

Integrating Multiple Inter-dependent Site-level Projects into One Program-level Risk Analysis

2023 NASA Cost and Schedule Symposium at JPL

David Hulett, Ian Bailey, Lorrie Tietze

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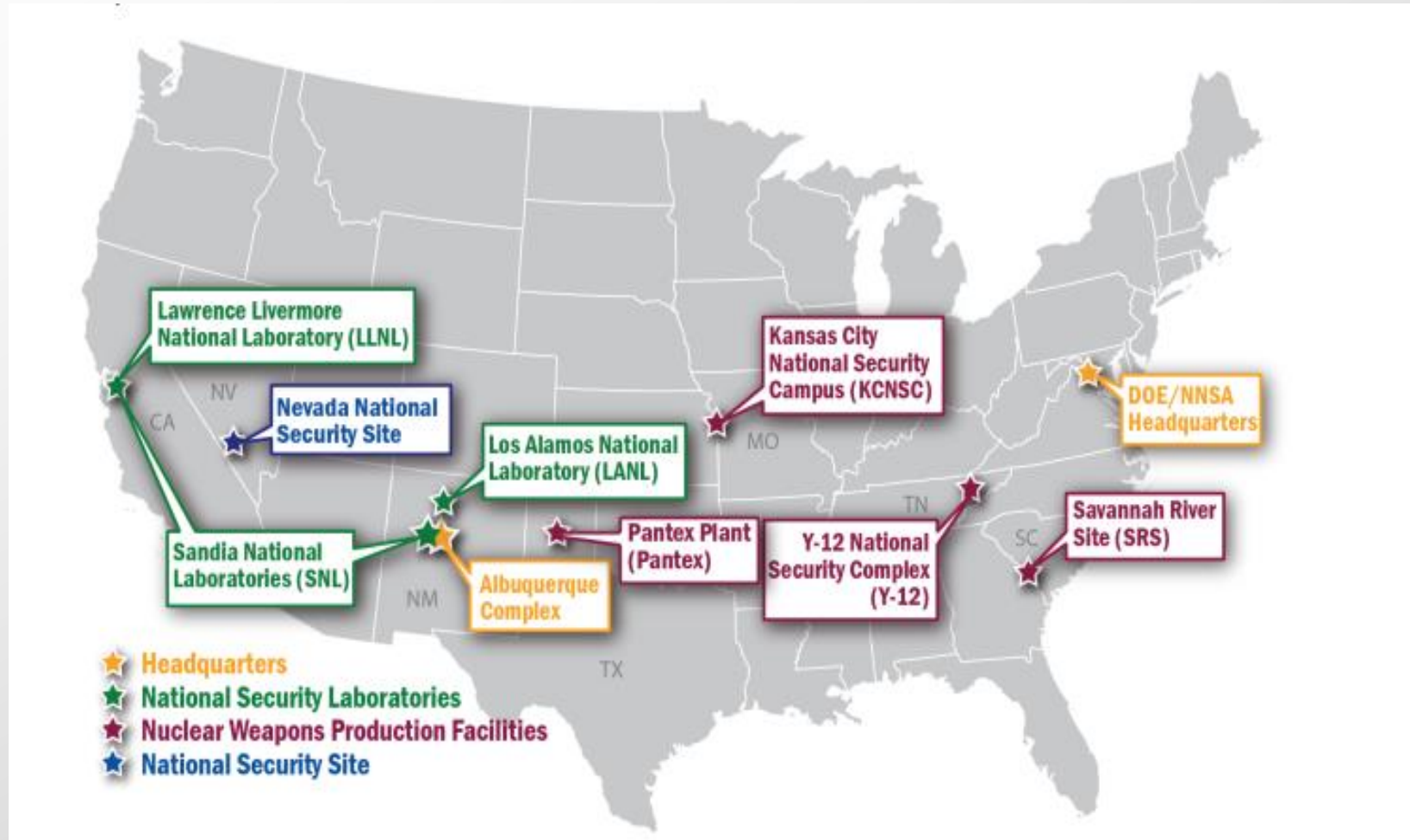
- Challenges/Context
- Why Do This?
- What Have We Done So Far?
- Integrated Program Model – (NNSA Integrated Master Schedule or NIMS)

NNSA's Complex Contractual Relationships

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Most Modernization Programs (MPs) draw on at least six Independent Management & Operating (M&O) Organizations:

- All with their own scheduling, cost, and risk management groups
- No single “Prime” controls the integrated schedule
- LANL and SNL also have separate production agencies



Source: “The nuclear security enterprise”, Fiscal Year 2022 Stockpile Stewardship and Management Plan Report to Congress, March 2022,

[FY 2022 SSMP March 2022.pdf \(energy.gov\)](https://www.energy.gov/fy-2022-ssmp-march-2022.pdf)

Why Effective QRAs Are Essential to MPs

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- Typical Modernization Program (MP):
 - 8-12 years of development/testing/certification
 - Additional 6-14 years of production
- Planning Estimates (Class V/IV $\sim +100\%/-25\%$)
 - Performed before conceptual design review or final product definition
 - Program scope/down-selects should be risk-informed
- Baseline Estimates (Class III $\sim +30\%/-10\%$)
 - At completion of Feasibility Design must be risk-informed
 - Quantitative Risk Analyses (QRAs) are basis for management reserve and contingency
- For NNSA programs, time is the largest contributor to cost
 - Discrete work taking longer and extending the project overhead contribute to cost
 - Top schedule risks to the program must be identified to get to a reliable/credible cost

Why Do This?

