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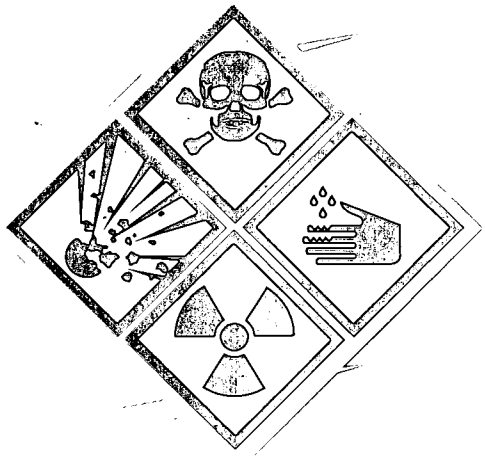
ABSTRACT

This implementation guide is intended to help educators use the Skills Standard for Hazardous Materials Management Technology (HMMT). It begins with a description of HMMT and a summary of the 13 job functions of the standard. Within each job function are supporting skills and knowledge that an HMMT worker must possess to be able to accomplish the job function successfully. Following the job functions is a more detailed breakdown of the supporting knowledge and skills related to the disciplines of mathematics, chemistry, toxicology, physics, and computer technology. Employability skills identified by the Secretary's Commission on Achieving Necessary Skills are elaborated next. The relationship of the Quality Movement to the skills demanded of HMMT workers is discussed. The guide discusses the origins of the project, the research methodology used, and the committees formed to develop the standard. It defines skill standards, emphasizes the importance of creating local industry-specific HMMT programs, and discusses the future of skill standards. Implications for curricula and assessment include four assessment scenarios. Appendixes include general requirements for HMMT programs, depiction of a model program, and members of the HMMT advisory committee and participating institutions. (YLB)

NATIONAL VOLUNTARY SKILLS STANDARD IMPLEMENTATION GUIDE

HAZARDOUS MATERIALS MANAGEMENT TECHNOLOGY PROGRAMS



CENTER FOR OCCUPATIONAL RESEARCH AND DEVELOPMENT

National Voluntary
Skills Standard

IMPLEMENTATION GUIDE

HAZARDOUS MATERIALS MANAGEMENT TECHNOLOGY

January 1997

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A coalition of experts in environmental technology has donated hundreds of hours to the project, shaping technical aspects of this standard. Their names and affiliations are given in the appendix.

The involvement of the following professional societies has made this standard known and recognized throughout their memberships. With their assistance, literally thousands of professionals have assisted with the development of the information provided in this standard. They are: Hazardous Materials Control Resources Institute (HMCRI), National Association of Environmental Professionals (NAEP), National Environmental Health Association (NEHA), National Environmental Training Association (NETA), and Partnership for Environmental Technology Education (PETE).

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James R. Johnson
Project Director

PREFACE TO IMPLEMENTATION GUIDE

Until the last few years, the United States remains the only major industrialized nation without standards to define the skills required for industrial occupations. Most of our schools had to prepare students for vocations by guessing what skills they might need. Consequently, many students have left school thinking they had the ability to perform as technicians in industry only to find their skills did not measure up to employer expectations.

Recognizing this problem, state and national leaders called for educational reform to prepare our children and adults for lifelong learning and to perform in occupations relevant to the Information Age. This spawned *Educate America: Goals 2000*, an educational reform act that produced a demand for twenty-two updated, industry-driven educational standards. One of the industries selected to have standards written for it was the hazardous materials industry.

As a result of educators and business/industry representatives working together, *The National Voluntary Skills Standard for Hazardous Materials Management Technology* document was written and printed. This standard is being used across the nation, providing a framework by which HMMT curricula can be developed or adapted to meet local industry needs.

In light of meeting these needs, this implementation guide has been created to help educators and others implement the HMMT skill standard successfully. The guide provides information regarding the origins of the project, the research methodology used, and the committees formed to develop the standard. In addition, the guide defines skill standards, emphasizes the importance of creating local industry-specific HMMT programs to prepare students and workers for modern-day environmental occupations, and discusses the future of skill standards.

HAZARDOUS MATERIALS MANAGEMENT TECHNOLOGY

Environmental technology encompasses several important groups of occupations. Water and Waste Water Technology is one example; Hazardous Materials Management Technology is another.

However, within the field of hazardous materials management technology there are also different occupations, each requiring a different group of skills. In some environmental occupations, a Hazardous Materials Management Technician (HMMT) needs only a limited set of hazardous materials management skills while in other occupations a much more rigorous set of skills is required. Indeed, some occupations may even require that an HMMT obtain specialized skills in related occupational areas such as safety and health, management, regulations, laboratory operations, remediation, and so on. This concept is illustrated in Figure 1, which begins by showing that all technicians need foundational skills related to communications, mathematics, science, logical reasoning, and interpersonal relations.

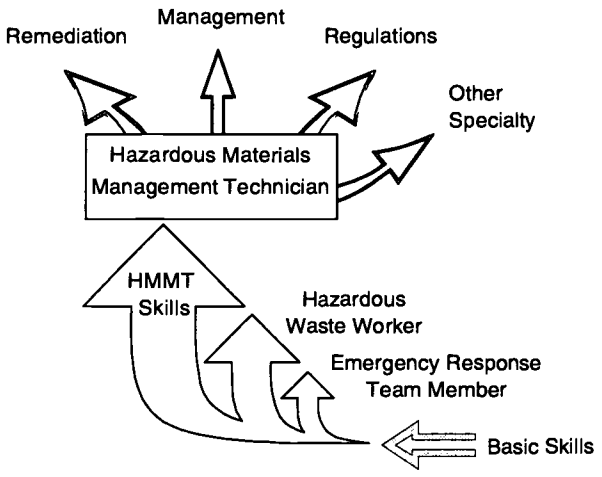

Figure 1

As occupational skills are acquired, a person may be employable in some hazardous materials management occupations (i.e., Hazardous Waste Worker) even though that person does not have all the skills required of an HMMT.

This project defines HMMT occupational areas. The tasks performed by HMMTs can span a range of activities. To provide some parameters, the Advisory Committee *arbitrarily* grouped the activities of an HMMT into the following four subsections:

1. **Laboratory/Analytical Technician (LAT):** The primary area of specialty and focus for this individual is the analysis and testing of chemical compounds in a laboratory setting. The tasks this person may be required to accomplish range from the initial preparation of samples for analytical testing to the operation of complex and highly sensitive instrumentation.

2. **Compliance/Regulations Technician (CRT):** This individual's primary area of specialty and focus is interpreting and implementing regulations, and ensuring industry compliance with the same regulations. The tasks this person may be asked to accomplish range from inspection to enforcement, to suggestions of statements to meet changing or new regulations.

3. **Field Operations/Remediation Technician (FORT):** The FORT's primary area of specialty and focus is the practical aspects of working with mixed hazards and materials in the field. The tasks this person may be asked to accomplish

range from the collection of samples, data, and information to the implementation of remedial and corrective actions.

4. **Treatment/Storage/Disposal Technician (TSDT):**
This individual's primary area of specialty and focus is the methods and techniques for safe, effective, and efficient treatment, storage, and disposal of mixed materials and wastes. The tasks this person may be asked to accomplish range from the handling and transportation of hazardous materials and wastes to the implementation of effective treatment and disposal methods.

As previously stated, the tasks performed by an HMMT can span a wide range of activities. The above groupings have been arbitrarily created in an effort to provide some parameters for this assessment. Based on our experience in the field, we recognize that finely dividing the tasks into one category or another is impractical. HMMTs are called upon by their employers to be multifaceted, and there is no such thing as a typical day in the life of any of the above-stated groupings of individuals.

INTRODUCTION TO THE STANDARD

For the sake of clarity and organization, we have divided the Skills Standard into thirteen job functions. The job functions, as found on the following pages, are not listed in order of importance. They serve as headings for general statements of occupational requirements, skills, and knowledge. Within each job function are supporting skills and knowledge that an HMMT must possess to be able to accomplish the job function successfully. It should be noted that a supporting item may apply to more than one job function. However, the items are listed within that job function where they appear to be a primary skill. These job functions and the supporting knowledge and skills are considered to be the "occupational" portion of the standard.

Because of wide variation in the skills needed by different occupational groups within this technology, the Project Team did not include statements related to specific laws, rules, and regulations. Instead, the Skills Standard reflects a broad-stroke approach in the application of laws, rules, and regulations. Additionally, you will note the use of the term "such as" throughout the Skills Standard. This term was used to provide limited examples. Wherever the term is used, it is assumed that the reader will understand that the items that follow are not to be considered an exclusive list, but only examples, of applicable skills, equipment, and so on.

Immediately following the job functions is a more detailed breakdown of the supporting knowledge and skills related to the disciplines of mathematics, chemistry, toxicology, physics, and computer technology. Following these related academic skills are statements regarding the application of the SCANS report to HMMT and the relationship of the Quality Movement to the skills demanded of HMMTs. The final section of this Standard gives guidance to curriculum developers when they convert the defined skills into educational curricula.

JOB FUNCTION (A):
Evaluate hazardous materials and hazardous waste sample data.

Supporting knowledge/skills:

1. Perform mathematical calculations following existing formulas and reference materials
2. Read and interpret blueprints, charts, curves, graphs, maps, plans, and spreadsheets from plotted and tabulated data
3. Collect, tabulate, and assist in the evaluation of data, using appropriate techniques and technology such as:
   - calculators
   - computers
   - databases
   - graphics
   - spreadsheets
4. Check laboratory and/or field sample analyses by comparing to regulatory limits

JOB FUNCTION (B):
Safely handle hazardous materials and hazardous wastes.

Supporting knowledge/skills:

1. Use chemical reference materials to obtain information on proper chemical handling
2. Recognize, apply, and respond appropriately to chemical-hazard information
3. Direct personnel in the proper handling and control of hazardous materials and hazardous wastes
4. Identify and implement safe ergonomic controls and procedures
5. Demonstrate safe handling procedures for chemical containers such as:
   - bulk containers
   - drums
   - portable and stationary tanks
6. Identify and respond to emergencies, alarms, and abnormal situations in accordance with written procedures
7. Identify and implement safe chemical-handling procedures such as:
   - bonding
   - fire control
   - grounding
   - storage
   - vapor control
   - ventilation
8. Provide on-the-job training as required

JOB FUNCTION (C):
Respond to hazardous-materials and hazardous-waste emergency situations in accordance with regulatory requirements.

Supporting knowledge/skills:

1. Perform as a team member on an emergency-response team
2. Ensure that adequate spill-control equipment and supplies are available at all times
3. Develop and implement an emergency-response program
4. Demonstrate competency and maintain certification in first aid and Cardio-Pulmonary Resuscitation
5. Follow guidelines for controlling leaks from containers
6. Consider environmental consequences of emergency situations and respond appropriately

JOB FUNCTION (D):
Operate equipment related to hazardous materials and hazardous-waste operations.

Supporting knowledge/skills:

1. Identify and describe the safe and proper use of equipment such as:
   - drum crushers
   - hand tools
   - heavy equipment
   - monitoring and sampling equipment and instrumentation
   - motorized lifting devices
   - power tools
   - pumps, valves, and meters
2. Identify, describe, and use appropriate equipment-decontamination procedures
3. Identify, describe, and use appropriate operations and maintenance procedures, plans, and manuals
4. Identify, describe, and use appropriate health and safety equipment such as:
   - communication systems
   - eyewashes and safety showers
   - fire extinguishers, vehicles, and equipment
   - first aid

JOB FUNCTION (E):
Identify and label hazardous materials and hazardous waste in accordance with regulatory requirements.

Supporting knowledge/skills:

1. Identify, characterize, and label hazardous materials by chemical and physical properties, such as:
   - color
   - corrosivity
   - density
   - flammability
   - reactivity
   - specific gravity
   - toxicity
   - viscosity
2. Identify and characterize hazardous wastes according to regulatory standards such as:
   - acute toxicity
   - corrosivity
   - ignitability
   - reactivity
   - toxic characteristic leachate procedure (TCLP)
3. Provide proper labeling for hazardous wastes
4. Use chemical reference materials to obtain identification and labeling information
5. Check for correct labels and Material Safety Data Sheets (MSDSs) when shipment is received
6. Label containers of repackaged materials with appropriate warnings and expiration information
7. Direct personnel in the proper identification and labeling of hazardous materials

JOB FUNCTION (F):
Calibrate, operate, and maintain instrumentation.

Supporting knowledge/skills:

1. Operate, record, and evaluate meter- and gauge-reading trends and implement appropriate actions
2. Perform routine maintenance of equipment and instrumentation
3. Operate gauges, meters, and monitoring and sampling instrumentation
4. Calibrate and operate field and laboratory instrumentation such as:
   - air-monitoring instrumentation
   - groundwater-monitoring instrumentation
   - soil-monitoring instrumentation
   - solid-waste-monitoring instrumentation
   - surface-water-monitoring instrumentation
5. Identify the need for and comply with factory calibration
6. Describe the difference between fluid and factory calibration and demonstrate their appropriate use

JOB FUNCTION (G):
Compile, record, and maintain required documents for hazardous-materials and hazardous-waste management activities.

