



# Radioactive Waste Management

# Generic Waste Acceptance Criteria (WAC) and the UK Disposability Assessment Process

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# Structure of Presentation

- Derivation of Generic Waste Packaging Specifications
  - Historic Low Heat Generating Waste (LHGW) specifications
  - Basis in generic Disposal System Safety Case (DSSC)
  - Evolution to requirements
  - Systematic development of High Heat Generating Waste (HHGW) requirements
  - Relationship between specifications/requirements and WAC
- Assessment and endorsement against generic specifications
  - Disposability Assessment process
  - Current position and progress
- Maintenance of existing endorsements and non-compliance
  - Periodic Review
  - Cross-cutting review
  - Management of non-compliance

# Derivation of Generic Waste Packaging Specifications

# Getting Packaging Right First Time

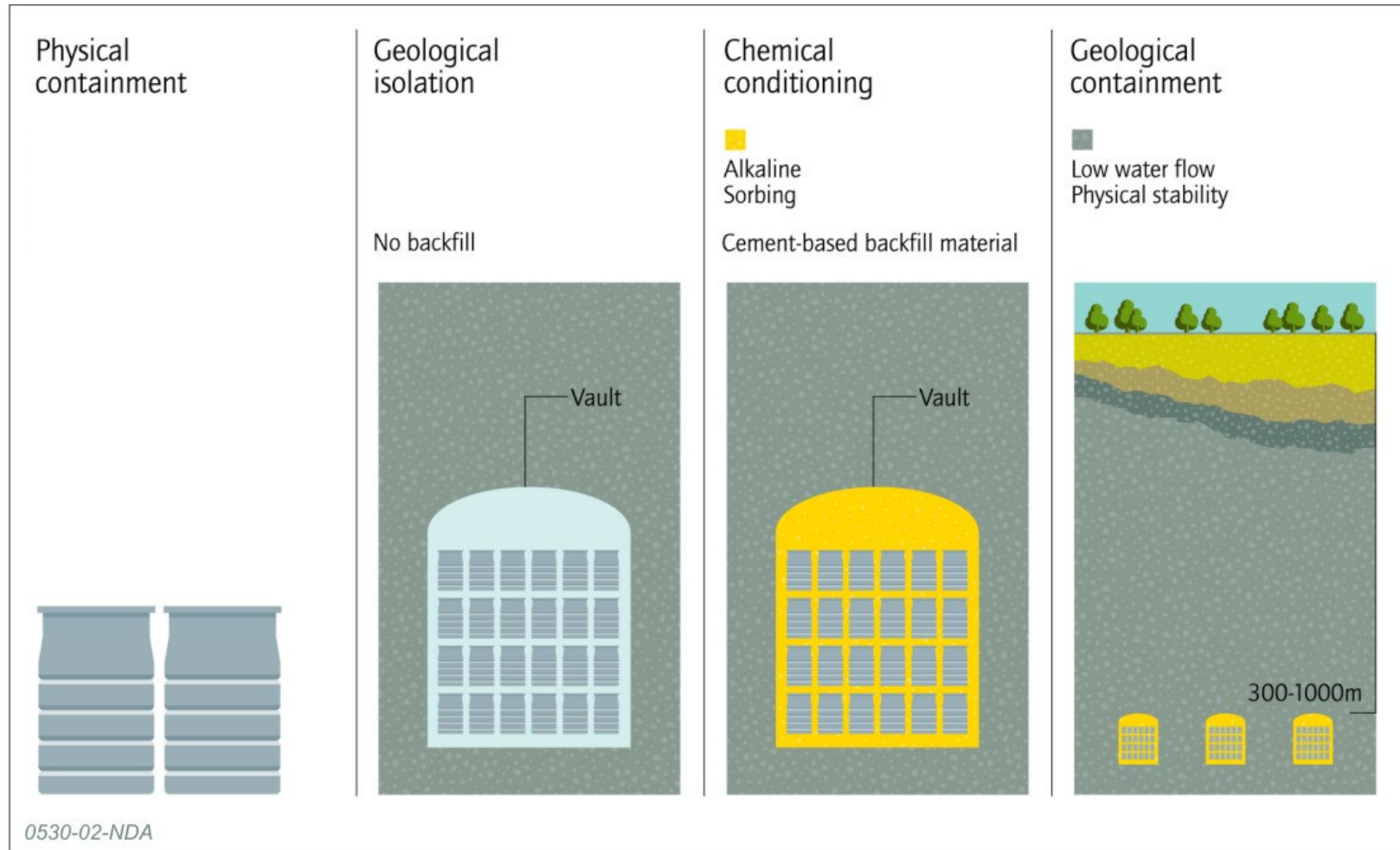


# Illustrative Geological Disposal Concepts

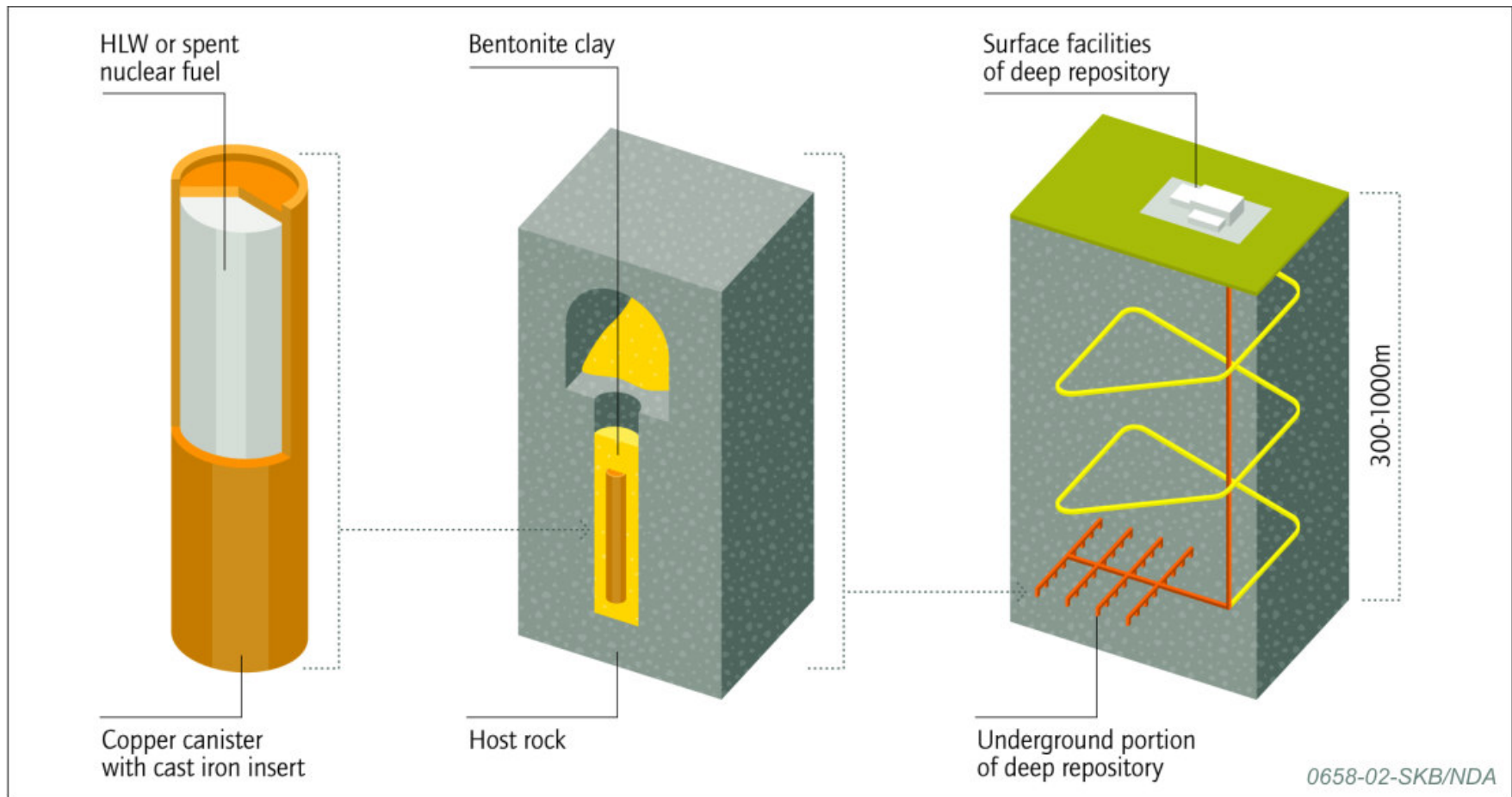
Host rock	Illustrative Geological Disposal Concept Examples <sup>d</sup>	
	ILW/LLW	HLW/SF
Higher strength rocks <sup>a</sup>	UK ILW/LLW Concept (NDA, UK)	KBS-3V Concept (SKB, Sweden)
Lower strength sedimentary rock <sup>b</sup>	Opalinus Clay Concept (Nagra, Switzerland)	Opalinus Clay Concept (Nagra, Switzerland)
Evaporites <sup>c</sup>	WIPP Bedded Salt Concept (US-DOE, USA)	Gorleben Salt Dome Concept (DBE-Technology, Germany)

