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Chilean Experience with Shipment of Research Reactor Spent Fuel

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CHILEAN EXPERIENCE WITH SHIPMENT OF RESEARCH REACTOR SPENT FUEL

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1.- Introduction

On May 14, 1996 the Executive Director of the Chilean Nuclear Energy Commission (CCHEN) received a letter from the Embassy of the United States in Santiago informing about the decision of the U. S. Department of Energy to accept and manage in the United States all the spent nuclear fuel listed in the Environmental Impact Statement (EIS). As stated in the referred document, the fuel, all which contains uranium enriched in the United States, is to be accepted over a thirteen year period.

Countries listed in the EIS as developing ones will have the cost of fuel shipments and management subsidized by the United States. Arrangements will be made through the Department of Energy Office of Spent Fuel Management.

On May 31, 1996 the CCHEN´s Executive Director received a second letter from the Embassy of the United States in Santiago informing of the Record of Decision (ROD) for an environmental impact statement of a policy to manage foreign research reactor spent nuclear fuel. Additionally, the letter advised on the convenience of receiving an assessment team to familiarize reactor operators with the program, and to gather necessary information and make essential contacts in advance. A tentative shipment of all eligible South American spent fuel was planned for August 1996.

On June 10, 1996 a fax was received at CCHEN proposing a U. S. delegation to visit the RECH-1 research reactor. After the acceptance of CCHEN, the visit took place on June 21 at La Reina Nuclear Center where the delegation meet with CCHEN´s personnel.

On June 27, 1996 the CCHEN´s Board of Directors approved to participate in the first shipment of spent nuclear fuel to the United States from South America. From this date on, two main lines of activities were executed simultaneously: (i) Negotiations and Management and (ii) Technical Activities.

2.- Negotiations and Management

In order for the CCHEN to carried out the several and most diverse activities related to negotiations and management of this operation, it was decided to have a centralized and vertical organization at CCHEN. This was based on the fact that our institution has both roles, that is as Nuclear Regulatory Body and Reactor Operator, providing it with a very fluent communication and control relationships; although, each of these roles are well differentiated and independent within our institution.

The main activities related to this point were the negotiation of contractual matters, safeguard issues and managerial activities related to transportation, security, budget, cost scheduling and public relations with the media.

Above all these activities was the coordination and collaborative efforts performed between CCHEN and DOE, including Washington DC and Savannah River Site personnel. A very complex communication network at the United States side and the need for a clear understanding of documents, resolutions and schedules constituted a difficult test to undertaken by CCHEN personnel. To overcome parallel initiatives and to avoid misinterpretations it was decided at CCHEN to operate under a single general manager, directly supported by a technical manager. The main duties of the general manager were to interact with the United States side at the various levels, to report and consult permanently with the Executive Director and Board of Directors of the CCHEN on decision making issues.

2.1.- Contractual Matters

With respect to the legal framework related to this operation, there were a number of very subtle considerations which needed a quick acquisition and response time. The way this was resolved was through an intense communication link between the General Manager at CCHEN and the United States counterparts. This was also facilitated by the high level of expertise of DOE and Edlow International Co. personnel in charge. The issues related to Nuclear Liability and Title Transfer Location were particularly complex and required of significant efforts of all the parties involved.

At the end of July 1996, the U. S. Department of Energy and CCHEN signed a Contract to transfer 28 MTR type fuel elements from La Reina Nuclear Center to the Savannah River Site in South Carolina. These elements are part of the first 58 fuel elements used in the RECH-1 reactor.

2.2.- Safeguards

Based on the safeguards agreement between the Republic of Chile and the International Atomic Energy Agency (Article 92, INFCIRF/476), it was necessary to apply in the United States safeguards to the spent nuclear material in question. This nuclear material was under IAEA's control during its entire utilization and decay period at the RECH-1 reactor.

This was strictly a negotiation process that took place between the IAEA and the United States proper authorities which arrived to a successful outcome by August 16, 1996.

2.3.- Other Managerial Matters

Several activities were accomplished to insure the physical protection, arrangements with Customs both at the Port of San Antonio and Airport in Santiago.

Among the physical protection tasks the very first was the notification to the highest authorities of the Airport, Port and the Special Police and City Police Authorities. For this we followed the regulation established in the Supreme Act Nº 12 of 1995 "Regulations for the Safety Transportation of Radioactive Material" as well as those defined in the International laws on the subject.