Supporting knowledge/skills:

1. Compile and maintain a hazardous-materials inventory
2. Compile and maintain documentation of hazardous materials, such as:
   - chain of custody
   - equipment calibration and maintenance
   - exception reports
   - field notebooks
   - incident documentation
   - laboratory data
   - manifests
   - MSDSs
   - purchase orders
   - shipping documents
   - vendor invoices
3. Compile and maintain records to prepare compliance reports
4. Ensure current MSDSs are available in the workplace
5. Operate and maintain auditable record-keeping systems in accordance with regulatory requirements
6. Conduct and maintain a hazardous-waste inventory
7. Communicate with suppliers to obtain product identification and labeling
8. Identify and maintain an inventory of empty and full containers
9. Compile and maintain personal health and safety records
10. Read and interpret blueprints, flow diagrams, and schematics

JOB FUNCTION (H):
Implement procedures to comply with appropriate regulations.

Supporting knowledge/skills:

1. Read and apply regulatory standards to ensure compliance in operations
2. Obtain hazardous-materials and hazardous-waste permits and/or approvals
3. Describe the regulatory process, from the introduction of a bill to the promulgation of a regulation
4. Identify and describe the penalties for noncompliance
5. Differentiate between federal, state, and local hazardous-materials and hazardous-waste regulations and identify appropriate regulatory agencies
6. Identify regulatory changes and the impact they have on an operation
7. Comply with federal, state, and local hazardous-materials regulations
8. Conduct audits and inspections to ensure hazardous-waste management activities are in compliance with federal, state, and local regulations
9. Follow written, company-standard operating procedures
10. Comply with federal, state, and local health and safety regulations
11. Identify sources of current or timely regulatory information

JOB FUNCTION (I):
Implement applicable safety regulations and procedures.

Supporting knowledge/skills:

1. Demonstrate safe health and work habits
2. Read and implement regulatory standards and guidance relative to worker safety and health such as:
   - blood-borne pathogens
   - confined space
   - emergency egress
   - fire safety
   - hearing conservation
   - lockout/tagout
3. Identify and describe unsafe workplace and job conditions and implement corrective actions

JOB FUNCTION (J):
Select and use appropriate personal protective equipment and respiratory protection.

Supporting knowledge/skills:

1. Use and interpret chemical reference materials in the selection of appropriate personal protective equipment (PPE) and respirators
2. Communicate with suppliers and manufacturers to obtain personal protective and respiratory equipment information
3. Identify, describe, and use PPE appropriate to the work conditions
4. Identify and describe the elements of respiratory protection and PPE plans
5. Identify, describe, and use respiratory protection appropriate to the work conditions
6. Identify and describe hazards associated with the use and limitations of PPE and respiratory protection
7. Maintain and inspect PPE and respiratory protection systems according to regulations

JOB FUNCTION (K):
Collect, prepare, document, and ship samples for analysis.

Supporting knowledge/skills:

1. Perform and document sampling for hazardous-waste characterization purposes
2. Perform field tests according to instructions and procedures
3. Calibrate and operate, as required, field-test equipment such as:
   - air-monitoring equipment
   - bailers
   - hand augers
   - organic-vapor analyzers
   - pumps
   - radioactivity measuring equipment
   - split spoons
4. In accordance with instructions and/or procedure, collect samples such as:
   - air and soil
   - bulk materials
   - groundwater
   - solid wastes
   - surface water
5. Identify and demonstrate an ability to adjust procedures appropriately for potential sample interferences
6. Decontaminate equipment in accordance with quality-control/quality-assurance procedures
7. Identify and describe the appropriate use, limitations, and applications of sampling equipment such as:
   - colorimetric indicator
   - combustible-gas indicator
   - organic-vapor analyzer
8. Perform personnel-exposure monitoring in accordance with appropriate standards such as:
   - noise monitoring
   - oxygen monitoring
   - radiation dosimetry
   - temperature extremes
   - threshold limit value—biological-exposure indices
9. Prepare and ship samples to laboratory

JOB FUNCTION (L):
Transport and store hazardous materials and hazardous waste in accordance with applicable regulations.

Supporting knowledge/skills:

1. Monitor documentation related to the shipment of hazardous materials and hazardous wastes
2. Identify incompatible combinations of chemicals that could result in dangerous situations
3. Label containers with appropriate identification and expiration information
4. Safely package, load, document, and ship hazardous materials and hazardous wastes in compliance with appropriate regulations
5. Inspect hazardous-waste storage areas for compliance with appropriate rules and regulations
6. Properly segregate and store incompatible hazardous materials and hazardous wastes

JOB FUNCTION (M):
Operate hazardous-materials and hazardous-waste treatment and disposal systems.

Supporting knowledge/skills:

1. Record and maintain documentation of operations activities
2. Follow appropriate plans such as:
   - assessment plan
   - health and safety plan
   - initial sampling plan
   - remediation plan
   - risk-assessment plan
   - site-closure plan
   - standard operating procedures
   - waste-minimization plan
3. Assist and contribute to the development and revision of plans and reports such as:
   - assessment plan
   - health and safety plan
   - initial sampling plan
   - remediation plan
   - risk-assessment plan
   - site-closure plan
   - standard operating procedures
   - waste-minimization plan
4. Prepare and maintain hazardous-waste manifests and associated documents for inspection
5. Select appropriate drums and containers
6. Implement good housekeeping practices in the workplace
7. Check and document activities of hazardous-waste treatment and disposal contractors
8. Working individually or with others, develop improvements in the reduction, reuse, recycling, or disposal of waste streams
9. Coordinate collection and disposal of empty containers
10. Prepare accumulated hazardous waste for proper disposal
11. Identify and describe treatment, removal, and disposal systems such as:
    - bio-remediation
    - chemical and physical
    - deep-well injection
    - incineration
    - vitrification
    - volatile organic compounds
12. Identify and describe hazards associated with abatement of materials such as:
    - asbestos
    - fiberglass
    - lead
13. Identify and describe hazards associated with treatment, removal, and disposal systems and operations
14. Provide on-the-job training as required

RELATED ACADEMIC SKILLS

Mathematics

An HMMT requires a strong background in mathematics for two very important reasons. First, mathematics helps develop problem-solving skills and reasoning abilities that are required in every phase of a technician's occupational responsibilities. Second, specific mathematical skills are used as tools to solve specific job-related problems.

To develop problem-solving skills and reasoning abilities, an HMMT shall have completed with a secondary-level mathematics curriculum, including algebra and geometry, that adheres to the standards established by the National Council of Teachers of Mathematics (NCTM).

To summarize the specifics given in the NCTM Standards, an HMMT shall possess the following skills related to mathematical operations:

- Use a calculator to solve problems that have more than one step and involve fractions, decimals, and percents.
- Estimate answers to problems that involve several steps.
- Convert measurements for length, area, volume, capacity, and weight from English to metric units (and vice versa).
- Read, interpolate, and extrapolate data from tables and graphs.
- Calculate the perimeter, circumference, area, volume, and surface area of various two- and three-dimensional objects such as circles, rectangles, triangles, spheres, cylinders, rectangular solids, and cones.
- Read, interpret, and compare ratios.
- Solve problems related to proportions and concentrations using a variety of units including parts per million (PPM) and parts per billion (PPB).
- Read and use scale drawings to determine directions and distances on land maps.
- Read and write numbers in scientific notation and enter the values into a calculator to solve problems involving scientific notation.
- Translate a problem into an equation, then simplify and solve the equation.
- Read, write, and rearrange parts of an equation and solve for a given variable by substituting appropriate numerical values.
- Graph data as points on a coordinate system and determine the slope of a graphed line.
- Relate the slope of the line to gradients on topographic maps.
- Read and interpolate data from both linear and logarithmic graphs and scales.
- Distinguish between mean, mode, and median as measures of central tendency, and calculate these from a set of data.
- Draw a histogram to represent frequency distributions of data.
- Distinguish between range, trend, and standard deviation as measures of variability.
- Interpret the characteristics of a normal statistical bell curve.

RELATED ACADEMIC SKILLS

Chemistry

Skills related to the science of chemistry are essential to an HMMT. These skills must be identified with practical field applications and not specifically oriented toward laboratory or research chemistry. An understanding of the interrelationship of chemistry and biological systems is important. The following list gives specific skills related to chemistry that an HMMT must possess. The list does not include basic definitions and underlying theories that may be necessary for competency in these skills.

- Read and understand MSDSs.
- Use chemical handbooks to determine the chemical and physical properties of elements and substances.
- Describe the differences between ideal and real gases and give illustrations of each difference.
- Show the relationship between pressure, volume, and temperature for ideal gases.
- Measure atmospheric pressure and distinguish between atmospheric and gauge pressure.
- Measure the mass and volume of solids and liquids, and calculate their densities.
- Calculate the density of a gas.
- Determine the melting point and the boiling point of substances by using chemical reference materials.
- Classify and give common examples of pure substances and homogeneous and heterogeneous mixtures.
- Define acids, bases, and salts in terms of their properties, reactivities, and corrosivities.
- Perform laboratory and field tests to determine the purity of a water sample.
- Describe the properties of solutions, and define solvents (including water) and solutes.
- Calculate molar, molal, weight percent, volume percent, and normal concentrations of solutions.
- Perform a titration to determine the concentration of an acid or base.
- Demonstrate the differences between inorganic and organic chemicals in terms of their densities and flammabilities.
- Use proper handling techniques for chemicals in general, and describe actions necessary in case of accidents.
- Demonstrate general laboratory safety practices and the use of safety equipment.
- Define toxicity, flammability, corrosivity, and reactivity.
- Identify the hazardous properties of common chemical elements in terms of their toxicity, flammability, corrosivity, or reactivity.
- Define pH and use common indicators and meters to determine the pH of soil, liquid, and dissolved gaseous materials.
- Describe alpha, beta, and gamma radiation in terms of their penetration through different materials and the effect such radiation has on body tissue.
- Demonstrate the transmutation of elements that takes place in alpha and beta decay.
- Define the half-life of radioactive species and measure the level of radiation with common instruments and dosimetry techniques.

RELATED ACADEMIC SKILLS

Toxicology

The following skills relate to the body's reaction to exposure to hazardous materials and hazardous wastes.

- Conduct a hazard analysis on a product based on the toxicological properties listed on the MSDS and reference sources.
- Demonstrate and apply the concepts of toxicological hazards such as: target organ, Threshold Limit Values (TLV), Time-Weighted Average (TWA), Short-Term Exposure Limit (STEL), Ceiling (C).
- Describe possible signs and symptoms of adverse exposure to a particular compound based on the chemical composition.
- Follow appropriate first aid measures to minimize acute or chronic effects after exposure to a chemical.
- Describe the routes of exposure for chemicals to enter the body.
- List the common ways of describing the chemical toxicology, such as: dose, dose/response, LD_{50}, LC_{50}.
- Determine if an exposure poses an acute, chronic, or acute and chronic effect on an individual.
- Describe common types of chemical interactions, such as: additive, synergistic, potentiation, and antagonistic.
- Explain the procedure and results obtained from a TCLP toxicity text.
- Describe potential adverse effects of chemicals on the major target organs in the body: liver, lungs, kidney, skin.
- Consult with reference materials to determine the target organ of a chemical to properly protect against exposure.
- Apply information on an MSDS to safely respond to a spill. This could include: emergency response, personal protective equipment, spill-clean-up material.
- Describe the signs and symptoms of exposure to a chemical being used allowing you to determine if there has been an exposure due to failure of chemical protective clothing (CPC).
- Describe the function of the skin as a protective barrier and how damaged skin could lead to increased absorption of the chemical and local or systemic effects.
- Apply treatment procedures for chemical inhalation, ingestion, percutaneous absorption, or mucous-membrane contact with chemical if CPC fails.
- Demonstrate the use of appropriate measures to treat a person or equipment during an exposure incident.
- Describe the adverse reactions of chemicals that could affect the body and the procedure used to minimize exposure. Describe the proper treatment protocol if there is an exposure.

