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PANGEA
AN INTERNATIONAL REPOSITORY
David L. Pentz, Chairman of Pangea Resources Australia Pty Ltd
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Thank you very much for the introduction, Mr. Chairman, ladies and gentlemen.

While I consider it an honor to present to you today a summarized view of what has been called the Pangea Concept, in some ways I wish that I was delivering this address later in this year. Not, I hasten to say, because I wish to be older and wiser. But because we had planned for the Pangea concept to be presented in a more orderly manner where all of the affected parties, including governments, potential clients and interested environmental and aboriginal groups would have been provided with appropriate briefings prior to a planned media launch. This is not because we wish to be secretive, but because we believe those persons and groups directly affected by any major project have a right to hear it first directly from the project proponent. Extra preparation time would have enabled a more knowledgeable, efficient and reasoned response to inevitable questions, not just in Australia, but worldwide.

This was not to be the case. A video outlining the Pangea concept was prematurely released by a representative of Friends of the Earth in Sydney, Australia in December, 1998. A resultant benefit to Pangea, however, was that this event allows us to conduct our business more publicly and begin open communications at an earlier date.

However, the fact that I am standing here today as Chairman of Pangea indicates that the company I represent continues to believe that this concept can be realized.

I would not be honest with you if I told you that we know precisely how we will proceed for the concept to be translated into a functional international waste management organization. I strongly believe that the robust nature of our proposal contains elements which are unique and compelling, and which we hope will be appealing both to Australia and to the world.

At the outset I should say explicitly that no government has yet endorsed Pangea; indeed, at this time we do not seek such endorsement or approval. Rather, we seek the opportunity to engage both state and federal governments in Australia in a reasoned, objective and calm dialogue to examine a path forward for our mutual benefits. We also seek to stimulate and engage in an open discussion with the public and those groups who take a direct interest in our proposal. At the same time, we are seeking on an international basis, to brief other governments about our vision for an international repository for the final disposal of long lived radionuclides.

For the rest of my address, I have chosen to present it in five parts. Initially I will briefly summarize for you the history of how the Pangea concept evolved. This will enable you to understand the backdrop of how the objectives were developed. You should also understand that these objectives have been expanded and modified from the early days, and are now significantly

better understood and defined. I will then summarize the overall strategy which underpins Pangea. Inevitably, I will share with you our view of Pangea's underlying philosophy and ethics, which we believe to be essential for the success of the concept. Finally, I will give you a brief progress report and will broadly outline the road we currently see ahead.

Pangea evolved, as most ideas do, as a result of the confluence of events and people. The Pangea concept can be traced to the Synroc Study Group which began its activities in late December 1988. The Synroc Study Group was a vehicle set up by the Australian government to study possibilities in a global context for the commercial potential for Synroc. This effort was conducted by ANSTO, the Research School of Earth Science at ANU, and four leading Australian-based resource companies. This work progressed towards a conceptual plan for a reprocessing facility located in Australia. A geological disposal facility was also planned to take the resultant immobilized materials and to provide for the option of direct spent fuel disposal, bypassing the reprocessing facility. While the Pangea concept has evolved from some ideas of the Synroc Study Group, the relevance of the Synroc technology to a global solution in partnership with Pangea remains intact. I should point out that we believe ANSTO's continued development of Synroc technology is an integral part of nonproliferation and that an Australian international repository will be compatible with the successful completion of Synroc's mission. ANSTO is not, however, actively engaged in our concept.

In 1992 a public announcement, by the then-responsible minister in the federal government in Canberra, did not elicit the usual negative response that many other nations have experienced towards a proposal for a nuclear disposal facility. In fact its announcement was virtually unnoticed by the media and public.

In parallel with these events it became clear to myself, and other colleagues working as consultants to the nuclear waste management business, that despite the diligent best efforts of scientists, engineers and government policy makers, many national programs were suffering delays, cost overruns, and in some unfortunate cases significant loss of investment in the siting process of national repositories. The unexpected complexity of making a safety case in heterogeneous geologic media was a key factor contributing to these problems. Our analysis was that if an international repository was possible, then the maxim "keep it simple, stupid" should be a key component of our strategy. We also believed that public confidence in safety assertions would be more easily obtained if they were based, to the degree possible, on simple and robust geological systems.

Another significant aspect, and one of growing importance and urgency, was that we recognized that with the end of the Cold War, an enormous effort would be required to attain the goal of total nuclear disarmament as embodied in the Non-Proliferation Treaty, to which I believe 181 nations have signed. To reach that goal, there will be a requirement to safely dispose of large quantities of appropriately conditioned nuclear weapons materials liberated as the result of progress towards world nuclear disarmament. The more recent economic difficulties in Russia, and the ever increasing concern about the security of weapons grade materials, led us to the view that creative and different approaches are urgently required to minimize the risk of theft of nuclear materials and prevent reconstitution of weapons grade material into warheads. Since the

vast majority of weapons grade materials are likely to be converted to fuel for light water reactors, an international repository for the resulting spent fuel would certainly expand the range of options and provide economic incentives for disarming weapons states.

