counting defense) was during the New Deal. It did build many fine projects, and it helped hundreds of thousands of individuals. It had little if any lasting effect on the economy as a whole.

The last counter-cyclical experience occurred during the recession of 1982–83. To help the unemployed and help stimulate a flat economy Congress threw a few billion into public works and expanded unemployment benefits.

There is nothing in this proposed amendment that would bar Congress from taking such modest steps again. If a crisis like the Depression occurred again, a three-fifths majority in each house could bypass the amendment's spending restrictions.

If there were a crisis, the people would respond just as they did in the 1930s. They threw out a catatonic GOP and installed Democrats, giving them a three-to-one margin.

The Democrats are on the wrong side of this one. Balancing the budget is a liberal concept, in the classic sense of the word, liberating.

Interest on the debt nearly equals all the government spends on discretionary programs, such as disease control, transit, research, aid to cities, education and foster care.

Interest payments are crowding out aid to the underprivileged just as much as entitlements. Interest payments go to people rich enough to buy government securities in $10,000 and $100,000 lots—not exactly the guy in your neighborhood Legion hall.

It is a loser for the Democrats on demographic lines. It is the young voter—not the aging one—that is going to pay and pay and pay to get this debt off his back.

For every sophisticated argument against it, there is an even stronger common sense argument for balancing the budget—sooner than later.

The people aren't dumb.●

HOMICIDES BY GUNSHOT IN NEW YORK CITY

● Mr. MOYNIHAN. Mr. President, I rise to continue my weekly practice of reporting to the Senate on the death toll by gunshot in New York City. Last week, 12 people lost their lives to bullet wounds, bringing this year's total to 107.●

ALLEGATIONS REGARDING POTENTIAL NUCLEAR EXPLOSIONS IN A GEOLOGIC REPOSITORY FOR SPENT NUCLEAR FUEL

● Mr. JOHNSTON. Mr. President, last Sunday, the New York Times published a front-page story alleging that geologic disposal of spent nuclear fuel in Yucca Mountain could result in an ''atomic explosion of buried waste.'' The story is based on a hypothesis proposed several months ago by two scientists at the Los Alamos National Laboratory, Dr. Charles D. Bowman and Dr. Francisco Venneri. Drs. Bowman and Venneri, neither of whom is a geologist, performed some crude calculations on what might happen to plutonium in a geologic repository. They assumed that 50 to 100 kilograms of pure plutonium-239 would slowly diffuse through nonabsorbing silicon dioxide—not any type of rock actually found under Yucca Mountain—and then gradually reach criticality as various neutron-absorbing elements in the nuclear waste diffused away over the millennia.

We have been told by the New York Times and by both Senators from Nevada yesterday that three teams of scientists at Los Alamos ''have been unable to rebut the assertion'' of Drs. Bowman and Venneri. This is simply not true.

The Los Alamos National Laboratory, in fact, did respond to these allegations. It formed three review teams. A ''Red Team'' was set up to serve in the role of skeptic. A ''Blue Team'' was set up to take the role of defenders of the Bowman-Venneri hypothesis. A ''White Team'' was set up to serve as a neutral judge of the work of the other two teams, and to render an overall judgment as to which was more credible.

What was the conclusion of the White Team? I ask that a two-page ''Summary Critique of Bowman-Venneri Paper by Internal Review Groups at Los Alamos,'' which was publicly released yesterday by the Los Alamos National Laboratory, as well as the complete text of the White Team report, entitled ''Comments on 'Nuclear Excursions' and 'Criticality Issues''' be printed in the RECORD at the end of this statement.

The White Team report is a devastating critique of the hypothesis of Drs. Bowman and Venneri. It states that:

> The geological situations in the Bowman paper are too idealized to validate the proposed scenario.
>
> The assumption of significant plutonium dispersion into the surrounding medium is without justification.
>
> The amount of water is overestimated by a factor of 1000. . . . There is no steam explosion.
>
> The assumptions about the behavior of the fissile mixture near criticality are not credible.
>
> There is no credible mechanism for releasing energy on a time scale short enough for even a steam explosion.

Even when the White Team started assuming that the impossible would happen, it still could not find the Bowman-Venneri hypothesis credible. For example, the White Team concluded:

> Even if dispersion and criticality are assumed (which is strongly objected to), the conclusion that an explosion would occur is incorrect.
>
> Even if dispersion, criticality, and energy release are assumed, there would be no serious consequences elsewhere in the repository or on the surface.

The florid story in the New York Times and the comments made on the floor yesterday by my distinguished colleagues from Nevada illustrate vividly how to misuse science in public policy debates.

