Advance Non-LWR Code Challenges

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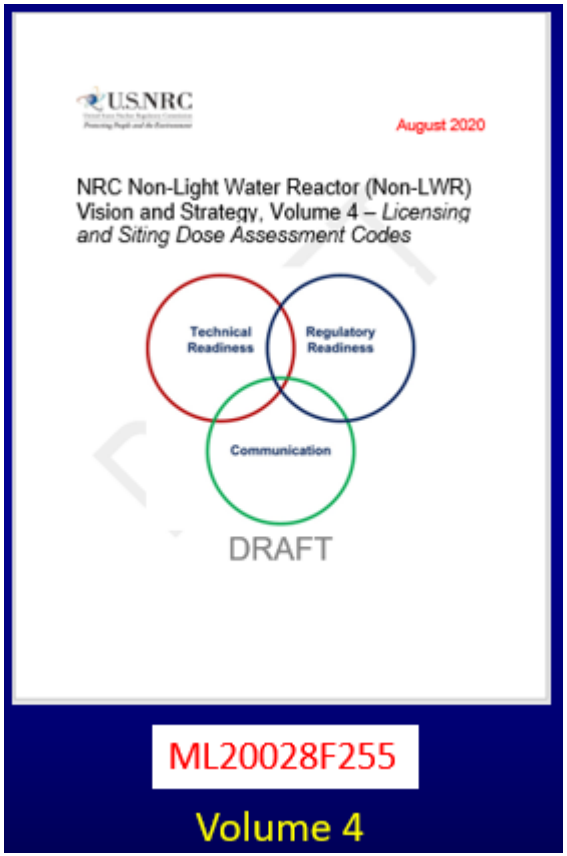
Volume 4: Licensing and Siting Dose Assessment Codes

- Landscape
  - Potential for a spectrum of Non-LWR and fuel designs
  - Over 10 licensing and siting dose assessment codes
  - Inconsistent code development practices, by various contractors, over decades
  - Overlap in code capabilities and need to use resources pragmatically
- Includes all current RAMP codes used for LWRs:
  - PAVAN, ARCON, NRCDose, GENII
  - RASCAL
  - RADTRAD, RESRAD, RADTRAN
  - HABIT
  - GALE
  - DandD



