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AN ELECTRONIC DESIGN GUIDELINE FOR INCORPORATING POLLUTION PREVENTION INTO U.S. DEPARTMENT OF ENERGY DESIGN PROJECTS

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An Electronic Design Guideline for Incorporating Pollution Prevention into U.S. Department of Energy Design Projects

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Abstract--The Pacific Northwest Laboratory[a] has developed a prototype pollution prevention electronic design guideline (EDG) for the U.S. Department of Energy (DOE), Waste Minimization Division (EM-334). The EDG contains a database of 267 opportunities to incorporate pollution prevention features into DOE design projects. Each opportunity provides supporting data that help the decisionmaker (designers, engineers, and project managers) evaluate the applicability and potential benefits of implementing pollution prevention in their particular project. The EDG's database was derived from both DOE and non-DOE sources including pollution prevention literature, industrial design personnel, and federal, state, and DOE sources. A key feature of the tool is the integration of photos, illustrations, and documentation to provide easy access to technical information on specific waste minimization opportunities in design.

Historically, pollution prevention activities within the U.S. Department of Energy (DOE) have focused on existing process waste streams. However, it is estimated that 70% of the cost over the life of a product is fixed by design (i.e., before the product is constructed or used) (1). In recognition of this pollution prevention opportunity, the DOE has funded the Hanford Site to incorporate it into the design of new products, processes, and facilities across the complex. Hanford Site contractors are now beginning their third year of leading this activity for DOE Headquarters (HQ). In 1993, this program funded the development of a training course *Orientation to Pollution Prevention for Facility Design*, and an associated Pollution Prevention Design Guideline (2); and in 1994, it funded the preparation of a Pollution Prevention Design Assessment (P2DA)

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Guidance Manual, and the design and development of a prototype pollution prevention software Electronic Design Guideline. The focus of current work is on continued promotion and widespread use of these tools throughout the DOE complex, and to a lesser extent, private industry.

The purpose of this paper is to describe the software tool: The Pollution Prevention Electronic Design Guideline (EDG). The EDG includes a database of pollution prevention design opportunities and supporting information intended for use as an information source for incorporating pollution prevention concepts into the design of facilities.

The EDG, in conjunction with the P2DA Guidance Manual, is designed to be used on a project-by-project basis. The P2DA process is analogous to the Waste Minimization Assessment method established by the U.S. Environmental Protection Agency for existing process waste streams (3). The EDG is introduced during the stage of the P2DA when design alternatives are being explored (after the anticipated waste streams have been quantified). As such, the EDG database is not exhaustive, and it is not computational (i.e., it does not compute the life cycle impacts of implementation). Its purpose is to raise awareness of existing technologies and design practices that can improve resource efficiency or decrease waste generation over the entire life of the project (construction, operations, and decommissioning), and to provide a template for the documentation. Because design is an iterative process, the EDG is also intended to be revisited with each successive design stage.

The EDG is intended to be used by architects and engineers who will evaluate the technical merit of discipline-specific design opportunities. It provides information on 267 opportunities to incorporate pollution prevention features into DOE design projects. After examining the opportunities, EDG allows the user to produce a report that compiles any notes or responses made to the opportunities. The output is a text file that can be edited using a word processing program.

OVERVIEW OF THE EDG TOOL

The purpose of the EDG is to provide specific information to project managers and others about pollution prevention opportunities that may apply to their design projects. The EDG was designed to allow the user to respond to each opportunity and create a summary report for use in tracking this information for a particular facility or project. The main functions and displays are reviewed in this section.

Introductory Window

The Introductory Window allows the user to choose between beginning a new pollution prevention analysis or updating an existing analysis.

Project Definition Window

The Project Definition Window is used to specify information about the project. The EDG uses this project information to filter and display only the applicable opportunities. This filtering is conducted based on the project design stage, project size, and the design disciplines or major systems applicable to the project. For example, the opportunities applicable to a large project may not be relevant to a small project. A Project Definition Window example is provided in Figure 1.

