This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.

Designation: E2637 – 17

Standard Guide for Utilizing the Environmental Cost Element Structure Presented by Classification E2150[1]

This standard is issued under the fixed designation E2637; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 The Environmental Cost Element Structure (ECES) covered by Classification E2150 (and Adjunct E2150) provides a consistent and comprehensive structure across all phases of environmental remediation projects and is a tool to improve the cost management of those projects. This guide is intended to facilitate the application of the ECES to any environmental remediation project, without regard to project size.

1.2 Classification E2150 establishes the broad, top-level framework for environmental remediation projects by providing a hierarchical list of project elements to two levels of detail. Its associated Adjunct E2150 supports the top-level structure by providing more detailed elements and definitions of the ECES to three additional levels of detail. Although it is assumed that the user is familiar with Classification E2150, much of the content of the classification is repeated in this guide to relieve the user of the burden of back-and-forth referencing during use. It is assumed, however, that all users of this guide will have at hand both Classification E2150 and the Adjunct E2150 during project planning.

1.3 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

E631 Terminology of Building Constructions

E833 Terminology of Building Economics

E917 Practice for Measuring Life-Cycle Costs of Buildings and Building Systems

E2150 Classification for Life-Cycle Environmental Work Elements—Environmental Cost Element Structure

2.2 *ASTM Adjunct:*[3]

Adjunct E2150 Adjunct to Classification E2150: Environmental Cost Element Structure at Levels 3, 4, and 5 and Definitions

3. Terminology

3.1 *Definitions*—For definitions of general terms used in this guide, refer to Terminology E631, and for general terms related to building economics, refer to Terminology E833.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *Comprehensive Environmental Response, Compensation and Liability Act (CERCLA)*—A congressional mandate, also known as *Superfund*, CERCLA prescribes actions and regulatory requirements for reducing risks to human health and the environment resulting from releases or threatened releases of hazardous substances into the environment.

3.2.2 *Resource Conservation and Recovery Act (RCRA)*—A congressional mandate that requires the management of regulated hazardous wastes and requires that permits be obtained for facilities (both public and private) that treat, store, or dispose of hazardous wastes. RCRA also establishes standards for these facilities and requires corrective actions (for example, remediation) of past releases of hazardous waste from regulated waste management units.

3.3 *Acronyms:*

3.3.1 *AST*—Aboveground Storage Tank

[1] This guide is under the jurisdiction of ASTM Committee E06 on Performance of Buildings and is the direct responsibility of Subcommittee E06.81 on Building Economics.

Current edition approved March 1, 2017. Published May 2017. Originally approved in 2008. Last previous edition approved in 2013 as E2637-13. DOI: 10.1520/E2637-17.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from ASTM International Headquarters. Order Adjunct No. ADJE2150A.

Copyright © ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959. United States

3.3.2 *CERCLA*—Comprehensive Environmental Response, Compensation, and Liability Act

3.3.3 *CLP*—Certified Laboratory Procedure

3.3.4 *CMS*—Corrective Measure Study

3.3.5 *COA*—Code of Accounts

3.3.6 *CWM*—Chemical Warfare Materials

3.3.7 *D&D*—Decontamination and Decommissioning

3.3.8 *DOE*—Department of Energy

3.3.9 *(EC)*^{2}—Environmental Cost Engineering Committee

3.3.10 *ECAS*—Environmental Cost Analysis System

3.3.11 *ECES*—Environmental Cost Element Structure

3.3.12 *EM*—Environmental Management

3.3.13 *EPA*—Environmental Protection Agency

3.3.14 *ER*—Environmental Restoration

3.3.15 *FRTR*—Federal Remediation Technologies Roundtable

3.3.16 *FS*—Feasibility Study

3.3.17 *HRS*—Hazard Ranking System

3.3.18 *HTRW*—Hazardous, Toxic, and Radioactive Waste

3.3.19 *LTSM*—Long-Term Surveillance and Maintenance

3.3.20 *O&M*—Operations and Maintenance

3.3.21 *OECD*—Organization of Economic Cooperation and Development

3.3.22 *PA/SI*—Preliminary Assessment/Site Investigation

3.3.23 *RA*—Remedial Action

3.3.24 *RACER*—Remedial Action Cost Estimating Requirement (System)

3.3.25 *RCRA*—Resource Conservation and Recovery Act

3.3.26 *RD*—Remedial Design

3.3.27 *RFA*—RCRA Facility Assessment

3.3.28 *RFI*—RCRA Facility Investigation

3.3.29 *RI*—Remedial Investigation

3.3.30 *SLTM*—Surveillance and Long-Term Monitoring

3.3.31 *S&M*—Surveillance and Maintenance

3.3.32 *SM&A*—Sampling, Monitoring and Analysis

3.3.33 *USACE*—U.S. Army Corps of Engineers

3.3.34 *UST*—Underground Storage Tank

3.3.35 *WBS*—Work Breakdown Structure

3.3.36 *WM*—Waste Management

4. Summary of Practice

4.1 The ECES is a comprehensive hierarchical list of work activities (tasks, items, or products) that may be required to accomplish environmental restoration, waste management, facility decontamination and decommissioning, or other environmental projects. Its activity-based structure provides a consistent and visible cost management framework, with sufficient detail and coverage of project types, so that it can be used by private industry and government agencies in the United States and other countries to track project costs.

