

# REGULATORY CONTROL ON THE DISPOSAL OF NATURALLY OCCURRING RADIOACTIVE MATERIAL (NORM) WASTE PRODUCED FROM PETROLEUM INDUSTRY IN MALAYSIA FOR SAFETY AND ENVIRONMENTAL SUSTAINABILITY

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## 1.0 ABSTRACT

Crude oil and its products and waste from petroleum industry contain Naturally Occurring Radioactive Materials (NORM). Human activities in the petroleum industry namely extraction, processing crude oil and natural gas activities generated significant number of wastes containing NORM. In addition, the specific activity concentration of these NORM waste may be enhanced due to technological and human activities, which eventually may pose potential environmental and health risk. This will require continuous attention by monitoring and surveillance during the disposal process in the petroleum industry. Typically, there are two types of NORM wastes generated in this petroleum industry such as oil sludge and scale. From the year 2020 till year to 2022, Malaysia had disposed 181.3 metric tonne of NORM wastes from the petroleum industry. Depend on specific activity concentration in the uranium and thorium contents, NORM wastes with specific activity concentration above 1 Bq/g need to obtain approval from regulatory authority before disposal. Then, those NORM waste will be transported and incinerated in an incinerator by the licensed facilities. This study presents the regulatory control of the disposal of NORM waste produced from the typical petroleum industry for safety and environmental sustainability. In conclusion, the regulatory control of the disposal of NORM waste generated from petroleum industry is warranted for radiation protection towards legislative compliance in ensuring safety of the public and workers and the protection of the environment.

Keywords: activity concentration, disposal, NORM, NORM Waste, petroleum Industry

## 2.0 OBJECTIVE

This study presents the regulatory control on the disposal of NORM waste generated from the typical petroleum industry in Malaysia.

## 3.0 INTRODUCTION

Human activities as a result of industrial operation such as petroleum industries has the potential to increase the risk of radiation exposure to the environment by concentrating the quantities of naturally occurring radiation beyond normal background levels. Currently, exploration of crude oil and natural gas activities are not subjected to the license under the Atomic Energy Licensing Act 1984 (Act 304), however this technology used radioactive material in oil and gas exploration called gauging activities are licensed under this act. All these activities are also governed by other relevant national law. In petroleum industry, the produced water is extracted from oil and was brought to the surface of the earth contain volatile metal materials. Naturally occurring radioactive radionuclides namely radium-226 ( $^{226}\text{Ra}$ ), radium-228 ( $^{228}\text{Ra}$ ), plumbum-210 ( $^{210}\text{Pb}$ ), and potassium-40 ( $^{40}\text{K}$ ) were also brought along to the surface of the earth may include high levels of radioactivity. During this process, sediments and various impurities are formed at sufficient temperatures with oil/water pumping to the surface and finally lead to precipitate and deposition in the oil and gas production valve, pump, tubular and the piping systems. Two types of common NORM wastes generated from this petroleum industry are oil sludge and scale (Figure 1). In Malaysia, NORM waste generator including oil sludge and scale with specific activity concentration above 1 Bq/g will subject to be licensed under Act 304.



Figure1: Oil sludge and scale waste

## 4.0 METHODOLOGY

The oil/gas processing plant owner shall appoint a contractor licensed by Department of Atomic Energy Malaysia to conduct surveillance during the plant maintenance and turnaround. The appointed contractor must notify Department of Atomic Energy Malaysia regarding the radiological monitoring works that will be carried out and shall submit the radiological monitoring report as soon as the work is completed. The oil/gas processing plant owner or the contractor acting on behalf of the oil/gas processing plant owner must submit an application to the Department of Atomic Energy Malaysia to obtain the approval to dispose the oil sludge and scale waste (NORM waste) generated during maintenance process. Approval of the disposal NORM waste above the Clearance Level with conditions will be granted to the applicants who meet the requirements.

## 5.0 LEGAL REQUIREMENTS

The Atomic Energy Licensing Act 1984 (Act 304) is the main Act in Malaysia that provides the regulation and control of atomic energy, for the establishment of standards on liability for nuclear damage and for matters connected therewith or related thereto. The control of radioactive waste management was made under the Atomic Energy Licensing (Radioactive Waste Management) Regulations 2011. Based on the Second Schedule of the Regulation, the activity concentration of the radionuclides below the clearance level is released from the control under Act 304. This Regulation is made in accordance with the IAEA Safety Standards, Basic Safety Standards 115 (1996) and Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards, GSR Part 3 (2014). Table 1 shows the control limit for licensing activities involving NORM. The disposal of oil sludge and scale waste containing NORM above the stated limit is subjected to regulatory control through licensing by the Department of Atomic Energy Malaysia.

