Exact Thermometry" presented by Ulrich Grigull, Technische Universität München.

There is one keynote paper of special interest to engineers in the nuclear field: "Some Thermohydraulic Problems Associated with the Safety of Water Cooled Nuclear Reactors" by Hugh C. Simpson, University of Strathclyde, Glasgow. He discusses issues raised at the 440-day inquiry into the proposed construction of a Westinghouse-type pressurized water reactor at Sizewell on the southeast coast of England. About 130 days were spent on safety considerations with a substantial proportion dealing with thermohydraulic problems associated with loss-of-coolant accidents (LOCAs). He focuses on the "evaluation model" approach to computer modeling and the "best estimate" codes. For the former, he finds that assumptions previously believed to have been conservative may be shown not to have been so upon examination of existing data. Further, the method does not lend itself to direct comparison with experiment. For the latter he shows that care must be taken not to oversimplify the models of complex thermohydraulic phenomena. Readers may also find material related to thermohydraulics in keynote papers concerning heat exchangers, buoyancy-influenced flows, boiling, and two-phase flows.

One of the 20 chapters in the remaining 5 volumes is entitled "Nuclear Reactor Heat Transfer." Of 23 papers, 13 deal in one way or another with LOCAs; 3 are on subchannel flow analyses or problems; 5 concern liquid-metal reactors; 1 is on condenser analysis, and 1 is on performance degradation by deposit formation on the gas side of boiler tubes in a carbon dioxide cooled reactor. Of the remaining chapters, those on interfacial phenomena, pool boiling, flow boiling, two-phase flow, heat exchangers, heat transfer augmentation, natural and mixed convection, and internal forced convection may be also of interest to readers of *Nuclear Technology*. These contain 176 papers among them, more material than one would usually find at many specialists' technical conferences.

The Assembly for International Heat Transfer Conferences has attempted to keep a geographical balance among the conference papers. Maximum limits on the number that may be accepted from each of the countries with major research activities are negotiated for each conference. This tends to keep paper quality high for countries with high levels of research activity that usually have paper submission levels in considerable excess of the respective limits. However, quality is somewhat spotty where such pressures are not great. In the opinions of most, that price is not too much to pay for maintaining a large and diverse international participation.

The publisher's price of $585 will keep most individuals from purchasing these proceedings. However, as the over 1500 conference participants have sets and many technical libraries will purchase them, most engineers in the field should have the opportunity to gain access to the work. The effort in doing so will be most worthwhile.

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Chernobyl and Nuclear Power in USSR

Author	David R. Marples
Publisher	St. Martin's Press, Inc., New York (1986)
Pages	228
Price	$35.00 hardcover ($14.95 softcover)
Reviewer	Ihor O. Bohachevsky

The explosion at the nuclear power plant in Chernobyl, USSR, on April 26, 1986, is a quintessential illustration of consequences to be expected when political, sociological, or financial considerations are allowed to prevail over technical requirements and constraints. Such misplacements of priorities are not limited to the area of nuclear energy or to totalitarian government systems but occur in all societies that are highly developed politically, economically, technologically, and sociologically.

There are many examples; in open societies they are publicized more readily than in closed societies where news dissemination is restricted. For economic, practical, and aesthetic reasons, the original roof design of a sports arena was modified many times to the extent that the original engineering stress analysis was rendered invalid. Because of pressure to complete construction on time and within budget, the general manager did not authorize a new stress analysis. Consequently, the roof collapsed under the weight of snow; fortunately the arena was unoccupied.

A wide-body jetliner was designed in such a way that the floor of the passenger cabin could buckle when the integrity of the baggage compartment was compromised in flight (for example, by accidental door opening). Because much capital had been invested in the production facilities, the engineering memorandum pointing out this deficiency was suppressed by corporate management and the author was warned not to mention the fact publicly under penalty of severe reprisals including dismissal. The design deficiency was corrected after two crashes resulted in losses of ~600 lives.

Through an oversight, the construction of an aerial walkway in the lobby of a hotel did not follow engineering design drawings. Instead of rebuilding correctly, the construction manager ordered a quick and inexpensive modification. The completed walkway collapsed when loaded with nearly 200 occupants, resulting in many injuries and deaths.

Finally, as has been so amply publicized, the solid rocket booster of the space shuttle *Challenger* exploded when launched against recommendations of the engineering staff of the rocket manufacturer.

The technical report released by the Soviet government in August 1986 and presented to the International Atomic Energy Agency (IAEA) in Vienna describes and analyzes the accident at Chernobyl reactor No. 4. The analysis clearly shows that the explosion resulted from deliberate violations of at least six operating rules and because of manual disablement of several automatic interlocks designed and installed to prevent such accidents. Consequently, the event may be

construed to indicate that regardless of the number of procedural and automatic safety devices provided in any facility, human operators can devise ways to deactivate or to circumvent them. Therefore of interest are studies of reasons that motivate or compel operators to override automatic safety devices; clearly, these reasons depend on political and economic systems that prevail in different societies.

