

Chairman's Address

PART II

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Good morning again.

In this second part of my speech, I plan to talk about the most fundamental aspect of nuclear safety — protecting the reactor core from damage. I'll pose the question:

What are the prospects and potential consequences of a core-damaging event somewhere in our industry?

In my discussion I will emphasize that the phrase “Nuclear Safety” is, above all else, about preventing damage to the reactor core. And before closing, I will share my vision for WANO going forward.

Our worldwide industry has made great progress in the past decade. Yet today we face a number of tough challenges that include:

- Maintaining a focus on safety while placing great emphasis on economic competitiveness
- Radioactive waste disposal
- The recently increased concerns and great emphasis on security
- Deregulation and re-regulation and so on.

This audience knows these and other challenges only too well!

But I want to focus on what remains our greatest vulnerability, and therefore our most important challenge. And that is protecting the nuclear reactor fuel from significant damage at each of our plants.

In my speech at the BGM in Victoria, British Columbia just over two years ago, I stressed the importance of a clear, unambiguous Message from the Top about nuclear safety. In a mailing after that BGM, we asked CEOs to provide feedback on how their nuclear organizations were ensuring that people at the working level receive and perceive the right messages about nuclear safety.

From the many letters I received in response — and in a range of discussions with executives in WANO — not just by me but by a number of colleagues — we sense some confusion and lack of focus about nuclear safety. To some nuclear safety encompasses everything at the nuclear plant, with little focus on protecting the core from damage. To others nuclear safety is more about industrial or personnel safety than it is about reactor safety.

What was most troubling is that there seemed to be some considerable reluctance to talk about the NUCLEAR part of nuclear safety. The heart of the phrase NUCLEAR SAFETY is about protecting the nuclear reactor fuel from damage. That

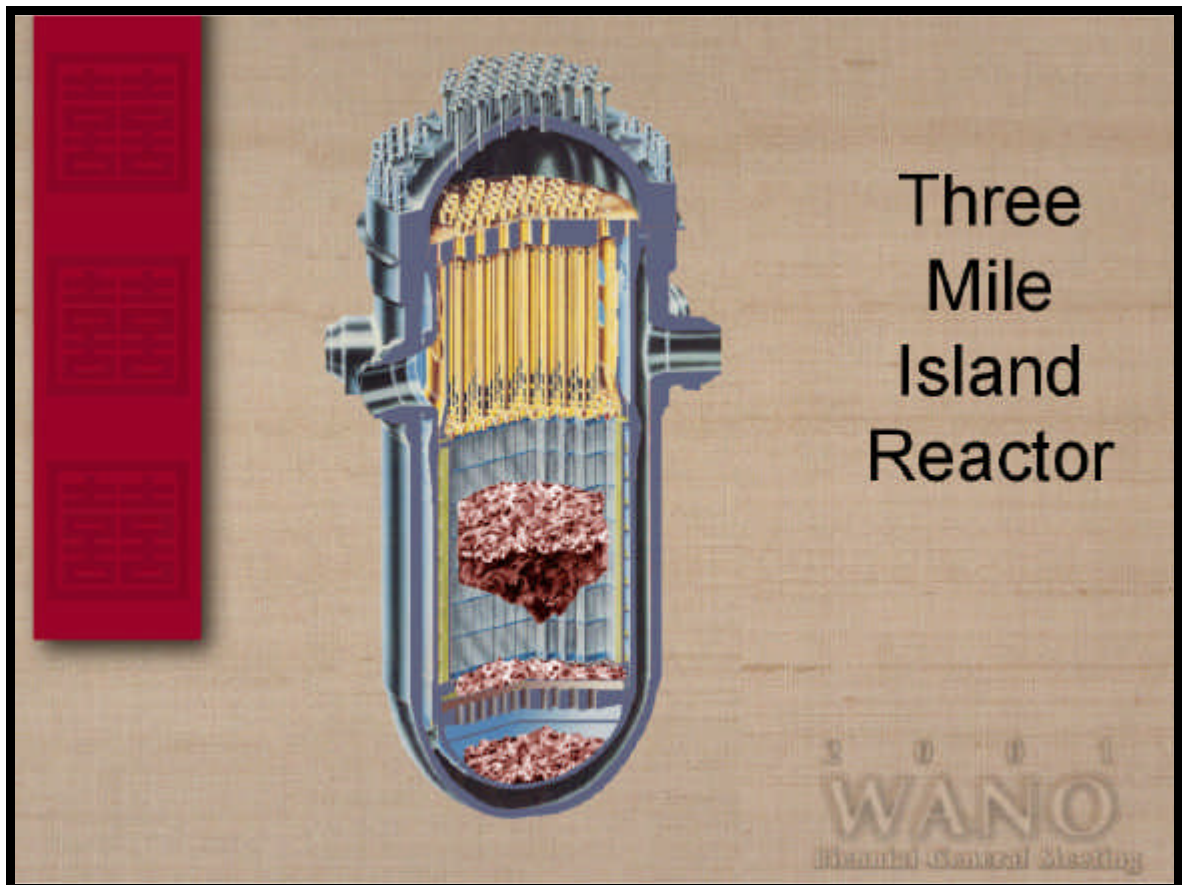
will be the focus of my speech today — and that should be the ongoing main focus of WANO's activities.

