secondary factor in the noncompliance. **Please note that you may enter a noncompliance code in the Contributing Cause column as many times as necessary to describe the secondary factors.**

Categories and Items	Root Cause	Contributing Cause
Human Error		
1. Individual responsibility or professional judgment	_____	_____
2. Fatigue, lack of alertness, distraction	_____	_____
3. Inexperience, lack of knowledge, lack of technical expertise	_____	_____
4. Other (specify) _____	_____	_____
Policies		
5. Unavailable policy	_____	_____
6. Unclear policy	_____	_____
7. Environmental objectives and targets unclear	_____	_____
8. Policy not followed	_____	_____
9. Pollution control technologies or other technical equipment needs not assessed	_____	_____
10. Other (specify) _____	_____	_____

SECTION 2 — Root and Contributing Causes

Categories and Items	Root Cause	Contributing Cause
Procedures		
11. Operating procedure not followed	_____	_____
12. Operating procedure unclear or out-of-date	_____	_____
13. Difficulty in relating operating procedures to actual facility operations and products	_____	_____
14. No written operating procedures available	_____	_____
15. Record keeping procedures inadequate	_____	_____
16. Definition of roles and responsibilities unclear	_____	_____
17. Reporting or notification procedures unclear	_____	_____
18. Pre-startup review omitted or inadequate	_____	_____
19. Other (specify) _____	_____	_____
Management		
20. No formal management structure to address noncompliance and follow-through	_____	_____
21. Management organization undefined	_____	_____
22. Management support or guidance not provided	_____	_____
23. Staffing - inappropriate level or expertise	_____	_____
24. Environmental aspects of facility process and operations not identified	_____	_____
25. Control and oversight of purchased materials, equipment, and services not provided or inadequate	_____	_____
26. Environmental planning or budgeting not completed	_____	_____
27. Result of economic competition	_____	_____
28. Other (specify) _____	_____	_____
Training		
29. Employee not trained	_____	_____
30. Training materials unclear or outdated	_____	_____
31. Training not available	_____	_____
32. Training requirements unclear	_____	_____
33. Other (specify) _____	_____	_____

SECTION 2 — Root and Contributing Causes

Categories and Items	Root Cause	Contributing Cause
Communications - difficulties between		
34. Employees	_____	_____
35. Management and employee	_____	_____
36. Facility and regulatory agencies	_____	_____
37. Other (specify) _____	_____	_____
Emergency Preparedness		
38. Emergency preparedness plan unavailable	_____	_____
39. Emergency preparedness plan insufficient	_____	_____
40. Implementation issues related to the emergency preparedness plan	_____	_____
41. Other (specify) _____	_____	_____
Process Upset or Failure - as a result of		
42. Over pressure	_____	_____
43. Over temperature	_____	_____
44. Runaway reaction	_____	_____
45. Raw material	_____	_____
46. Other (specify) _____	_____	_____
Compliance Monitoring		
47. Audit program insufficient	_____	_____
48. Audit follow-up procedures insufficient	_____	_____
49. Routine site and equipment compliance checks not conducted		
50. No system to ensure timely submittal of environmental reports to regulatory agency	_____	_____
51. Insufficient environmental data	_____	_____
52. Other (specify) _____	_____	_____

SECTION 2 — Root and Contributing Causes

Categories and Items	Root Cause	Contributing Cause
Regulations and Permits		
53. Conflicting permit conditions	_____	_____
54. Ambiguous federal regulations	_____	_____
55. Ambiguous state regulations	_____	_____
56. Regulatory change not communicated by regulatory agency	_____	_____
57. Contradiction between state and federal regulations	_____	_____
58. Inconsistent or contradictory federal regulations	_____	_____
59. Inconsistent or contradictory state regulations	_____	_____
60. Inconsistent or contradictory interpretation of federal regulations	_____	_____
61. Inconsistent or contradictory interpretation of state regulations	_____	_____
62. Facility unaware of applicability of a regulation	_____	_____
63. Rule implementation time frames are too short	_____	_____
64. Other (specify) _____	_____	_____
External Circumstances		
65. An act outside the control of the individuals who operate the process	_____	_____
66. External phenomenon (for example, weather, theft, flood, or fire)	_____	_____
67. Contracted services, such as haulers or handlers	_____	_____
68. Other (specify) _____	_____	_____
Equipment Problems (see the follow-up question on page 14)		
69. Design or installation	_____	_____
70. Equipment maintenance	_____	_____
71. Ordinary wear and tear	_____	_____
72. Site and equipment inspections not conducted	_____	_____
73. Failure to follow up on exceptions noted in inspections	_____	_____
74. Other (specify) _____	_____	_____

SECTION 2 — Root and Contributing Causes

Categories and Items	Root Cause	Contributing Cause
Other Categories or Items (specify)		
75. _____	_____	_____
76. _____	_____	_____
77. _____	_____	_____

Complete the following ONLY if you identified equipment problems as a cause on page 13. Complete the next line to identify which equipment problem you are describing. Check (✔) the appropriate box in the left column to indicate the type of equipment involved and then identify all functions lost using the key at the right.

Item Number _____ **Noncompliance Code** _____

Type of equipment:	**Function(s) lost:**	**Key:**
☐ Piping	_____	**a** Containment
☐ Tanks, vessels, reactors	_____	**b** Process control
☐ Pumps, compressors, blowers, turbines (rotating equipment)	_____	**c** Active mitigation (mechanical systems)
☐ Motors	_____	**d** Passive mitigation (natural systems or intrinsic processes)
☐ Heat exchangers	_____	
☐ Control valves	_____	**e** Material transport
☐ Solids handling	_____	**f** Other (specify)
☐ Instrumentation	_____	_____
☐ Other (specify) _____	_____	

(Use the forms on the next page to describe additional items, if necessary.)

SECTION 3

The purpose of this section is to identify the actions taken to address the violation(s) identified in the facility profile provided with the survey, to identify how the facility verified the effectiveness of those actions, and to describe the lessons learned.

For each action taken, complete all columns. *NOTE: If you need more space, please make copies of the page provided; it follows page 16.*

List the associated noncompliance codes (from the facility profile)	List all specific actions related to the noncompliance taken to prevent recurrence, including development or enhancements of procedures, corporate policies, or EMSs.	How did the facility verify that the action taken would ensure compliance? (For example, was the action verified through a self-assessment audit, root cause analysis, etc.?)	Describe any lessons learned and with whom the facility shared those lessons (for example, trade associations).
a.			
b.			
c.			

SECTION 3 — Response to the Noncompliance

List the associated noncompliance codes (from the facility profile)	List all specific actions related to the noncompliance taken to prevent recurrence, including development or enhancements of procedures, corporate policies, or EMSs.	How did the facility verify that the action taken would ensure compliance? (For example, was the action verified through a self-assessment audit, root cause analysis, etc.?)	Describe any lessons learned and with whom the facility shared those lessons (for example, trade associations).
d.			
e.			
f.			
g.			

SECTION 4

The table in this section presents a list of elements that typically are part of an EMS. The purpose of this section is to collect information that will allow comparison of EMS systems, UTC's management system SP001, and data collected in other root cause analysis projects.

Please read the descriptions below and check the appropriate response.

		Part of facility procedures in 1990?	
		Yes (✔)	No (✔)
A.	**Policy and Leadership**		
1.	Goals and objectives statement includes an environmental policy statement.		
2.	Top management defines environmental policy and sets goals and expectations for environmental performance.		
3.	Philosophy of continuous improvement is integrated into the environmental policy.		
4.	Environmental policy includes an explicit written commitment to regulatory compliance and pollution prevention.		
5.	Environmental policy is communicated to all levels of the workforce and is available to the public.		
B.	**Planning**		
1.	Environmental planning is part of the budget and business development process.		
2.	Planning process includes establishment of specific objectives and targets with time frames.		
C.	**Implementation, Operation, and Accountability**		
1.	Formal lines of authority and responsibility and accountability for environmental management have been established.		
2.	Environmental managers have organizational stature, independence, and authority to implement environmental programs and to make decisions about environmental protection.		
3.	Responsibility for environmental management is incorporated into personnel evaluations, rewards, and incentives.		
4.	A system is in place to review environmental procedures and update them periodically.		
5.	A system is in place for tracking and interpreting new federal, state, and local regulations and changes in such regulations and updating facility policies and directives for the organization's response.		
6.	Responsibility and accountability for environmental performance are shared by staff employees and managers at all levels.		