Physics

The ability to integrate and use different aspects of technology and to envision a "systems" approach to solving problems is very important for an HMMT. Therefore, competency in applying physics concepts to mechanical, thermal, electrical, and fluid systems must be demonstrated. Specifically, physics-related skills that must be performed or understood to fulfill the job functions of an HMMT are as follows:

- Describe what force, pressure, voltage, and temperature difference have in common, and predict what happens to an object when unbalanced forces act on it.
- Measure the mass and volume of an object and, from the results, calculate density and specific gravity.
- Measure atmospheric pressure and distinguish between absolute and gauge pressure.
- Determine the pressure in a fluid as a function of depth in the fluid.
- Differentiate between AC and DC electricity, and use a voltmeter to measure voltage at different points in a circuit.
- Define work in terms of force, distance, and energy, and calculate work done in mechanical, fluid, and electrical systems.
- Identify differences between open and closed fluid systems, and describe what is meant by work done in a fluid system.
- Measure and calculate rate in mechanical, fluid, electrical, and thermal systems.
- Measure and calculate volume-flow rate and mass-flow rate in various fluid systems.
- Measure resistance in mechanical, fluid, electrical, and thermal energy systems.
- Distinguish between streamlined and turbulent flow, and identify sources of resistance for a fluid moving through a pipe.
- Describe the relationship between potential energy, kinetic energy, and heat energy in the conservation-of-energy law.
- Define power as it applies to mechanical, electrical, fluid, and thermal energy systems.
- Measure and calculate the mechanical advantage of force transformers in mechanical, fluid, and electrical systems. These will include levers, belt- and gear-drive systems, hydraulic jacks, and voltage transformers.
- Describe the effects of momentum in mechanical and fluid systems.
- Explain how pumps and fans convert mechanical or electrical energy to fluid energy.
- Define and measure the efficiency of an energy convertor such as a motor or a pump.
- Explain the function of a fluid transducer such as a bourdon gauge, a barometer, a flowmeter, or an anemometer.

RELATED ACADEMIC SKILLS

Computer Skills

All employment environments in which HMMTs work require some useful knowledge and skills related to computer applications. The following computer skills are typically required for computer literacy in today's work environment:

Hardware

- Identify common computer hardware such as a keyboard, monitor, diskette drive, mouse, CD-ROM, tape drive, printer, and the casement housing the computer's electronics.
- Turn ON a computer system (i.e., the "computer," monitor, and printer).
- Reboot the computer system.
- Distinguish between different types of common data disks (i.e., 5.25" diskette, 3.5" diskette, hard diskette, CD-ROM).
- Distinguish between different types of common diskette drives (i.e., 5.25" diskette, 3.5" diskette, hard diskette, CD-ROM).
- Describe the function of a diskette.
- Identify Drive A, Drive B, Drive C, and additional drives.

Operating System

- Explain what an operating system is.
- Explain what a formatted diskette is.
- Format a diskette.
- Copy all files on one diskette to another diskette
- Copy one file on one diskette to another diskette.
- Delete a file.
- Identify a system prompt and basic dialog box.
- Describe the action required by a system prompt or basic dialog box.
- Describe a computer program.

Word Processor

- Load a word-processing program.
- Use a menu to select specified features of a program.
- Describe what a word-processing program does.
- Access and use HELP screens.
- Use arrow keys or mouse to move cursor to various parts of monitor display.
- Move individual characters or blocks of data from one location of a document to another.
- Move data from one document to another.
- Copy data from one document to another.
- Save data entered into a word-processing program to a diskette.
- Load a word-processing data file.
- Delete individual characters or blocks of data within a document.
- Place page breaks within a document.
- Use a "search" command to locate a character or a string of characters within a document.
- Use the "replace" command to locate and change a character or a sequence of characters within a document.
- Use the "undo" command to reverse the previous edit.
- Use a "spell checker" to locate and correct misspelled text within a document.
- Print a document.
- Use word-processing program to create a correspondence document that follows standard formatting guidelines for margins, tabs, and line spacing.

RELATED ACADEMIC SKILLS

Spreadsheet

- Describe what a spreadsheet program does.
- Load a spreadsheet program.
- Enter data into rows of a spreadsheet.
- Enter data into columns of a spreadsheet.
- Sum the data of a spreadsheet column.
- Sum the data of a spreadsheet row.
- Use simple formulas in spreadsheet cells to calculate desired values from data in other cells.
- Use a spreadsheet program to make a line chart of data.
- Use a spreadsheet program to make a bar chart of data.
- Use a spreadsheet program to make a circular (pie) chart of data.
- Save data entered into a spreadsheet program to a diskette.
- Load a spreadsheet file.

Database

- Describe what a database program does.
- Load a database program.
- Enter data into a database table.
- Save data entered into a database program to a diskette.
- Load a database table.
- Search for information in a (query) database table.

Communication, Network, On-line Service, and the Internet

- Set up and use a communications program (for the correct bit per second (bps) rate, parity, databits and stop bit e.g., 9600, N81 for 9600 bps, no parity, 8 data bits, and 1 stop bit) to communicate with a computer at another location.
- Connect to a dial-up, on-line service and search for programs or data, and participate in discussion groups or forums.
- Download file(s) from a remote computer to a local computer using a communications program.
- Access MSDS or other available databases via the Internet.

EMPLOYABILITY SKILLS

HMMTs, like other workers in industry, must have the-three part foundation and the five competencies described in the 1991 Secretary's Commission on Achieving Necessary Skills (SCANS) report. These SCANS skills are the workplace know-how that defines effective job performance today and therefore lies at the heart of job performance. No skills standard would be complete without this foundation and these competencies called employability skills.

The employability skills are covered in detail under particular sections of the HMMT Skills Standard while others are mentioned only in this section. This is not meant to downplay the need for HMMTs to have all the employability skills, but only to emphasize by stating in both places the particular areas of concentration HMMTs must have to perform well in their particular area of specialty.

FOUNDATION

Basic Skills

Reading: Locate, understand, and interpret written information in prose and in documents such as manuals, graphs, and schedules by being able to:

- determine the main idea or essential message
- identify relevant details, facts, and specifications
- infer or locate the meaning of unknown or technical vocabulary
- judge the accuracy, appropriateness, and plausibility of reports or other writing

Writing: Communicate thoughts, ideas, information, and messages in writing by being able to:

- create documents such as letters, memos, directions, manuals, reports, graphs, and flowcharts
- develop supporting documentation to the appropriate level of detail
- revise for correct information and appropriate emphasis
- edit for form, grammar, spelling, and punctuation

Arithmetic: Perform basic computations by being able to:

- use basic numerical concepts such as whole numbers and percentages in practical situations
- make reasonable estimates of arithmetic results without a calculator
- use charts to obtain or convey quantitative information

Mathematics: Perform basic mathematical logic by being able to:

- approach practical problems by choosing appropriately from a variety of mathematical techniques
- use quantitative data to construct logical explanations for real-world situations
- express mathematical ideas and concepts orally and in writing
- understand the role of chance in the occurrence and prediction of events

Listening: Receive, attend to, interpret, and respond to verbal messages and other cues, such as body language, in ways that are appropriate to the purpose. By listening, be able to:

- comprehend
- learn from
- critically evaluate
- appreciate
- support a speaker

Speaking: Speak by being able to:

- organize ideas and communicate oral messages appropriate to listeners and situations
- participate in conversations, discussions, and group presentations
- select an appropriate medium for conveying a message
- use verbal language and other cues, such as body language, appropriate in style, tone, and level of complexity to the audience and the occasion
- speak clearly and communicate a message
- understand and respond to listener feedback
- ask questions when needed

Thinking Skills

Creative Thinking: Generate new ideas by being able to:

- use imagination freely
- combine ideas or information in new ways
- make connections between seemingly unrelated ideas
- reshape goals in ways that reveal new possibilities

Decision Making: Demonstrate effective decision-making skills as follows:

- specify goals and restraints
- generate alternatives
- consider risks
- evaluate and choose the best alternatives

Problem Solving: Demonstrate the following problem-solving skills:

- recognize that a problem exists
- identify possible reasons for the problem
- devise and implement a plan of action to resolve the problem
- evaluate and monitor the progress of an action plan
- revise plan as indicated by findings

Seeing Things in the Mind's Eye: Organize and process symbols, pictures, graphs, objects, and other information by being able to:

- see a building from a blueprint
- understand a system's operation from schematics
- picture the flow of work activities from a narrative description

Knowing How to Learn: Acquire and apply new knowledge and skills by using efficient learning techniques in both familiar and changing situations by being aware of learning tools such as:

- personal learning styles
- formal learning strategies
- informal learning strategies

Reasoning: Discover a rule or principle underlying the relationship between two or more objects and apply it in solving a problem by being able to:

- use logic to draw conclusions from available information
- extract rules or principles from a set of objects or written text
- apply rules and principles to a new situation
- determine which conclusions are correct when given a set of facts and a set of conclusions

Personal Qualities

Responsibility: Exert high levels of effort to attain goals and persevere hard to become excellent at doing tasks by having the ability to:

- set high standards
- pay attention to details
- work well
- display a high level of concentration even when assigned an unpleasant task
- maintain high standards of attendance, punctuality, enthusiasm, vitality, and optimism in approaching and completing tasks

Self-Esteem: Demonstrate belief in own self-worth and maintain a positive view of self by exhibiting:

- knowledge of own skills and abilities
- awareness of impact on others
- knowledge of own emotional capacity and needs, and how to address them

Sociability: Demonstrate understanding, friendliness, adaptability, empathy, and politeness in new and ongoing group settings by being able to:

- assert self in familiar and unfamiliar social situations
- relate well to others
- respond appropriately to situations
- take interest in what others say and do

Self-Management: Assess own knowledge, skills, and abilities accurately by being able to:

- set well-defined and realistic personal goals
- monitor progress toward goal attainment
- motivate self through goal achievement
- exhibit self-control
- respond to feedback unemotionally and non-defensively
- be a "self-starter"

Integrity/Honesty: Be trusted and exhibit that trustworthiness by demonstrating the ability to:

- know when a decision or behavior breaks with commonly held personal or societal values
- understand the impact of violating beliefs and codes of an organization, self, or others
- choose an ethical course of action in all work assignments and personal involvement with others

COMPETENCIES

Resources

Identify, organize, plan for the use of, allocate resources to, and be able to demonstrate abilities in the following areas:

Time: Schedule time:

- select goal-related activities
- rank activities
- allocate time
- prepare and follow schedule

Money: Demonstrate financial responsibility:

- use and prepare budgets
- make forecasts
- keep records
- make adjustments to meet objectives

Material/Facilities: Manage materials and facilities by being able to:

- acquire supplies
- store supplies
- allocate and use materials or space efficiently

Human Resources: Understand the human element of the workplace by being able to:

- assess knowledge and skills of people
- distribute work according to knowledge and skills
- evaluate performance
- provide feedback

Interpersonal: Work with others and demonstrate the ability to:

- participate as a member of a team and contribute to the group effort
- teach others new skills
- work to satisfy customers' expectations
- exercise leadership
- communicate ideas that justify position
- persuade and convince others
- responsibly challenge existing procedures and policies
- negotiate agreements involving exchanges of resource and the resolutions of issues of divergent interests
- work well with persons from diverse backgrounds

Information: Acquire and use information:

- identify, assimilate, and integrate information from diverse sources
- prepare, maintain, and interpret quantitative and qualitative records
- convert information from one form to another
- convey information orally and in writing as the need arises

System: Understand complex interrelationships:

- comprehend own work in the context of the work of those around them
- understand how parts of systems are connected and anticipate consequences of system changes
- monitor and correct own performance
- identify trends and anomalies in system performance
- integrate multiple displays of data
- link symbols with real phenomena (e.g., display on computer screen with machine performance)

Technology: Work with a variety of technologies:

- select appropriate procedures, tools, or equipment including computers and related technologies
- apply technology to task by understanding overall intent and proper procedures for setup and operation of equipment
- maintain and troubleshoot equipment including computers and other technologies to prevent, identify, or solve problems

It is assumed that because of the basic nature of the employability skills that they would be an integral part of the education process.

Many of these skills are necessary in the quality process that most companies now use in the workplace. This has made them even more an entry-level job requirement.

HMMT AND THE QUALITY MOVEMENT

The HMMT will be required to be part of any quality team or work group. Often the HMMT will be asked to be the expert or to research the hazardous materials issues in production-improvement ideas. HMMTs will also be part of quality teams or work groups in the hazardous materials area of their plants or operation. It is necessary for the HMMT to have the ability to work in groups and to do basic statistical quality control, which are two fundamental areas of the quality process and the backbone of quality-process skills.

Knowledge of quality-process skills is necessary for all employees entering the workplace. These skills are used in a number of programs identified as Total Quality Management, Continuous Improvement, Zero Defects, Quality Circles, and so on, but all part of the Quality Movement. This movement can generally be thought of as a systematic approach that uses objective methods to improve productivity through employee involvement in continuous improvement of all products and services. Each quality program is different in content but generally requires the same skills of workers.