With that background, here is a picture of a reactor core that is intact and undisturbed.



The fuel region is often called the reactor core.

This next slide shows the Three Mile Island reactor after the 1979 event.



This is an artist's depiction of the damaged TMI core that was furnished by GPU Nuclear some time ago. As you can see, much of the reactor core is damaged. Much of the damaged fuel and cladding material slumped toward the bottom of the reactor vessel, and some 20 percent of the core material fell to the very bottom of the vessel.

I won't show a slide of the Chernobyl Unit 4 reactor because it was completely destroyed, and some of the reactor core was dispersed around the landscape. This was indeed an extremely serious core-damaging accident. And, as we all are aware, Chernobyl did not have a containment structure.

What are the prospects for the future? To give you my view, the likelihood of another accident as serious as Chernobyl at one of our members' plants is extremely low; approaching zero.

How about another event as serious as TMI? The probability is greater than for a Chernobyl-type accident, but still very, very low. I believe, and probabilistic safety assessment ? PSA ? studies show, that we have achieved improvements that markedly reduce the probability of another TMI-level accident.

But now let's consider an event that is much more likely than either of the two that dominate our history. Let's consider minor core damage, or relatively minor core damage.



This slide depicts a slightly damaged reactor core. This could be caused by a restriction or reduction of coolant flow, by a power transient, by power oscillations, or by local overheating due to local power peaking. Or the cause could be one that is unforeseen!

Such an event could cause relatively minor fuel damage and dislocation, but still make it difficult to remove and replace the damaged fuel. This should be of great concern to us for two reasons, as follows:

- First, the high economic cost of several months or more of shutdown time.
- And second, the risk that it could be classified as a much more serious event than it really is.

More on these two points later. But first let's look back at some events from our history.

Have events that led to minor fuel damage occurred a significant number of times in the past? The answer is yes; such events are spread throughout our history. Let me give just a few examples.

Going back over 30 years to October 1969: The following occurred at a gas-cooled, graphite-moderated reactor in Europe:

“A coolant flow restrictor was loaded into the fuel channel by manually overriding an automatic stop on the on-line refueling machine. One hundred and eighty kilograms of fuel were damaged during subsequent operation. No one

was injured, but the reactor was shut down for a year to complete cleanup operations and repair.”

In December 1984, the following event occurred at a BWR in North America:

“Control rods were withdrawn to increase power. Local power exceeded prescribed limits when the on-line core monitoring system, which was not properly programmed and tested, underestimated peaking power. Gaseous activity subsequently increased. Post-shutdown inspection found fuel damaged in 44 assemblies.”

In June 1985, the following event occurred at a plant in South America:

“With the plant operating in the load-following mode, operators were asked to increase power. Control rod motion to compensate for xenon burnout resulted in abnormally high local power peaking. Indications of this excessive power generation were misinterpreted, and reactor operation continued. The excessive local power in the core caused 46 fuel rods to fail...”

