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How the NDA Provides Transparency and Visibility of the Technical Deliverability of the R&D Programme – 13303

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ABSTRACT

The Nuclear Decommissioning Authority (NDA) was created under the UK Energy Act 2004 to ensure the UK historic civil public sector nuclear legacy sites are decommissioned safely, securely, cost effectively and in ways that protect the environment. The delivery will involve carrying out many unique projects within a high hazard environment requiring the very highest standards in safety, security and environmental management. Unique problems require unique solutions and there is a substantial amount of research and development required for each project. The NDA's R&D strategic objective is to ensure that delivery of the NDA's mission is technically underpinned by sufficient and appropriate research and development. This drives a requirement to provide transparency and visibility of the technical deliverability of the programme through the technical baseline and accompanying research and development requirements.

The NDA need to have confidence in the technical deliverability of the Site License Companies (SLCs) plans, provide overall visibility of R&D across the NDA Estate and ensure that appropriate R&D is being carried out in a timely manner. They need to identify where coordinated R&D programmes may be advantageous as a result of common needs, risks and opportunities and ensure key R&D needs across NDA are identified, prioritised and work programmes are costed and scheduled in the Lifetime Plans for individual sites and SLCs.

Evidence of the Site License Company's approach and their corresponding technical underpinning programmes is achieved through submission of a number of outputs collectively known as TBuRDs (Technical Baseline and Underpinning Research and Development Requirements).

This paper is a summary of the information generated by an independent review of those TBuRDs. It highlights some of the key messages, synergies and common R&D activities across the estate. It demonstrates the value of a consistent approach to collecting R&D data across multiple Sites with a view to enhancing knowledge transfer and improving delivery efficiency. It will be of interest to all who are running R&D programmes where other programmes may be carrying out similar activities.

INTRODUCTION

The Nuclear Decommissioning Authority (NDA) is accountable for delivery of decommissioning and clean up of the UK's civil nuclear legacy. The NDA's core objective is to ensure that the historic civil public sector nuclear legacy sites are decommissioned safely, securely, cost effectively and in ways that protect the environment. The delivery will involve carrying out many unique projects within a high hazard environment requiring the very highest standards in safety, security and environmental management. Unique problems require unique solutions and there is a substantial amount of research and development required for each project. Unique problems require unique solutions requiring technical underpinning, which for many projects requires a significant amount of research and development. The NDA's R&D strategic objective is to ensure that the delivery of the NDA's mission is technically underpinned by sufficient and appropriate R&D.

Under the Energy Act (2004) the NDA is required to promote and, where necessary, carry out research in relation to its primary function of decommissioning and clean-up. There are close links to other Energy Act requirements such as sharing of good practice, enabling innovation and developing skills.. This strategy defines the approach to ensuring sufficient and appropriate Research & Development (R&D) is carried out to deliver the mission. The R&D Strategy covers technical underpinning work carried out by the SLCs and R&D sponsored directly by the NDA. Technology and the underpinning R&D are fundamental to ensuring the safe, cost-effective delivery of our mission. Together with innovation and the sharing of good practice both nationally and internationally, the intelligent application of R&D can reduce costs and timescales.

This drives a requirement to provide transparency and visibility of the technical deliverability of the programme through the technical baseline and accompanying research and development requirements. The NDA need to:

- Have confidence in the technical deliverability of the Site License Companies (SLCs) plans.
- Provide overall visibility of R&D across the NDA Estate and ensure that appropriate R&D is being carried out in a timely manner.
- Identify where coordinated R&D programmes may be advantageous as a result of common needs, risks and opportunities.
- Ensure key R&D needs across NDA are identified, prioritised and work programmes are costed and scheduled in the Lifetime Plans for individual sites and SLCs

Evidence of the Site License Company's approach and their corresponding technical underpinning programmes is achieved through submission of a number of outputs collectively known as TBuRDs. This stands for "Technical Baseline and Underpinning Research and Development

Requirements" and is documented in an NDA procedure ("EGG10"[1]). Rev 5 is now on the website – perhaps reference that one

There are a number of separate documents that make up the TBuRD:

- A Technical Management Summary that explains the technical governance and assurance processes of the Site License Company.
- Process Wiring Diagrams (PWD) which highlight planned technologies and their maturities for whole systems.
- A Table that lists all R&D activities detailing plans to resolve technical issues.
- A Technology Map giving a high level representation of the SLCs technology issues and opportunities.
- An Annual Technical Report which details any changes in governance / assurance processes and any significant in-year changes to the baseline and R&D requirements.

