Phase IV: Develop and Test the Quantitative Approach of the *IH Value Strategy*

Introduction

The purpose of Phase IV of the Value of the Industrial Hygiene Profession study was to develop and test a quantitative method for determining and illustrating the business value of IH programs and practices.

The overall study is aimed at identifying the ultimate benefits gained through IH programs and/or activities undertaken to mitigate or reduce health risk to the workforce. Both the *Quantitative* and *Qualitative Approaches* are designed to enable the industrial hygienist to identify the impact(s) of risk reduction initiated by such activities, determine its value, and present a value proposition for investing in IH to key stakeholders.

The team found that there were several factors involved in deciding which approach, quantitative or qualitative, was appropriate for a given analysis, including the amount of accessible data, the time available in which to perform the analysis, the audience to whom the IH Value Proposition will be addressed, and the type of IH program or activity to be analyzed. As a result, the team concluded that one could use a *Quantitative Approach*, using concrete data based on experience or educated estimate of future expenditures, or a *Qualitative Approach*, based on estimating a combination of tangible and intangible value.

Background

Demonstrating value requires tracking change or potential change in the level of health risk and measuring potential improvement. The basic principle for making the IH Value Proposition is that, generally, the difference between the combined costs of operating a manufacturing or service process and managing an existing IH hazard and the costs of operating it following the intervention represent net reduced costs to the enterprise; reduced costs less the costs of the intervention represent cost savings, and the savings plus the other benefits represent the value realized. Simply put:

Pre-intervention costs (A) – Post-intervention costs (C) = Reduced costs (D)

Reduced costs (D) – Intervention costs (B) = Net Savings (E)

Net Savings (E) + New Revenue + Other benefits (O) = **Value**

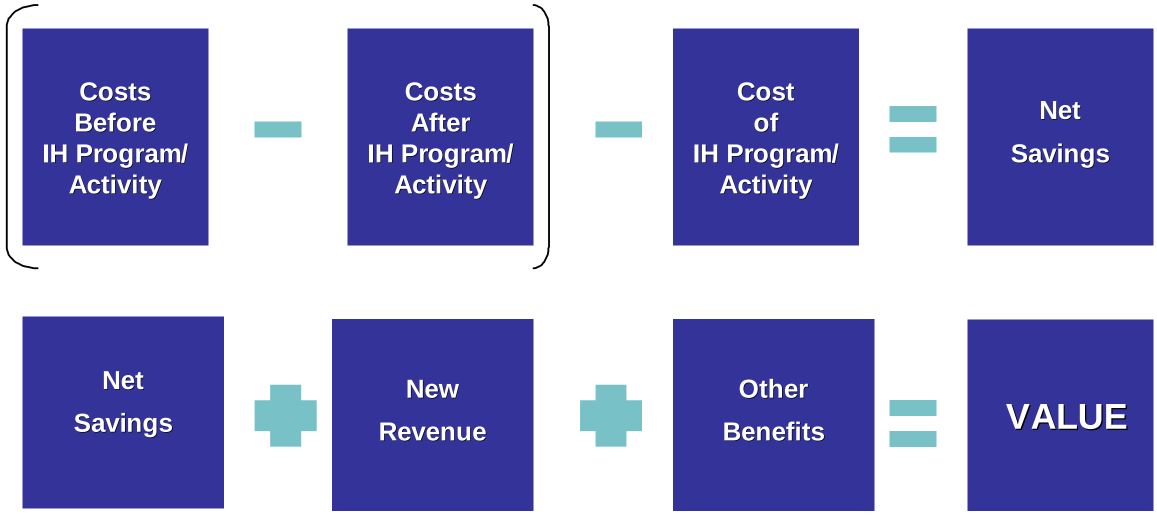

Figure IV-1. IH Value Equation.

ROHSEI

This phase of the project, development of the *Quantitative Approach*, started with the assumption that the Return on Health, Safety and Environmental Investment (ROHSEI) value proposition and financial analysis instrument could provide a basis for an expanded framework for cost/benefit data collection and analysis. ROHSEI was developed in 1995 by a task force of 15 Fortune 500 companies that were members of the ORC Worldwide Occupational Safety and Health Group, in conjunction with Arthur Andersen, LLP, the former accounting firm. The companies sponsored the development of a process and supporting tools designed to help health, safety, and environmental (HSE) professionals answer important questions about their programs and activities, such as:

- What HSE investments should we make?
- How do we know we are doing the "right things" in the "right way"
- To which projects should we allocate our resources?
- Which HSE investments create the greatest value to the organization?
- How do we demonstrate the value of our investment decisions?

Financial metrics can help decision makers understand the direct impact to affected budgets and the organization's bottom line in well-understood terms. ROHSEI incorporates generally accepted accounting principles so as to facilitate communication of the value of HSE investments in terms of key financial metrics such as net present value (NPV), return on investment (ROI), internal rate of return (IRR), discounted payback period (DPP), and others that have proven to be used most frequently by Chief Financial Officers (CFOs). This enables industrial hygienists and other HSE professionals to define the value of IH programs and activities by using common financial metrics where adequate data exist. It also makes it possible for them to link IH programs and activities to the financial objectives of their organizations. ROHSEI has been used successfully to develop a wide variety of HSE business cases, including process safety management, selection of fire protection systems, fleet safety, storm water system design, machine guarding risk assessment, behavior-based safety programs, and disability management programs. With respect to IH, professionals have reported using the ROHSEI process to analyze both IH management and workplace protection business decisions, including issues such as selecting an MSDS tracking system, implementing an interactive S&H training system, and developing an Internet-based S&H publishing process. Fewer studies are known that examine the value of IH for improving employee health protection, other than those related to ergonomics.