0649-02-NDA

# DSSC: Multi-barrier Containment for LHGW

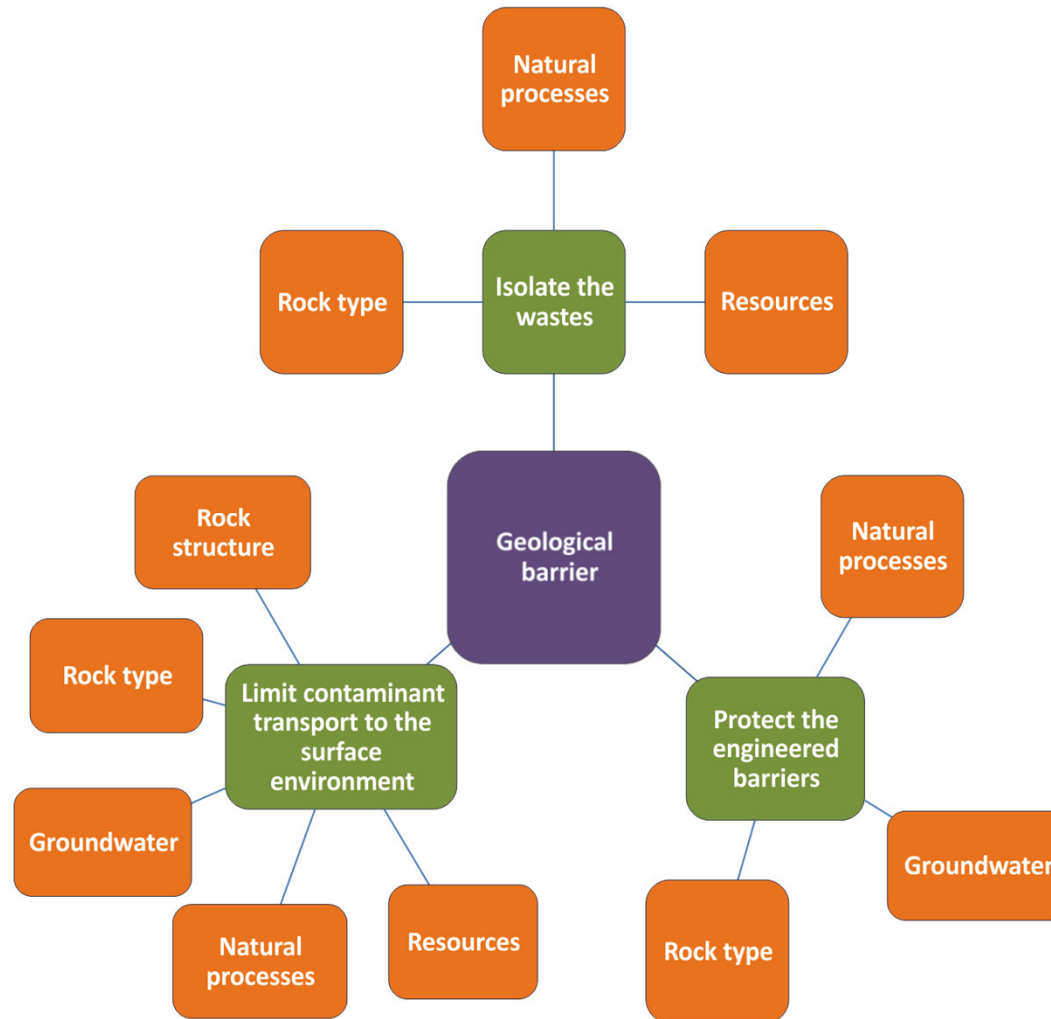


# DSSC: Multi-barrier Containment for HHGW

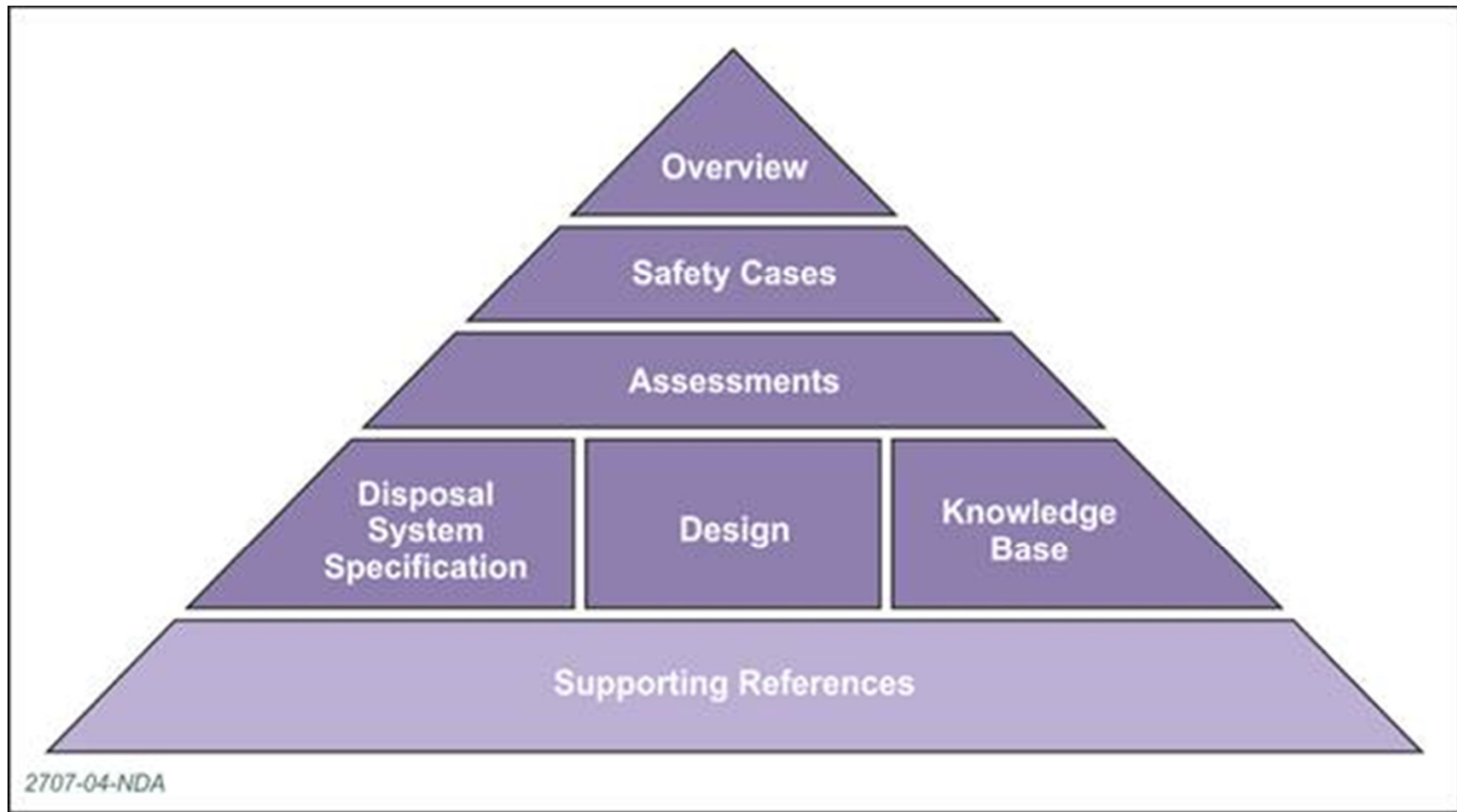




# Developing a Generic Safety Case

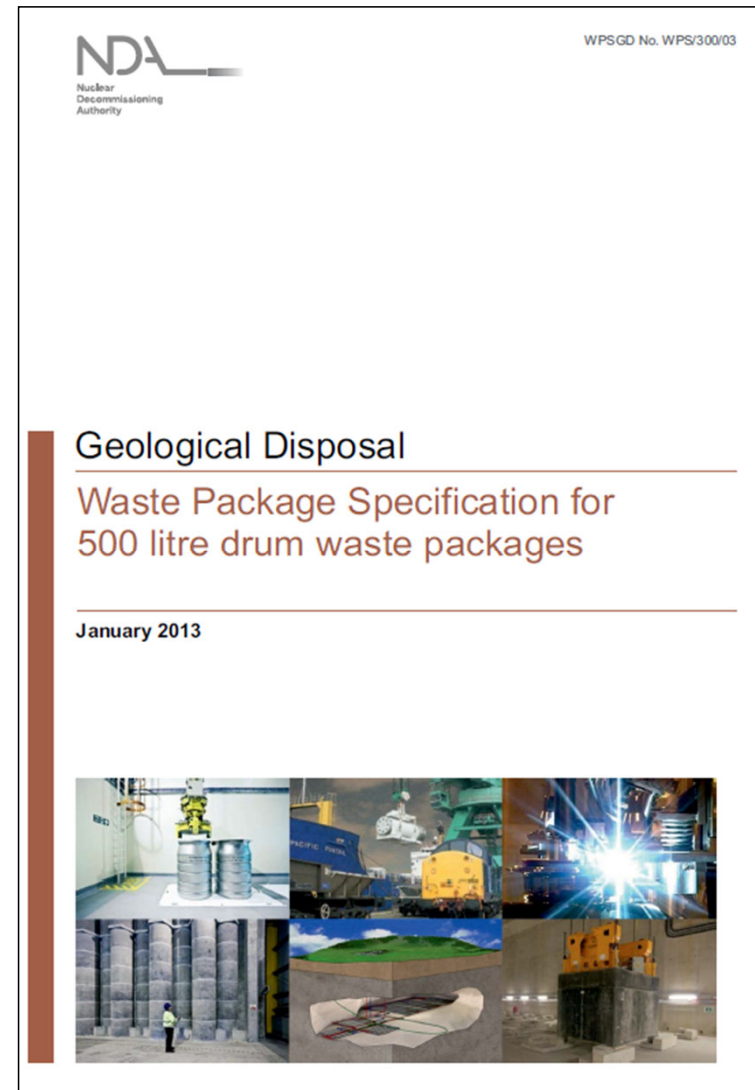