The SLCs generally produce updated documents on an annual basis to be delivered by year-end (December to March).

FINDINGS

Do the TBuRDs meet the objectives?

The TBuRD requirements have been independently reviewed against world best practice for the management and governance of R&D. It was concluded that TBuRDs are an excellent example of good practice.

Sources studied include:

- The United States Federal Government, the prime source of information both in terms of availability of information but also in its closeness to the UK scope of work being carried out.
- Review of private sector R&D governance
- French public sector R&D.

What was clear from the literature studied is that there are a number of themes that are consistently cited as weaknesses in the management of R&D, which the TBuRDs address particularly well:

[1] http://www.nda.gov.uk/documents/upload/EGG10-Technical-Baseline-and-Underpinning-Research-and-Development-Requirements-Rev4.pdf

- TBuRDs provide a strong strategic oversight mechanism
    - It looks not just at budgets, expenditure and reporting but also that of needs duplication, overlap and fragmentation. In summary it improves confidence that work isn't duplicated or repeated both within SLC programmes and across the NDA estate.

- TBuRDs reflect a portfolio approach to the overall programme including;
    - Ensuring there is a link between an individual project/programme and that of the mission/objectives.
    - Balancing the resultant overall programme across multiple programmes and missions.
    - Using a rigorous methodology for the prioritisation of Needs and Projects
    - Measuring the effectiveness and benefit of all projects.

- TBuRDs provide the underpinning data to develop improved sharing of information, knowledge exchange and joint efforts.

In summary, the TBuRDs evidence-based approach is powerful in that it:

- There isn't anything comparable to them in any of the US Agencies or in UK and EU public and private sectors.
- Provides evidence-based data for decision-making and oversight of complex, inter-site R&D.
- Allows the NDA to understand what R&D is being undertaken across the estate and to know where the major areas of work are in order to prioritise NDA effort.
- Helps to identify potential synergies in order to save time and cost across the estate.

What is the evidence saying?

The review analysed the results based on the TBuRD submissions from each Site Licence Company and considered a number of questions from an estate-wide perspective:

- Where is the bulk of the R&D activity being carried out and in what areas?
- When is the bulk of the work starting and when is it due to complete?
- What is the general level of technology maturity?

- Are there any gaps or synergies

What are the major areas of work?

Figure 2 below shows how the workload is distributed across the SLCs. The bulk of work is being carried out at Sellafield Limited (SL), which has more than 75% of tasks and 90% of lifetime R&D expenditure. Dounreay Site Restoration Limited (DSRL), Research Sites Restoration Limited (RSRL) and Magnox Limited (MXL) have roughly equal volumes of work with Low Level Waste Repository Limited (LLWR) the smallest workload. Some of these SLCs run multiple Sites and these are displayed on the NDA website (http://www.nda.gov.uk/sites/).