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- Improve credibility, accuracy, and predictability of our programs and their schedules and cost estimates
- Make Program scope/schedule/cost trade-offs more effective
- Use probabilistic, risk-informed analysis to prioritize mitigations/management
- Enable schedule risk analysis of the overall program – vs. individual projects that sub-optimize the program

Challenges / Context

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NNSA MPs are long, precise, high consequence, complex programs

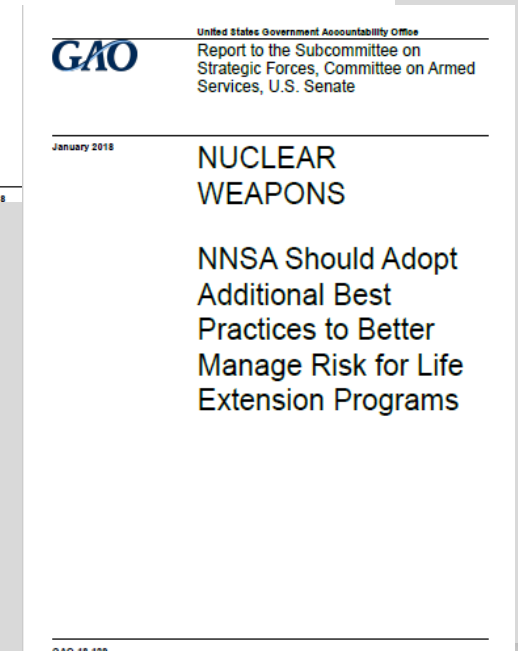
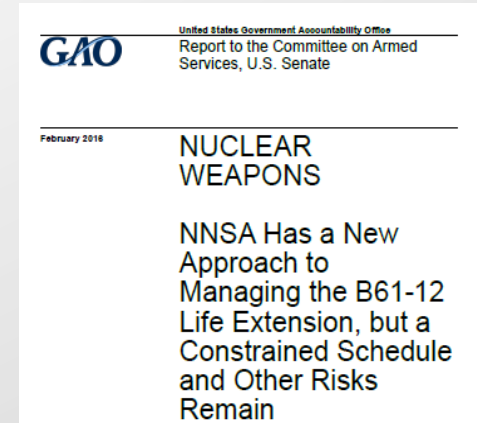
- Stopped nuclear weapons production/testing in 1991 (international ban on underground testing)
- Re-started refurbishments in 2001 → Life Extension Programs start-up (MPs)
- Initial programs were consistently late and substantially over cost
- 2014 – EVMS requirements re-started (led to more robust scheduling)
- 2017/2018 – Initial investment in detailed schedule quantitative risk analysis (QRA)

Received public and agency criticism for schedule and cost increases

- Not following all GAO cost estimating best practices (2009-2010)
- Need to improve quantitative risk analysis (2018)

Since then:

- W80-4 Cruise missile warhead site and representative program level QRAs (2018)
- QRAs added to NNSA Site Program Management Requirements documents
- W87-1 ICBM Modernization integrated site and program-level QRAs (tied directly to site execution schedules in 2022)



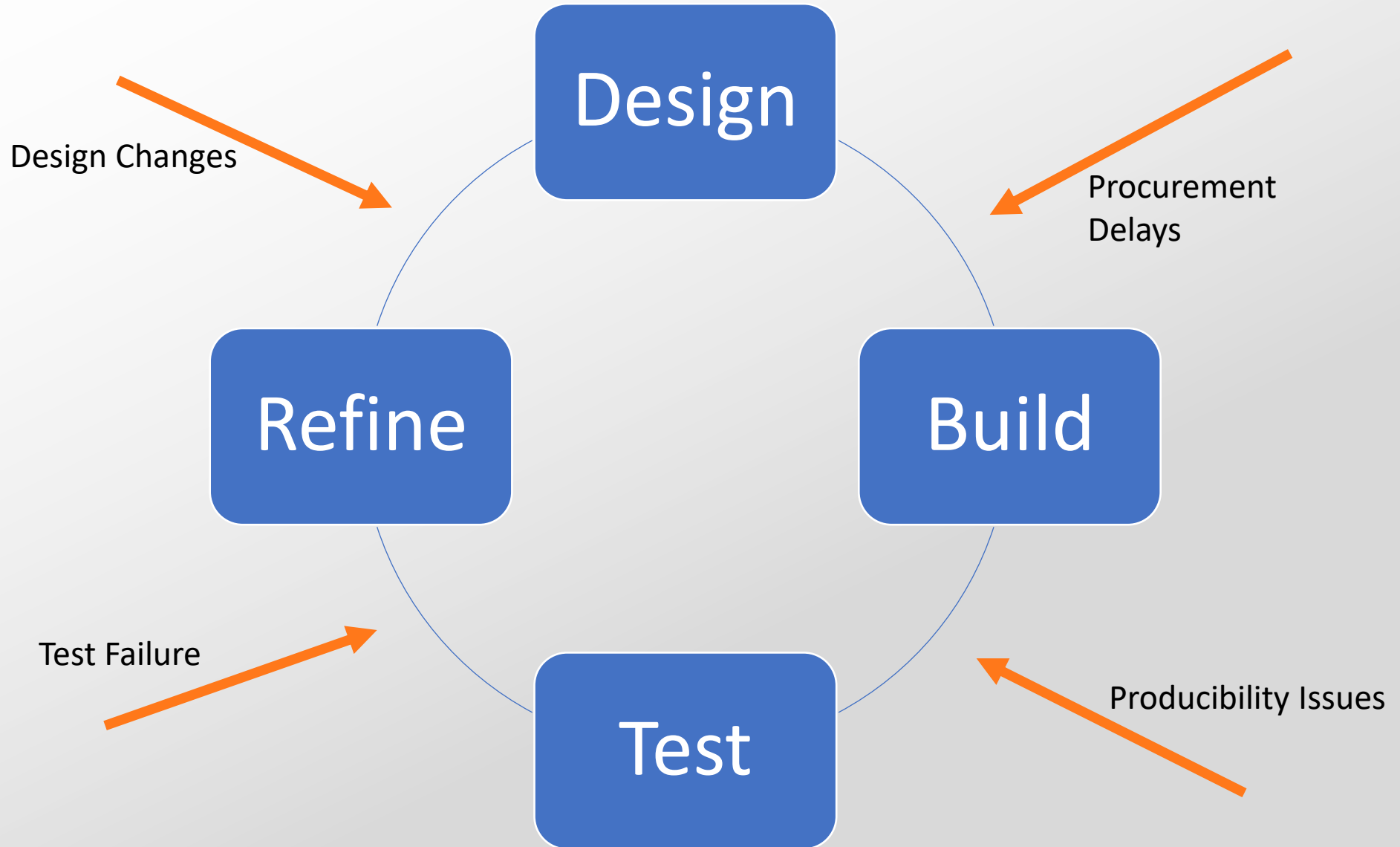
What Have We Done So Far?