4.2 While primarily a cost structure, the ECES can also serve as a model for developing a work breakdown structure (WBS). A WBS provides a framework for managing the cost, schedule, and performance objectives of a project. The WBS framework allows a project to be separated into logical component parts and makes the relationship of the parts clear. It defines the project in terms of hierarchically related action-oriented elements. Each element provides logical summary points for assessing technical accomplishments and for measuring cost and schedule performance.

4.3 It is recommended that projects using the ECES and associated dictionary routinely report costs to Level 3 in the cost structure. More detailed reporting levels (that is, sub-Level 4 and beyond) are provided to allow users to address high risk, high value, or high technological interest areas of projects. Because the combined life-cycle phases of environmental projects often span several decades, use life-cycle cost analysis (see Practice E917) for evaluating an environmental project or project alternatives over a designated study period. Use of life-cycle cost analysis is required for the comparison of alternative environmental remedies in CERCLA Remedial Investigation/Feasibility Studies which lead up to Records of Decision.

5. Significance and Use

5.1 In addition to its cost management and project management functions, the ECES can also be used to support a number of other program and project functions. These functions include:

5.1.1 Bid solicitation, collection, and evaluation;

5.1.2 Communicating project data between installations, complexes, agencies, and industry;

5.1.3 Providing a project checklist;

5.1.4 Cost and schedule estimating;

5.1.5 Historical cost/schedule data collection;

5.1.6 Historical project data collection (for example, technology deployments, project conditions);

5.1.7 Validating and calibrating cost estimates and software tools; and

5.1.8 Establishing and disseminating best practices and lessons learned.

5.2 Several government agencies are already incorporating this structure into existing and future cost estimating models, databases, and other similar software tools and systems.

6. Procedure

6.1 *Overall Structure*—The hierarchical nature of the ECES cost structure (Fig. 1) allows detailed cost data at Level 3 to be summarized into higher level cost elements in a standardized fashion. It is recommended that the ECES be used as a common standard through its top three levels. Appendix X1 provides an example showing how to use the ECES at Level 3 throughout the life-cycle of a project. The use of Level 4 or lower is optional. Similarly, while Level 5 is generally deemed to provide a sufficiently low level of detail for most projects, the project managers are free to add further lower levels for their specific projects or portions of their projects. Care must be taken in developing the associated numerical codes,

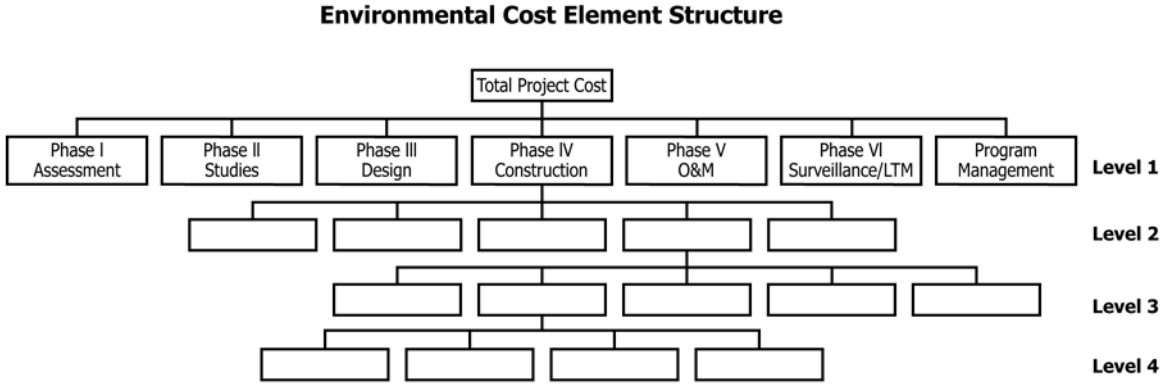

FIG. 1 Hierarchical Structure of the Environmental Cost Element Structure

however, to assure that each level directly relates to the next higher level so that the project costs can readily be "rolled up" for reporting purposes.

