

**Submission**  
**to**  
**Uranium Mining and Processing and Nuclear Energy Review**  
**by**  
**The Nuclear Fuel Leasing Group**

**18<sup>th</sup> August 2006**

**1. Introduction**

- 1.1. This submission has been prepared by the Nuclear Fuel Leasing Group (NFLG) to the Uranium Mining and Processing and Nuclear Energy Review (UMPNER). The NFLG has four founding parties who are Dr John White, Mr David Pentz, Mr Daniel Poneman and Mr Michael Simpson. These parties and their associates form an international group from Australia, the US and the UK. Over the past ten years they have worked together to find a way in which nuclear energy can play its part in supplying the world's energy needs without at the same time increasing the risks of nuclear weapons proliferation and environmental damage. This submission proposes such a solution for the UMPNER's consideration. Further details of the NFLG and short resumes of the principals are included in Appendix 1.
- 1.2. Australia's natural resources give it the potential to play a major role in satisfying world energy demands in a way that helps to combat global warming. Australia has the world's largest uranium reserves. This is both an opportunity and a responsibility regardless of whether Australia chooses to utilise nuclear energy for its own energy needs. This submission contends that Australia needs to promote a new approach to the nuclear fuel cycle, Nuclear Fuel Leasing (NFL), if it is to realise this opportunity in a way that satisfies security, ethical and environmental demands.
- 1.3. This submission sets out why nuclear fuel leasing is both desirable and feasible. It is divided into two parts; Part 1, which covers our contribution, which could be made public, and Part 2, which covers matters that are commercially sensitive and is therefore a confidential submission.
- 1.4. Part 1 addresses the following topics:
  - Background.
  - The main elements of nuclear fuel leasing concept.
  - The benefits of nuclear fuel leasing in enhancing the international regime of nonproliferation and safeguards.

- The benefits of the proposal developed by the NFLG for an Australian Nuclear Fuel Leasing company (ANFL) to obtain added value versus alternative options of establishing components of the fuel cycle in addition to uranium mining.
- The benefits from nuclear fuel leasing in relation to other nuclear operations in Australia such as dealing with the Lucas Heights spent fuel and the possible future establishment of a commercial nuclear power industry in Australia or of nuclear propulsion capability for naval vessels/submarines.
- The ethical and environmental reasons for adopting nuclear fuel leasing.
- The differences between an Australian nuclear fuel leasing business and an Australian storage and geologic repository for foreign reactor spent fuel (e.g. the former Pangea proposal).
- Outline of the policy and governmental actions that would be required to enable an Australian nuclear fuel leasing business to be implemented including licensing and regulatory oversight.
- A preliminary schedule of main activities and milestones associated with setting up and operating the Australian Nuclear Fuel Leasing Company (ANFL).
- Other benefits of the ANFL proposal.

## PART 1

### 2. Public Submission

- 2.1. **Background.** The world faces potentially conflicting demands for increased energy supplies and reduced carbon emissions. There seems little doubt that to preserve the planet, renewable sources of energy will be needed. The pace of development of renewable solutions makes it very unlikely that they alone can meet the demands and the rights of developing countries for increased energy supplies to raise living standards for some time into the future. Nuclear energy is seen by many as the only practical answer to bridge the gap. However, public and governmental concerns over the use of nuclear power stand in the way of its growth. These concerns include the safety of reactors, radiation emissions, the problem of dealing with wastes (and the resultant uncertainty over costs) and security, both proliferation issues and terrorism.

Strong arguments and actions are needed to respond to and to overcome these concerns, especially as actions already being taken in developing countries show that some increase in the use of nuclear power will happen. On the safety issues, the case rests on modern reactor designs and the track record of the industry in the 20 years since Chernobyl. To meet the challenges on wastes and security, a new approach is required on the supply of fuel to reactors and the management of used fuel once it is discharged from reactors (spent fuel). Fuel leasing is such an approach.

- 2.2. **The main elements of the nuclear fuel leasing concept** as conceived by the NFLG are a service that provides an alternative to nuclear power plant (NPP) operators in which the Australian Nuclear Fuel Leasing company (ANFL) contracts for uranium from Australian mines only, buys conversion services, contracts for enrichment services with the technical specifications provided by the NPP fuel designers, contracts for fuel fabrication services to specifications provided by the NPP operator and contracts for all fresh fuel transportation services. After some 3 to 5 years generating electricity in the lessee's NPP reactor, the spent fuel is removed from the reactor and placed in the NPP cooling pond for between 9 to 20 months. ANFL will then contract for spent fuel transportation services and provide final reprocessing or storage and disposal facilities.