The communication at the highest level of the National Emergency Office and the Authorities mentioned above was facilitated due to the unique position of CCHEN within the Government structure. As a result of this, all the planning and coordination at the various levels was straight forward and expeditious. From this experience, we learned that a high degree of coordination and brief but accurate information was needed to provide to the Authorities in charged, and in this way to guarantee a quick response and to maintain the complete operation under a rigorous centralized control.

For Custom we proceeded in the same way; that is, a formal letter from our Executive Director to the General Director of Customs initiated a process and set up the framework for the follow-up events. All the paperwork and authorizations to do the "temporary admission" of the shipping cask and equipment, and also the "re-exportation" of the spent fuel elements, were done efficiently and in prompt manner. In particular, the operations at the Port in all aspects were really impecable.

2.4- Public Relations

One important aspect during this operation was the CCHEN's handling of the media with respect to public reaction to the transportation of nuclear material. Although the Chilean public in general is not negative to nuclear energy (there are no nuclear power plants in Chile), the influence of the international Green Peace organization tends to bias people to overreact to nuclear activities. In this respect, it was decided at CCHEN to maintain a low profile during the entire operation and only to inform the public through a formal Press Conference. This conference was called by CCHEN's authorities by special invitation to well recognized press media, including TV, Radio and print press, and it took place al CCHEN's headquarters two days before the shipment. The main reason to do this was to inform the public and politicians about the character and benefits of this initiative; as well as of all the safety and security measurements being taken for the handling and transportation of the spent nuclear fuel.

The result of this press conference was achieved 100% with respect to the proposed objectives. It was clear to the media that the work of all the parties involved was thoroughly studied, planned and executed in a serious, detailed and responsible manner. Moreover, it was emphasized that CCHEN was fully complying with the Chilean law and the international regulations related to the transport of nuclear material. Incidentally, it was CCHEN which proposed this same set of laws to the Chilean Parliament several years ago. After the press conference the reaction of the Green Peace followers in Chile was practically null, and from then on the Press was given moderated and controlled access to cover the related news.

3.- Technical Activities

Together with the negotiation and management activities it was necessary to collect the technical information of the spent fuel elements and to initiate several technical activities at the RECH-1 research reactor. Among the most important activities were the gathering of the technical information to fill out the Appendix A (Agreement Spent Nuclear Fuel Acceptance Criteria) of the contract between the United States Department of Energy and CCHEN. Other activities were to prepare the RECH-1 reactor to accept the necessary equipment to transfer the spent fuel elements from the reactor pool to the shipping cask situated outside of the reactor building, to write the physical protection plan for loading and transport the spent fuel elements, the risk prevention plan and the operation procedures for preparing the RECH-1 reactor for transfer operations. The plans and procedures were approved by the Nuclear Regulatory Body within CCHEN.

During the meeting with the United States Delegation at the La Reina Nuclear Center on June 21, 1996 it was agreed that 28 spent fuel elements could be sent in the first shipment from the RECH-1 reactor to the Savannah River Site. Another important conclusion was the impossibility to remove or chop off the end-boxes and/or end-fitting from the fuel elements.

NAC International Inc. provided the necessary equipment for the shipment of the spent nuclear fuel to the United States. These were the MTR Fuel transfer System and the NAC LWT shipping cask. To move the heavy materials and facilitate the operations involved in the loading and transport of the spent fuel elements, a crane of 50 metric ton of capacity, trucks, forklift and pneumatic scaffoldings were rented locally.

3.1.- Technical Information of the Spent Nuclear Fuel

The physical and chemical characteristics, approximate isotopic composition, dimension and weight of the spent nuclear fuel was given in Appendix A of the Contract as required by the Savannah River Site for the acceptance of the spent MTR fuel. At RECH-1 reactor the complete history and technical information per each fuel element is permanently tracked and maintained. This includes manufacturing specification and drawings and the fuel irradiation history of the fuel elements which made a straight forward task to fill out the information in Appendix A.

The HEU MTR type fuel elements for the RECH-1 research reactor were fabricated by the United Kingdom Atomic Energy Authority (UKAEA) at Dounreay, Scotland in 1973. Each fuel element comprises of sixteen flat plates connected to a lower spigot fitting and carrying cross-rods in an upper fitting provided for lifting the element. The fuel plates are composed of enriched uranium (80% U-235) aluminum alloy sandwiched between the high purity aluminum. The outer plates load a half of the uranium content of the inner plates. A summary description of the fuel element and the fuel plate are shown in Tables 1 and 2, respectively.

