AN ADVANCED TOOL FOR APPLIED INTEGRATED SAFETY MANAGEMENT

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ABSTRACT

WESKEM, LLC’s Environmental, Safety and Health (ES&H) Department had previously assessed that a lack of consistency, poor communication and using antiquated communication tools could result in varying operating practices, as well as a failure to capture and disseminate appropriate Integrated Safety Management (ISM) information. To address these issues, the ES&H Department established an Activity Hazard Review (AHR)/Activity Hazard Analysis (AHA) process for systematically identifying, assessing, and controlling hazards associated with project work activities during work planning and execution. Depending on the scope of a project, information from field walkdowns and table-top meetings are collected on an AHR form. The AHA then documents the potential failure and consequence scenarios for a particular hazard. Also, the AHA recommends whether the type of mitigation appears appropriate or whether additional controls should be implemented. Since the application is web based, the information is captured into a single system and organized according to the $\geq$200 work activities already recorded in the database. Using the streamlined AHA method improved cycle time from over four hours to an average of one hour, allowing more time to analyze unique hazards and develop appropriate controls. Also, the enhanced configuration control created a readily available AHA library to research and utilize along with standardizing hazard analysis and control selection across four separate work sites located in Kentucky and Tennessee. The AHR/AHA system provides an applied example of how the ISM concept evolved into a standardized field-deployed tool yielding considerable efficiency gains in project planning and resource utilization. Employee safety is preserved through detailed planning that now requires only a portion of the time previously necessary. The available resources can then be applied to implementing appropriate engineering, administrative and personal protective equipment controls in the field.

INTRODUCTION

The fundamental objective of the Department of Energy's Integrated Safety Management (ISM) Program (1) is to systematically integrate safety into a project by defining work scope, identifying and analyzing work hazards, developing and implementing hazard controls, performing work within those controls, and collecting employee feedback. Typically, the elements of the ISM Program are contained in a site-specific environmental, safety & health (ES&H) plan specifying regulatory and contractual requirements. Because of the contractual nature of a site-specific ES&H plan, it can have limited application when encountering unique or changing field conditions. Identifying and categorizing hazards likely to be encountered and compiling ES&H practices from previous projects would significantly streamline worker protection information and prevent duplication. Also, a project-planning tool such as an interactive database accessible at multiple locations offers inherent flexibility to implement ISM in a streamlined and consistent manner.

The Situation

WESKEM, LLC is a field-response waste management company formed in February 2000 and is comprised of over 300 salary, bargaining-unit and sub-tier subcontractor employees operating at four different locations in Paducah, Kentucky, and Oak Ridge, Tennessee. Activities consist of the collection, database inventory, characterization, sorting, treatment, segregation, packaging, interim storage and transportation of hazardous, radioactive and mixed wastes including asbestos and polychlorinated biphenyls (PCBs). Because of the hazardous nature associated with these activities and distance between these four locations, the ES&H Department wanted to verify that hazard analyses and controls were being effectively communicated to field operation workers and, in return, input from field operations was being effectively communicated to work planners. The ES&H Department assessed that a lack of consistency, the potential for poor communication, and the use of antiquated communication tools could result in varying operating practices, as well as a failure to capture and disseminate appropriate ISM information between these sites.

To address these issues, the ES&H Department established an Activity Hazard Review (AHR)/Activity Hazard Analysis (AHA) process for systematically identifying, assessing, and controlling hazards associated with project work activities during work planning and execution. This process was intended to ensure that WESKEM, LLC employees (e.g., supervisors, operators, subcontractors, etc.) involved with performing work also participated and provided active feedback into these processes.

Activity Hazard Review (AHR) Form

Work groups consisting of WESKEM, LLC employees are directly involved with identifying and categorizing operational hazards associated with the scope of work. Depending on the scope of a project, information from field walkdowns and table-top meetings are collected on an AHR form. The form is used to identify and categorize the types of hazards likely to be encountered during work activities.