The desire to manage the growing quantities of plutonium contained within commercial spent fuel is also a very important nonproliferation objective for several countries, not least the US. Again, we envision an international repository significantly contributing in this area.

Over the period of 1992-1995, with this history and the confluence of events, my colleagues and I began to define the objectives for forming an international disposal corporation. This has as its centerpiece a geological repository located in suitable and very simple geology and topography with a robust arid climate whose safety could be predicted with relative ease. We established a very rigorous set of siting criteria and then screened this against relevant global information from which four regions within several nations were identified. Subsequently, we considered further important criteria to find the optimum host country. These included a country that has an international history of strong support for nonproliferation, which has a stable democratic society, and which is trusted by most nations of the world.

With this history in mind, let me list for you the objectives of Pangea:

1. to site a geological disposal facility in a stable democratic country, where the geology and biosphere conditions meet the test of simplicity, coupled with robustness required to demonstrate that the performance of the facility from a safety standpoint, will meet the highest international standards and safeguard requirements.
2. to create a corporation for geological disposal capable of accepting spent fuel, vitrified high level waste, long-lived intermediate level waste, and appropriately conditioned long-lived nuclear weapons materials such as immobilized plutonium. To the degree necessary, the disposal facility would have short-term storage capabilities necessary for imported nuclear materials to reach safe disposal conditions.
3. to provide for those countries who wish to use Pangea's services, an economic and environmentally acceptable alternative to disposal within their own national territories.
4. to provide a safe and secure transportation service from a location where the nuclear materials exist to the repository location.
5. to provide a service which facilitates creative alternatives for disposal of surplus weapons grade material which has either been formed into fuel for light water reactors or immobilized within technically safe media.
6. to provide the host country with the opportunity to play an unprecedented international role in enhancing nonproliferation.
7. to provide a new dimensions which encourages nuclear weapons states to disarm, by transforming the resultant weapons grade materials so that they are not available for reconstitution back into warheads.

It is obviously an objective of Pangea that the corporation should be profitable but not profit driven. Needless to say, Pangea will be a risky concept and therefore it is appropriate, if we are

successful, that those organizations that support Pangea now and in its future development phases should be rewarded if in proportion to the risks they have taken.

We strive to be seen as an open organization. Therefore, we will conduct ourselves with government officials, senior politicians, the public, interested environmental and aboriginal groups, and potential customers in such a manner as to engender trust and mutual respect.

The underlying strategic framework of Pangea can be represented by three intersecting components. The first component of our strategy is the technical component which is primarily focused on demonstrating safety. Without demonstrable safety no international repository, such as Pangea, will be implemented. The second component is the economics of an international repository as they relate to both a commercial undertaking and in terms of providing adequate rewards for the host country and its people. The third is the political and public acceptance component both within the host country and internationally.

Our belief is that for any repository to work, particularly one that is international, there must be a recognition that each one of these components is interrelated with the other. At different stages of the development of the project one component may assume more importance than another. However, at all times we must consider all three components, because to change the strategy of one component may require alterations to the strategies of the other two.

Our search for a suitable location for an international repository, as previously briefly discussed, was focused initially on long term safety considerations without considering the other interrelated components in order to reduce the globe to a manageable number of alternatives.

In a special session at this conference on Wednesday morning on international concepts, two of my colleagues will deliver papers that will more fully explain some of the technical aspects of our concept.

Our current focus on Australia was arrived at by adding considerations of a societal and political nature and to a lesser extent economics. This enabled us to identify extensive adjacent sedimentary basins extending from central Western Australia into northern Southern Australia that we believe are among the world's best regions for deep geologic disposal of long-lived radionuclides.

It is worth emphasizing here that an international repository must meet the technical requirements and national long-term safety standards that exist in all other countries for repository programs. The international treaty produced by IAEA in September 1997 covering the management and disposal of spent fuel and HLW was signed by most nations of the world and requires that the host facility or system meets the highest national and international standards.

By focusing on simplicity, both of the geology and the biosphere, we expect the geological barrier to a repository system to be the primary barrier, in contrast to some other potential repository sites where the waste form and the engineered barriers are required to be more dominant. There is a side benefit to this strategy in that we expect to require less complex and

significantly less expensive engineered barriers. We also see a potential public acceptance benefit that reliance on a simple geological barrier will be more acceptable to a public which is increasingly confused by apparent "scientific conflicts" over issues not readily understandable by the layperson.