Step No. 1. Ignore peer review. The New York Times clearly knew that an internal laboratory review of the Bowman-Venneri hypothesis had taken place, but got the story of that review completely wrong. Is there any way to characterize the above statements as being ''unable to lay [the Bowman-Venneri hypothesis] to rest,'' as the New York Times reported? I don't see how. And, of course, no external review by a scientific journal of this paper has taken place—it isn't even clear whether Drs. Bowman and Venneri have submitted their calculations to any journal, other than the New York Times, for consideration.

Step No. 2. Do not even bother to get your facts straight. The true story of the internal Los Alamos review of this paper was readily available yesterday to any Member of this body who would have taken the time to call anyone at the laboratory whose name was mentioned in the New York Times story.

Step No. 3. Just jump on any news story that seems to support your preconceived view. Blow up the headline into a big chart, and head directly to the Senate floor.

Unfortunately, this is not the first time that we have seen bad science injected into the debate over a permanent geologic repository for spent nuclear fuel. In 1989, another DOE scientist named Jerry Szymanski interpreted some mineral deposits adjacent to the Yucca Mountain site as evidence that ground water repeatedly had risen well above the level proposed for the repository in the geologically recent past. If such an event were to occur in the lifetime of the repository, it would flood the waste packages and could result in a release of radioactive material to the environment. But before this hypothesis could be properly reviewed by other scientists, Szymanski's report became a media sensation fueled by, among others, the New York Times. Eventually, a distinguished group of scientists from the National Academy of Sciences was asked to evaluate Szymanski's interpretations and the data upon which he had based those interpretations. This panel concluded what the vast majority of DOE and U.S. Geological Survey scientists had concluded already: that the mineral deposits were produced by rainwater at the surface and had nothing to do with fluctuations in the ground water table at all. That was in 1992. Notwithstanding the NAS conclusion, the State of Nevada continues to pay large sums of money to Szymanski, now an independent consultant, to continue beating a dead horse.

So let me respond in detail to the specific charges made yesterday by my distinguished colleagues from Nevada.

The distinguished junior Senator from Nevada charged that a ''discussion has been going on for months and months and months'' involving ''three teams comprised of 10 scientists—that is 30 scientists [that] have been unable to rebut the assertion that there is a genuine fear that an explosion can occur in a geologic repository.'' In fact, the scientists at Los Alamos were able to rebut the assertion, and did.

The distinguished senior Senator from Nevada complained that the Bowman-Venneri hypothesis had not been

mentioned in public hearings or debates. Well, that's how scientific review works. Scientific results ought to get careful peer review within the scientific community before they are served up in the Sunday New York times. If a scientific result can withstand neutral scrutiny—which is what Los Alamos was in the process of doing—then it should be published in the open scientific literature and we can start the debate as to what its relevance to policy might be. None of us is served by fragmentary and distorted accounts of scientific research in the public media.

The distinguished senior Senator from Nevada characterized the Bowman-Venneri calculations as ''evidence by a scientific community that says an explosion could occur.'' Do my colleagues really believe that a crude, theoretical calculation, predicated on all sorts of inaccurate assumptions for example, that the rock under Yucca Mountain is pure silicon dioxide, constitutes evidence? Evidence usually means something real. You can make up any theoretical calculations you like, and if you are not going to be constrained by reality, you can come up with some pretty interesting answers. But you will not get any evidence that way.

The distinguished senior Senator from Nevada stated that ''it is not as if it has not happened before. In the former Soviet Union, they had an explosion from nuclear waste.'' He would have us believe that the Soviet explosion is somehow relevant to geologic disposal of spent nuclear fuel. Not so. The Soviet explosion occurred in a nuclear waste tank at Tomsk, not in a geological repository. The explosion was caused by red oil—a byproduct of reprocessing spent nuclear fuel. The whole idea behind the current DOE waste program, and geologic storage in a location such as Yucca Mountain, is not to reprocess.

The distinguished senior Senator from Nevada says that his information is ''not sensationalism'' and that it ''comes from the scientific community.'' Well, publication in the New York Times hardly constitutes peer review. It is sensationalism, pure and simple.

Finally the distinguished senior Senator from Nevada said that these results came ''from one of the finest scientific labs in the world.'' Now that we can see what Los Alamos actually has to say about the Bowman-Venneri hypothesis, will the Senators from Nevada accept what the Los Alamos review team had to say?

In summary, it is not true that, as both Senators from Nevada tried to tell us yesterday: ''Thirty scientists * * * have tried to prove it wrong for 10 months. They cannot.'' As it turns out, they can shoot this hypothesis full of holes, and they did.