Quality Control and Assurance

An HMMT should have a basic understanding of statistical quality control and should have abilities in the following areas:

Process: Describe a manufacturing or production process by being able to:

- make a process chart
- construct histograms, run charts, scatter diagrams, and normal distribution curves from data obtained by counting or measuring
- determine production quality by calculating process capability and tolerance bands and comparing them to a normal distribution curve

Control: Adjust a process by using information from a control chart, which requires the ability to:

- design control charts for X and R for a process
- use a measurement-control chart for X and R to keep a process in control
- use an attribute-control chart for P to keep a process in control

Statistics: Use basic statistical measures to track work processes by being able to:

- calculate mean, mode, and median for a set of data
- draw a histogram to represent frequency distributions of data
- calculate the range and standard deviation to describe a set of data

Probability: Use statistical probabilities to determine the rate of occurrence in a process by being able to:

- find the probability of a simple event
- determine the number of ways a simple event can occur
- draw a diagram and/or a chart to help find probability

Group Process

The HMMT should be able to work in a quality-process team and should have abilities in:

Teamwork: Participate as member of a team and contribute to the group effort by having the ability to:

- exercise leadership
  1. communicate ideas that justify position
  2. persuade and convince others
  3. responsibly challenge existing procedures and policies
- employ the appropriate team role in contributing to the group effort
- negotiate agreements between groups or individuals with conflicting issues
- work well with persons from diverse backgrounds

Communication: Communicate and listen in a group setting by being able to:

- receive, attend to, interpret, and respond to verbal messages and other cues, such as body language, in ways that are appropriate to the purpose
- organize ideas and communicate oral messages appropriate to listeners and situations
- participate in conversations, discussions, and group discussions
- select an appropriate medium for conveying a message
- use verbal language and other cues, such as body language, appropriate in style, tone, and level of complexity to the audience and the occasion
- speak clearly and communicate a message
- understand and respond to listener feedback
- ask appropriate questions

Problem Solving/Decision Making: Demonstrate effective problem-solving and decision-making skills as follows:

- recognize that a problem exists
- identify possible reasons for the discrepancy
- specify goals and restraints
- generate alternatives
- consider risks
- evaluate and choose the best alternatives
- devise and implement a plan of action to resolve a problem
- evaluate and monitor action-plan progress
- revise plan as necessary

Introduction

During the past decade there has been a phenomenal growth in concern for the environment. This growth, as a result of ever-increasing federal, state, and local regulations and restrictions, has led to the development of numerous employment opportunities. These positions initially were filled by professionals who "grew up" with the Hazardous Materials (Hazmat) industry. However, in recent years, as regulations and procedures have become more standardized and routine—and as concern has increased for the minimization of costs in a competitive marketplace—many responsibilities previously assumed by professionals have been transferred to technician-level personnel. This transition has revealed the need for more clearly defined educational goals and training in specific skills for those who want to work in the environmental area. It has also caused the federal government to recognize the need for measurable standards by which to judge whether a person is qualified to perform certain job functions.

Until recently, every major industrialized nation except the United States had measurable national standards that define the skills required for industrial occupations. Most of our schools had to prepare students for vocations by guessing what skills they might need, and many students left school thinking they had the ability to perform as technicians in industry only to find that their skills did not measure up to employer expectations.

Recognizing this problem, state and national leaders called for educational reform to prepare both children and adults for lifelong learning and for success in occupations relevant to the Information Age. This spawned *Educate America: Goals 2000*, an educational reform act that produced a demand for twenty-two updated, industry-driven educational standards.

The Hazmat industry was one of the twenty-two industries selected to have standards written for it. The goal of this standard-development project was to define the skills and knowledge needed by hazardous materials management technicians (HMMTs) to meet the demands of today's workplaces. The Center for Occupational Research and Development (CORD) was given funding by the U.S. Departments of Labor and Education to develop this standard.

To meet this challenge, CORD embarked on an eighteen-month process involving representatives of education, industry, and government. Throughout, professional societies whose primary purposes involve environmental issues and the control of hazardous materials participated in the project. These societies included the National Environmental Health Association (NEHA), National Environmental Training Association (NETA), National Association of Environmental Professionals (NAEP), Hazardous Materials Control Resources Institute (HMCRI), the Partnership for

Environmental Technology Education (PETE), the Institute for Hazardous Materials Managers (IHMM), and the Academy of Hazardous Materials Managers (AHMM).

Implementation Guide

To help educators and others implement the HMMT skill standard successfully, CORD created this implementation guide. The guide discusses the origins of the project, the research methodology used, and the committees formed to develop the standard. It defines skill standards, emphasizes the importance of creating local industry-specific HMMT programs to prepare students and workers for modern-day environmental occupations, and discusses the future of skill standards.

Using the guide, local HMMT programs will be able to decide how the skills and knowledge defined in the standard can be integrated with curricula so instructors can prepare both new students and seasoned employees to handle hazardous materials safely and efficiently.

Origins of the Skill Standard Process

In 1989, Americans had begun to acknowledge the deficiencies in U. S. educational and training systems—deficiencies that affected the workforce preparedness of students and employees. To address the problem, in September of that year former president George Bush and the nation's fifty governors met in Virginia to reform the ways U.S. schools prepared students for life and work. From this meeting, the National Education Goals emerged.

These goals provide detailed specifications of the results that effective education must achieve, results now monitored at national and state levels by a bipartisan panel. The goals became more powerful in March 1994, when congress, acting on the advice of major educational and industrial groups, approved the *Goals 2000: Educate America Act.*

According to the National Education Goals Panel, the goals of the act can be summarized as follows:

- All students are healthy and prepared to learn.
- The graduation rate of high school students increases.
- Students demonstrate competency in challenging subject matter in preparation for citizenship and productive employment.
- Students show top achievement in mathematics and science.
- All adults are literate and are lifelong learners.
- All schools are safe, disciplined, and drug-free.
- Teachers have access to training and professional development opportunities.
- Parents and families join schools in providing students with environments that facilitate health and learning.

With these goals in mind, a new challenge arose: how to address the changing methods by which students' knowledge and their ability to perform tasks are measured. In

response, it was decided that a validated system of educational standards was needed, and so the U.S. Departments of Labor and Education funded the National Skill Standards projects. These projects were to develop standards that would define the knowledge, skills, attitudes, and level of ability needed to successfully function in twenty-two occupational areas. Different organizations took on the task of developing and pilot-testing the skill standards for these industries.

The National Skill Standards projects had two main goals: the first, to develop cooperative alliances among employers, unions, and educators; the second, to increase the knowledge and understanding of how skill standards and certification are developed, implemented, recognized, accepted, and used.[1] (Since voluntary [as opposed to mandatory] occupational skill standards are a relatively new concept in this country, no uniform process yet exists for developing them.)

The advantages of having skill standards include the following:

1. Employees will have a clear picture of the skills they must possess to be successful in the relevant occupation.
2. Training providers can be held more accountable, since a clear set of performance expectations is outlined.
3. U.S. businesses will be more competitive in the global marketplace, since their workers will have an understanding of and an ability to perform tasks successfully.
4. Educational institutions and curriculum developers will have a clearly defined set of expectations provided by industry.
5. Less emphasis will be placed on obtaining degrees and more emphasis will be placed on developing job-related skills, giving a wider segment of the population access to jobs that pay living wages.

Project Staff and Consultants

The professional staff at CORD coordinated the development of the HMMT skill standard. Project director James Johnson assembled several committees of independent consultants to provide the CORD staff with technical and evaluative assistance throughout the program and to serve as members of the project team.

The stated goal of the project, as given in the proposal document, was to "organize and manage a coalition of organizations related to the hazardous materials industry, which will identify the skills necessary and the training required for hazardous materials management technicians (HMMT)." According to the proposal, the following activities were to be accomplished:

1. Research those businesses and industries involved in hazardous materials management (HMM).
2. Form a coalition of participants in the project.

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[1] National Center for Research in Vocational Education. Centerfocus, Number 11/April 1996, 1-5. Other projects are underway to identify and standardize foundational skills for all occupations.

3. Select and empower a technical committee including business, education, and labor leaders.
4. Design, through a participatory, iterative process, a model skill standard for the industry.
5. Devise a method for assessing and evaluating the model.
6. Promote a process for maintaining and updating the skill standard.
7. Secure a third-party evaluator to conduct a summative evaluation of the skill standard project.

National Advisory Committee

In researching the businesses and industries involved in hazardous materials management, project team members interviewed more than one hundred fifty technicians, employers, consultants, and educators actively involved with hazardous materials. The project staff also conducted site visits to various locations.[2] The involvement of professional societies in the development of the standard was requested, and six responded with active participation.[3]

In addition to the project staff and consultants, a national advisory committee had to be assembled to guide the project and third-party evaluators had to be involved. Accordingly, project staff asked forty interested and knowledgeable people to participate on the advisory committee and selected Dr. Jerry Riehl and Robert Bear, P.E., as third-party evaluator and chairman of the advisory committee.

The committee, which included representatives of various regulatory agencies, provided different perspectives. The composition of the HMMT advisory committee, which also represented different geographical areas, is shown in Table 1. Even as the members of the committee changed over time, this representation was kept as stable as possible.

The advisory committee represented both large and small businesses, as well as government, labor, professional societies, and education. The committee's tasks were to provide advice and guidance for the project and to participate in the development of job-level descriptions of the skills and behaviors needed by HMMT employees. Selected members of the committee also served on two subcommittees: one of which was responsible for evaluating the certification requirements for HMMT, and the other for developing occupational titles.

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[2] Shown in Table 3, Appendix A.

[3] These were the National Environmental Health Association (NEHA), the National Environmental Training Association (NETA), the National Association of Environmental Professionals (NAEP), the Hazardous Materials Control Resources Institute (HMCRI), the Partnership for Environmental Technology Education (PETE), and the Institute for Hazardous Materials Managers (IHMM).

Table 1. HMMT Skill Standard Project National Advisory Committee Membership

Type of Institution Represented	Representatives
Industry	13
Consultant/Remediation	7
Municipal	2
Unions	3
Societies	6
Government	2
Military	3
Colleges (2- and 4-Year)	13

The technical advisory committee met in December 1993 to determine the scope of the standard. During this meeting committee members decided to include all the topics identified by the Occupational Safety and Health Administration (OSHA) training requirements. Then, all HMMTs meeting the standard would be certifiable according to that agency's requirements.

It was also decided that regional variations must be considered to determine how they would affect the skills and knowledge expected of an HMMT.

Defining a Technician

The first task the committee faced was to define an HMMT. To do this, members had first to consider existing definitions of technicians, among which was one by Anthony Carnevale. In differentiating technicians from technical professionals like doctors, engineers, and scientists, Carnevale states:

> Technicians include employees whose primary expertise lies in a particular technical specialty area. While technicians have a considerable depth of knowledge and highly developed skills in their areas of expertise, they generally lack the breadth of knowledge in the theoretical aspects of their specialties that is required of technical professionals. Although many technicians are graduates of four-year colleges, many have developed their skills and knowledge through technical or vocational schools, community colleges, or on-the-job training. After technical and non-technical professionals, technicians are the most highly educated and well-trained employees in the American workforce.[4]

[4] Carnevale, Anthony P., et al., *Training the Technical Workforce.* San Francisco, CA: Jossey-Bass, Inc., Publishers, 1990, 3.

In other words, technicians usually receive training that has its basis in theory, but is focused more directly on applying theory to the task at hand than is the training of technical professionals. This is not to say that technicians do not have an understanding of theoretical concepts, only to imply that their experience and training are directed more toward the implementation of the theory than to the actual concepts underlying the practices themselves.

A definition more specific to the area the committee was addressing appears in the *Dictionary of Occupational Titles,*[5] which defines HMMTs as individuals who:

> . . . provide information and advice on ways to collect, transport, handle, store, and dispose of toxic wastes. They help monitor and direct the cleanup of land, water, and air. These technicians survey industries to learn what disposal methods they use. They look at hazardous waste treatment and disposal from the standpoint of both effectiveness and cost. From their findings, they make recommendations for ways to collect, move, store, treat, and dispose of wastes. They offer advice and technical aid to members of industry and government.

Differing Areas for Environmental Technicians

To narrow the definitions, the committee had to answer several questions, among which were the following: Is the person who responds to an emergency such as a chemical spill or a fire an HMMT, or a firefighter with some special skills? Does an HMMT work with shorter-term emergency response tasks like the cleanup or remediation of contaminated sites, or on long-term pollution-prevention projects?

The committee had to acknowledge that within the field of hazardous materials management are occupations requiring different but related skills. HMMTs—especially those who work for the state or federal government—draft regulations for handling hazardous waste, help develop programs to prevent spills of hazardous waste, review company and/or agency plans for spill prevention and suggest changes, and help develop regulations for reporting spills and for measuring the environmental damage caused by those spills.

Thus, in some jobs, HMMTs need only a limited set of Hazmat skills, while in others, they need a much more rigorous set. Indeed, some occupations may even require an HMMT to obtain specialized skills in related occupational areas such as safety and health, management, regulations, laboratory operations, or remediation.

Considering all the above, the project team realized that technicians working in an environmental occupation can be employed in the following areas:

- hazardous materials management;
- water/wastewater quality management;
- air quality management, solid waste management
- occupational safety and health.

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[5] Chronicle Guidance Publications, 1985, 4.