The leased, Australian owned, spent fuel will be moved from the NPP reactor to the site of cooling spent fuel storage. ANFL will arrange for spent fuel to be stored for approximately 27 to 30 years in Australia and then be transferred to a co-located spent fuel geological disposal facility. The cooling period for spent fuel is required so that spent fuel in an engineered container system will not cause the adjacent rock temperatures to exceed 100 degrees Centigrade, which is important for long-term safety assurances of the repository. The engineered container system with the enclosed spent fuel assembly could be finally placed in an underground storage disposal facility. This facility would be used solely for Australian origin spent fuel

All steps for the provision of fresh fuel in the proposed leasing service are currently in routine operation and are obtained by the NPP operators or utilities through contracts with suppliers. The storage of spent fuel is currently permitted to be in “away from reactor” locations or at reactor storage facilities. Spent fuel and waste products from reprocessing are planned to be finally disposed of in national facilities either under the responsibility of utility controlled and financed organisations or in government controlled facilities. The early removal of spent fuel from the NPP reactor site and transport in specially designed transport casks has been practiced by the Swedish national spent fuel management company (SKB) for the Swedish Utilities since 1983. It has operated with an exemplary, accident free safety record throughout this period. No leased spent fuel storage facility currently operates though it is contemplated in the Global Nuclear Energy Partnership documents and by Russian Federation legislation.

Nuclear fuel leasing represents changes in procurement practice. The essential difference however is that ownership of the nuclear fuel materials remains at all times with the leasing company and is not transferred to the NPP owners. Thus the choice of location for the holding and storage of the material at all stages of the fuel cycle rests with the leasing company. Further the choice of location where the material is processed is also with the leasing company.

**2.3. *Nuclear fuel leasing will significantly enhance the international regime of nonproliferation and safeguards***, by creating a system of control not possible with the current commercial market.

**2.3.1.** The essential ingredients for nuclear weapons can be obtained either by enriching uranium to very high levels or by extracting plutonium from spent nuclear fuel. The entity controlling the NPP can currently choose to set-up enrichment capabilities within its jurisdiction and then make highly enriched uranium for military purposes with similar technology, or can use the spent fuel it owns and stores to acquire weapons useable plutonium. The current safeguards regime relies on the signatories to the Non Proliferation Treaty (NPT) choosing not to take inappropriate advantage of the benefits of the treaty and then act clandestinely, or withdraw once the benefits have been obtained to pursue a weapons program. Nuclear fuel leasing very significantly reduces this threat because:

- There is no requirement or justification for indigenous enrichment capabilities. Without such capability there would be no opportunity to divert use of the enrichment technology to enrich material to the levels required for military purposes.
- The fabricated fuel assemblies will be uniquely tracked at all times, unlike uranium yellow cake, and so cannot be diverted clandestinely for other purposes. Control of the material prior

to completion as fuel assemblies rests with the ANFL and its subcontractors, not the NPP or utility.

- There is rapid removal of leased spent fuel and therefore minimal opportunity for diversion of the spent fuel for weapons purposes. If lessees renege on the lease agreement there can only be a very limited amount of fuel in their possession, all future fresh fuel deliveries under the contract would be halted and the IAEA would be immediately informed.
- The terms of the lease would dictate that the fuel would only be subjected to a defined fission process compatible only with commercial power production. This would be strictly checked and would thus restrict any possibility of tailoring the reactor operations to optimize the production of weapons grade plutonium. Again, reneging on the terms of the lease, would offer only a short-lived benefit while also providing timely warning to governments of the need to address the proliferation risks.

The terms of the lease would require that the leased fuel would be subject to a full IAEA safeguards regime including the most recent IAEA Additional Protocol. The fuel would be subject to inspections during any stage of the production of the fresh fuel, during its period in the client's reactor and finally at any point once the spent fuel leaves the lessee's reactor site. This would include transportation, surface storage, spent fuel encapsulation and finally in the operating of the Australian leased spent fuel geological storage facility.

- 2.3.2. The implementation of an Australian nuclear fuel leasing service would be the best way to significantly enhance the current safeguards policy of the Australian Government. It is recognised particularly in the initial years that not all of Australian uranium production could be leased. With some countries current arrangements for ensuring non-diversion may already be considered adequate. If Australia is to supply an expanding demand, however, particularly in countries with little or no previous nuclear experience, the additional benefits afforded by nuclear fuel leasing are arguably necessary. Leasing would provide a demonstration of best practice to the international community that in time may well become the global standard.