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- Program-specific Requirements for site schedule organization and performance
 - Focus on handoffs (site-to-site, component-to-component, organization-to-organization)
 - Sites send representative durations to the NNSA Integrated Master Schedule (NIMS)
- Program NIMS structure for program organization and performance
 - NIMS assembles the participating site-level project durations, their risks and their interactions - for instance giving a product (e.g. a design) to another site (e.g. component production)
 - Track the product through multiple interdependent actions to final assembly (FPU)
 - Still Using Deterministic durations at this point
- Apply site-level risks to sites' schedules, program-level risks at the Program level
- Continue to add GAO Best Practices to NNSA program management requirements
- Still working on developing the probabilistic NIMS for the W87-1 and future MPs

Development Process Flow & Example Risks

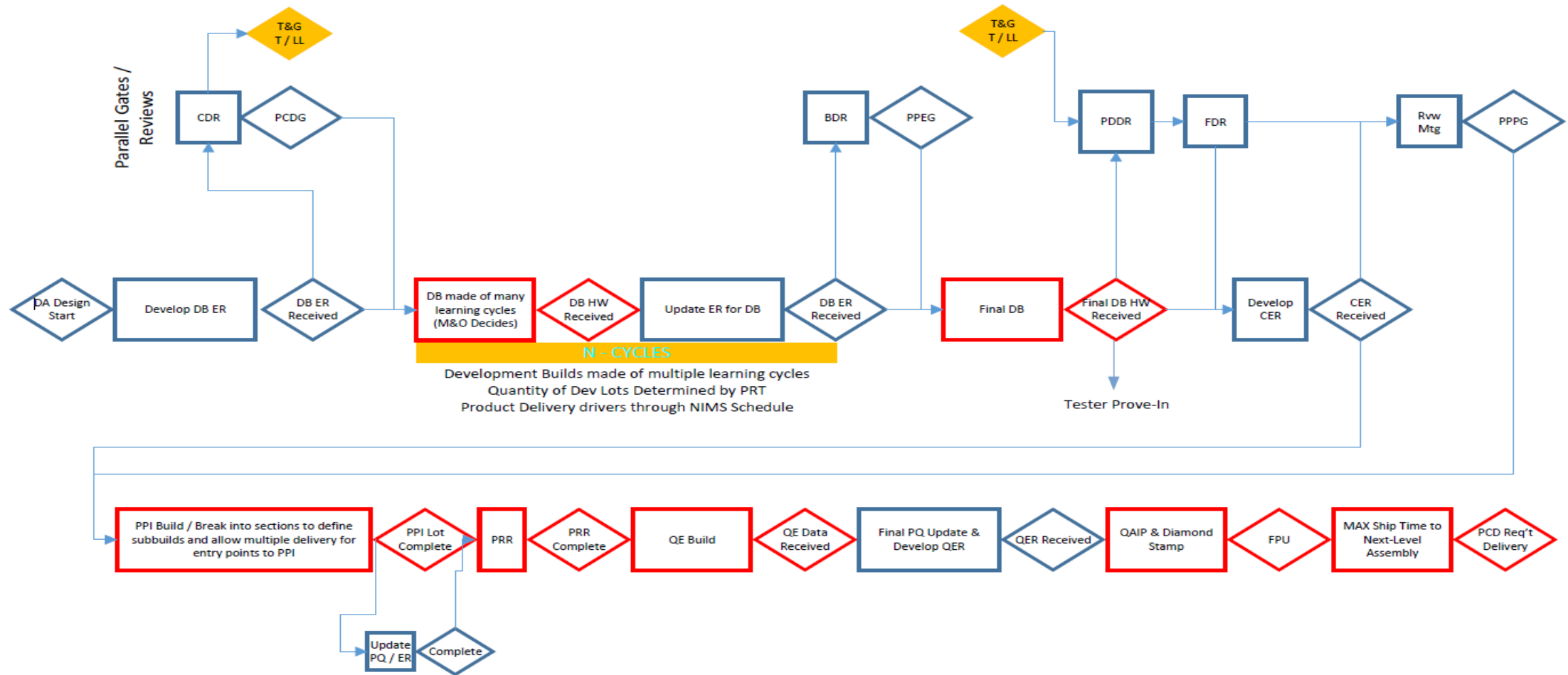
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Handoffs and Loops are Complicated!

