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Hazardous Waste Engineering
Research Laboratory
Cincinnati OH 45268

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EPA

Project Summary

Design, Construction, and Maintenance of Cover Systems for Hazardous Waste: An Engineering Guidance Document

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This document emphasizes the special characteristics of solid waste management as they bear on cover systems. Cover systems typically consist of two to four layers of soil and other materials and resemble a highway pavement system in many respects. This similarity facilitates the preparation and use of construction and maintenance specifications. Example specifications are in the appendices of the full report.

Criteria and methods are provided for engineering analyses of percolation, erosion, stability, flooding, freezing, and settlement. Techniques are available for compensation for each of these threats, again using recognized design and construction methods. Finally, guidance is included on methods of maintenance and repair over the unusually long design life of a solid and hazardous waste disposal facility.

This Project Summary was developed by EPA's Hazardous Waste Engineering Research Laboratory, Cincinnati, OH, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

Regulations for the management of hazardous waste disposal facilities have been promulgated by the Environmental Protection Agency (EPA) as directed by the Resource Conservation and Recovery Act (RCRA). New hazardous waste disposal facilities must meet the requirements of Title 40, Code of Federal Regulations, Part 264 (40 CFR 264) in order to receive a permit. RCRA also dictates actions for correcting old sites presenting endangerment. As a part of its response to RCRA, the EPA has issued technical documents to assist in the complex and important task of planning adequate disposal facilities.

The full document of this project provides technical guidance on design, construction, and maintenance of cover for hazardous waste facilities based largely on waste management practice, concepts in soil construction, and innovations to encourage new designs and practice developed by creative and competent engineers within the limits of RCRA regulations. Suitable designs are ultimately translated into construction therefore, and some of the guidance is formulated directly as specifications.

Basis of Technical Design

The physical characteristics of the site and the configuration of its surface are among the most important factors upon which cover design is based. Sometimes, site characteristics directly influence design of the entire disposal unit or the assemblage of disposal units; for exam-

ple, it is necessary to limit the size of disposal units or waste cells in hilly terrain, and their orientation and arrangement may also be restricted by operational considerations. Broad, flat sites present fewer restrictions on size, orientation, and arrangement of the disposal units.

The character of the waste can have long-term impacts on the cover and its performance in relation to subsidence, differential offset, and soil particle migration. It is even helpful conceptually to regard the disposal unit as the lower component or foundation of the cover with a transition to the backfill soil within the waste cells. Influences follow either from the voids and other physical condition of the waste at the time of burial or from chemical-related changes that take place over a long period. Characterizing the waste focuses attention on unfavorable eventualities that in some cases may be avoidable. Certain worthwhile limitations on waste character and form as well as placement procedures may be incorporated in the plan of operations.

The chemical constitution and the reactivity of bulk and containerized waste always deserve careful consideration in cover design and the design of the disposal unit. A listing of wastes to go into each cell is already required in Subpart B, 40 CFR 270. In large disposal facilities, this undertaking may be complicated or simplified by any operational plan to segregate wastes into subcells according to waste type. The eventual deterioration and breakdown of initially rigid elements such as steel barrels, bale straps, and boxes will have to be evaluated as to their expected histories and the ultimate effects. Although it is frequently found that metals and sometimes even paper are little affected by burial in the short term (e.g., at the Savannah River Plant), the long-term effects over tens of years and to the design life of the facility must be addressed to the highest degree available with state-of-the-art knowledge and practice.

The potential for generation of gases or liberation of volatiles should also be considered in cover and disposal unit design. It may be necessary to provide diversions and vents for gases blocked from their upward pathways by the cover. Vents to the atmosphere may be adequate for toxic components of low concentration that will be quickly dispersed in the air to acceptable levels. In extreme cases where the gas or volatile component may reach a harmful concentration, it may be necessary to provide on line or contingency features for absorption filters or other means of reducing concentration of toxic components. General categories of reactive wastes that can conceivably affect the performance of cover are volatile organic chemicals, inorganic acids, materials capable of reacting with others in the waste cell, materials capable of undergoing volume change, and saturated materials.

The hydrological environment of a disposal site constitutes the most influential combination of related external factors in cover design and maintenance. The several aspects of climate, particularly the precipitation regime have direct impacts on the performance of the cover in blocking percolation into the waste cell. Besides being foremost among general constraints to cover design, the climate enters into detailed analysis and evaluation of proposed cover designs.

The importance of the hydrological system can be illustrated by considering two extreme cases. It is believed that most of the low rainfall of a typical year at the arid Hanford and Richland, Washington, LLRW disposal facilities penetrates no more than a few meters of depth. Since the ground water is at much greater depth, most radionuclides carried downward by percolating water stop well above the water table. Thus, these facilities and another hazardous waste facility to the south near Arlington, Oregon, benefit directly from the dry regime. On the other hand, uncontrolled waste sites in the relatively damp midwestern and eastern United States frequently exhibit ground-water contamination plumes of serious dimensions and concentrations despite the presence of cover over the waste in some cases. Major storm events must also be considered, since even an arid region can be subjected to infrequent but major storms that cause anomalous ground saturation and percolation to a depth ordinarily not reached. Accordingly, a rather complete review of expectable storm events and their frequencies should be required in preparing the background on the hydrological system.

Other aspects of the hydrological system that need to be reviewed are the evapotranspiration history, the water-retention characteristics of the near-surface soil, and surface runoff parameters as well as available measurements at gaging stations. In the broader sense of hydrology, the ground-water system constitutes an important part. Familiarization with ground-water configuration, flow directions, and velocities is essential, if for no other reason than to plan and to anticipate contingencies for unexpected performance or even failure of the containment system.

General Design Concepts

Once the functions of the cover have been established or constrained by regulation or standard or by clearcut technical objectives such as reduction of percolation to insignificant levels, elements of the design are defined and integrated using conventional design methods.

A key task of cover design is the selection of suitable materials. The cover usually will include a synthetic membrane and a large volume of soil or soil-like material, but other materials are sometimes included also: i.e., Portland cement, bituminous concrete, seal coats, and geotextiles. Guidance on suitability of various types of soil for performing cover functions and for general long-term service ranking for various engineering functions has been developed based on considerable experience in the Bureau of Reclamation, Corps of Engineers, and other construction and engineering organizations. Classification is according to the Unified Soil Classification System (USCS).

Emphasis on the best soil for the cover will occasionally be unfeasible, since the soils available at or near the site will be chosen for reasons of economy. The strategy of cover design targets the most effective use of those available materials, usually in a layered construction. The availability of material may extend offsite. Fly ash available in the near vicinity continues to be an attractive possibility for use because of its relatively fine grain size which, by careful compaction or addition of reactive chemicals, can be brought to a strength and permeability that may be suitable for fulfilling cover functions.

Example Designs

The appendix in the full report provides guidance on preparing specifications for four example designs. The preparation of plans and specifications demands careful attention to detail, and sometimes the choice of wording can have costly legal ramifications. Therefore, the specifica-

tions in the appendix as well as the designs themselves are intended for guidance rather than for direct application at any facility.

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The complete report entitled "Design, Construction, and Maintenance of Cover Systems for Hazardous Waste: An Engineering Guidance Document," (Order No. PB 87-191 656/AS; Cost: $18.95, subject to change) will be available only from:

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