The above cases indicated to the IH value study team that the general ROHSEI process could readily be adapted to address the value of IH in protecting employee health at different levels of detail. Thus, opportunity exists to develop business analyses to demonstrate value of IH programs and activities to business.

It was understood from the beginning of the study that the final *Quantitative Approach* would be designed to be used both with the ROHSEI software and independently of ROHSEI. Industrial hygienists would have the option to use the *Quantitative Approach* either by hand, using the equations included with the instructions, or with Excel or other financial management software. It may be possible to calculate simple quantitative analysis without the use of software; however, multiyear projects that have multiple scenarios and parameters and that involve the time value of money will generally require electronic computational capability.

Problem Statement

The goals of Phase IV, development of the *Quantitative Approach*, were to:

1. Identify the elements to be incorporated into the *Approach*, including elements that are indicators of financial performance and/or program/activity success related to IH program activity and investment.

2. Test the *Approach* with respect to:
   usability
   sensitivity, and
   the ability and willingness of IH program managers to collect, track, and analyze the required inputs.

3. In addition, the challenge of enabling roll-up of individual IH program elements to represent a complete IH program, as called for in the original proposal and the statement of work (and as illustrated in the chart that follows on the next page), had to be addressed.

Study Approach

Adaptation of ROHSEI

The team projected that the ROHSEI instrument could serve as the starting point for the *Quantitative Approach*. From it, the elements of an IH program or activity could be identified, and IH project intervention data collected and analyzed. Customizing the ROHSEI strategy specifically to evaluate IH applications required modification of the existing global parameter definitions to apply uniquely to IH value proposition analysis. The study team created 153 user-defined parameters specific to IH to reflect the range of data that could be collected for value propositions that assess the value of moving the level of employee protection up the IH hierarchy of controls. The parameters were aligned with the steps in the IH Value Equation (Figure IV-2), and a method and tools were developed to collect data for IH interventions at the process, facility, and program levels.

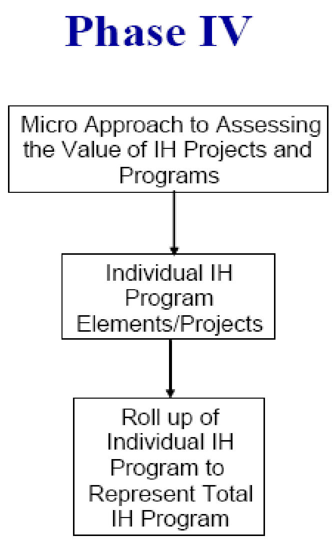

Figure IV-2. Outline of Phase IV Approach.

Although the overall ROHSEI process has been used successfully for 10 years it was important to pilot the data collection tool for IH interventions and subsequent entry of data into the ROHSEI software to demonstrate the successful development of a value proposition for IH programs and/or activities. ORC member companies were contacted to determine if value propositions had been developed for successful IH interventions and, if so, could the data be utilized for the study. Although most of the companies contacted agreed to participate, very few had developed value propositions for previous IH programs and/or activities, and none had post-intervention measures as to the value the organization realized from the intervention. The lack of post intervention business outcomes was surprising and will be explored in detail in subsequent phases of the study.

Therefore, in order to confirm that the ***IH Value Strategy*** could be used successfully, retrospective analyses of both the costs and the benefits of past IH programs and activities had to be reconstructed. Company study participants were eager to develop these costs and benefits, but had to be guided stepwise through the data collection form. With explanation, the study participants were able to reconstruct and accurately capture costs at all stages of their IH programs and activities.

Based on the data collected during Phase I of the project, which involved assessing the availability of IH and health data within ORC member companies, and a second survey of IH program characteristics, potential participants were contacted and asked to provide IH programs or activities that could serve as examples for testing the *Quantitative Approach*, as well as sources for lessons learned about how IH can add value to an organization. Twenty-eight companies volunteered.

The first step in creating the strategy was to develop a questionnaire for gathering cost data by adapting cost/benefit parameters contained in the ROHSEI program to IH applications. These parameters are primarily safety program oriented and do not address IH programs and activities specifically. Some also were found among information housed in the ORC library and other ROHSEI user libraries, and others were added based on the unique characteristics of IH practice.

The initial questionnaire was designed to reflect the before and after approach taken in the IH Value Equation (Figure IV-1), by asking participants first to identify capital costs associated with managing the original IH hazard, and then provide operating costs (expenses) of same. A second section of the questionnaire requested cost information related to the implementation of the program or activity intended to mitigate the hazard, again in terms of capital and operating costs. The third and final section focused on the costs that were expected or had resulted for the same parameters following the implementation. These costs were projected over a three-year period, and the depreciation of capital costs considered as well. The differences between the costs before and costs after IH activity were regarded as cost savings. Cost of implementation of program or activity subtracted from cost savings was regarded as net benefit. A fourth section captured other benefits that had been or were expected to be realized from the IH program or activity.