# 2016 generic DSSC

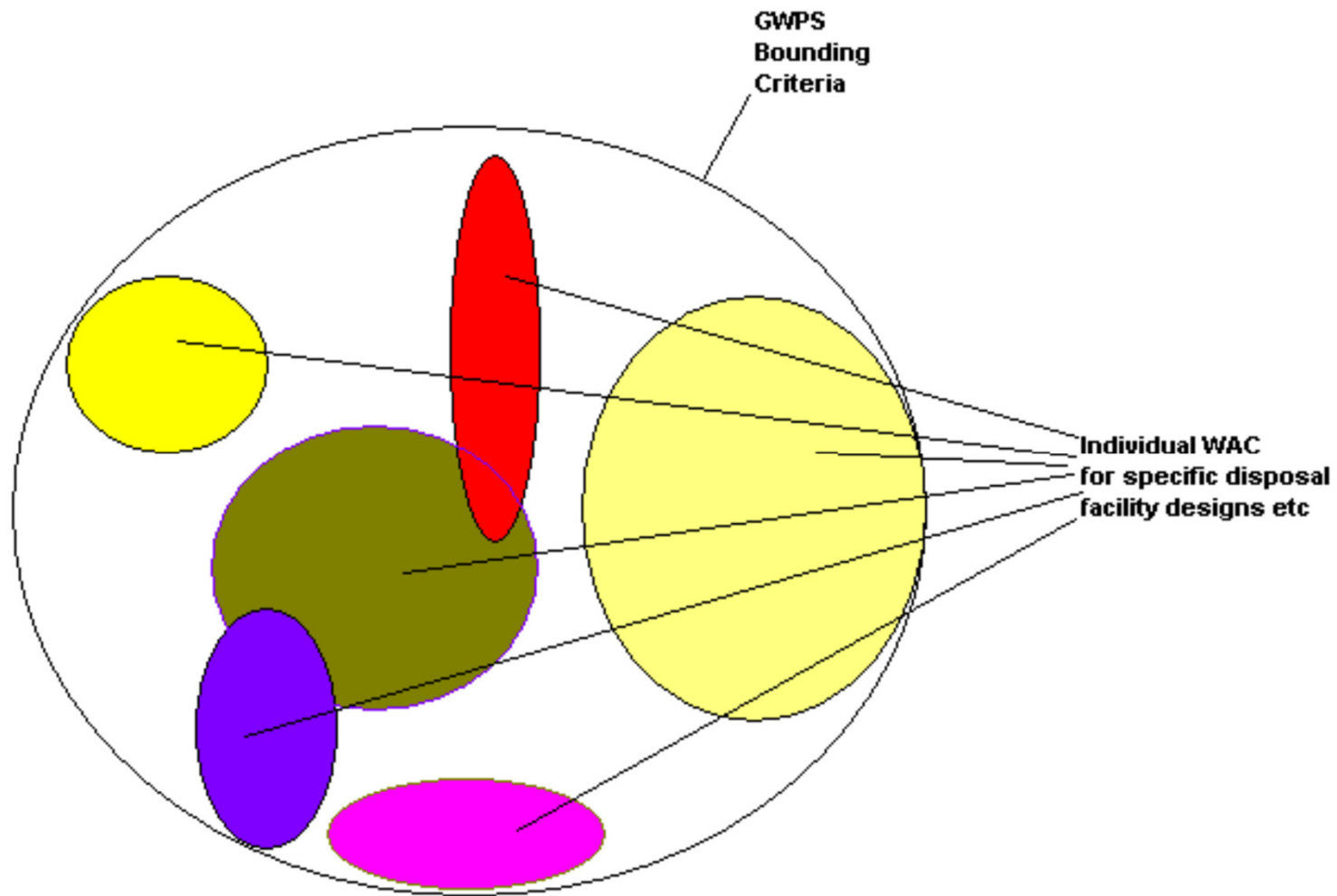


# Waste Packaging Specifications

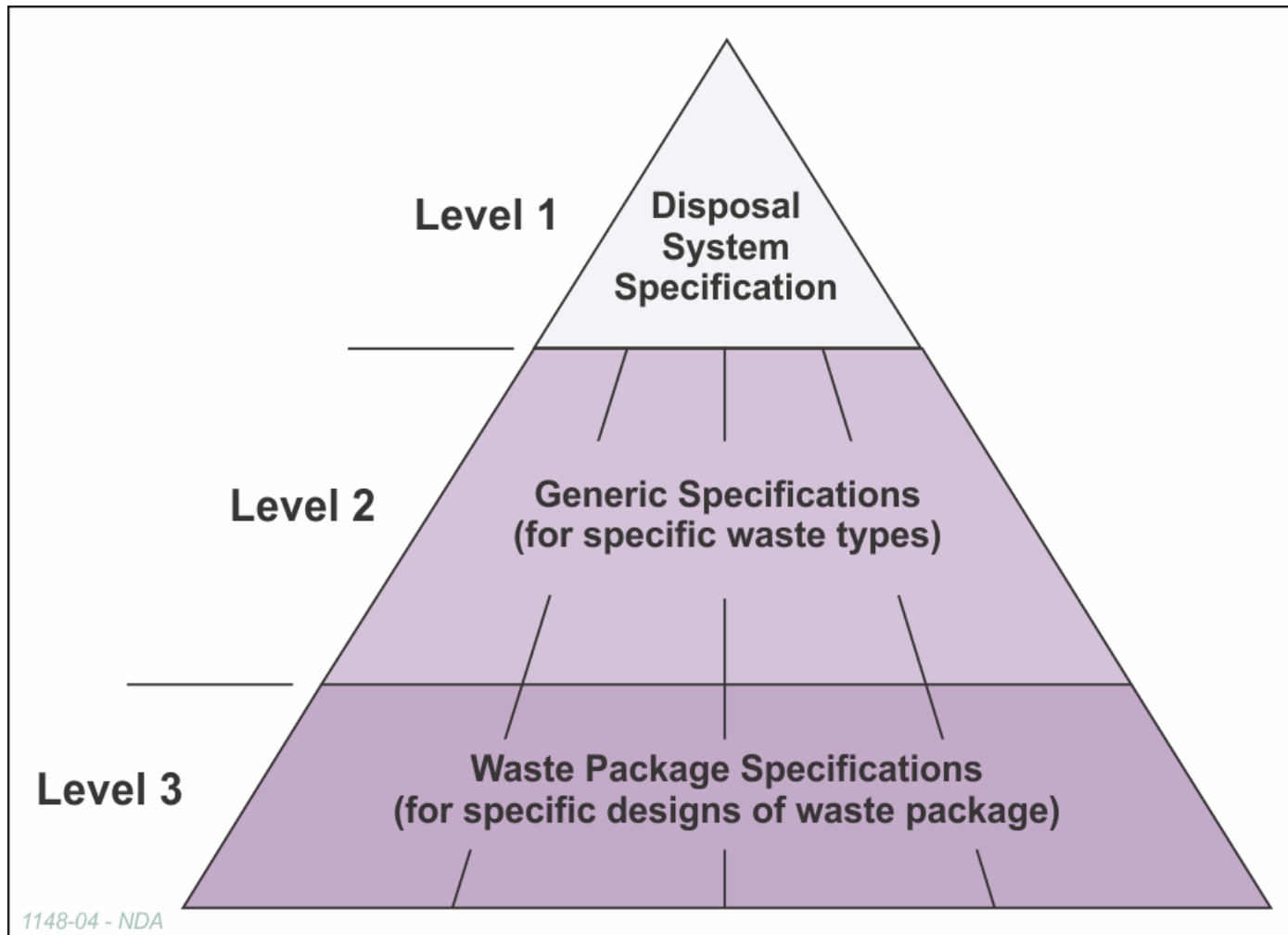
- Waste Packaging Specifications define the key features and requirements for waste packages
- Precursor of GDF waste acceptance criteria but broader in application, recognising uncertainty associated with generic siting requirements
- <http://www.nda.gov.uk/publications/>
- Current version is WPS/220