Based on the irradiation history of each spent fuel element, the additional information required in Appendix A was determined. Particularly, the following parameters were evaluated; burnup and the content of Special Nuclear Material (SNM) after irradiation, period of time that the fuel element stays in core, irradiation time, cooling time, energy obtained per fuel element, dose rate at 1 meter in air and decay heat. All of this information is shown in Tables 3 and 4.

3.2.- Reactor Preparation

Another important activity was to prepare the RECH-1 reactor to load the spent fuel elements into the shipping cask using the NAC's Fuel Transfer System. This is a dry transfer system and consisting of a transfer cask with MTR fuel basket grapple, a transfer cask carriage, a cask adapter and a pool adapter. Due to physical restrictions at the RECH-1 reactor, the transfer cask was used to move spent fuel from the reactor pool to the shipping cask located right outside the reactor building.

A complete technical information of the NAC's equipment was received at CCHEN in advanced. Using this information, the reactor personnel prepared the platform of the reactor and selected the proper location to install the pool adapter base to support the pool adapter. The disposition of the pool adapter is shown in Fig. 1. The platform of the reactor and all working areas were cleared to prevent accidents and to provide enough space for workers.

To prevent any difficulty during the loading operation, a complete inspection of the 20 metric ton overhead crane and the air compressor system was done. The latter one is needed for the pneumatic operation of the cask and tools.

A line of demineralized water was installed for decontamination purposes and to fill out the cask prior to shipment, with the purpose to take water samples to verify the Cs-137 concentration acceptable for shipping. Helium was required for leak testing of the shipping cask closure lid. For this reason, a bottle of helium was provide at the operation area. Helium was also used to fill the cask cavity and maintain the fuel elements under an inert atmosphere during the transport.

In order to have all the 28 spent fuel elements closer to the area where the fuel baskets were to be loaded, these elements were relocated from their original storage racks. Reactor personnel fully documented the new set up of the elements. A temporary platform to support the fuel basket in the reactor pool was also installed.

The Article V.D. and Appendix B (Agreement Transport Package (Cask) Acceptance Criteria) of the Contract requires that a water sample of the storage pool be taken and shipped in accordance with the instructions received from the Savannah River Site.

Fig. 2 shows the Provisional Cask Loading Diagram with a sketch of the fuel element positions with identification numbers of the authorized fuel elements. Fig. 3 illustrates the basket locations in the cask cavity. After the cask was actually loaded, the Provisional Cask Loading Diagram was replaced by a Definitive Cask Loading Diagram describing the final arrangement of the elements in the cask loading. In our case, the Definitive Cask Loading Diagram only confirmed the provisional one.

3.3.- Loading Operation

On August 2, 1996 the giant Antonov 124 cargo plane arrival in Santiago carrying an ISO container housing the shipping cask; and the necessary equipment from the United States. CCHEN's personnel received the material at the airport and coordinated the 20 Km transportation to La Reina Nuclear Center.

The loading operation was based on the NAC´s Procedure for the MTR Fuel Dry Transfer System used in conjunction with a NAC LWT shipping cask. This procedure provides with the necessary steps to operate the system, assisting the user to prepare the requirement for the operation and to inform the user with the operation features of the system. In spite of the details contained in this operating Procedure, the presence of qualified personnel of NAC International Inc. was essential to expedite the preparation before and during the loading. In this sense, the Procedure is meant to be utilized as a guide by experienced personnel.

After a inspection for damage, the equipment was removed from the boxes on August 19, 1996 and set up at the designed location. When the lid from the container was removed, a Health Physics survey of the shipping cask and adjacent surface of the container were performed.

Once the top and bottom impact limiters from the shipping cask were removed, the shipping cask was carefully raised to a vertical position on the rear cask support and lift it to place onto the base plate. The pressure in the cask cavity was equalized using a vent valve and then the closure lid was removed. Through visual inspection of the cask cavity, six empty baskets were found into it. These baskets were removed using the transfer cask and decontamination of the cask cavity took place.