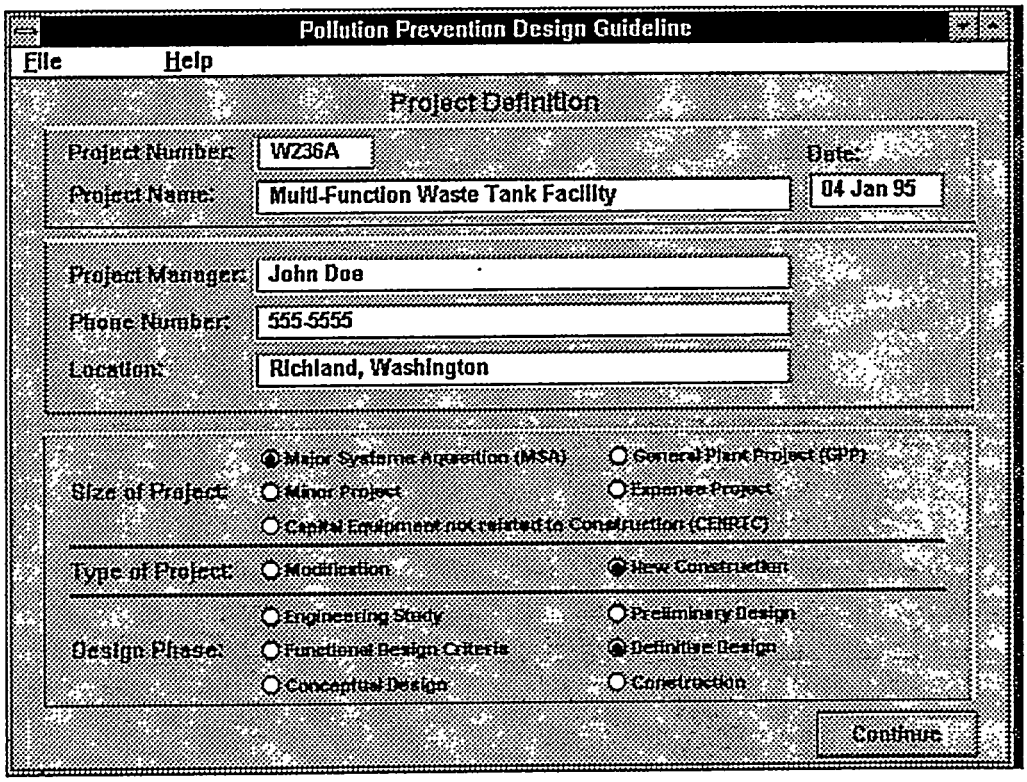

Figure 1. Project Definition Window

The Project Definition Window solicits information about the project, including a project number, project name, and date; project manager information; and project data such as size and type of project, and the applicable design

phase. The size of the project is characterized according to DOE Order 4700.1 (4), which uses the following definitions: Major System Acquisition (MSA), Major Project, Minor Project, Capital Equipment Not Related to Construction (CENRTC), General Plant Project, and Expense Project. The type of project includes modification and new construction. The design phase is also characterized according to DOE Order 4700.1 by the following categories: Engineering Study, Functional Design, Conceptual Design, Preliminary Design, Definitive Design, and Construction.

Applicable Divisions Window

The DOE divides facility design requirements into 16 divisions in its DOE Order 6430.1A, *General Design Criteria* (5). These divisions are based on the Construction Specifications Institute (CSI) Masterformat system, and are therefore organized similar to specifications developed on non-DOE design projects. Accordingly, the EDG database is also organized into 16 divisions (see Table 1). The user may designate which divisions are applicable to the project, and may assign responsible individuals to examine the opportunities in each division for possible use in the project. Only those divisions that are identified will be available for review. For example, a project that does not include special nuclear facilities will not need to consider opportunities that apply only to this type facility. Figure 2 shows an example of the Applicable Divisions Window.