HAZARD IDENTIFICATION

1. PHYSICAL HAZARDS

K	S	N	Hazard
☐	☐	☐	Cold Stress (Outside work temp < 30°F)
☐	☐	☐	Heat Stress (Inside/Outside >85°F)
☐	☐	☐	Noise (Is louder than conversational speech)
☐	☐	☐	Slip/Trip/Fall (wet, steep, poor housekeeping)
☐	☐	☐	Enclosed Space (Roll-off bins, B25 boxes)
☐	☐	☐	Confined Space (Storage tank, underground tanks, limited entry)
☐	☐	☐	Oxygen Deficient (<19.5%)
☐	☐	☐	Oxygen Enriched (>23%)
☐	☐	☐	Hydrogen
☐	☐	☐	Ergonomics (repetitive motion, vibration, unusual work position for long period of time)
☐	☐	☐	Manual Lifting
☐	☐	☐	Compressed Gases/ Cylinders (welding cylinders, propane tanks)
☐	☐	☐	Pressurized Systems* (other than air)
☐	☐	☐	Vacuum System
☐	☐	☐	Compressed Air*
☐	☐	☐	Explosive
☐	☐	☐	Vibration/Shock Sensitive
☐	☐	☐	Mechanical/Moving Parts (operating equipment)
☐	☐	☐	Sharp Edges/Corners
☐	☐	☐	Inclement Weather
☐	☐	☐	Work On or Near Water
☐	☐	☐	Moving Equipment/Vehicles
☐	☐	☐	Insufficient Lighting
☐	☐	☐	Other ____________________ ____________________ ____________________ ____________________

2. SAFETY/CONSTRUCTION HAZARDS

K	S	N	Hazard
☐	☐	☐	Demolition
☐	☐	☐	Drum Handling
☐	☐	☐	Elevated Work (>4 feet above ground)
☐	☐	☐	Hazardous Energy (electrical/hydraulic/ pneumatic/steam/etc.)
☐	☐	☐	Concealed/Underground Hazards
☐	☐	☐	Excavation/Trenching
☐	☐	☐	Hoisting/Rigging
☐	☐	☐	Overhead Hazards
☐	☐	☐	Welding/Cutting/Burning
☐	☐	☐	Drilling/Penetration
☐	☐	☐	Other ____________________ ____________________ ____________________ ____________________

3. UTILITY HAZARDS	
K S N	K S N
☐☐☐ Electrical	☐☐☐ Overhead Utility Lines
☐☐☐ Gas	☐☐☐ Septic/Sewer
☐☐☐ Plumbing (Water supply)	☐☐☐ Other Concealed/Underground Utilities ________ ________
☐☐☐ Telephone	

4. CHEMICAL HAZARDS*	
K S N	K S N
☐☐☐ Asbestos	☐☐☐ Corrosive (pH<2, pH>12)
☐☐☐ Lead	☐☐☐ Carcinogen
☐☐☐ Man-Made Fibers (fiberglass)	☐☐☐ Mutagen
☐☐☐ Flammable (flash point <140°F)	☐☐☐ Reproductive Toxin
☐☐☐ Combustible (flash point <200°F)	☐☐☐ Pyrophoric (white phosphorus, lithium hydride)
☐☐☐ Mercury	☐☐☐ Other ________ ________ ________ ________
☐☐☐ Heavy Metals (Pb, Cd, Ni, etc.)	
☐☐☐ Toxic (H_2S)	
☐☐☐ Incompatible Chemicals	Route of Exposure
☐☐☐ PCBs	☐ Ingestion
☐☐☐ Inorganics (chlorides, fluorides, etc.)	☐ Inhalation
☐☐☐ Volatile Organics (Benzene, Methylene Chloride, TCE)	☐ Absorption
☐☐☐ Oxidizers (methyl ethyl ketone peroxide, sodium nitrate, hydrogen peroxide)	

5. IONIZING RADIOLOGICAL HAZARDS*	
K S N	Route of Exposure
☐☐☐ External Exposure	☐ Ingestion
☐☐☐ Internal Exposure	☐ Inhalation
☐☐☐ Contamination	☐ Absorption
☐☐☐ Fissionable Material	

6. NON-IONIZING RADIOLOGICAL HAZARDS*	
K S N	K S N
☐☐☐ High Voltage	☐☐☐ Microwave
☐☐☐ RF	☐☐☐ Ultraviolet (excluding sunlight)
☐☐☐ Laser	☐☐☐ Ultraviolet (from sunlight)

7. BIOLOGICAL/VECTOR HAZARDS

K	S	N		K	S	N	
☐	☐	☐	Bacterial/Fungi	☐	☐	☐	Rodents (carriers of Haunta virus)
☐	☐	☐	Plants (Allergens, i.e., poison ivy, etc.)	☐	☐	☐	Insects, Spiders, Snakes
☐	☐	☐	Medical Waste	☐	☐	☐	Other Wildlife
☐	☐	☐	Parasites				____________________

8. HAZARDOUS WASTE* (Does area contain labeled waste)

Waste Codes (if known. If not known, complete identified characteristics below.)