The benefits of nuclear fuel leasing in enhancing the international regime of nonproliferation and safeguards can be demonstrated by examining what has happened as a result of recent history related to North Korea and most recently Iran. These countries were signatories of the NPT and yet were carrying out clandestine nuclear fuel cycle activities directly related to producing weapons grade materials. The IAEA safeguards could not prevent these

activities and did not discover them until after they had occurred, contrary to the purposes of the NPT to which both countries had subscribed. In the case of Iran its secret uranium enrichment programme remained unconfirmed for eighteen years until Iranian dissidents disclosed the existence of the Natanz facility in 2002.

These events and other historic actions demonstrate that conventional nonproliferation safeguards do not prevent clandestine nuclear fuel cycle activities and are, in fact, not designed or intended to do so. Other measures are needed and indeed the solution being proposed by Russia for Iran is in effect a nuclear fuel leasing proposal.

- 2.3.3. Concerns about the effectiveness of the current NPT are widely shared and nuclear fuel leasing has been prominent in discussions of possible ways forward. The Director General of the IAEA and Nobel Laureate, Mohammed ElBaradei, has put forward proposals, which include nuclear fuel leasing. Several governments have engaged in serious discussion aimed at finding a solution that can be implemented. In association with this year's General Conference, the IAEA will be hosting a Special Event exploring various approaches to assurances in the nuclear fuel cycle, attracting high-level participation from several governments.

In this vein, the Bush Administration - through its launch of the Global Nuclear Energy Partnership (GNEP) - has attempted to create a new opportunity to strengthen nuclear supply arrangements, including through the introduction of nuclear fuel leasing. The GNEP is based on the premise that the world needs significant expansion of nuclear power to meet growing demands for carbon-free electricity, and that this expansion in turn requires the recycling of plutonium and other nuclear materials out of spent fuel, as well as the use of advanced reactors to burn the transuranics and therefore close the nuclear fuel cycle. The GNEP includes an initiative on reliable fuel services, under which the US Government would build a consortium of fuel supplier nations that would guarantee supplies to other states that refrain from engaging in their own enrichment and reprocessing activities. Nuclear fuel leasing may provide the most politically acceptable mechanism for implementing this proposal, as it requires no renunciation of sovereign rights to engage in particular nuclear activities, but merely a commercial choice to lease nuclear fuel on commercially attractive terms for an agreed period of time.

In his 18 February, 2006 speech in Milwaukee on the Advanced Energy Initiative, President Bush elaborated on the GNEP objectives to address spent nuclear fuel, eliminate proliferation risks, and expand the promise of clean, reliable, and affordable nuclear energy. In that speech, the President emphasized that his

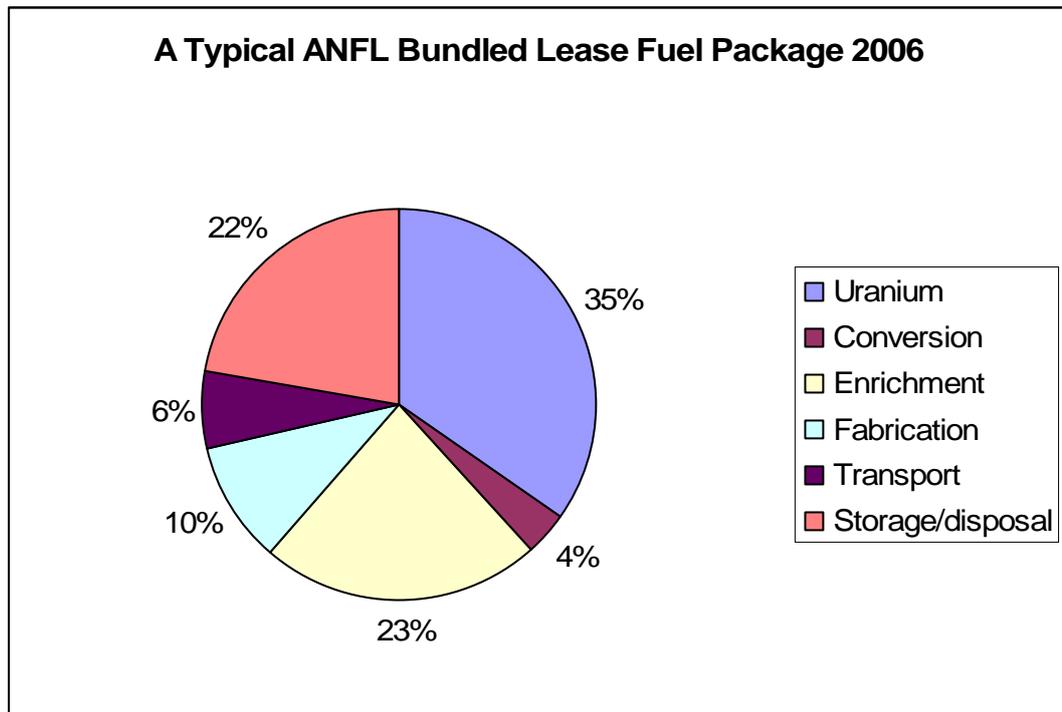
Administration would be reaching out to work with other nations on the GNEP.

