



ENGINEERING SCHOOL OF SUSTAINABLE
INFRASTRUCTURE & ENVIRONMENT

Multifunctional Cement-Based Materials to Improve the Service Life of NPP Concrete Structures

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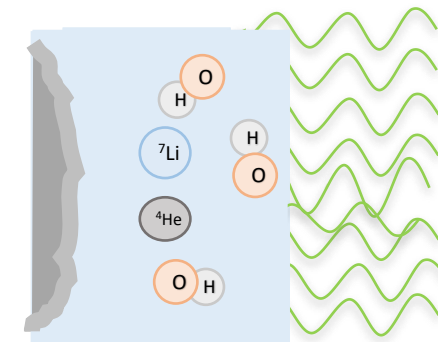
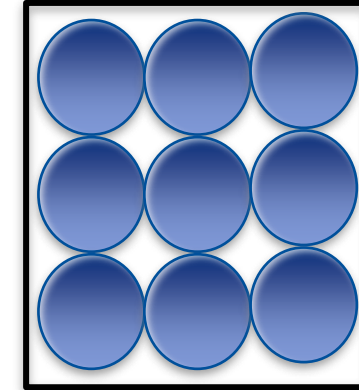
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Introduction

- Nuclear power plants (NPPs)
 - Original lifespans of 40-years
 - Service lives extended to 60 and 80 years
 - Neutron radiation degrades concrete
- Concrete biological shields (CBSs)
 - Radiation-induced volumetric expansion (RIVE)
 - Alkali silica reactivity via RIVE
- Boron
 - Effective at neutron shielding
 - Convert to lithium after neutron absorption

Acoustic damage Helium expansion



Cross-section of concrete

Design Methodology

Provides combined
neutron shielding and
ASR mitigation

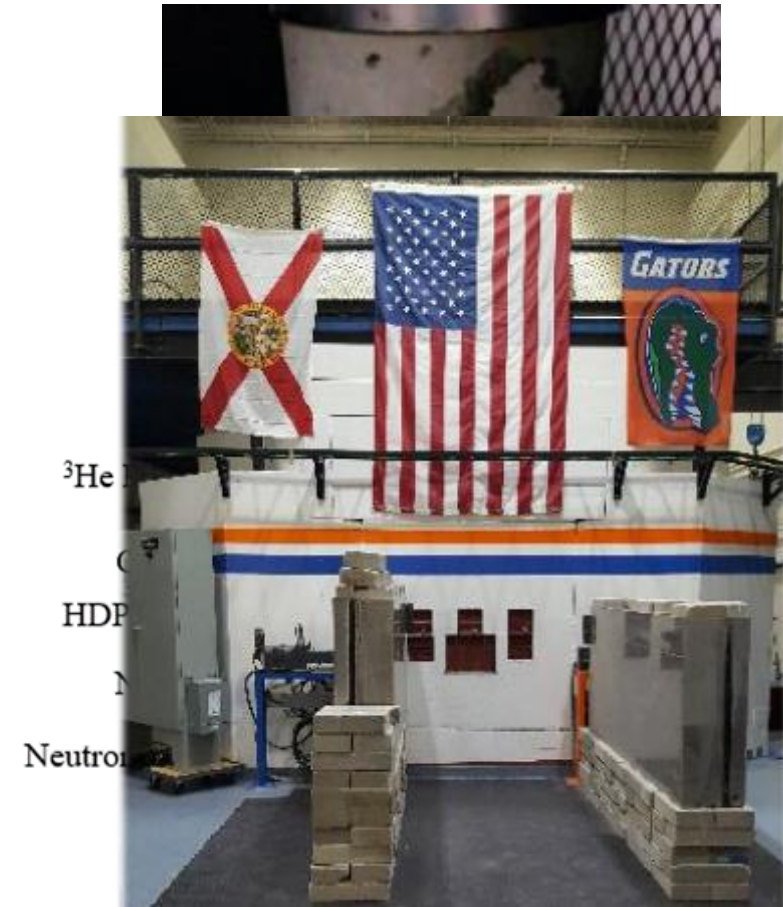
New
Construction

Retrofit – Service
Life Extension

Provides highly
efficient thin
shielding to halt
further damage from
service life extension

