so it went for each of the issues that the commission had to confront: mining, emergency core-cooling, waste disposal, thermal pollution, environmental impact — in every case the commission tried to balance its desire not to impede nuclear power with its responsibility to assure public health and safety. Although it is easy in retrospect to criticize the commission for being overly permissive in its regulation of nuclear energy, the results as seen in 1993 are proof that something was being done right. Despite the accident at Three-Mile Island, no member of the US public has been harmed by nuclear power.

That an official history of a US government agency pulls no punches, but gives the facts just as they were, is remarkable. Walker and the Nuclear Regulatory Commission are to be congratulated for providing us with so balanced and accurate an account of how nuclear regulatory policy was established in the United States. □

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Ancient aquatecture

M. J. T. Lewis

Roman Aqueducts and Water Supply. By A. Trevor Hodge. *Duckworth: 1992. Pp. 504. £55, $78.*

ROMAN aqueducts are a never-failing source of interest to archaeologists, engineers and laypeople alike. So it is astonishing that no general study has hitherto been published in English or (of anything like this quality) in any other language. Hodge triumphantly combines deep scholarship and lucid interpretation, while guiding nontechnical readers considerately and painlessly through the inevitable quagmire of hydraulic principles. He follows the water over its whole course from intake to domestic plumbing, and finally sees it down the drain. En route he discusses the Romans' predecessors, wells and cisterns, surveying, irrigation, mills and baths, and urban distribution. The book is thorough, utterly practical and highly readable — even at times funny — and it will be a long time before it is superseded.

Our knowledge about the subject is limited to two principal literature sources. Frontinus's justly famous book on the aqueducts of Rome is informative about administration but thin on technology, and does not necessarily apply to other cities. Vitruvius, although trying to describe the practicalities, does not always succeed, to the point where one wonders if he knew what he was talking about. The great bulk of the evidence, then, is archaeological. The most obvious components — the arcades striding across the Campagna, the mighty bridges of Segovia and Tarragona or the Pont du Gard — are the least typical, for the aqueducts mostly ran underground in cut-and-cover trenches or in tunnels. With all their accessories such as dams, inverted siphons, settling tanks and water towers, aqueducts provide plenty of scope for debate about how they worked.

So, inevitably, not all specialists will agree with Hodge's conclusions. He emphasizes the risk, for instance, of mains pressure blowing the plug of domestic taps out of their housings, without considering the attempts to hold them down; and many would question his remarks that most Roman watermills were supplied by aqueduct, or that in northern Europe the horizontal waterwheel predominated.

His subject is so large that some prime examples have found no place: Dorchester's open-channel aqueduct; Mérida's fine system of sewers; Frontinus's information on the maintenance staff at Rome. Hodge shirks the fascinating issue of Lincoln, where the aqueduct's source lay 30 metres below the water tower. And Norman Smith's recent paper on the Pont du Gard, although in the bibliography, is not discussed. Smith suggests that the topmost tier of small arches, a unique feature, was a last-minute addition to retrieve a disastrous error in levelling. With these arches, the aqueduct just worked, falling only 6 metres in 25 km between Gard and Nîmes, the minimum gradient being an extraordinary 7 cm per km; without the arches, the aqueduct would not flow. The idea is plausible, for Roman engineers, like any others, were not infallible.

Such omissions as these, however, are minimal when set against the whole. Many a hoary myth is laid to rest, most notably that the Romans avoided pressure systems because of the weakness of their pipes. On the contrary, Hodge clearly shows that when crossing a valley up to about 50 metres deep (as at the Pont du Gard), they used a bridge; if deeper, they used an inverted siphon. To cite the extreme instances, at Beaunant near Lyon the head was 123 m and the pressure 1,207 kPa (175 lb in^{-2}), whereas on the Hellenistic siphon at Pergamon the figures were about 190 m and 1,825 kPa (265 lb in^{-2}). So much for fear of pressure: these siphons were not only built with lead pipes, but worked.

With such achievements, few would deny that Roman aqueducts were a magnificent feat of engineering and organization. This, and the benefits they brought, Hodge fully acknowledges. Neither is he starry-eyed about them, for he sees them in context. Often they were status symbols, crippling to the council's budget, built to keep up with the municipal Joneses, supplying vast quantities of water to cities whose drains could not cope. Most urban dwellings, moreover, were not on the mains for reasons of cost or lack of head, and continued to rely on wells and rainwater cisterns just as they always had. Which goes to show that in no age or society does engineering, however prestigious and expensive, necessarily impart universal benefit. □

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Bernard Cox/Architectural Association

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Spanish spans — view along the aqueduct at Segovia.