Company representatives were asked to complete one data collection sheet for each IH program or activity, identified through a telephone interview with an ORC team member as a candidate for the study. In order to provide these data, participants were required to research site records to reconstruct the conditions that existed at the time just preceding the implementation of the IH program or activity under study. ORC team members emphasized that because the quantity and quality of the data would determine the effectiveness of the analysis, participants should make every attempt to obtain information for each data element on the form.

The ***Strategy*** is built on the presumption that it is preferable to have an educated guess to estimate the value of a given parameter rather than not to include data. Recognizing that it may not have been feasible to complete all of the data fields, and that not all may have applied to each case, the team requested that participants provide hard data or estimate a value for the data fields that were appropriate. Companies were assured that all information provided would be kept strictly confidential and not disclosed to anyone without their permission.

To simplify the construction of the value proposition using the ROHSEI software, each data element on the data collection template was correlated numerically with an IH user-defined parameter to simplify the process of entering data into the ROHSEI software. The data collection template was designed to intuitively reflect how value propositions are developed.

For the majority of IH case studies, ORC consultants conducted site visits to complete the analysis of the programs and activities, to review relevant data, and request additional information. The site visits were useful also because of the lessons and insights gained about the roles industrial hygienists play in their organizations and the different ways they contribute value. A summary of lessons learned is found beginning on page 127 of this section.

Representative IH Programs and Activities

As a means to identify "sentinel" IH projects and programs that were to be analyzed and then aggregated to represent an entire IH program, the team identified common areas of focus for typical IH programs. These included biological and chemical exposures, ergonomics, noise, and physical hazards (including heat, cold, vibration, and radiation). Additionally, for each area of concern, the hierarchy of controls was considered as a way to gauge the relative degree of reliability of protective measures taken to control the hazard. Three levels: PPE/Administrative/Work Practice Control, Engineering Control, and Hazard Elimination were used. By this means, the project team would be able to demonstrate the relative value of protective measures across a typical IH program based on the level of control.

Projects identified and completed field study examples were received in the following program categories:

1. Biological Exposure; Hazard Elimination (1 project)
2. Chemical Exposure; PPE/Administrative/Work Practice Controls (1 project)
3. Chemical Exposure; Engineering Controls (5 projects)
4. Chemical Exposure; Hazard Elimination (2 projects)
5. Ergonomics; Engineering Controls (3 projects)
6. Noise; PPE/Administrative/Work Practice Controls (2 projects)
7. Noise; Hazard Elimination (2 projects)

In addition, three projects that provided general lessons learned and qualitative but very broad quantitative information, were also analyzed. Two of these were in the Other Physical Hazards; PPE/Administrative/Work Practice Controls category and one was in the Chemical Exposure; Engineering Controls category. Sixteen of these studies are described in the Phase V section of this report and are referred to in this section for findings and lessons learned.

The 19 projects for which field study data were collected were fewer than the original 28 projected, for a variety of reasons. Primarily, company contacts were unable to place the study at the top of their lists of priorities because of heavy work loads. In some cases, contacts commented that the information-gathering process was too complex, leading the team to re-design the data collection forms. Still others were unable to gain cooperation from their colleagues at the site or business unit level.

Study Findings

The projects and case studies analyzed during this study could not meaningfully be aggregated to constitute a representative IH program because of the lack of consistency between data collection approaches, and the differences in completeness of data among participating companies. Had training in the overall concept of looking for value and the importance of documenting sources been provided, it is likely that this goal could have been accomplished.

However, doing so is possible where cost and benefit data are available for all the projects to be combined. Because of the need for consistency in data quality and quantity, it is more practical to add together all cost and benefit data for a group of programs and/or activities within a company and treat them as one program or activity, calculating financial metrics to demonstrate value. This would require working with the calculated benefit for each sub-activity rather than beginning with costs associated with individual program components.

	Biological Exposure	Chemical Exposure	Ergonomics	Noise	**Other Physical:** Heat, Cold, Vibration Radiation
PPE/ Administrative Controls		X		X	X
Engineering Controls		X	X	X	X
Eliminate Hazard	X	X		X	

Figure IV-3: Quantitative Strategy Matrix – Projects

As described earlier, a means to identify "sentinel" IH projects and programs that could be analyzed and then aggregated to represent an entire IH program, is to identify the common areas of focus for typical IH programs within a company, such as biological, chemical, ergonomic, noise, and other physical hazards, and collect appropriate data on an ongoing, yearly basis. The costs and benefits of each individual project and program can then be calculated for each year, using the value equation provided in the strategy (cost before-cost after, etc.). Without double-counting, these numbers in turn can be added together to represent a total cost before, cost after, cost of implementation, etc. These aggregated numbers then can be used to calculate financial benefit for the sum total of IH programs and activities.

Using the parameters of the *Quantitative Approach* consistently across programs and activities will provide adequate data to use for value analysis. Having the data on hand will enable the industrial hygienist both to respond spontaneously to questions from management and to make the value proposition effectively as a matter of routine.