These areas fall into four technician groups:

1. Field operations and remediation technicians (FORT). Activities in this area include cleaning up contaminated outdoor sites like Superfund sites or leaky, underground petroleum tanks at gas stations and nuclear facilities.
2. Treatment, storage, and disposal technicians (TSDT). Activities in this area include the work done within oil refineries, chemical process industries, municipal waste treatment facilities, and disposal locations such as incinerators.
3. Compliance/regulations technicians (CRT). Activities in this area include understanding and applying regulations set by the Environmental Protection Agency, OSHA, and state regulatory groups.
4. Laboratory/analytical technicians (LAT). Activities in this area include collecting, testing, and analyzing contaminated soil, air, and liquid samples.

Table 2 shows the basic skills needed by all technicians, and the different HMM occupations an employee/student can fill without having *all* the skills required to be an HMMT.

Table 2. HMMT Specialties and Activities

Activity	Type of HMM Technician			
	LAT	CRT	FORT	TSDT
Remediation	■	■	■■	■■
Corrective Activities	■	■■	■	■
Waste Treatment and Management	■	■	■	■■
Source Minimization and Recycling	■	■	■■	■■
Disposal Activities	■	■	■	■■
Monitoring Activities	■	■	■■	■
Transportation Activities	■	■	■	■■
Emergency Response Activities	■	■	■■	■

■ Area of Specialization

■■ Primary Area of Specialization

Job Titles, Task Lists, and Focus Groups

The advisory committee next reviewed a list of job titles and tasks compiled by project staff with the help of Texas State Technical College in Waco, Texas. To refine the list, committee members and others provided job descriptions for employment categories grouped under the broad title of HMMT. An activity journal to record job functions for which they were responsible during a typical day—as well as weekly, monthly, and

annual tasks—was then distributed to more than one hundred employed technicians, of whom fifty returned responses.

The activities listed in the journals and the task statements from the job descriptions were used to draw up an outline containing one hundred seventy-five task statements. These were grouped, and then a critical verb was associated with each statement. This outline became the draft survey document that formed the main topic of discussion at three of the regional focus-group meetings, the first of which was held in New Orleans in April 1994. At this meeting, staff asked the participants to verify or change the verb given in each of the task statements. (This continued the Delphi[6] technique employed throughout Phase One.)

Gathered in groups according to the four major areas of HMMT (shown in Table 2 and listed above), the participants were also asked to rate each statement according to how frequently the task would be done and how important it would be.

A second draft of the survey was considered at a meeting held in Hagerstown, Maryland, in June 1994. The following week, at a meeting in New Orleans, another focus group reviewed the survey. Changes from these focus groups were integrated into the survey to be used at a meeting held in conjunction with the NEHA annual convention later that month.

At this meeting, the advisory committee studied modified versions of the task/activity outline and made further changes. These included converting the outline into a survey which would be distributed to large numbers of employers for validation,[7] and the formation of an additional subcommittee to consider the certification and assessment of individuals against the standard.

A revised draft of this survey was mailed to all attendees of a July 1994 meeting of the certification and assessment committee. Committee members also sent a copy of the draft to a small group of individuals in their geographical area for review, comments, and suggested changes. The feedback thus gained would ensure the survey's completeness before its general dissemination.[8]

Other Activities

The third-party evaluators had been included in the project planning process and maintained ongoing communication with the director throughout the project. When Dr. Riehl's health made him unable to continue as an active member of the evaluation team, Jean Drevdahl was appointed to complete the second formative report to be used for mid-course adjustments, and for the summative report.

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[6] Using the Delphi process, researchers gather data, make a proposal, send the proposal to stakeholders for modification, then receive back the original proposal and make the suggested modifications.

[7] NEHA subcontracted to design, distribute, collect, and accumulate data from this survey.

[8] The information obtained from this step was returned to NEHA on August 1, 1994.

During July, the certification subcommittee met and recommended the following:

1. Training programs should be accredited by an organization of educational providers including public schools, private schools, and consulting agencies like PETE. HMMT programs must be consistent with the skill standard, and teacher qualifications, facilities, lab-to-lecture ratio, and hours of instruction must all be considered.
2. A certification program for those graduating from accredited programs should be established and operated by professional societies or agencies. A comprehensive certification for a "general" HMMT should be maintained by a technician-oriented organization (such as the Federation of Environmental Technicians[9] [FET]).
3. After completing a comprehensive HMMT program, students should be able to seek a specialization certificate in some subset of HMMT, such as nuclear technology.
4. The skill standard must be the basis for any certification program, and assessment tests must contain some performance-based items.
5. Certification should be directed toward "job entry" skills, with a degree not being required for certification.
6. Periodic recertification and assessment should be built into the program.
7. A continuing education requirement should be incorporated into the recertification process.
8. A database for data from schools with HMM programs should be completed.
9. Presentations about the skill standard project should be made at various community college meetings.
10. An article on the project should be submitted to a publisher.

All skill standard advisory committee members and members of four professional societies[10] received a copy of the skill standard survey. Each of these societies cooperated in mailing the survey to their membership. In addition, students from PETE schools in three regions of the country conducted phone interviews with potential employers of HMMTs to determine their specific needs.[11] The results were analyzed by the survey review team.

In August 1994, a project team meeting was held to evaluate the data returned from the survey and to condense the information into one of the formats suggested by the Department of Education. From this meeting came thirteen HMMT job descriptions with associated tasks. These became the core of the standard.

During Phase One of the project, two issues of a newsletter entitled *Skills Standard Report* were also produced and mailed to almost 1,000 representatives of industry and education.

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[9] This organization was identified subsequent to the meeting.

[10] NEHA, NAEP, HMCRI, and NETA.

[11] The goal was to obtain two hundred completed surveys, and two hundred forty, or 20.9% of the mailed surveys, were returned.

Result

As a result of the eighteen-month process, in October 1994 the HMMT skill standard was disseminated at the Roney Teaching Center in Waco, Texas, to representatives of twenty-five colleges. Of these, about half had an existing Hazmat program and wanted to ensure their curriculum contained the skills and tasks listed in the standard. The others were interested in starting a Hazmat program and wanted to ensure their curriculum would meet the demands of the skill standard.

Industrial experts involved in the standard's design made presentations and worked with the educators to formulate methods for developing new HMMT programs and for measuring existing programs against the standard.

Workshop participants took part in group tours of three different industries in Waco that employ HMMTs.[12] During these tours, the workshop participants were able to observe the HMMTs at each of the worksites and compare their job functions to the standard. Thus they were able to validate the skills and tasks listed in the standard.

In discussions throughout the day, educators found that a number of factors are involved in integrating skill standards with curricula.

Integrating the Standard with Educational Curricula

To help educators identify and address the factors involved in integrating the standard, it is helpful to follow the process used to develop the standard:

Step 1: Form an advisory committee that includes representatives of business and industry who are *stakeholders* in the process—involved in providing school-to-work experiences for students (mentoring programs, internships, and so on), jobs to graduates of the program, equipment, or financial aid.[13]

Step 2: Define local HMMT needs with input from a variety of employers. If all four categories of HMMTs are represented in local businesses and industries, try to involve one of each on the committee. Do not limit yourselves to asking for participation from groups such as fire or police departments. Also consider firms that apply coatings, process food or other biological agents, change automobile oil, and perform other tasks involving hazardous materials. Question local businesses carefully to determine who their Hazmat workers are. Titles are not always reliable, since HMMT duties may be combined with other duties.

Step 3: Amend existing curricula to address these needs, incorporating relevant skills and/or tasks from the standard. Since the standard was developed by a process of obtaining national consensus, be sure to adapt it to meet the needs of the local businesses handling hazardous materials.

Step 4: Present the curricula to an advisory committee, for review and careful discussion to determine that it meets local needs.

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[12] Allergan, Marathon Power Technologies, and Plantation Foods.

[13] See Advisory Committee Tasks on following page.

Step 5: Survey potential employers to validate the curriculum elements for compliance, certification, or a degree.

Step 6: Obtain accreditation for the educational provider and certification for the students from the professional societies involved in developing the standard. Making sure a program meets local needs and yet adheres to the national standard ensures widespread industry support for the program and its students.

Professional societies involved in developing the standard can add to the marketability of an educational institution and its graduating students [i.e., the school can be accredited by PETE on the basis of its Hazmat program's adherence to the skill standard, the experience of its faculty, and its facilities.]

Students can be certified by NEHA on the basis of their knowledge and competencies.

Advisory Committee Tasks

An advisory committee composed of practitioners with an active interest in the institution and the program and with intimate knowledge of current practice can significantly help the growth and development of an HMM technology program.

The advisory committee supports the program by:

1. meeting regularly with the administration and faculty
2. helping ensure the technical currency of the program
3. maintaining close liaison with supporting and employment agencies
4. reviewing program offerings and course content to help ensure that the current and future needs of the HMM specialty are met
5. helping recruit competent faculty members and potentially capable students
6. helping place students after graduation or during school-to-work programs
7. obtaining financial and material resources for the institution
8. making the community aware of the HMM program.

To be effective, advisory committees must be properly supported, logistically and administratively. They should be given meaningful assignments that are properly within their areas of expertise, and their advice should be considered carefully. Whenever their advice cannot be taken, good reasons should exist and be explained.

Educational Paths and the Skill Standard

There are two distinct pathways to HMMT education. Workers who are already employed in the industry often take OSHA and RCRA[14] courses that concentrate on teaching the safe handling of hazardous materials and waste. This training frequently results in certificates and requires periodic refresher courses. While workers undergoing this training are often seeking to improve their knowledge and skills, the company sends its workers to comply with federal and state regulations.

[14] The Resource Conservation and Recovery Act.

The second pathway involves formal education programs leading to a degree. Many postsecondary institutions offer two-year programs related to environmental technology, with some offering more specific programs related to hazardous materials management technology.

Regardless of the educational pathway chosen by those wanting to enter the field, the desired result is qualified HMMTs. Developing or amending a program to comply with a national standard ensures widespread industry support and well-prepared students with portable credentials. Until this year, such a national standard was nonexistent, even though Hazmat has been a heavily regulated industry for a number of years.

Program Content and Orientation

An HMMT program should be sequenced to accommodate both full- and part-time students and to allow multiple entry and exit points, if possible. The program content should provide an integrated educational experience directed toward the development of the ability to apply pertinent knowledge to the solution of practical problems in the Hazmat field and related environmental health and safety technology vocations.

HMMTs must have experience in using a computer to solve problems, and they should have a working knowledge of computer applications relevant to the field. Hence, the curriculum should include an introduction to computers, their applications, and to the information infrastructure, which can be used for technical problem-solving and practical applications. All students and faculty should have access to computers.

Curriculum Elements

Following is an outline of the courses needed to meet the quantitative minimum course requirements for an associate of science degree in Hazmat.

Technology Area (19 credits)

The technology course requirements based on the skill standard are designed to provide HMM knowledge and skills, and the fundamental elements of problem-solving—synthesis, analysis, and evaluation. The courses should include a number of realistic applications of HMM technology, including constraints such as economic factors, safety, reliability, and social impact.

Basic Sciences and Mathematics Area (20 credits)

HMMTs need a good understanding of basic sciences and mathematics for success in their field. The science courses offered should emphasize the understanding of measurement and the quantitative expression of the phenomena of nature. Laboratory work that includes experimentation, observation, and accurate measurement is a requirement in studying chemistry and physics.

The mathematics component of the program must include selected topics applicable to HMM. The overall program must include solid geometry, ensure that participants are

literate in mathematical analysis, and permit the use of mathematical tools in basic sciences and technology courses.

Communications, Humanities, and Social Sciences (23 credits)

Communications: Good oral and written communication skills are needed. Regardless of the depth of their technical capability, technically trained individuals should not be considered prepared for the workplace if they cannot communicate their technical findings and thoughts clearly to others around them, both orally and in writing.

Humanities and Social Sciences: HMMTs should acquire an appreciation and understanding of their cultural heritage, the complexities of interpersonal relationships, and a system of values essential to making intelligent and discerning judgments. Many HMMTs also need to develop a sensitivity to community concerns and a practical knowledge of government processes. Specific courses in this area will vary from student to student and institution to institution, but this does not minimize their importance. (Physical education and military drill *do not* qualify as humanities or social sciences.)

Remedial Work: Remedial courses are designed to remove deficiencies in the basic skills of entering students, and so are at a level lower than expected in college credit work. Such courses, particularly in the area of mathematics, basic science, and communications, should not be used to meet the minimum curricular content requirements.

Entrance Requirements

High school graduation or its equivalent is required for entry into an associate degree of science program. Each student must present either a high school transcript indicating graduation or a certification of equivalency. The transcript or certificate should document sufficient background in mathematics and science for the student to achieve the objectives of the program. If such a background is not evident, the student's ability should be determined by a pre-entrance assessment.

High School Preparation

Students interested in entering a college-level hazardous materials management technology or other related environmental health and safety educational program should, if possible, participate in an applied academics program like Tech Prep[15] while they are in high school.

In a Tech Prep program, the academic basics every student needs are taught—science, mathematics, English, social studies, and career preparation—but they are taught in the context of work or everyday life. For example, the principle of a change of momentum might be taught in the context of an automobile collision or a golf game; quadratic equations might be introduced with familiar objects that have a parabolic shape, like a flashlight with its curved reflector, or a satellite dish.