Table 1: Control limit (licensing) for the activity concentration of raw material and waste containing NORM

Radionuclide	Activity Concentration (Bq/g)
$^{40}\text{K}$	10
Each radionuclide in the chain of Uranium and Thorium decay series	1

## 6.0 RESULTS AND DISCUSSION

Figure 2 shows the number of drums contain NORM waste consist of oils sludge and scale that had been approved for disposal from the year 2020 to 2022. In average, 413 drums had been disposed annually from the year 2020 to 2022. Due to different abundancy of Uranium/Thorium inside the crude oils, the laboratory analysis results showed that 428 drums (35%) demonstrated result with above the Clearance Level ( $\geq 1$  Bq/g) and the rest of 811 drums (65%) demonstrated data with below the Clearance Level ( $\leq 1$  Bq/g).

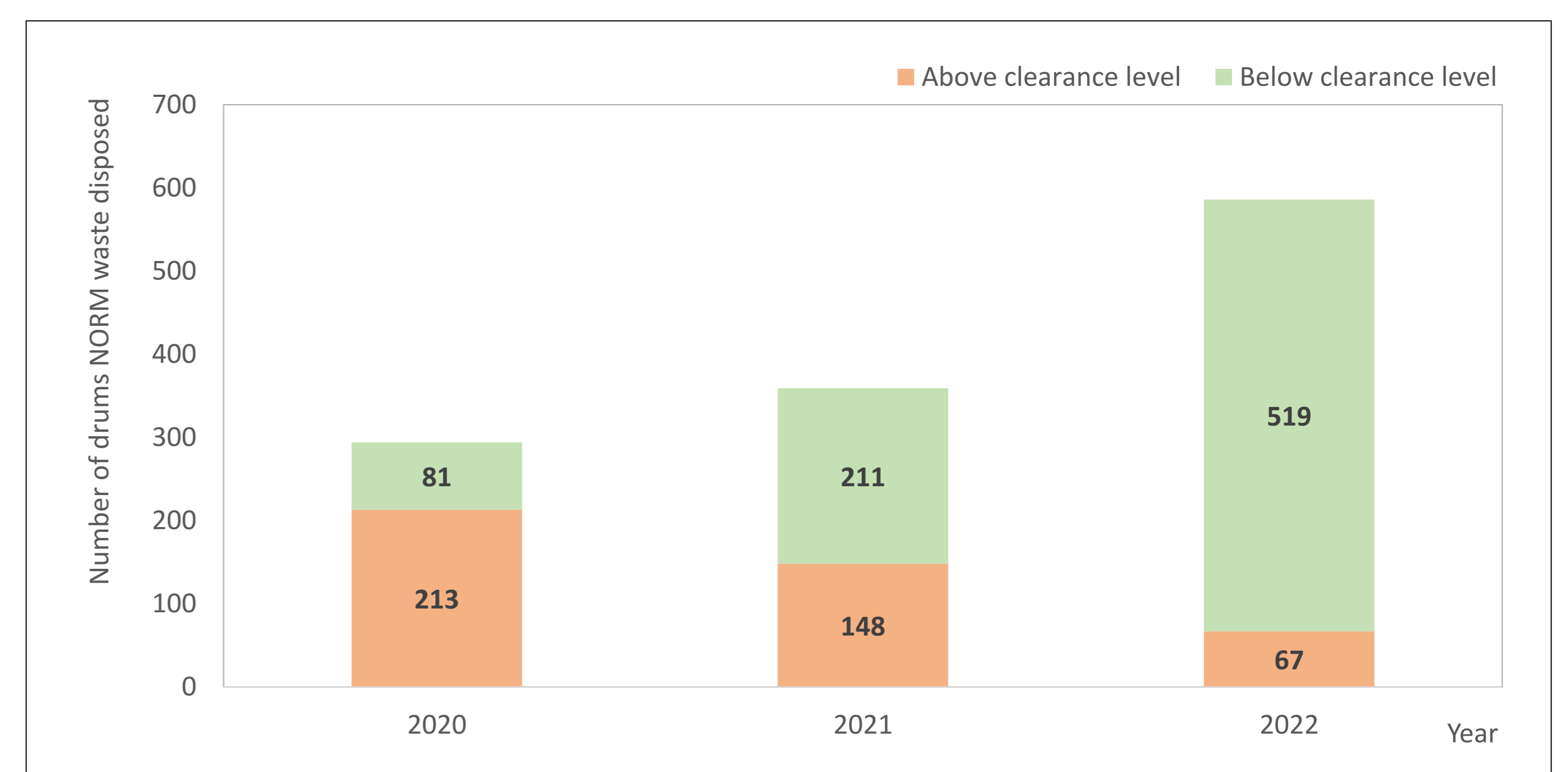


Figure 2: Number of drums containing NORM Waste approved for disposal from the year 2020 to 2022

Table 2 shows the range of activity concentration for specific radionuclides in NORM waste and the in-situ external dose at drums surface result is in the range from 0.06 - 52.13  $\mu\text{Sv}/\text{hour}$ . The drums will be collected by the waste collector licensed under Act 304. In addition, the transportation to the disposal facility shall be conducted in accordance with the current Radiation Protection (Transport) Regulations 1988.

