THE STATUS OF SITING ACTIVITIES FOR A LOW LEVEL WASTE REPOSITORY IN THE PHILIPPINES

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Abstract

The process of site selection for a low level waste repository was initiated in 1976 when the Philippine Government decided to go nuclear and constructed the first Philippine Nuclear Power Plant in the Bataan Peninsula. However, all siting activities were suspended when the nuclear power plant was mothballed and the final decision was made to convert the plant into a combined cycle power plant. In 1995, an inter-agency committee was created under the Nuclear Power Steering Committee and mandated to conduct studies on siting of radioactive waste disposal facilities and at the same time, perform R&D activities in support of the project. This paper describes the various siting activities carried out to date.

1. INTRODUCTION

The Philippine Nuclear Research Institute (PNRI) has the sole responsibility of dealing with the safe management of radioactive wastes generated from industrial, medical and research applications of radioactive materials. To accommodate the wastes collected from its clientele as well as the wastes generated from the day to day operation of the Institute, treatment and interim storage facilities are being maintained by the PNRI inside its compound in Quezon City. However, in view of the limited capacity of these facilities, the eventual permanent disposal of all the wastes stored inside the compound will have to be addressed.

In 1994, an interagency committee composed of the PNRI as the lead agency, the National Power Corporation (NPC), the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA), the Philippine Institute of Volcanology and Seismology, (PHIVOLCS), and the Science and Technology Information Institute (STII) was constituted to continue with the previous studies and activities pertaining to the siting of radioactive waste disposal facilities. The Committee agreed on a disposal concept of an engineered structure excavated in shallow ground for low level to short lived intermediate level wastes.

In 1995, the above project was given more importance when the Philippine government announced its decision to pursue a nuclear power development program for the next century. A subcommittee was created under the Nuclear Power Steering Committee and mandated to conduct studies on siting of radioactive waste disposal facilities and at the same time, perform R&D activities in support of the project. The outputs from these studies are intended to address several issues in nuclear energy development, the most important of which is the long term protection of the human environment from the harmful effects of radiation emanating from the operation and existence of a permanent disposal facility.

2. SITING ACTIVITIES

The process for site selection activities was initiated in 1976 when the country decided to construct its first Nuclear Power Plant (PNPP-1). This was undertaken by an interagency committee, which was tasked to study the possibility of establishing a national radwaste management centre. Initially 13 candidate sites from all over the archipelago were identified for preliminary survey. Using stringent criteria, the committee identified the 3 most suitable sites that warranted further

investigation. These sites were all situated in Luzon, the second largest island in the Philippines. However, the immediate need for a repository for the PNPP-1 wastes shifted the attention of the committee to prioritise its site characterisation to the 3 areas inside the PNPP-1 reservation area. The extensive studies done in the PNPP-1 site were to determine and to confirm its suitability for a shallow ground disposal facility. But in 1986 all work activities pertaining to siting were reduced to a minimum level pending the decision of the government to operate the PNPP-1 or not. Figure 1 shows these previously identified candidate sites for the proposed national radwaste management centre.

The decision of the government to again pursue a nuclear power program in the next century led to the creation of a new working committee tasked to conduct studies for siting of disposal facilities. Initially, the short list of candidate sites identified during the last 2 decades was reviewed. Considering that the Philippines is located in the *Ring of Fire*, the assistance of the Philippine Volcanology and Seismology Agency and the Philippines' Bureau of Mines, both government institutions, were requested to provide the information on the current geologic characteristics of these sites. It was ultimately confirmed that these candidate sites are no longer acceptable considering the current developments in these areas as well as on the updated information regarding the presence of active faults.

Having declared the previously identified sites as no longer suitable for the purpose, the committee focused its attention to the location of the PNPP-1 and took advantage of the extensive studies that were already established. The geologic logging and trench mapping performed in Cabigo Point, an area covered by the PNPP-1 reservation area indicated that it is capable of supporting structures having a maximum design load of 28 160kg/cm2 at an elevation of 59 meters above mean sea level. At the same time, an ocular survey was performed in a nearby province, which was recently found to be fault free. A specific site was singled out for further survey and inspection.

On the other hand, the site screening procedure was revised and updated based on international information detailing the technical guidance for siting of disposal facilities. Appropriate activities and workplans were established to identify other potential sites on a regional scale.

