

letters

ety would be much lower than the present system. Not only because so much is now certified about each individual that is irrelevant to a specific application, but because without the insistence on in-school certification, the schools themselves could be more effective and far less costly. Both local and national funds could go much further if they were diverted from the demands of certification and were applied to the broader range of educational environments that have been developing during the past half century.

Kids play hooky from school to come to the Exploratorium. That is supposed to be bad, but I think it is good and maybe the beginning of a trend.

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Fusion reactor hazards

Bernard Cohen's letter in the November issue (page 15) correctly points out that fusion power reactors may generate as much as 10^5 times as much tritium as fission power reactors presently do, and he expresses a legitimate concern regarding the containment and control of that inventory. We in the Division of Controlled Thermonuclear Research have appreciated these problems ever since they surfaced in our first fusion-reactor conceptual designs some years ago. From the first, we have accepted as a basic premise that fusion power reactors must control routine and accidental radioactive effluents and resultant offsite exposures at least as well as the "as low as practicable" guidelines for fission-reactor designs.

In all of our conceptual design work we have been proceeding on the basis that tritium releases cannot exceed the current stringent controls on fission reactors, and we have included specifications (such as tritium monitoring, containment, extraction, recycle and disposal systems) to ensure "near zero release" of tritium from these preliminary reactor designs. We have instituted a vigorous R&D program with the specific aim of developing and demonstrating tritium control systems that will perform at least as well, in terms of total curies released, as do tritium control systems for fission power reactors. We are happy to say that all of our preliminary design studies to date indicate that the tritium in fusion reactors can be contained and controlled to the point where total tritium released from fusion power reactors will not be any more of a problem than it is in fission reactors. In this regard, we would like to reiterate a major point made by Cohen: If tritium releases can be kept to the level obtained in fission systems, the expo-

sure of the public to radioactive releases will be truly negligible in the context of present-day power systems. The tritium release problem in fusion reactors appears to us readily manageable and should in no way require the public to make any safety tradeoff in accepting fusion power as an energy source.

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Colonies in space

I read with interest and pleasure Gerald K. O'Neill's article "The colonization of space" (September, page 32). As an avid science-fiction reader, however, I was distressed to see that O'Neill did not mention two recent stories directly related to his concepts. These stories are "Rendezvous with Rama" by Arthur C. Clark (1973, Ballantine Books) and "Ringworld" by Larry Niven (1972, Ballantine Books). The first of these discusses the cylindrical geometry in considerable detail, and the second scales up the concept to a ring of about 1 AU radius, about 200 000-km wide and with 100-km sidewalls. I hope some of your readers will read these books as well as the fascinating article.

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Although O'Neill's article gives a detailed discussion of how to live and work in space, including the transportation of needed raw materials from off-Earth sources, he ignores the matter of getting the colonists off the Earth. Using his figures for the reduction of the population level from 16.5 billion to 1.2 billion within 30 years, and assuming that the population growth remains at 1.98% per year, one finds that in 2050 it will be necessary to remove 621 people/minute, just to keep the population stable. This is the equivalent of 2 jumbo jets, every minute, around the clock. By ignoring population growth, we find that 970 people/minute must leave to achieve the desired reduction in 30 years. Combining growth with backlog, we find that to meet the stated program we must start out launching 1531 people/minute, and gradually taper off to 1015 people/minute until the optimum population of 1.2 billion is reached. Then a leisurely 45 colonists/minute will suffice to maintain the status quo. Even ignoring the complexities of severing the colonists' ties on Earth, such as homes, jobs, and so on, he sees that the logistics of "The Great Exodus" would tax the Earth's waning resources to nearly the same magnitude

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