



GDF – Design Delivery

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The GDF megaproject...

- Disposal areas **200-1000m** deep
 - **300+ km** of tunnels & disposal galleries
 - **300+** disposal vaults and tunnels
 - Surface footprint **c.1km²**
 - Subsurface footprint **20-25 km²**
- **10,000,000m³** of rock excavated
 - **7,000,000m³** of construction materials
 - **750,000m³** of packaged waste
 - **310,000** packages to be disposed of
 - **28,200,000TBq** of radioactivity

	Feasibility	Concept Design - Two Sites		Detailed Design - One Site		Construction
	Pre-Concept	Initial Concept	Final Concept	Prelim	Detailed	Post-Detailed
Management	Project Eng Mgt Plan Design principles & strategy Design Mgt Arrangements Initial parametric est	Technology Plan Design codes & standards Parametric delta estimate	Construction Sequence Evolved estimate	Commissioning Sequence Bottom-up estimate	Manufacturing Plan Final estimate	Change management Material state management Cost accounting
Integration	Concept of Operations Whole GDF requirements Design policies Master assumptions list	System architecture model System requirements Spatial block diagram Initial product breakdown Functional interfaces defined	Verification strategy Initial spatial arrangement Product breakdown structure "Design for X" analysis System interfaces defined	Verification plans Facility layout & process flows Availability & reliability model Complex interface prototyping	All GDF system rqt's proven All interfaces verified Load schedules finalised Complex interface proving	Change management
Safety	External hazards identified Safety mgt arrangements Security threat assessment Initial site evaluation (ISE) Prelim Safety Report (Generic) CDM plan	Hazard mgt strategies Design basis defined (BOD) Safety functional rqt's (SFRs) Prelim Safety Report (Outline)	Functional failure analysis System cat & class Principal internal hazards IDd Enhanced site evaluation (ISE+) Prelim Safety Report (Initial) Outline security case	HAZOP Operating modes assessment Beyond design basis tests Env impact assessment Prelim Safety Report (Final) Outline site emergency plans	Through-life safety artefacts Safety functions proven Environmental case (ops) Prelim env safety eval (PESE) Preconstruction safety report Construction phase plan	Safety assessment of defects Env safety case (IESC etc.) Precommissioning safety report Preoperational safety report
System	Candidate system list Potential concepts explored Feasibility assessments	Principal systems identified System interfaces identified Initial system models	Select relevant standards System requirements defined System concepts selected System interfaces defined	BoM/BoQ Intelligent diagrams (P&IDs) Power etc. demands chilled Control schema Rqt compliance assertion Reliability block diagrams System failure modes assessed	System rqt's proven Commissioning plans Maintenance schedules Operating instructions	Commissioning test forms
Component	Technology development	Critical components identified	Major components identified	All components identified Component specs finalised Initial mounting arrangements Initial stress calcs	Components fully detailed All specs satisfied Manufacturing drawings Maintenance instructions	Commissioning test forms

What is a design?

- Wide range of products
- Digitised – twin / BIM
- Reconciles complex requirements
- System of systems
- Significant integration
- Hazard management
- Significant safety functions
- Physical and non-physical
- Not a “GDA” implementation

