ANALYSIS OF WATERS ASSOCIATED WITH ALTERNATIVE FUEL PRODUCTION

Jackson/Wright, *editors*

ASTM STP 720

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Foreword

The symposium on Analysis of Waters Associated with Alternative Fuel Production was held 4–5 June 1979 in Pittsburgh, Pa. The American Society for Testing and Materials sponsored the event through its Committee D-19 on Water and its Subcommittee D19.33 on Water Associated with Synthetic Fuel Production. Presiding as chairman was L. P. Jackson, Laramie Energy Technology Center, U.S. Department of Energy, who also served as editor of this publication. C. C. Wright, Aramco, served as coeditor.

Related ASTM Publications

Measurement of Organic Pollutants in Water and Wastewater, STP 686 (1979), $36.50, 04-686000-16

Methodology for Biomass Determinations and Microbial Activities in Sediments, STP 673 (1979), $22.50, 04-673000-16

Biological Data in Water Pollution Assessment: Quantitative and Statistical Analyses, STP 652 (1978), $17.50, 04-652000-16

Oil Field Subsurface Injection of Water, STP 641 (1977), $10.75, 04-641000-16

Biological Monitoring of Water and Effluent Quality, STP 607 (1976), $24.25, 04-607000-16

Water Quality Parameters, STP 573 (1975), $29.50, 04-573000-16

Manual of Water, STP 442A (1978), $28.50, 04-442010-16

A Note of Appreciation to Reviewers

This publication is made possible by the authors and, also, the unheralded efforts of the reviewers. This body of technical experts whose dedication, sacrifice of time and effort, and collective wisdom in reviewing the papers must be acknowledged. The quality level of ASTM publications is a direct function of their respected opinions. On behalf of ASTM we acknowledge with appreciation their contribution.

ASTM Committee on Publications

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Introduction

Commercial production of energy from nontraditional or alternative sources is an approaching reality in this country and indeed worldwide. Many of these new technologies, which are currently in the research and development phase, produce water as a by-product of the process. This water is frequently laden with significant concentrations of organic and inorganic components. The cleanup of this water prior to discharge or recycling is a necessity brought about by today's current concern over national, regional, and local environmental quality and the operating characteristics and requirements of modern industrial plants. To design, operate, and maintain the necessary water cleanup technologies effectively, an accurate knowledge of the nature and concentrations of the organic and inorganic material in the water is required.

Many of the materials found in these waters are present in concentrations and forms seldom before encountered or addressed. The technical community associated with developing these new energy technologies and other interested parties joined together in 1977 in ASTM Committee D-19 on Water to form Subcommittee D19.33 on Water Associated with Synthetic Fuel Production to characterize these waters accurately. The subcommittee, with the endorsement of the committee, presented a symposium on Analysis of Waters Associated with Alternative Fuel Production in Pittsburgh, Pa., on the 4th and 5th of June 1979. The objective of this symposium was to allow the technical community and members of the American Society for Testing and Materials, in particular, to become acquainted with the nature of the waters and attendant analytical problems arising from the production of fossil fuels from heretofore little-used natural resources and new technologies. It was intended that this gathering would serve as a stimulus for the updating of current methods of testing or for the development of new procedures to satisfy the needs of those charged with providing new sources of energy and to satisfy the regulatory agencies, which must assess the potential impacts of these new technologies on society.

The sixteen papers presented in this volume meet the stated objectives of the symposium. These papers will serve to acquaint the reader concerned with analysis of waters with a wide variety of problems and perhaps a few solutions. In the main, this volume serves as an introduction into a new technical area. We hope that in two or three years we will be able to present another symposium, which will present more solutions to these unusual analytical problems.

L. P. Jackson

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Guideline Considerations for Selecting Analytical Methods and for Cost Analysis Associated with Monitoring Waters Associated with Alternative Fossil Fuel Technologies

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REFERENCE: Rolan, R. G., Busacca, M., Kangas, M. J., Mezga, L. J., Cornett, C. L., and Faller, A., **"Guideline Considerations for Selecting Analytical Methods and for Cost Analysis Associated with Monitoring Waters Associated with Alternative Fossil Fuel Technologies,"** *Analysis of Waters Associated with Alternative Fuel Production, ASTM STP 720,* L. P. Jackson and C. C. Wright, Eds., American Society for Testing and Materials, 1981, pp. 3-17.