Description of the *Quantitative Approach* and its components

The *Quantitative Approach* of the ***IH Value Strategy*** is designed to enable the industrial hygienist to identify the impacts of changes that have been or will be made to a manufacturing or service process by an IH program or activity to control or eliminate IH risk, to capture and analyze the costs and benefits (including interventions to control a specific hazard) of those changes, and to present the value proposition for the IH program or activity either prospectively or retrospectively.

Identify Impact of Change

The *Approach* is based on identifying and determining the value of the changes that are impacts of IH programs and activities on the entire manufacturing or service process, both upstream and downstream of the intervention, as well as the direct value of the programs and activities themselves. (See Figure IV-4, Step 5-6.) The basic principle for making the value proposition is that, generally, potential benefit is represented by the difference between the costs of operating a process that requires management of an existing IH hazard and the costs of operating it following an intervention to reduce health risk. This cost, less the costs of the intervention represents potential cost savings, and these potential savings plus new revenue and other benefits represent the value realized. The value can then be expressed through financial metrics that are recognized by business leaders and that can be compared to key financial business objectives.

The ***Strategy*** enables the industrial hygienist to quantify the value realized from activities that control IH hazard(s) by changing the level of worker protection from use of PPE to a higher level of control such as local exhaust ventilation, substitution, or elimination, (with the higher levels of control being more desired from a health protection standpoint) in terms of their economic benefit.

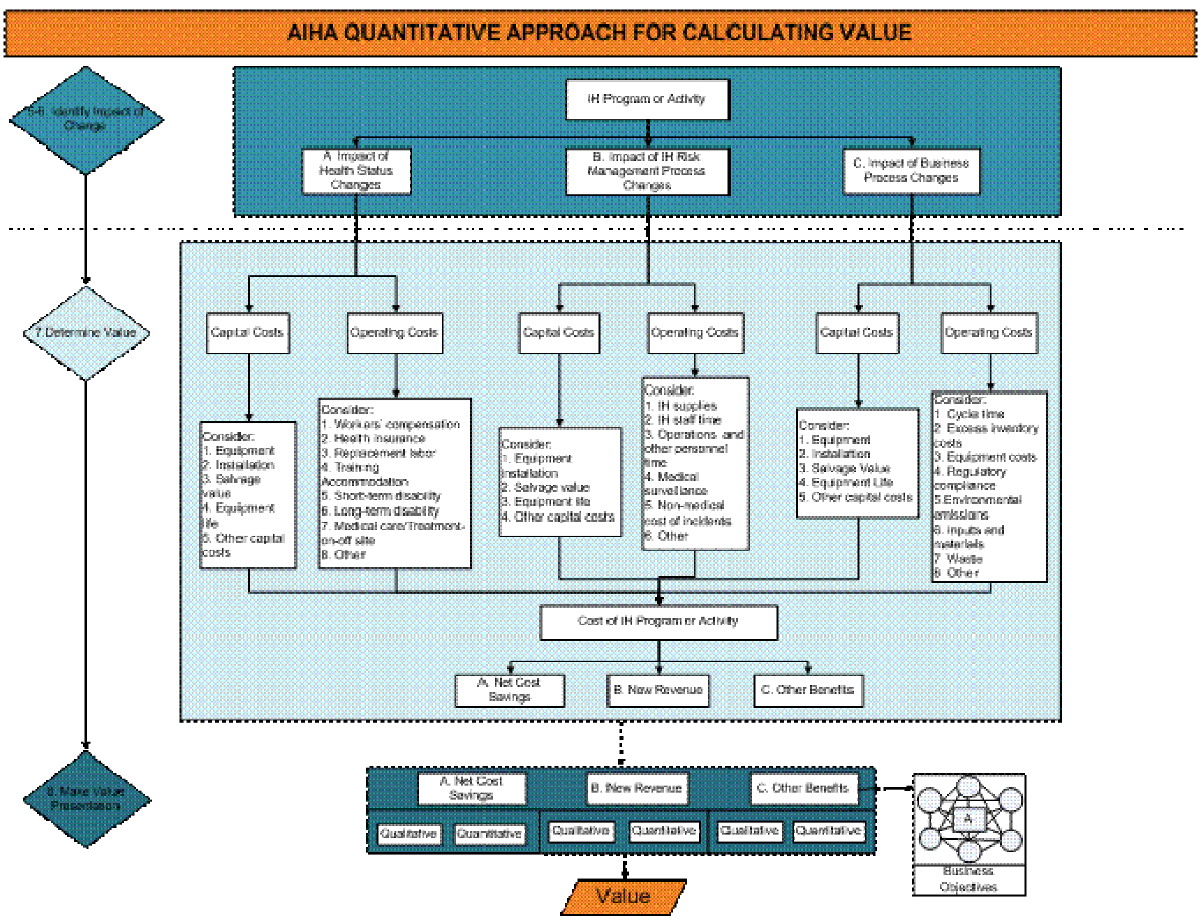

Figure IV-4. The Quantitative Approach.