Let me discuss for a few moments the second component of our interrelated strategy, namely, the economic considerations. I have stated that an important Pangea core value is that we will be profitable but not profit driven. We believe it important that Pangea is a commercial undertaking because we will need to deliver appropriate and significant benefits to the host country, which we hope will be Australia. The most important benefits to the host country, in our view, will not be the direct economic benefits of taxes and royalties on the profits of the corporation; rather they will be the broader regional and international political benefits, many of which can be converted into economic consequences. However, our current business plan is targeted for design purposes to receive 75,000 metric tonnes of spent fuel with a capital cost of \$6 billion and an annual operating cost of \$450 million. This will produce a significant economic stimulation in Australia of the order of 1% of the gross national product. The repository and associated fabrication and construction requirements will have long term employment benefits to Australia, creating as many as 70,000 jobs. This commercial scheme will also provide the repository, which can be used to dispose of unwanted nuclear materials from disarmament, with the economic basis for realizing the majority of Pangea's potential security and nonproliferation benefits.

I would now like to spend a few minutes focusing on national and international politics, which clearly in most people's minds is the most difficult component.

Let me reiterate our belief that the host country must have political credibility and therefore should be a First World stable democracy. Stability is necessary because implicitly there must be international trust in the political system of the host country, and because democracies are more likely to withstand the tests of longevity and international public opinion.

I would now like to address another fundamental issue often raised in the development of a political and public acceptance strategy for an international waste disposal facility. Why should nations who have generated nuclear materials not dispose of their own wastes within their own national boundaries? Firstly, a nation that generates waste must be responsible for the safe management and disposal of its waste. However, this does not preclude a country from exporting waste for disposal in another country. Indeed, the Basel and Vienna Conventions both embody the philosophy that this practice is acceptable to the international community. It is clear, however, that a nation should not move its waste to another nation unless it is convinced that this is a responsible action, based on mutual agreements between partners. A responsible action will weigh all aspects of safety, security, sustainability, economics and geopolitical considerations.

The world has easily traded in food, manufactured goods, raw materials, and nuclear fuel for power reactors including uranium ores that ultimately give rise to radioactive waste. International transfer of waste should bring advantages to both the customer and the host nation and, ideally, for the global environment. There are many small countries in the world with limited nuclear power programs where the economic base to build a safe and permanent disposal

facility is challenging. Further, subsequent to the Kyoto Conference, the concept of international trading of environmental permits associated with the global challenge of greenhouse gases is an example where trading in the environmental benefits of one country with the disadvantages of another has been accepted as an appropriate way of handling a global challenge. It is conceivable that an international repository can be considered in the same light.

It is with these considerations in mind we concluded that an international repository, as an alternative to disposal within a sovereign nation's boundaries, ought to be available to the world, but we recognize that some nations will wish to proceed with national solutions. We also recognize there are those today who will wish to oppose any international solution to disposal of long-lived unwanted nuclear waste because they fear this will remove an important obstacle to further commercial nuclear power production. The purpose of Pangea is focused on dealing with waste from existing commercial reactors and the products from the dismantlement of nuclear weapons programs.

The most compelling reasons for an international repository are not just environmental and ethical considerations, but relate to preventing further proliferation of nuclear weapons and to removing from the human environment the materials resulting from the dismantlement of existing nuclear warheads. Surely, if a nation can credibly make a contribution to nuclear nonproliferation and encourage disarmament, this will bring significant moral benefits to the population of the host country.

In my opening remarks I touched on the nexus between disarmament and nonproliferation on the one hand and an international repository on the other. This perhaps requires further elaboration. There is growing recognition on the part of military strategists that adequate nuclear defense on the part of Russia and the USA does not require the huge arsenals that existed at the height of the Cold War. Indeed, thankfully, it is now possible to conceive of a world say ten years from now in which there has been a ten fold reduction in nuclear warheads. What will happen to the existing and future dismantled warheads and associated military production of weapons grade materials?

The answer in the short term is they must be stored with the highest degree of security. But already the process has begun of transforming the HEU into light water reactor fuel in order to take a step towards ensuring these materials may never again be reconstituted into warheads. Similarly, much smaller quantities of plutonium will be liberated by dismantlement, some of which could be converted into MOX fuel for light water reactors. What will happen to the fuel as it is discharged from the reactors?

The US will wish to ensure that the resulting spent fuel from the light water reactors will be securely stored and disposed of as quickly as possible within the constraints of safety. At the present moment about 15,000 tonnes of Russian LEU is contracted to come to the US to be converted into fuel for light water reactors. After we reach the level of disarmament currently being discussed today and all of the HEU from Russia and the US is converted into fuel for power reactors, the total spent fuel will exceed 50,000 tonnes. In order to maximize the rate at which HEU is converted from a weapons grade form to spent fuel, it is likely that reactors from

several countries would have to be employed. Where can this spent fuel be most securely and safely disposed of?