6.2 *Level 1*—Level 1 of the structure includes seven cost categories. The first six categories represent the six life-cycle phases of an environmental project. The final category—Program Management, Support, and Infrastructure—is included to address costs that are not attributable to a distinct project or are program management costs. Throughout the rest of this guide, the Level 1 cost element for Program Management, Support, and Infrastructure will be referred-to as Phase 8, to simplify references to the Level 1 cost elements. With minor variations in the definitions, these project life-cycle categories apply to all environmental projects and programs, including environmental remediation, waste management, decontamination and decommissioning, ordnance and explosive retrievals, underground and above-ground storage tanks, and other environmental work.

6.2.1 *Phase 1: Assessment*—Assess and inspect site, prepare site inspection reports.

6.2.2 *Phase 2: Studies*—Risk assessment, characterization and investigations, development and analysis of treatment or remediation options, and treatability studies.

6.2.3 *Phase 3: Design*—Engineering design and pre-construction activities of treatment or remediation alternatives.

6.2.4 *Phase 4: Construction*—Construction of selected treatment or remediation alternatives. Includes start-up, but excludes all operations.

6.2.5 *Phase 5: Operations and Maintenance (O&M)*—Includes all operations and maintenance for the selected treatment or remediation alternatives. Phase ends when cleanup or waste treatment goals are met.

6.2.6 *Phase 6: Surveillance and Long-Term Maintenance (SLTM)*—Operations have ceased or were not integral to selected treatment or remediation alternatives.

6.2.7 *Phase 7: Reserved for Future Use*.

6.2.8 *Phase 8: Cross Cut*—Program-wide activities that are required, but cost is not specific to a single or distinct project (for example, program management, support, and infrastructure).

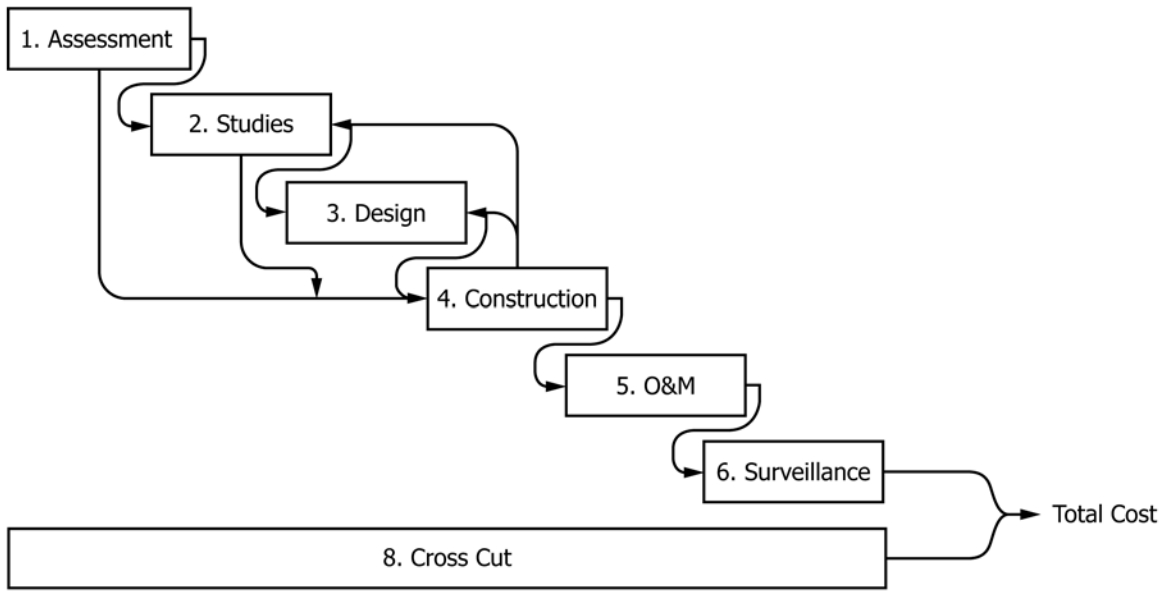

FIG. 2 Level 1 Cost Categories

NOTE 1—Fig. 2 illustrates the life-cycle nature of the seven Level 1 cost elements.

6.3 *Level 2*—Level 2 of the ECES represents major elements necessary to perform work in an environmental project. There are 34 elements included in this structure (see Table 1). It should be noted that in the Level 2 structure, Level 2 elements are marked with life-cycle phase numbers in the left columns. These numbers represent the applicability of that phase to that element. This is not necessarily all-inclusive. There may be cases where that element may be applicable for a phase that is not marked. For example, an overall Project Plan developed at the beginning of a project, especially a large and complex project, will often be followed by very detailed *Work Plans* that cannot be developed until much more information is available later in the project, for example, at Phase 4 or Phase 5. This structure is flexible, and the user can use other phases even though they are not marked in the columns.