SECTION 4 — Elements of an Environmental Management System

		Part of facility procedures in 1990?	
		Yes (✔)	No (✔)
C.	**Implementation, Operation, and Accountability (continued)**		
7.	A system is in place through which employees can communicate about environmental issues and concerns directly with top management or environmental managers.		
8.	A system is in place to ensure that personnel who have environmental responsibilities have the relevant background and training to carry out their responsibilities.		
9.	A system is in place to ensure that environmental reports required by federal and state regulations are prepared routinely and submitted on a timely basis.		
10.	Procedures are established to identify the potential for and response to emergency situations.		
D.	**Performance Measurement and Corrective Action**		
1.	A preventive maintenance program has been developed and implemented to ensure proper operation of pollution control equipment.		
2.	Environmental compliance audits are conducted at least every three years.		
3.	Audits are conducted by persons independent of the unit that is the subject of the compliance audit.		
4.	Results of compliance audits are reported directly to facility management.		
5.	A formal system is in place for follow-up of exceptions noted in inspections or audits and supported by management review.		
6.	Periodic audits of the management system are conducted at the facility.		
7.	The integrity and efficacy of the management system are reviewed periodically and revisions are made as necessary.		
8.	A written description of the management system is in place that describes its organizational and functional structure and elements.		
9.	A designated point of contact is in place for records related to the management system.		
E.	**Management Review and Reporting**		
1.	Top management reviews the EMS regularly to ensure its continuing adequacy and effectiveness.		
2.	Documented review addresses possible need for changes in policy, objectives, and other elements of the EMS.		

SECTION 5

1. Was the facility engaged in pollution prevention activities in 1990?

   ☐ Yes ☐ No

   If yes, for how long had the facility been engaged in those activities? _____

2. Was a pollution prevention plan required by state law in 1990?

   ☐ Yes ☐ No

3. Did the facility have a pollution prevention plan in 1990?

   ☐ Yes ☐ No

   If yes, when did the facility adopt this plan? _____

4. Please indicate on the check list below which elements of a pollution prevention program were in place at the facility in 1990.

Elements of a Pollution Prevention Program	Present in 1990	
A. Policy, Leadership, and Accountability		
1. Designated pollution prevention goals with specific targets for reduction of volume or toxicity	**Y**	**N**
2. Senior operations managers demonstrate commitment and leadership by fostering participation in pollution prevention work groups	**Y**	**N**
B. Organization		
1. Established formal pollution prevention team at the facility level	**Y**	**N**
2. Established formal pollution prevention team at the operations level	**Y**	**N**
3. Established partnership with federal, regional, or state pollution prevention agencies and organizations	**Y**	**N**
4. Employed available federal, state, or other pollution prevention resources, such as agency publications or information clearinghouses	**Y**	**N**

SECTION 5 — Pollution Prevention and Waste Minimization

Elements of a Pollution Prevention Program	Present in 1990	
C. Planning		
1. Developed a facility environmental baseline (in addition to those chemicals and quantities that must be reported to the Toxic Release Inventory under section 313 of the Emergency Planning and Community Right-to-Know Act [EPCRA])	**Y**	**N**
2. Developed a site map as part of the facility environmental baseline. The site map includes the following elements:	**Y**	**N**
A. Discharge points ("outfalls") and the types of pollutants likely to be discharged to each drainage area	**Y**	**N**
B. Discharge patterns and direction of flow	**Y**	**N**
C. Surface-water bodies, including any proximate stream, river, lake, or other body of water that receives storm water discharges from the site	**Y**	**N**
D. Structural control measures (physically constructed features used to control storm water flows)	**Y**	**N**
E. Locations of significant materials exposed to storm water	**Y**	**N**
F. Locations of industrial activities	**Y**	**N**
3. Developed a materials inventory for all pollutants that are produced, handled, stored, treated, or disposed of on-site	**Y**	**N**
4. Identified all sources that generate waste	**Y**	**N**
5. Conducted a pollution prevention opportunity assessment	**Y**	**N**
6. Developed priorities and rank for facility wide pollution prevention activities	**Y**	**N**
7. Established numerical target goals for reducing pollution by a certain amount and a schedule with milestone dates for achieving those goals	**Y**	**N**
8. Identification of obstacles to implementing the pollution prevention plan	**Y**	**N**
9. Use less energy or fewer materials to perform a task by designing new production processes or modifying existing ones or by improving maintenance	**Y**	**N**
10. Consider pollution prevention opportunities from a multimedia perspective (that is, considering air, water, and land as a unified whole, while avoiding the transfer of risk from one medium to another)	**Y**	**N**
11. Application of environmental management hierarchy throughout pollution prevention decision making (that is, source reduction has the highest priority, recycling is the next preferable approach, and treatment and disposal is the last-resort measure)	**Y**	**N**
12. Changing inputs or reducing the reliance on toxic or hazardous raw materials by substituting non-toxic for toxic feedstocks in the manufacture of a product	**Y**	**N**
13. Implementation or participation in EPA's "33/50" Program for the reduction of 17 identified chemical wastes	**Y**	**N**
14. Substitution of environmentally-preferable products for chlorofluorocarbons (CFC) or other ozone-depleting compounds	**Y**	**N**

SECTION 5 — Pollution Prevention and Waste Minimization

Elements of a Pollution Prevention Program	Present in 1990	
C. Planning (continued)		
15. Expanded time horizon analysis for evaluating true economic benefits and costs of pollution prevention	**Y**	**N**
16. Annual plan addresses compliance with legal and company or corporate policies and standards for pollution prevention	**Y**	**N**
17. Annual plan defines timing and responsibility for completion of pollution prevention activities	**Y**	**N**
18. Developed product stewardship plans for all products	**Y**	**N**
D. Rules and Procedures		
1. Perform total cost accounting (or full cost environmental accounting) to allocate direct and indirect costs to specific products and processes	**Y**	**N**
2. Include pollution prevention considerations in production decision making	**Y**	**N**
3. A formal procedure is in place to review pollution prevention opportunities for each new process or process modification	**Y**	**N**
E. Assessment, Control, and Prevention		
1. Maintain a waste tracking system to track all waste generated by type and by process	**Y**	**N**
2. Replace hazardous chemicals with less toxic alternatives that have equivalent performance specifications	**Y**	**N**
3. Improve materials management practices to prevent expiration of or damage to products	**Y**	**N**
4. Consider environmentally conscious design elements for any activity that reduces waste generation through operation and maintenance changes	**Y**	**N**
5. Routinely check storage areas and containers for leaks and spills	**Y**	**N**
6. Maintain equipment in good working order to extend its useful life	**Y**	**N**
7. Keep work areas neat and organized to reduce the chance of spills or releases of chemicals	**Y**	**N**
F. Education and Training		
1. Initial training curriculum is in place that includes pollution prevention policy and practices, risk and hazards, and source reduction opportunities	**Y**	**N**
2. Initial baseline training for engineers and follow-up periodic training on UTC's "Design for Environment" issues	**Y**	**N**
G. Communications		
1. Process is in place to collect and evaluate the comments of **internal** sources as a component of evaluation of the pollution prevention program	**Y**	**N**
2. Written pollution prevention policies and activities available to suppliers	**Y**	**N**
3. Written pollution prevention policies and activities available to customers	**Y**	**N**

SECTION 5 — Pollution Prevention and Waste Minimization

Elements of a Pollution Prevention Program	Present in 1990	
G. Communications (continued)		
4. Written pollution prevention policies and activities available to the public	**Y**	**N**
5. Process is in place to collect and evaluate the comments of **external** sources as a component of evaluation of the pollution prevention program	**Y**	**N**
H. Inspections and Audits		
1. Annual pollution prevention audits performed to identify new opportunities for waste reduction	**Y**	**N**
I. Program Evaluation and Results		
1. Annual review of pollution prevention policy	**Y**	**N**
2. Annual evaluation of implementation and effectiveness of the pollution prevention plan	**Y**	**N**
3. Annual review and analysis of tracking system data to measure progress toward pollution prevention goals and objectives	**Y**	**N**
4. Experienced fewer work-related injuries and exposures of workers to hazardous substances	**Y**	**N**
5. Experienced reduced liability for on- and off-site treatment, storage, and disposal	**Y**	**N**

