letters

Storing radioactive wastes

I would like to comment on the article entitled "Radioactive waste bound in crystals," which appeared in April's Search and Discovery (page 21). There are currently many proposals of ways to improve on borosilicate glass for use in the disposal of radioactive wastes. Some of these proposals may have considerable merit. The important point to remember, however, is that borosilicate glass is available *now*, not in ten years, and this technology is sufficient to achieve the goal of long-term isolation of these wastes.

Most proposals for the use of borosilicate glass would maintain the temperature of the glass below 100 °C. Burial would be at a depth of about 1000 meters, where the lithostatic pressure does not exceed 200 bars. Under these conditions it is not possible for *running* water to exist above 300 °C, the point at which the leachability of glass is a problem. Significant amounts of water would reduce the temperature in the formation. Even if the temperature were higher than 300 °C, the pressure would not be high enough to prevent steam formation. Questions concerning leachability have been the main arguments against the use of glass.

Although current plans call for the engineering of multiple barriers (glass, cannister, backfill, geology) to contain the radioactive wastes, in the last analysis it is none of these engineered barriers that provides the guarantee that these wastes are indeed sequestered for the millenia. Rather it is nature herself who provides this assurance. The laws of chemistry and physics (ion exchange, adsorption, bonding and so on) are capable of immobilizing the hazardous radioactive isotopes in the surrounding earth even if all the engineered barriers fail.

Nature has been kind to us. A demonstration of radioactive waste disposal already exists (Nature's Nuclear Reactor, G. A. Cowan, Encyclopaedia Britannica, 1978 Yearbook of Science and the Future, page 186.) At Franceville, in Gabon, West Africa, a "natural reactor" operated two billion years ago. One can go there to the Oklo surface mine, located in the tropical rain forest, and measure the migration of the reactor's biologically important fission products. In the last two billion years they have not moved more than a few meters. The water conditions and closeness to the surface of the Oklo mine are hardly ideal for sequestering wastes.

The technology needed for radioactive waste disposal exists today. Better solutions probably will be available in the future. But the resolution of the problem cannot wait for tomorrow—we should use current technology to demonstrate that a solution exists. Otherwise we shall be forever waiting for a "better" solution to be developed.

FRANK J. RAHN
Electric Power Research Institute
5/5/80 *Palo Alto, California*

COMMENT: Frank Rahn makes the point that an appropriately engineered glass waste form technology could essentially be deployed *starting "now"* for reasonably safe use at a design temperature below 100 °C. I fully concur. Our earlier work showing rapid reaction of typical waste glass formulations at the earlier design temperatures (350–500 °C) has led to major adjustment in such design. In addition, however, I would like to point out some very significant omissions in the reasoning of the "must do something quickly about radwaste" school of thought.

Technical radwaste management (RWM) is a system with four elements: planned storage; waste form; isolation, say in the deep seabed or rock; and emplacement (including transportation). The lack of urgency in rushing off to make concrete, ceramics or glass forms stems from the simple fact that the other components of the RWM systems are much further behind in development schedule than the waste form. What will we do with the blocks of concrete or ceramic or glass? We have as yet no repository in sight; no regulation, no criteria, no standards. We could not possibly transport it across too many state borders today, and social acceptance will come slowly even if we start educating actively *now*.

We do indeed have glass, concrete and ceramics as waste-form options for low-temperature forms. We will have

Meet the Programmable Digitizer that sets two new standards for Signal Processing Systems. The 7612D.

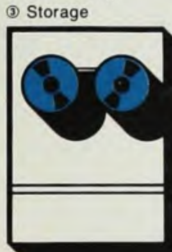
The standard for accuracy. The standard for measurement power.

Tektronix now offers two significant breakthroughs for automatic waveform measurements.

Meet the new standard for signal accuracy, the 7612D. Its precision comes from a new type of analog-to-digital converter. The result is a high-performance data acquisition system component featuring an eight-bit, 200 MHz sampling rate, with high resolution and bandwidth.

