# 5 Summary of the report

The Australian company Lynas plans to import ore concentrate from its Mt. Weld mine in Australia to Malaysia and to process this concentrate in its Lynas Advanced Materials Plant (LAMP) in Kuantan/Malaysia. Lynas has constructed part of the facility and has been issued a temporary operating license (TOL) by the responsible state agencies.

Oeko-Institute was commissioned by the Malaysian non-governmental organisation "Save Malaysia Stop Lynas" (SMSL) to evaluate the emissions from this plant via air and water, the safety issues as well as the waste management in respect to their environmental consequences.

## Emissions of radon over the stack

The ore concentrate has a considerable thorium content. Accumulated radon in the ore concentrate is released in the cracking stage of the facility when the ore matrix is decomposed. Radon cannot be filtered and therefore causes air emissions and subsequent radiological exposures in the vicinity of the plant. The dose calculations were reviewed and several minor inconsistencies were found, as well as missing documentation. The reviewed dose results can be summarized as follows:

- The environmental consequences from the emission of radon over the cracking facility's stack are small.
- Even when introducing more strict assumptions in the dose calculation the associated dose and risk remains negligible.
- Small risks should be communicated as such. They should not be compared with natural background levels, because the natural background risk level is not zero and is not always below acceptable levels, based on given current knowledge and understanding. Such comparisons are in most cases unscientific and misleading.

## Emissions of sulfuric acid and dust over the stack

In the cracking stage of the facility the ore concentrate is heated with concentrated sulfuric acid. The resulting gas stream passes a waste gas treatment system to remove sulfuric acid mist and other acidic substances as well as dust and then is discharged over stacks. In another part of the facility, separated rare earth oxalate is roasted in a furnace oven. Waste gas from this process is not filtered for dust removal and is discharged directly to the air.

The analysis and comparisons of these emissions shows that

- no reasons are given for the decision to operate the calcination stage without a waste gas treatment system, while other similar examples show that at least a simple dust removal method should be used,
- the static Malaysian environmental regulation in respect to air quality is inappropriate, because it neither reflects improved knowledge on adverse toxicological effects nor does it encourage to the application of improved technical capabilities to reduce emissions; the regulation should be improved by adopting dynamic limits taking advantage of technical improvements,
- the treatment systems of Lynas for abating emissions of acidic gases and acids as well as for dust are neither state-of-the-art nor best-available-technology and causes sulfuric acid emissions that are too high by a factor of at least two and $PM_{10}$ dust emissions that are too high by an even larger factor.

### Discharges via the water pathway

The Lynas facility uses water in the cracking stage to dissolve the rare earth compounds. Rare earth elements are stripped from that water solution, the water is neutralized, sludges are removed, the water is collected in a pond, mixes with precipitate and stormwater, and, after monitoring measures, discharged to an earthen channel that transports the wastewater over three kilometers to river Balok, where it is further diluted and finally flows to the South China Sea.

The following conclusions can be drawn from the critical evaluation of the discharges via the water pathway:

- The documents, including the Preliminary Environmental Impact Study, do not provide information on the by-product content of the ore concentrate. No balance calculations can be made for other toxic constituents of the ore.
- The analysis of process water prior to its treatment considers only those constituents which are mentioned in the Malaysian Water Quality requirements for effluents, and even omits analysis of some of the constituents listed there without naming reasons for that omission.
- Specific constituents of the wastewater of the LAMP facility such as rare earth elements and salt are not even mentioned, their concentrations are not calculated and the environmental consequences are not identified, discussed and evaluated, as would be required in a Preliminary Environmental Impact Study.
- A detailed calculation of the salt content of process water was performed and it is shown that the salt content (mainly calcium chloride) is only slightly below that of average seawater and by a factor of at least 15 higher than water that can be used for irrigation. The salt is not removed in the water treatment stages and will be discharged completely.
- The transport of the discharged water with toxic constituents, a frequently high chemical oxygen demand and high salinity in an open earth channel, accessible

by humans and animals, is unacceptable. Water of this low quality should be transported in a pipeline that does not allow seepage to escape to the groundwater and prevent unintended water use.

- The already high chemical oxygen demand of Sungai Balok should not be further increased by allowing additional COD discharge, the approach should rather be to improve overall water quality by removing or reducing the other sources.

### Hazards and their control in the production process

The facility stores and handles large amounts of concentrated acids. This is associated with the potential risk that tanks will leak. Rapid detection, preventive measures and the ability to limit the consequences for the environment are necessary. The plant further uses chemicals that are flammable; the possible consequences of fires have to be assessed.