6.4 *Level 3*—Level 3 of the structure consists of more detailed elements required to perform the tasks at the Level 2 of the ECES. See the structure for the Level 3 elements, and the Level 3 ECES dictionary, in the following sections, for more

TABLE 1 Level 1 and Level 2 Classification Matrix

Level 1								Level 2	Environmental Management
Ph1	Ph2	Ph3	Ph4	Ph5	Ph6	Ph8	Sub-Proj.		
Assess.	Studies	Design	Const.	O&M	SLTM	Prog. Mgmt/Infra.	a to z		ENVIRONMENTAL COST ELEMENT STRUCTURE
						8		.01	PROGRAM MANAGEMENT, SUPPORT, AND INFRASTRUCTURE (Optional-Installation/Complex Wide Activities)
1	2	3	4	5	6	8		.02	PROJECT MANAGEMENT AND SUPPORT (Operable Unit/Solid Waste Management Unit)
1	2	3	4	5	6	8		.03	PREPARATION OF PLANS
1	2	3	4	5	6			.04	STUDIES/DESIGN AND DOCUMENTATION
1	2	3	4	5	6	8		.05	SITE WORK
1	2	3	4	5	6	8		.06	SURVEILLANCE AND MAINTENANCE
1	2	3	4	5	6			.07	INVESTIGATIONS AND MONITORING/SAMPLE COLLECTION
1	2	3	4	5	6			.08	SAMPLE ANALYSIS
1	2	3	4	5	6			.09	SAMPLE MANAGEMENT/DATA VALIDATION/DATA EVALUATION
	2	3						.10	TREATABILITY/RESEARCH AND DEVELOPMENT
			4	5				.11	TREATMENT PLANT FACILITY/PROCESS
			4	5	6			.12	STORAGE FACILITY/PROCESS
			4	5	6			.13	DISPOSAL FACILITY/PROCESS
			4					.14	ORDNANCE AND EXPLOSIVES REMOVAL AND DESTRUCTION (CWM is in X.11 AND X.20–X.30)
			4		6			.15.	DRUMS/TANKS/STRUCTURES/MISC. AND REMOVAL
			4	5	6			.16	AIR POLLUTION/GAS COLLECTION AND CONTROL
			4	5	6			.17	SURFACE WATER/SEDIMENTS CONTAINMENT, COLLECTION, OR CONTROL
			4	5	6			.18	GROUNDWATER CONTAINMENT, COLLECTION, OR CONTROL
			4	5	6			.19	SOLIDS/SOILS CONTAINMENT (for example, CAPPING/BARRIER), COLLECTION, OR CONTROL
			4	5				.20	LIQUIDS WASTE/SLUDGES (for example, UST/AST) CONTAINMENT, COLLECTION, OR CONTROL
			4	5				.21	IN SITU BIOLOGICAL TREATMENT
			4	5				.22	EX SITU BIOLOGICAL TREATMENT
			4	5				.23	IN SITU CHEMICAL TREATMENT
			4	5				.24	EX SITU CHEMICAL TREATMENT
			4	5	6			.25	IN SITU PHYSICAL TREATMENT
			4	5				.26	EX SITU PHYSICAL TREATMENT
			4	5				.27	IN SITU THERMAL TREATMENT
			4	5				.28	EX SITU THERMAL TREATMENT
			4	5				.29	IN SITU STABILIZATION/FIXATION/ ENCAPSULATION
			4	5				.30	EX SITU STABILIZATION/FIXATION/ ENCAPSULATION
			4	5				.31	FACILITY DECOMMISSIONING AND DISMANTLEMENT
1	2	3	4	5				.32	MATERIAL HANDLING/TRANSPORTATION
1	2	3	4	5	6			.33	DISPOSAL
			4	5				.34	AIR-EMISSION AND OFF-GAS TREATMENT
1	2	3	4	5	6	8		.9X	OTHER (Use Numbers 90-99)

detailed descriptions of the elements, their uses, the components which comprise of the elements, and other information.

6.5 *Levels 4 and 5*—The use of the Level 4 and 5 ECES elements is optional. To aid project managers that elect to use Levels 4 and 5, the EC^2 developed detailed ECES elements for Construction and Operations and Maintenance, but not for environmental technologies (ECES components under X.21 to X.30).

6.5.1 For environmental cleanup technologies, the EC^2 agreed to include a limited set of elements based on the Federal Remediation Technologies Roundtable (FRTR) recommendations. For environmental cleanup technologies, individual organizations, programs, or agencies can use a more detailed set of Level 4 elements, as long as the elements can be summarized to the FRTR Level 4 elements.

NOTE 2—The ECES considers all possible items and activities by including the *Other* items at Level 2 and lower levels. The *Other* items are designated by the number "X.9x.xx" These "X.9x.xx" elements are reserved for activities which are unique or for special tasks that cannot be described closely by available elements.