100's x MDAL / Requirements

100's x key decisions

1,000's x decisions

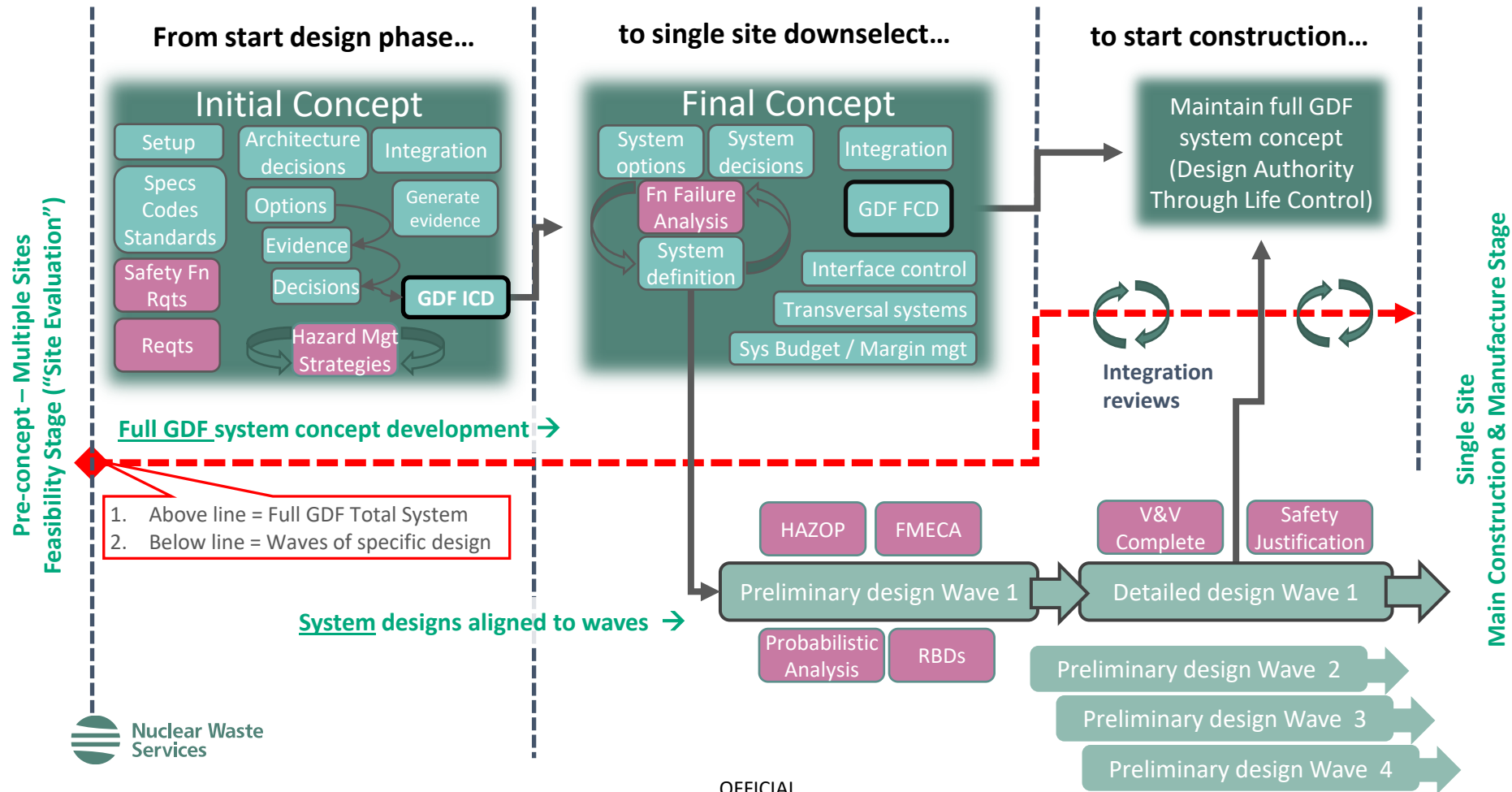
10,000 x component specs

100,000 x detailed drawing elements

Through life configuration

The design process...

OFFICIAL



OFFICIAL

Potential waves & associated permissions

Wave 0: Deep boreholes & other site characterisation work

- **DCO1 & Initial Site Evaluation:** qualitative, the feasibility of constructing a GDF at the potential site

Wave 1: To safe (non-rad) human access at repository depth

- **DCO2 & Preliminary Environmental Safety Evaluation:** qualitative arguments supported by assessments based on available site knowledge and data, high confidence in credible disposal concept [infeasible conceptualisations ruled out]

Wave 2: To active repository (First Waste Emplacement)

- **Initial Environmental Safety Case:** enough evidence to inform a decision on whether disposal can be authorised *in principle*, environmental permit to construct first disposal area based on high-confidence EBS design [design underwritten, long-term post closure case not yet concluded]
- **Pre-Operational Environmental Safety Case:** final hold point before waste is placed in the disposal facility, adequately underwritten post-closure case updated to take account of knowledge and understanding gained during underground operations