In a 4+2 Tech Prep program, each of the four years in high school builds on the contextual foundation of the earlier year, with students in grades 11 and 12 beginning to

[15] Technical Preparation

take technical courses that will lead to their academic and career goals. In a 2+2 Tech Prep, the last two years of high school and a two-year postsecondary course are designed in a manner similar to a 4+2 program, so that students in grades 11 and 12 continue to build on their academic foundation, but also take technical courses, applied academics, and possibly participate in learning experiences at selected workplaces.

One of the critical components of Tech Prep programs is the articulation agreement drawn up between the high school and the two-year postsecondary institution. This agreement ensures that the students do not have to duplicate at the college level courses they have taken in high school. The agreement also sometimes awards advanced credit for specific courses taken during high school.

Whether a Tech Prep program is available or not, students wanting to enter the environmental field should complete the high school courses discussed below. School advisors who guide their environmentally oriented students to study these courses will help their students gain a solid basis on which to build their technological knowledge and skills.

Mathematics: Three years, to include algebra I, geometry, and algebra II. The skills taught in geometry and algebra II are required to complete tasks in environmental technology occupations. Algebra II skills are also needed to comprehend the required high school and college science courses, like chemistry and physics. The suggested sequence of high school math courses is algebra I, geometry, and algebra II.

Science: Four years, to include biology, chemistry, and two additional years in science—physical science, earth science, ecology, environmental science, anatomy and physiology, oceanography, geology, or physics, for example. In high school science, the student's objective is to acquire a fundamental awareness of nature and its phenomena. The science courses taken should emphasize awareness and understanding of the fundamental laws of biology, chemistry, and physics, with emphasis on the measurement of natural phenomena. A diverse overview of the sciences prepares a student for college-level chemistry and physics.

Technical Core: Two years of *technology education*, which is generally defined as a comprehensive, action-based educational program concerned with technologies, their evolution, use, and significance in industry's organization, personnel, systems, resources, and products, including those products' social and cultural impacts. Technology education electives may include technology studies, principles of technology/applied physics, or introduction to environmental technology.

Overlapping Skills and Knowledge

While the skill standard project team identified the core knowledge and three groups of skills needed for success in the role of an HMMT, a survey of educators indicates that a significant part of the standard also applies to other environmental occupations. After all, those desiring to work in environmental technologies of many kinds need core knowledge in common with each other, and often must develop a number of the same skills. For example, a person studying to be a water/wastewater minimization technician would have to study the same core subjects—mathematics, biology, chemistry, computer technology, and so on—as one studying to be a hazardous material management

technician. Those studying to work with air quality would need much of the same knowledge and many of the same skills as those studying to work in the areas of water quality, solid waste, and health and safety. However, those wanting to work with wildlife, in parks and recreation, and in environmental planning would have little overlapping of knowledge and skills with the groups already mentioned. This concept is illustrated by Figure 1, in which technologies with a chemical or biological basis form the first building block of a curriculum. Onto this, other skills, knowledge, and competencies are added as the student's career path becomes more specific.

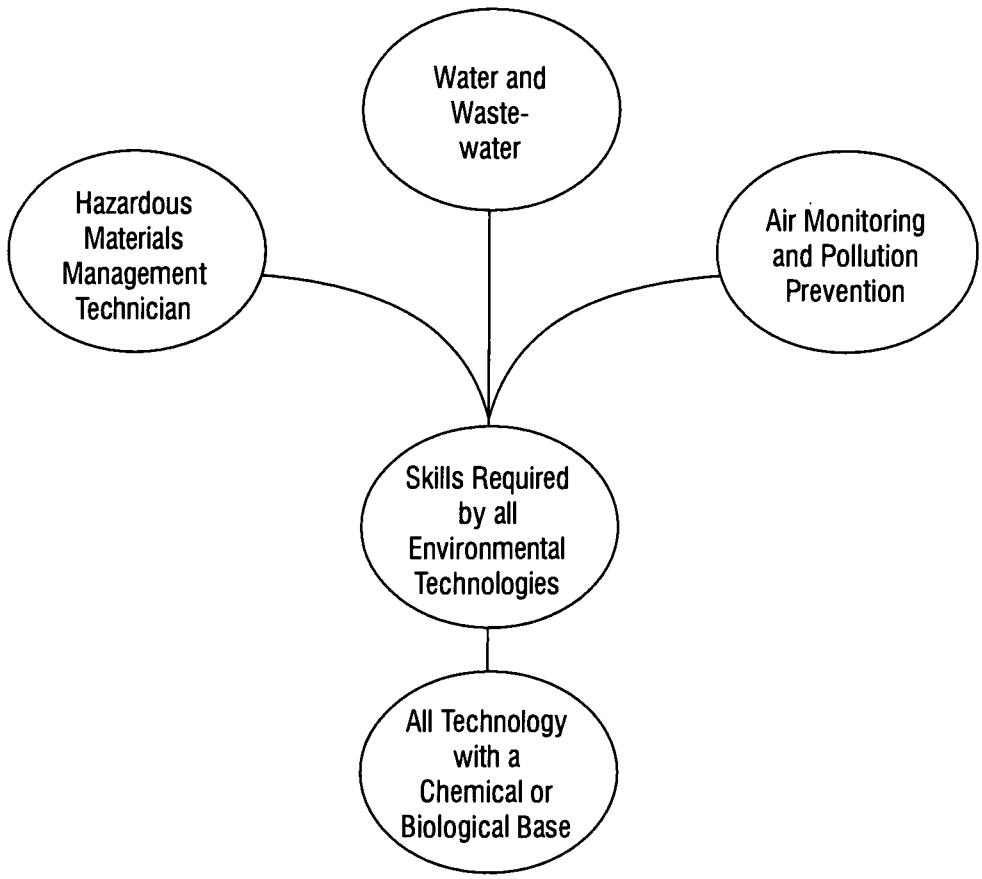

Figure 1. Skills Needed for Environmental Technology

Credit for Prior Learning and Experience

Participants in HMMT programs should be encouraged to apply for credit for prior learning and experience. Credit should be given or requirements waived based on the program participants' description and documentation of all knowledge and skills, as well as previous occupational work experience. Evaluation of credit for prior learning should be completed as early in the program of study as possible, but actual credit or a waiver

need not be issued immediately. All credit for prior learning or waiver of program requirements should be documented on the official program transcript.

Credit may be granted on the basis of:

- examination
- 4+2 or 2+2 programs with area high schools
- prior work experience relevant to the courses in question
- an assessment of non-credit formal learning activities
- portfolio development.

Requirements—like the maintenance of a minimum grade point average and completion of a minimum number of credits in residence—may be attached to credit for prior learning.

Facilities

An HMMT program can be operated successfully only when supported by adequate physical plant facilities, including office and classroom space, laboratories, and shop facilities suitable for instruction. Laboratory facilities vary, and equally good programs can result from support by laboratories quite different in design and equipment. In every case, however, the laboratory facilities must reflect the requirements of the offered educational program; that is, they must be equipped with instruments and other equipment of the kind and quality used by HMMTs.

A comprehensive review of the HMMT skill standard, advice from a local advisory committee, and input from technical faculty should be used to develop a prioritized instrument and equipment list. It is important that the laboratory space provide a variety of realistic applications of HMM technology, including sampling and monitoring activities, use of personal protective equipment, and Hazmat handling simulations. Adequate funding must be available for continuing selective replacement of obsolete or worn-out instruments.

HMM functions increasingly depend on the use of computers for technical calculations, data acquisition and processing, process control, design, and other developing functions and applications. The computer facilities available to the students and faculty, therefore, must encourage the use of computers. The general computer requirements for HMM-related courses can be met in a number of ways, with on-site or off-site centralized or decentralized systems, as long as the systems are accessible to the students and faculty.

Compliance Oriented/Required Courses

Many businesses and industries whose employees might need to know how to deal with hazardous materials require their employees to complete short-term Hazmat training. For example, a firefighter may have to take an emergency response course that would emphasize the skills—outlined in the standard—needed for a firefighter to work with or

around hazardous materials. When he/she completes the course and the instructor feels the skills have been mastered, he/she receives a certificate of completion.

Certification Programs

Two situations in which certification is needed include the retraining of workers displaced from other occupations due to economic changes, and the training of workers who need new skills to advance in their career or to pursue a new one. The standard outlines the tasks and skills that can be used to provide hands-on training to allow these workers the fastest possible return to the workplace. Such training programs are traditionally offered on a part-time, evening basis.

One or two courses are generally taken per semester and they may be taken in one- or two-week formats. Since they do not address the academic skills identified by the skill standard or the basic employability competencies described in the 1991 SCANS[16] report, certificate-level programs are not generally recommended for entry-level students.

However, certificate programs may sometimes be combined with traditional A.S. and A.A.S (associate of applied science) programs. For example, a student completing the requirements for a business or transportation logistics program might add a Hazmat certificate to his or her portfolio by attending one additional semester of college. Obtaining such a certificate greatly enhances a student's employability.

Technical core course requirements for certification include:

4 hrs Hazardous Materials Worker Safety
3 hrs Site Sampling and Monitoring
3 hrs Regulations and Resources I
3 hrs Regulations and Resources II
3 hrs Basic Industrial Hygiene
3 hrs Industrial Waste Processes

Bridge Programs

Specialized Bridge programs like *Transformations*[17] are designed for those students at postsecondary institutions who need instruction in basic skills and technology. They are especially helpful to those who have been out of the classroom for some time or who lack the academic foundation needed to successfully complete two-year postsecondary curricula.

Bridge programs present a blend of mathematics, science, computer, and occupationally relevant knowledge and skills that serve as a foundation for lifelong learning and can help displaced workers acquire foundational skills for the appropriate occupational setting.

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[16] The Secretary's Commission on Achieving Necessary Skills
[17] For information about *Transformations*, call 1-800-972-2766.

Associate Degree Courses

The skills identified in the standard are targeted to those students who have completed high school and need little remediation before entering technician courses. On completing the 63 required courses, students receive an A.S. or an A.A.S. degree.

The curriculum outline below shows the courses needed to receive an A.S. Degree in Hazmat and the order in which they might be taken.

First Semester	
Composition I	3 hrs
Introduction to Environmental Technology	3 hrs
Introduction to Chemistry	3 hrs
Culture and Technology	3 hrs
American Government	3 hrs
Second Semester	
Bio-Organic Chemistry	4 hrs
Regulations and Resources	3 hrs
Fundamentals of Communication	3 hrs
Basic Reasoning	3 hrs
Math for Decision Making	4 hrs
Third Semester	
Toxicology	3 hrs
Principles of Microeconomics	3 hrs
Regulation and Resources II	3 hrs
Sampling and Monitoring	3 hrs
Hazardous Materials Worker Safety	3 hrs
Fourth Semester	
Basic Industrial Hygiene	3 hrs
Industrial Waste Processes	3 hrs
Introduction to Physics	3 hrs
Technical Writing	3 hrs
Introduction to Ethics	3 hrs

Beyond A.S. Degrees (B.S., M.S., Ph.D.)

Even those with advanced degrees in a Hazmat field may find they need courses to familiarize them with specific applications. The standard helps them identify where the hands-on skills are needed. Table 3 shows the paths postsecondary students can take to reach their educational and certification goals.

Implications for Curricula and Assessment

The role of standards in integrating vocational and academic education is critical, but controversial. At stake are issues such as who should set standards; whether standards should be established at the national, state, or local level; and what degree of specificity and scope standards should reflect. However, standards are serving the educational community well in many ways. Even as their validity and importance are being examined, standards are forcing school reform debates to be carried out in more concrete terms than before, because standards separate issues concerning *what* content is taught from issues concerning *how* that content is taught. Standards also clarify the positions and interests of various stakeholders in the education of children and youth.

Assessment

Assessment addresses both the process and the product involved in meeting a standard. During the development of the standard, educators and representatives from business and industry discussed how assessment should be defined and how those enrolled in HMMT programs should be assessed and qualified. During this discussion, it became apparent that traditional teaching and assessment methods are no longer appropriate for today's environmental technicians.

This is because current teaching methods are structured so that many educators focus on teaching and assessing the performance of tasks. But teaching and assessing discrete tasks outside a work-related context does not adequately prepare students for success. Curricula must be set in the context of the workplace, and must integrate standards, career preparation, and assessment methods that include hands-on demonstrations of skills.

In light of the skill standard, using varied methods of assessment to gauge the way students apply concepts in real-world situations is more effective than using only one method. Some educators now require students to keep a portfolio, give on-demand demonstrations, analyze case studies, and work on semester-long projects to prove mastery of elements from both SCANS and the skill standard. Integrating the skill standard into assessment allows teachers to identify the skills in which workers are deficient and thus brings focus to industry training and retraining programs.

