International Peer Review Terms of Reference

TELLUS

Review of the Design of the Sandy Ridge Disposal Facility

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for Tellus Holdings

Submitted by A Baker, Eden NE

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Table of Contents

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1. INTRODUCTION

In this document, we report a review of proposed co-disposal of hazardous and radioactive wastes at a new near-surface disposal facility, the Sandy Ridge Facility. The review was undertaken on behalf of Tellus Holdings Ltd.

The proposal involves mining of kaolin clay for export and storage and disposal of hazardous, radioactive and intractable waste in mine voids. It is proposed that up to 100,000 tpa of waste will be disposed in the mine voids ('cells') over a 25 year period (i.e. disposal of 2,500,000 tonnes of waste in total).

Cells would be filled in layers with multiple sections in each layer. Each layer would be divided into sections containing wastes of similar characteristics. Each section will be backfilled, compacted and all air pockets/voids excluded. Each layer will be compacted, until approximately 7m below the ground surface, where a thick capping layer of low permeability clay will be installed to prevent water ingress into the cell. Following this, more backfilling and a clay domed cap would be situated on the top of the cell, to shed any rainfall. During the waste disposal process, a roof canopy is positioned over the cell to exclude rainfall prior to the thick capping layer being installed. After 10 years of monitoring a further un-compacted cap of yellow clayey sands is placed over the compacted clay dome to allow revegetation.

The hazardous wastes are toxic wastes from the mining, oil and gas and heavy industries, from agriculture and generated from man-made or natural disasters. The radioactive wastes are Very Short Lived Waste, Very Low Level Waste or Low Level Waste (LLW) [1].

Waste Acceptance Criteria (WAC) have been developed. It is intended that the WAC would ensure that no person is exposed above the appropriate dose limits. A zoning procedure has been developed to avoid adverse interactions between wastes of different types.

The radioactive wastes are generally the bye-product of medical research and industry, operation of research facilities (e.g. laboratory coats, overshoes, gloves), Naturally Occurring Radioactive Material (NORM), NORM occurring on pipework and scale from industry, oil spills containing NORM and orphan sources (i.e. gauges and instrumentation). Wastes that will not be disposed include: infectious materials, nuclear material, uncertified waste, putrescible waste and gases.

A multi-barrier system is used to provide long-term containment and isolation of the waste. After the placement of waste in the cell has been completed, the following protection measures will be implemented.

- An all-weather cover will be maintained over the cell until it is backfilled and capped to allow for protection from all weather conditions, preventing the possibility of creating leachates or contaminated surface water.
- Any airspace surrounding the placed waste will be backfilled with kaolin processing plant waste product (low value kaolin and quartz sand) to fill all void space and provide stability.
- The cell will then be backfilled with compacted clay, silcrete, laterite and yellow sand.
- The surface of the cell will be covered with a domed clay cap to exclude rainfall.

After a period of subsidence monitoring to confirm the stability and integrity of the clay capping, topsoil will be placed over the cap and the area re-vegetated with species of local provenance. Local species would be selected based on their root system penetration (depth), ensuring that the capping design is not compromised.

The site will be managed for an extended period following closure before returning ownership to the State, a period termed institutional control. It is intended that the institutional control period (ICP) will ensure the wastes stored and disposed of in the repository are undisturbed for a period of time until they no longer pose a risk to human health and the local environment.

Details of the proposal are contained in reference [1].

The objective of this review is to undertake an independent peer review of the engineering design of waste cells to confirm best practice design has been met.

The required scope of the review includes:

- '*... consideration of the engineering design of waste cells to show best practice design for containment of wastes. This will draw on international best practice and expertise in encapsulating similar wastes around the world';*
- *' ... consideration of the waste material types intended for emplacement in the waste cells, to ensure long term encapsulation of wastes that reduces any risks to human health, the environment and environmental values to an acceptable level*.'

Any offsite activities are not within the scope of the review.