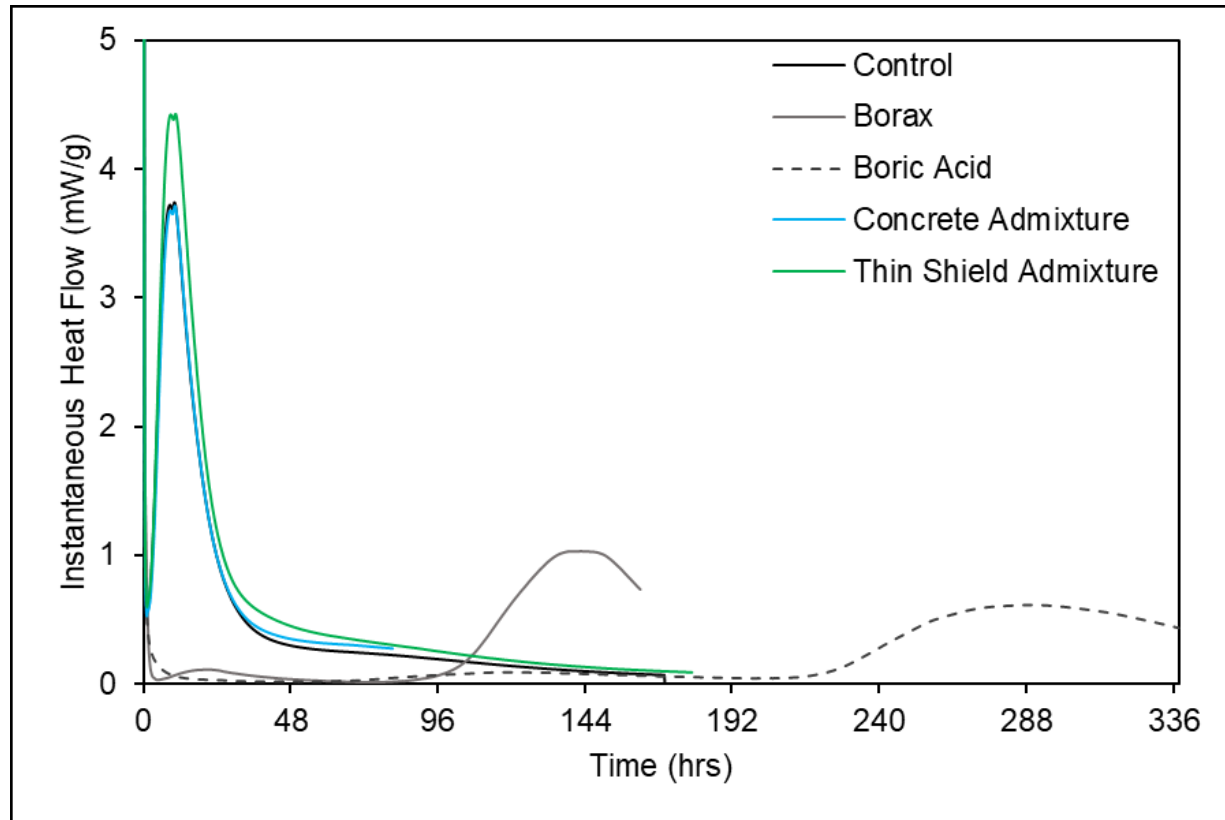
Experimental Plan

- Boron Compound Selection
 - Isothermal Calorimetry
 - Setting Time
 - Strength
- Neutron Shielding Performance
 - Small-scale neutron source
 - Large-scale neutron source – University of Florida Training Reactor
- Long-Term Neutron Exposure
 - Damage assessment