The book under review does not discuss the accident at Chernobyl from the general point of view indicated above; the author elects to limit the scope to the discussion of the Soviet nuclear power industry. He maintains that the magnitude and the speed of the nuclear energy development program in the USSR exceed available technical means and resources. The goals set by the central leadership of the Communist Party of the Soviet Union are too ambitious, and rigid insistence that they should be met shows that politico-economic considerations are being placed above human and technical limitations. Thus, without stating so explicitly, the book uses a specific example to imply the general principle that placement of priorities on politico-economical factors without regard for labor and technological resource limitations eventually and inevitably leads to a disaster. However, the very narrow scope of the book is its first weakness.

The second weakness stems from the author's decision to complete the book before a fairly detailed technical report became available at the end of August 1986. Therefore, only information from early Soviet press releases and other media sources could be utilized. Consequently, the book is weak in the area of technical facts; however, it is strong in the areas of mass media speculations and political maneuverings.

The book consists of an introduction, seven chapters, and an epilogue added to include a brief mention of the official Soviet report to the IAEA. Also provided are informative notes, references, and appendixes with names of persons involved in the affair, sources of information, and official statements and actions.

In the introduction the author summarizes his objectives, indicates the scope, and outlines the presentation of the material.

The first chapter, "Chernobyl Diary, 28 April–14 May 1986," discusses the way that Soviet authorities provided information about the accident during the first 3 weeks. The hostile tone of the presentation detracts from the purpose in a study of economic and technical matters. The discussion is deficient in two respects. First, the prevailing wind direction (toward Finland and Scandinavia) on the day of the accident is not mentioned, and Finnish and Swedish observations and warnings issued to the population are ignored. The wind direction was an important factor in this accident, and the precautionary measures recommended by Scandinavian government agencies were not significantly different from those issued by the Soviet government.

Second, the Soviet authorities are accused of deliberately misleading the public in order not to jeopardize their nuclear energy development program. However, it is also plausible that they themselves were confused and ignorant of the facts (there is confusion and chaos following an accident of that magnitude at all levels anywhere) and that concern about precipitating panic was real and justified. Events discussed in Chaps. 6 and 7 and some of the disciplinary actions listed in Appendix 1 indicate that apprehension about panic was a serious consideration; actions intended to forestall panic may indicate a sense of responsibility.

Chapter 2 examines the energy problems facing the Soviets. The discussion lacks focus and conclusions. Production figures are not related to requirements and there is no indication which sectors of the economy suffer when quotas are not met. Similarly, reserves are quoted in terms of current rates of consumption, which is not informative unless anticipated growth rates are given. This is especially true in cases of exponential growths that are commonly postulated in economic studies.

In Chap. 3 attention is focused on political, technical, and societal difficulties encountered in the development of nuclear power in Eastern Europe; however, these are not compared to the difficulties encountered in the United States and Western Europe. The author does not indicate any viable alternative to nuclear power; therefore the discussion shows implicitly that long-range policy decisions of these governments to develop nuclear energy may well have been unavoidable.

Chapter 4 discusses nuclear power development in the tenth and the eleventh 5-yr plans (1976–1980 and 1981–1985) and examines the prospects for the twelfth 5-yr plan and beyond to year 2000. It outlines the Ukraine's pivotal role in this plan and describes history and recent developments at individual power stations in the Ukraine.

In Chap. 5 the discussion of Chap. 4 is extended to encompass the entire USSR. In particular, the question of reactor safety is addressed. The problems of incompetence and mismanagement, and of low morale, training, and motivation of the work force, are discussed at length; technical details of reactor designs are not discussed. For example, the existence of a "positive void coefficient" in graphite core reactors is not mentioned. Dearth of correct technical information is the third shortcoming of the book.

Chapters 6 and 7 describe the accident and its aftermath. As indicated earlier, they were written before the presentation and discussion of the Soviet report at the IAEA meeting in Vienna. Therefore the material was dated before it appeared in print. Nevertheless, these chapters complement the technical report with discussions of political events and social conditions immediately following the accident.

The author is of the opinion that nuclear power development in the USSR will proceed as planned with possibly greater caution and difficulties. That is to be expected; after all, ocean liners were not abolished after the *Titanic* sank, air travel continues in spite of occasional mid-air collisions and other crashes, and nobody advocates elimination of hotels because of fires. It is unfortunate that the author did not place nuclear power into the above perspective. The reactor explosion at Chernobyl was nearly the most serious type of accident ever postulated in standard risk analyses: the equivalent of a "core meltdown" accompanied by breach of primary and secondary containments. (The term "core meltdown" is not applicable in a strict sense to graphite core reactors; only the fuel rods can melt.) Yet it caused far fewer fatalities (31 to date) than the other types of disasters mentioned above.

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