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Component Hand-offs

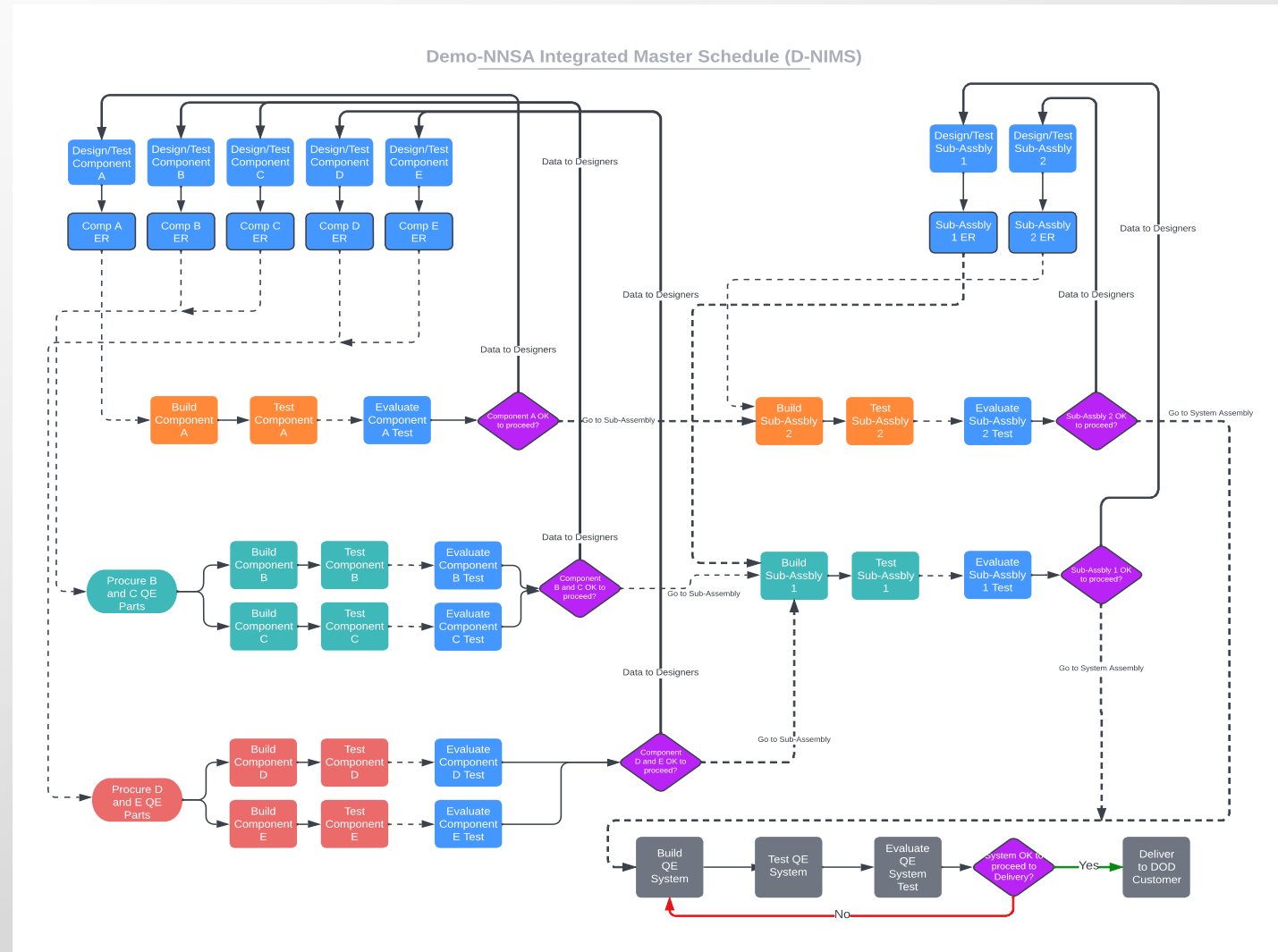


With all the handoffs and complexity, how do you model this at the program level?

A New Way to 'See' the Program Schedule

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- Program creates a NIMS with all the handoffs
 - Summary
 - Deterministic (so far)
- Individual sites transfer summary durations to the NIMS (sets up the 'send handoff')
- NIMS schedules the timing of the handoffs (determines the 'receive handoff')
- Program sends the integrated durations/dates back to the sites for incorporation into their schedules
- Currently deterministic, Risks added at each site
- Tasks include durations, hand-offs, uncertainties, and both site and program risks



NNSA Steps to Integrated Program QRAs

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Integrated Program QRA Case Study Progression:

- Step 1:** Independent deterministic site-level schedules but little Sender/Receiver inputs
- Step 2:** Independent probabilistic site-level schedules but little Sender/Receiver inputs + site level risks and program risks interpreted by sites
- Step 3:** Deterministic Sender/Receiver dates integrated via the D-NIMS (NNSA Integrated Master Schedule) and Sender/Receiver inputs traded between sites
- Step 4:** Deterministic Sender/Receiver dates integrated via the D-NIMS (NNSA Integrated Master Schedule) and Sender/Receiver inputs traded + site level risks and program risks interpreted by sites
- Step 5:** Deterministic Sender/Receiver dates integrated via the D-NIMS (NNSA Integrated Master Schedule) and Sender/Receiver inputs traded + site level risks without program risks
- Step 6:** Deterministic program schedule comprised of P50 site durations (represents site risks)
- Step 7:** Probabilistic program schedule comprised of P50 site durations with program risks (assigned to multiple sites in program schedule)