ABSTRACT: Considerations for developing detailed environmental monitoring plans are described for fossil energy research, development, and demonstration facilities funded by the U.S. Department of Energy (DOE); this approach applies as well to other fossil energy technologies not currently funded by the DOE.

This paper focuses on a systematic approach to technical and cost aspects of methods selection for chemical, physical, biological, and support parameters. Emphasis is placed on methods selection for inorganic and organic chemical parameters for both process and ambient waters.

KEY WORDS: monitoring, fossil fuels, energy, cost estimates, methods selection, analysis, water, alternative fuels, aquatic toxicology

Petroleum resources in the United States and other countries are being depleted rapidly, resulting in renewed interest in developing alternative fuels technologies. A principal focus of this effort is on technologies designed to convert coal into liquid and gaseous fuels (synfuel). The development of synfuel technologies is one of the major missions of the U.S. De-

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partment of Energy (DOE), as is the assurance that the technologies developed will be environmentally "acceptable" (Department of Energy Organization Act of 1977).

The Office of Fossil Energy of the DOE (then part of the Energy Research and Development Administration) responded early to this goal of environmental acceptability by commissioning the development of monitoring guidelines for all fossil energy research, development, and demonstration facilities funded by the DOE. This work, performed by Dalton·Dalton·Newport, is outlined in this paper. The portion of the guidelines [*1*][7] described here is a systematic approach to the selection and cost analysis of methods for analyzing waters associated with the facilities to be monitored.

The approach developed for the detailed design and specification of environmental monitoring projects for research, development, and demonstration facilities covers effluent and ambient monitoring for the following technologies:

Coal gasification
Coal liquefaction
Magnetohydrodynamics
Fluidized-bed combustion
Combined power cycles
Coal-oil slurry combustion
In situ coal gasification
Surface shale oil retorting
In situ shale oil retorting
Recovery of oil from tar sands
Enhanced oil recovery
Enhanced gas recovery
Advanced well-drilling technologies

This paper does not address monitoring by the Occupational Safety and Health Administration (OSHA), U.S. Department of Energy, nor does it address process monitoring, the monitoring of socioeconomic effects, or the monitoring of raw material extraction (for example, coal mining), unless such extraction is an integral part of the technology under development.

Fossil energy research, development, and demonstration facilities require environmental monitoring for two basic reasons. The first is related to compliance with federal, state, and local laws and regulations and the second to the programmatic aspects of developing environmentally acceptable ways of using fossil fuels. With respect to the former reason, the DOE is required by federal law and presidential executive order to monitor any facilities that have a national pollution discharge elimination system permit (for water) or a new source permit (for air). Second, if the DOE can demonstrate, through monitoring, that it is in compliance with all applicable standards and regulations, this demonstration should serve to promote public acceptance of advanced fossil energy technologies. In addition, such monitoring permits the DOE to protect public health, safety, and welfare by modifying operations if the changes in ambient (air, water, or

[7] The italic numbers in brackets refer to the list of references appended to this paper.

land) environmental conditions produced by a government-funded facility exceed tolerable limits.

Guidelines for environmental monitoring are needed to assure a uniform monitoring plan design for all of the various types of facilities and projects that the DOE may fund. Standard design will also help insure that data collected on environmental effects will permit comparisons among competing technologies; thus, decisions to pursue the most acceptable technologies can be based on environmental, as well as technical and economic, considerations.

After guidelines are developed, they should be evaluated to identify problems that might limit their utility, and then revised accordingly. The monitoring guidelines developed for the DOE were evaluated by developing a detailed environmental monitoring plan for a hypothetical, demonstration-scale, coal gasification plant. The evaluation results were the basis for several minor refinements in the initial guidelines.

Description of Guideline Considerations

Overall Scheme

The overall design process for development of a monitoring program is presented in Fig. 1. The design process is based on five interrelated data inputs:

1. Monitoring objectives
2. Impact-generating aspects of the facility
3. Sensitivities of the nearby environment
4. Technical considerations of monitoring
5. Costs

The first and perhaps most important input (Step 1, Fig. 1) provides the structure and direction for the entire monitoring program. Identification of monitoring objectives requires knowledge of the needs of the potential users of the data generated by the monitoring program.