The process for siting was divided into 2 major stages, i.e. site screening stage and site evaluation stage. Site screening mainly involves a desk compilation of existing information and data from a wide variety of government and private institutions. If necessary, field investigations using geological, hydrological and surface environment methods will be employed to verify, update and confirm existing data. Reconnaissance field investigations will be carried out by performing airborne surveys of selected candidate regions and areas supplemented by ground investigations, as appropriate. It is envisioned that a small number of candidate areas will be identified and subjected to further detailed site investigations.

Site evaluation will proceed as soon as candidate areas identified in the first stage warrants detailed surface and subsurface investigations. This will include locating and constructing boreholes and exploratory shafts to allow characterisation of underground surfaces.

3. SITING FACTORS AND ASSOCIATED CRITERIA

The site screening procedure is divided into two major factors, the *primary and secondary factors*. The primary siting factor was given a weighting value of 60% and includes the geologic, hydrogeologic and topographic characteristics of the proposed site. The secondary factor with a weighting value of 40% involves siting factors such as demography, meteorology, surface hydrology and land use. This screening procedure was used to evaluate sites on a regional scale with the intention of identifying a preferred candidate site. More stringent criteria will be developed for final site selection. A complete description of the technical factors that need to be considered during the site screening process is presented in Table 1.

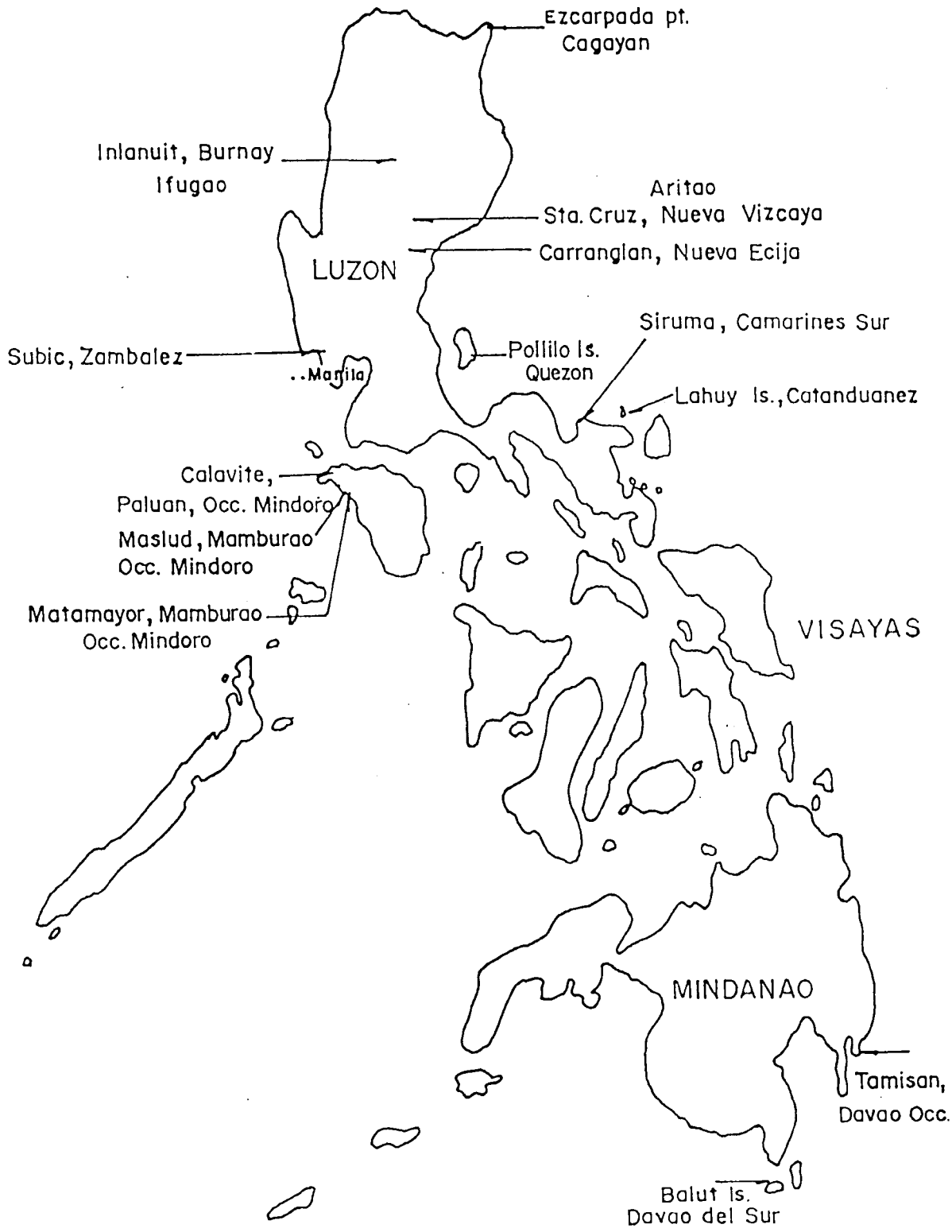

FIG 1 Candidate sites for the proposed National Radwaste Management Center (NRMC)

The conditions that will be regarded as acceptable and not acceptable to the potential suitability of the area are also given. Since some of the factors are not quantitative in nature, subjective decisions in some cases are made concerning the application of the criteria.