Table 1. The 16 Divisions Used in the EDG

1: General Design Requirements
2: Site and Civil Engineering
3: Concrete
4: Masonry
5: Metals
6: Wood and Plastic
7: Thermal and Moisture Protection
8: Doors and Windows
9: Finishes
10: Specialties
11: Equipment
12: Furnishings
13: Special Facilities
14: Conveying Systems
15: Mechanical
16: Electrical

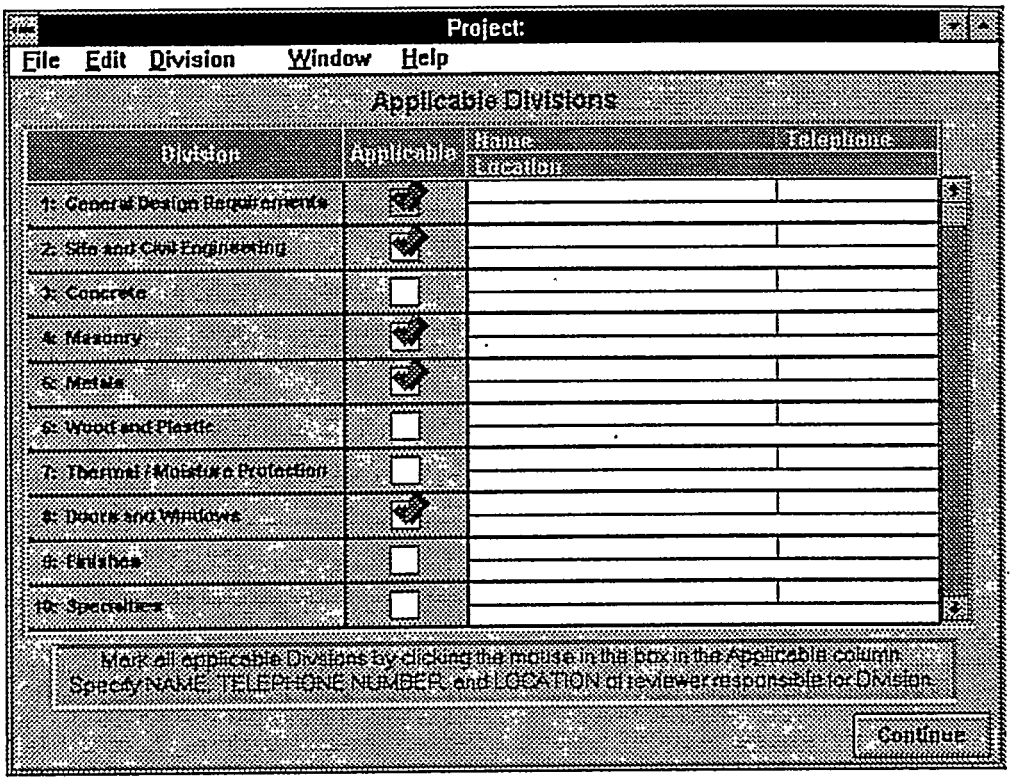

Figure 2. Applicable Divisions Window

Pollution Prevention Opportunities Window

The Pollution Prevention Opportunities Window is the main display for the EDG, providing information on each pollution prevention opportunity (see Figure 3). The user may display opportunities from any of the 16 divisions by selecting the desired division from a menu or by using the mouse to click on the left or right arrow key located on the left side of the division title at the top of the window.

Within each division, pollution prevention opportunities are further sorted by the hierarchy established in the Pollution Prevention Act of 1990 (6): source reduction (A); recycling (B); treatment (C); and disposal (D). These pollution prevention hierarchy categories are indicated by color-coded, tabbed folders that can be accessed by using the mouse to click on one of the tabs beneath the division title. The number of pollution prevention opportunities vary within the 16 divisions and pollution prevention hierarchies (most are contained in folder A, keeping the priority on source reduction over recycling, treatment, or disposal).