6.6 *Units of Measure: Metrics*—Another important aspect of this structure is the assignment of units of measure or metrics. As used in this document, the term *metrics* is defined as measurable parameters associated with each element of the ECES. Metrics are assigned to each level element of the ECES. The primary unit of measure (UOM) for each ECES element is defined as the single most important parameter associated with that element for each phase. The Adjunct E2150 provides primary units of measure for each element at ECES Levels 3, 4, and 5.

6.6.1 *Secondary Parameters*—To make ECES more valuable to the estimators, managers, and analysts; additional cost driving parameters for all Level 3 ECES elements must be identified. The purpose of secondary parameters is to identify and capture those characteristics that impact environmental management project cost. Cost driving parameters are data that characterize activities or sub-activities and significantly effect cost. These cost driving parameters are readily available to the work managers who are acquainted with the work and can be included while reporting the cost data without requiring additional resources. As an example, Element 4.18.01 (Phase 4) Extraction Wells will commonly have an associated parameter of each (that is, $X/each well). However, additional cost driving parameters are necessary to define this activity in a meaningful way. The additional cost driving parameters for this activity would include depth and diameter of the well, the construction material of the well, site conditions or physical state of media, and other parameters. Other typical cost driving parameters might be given in terms of square feet, pounds, tons, gallons, cubic meters, etc. This information should be readily available to the project manager, and should be recorded in a format (for example, tabular) that is conducive to database entry and management. The objective is to be as precise and descriptive as possible for cost management purposes, as well as for cost comparisons among similar projects. In environmental clean-up projects, the type of waste generated becomes a key cost driving parameter because of the regulatory requirements for packaging, handling, transportation, and disposal. Appendix X2 proposes a roster of waste categories, and Appendix X3 presents numerous other secondary parameters related to the ECES Level 3 elements.

7. Program-Specific Cost Category Definitions

7.1 The seven project phases listed earlier (6.2) apply to environmental restoration, waste management, and facility D&D projects, but there are slightly different definitions for each as shown below.

7.2 For environmental restoration projects conducted under CERCLA, the phases are:

7.2.1 Preliminary Assessment/Site Investigation (PA/SI),

7.2.2 Remedial Investigation/Feasibility Study (RI/FS),

7.2.3 Remedial Design (RD),

7.2.4 Remedial Action (RA),

7.2.5 O&M, and

7.2.6 Post-Closure Surveillance and Long-Term Monitoring.

7.3 For environmental restoration projects conducted under RCRA, the phases are:

7.3.1 RCRA Facility Assessment,

7.3.2 RCRA Facility Investigation/Corrective Measures Study (RFI/CMS),

7.3.3 Design portion of Corrective Measures,

7.3.4 Corrective Measures,

7.3.5 O&M, and

7.3.6 Post-Closure Surveillance and Long-Term Monitoring.

7.4 For waste management projects, the phases are:

7.4.1 Preliminary Planning—Waste/Special Material Operations,

7.4.2 Pre-Conceptual Design/Research and Development,

7.4.3 Waste Management Facility Design,

7.4.4 Waste Management Facility Construction,

7.4.5 Waste Management Facility O&M, and

7.4.6 On-Site Storage/Disposal Facility Surveillance and Long-Term Monitoring.

7.5 For facility D&D projects, the phases are:

7.5.1 Pre-Decommissioning Actions,

7.5.2 Facility Shutdown/Decommissioning and Research and Development,

7.5.3 D&D Design,

7.5.4 D&D Construction,

7.5.5 D&D Operations and Maintenance, and

7.5.6 Post-Closure Facility Surveillance and Long-Term Monitoring.

NOTE 3—While the definitions for these phases are different, they each represent the same life-cycle phases for their respective project types. For the purposes of this structure and dictionary, only the generic titles mentioned above will be included in the following definitions of ECES elements. Each second-level and third-level element definition is structured to consider the effect that each phase has on the definition for that element. If the definition for an element changes according to phase, it will be documented.

7.6 *Subproject Identification (Optional)*—There is an optional level category (field or column in the matrix format) between the Level 1 (that is, Phases 1 through 6) and the Level 2 ECES elements. This level is optional because not all projects

have subprojects. An example of a project with subprojects may be where the same site (waste release site or single area of contamination) has more than one substantially different technical approach. For instance, a single project may require contaminated soil (hot spot) excavation and capping as well as groundwater pump and treat. In this case the project may be better organized by according to subproject. There could be one (or two) subproject(s) to address the soil excavation and capping and another subproject to address groundwater.

7.6.1 In the matrix format, this optional level appears between the six phases and the numbering for the second level. The conventions for using this optional level are as follows:

7.6.1.1 If there are subprojects, then alpha characters will be used starting with the letter *A*. It is unlikely that any one project would have more than five subprojects, but there is no established limit. If there are more than five, then it may be desirable to divide the project into two or more projects.