Before we call a halt to all attempts to find a solution to our nuclear waste problems, or before we set up mini-repositories for spent nuclear fuel at every nuclear plant in the Nation, let's see the Bowman-Venneri hypothesis for what it is—a preliminary calculation with a highly questionable connection to the real world. If scientists at Los Alamos want to pursue such calculations, that is their right. But we should not let ourselves be swayed by sensational reports based on sketchy theories. Good policy can and should only be based on good, peer-reviewed science.

The material follows:

[The attached paper is a summary of the work of the three review teams that have examined the paper on possible criticality at the planned Yucca Mountain Repository. It was compiled by the senior manager at Los Alamos National Laboratory who supervises the author of the original paper.]

SUMMARY POINTS OF BOWMAN-VENNERI PAPER—''UNDERGROUND AUTOCATALYTIC CRITICALITY OF PLUTONIUM AND OTHER FISSILE MATERIAL''

(By Charles Bowman and Francesco Venneri)

1. Underground storage as presently recommended could lead to autocatalytic criticality and uncontrolled dispersal of thermally fissile material with significant nuclear energy release and possibly nuclear explosions in the 100-ton range.

2. Fissile material when emplaced underground is subcritical. However, once containment is breached, the fissile material is free to disperse in the underground matrix either through natural (diffusion, earthquakes, water flow) or unnatural means (human intervention).

3. The underground matrix contains good moderators such as water and rock (silicon dioxide) in various proportions. Under certain conditions of fissile material density, radius, water and rock composition, the fissile material can reach criticality due to neutrons moderated in the rock/water mixture. The criticality can have either positive or negative feedback. Negative feedback would mean that the nuclear reactions would decrease as the mixture heated up and expanded and hence go subcritical. Positive feedback means that the nuclear fission is self-enhancing (autocatalytic). Hence the nuclear reactions continue to grow to supercriticality and possibly explosive conditions.

4. Neutron poisons, such as boron, that are added to the spent fuel when emplaced underground to prevent criticality have different solubilities than fissile materials and thus would be leached out from the fissile material area.

5. Without water, 50–100 kg of fissile material is required to reach autocriticality. As small an amount as 1 kg of fissile material can reach autocriticality with water present.

SUMMARY CRITIQUE OF BOWMAN-VENNERI PAPER BY INTERNAL REVIEW GROUPS AT LOS ALAMOS

GEOLOGIC EMPLACEMENT

1. The geological situation in the Bowman paper are too idealized to validate the proposed scenario. Pure silicon dioxide, a weak neutron absorber, is not a common geological material and has not been proposed as a repository material. Other elements present in all proposed geological formations absorb neutrons much more strongly than pure silicon dioxide, which reduces the reactivity of the mixture.

2. For periods less than 10,000 years, the presence of Plutonium 240 (half-life of 6,500 years) would also reduce reactivity strongly.

MATERIAL DISPERSION UNDERGROUND

1. The assumption of significant dispersion of plutonium into the surrounding geologic medium is without justification. Geologic processes take millions of years by which time the plutonium-239 (half-life of 24,000 years) would have decayed to 235 U which is less reactive.

2. The Bowman paper argues that water flowing down through the repository would dissolve glass logs in about 1,000 years and leave a fragile powder of plutonium that could disperse through steam ''explosions'' caused by criticality heating of the water in the vicinity of the Pu log. However, the amount of water is overestimated by a factor of 1,000 so that the correct time scale is on the order of a million years. Also the temperature gradient is over estimated by a factor of ten so that there is no steam ''explosion.'' Also the leaching process could leave a residue as strong as the original log.

3. Material is not likely to be dispersed into symmetric shapes by rather along fractures which would provide more difficult geometries for criticality.

CRITICALITY

1. The assumptions about the behavior of the fissile mixture near criticality are not credible.

2. As the fissile/rock/water mixture approached criticality, it would slowly heat and expand which would drop its reactivity below critical and mixture would cool. Thus the mixture would have a negative temperature coefficient.

EXPLOSIONS/ENERGY RELEASE

1. Even if dispersion and criticality are assumed (which is strongly objected to), the conclusion that an explosion would occur is incorrect.

2. There is no credible mechanism for releasing energy on a time scale short enough for even a steam explosion. A nuclear explosion must make the transition from critical to highly supercritical in a fraction of a second. A credible means to force this transition in a repository has not been found.

3. Even if dispersion, criticality and energy release are assumed, there would be no serious consequences elsewhere in the repository or on the surface.