SECTION 5 — Pollution Prevention and Waste Minimization

5. Did pollution prevention activities at the facility meet the following criteria for success in 1990?

a. Improved compliance with applicable federal, state, and local environmental requirements and regulations	**Y**	**N**
Please explain _____		
b. Reduced waste management operations or costs and the purchase of raw materials	**Y**	**N**
Please explain _____		
c. Reduced the probability that the facility might cause environmental contamination that may result in environmental liabilities	**Y**	**N**
Please explain _____		
d. Improved the productivity of staff by providing a cleaner, healthier working environment through reduction of the amounts of toxic materials used	**Y**	**N**
Please explain _____		
e. Increased efficiency through innovative pollution prevention techniques identified and implemented under the pollution prevention program	**Y**	**N**
Please explain _____		

SECTION 6

For Reference Only - For Use in Completing Sections 2 and 3

Character Term

A Corrective Action Activities
Although not necessarily indicative of noncompliance with regulations, this category addresses corrective action activities imposed by a legal agreement such as a º3008(h) or º3013 order under RCRA.

B Equipment/Unit Design
Noncompliance resulting from design deficiencies for structures, systems, or resources.

C Exceedance
Failure to meet discharge limit(s), as defined in the facility's permit or by regulation.

D Failure to Respond
Failure to respond to an information request.

E Labeling
General noncompliance with regulations that require labels and placards.

F Legal Agreement
Failure to correct a violation in accordance with any agreement or to achieve a milestone as required under any agreement.

G Monitoring/Detection/Control
Failure to comply with monitoring, detection, or control requirements.

H Operations and Maintenance
General noncompliance of an operational and maintenance nature, such as: the use of defective containers; failure to close hazardous waste containers; lack of aisle space in storage areas; or failure to perform required inspections, calibrations, and maintenance of any equipment.

Character Term

J Record Keeping (incomplete or late)
Noncompliance related to operating records or files, not maintained in accordance with regulations. Includes failure to maintain training records as required by regulation and failure to file complete and accurate manifest reports.

K Report Submissions and Reporting
General failures to submit required reports or the submittal of incomplete or inaccurate reports to the regulating agencies. Includes failure to report spills or releases to the regulating agencies in a timely manner, as defined by regulation.

L Spills/Releases
Noncompliance related to spills or releases.

M Testing
Failure to perform sampling or analysis in accordance with prescribed procedures or permit criteria.

N Training/Certification
Failure to train environmental personnel in the performance of their duties, as specified by regulation (includes inadequate training and failure to conduct refresher training). Includes lack of training and certification records and failure to provide certification training.

O Unpermitted/Unauthorized Activity
Noncompliance resulting from unpermitted or unauthorized activities or equipment. Includes noncompliance with permit requirements and failure to obtain a permit or authorization.

P Waste Identification
Failure to identify or characterize waste as required by regulation.

SECTION 6 — Definitions of Noncompliance Categories / Statutes

Statutes

Character	Statute
1	Clean Air Act (CAA)
2	Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)
3	Clean Water Act (CWA)
4	Emergency Planning and Community Right-to-Know Act (EPCRA)
5	Resource Conservation and Recovery Act (RCRA)
6	Toxic Substances Control Act (TSCA)

Post-Environmental Management System (EMS) Survey for the EMS Implementation Study

A joint study by

United States Environmental Protection Agency Region 1

and

United Technologies Corporation

June 29, 1999

If you have any questions about this survey, please contact:

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Overview and Introduction

In 1993, the United States Environmental Protection Agency (EPA) and United Technologies Corporation (UTC) filed a consent decree in the United States District Court for the District of Connecticut settling a multimedia enforcement action. Under the settlement, UTC agreed to develop and implement environmental management systems (EMS) in all of its facilities in New England (currently 19, including Hamilton Standard Division, Pratt & Whitney Division, Sikorsky Aircraft Division, and UT Research Division). EPA and UTC seek to understand the causes of noncompliance and specifically the relationship between environmental performance and the existence and level of implementation of EMSs at the facility level.

Included with this survey is a facility-specific profile that presents the findings of violation as noted in the Haley & Aldrich compliance audit. The profile included with this survey was developed by UTC.

The objectives of this project are to:

- Quantify the effect the implementation of an EMS has on compliance
- Quantify the changes in root causes of noncompliance before and after implementation of an EMS at a facility
- Determine whether the level of implementation and acceptance of an EMS has a measurable effect on compliance or on the root causes of noncompliance

For this project, root cause analysis is the process of: (1) identifying factors that caused or contributed to a noncompliance event, (2) evaluating what can be done to prevent such incidents from recurring, and (3) identifying opportunities to improve compliance practices and EMSs.

Overview and Introduction

The survey contains five sections. Only Sections 1 through 4 require responses. **Section 5 is for reference only.** Please complete all the items in sections 1 through 4. Thank you for your cooperation and support.

Section	Title	Purpose
1	Facility Information	Establish a profile of the facilities completing the survey
2	Root and Contributing Causes	Determine the root and contributing causes of noncompliance
3	Response to the Noncompliance	Identify the actions taken to address noncompliance events; evaluate how a facility verified the effectiveness of the actions; and describe lessons learned
4	Pollution Prevention and Waste Minimization	Evaluate the status of pollution prevention and waste minimization activities
5	Definitions of Noncompliance Categories	Provide definitions for completing Section 2

The following definitions apply to terms used in this survey.

Environmental impact - any change in the environment, whether adverse or beneficial, wholly or partially resulting from an organization's activities, products, and services.

Environmental management system - the part of the overall management system of a facility that includes organizational structure, planning activities, responsibilities, practices, procedures, processes, and resources for developing, implementing, achieving, reviewing, and maintaining the environmental policy.

Environmental performance - measurable results of the environmental management system, related to an organization's control of its environmental aspects, based on its environmental policy, objectives, and targets.

Pollution prevention - use of processes, practices, or products that avoid or reduce the generation of pollutants before recycling, treatment, or disposal, which may include source reduction and closed-loop (within-process) recycling, as well as conserving such resources as energy and water.

Product stewardship - incorporation of health, safety, and environmental protection as an integral part of a product's life cycle, from manufacture, marketing, and distribution to use, recycling, and disposal.

SECTION 1

The purpose of this section is to collect facility information that is important in supporting the analysis of responses. Please respond NA, or not applicable, to items that are not applicable to the facility.

---

1. Please provide the **primary** four-digit Standard Industrial Classification (SIC) code of the facility.

2. How many employees are located at the facility?
(Please check one box each for A and B.)

   A. Full-time employees

   ☐ 0-9 ☐ 10-49 ☐ 50-100 ☐ 101-500 ☐ More than 500

   B. Full-time contractors

   ☐ 0-9 ☐ 10-49 ☐ 50-100 ☐ 101-500 ☐ More than 500

3. What are the job responsibilities of the person(s) completing this survey?
(Check all that apply.)

   ☐ Compliance staff ☐ Operator ☐ Environmental engineer

   ☐ Corporate management ☐ Plant management ☐ Engineer (other than environmental)

   ☐ Other (specify) _____

4. Identify the activities currently performed at the facility (for example, production, packaging, storage, and research and development).

   _____

   _____

5. How many years has the facility been in operation (as of today)?

   ☐ 1-5 ☐ 6-10 ☐ More than 10

6. What is the total standard hours for the facility (for 1998)? _____

SECTION 1 — Facility Information

7. Does the facility employ the following essential elements of an environmental management system in 1990? Circle Y (Yes) or N (No).