TABLE 1. PRELIMINARY SITING FACTORS AND ASSOCIATED CRITERIA

FACTORS	CRITERIA	
	ACCEPTABLE	*UNACCEPTABLE*
SUBSURFACE HYDROLOGY:		
-- Groundwater Level	More than 20 m. deep	Less than 15 m. deep
-- Groundwater Recharge		Primary recharge zones of major aquifers
-- Groundwater Discharge		Major discharge areas
-- Hydrogeologic Units	Hydraulic Conductivitiy less than 10^{-5} cm/s	
SURFACE WATER HYDROLOGY		
--Flooding	Prefer sites with highest recurrence interval	Areas within the 100 year flood plain or coastal high hazard zone
-- Site Slope		Slopes greater than 5%
-- Upstream Drainage Area	Sites with least upstream drainage area and where drainage is most manageable	
GEOLOGY:		
-- Tectonic Processes	Stable region	Areas with active tectonic processes
-- Surface geological Processes	Sites with least impact from surface processes	
-- Rock Formation/Lithology	Areas with rocks that are homogeneous, low degree of fracturing and low fissility	
-- Natural Resources	Lowest potential for economically significant natural resources	

TABLE 1. (cont.)

SOILS:		
-- Soils Characteristics	Area with homogeneous soils, more than 3 m thick, with high sorption capacity and low shrink/swell potential	
-- Hydraulic Conductivity		Areas with permeabilities generally greater than 10^{-4} cm/s
TOPOGRAPHY:		
-- Land Surface	Prefer grade of 2% to 5%, minimal uypstream drainage, and manageable drainage	Areas with steep slopes
METEOROLOGY:		
-- Precipitation/Evaporation Rate	Areas with lower annual precipitation	Areas with evaporation less than precipitation
-- Severe storm potential	Lowest occurrence of extreme windspeed and baby tornadoes	High occurrence of extreme windspeed
METEOROLOGY:		
-- Dispersion Potential	Highest dilution potential and wind direction persistence	Low atmospheric stability
LAND USE:		
-- Population	Sites with fewest residents in the area	Areas with density greater than 400 per sq. mile
-- Land Use Compatibility		Parks, Preserves, Urban areas. Incompatible adjacent areas
-- Prime Farmland	Farmland of lower productivity	Prime Farmland
-- Transportation and Site Accessibility	Sites with better access to surface water and rail routes	Areas without adequate surface water and rail routes

In the primary siting factor, only the general exclusion criterion (groundwater level less than 50 ft deep and primary recharge zones of major aquifers) is applied to the whole archipelago to identify the potential regions of interest. The primary hydrologic exclusion criteria that will be considered are groundwater levels and groundwater recharge. Any area excluded from this stage will not be considered further in the study. Areas that were not excluded will be characterised further using the following factors: groundwater levels and discharge, hydrogeologic units, soil characteristics and hydraulic conductivity, land surface slope, tectonic and surface geological processes, rock formations and occurrence of natural resources. Sites with deepest water level, lowest recharge potential and groundwater discharge, lowest conductivity and solubility, highest sorption capacity and least complicated geology will be most preferable.

The secondary factor requires potential candidate sites to be evaluated using their meteorological, demographic, hydrological and land usage characteristics. The surface water hydrology uses flooding and site slope/upstream drainage factors. These factors minimise any chance of water infiltration into the waste that may cause migration out of the facility. Sites with the highest flooding recurrence interval (>100 years) and least slope (<5%) are preferred. The preferred meteorological characteristics on the other hand require sites to have lowest annual precipitation and highest dilution potential and wind direction persistence. Areas with population density greater than 400 per square mile are excluded. Sites with better access to surface water and rail routes are preferred.