Given its leadership roles both as a major (and, in future, probably the largest) supplier of uranium and as a widely respected proponent of international non proliferation efforts, Australia could play a key role in establishing new standards for non proliferation. Under the concept described in this submission, the Australian Government would facilitate the return to Australia of spent fuel derived from Australian uranium. This would enable nuclear fuel leasing and set a first example of what could be achieved. Indeed it would provide a cheaper and more immediate option to reform the nuclear fuel cycle than would the introduction of the new type of reprocessing considered in the US proposal. It would thus allow earlier access to the non proliferation benefits being sought under GNEP while other options were being developed. However it would not require government funding or involvement in the nuclear fuel cycle supply market. By demonstrating leadership in this role, Australia should be placed to shape future developments in this area and strengthen its strategic position on the world stage.

**2.4. *The financial benefits of Australian nuclear fuel leasing as an added value to Australian uranium production*** is composed of three elements:

- *Enhanced sales of Uranium.* Australia is a major supplier of world uranium. It has much to gain from an expansion in world demand. Nuclear fuel leasing, through its improved nonproliferation controls can facilitate that expansion by overcoming reservations and opposition to expansion based on security concerns. The attractions of the leasing service would also give Australian uranium producers a competitive advantage over other world suppliers. Further the sale of uranium as part of a nuclear fuel leasing package offers stability in pricing and hence eases investment decisions for uranium miners.
- *Added value from the front end of the fuel cycle.* Historically uranium sales have represented only some 25% of the value of the front end fuel cycle markets. Current demand driven rises in uranium prices may increase this up to say 35%, but Australian officials have also raised the issue of whether Australia should consider participating in other elements of the front end fuel cycle. Figure 1 shows the relative sizes of the potential nuclear fuel cycle markets in a leasing model.

Figure 1



The obvious way to participate in the other stages of the nuclear fuel cycle would be through vertical integration, i.e. considering the addition of Australian conversion, enrichment and fuel fabrication capability. There is however significant sensitivity over the location of new enrichment facilities. There is also the separate question of when the market demand would justify the significant investment required to establish an enrichment capability in Australia.

These are issues to be resolved elsewhere. For this submission we would note that ANFL could provide a leasing service sub-contracting the enrichment to existing overseas suppliers. ANFL would still obtain margin from all the front end stages of the fuel cycle covered by the lease, and the significant margins in the back end stages of transport, reprocessing and storage.

- *Revenues from long-term storage and geological disposal of spent fuel.* Research conducted by the principals in NFLG shows that Australian geology provides the opportunity for the creation of a repository which would not only set world standards in containment and hence safety, but would also be low cost compared to other repositories worldwide. This would make Australian-origin leased fuel sufficiently attractive to make the repository self financing and profitable. ***These profits can only be realized if the repository is located in special “High Isolation” sites that can be found in large but restricted areas of South Australia and Western Australia. It should be noted that there***

*are no known areas occurring in any other state or territory of Australia. Those known in South and Western Australia are the world's best. Further, Australia would be gaining value by making use of these natural resources that would otherwise be of no benefit other than as a geological phenomenon.* The technical case for High Isolation sites is perhaps best summarised in a paper to the 1999 Waste Management conference in Tucson, USA.<sup>1</sup>

The above benefits are financial but there will be additional benefits of direct employment both during characterization of the essential facilities associated with transport, storage, encapsulation and finally geologic disposal, then construction and operation. The following table provides a  $\pm 10\%$  preliminary estimates of manpower employment. The values should be considered illustrative rather than definitive, and are based either directly on business model projections or calculations assuming a percentage of the capital cost estimates for facilities and assumed annual labour cost of US\$90,000.