Essential Elements of a Environmental Management System		Present Today	
A.	**Policy and Leadership**		
1.	Written environmental policy or mission statement	**Y**	**N**
2.	Written environment, health, and safety (EH&S) policy defined by top management that sets forth management's philosophy, commitment, and goals and expectations	**Y**	**N**
3.	Written EH&S policy includes explicit commitment to regulatory compliance	**Y**	**N**
4.	Written EH&S policy includes explicit commitment to pollution prevention	**Y**	**N**
5.	Philosophy of continuous improvement is integrated into environmental policy	**Y**	**N**
6.	Written EH&S policy available to employees	**Y**	**N**
7.	Written EH&S policy available to customers	**Y**	**N**
8.	Written EH&S policy available to suppliers	**Y**	**N**
9.	Written EH&S policy available to the public	**Y**	**N**
10.	Communication of EH&S policy to all employees	**Y**	**N**
11.	Communication of EH&S policy to all customers	**Y**	**N**
12.	Communication of EH&S policy to all suppliers	**Y**	**N**
13.	Annual review of EH&S policy	**Y**	**N**
14.	Senior operations managers demonstrate commitment and leadership by ensuring EH&S is incorporated into the business decision-making process (for example, purchasing, engineering, and manufacturing)	**Y**	**N**
15.	Senior operations managers demonstrate commitment and leadership by participating in EH&S activities with employees (for example, meetings, inspections, and audits)	**Y**	**N**
16.	Senior operations managers demonstrate commitment and leadership by fostering participation in external groups	**Y**	**N**
17.	Written procedures define how the operation implements the EH&S policy	**Y**	**N**
B.	**Organization**		
1.	Formal lines of authority and responsibility and accountability for environmental management established	**Y**	**N**
2.	Committee established to direct and coordinate the overall EH&S program	**Y**	**N**
3.	Scheduled meetings of the EH&S committee	**Y**	**N**
4.	Environmental managers have organizational stature, independence, and authority to implement environmental programs and to make decisions about environmental protection	**Y**	**N**
5.	EH&S technical staff available to provide technical consulting or advice	**Y**	**N**
6.	Written EH&S implementation plan for all tenants sharing the site	**Y**	**N**
7.	System in place to ensure that appropriate procedures, programs, and activities exist	**Y**	**N**
8.	System in place to ensure that personnel who have environmental responsibilities have relevant background and training	**Y**	**N**
9.	System in place to ensure that adequate technical skills are available to the operation	**Y**	**N**
10.	System in place to ensure employee participation in the development and implementation of EH&S programs and activities	**Y**	**N**

SECTION 1 — Facility Information

Essential Elements of a Environmental Management System		Present Today	
B.	**Organization (continued)**		
11.	System in place to review and approve operation-wide policies, plans, programs, and other initiatives	**Y**	**N**
12.	System in place to provide direction to line and functional staff	**Y**	**N**
13.	System in place for tracking and interpreting new federal, state, and local regulations and changes in such regulations and updating facility policies and directives for the organization's response	**Y**	**N**
14.	System in place to ensure that environmental reports required by federal and state regulations are prepared routinely and submitted on a timely basis	**Y**	**N**
15.	EH&S technical coordinator (senior level) in place for each operation	**Y**	**N**
16.	EH&S technical coordinator in place to assess EH&S conditions and advise management of appropriate prevention and control strategies	**Y**	**N**
17.	Staff participation in EH&S management system throughout all functional areas (for example, finance, marketing, purchasing, and engineering)	**Y**	**N**
C.	**Planning**		
1.	Written annual EH&S plan incorporated into the overall operation's business plan	**Y**	**N**
2.	Annual plan includes numerical targets and goals	**Y**	**N**
3.	Annual plan includes objectives and activities to achieve targets and goals	**Y**	**N**
4.	Annual plan addresses risk reduction	**Y**	**N**
5.	Annual plan addresses compliance with legal and company or corporate policies and standards	**Y**	**N**
6.	Annual plan specifies timing and responsibility for completion	**Y**	**N**
D.	**Accountability**		
1.	Written accountability system includes the achievement of EH&S goals	**Y**	**N**
2.	Accountability system holds all employees accountable for assigned responsibilities and activities to attain EH&S goals and objectives	**Y**	**N**
3.	Accountability system holds all employees accountable for complying with EH&S policies, rules, procedures, regulations, and environmental performance	**Y**	**N**
4.	Accountability system holds operations and functional management accountable for management practices in the area of responsibility of each	**Y**	**N**
5.	Accountability system addresses recognition of superior performance	**Y**	**N**
6.	Accountability system addresses incorporation of EH&S performance into the operation's pay-for-performance program	**Y**	**N**
7.	Accountability system addresses incorporation of EH&S into job descriptions and performance appraisals, as a key element of each	**Y**	**N**
E.	**Assessment, Prevention, and Control**		
1.	Process in place to continually identify, assess, and set priorities among EH&S hazards and risks	**Y**	**N**
2.	Preventive maintenance program developed and implemented to ensure proper operation of pollution control equipment	**Y**	**N**
3.	Strategy in place to effectively manage risks; strategy defines prevention methods and controls that would eliminate or minimize inherent risks	**Y**	**N**

Essential Elements of a Environmental Management System		Present Today	
E.	**Assessment, Prevention, and Control (continued)**		
4.	Employee medical program in place that complies with local laws, promotes health, and provides treatment for and management of occupational injury or illness	**Y**	**N**
5.	Emergency planning and response capability in place that includes measures to protect people, the environment, and property from fire and explosion, chemical spills or releases, natural disasters, or any other major risk to people or the environment	**Y**	**N**
6.	Written emergency action plan in place	**Y**	**N**
7.	Integration of EH&S into the product development and procurement process	**Y**	**N**
F.	**Education and Training**		
1.	Initial training curriculum in place that includes EH&S policy	**Y**	**N**
2.	For a new job responsibility or a change in process, initial training curriculum in place specific to that job responsibility	**Y**	**N**
3.	Refresher training program in place	**Y**	**N**
4.	Mandatory training program in place that includes EH&S policy (and other management policy) that provides specific EH&S requirements that are conditions of employment	**Y**	**N**
5.	Job-specific training curriculum in place that addresses hazards, risks, and prevention and control practices	**Y**	**N**
6.	Documented training program and tracking system in place	**Y**	**N**
G.	**Communications**		
1.	Documented communication plan in place for internal communication of EH&S issues and information	**Y**	**N**
2.	Documented communication plan in place for external communication of EH&S issues and information	**Y**	**N**
3.	Documented communication plan for discussing EH&S performance, including progress toward goals and activities and accomplishments, as well as incidents and rules, procedures, and general awareness	**Y**	**N**
4.	Process in place to collect and analyze comments as a component of EH&S program evaluation	**Y**	**N**
5.	Process in place to provide technology transfer to other parts of the operation and to external entities about EH&S lessons learned	**Y**	**N**
H.	**Rules and Procedures**		
1.	Written EH&S rules and procedures in place and integrated into work instructions	**Y**	**N**
2.	EH&S rules and procedures based on hazards, risks, applicable regulatory requirements, and company standards	**Y**	**N**
3.	EH&S rules and procedures reviewed with affected employees	**Y**	**N**
4.	Compliance with EH&S rules and procedures enforced by operations management	**Y**	**N**
5.	Violation of EH&S rules and procedures treated in same fashion as violation of other company rules and procedures	**Y**	**N**