Table 2: Range of specific activities for specific radionuclides in NORM waste

Radionuclide	$^{226}\text{Ra}$	$^{228}\text{Ra}$	$^{40}\text{K}$
Activity concentration [Bq/g]	0.052 - 170	0.064 - 210	0.160 - 47

Figure 3 shows that 181.3 metric tonne of NORM wastes had been disposed from the petroleum industry in Malaysia. Currently, NORM waste will be incinerated and the remain ashes will be disposed as secured landfill at the licensed facility under Act 304. A comprehensive environment monitoring programme has been carried out by the licensee to ensure safety of the people and the environment.

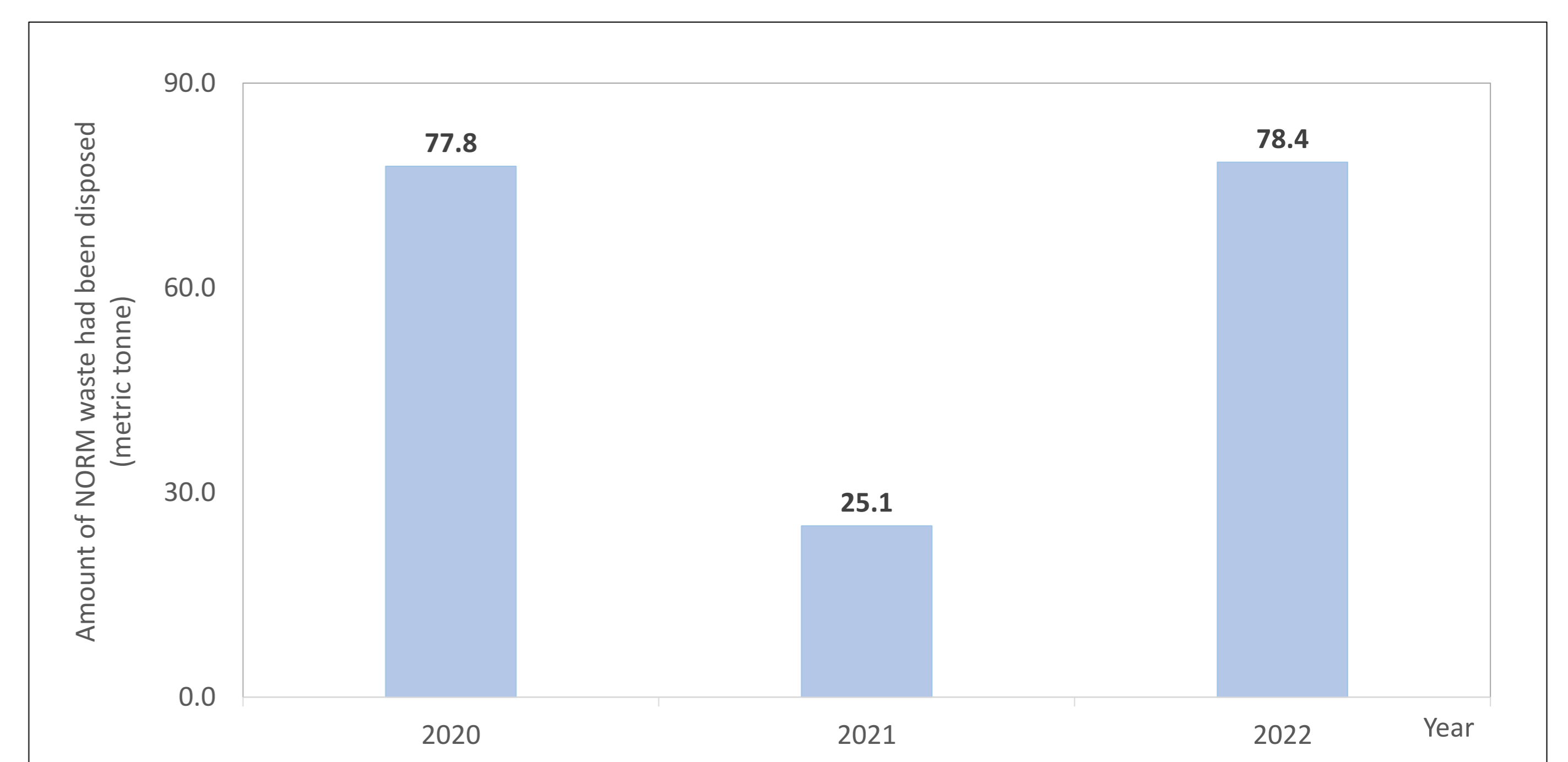


Figure 3: Total amount NORM waste hand been disposed into the licensed disposal facilities from the year 2020 to 2022.

## 7.0 CONCLUSION

In conclusion, the regulatory control of the disposal of NORM waste produced from petroleum industry is warranted for radiation protection towards legislative compliance in ensuring safety and environment sustainability.