7.6.1.2 If an element such as Community Relations has application to all subprojects then the letter *X* will be used. The numbering for this ECES element would then be:

(1) 1.X.02.02 for Phase 1 and 2.X.02.02 for Phase 2—etc.

7.6.1.3 However, if the distinction of Community Relations is important, then it may numbered:

(1) 1.A.02.02 for Phase 1—2.A.02.02 for Phase 2—etc.

(2) 1.B.02.02 for Phase 1—2.B.02.02 for Phase 2—etc.

7.6.1.4 If the same ECES element is required for more than one subproject, then it will be repeated accordingly. For example, if Contaminated Soil Collection is needed for Phase 4 activities in Subproject—A and Subproject—C, then this ECES element will be used twice.

(1) 4.A.19.02 for Subproject—A and 4.C.19.02 for Subproject—C.

7.6.1.5 Further, suppose that the ECES element Disposal Tipping Fees are required for all subprojects during Phase 4. The numbering for these ECES elements would then be:

(1) 4.A.33.03 for Subproject—A, 4.B.33.03 for Subproject—B, and 4.C.33.03 for Subproject—C; or

(2) 4.X.33.03 for all subprojects if the distinction for this element is not important between subprojects.

7.6.1.6 If there are no subprojects, then there will be no alpha characters in the ECES number. In this case the numbering for the ECES element Disposal Tipping Fees for Phase 4 would be:

(1) 4.33.03

7.6.2 This optional level is not considered to be one of the ECES levels. Whether or not it is used, Level 1 of the ECES is still Phases 1 through 6 and 8, and the Level 2 is still the 34 major ECES elements from Program Management, Support, and Infrastructure to Disposal—Commercial.

8. Keywords

8.1 CERCLA; characterization; cleanup technology; code of accounts; cost elements; cost estimation; cost management; decommissioning; decontamination; ECES; environmental cost element structure; environmental management; environmental remediation; environmental restoration; life-cycle costs; life-cycle phases; operation and maintenance; phases; program management; project management; RCRA; remediation; site investigation; standard classification; surveillance and long-term monitoring; waste management; WBS; work breakdown structure

APPENDIXES

(Nonmandatory Information)

X1. EXAMPLE OF USE OF THE ECES

X1.1 The following example is provided to show how to use the ECES throughout the life-cycle of a project. This hypothetical project involves a site that may or may not be contaminated with organic and inorganic hazardous waste.

X1.2 *Project Description*—The site is located in the Mid-Atlantic region of the country with very sandy soil and shallow groundwater. The assessment conducted discovered that the groundwater is contaminated with benzene, toluene, ethylbenzene, and xylene (BTEX), lead, and high levels of arsenic. As part of Phase 2 studies, it was also found that the contaminants pose an unacceptable risk to a nearby community. Based on a cleanup technology alternative study, engineers will select groundwater pumping followed by coagulation/flocculation/precipitation and ion exchange as a final step. The treatment units need to treat approximately one million gallons of groundwater per day. To remove the BTEX, Ultraviolet Photolysis will be used. A treatment train will be designed and constructed to clean up the site. The technologies (treatment train) will be housed in a treatment train facility. The O&M costs which contribute to the O&M of the all the treatment train technologies will be captured as costs of the treatment train facility. For those O&M costs which can be clearly identified for a specific technology, those costs will be captured under that technology. These technologies will operate for fifteen years, and the site will allow natural attenuation to reduce the trace amount of contaminates left.

X1.3 *Code of Accounts*—The following tables indicate typical activities that would occur in each phase of the project over its life cycle. They are given at ECES Level 3 to indicate the adequacy of Level 3 as the recommended cost reporting level. The code numbers that identify each activity (for example, 1.03.03) are intended to form the Code of Accounts for the project. They can also be used in developing the WBS for the project, thus maintaining a direct relationship between the cost and technical descriptors for the project.

X1.4 See Tables X1.1-X1.7.