SECTION 1 — Facility Information

Essential Elements of a Environmental Management System		Present Today	
I.	**Inspections and Audits**		
1.	Inspection and audit programs in place (evaluate implementation of programs, procedures, and policies; evaluate relevant physical conditions; evaluate action of employees)	**Y**	**N**
2.	Corrective action program in place (findings and deficiencies identified during inspections and audits reviewed to identify appropriate corrective action, including timely and effective implementation)	**Y**	**N**
3.	Environmental compliance audits conducted at least every three years	**Y**	**N**
4.	Audits conducted by persons independent of the unit subject to the compliance audit	**Y**	**N**
5.	Results of compliance audits reported directly to facility management	**Y**	**N**
6.	Periodic audits of the environmental management system conducted	**Y**	**N**
7.	Independent assurance reviews conducted periodically by corporate EH&S staff	**Y**	**N**
J.	**Incident Investigations**		
1.	Written procedure in place for reporting and investigation of incidents	**Y**	**N**
2.	Incident investigation tracking system in place	**Y**	**N**
3.	Routine root cause analysis completed for incidents	**Y**	**N**
4.	Corrective action program in place (findings and deficiencies identified during incidents reviewed to identify appropriate corrective action, including timely and effective implementation)	**Y**	**N**
K.	**Documents and Records Management**		
1.	System in place to create, distribute, control, and manage documents and records prepared in support of the EH&S program	**Y**	**N**
2.	Designated point of contact in place for records related to the environmental management system.	**Y**	**N**
3.	Written description of the environmental management system in place that describes its organizational and functional structure and elements.	**Y**	**N**
L.	**Program Evaluation**		
1.	Annual evaluation of EH&S management system's implementation and effectiveness	**Y**	**N**
2.	Annual assessment of facility's overall regulatory compliance	**Y**	**N**
3.	Regular review of environmental management system by top management to ensure adequacy and effectiveness	**Y**	**N**
4.	Tracking system in place to measure progress toward attainment of goals of the EH&S program	**Y**	**N**
5.	Periodic reviews to ensure integrity and efficacy of environmental management system and revisions made as necessary	**Y**	**N**
6.	Corrective action program in place (findings and deficiencies identified during program evaluation reviewed to identify appropriate corrective actions and incorporate appropriate corrective actions in the annual EH&S plan)	**Y**	**N**

SECTION 1 — Facility Information

8. Has the facility made an inventory of current or potential environmental impacts associated with its operations, services, and products?

☐ NO ☐ YES If YES, which? ☐ Current ☐ Potential

If yes, did an inventory of environmental impacts affect the facility's ability to manage compliance with environmental regulations?

Explain briefly the level of detail contained in the inventory of environmental impacts and how the inventory has been used.

9. What indicators (for example, environmental indicators such as fines, or pollution prevention indicators such as wastewater discharge) are **being used** in 1998? Please list them in the table below, indicating how they were used and any associated goals or targets established. Please indicate as well whether each item was selected in response to a regulatory requirement.

Indicator	How Used	Goal/Target	Regulatory Requirement?
a.			**Y** **N**
b.			**Y** **N**
c.			**Y** **N**
d.			**Y** **N**
e.			**Y** **N**
f.			**Y** **N**
g.			**Y** **N**

SECTION 1 — Facility Information

Please provide the 1998 values for the indicators listed above (following the example provided).

Indicator	Non-normalized Value	Normalization Factor	Normalized Value
Wastewater discharge	100,000 gal/day	1,000,000 pounds product	0.1 gal/day/pound
a.			
b.			
c.			
d.			
e.			
f.			
g.			

10. Does the facility participate in community outreach activities (for example, reporting of environmental performance, involvement in conservation activities, or marketing energy use)?

☐ NO ☐ YES

If yes, briefly describe the activities and the motivation for participating. Also indicate whether implementation of an EMS has motivated participation or changed the types of activities in which the facility participates (use a separate sheet if additional space is required).

SECTION 2

Several factors can cause or contribute to an incident of noncompliance. The purpose of this section is to determine the **root** and **contributing causes** of the violation(s) listed in the facility profile provided with this survey.

A **root cause** is a primary factor in an incident of noncompliance. For this survey, please identify no more than three root causes for each noncompliance code.

A **contributing cause** is a secondary factor in an incident of noncompliance.

Please follow these instructions for completing the table in this section:

Step 1: Root Cause. In the following table, enter each noncompliance code from the facility profile in the **Root Cause** column next to items that were primary factors in the noncompliance. **For the Root Cause column, enter each noncompliance code no more than three times.**

Step 2: Contributing Cause. On the same table, enter the appropriate noncompliance code from the facility profile in the **Contributing Cause** column next to each item that was a secondary factor in the noncompliance. **Please note that you may enter a noncompliance code in the Contributing Cause column as many times as necessary to describe the secondary factors.**

Categories and Items	Root Cause	Contributing Cause
Human Error		
1. Individual responsibility or professional judgment	_____	_____
2. Fatigue, lack of alertness, distraction	_____	_____
3. Inexperience, lack of knowledge, lack of technical expertise	_____	_____
4. Other (specify) _____	_____	_____
Policies		
5. Unavailable policy	_____	_____
6. Unclear policy	_____	_____
7. Environmental objectives and targets unclear	_____	_____
8. Policy not followed	_____	_____
9. Pollution control technologies or other technical equipment needs not assessed	_____	_____
10. Other (specify) _____	_____	_____

SECTION 2 — Root and Contributing Causes

Categories and Items	Root Cause	Contributing Cause
Procedures		
11. Operating procedure not followed	_____	_____
12. Operating procedure unclear or out-of-date	_____	_____
13. Difficulty in relating operating procedures to actual facility operations and products	_____	_____
14. No written operating procedures available	_____	_____
15. Record keeping procedures inadequate	_____	_____
16. Definition of roles and responsibilities unclear	_____	_____
17. Reporting or notification procedures unclear	_____	_____
18. Pre-startup review omitted or inadequate	_____	_____
19. Other (specify) _____	_____	_____
Management		
20. No formal management structure to address noncompliance and follow-through	_____	_____
21. Management organization undefined	_____	_____
22. Management support or guidance not provided	_____	_____
23. Staffing - inappropriate level or expertise	_____	_____
24. Environmental aspects of facility process and operations not identified	_____	_____
25. Control and oversight of purchased materials, equipment, and services not provided or inadequate	_____	_____
26. Environmental planning or budgeting not completed	_____	_____
27. Result of economic competition	_____	_____
28. Other (specify) _____	_____	_____
Training		
29. Employee not trained	_____	_____
30. Training materials unclear or outdated	_____	_____
31. Training not available	_____	_____
32. Training requirements unclear	_____	_____
33. Other (specify) _____	_____	_____

SECTION 2 — Root and Contributing Causes

Categories and Items	Root Cause	Contributing Cause
Communications - difficulties between		
34. Employees	_____	_____
35. Management and employee	_____	_____
36. Facility and regulatory agencies	_____	_____
37. Other (specify) _____	_____	_____
Emergency Preparedness		
38. Emergency preparedness plan unavailable	_____	_____
39. Emergency preparedness plan insufficient	_____	_____
40. Implementation issues related to the emergency preparedness plan	_____	_____
41. Other (specify) _____	_____	_____
Process Upset or Failure - as a result of		
42. Over pressure	_____	_____
43. Over temperature	_____	_____
44. Runaway reaction	_____	_____
45. Raw material	_____	_____
46. Other (specify) _____	_____	_____
Compliance Monitoring		
47. Audit program insufficient	_____	_____
48. Audit follow-up procedures insufficient	_____	_____
49. Routine site and equipment compliance checks not conducted		
50. No system to ensure timely submittal of environmental reports to regulatory agency	_____	_____
51. Insufficient environmental data	_____	_____
52. Other (specify) _____	_____	_____

SECTION 2 — Root and Contributing Causes

Categories and Items	Root Cause	Contributing Cause
Regulations and Permits		
53. Conflicting permit conditions	_____	_____
54. Ambiguous federal regulations	_____	_____
55. Ambiguous state regulations	_____	_____
56. Regulatory change not communicated by regulatory agency	_____	_____
57. Contradiction between state and federal regulations	_____	_____
58. Inconsistent or contradictory federal regulations	_____	_____
59. Inconsistent or contradictory state regulations	_____	_____
60. Inconsistent or contradictory interpretation of federal regulations	_____	_____
61. Inconsistent or contradictory interpretation of state regulations	_____	_____
62. Facility unaware of applicability of a regulation	_____	_____
63. Rule implementation time frames are too short	_____	_____
64. Other (specify) _____	_____	_____
External Circumstances		
65. An act outside the control of the individuals who operate the process	_____	_____
66. External phenomenon (for example, weather, theft, flood, or fire)	_____	_____
67. Contracted services, such as haulers or handlers	_____	_____
68. Other (specify) _____	_____	_____
Equipment Problems (see the follow-up question on page 14)		
69. Design or installation	_____	_____
70. Equipment maintenance	_____	_____
71. Ordinary wear and tear	_____	_____
72. Site and equipment inspections not conducted	_____	_____
73. Failure to follow up on exceptions noted in inspections	_____	_____
74. Other (specify) _____	_____	_____

SECTION 2 — Root and Contributing Causes

Categories and Items	Root Cause	Contributing Cause
Other Categories or Items (specify)		
75. _____	_____	_____
76. _____	_____	_____
77. _____	_____	_____

Complete the following ONLY if you identified equipment problems as a cause on page 13. Complete the next line to identify which equipment problem you are describing. Check (✔) the appropriate box in the left column to indicate the type of equipment involved and then identify all functions lost using the key at the right.