Advanced Reactor Landscape

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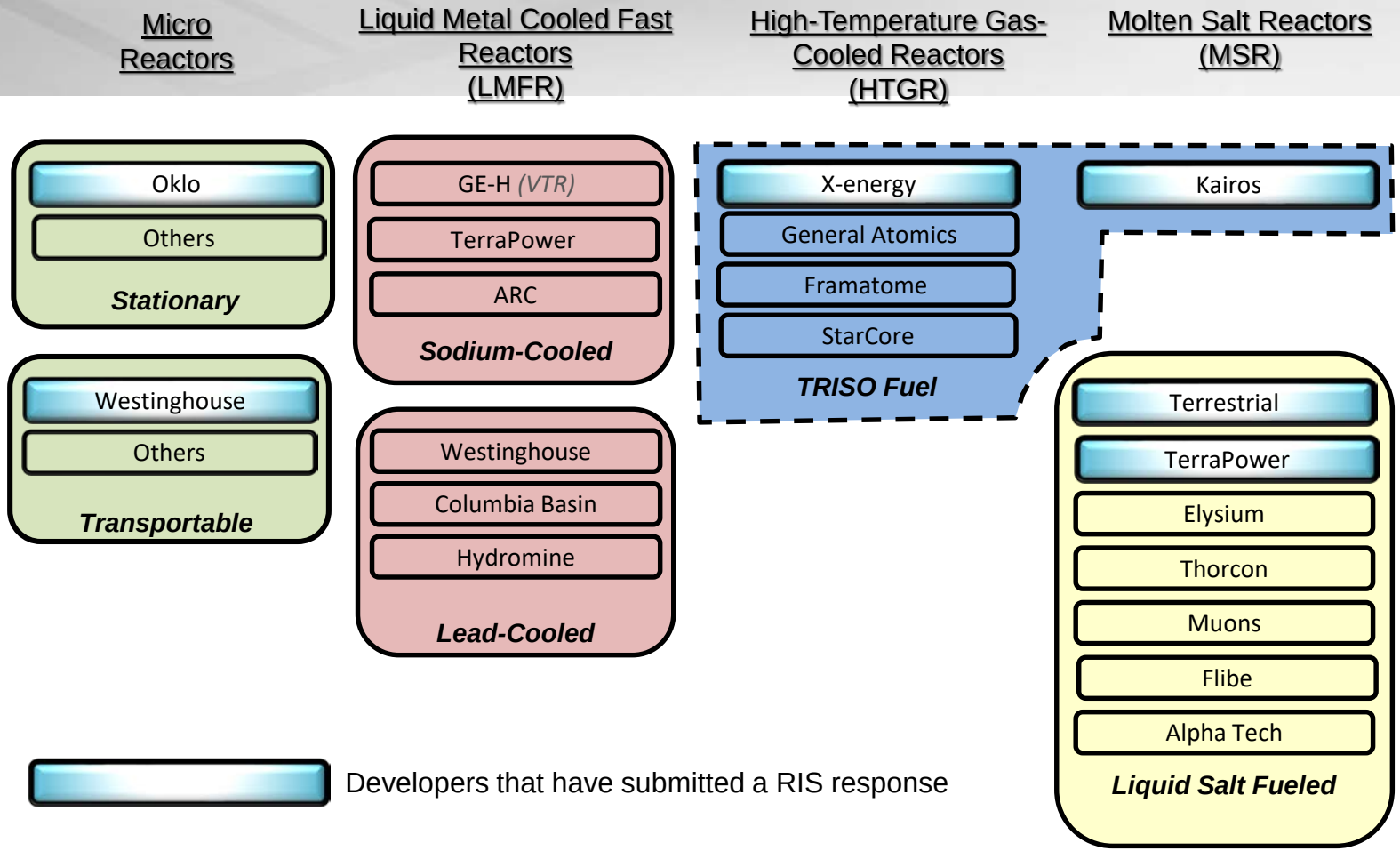