Mirroring the structure of the *Qualitative Approach* presented in the Phase III section of this report, the *Quantitative Approach* tracks and calculates the financial impact on three key areas: health status, the IH risk management process, and the business process. Other areas that may be impacted such as product quality, productivity, and employee morale may also be evaluated, where quantitative information exists. The *Approach* calls for the user to capture before and after costs in each of the three areas, the costs of the IH program or activity itself, any new revenue that may be generated as a result of process changes, and other benefits that may be quantified. The elements that contribute to understanding the impact within each area are also identified to facilitate and simplify data gathering and analysis. Users are urged to consider every potential source of benefit carefully, so as to build the best possible value proposition for their IH program or activity.

Impact on Health Status

In this *Approach*, the impact of IH programs and activities on employee health status is captured in terms of the total cost impact on occupational illness. (See Figure IV-4, Step 5-6 A.) This cost is further defined as operational cost associated with administration and treatment of occupational illnesses associated with the hazard(s). Capturing the true cost of occupational disease is a difficult challenge for several reasons, including the long latency of many illnesses, the failure of both employees and the medical profession to attribute many conditions to occupational exposures, and the pressure to avoid reporting work-related conditions in general. Examining non-occupational records may be one way to increase knowledge about the incidence of occupational illnesses, however, it is fraught with its own difficulties and is for the most part impractical for industrial hygienists to do so as to obtain meaningful results.

By determining the before and after costs of fatality cases, days away from work injury/illness cases, restricted work injury/illness cases, medical treatment injury/illness cases, and first-aid treatment injury/illness cases, a basic knowledge of readily-identifiable cost impact on health status can be attained. Although the *Approach* does not call for investigation into additional areas of potential health costs, the IH who has access to the health records and understanding of how to identify occupationally-related disease is not precluded from using it in the ***Strategy***.

It turns out, based on the findings of this study, that while it is important to understand the impacts of IH programs and activities on health status, such information may not be as significant to the value proposition as are the process benefits. In terms of the best place to focus efforts for the best return, users should consider the options carefully.

Impact on the IH Risk Management Process

Managing health hazards and risks requires human and material resources and affects the manufacturing or service process. This can represent significant cost. When there is a change in the level of risk in the process, there will likely be changes in the resources required to manage it. Capturing the cost impact of such changes is a major step in making the IH value proposition.

The two categories of costs that must be quantified in order to understand the full impact of an IH program or activity are capital costs and operating costs. Capital costs are costs incurred on the purchase of land, buildings, construction, and equipment to be used in the production of goods or the rendering of services. Operating costs are the recurring expenses which are related to the operation of a business, or to the operation of a device, component, piece of equipment, or facility. Both types of costs can be obtained by working with engineering and operations managers.

Capital costs are sometimes associated with managing a hazard before any IH intervention is made. In evaluating the incremental costs associated with an IH program or activity, capital costs must be included as part of the original scenario, or the base case, as well as after the change has been implemented. Capital costs associated with implementing the IH program or activity itself must also be captured in order to calculate the net savings from the change.

The ***Strategy*** includes costs that are generally classified as capital and required to be budgeted separately, such as the cost of the purchase of equipment and buildings that have a multiyear life expectancy; the costs associated with the installation of capital equipment; any other capital expenses that are associated with the base case, including design and engineering time or software that is specifically purchased for use in the capital project; any residual value that the capital equipment will have once the useful life of the equipment has ended; and the expected life of the equipment (this parameter is required in order for the capital equipment to be properly depreciated for tax purposes).

For most projects a capital cost is usually an up-front, one-time expense. However, it is possible that a capital cost could occur over multiple time periods. The strategy has the ability to address capital costs that may be required in multiple years. A financial specialist for the organization should be consulted to determine if a particular equipment purchase would be treated as a capital expense, and how various costs and benefits should be captured and recorded.

Operating costs are usually a significant part of managing hazards and risks before an IH program or activity is implemented. There will often be a change in these costs following implementation of such a program or activity, and often (but not always) the change will result in cost savings. The difference between pre-intervention operational costs and post-intervention operational costs represents the resulting net operating savings (or loss).

Categories of operating costs that may be spent to manage the health risk include: time spent by operations, IH and safety, and other personnel; the costs for vendors, consultants and contract labor; costs for IH supplies, operations and maintenance; medical surveillance costs; and other costs, including excess insurance premiums, fines and penalties, legal proceedings and settlements, and emergency response. Each category of cost is significant depending on the specific issues presented by the hazard or risk.

In addition to the previous "routine" operating costs, the ***Strategy*** asks industrial hygienists to include excess or incremental costs that result from non-routine events, or incidents, that were caused by the IH risk but that may or may not have resulted in illness or injury. Potential cost savings are determined by calculating the difference between the cost of incidents before the hazard is (or was) abated to the expected cost of incidents after the hazard is (or was) abated. The categories of costs included here are the same as those for the routine costs, only more narrowly focused on incidents alone. Users are cautioned not to double-count costs in these two categories.

The costs of past incidents (before abatement) can best be determined by calculating the average cost per incident for each parameter over the past 5-year period, then multiplying by the number of incidents over the same period. To determine the expected cost of future incidents following the abatement, the total 5-year average cost of incidents for all parameters is multiplied times the projected number of incidents based on the reduction in health risk expected due to the intervention.