4. SAFETY ASSESSMENT

A preliminary investigation of the impact of the planned facility was carried out using the computer code Disposal Unit Source Term (DUST) developed at Brookhaven National Laboratory [1]. The code was used to calculate the concentration and release rates of selected radionuclides out of a generic facility at varying time intervals. The calculation was based on an assumed radionuclide inventory, waste form characteristics, type of waste containers and other various physical processes that can eventually cause a release. The DUST code is very useful for parameter sensitivity analyses as well as for screening of critical radionuclides. Table II shows the assumed activity of selected radionuclides at site closure.

The current plan for the disposal of low level and short lived intermediate level wastes is to build the facility above the water table. The assessment scenario assumes that the disposal facility is a reinforced concrete pit, excavated in shallow ground. The cover is assumed to be about 5 meters thick and will consist of alternate layers of soil, sand and an impermeable layer like clay, after disposal operations have ceased.

The transport of radionuclides within the disposal facility was modelled using the multi-cell mixing cascade model [2]. This model is based on an analytical solution of the advective transport equation with radioactive decay and chemical retardation for constant flow and material properties. The distribution coefficient (Kd value) for each element was based on a cementitious environment and taken in Ref. [3].

TABLE II. INVENTORY AT SITE CLOSURE

Radionuclide	Amount, TBq
C-14	7.40 E-06
Cs-137	1.75 E-01
I-129	1.85 E-06
H-3	1.00 E-04
Ni-63	3.51 E-01

Table III gives the results of the estimated maximum concentration and the annual input to the groundwater table. The preliminary estimates of potential doses to a critical group of inhabitants from the water ingestion pathway are likewise given in Table IV. The results are far below the internationally accepted dose limits for members of the public.

TABLE III. MAXIMUM CONCENTRATION AND FLOW RATES OF SELECTED RADIONUCLIDES

Radionuclides	Maximum Concentration (KBq/li)	Flow Rate (KBq/y)
C-14	7.25 E-03	7.47
Cs-137	6.0 E+02	6.21E+04
I-129	1.72 E-09	17.7 E+01
H-3	8.58E-07	8.84E-01
Ni-63	7.25 E-06	6.96E-02

TABLE IV. DOSE PROJECTIONS DUE TO DRINKING WATER PATHWAY

Radionuclide	Annual Effective Dose Equivalent (mSv)
C-14	3.52 E-08
Cs-137	7.19 E-03
I-129	2.80 E-06
H-3	1.21 E-10
Ni-63	3.90 E-06

The results of this assessment are very preliminary because these are based on generic parameters. Thus, the calculated radionuclide concentrations, release rates and the subsequent dose projections are only indicative until site specific data are obtained.

5. PUBLIC INFORMATION

Based on international experience, public involvement has been noted to be of utmost importance in almost all phases of the siting program. As work progressed in the Cabigo Point area, the committee designed survey instruments containing information on the social, economic and cultural dimensions of the potential beneficiaries of the project. The people's perceptions and attitudes towards the project were gathered. The survey revealed that majority of the residents living around the area disapproves of any nuclear related activities. It was believed however that their attitude was borne out of ignorance and inadequate knowledge of nuclear energy. The survey concluded there was a need for more information dissemination, especially on the advantages and disadvantages of nuclear energy. Scientific facts regarding nuclear energy and nuclear wastes should be presented and explained to the public in layman's terms.

Having had some experience in the previous undertaking, an information package in the form of a storyboard was developed to discuss and illustrate the various steps involved in the safe management of radioactive wastes. A survey questionnaire on public awareness and acceptance designed for professionals was prepared to complement the storyboard. These were presented during the 7^{th} biennial convention of the Philippine Association for Radiation Protection. The results of the survey indicated that majority of the respondents are aware of the basic aspects of radioactive waste management and are interested to know more about its long term disposal and safety.

6. FUTURE ACTIVITIES

The interagency committee led by the Philippine Nuclear Research Institute will continue with its site screening activities in support of the nuclear power development program of the government to:

(a) Gather, analyse and map existing regional scale data for the different candidate regions addressing the 3 main components of the site screening procedure (hydrology, geology and environmental status assessment);
(b) Conduct surface investigations of relatively short duration at the preferred location;
(c) Recommend the most suitable areas for thorough surface and subsurface investigations;
(d) Recommend the most appropriate treatment and conditioning options for the types of wastes considered for disposal;
(e) Complete a scoping exercise for the safety assessment of generic facilities and recommend sensitive parameters to be considered in the site evaluation stage;
(f) Prepare additional information packages for various types of mass communication media.

Further to these activities, the members of the committee will continue to participate in international fora to keep abreast with the current and future developments not only in the siting of disposal facilities but also in the effective management of radioactive waste as a whole.

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