The review was based on the following Tellus documents and drawings:

- *Sandy Ridge Proposal, Draft Public Environmental Review for Adequacy*, 7th June 2016 (the 'PER' [1]).
- *Disposal of Radioactive Waste-Sealed Sources*, final, 1st July 2016.
- *Sandy Ridge Facility Waste Acceptance Criteria*, Draft V7, June 2016.
- *Sandy Ridge Facility Waste Acceptance Policy*, Draft V2, July 2016.
- *Sandy Ridge Facility Waste Acceptance Procedure*, Draft V2, July 2016.
- *Sandy Ridge Facility Waste Storage and Permanent Isolation Zoning Guide*, Draft V2, July 2016,
- *Sandy Ridge Pre-feasibility Study, Waste Isolation Shaft in a Cell, Backfill General Arrangement,* Drawing No C5409-6310-CE-004/B, September 2015.
- *Sandy Ridge Pre-feasibility Study, Waste Isolation Cell, Overall Layout Arrangement,* Drawing No C5409-6310-CE-005/A, August 2015.
- *Sandy Ridge Pre-feasibility Study, Waste Isolation Cell, 23m BGL Cell General Arrangement,* Drawing No C5409-6310-CE-006/A, September 2015.
- *Sandy Ridge Pre-feasibility Study, Waste Isolation Cell, 23m BGL Cell Sections and Details,* Drawing No C5409-6310-CE-007/A, September 2015.
- *Sandy Ridge Pre-feasibility Study, Waste Isolation Cell, 23m BGL Cell Co-Disposal Typical for NORM and Radioactive Materials,* Drawing No C5409-6310-CE-011/B, March 2016.
- *Sandy Ridge Waste Arrangement 160715,* Excel file.

- *The Assessment of Long-term Recharge to Encapsulated Waste Isolation Cells - Sandy Ridge Project,* (pdf file CyModHydrologyV3.R2-2), March 2016.
- *Radiation Risk Assessment-Post Closure-Sandy Ridge Facility,* Draft dated 15th May 2016.

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2. APPROACH

We have assessed the PER and other documents on the basis of the following.

- Our general knowledge of the design and underpinning approaches in other near-surface repositories for the disposal of LLW.
- The recommendations of the IAEA as covered by the Requirements set out in the IAEA document ' *IAEA Safety Standards, Disposal of Radioactive Waste, Specific Safety Requirements SSR-5, 2011'* [2]. We have presented the review against those requirements that we consider to be most relevant.
- We have reviewed Subsection A4 of the ARPANSA document '*Protecting People and the Environment from the Harmful Effects of Radiation, Licensing of Radioactive Waste Storage and Disposal Facilities', March 2013* [3]. As a result, we have identified one additional requirement relating to co-disposal.

The review has been undertaken and led by Andy Baker, an expert in the disposal of radioactive wastes. Until 2007, Andy managed the Environment Agency's Nuclear Waste Assessment Team[1], providing the technical lead on radioactive waste management and disposal issues within the UK's Environment Agency. Earlier in his career, Andy worked as a technical consultant on a wide range of radioactive waste management and disposal issues. He contributed to and managed a number of repository safety cases, including many key assessments (Nirex 95 and Nirex 97[2]) within the UK deep geological disposal programme and assessments of overseas repositories, including the Australian National Repository. He currently has a role as a consultant at the UK's Low Level Waste Repository[3] where he is responsible for the technical integration of the repository's Environmental Safety Case.

Andy was supported by Sandy Anderson, a senior manager with extensive experience of peer review. Sandy is a mechanical engineer having wide experience of structural mechanics and the preparation and review of Nuclear Safety Cases. He has a wide understanding of radioactive waste management. Over the past few years, he has become more involved with major projects and plan facilities. This included dealing with siting and facility design, planning applications and environmental permitting, site investigations, foundation design and justification, and plant commissioning from a regulatory perspective.