Impact on Business Process

The change(s) to the manufacturing or service process that result from an IH intervention may have impacts on other aspects of the business (downstream effects) that are independent of their impacts on health and risk management. These impacts may be in many different aspects of the process, but may not be obvious or intuitive to IH professionals. In order to fully account for the value of IH programs and activities, industrial hygienists should give careful attention to understanding all of their business process impacts. In general, some partnership with management directly involved in the business process is essential.

Just as in the IH risk management area, in the business process section the ***Strategy*** prompts industrial hygienists to consider possible impacts in the areas of capital and operating costs. In this case, capital expenditures are not those that are required to implement the program or activity itself, but rather are made in response to the program or activity because the change to the process requires new or different land, buildings, or equipment. Capital cost categories are the same as those requested for the IH risk management process impacts.

Operating costs, however, are oriented toward effects that change the functioning of the process by increasing or decreasing factors such as cycle time, equipment costs, materials and inputs, inventory costs, regulatory compliance, environmental emissions, and waste. Cycle time is controlled by process steps and motion and non-value-added processing. Inputs include material recovery and substitution, and energy consumption. Excess inventory costs are determined by inventory turnover. Equipment costs include maintenance, equipment downtime, and costs of operating the equipment. Costs of treatment of environmental emissions may be through waste water, air, hazardous waste, and solid waste. Finally, collection, disposal, and recycling account for costs of waste.

Determine Value

Net savings and/or avoidance of cost are determined by comparing the total cost of managing the hazard before the IH program or activity was initiated to the total cost after the program or activity was implemented. The cost of the IH program or activity itself is then subtracted from the difference to calculate the actual cost savings. In the ROHSEI program, this number is referred to as benefit, and is the information that is used to calculate the financial metrics used in discussions of value. The ***IH Value Strategy***, *Quantitative Approach* incorporates additional factors into the calculation of value—new revenue and other benefits.

An important consequence that often results from eliminating health risk by implementing an IH intervention is creation of new sources of revenue for the organization. New revenue is different from cost savings, in that it represents a new opportunity made possible through process improvement and cost savings measures. It can be generated in different ways, including by increasing demand for products and services, by increasing production and service capacity, or by enabling an increase in price. Sometimes an IH program or activity can result in process efficiency gains that enable a company to produce more with the same labor and infrastructure. Where there is a market or demand for that increased production, or where new sales are generated, the resulting income can be considered new revenue.

In addition to the cost and revenue benefits IH may contribute in the areas of health status, IH risk management, and business process, IH programs/activities may generate other benefits that support or contribute to key business objectives. The *Quantitative Approach* encourages industrial hygienists to consider whether specific contributions can be identified that are related to operational, growth, human resource, product or service, reputational, or other business objectives. Such contributions may be difficult to quantify in some cases, but those for which a dollar value can be assigned can be incorporated into the calculation. Those that cannot be given a monetary value may be included in the *Qualitative Approach* (See the Phase III section of this report).

The dollar amounts from net savings/cost avoidance, new revenue, and other benefits can then be combined into a single benefit figure, which represents the sum total of all the benefit gained (or lost) as a result of the IH program or activity. To understand the meaning of this benefit relative to the financial objectives of the organization, this benefit is usually expressed in terms that explain its value. Metrics commonly used by companies to express value include:

Net Present Value (NPV): Today's value of a series of future costs and benefits, this is calculated by subtracting the total of all discounted costs from the total of all discounted benefits. The model calculates NPV based on costs, benefits, and the discount rate that are entered by the user.

$$\mathbf{NPV} = \sum_{i=1}^{t}\left[\frac{(B_i - C_i)(1+n)^i}{(1+r)^i}\right] = \sum_{i=1}^{t}\left[\frac{B_i(1+n)^i}{(1+r)^i}\right] - \sum_{i=1}^{t}\left[\frac{C_i(1+n)^i}{(1+r)^i}\right]$$

Internal Rate of Return: The internal rate of return for a project's costs and benefits is the interest rate when the net present value of the project is set to equal zero. The model calculates IRR based on costs and benefits that are entered by the user.

$$\mathbf{IRR} = r \ when = \sum_{i=1}^{t}\left[\frac{B_i - C_i}{(1+r)^i}\right] = 0$$

Return on Investment (ROI): This is calculated by dividing the net present value by the present value of the project costs. The net present value is calculated by subtracting the present value of project costs from the present value of project benefits. The model calculates ROI based on costs, benefits, and the discount rate that are entered by the user.

$$\textbf{ROI} = \frac{\sum_{i=1}^{t}\left[\frac{(B_i - C_i)(1+n)^i}{(1+r)^i}\right]}{\sum_{i=1}^{t}\left[\frac{C_i(1+n)^i}{(1+r)^i}\right]} = \frac{\sum_{i=1}^{t}\left[\frac{B_i(1+n)^i}{(1+r)^i}\right] - \sum_{i=1}^{t}\left[\frac{C_i(1+n)^i}{(1+r)^i}\right]}{\sum_{i=1}^{t}\left[\frac{C_i(1+n)^i}{(1+r)^i}\right]}$$

Discounted Payback Period refers to the amount of time it takes for a project to pay for itself. As such, the project is "paid back" in the year that the *cumulative* discounted benefits exceed the *total* discounted costs. Note that this metric uses straight-line extrapolation to calculate payback period to the nearest tenth of a year.