☐ No Labeled Drums Present

METALS				VOLATILES			
K	S	N		K	S	N	
☐	☐	☐	Arsenic (D004)	☐	☐	☐	Benzene (D018)
☐	☐	☐	Barium (D005)	☐	☐	☐	2-Butanone (MEK) (F005)
☐	☐	☐	Cadmium (D006)	☐	☐	☐	1,4 Dichlorobenzene (D027)
☐	☐	☐	Chromium (D007)	☐	☐	☐	Ethylbenzene
☐	☐	☐	Lead (D008)	☐	☐	☐	Tetrachloroethylene (D039 or F002)
☐	☐	☐	Mercury (D009)	☐	☐	☐	Toluene (F005)
☐	☐	☐	Selenium (D010)	☐	☐	☐	1,1,1-Trichloroethane (F002)
☐	☐	☐	Silver (D011)	☐	☐	☐	Trichloroethylene (D040)
☐	☐	☐	Other ____________________	☐	☐	☐	Xylene (F003)

WASTE CHARACTERISTICS				OTHER			
K	S	N		K	S	N	
☐	☐	☐	Corrosive (D002)	☐	☐	☐	Asbestos
☐	☐	☐	Exothermic Reaction	☐	☐	☐	PCBs
☐	☐	☐	Ignitable (D001)	☐	☐	☐	Soil Debris
☐	☐	☐	Reactive (D003)	☐	☐	☐	Hydrocarbon Impacted Waste
☐	☐	☐	Toxic				☐ <100 ppm ☐ Unknown
							☐ >100 ppm

WASTE CATEGORY	TRANSPORTATION (if moving waste)
K S N	K S N
☐☐☐ Bio-Hazard	☐☐☐ On-Site (must comply with DOE/EPA equivalency)
☐☐☐ Mixed	☐☐☐ Over Public Roads (must comply with DOT/EPA laws)
☐☐☐ Radiological	
☐☐☐ RCRA	
☐☐☐ Sanitary Industrial	
☐☐☐ TSCA	
9. ENVIRONMENTAL (Does FWR involve the following activities?)	
K S N	K S N
☐☐☐ Air Emissions (>10 tons/year of HAP)	☐☐☐ Clearing or Excavation
☐☐☐ Liquid Discharge (above effluent limits)	☐☐☐ Other ______________________ ______________________
☐☐☐ Petroleum Storage (>600 gallons)	
HAZARD CONTROLS (To be completed by ES&H during pre-planning meetings)	
10. PROTECTIVE CLOTHING	
R P N	R P N
☐☐☐ Anti-C	☐☐☐ Disposable Suit (Saranex®)
☐☐☐ Aprons	☐☐☐ Chemical Resistant Gear
☐☐☐ Company Work Clothing	☐☐☐ Heat/Flame Resistant Clothing
☐☐☐ Disposable (Tyvek®) Suits	☐☐☐ Other ______________________ ______________________
11. HAND PROTECTION	
R P N	R P N
☐☐☐ Chemical Gloves	☐☐☐ Standard Work Gloves
☐☐☐ Leather Work Gloves	☐☐☐ Heat/Flame Resistant Gloves
☐☐☐ Kevlar® (Cut Resistant) Gloves	☐☐☐ Other ______________________ ______________________
☐☐☐ Mesh Gloves	
12. EYE/FACE PROTECTION	
R P N	R P N
☐☐☐ Safety Glasses with Side Shields	☐☐☐ Face Shield
☐☐☐ Impact Resistant Goggles	☐☐☐ Welding Helmet
☐☐☐ Chemical Goggles	☐☐☐ Other ______________________ ______________________
☐☐☐ Shaded Lens for UV (Welding) or Laser	