Item Number _____ **Noncompliance Code** _____

Type of equipment:	**Function(s) lost:**	**Key:**
☐ Piping	_____	**a** Containment
☐ Tanks, vessels, reactors	_____	**b** Process control
☐ Pumps, compressors, blowers, turbines (rotating equipment)	_____	**c** Active mitigation (mechanical systems)
☐ Motors	_____	**d** Passive mitigation (natural systems or intrinsic processes)
☐ Heat exchangers	_____	
☐ Control valves	_____	**e** Material transport
☐ Solids handling	_____	**f** Other (specify)
☐ Instrumentation	_____	_____
☐ Other (specify) _____	_____	

(Use the forms on the next page to describe additional items, if necessary.)

SECTION 3

The purpose of this section is to identify the actions taken to address the violation(s) identified in the facility profile provided with the survey, to identify how the facility verified the effectiveness of those actions, and to describe the lessons learned.

For each action taken, complete all columns. *NOTE: If you need more space, please make copies of the page provided; it follows page 16.*

List the associated noncompliance codes (from the facility profile)	List all specific actions related to the noncompliance taken to prevent recurrence.	How did the facility verify that the action taken would ensure compliance? (For example, was the action verified through a self-assessment audit, root cause analysis, etc.?)	Describe any lessons learned and with whom the facility shared those lessons (for example, trade associations).	Describe any changes, additions, or clarifications to SP001, facility procedures, or the facility's EMS to prevent recurrence of the noncompliance.
a.				
b.				
c.				

SECTION 3 — Response to the Noncompliance

List the associated noncompliance codes (from the facility profile)	List all specific actions related to the noncompliance taken to prevent recurrence.	How did the facility verify that the action taken would ensure compliance? (For example, was the action verified through a self-assessment audit, root cause analysis, etc.?)	Describe any lessons learned and with whom the facility shared those lessons (for example, trade associations).	Describe any changes, additions, or clarifications to SP001, facility procedures, or the facility's EMS to prevent recurrence of the noncompliance.
d.				
e.				
f.				
g.				

SECTION 4

1. Is the facility currently engaged in pollution prevention activities?

   ☐ Yes ☐ No

   If yes, for how long has the facility been engaged in those activities? _____

2. Is a pollution prevention plan required by state law?

   ☐ Yes ☐ No

3. Does the facility currently have a pollution prevention plan?

   ☐ Yes ☐ No

   If yes, when did the facility adopt this plan? _____

4. Please indicate on the check list below which elements of a pollution prevention program are in place at the facility.

Elements of a Pollution Prevention Program	Present in 1990	
A. Policy, Leadership, and Accountability		
1. Designated pollution prevention goals with specific targets for reduction of volume or toxicity	**Y**	**N**
2. Senior operations managers demonstrate commitment and leadership by fostering participation in pollution prevention work groups	**Y**	**N**
B. Organization		
1. Established formal pollution prevention team at the facility level	**Y**	**N**
2. Established formal pollution prevention team at the operations level	**Y**	**N**
3. Established partnership with federal, regional, or state pollution prevention agencies and organizations	**Y**	**N**
4. Employed available federal, state, or other pollution prevention resources, such as agency publications or information clearinghouses	**Y**	**N**

SECTION 4 — Pollution Prevention and Waste Minimization

Elements of a Pollution Prevention Program	Present in 1990	
C. Planning		
1. Developed a facility environmental baseline (in addition to those chemicals and quantities that must be reported to the Toxic Release Inventory under section 313 of the Emergency Planning and Community Right-to-Know Act [EPCRA])	**Y**	**N**
2. Developed a site map as part of the facility environmental baseline. The site map includes the following elements:	**Y**	**N**
A. Discharge points ("outfalls") and the types of pollutants likely to be discharged to each drainage area	**Y**	**N**
B. Discharge patterns and direction of flow	**Y**	**N**
C. Surface-water bodies, including any proximate stream, river, lake, or other body of water that receives storm water discharges from the site	**Y**	**N**
D. Structural control measures (physically constructed features used to control storm water flows)	**Y**	**N**
E. Locations of significant materials exposed to storm water	**Y**	**N**
F. Locations of industrial activities	**Y**	**N**
3. Developed a materials inventory for all pollutants that are produced, handled, stored, treated, or disposed of on-site	**Y**	**N**
4. Identified all sources that generate waste	**Y**	**N**
5. Conducted a pollution prevention opportunity assessment	**Y**	**N**
6. Developed priorities and rank for facility wide pollution prevention activities	**Y**	**N**
7. Established numerical target goals for reducing pollution by a certain amount and a schedule with milestone dates for achieving those goals	**Y**	**N**
8. Identification of obstacles to implementing the pollution prevention plan	**Y**	**N**
9. Use less energy or fewer materials to perform a task by designing new production processes or modifying existing ones or by improving maintenance	**Y**	**N**
10. Consider pollution prevention opportunities from a multimedia perspective (that is, considering air, water, and land as a unified whole, while avoiding the transfer of risk from one medium to another)	**Y**	**N**
11. Application of environmental management hierarchy throughout pollution prevention decision making (that is, source reduction has the highest priority, recycling is the next preferable approach, and treatment and disposal is the last-resort measure)	**Y**	**N**
12. Changing inputs or reducing the reliance on toxic or hazardous raw materials by substituting non-toxic for toxic feedstocks in the manufacture of a product	**Y**	**N**
13. Implementation or participation in EPA's "33/50" Program for the reduction of 17 identified chemical wastes	**Y**	**N**
14. Substitution of environmentally-preferable products for chlorofluorocarbons (CFC) or other ozone-depleting compounds	**Y**	**N**

SECTION 4 — Pollution Prevention and Waste Minimization

Elements of a Pollution Prevention Program	Present in 1990	
C. Planning (continued)		
15. Expanded time horizon analysis for evaluating true economic benefits and costs of pollution prevention	**Y**	**N**
16. Annual plan addresses compliance with legal and company or corporate policies and standards for pollution prevention	**Y**	**N**
17. Annual plan defines timing and responsibility for completion of pollution prevention activities	**Y**	**N**
18. Developed product stewardship plans for all products	**Y**	**N**
D. Rules and Procedures		
1. Perform total cost accounting (or full cost environmental accounting) to allocate direct and indirect costs to specific products and processes	**Y**	**N**
2. Include pollution prevention considerations in production decision making	**Y**	**N**
3. A formal procedure is in place to review pollution prevention opportunities for each new process or process modification	**Y**	**N**
E. Assessment, Control, and Prevention		
1. Maintain a waste tracking system to track all waste generated by type and by process	**Y**	**N**
2. Replace hazardous chemicals with less toxic alternatives that have equivalent performance specifications	**Y**	**N**
3. Improve materials management practices to prevent expiration of or damage to products	**Y**	**N**
4. Consider environmentally conscious design elements for any activity that reduces waste generation through operation and maintenance changes	**Y**	**N**
5. Routinely check storage areas and containers for leaks and spills	**Y**	**N**
6. Maintain equipment in good working order to extend its useful life	**Y**	**N**
7. Keep work areas neat and organized to reduce the chance of spills or releases of chemicals	**Y**	**N**
F. Education and Training		
1. Initial training curriculum is in place that includes pollution prevention policy and practices, risk and hazards, and source reduction opportunities	**Y**	**N**
2. Initial baseline training for engineers and follow-up periodic training on UTC's "Design for Environment" issues	**Y**	**N**
G. Communications		
1. Process is in place to collect and evaluate the comments of **internal** sources as a component of evaluation of the pollution prevention program	**Y**	**N**
2. Written pollution prevention policies and activities available to suppliers	**Y**	**N**
3. Written pollution prevention policies and activities available to customers	**Y**	**N**

