The Approach of the United Kingdom's Nuclear Installations Inspectorate to Prioritisation of the Work Associated with Remediation of the UK's Nuclear Liabilities.

P. Connolly, P. Addison
Her Majesty's Nuclear Installations Inspectorate Principal Inspectors.
Health and Safety Executive
St Peters House, Balliol Road, Bootle
Merseyside, L20 3LZ, United Kingdom

ABSTRACT

This paper presents a methodology developed within the United Kingdom (UK), Health and Safety Executive's Nuclear Installations Inspectorate for ranking both the plants within a nuclear licensed site, and (by using nationally applicable scales) between such sites, in order of priority with respect to the need for their remediation.

It outlines the requirements for a system of prioritisation that can be applied to the programme of work needed to satisfactorily address the safety related concerns presented by the UK's nuclear radioactive waste and decommissioning liabilities.

It makes reference to the system being developed for the recently established Nuclear Decommissioning Authority by a working group involving a wide range of stakeholder interests and into which the UK's health, safety and environmental regulatory organisations have made significant contributions. A specific component of this system is a measure of the hazard potential that the various radioactive waste streams represent and a metric has been jointly developed to address this. However, ensuring the safety of the workers and the public requires a wider range of considerations than just hazard alone. This paper describes how a comprehensive yet pragmatic regulatory methodology has been developed to inform the prioritisation of the remediation of radioactive waste streams on the basis not only of their hazard potential, but also on the state of the facilities in which they are held, the stability and state of characterisation of the wastes themselves, and the worker dose uptake associated with them if their remediation is postponed.

This system enables the plants on a nuclear site to be ranked in order of the importance of their remediation if all of these safety related drivers are given equal weights and provides the basis against which meaningful regulatory decisions can be taken on the acceptability of licensees' programmes. The paper also outlines the work that has been undertaken to present the data in the form of a 'Prioritisation Calculator' that can be used to combine the results for different UK sites and which can also compare the effects of applying different weightings to the drivers for prioritisation.

An approach being developed in parallel by the Nuclear Decommissioning Authority is designed to take maximum benefit from existing systems including that described in this paper. The Nuclear Decommissioning Authority approach however needs to take account of considerations, in addition to safety, that address value for money and factors these into the results of their prioritisation system. Accordingly, this paper therefore also touches on the relationship between the regulatory prioritisation system and the approach being developed for the Nuclear Decommissioning Authority.

INTRODUCTION

This paper presents a straightforward methodology developed by the UK Health & Safety Executive's Nuclear Installations Inspectorate (NII) for ranking both the plants within a nuclear licensed site, and (by using nationally applicable scales) between such sites, in order of priority with respect to the need for their remediation. The work in this paper has been carried out in support of the NII's mission which is; *"to secure effective control of health, safety and radioactive waste management at nuclear sites for the protection of the public and workers and to further public confidence in the nuclear regulatory system by being open about what we do."*

The NII is part of the Health and Safety Executive (HSE) and carries out the regulation of nuclear licensed sites in the United Kingdom (UK). The main legislation covering the safety of workers and the general public at nuclear installations in the UK is the Health and Safety at Work Act 1974 [1] and its associated statutory provisions, which include the Nuclear Installations Act (as amended) 1965 [2] (NIA 65).

Under NIA 65, no site may be used for installing or operating any nuclear installation unless a site licence has been granted by the HSE. NIA65 allows HSE to attach such conditions to the site licence as may appear to HSE to be necessary or desirable in the interests of safety, or as it may think fit with respect to the handling, treatment and disposal of nuclear matter, including radioactive waste. It is largely through this route that we achieve our regulatory aims. The conditions, which are attached to a licence, are essentially goal setting and generally require the licensee to make and implement adequate arrangements for various site management activities. The arrangements that the licensee develops constitute elements of a safety management system to suit its business needs. The non-prescriptive nature of the licence conditions enables a continuous and flexible form of regulation that can be applied throughout all stages in the operation of a nuclear installation, including decommissioning.

BACKGROUND

In July 2002, the UK Government published a consultation paper 'Managing the Nuclear Legacy – A Strategy for Action' [3] setting out proposed arrangements for dealing with the UK's civil nuclear legacy waste. This legacy represents about 85% of total UK nuclear liabilities and is wholly the responsibility of Government. The Energy Act 2004 implemented these proposals and established the Nuclear Decommissioning Authority (NDA) as the executive authority.

It was clear that the amount of Government funding provided to the NDA would be a key factor in determining what could be achieved in terms of the cleanup and decommissioning work on Nuclear Licensed Sites, and how quickly this work could progress. Furthermore there would need to be assurance that the most important things are being addressed and the most urgent things are being done first, that there is a proper balance between sites and between projects in the allocation of the funds, and that the way in which funds are apportioned is fair and transparent.

In March 2004, the Government's Department of Trade and Industry (DTI) established a 'Prioritisation' Working Group to develop a methodology for achieving such a system of prioritisation. In addition to DTI staff tasked with forming the NDA, the working group had representatives from the UK nuclear industry, the Regulators, Government, local government and independent consultants bringing a variety of views.

In parallel with this activity, and whilst participating fully in the working group, the NII had identified the need for a procedure to prioritise, on safety related grounds, for all nuclear licensed sites, the order of

remediation of plants and / or major facilities which have reached the end of their operational lives and the waste retrievals from operational plants which have associated legacy holdings.
The procedure identified for this purpose also needed to address how prioritisation leads into the programming of these remediation and retrieval activities to establish milestones for monitoring and enforcement as necessary.

SCOPE AND PROCESS

It needs to be emphasised that the scope of the work is aimed at prioritising remediation activities only. The work is not intended to address the balance of priority between commercial operations and clean-up activities as the criteria that need to be applied for this will be different. Also the NII must remain neutral in respect of decisions on commercial activities as long as they are conducted safely.

It is also important to note that the process is applied to buildings/plants rather than to projects. The objective is to sort them into their respective rankings for priority of remediation on the basis of the risks that are presented by the buildings themselves and their inventories.
The first step of the process is therefore to apply an Operations / Clean-up filter to establish the list of candidate plants for each site. Appendix I describes the issues involved and the way in which this initial broad filter is applied.