In November 1988, the following event occurred at a plant in North America:

“Power was raised rapidly to avoid a shutdown due to xenon buildup while operating with an abnormal control rod configuration. The abnormal control rod configuration was to compensate for reactivity loss due to the unavailability of the on-line refueling equipment. Damage to 191 fuel rods occurred.”

These examples were taken from a study done in 1991 by INPO, with the help of its international participants. Notice that all the events in these examples were in Europe or in the Americas. I have covered just 4 of 10 such fuel-damaging events known to have occurred at commercial nuclear plants in the West prior to 1991. There have surely been similar events in other parts of our worldwide community.

One could now ask, have there been events of this nature since 1991? The INPO study has not been updated, and I don't know of any other comparable study. But a review of WANO's database since 1993 reveals five examples of events that involve fuel damage and several other precursors.

Let me give just two recent examples:

- In 1999 at a BWR in Europe, reactor power oscillations were experienced and peak power momentarily exceeded 132 percent before an automatic scram terminated the transient.
- And just last year, at a plant in Europe, 92 fuel rods were damaged and a considerable amount of fuel dispersed into the coolant, apparently due to excessive vibration and other causes.

Suppose an event of the nature of some of these examples occurs in the future, localized fuel damage results, and the fuel cannot be removed by the normal methods ? that is, with the normal refueling machinery.

The event will certainly become a serious economic setback, as I mentioned, because it will take several months ? or even a year or more ? to evaluate the situation, to develop special tools and methods to remove the damaged fuel, and to get the regulators' approval.

In addition, as I mentioned, such an event could be a setback for our entire industry, and potentially a major setback if it is mischaracterized.

Minor fuel damage means, by definition, that the fuel cladding, the first barrier of protection, is breached. As we

consider the future prospect of breaching the fuel cladding, it is important to keep in mind that in most reactors, the cladding thickness is under one millimeter, or for those of us who think in the British system, about 26 thousandths of an inch. By contrast, the second barrier, the reactor vessel, is several inches of steel. And the third barrier, the containment shell, is over two feet of concrete and steel.

In this context it is easier to see that while breaching the clad is highly undesirable, it is unrealistic to think that it will not happen.

Remember also that we are uprating fuel output, and indeed, uprating the overall power output at plants around the world. The U.S. National Energy Strategy, recently issued by President Bush, specifically encourages nuclear power plant uprates. This is a good thing, and it is certainly not my intent to discourage uprates. We must rely on our suppliers, regulators, and our own engineers to retain the necessary margins.

At any one plant, an uprate is a good thing. But in the aggregate worldwide, these uprates increase the possibility of breaching the fuel cladding.

By decreasing our margins, we are relying more and more heavily on our operators, engineers, and managers to make the right decisions, and to make them in a timely manner.

In the years following TMI, utilities in the West developed extensive and comprehensive emergency plans to deal with a nuclear accident. And we have done a great deal to address loss of coolant accidents, station blackouts, and a range of other things.

But somehow there seems to be a veil of mystery about and a lack of focus on the area I am discussing. This remains true even though research of our history shows that the number of events involving minor core damage is an order of magnitude greater than the ones involving major core damage.

In my view, a core-damaging event that is serious, but much less severe than TMI, is our industry's greatest vulnerability.

WANO's role — indeed its mission — is to help its members avoid such events. But let me take off my WANO hat and talk about what happens if a core-damaging event occurs in the future. I will speak for the next few minutes:

- As someone who has over 40 years in the nuclear field, mostly in the nuclear safety arena.
- As one who has visited some two-thirds of the commercial nuclear plants in the world — 270 units

in 28 countries — and has talked to literally hundreds of operators and executives about their perspectives on safety.