On August 20, 1996 the written authorization from the DOE to initiate the loading of the spent nuclear fuel into the shipping cask was received. Thus, on August 21, 1996 the loading operation of 28 spent fuel elements was fully carried out. During the process loading of each spent fuel element, in accordance to Article X.E. of the Contract, a description of the observable physical condition was recorded. The results showed no visual evidence of corrosion, pitting cuts or any other physical indication of damage of the authorized fuel elements.

The cask cavity was flooded with demineralized water to do radiological contamination surveys in accordance with the specifications giving in Appendix B. During the same day, at 19:30 hr the first water sample was taken; followed by a second sample collected at 08:30 hr of the next day. The average Cs-137 concentration of 382 Bq/l for the first water sample and 610 Bq/l for the second sample were registered. The level of activity should be under the value specified in Table 1 of the Appendix B. In the case of NAC LWT shipping cask, the Cs-137 concentration must to be less than 278 dpm/ml (4,630 Bq/l).

To remove the water from the shipping cask, pressurized air was blown into the cavity followed by vacuum dried process according to the operating Procedure. Then, the cask cavity was filled with helium and the closure lid was leak tested.

After accomplishing all the about test, the shipping cask was moved back to the container and the impact limiters were reinstalled. When the container lid was installed it was sealed by a IAEA´s inspector who verified the nuclear material during the loading. Finally, the health physics surveys and the shipping documents were completed.

All the associated equipment used in the operation were packed back in the designated boxes in the same original configuration.

3.4.- Transport to the Port of San Antonio

The last operation was to transport the shipping cask from La Reina Nuclear Center to the port of San Antonio located about 120 Km from Santiago. The transport was done by using the highway from Santiago to San Antonio. The route was selected by the Physical Protection and Risk Prevention Group among other alternatives. The convoy consisting of the container-truck, transit police cars and vans with CCHEN and NAC personnel. This convoy was additionally protected by Special Police Group.

On August 26, 1996 the written authorization from DOE for shipping was received. The same night the convoy left La Reina Nuclear Center towards San Antonio, reaching the port after four hours journey. After arrival at port the container-truck proceeded immediately to the pier where a vessel chartered for this operation was waiting to pick up the container.

On Sunday, September 22, 1996 the ship arrived at the Charleston Naval Weapons Station in South Carolina carrying two NAC LWT shipping casks. One from Chile and the other one from Colombia. The containers were transported by train reaching Savannah River Site the evening of September 22.

4.- Conclusions

It is essential for the Reactor Operator to identify the different local authorities who are responsible for the decisions on the diverse issues related to the operation. In some countries it is conceivable that the decision making process could involve many Government institutions and/or branches, causing compressible complications and delays.

It is recommended for the Reactor Operator to have legal advice at their own Institution and/or at the Ministry of External Affairs.

An important issue is for the Reactor Operator to have a complete understanding of the rights and obligations pertaining to the original contract of the U.S. supplied enriched uranium.

Due to the diversity of tasks to undertake by the Reactor Operator we found essential to work under a centralized and vertical organizational scheme with a General Manager of the operation supported closely by a Technical Manager who is responsible for the normal operation of the reactor. It is highly recommended for both managers to have a capability of communicating with their respective counterparts in the United States. It is also advisable to identify the Top Manager of the U.S. counterpart from the beginning of the operation.

It is recommended for the Reactor Operator to have detailed documentation of the fuel element characteristics, specifications, drawings, irradiation history, water quality records among others.

It was found that the presence at the reactor site of an experience person from the cask owner company, before and during the operation, was very important. This is to resolve critical technical issues that arise and to facilitate the communication traffic between the parties.

Table 1

(c) Full 'Assembly' Description

Number of subassemblies/elements	16 (14 inner plates + 2 outer plates)
Over-all dimensions (cm)	99.3 x 7.46 x 7.47
Over-all weight (g)	4788
Casing Material (Zr, Al, etc.)	----------
Casing dimensions (cm), weight (g)	----------
Side plate material	Aluminum
Side plate dimensions (cm), weight (g)*	65.09 x 7.4 x 0.485, 566
Spacer material	----------
Spacer dimensions (cm), weight (g)	----------
End box material	Aluminum
End box dimensions (cm), weight (g)	See draw. RECH-1-80-00 to -03, 544.6
Braze or weld material	Aluminum
Braze or weld dimensions (cm), weight (g)	Accounted in the box weight
Other structural material in assembly (include dimensions and weight)	----------

*Side plate weight shall account for any slot volume(s).