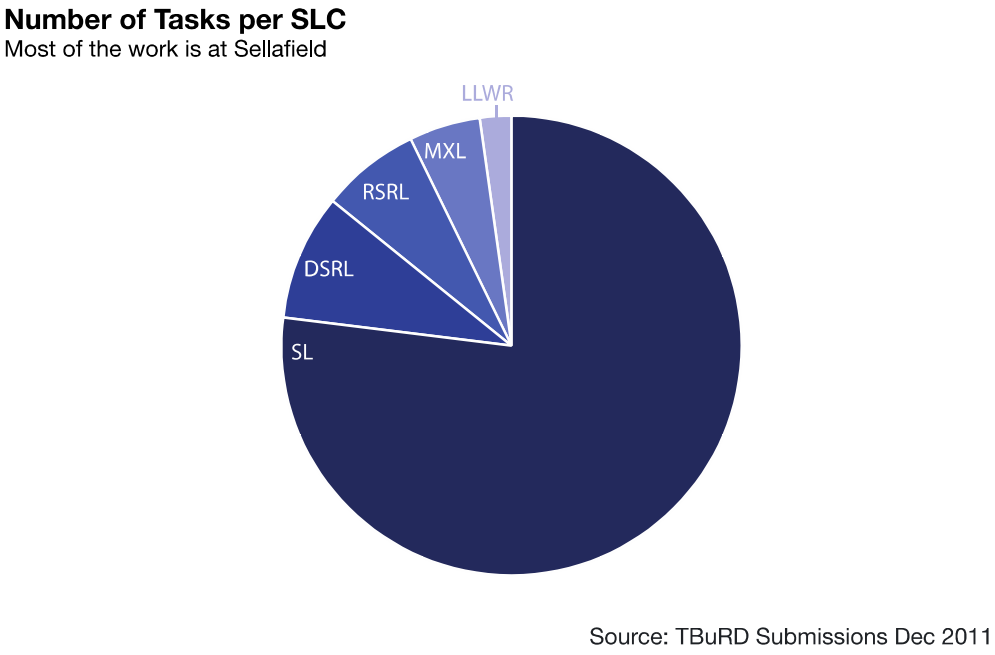


Figure 2

In order to bring a clear focus to the NDA mission, strategic themes have been assigned under which they group all activities. These include:

1. Site Restoration – their approach to decommissioning redundant facilities and managing contamination in ground and groundwater.

2. Spent Fuels – their approach to managing the diverse range of spent nuclear fuels for which they have responsibility, including Magnox, oxide and exotic spent fuels.
3. Nuclear Materials – their approach to dealing with the inventory of uranics and plutonium currently stored on some of their sites.
4. Integrated Waste Management – their approach to managing all forms of waste arising from operating and decommissioning their sites, including waste retrieved from legacy facilities. It also ties in the wider work of the Radioactive Waste Management Directorate on implementing geological disposal.

The TBuRD data was analysed along these strategic themes to identify where the majority of R&D was being carried out. Figure 3 shows the distribution of tasks across these themes. The data showed that the majority of R&D activities were in the processing & treatment of wet Intermediate Level Waste (ILW) and the waste retrieval of wet ILW. 75% of these tasks are at Sellafield which would be expected since this is a primary focus of work at Sellafield.

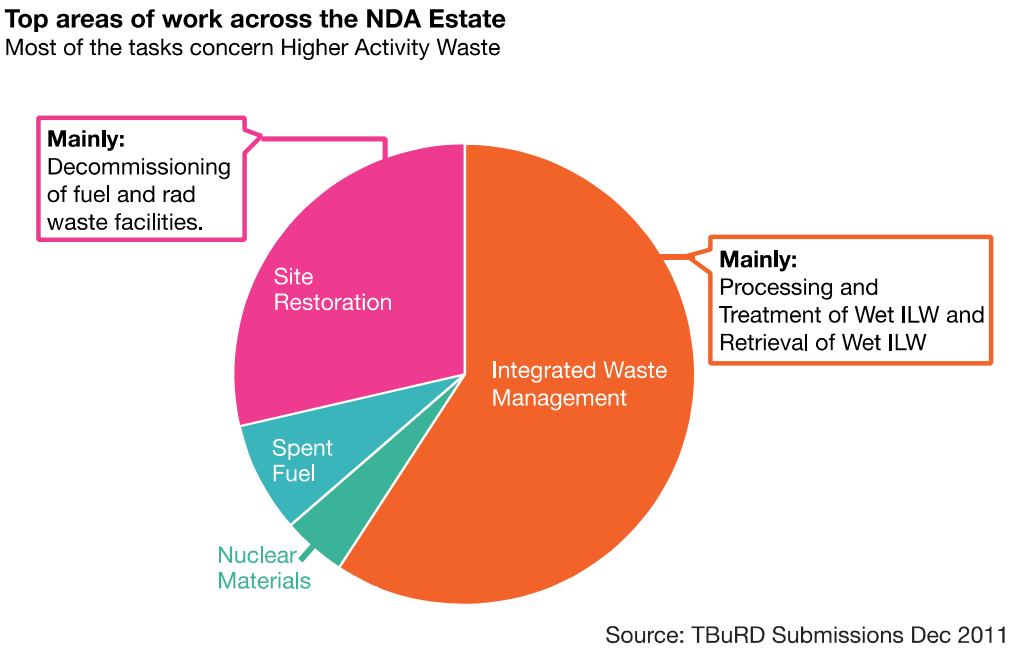


Figure 3

It is also evident from analyis of the data that the opportunities (tasks that could improve the current baseline plan), were also in processing and retrieval of wet ILW presenting possibilities for encouraging innovative technologies from the Supply Chain.