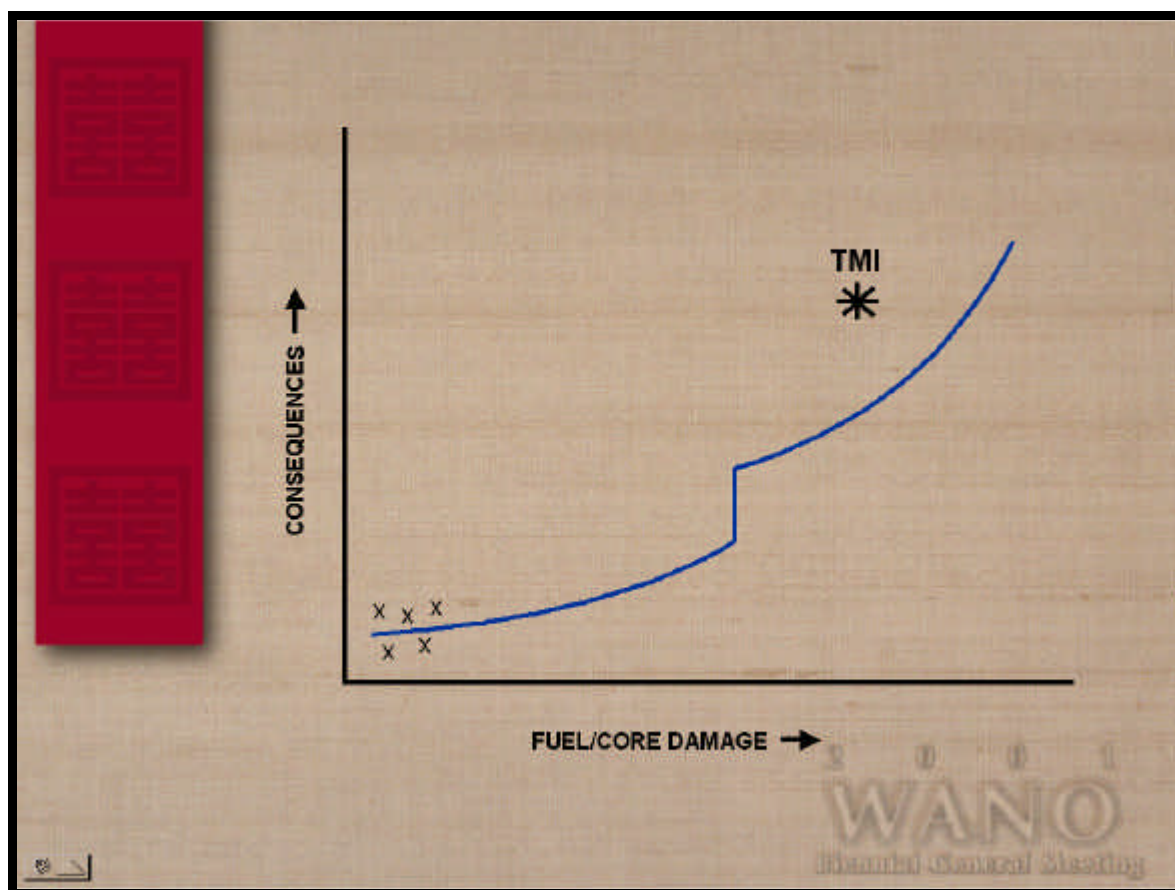
- As someone whose career will soon come to a close, but whose interest in the welfare of this industry will, hopefully, continue for years to come.

On this matter of nuclear safety, as I've mentioned, I find a widespread hesitancy to discuss reactor core damage in our industry — not only at the executive level, but at the operator level as well.

The range of core damage between minor localized clad failures and TMI-level core damage is a gray, often unexamined area.

At some point in this range there is a transition from minor core damage, then to significant core damage, then to severe core damage; the latter being the case for TMI.

Let's look at a slide that I hope will enable a better discussion.