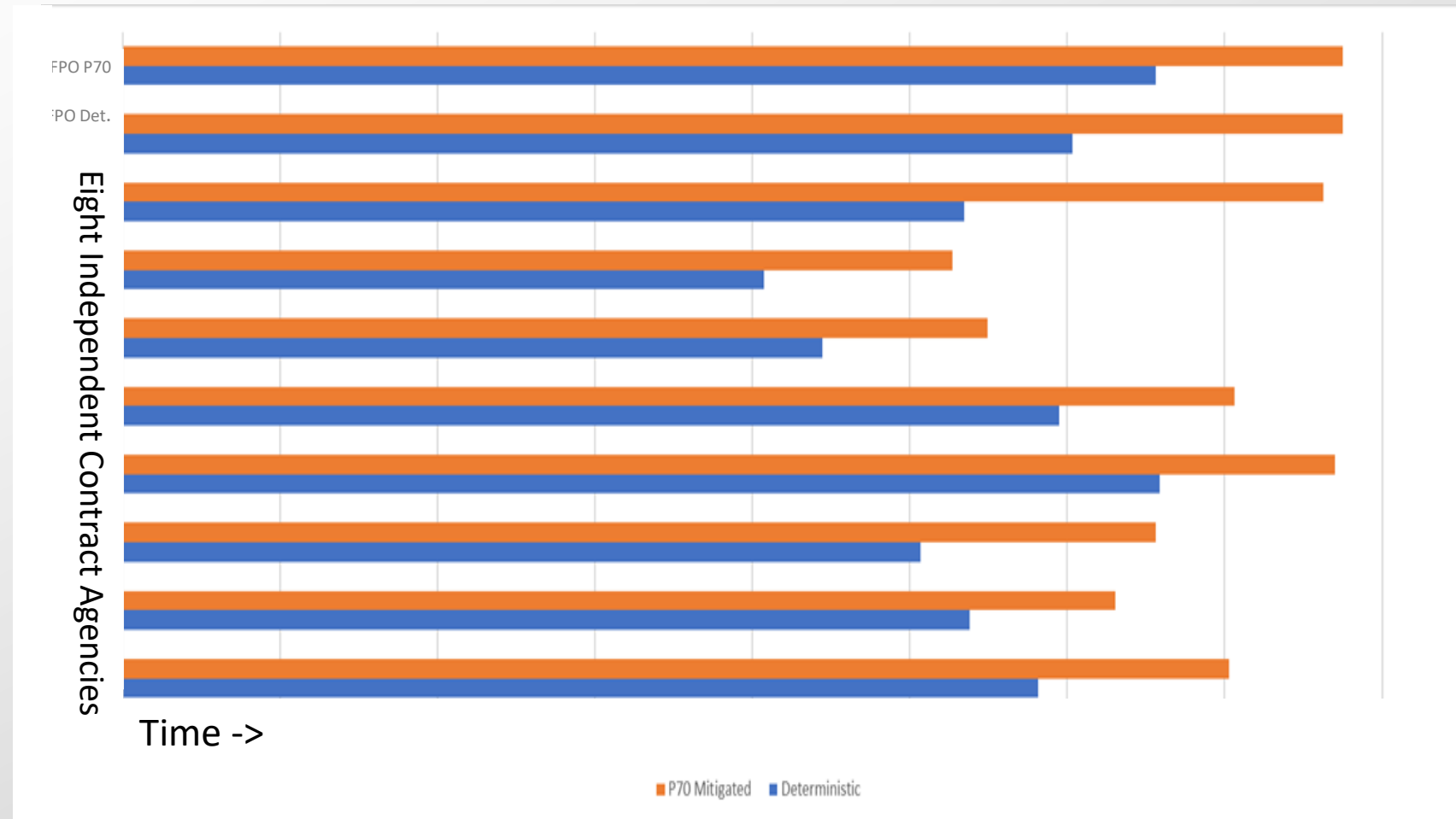
“Old” Results – Independent (Stovepipe) Deterministic

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Site deterministic results

- Sites somewhat disconnected and operating to their own schedule
- Hand-off dates communicated separately
- Sender-receiver dependency shifts some bars “to the right”
- A critical path emerges that has most of the sites represented but not fully integrated
- P70 represents a 70% confidence in that date or duration or earlier / shorter

