BWX Technologies, Inc.

Reactor Developer Perspectives on Opportunities for Improvement

NRIC-NEI-EPRI Nuclear Quality Assurance Challenges Workshop

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BWX Technologies employs nuclear technology to solve some of the world's most important problems

OUR MISSION

- Global Security
- Clean Energy
- Nuclear Medicine
- Space Exploration
- Environmental Remediation

$2.5B
2023 Revenues

415
Reactors delivered for Naval Nuclear Power

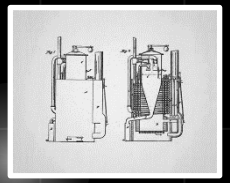
300+
Commercial nuclear steam generators

7,800+
Employees

165-Year History of Innovation

75-Year History of Nuclear Technology

BWXT
BWX Technologies, Inc.



1856
Stephen Wilcox patented the water tube boiler

1953
Designed and fabricated components for the world's first nuclear powered submarine the USS Nautilus

2015
Delivered the 400th nuclear core to the U.S. Navy

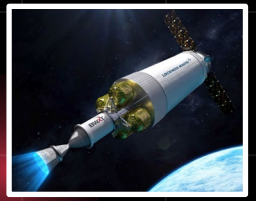
2017
Awarded NASA Nuclear Thermal Propulsion Reactor Design contract

2018
Entered the nuclear medicine market

2019
Awarded first Columbia-class contract

2020
Awarded Savannah River Site contract

2022
DoD contract to build Pele the first microreactor in the United States



2023
BWXT to provide nuclear reactor engine and fuel for DARPA NASA DRACO space project

NON-NUCLEAR | NUCLEAR | **BWXT ERA**

BWXT

60+ Years of Commercial Nuclear Power Experience

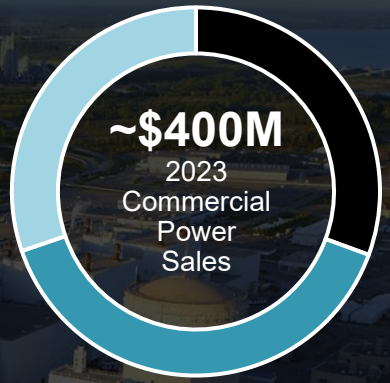
#1 Supplier & Sole Manufacturer
of large nuclear components in North America

Strong
customer relationships

Developer of CANDU
On-Power Refueling Technology

1 of 2
Fuel manufacturers in the Canadian market

Specialized
Field services capabilities



Recurring
Installed Base

- CANDU fuel
- Fuel handling
- Inspection & maintenance services
- Waste containers
- Engineering services
- Field services

Original Equipment
Life Extension / New Build / SMR

- Steam generators
- Reactor pressure vessels
- Heat exchangers
- Specialty reactor components
- Waste containers
- Engineering services
- Field services

Paper Reactor Memo by Admiral Hyman Rickover

The Journal of Reactor Science and Technology, Volume 3, No. 3

Academic reactor:

- It is simple.
- It is small.
- It is cheap.
- It is light.
- It can be built very quickly.
- It is very flexible in purpose.
- Very little development is required.
- Mostly “off-the-shelf” components.
- The reactor is in development; not being built.

Practical reactor:

- It is being built now.
- It is behind schedule.
- Requires immense development.
- It is very expensive.
- It takes a long time to build
- It is large.
- It is heavy.
- It is complicated.