It is important to note that our review is at a strategic level so we have not evaluated every calculation and report in detail.

1 The Environment Agency is responsible for regulating the disposal of radioactive waste in England (and previously in England and Wales).

2 Nirex was the UK body set up to examine safe, environmental and economic aspects of deep geological disposal of intermediate and low level radioactive waste. The role previously filled by Nirex is currently undertaken by the UK Radioactive Waste Management Ltd. (RWM).

3 The UK national repository for the disposal of low level waste.

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3. REVIEW

As noted above, the review has been performed against a set of IAEA criteria, which are addressed in turn below.

3.1 General Comments

On the basis of knowledge of other disposal facilities for the disposal of LLW worldwide, we consider that the design of the Sandy Ridge Facility is excellent. It is a multi-barrier system comprising the following components.

- Metal and concrete filled containers for spent sealed sources.
- The use of impermeable fill within the cells to separate wastes of different characteristics or wastes disposed at different times.
- The construction of a thick clay cap that will encourage runoff and prevent infiltration.
- The presence of an extensive and thick natural clay liner.
- A generally dry environment where evaporation considerably exceeds precipitation.

The Sandy Ridge Facility is centrally located within a large expanse of State land in South-Western Australia. The local environment is arid with low annual rain flow, geologically stable with low seismic activity and remote from large centres of population. Based on our judgment, the design is likely to perform well during the longer term and it appears from the assessments performed that radiation doses will be very low during operations.

A comprehensive technical programme has been undertaken to underpin the disposal approach and demonstrate that the Tellus proposal for a combined purpose mining and waste facility is well founded, safe and geologically stable well into the future. This includes suitable site characterisation and consideration of safety issues; including an upper estimate of radiological dose uptake to workers on-site and members of the public both during normal operation and during the transport of waste materials to the site by road. A transport risk assessment of accidents occurring during transit has been provided to establish that these risks are tolerable (although assessment of off-site transport is outside the scope of this review).

At the current stage of development, some documents lack detail and insufficient argument and evidence is provided to underpin the safety arguments and hence the suitability of the design. However as part of the safety case process, it is the intention to carry-out hazard identification studies (HazOp, Hazan or SWIFT) and an Engineering Schedule developed that will contain the performance requirements for any required engineered key safety systems.

An indication of the timescale over which the facility will operate is provided, together with an estimate of the total volume of waste. We understand that 2.2% of this waste is planned to be radioactive waste. The quantity of radioactive waste is important context, which it would be helpful to make more prominent.

It is noted also that the proposal is generally favourable from an environmental perspective in that it involves the reuse of an opening created by mining activities.

We have presented the remainder of this section against certain specific requirements set out by the IAEA in SSR-5 [2].

3.2 Optimisation and the Role of Safety in Design

IAEA SSR-5 Requirement 4: Importance of safety in the process of development and operation of a disposal facility

Throughout the process of development and operation of a disposal facility for radioactive waste, an understanding of the relevance and the implications for safety of the available options for the facility shall be developed by the operator. This is for the purpose of providing an optimized level of safety in the operational stage and after closure.

It is clear that the design of the disposal facility has been developed with safety issues in mind.

The multiple barrier approach compares very well with current practice and regulatory requirements for repositories (and indeed power reactors and other nuclear facilities) across the World. This approach ensures Defence-in-Depth against challenge from both known natural hazards and, more importantly, from unrevealed faults.

The proposed design incorporates best practice in respect of characterizing and segregating the wastes. The design concept is a development of a nearby mixed waste facility at Mount Walton, where non-radioactive waste packages were entombed in a clay void created by mining, and this latter facility has operated without incident for over 20 years. The proposed design improvement added to cater for radioactive waste is to build isolated shafts within the cells as the layers of non-radioactive waste are completed and backfill levelled. Once the cell has been filled with non-radioactive waste, the shafts are then loaded with waste packages. In a separate store for higher activity wastes, the material will be transferred into double skinned steel waste containers (a 60 litre container within a 200 litre container) and the internal void filled with an annulus of concrete shielding. Higher activity waste packages would be disposed at the bottom of each shaft, with lower activity packages stored at higher levels. This in itself represents good practice as all three major factors affecting the control of radiation dose are addressed, i.e. time, distance and shielding.

