

The Legacy of Taiwan Lanyu LLW Interim Storage Site- 17491

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ABSTRACT

The Lanyu (Orchid Island) LLW (Low Level Waste) interim storage facility for the Taiwan LLW is located on Lanyu Island off the coast of Taiwan (Republic of China). It is perhaps the only outdoor LLW interim storage facility in the world. The shipment of LLW to the Lanyu LLW interim storage facility began in May 1982 and ceased in June 1995 after strong opposition from the local aboriginal Yamei tribe people. Since the shipment of LLW to the Lanyu LLW storage facility ceased in 1995, the LLW in Taiwan has been stored temporarily at the indoor facilities at the Taipower (Taiwan Electric Power Company) three operating NPPs (nuclear power plants) and the INER (Institute of Nuclear Energy Research).

The current Taiwan government has recently begun to lay out a multi-faceted plan to address the Lanyu LLW interim storage facility and evaluate different options of relocating Lanyu LLW to other possible sites. However, many challenges remain, notably the site selection for the LLW final disposal site.

INTRODUCTION

Taiwan began the construction and operation of nuclear power plants in the early 1970s. As of today, Taiwan has three NPPs in operation, each with two reactor units: four BWRs and two PWRs. Taipower, a government owned electric company in Taiwan, operates all three NPPs and has the responsibility for the management and final disposal of radioactive waste and spent nuclear fuel. The government regulatory agency for radioactive materials and nuclear facilities including the Lanyu LLW storage facility is the Taiwan AEC (Atomic Energy Council).

In addition to the LLW generated at the three Taipower NPPs, there is other LLW generated from the small users of radioactive materials (universities, hospitals, research facilities, industries, etc.), which are shipped to a centralized storage facility at the INER (Institute of Nuclear Energy Research).

In the early 1970s, the Taiwan government decided to store the LLW generated in Taiwan temporarily on Lanyu Island, a small island 65 Km off the southeast coast of Taiwan as shown in Figure 1. The local people on Lanyu Island are mostly Yamei, one of the 16 aboriginal tribes in Taiwan.



Fig. 1: The Location of Lanyu Island (Orchid Island) in Relation to Taiwan (Source: Google Map)

The decision to build a LLW storage facility on Lanyu Island was controversial. Before the construction of the Lanyu LLW Storage facility began in 1978, the Taiwan AEC discussed the plan to construct a LLW storage facility on Lanyu Island with the local aboriginal people. The Taiwan government claimed that the AEC had a meeting with the representatives of the Lanyu local aboriginal people and informed them the nature of the LLW storage facility [1, 2] and the representatives agreed. However, the local aboriginal people claimed that they were misled to believe that the facility to be built was a fish cannery [3].

It is clear that there were misunderstandings, or misinformation, and the local people were not provided with clear information about the LLW storage facility. Furthermore, the local people were not given an opportunity to participate in the decision making of building a LLW interim storage facility on the island. This resulted in the mistrust of the Taiwan government from the local aboriginal people about the Lanyu LLW Storage Facility.

After the shipment of LLW waste to the Lanyu LLW storage facility began in May 1982, the local aboriginal tribe realized that the facility was not a fish cannery, rather a LLW storage facility, and began the protest against the LLW storage facility. The LLW shipment was ended in June 1995 after a strong protest from the local aboriginal people. Since June 1995, Taiwan LLW has been temporarily stored at the indoor storage facilities at the three Taipower NPPs and the INER. Figure 2 below shows a LLW indoor storage facility at a Taipower NPP.



Fig. 2: Left, Building of a Taipower Indoor LLW Storage Facility; Right, Inside of a Taipower Indoor LLW Storage Facility

DISCUSSION

There are 23 LLW storage trenches of various sizes at the Lanyu LLW Storage Facility, as shown in Figure 3 below.



Fig. 3: Arial View of the Lanyu LLW Storage Facility
Source: Google Pictures

The dimension of a Lanyu LLW storage trench is 5.4 m wide, 4.5 m high (3m below the ground level and 1.5 m above the ground level), and its length varies from 24.7 m to 87.75 m. A 17-35 cm thick concrete cover is placed on the top of the trench. Figure 4 below shows the Lanyu LLW storage trench design [4].