SECTION 4 — Pollution Prevention and Waste Minimization

Elements of a Pollution Prevention Program	Present in 1990	
G. Communications (continued)		
4. Written pollution prevention policies and activities available to the public	**Y**	**N**
5. Process is in place to collect and evaluate the comments of **external** sources as a component of evaluation of the pollution prevention program	**Y**	**N**
H. Inspections and Audits		
1. Annual pollution prevention audits performed to identify new opportunities for waste reduction	**Y**	**N**
I. Program Evaluation and Results		
1. Annual review of pollution prevention policy	**Y**	**N**
2. Annual evaluation of implementation and effectiveness of the pollution prevention plan	**Y**	**N**
3. Annual review and analysis of tracking system data to measure progress toward pollution prevention goals and objectives	**Y**	**N**
4. Experienced fewer work-related injuries and exposures of workers to hazardous substances	**Y**	**N**
5. Experienced reduced liability for on- and off-site treatment, storage, and disposal	**Y**	**N**

SECTION 4 — Pollution Prevention and Waste Minimization

5. Do pollution prevention activities at the facility meet the following criteria for success currently?

a. Improved compliance with applicable federal, state, and local environmental requirements and regulations	**Y**	**N**
Please explain _____		
b. Reduced waste management operations or costs and the purchase of raw materials	**Y**	**N**
Please explain _____		
c. Reduced the probability that the facility might cause environmental contamination that may result in environmental liabilities	**Y**	**N**
Please explain _____		
d. Improved the productivity of staff by providing a cleaner, healthier working environment through reduction of the amounts of toxic materials used	**Y**	**N**
Please explain _____		
e. Increased efficiency through innovative pollution prevention techniques identified and implemented under the pollution prevention program	**Y**	**N**
Please explain _____		

SECTION 5

For Reference Only - For Use in Completing Sections 2 and 3

Character Term

A Corrective Action Activities
Although not necessarily indicative of noncompliance with regulations, this category addresses corrective action activities imposed by a legal agreement such as a º3008(h) or º3013 order under RCRA.

B Equipment/Unit Design
Noncompliance resulting from design deficiencies for structures, systems, or resources.

C Exceedance
Failure to meet discharge limit(s), as defined in the facility's permit or by regulation.

D Failure to Respond
Failure to respond to an information request.

E Labeling
General noncompliance with regulations that require labels and placards.

F Legal Agreement
Failure to correct a violation in accordance with any agreement or to achieve a milestone as required under any agreement.

G Monitoring/Detection/Control
Failure to comply with monitoring, detection, or control requirements.

H Operations and Maintenance
General noncompliance of an operational and maintenance nature, such as: the use of defective containers; failure to close hazardous waste containers; lack of aisle space in storage areas; or failure to perform required inspections, calibrations, and maintenance of any equipment.

Character Term

J Record Keeping (incomplete or late)
Noncompliance related to operating records or files, not maintained in accordance with regulations. Includes failure to maintain training records as required by regulation and failure to file complete and accurate manifest reports.

K Report Submissions and Reporting
General failures to submit required reports or the submittal of incomplete or inaccurate reports to the regulating agencies. Includes failure to report spills or releases to the regulating agencies in a timely manner, as defined by regulation.

L Spills/Releases
Noncompliance related to spills or releases.

M Testing
Failure to perform sampling or analysis in accordance with prescribed procedures or permit criteria.

N Training/Certification
Failure to train environmental personnel in the performance of their duties, as specified by regulation (includes inadequate training and failure to conduct refresher training). Includes lack of training and certification records and failure to provide certification training.

O Unpermitted/Unauthorized Activity
Noncompliance resulting from unpermitted or unauthorized activities or equipment. Includes noncompliance with permit requirements and failure to obtain a permit or authorization.

P Waste Identification
Failure to identify or characterize waste as required by regulation.

SECTION 5 — Definitions of Noncompliance Categories / Statutes

Statutes

Character	Statute
1	Clean Air Act (CAA)
2	Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)
3	Clean Water Act (CWA)
4	Emergency Planning and Community Right-to-Know Act (EPCRA)
5	Resource Conservation and Recovery Act (RCRA)
6	Toxic Substances Control Act (TSCA)

Corporate Survey
for the
Environmental Management System (EMS)
Implementation Study

A joint study by

United States Environmental Protection Agency Region 1

and

United Technologies Corporation

August 10, 1999

If you have any questions about this survey, please contact:

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Corporate Survey

In 1993, the United States Environmental Protection Agency (EPA) and United Technologies Corporation (UTC) filed a consent decree in the United States District Court for the District of Connecticut settling a multimedia enforcement action. Under the settlement, UTC agreed to develop and implement environmental management systems (EMS) in all of its facilities in New England (currently 19, including Hamilton Standard Division, Pratt & Whitney Division, Sikorsky Aircraft Division, and UT Research Division). EPA and UTC seek to understand the causes of noncompliance and specifically the relationship between environmental performance and the existence and level of implementation of EMSs at the facility level.

The objectives of this project are to:

- Quantify the effect the implementation of an EMS has on compliance
- Quantify the changes in root causes of noncompliance before and after implementation of an EMS at a facility
- Determine whether the level of implementation and acceptance of an EMS has a measurable effect on compliance or on the root causes of noncompliance

For this project, root cause analysis is the process of: (1) identifying factors that caused or contributed to a noncompliance event, (2) evaluating what can be done to prevent such incidents from recurring, and (3) identifying opportunities to improve compliance practices and EMSs.

This corporate survey seeks to gain a historical perspective that will augment the information gathered through the pre-EMS and post-EMS surveys. This survey also will help EPA and industry evaluate traditional and innovative compliance and enforcement activities. The items included seek corporate views about improving compliance with existing regulatory requirements and developing compliance assistance tools and activities. Responses will not be considered a formal petition to amend, modify, or repeal any regulation, nor will responses be used to assess the basis on which a rule was developed.

Corporate Survey

Please use additional paper if more space is needed to answer any of the following questions.

1. The table below contains a list of elements that typically are part of an EMS. Please read the descriptions and check (✓) the appropriate response.

		Part of corporate/ division policy in 1990?	
		Yes (✓)	No (✓)
A.	**Policy and Leadership**		
1.	Goals and objectives statement includes an environmental policy statement.		
2.	Top management defines environmental policy and sets goals and expectations for environmental performance.		
3.	Philosophy of continuous improvement is integrated into the environmental policy.		
4.	Environmental policy includes an explicit written commitment to regulatory compliance and pollution prevention.		
5.	Environmental policy is communicated to all levels of the workforce and is available to the public.		
B.	**Planning**		
1.	Environmental planning is part of the budget and business development process.		
2.	Planning process includes establishment of specific objectives and targets with time frames.		
C.	**Implementation, Operation, and Accountability**		
1.	Formal lines of authority and responsibility and accountability for environmental management have been established.		
2.	Environmental managers have organizational stature, independence, and authority to implement environmental programs and to make decisions about environmental protection.		
3.	Responsibility for environmental management is incorporated into personnel evaluations, rewards, and incentives.		
4.	A system is in place to review environmental procedures and update them periodically.		
5.	A system is in place for tracking and interpreting new federal, state, and local regulations and changes in such regulations and updating facility policies and directives for the organization's response.		
6.	Responsibility and accountability for environmental performance are shared by staff employees and managers at all levels.		
7.	A system is in place through which employees can communicate about environmental issues and concerns directly with top management or environmental managers.		