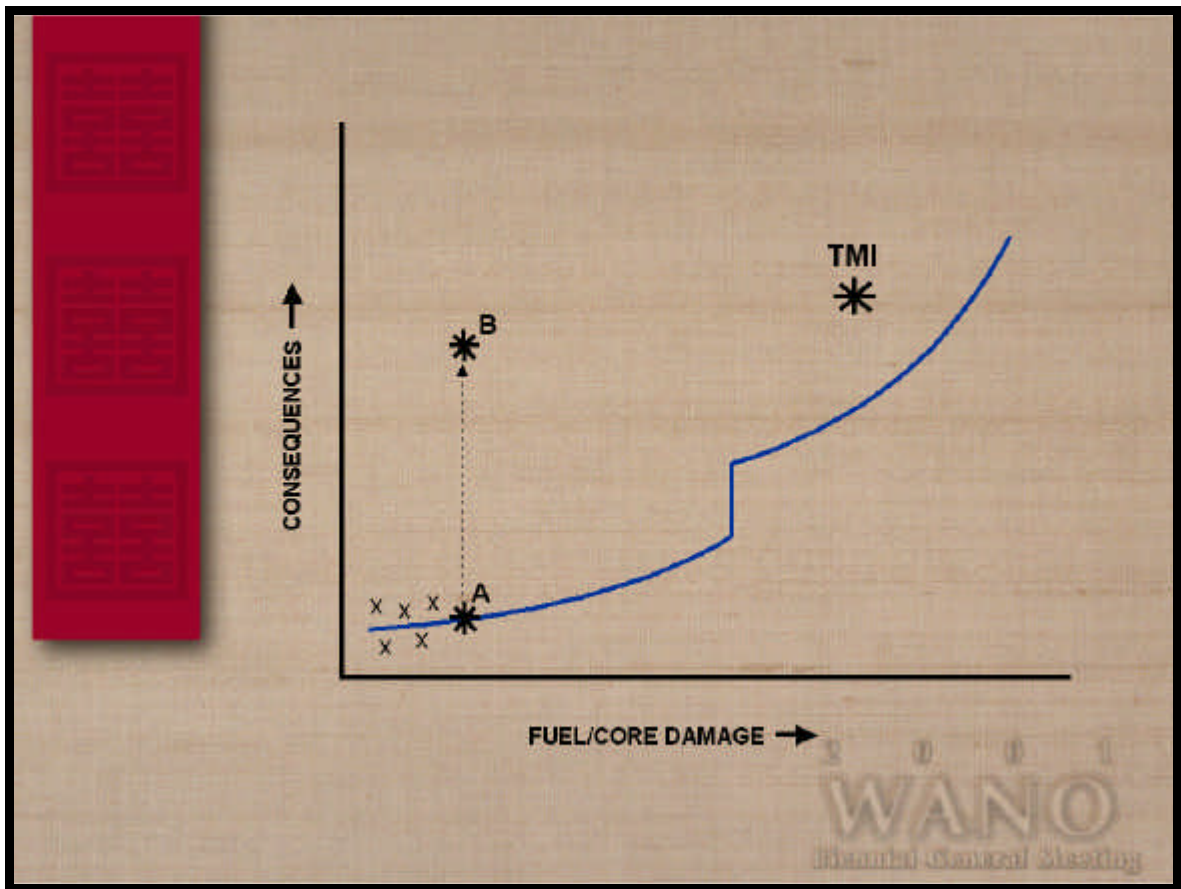


This slide plots the consequences versus the extent of fuel damage. Think of this as consequences to the worldwide industry rather than just to the plant involved. Also, think of this curve as representing the consequences that are reasonable and fair based on the actual event.

The small x's on the left represent events that involve minor fuel damage, such as those I have just discussed.

The asterisk on the right represents TMI. Note that it is above the curve. That is because the consequences of TMI were greater than they should have been because we weren't prepared. The consequences scale is not linear. In other words, the consequences of TMI were orders of magnitude worse than the other events on the slide.

The break or discontinuity in the curve is the point at which the plant becomes unusable in the future, as was the case for TMI. This is the point at which the economic impact on the affected utility goes from millions of dollars to billions of dollars.



Now let's add a future hypothetical event to the slide. The event shown at point A includes slightly more fuel damage than the ones I discussed. In this range some localized melting of fuel will occur. Note that the reasonable and fair consequences are about the same as for the earlier events.