# Bounding Specifications



# Hierarchy of Packaging Specifications



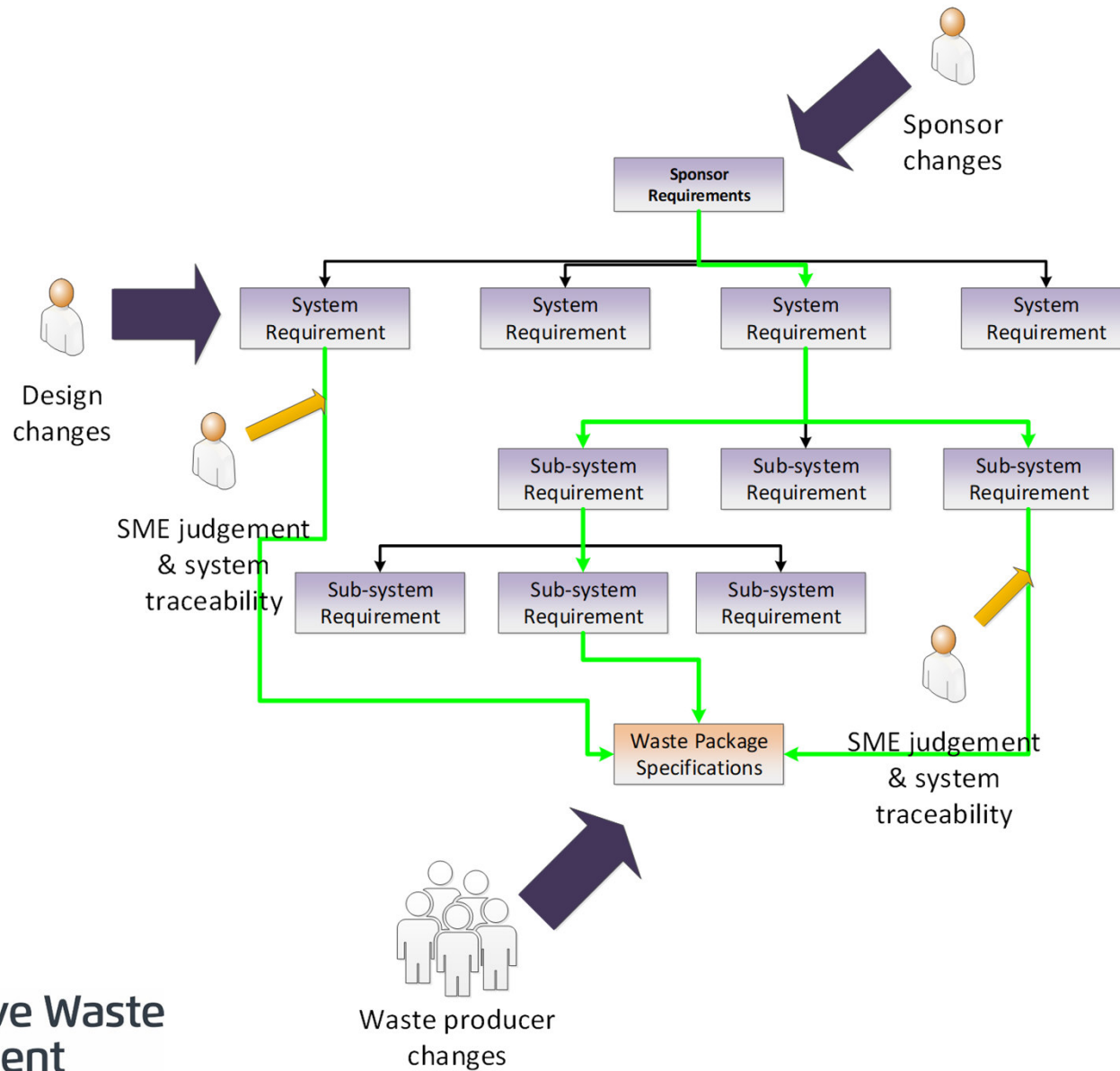
# Development of Packaging Specifications

- RWM uses a well-established methodology for the production of the packaging specifications which requires that they are founded on:
  - The definition of disposal concepts for the waste type (e.g. LHGW);
  - Generic designs of the transport and disposal facility systems as they apply to waste packages containing that waste type;
  - Generic safety assessments for the transport and disposal of the waste packages (the latter covering both disposal facility operations and the post-closure period);
  - Regulations for the storage, transport and disposal of the waste.
- The aim of each specification is to define the bounding requirements for all relevant waste packages
- All of the packaging specifications adopt a similar form by defining the standard features (e.g. dimensions, lifting features etc.) and performance requirements (external dose rate, impact and fire accident performance etc.)