The analysis and the potential consequences of specific hazards posed by the plant to the environment

- have not been adequately assessed (tank spill control measures), so that unacceptable consequences for soil and groundwater would result, or
- have not been taken into account (sulfuric acid vapor release, fire extinguishing liquid loss), so that their potential consequences have not been assessed.

### Wastes from the production process

The facility produces large amounts of three different waste types. In the cracking stage the insoluble part of the ore concentrate, together with radioactive thorium, form the WLP waste. The second waste type produced stems from the acid removal from the offgas in the cracking stage, mainly consisting of gypsum with several by-products and is called FGD waste. The third waste type is the condensed sludge from the neutralization stage called NUF waste, also mainly consisting of gypsum with by-products. The wastes are stored in separate storage facilities on the site.

The following conclusions are derived from a detailed analysis of the waste management issues of the LAMP facility:

- The design of the Residue Storage Facilities (RSF) is not state-of-the-art with respect to leakage prevention. A state-of-the-art design would use 2.5 mm HDPE and at least two 25 cm layers of clay instead of 1 mm HDPE and only a single 30 cm layer of clay. The inappropriate layout will result in leakage of radioactive and toxic constituents to the near groundwater even under normal operating conditions. As the layers underneath the facility are not qualified as barriers and do not guarantee the enclosure of those constituents, the spreading of the constituents is not substantially reduced or delayed. It is an open question whether this inappropriate design is compatible with the minimization require-

ment established in the Malaysian regulation for the control of radioactive waste and its storage.

- The RSF for the waste from the Water Leach Purification (WLP) process stage with the highest radionuclide and toxic content
  - is, due to its limited capacity, not designed to store the wastes produced before a safe external permanent disposal facility has been established. This will put undue pressure on the sensitive process of careful site selection for the permanent disposal facility, resulting in a possible reduction in the quality and transparency of the site selection process as well as the regulatory process. The capacity bottleneck will result in unplanned measures becoming necessary at the LAMP, performed with reduced quality or as sub-standard solution.
  - is inadequately designed to safeguard against heavy rain and the monsoon season. Storing the waste in the RSF requires a certain drying period prior to emplacement. This natural drying process is unlikely to work in periods of heavy rain and high humidity. To develop appropriate alternative procedures requires the establishment of additional technical steps and this will inevitably increase the dose for workers who have to handle those wastes. This additional exposure has not been accounted for in the Radiological Impact Assessment (RIA).
  - has not been designed to cope with enhanced scale enrichment of radium within the WLP stage of the facility and its associated waste category with a much more intense radiation level to be stored in the RSF. No procedure has been prepared for these wastes. The high potential for substantially higher doses for workers and the associated risks have not been recognized and planned for.
  - should not be designated as a permanent disposal facility, because basic site suitability criteria, facility design and the long term isolation potential of the facilities are significantly deficient. Their insufficient base layers cannot be upgraded to meet the more stringent and time-resilient requirements of a permanent radioactive waste disposal site.
- The option of releasing WLP wastes to the public domain, either in its original form or in a mixture with other diluting substances such as concrete or fixing agents, would lead to excessive exposure of radioactive doses to individuals and to the general public via direct gamma radiation, posing a health hazard further afield. This option poses an unacceptable risk to the general public and should be banned and ruled out completely.
- A safe and publicly acceptable way to establish a permanent disposal facility (PDF) for the WLP waste must be seen as a prerequisite for the management of these wastes. This includes a complete and comprehensive safety case, sound and approved site selection and suitability evaluation criteria, the broad consent

of the affected public and a carefully checked construction license for such a PDF. The expectation in the Temporary Operating License (TOL) for the LAMP facility that this process could be performed within only 10 months with the necessary quality, transparency, durability, reliability and the successful completion of the necessary consultation processes is highly unrealistic and risky. In fact, this 10 months period has now lapsed since the TOL was approved on the 30th of January 2012, yet a permanent site for the PDF has not been identified. The fact that LAMP can only continue its operation if such a PDF is able to dispose of the initial wastes produced in the first five years of the waste generation process should be evaluated as a strong condition to bind the issuance of a license for LAMP to that construction license for the PDF. No waste generation should be allowed until the necessary steps to establish such a facility have been performed to the required safety standards and until this management option has been finally established.

- The current approach towards ensuring that the necessary funds for facility decommissioning, cleanup and waste isolation are in place and secured is neither state-of-the-art nor reliable and transparent. The government of Malaysia should establish a sound and well-defined funding system, to be applied to facilities where later decommissioning, cleanup and disposal operation is vital to guarantee for public health and safety in the long term. As long as this is not established with the necessary standard and transparency, the operation of those facilities should not be allowed in order not to place undue burdens on future generations.