Advanced Reactor Landscape

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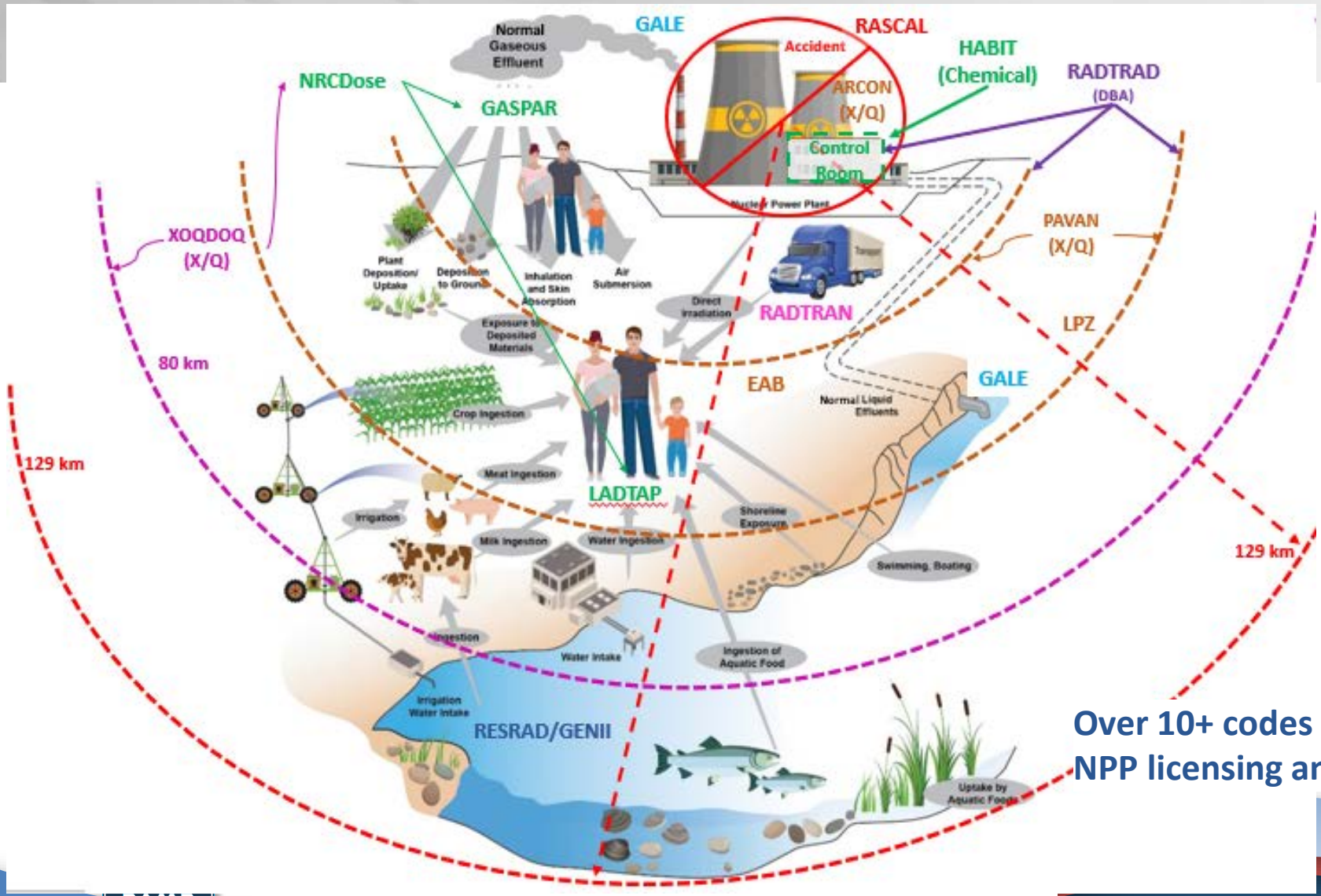
	Non-LWR Plant Description	Examples	Fuel Types
1	HTGR; prismatic core, thermal spectrum	Framatome	TRISO (rods or plates)
2	PBMR; pebble bed core, thermal spectrum	X-energy, Starcore	TRISO (pebbles)
3	GCFR; prismatic core, fast spectrum	GA	SiC clad UC (plates)
4	SFR; sodium cooled, fast spectrum	PRISM, ARC, TerraPower	Metallic (U-10Zr)
5	LMR; lead cooled, fast spectrum	Westinghouse, Columbia Basin, Hydromine	(Possibly nitride fuel.)
6	HPR; heat pipe cooled, fast spectrum	Oklo, Westinghouse	Metallic (U-10Zr)
7	MSR; prismatic core, thermal spectrum	AHTR	TRISO (plates)
8	MSPR; pebble bed, thermal spectrum	Kairos	TRISO (pebbles)
9	MFSR; fluoride fuel salt, thermal/epithermal spectrum	Terrestrial Thorcon, FliBe	Fuel salt
10	MCSR; chloride fuel salt, fast spectrum	TerraPower, Elysium	Fuel salt

RAMP

Licensing and Siting Dose Assessment Codes



Over 10+ codes used for NPP licensing and Siting.

Image adapted from BNWL-1754, Models and Computer Codes for Evaluating Environmental Radiation Doses.