# Evolution to Requirements

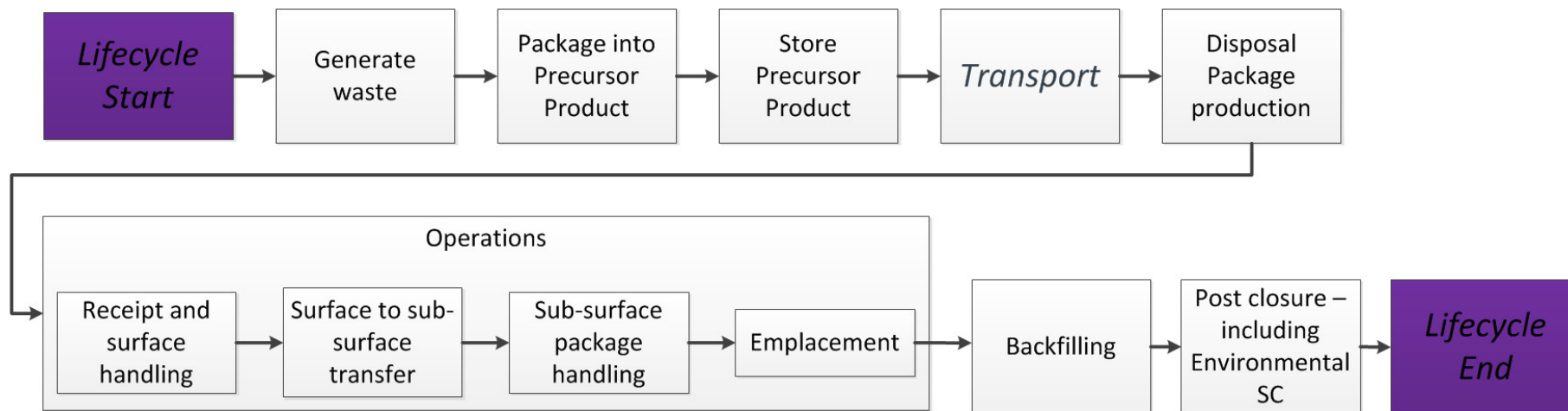
- Use a full and robust systems engineering approach to derive, develop and organise the disposal requirements for waste packages to a level that is appropriate for current knowledge base and programme
- Addressing challenges emerging from historic specifications approach:
  - Underpinning for the WPS is not rigorous or well-documented – in some cases, cannot be directly linked to safety cases
  - Lack of clear and traceable ownership of individual elements
  - No single source of information
  - Poor requirements management and tools across organisation, so poor flow of requirements to WPS
  - Programme of work to address underlying issues not recognised
- Clear placement of packaging requirements within a comprehensive approach for the GDF and safety cases

# Requirements and Packaging Specifications





# Packaging Life-cycle for Requirements



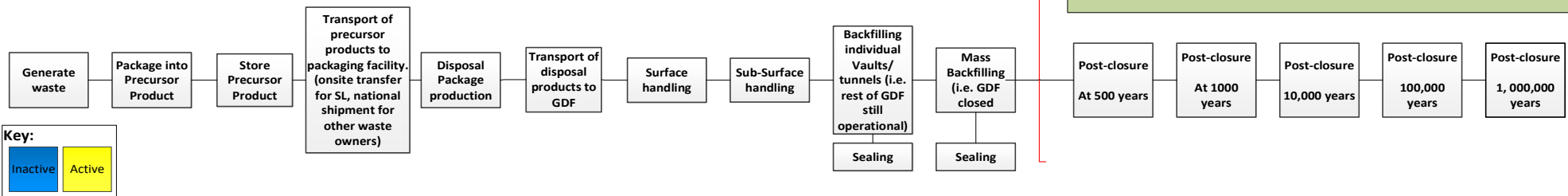
# Elicitation of Functions

Waste	Waste	Waste	Waste	Waste	Waste	Waste	Waste	Waste	Waste
Conditioning media	Conditioning media	Conditioning media	Conditioning media	Conditioning media	Conditioning media	Conditioning media	Conditioning media	Conditioning media	Conditioning media
Furniture	Furniture	Furniture	Furniture	Furniture	Furniture	Furniture	Furniture	Furniture	Furniture
Disposal Container	Disposal Container	Disposal Container	Disposal Container	Disposal Container	Disposal Container	Disposal Container	Disposal Container	Disposal Container	Disposal Container
Disposal Package	Disposal Package	Disposal Package	Disposal Package	Disposal Package	Disposal Package	Disposal Package	Disposal Package	Disposal Package	Disposal Package
Transport Container	Transport Container	Transport Container	Transport Container	Transport Container	Transport Container	Transport Container	Transport Container	Transport Container	Transport Container
Transport Seals	Transport Seals	Transport Seals	Transport Seals	Transport Seals	Transport Seals	Transport Seals	Transport Seals	Transport Seals	Transport Seals
Vault construction	Vault construction	Vault construction	Vault construction	Vault construction	Vault construction	Vault construction	Vault construction	Vault construction	Vault construction
Buffer (local backfill)	Buffer (local backfill)	Buffer (local backfill)	Buffer (local backfill)	Buffer (local backfill)	Buffer (local backfill)	Buffer (local backfill)	Buffer (local backfill)	Buffer (local backfill)	Buffer (local backfill)
Mass Backfill	Mass Backfill	Mass Backfill	Mass Backfill	Mass Backfill	Mass Backfill	Mass Backfill	Mass Backfill	Mass Backfill	Mass Backfill
EDZ (a subset of geology)	EDZ (a subset of geology)	EDZ (a subset of geology)	EDZ (a subset of geology)	EDZ (a subset of geology)	EDZ (a subset of geology)	EDZ (a subset of geology)	EDZ (a subset of geology)	EDZ (a subset of geology)	EDZ (a subset of geology)
Host geology	Host geology	Host geology	Host geology	Host geology	Host geology	Host geology	Host geology	Host geology	Host geology

This portion of the lifecycle is intended to indicate that the barriers will cease to perform their intended function over given time periods (will be different for different waste streams).

This portion requires further development and input from technical's ICs.

Waste	Waste	Waste	Waste	Waste
Conditioning media	Conditioning media	Conditioning media	Conditioning media	Conditioning media
Furniture	Furniture	Furniture	Furniture	Furniture
Disposal Container	Disposal Container	Disposal Container	Disposal Container	Disposal Container
Disposal Package	Disposal Package	Disposal Package	Disposal Package	Disposal Package
Transport Container	Transport Container	Transport Container	Transport Container	Transport Container
Transport Seals	Transport Seals	Transport Seals	Transport Seals	Transport Seals
Vault construction	Vault construction	Vault construction	Vault construction	Vault construction
Buffer (local backfill)	Buffer (local backfill)	Buffer (local backfill)	Buffer (local backfill)	Buffer (local backfill)
Mass Backfill	Mass Backfill	Mass Backfill	Mass Backfill	Mass Backfill
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**Key:**