As part of the continuing, and hopefully accelerating, disarmament process, the fuel can be disposed of in an international repository in one of the safest locations of the earth. This would enable an international repository to play a key role in improving international security and advancing permanent disarmament. If international repositories are accepted as an important and urgent component of assuring permanent disarmament and can also contribute to reducing the theft potential of weapons grade materials, then the basis for support of the international repository concept may well include many of those who have traditionally been opposed to the further development of nuclear power. Many of the opponents of nuclear power have also been strong advocates for nuclear disarmament, and therefore must support any effort which will improve the global environment.

In summary, we believe that the principle of trust and symmetry between nuclear weapon states, coupled with the presence of an international repository in a non-weapons state, would open up new considerations to enhance nuclear security and nonproliferation in the near future. Difficult challenges often require an expansion of the alternatives in order to arrive at new and improved solutions.

In concluding my remarks on Pangea's strategy, I want to emphasize our belief that the most important political and public acceptance component will be to demonstrate the high moral and ethical values of the enterprise. Assisting in reducing the possibility of the use of a single nuclear weapon and contributing to the solution of a global environmental problem surely qualify as adequate political benefits. Even significant economic and related benefits are likely to play a secondary, though important, role if the public and their governing representatives in the host country are to accept an international repository.

Equally, there must be acceptance by the international community of the correctness and value of this alternative solution. We believe there are vast areas in the region which will be suitable for us technically so that we can avoid any conflict with aboriginal concerns. However, it is important to state that we will encourage the aboriginal people in the region to share in the moral, political and economic benefits of the enterprise. We expect them to play an important role in ensuring that the facility does not invade the sacred lands of their aboriginal ancestors, and we will seek their cooperation in assisting in the development and long term monitoring of the facility.

Pangea has been supported by BNFL and Nagra and by Golder Associates, who provided the support which enabled the original concept to be progressed. As a result of the premature disclosure and ongoing media attention in Australia in December, it is useful to clarify what we understand to be the current political situation.

Firstly, it is not government policy to import nuclear waste into Australia. This has been reiterated several times by government officials. In order for Pangea to be successful, we would have to meet full scale licensing and environmental impact requirements in order to receive

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government import permits. Secondly, we are not seeking any financial support from either the state or federal governments in Australia.

In the past few days we have submitted our project proposal to the Australian government to initiate discussions which will enable us to more fully assess the feasibility and strategy of our proposal. This will enable us to engage in a dialogue with the government on the merits of the proposal.

We have presented the Pangea concept to individuals in the US government engaged in the diplomacy of disarmament. The US government has stated it is not supporting any specific international repository proposal at this time, although it does broadly support the international repository concept.

We will continue to explore security, nonproliferation, and disarmament objectives internationally. We will strive to enter into rational discussions to explore the possibility of an international repository in Australia. Pangea will continue to pursue its objectives focused on the extensive region which straddles Western Australia and South Australia. We will continue to promote what we believe are the significant and unprecedented benefits which we expect Australia to receive along with reciprocal benefits for the world at large.

In closing, I offer the following thoughts. Pangea is not intended to be a panacea for nuclear waste disposal issues. It is only intended to provide an alternative for those who would wish to use its services. It is a global solution to a global problem and it is our fervent wish to make a significant contribution to world security. We do not believe the Pangea concept to be in competition with other alternative solutions, including national solutions. We believe that we have the broad outline of a successful strategy but like other similar endeavors the pathway may turn out to be different from that which we currently believe to be the optimum.

I hope I have outlined today enough of the Pangea concept so that at least some of you will understand our continued cautious optimism and enthusiasm. As a minimum, I hope you will wish us success.

Finally, but perhaps most importantly, I wish to acknowledge the contributions of the Pangea senior management team, including Gregg Butler, Charles McCombie, Peter Winter, Ralph Stoll and Jim Voss. It should be recorded that Jim Voss, who has acted as my longest serving colleague in this venture, was a mainstay of the early development of the concept and today is providing, along with the newer members of the management team, invaluable service and support. I also acknowledge the support provided by several key individuals from the supporting companies of Pangea without whom we would not be where we are today and who continue to provide valuable service. The unpaid advice from several experts in international disarmament and nonproliferation is also gratefully acknowledged here.

No idea is the property of any single individual. If we are successful it will be because of the value of the idea and the team of people who are dedicated to Pangea's success.

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On purely actuarial statistics, as the oldest member of the team, it is certain, making comparisons with other nuclear waste programs, that I will not be the Chairman of this corporation when the first canister of spent fuel arrives, but I hope to defy statistics and still be around to clink the champagne glasses.

Thank you very much.