13. RESPIRATORY PROTECTION	
R P N	R P N
☐☐☐ Half-Face Respirator	☐☐☐ Supplied Air
☐☐☐ Full-Face Respirator/PAPR	☐☐☐ Self-Contained (SCBA)
☐☐☐ Respirator Cartridge/Canister ____________ ____________	☐☐☐ Special Ventilation (NAM)
14. FOOT PROTECTION	
R P N	R P N
☐☐☐ Safety-Toed Shoes or Boots	☐☐☐ Liquid Impermeable Footwear or Covers
☐☐☐ Slip-Resistant Soles	☐☐☐ Other ____________
☐☐☐ Chemical Resistant Boots	
15. HEAD PROTECTION	
R P N	R P N
☐☐☐ Hard Hat	☐☐☐ Hoods
☐☐☐ Welding Helmet	☐ Tyvek® ☐ Other ____________
☐☐☐ Other ____________	☐ Anti-C
16. HEARING PROTECTION	
R P N	R P N
☐☐☐ Ear Plugs	☐☐☐ Other ____________ ____________
☐☐☐ Ear Muffs	
17. TEMPERATURE EXTREME PROTECTION	
R P N	R P N
☐☐☐ Cold Wear Gear	☐☐☐ Drinking Water
☐☐☐ Special Instructions for Work/Rest	☐☐☐ Other ____________
18. ELECTRICAL PROTECTION	
R P N	R P N
☐☐☐ Identification of Concealed/Underground Conductors	☐☐☐ GFCI Protection
☐☐☐ Energy Isolation (LOTO)	☐☐☐ Equipment/System Grounding
☐☐☐ Insulated (Rated) Rubber, Fiberglass, or Plastic Electrical PPE	☐☐☐ Insulated Tools
☐☐☐ Line Clearance Minimums	☐☐☐ Other ____________ ____________

19. FIRE/EXPLOSION PROTECTION	
R P N	R P N
☐☐☐ Non-Sparking Tools	☐☐☐ Fire Watch
☐☐☐ A-, B-, C- Rated Fire Extinguisher	☐☐☐ Special Notification
☐☐☐ Grounding/Bonding for Dispensing Flammable Liquids	☐☐☐ Other ____________________ ____________________

20. FALL/ARREST PROTECTION	
R P N	R P N
☐☐☐ Safety Harness (required for all arrest)	☐☐☐ Tie-Off Point
☐☐☐ Safety Belt (Positioning/Restraint only)	☐☐☐ Guard Rail
☐☐☐ Lanyard	☐☐☐ Boundary Warning
☐☐☐ Lifeline	☐☐☐ Other ____________________

21. SPECIAL RESCUE/RETRIEVAL EQUIPMENT	
R P N	R P N
☐☐☐ Personal Flotation Devices	☐☐☐ Rescue Tripod
☐☐☐ Rescue Line/Harness	☐☐☐ Other ____________________ ____________________
☐☐☐ Life Rings with Rope	

22. MONITORING	
R P N	R P N
☐☐☐ Industrial Hygiene Monitoring	☐☐☐ Oxygen
☐☐☐ Toxic (H_2S)	☐☐☐ Combustible Gas
☐☐☐ Heat Stress Monitor	☐☐☐ Radiological Exposure/Contamination
☐☐☐ Chemical Monitor (Colorimetric)	☐☐☐ Thermoluminescent Device
☐☐☐ Noise	☐☐☐ Other ____________________ ____________________
☐☐☐ Volatile Organic Compounds	
☐☐☐ Explosive (LEL)	

23. ENVIRONMENTAL MONITORING	
R P N	R P N
☐☐☐ Air Emission Monitoring	☐☐☐ RCRA Storage Area Inspections
☐☐☐ Liquid Emission Monitoring (NPDES)	☐☐☐ Other ____________________ ____________________
☐☐☐ SPCC Monitoring	
☐☐☐ Waste Drum Inspections	

24. PERMITS	
R P N	R P N
☐☐☐ Confined Space Entry	☐☐☐ Radiation Work Permit
☐☐☐ Excavation/Penetration	☐☐☐ Welding/Burning/Hotwork
☐☐☐ Lockout/Tagout	☐☐☐ Other ________________
☐☐☐ Fall Protection	________________
25. SPECIAL PLANS OR PROCEDURES OR GUIDELINES (other than existing Weskem SOPs)	
R P N	R P N
☐☐☐ Carcinogen Control	☐☐☐ Hearing Conservation Control
☐☐☐ Asbestos Work Authorization	☐☐☐ Respiratory Protection
☐☐☐ Chemical Hygiene Plan	☐☐☐ Heat Stress
☐☐☐ Exposure Control (for handling bloodborne pathogens, medical waste)	☐☐☐ Hoisting and Rigging Lift
	☐☐☐ Other ________________ ________________
26. OTHER MISCELLANEOUS	
R P N	R P N
☐☐☐ Shoring/Sloping Protection for Excavations	☐☐☐ Barricades/Access Control
27. WALKDOWN CONDUCTED	☐ **YES** ☐ **NO**
28. COMMENTS	

If a hazard applies, a check is marked in the "K"nown box. If a hazard is suspected or may be present, a check is marked in the "S"uspect box. If a hazard does not apply, a check is marked in the "N"ot present box. This planning process elevates the scope of work to a task-specific hazard review. The work group members and those implementing the work then sign the AHR form.