Wave 3: To completion of [first category]: e.g. ILW

Wave 4: To completion of [second category]: e.g. HHGW

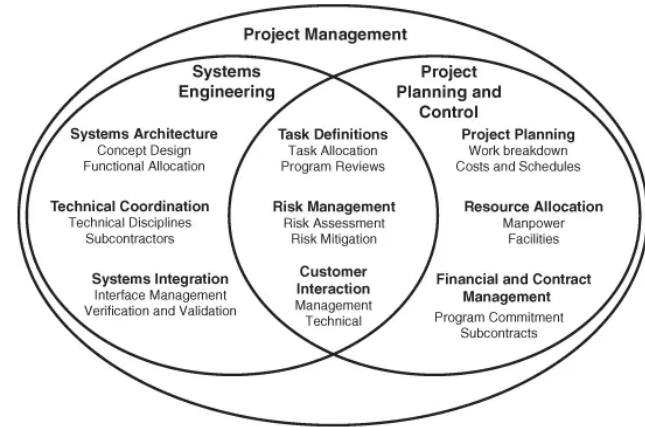
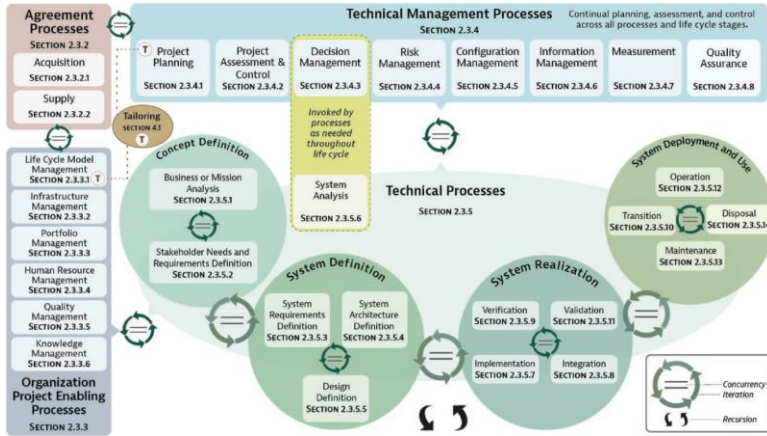
Wave 5(+): Mid-life upgrades; future capability; closure

Plus: associated works (external infrastructure: transport, power, etc.)

“Permissioning” per wave, based on maturing evidence to finalise design/safety case for remaining waste types, with hold points controlling detailed construction release within

Information needs

- Near-term focus on what must be done to *eliminate risk of unfeasible solution* by FCD
 - e.g. define bounding values for various geological parameters of the host and surrounding rocks
 - uncertainties in fundamental materials compatibility (container material, bentonite, backfill cement, plugs & seals)
- Detailed information needs & satisfaction approach being formalised to support ISE / DCO#1
 - both “top down” (design & safety case needs) and “bottom up” (research topic areas & borehole technical capability)
 - substantive deliverables in FY25 (info needs v1, site characterisation plans, site-specific R&D plans)
- Research need (upscaling from lab to field)
 - Surface laboratory based (e.g. on material and fluids acquired from drilling the site) and modelling
 - Sub-surface, appropriately representative – can be off-site if facility (Bure, Mont Terri, Grimsel...)
 - Sub-surface, host rock ← only *direct* interaction with GDF schedule



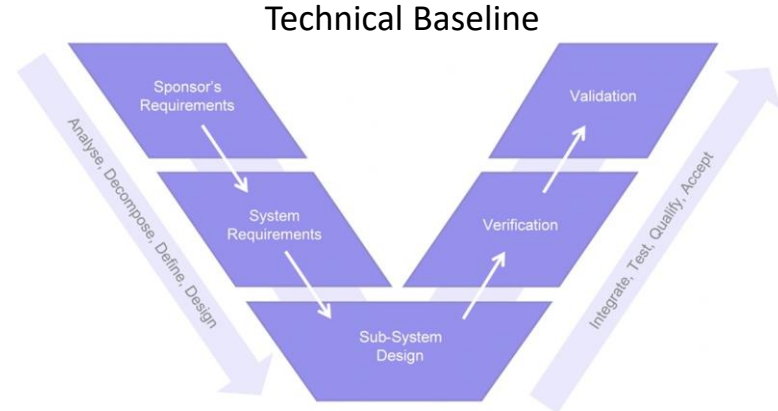
Suitable site

✓ SIX FACTORS

6 siting factors inform whether somewhere is suitable to host a Geological Disposal Facility (GDF).