SAFETY RELATED PRIORITISATION REQUIREMENTS

Having established the lists of candidate plants, the requirements that need to be incorporated into any system of prioritisation to address NII's interests need to be identified. The starting point is therefore to identify the range of safety considerations related to NII's mission. The approach to prioritisation being adopted by NII uses a set of safety related 'drivers' built up from the wide range of mission-related elemental safety considerations. These elemental components have been subsumed into a set of five overarching 'drivers' to provide a manageable framework for application. These are:

Regulatory Enforcement / Agreement

This driver refers to plants / projects for which there exist legally based regulatory requirements and addresses the following elemental criteria:

1. Legal requirements/public commitments
2. Position of waste stream in the staged process to passivation and disposal.

These criteria are already effectively established insofar as there are a number of legally binding licence instruments on various UK plants arising from NII's routine regulatory duties. There are also a number of undertakings made by licensees which have been incorporated into their programmes without recourse to licence instruments and which in several cases have been made public. (The legal requirements may generate additional priorities in respect of other plants that will be needed as enablers to the discharge of those requirements). In addition, if it is unlikely that waste streams will be taken to safe passive states in a timely manner, the need or otherwise for additional enforcement action will have to be considered.

In developing the methodology for applying the drivers it was recognised that there was little advantage in including this particular driver into the NII prioritisation framework since work to which this driver applies is non-discretionary and would always attract a top priority. Nevertheless, it was felt that the facilities to which this driver applies should be evaluated against the other drivers to assist in informing their relative positions in relation to programming. (Work is also ongoing in respect of the development of regulatory schedules, which are intended to address the scope of formal 'regulatory requirements' in a wider sense than just enforcement notices and instruments.)

Hazard Potential Indicator
The hazard potential indicator was established through a multipartite working group involving licensees, regulators, stakeholders and the NDA. It addresses the hazard presented by a waste in the form it is in and also provides a comparative measure for demonstrating and communicating the relative benefits of various treatment options with respect to passivation. A technical paper, guidance document and calculator have been published [4].

Ongoing Facility Safety
This driver introduces a concept of a period of prudent custodianship in relation to the buildings and structures housing wastes. It addresses the integrity of these for the period over which building functionality has to be maintained for continued safe custodianship of the wastes contained within them. The concept demonstrates the need for having a wider range of drivers for prioritising work from a safety viewpoint than just the hazard potential indicator. It addresses the following elemental criteria:

1. Remnant Design Life/intent (from original Plant Safety Report).
2. Current condition/defects.
3. Contingency provisions.
4. Modern standards comparison.
5. Periodic Safety Review (PSR) Programme.
6. Structure Fragility containing consequence/risk.
7. Uncertainty of structure.
8. Interaction with other plant (Failure consequence).

Waste Uncertainty Criterion
This measure provides a ranked list of the reasons for which retrieval timescales might prove uncertain and likely to require extension. It covers the long term changes in physical waste forms associated with degradation of wastes which will make their handling requirements different and more difficult as time progresses, the uncertainty of inventory which will generate programme holds as work progresses and further information comes to light, and the inventory uncertainty which dictates the need for extended programmes associated with sampling and characterisation.

Mobilisation
This driver provides a ranked list of the reasons to mobilise early starts to retrievals. Essentially it covers avoiding various dose implications of waiting, taking advantage of current operational experience before it is lost, maintaining continuity of existing work/teams, mobilising infrastructure which is now in a position for work to commence, providing footprints for other significant remediation projects, and trialing grounds for more complex remediation projects. During the development of this driver the need was identified to address two separate concepts, one related mainly to skills, effort, and continuity, and the other related to avoidable dose burdens of legacy/redundant plants. The former was termed the Continuity and Trialing driver, and the other, the Legacy Dose Driver. As they have evolved, the Legacy Dose Driver has been developed further and is addressed below, while the development of the Continuity and Trialing driver has led to it being moved outside the prioritisation framework on the basis that it only re-justifies continuation of work which is effectively already top priority, and that its component elements are naturally dealt with through other aspects of the process and its application.

Legacy Dose Driver
This driver provides the recognition that the 'mortgage' costs widely referred to in relation to legacy plants comprise three components rather than just the financial costs. The additional components are the ongoing doses and discharges associated with a plant that is not being remediated but subject only to ongoing care and maintenance. Reducing the ongoing dose component is the direct concern of NII in relation to worker dose issues and considerations of reasonable practicability, while the discharges component is the direct concern of the environmental regulators in relation to public dose and environmental detriment. The legacy dose driver has therefore been developed to permit a broad categorisation of plants into those of effectively high, medium, and low concern based on the typical dose levels associated with the plant and the numbers of personnel exposed to these doses for care and maintenance activities. The environmental regulators are separately developing appropriate measures for addressing environmental effects and the public dose component. It is anticipated that the latter measure could then be incorporated into the database as a 'Public Dose Driver'.

APPLICATION OF SAFETY DRIVERS

The NII drivers described above are addressed through a system of '*descriptors'*.

Allocation of descriptors
For each driver, a set of descriptors has been drawn up to describe the range of hypothetical plants that address the various combinations of the elemental components of the driver. An example of these descriptors is included at Appendix II for the Ongoing Facility Safety driver. The descriptors are ordered on an ascending scale typically from 1 to 10 representing very poor (top priority), to very good (bottom priority), and the plants / facilities to be prioritised are matched to the nearest appropriate descriptor under each driver. The allocated priority number for all the drivers are then simply added up to provide an unweighted summary score for each plant / facility. This leads to a low score equals high priority listing of all plants and facilities.

Substantiation
Underpinning justifications for the descriptor allocations for each plant are provided through reports compiled by the specialist NII inspectors relevant to each driver and these are recorded in drop down menus within the database that forms the framework for the prioritisation process. The specialist reports will be subject to internal consultation with a range of experienced inspectors to provide a rationalised, validated approach and audit trail.