Activity Hazard Analysis (AHA) Database

The AHA database documents the potential failure and consequence scenarios for a particular hazard. Also, the AHA information recommends whether the type of mitigation (e.g., engineering, administrative or personal protective equipment [PPE]) appears appropriate or whether additional controls should be implemented. The previous AHA method that was initially developed at the start of operations in February 2000 consisted of a cumbersome, ten-column format that was completed by hand or by cutting and pasting information from previously developed AHAs. The process was very time consuming, requiring an average of four hours per AHA, and was lacking essential programmatic components such as configuration control and an AHA library to compile information, feedback and lessons learned from previous projects. This approach was inefficient since information could not be utilized across all four locations, but could result in developing inconsistent hazard analyses for similar projects.

The Streamlined AHA Method

Information technology tools were then used as leverage in planning and information management needs between the four locations. A network database application called the Activity Hazard Analysis System (AHAS) was developed to perform an AHA. The AHA information is accessible through the main menu shown in Figure 1.

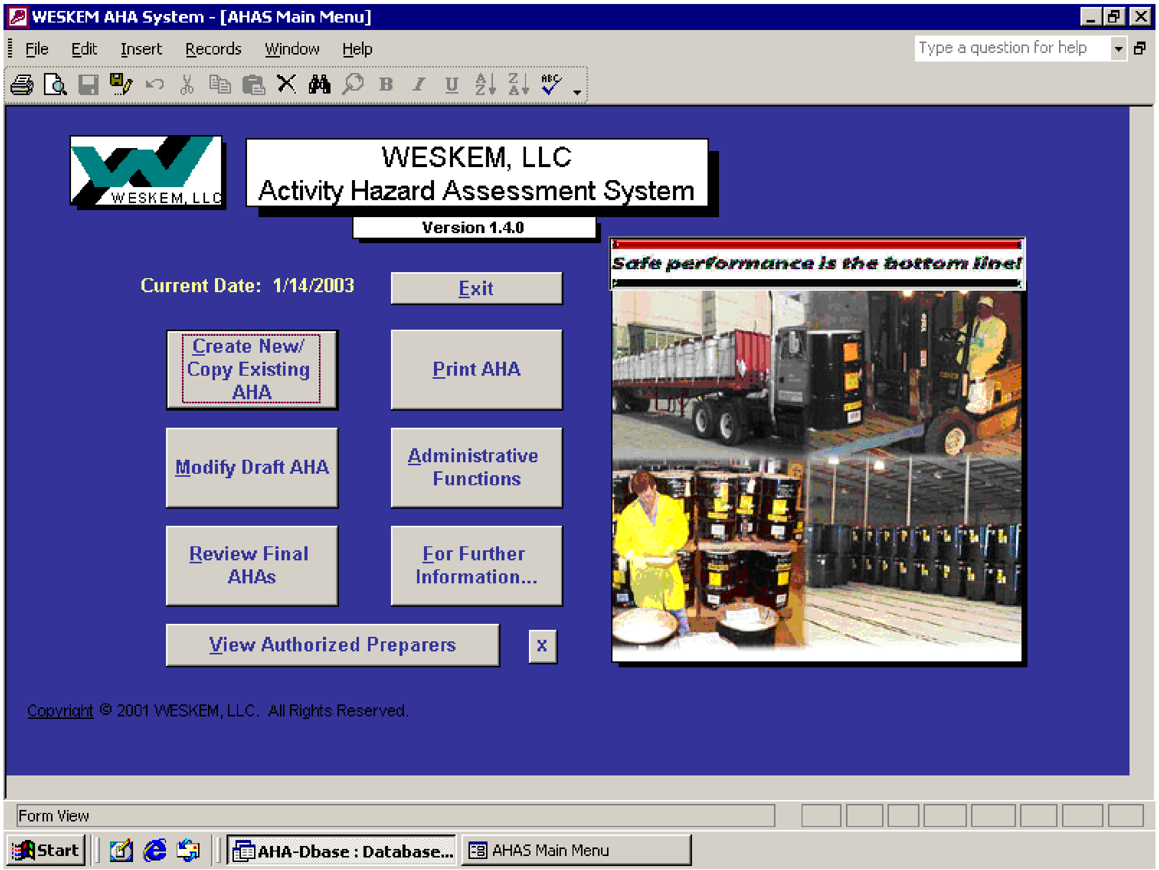

Figure 1. AHA Main Menu

Depending on the job scope, information consisting of job location and description, other subcontractors, tools and equipment, PPE, special instructions, work activities, potential hazards, and required actions, controls or methods of compliance are identified and edited on the AHA edit screen shown in Figure 2. Since the application is web based, the information is captured into a single system and organized according to the ≥200 work activities already recorded in the database.

