Deep underground disposal remains the most likely solution for long-term management of high-level radioactive wastes. The concept has been accepted worldwide, and, as a consequence, extensive research and development is ongoing in many countries. Exchange of information, therefore, is essential to minimize duplication of effort and pursuits of traveled paths, as well as to optimize planning of further investigations. A workshop with a narrowly focused topic yet with divergent inputs, as organized here, presents an ideal approach to such an exchange.

The volume under discussion, *Proceedings of a Workshop on Borehole and Shaft Plugging* held in Columbus, Ohio, May 7-9, 1981, and organized jointly by the Organization for Economic Cooperation and Development Nuclear Energy Agency and the U.S. Department of Energy (DOE) constitutes a most timely and valuable contribution to an important subtopic in geological waste isolation. Man-made penetrations, such as shafts and boreholes, of the rock mass surrounding a repository are necessary to provide access for waste emplacement and probably desirable for site investigations. Yet they could become preferential pathways for radionuclide migration, e.g., by facilitating the flow of water (or gas) into and out of a repository. To maintain and guarantee the degree of isolation provided by the repository surroundings, host rock, and sealed perforations, it will be necessary, therefore, to design and emplace shaft and borehole plugs that will provide isolation compatible with long-term safety requirements, to demonstrate the feasibility of plug construction, to assess the plug performance, and to evaluate the consequences of plug performance on the overall level of isolation that can be provided by the rock mass surrounding a repository.

The significance attached to this sealing problem, as well as the intensity and multiple approaches with which it is being investigated, is well demonstrated by the fact that the Proceedings contains publications originating in 7 different countries, and by the attendance at the workshop of some 60 representatives from 13 countries. The Proceedings then presents a quite comprehensive summary of most active and planned research programs on borehole and shaft sealing.

The contributions can be classified very broadly as: program overviews and outlines of planned studies, discussions of seal performance requirements, presentations of preliminary or draft plug designs, results of plug performance tests, and results of research on sealing materials—especially as influenced by the geochemical environment within which they will be emplaced. Of particular value is the transcription of the concluding panel discussion, which summarizes concisely the current state-of-the-art, identifies gaps in present knowledge, thereby identifying research needs, and draws attention to the necessity for specifying plugging performance requirements.

Program overviews include the U.S. DOE efforts directed by the Office of Nuclear Waste Isolation, concentrating on bedded salt, domed salt, and granite disposal, and by the Basalt Waste Isolation Project, concentrating on basalt; the German and Dutch projects on salt penetration sealing; the sealing aspects of the Belgian repository in clay; the Swedish studies on plugging with compacted bentonite; and the Canadian rock-grouting research.

A wide variety of fairly detailed plug designs is included, generally qualified by their designers as preconceptual, draft, or preliminary, even though it is obvious that considerable thought and careful engineering form their basis. The concept of multiple component seals appears to be followed widely, with salt plugs to be used in salt, various combinations of concrete, cement, and bentonite dominating the approach to plugging in other rocks. Uncertainties seem greatest with respect to the requirements that need to be satisfied and with respect to long-term material behavior.

A series of papers describes in detail the full range of aspects considered in the Sandia National Laboratories borehole plugging program. This includes what remains today (November 1981) as the only emplacement and performance testing of *in situ* borehole plugs at great depth, hence the particular importance of the data, techniques, and analyses presented here.

The other subject on which extensive experimental and theoretical results are given is the chemical stability analysis of sealing materials. The importance of this topic follows from the extreme longevity requirements for the seals, and hence the need to predict their aging behavior with satisfactory reliability. This volume includes papers that address the necessary thermodynamical-geochemical characteristics, modeling possibilities and requirements, as well as ongoing experimental investigations on materials such as cements, a wide variety of cement-based mixtures, and compacted bentonite.

All in all, this volume provides an excellent overview of the present knowledge of borehole and shaft plugging. It indicates the directions in which current research and development is progressing, and identifies remaining problems and uncertainties. The book is an essential reference and compendium for anyone involved in repository sealing. It should be of interest to people with a more general interest in geological waste isolation as well.

Jaak J. K. Daemen is an assistant professor in the Department of Mining and Geological Engineering, University of Arizona, Tucson, Arizona. He graduated as a mining engineer from the University of Leuven, Belgium, and obtained his PhD degree in geo-engineering from the University of Minnesota. He has been involved for over a decade in rock mechanics research and engineering for tunnels, shafts, and underground mines. His publications on design of underground structures in rock have been quoted extensively in major state-of-the-art survey publications. Dr. Daemen is presently directing a major research project on borehole plugging for the U.S. Nuclear Regulatory Commission. This project includes laboratory and field testing of the performance of a variety of plugs installed in different rock types.