Output
The output of the process is a database with NII's list of plants and facilities for each site, ranked for priority on safety grounds with recorded justifications, and with all drivers carrying equal weight. This will provide NII with information for comparison with the licensee's proposed programmes for remediating the sites, and will also provide the data for NII's input to the NDA prioritisation process. The process is not intended to deliver mechanistically derived absolute values but provides the framework of an aid to decision making through which the effects for instance of different weightings of drivers can be judged. It is proposed to apply national scales within the process rather than scales re-baselined for each site. This means that there will be sites that do not have a priority 1 against some of the drivers. Through this process these safety drivers will be considered alongside the wider national drivers or 'attributes' whose effect on the results will then become clear and provide the basis for considered debate.

Programming from Prioritisation

Having established a prioritised listing of plants/facilities, each item in the prioritised list then needs to be expanded to incorporate the portfolio of associated plants, facilities and projects which are the necessary enablers for its remediation. This will include research and strategy development projects, see Appendix III. This information will need to be provided by the licensee and must include portfolios for the alternative strategic options for each plant's remediation. Combined with strategic decision points, this provides the basis for establishing programme expectations that can be compared with the detailed near term work plan proposals.

THE PRIORITISATION CALCULATOR TOOL

The basis of the tool developed for prioritisation is a Microsoft Excel © spreadsheet, which provides the database record for information on the drivers and their descriptors for all of the NDA sites. In populating this spreadsheet, to ensure that the descriptors are consistently applied in a repeatable way, guidance notes are provided in the form of high-level questions that need to be addressed in relation to the overall purpose of the driver. This guidance is extended to a set of more detailed questions for the non-numeric descriptors. These lists provide generic questions for a standardised set of component factors that need to be addressed for each driver. The guidance provided in the form of these generic question sets is included at Appendix IV.

In considering the generic questions, the regulatory specialists charged with generating the data, record a brief summary statement against each component of the driver describing the status of that component in relation to the specific plant in question. By comparison against the descriptors, these statements provide an underpinning justification for the particular descriptor allocation, which is then used as the priority score for that driver.

The descriptor scores are entered into the spreadsheet, which enables the qualitative supporting data to be entered alongside it in drop down menus. This provides a tool that can be interrogated at any time and revised as waste streams are remediated or building conditions change (Fig. 1).

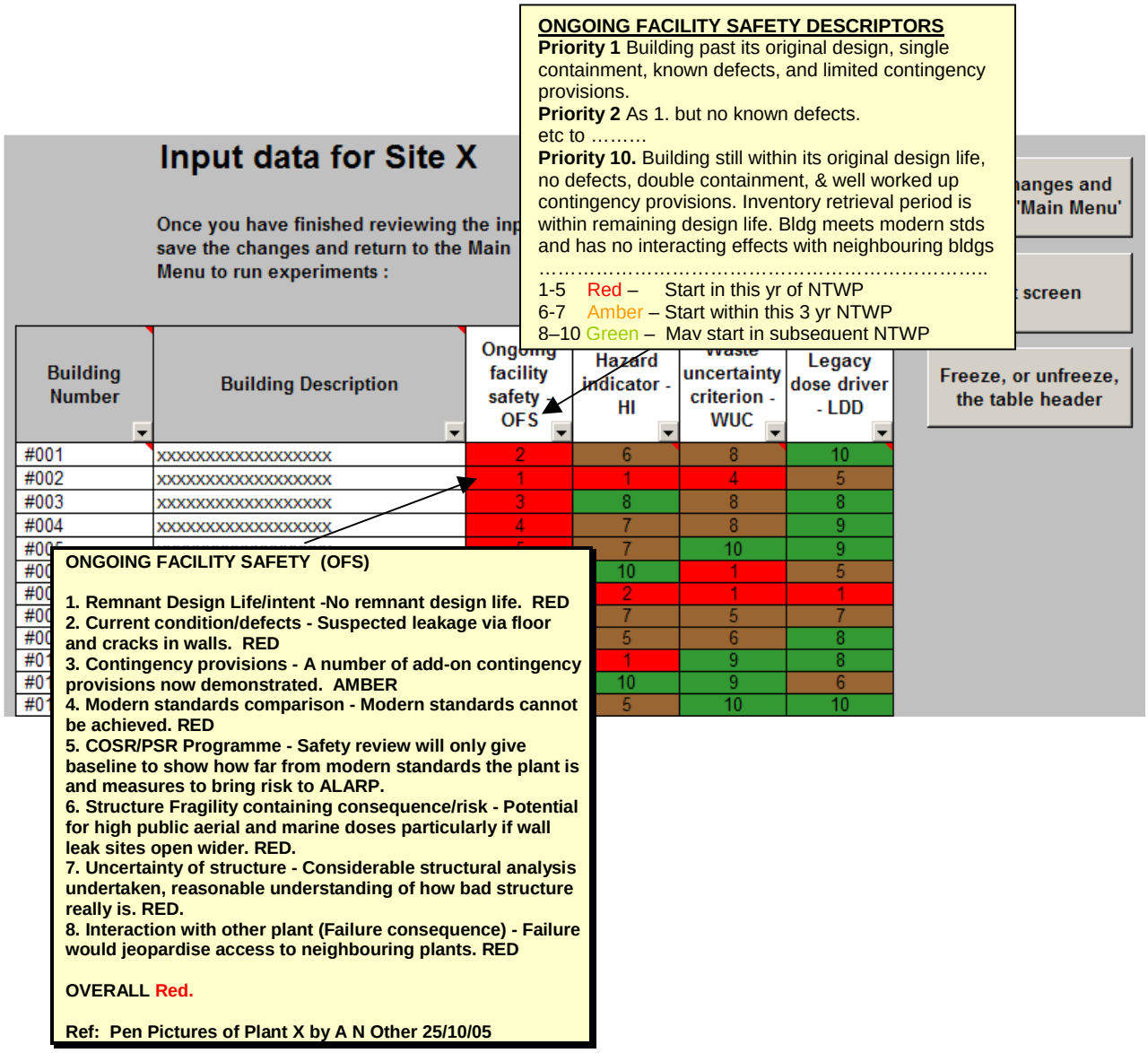


Fig. 1: Basic Spreadsheet forming the Core of the Database

This basic sp ible means of manipulating

The calculat and comparisons of different weighting scenarios to be demonstrated. Fig. 3 shows five sets of results corresponding to a different weighting scenario in each case, the first with all four drivers equally weighted and the remaining four with each driver in turn scored alone at 100%.