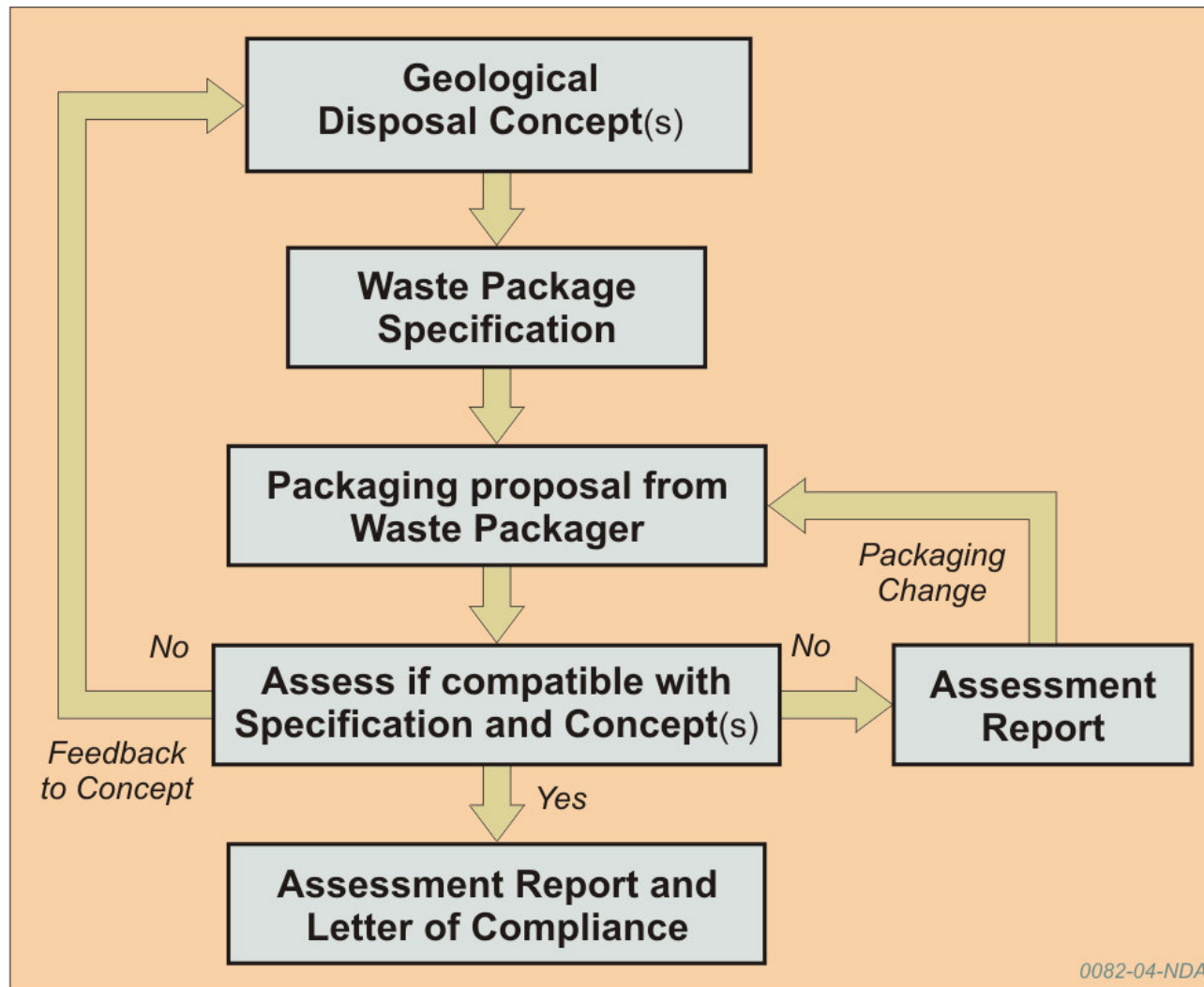
Inactive	Active
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# Evolution to Waste Acceptance

- Definition of WAC for a disposal facility has two strands:
  - The definition of the WAC themselves
  - Procedures by which the acceptability of individual waste package can be judged; the acceptance process
- WAC ultimately will be derived from the safety case submissions for an operational GDF, based on evolution of packaging requirements
- Extended period before disposal allows progressive increase in confidence in the acceptability and early action if deviations are recognised
- Development of WAC, and waste acceptance, is an evolutionary process over an extended period, enabled through:
  - Increasing clarity of the criteria that ultimately would become WAC
  - Maintenance of clear and sufficient records
  - Building confidence in the condition of waste packages