Making the Academic a Reality

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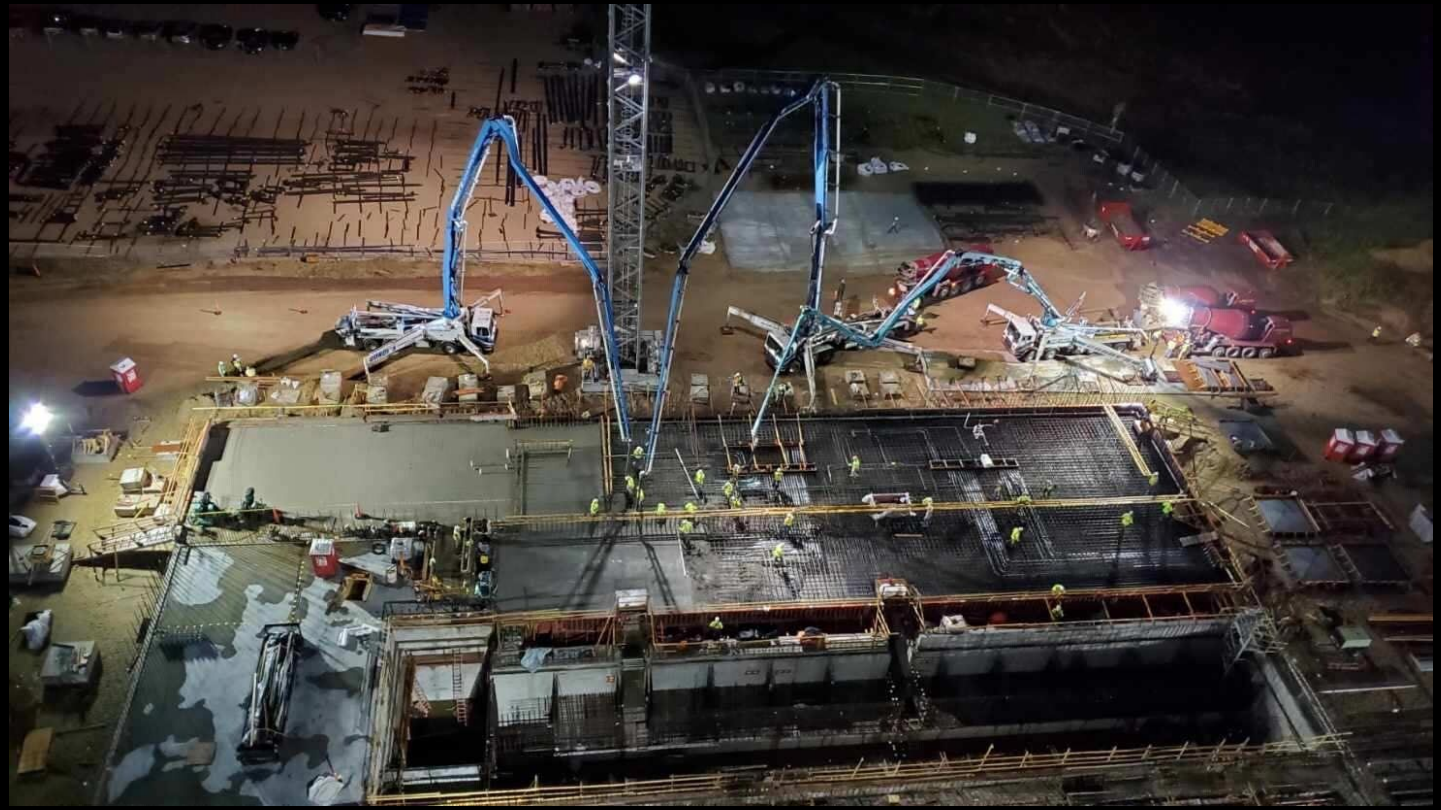
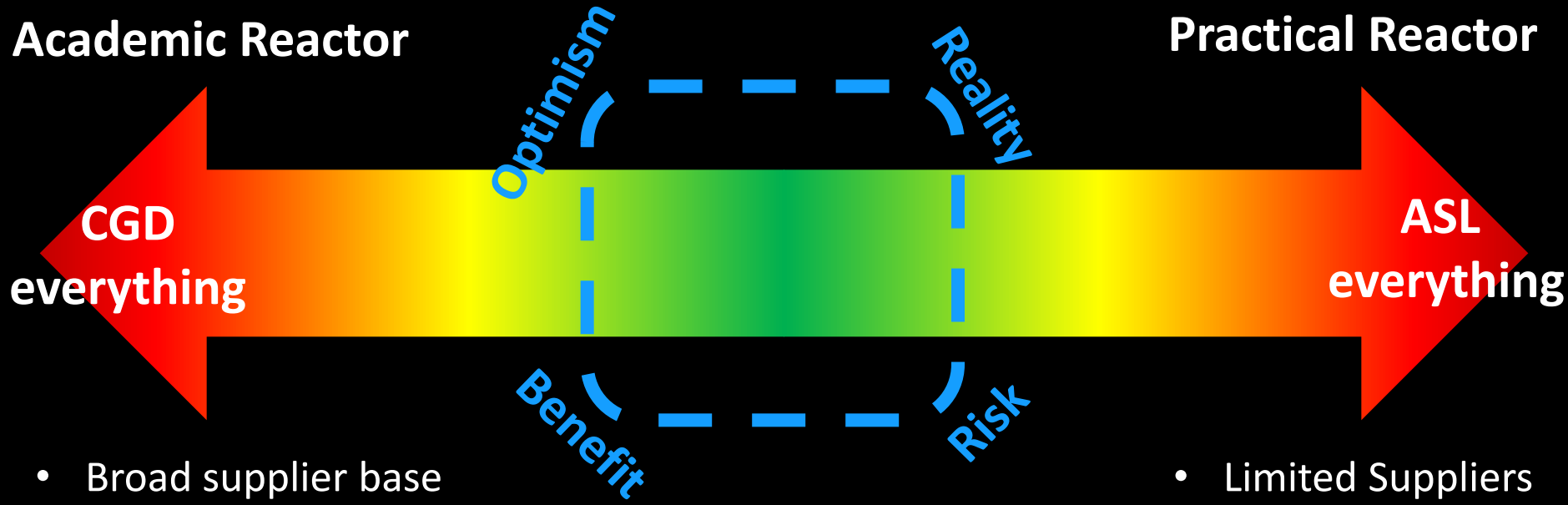
Making the Academic a Reality