Modeling Challenges for RAMP Codes

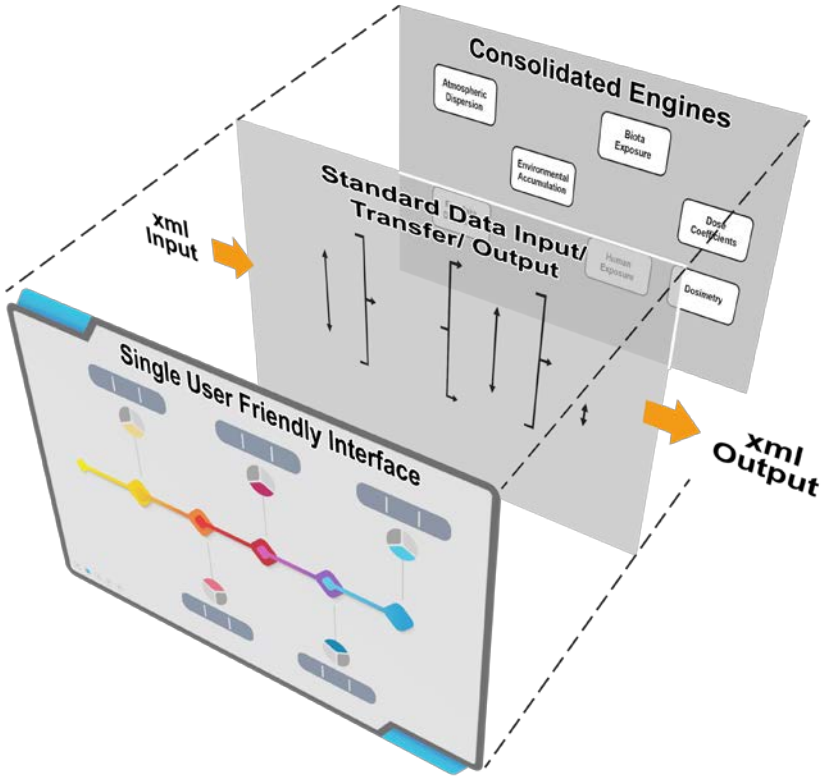
Several technical issues were identified in NRC Non-Light Water Reactor (Non-LWR) Vision and Strategy, Volume 4 — Licensing and Siting Dose Assessment Codes, including:

1. Consolidation of RAMP codes into a common or single code
2. Core radionuclide inventory determination accounting for fuel form, geometry and other relevant characteristics and resulting source term
3. Near-field atmospheric dispersion modeling
4. Selection of relevant and applicable Dose Coefficients
5. Environmental exposure pathways

Volume 4: Code Readiness Tasks

Approach (Tasks)

1. Consolidate/Modernize Dose Assessment Codes
2. Improve characterization of Source Terms
3. Improve Atmospheric Transport & Dispersion Models
4. Update Dose Coefficient values
5. Develop Environmental Pathway Models



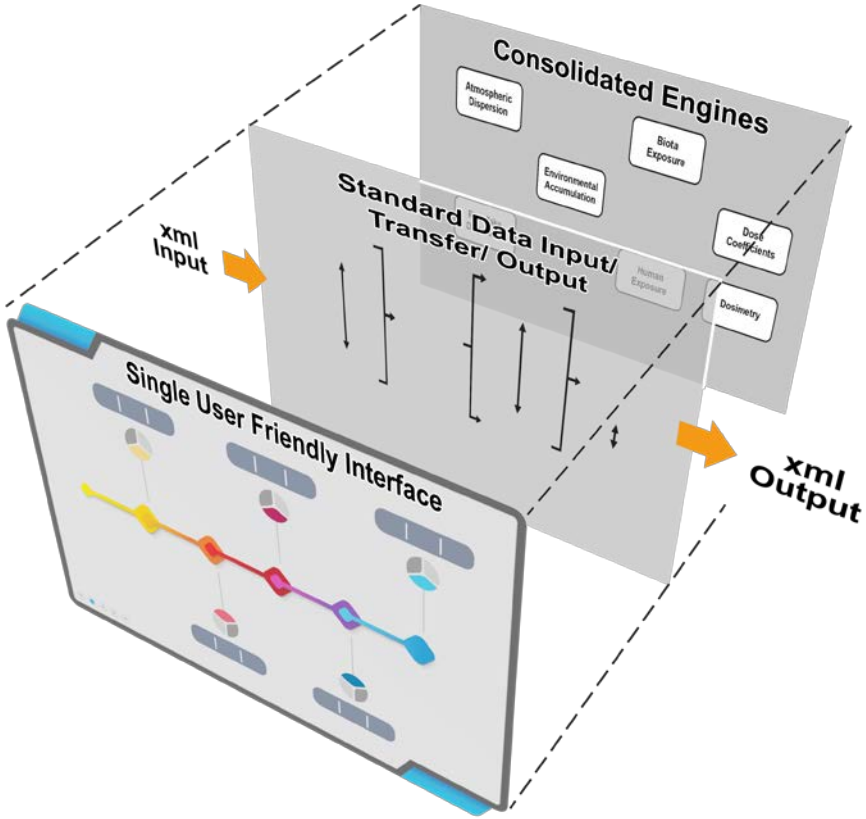
Code Consolidation and Modernization (Task 1)