	Licensing, permitting, characterization	Initial Construction	Annual Operation
Port & Transportation	30 (over 2 years)	1,000 (over 4 years)	40
Storage	20 (in 1 year)	800 (over 2 years)	140
Repository	2,000 (over 9 years)	5,400 (over 10 years)	300
Management	12 (over 4 years)	120 (over 4 years)	40

2.5. *There are benefits from nuclear fuel leasing in relation to existing nuclear requirements and the possible future establishment of a commercial nuclear power industry in Australia.* The French Supreme Court has now ruled that Australia should take back the spent fuel generated at the Lucas Heights reactor that was previously sent to France for reprocessing. For the volume of material involved it would be extremely costly for the Australian Government to research and fund a stand alone final storage solution for spent fuel material from this source. Support for the ANFL proposal could provide a more cost effective solution.

As for future requirements, the case for participation in an international nuclear fuel leasing business does not rest on a decision regarding whether Australia itself should have nuclear power plants. However if Australia were to choose to include nuclear power in its future choice of energy sources, then participation in fuel leasing could provide advantages for the fledgling Australian nuclear power industry:

- The first would be the lessening or even the removal of the capital costs for spent fuel management. Spreading the costs of an Australian spent-fuel management program over the much wider customer base of

---

<sup>1</sup> **High-Isolation Sites for Radioactive Waste Disposal; Miller, Black, McCombie, Pentz, Zuidema; Proceedings of Waste Management 1999.**

utilities as lessees of Australian-origin that would exist beyond Australia's own nuclear power program would reduce the per-kilowatt-hour costs of nuclear power in Australia.

- The second, smaller, benefit would be that the Australian nuclear power utilities could lease their fuel from the leasing company thereby removing the costs associated with establishing full nuclear fuel cycle buying capabilities.

Similarly, if a nuclear propulsion option were to be adopted for submarines and other naval vessels, the existence of a nuclear fuel leasing business would offer fuel management cost savings for that option.

- 2.6. ***There are further ethical and environmental reasons why Australia should take the lead in nuclear fuel leasing.*** Australia has played a key role in recent decades in providing global leadership on important environmental agreements and demonstrations that have created the climate for the global warming debate today. "Landcare" at the local level and the "Antarctic Treaty" at the international level are two such examples. Leadership and facilitation of the AP6 agenda for greenhouse gas reductions may be emerging as another. ANFL's proposal for nuclear fuel leasing can make a significant contribution to the AP6 aims, especially related to China's and India's rapidly growing requirements for clean and secure energy.

It is incumbent on Australia, as a major global supplier of uranium, to consider a "life cycle" stewardship of the material. Australia is host to world's best practice mining and geology expertise and applications, and has the most stable geology in the world for reclamation and storage. There is a strong environmental and ethical rationale ensuring that nuclear material from Australian sources is handled safely and responsibly and does not contribute to unresolved environmental problems in countries that need nuclear energy but are less well equipped to deal with the legacy of their energy production either due to the size of their programme or their geological assets.

- 2.7. ***The differences between an Australian nuclear fuel leasing business and an Australian spent fuel storage and geologic repository for foreign reactor spent fuel*** are significant.

- The Australian nuclear fuel leasing business will only use fuel derived from Australian uranium mines whereas an international repository would accept fuel from any uranium source. The rationale for the international repository would be purely commercial. The rationale for nuclear fuel leasing however is to ensure that the Australian uranium mining can expand to meet world demands for increased energy with reduced carbon emissions and that this expansion is conducted in a way which minimises proliferation risks and meets ethical and environmental concerns.

- As described above, near surface storage of spent fuel would be required for approximately 30 years for the new Australian leased fuel to be sufficiently cool for final geologic storage. Therefore the construction of a repository would be delayed for at least 20 years after the receipt of the first leased spent fuel assemblies. This would allow the repository to be self-financing.