[The attached paper is the preliminary work of a team of scientists at Los Alamos National Laboratory. The team was asked to review the papers that have been generated dealing with the issue of possible criticality at the planned Yucca Mountain Repository. Further analysis may be conducted, and possible further modifications of the estimates contained in this paper may occur, in the normal process of scientific investigation. The paper of the review team as it stands now does contain considerable work by the team.]

COMMENTS ON ''NUCLEAR EXCURSIONS'' AND ''CRITICALITY ISSUES''

The Laboratory provided a technical review of a paper by Drs. Bowman and Venneri on the ''Nuclear Excursions and Eruptions from Plutonium and Other Fissile Material Stored Underground,'' which argued that the dispersal of plutonium (Pu) stored underground could increase its reactivity to the point where critically, auto-catalytic reaction, and explosive energy release could occur.

The review concluded that the probability of each of these steps is vanishingly small and that the probability of the occurrence of all three is essentially zero. Moreover, even if these steps could occur, any energy release would be too small and slow to produce any significant consequences either in the repository or on the surface.

The authors of ''Nuclear Excursions'' provided responses to the issues raised in that review in the form of a paper entitled ''Criticality Issues for Thermally Fissile Material in Geologic Storage.'' The white team and the leaders of the blue and red teams reviewed the responses in ''Criticality Issues,'' met to discuss them, determined that they are flawed for essentially the same reasons as the original paper, and concluded that they do not significantly impact the conclusion of the review that the probability of the chain of events postulated in ''Nuclear Excursions'' and ''Criticality Issues is essentially zero and that even if they could occur, any energy release would be too small and slow to produce significant consequences.

EMPLACEMENT

The geological situations discussed in ''Nuclear Excursions'' were too idealized to provide a useful framework for analysis or to validate the proposed scenario. That was pointed out in the review, but those situations were still used in ''Criticality Issues.'' ''Nuclear Excursions'' postulates the emplacement of fissile materials in geologic formations of pure silicon dioxide. Pure silicon dioxide is a weak neutron absorber, is not a common geologic material, and has not been proposed as a repository material. Other elements present in all geologic formations that have been proposed absorb neutrons much more strongly than pure silicon dioxide, which reduces the reactivity of the mixture.

Furthermore, ''Nuclear Excursions'' performs most of its yield calculation for pure Pu–239; so does ''Criticality Issues.'' The weapons plutonium of interest has a significant fraction of Pu–240, which is a strong absorber that further reduces reactivity. Even for the maximum loading postulated in ''Nuclear Excursions,'' weapons plutonium could never disperse to a condition of criticality in real, dry repository materials. It is argued that the Pu–240 would decay, leaving the more reactive Pu–239, but that would happen over several times the 6,500 year half life of Pu–240. Even then the Pu–240 would be replaced by its daughter U–236, which is also a strong absorber. Moreover, as noted above, the calculations in both papers ignore minor soil constituents with very large absorption cross sections. When they are properly included, it may not be possible to achieve criticality for the assumed conditions even without the Pu–240.

The assumption of significant dispersion of plutonium into the surrounding geologic medium in ''Nuclear Excursions'' is without justification. Geological processes would take millions of years, by which time plutonium would have decayed to uranium-235, which is less reactive than Pu-239. We have not discovered a credible process that would produce more rapid dispersal. Anthropogenic measures are unlikely and are routinely accounted for in repository analyses. ''Criticality Issues'' argues that water flowing down through the repository would dissolve the glass log in 1,000 years and leave a fragile powder, but its calculation overestimates the amount of rainfall on and water in the repository by factors of 1,000, so the correct time scale for dispersal is again about a million years.

It has also been noted that the temperature gradient driving the process is overestimated by an order of magnitude and that the leaching process could leave a residue as strong as the original log.

CRITICALITY

The assumptions about the behavior of the fissile mixture near criticality are not credible. ''Nuclear Excursions'' assumed that the rock in which the fissile material is placed is rigid and would prevent the expansion of the material and permit the achievement of super criticality. That was based on an improper interpretation of the published equation of state. In reality, rock is compressible, and even at depths of several kilometers, lithostatic stresses are small and anisotropic, so that confining stresses are small. Even if it fractured the rock, it would not do so in a spherically symmetric manner. Even if the mixed material became critical, it would slowly heat and expand, which would drop its reactivity below critical, after which its neutron flux would drop, and the mixture would cool. That is, the mixture has the negative temperature coefficient of many fissile assemblies. This was pointed out in detail in the review.