* FPO – Federal Program Office

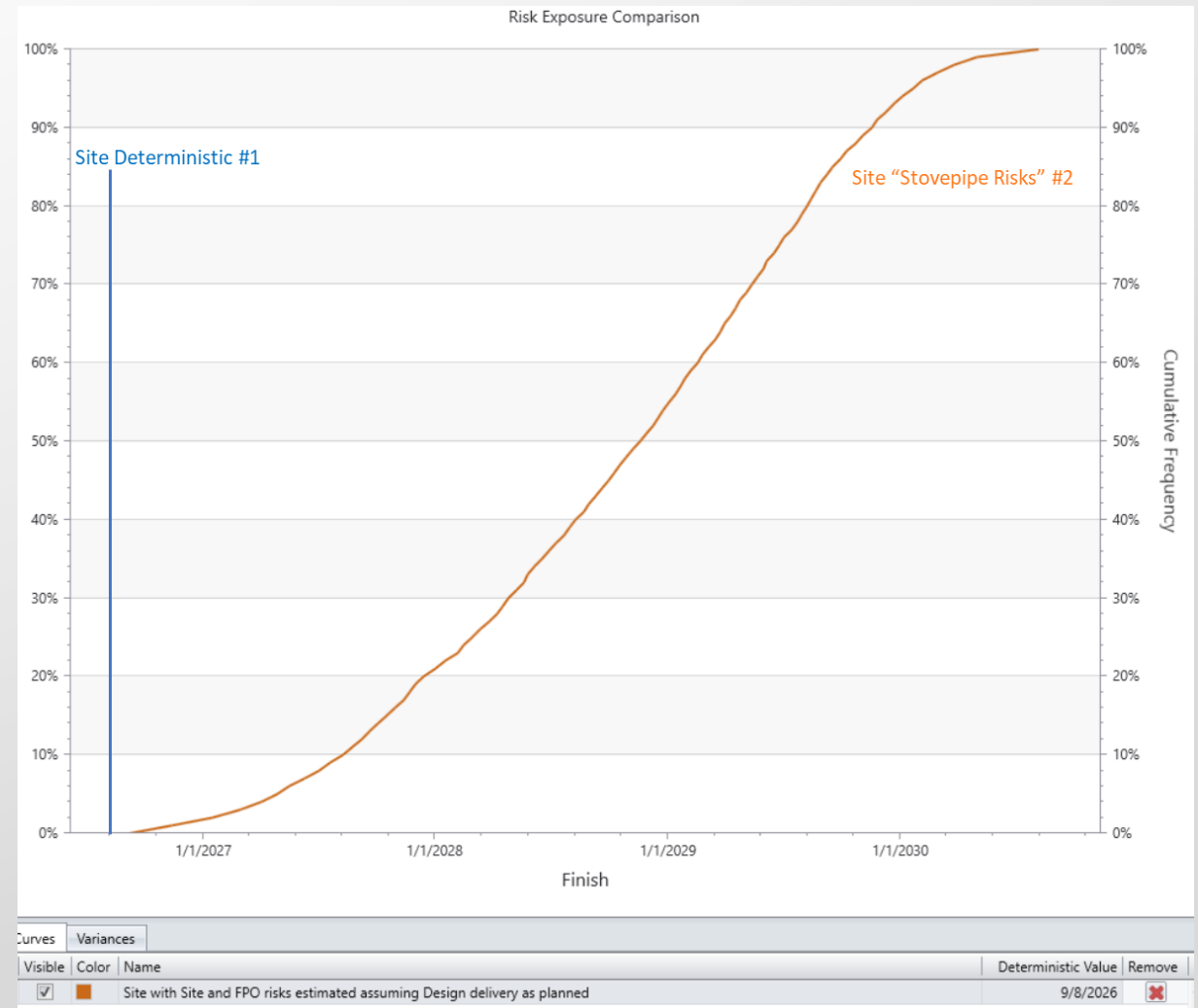


Step 1+2 Results – Independent Site Level Risks

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Site-only Quantitative Risk Results

- No integration of Sender/Receiver Dates
- Site-Estimated Risks (both site and program level impacts)