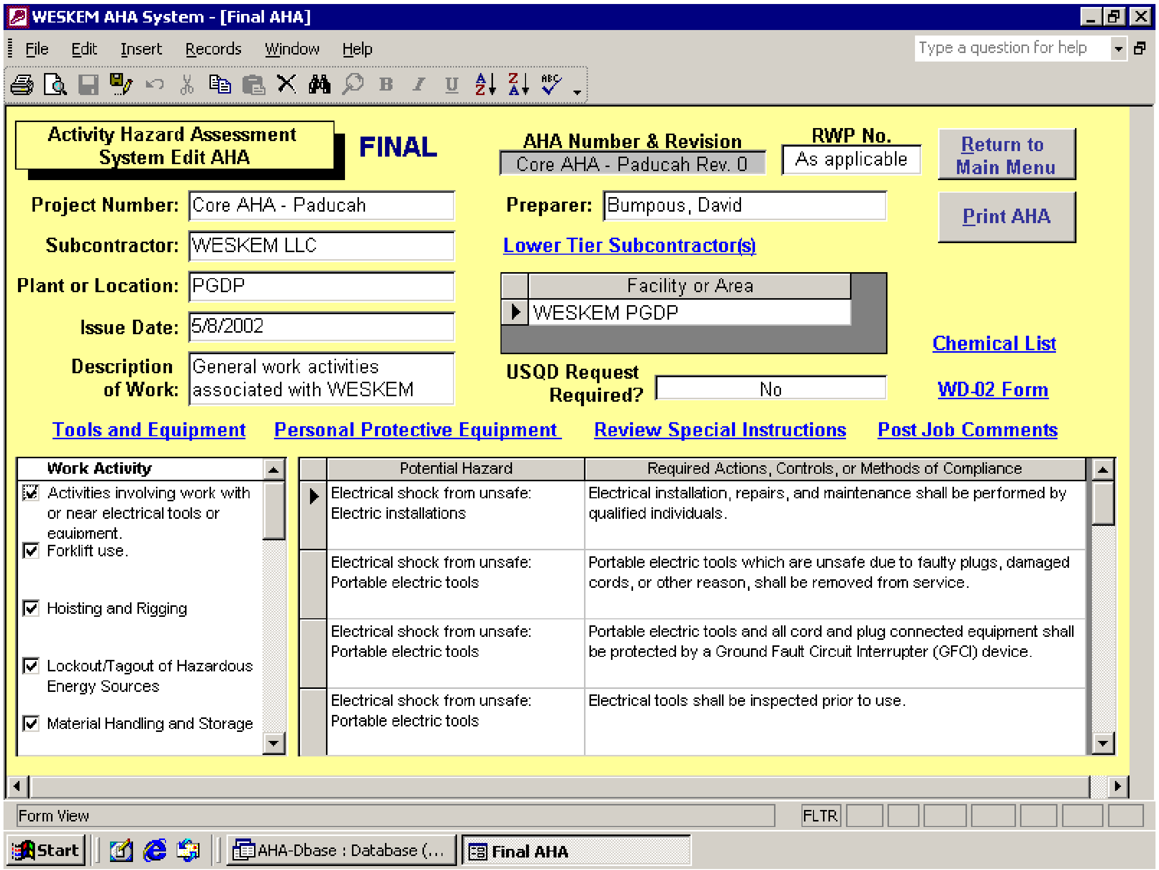

Figure 2. AHA Edit Screen

The AHA information is then compiled and printed in a three-column format, shown in Figure 3, and is included as part of the work package. Space is provided to collect post-job comments and employee feedback in the field that can then be added to the AHA database electronically. If field changes are made and approved by the ES&H Representative, the AHA is annotated and employees are updated accordingly.