The users of monitoring data may be quite diverse, for example, facility design engineers and operators, environmental protection personnel, and standards setters. Specific monitoring data requirements are identified by establishing who the potential users are, determining their needs, and formulating objectives based on this information. Also, monitoring objectives will differ for the various stages of process development. The monitoring objectives for a pilot plant might emphasize, for example, effluent characterization, while a program for a demonstration facility might emphasize monitoring for compliance with applicable or potential standards. Therefore, objectives should be prioritized according to the types of users and stage of process development.

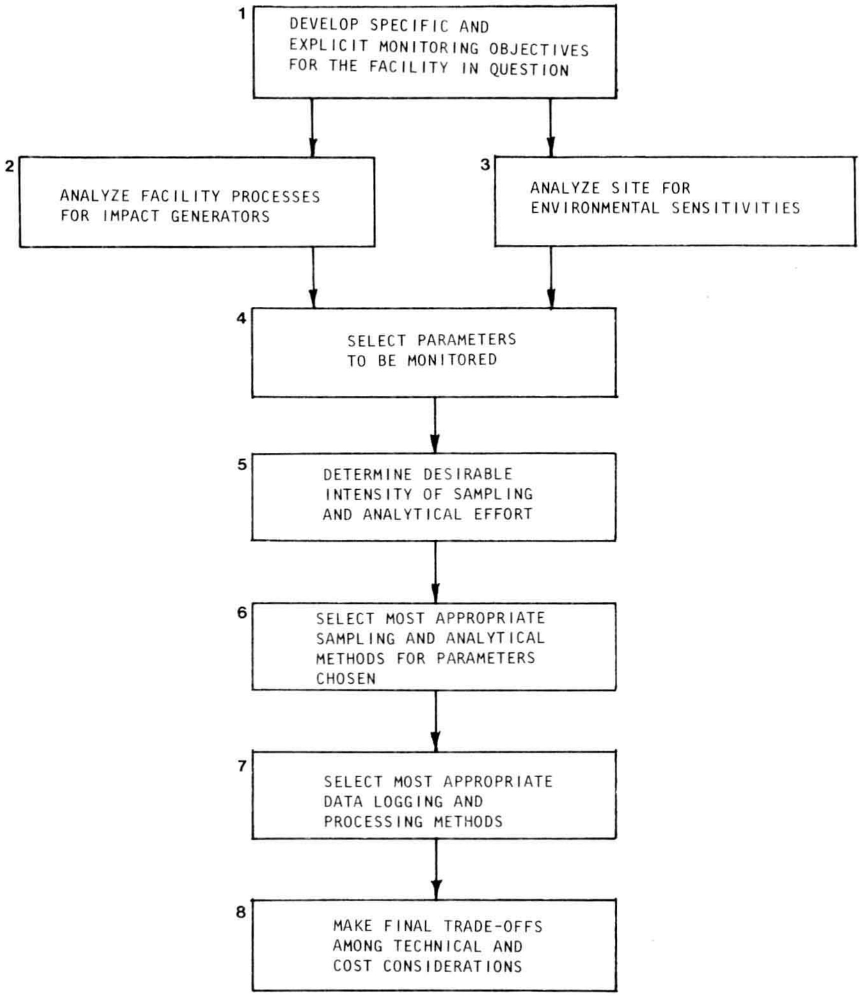

FIG. 1—*Overall process for the design of an environmental monitoring project. The asterisk (*) after Point 3 indicates that this step is not used for laboratory-scale, bench-scale, or PDU-scale projects.*

The monitoring program objectives must recognize three stages in the development of a facility. The first is preconstruction, during which time, at least two years of broad baseline monitoring is required in order to establish existing conditions at the site. The baseline is the standard of comparison for all subsequent changes at the site; one can never go back in time to collect baseline samples once construction has begun. Thus, even if one expects a particular pollutant from the process to be only a minor component in the effluent, or well controlled, it is still prudent to collect baseline data on its background levels.