Do the fuel elements contain Sodium (Na) ? Yes ❑ 'No ❑

Table 2

(a) Fuel 'Element' Description	INNER	OUTER
Fuel element type (plate, disc, rod, tube, etc.)	Plate	Plate
Nominal dimensions (include clad and bond, cm)	62.55 x 7.163 x 0.15	65.09 x 7.163 x 0.15
Active length of fuel element (cm)	59.69	59.69
Nominal total weight of fuel element (g)	194.0	197.7
Nominal weight of SNM before irradiation (g)	13.75	6.87
Total U (g ± g uncertainty)	13.75 ± 1.00	6.87 ± 0.25
U-235 (g ± g uncertainty)	11.0 ± 0.8	5.5 ± 0.2
Total Pu (g ± g uncertainty)	----------	----------
Pu-239 (g ± g uncertainty)	----------	----------
Thorium (g ± g uncertainty)	----------	----------
Chemical form of SNM (e.g., UO_2, UAl_x-alloy, UC, etc.)	UAL-Alloy	UAL-Alloy
Weight of SNM (g)	----------	----------
Fabricated form of SNM (pellets, slugs, ribbons)	----------	----------
Alloy or dispersing material (Al, SS, etc.)	Aluminum	Aluminum
Alloy or dispersing material weight (g)	41.69	43.57
Cladding material (Al, SS, etc.) & method of sealing	Aluminum	Aluminum
Clad thickness (cm), weight (g)	0.046, 138.6	0.046, 147.3
Bonding material, if any (Na, Al-Si, etc.)	----------	----------
Bond thickness (cm), weight (g)	----------	----------
Spacers, inactive material (MgO, SS, etc.)	----------	----------
Spacer dimensions (cm), weight (g)	----------	----------
Other materials contained in the fuel element: (include dimensions and weights)	----------	----------

Table 3. Fuel Irradiation History. General Summary

Unique ID No.	Total Weight fuel asse.	Fuel Ass. Loaded on	Fuel Ass. Discharged on	Time in Reactor Core	Irradiation Time	Cooling Time	Dose Rate at 1[m] in air	Decay Heat
	[g]	dd-mm-yy	dd-mm-yy	[days]	[days]	[days]	[rem/h]	[W]
D561	4779	18-Mar-81	02-Jan-92	3934	517	1699	71.0	5.38
D560	4788	18-Mar-81	02-Jan-92	3934	517	1699	72.3	5.46
D551	4781	31-May-75	02-Jan-89	4956	652	2794	55.4	3.26
D543	4761	12-Oct-74	02-Jan-89	5190	683	2794	55.7	3.21
D572	4766	31-May-75	02-Jan-89	4956	652	2794	54.9	3.22
D577	4797	31-May-75	02-Jan-89	4956	652	2794	55.4	3.25
D526	4789	09-Oct-74	02-Jan-89	5193	683	2794	58.5	3.36
D528	4775	09-Oct-74	02-Jan-89	5193	683	2794	55.6	3.20
D508	4779	27-Apr-77	02-Jan-89	4260	560	2794	55.5	3.48
D534	4787	29-Apr-75	02-Jan-89	4988	656	2794	55.3	3.24
D583	4782	27-Jan-75	02-Jan-89	5080	668	2794	57.2	3.32
D595	4744	31-May-75	02-Jan-89	4956	652	2794	57.7	3.39
D538	4778	31-May-75	02-Jan-89	4956	652	2794	55.5	3.26
D545	4793	31-May-75	02-Jan-89	4956	652	2794	56.0	3.29
D549	4786	31-May-75	02-Jan-89	3131	412	2794	58.9	3.96
D576	4819	27-Jan-75	30-Nov-88	5048	664	2826	57.0	3.30
D559	4803	31-May-75	30-Nov-88	4924	648	2826	57.7	3.39
D540	4785	31-May-75	11-Oct-88	4875	641	2875	57.5	3.37
D558	4806	31-May-75	11-Oct-88	4875	641	2875	57.1	3.35
D547	4804	31-May-75	11-Oct-88	4875	641	2875	57.1	3.34
D588	4810	31-May-75	03-Aug-88	4807	632	2948	55.5	3.25
D578	4795	31-May-75	03-Aug-88	4807	632	2948	56.4	3.30
D537	4784	31-May-75	03-Aug-88	4807	632	2948	56.2	3.29
D546	4796	31-May-75	11-May-88	4720	621	3030	54.4	3.19
D536	4802	31-May-75	11-May-88	4720	621	3030	53.9	3.16
D539	4785	31-May-75	11-May-88	4720	621	3030	55.8	3.26
D529	4792	09-Oct-74	11-May-88	4957	652	3030	55.4	3.19
D530	4790	09-Oct-74	02-Dec-87	4798	631	3189	54.0	3.11

Table 4. Fuel Irradiation Histroy. Assembly Specific Data.