What are the schedules and cost profiles?

It is apparent from the data submitted at that point that the programmes are focused on the shorter term. It is easier to plan known work occurring in the near term compared to that in the longer term. It's also true that a major element of the delivery programme is also due for completion in the near term. Figures 4, 5 and 6 below show the number of new starts, their expected completion date and the approximate expenditure.

Figure 4 shows a significant number of activities are planned to start in 2011 compared to later years. Figure 5 shows that the majority of activities are planned for completion by 2013. The Site lifetime plans drive the R&D programme and this data mirrors those in that it is necessary to complete a significant number of activities in the short term. This correspondingly means they have to have already started, or be starting very soon, in order to have sufficient time to complete the activities by the target date.

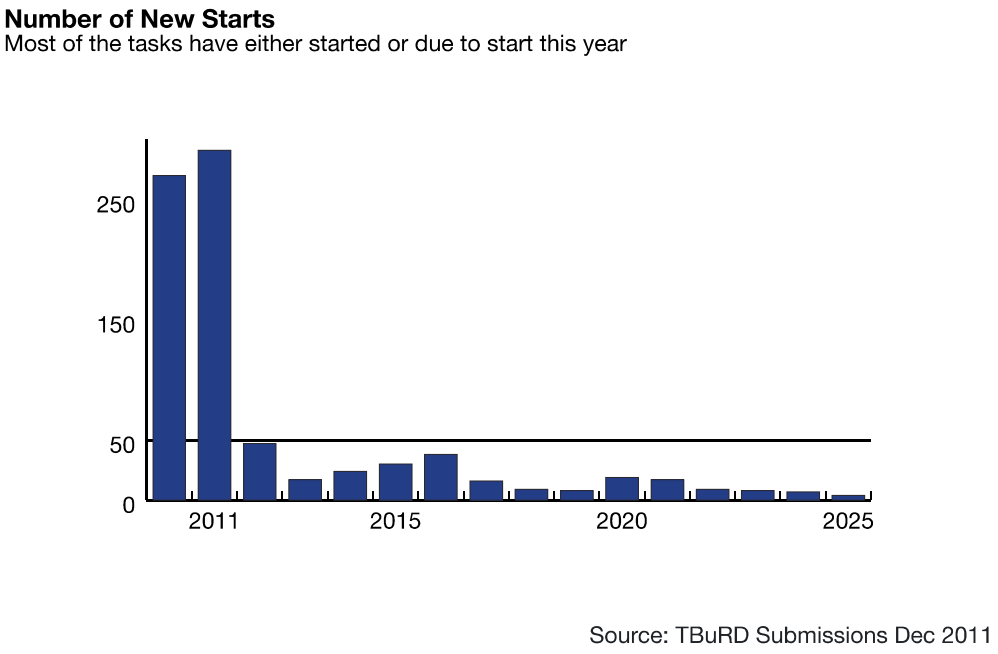
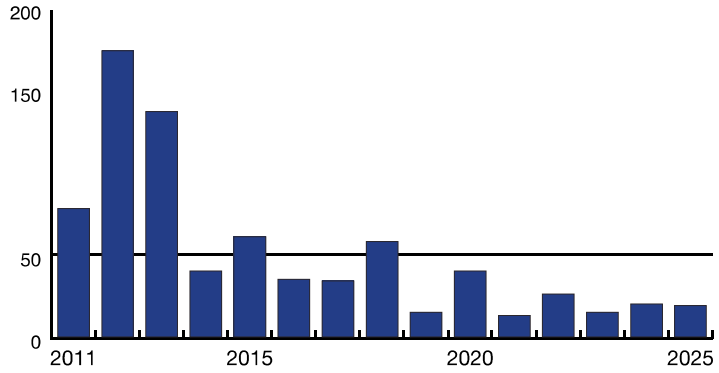