		Part of corporate/ division policy in 1990?	
		Yes (✓)	No (✓)
C.	**Implementation, Operation, and Accountability (continued)**		
8.	A system is in place to ensure that personnel who have environmental responsibilities have the relevant background and training to carry out their responsibilities.		
9.	A system in place to ensure that environmental reports required by federal and state regulations are prepared routinely and submitted on a timely basis.		
10.	Procedures are established to identify the potential for and response to emergency situations.		
D.	**Performance Measurement and Corrective Action**		
1.	A preventive maintenance program has been developed and implemented to ensure proper operation of pollution control equipment.		
2.	Environmental compliance audits are conducted at least every three years.		
3.	Audits are conducted by persons independent of the unit that is the subject of the compliance audit.		
4.	Compliance audit results are reported directly to facility management.		
5.	A formal system is in place for follow-up of exceptions noted in inspections or audits and supported by management review.		
6.	Periodic audits of the management system are conducted at each facility.		
7.	The integrity and efficacy of the management system are reviewed periodically and revisions are made as necessary.		
8.	A written description of the management system is in place that describes its organizational and functional structure and elements.		
9.	A designated point of contact is in place for records relating to the management system.		
E.	**Management Review and Reporting**		
1.	Top management reviews the EMS regularly to ensure its continuing adequacy and effectiveness.		
2.	Documented review addresses possible need for changes in policy, objectives and other elements of the EMS.		

2. List three regulations (state or federal) under which increased compliance assistance could improve overall environmental compliance. Identify the three regulations with which compliance is most difficult. Identify compliance assistance tools or regulatory reforms that would help ensure compliance with the regulatory provision or language.

Regulatory Provision or Language	Compliance Assistance Tools or Regulatory Reforms

3. Describe any other regulatory reform initiatives or opportunities (existing or future) that would facilitate more efficient compliance with environmental requirements.

4. What industry evaluation methods (for example, compliance audits or EMS audits) could be used as substitutes for traditional compliance inspection, and how could facilities or government demonstrate the credibility of such evaluation methods to the public?

5. What incentives could EPA use to acknowledge or reward sustained compliance?

6. If personnel of regulatory agencies have provided compliance assistance, was that assistance effective?

   ☐ YES ☐ NO

   If YES, who was the government agent (by job description) and what did the agent do? How was that assistance useful?

   If NO, how can regulatory agencies improve their efforts to provide such assistance?

7. In the case of concluded civil or judicial actions that involved your division, could supplemental environmental projects (SEP) have been incorporated to provide more environmentally beneficial settlements? If so, please provide specific examples.

8. Check (✓) the appropriate **YES** or **NO** column to indicate the sources of compliance assistance your division has used. Indicate how useful you found each source by circling the appropriate number. If you did not use a source, indicate how useful you think it would be.

Yes (✓)	No (✓)	Compliance Assistance Sources	Not Very Useful				Very Useful
		Agency hotlines	1	2	3	4	5
		Conferences	1	2	3	4	5
		Consultants	1	2	3	4	5
		Federal employees	1	2	3	4	5
		State employees	1	2	3	4	5
		Your division's employees	1	2	3	4	5
		Internet	1	2	3	4	5
		Other facilities	1	2	3	4	5
		Federal publications	1	2	3	4	5
		State publications	1	2	3	4	5
		State compliance assistance organizations	1	2	3	4	5
		Tools developed by the division	1	2	3	4	5
		Trade associations	1	2	3	4	5
		Universities	1	2	3	4	5
		Vendors and suppliers	1	2	3	4	5
		Other (specify) _____	1	2	3	4	5
		Other (specify) _____	1	2	3	4	5

9. Does your division participate in any voluntary programs sponsored by state or federal regulatory agencies?

☐ YES ☐ NO

If YES, please identify the program(s) and explain its effect on compliance.

If NO, please explain why.

10. On a scale of 1 to 5 (with 5 the most helpful), rate each of the following areas for its helpfulness in improving compliance.

Area	Least Helpful				Most Helpful
More clearly defined commitment on the part of management	1	2	3	4	5
Increased number of employees	1	2	3	4	5
Increased involvement of employees	1	2	3	4	5
Increased involvement of facility management	1	2	3	4	5
Increased exposure of agency personnel to manufacturing operations	1	2	3	4	5
Improved communication between industry and regulatory agency personnel	1	2	3	4	5
Improved access to agency expertise	1	2	3	4	5
Improved communication between the corporate level and facilities	1	2	3	4	5
Improved facility management system	1	2	3	4	5
Improved communication among facilities	1	2	3	4	5
Improved record-keeping procedures	1	2	3	4	5
Improved task-tracking system	1	2	3	4	5
Improved legislative tracking system	1	2	3	4	5
Improved understanding of the regulations	1	2	3	4	5
More clearly defined responsibilities	1	2	3	4	5
More modern equipment	1	2	3	4	5
Other (specify) _____	1	2	3	4	5
Other (specify) _____	1	2	3	4	5

11. Did your division participate in any of the following Region 1 outreach programs? Any state programs?

	Participated?	
	Yes (✓)	No (✓)
A. Emergency Planning and Community Right-to-Know (EPCRA) Workshops		
1. Meeting Your EPCRA Obligations: Current & NEW Requirements (January 13, 1998)		
2. EPCRA Awareness - Do You Know Enough? (February 11, 1998)		
3. Toxics Release Inventory (TRI) Workshops (April 22, 28, and 30 and May 5, 7, 19, and 20, 1998)		
4. TRI "New Industries" Workshops (March 11, 12, 18, and 25, 1998)		
B. Solid Waste and Global Climate Change Events		
1. Northeast Recycling Investment Forum (May 5, 1998)		
2. WasteWise Satellite Forum (June 17, 1998)		
3. Raising Capital: A Practical Seminar for Northeast Recycling Businesses (November 17, 1998)		
4. Pay-as-You-Throw Solid Waste Workshop (June 18, 1998)		
C. Center for Environmental Industry and Technology (CEIT) Events		
1. Stormwater Treatment Technologies Trade Shows (November 17 and 19, June 4, and October 27 and 29, 1998)		
2. Golden Opportunities Seminar Series for Environmental Technology Innovation, Environmental Technology Verification: Accelerating the Commercialization of Innovative Environmental Technologies (December 9, 1997)		
3. On-Site Insights Workshop: Innovative Technologies for Site Assessment and Monitoring (March 30, 1998)		
4. Small Systems Water Treatment Technologies: State-of-the-Art Workshop (April 1, 1998)		
5. Innovative On-Site Wastewater Technologies Trade Shows (April 6 and 8, 1998)		
6. Workshop for Increasing the Use of Innovative Technologies on Small Hazardous Waste and Petroleum Sites (April 28, 1998)		
7. Environmental Venture Capital Forum (May 7, 1998)		
8. EPA Regional Conference, Implementing an Action Plan for a Sustainable New England—Opportunities for the Environmental Industry and Other Businesses: A Continuing Dialogue with the White House and Federal Agencies (March 7, 1998)		

Corporate Survey

	Participated?	
	Yes (✓)	No (✓)
D. New England Environmental Assistance Team (NEEATeam) Events		
1. ACIDS AND BASES: Reducing Cost and Waste, a One-Day Workshop on Pollution Prevention Opportunities (April 28 and May 12 and 19, 1998)		
2. Expecting Inspections: Environmental Compliance and Pollution Prevention for Municipal Highway Garages (June 24 and July 8, 15, and 22, 1998)		
3. Chemical Industry Audit Project: Focus Group (November 24, 1997)		
4. Chemical Industry Audit Project: Environmental Regulations for the Chemical Industry Workshops (May 28 and June 2 and 11, 1998)		
5. Chemical Industry Audit Project: Compliance Assistance Workshops for the Chemical Industry (February 10, 17, 23 and 25, 1998)		
6. Environmental Regulations/Job and Classroom Resources (October 29, 1997)		
7. Maximum Achievable Technology Standard (MACT) Workshop for the Aerospace Industry (August 4, 1998)		
8. RCRA Subpart CC Compliance Assistance (Organic Air Emission Standards for Containers and Tanks) Seminars (June 23 and 25, 1998)		
9. Metal Finishing Workshop: An Update on Regulations and New Technologies for the Metal Plating and Finishing Industries (September 30, 1998)		
10. New England Auto Air-Conditioning Workshop and Technology Trade Show: Regulations, Retrofit Procedures and New Technologies (March 28, 1998)		
11. Printwise Technology Open House (October 21, 1997)		
E. Innovative Environmental Performance (IEP) Team Events		
1. Star Track Opening Conference (June 24, 1998)		
F. Other Region 1 Outreach Programs (Please list title and date)		
1.		
2.		
G. State Outreach Programs (Please list title and date)		
1.		
2.		
3.		
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