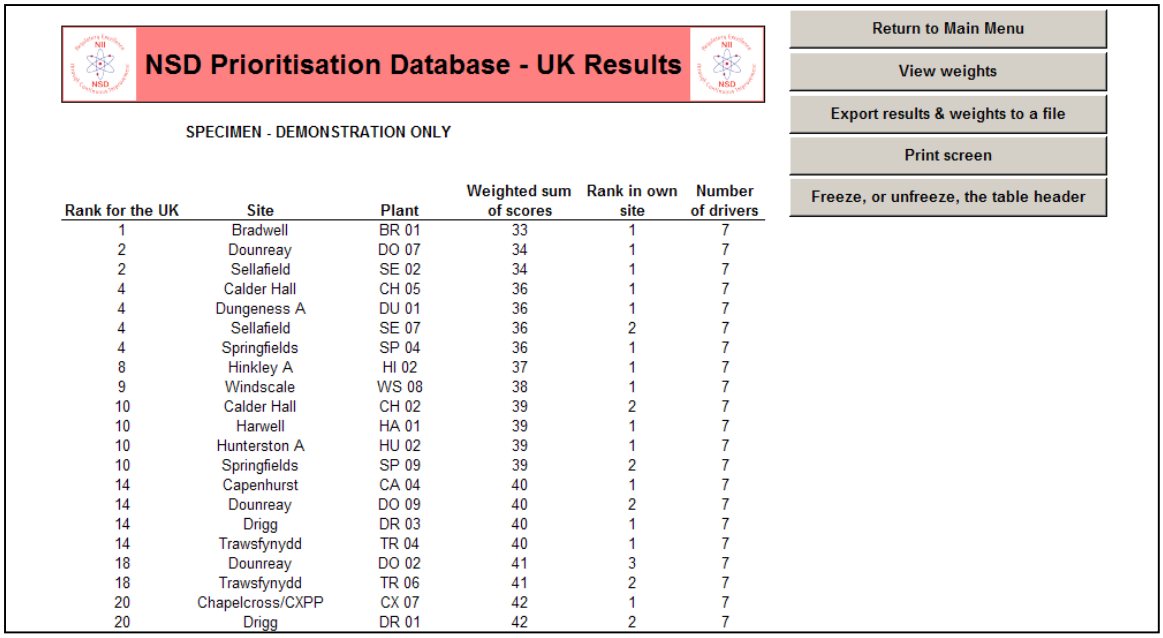
Results of five scenarios for Sellafield.

Return to Main Menu | Highlight individual plants | Highlight all plants | Clear all highlights | Export these results to a file | Print page | Hide/unhide the number of drivers

Scenario 1		Scenario 2		Scenario 3		Scenario 4		Scenario 5			
OFS 100%		OFS 100%		OFS 0%		OFS 0%		OFS 0%			
HI 100%		HI 0%		HI 100%		HI 0%		HI 0%			
WUC 100%		WUC 0%		WUC 0%		WUC 100%		WUC 0%			
LDD 100%		LDD 0%		LDD 0%		LDD 0%		LDD 100%			
Rank	Facility Score	Rank	Facility Score	Rank	Facility Score	Rank	Facility Score	Rank	Facility Score	Facility Scen 1	# of drivers
1	SE 07 11.0	1	SE 01 2.0	1	SE 02 1.0	1	SE 06 1.0	1	SE 07 1.0	SE 07	4
2	SE 02 12.0	1	SE 02 2.0	1	SE 10 1.0	1	SE 07 1.0	2	SE 02 5.0	SE 02	4
3	SE 06 23.0	3	SE 03 3.0	3	SE 07 2.0	3	SE 02 4.0	2	SE 06 5.0	SE 06	4
4	SE 01 26.0	4	SE 04 4.0	4	SE 09 5.0	4	SE 08 5.0	4	SE 11 6.0	SE 01	4
5	SE 03 27.0	5	SE 05 5.0	4	SE 12 5.0	5	SE 09 6.0	5	SE 08 7.0	SE 03	4
5	SE 08 27.0	6	SE 06 7.0	6	SE 01 6.0	6	SE 01 8.0	6	SE 03 8.0	SE 08	4
7	SE 04 28.0	6	SE 07 7.0	7	SE 04 7.0	6	SE 03 8.0	6	SE 09 8.0	SE 04	4
7	SE 09 28.0	8	SE 08 8.0	7	SE 05 7.0	6	SE 04 8.0	6	SE 10 8.0	SE 09	4
7	SE 10 28.0	8	SE 11 8.0	7	SE 08 7.0	9	SE 10 9.0	9	SE 04 9.0	SE 10	4
10	SE 05 31.0	8	SE 12 8.0	10	SE 03 8.0	9	SE 11 9.0	9	SE 05 9.0	SE 05	4
11	SE 11 33.0	11	SE 09 9.0	11	SE 06 10.0	11	SE 05 10.0	11	SE 01 10.0	SE 11	4
11	SE 12 33.0	12	SE 10 10.0	11	SE 11 10.0	11	SE 12 10.0	11	SE 12 10.0	SE 12	4

Fig. 3: Comparison of Different Weighting Scenarios.

The calculator also enables combination of results for all UK plants to display a national ranking of plants based on the selected weighting scenarios. The form of the print out is shown in Fig. 4 below using hypothetical data.



NSD Prioritisation Database - UK Results

SPECIMEN - DEMONSTRATION ONLY

Return to Main Menu | View weights | Export results & weights to a file | Print screen | Freeze, or unfreeze, the table header

Rank for the UK	Site	Plant	Weighted sum of scores	Rank in own site	Number of drivers
1	Bradwell	BR 01	33	1	7
2	Dounreay	DO 07	34	1	7
2	Sellafield	SE 02	34	1	7
4	Calder Hall	CH 05	36	1	7
4	Dungeness A	DU 01	36	1	7
4	Sellafield	SE 07	36	2	7
4	Springfields	SP 04	36	1	7
8	Hinkley A	HI 02	37	1	7
9	Windscale	WS 08	38	1	7
10	Calder Hall	CH 02	39	2	7
10	Harwell	HA 01	39	1	7
10	Hunterston A	HU 02	39	1	7
10	Springfields	SP 09	39	2	7
14	Capenhurst	CA 04	40	1	7
14	Dounreay	DO 09	40	2	7
14	Drigg	DR 03	40	1	7
14	Trawsfynydd	TR 04	40	1	7
18	Dounreay	DO 02	41	3	7
18	Trawsfynydd	TR 06	41	2	7
20	Chapelcross/CXPP	CX 07	42	1	7
20	Drigg	DR 01	42	2	7

Fig. 4: UK-Wide List of Plant Rankings.