An alternative business that accepted spent fuel (derived from overseas uranium sources) from foreign reactors for final storage would have a fundamental difference. The analysis for this business conducted by the Pangea Resources company in the 1990s showed that the market for foreign spent fuel management would be primarily composed of old spent fuel that has been stored for many years (in the countries where it was created) and was already adequately cooled for final geologic storage. This business would therefore dictate that the repository was constructed as soon as possible. **As a result the maximum negative cash flow is much larger for a foreign spent fuel storage business than for the Australian nuclear fuel leasing business.**

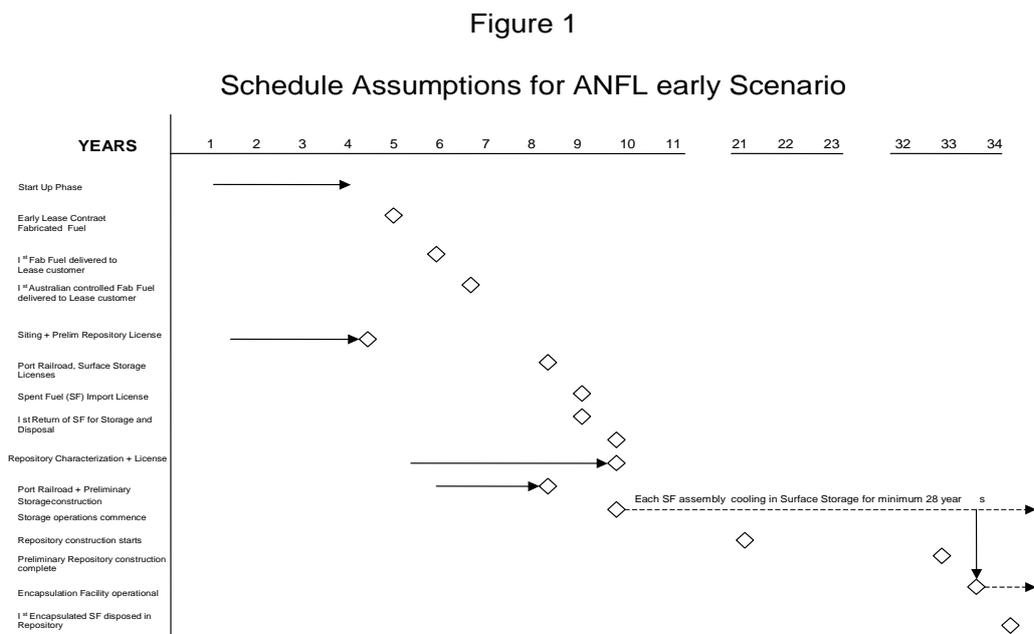
2.8. *Outline of the policy and governmental actions required to enable an Australian nuclear fuel leasing business to be implemented including licensing and regulatory oversight.*

An essential element of the nuclear fuel leasing business as described would be the availability of a final storage solution for the spent fuel. The ultimate responsibility for an Australian based repository site and its contents would inevitably rest with the Australian government. The Australian government would need to acknowledge and accept this responsibility. For it to do so, it would have to be convinced of the safety case for such a site. Further given the characteristics of spent fuel and the leasing business from energy, commercial, safety, environmental and security perspectives, operations will inevitably need to be subject to important government regulation and oversight.

The nuclear fuel leasing business and the associated storage and disposal processes will require governmental authorisation through the issuing of a variety of site suitability, construction and operating licenses. This would include; a license to import Australian leased spent fuel, a license to operate a spent fuel transport cask ship off loading facility, and a license to use rail transport to transfer the spent fuel shipping casks from the port to the storage/disposal site. After the preliminary site characterization is completed and a preliminary long term safety analysis is adequately complete and demonstrates that it meets long-term safety standards, the government would issue a site suitability license. This would be followed by further detailed environmental, geologic, hydrogeologic and geochemical investigations coupled with detailed engineering design of the waste encapsulation system and repository design. When this was completed a final operational and long-term safety report would be considered by the regulatory authorities. When those authorities determined that the report demonstrated that the proposed facilities

complied with the requisite performance criteria, then the license to construct and operate the storage and disposal facilities would be granted.

2.9. ***A preliminary schedule of main activities and milestones associated with setting up and operating the Australian Nuclear Fuel Leasing company (ANFL) is shown in Figure 2 below:***



2.10. ***Other Benefits of the ANFL proposal:***

- ANFL would be internationally predominant and have significant surplus cash flows and institutional/political support. It will have unparalleled ability to sponsor R&D aimed at improving technological possibilities for converting spent fuel into useful products or inert safe material.
- The transportation of leased spent fuel is planned to use current technology of specially designed ships and transport container casks for the leased spent fuel return to Australia. Some very preliminary consideration has been given to the feasibility of using specially designed or modified submarines to remove any high seas threats. If further research suggests that such a modification of the transport system is practical this may be considered in the future. The Australian Submarine Corporation (ASC) and the Adelaide-to-Darwin railway line could provide strategic capabilities to the ANFL proposal.