Fouling of Heat Transfer Equipment

Editors	E. F. C. Somerscales and J. G. Knudsen
Publisher	Hemisphere Publishing Corporation, New York (1979)
Pages	743
Price	$75.00
Reviewer	Peter Griffith

This book contains the proceedings of a conference held at Rensselaer Polytechnic Institute in 1979 concerned with the "Fouling of Heat Transfer Equipment." Experts in the various fields that are included under the title, *Fouling of Heat Transfer Equipment*, presented review papers while sessions on a variety of topics allowed research papers to be presented. The standard of the review papers is very high with informed, critical appraisals of the state-of-the-art in a variety of topics. Excellent lists of references are included. A generally high standard prevails in the research papers too, though the coverage, of necessity, must be more spotty.

Except for isolated experimental results included to illustrate a point, design data and recommendations for design are completely lacking. Though many authors cited the inadequacies of the Tubular Exchanger Manufacturer's Association (TEMA) standards, including comments such as that they are conservative, they are nonconservative, and they didn't show the time dependence that must be there, no attempt was made to sift and evaluate published data to come up with a better standard. In spite of this conference, one cannot expect to find recommendations or better values for design than those included in the TEMA standards.

Of the six different kinds of fouling cited (i.e., precipitation fouling, particulate fouling, chemical reaction fouling, corrosion fouling, biological fouling, and freezing fouling), only two, precipitation and freezing fouling, have well-established theories and data bases that allow one to do rational designs for certain pieces of equipment. The pieces of equipment for which such information exists include seawater desalting evaporators and the oil chillers used in applications in which wax is liable to solidify out.

Peter Griffith is professor of mechanical engineering at Massachusetts Institute of Technology (MIT), which he has been associated with since 1952. His research at MIT has been concerned with multiphase flow, boiling, condensation, and supercritical heat transfer and has resulted in more than 50 papers in these areas. His summer work and consulting in these same areas have been concerned with nuclear safety, water side heat transfer in boilers, and heat exchanger design procedures for the power, chemical, and aerospace industries. His contact with fouling has been entirely as a user of fouling information.

Nuclear Reactor Safety Heat Transfer

Editor	Owen C. Jones, Jr.
Publisher	Hemisphere Publishing Corporation, Washington, D.C. (1981)
Pages	959
Price	\$99.00
Reviewer	Clifford J. Cremers

This book originated with the assemblage of material for a 40-h course on the title subject that was held in August 1980, at the International Centre for Heat and Mass Transfer in Dubrovnik, Yugoslavia. The 25 chapters are grouped into five major sections and together present material across the spectrum of heat transfer in nuclear reactor safety technology and represent the contributions of 23 different authors.

The section "Overview" takes the reader through a history of nuclear energy conversion followed by discussions of the different reactor concepts and the safety problems associated with each. The second section, entitled "Fundamental Concepts," has chapters on the transient responses of light water reactor (LWR) and liquid-metal fast breeder reactor (LMFBR) systems as well as chapters on flow and heat transfer in single- and two-phase systems. The section ends with a chapter on the modeling of the coolant flow and heat transfer in nuclear reactor systems during both normal and off-design operating conditions. Up to this point, the book would make an excellent and up-to-date text for a graduate level first course on nuclear reactor safety.

The meat of the book is contained in the two sections "Design Basis Accident: Light Water Reactors" and "Design Basis Accident: Liquid Metal Fast Breeder Reactors." The first of these, in successive chapters, takes the reader from the loss-of-coolant accident through blowdown and emergency cooling water injection to core reflooding and fuel rod rewetting. These include descriptions of the thermohydraulic phenomena themselves as well as the parameters that affect them. A final chapter, on current methods of LWR system safety analysis, describes major codes in recent use and compares their relative capabilities, especially for predicting phenomena for which there are experimental data available.

The LMFBR section begins with a discussion of the initiators for core disruptive accidents and subsequent failure propagation. Some details of the latter, clad relocation and fuel motion, are then explored. Subsequent attention is given to the removal of postaccident heat from within the reactor vessel and then, once the molten core material has breached the vessel wall, the heat from the containment structure. Again there is a final chapter that discusses the recent codes developed to model these phenomena.

A final section on special topics deals with the details of some specific phenomena alluded to in earlier sections including vapor explosions, natural convection cooling in reactors, blockages in LMFBR subassemblies, sodium boiling, and experimental methods in two-phase flows. A detailed discussion of the accident at Three Mile Island and the lessons to be learned from it conclude the book.

Nuclear Reactor Safety Heat Transfer is a complete and well-organized book with copious and up-to-date references. The flow of material is smooth, which is a difficult thing to accomplish when the works of so many authors are joined. It will be a most helpful reference book for practicing engineers and students in this critical field.

Clifford J. Cremers is presently professor and chairman of the Department of Mechanical Engineering at the University of Kentucky, where he has been since 1966. Before that he was on the faculty at the Georgia Institute of Technology, where he went after receiving a PhD from the University of Minnesota in 1964. He teaches courses across