Detailed use of the calculator is described in an internal NII guide, which is currently being re-drafted to provide a user friendly interface reflecting the latest developments in the calculator.

EARLY RESULTS

Using the above methodology, a ranked list of plants has been generated for the most complex UK chemical site and for a small number of plants on the next most complex. The use of nationally applicable scales in these rankings has enabled a comparison of the plants within these two sites to be undertaken using the calculator developed for that purpose.

The early results reflect intuition in respect of the results generated within the sites and provide an underpinning justification for less intuitive rankings between sites in the UK listing.

The results have been left as unweighted additive combinations of the drivers to emphasise that their purpose is not to provide a single 'right answer', but rather to provide the underpinned data needed to inform the constructive debates that need to be held in relation to constraints and decision making on prioritised programmes.

APPLICATION OF RESULTS

Having established the ranked lists of plants for a site this can be used as a yardstick for high-level regulatory judgement of licensees' programmes for remediation of their sites (referred to as lifecycle baselines). The licensees' current programmes have been generated using separate processes to date but essentially addressing the same set of core attributes developed in the Prioritisation Working Group.

The common basis of the main attributes applied to the prioritisation process, taking account of additional attributes required by the NDA, means that any gross discrepancies between the licensees' programmes and regulatory judgements can be examined and the reasons for them identified. Once the licensees' remediation programmes adequately reflect regulatory needs, the issue becomes one of implementation, more detailed programming and regulating adherence to the programmes.

The more detailed programming in the short term is embodied in the licensees' near term work plans and these are driven by driven by NDA Performance Based Incentives under the contract, but this is not enough for regulatory needs. What NII requires is an inspectable means of assuring progress against generic achievement milestones, which reflect the objectives of the remediation task.

INSPECTION AND MONITORING OF PROGRESS

'Prioritisation' is not yet driving regulatory inspection and programmes in a meaningful and proactive way. Historically, continuing slippage of programmes has been a problem, as 'ever-improving' options for the remediation activities are investigated and proposed by the licensees. Even using milestones as regulatory landmarks for the major projects proposed by the licensees has not ensured proactive regulatory engagement. As projects develop there remains a tendency for licensees to repeatedly re-baseline programmes along the lines of alternative approaches that meet the needs of the most recently developed criteria.

An approach to regulation of remediation programmes is being developed based upon management by objectives. This utilises the results of the 'Prioritisation' methodology to provide simple progress metrics that can be applied to programmes in parallel with a set of generic remediation objectives. By formally agreeing the generic milestone points with the licensees in advance, these metrics could then be used as evidence of progress towards acceptable end-points, or of unsatisfactory performance that may need a regulatory response proportionate to the seriousness of the slippage. Progress against the generic objectives would be reviewed on a regular basis.

RELATIONSHIP BETWEEN REGULATORY AND NDA APPROACHES

The approach being adopted by the NDA is to prioritise plants on a similar basis to that of the regulators using their drivers but extended to include a driver of 'value for money'. The projects that deliver remediation against these prioritised plants are then measured for progress using time based versions of the drivers or 'metrics'. This also assists in providing an input to optioneering processes since the projects that deliver maximum progress can then be preferentially selected in a limited resource environment.

The NII approach provides the safety related basis for ordering the plants in both systems as described earlier. The programming issues however are dealt with differently. Having established a prioritised list of plants, the licensees' programmes for their baseline remediation are then examined. These programmes address a portfolio of projects in each case covering the upstream and downstream plants and facilities, the research and development projects underpinning the programmes, and the infrastructure projects necessary to support them. Historically the difficulty with regulation of these programmes has been the reactive nature of the regulatory monitoring process. Using the 'Management by Objectives' approach described above however, it should now be possible to establish a set of generic project milestones, which implicitly assure progress and map these onto declared milestones in the licensees' baseline programmes. Credit will then be given for achievement of these milestones in the form of a score proportional to the prioritised ranking of the plant. Failure to achieve milestones on the other hand would be reviewed regularly and would potentially attract enforcement actions to bring the programmes back onto track.

In this way, there would be an automatic rein on disproportionate effort by licensees to achieve acceleration driven by NDA measures on specific projects that do not necessarily reflect the primary safety concerns, and on delaying projects which involve significant spends solely for financial benefit.

The overall outcome of the wider prioritisation process for NII will therefore effectively be a set of remediation objectives or targets informed by safety related priorities that will form a yardstick for negotiation of NDA proposals for alternative balances of progress options.

Whilst every attempt will be made at working level to rationalise the NDA and NII prioritisation results it is nonetheless anticipated that there will be constructive tension between the processes that will lead to considered debate to develop the most appropriate remediation of the UK's nuclear liabilities. In this way, future Government and policy discussions will be framed around the same common terms.

AREAS FOR DEVELOPMENT

A significant area for development in both the regulatory and NDA systems is that of weighting of scores. The NII system currently presents its results in the form of ranking based on the unweighted sum of the scores for the safety drivers. This recognises the fact that the output of the process is a data set to help inform decision making rather than an absolute result in its own right. It is therefore appropriately set up as a broad-brush overview rather than a precise mathematical model. In this way, a valid view of priority issues can be established even though the equal banding scales used for the drivers are not truly linear. The additive approach of the NII system is considered fit for purpose although it uses non-linear data bandings.

The NDA approach on the other hand is working towards a purer mathematical approach with its attendant complexities. It employs data scales which as far as possible reflect their non linearity in the scoring. Their combination is multiplicative to give a result which may be considered to be more representative of an absolute score but whose derivation also involves certain subjectivities. The incorporation of the regulatory drivers into the NDA system therefore necessitates modification of the scoring and weighting of the drivers and their descriptors, and of their means of combination. In particular there exists the potential for the relative weightings of the safety related drivers eventually fixed upon by the regulators, to be altered in the balance adopted for NDA's wider system. Successful negotiation of mutually acceptable outcomes will therefore be highly dependent upon clarity of these differences.