Figure 4

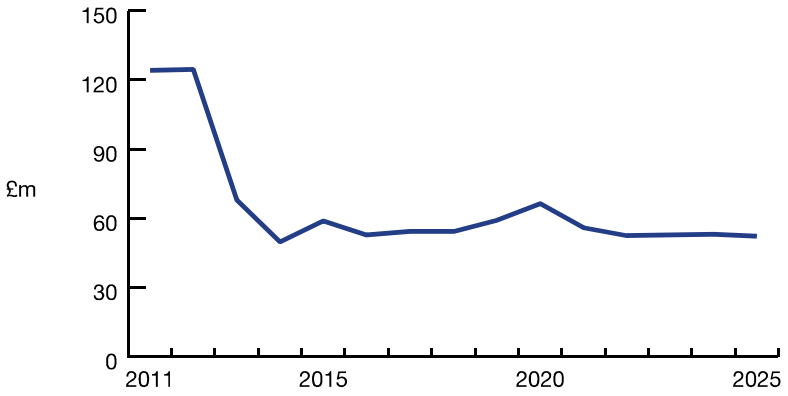
Number of Tasks Due For Completion
Most of the tasks are due to finish by the end of 2013



Source: TBuRD Submissions Dec 2011

Figure 5

15 Year Cost Profile
A sharp drop off in expenditure followed by flat expenditure per year, slight peak for 2020



Source: TBuRD Submissions Dec 2011

Figure 6

Figure 6 above, also shows the number of activities with an early initial spend to complete the near term tasks and a lower level of expenditure after 2013.

The above graphs may well demonstrate the classic "bow wave" effect where the new starts and expediture profiles simply move to the right as every year brings into focus more immediate activities. This has implications for the R&D programme of course, but also for the Site lifetime plans since the target date is driven by those requirements. Any drifting of these programmes could well adversely affect delivery of the lifetime plans. This will become better known as data for the 2012 submissions are analysed and progress accounted for.

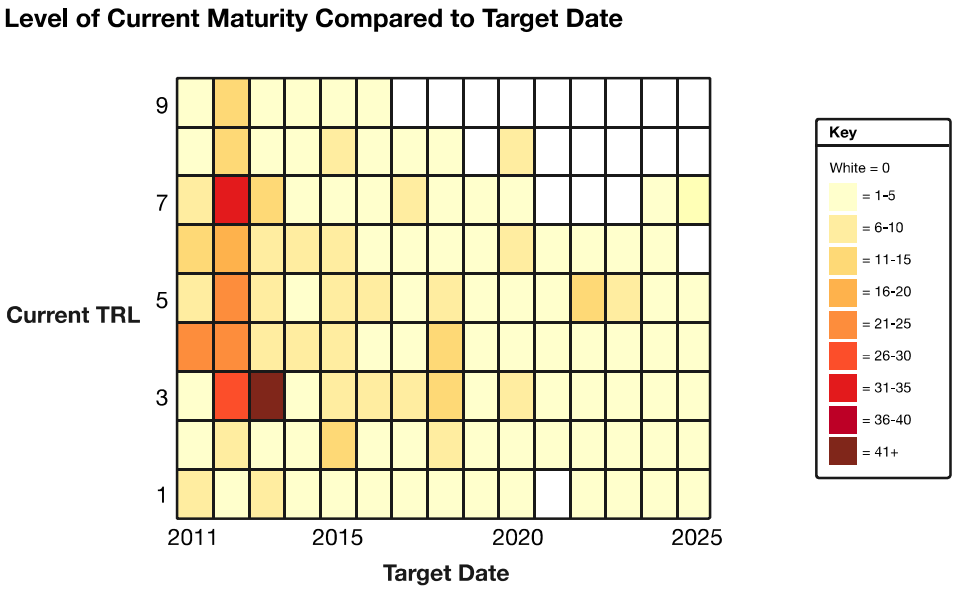
Is there time for the technology to mature?

Figure 7 illustrates the maturity of tasks compared to the target date. This diagram adds additional information to the schedule graphs above to describe the level of technological maturity currently compared to when it is needed. The x-axis is the Maturity which is the current Technology Readiness Level (TRL) as rated by the SLC. The TRL is an indication of whether the technology is ready for deployment with low numbers being immature (technology is only at a basic science level or carried out at lab scale) and high numbers being very mature (the technology has been tested in a similar environment to that expected on the plant). The y-axis is target date, the date when the technology is required for deployment or insertion. The grid shows the number of activities that correspond to this combination and are colour coded such that the more red the square the greater the number of tasks.