But suppose the event is mischaracterized by industry spokesmen and the media. We could have headlines about a meltdown, and the event could quickly be seen as another TMI

by our publics. The consequences then jump to point “B”, as shown on the slide.

Let’s look for a moment at the International Nuclear Event Scale, or INES, as worked out by the International Atomic Energy Agency, and the Nuclear Energy Agency of the OECD. This scale has been widely adopted by our worldwide industry.

It classifies “severe core damage” as a level 5 accident. It classifies “significant core damage” as a level 4 accident.

Minor core damage or fuel damage is not classified.

Some would say any core damage is significant. If that is the interpretation, then relatively minor core damage could be classified as a level 4 accident using the INES scale.

This further illustrates my point that this arena is underexamined and underdefined. Yet, as I said earlier, the number of events we have had that involve minor core damage is an order of magnitude greater than events that involve severe core damage.

Another important point is that the method by which the clad is damaged can have a significant influence on the overall impact of the event.

If cladding is damaged by foreign material blocking flow or fretting, and extensive fuel leaking occurs, the impact would be serious enough. But if fuel were to be damaged by localized

fuel overheating as the result of operator error, or as a result of a safety system malfunction, the perception of the event could be very different and the overall impact much greater.

We should discuss, analyze, and train our personnel about core damage that is well shy of a TMI-like event. And we should make advance judgments of what constitutes a serious incident, and what constitutes an accident.

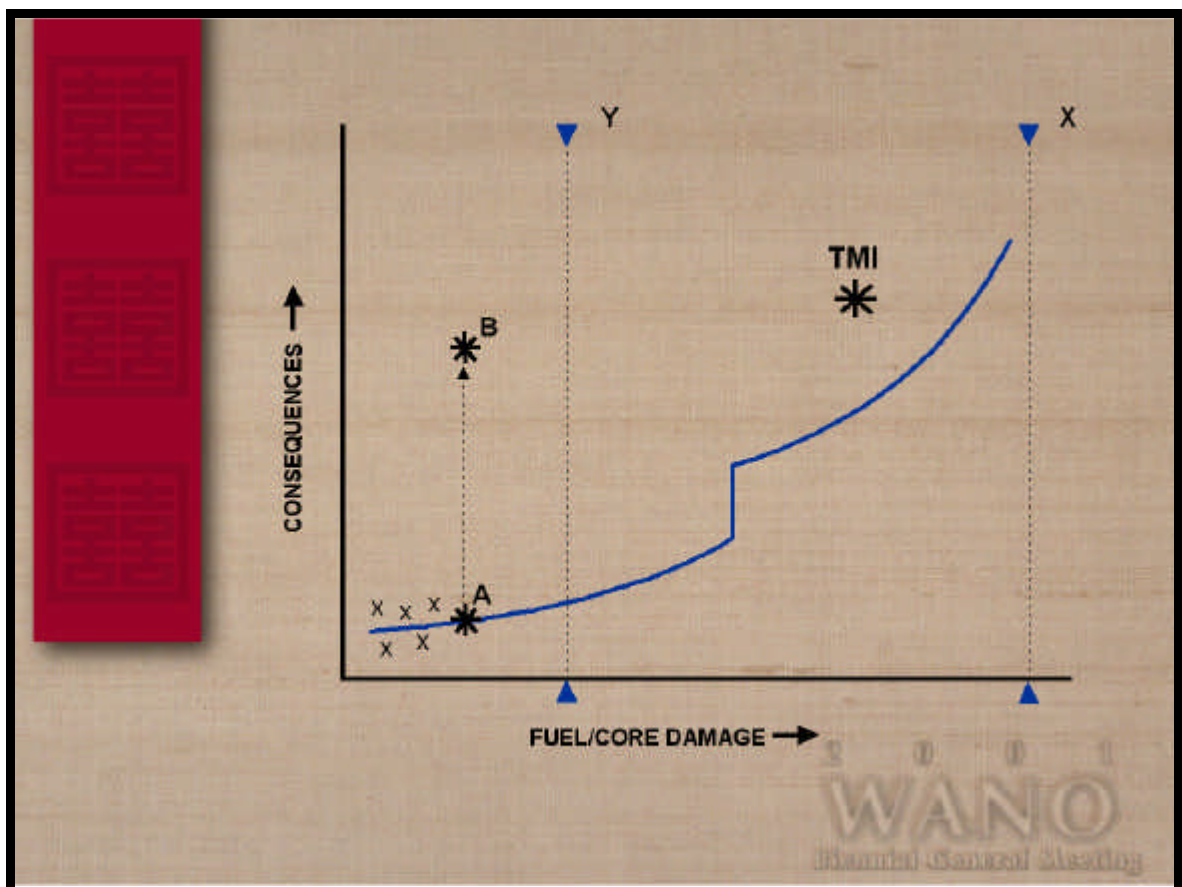
Recognize that in the range we are discussing:

- only the first of three barriers to fuel release is breached
- there would be no injury to plant staff
- there would be no threat at all to public health and safety
- the plant could be re-started after the damaged fuel is removed using special equipment.
- there would be no significant setback for other utilities in the worldwide community, UNLESS the event is misunderstood and misclassified.

There is a very important lesson from the TMI experience that applies to this last statement. Even several months after the TMI event there was still extensive ongoing debate over whether the degree of core damage was minor or major! Thus,

the consequences of the TMI event were enormous and irreversible long before we knew the extent of core damage. Let me say that again: The consequences of the TMI event were enormous and irreversible long before we knew the extent of core damage.

Let's look again at the previous slide and examine our prospects for the future:



I believe that through the extensive work we have done over the past two decades, we have successfully moved our “reasonable risk envelope” from here (right vertical line on slide [X]) to somewhere in here (left vertical line on slide [Y]).

But we have not moved the “reasonable risk envelope” all the way to the left.

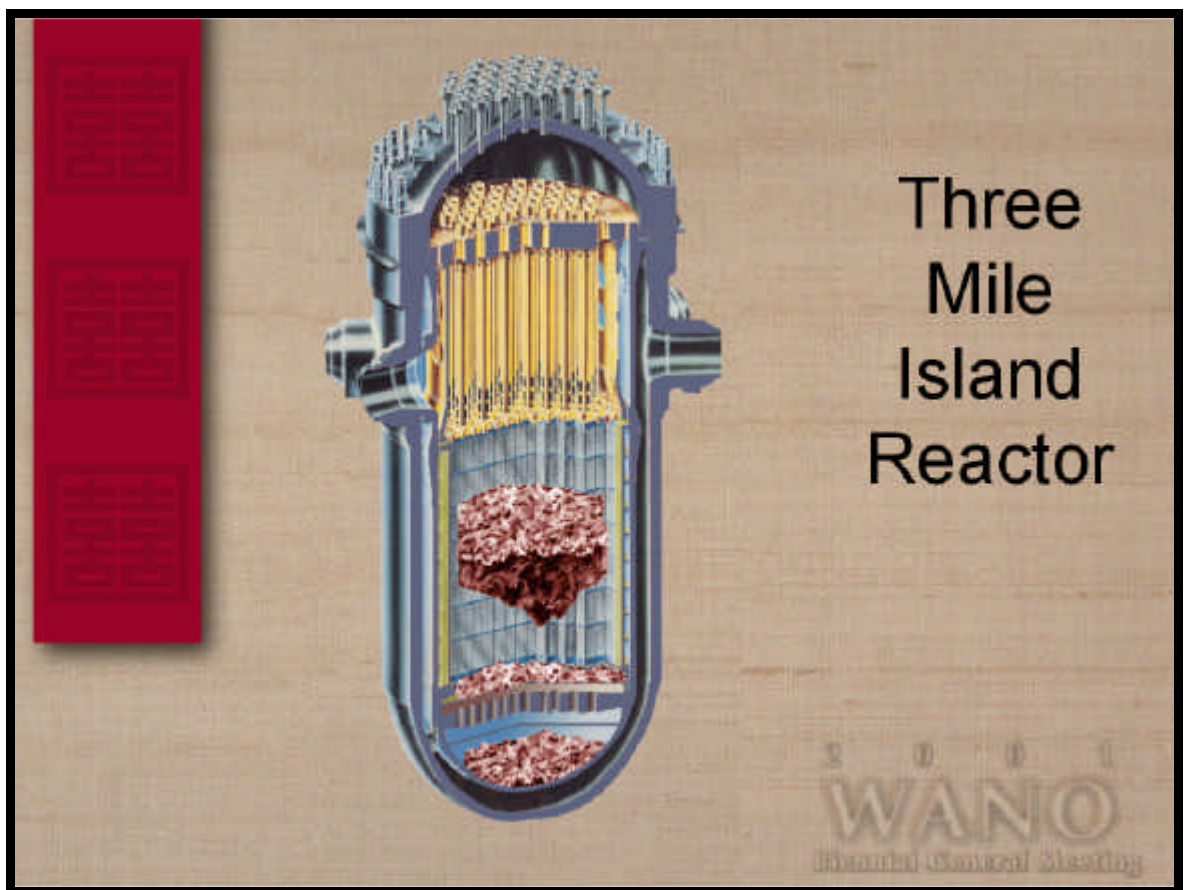
Thus, this area (left of vertical line [Y]), or an event in this area that is misclassified, is our biggest vulnerability and therefore, as I said earlier, our **most important** challenge.