- Given the large number of Non-LWR technologies being conceived and developed, it will be resource intensive to modify each of the siting, licensing, and emergency response codes for each design type.
- Therefore, the staff is proposing to consolidate and integrate them into several codes (i.e., two or three) that are modular, flexible, efficient, and user-friendly.

Code Consolidation Approach

The three pillars to the dose assessment code consolidation process:

- **Create consolidated engines**
- **Develop a standardized data transfer schema**
- **Build a single user interface**



PNNL-29717, Health Physics Codes Consolidation and Modernization

Source Term (Task 2)

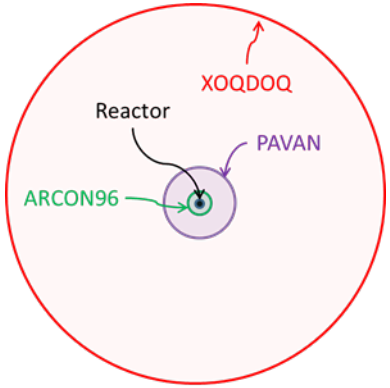
- Identify source terms inputs (i.e., radionuclide fuel inventories, reactor coolant inventories, plant design and operational data) for each of the Non-LWR designs.
  - Normal (Routine) source terms
  - Severe Accident source terms
  - Design-Basis Accident source terms
  - Transportation source terms

Source Term (Task 2)

- Source Term Considerations:
  - Source term/release rate framework database will:
    - Leverage activities from Volumes 1, 2 and 3
    - Estimate inventory in core/release from core
    - Identify dominate release pathways
    - Characterize mechanism to reduce release (e.g. filters)
    - Estimate release rates,
    - Use operational data where applicable

ATD Module (Task 3)

- ATD consolidation in Phases:
  - Phase 1: Consolidate ARCON, PAVAN & XOQDOQ.
  - Phase 2: Evaluate the applicability of the near-field and ATD models for Non-LWR technologies.
- These phases would leverage the experience of the meteorology staff and MACCS near-field modelling efforts from Volume 3.



Dispersion Distances

Dose Coefficient Module (Task 4)

- This task involves:
  - Developing dosimetry modules/engines that have the flexibility to use different dose models and dose coefficient values
  - Examining dose coefficient models with respect to aerosol particle size in addition to exploring the impact of tritium and carbon-14 biokinetics since these radionuclides may be in higher quantities in non-LWRs.

Dose Coefficient Considerations

- Current State
  - Some codes can choose different data sets.
  - Leveraging DCFPAK datasets with US EPA.
  - Possibly acquiring international dosimetry codes.
  - Training RPB staff on specific designs where internal dosimetry could be significant such as MSRs.
- Vision for module:
  - Flexible Engines for different dose coefficient values
  - Dose Coefficient Package Code (DCFPAK)
  - Aerosol particle size relative to dose coefficients
  - H-3 and C-14 relationship to dose coefficients

Environmental Pathways (Task 5)

- Further developing the aquatic pathways (river/lake/ocean dispersion), environmental accumulation, and human/non-human biota consequence modules for codes.
- Lower priority because they are less dependent on Non-LWR designs and fuel types.
- Explore the feasibility of radionuclide particle size behavior in the environment for some non-LWR designs.

Questions?

Thank You!