Table 3. Postsecondary Student Groups Entering Hazardous Materials Management Technology Education Programs

Category	Description	Related to skill standard
Associate Degree	a. High school graduates directly entering postsecondary programs (average age = ~18).	Educational program must be designed to equip students with all skills identified in the standard. An integrated curriculum is advised. Result = A.S. degree in Hazmat.
	b. High school (or GED) graduates entering programs after significant, work-related delay in their educational process (average age = ~26).	Educational program must be designed to equip students with all skills identified in the standard. Special preparatory programs such as Bridge programs may be needed to help students acquire foundational skills. Result = A.S. degree in Hazmat.
Certificate Programs (retraining for specific jobs)	a. Retraining of workers displaced from other occupations due to economic changes such as base closures, etc. These individuals may not have the basic skills needed to successfully compete in a technical (associate degree) program. (Average age may vary, but often exceeds 35.)	Specialized Bridge programs are needed to help students acquire foundational skills. Occupational skills required will be selected portions of the skills identified in the standard. Exact skills will vary with different occupational settings. Result = certificate of completion of a hazardous materials worker program.
	b. For workers in need of new skills to advance within a career or pursue a new career. Individuals have basic skills (some advanced degrees) but not specific technical skills (average age 30+).	Customized training programs needed.
Compliance Oriented/Required (short-term training courses)	Employees in related occupations who are required to have Hazmat training (i.e., fireman taking an emergency response course or an emergency response team from any industry taking a 40-hour HAZWOPER[18] course or an 8-hour refresher course).	Customized short-term training programs will vary according to the requirements specified. The goals of the short course should be coordinated with the standard by identifying specific skills (knowledge or competencies) listed in the standard. Results = certificate of completion.

[18] Hazardous Waste Operation and Emergency Response (an OSHA course).

Assessment Scenarios

The integration of the skill standard into assessment activities is best demonstrated with scenarios. A scenario that includes a routine job function and a problem-solving situation can reveal whether a student has the required technical and higher-order thinking skills. Scenarios are useful assessment tools because they allow educators to redirect previous assessment methods—paper and pencil testing, perhaps—and allow students to be graded on hands-on skills as well as soft skills like writing, communication, and teamwork.

Following are example scenarios used to assess student competencies and determine core skills and knowledge. The scenarios show the step-by-step thought and skills processes required by technicians to deal with an immediate or long-term hazardous materials situation. After each scenario, the job function and supporting knowledge/skills outlined in the skill standard are listed in table form.

Scenario 1

A transfer pump in the hazardous waste collection area of a factory is reported to be leaking. The leak is contained in the secondary containment area around the pump, the pump is turned off, and the feed valve is closed. The product is a spent plating solution with a low pH, and has copper and other trace metals in solution. The MSDS[19] for the plating solution is on file. You are assigned to work with the maintenance department as attempts to diagnose the problem, repair or replace the damaged part, and return the pump to routine operation. Your job is to ensure the safety of the personnel working on the project, handle the chemicals both in the containment area and in the pump, minimize damage to plant equipment, and place the equipment back in operation as soon as possible.

1. Given the MSDS for the plating solution, list acute and chronic hazards of this material, the personal protective equipment that should be used, and the safety materials that should be on site as the repair is made.
2. What should be done with the approximately six inches of material in the secondary containment area? Assume you have access to basic supplies and equipment.
3. Before the maintenance staff begins work on the pump, what actions should be taken to ensure safety?
4. After the pump has been repaired, how would you decontaminate the area?

[19] Material Safety Data Sheet

Job Function	Supporting Knowledge/Skills
A	2
B	1,2,3,4,6,8
C	2,6
D	1,2,3,4
G	2,4,10
H	1,6,7,8
I	1,2,3
J	1,2,3,4,5,6,7
L	1,2,3,4,5
M	1,4,5,6,13

Scenario 2

A new chemical has been specified for use in the production process by the plant operations department. The operations department describes the chemicals as both volatile and flammable. The first shipment is due next week.

1. List the activities that should be conducted before the chemical arrives.
2. List what should be done at the time of its arrival.

Job Function	Supporting Knowledge/Skills
B	1,2,3,5,6,7
C	2,3,5,6
E	1,2,3,4,5,6,7
G	4,6,7,8
H	1,2,4,5,7,9,10
I	1,2,3

Scenario 3

The sludge-holding tank is full and you need to dispose of 10,000 gallons of the plant's sludge on the company land managed for this purpose. Sludge from your wastewater-treatment plant has an analysis of 3,200 of mg/l total solids and the metals analysis in the table below.

1. Can this sludge can be land applied?
2. Which metal is of most concern in this tank of sludge?
3. Calculate the annual whole sludge application rate (AWSAR) or this sludge based on the annual pollutant loading rate (APLR) of AWSAR = APLR / C × 0.001
4. Calculate the number of acres of land needed, given conversion charts and tables.

Metal	Concentration from Lab	APLR[20] kg/hectare/year	Ceiling Concentration mg/kg
Arsenic	10 mg/kg	2.0	75
Cadmium	10 mg/kg	1.90	85
Chromium	1,000 mg/kg	150.00	3,000
Copper	3,780 mg/kg	75.00	4,300
Lead	150 mg/kg	15.00	840
Mercury	2 mg/kg	0.85	57
Nickel	387 mg/kg	21.00	420
Selenium	15 mg/kg	5.0	100
Zinc	2,000 mg/kg	140.00	7,500

Job Function	Supporting Knowledge/Skills
A	1,2,3,4

Scenario 4

You are a member of an industrial emergency response team. Your company has sent you to visit a large manufacturing plant in a neighboring city to learn some of their techniques and adapt some of their ideas and procedures to your facility.

Shortly after you arrive, the emergency response team receives a call to respond to a spill at the loading dock. While unloading 55-gallon drums of toluene, the dock crew moved three polyethylene drums on the tractor trailer. During the move, one of these drums was dropped six feet onto a drum of toluene near the loading dock. Both drums are damaged and leaking. The loading dock crew complained of strong vapors and headaches. All personnel have been evacuated from the immediate area. A perimeter has been established by plant security.

The Incident Commander invites you to observe. You accompany the team to the warehouse and find the situation as described.

The team quickly establishes that one damaged drum contains toluene but that no one present knows the contents of the second drum that was dropped. The contents of the drum are leaking and mixing with the toluene. No reaction is visible. The puddle from the two drums is slowly moving toward a storm drain. The team has suited up in "Level B" PPE, back-up are set, a perimeter is set, and decontamination procedures are set up.

Prioritize the given responses according to what you would do first, second, third, or not at all.

[20] Annual Pollutant Loading Rate

Job Function	Supporting Knowledge/Skills
B	1,2,3,4,5

Scenario 5

Part of your job function is to manage your company's hazardous waste accumulation site. The company has a contract with ABC Disposal to pick up waste paint solvents every ninety days. Drums of waste paint and solvent are delivered from three satellite accumulation areas as the drums are filled. Generally two to three drums are received per quarter. Presently one drum of waste solvent is in the accumulation area. A drum from the west paint shop is going to be delivered this morning and ABC Disposal will be collecting waste this afternoon. In addition to the waste paint solvents, the storage area has one fifteen-gallon drum of lab-packed oxidizers from the quality control lab that is scheduled to be shipped for disposal next week.

1. Describe the actions you will take this morning when the drum from the west paint shop is delivered.
2. Describe the actions you will take in making a general inspection of the accumulation area.
3. What are the most common violations found in a waste accumulation area by RCRA inspectors?
4. Describe the actions you will take this afternoon when ABC Disposal collects the waste material.
5. Describe the record-keeping requirements for the shipment of waste by ABC Disposal.
   - What documents should you receive from ABC Disposal and when?
   - What documents must you sign?
   - What documents must you file and for how long?
   - What, if any, documents must you file with regulatory agencies?

Job Function	Supporting Knowledge/Skills
E	2,3,4,5
G	3,4,5,6,7,8
L	1,2,3,4,5,6

Wherever the assessment scenarios reveal deficiencies in student knowledge, both the instructor and student benefits, since the areas of weakness can be addressed.

Job Descriptions

Just as teachers must change their approach to teaching and assessment, so too must industry change their approach to the way they define jobs. Traditional job descriptions

that emphasize the mastery of specific knowledge, skills, and tasks, but are divorced from real work applications, must be put aside.

New criteria for job applicants must emphasize traditional knowledge, skills, and tasks, *and* employability skills like problem solving, decision making, and teamwork. And these should be put in context in the job description.

Other Voluntary Standards

In addition to the voluntary HMMT skill standard, the ISO[21] 14000 standard—the environmental counterpart of the ISO 9000 international quality standards familiar to many companies—must be considered by those in the Hazmat industry. ISO 14000 is a single environmental standard that helps companies meet environmental goals and regulations, regardless of their location. Although designed to be used in conjunction with international trade, the ISO 14000 standard impacts companies doing business nationally, regionally, and locally.

In sharp contrast to most environmental regulations, ISO 14000 does not include specific environmental goals, focusing instead on an organization's operations and procedures. It moves the responsibility for environmental stewardship from an individual or department to all employees. It promotes the adoption of both a management system that brings companies into compliance with government regulations and voluntary codes of practice that promote continual improvement in environmental management and pollution prevention. Companies that demonstrate compliance to these standards and whose management is trained and registered with ANSI can have their compliance certified.

The minimum commitment needed to meet ISO 14000 standards includes compliance with legislation, regulations, and other requirements, as well as continuous improvement and pollution prevention.

The ISO 14000 standard is voluntary, yet most national and international companies—large and small—find that observing it helps regulate Hazmat production and allows them to stay competitive in the global market.

The HMMT Skill standard Development Process—Summary

Step 1: The project research staff assigned to develop the skill standard conducted a review of the literature to determine the stakeholders in the industry.

Step 2: Representatives of business, industry, labor, and education were invited to form the advisory committee. Committee members were from diverse areas of the United States, and as the makeup of the committee changed over the course of the project, its geographical and background representation was kept as stable as possible.

Step 3: A third-party evaluation team was formed to review and evaluate the project's progress. Reports of their evaluations, along with recommended mid-course

[21] International Standards Organization

corrections, were provided to the Department of Education and the project team every six months.

Step 4: The data gathered during the literature review became the basis for a preliminary proposal presented by project staff to the advisory committee.

Step 5: A list of tasks performed by HMMTs was drawn up and reviewed.

Step 6: Focus-group meetings were conducted at different locations throughout the United States to review the evolving task list. Different locations were chosen because employment trends indicate different occupational needs in different geographical areas.

Step 7: The advisory committee compiled the job descriptions and sent out a job analysis survey listing different statements of technician duties.

Step 8: From the responses, a hierarchy of job descriptions was created with thirteen groupings. These thirteen descriptions were then validated by expert professional judgment and formed the core of the standard.

Step 9: Presentations about the standard were given at various community college meetings, two PETE meetings, two semi-annual meetings of the National Coalition of Advanced Technology Centers (NCATC), and two National Tech Prep Network (NTPN) meetings. These latter presentations allowed representatives of secondary and postsecondary schools to learn about the skill standard and to realize the need for a solid science foundation for students interested in Hazmat as a career.

Step 10: The standard was disseminated.

Step 11: Workshops were conducted to help educators understand how to integrate the standard into existing curricula and into the development of new curricula.

Step 12: A database was constructed in which data from schools with hazardous materials management programs could be entered. Four general topics were addressed:

- School information, including contact name, address, and phone number
- Program information, including type, length, degree, or certificate
- Course information, including course title and length
- Textbook information for each course in the program

Step 13: A report summarizing the development of the standard was written.

Step 14: This implementation guide was written.

The National Voluntary Skills Standard for Hazardous Materials Management Technicians is currently being implemented across the nation, providing a framework by which HMMT curricula can be developed or adapted to meet local industry needs.

If you are involved in adapting or developing curricula to incorporate the standard, please review the section *Integrating the Standard with Educational Curricula,* beginning on page 34.

Projected Changes in Environmental Technology

Trends and Jobs

Businesses across the nation have recognized the need to develop environmentally sensitive manufacturing techniques, manufacturing processes, and products. With this increase in environmental concern and awareness comes an increased need for well-prepared technicians. Employees with environmental education and training—of whom HMMTs make up a large percentage—are assets to businesses and represent a growing segment of tomorrow's workforce.

According to a 1992 survey by the National Center for Research in Vocational Education (NCRVE), 814,000 HMMTs were employed in the environmental service industry. This industry includes private firms and government agencies that provide environmental-waste management, hazardous-waste removal, and other environmental management services. The NCRVE study also estimated that the environmental service industry would need an additional 491,000 employees by 1995, which would represent an increase of 60 percent over a three-year period. (These estimates depended greatly on government funding and, therefore, were subject to change as national priorities varied.)

NCRVE calculated that, when considered together, the environmental service industry and those private and public entities that generate hazardous waste (including manufacturing, agriculture, mining, public utilities, and national energy laboratories) employ nearly two million American workers—about 1.5 percent of the employed civilian labor force. And the need could grow even more than predicted, depending on federal, state, and local regulations that might require more extensive management of hazardous materials.