Let me now pose some questions:

1. Are we prepared to quickly and decisively identify and properly characterize relatively minor core damage?
2. Are we prepared to communicate such an occurrence as a serious economic event — but not a threat to plant staff or public health and safety in a compelling way ? to our stakeholders, including the media? Are our suppliers and the various industry support organizations prepared to help?

3. In this regard, is minor core damage adequately covered in your emergency plan?
4. And last but not least, are our regulators prepared to deal constructively with such an event?

In summary, I would say that a Chernobyl-level accident is extremely unlikely going forward.



A TMI-level accident is of concern, but much, much less so than 20 years ago.

But a minor or relatively minor core-damaging event should be of great concern,



because history and a rational analysis tell us that such events are likely to occur in the future.

Virtually all utilities could be the captive victim of the weakest link in the chain once again if such an event is misunderstood and mischaracterized.

In the 1960's and 1970's we were not prepared for the TMI accident because we were under the illusion that such an event would not happen. We were hoping for success rather than preparing. Now, over 20 years later I worry that we may be complacent and may again be hoping and not preparing.

Several months ago, a friend gave me a new book entitled HOPE IS NOT A METHOD. That is a powerful title and surely applies to our situation.

It would indeed be a great tragedy if our budding renaissance were to be set back by our lack of insight and planning in this vital area.

I don't claim to have all the answers, but I see this as a challenge we must face. We should provide the leadership to ensure our future, rather than hoping for the best.

Meeting this challenge will require efforts not only by every utility, but also by organizations that support the industry.

In closing, I'll return to my WANO chairmanship role and share with you my VISION.

As I have mentioned, since we last met in Victoria, British Columbia, the WANO regional directors, the WANO regional governing boards, and ultimately the WANO Governing Board

worked out and approved a progressive set of long-term goals. You have a copy in your folders.

Thus, the first part of my vision is that during its second decade, WANO will successfully carry out these goals, both in spirit and intent.

The second part of my VISION is that WANO members will become more open and transparent with each other regarding events, and that the WANO Operating Experience Program will be one of our strongest programs. That was a key reason for WANO's formation, and it is so important to worldwide plant safety.

The third part of my VISION is that all WANO members will increasingly take ownership of WANO programs and use them as a resource for their own improvement. The many members who have already made peer reviews an ongoing and recurring part of their business plan — in other words who have taken ownership — have found them invaluable in improving and ensuring high levels of performance.

The fourth and most fundamental part of my VISION is that WANO members will focus on and avoid core-damaging events, and that WANO can be of great assistance in this arena.

Thank you for your attention.