Details of the position of all non-radioactive and radioactive wastes within each cell will be in accordance with and recorded in a Waste Management Plan for each cell. The Waste Management Plan will be developed once the exact nature of the received wastes is known. However, the wastes will conform to the Waste Acceptance Criteria (WAC) developed by Tellus.

It is clear that alternative options have been considered in developing the design and that some options assessments have been carried out.

It is noted that the full benefits of optimisation have yet been realised by the design concept. For example, it is not clear that different options for waste treatment, handling and emplacement have yet been considered, noting that such consideration might offer the potential of reducing double handling and consequent worker doses. We recognise that consideration could occur during the detailed design phase.

Although there is not a clear link in the documentation between the design and the safety case, which would be considered best practice, it is not considered necessary at this stage. However, the detailed safety case covering Reference Design and seeking regulatory permission to proceed with construction will need to demonstrate compliance with over-arching design safety principles in addition to meeting specific safety functional requirements identified through hazard identification studies. Evidence of design alternatives, optimisation and elements of Human Factors involvement, regular maintenance and the maintenance of any safety important/ safety related systems (including radiation monitoring systems) to continue to perform their required safety function over the 25-year operational period before the site is locked down into a safe, passive state will be required. Using such an approach, the end result will be a safety informed design of the Sandy Ridge facility and the minimum requirement for regulatory oversight.

The proposal assumes that optimisation requirements can be addressed by working to criteria that are half of the appropriate regulatory criteria. This is not consistent with the spirit of optimisation, which requires that reduction in impacts be considered until the point at which such reductions are disproportionate in terms of cost or some other aspect of the system[4].

3.3 Passive Safety

IAEA SSR-5 Requirement 5: Passive means for the safety of the disposal facility

The operator shall evaluate the site and shall design, construct, operate and close the disposal facility in such a way that safety is ensured by passive means to the fullest extent possible and the need for actions to be taken after closure of the facility is minimized.

An acceptable approach is pursued during the operational period. Our view is that subject to further development of the safety case (which would be required for licensing), the design is capable of providing passive safety after the end of management control.

3.4 Understanding and Confidence

IAEA SSR-5 Requirement 6: Understanding of a disposal facility and confidence in safety

The operator of a disposal facility shall develop an adequate understanding of the features of the facility and its host environment and of the factors that influence its safety after closure over suitably long time periods, so that a sufficient level of confidence in safety can be achieved.

We consider that a sensible programme of work has been undertaken to understand the site covering surface characteristics, landform evolution, hydrology, hydrogeology and other aspects. We think this is a suitable basis for developing a safety case and a facility design.

We are not sure that consideration of all aspects of climate change (impacts on rainfall and infiltration, changed potential for flooding, changes to the characteristics of the surface environment and influences on the rate of erosive processes) have been fully documented. As documented below, with respect to human intrusion, we think that further work is needed to justify appropriate cases and calculations to determine appropriate limitations on the sources that could be disposed to the facility.

3.5 Multiple Safety Functions

IAEA SSR-5 Requirement 7: Multiple safety functions

The host environment shall be selected, the engineered barriers of the disposal facility shall

4 In the UK the requirement is to reduce impacts until the costs (including time and effort) of doing so are "grossly disproportionate". Part of the intent is to ensure that relatively minor adjustments are not precluded on an overly simplistic cost-benefit model. However, recognising that decreasing benefit will accrue at very low doses, a "threshold of optimisation" is also adopted below which it is necessary only to demonstrate that Best Available Techniques have been applied.

be designed and the facility shall be operated to ensure that safety is provided by means of multiple safety functions.