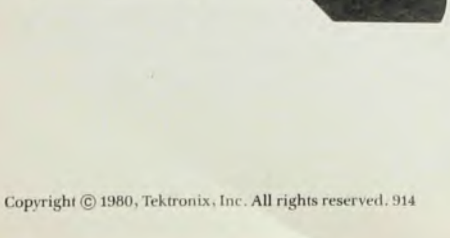
The standard for measurement power is also yours when you link the 7612D with one of Tek's Signal Processing Systems. These complete systems offer computer processing intelligence and total software control. The five major system components are illustrated below.

① Acquisition



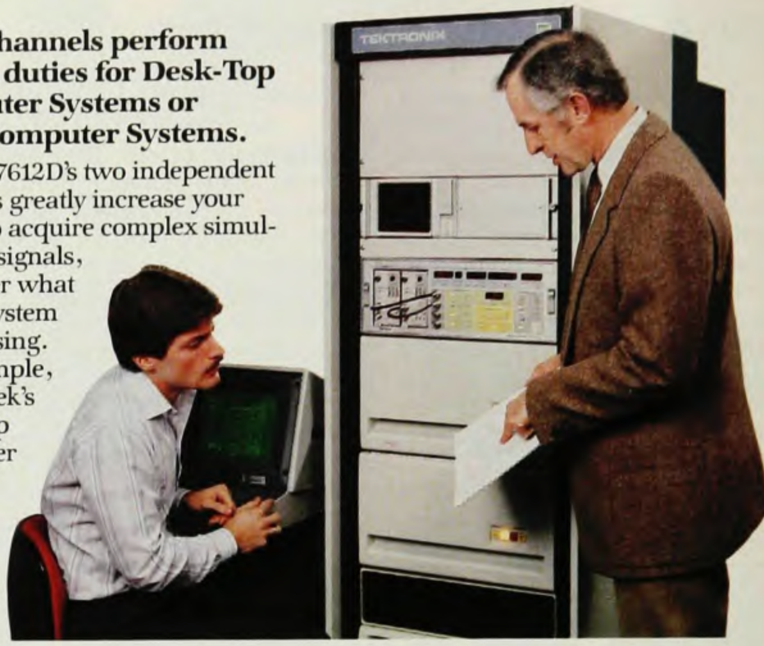
Five major system components and Tek's comprehensive software meet your measurement needs.

② Processing
③ Storage
④ Display
⑤ Documentation



Dual Channels perform double duties for Desk-Top Computer Systems or Mini-Computer Systems.

The 7612D's two independent channels greatly increase your power to acquire complex simultaneous signals, no matter what type of system you're using. For example, there's Tek's Desk-Top Computer Based System: The 7612D with the 4052 Graphic Computing System. This system offers enhanced BASIC Software and special Signal Processing ROM Packs. These ROM Packs provide 15 commonly used waveform analysis functions, like the location of a waveform's maximum and minimum or its fast Fourier transform.



For the speed of a Mini-Computer Based System, team the 7612D with either the Tektronix CP1100 or CP4100 Series DEC* Compatible Controllers. They feature the unique TEK SPS BASIC Software, which processes waveforms as if they were single-valued variables. And its interactive language is modular in design. So the novice won't be overwhelmed by its complexity and the expert won't be limited by its simplicity.

Full Programmability Increases Productivity.

In addition to improving your accuracy and measurement power, the 7612D also increases productivity through programmability. Human errors are reduced, measurements are repeatable and operators can be made available for other tasks.

Learn how the 7612D can be used in your present system or in one of Tek's complete Signal Processing Systems. Call or write the Tek SPS Specialist nearest you.

And get your system up two standards.

*Registered trademark of Digital Equipment Corporation

Tektronix®
COMMITTED TO EXCELLENCE

U.S.A., Asia, Australia, Central & South America, Japan
Tektronix, Inc.
P.O. Box 1700
Beaverton, OR 97075
Phone: 800/547-1512
Oregon only 800/644-9051
503/644-0161
Telex: 910-467-8708
Cable: TEKTRONIX

Europe, Africa, Middle East
Tektronix International, Inc.
European Marketing Centre
Postbox 827
1180 AV Amstelveen
The Netherlands
Telex: 18312

Canada
Tektronix Canada Inc.
P.O. Box 6500
Barrie, Ontario L4M 4V3
Phone: 705/737-2700

letters

better ones soon, in plenty of time to meet the most optimistic schedule for the installation of the rest of the system.

