Federal Register of 9 September (p. 38425) for general comment by the public and the scientific community.

The NIH also welcomes comments from the readers of *Science*. Copies of the document are available from Dr. Rudolf G. Wanner, Associate Director for Environmental Health and Safety, Division of Research Services. His address is Room 4051, Building 12A, National Institutes of Health, Bethesda, Maryland 20014. Comments on the draft statement should be submitted to the Director, National Institutes of Health, Bethesda, Maryland 20014, by 18 October 1976.

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Fusion as an Energy Option

The recent series of *Science* articles on fusion power by William D. Metz (Research News, 25 June, p. 1320; 2 July, p. 38; 23 July, p. 307) accurately expresses many of the current concerns of the utility industry about the U.S. fusion program. The articles, however, fail to express the utilities' belief in the need for development of fusion as a commercially and environmentally viable energy source and their confidence that, with proper management, this can be carried out successfully. Fusion power is one of the very few energy options that can provide central-station electric power on a scale sufficient to meet our future needs.

Although the *Science* articles are exceptionally well researched and technically informative, the editorial comments contained therein and in Philip H. Abelson's editorial of 23 July (p. 279) tend to put fusion in an unjustifiably grim perspective. First, the technological problems of neutron damage to materials and of containment and disposal of radioactive by-products have long been known to fusion researchers, if not to the public. It is encouraging that the engineering problems of fusion have been recognized early and are already being tackled.

Second, the early design studies of conceptual fusion reactors—unfortunately mislabeled "reference" designs—have quite naturally yielded cumbersome and expensive products. The purpose of these studies was to identify engineering problem areas; this aim is almost diametrically opposite to that of designing a power plant suitable for commercial application. Again, we are encouraged that this step has been taken

and are confident that future designs will bear little resemblance to these "protozoic" behemoths.

Third, the comparison in Abelson's editorial between the cost ($10 billion) of a 10-megawatt fusion plant and that of a 10-Mw solar electric plant ($100 million) is deceptive. The 10-Mw figure for fusion is a nominally chosen small positive number to indicate breakeven; fusion reactors would not come in such small sizes. If a fusion reactor took 1000 Mw to energize and produced 1010 Mw of electric power, it would have a net output of 10 Mw. However, if the plasma confinement time turned out to be twice as long as assumed (and this is well within the present range of uncertainty), the same reactor would produce 2020 Mw, for a net of 1020 Mw. By contrast, increasing the capacity of a 10-Mw solar plant to 1000 Mw would entail a 100-fold duplication of collecting panels and energy storage facilities. Furthermore, the $100 million figure quoted above is for a single solar electric installation; the $10 billion figure is the integrated cost of the entire fusion R & D program up to 1990.

The cost of developing fusion into a commercial energy source will be comparable to that of any major space, military, or weapons program; its importance to national security could be just as great. The technological problems of putting an American on the moon were staggering; yet they were solved when the nation put its resources behind the space program. Similarly, fusion needs the strong and consistent support of the public and of Congress if it is to become a reality. Without such support the program is destined to failure.

Regardless of how the program has fared in the past, the necessary dialogue between the users (the utilities) and the developers (the government) is now under way. The Electric Power Research Institute (EPRI) and the utilities believe that the fusion program should, at this time, remain broad-based while moving purposefully toward the goal of commercialization. By working closely with the Energy Research and Development Administration (ERDA), EPRI is reflecting utility viewpoints and design requirements into the national R & D effort. The inherent flexibility of fusion, which gives it many options for achieving our energy goals—in terms of plasma configurations, heating methods, fuels, and energy converters, as well as of hybrid schemes such as fission fuel production and waste burning and synthetic chemical fuel production—gives us confidence in the eventual success of the development effort.

The utility industry supports fusion research not only through EPRI but also through individual corporations, such as the Texas Atomic Energy Research Foundation, the Wisconsin Electric Utilities Research Foundation, and Northeast Utilities. Together with ERDA, we feel that, if the fusion R & D program is not prematurely condemned for identifying its problems, these obstacles can be overcome or circumvented. Furthermore, we fully expect that the requirements of the utility industry and of society will be taken into account as the program proceeds toward commercial application.

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