Appendix A

In researching the businesses and industries involved in hazardous materials management, project team members interviewed technicians, employers, consultants, and educators and conducted site visits to various locations, as shown below in Table 4.

Table 4. Site Visits

Location	Date	Attendance	Assisting Organization
Seattle, WA	2/23/94	33	South Seattle Community College
Miami, FL	3/8/94	12	Local chapter of NEAP
Albuquerque, NM	3/11/94	14	American Society of Safety Engineers
New Orleans, LA	4/30/94	6	HMCRI
Hagerstown, PA	6/6/94	12	Hagerstown Junior College
New Orleans, LA	6/12/94	8	NAEP
Nashua, NH (near Boston, MA)	8/25/94	≈30	New Hampshire Community College

Surveys

After the standard was completed, three surveys were sent out: two that specifically addressed representatives of business and industry in the Hazmat industry, and one that addressed educators at postsecondary schools offering Hazmat programs.

One survey, sent out by Bob Bear, P.E., gathered demographics, described the four areas of specialization for HMMT as defined in the standard, and asked the business or industry to categorize their technicians according to those groupings. Then it gave an Importance of Skills scale accompanied by a skill standard statement, and asked the responders to indicate how important they considered the particular skill statement.

A Frequency of Use scale accompanied the Importance of Skills scale, and respondents were asked to respond to each item from the perspective of two questions: How important it is for the company's hazardous materials technicians to be able to demonstrate the skill; and how often their Hazmat technicians use the skill in their work with the employer. These were followed by an Importance of Skill scale accompanied by statements of basic skills. The employers were asked to indicated on this scale of one to five how important they considered the particular skill. The following table represents these responses.

The survey sent out by Jean Drevdahl to educators at schools with Hazmat programs asked for demographics and the type of program offered, then requested educators to respond to statements about information included in the curriculum to meet specified job functions.

It also included a copy of the questions listed below in the Hazardous Material Management Technology Skills Standard Project Evaluation from Industry and Business Representatives Questionnaire, which was sent out to industry and business. It asked the following questions:

1. Will these standards be incorporated into job descriptions for HMMTs at your organization? If so, please explain.
2. Will these standards be referred to or attached to the hazardous materials manual at your organization? If so, please explain.
3. Will these standards be used as a baseline skill requirement for entry-level personnel working as a HMMT? If so, please explain.
4. Will these standards be used to evaluate existing personnel for performance related to hazardous materials management? If so, please explain.
5. Will these standards be used in the development of company-specific training programs? If so, please explain.
6. If you knew that these standards were incorporated into an associate degree curriculum at a local community or technical college, would you give priority to graduates with these degrees applying for positions as HMMTs?
7. What type of evidence (credential) would you consider most important to verify that a potential employee possessed the skills described in the standard? Please explain your response.
    - Certificate of competency (verifying that a person possessed the skills) given by a testing agency
    - Associate degree in Hazardous Materials Management from ***any*** community college
    - Associate degree in Hazardous Materials Management from a community college that has been accredited by a peer review process
    - Resume only
    - Certification (given by a professional organization with voluntary participation)
    - State license

The responses to all three surveys have been collated. However, the input from educators was minimal, since they said their survey was too detailed and time-consuming. It is hoped that further research can be done to determine how to help educators and employers in the industry use the standard as fully as possible.

Appendix B

General Requirements for HMMT Programs

HMMT programs should be accredited at the associate of science or associate of applied science level. Colleges are encouraged to be innovative in program arrangement consistent with the intent of the minimum criteria.

Program Level and Course Requirements

An accreditable A.S. program is characterized by the following quantitative minimum course requirements:

62 total semester-hour credits or the equivalent

19 semester-hour credits or the equivalent in the technology area

20 semester-hour credits or the equivalent in the sciences and mathematics area

23 semester-hour credits or the equivalent distributed in composition, speech, humanities, and or history and social sciences

Course Topics

Introduction to Environmental Technology

3 credits, 48 hrs lecture, 0 hrs lab

1. How Did We Get to This Point?
2. Governmental Processes
3. Basic Toxicology
4. Basic Ecology
5. Examining the Environmental Compartments
6. Hazardous Materials
7. Occupational Safety and Health
8. Hazardous and Non-Hazardous Waste
9. Wastewaters
10. Air Pollution
11. Nuclear Materials
12. Pollution Prevention and Waste Reduction

Site Sampling and Monitoring

3 credits, 32 hrs lecture, 32 hrs lab

1. Site Investigations
2. Sampling Approaches and Plans

3. Sampling the Sample
4. Field Monitoring for Acute Hazards
5. Personnel Monitoring for Chronic Hazards
6. Sampling Soils, Sediments and Geologic Materials
7. Sampling Surface and Ground Water
8. Sampling Air Quality
9. Sampling Containers
10. Field Analysis
11. Sample Preservation and Shipping
12. Data Validation and Interpretation

Industrial Waste Processes

3 credits, 48 hrs lecture, 0 hrs lab

1. Introduction to Waste Steams
2. Waste Stream Regulation
3. Application of Waste-Reduction and Treatment Technologies
4. Physical Treatment Technologies
5. Chemical Treatment Technologies
6. Biological Treatment Technologies
7. Thermal Treatment Technologies
8. Pollution Prevention and Waste Minimization

Regulations and Resources I

3 credits, 48 hrs lecture, 0 hrs lab

1. Hazardous Materials Characteristics and Lists
2. Using the Code of Federal Regulations
3. OSHA's Hazardous Material Regulations
4. Controlling Employee Exposures
5. Health Effects and Medical Surveillance
6. Introduction to Hazardous Materials Worker Health and Safety
7. Major Environmental Acts Related to Hazardous Materials
8. Community Right to Know and Contingency Planning

Regulations and Resources II

3 credits, 48 hrs lecture, 0 hrs lab

1. RCRA Requirements for Managing Hazardous Waste
2. Waste-Reduction Strategies

3. Water-Protection Regulations
4. Air-Protection Regulations
5. Low-Hazard Solid-Waste Management
6. Hazardous Material Transportation
7. Environmental Systems Management

An Associate of Science (AS) Degree Based on the HMMT Standard

Courses required to meet the HMMT National Voluntary Skills Standard are bolded, italicized, and underlined. Courses required to fill related academic skills identified by the standard are in bold, and italicized. Other courses fill average community college requirements for a two-year A.S. or A.A.S. degree and basic employability competencies described in the 1991 Secretary's Commission on Achieving Necessary Skills (SCANS) report. The two-year degree encompasses 63 semester credits.

English Composition

3 hrs Composition I
3 hrs Technical Writing

Speech

3 hrs Fundamentals of Communication

Humanities

3 hrs Introduction to Ethics*
3 hrs Culture and Technology*
3 hrs Basic Reasoning*

Social Sciences

3 hrs Principles of Microeconomics*
3 hrs American Government*

**recommended, but other humanities or social sciences courses may be substituted.*

Mathematics/Science

3 hrs ***Introduction to Chemistry***
4 hrs ***Bio-Organic Chemistry***
3 hrs ***Introductory Physics***
3 hrs ***Toxicology***
4 hrs ***Math for Decision Making***
3 hrs ***Introduction to Environmental Technology***

Technical Courses

4 hrs ***Hazmat Worker Safety***

3 hrs ***Site Sampling and Monitoring***

3 hrs ***Regulations and Resources I***

3 hrs ***Regulations and Resources II***

3 hrs ***Basic Industrial Hygiene***

3 hrs ***Industrial Waste Processes***

Appendix C

Model Program

During the development of this implementation guide, CORD staff asked what was needed by most educators when starting new programs or when changing existing ones. The answer was the same: model programs. It is important to note there are many successful programs available. We requested program information from several sites, and chose Springfield Technical Community College as a model program. Representatives have provided the following program information and encourage inquiries.

Associate of Science Program, Environmental Technology Springfield Technical Community College Springfield, Massachusetts

The environmental technology program at Springfield Technical Community College (STCC) evolved in response to changing community and employer needs, to regulatory expansion, and to the fact that students must be prepared to work competently in the changing field of environmental technology. Following is a profile of STCC's program, along with information on how the skill standard played a part in its development.

Program Evolution

STCC's environmental technology courses evolved from its wastewater operator program. Previously, upon receiving an associate of science degree or completing a wastewater certificate program, students were eligible to take the wastewater or drinking water operator exam in Massachusetts or Connecticut. Due to low enrollment and in response to changes in employer needs and job markets, program evolution was initiated through curriculum changes over a period of five years. The main emphasis was to provide students with a well-rounded program—including knowledge, skills, and training that would prepare them for the workplace. Local industry played an important part in curriculum development. By talking with industry representatives, staff members were able to outline needs, which provided a direction for curriculum development. Advertisements placed by industry in local newspapers helped staff consider where the program was lacking and how to make improvements. For example, a local company was looking for an environmental/safety technician who possessed the ability to address wastewater pretreatment, hazardous materials/waste, and occupational safety. Ads like this one made it clear that teaching basic job functions was not enough; curriculum had to be written to integrate several areas of knowledge or training.

Fulfilling needs of industry by providing a better-trained graduate was STCC's goal. In addition to reading advertisements and soliciting the views of local industry, staff

organized an advisory committee of representatives from local wastewater treatment plants; environmental firms; industry for environmental safety, occupational health and safety, and wastewater pretreatment; and regulatory agencies.

Also important to the process and program success were the guidance and support of STCC's administration. Throughout the development process, the administration was supportive and approved changes, which allowed the program to evolve as needed.

Using the Skill Standard

While working with the advisory committee and writing curriculum, staff used the skills standard document as a guide to be certain that the training was based on a national standard while meeting local industry-specific needs. For example, in designing the toxicology course, which was new to the program, staff used the document to structure the course. Also, in developing the hazardous waste regulatory and operations courses, soft skills such as communication, problem solving, and team building were considered. Staff incorporated these skills into the curriculum to better equip students with these skills. The laboratory for the hazardous waste course is structured to get students actively involved in role playing, team working, and communicating (written and oral) as if in a real-world situation.

Degrees and Certification

In addition to an associate of science degree, the environmental technology program offers a certificate of completion in water/wastewater technology, a certificate of completion for hazardous waste technicians, and a certificate of completion for professionals working in occupational health and safety. After receiving a certificate of completion, which signifies successful completion of coursework, workplace practicums, or co-ops (previous training and educational degrees also are considered), students are eligible to take the wastewater or drinking water operator exams for Massachusetts and Connecticut. They also are issued a voluntary compliance training certificate from OSHA, U.S. Department of Labor, and a certificate of completion of a 40-hour basic hazardous waste operations course.

Measuring Success

Success of this program is based on an increase in enrollment and a greater than 90 percent placement rate. Graduates of the degree or certification program are employed in the fields of hazardous waste, water/wastewater, health and safety, environmental regulations and laboratory analysis. Graduates also enroll in complementary programs or in bachelor degree programs.

When inquiries are made about the program from other educational institutions, requests focus on the curriculum, course content, and textbooks used. Inquiries concerning practicums concern the length of the practicum, nature of activities, and value to students when seeking employment.

The Future

In 1996, the environmental technology department received a one-year grant[22] for developing a recycling curriculum that includes a co-op. In 1997 the course will become a permanent part of the curriculum, thus offering another skill and option to students. In addition to the curriculum, staff will continue to monitor employer needs and make program changes to meet those needs. To prepare for the future, STCC staff is working to improve communication with local high schools. Specifically, efforts are being made to work on including transfer credit of students enrolled in the Tech Prep program at the high school. In addition, staff has solicited local state colleges inquiring interest in working with STCC's environmental technology and biology departments. The partnership will allow students to take courses at the community and state colleges toward degrees at each institution. Students could take courses at the community colleges and have credit transfer to state colleges facilitating transfer from a two-year to a four-year college. The state college departments represent biology and regional planning departments. Syllabi have been forwarded for review.

For further information, contact Dan Smola, Department Chair, or Carol Kwapien, faculty, at (413) 781-7822, ext. 3657.

[22] Funding was provided by the Massachusetts Department of Environmental Affairs, Massachusetts Department of Environmental Protection, Massachusetts Department of Community Colleges, and Massachusetts Office of School-to-Work Transition.

Appendix D

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Appendix E

Participating Professional Societies and Institutes

Hazardous Materials Control Resources Institute
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Rockville, Maryland

Hazardous Materials Training and Research Institute
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Doug Feil, Associate Director
Cedar Rapids, Iowa

National Association of Environmental Professionals
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National Environmental Health Association
Nelson Fabian, Executive Director
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National Environmental Training Association
Charles Richardson, Executive Director
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Partnership for Environmental Technology Education
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Pleasanton, California

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The Center for Occupational Research and Development (CORD) is a nonprofit public-service organization. CORD helps educators in schools and industry address the technical education, training, and retraining needs of workers—today and tomorrow. CORD's staff offers its extensive experience in engineering, science, technology, education, and business through a wide range of educational services.

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