Discounted payback period is the year (y) when

$$\sum_{i-1}^{y}\left[B_i\frac{(1+n)^i}{(1+r)^i}\right] - \sum_{i-1}^{t}\left[C_i\frac{(1+n)^i}{(1+r)^i}\right] \geq 0$$

Where t denotes the total lifetime of the project (duration of analysis).

Production equivalent units: Shows returns in terms of production units. If production equivalent units is calculated to be 10, this means that the project's NPV is equivalent to the profit earned from 10 units of production. If production equivalent units is calculated to be -5, this means that the project's return is equivalent to the loss of profit from producing 5 units.

Additional input this metric requires: profit per unit.

$$\textbf{Production equivalent units} = \frac{\sum_{i=1}^{t}\left[\frac{(B_i - C_i)(1+n)^i}{(1+r)^i}\right]}{\textit{profit per unit}}$$

Impact on unit cost: This metric indicates how a project's costs and benefits impact unit costs. This metric is most meaningful when either a project affects only one production line or when it affects similarly multiple production lines. Impact on unit cost is calculated by dividing the net present value of the project by the production volume that the project impacts. For example, if the net present value a project is $1,000 (indicating a net contribution) and the production volume impacted is 200,000 units, then impact on unit cost = - 0.05, which means that the project reduces the unit cost by 5¢. On the other hand, if impact on unit costs is calculated to be 0.10, then this means that the project increases the unit cost by 10¢.
Additional input this metric requires: average monthly production volume.

$$\textbf{Impact on unit cost} = \frac{-NPV}{monthly\ production\ volume \times 12} = \frac{-\sum_{i=1}^{t}\left[\frac{(B_i - C_i)(1+n)^i}{(1+r)^i}\right]}{monthly\ production\ volume \times 12}$$

Percent impact on unit cost is calculated by dividing impact on unit cost by the unit costs before the project is begun. This metric is provided because some may believe that dealing in absolute numbers is somewhat limiting, and that more insight can be gained from relative numbers. To illustrate this, suppose impact on unit cost is 0.10 as it was in the prior example. This means that the project increases the unit cost by 10¢. This may or may not be important, depending on what the unit cost is. If the unit cost is $2.00, then percent impact on unit costs is calculated as $0.10/$2.00 which is 0.05 or 5%. This means that the project increases the unit cost by 5%, which is generally considered to be significant and can be a substantial determent to approving the project. However, if the unit cost is $300, percent impact on unit costs is calculated as $0.10/$300 which is 0.00033 or 0.033%, which is generally considered to be insignificant and would not serve as a determent to approving the project.

Additional inputs this metric requires: unit cost, monthly production volume.

Present the Value Proposition

The financial metrics are only part of the full value proposition equation. Together with the benefits identified through the qualitative portion of the ***IH Value Strategy***, the industrial hygienist can develop a complete picture of how IH programs or activities have contributed to the key business objectives of the organization. Further details on how to create a value proposition presentation for management are given in the Phase V section of this Report.

Presentation of pilot test results

Understanding of Mission, and Use of Data Collection Forms

Nearly all of the company contacts who offered case study data were able to provide the type and quality of information sufficient for a financial analysis with minimal instruction. In most cases, however, the examination of the potential benefits of the projects under study was fairly narrow and left a large amount of savings out of the equation, particularly in the area of employee productivity.

It is clear that if industrial hygienists are to be able to make effective use of the ***IH Value Strategy***, training in the conceptual framework of ferreting out as much benefit as possible will be as important, if not more so, than training on the mechanics of performing the financial analysis. Industrial hygienists must be committed to finding every scrap of value in their programs and activities in order to make as strong a case as possible.

Many of the parameters included in the data sheets were not used by the respondents, for a combination of reasons. Several industrial hygienists commented that there were too many, and that the form was too long. This comment led to re-configuration of the data collection form, to which a summary form was added to enable users to add aggregated data. The comment indicated that there was a general lack of understanding of the degree of effort and detail required for thorough value analysis. Another reason for not using certain parameters was lack of understanding of their meaning, which indicated that definitions would be needed. Development of instructions and definitions is a key part of making the data collection tools as effective as possible. Of course, these must be supplemented by training in the use of the strategy.

Another factor was that not all parameters were applicable to all cases. Some, such as emergency response, excess insurance premiums, and fines and penalties were almost never used. This does not mean that they should be excluded, because they will be very important to some cases, such as those that involve flammable, reactive, or explosive materials. As predicted, the parameters dealing with health-related incidents and illnesses also were rarely used, for reasons mentioned earlier with respect to detecting and recording them.

The pilot case studies also demonstrated that the cross referencing of the data collection template to the customized ROHSEI IH user parameters allowed the data entry to be conducted in a very efficient manner. This will specifically simplify the use of ROHSEI as a data collection tool and financial calculator. It should also assist users of the ***IH Value Strategy*** who choose to use other financial software tools to generate the financial metrics, particularly if multiple analyses are performed over a period of time.