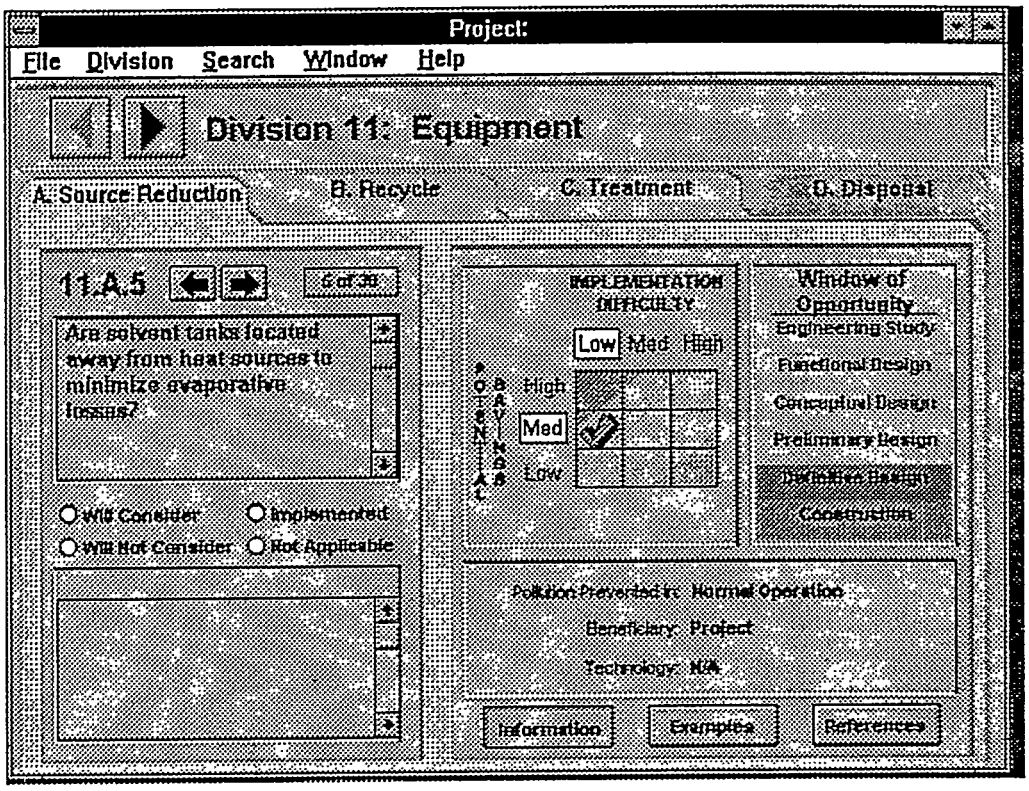

Figure 3. Pollution Prevention Opportunity Window

USING THE EDG

The EDG user interface was designed to be quickly learned and easy to use. Using a mouse, the user clicks on objects displayed in the windows to make selections, navigate between windows, or sequence through information displayed on the screen. The functions located in the pull-down menus include file menu operations to allow the user to create a new analysis, load or save an analysis, and produce a report; navigate the 16 divisions; search for key words in the EDG database; navigate between the EDG windows; and use context-sensitive help.

Examining Pollution Prevention Opportunities

For each opportunity examined, the user indicates on the screen whether/ how the opportunity will be considered for the current project. Additional remarks are requested and saved for later documentation. To help the user assess whether or not the opportunities listed are applicable to the current project, additional information is displayed at the right of the screen.

Examples or references are available to the user by clicking on one of the buttons at the bottom right corner of the window. The default information can be accessed by clicking on the **Information** button when viewing examples or references. The following types of data are provided:

- ***Implementation/Savings Matrix*** portrays the relative difficulty of implementing the opportunity, as well as the potential savings. Most desirable is the combination of low implementation difficulty and high savings. Least desirable is high implementation difficulty and low potential savings. The position of the check in the matrix (as well as color-coding) indicates the situation for the displayed opportunity relative to the other opportunities in the database. Because all opportunities in the database are pollution prevention techniques or features, even the least desirable position offers an opportunity for a positive outcome in terms of pollution prevention. Further explanation and tailoring of this matrix to local conditions is available from a more detailed worksheet that displays the underlying rationale.

- ***Window of Opportunity*** shows the time period (phases) during which the opportunity should be implemented. Six phases are defined: Engineering Study, Functional Design, Conceptual Design, Definitive Design, Procurement, and Construction. For example, design details such as purchasing building materials of recycled content would not need to be considered until the Definitive Design phase, whereas opportunities on the systems level, such as in-process recycling, would need to be considered during earlier stages of design. In general, the benefit will be greater if the opportunity is implemented in the earliest phase identified within the window of opportunity.