Rahn's letter stating that glass is available as a waste form now perpetuates—unwittingly I am sure—other gross misconceptions of the public, including most scientists. Glass as a waste form, far from having the maximum experience behind it, is the latest entry, well behind its two competitors, ceramics and concrete-encapsulated forms. The fact is that in the entire world there is a total of some 35 megacuries of real radwaste glass. But the world has not been told of DoE's real success stories. For ten years at Hanford, some 300 megacuries of radwaste have been converted to crystalline ceramics (albeit in poorly chosen phases) and doubly canned in hastelloy and stainless steel. Waste *solidification* into *crystalline* forms is not only available, it has been and is going on *now* in the US. Even more dramatic is the ignorance, that waste *solidification and disposal* is going on every day *now* in the US. I refer to the exemplary work of Oak Ridge's Chemical Technology Division in in-situ emplacement and solidification into concrete, which also has been going on for ten years. The USSR in a simpler variant had already disposed of 100 megacuries in 1967; by now several hundred megacuries have been *ultimately disposed of* by in-situ solidification in mineral-encapsulated forms. Not only does experience therefore come out on the side of crystalline options, but cost and process safety would suggest that for low-temperature wastes (below 100 °C) equally insoluble but much simpler and cheaper options based on concrete will save the taxpayer billions of dollars.

The danger to the public's health from radioactive waste, in whatever solid, glass or concrete on any comparative scale, are essentially trivial. Yet as we have seen in Harrisburg, much damage can be done mainly from psychological trauma and societal gross over-reaction. One canot cure such trauma by apparently accepting the validity of the exaggerated threat and turning to speedy action. Exactly the undesired effect is caused by suggesting urgency—it exacerbates things. The pro-nuclear forces of the "don't just stand there, do something" school forget that the absolute minimum time between authorization and pronouncement of success of any kind by "demonstration" is 25 years. Can nuclear power wait that long? No. Active vigorous education and interpretation is vastly more important. Among the most important facts to be conveyed to the public is that nuclear wastes have been for ten years and are being solidified and disposed in concrete, and that enormous amounts of nuclear waste have been successfully solidified into crystalline ceramics for a decade.

RUSTUM ROY
The Pennsylvania State University
7/9/80 *University Park, Pennsylvania*

Refereeing justice

Although there are substantial differences between a judicial trial and the procedure involved in refereeing a technical paper, in the cases in which an adversary relationship does arise between author and referee, the similiarities are great enough to invite comparison. Viewed in this light, with the author standing as the accused, the journal editor as judge and the referee serving at once as witness for the state, prosecuting attorney and jury, a more biased and inequitable system would be difficult to imagine. The author does not have the right to face his accuser; the judge not only favors the prosecution but often does not scrutinize the evidence offered by the defendant; the defendant is often found guilty on the vote of a single juror (referee); and the accused is presumed to be guilty until he proves himself innocent. In general, every safeguard offered the accused in a judicial trial is not only lacking, but is reversed and given to the referee.

The reason for this state of affairs is not only that it is difficult to find a system which both preserves the rights of authors and also maintains a reasonable limit on the time and effort going into the refereeing procedure but also, to a large extent, that those responsible for setting up and operating the system not only make little effort themselves, but often actively oppose efforts made by others to effect improvements.

Because of space limitations it is not possible here to detail the various (some relatively simple) changes in procedure which would improve the system; but a single illustrative example, namely the institution of reciprocal anonymity, will suffice. This suggestion, which is by no means new, is widely opposed by those in positions to make changes, and a common reason given for this opposition is that "in most cases the referee would recognize the author so it wouldn't do much good." In fact, I doubt whether anyone has the slightest idea of the fraction of cases in which an author would be known without his identity appearing explicitly on the paper. In any event, if the anonymity were maintained in even a relatively small fraction of cases it would represent a definite improvement in the existing system.

The reason for the opposition to such

continued on page 69