As an example, the darkest red box down in the bottom left of the diagram illustrates that there are a significant number of activities that are currently at TRL 3 but needed by 2013.

Tasks in the bottom left are those that are currently at a low maturity but are needed in the near term - within 3 or 4 years. These have been termed "High Risk"; not because they are necessarily impossible to achieve but because, typically, it is considered challenging to move technology so quickly through the maturity levels.

The diagram shows that most of the activities are currently at low TRLs but needed by 2013. This requires extremely fast maturation plans and there could be a risk that the technology won't be ready for deployment in a timely manner. However, it could also be the case that the activities are relatively straightforward and can get to the required maturity in good time. This view of the data allows the NDA and SLCs to ask those questions and drill down in more detail where required. It helps to prioritise effort on the areas that are of most concern.



Source: TBuRD Submissions Dec 2011

Figure 7

What are the potential synergies?

The synergies diagram, Figure 8, shows the volume of work being carried out in each strategy topic area. The line thicknesses are proportional to the amount of work being done by each SLC.

We have established that a large majority of work is being carried out within the Integrated Waste Management (IWM) topic area and that Sellafield has the largest workload. This can be seen by the length of the circumference section shown in orange next to SL. However it is also clear that there is a substantial number of activities in IWM in all of the other SLCs so there could be potential to identify shared R&D challenges and programmes. For Nuclear Material and Spent Fuel (NM-SF) there are fewer SLCs involved – mainly SL and DSRL – and so less opportunity to identify shared R&D challenges and programmes. Site Restoration touches all the SLCs to a certain extent although the majority of activities lie at SL.

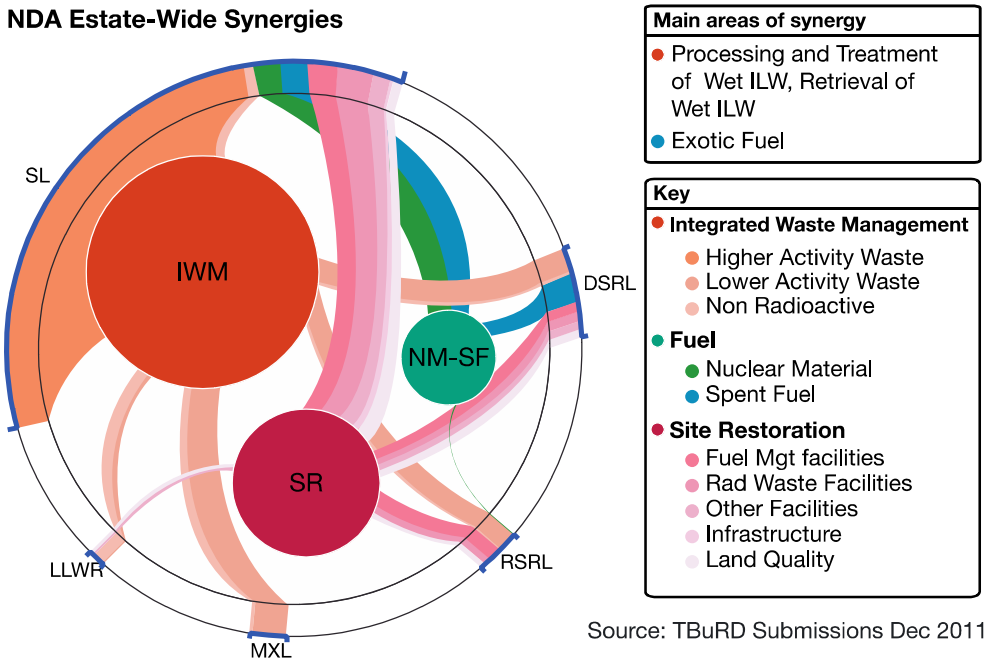


Figure 8

The diagram can be used to highlight potential areas where synergies may exist and then the SLC TBuRD submission R&D Tables can be used to look at the activities in detail.