TABLE X1.1 Phase 1—Assessment

ECES Code	ECES Title
1.02.01	Project Management/Support/Administration
1.03.01	Workplan (for Preliminary Assessment)
1.03.02	Chemical Data Acquisition Plan
1.03.03	Sampling and Analysis Plan
1.07.01	Site Reconnaissance
1.07.03	Site Survey/Radiation Monitoring
1.07.15	Monitoring Well
1.07.04	Hydrogeological Investigation (Groundwater)
1.07.08	Air Monitoring and Sampling
1.07.09	Groundwater Monitoring and Sampling
1.07.11	Soil Sediment Sampling
1.09.01	Prepare and Ship Environmental Sample
1.08.01	Air/Gas Sample Analysis
1.08.02	Groundwater Sample Analysis
1.08.04	Soil/Sediment Sample Analysis
1.09.04	Provide Sample Management
1.09.08	Data Reduction, Tabulation, and Evaluation/Analysis

TABLE X1.2 Phase 2—Studies

ECES Code	ECES Title
2.02.01	Project Management/Support/Administration
2.02.03	Regulatory Interaction
2.02.04	Institutional Controls
2.03.01	Workplan (for RI/FS)
2.03.04	Health and Safety Plan
2.03.10	Risk Assessment Plan
2.03.11	Technical Goals and Objectives
2.07.15	Monitoring Well
2.04.02	Human Health Risk Assessment
2.04.05	Environmental Investigation Report
2.04.08	Evaluation Alternatives
2.04.10	Document Feasibility
2.04.16	Engineering Evaluation/Cost Analysis

TABLE X1.3 Phase 3—Design

ECES Code	ECES Title
3.02.01	Project Management/Support/Administration
3.02.03	Regulatory Interaction
3.04.17	Record of Decision
3.04.11	Environmental Management Project Design
3.04.13	Facility Design

TABLE X1.4 Phase 4—Construction

ECES Code	ECES Title
4.02.01	Project Management/Support/Administration
4.02.03	Regulatory Interaction
4.03.01	Workplan (for RA/Construction)
4.04.19	Post Construction Design Report
4.05.01	Mobilization
4.05.29	Communications
4.05.31	Overhead Electrical Distribution
4.07.09	Groundwater Sampling and Monitoring
4.08.02	Groundwater Sample Analysis
4.18.01	Extraction Wells
4.11.04	Treatment Train Facility (to house the technologies)
2.24.15	Coagulation/Focculation/Preciptation
4.24.07	Ion Exchange
4.24.13	Ultraviolet Protolysis
4.05.36	Demobilization

TABLE X1.5 Phase 5—Operations and Maintenance

ECES Code	ECES Title
5.02.01	Project Management/Support/Administration
5.02.03	Regulatory Interaction
5.07.08	Air Monitoring and Sampling
5.07.09	Groundwater Sampling/Monitoring (ongoing and not technology specific)
5.08.01	Air/Gas Sample Analysis (ongoing and not technology specific)
5.08.02	Groundwater Sample Analysis
5.11.04	Treatment Train Facility (O&M)
5.24.15	Coagulation/Focculation/Precipitation
5.24.07	Ion Exchange
5.24.13	Ultraviolet Photolysis

TABLE X1.6 Phase 6—Serveillance and Long-Term Maintenance

ECES Code	ECES Title
6.02.01	Project Management/Support/Administration
6.02.03	Regulatory Interaction
6.07.08	Air Monitoring and Sampling
6.07.09	Groundwater Sampling/Monitoring Sampling (ongoing and not technology specific)
6.08.01	Air/Gas Sample Analysis (ongoing and not technology specific)
6.08.02	Groundwater Sample Analysis
6.02.04	Institutional Controls
6.26.06	Extraction Wells (after well P&A to ensure no contaminate pathway)
6.06.02	Outdoor Surveillance and Maintenance

TABLE X1.7 Phase 8—Cross Cutting (Optional)

ECES Code	ECES Title
8.01.01	Personnel Resources
8.01.02	Program Support
8.01.03	Program Infrastructure
8.01.04	Government Personnel Resources
8.01.05	Government-Program Support
8.01.06	Government-Program Infrastructure

X2. PROPOSED WASTE CATEGORIES

X2.1 See Table X2.1 for proposed waste categories.

X2.2 In Appendix X3, provision is made for associating these waste types with the other cost driving parameters. An example is presented by indicating possible waste types generated, by their numbers given in Table X2.1, with selected ECES Level 3 elements. The numbers in Columns 17–36 of Appendix X3 refer to the project phase numbers.