Assembly	Pre-Irradiation		Post-Irradiation											
Unique ID No.	U	U-235	U	U-235	U-236	Np -237	Pu	Pu-239	Pu-241	Time in Reactor	Cooling Time	Power Level	Exposure Burn up	Decay Heat
	[g]	[g]	[g]	[g]	[g]	[g]	[g]	[g]	[g]	[days]	[days]	[MWd/asse.]	[%]	[Watt]
D561	202,300	161,840	134,921	81,571	13,837	0.13	0.7451	0.58	0.04	3934	1699	69.5	49,598	5.38
D560	202,450	161,970	134,174	80,626	14,023	0.13	0.7453	0.58	0.04	3934	1699	70.6	50,222	5.46
D551	205,850	164,680	140,337	86,705	13,448	0.11	0.7142	0.57	0.03	4956	2794	70.2	47,349	3.26
D543	206,780	165,420	140,890	86,991	13,516	0.11	0.7142	0.57	0.03	5190	2794	67.9	47,412	3.21
D572	203,310	162,650	138,455	85,426	13,322	0.11	0.7142	0.57	0.03	4956	2794	66.9	47,478	3.22
D577	205,990	164,790	140,501	86,843	13,439	0.11	0.7142	0.57	0.03	4956	2794	68.6	47,301	3.25
D526	209,730	167,780	139,506	85,558	13,701	0.12	0.7348	0.58	0.03	5193	2794	71.4	49,006	3.36
D528	206,330	165,060	140,914	86,830	13,616	0.11	0.7142	0.57	0.03	5193	2794	69.4	47,395	3.20
D508	208,000	166,400	142,324	88,224	13,474	0.11	0.7141	0.57	0.03	4260	2794	67.6	46,981	3.48
D534	205,610	164,490	140,238	86,683	13,411	0.11	0.7142	0.57	0.03	4988	2794	69.7	47,302	3.24
D583	204,600	163,680	136,979	83,275	13,756	0.12	0.7348	0.58	0.03	5080	2794	68.4	49,123	3.32
D595	207,840	166,270	139,706	85,168	13,981	0.12	0.7247	0.57	0.03	4956	2794	72.1	48,777	3.39
D538	205,810	164,650	140,128	86,475	13,479	0.11	0.7142	0.57	0.03	4956	2794	69.2	47,479	3.26
D545	206,750	165,400	140,499	86,520	13,609	0.11	0.7143	0.57	0.03	4956	2794	67.2	47,691	3.29
D549	206,910	165,530	140,471	86,285	13,721	0.12	0.7143	0.57	0.03	3131	2794	69.8	47,873	3.96
D576	204,490	163,590	136,935	83,131	13,877	0.12	0.7349	0.58	0.03	5048	2826	65.6	49,183	3.30
D559	205,240	164,190	136,689	82,627	14,066	0.13	0.7451	0.58	0.03	4924	2826	70.3	49,676	3.39
D540	206,960	165,570	138,084	83,627	14,122	0.12	0.7350	0.58	0.03	4875	2875	70.0	49,492	3.37
D558	206,250	165,000	137,935	83,674	14,035	0.12	0.7349	0.58	0.03	4875	2875	70.9	49,288	3.35
D547	205,510	164,410	137,184	83,101	14,021	0.12	0.7350	0.58	0.03	4875	2875	69.3	49,455	3.34
D588	204,500	163,600	137,101	83,411	13,810	0.12	0.7348	0.58	0.03	4807	2948	67.1	49,015	3.25
D578	206,780	165,420	139,310	83,999	14,437	0.12	0.7349	0.58	0.03	4807	2948	67.0	49,221	3.30
D537	205,830	164,660	137,711	83,593	13,981	0.12	0.7349	0.58	0.03	4807	2948	69.0	49,233	3.29
D546	203,750	163,000	137,961	83,261	14,649	0.12	0.7348	0.58	0.03	4720	3030	70.2	48,920	3.19
D536	202,710	162,170	137,659	83,155	14,190	0.12	0.7247	0.57	0.03	4720	3030	70.8	48,724	3.16
D539	206,280	165,020	138,002	83,371	14,210	0.12	0.7350	0.58	0.03	4720	3030	67.9	49,478	3.26
D529	205,500	164,400	137,441	83,085	14,146	0.12	0.7350	0.58	0.03	4957	3030	70.8	49,462	3.19
D530	206,280	165,020	137,862	83,583	14,055	0.12	0.7349	0.58	0.03	4798	3189	68.8	49,350	3.11