Containment and isolation of the waste shall be provided by means of a number of physical barriers of the disposal system. The performance of these physical barriers shall be achieved by means of diverse physical and chemical processes together with various operational controls. The capability of the individual barriers and controls together with that of the overall disposal system to perform as assumed in the safety case shall be demonstrated. The overall performance of the disposal system shall not be unduly dependent on a single safety function.

As noted in subsection 3.1, the facility is an excellent multi-barrier system.

3.6 Containment

IAEA SSR-5 Requirement 8: Containment of radioactive waste

The engineered barriers, including the waste form and packaging, shall be designed, and the host environment shall be selected, so as to provide containment of the radionuclides associated with the waste.

Containment shall be provided until radioactive decay has significantly reduced the hazard posed by the waste. In addition, in the case of heat generating waste, containment shall be provided while the waste is still producing heat energy in amounts that could adversely affect the performance of the disposal system.

The design conforms very well with the requirement to provide containment (see subsection 3.1).

3.7 Isolation

IAEA SSR-5 Requirement 9: Isolation of radioactive waste

The disposal facility shall be sited, designed and operated to provide features that are aimed at isolation of the radioactive waste from people and from the accessible biosphere. The features shall aim to provide isolation for several hundreds of years for short lived waste and at least several thousand years for intermediate and high level waste. In so doing, consideration shall be given to both the natural evolution of the disposal system and events causing disturbance of the facility.

The design provides good isolation from the perspective of natural events.

Institutional control will ensure that no intrusion occurs for the period of that control. After that point, intrusion is possible, but unlikely given the location and environment of the facility.

Wastes are emplaced at a depth of at least 7m, which means that only a restricted set of human intrusion scenarios would require consideration.

3.8 Step by Step Evaluation

IAEA SSR-5 Requirement 11: Step by step development and evaluation of disposal facilities

Disposal facilities for radioactive waste shall be developed, operated and closed in a series of steps. Each of these steps shall be supported, as necessary, by iterative evaluations of the site, of the options for design, construction, operation and management, and of the performance and safety of the disposal system.

The proposal describes appropriate periods and their duration over the lifetime of the facility e.g. closure, operations and institutional control.

We are aware that further work will be done in certain areas e.g. in terms of the licensing process. However, there is no evidence of a clear plan for reviewing the design, safety and underpinning documents in a staged manner. Such staged reviews should be proportionate to the hazard and would be considered part of good practice. As a result of such reviews updates to design or operating procedures might be agreed, for example. Such a staged process may be part of or could be incorporated in the forward work plan.

3.9 Safety Case and Safety Assessment

IAEA SSR-5 Requirement 12: Preparation, approval and use of the safety case and safety assessment for a disposal facility

A safety case and supporting safety assessment shall be prepared and updated by the operator, as necessary, at each step in the development of a disposal facility, in operation and after closure. The safety case and supporting safety assessment shall be submitted to the regulatory body for approval. The safety case and supporting safety assessment shall be sufficiently detailed and comprehensive to provide the necessary technical input for informing the regulatory body and for informing the decisions necessary at each step.

A safety case is appended to the PER. It is not yet sufficiently well developed to confirm that both operational and long-term impacts are acceptable and hence whether the design will perform appropriately. We understand that the safety case will be further developed for licensing purposes. However, at this stage, the safety statements and the PER overall gives confidence that the facility location, transport route, and radiation exposure to workers, the public, wildlife and plants are well within acceptable limits (excepting the comments on human intrusion that are set out below). The use of self-healing clay as the main structural barrier also installs confidence that the release of contamination (toxic and radioactive) would be minimal and well within acceptable limits.

In the PER, information is presented to indicate that erosion of the facility is not of concern. Other information is presented to indicate that any releases as a result of any dissolution of radionuclides in pore water and subsequent transport would be very low owing to the excellent multi-barrier system. Some further quantification of these arguments would be desirable s the case is developed.