Making the Academic a Reality

Making the Academic a Reality

Commercial Grade Dedication - Challenges



- Broad supplier base
- Shorter lead times
- Lower Cost
- Higher risk to implementation

- Limited Suppliers
- Long lead times
- Higher Cost
- Lower risk to implementation

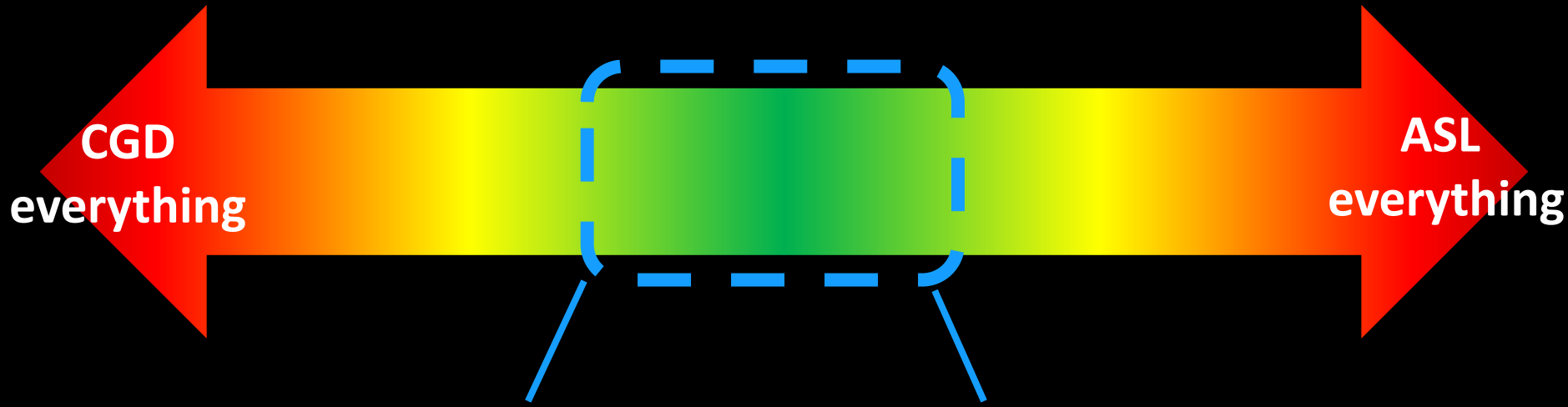
Caveats & Acknowledgements

Neither approach will eliminate all causes of delays and overruns

Non-Conformances

Interference & Fit-up

Commercial Grade Dedication – Finding the Sweet Spot



Identify Safety Function(s)
Define Critical Characteristic(s)
Determine acceptance criteria

Special Tests & Inspection
Commercial-Grade Survey
Source Verification

Existing Resources and Guidance

- NRC Reg Guide 1.164
- EPRI TR-106439
- EPRI 3002002982
- EPRI Report TR-017218
- NEI 17-06
- IEEE Std 323
- DOE-HDBK-1230-2019
- EPRI CBT
- NEI workshops/training

Is this enough?

In-person training, workshops, and practice increase confidence and application.

Looking Forward: What about computational software?

- Manufacturing advances outpacing computational capabilities
- New codes and methods, e.g. NEAMS tools, suitable for proof-of-concept, prototyping, testing.
- V&V is a long way off, and often requires experimental benchmarks

Closing thoughts

- CGD is an important to the advanced reactor community
- CGD is not a magic bullet for cost and schedule concerns
- Choosing to CGD (or not) should be weighed carefully based on the item's function and the ability to verify its critical characteristics
- More workshops / training needed to increase confidence in success
- More attention should be given to new/emerging software V&V