Fig 1 - Disposition of the Fuel Adapter and Storage Racks.

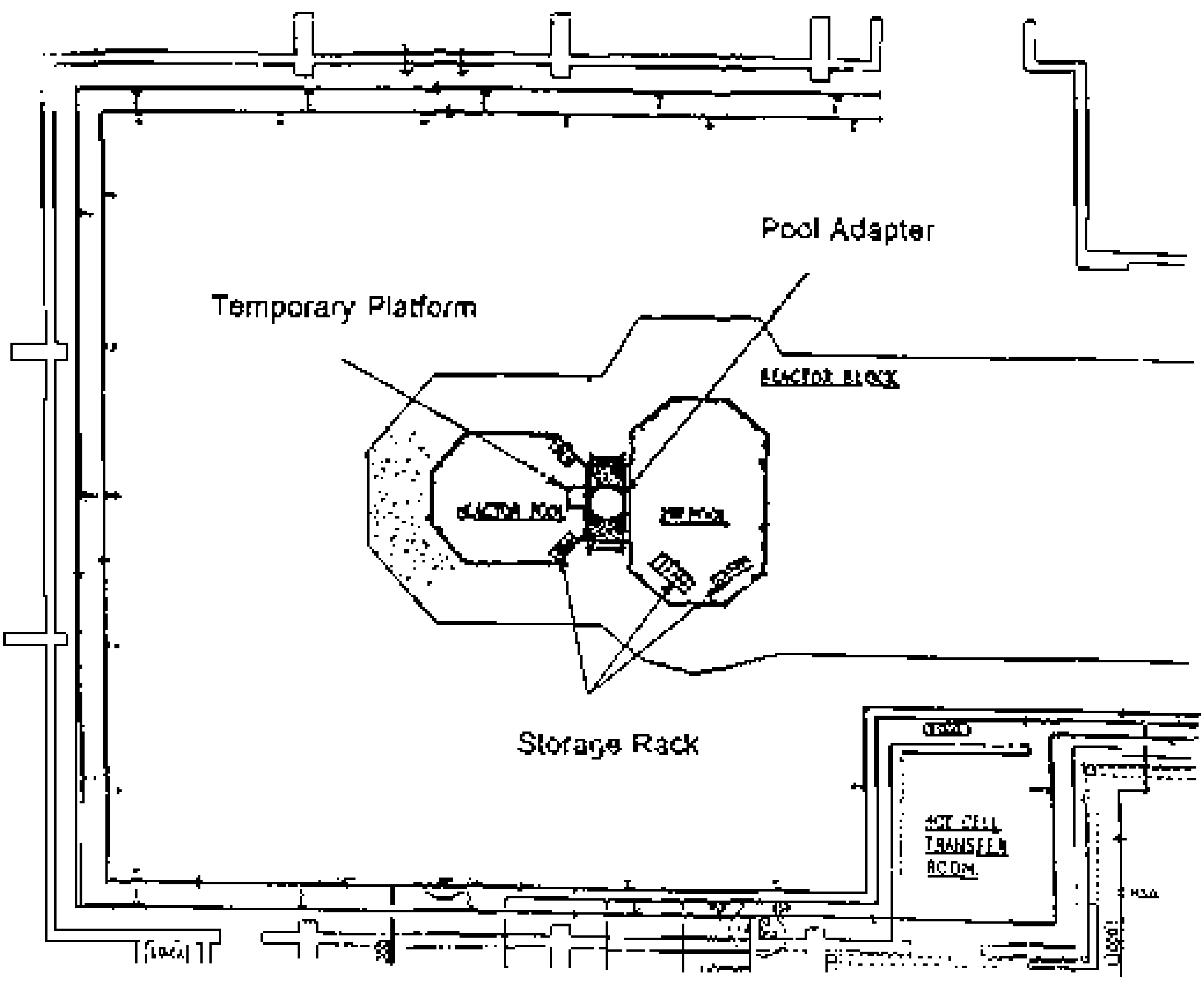

Figure 2

Provisional Cask Loading Diagram