Nevertheless, ''Criticality Issues'' again argued that fissile material could diffuse through criticality, although it shifted its argument to soils with very high amounts of water, which have higher reactivity. However, the essential physics is the same as for dry rock. The mixed material would slowly heat and expand, which would drop its reactivity, which would cause it to cool. Hydrated mixtures also generally have negative temperature coefficients. Moreover, the first time the mixture underwent this cycle, it would drive off the water, after which it would be left far below critical, dry, and with no mechanism for the reinsertion of water. Thus, there is nothing new in ''Criticality Issues,'' it simply repeats the stability errors made in ''Nuclear Excursions.''

There are some interesting tradeoffs between the negative temperature coefficient of such mixtures from expansion and the potentially small positive coefficient from absorption and Pu-239 resonance broadening, but those effects are delicate and comparable even at high hydration. Unfortunately, they cannot be evaluated from the calculations in ''Criticality Issues,'' which were apparently all performed for cold soil, pure SiO_2, and pure Pu-239. All three of those restrictions would have to be removed to provide an assessment beyond that in ''The Myth of Nuclear Explosions at Waste Disposal Sites.'' Given the simplicity and ease of monitoring for the development of the conditions postulated, that is readily addressed.

ENERGY RELEASE

Even if dispersion and criticality are assumed, the conclusion that an explosion would occur is incorrect. ''Nuclear Excursions'' postulates ''auto-catalytic'' behavior in which the release of energy leads to greater criticality, but the discussion above shows that in dry repository material, the release of energy instead reduces criticality and shuts the reaction off. ''Criticality Issues'' postulates autocatalytic behavior in hydrated mixtures, but the discussion of the previous section shows that to the extent that the phenomena has been quantified by earlier work, the release of energy reduces criticality there, too.

The postulated mechanisms for explosion are not credible; the most that appears possible is heating and evaporation of some water before a smooth shut down. There is no credible mechanism for releasing energy on a time scale short enough for even a steam explosion. A nuclear explosion must make the transition from critical to highly supercritical in a fraction of a second. A credible means to force the transition in a repository has not been found. Thus, the assertion that an explosion would occur is incorrect.

Even if dispersion, criticality, and energy release are assumed, which appear virtually impossible on the basis of the arguments above, there would be no serious consequences elsewhere in the repository or on the surface. Calculations indicate containment volumes very small compared to the nominal spacing between storage elements; thus, there could not be any coupling between storage elements or any possibility of greater energy releases through synergisms.

RELATION WITH OTHER WORK

That the critical mass may be reduced by dilution by moderating material discussed in the paper is well understood by the nuclear community. Fermi used it to full advantage when he assembled the first pile under the grandstand at Stagg Stadium.

Fermi also used the advantages of heterogeneity in minimizing resonance losses in natural uranium, although that is irrelevant to the discussions of Pu reactivity here.

The National Academy of Science report does not suggest emplacement of weapons plutonium in the manner discussed by ''Nuclear Excursions,'' although it did comment on the advantages of higher fissile loading. The Academy was alert to the potential for criticality and qualified its recommendations by stating that further analysis and discussion were needed before deciding on the best and safest geologic disposition of weapons and reactor spent fuel.

SUMMARY

We should always be alert to unintended consequences and open to discussions that illuminate potential dangers in nuclear waste storage. ''Nuclear Excursions'' argued that there were serious dangers in proposed repository concepts. We disagreed with the paper's major assumptions and found its major conclusions to be incorrect for fundamental, technical reasons, which were stated in detail and in writing. ''Criticality Issues'' did not respond to those reasons, but introduced a new scenario, in which it made the same technical errors in a new context. We have pointed those errors out above. At this point we find no technical merit in either paper. However, the papers treat technical matters and apparently contain no classified material; thus, in accord with the laboratory's policy of open and unrestricted research and discussion on unclassified matters, the authors should be free to submit their paper for publication in a peer reviewed journal.

That said, we do not find any value in these two papers that would justify publication in their current form, and we do not see how to produce such a paper from them. They contain fundamental errors in concept and execution. They show no grasp of such elementary concepts as the time scale for the approach to criticality and energy release and the crucial role of the negative temperature coefficient of the mixtures treated. Worse, they show no appreciation of these points even after they were pointed out forcefully in the review. That is compounded by the constantly shifting scenarios in the papers and the alarmist estimates of potential effects, which have become less credible and more shrill throughout this process.

The authors apparently show little interest in technical suggestions or inclination to respond to it. Thus, it would not appear to be useful to continue this one-sided discussion, which we take to be concluded. If this program is continued, and these individuals remain associated with it, the laboratory would be well served by establishing a permanent red team, funded by this program and composed of independent members from the cognizant technical divisions, and giving them the responsibility of checking each calculation done by them.●

Mr. ASHCROFT. Mr. President, the following unanimous consent requests have been agreed to by the minority leadership, as well as the majority.