The NDA are also presenting a paper to WM'06 on the issue of prioritisation and delegates are invited to take the opportunity of examining the relative processes for their synergies and areas for development.

REFERENCES

1. 'The Health & Safety at Work etc. Act 1974 Chapter 37'. (Act of Parliament). *HMSO Publication, Reprinted 1991*. ISBN 0-10-543774-3
2. 'The Nuclear Installations Act 1965 Chapter 57'. (Act of Parliament). *Amended December 1995. HMSO Publication.*
3. 'Managing the Nuclear Legacy – A strategy for action'. *2002. Government White Paper Cmd 5552.*
4. 'The Use of a Hazard Indicator as a Long Term Performance Indicator by the NDA for Public Sector Nuclear Liabilities' *P. Fawcett, BNFL; R. Sellers, NDA; A. Hart, NII; G. Butler, IDM; G. Linekar, UKAEA (UK)*. Paper to 10th International Conference on Environmental Remediation and Radioactive Waste Management (ICEM'05), September 2005.

ACKNOWLEDGEMENTS

The authors would like to acknowledge the significant contributions to the development of the work described in this paper which has been provided through Dr Duncan Shaw, Aston Business School, Birmingham, UK, who has carried out the necessary programming and testing of the Microsoft Excel © spreadsheets on an evolutionary basis to provide the extensive degree of functionality and demonstrability available in the current calculational model.

APPENDIX I - 'OPERATIONS / SUPPORT' vs 'LEGACY / CLEAN-UP' FILTER

The purpose of this filter is to separate from the total list of plants and facilities those that are concerned solely with commercial operations. For these plants and facilities, prioritisation of remediation activities is not relevant until they reach the end of their useful lives and are transferred to remediation management. The justification for any expenditures on these plants and facilities must be annually reviewed by the NDA to provide the assurance that this represents an overall cost benefit taking account (on a lifetime basis) of *inter alia*; the costs of the investment work, the amount of additional waste / legacy generated and the costs of its treatment (including decommissioning costs of any new treatment plants needed for it), the future potential for use of the plant for waste treatment, the baseline operations and management costs, and the revenue / additional revenue projected to accrue from operation of the plant / facility.[1]

It is also important to differentiate between general operations and commercial operations. The former applies to all operations / support work including basic activities fundamental to securing continued licensability. It would therefore include such things as health physics, transport, safety case production /implementation, and security, which represent the minimum level of day to day safety related activities necessary to support ongoing licence compliance. Much of the work in this area of general operations represents an essential baseline of activity necessary to ensure continued safe operation of the site and expenditure in these areas is considered a mandatory requirement that the licensee must continue to undertake at an appropriate level. The routine regulatory regime provides the necessary controls and monitoring to ensure that this baseline compliance is achieved and there is no need for NII to separately justify the prioritisation of these non-discretionary activities.

General operations however, would also include direct plant operations, management, and project work, on both legacy/waste treatment plants and on commercial/dual purpose plants such as THORP. Prioritisation of any of these plants which have a legacy component (including dual purpose plants), and also of the redundant plants and facilities is entirely valid with a view to securing appropriate improvements in levels of safety in a timely manner.

The NII approach addresses the remediation of existing liabilities which take the form of redundant plants and facilities, those stores and / or processing facilities containing the end-point legacies of commercial operations, and those operational plants whose inventory includes material which is unsatisfactorily packaged or on the verge of becoming a legacy by virtue of becoming unsuitable for handling within the existing operational facility.

NII would not prioritise proposed projects for plants that are provided solely for operational support regardless of whether they are purely commercial or required for 'baseline' safety of the site. We would not therefore explicitly prioritise projects associated with much of the existing infrastructure provisions that are fundamental to the ability to continue to operate the site within the terms of the licence even where such provisions may be supporting remediation activities.

In summary, we are prioritising remediation of relevant plants on safety grounds, not spend across the site.

[1] Although the 'tests' required for justification of expenditure on operations are yet to be established, an additional element in support of their case may be a projected future use as a waste treatment route for other plants' legacy and/or decommissioning wastes. This may help to justify expenditure on asset maintenance and improvement projects during operational life.

APPENDIX II - EXAMPLE OF DESCRIPTOR LIST - 'ONGOING FACILITY SAFETY'

Priority 1 - Building past its original design life/intent, single containment, known/believed significant defects, and limited contingency provisions[2].
Building is not qualified to withstand modern design basis hazards.
This category includes below ground structures, which are likely to be subject to water ingress or provide leak paths to earth/groundwater.
Priority 2 - Building past its original design life/intent, single containment, and limited contingency provisions but no known/believed significant defects.
Building is not qualified to withstand modern design basis hazards.
This category includes below ground structures that are believed to be intact but provide a realistic potential for leak and escape. (i.e. as Priority 1, but no known defects).
Priority 3 - Building past its original design life/intent, and single containment, but no known/believed significant defects and well worked up contingency provisions.
Building is not qualified to withstand modern design basis hazards. (i.e. As Priority 2. but well worked up and engineered contingency provisions).
Priority 4 - Building past its original design life/intent, but no known/believed significant defects, double containment, and well worked up contingency provisions.
Building is not qualified to withstand modern design basis hazards.
Also within this category are buildings that are not themselves associated with a hazardous inventory, and which may or may not be within their design lives, but whose failure would have a significant adverse impact on buildings with a hazardous inventory.
(i.e. As Priority 3 but double containment designed into the building. Category also includes low hazard buildings with significant risk of failure that could affect higher hazard buildings).
Priority 5 - Building still within its original design life/intent, and no known/believed significant defects, has double containment, and well worked up contingency provisions. Building is not however qualified to withstand modern design basis hazards and retrievals would take longer than remaining design life available. (i.e. As Priority 4 but some remnant design life although inventory retrieval would extend beyond the life remaining).
Priority 6 - Building still within its original design life/intent, and no known/believed significant defects, has double containment, and well worked up contingency provisions. Inventory retrieval period would not extend beyond the remaining design life available. Building is not however qualified to withstand modern design basis hazards. (i.e. As Priority 5 but inventory retrieval would be completed within the remaining design life of the building).
This category also covers redundant buildings which have undergone Post Operational Clean Out (POCO) but whose structural integrity is very poor.
Priority 7 - Building still within its original design life/intent, and no known/believed significant defects, has double containment, and well worked up contingency provisions. Inventory retrieval period would not extend beyond the remaining design life available. Building is also qualified to withstand modern design basis hazards but as a result cuts are being imposed on Periodic Safety Review (PSR) follow-up work.
(i.e. As Priority 6 but building qualified to modern standards although only limited implementation of PSR follow up programmes is being pursued).
This category also covers redundant buildings that have undergone POCO and whose structural integrity meets a minimal level of acceptability subject to an ongoing programme of maintenance.