La Reina Reactor

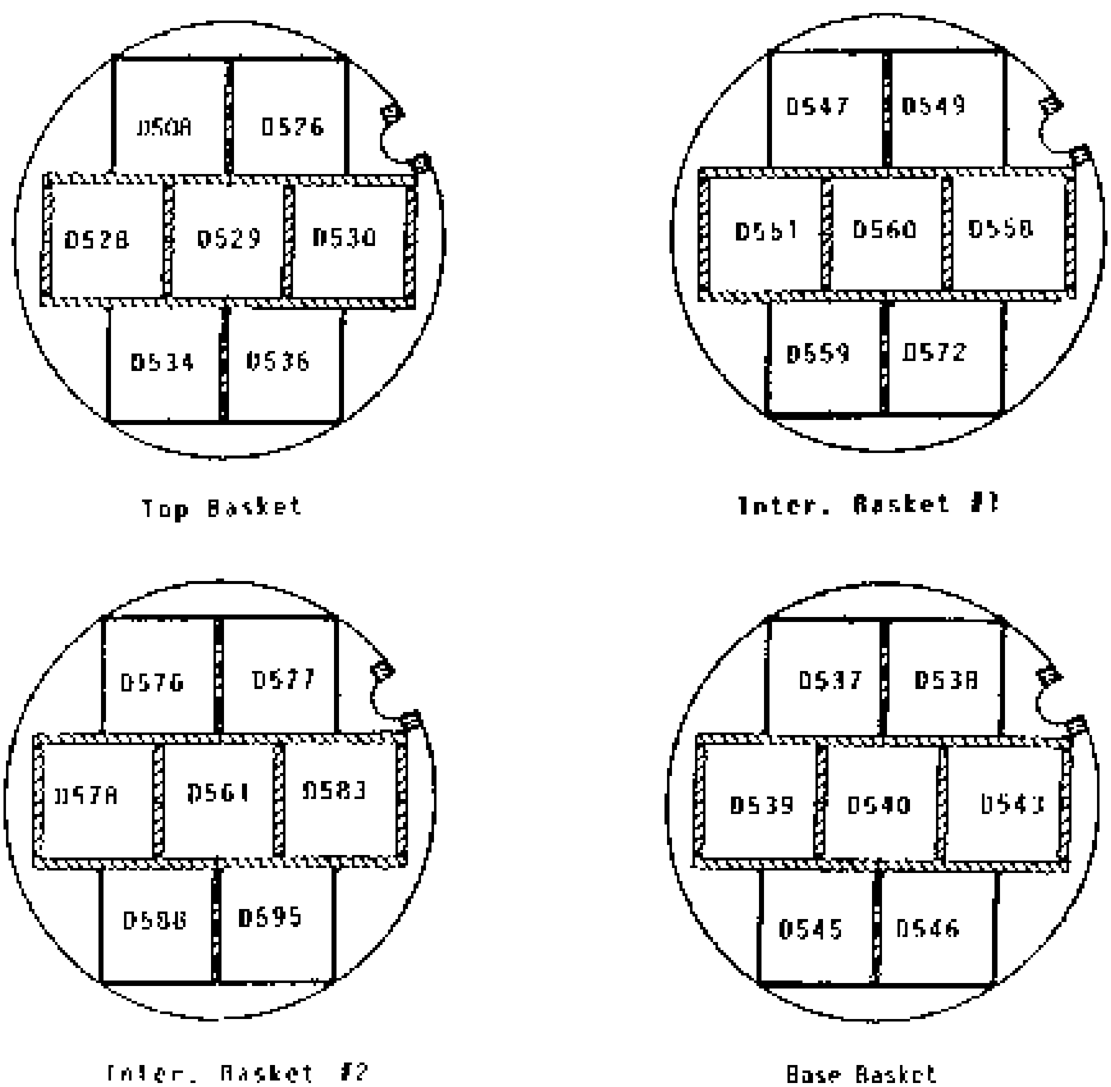

Figure 3

Provisional Cask Loading Diagram
La Reina Reactor