TABLE X2.1 Proposed Waste Categories

Categories
1. Sanitary Waste
2. PCB Waste
To include radioactive PCB waste
3. Asbestos Waste
To include radioactive asbestos waste
4. Hazardous Waste
Waste that appears on one of the four RCRA hazardous wastes lists or exhibits at least one of four characteristics: ignitability, corrosivity, reactivity, or toxicity
5. Mixed Radioactive Waste
Waste containing both hazardous waste ("listed waste" and exhibits hazardous characteristics as defined in 40 CFR Part 261, Subpart C, or both) and low level radioactive waste (source material, special nuclear material, or by-product material subject to the Atomic Energy Act of 1954)
6. Naturally Occurring Radioactive Material (NORM)
Fly ash produced from burning coal (may contain uranium, thorium or other naturally occurring radionuclides)
Bulk wastes produced when mining uranium ores using underground mining, in-situ leaching, or surface excavation methods (typically containing radium, uranium and thorium)
7. Uranium Mill Tailings [(11e.(2)] Waste
Waste rock (fine grained, sand-like, and silt materials) and processing equipment generated from mining and milling operations
8. Low Level Radioactive Waste (LLW)
Radioactive waste not classified as high level waste, transuranic waste, or spent nuclear fuel, and does not contain RCRA-hazardous waste
LLW accounts for approximately 90 % of all radioactive wastes; approximately 95 % of LLW is Class A
Class A—loses its radioactive hazard in <100 years
Class B—loses its radioactive hazard in <300 years
Class C—loses its radioactive hazard in <500 years
Classes B and C—require High Integrity Containers (HIC) and transport in lead or steel cylinders (casks) to go to Envirocare
9. Transuranic Waste (TRU)
Trans = beyond; uranic = the weight of uranium (that is, plutonium, neptunium, americium, etc.)
≥100 nanocuries/gram of waste with a half life of >20 years
10. Contact Handled Transuranic Waste (CH TRU)
Contained in 55-gallon metal drums or metal boxes
Alpha emitter: shielded by outer layer of person's skin or sheet of paper
Maximum radiation dose at the surface of CH TRU container is 200 mrem/h
11. Remote Handled Transuranic Waste (RH TRU)
Handled and transported in shielded casks
Gamma emitter (very penetrating)—requires concrete, lead, or steel to block
Unshielded container at surface emits >200 mrem/h
12. Spent Nuclear Fuel (SNF)
Nuclear fuel assembly (solid ceramic pellets of enriched uranium sealed in strong metal tubes) removed from reactor after three to four years of use
Spent nuclear fuel fines (that is, West Valley)
13. High Level Radioactive Waste (HLW)
Highly radioactive sludge-like residue, a byproduct of reprocessing spent nuclear fuel (chemical treatment of spent nuclear fuel to separate out uranium and plutonium)
Contains a combination of RCRA hazardous constituents, transuranic elements or isotopes, and highly radioactive fission products in concentrations requiring permanent isolation

X3. SECONDARY PARAMETERS

X3.1 To make ECES more valuable to the estimators, managers, and analysts; additional cost driving parameters for all Level 3 ECES elements must be identified. The purpose of secondary parameters is to identify and capture those characteristics that impact environmental management project cost.

X3.2 Cost driving parameters are data that characterize activities or sub-activities and significantly effect cost. These cost driving parameters are readily available to the work managers who are acquainted with the work and can be included while reporting the cost data without requiring additional resources. As an example, Element 4.18.01 (Phase 4) Extraction Wells will commonly have an associated parameter of each (that is, $X/each well). However, additional cost driving parameters are necessary to define this activity in a meaningful way. The additional cost driving parameters for this activity would include depth and diameter of the well, the construction material of the well, site conditions, or physical state of media and other parameters. This information should be readily available to the work manager.

X3.3 The cost driving parameters associated with Level 3 elements of ECES are presented in a matrix format. The first row of the matrix identifies the secondary parameters or measures while the first four columns represents the ECES numbers and titles. The numbers marked within the matrix represents those ECES phases where these parameters are most applicable and the bolded numbers represent primary unit of measure. The numbers are used as a guideline, and users are free to use any parameters as appropriate. For example, the WBS Element X.22.09, Trickling Filter, is marked with the numbers "4,5" in *Materials Used* column. This indicates that during both Phases 4 and 5, the materials used are one of the costs driving parameters.

X3.4 Among the key cost driving parameters in environmental clean-up projects is the type of waste generated, because of the regulatory requirements governing their packaging, handling, transportation, and disposal. The more difficult and dangerous the waste, the more stringent are those requirements. Accordingly, the following matrix provides for

identifying the waste type(s) that must be accounted-for in various ECES activity elements. Such activities include the development of treatment plans and other project documents as well as the activities noted above. Examples are provided wherein the waste types can be identified, using the numbers assigned to the waste types in Appendix X2.

ASTM International takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, are entirely their own responsibility.

This standard is subject to revision at any time by the responsible technical committee and must be reviewed every five years and if not revised, either reapproved or withdrawn. Your comments are invited either for revision of this standard or for additional standards and should be addressed to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. If you feel that your comments have not received a fair hearing you should make your views known to the ASTM Committee on Standards, at the address shown below.

This standard is copyrighted by ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959, United States. Individual reprints (single or multiple copies) of this standard may be obtained by contacting ASTM at the above address or at 610-832-9585 (phone), 610-832-9555 (fax), or service@astm.org (e-mail); or through the ASTM website (www.astm.org). Permission rights to photocopy the standard may also be secured from the Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923, Tel: (978) 646-2600; http://www.copyright.com/