Human intrusion is likely to be a critical pathway in determining limits on the spent sources that should be disposed in the facility (operational safety will also require consideration in this respect). International guidance indicates that such human intrusion after the loss of knowledge about the site should be considered on the basis of dose criteria. The value adopted in the proposal for the dose criterion is 10 mSv yr^{-1}, which seems appropriate.

The approach followed to define activity limits for disposed sources is to use generic concentration limits that were derived by the National Health and Medical Research Council (NHMRC) and published in 1992 [4]. When setting limits on the size of individual sources, the activity has been diluted over the material within the container containing the source. We are concerned that this approach is not consistent with best practice in a number of respects.

- The original calculations were undertaken in 1992 and there have been many developments since that time both pertaining to best practice in assessing the impacts of human intrusion and in recommended dose coefficients and other parameters used in such assessments.

- There may be specific aspects of the design of the Sandy Ridge Facility that may differ from the generic design assumed in the code of practice, e.g. the waste at Sandy Ridge may be at greater depth and different cases may be appropriate for evaluation. Both good practice and references [4,5] indicate that a site- and design-specific evaluation of the human intrusion pathway should be presented.
- The approach involves averaging the source activities over the waste package to derive an average specific activity. It is not clear that this is appropriate since there are potential cases that involve direct exposure to the source, e.g. following geotechnical borehole investigations and retrieval of and exposure to a source (such cases are routinely considered in many safety assessments internationally). For handling, skin doses might require consideration.
- The proposition, potential doses and safety arguments for a suitable set of cases are not clearly set out in the proposal and are not easily available for scrutiny as part of the site safety case.

We note that disposal of sources at a depth of at least 7m would rule out many sorts of human intrusion and human intrusion may be very unlikely at the site.

We have also received a draft Radiation Risk Assessment [6]. Estimates of radiation dose are provided in the report, but further limits on source activities are not set out. We have not evaluated the calculations in detail. However, we note the following.

- The chosen dose limits seem to be too low.
- Some of the calculations are very cautious in terms of residence times and some of the doses are unexpectedly high for the waste under consideration.
- The choice of scenarios is not justified and seems inappropriate (e.g. archaeological excavation or borehole drilling should at least be considered since these are conventional in many human intrusion assessments).
- The requirement is for a suitable test to determine the upper activity limits for sources that can be disposed in the waste facility - the chosen case (digging an excavation next to the shaft containing waste, coupled with long-term occupancy of that excavation) seems difficult to justify and rather unconventional.

The WAC for sources [8] appear currently to be based on a generic calculation, which is not best practice. However, we understand that work is progressing in this area.

It is not clear that a radiological assessment has been performed of a fire in the waste. The documentation indicates that some flammable wastes will be accepted for treatment and hence would be stored somewhere on the site for a period.

It is very good that an assessment of radiological impacts to non-human biota has been performed using the ERICA assessment tool. However, a very cautious approach has been used to infer action, based on doses to an individual in close proximity to the waste. The intent of the ERICA approach is not to protect such an individual, but to protect the wider population. Hence decisions should be reached based on radiological impacts to a representative member of a population in the general area of the site. Corresponding doses are likely to be very low.

3.10 Site Characterisation

IAEA SSR-5 Requirement 15: Site characterization for a disposal facility

The site for a disposal facility shall be characterized at a level of detail sufficient to support a general understanding of both the characteristics of the site and how the site will evolve over time. This shall include its present condition, its probable natural evolution and possible natural events, and also human plans and actions in the vicinity that may affect the safety of the facility over the period of interest. It shall also include a specific understanding of the impact on safety of features, events and processes associated with the site and the facility.

We believe that the approach to site characterisation is excellent and suitable to support the design and safety case.