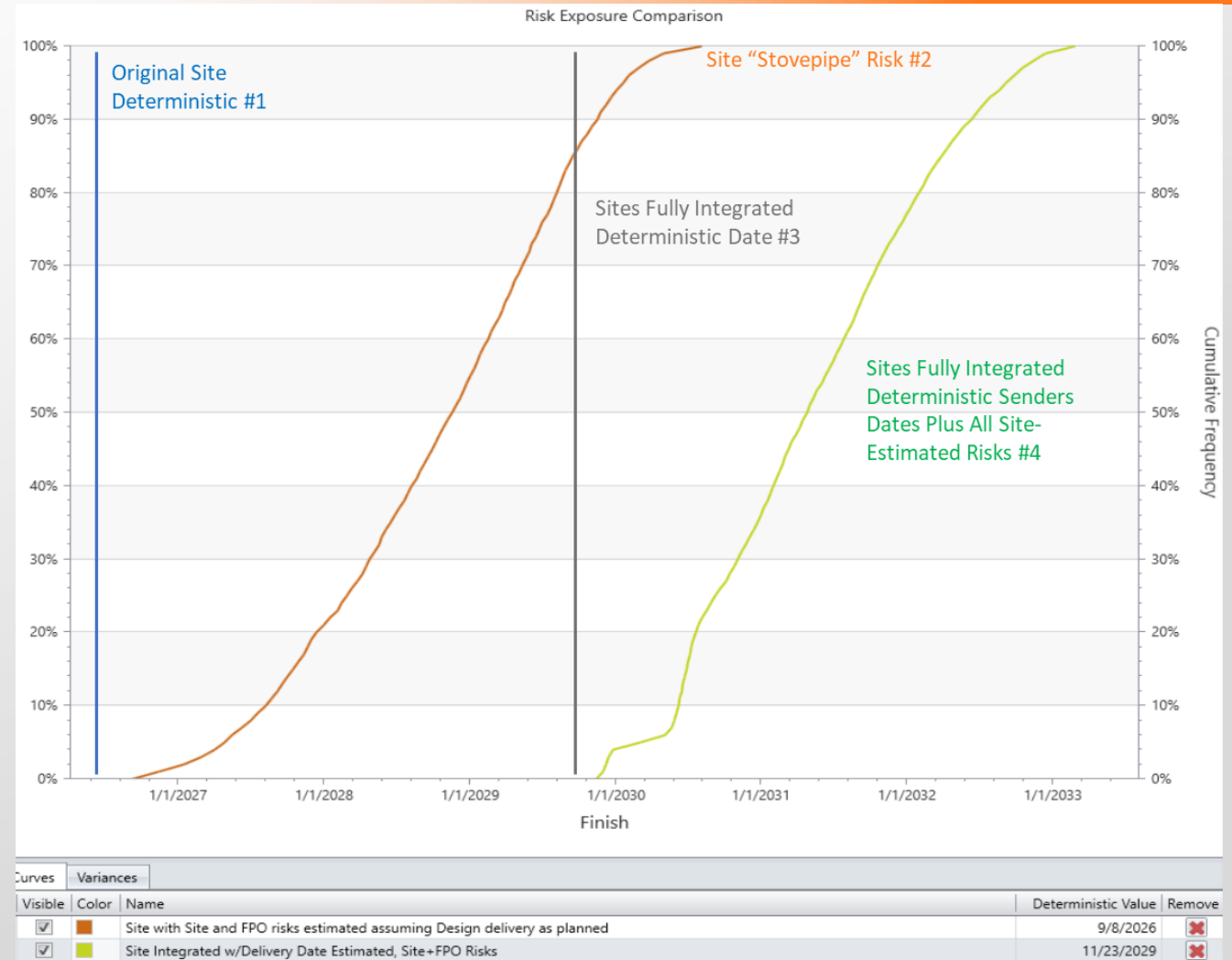


Step 3 + 4 Results – Integrated Deterministic Durations with Site-Estimated Risks

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Site Quantitative Results:

- Curves 1 and 2 - from previous slide
- Curve 3 – Integrated Deterministic (D-NIMS)
 - D-NIMS Schedule model built with all site work represented by summary activities and site-based durations – includes and harmonizes ALL handoffs
 - Sites send durations to D-NIMS → D-NIMS calculates the dates → D-NIMS sends updated dates go back to the sites (D-NIMS is the translator between sites)
 - For NNSA: ~8,500 activities and handoffs are incorporated
- Curve 4 – Integrated Deterministic with Site-Estimated Risks (both site and program level impacts)

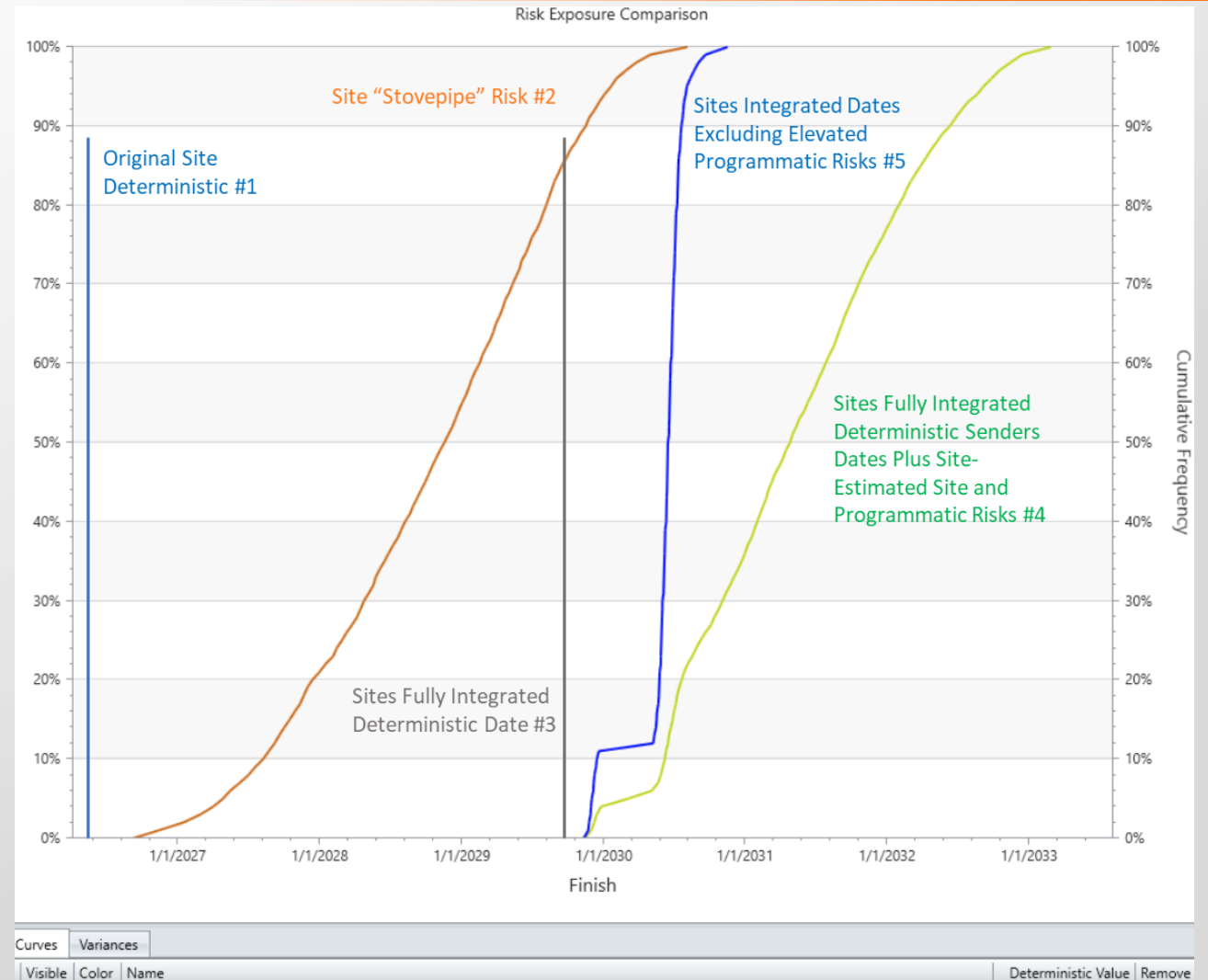


Step 5 Results – Integrated Dates, Site-Only Estimated Risks

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Site Quantitative Results:

- Curves 1 - 4 - from previous slide
- Curve 5: Programmatic Risks pulled out of site-level schedule risk analysis
 - Elevated to the program responsibility
 - Will be included in the program risk analysis
- But D-NIMS can be more than just a translator - it can also be used as the Program Schedule Risk Model



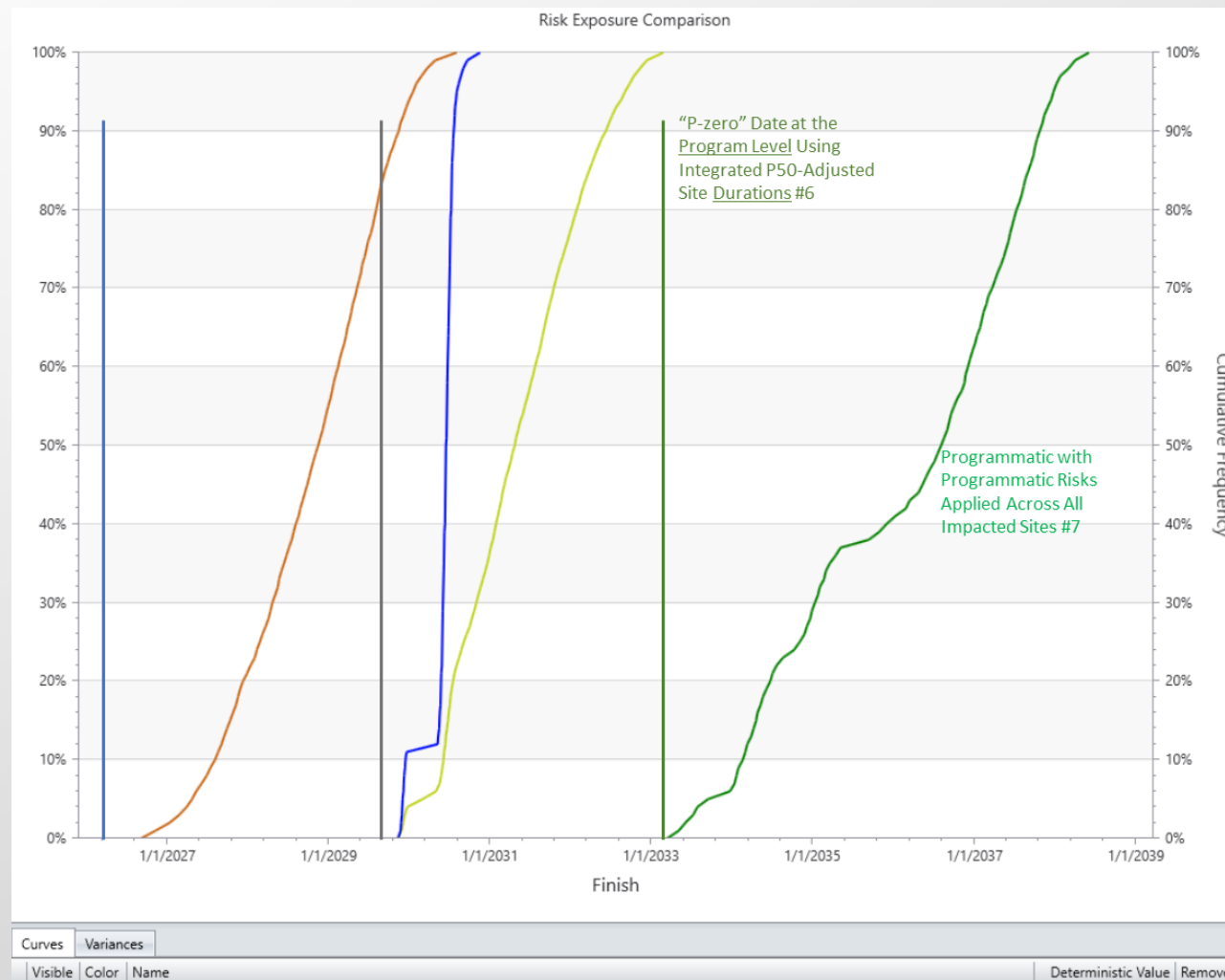
Improve Program level risk evaluation and handling – consistency across sites and coordination of effort

Step 6 + 7 - Program Level Results

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Programmatic Quantitative Results:

- Curves 1 - 5 - from previous slide
- Curve 6: Use D-NIMS as the program schedule and model. Substitute the Sites' P50 risk-informed output durations and giver-receiver dates (site-only risks) in place of the site deterministic durations
- Curve 7: D-NIMS Program Schedule includes the program risks
 - Program risks applied to the summarized site level work included in the D-NIMS program schedule
 - Enables effective and consistent risk impact, across all affected sites, to show more realistic program completion dates



Process transforms a deterministic initial schedule into a reliable, integrated program schedule.

Summary/Next Steps

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Why We Are Doing This!

- Improve credibility, accuracy, and predictability of our programs
- Make Program scope/schedule/cost trade-offs more effective
- Use probabilistic risk-informed analysis to prioritize mitigations/management
- Enable schedule risk analysis of the overall program – vs. individual projects that sub-optimize the program

Next Steps

- Complete development of P50 Adjusted Durations into Probabilistic NIMS
- Continue to reinforce QRA Management Requirements/Expectations and Results
- Work with other DOE Agencies/Organizations to continue to improve QRAs and NNSA Programmatic Impacts