The Nuclear Waste Research Forum (NWRF) has created a number of working groups dedicated to sharing of information within the nuclear industry. The current groups looking at technical aspects are focused on characterisation, waste packaging and storage, decommissioning and land quality. These groups were identified by NWRF based on their review of where the common R&D needs and opportunities across the organisations lay. These groups are clearly a good fit with the identified synergies and they will be in a good position to utilise this information to improve sharing and knowledge transfer. This Forum has representatives from beyond the NDA SLC estate.

What are the Key Issues and Opportunities?

- Sellafield Limited dominates the R&D portfolio with 75% of the activities and 90% of the expenditure taking place at Sellafield.

- Legacy Ponds and Silos at Sellafield have a large number of tasks currently at low technological maturity needed in a relatively short timescale. This is in the area of Inventory & Characterisation, POCO/Waste Retrieval and Process/Treatment, all mainly dealing with Wet ILW. There is a risk that the R&D will not be ready when planned which may impact the Lifetime Plans.
- The cost profiles and subsequent front end loading of plans may indicate that the cost and schedules for activities – even the near term ones – are relatively immature. There is a risk that once these activities are more accurately detailed, potentially using maturation plans that the costs will increase and the schedule move to the right, which will also impact the Lifetime Plans. This analysis has provided the opportunity to investigate this potential issue further.
- There are opportunities across the estate and almost 15% of all the activities are involved with trying to realise opportunities. However, they have not yet been fully quantified in the TBuRD submissions. Most of the opportunities are in the same area as the key issues (Inventory and Retrievals) but there are also a number in Disposal that have more inter-SLC impact. There are also a number in Nuclear Material activities that affect mainly Sellafield Limited and DSRL.
- There is significant estate wide work in Integrated Waste Management and particularly with Higher Activity Waste. Although Sellafield dominates there is still a significant amount of this work elsewhere.
- Solid ILW is a significant area across-estate.
- Most of the Sites have activities covering contaminated land and also treatment facilities decommissioning.
- The Nuclear Waste Research Forum working groups reflect the areas where the greatest commonality of R&D activities lie. These groups comprises members from all the Site License Companies and other waste producing organisations so are well placed to identify areas that are of most benefit for collaboration.

Analysis of the data (figure 10 below) also showed some changes between the submission in March and December. The workload has increased even though overall lifetime expenditure has stayed relatively unchanged. The profile of technology maturity has remained fairly unchanged but with more activities added particularly at the low end of maturity level.