We are not sure that all aspects of climate change have been considered. They appear to have been considered in terms of near-surface hydrology [7], but arguments do not appear to be presented in relation to other aspects.

3.11 Design

IAEA SSR-5 Requirement 16: Design of a disposal facility

The disposal facility and its engineered barriers shall be designed to contain the waste with its associated hazard, to be physically and chemically compatible with the host geological formation and/or surface environment, and to provide safety features after closure that complement those features afforded by the host environment. The facility and its engineered barriers shall be designed to provide safety during the operational period.

The design is based on the design of another facility that has been operating successfully. It generally seems appropriate and consistent with good practice. As noted elsewhere, for licensing purposes, it would be desirable to demonstrate performance of the design quantitatively.

3.12 Waste Acceptance

IAEA SSR-5 Requirement 20: Waste acceptance in a disposal facility

Waste packages and unpackaged waste accepted for emplacement in a disposal facility shall conform to criteria that are fully consistent with, and are derived from, the safety case for the disposal facility in operation and after closure.

WAC are documented both for hazardous and radioactive wastes and a broadly suitable process has been set out for waste acceptance [8,9]. This is necessary as it must be ensured that only wastes that are compatible with the design are disposed.

The general requirements on the sorts of materials that would be disposed seem appropriate. We note the need to consider the acceptability of wastes that might potentially generate gas, which we understand is addressed by Gate 11 of the WAC [8]. We note that voidage is considered in the WAC, although it might be appropriate to have some quantitative limit, given the potential impact on the stability of the cap.

We have commented above about the use of generic waste acceptance criteria with respect to human intrusion and commented that good practice would be to develop WAC that are specific to the site and design and consistent with the safety case. In reference [8] site specific criteria are quoted for NORM wastes based on calculations with the RESRAD program. It is stated that these calculations addressed post-closure and human intrusion scenarios. However, the question arises as to whether any WAC are required to mitigate any impacts during the period of operations. It may be that this is not required, but setting out the arguments would be best practice. The use of a 'sum of fractions' approach is appropriate.

3.13 Management Systems

IAEA SSR-5 Requirement 25: Management systems

Management systems to provide for the assurance of quality shall be applied to all safety related activities, systems and components throughout all the steps of the development and operation of a disposal facility. The level of assurance for each element shall be commensurate with its importance to safety.

From reviewing the PER and contents of the appendices provided, it is evident that Tellus Holdings operate a responsible Safety Culture across all levels of operation and management.

3.14 Co-Disposal

ARPANSA Guidance for Near-surface Disposal facilities Subsection A4.2

Proposals for co-disposal of radioactive waste with other hazardous wastes (chemical or biological) in the one facility should be assessed for the potential long-term effects of co-location of such wastes.

The review team was explicitly asked to consider the issue of co-disposal of hazardous and radioactive wastes. Co-disposal of different sorts of waste is an issue that has received attention in many repository programmes. The following issues might arise.

- Complexants generated from the hazardous waste might enhance transport of radionuclides.
- During operations, workers might be exposed to radiological hazards and might incur doses that might be avoided.
- Gas production from the hazardous wastes might degrade barriers intended to contain the radioactive wastes.
- Heat generated from the radioactive wastes might have an impact on the containment of the hazardous wastes.
- Design requirements for radioactive and hazardous wastes might differ and different design solutions might be required.
- After closure, cross contamination might occur and this might complicate any retrieval options if retrieval were to be required.

We do not believe that any of the above represent an issue, apart from possibly the potential for gas production. Taking each issue in turn:

The disposal system should do an excellent job of preventing significant environmental impacts as a result of releases in groundwater. Hence complexants would not be a significant issue.

Radioactive wastes will either be emplaced in a layer that will be covered by kaolinised granite backfill or in separate shafts and hence workers are likely to be substantially protected from exposure to radiation while undertaking non-radwaste operations in the cells.