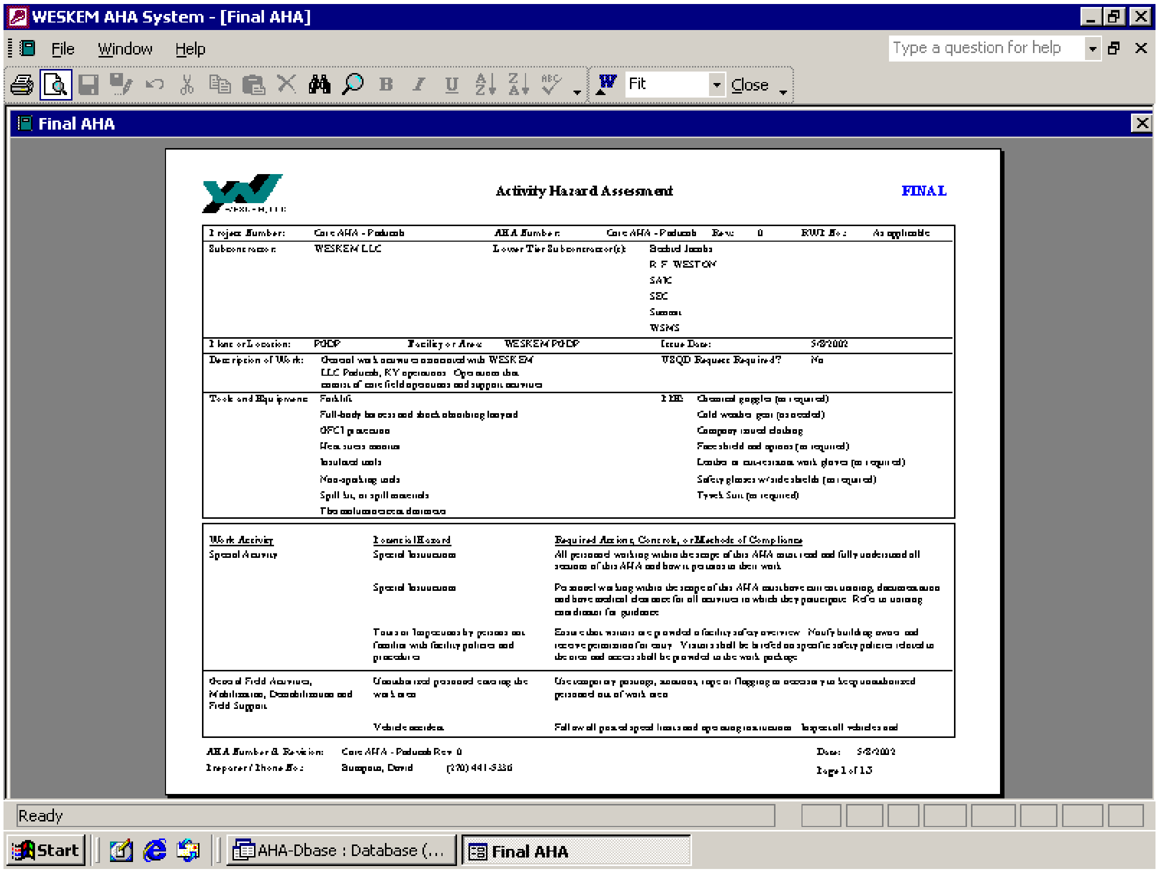

Figure 3. Example AHA Printout

The initial network-based AHAS was developed over a six-month period using Microsoft® Access 2000 and Visual Basic for Applications. In Spring 2001, all four geographical locations were operating off one central server. Microsoft® Access 2000 was utilized because of employee familiarity and having already been installed on all client/server systems. In addition, follow-up customization and programming, shown in Figure 4, could be performed very easily compared to other systems.