# Assessment and Endorsement against Generic Specifications

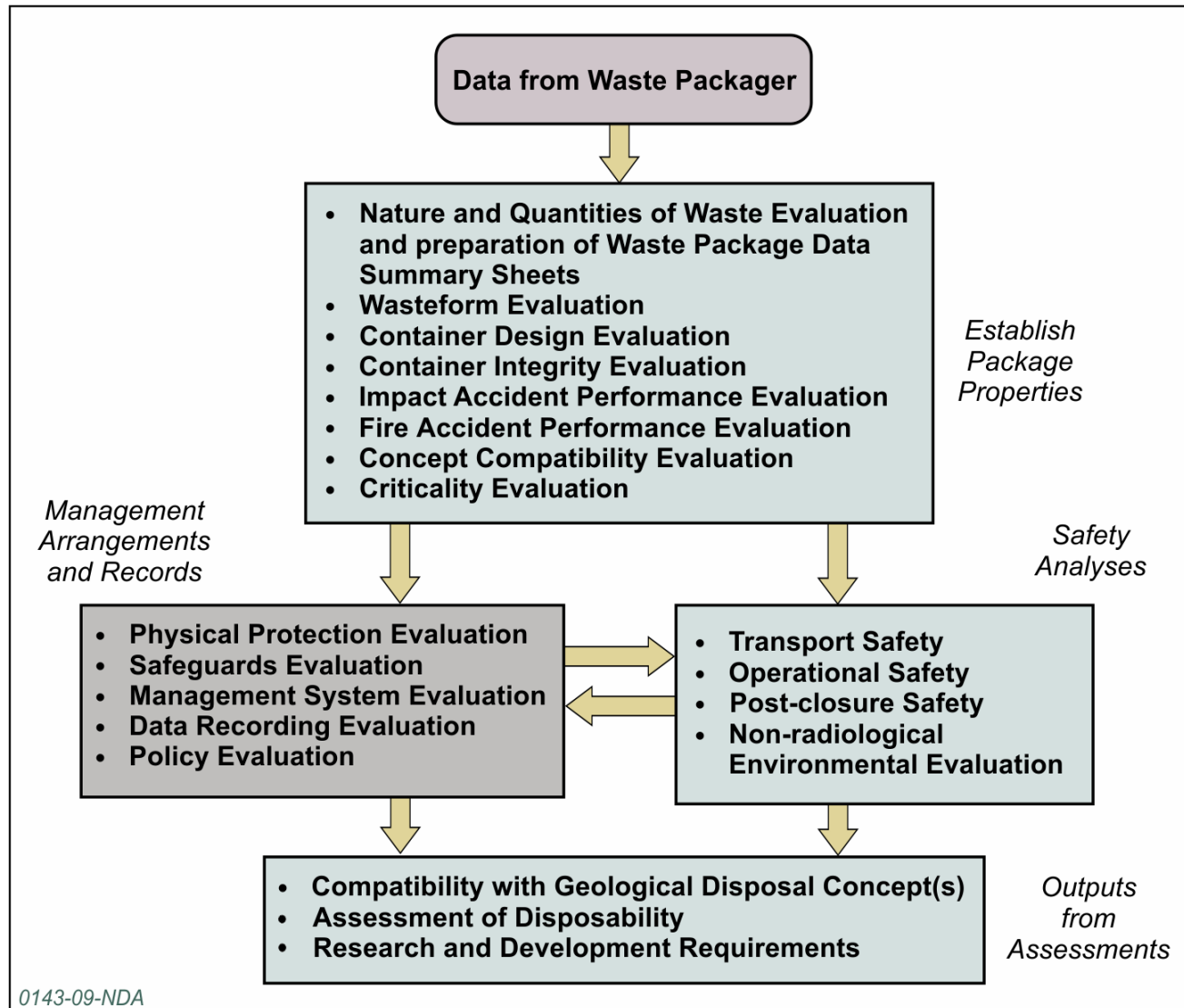
# Assessment Process – Overall Picture



# Assessment Process – Key Elements

- Inventory challenge:
  - Origin of waste, fissile content, variability / uncertainty
- Package design and properties:
  - Container type, immobilisation matrix (if any), accident performance
- Compliance with disposal system:
  - Disposal concept and design, package specifications
- Fulfilment of management requirements
  - Records, Management System, criticality compliance
- Compatibility with safety cases:
  - Transport, operations, environmental (post-closure)

# Assessment Process – Detailed Structure



# Significance of a Letter of Compliance (LoC)

- Obtaining endorsement through the issue of a Letter of Compliance (LoC) from RWM means that:
  - The packaging proposals are in line with the specifications and requirements for a GDF (i.e. they are being packaged in line with Government policy)
  - The GDF is being designed to accommodate these wastes as a feed stream
  - The waste packager has a statement (essentially a snapshot) of the situation/progress with the disposability assessment at any point in the process
- Endorsement may be offered in a staged manner to support development of packaging proposals over time:
  - Conceptual (initial support for the general concept)
  - Interim (confirmation of process through R&D)
  - Final (endorsement of the complete process as implemented)



# Innovative Packaging Proposals

- RWM welcomes innovative packaging proposals
- Packaging proposals that are not intended to comply with an existing Waste Package Specification (WPS) and/or to fulfil the currently understood safety functions of a GDF
- Procedure in place to define and analyse information requirements prior to Disposability Assessment, areas to be considered include:
  - GDF design changes and handling challenges
  - Complexity and impact on operating regime
  - Applicability of safety cases and fulfilment of safety functions
  - Knowledge gaps
- Disposal of innovative packages might incur costs and dis-benefits for geological disposal
  - Need to understand balancing benefits earlier in the lifecycle to justify change

# Maintenance of Existing Endorsements and Non-compliance

# Periodic Review and Package Assurance

- Maintain and manage the validity of existing endorsements and maintain confidence in the disposability of both waste packages currently being produced and existing waste packages in interim storage
- Manage confidence when challenged by the following:
  - Evolution of the Disposal System Safety Case;
  - Acquisition of new knowledge (arising knowledge);
  - Recognition of changes to regulatory expectations for disposal;
  - As a result of modification to the existing scope of an endorsement;
  - Identification of significant issues or shortcomings with an endorsement.
- Primary activities:
  - Annual Review (Q3 each year)
  - Periodic Review Disposability Assessment
  - Cross-cutting reviews
  - Technical Audits

# Consolidation and Annual Review

- Programme of Disposability Assessments determined by waste custodians, with assessment not planned systematically
  - Commenced in late 1980's, almost 1000 assessments completed
- Currently, there are about 140 Final stage Letters of Compliance (LoCs)
- Many overlap or represent incremental changes as process scope evolves
- Final stage LoCs are being consolidated
  - Similar wastes, similar packaging processes, similar packages
- Annual Review tests the status of each endorsement, capturing any changes during the current year
  - Identifies any requirement for updated or improved Disposability Case
  - Identification of drivers for Cross-cutting Reviews
  - Status of previous Technical audits

# Periodic Review Disposability Assessment

- Updating of the 'Disposability Case' to current basis (eg new DSSC) through a further, targeted Disposability Assessment
  - Integration of recent changes, extensions and/or removal of qualifications
  - Use data from package records for assessment inventories
  - Support the consolidation into singular endorsement, re-visiting and aligning the arguments supporting individual previous assessments
- 
- Also may be used to provide modern basis for endorsement consistent with knowledge management expectations (improved documentation *etc*)

# Cross-cutting Review

- 'Single issue' review across some or all existing ~~consolidated~~ endorsements
- Driven by 'arising knowledge' from continuing programmes of technical development, including external sources
- May be recognised through Annual Review or initiated *ad hoc*

# Management of Emergent Non-compliance

- (Periodic Review) Disposability Assessment or Cross-cutting Review may recognise that existing endorsement is not longer valid, or not applicable to some fraction of the waste (emergent non-compliance)
- Early recognition allows timely action:
  - Additional research or development to address the challenges
  - Recognition of requirement for (or risk of) future re-work of waste packages
  - Introduction of special arrangements or potential changes to the Disposal System requirements to accommodate challenges

# Summary and Key Points



# Summary

- Existing packaging specifications are derived from generic safety cases
- Evolving into a requirements-based system, providing more traceability and consistency
- Disposability Assessment systematically tests compatibility of proposals and audits the completeness of safety cases/requirements for real wastes
  
- Assurance approach provides for continuing maintenance of the validity of the endorsements (and packages produced under them)
- Provides for early recognition of emerging non-compliance, allowing timely intervention and/or risk management
  
- Continuous management of acceptability of wastes, providing gradual waste acceptance and confidence in future disposal