Gas production could cause damage to the barriers if significant gas producing wastes were disposed. However, the disposal of reactive wastes is prohibited and water content of the wastes is likely to be low. As noted above, we understand that gas producing wastes would be excluded by Gate 11 of the WAC [8], although it might be better to make this more explicit

LLW does not produce significant heat.

The design appears to be appropriate for radioactive and hazardous wastes.

Use of kaolinite and other barriers within the cells and low water contents should mitigate against cross contamination.

Hence we consider that co-disposal is a suitable solution.

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4. FINAL REMARKS

Our overall findings based on the stated scope and review of the listed documents is as follows.

We consider that the design of the disposal facility is excellent and that the proposed multi-barrier system offers very good prospects of excellent long-term performance that would be comparable or in excess of that for many other LLW disposal facilities in other countries. This is facilitated by the favourable hydrological and hydrogeological environment.

However, we are concerned that the radionuclide specific activity limits for the sources that are suitable for disposal in the facility have not yet been set out adequately with consideration of design- and site-specific issues. We are aware that this is an area that Tellus are considering further.

A detailed safety case (or Pre-Commencement Safety Case, PCSR) will need to be developed for in-cell activities. Of initial concern for non-radioactive wastes would be whether a diesel fire resulting from insufficient dump truck maintenance could result in a tyre fire and what affect this would have on the toxic waste containers. Also, vehicle impacts in general would need consideration.

On the radiological side, the key concerns would be the design of the waste store and mechanical handling accidents involving the placing of ILW within the storage shafts, i.e. dropped/snagged load events, dynamic loads in general and the structural integrity of a single load path.

We would expect the detailed safety case to provide both detailed argument and supporting engineering calculations to demonstrate that the design would perform appropriately.

Similarly, we think that the waste management plan is not yet sufficiently developed to provide assurance that all aspects of waste storage, handling and emplacement will be appropriately managed.

The facility involves the co-disposal of both radioactive and hazardous wastes. Although arguments have not been identified in the documents that we have reviewed, we do not believe this represents a problem.

We note that the proposal involves reuse of mining void and is therefore environmentally beneficial. There are strong advantages also in managing and disposing of radioactive waste in one location rather than leaving it distributed at a range of different sites where there may be varying degrees of control and monitoring.

Overall, we consider that the proposal is sound from a technical viewpoint and that it is appropriate to proceed, notwithstanding our reservations in certain areas, which could be addressed by the programme as it moves forward.

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5. REFERENCES

1 Tellus, *Sandy Ridge Proposal, Draft Public Environmental Review for Adequacy*, 7th June 2016.

2 IAEA, *IAEA Safety Standards, Disposal of Radioactive Waste, Specific Safety Requirements,* IAEA Safety Standard Series SSR-5, 2011.

3 Australia Radiation Protection and Nuclear Safety Agency, *Protecting People and the Environment from the Harmful Effects of Radiation, Licensing of Radioactive Waste Storage and Disposal Facilities,* March 2013*.*

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5 Australia Radiation Protection and Nuclear Safety Agency, *Classification and Disposal of Radioactive Waste in Australia - Consideration of Criteria for Near Surface Burial in an Arid Area,* Technical report 152, 2010.

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Appendix A. Units and Prefixes

SI units of radiation and radioactivity

Quantity	SI unit and abbreviation
Absorbed dose	Gray (Gy)
Effective Dose	Sievert (Sv)
Radioactivity	Becquerel (Bq)

Multiples and sub-multiples of SI units

Factor	Prefix and abbreviation	Factor	Prefix and abbreviation
10^{18}	exa (E)	10^{-3}	milli (m)
10^{15}	peta (P)	10^{-6}	micro (μ)
10^{12}	tera (T)	10^{-9}	nano (n)
10^{9}	giga (G)	10^{-12}	pico (p)
10^{6}	mega (M)	10^{-15}	femto (f)
10^{3}	kilo (k)	10^{-18}	atto (a)

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