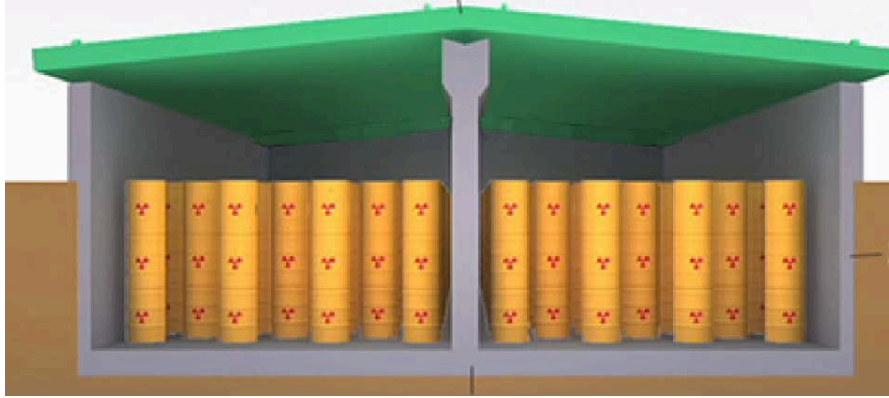


Fig. 4: Lanyu LLW Storage Trench Design

The LLW waste was first solidified using concrete at the generator sites and placed in 55-gallon stainless steel drums before being shipped to the Lanyu Storage Facility. Table 1 below shows the number of LLW drums from each of the four LLW generating sources stored at the Lanyu LLW storage facility before the shipment operations ceased in 1995.

TABLE I. Number of LLW Drums from Each Generating Source as of June 1995

NPP#1	NPP#2	NPP#3	INER	WRC*	Total # of Drums
42,028	37,488	6,336	11,292	528	97,672

* WRC: Waste Reduction Centers at the Taipower NPPs

Since Lanyu Island is situated in a tropical weather region, it has high annual rain precipitation, warm temperature year round, and moist air with high salt content. In this environment, metal drums tend to corrode. Although the trenches of the Lanyu LLW storage facility have a concrete cover over the trenches, the air inside the trenches is about the same as the ambient air outside. The mild steel LLW drums began to experience corrosion after 30 some years of outdoor storage. In 1997, the Taiwan AEC published a regulation for the Lanyu LLW drums integrity inspection and repackaging.

Taipower began the inspection and repackaging of the Lanyu LLW drums in December 2007 and this activity was completed in November 2011. During the inspection and repackaging, there were four categories of drum corrosion status identified depending on the corrosion situations of the waste drums. Figure 5 below shows the photos of four different categories of corrosion status found during the inspection.





Category 1 180 drums	Category 2 30,672 drums	Category 3 64,410 drums	Category 4 2,410 drums
			

Fig. 5: Four Different Categories of 97,672 Lanyu LLW Drums Before Rectification [1]

The following rectifications were taken for the four different categories of drum corrosion status:

Category 1: No sign of corrosion and paint in good condition: no rectification was needed and drums were to the trenches.

Category 2: LLW drum containers show some peeling paint and minor rust, but no sign of corrosion. After repainting, drums were returned to the trenches.

Category 3: LLW drums show severe corrosion; however, the solidified waste inside remained intact. Placed those drums in the new 0.914 m by 1.219 m (3 feet by 4 feet) galvanized steel containers and the containers were returned to the trenches.

Category 4: LLW drums were broken and the solidified waste inside also broken loose. The LLW loose pieces were re-solidified on site at the Lanyu LLW Storage Facility and placed in new 55-gallon galvanized steel drums and the new drums were returned to the trenches.



Fig. 6: Left, 55-gallon drums In a Storage Trench; Right, 0.914 m by 1.219 m (3 feet by 4 feet) Galvanized Steel Containers in a Storage Trench, as of November 2011

Figure 6 shows typical LLW drums in a trench at the Lanyu LLW storage facility after the completion of rectification in November 2011 [4].

The classification of LLW in the Taiwan AEC regulation is the same as that in the US 10 CFR Part 61, i.e., Classes, A, B, C, and Greater than Class C. TABLE II shows the number of drums in each classification stored at the Lanyu storage facility in November 2011, after the inspection, repackaging, and rectification were completed [1, 2].

TABLE II: The Number of Drums in Each of the LLW Classification at Lanyu LLW Storage Facility as of November 2011

Class A	Class B	Class C	Greater Than Class C	Total Number of Drums
94,970	811	4,358	138	100,277

During the inspection and rectification, there were 2410 drums of Category 4. The broken off loose pieces of the LLW waste from those Category 4 drums were solidified onsite at the Lanyu LLW Storage Facility. As a result, the total number of drums increased by 2605, from 97,672 to 100,277. After the rectification, the LLW drums were classified, shown in TABLE II, according the AEC LLW classification regulation.