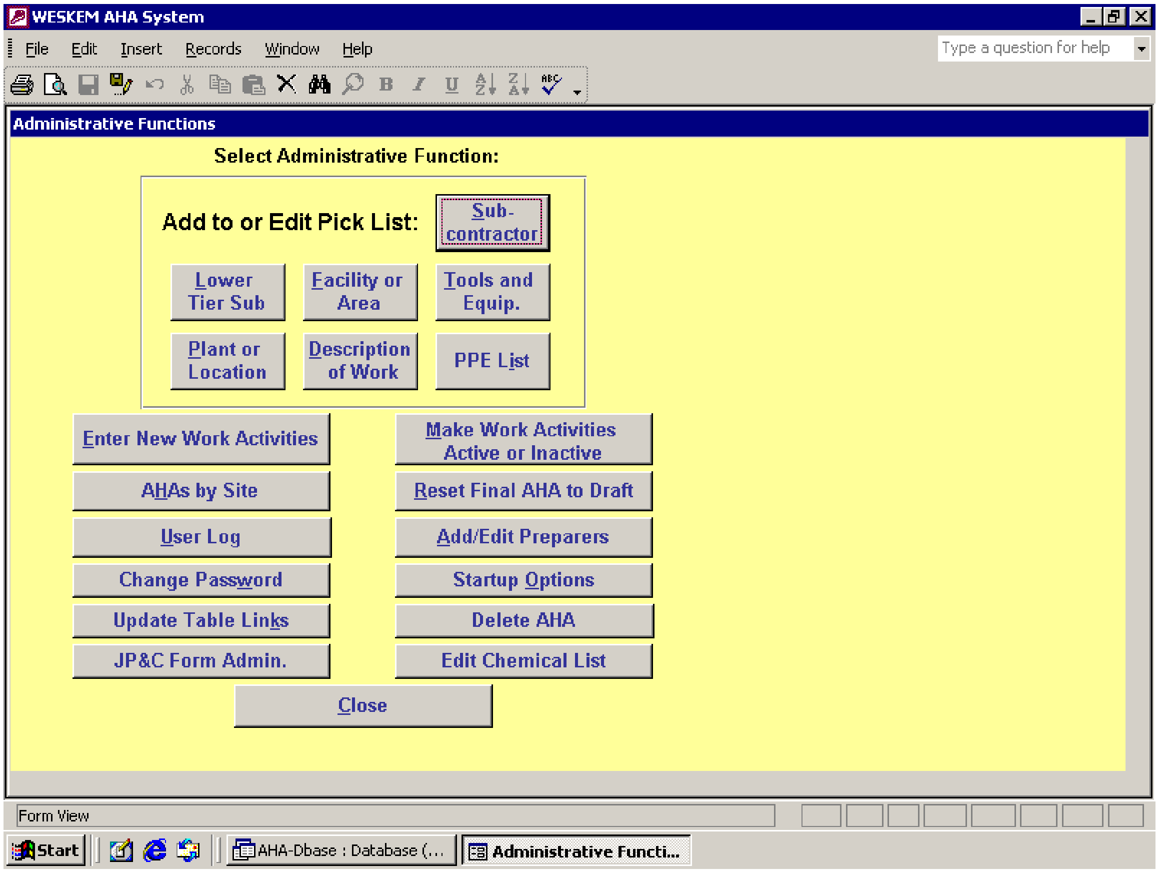

Figure 4. AHA Administrative Functions

AHAS Requirements

The AHAS features consist of user-level security (e.g., usernames and passwords are required for accessing the system), a comprehensive menu-driven interface, customized menus and toolbars, error trapping, and data validation. It is optimized for five simultaneous users, but can support up to 255 users. Operating the AHAS requires a Pentium III 600 MHz processor client machine with 64 MB RAM and Win9X, Win2000, or WinXP, Microsoft® Access 2000, and a Pentium III 600 MHz processor network server with Win2000 or WinXP and 128 MB RAM. The AHAS network requirements consist of a 10 BaseT Local Area Network (LAN) with optimal performance achieved using a 100 BaseT LAN. In addition, Win2000, WinXP terminal server, or a compatible client terminal can be used for connecting to the system and accessing the AHAs remotely (e.g., T1 Line). A typical operation is completed in <5 seconds under optimal conditions using a terminal server. A terminal server is a server-based application that allows users to run applications at the server level, thus taking the burden off the employee's personal computer (PC). The terminal server only transmits screen shots that are very small in comparison with the data that is normally transmitted from the server to a standard PC.

CONCLUSION

This experience in developing the AHR/AHA system provides an applied example of how the ISM concept evolved into a standardized field-deployed tool yielding considerable efficiency gains in project planning and resource utilization. Use of the streamlined AHA method improved cycle time to an average of one hour allowing more time to analyze unique hazards and develop appropriate controls. Also, the enhanced configuration control created a readily available AHA library to research and utilize along with standardizing hazard analysis and control selection across four separate locations.

Since group interaction throughout the AHR/AHA process is the centerpiece for communicating hazards and controls, employees understand the hazards and agree to comply with the controls before deploying to the field. The employees are expected to improve on the identification and control of hazards whenever possible. Therefore, employee safety is preserved through detailed planning that now requires only a portion of the time previously necessary. Additional resources can then be applied to implementing appropriate engineering, administrative and PPE controls in the field, which is where the identified and potential hazards affect the employees directly.

REFERENCES

1. Assistant Secretary for Environment, Safety and Health, Safety Management System Policy, DOE P 450.4, U.S. Department of Energy, Washington, DC. October 15, 1996.