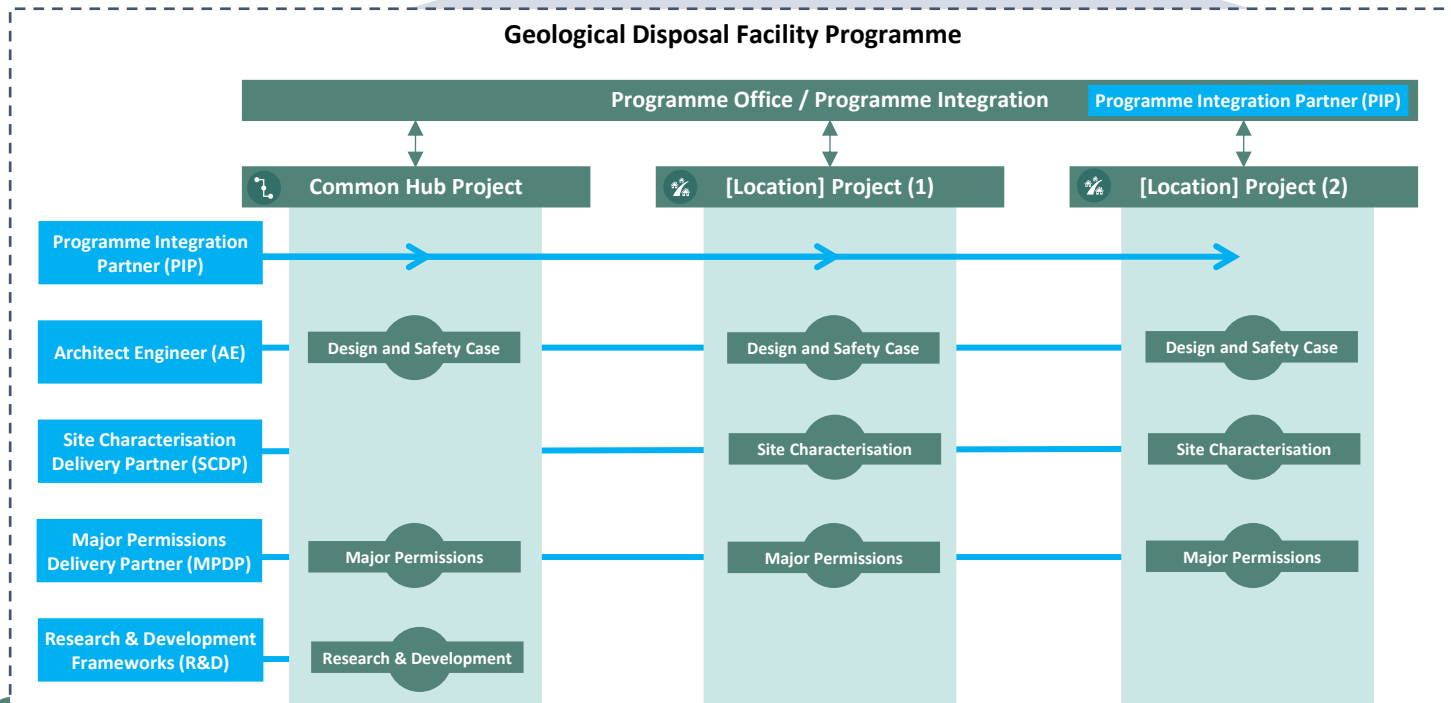
- ✓ SAFETY AND SECURITY
- ✓ COMMUNITY
- ✓ ENVIRONMENT
- ✓ ENGINEERING FEASIBILITY
- ✓ TRANSPORT
- ✓ VALUE FOR MONEY

- Site(s) selected for characterisation based upon likely feasibility.
- Site Descriptive Model ready to support launch of concept design.
- Site Characterisation Plan issued to fulfil information needs.
- Initial Site Evaluation issued to demonstrate that characterisation will not compromise site integrity.



GDF Delivery Model - How might it look?

Nuclear Waste Services Owners Engineer (OE)



I
C

Design Authority

NDA / NWS Independent Oversight and Audit

Owners Engineer (OE)



Thank you