[2] Contingency provisions should be taken to mean not only the means of redressing faults and restoring services and control for design basis faults, but also the means of implementing the Symptom Based Emergency Response Guidelines for Beyond Design Basis Accidents including plans for relocation of inventory.

Priority 8 - Building still within its original design life/intent, and no known/believed significant defects, has double containment, and well worked up contingency provisions. Inventory retrieval period would not extend beyond the remaining design life available. Building is also qualified to withstand modern design basis hazards and all PSR follow-up work is being implemented. Failure of neighbouring buildings however, could have significant adverse impact on the building in question.
(i.e. As Priority 7 except that PSR follow-up programmes are being fully implemented, but additionally, building is at risk from neighbouring facilities).
Priority 9 - Building still within its original design life/intent, and no known/believed significant defects, has double containment, and well worked up contingency provisions. Inventory retrieval period would not extend beyond the remaining design life available. Building is also qualified to withstand modern design basis hazards and all PSR follow-up work is being implemented. Building not at risk from adjacent facilities, but building failure could have significant adverse impact on neighbouring higher hazard buildings/facilities.
(i.e. As Priority 8 but building presents potential risk to neighbouring facilities).
Priority 10 - Building still within its original design life/intent, and no known/believed significant defects, has double containment, and well worked up contingency provisions. Inventory retrieval period would not extend beyond the remaining design life available. Building is also qualified to withstand modern design basis hazards and all PSR follow-up work is being implemented. Building not at risk from adjacent facilities, and doesn't itself present a risk to neighbouring higher hazard buildings/facilities.
(i.e. As Priority 9 but building not at risk from, or a risk to, neighbouring facilities).

Application notes related to building or ground contamination:
Buildings which have a known history of radioactive or chemical contamination resulting from leaks, spills, or incidents, that:

- have not been comprehensively physically repaired, and are believed to be subject to continuing or possible future leakage or spread of associated ground contamination are included in category 1.
- which (having been physically repaired, are no longer believed to be subject to ongoing leakage or spread of associated ground contamination, are included in category 2 unless structural issues warrant a higher classification.
- which were known to be 'one-offs' and/or have been subject to remedial action such that they are no longer believed to be subject to present or future leakage or spread of associated ground contamination, are included in category 3 unless structural issues warrant a higher classification.

Similarly, a facility which is not a building *per se* but is a specific area of ground associated with historical raw waste (or short-term-packaged waste) disposals, or recorded historical leaks and therefore known to be contaminated:

- where the contamination is believed to be spreading and has potential to extend beyond the site boundary or pollute an environmental receptor (such as an aquifer), is included in category 1.
- where the contamination is believed to be spreading but has only limited potential to extend beyond the site boundary or pollute an environmental receptor, is included in category 2.
- where the contamination is monitored and/or controlled and is therefore believed not to be spreading significantly and does not threaten pollution of an environmental receptor, is included in category 3.

APPENDIX III - EXAMPLE OF A PORTFOLIO OF PROJECTS FOR REMEDIATION OF A FUEL STORAGE POND

Plants	Facilities	Research/Development	Infrastructure
Inventory/skip export provisions (building/cells)	Off-site test facility	Simulant development	Asset maint (bldg fabric & support systems)
Solids encapsulation /treatment Plant	On plant maint facility	Sludge sampling	Contingency provisions
Local effluent treatment plant	Skip handling m/c refurbishment	Porous cladding	Surveys/dose control measures
Local sludge treatment plant inc buffer tankage.	Sludge export line provision	Sludge pumping trials	Pond purge provisions
Local decontamination plant	Skip wash facility	Sludge head deployment provisions	Water layering
Transport flask maintenance building.	Skip transfer provisions (refurb)	Re-canning equipt (small-piece)	Fuel transport flasks
Inventory characterisation plant.	Mezz room & decanner settling tank decontam facility.	Skip handling m/c tooling (debris etc)	ILW flasks
Pond water settling tanks building		Skip orientation equipment	Magazines?/magazine flasks
		Sludge/debris recovery trials on less complex plant (Trialing grounds)	Crane/handling equipment rail maintenance
		Hydraulic shears for solids	Enabling plant (footprint plant) demolition
		Prove decontam route	
		Waste product specifications for all waste streams	
		Fuel / grout interaction trials	

APPENDIX IV - GENERIC QUESTION SETS FOR GUIDANCE ON ALLOCATION OF DESCRIPTORS

High level questions at the driver level

A means of maintaining focus on the intention behind the drivers whilst populating the database is to have simple test questions for each. With this in mind, the following list of questions has been drawn up for application of the drivers:

Ongoing Facility Safety

1. Has the building or facility passed its period for prudent custodianship of its waste content with regard to its original design life and its current state?
2. How far does it depart from the ideal with regard to defects, contingency provisions, and modern standards?
3. What is its status with respect to leakage and contribution to spread of ground contamination?

Waste Uncertainty Criterion

4. Is the waste/containment matrix degrading, and if so, is the degradation being monitored and managed?
5. Is the waste chemically reactive to the extent that there is significant potential for dispersal of associated activity even if it is being monitored and managed?
6. Is the inventory uncertainty (overall building contents or degrading waste physical state) likely to extend the retrieval timescales?

Legacy Doses.

Is there a significant ongoing dose burden associated with simply maintaining the status quo of the 'asset' (liability) which is not justified on ALARP grounds and runs contrary to Cm2919 ?

Security.