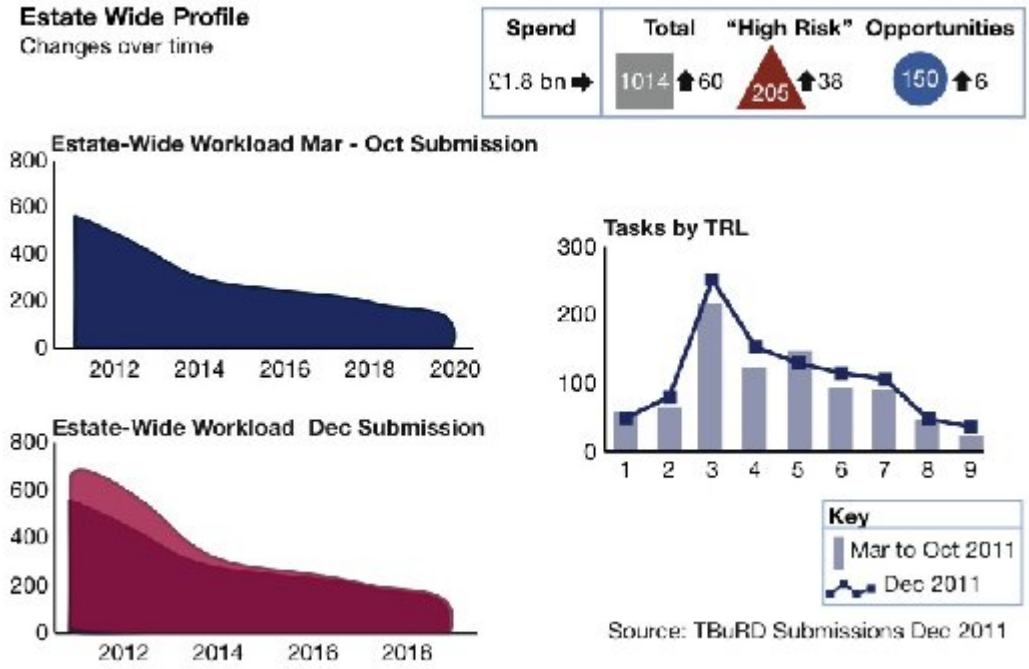

Estate Wide Profile
Changes over time
Spend
£1.8 bn
Total
1014
60
"High Risk"
205
38
Opportunities
150
6
Estate-Wide Workload Mar - Oct Submission
800
600
400
200
0
2012
2014
2016
2018
2020
Estate-Wide Workload Dec Submission
800
600
400
200
0
2012
2014
2016
2018
Tasks by TRL
300
200
100
0
1
2
3
4
5
6
7
8
9
Key
Mar to Oct 2011
Dec 2011
Source: TBuRD Submissions Dec 2011

Figure 10

CONCLUSIONS

The purpose of this independent peer review was to provide the NDA with a view on the compliance of the TBuRD submissions from each SLC, whether the TBuRDs were an adequate mechanism for R&D management and oversight and to identify where the common R&D activities lie across its estate.

From a thorough review of a large number of published documents on R&D management and oversight, it is clear that the NDA TBuRD is an excellent methodology.

It should be seen as best practice in that it:

- Provides evidence-based data for decision-making and oversight of complex, inter-site R&D.
- Allows the NDA to understand what R&D is being undertaken across the Estate and to know where the major areas of work are in order to prioritise NDA effort.
- Helps to identify potential synergies in order to save time and cost across the estate.
- There isn't anything comparable to them in any of the US Agencies or in UK and EU public and private sectors.

TBuRDs are an essential tool to underpin challenges and provide direction when resources are limited.

The review of compliance indicated strengths and weaknesses for each SLC and highlighted areas of common areas for improvement across the estate. It has also been of benefit to the SLCs in that they can both improve the quality of their TBuRDs and make use of the information to inform their own R&D programmes.

The data highlighted the key issues and opportunities across the estate where there is significant activity within the Integrated Waste Management topic area and particularly with Higher Activity Waste. Although Sellafield dominates this area there is still a significant amount of this work in the other Site License Companies with potential for collaboration and sharing of good practice.

This analysis and performance assessment has been beneficial in that it has provided an evidence-base for which to further investigate. It has consolidated a large amount of information into manageable elements that can then be analysed in more detail as required.. It has helped as a conduit to channel complex SLC specific knowledge towards having an estate wide perspective.

It confirmed that the NWRF working groups are aligned to the areas with the most synergy in R&D activities and therefore offer the best opportunity to realise collaboration.

In total, 27 recommendations have been made and these have been grouped into 7 work packages:

1. **Improvements to the TBuRD Specification.** These revolve around clarification of the wording. The aim is to make the wording and terminology more specific such that the SLCs can be more consistent in their TBuRD submissions. This will reduce errors (and variations) in submissions that will make it easier to aggregate data across the estate.
2. **Improvements to the Process Wiring Diagrams (PWD).** It was recommended that a wiring diagram based on plant/facilities was produced as well as those based on process steps.
3. **Improvements to TRL process.** It was recommended that the quality and consistency of TRL levels would be improved by the enhancement of standard guidance along with training. The process would be improved by implementing an assessment process for TRL level and the use of Technology Maturation Plans (TMPs).
4. **Improvements to R&D Table.** There were a number of recommendations for improving the R&D table to improve data consistency, provide additional data and to assist in understanding the technologies being considered. It was also recommended to move from the existing spread sheet solution to a database solution to help with data quality and to provide the ability to share task information more readily across the SLCs.
5. **Checking and Validation.** It was recommended that SLCs improve internal checking and validation prior to submission. In addition the NDA should review specific issues with each SLC.
6. **R&D Norms for Schedule.** It was recommended that data is collected on historical R&D in order to help underpin cost and schedule estimates and in particular to indicate the time required to move through the TRLs for different types of technologies.
7. **Implement Value and Effectiveness Measures.** It was recommended that measures for value for money and measuring effectiveness be introduced as integral to the TBuRD process.

These recommendations are currently being considered and, where appropriate, will be implemented.

A summary of the work undertaken can be found on the NDA website (http://www.nda.gov.uk/research/index.cfm)