Boron Compound Selection

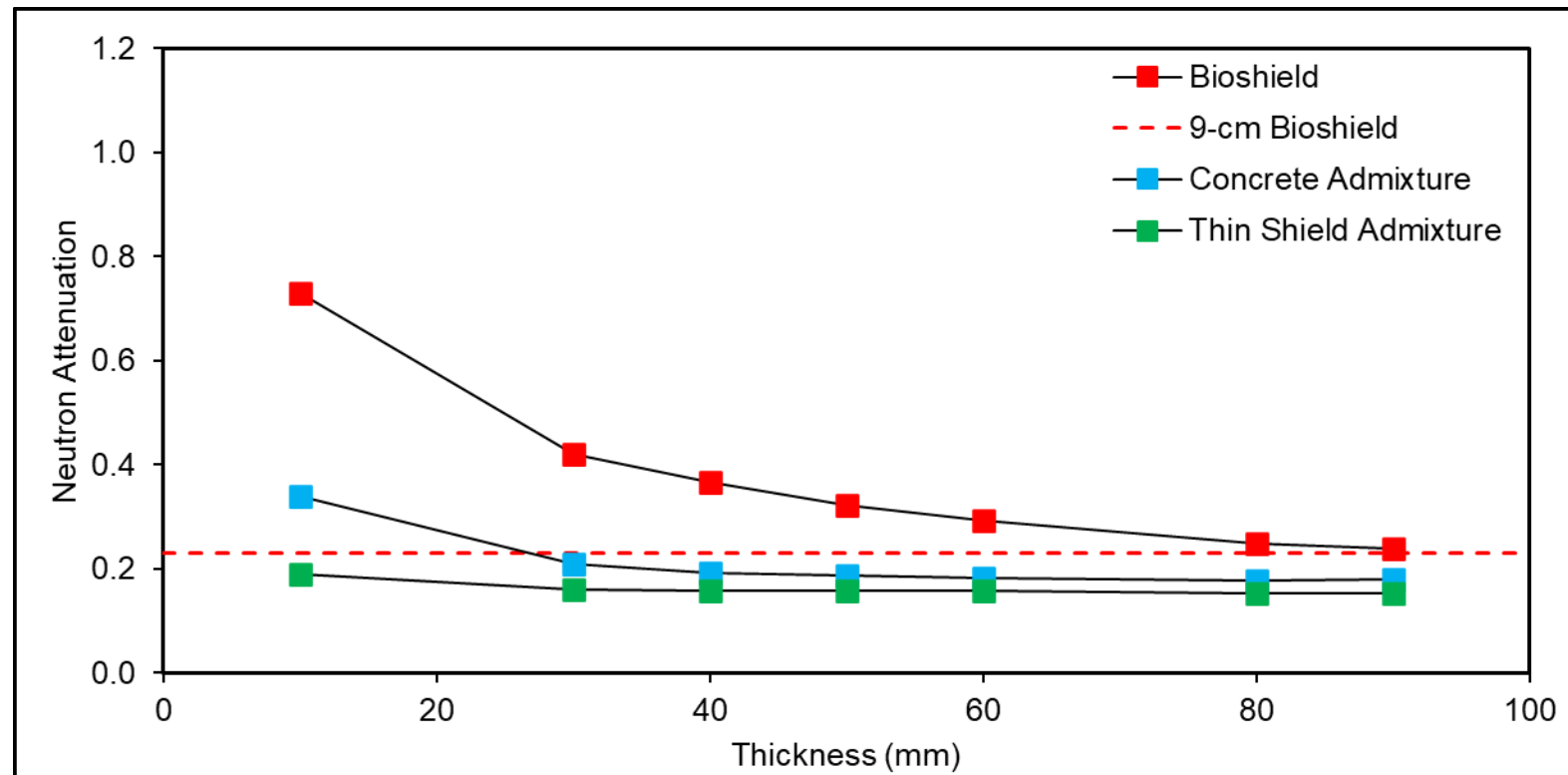
Isothermal Calorimetry



Setting and Strength

Mixture	Final Setting	28 Day Strength (psi)
Control	5 hrs 36 mins	6630
Borax	47 hrs 45 mins	4860
Admixture	5 hrs 31 mins	6310

Attenuation via Small-Scale Source



Planned - UFTR

- Attenuation via Large-Scale Source
 - Attenuation through depth measured using dosimeter arrays
- Long-term irradiation
 - Equivalent to 5 years of in-situ CBS neutron exposure
 - Damage will be assessed petrographically



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