- ***Pollution Prevented in*** shows the life cycle phase in which pollution prevention effects are realized. Life cycle phases are Engineering/ Procurement, Construction, Start Up, Normal Operations, Off-Normal Operations, and Decommissioning. For example, some of the opportunities in the EDG, such as equipment selection suggestions, will prevent pollution during operation of the facility. On the other hand, recommendations to use like materials to facilitate recycling of building materials, will not realize a benefit until the facility is decommissioned.

- ***Beneficiary*** indicates who will realize the benefits. For most opportunities, one group tends to receive particular benefit by implementing the technology. The groups identified in the EDG include Project (typically benefitted by process improvements); Site (typically benefitted by applying pollution prevention concepts to utilities, e.g., water, electricity, and

energy); Region (typically benefitted by recycled content products); and Global (typically associated with ozone depletors).

- ***Technology Availability*** identifies whether a new or existing technology is involved. The following categories are defined: Off-the-Shelf, Experimental, Not Applicable (i.e., no technology is being implemented).

Viewing Examples and References

Examples and references are available in the Pollution Prevention Opportunities Window to help the user assess whether or not opportunities are applicable and appropriate to the current project. To view an example, the user may click on the **Example** button, which displays available photographs, diagrams, or other applicable information to illustrate the opportunity. Applicable references are available by clicking on the **References** button. The References display includes the applicable paragraph from DOE Order 6430.1A, if the opportunity is required by DOE Order, and other relevant references may also be listed.

Context-Sensitive Help

Two levels of help are available while using the EDG: overview help and help notes. Overview help is available on the Help pull-down menu. The overview will provide general information about the current window. Help Notes apply to specific objects displayed on the screen: clicking the right-hand button on the mouse with the mouse cursor over a displayed object will give the user access to associated information and instructions, which will appear in a Help Note box.

PLANS FOR DEPLOYMENT

DOE Deployment

The EDG tool is currently being deployed across the DOE complex. The tool will eventually become part of the collection of resources and tools that are being put in place, namely, the *Orientation to Pollution Prevention for Facility Design* training course and the P2DA Guidance Manual. The P2DA Guidance Manual and the EDG have been tested on eight design projects of various sizes and design stages at different DOE sites. Results of these trial case studies are

described elsewhere.[a] With regard to the EDG, feedback from case studies has been incorporated into the latest version of the tool.

Commercialization

Development of an EDG version for possible commercial or industrial application is under consideration. The database contains examples that apply to commercial facility design, but much of the context and terminology are DOE-specific. Results of a focus group (held in November 1994) with architectural and industrial firms suggest that a more comprehensive database and commercially relevant terminology will be required, as well as the capability for users to add their own data to the EDG database. The commercialization option is currently being investigated.

Benefits

Product design is a major determinant of the total life-cycle cost of a product. A small investment in predesign for pollution prevention can yield economic benefits. The availability and use of the tools being developed for pollution prevention by design will help institutionalize these concepts for widespread implementation by the design audience.

LITERATURE CITED

1. Fabrycky, W. 1987. "Designing for the Life Cycle." *Mechanical Engineering*, January 1987, pp. 72-74.

2. U.S. Department of Energy. 1994. *Orientation to Pollution Prevention for Facility Design*, Quality Training & Resource Center, Richland, Washington.

3. U.S. Environmental Protection Agency. 1988. *Waste Minimization Opportunity Assessment Manual.* EPA/625/7-88/003, Washington, D.C.

4. U.S. Department of Energy. 1987. *Project Management System*, DOE Order 4700.1, U.S. Department of Energy, Washington, D.C.

(a) Dorsey, J. A, E. A. Raney, and F. L. Greitzer, "Practicing Pollution Prevention at the U.S. Department of Energy: Case Study Results," (to be presented at the Air & Waste Management Association 88th Annual Meeting & Exhibition, San Antonio, Texas in June 1995).

5. U.S. Department of Energy. 1989. *General Design Criteria*. DOE Order 6430.1A. U.S. Department of Energy, Washington, D.C.

6. United States Code. 1990. *Pollution Prevention Act of 1990*. United States Code 6601-6610. Public Law 101-508.