During the second phase, the construction of the facility, monitoring of the same parameters will generally continue. If additional information becomes available on process effluents during this period, there may be a need to make some modifications (usually additions) to the monitoring design. Monitoring before and during construction should also address the need for gathering data to support permits required under appropriate federal, state, and local regulations.

In the operational phase, baseline monitoring should continue through the early facility shakedown. As "typical" process effluents are generated, they should be characterized chemically, and potential health and ecological effects should be identified. When these analyses are complete, the monitoring plan should be thoroughly reevaluated to focus more intensely on potential problem parameters and to reduce or eliminate monitoring of parameters that appear less likely to create problems.

Step 2 of Fig. 1 is the analysis of the facility for possible impact generators (those characteristics of the facility that may affect the surrounding environment, such as air and water effluents). This is the first step in determining which parameters should be monitored. Most nonconstruction impact generators are process effluents, and the effectiveness of the monitoring is closely linked to how much is known about the nature and amounts of these effluents. Generally, very little is known. (Indeed, if much were known, DOE projects would not be experimental, and monitoring could be restricted to regulated pollutants.) Consequently, it is usually necessary to extrapolate data using effluent characterizations from earlier process development stages or from similar processes that have been more thoroughly studied. Although process refinements, scale-up effects, changes in input materials, and added pollution controls make prediction of effluents based on prototype facility data uncertain, these data are generally the best available starting point for parameter selection.

Step 3 (Fig. 1) involves procedures for analyzing the site for environmental sensitivities, that is, any aspect of the site and surroundings that would appear to be vulnerable to change. Though many fossil energy facilities may be sited in highly industrialized areas, it is not unusual for such facilities to be located in natural or seminatural ecosystems. It is essential to approach the identification of environmental sensitivities from this point of view. The study of ecosystems, though in its infancy, has revealed three major principles of prime relevance to monitoring program design:

1. Final disposal of wastes can never be achieved. All materials eventually enter ecological systems, either in the original or transformed state.

2. All parts of an ecosystem interact, directly or indirectly, with all other parts. In many cases, the types or degrees of effects from these interactions

are unpredictable because of current lack of knowledge regarding the details of ecosystem functioning.

3. Ecosystems are self-maintaining and self-regulating. Over relatively long periods of time, the various components tend to stay in equilibrium; however, human activities can disrupt that equilibrium, resulting in a new equilibrium that is deleterious to some plants and animals. Some populations may become extirpated or extinct, while others become more abundant. Such changes are often undesirable from a human perspective.

The implications of these principles for monitoring program design are as follows:

1. Ideally, every component of every effluent should be monitored unless or until it is clear that it (*a*) is not hazardous, (*b*) has stabilized in a nonhazardous form or location in the ecosystem, or (*c*) is dispersing out of the system at such a rate and concentration as to be nonhazardous.

2. Effects of pollutants can show up in unexpected places because of poorly understood environmental transport and dispersal mechanisms and the tendency of some pollutants to concentrate in certain biotic components of the ecosystem. Thus, environmental monitoring should attempt to monitor pollutants in all of the major transport media and potential sinks (atmosphere, surface water, groundwater, soil, and the biota).

3. Changes in the structure, or functioning, or both of the biotic part of the ecosystem are often induced by pollutants or other manmade impact generators. The cause of such changes may not be easily identifiable, but they indicate that the system is under stress and the cause should be sought.

4. Undesirable changes in the ecosystem are often caused not by the direct effects of a pollutant, but by indirect effects transmitted through the system. For example, the decline of a game fish population may be caused indirectly through the effect of a pollutant on the minnow populations on which the game fish feeds. Therefore, monitoring changes in the "most valuable" populations is not necessarily sufficient.

5. No one individual or discipline possesses the perspective or technical ability to design an environmental monitoring program. A team approach with many disciplines is required. Geology, hydrology, air quality, meteorology, water chemistry, and aquatic and terrestrial biology are perhaps the most central disciplines, but others may also be needed, depending on the project.

As previously noted, information must be obtained on a broad range of environmental factors during baseline monitoring, in order to characterize the ecosystem properly. Typical data categories might include geologic, atmospheric, terrestrial, and aquatic categories. It is significant to note that the factors relevant to identifying potential environmental sensitivities are also those needed for the environmental assessment (and possibly the impact