As shown in TABLE II, most of the LLW are in Class A, ~ 95% of the Lanyu LLW drums. The average radioactivity per drum for the Lanyu LLW is 3.59×10^9 Bq/drum, and it ranges from 1.04×10^3 Bq/drum to 4.92×10^{13} Bq/drum. The key radionuclides are Cs-137 and Co-60 [4].

The average radioactivity for the Greater Than Class C waste is 9.1×10^{11} Bq/drum and the key radionuclides are Ni-63, Pu-241, C-14, I-129, Pu-239, Am-241, and Pu-238. The waste form is primarily the solidified ion-exchange resins and the solidified high concentration of radioactive liquid waste. The radioactivity of the LLW drums is calculated with decay correction at the year 2020 [4].

After the shipment of LLW drums to the Lanyu LLW storage facility ceased in 1995, the local aboriginal people have continued to protest the operation of the facility and have demanded the Taiwan government remove all the LLW from the facility. In the last twenty years or so, certain high-level government officials in Taiwan had made promises to move all the LLW out of the Lanyu interim storage facility. However, nothing has happened and the LLW remains on Lanyu Island.

The newly elected Taiwan president Ms. Tsai made a public apology to the Taiwan aboriginal tribes in early August 2016 for the government injustice policy toward the Taiwan aboriginal tribes in the past. However, she fell short of promising a commitment to a direct negotiation with the Lanyu local Yamei tribe to move the Lanyu LLW out of Lanyu Island within a reasonable period of time. Her government has recently begun to lay out a multi-faceted plan to address the Lanyu LLW Storage Facility including more open dialogs with the local aboriginal people and evaluating different options of relocating Lanyu LLW to other possible sites.

To move forward the final disposal of LLW, in 2006, the Taiwan Legislature passed the LLW final disposal site selection regulation. One of the key elements of the regulation requires that for the recommended site, the local municipality of the site should hold a referendum to decide if the local people would accept the recommendation that their community would host the LLW final disposal site. From the public participation point of view, it is a positive approach. However, due to the oppositions from the local politicians, the Taiwan government has not been able to hold the referendum for the recommended sites.

Because of the lack of progress in the site selection of the LLW final disposal site in the last ten years, Taipower began to plan for a longer period of LLW interim storage up to 50 years before the final disposal. In October 2016, it was reported in the Taiwan news media that Taipower recently completed a feasibility study for a mid-term (40-50 years) LLW storage facility on an uninhabited island by evaluating many possible uninhabited islands. Taipower plans to store all the existing LLW (including LLW in the Lanyu Storage Facility) and the future LLW generated from the decommissioning of three Taipower NPPs on this uninhabited island. The news has drawn criticisms from the Taiwan environmental groups.

CONCLUSIONS

The Lanyu LLW storage facility has been a controversial facility in Taiwan for the past thirty some years and has both technical issues and political issues.

Some of the technical issues are:

- (1) The Lanyu Island storage facility is near the ocean coast of Lanyu Island and in a tropical weather region with warm temperature, high humidity, and high annual precipitation, and is not a good location for an interim storage facility.
- (2) Although the design of storage trenches has a concrete cover on the top, the storage trenches expose the LLW drums to the ambient air all the time.

Some of the political issues are:

(1) The Taiwan government was not able to fully explain the nature of the Lanyu LLW storage facility to the local aboriginal people and did not allow the local aboriginal people to participate in the decision making process before the construction of storage facility. These lead to the mistrust of the Taiwan government and strong protest from the local people.

(2) Taiwan politicians in the past had made empty promises to remove all the LLW from Lanyu Island. It created more distrust of the Taiwan government from the local aboriginal people.

Due to the nature of the environment on Lanyu Island, even after the rectification and repackaging of the LLW at the Lanyu LLW storage facility was completed in 2011, the corrosion will continue. The longer the LLW drums are stored there, the more corrosion would occur.

Although the current Taiwan government has recognized the past injustice policy toward the Lanyu aboriginal people and begun to address the Lanyu LLW storage facility, the question is whether the current Taiwan government has a commitment and is willing to lay out a workable plan to move the Lanyu LLW out of Lanyu in a timely schedule.

Eventually, Taiwan government and the people in Taiwan need to face the reality of addressing the LLW storage and final disposal. Perhaps, if the Lanyu LLW Storage Facility issue can be resolved successfully in the next five to ten years, it would be an important step forward for Taiwan LLW site selection for LLW mid-term storage and final disposal.

REFERENCES

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