Summary of Lessons Learned

In addition to the technical aspects of data collection and use, the case studies provided numerous insights into the cost and benefit aspects of implementing IH programs and activities, and highlighted the significance of IH participation in business processes. Industrial hygienists contribute to business value in many ways, and should be able to understand and articulate their specific contributions.

The benefits of making IH-related process improvements that many times are designed to reduce or eliminate employee health exposures often also result in significant business improvements and/or savings. IH professionals can be the catalysts to drive management actions, and to enable organizations to make process or business changes that not only protect employees but also result in significant business improvements that can save money and enhance an organization's competitive advantage. (See Figure IV-5 for summary of financial analysis of specific projects by hierarchy level.) The study found that:

1. The hierarchy of controls generally applies for financial and economic reasons as well as IH reasons, although it is not a one-to-one relationship. The financial aspects vary with the industry and the type and magnitude of risk.

    - The greatest cost savings and other benefits tended to be associated with hazard elimination and the elimination of PPE usage.
    - Material substitution can have very large pay-offs because the change often has impacts that create efficiencies throughout the business process.
    - Containment projects can result in improvements in employee health exposures and significant savings in labor and waste disposal costs with little incremental capital investment.
    - Engineering controls are most often, but not always, better financially than PPE. In cases where financial benefit cannot be shown for engineering controls, there are often other benefits that make them preferable.
    - The use of PPE versus engineering controls or containment is usually the least effective and most costly way to protect people. The economic circumstances of PPE programs support the IH hierarchy of controls. However:
        - PPE can be a cost-effective measure to protect employees in high noise areas
        - Relying on PPE as the primary means of protection requires extraordinary measures to ensure that expected levels of protection are validated in actual field operations
        - Even in highly responsible organizations management may delay taking action if they have the perception that employees are adequately protected by PPE.

2. Sound IH investigations and measurement can be a key to simultaneously reducing employee exposures, ensuring regulatory compliance and contributing to business profitability.

3. Industrial hygienists, working together with business partners, can help maintain the overall viability of a business and protect revenue streams.

    - IH expertise can be an essential component of making a process work.

    - Industrial hygienists can provide technical knowledge and advice that enables a process to continue functioning during a repair instead of having to be shutdown, thus preserving revenue.

    - Integrating industrial hygienists into the planning of operations at the right time is of key importance. Early communication of IH hazards to management will allow for more efficient and less risky interventions.

    - Industrial hygienists need to help management realize and learn where IH fits in the process and where it can be most effective.

4. Health and safety consequences should be considered when work systems are designed or retrofitted to ensure the benefits to the organization are optimized.

5. IH value can be demonstrated even where benefits are negative.

6. Industrial hygienists add intellectual capital to the business by providing the ability to solve problems that cannot be addressed by other professions.

7. Utilizing IH principles and practices of hazard elimination and product containment can achieve reductions in the potential for both employee and community exposures to potentially hazardous substances.

8. Integrating IH concepts into process redesign can significantly expand production capacity

9. Improvement in health and safety conditions often results in improved labor productivity.

Potential Strategy Application:

The case studies have shown that the approach taken in developing the ***Strategy*** is versatile enough to be applied for quantitative IH value analysis in a wide range of industries, types of hazards and risks, and levels on the IH hierarchy of controls. It is also comprehensive in its potential to maximize the calculated value of IH programs and activities, because it includes parameters that are directly linked not only to those programs and activities but also to their downstream process effects. This is a component that is missing from the current ROHSEI program.

This strategy is applicable wherever a ROHSEI analysis is appropriate, but may be able to perform better for making the value proposition because of its capability to capture quantitative data for a wider range of benefits related to IH programs and activities.

Conclusion: Next Steps:

All of the goals outlined in the Problem Statement were achieved during the course of Phase IV.

As a result of the pilot site visits and retrospective value analyses, the study team is confident that when the ***IH Value Strategy*** data collection template is properly used, the output of the ***Strategy*** will represent accurately the direct and measurable financial benefits that organizations have received from implementing IH programs and activities.

Hierarchy Level	Case/Type of Exposure	NPV	1RR	ROI	DPP
Hazard Elimination	8. Chemical	Avoided $20 million in costs	n/a	n/a	n/a
Hazard Elimination	6. Noise	$198,015/ $47,249	161%	98%	0.6 yr
Hazard Elimination/ Material Substitution	7. Biological	$991,888	120%	22%	0.5 yr
Material Substitution	2. Chemical	$504,694	n/a	293%	0 yr
Engineering/ Containment	1. Chemical	$76,668	16%	7%	4.2 yr
Engineering/ Containment	9. Chemical	$23,629	14%	n/a	3.8 yr
Engineering/ Containment	10. Chemical	$27,585	98%	n/a	0.9 yr
Engineering/ Containment	11. Chemical	$4, 520,723	70%	59%	1.5 yr
Engineering/ Material handling	4. Ergonomic	$39,708	32%	25%	3.1 yr
Engineering/ Ventilation	5. Chemical	($1,005,597)	-25%	-56%	n/a
Engineering/ Material handling	12.Ergonomic	($1,385)			
PPE/ Administrative	3. Noise	($49,467)	n/a	-66%	n/a

Figure IV-5. Summary of Financial Analysis of Case Studies, by Hierarchy Level.