Would compromises to facility integrity arising from design basis security threats potentially lead to significant radiological exposures/releases from a particular facility, and if so, how much more (if anything) could be done to strengthen its protection or reduce its inventory?

Hazard Indicator.

Dealt with through an independent work stream on the basis of three questions:

7. How much material is there, and how harmful could the radioactivity in it be to people?
8. How much of the material would be released if the protection provided by its storage method was lost completely for a short period of time – for example for one day
9. For the current/proposed storage mode, what monitoring period would a competent and experienced design engineer be likely to propose at the design stage as being necessary to ensure containment, based on the intrinsic hazard of the material, the mode of storage, and how these might evolve?

Detailed questions at the descriptor level

Generic question sets which are used to guide statements to support descriptor allocations are given in the following tables for the 'Ongoing Facility Safety' and 'Waste Uncertainty' descriptors:

Ongoing Facility Safety – Elemental components.

Component	Generic questions
Remnant Design Life/intent (from original Plant Safety Report).	Is the building within its original design life and can the inventory housed within the building be retrieved within the design life remaining? If there was no specific design life was there any life intent supported by the Plant Safety Report and is that still being met?
Current condition/defects.	Has the building been maintained in a condition equivalent to its original design? Are there any significant known defects which impinge on the building's functionality or containment?
Contingency provisions	Does the building include contingency provisions to recover from loss of containment/loss of inventory? Are these incorporated as part of its design, minimal/ad hoc arrangements, or totally dependent on operator response and emergency arrangements? Are SBERGs and Severe Accident Guidelines or equivalent applicable to the building and available?
Modern standards comparison.	Does the building meet modern structural design standards for nuclear plant? If remedial programmes have been implemented to improve the plant's structural capability, does the agreed life extension cover the period needed for retrievals? Does the building provide double containment for its inventory? Is it capable of withstanding design basis events as currently defined for internal and external hazards? Does it incorporate monitoring, inspection, and testing to support an ageing management regime.
Periodic Safety Review Programme.	Have remedial programmes for shortfalls against modern design standards comparisons been fully implemented or have reduced programmes been implemented in the past on the basis of remaining life etc.? What is the projected lifetime of the building under the last periodic safety review and what conditions attach to that projection? Are these being or have they been met?
Structure Fragility containing consequence/risk.	Does the building have weaknesses against design basis events that cannot realistically be addressed other than through mitigation? Are the consequences of failure applicable to the building as a whole or would failure be restricted to a localised part/parts of the building? If restricted, does this have a significant effect on the potential consequences?
Uncertainty of structure.	Are the programmes of monitoring and inspection of the building adequate and supported by sufficent analysis to provide predictive judgements on the structural capability of the building to support retrieval operations and equipment/facilities? Are there areas of the plant which are inaccessible or which for other reasons it is not possible to obtain appropriate data.
Interaction with other plant (Failure consequence).	Does the building have a radiological inventory and is it susceptible to damage from the collapse of, or other events on, neighbouring buildings (including projectile damage)? Is the building itself an ageing or vulnerable facility which although it may not have any radioactive inventory itself, represents a hazard to neighbouring buildings which do?
Overall Building Descriptor Value	TRAFFIC LIGHT

The overall building "traffic lights" allocation has the following key:

Red — Building past its "sell by date". No longer fit for purpose. To be assured of safety retrievals should start now.

Amber — There is some margin between the building life and expected retrievals period but retrievals need to be started in the Near Term Work Plan.

Green — There is plenty of margin for retrievals which therefore do not need to be programmed for the immediately foreseeable future (could delay starting to at least 2007).

Similarly, 'traffic light' colours are applied to each elemental component statement for each plant in the database, which directly contributes to ongoing facility safety driver, in order to give the overall building traffic light allocation for simple visual representation of which plants warrant highest licensee and regulator attention under facility safety.

Waste Uncertainty Driver – Elemental components.

Component	Building 1 Waste stream A	Generic Questions
Waste structure/Stability		Is any of the raw waste physically or chemically degrading or otherwise changing, does it have potential to do so, and/or are the degradation processes generating or capable of generating any hazardous materials or gases themselves? Is any such degradation being monitored/managed?
Package Waste Stability		Are any of the packaged wastes/packages degrading or disintegrating, do they have potential to do so, and/or are the degradation processes generating or capable of generating any hazardous materials or gases themselves? Is any such degradation/disintegration being monitored/managed?
Fissile		Is there uncertainty about the composition of the waste which could lead to potential criticality problems if the waste degrades/disintegrates or could lead to such problems if the waste was consolidated during retrievals?
Confidence in Character of waste		Is the quantity, location and composition of the waste known, or if not, could it be ascertained by sampling? Alternatively, is complete characterisation only likely to be possible as the waste is retrieved?
Retrievability		Is the nature of the waste sufficiently stable and the characterisation of the bulk sufficiently well known that there is confidence that the wastes will withstand the material handling methods developed for retrieval without disintegration or damage and without necessitating significant holds in the retrieval programme to consider alternative handling methods as new inventory is uncovered?
Processability		Are the processing methods that have been developed likely to need to be re-designed or modified completely or in part to accommodate any differences arising in the nature of the wastes due to physical, radiological or chemical changes occurring in the wastes with time? (an example might be shielding for Americium ingrowth)
Disposability		Is a Letter of Comfort available for disposal of the proposed product? Alternatively, is there an adequate degree of knowledge and certainty of the waste such that sufficient segregation and characterisation can be achieved to render a Letter of Comfort feasible? If not, is the technology to be able to do so likely to be realised within the next 30 years? (In the former cases there is no justification for prioritisation solely on this component of the driver. In the latter case however, if technology is unlikely, 'foreclosure of options' should be accepted and treatment of these uncertain wastes prioritised to allow for early processing into passivated products.)
Waste stream A descriptor value		**3 (by comparing the 'Explanations' above against the 'Descriptor list' in relation to the bulk of the inventory in this waste stream)**

Produce similar tables for other main waste streams, i.e. for Pond sludge and Pond water

Overall Building Descriptor Value (Highest scoring waste stream)	**1 (Pond Sludge stream)**

(Red = Start now, Amber = start as soon as practicable & within this NTWP, Green = flexibility on start)