Dynamical System Scaling Methodology

Dr. José N. Reyes, Jr.

Chief Technology Officer

February 29, 2012

U.S. Nuclear Regulatory Commission
Pre-Application Meeting
Rockville, MD

NuScale Power™

DRAFT

© NuScale Power, LLC 2012

Introduction

- As part of its pre-engagement activities with NRC, NuScale is seeking feedback on its scaling methodology topical report.
  - *Dynamical System Scaling (DSS) Methodology, NP-TR-1010-867, Revision 1* was issued to NRC on February 2011.

- Independent review of DSS Method and supporting mathematics was performed by M.L. Corradini and M. Sracic, University of Wisconsin-Madison with support from faculty in dynamical systems analysis and dynamical system identification.

DRAFT
© 2012 NuScale Power, LLC

Presentation Objectives and Outline

- Objective of this presentation is to provide an overview of the Dynamical System Scaling Methodology
  - Part 1: [[ ]] 3(a)(b)
  - Part 2: Dynamical System Scaling (DSS) – Integral System Scaling
  - Part 3: Application of the DSS Methodology to the Evaluation Model Development and Assessment Process (EMDAP) described in NRC Regulatory Guide 1.203.
  - Part 4: Application to Single-Phase Natural Circulation

DRAFT
Proprietary Class 2
© 2012 NuScale Power, LLC
NuScale Power™

PART 1

[[ ]]3(a) (b)

DRAFT

Proprietary Class 2
© 2012 NuScale Power, LLC

NuScale Power™

[[

]]3(a)-(c)

DRAFT

Proprietary Class 2
© 2012 NuScale Power, LLC

NuScale Power™

[[

]]3(a)-(c)

DRAFT

Proprietary Class 2
© 2012 NuScale Power, LLC

NuScale Power™

Definitions

- **System:** A finite control volume containing a conserved quantity such as mass, momentum, or energy and acted upon by internal and external agents of change.

- **Conserved Process:** The sequential transition of the state of the system; the transition sequence governed by an integral system balance law constrained by the system's initial state and boundary conditions.

DRAFT
© 2012 NuScale Power, LLC

[[

]]3(a)-(c)

DRAFT

Proprietary Class 2
© 2012 NuScale Power, LLC

NuScale Power™

[[

]]3(a)-(c)

DRAFT

Proprietary Class 2
© 2012 NuScale Power, LLC

NuScale Power™

[[

]]3(a)-(c)

DRAFT

Proprietary Class 2
© 2012 NuScale Power, LLC

NuScale Power™

[[

]]3(a)-(c)

DRAFT

Proprietary Class 2
© 2012 NuScale Power, LLC

NuScale Power™

[[

]]3(a)-(c)

DRAFT

Proprietary Class 2
© 2012 NuScale Power, LLC

NuScale Power™

[[

]]3(a)-(c)

DRAFT

Proprietary Class 2
© 2012 NuScale Power, LLC

NuScale Power™

[[

]]3(a)-(c)

DRAFT

Proprietary Class 2
© 2012 NuScale Power, LLC

NuScale Power™

[[

]]3(a)-(c)

DRAFT

Proprietary Class 2
© 2012 NuScale Power, LLC

NuScale Power™

[[

]]3(a)-(c)

DRAFT

Proprietary Class 2
© 2012 NuScale Power, LLC

NuScale Power™

[[

]]3(a)-(c)

DRAFT

Proprietary Class 2
© 2012 NuScale Power, LLC

NuScale Power™

[[

]]3(a)-(c)

DRAFT

Proprietary Class 2
© 2012 NuScale Power, LLC

NuScale Power™

[[

]]3(a)-(c)

DRAFT

Proprietary Class 2
© 2012 NuScale Power, LLC

NuScale Power™

[[

]]3(a)-(c)

DRAFT

Proprietary Class 2
© 2012 NuScale Power, LLC

NuScale Power™

[[

]]3(a)-(c)

DRAFT

Proprietary Class 2
© 2012 NuScale Power, LLC

NuScale Power™

[[

]]3(a)-(c)

DRAFT

Proprietary Class 2
© 2012 NuScale Power, LLC

NuScale Power™

[[

]]3(a)-(c)

DRAFT

Proprietary Class 2
© 2012 NuScale Power, LLC

NuScale Power™

[[

]]3(a)-(c)

DRAFT

Proprietary Class 2
© 2012 NuScale Power, LLC

NuScale Power™

[[

]]3(a)-(c)

DRAFT

Proprietary Class 2
© 2012 NuScale Power, LLC

NuScale Power™

[[

]]3(a)-(c)

DRAFT

Proprietary Class 2
© 2012 NuScale Power, LLC

NuScale Power™

PART 2

Application of DSS to integral Systems

DRAFT

© 2012 NuScale Power, LLC

IST Facility Scaling Objectives

- To develop a properly scaled test facility, the following specific objectives must be met for each operational mode of interest.
  - The thermal hydraulic processes that should be modeled have been identified.
  - The similarity criteria that should be preserved between the test facility and the full-scale prototype have been obtained.
  - The priorities for preserving the similarity criteria have been established.
  - Specifications for the test facility design or modifications have been provided.
  - Biases due to scaling distortions have been quantified.
  - The critical attributes of the test facility that must be preserved to meet Quality Assurance requirements have been identified.

DRAFT
© 2012 NuScale Power, LLC

[[

]]3(a)-(c)

DRAFT

Proprietary Class 2
© 2012 NuScale Power, LLC

NuScale Power™

[[

]]3(a)-(c)

DRAFT

Proprietary Class 2
© 2012 NuScale Power, LLC

NuScale Power™

[[

]]3(a)-(c)

DRAFT

Proprietary Class 2
© 2012 NuScale Power, LLC

NuScale Power™

[[

]]3(a)-(c)

DRAFT

Proprietary Class 2
© 2012 NuScale Power, LLC

NuScale Power™

[[

]]3(a)-(c)

DRAFT

Proprietary Class 2
© 2012 NuScale Power, LLC

[[

]]3(a)-(c)

DRAFT

Proprietary Class 2
© 2012 NuScale Power, LLC

NuScale Power™

[[

]]3(a)-(c)

DRAFT

Proprietary Class 2
© 2012 NuScale Power, LLC

NuScale Power™

[[

]]3(a)-(c)

DRAFT

Proprietary Class 2
© 2012 NuScale Power, LLC

NuScale Power™

PART 3

Application of DSS to EMDAP

DRAFT

© 2012 NuScale Power, LLC

[[

]]3(a)-(c)

DRAFT

Proprietary Class 2
© 2012 NuScale Power, LLC

NuScale Power™

[[

]]3(a)-(c)

DRAFT

Proprietary Class 2
© 2012 NuScale Power, LLC

NuScale Power™

[[

]]3(a)-(c)

DRAFT

Proprietary Class 2
© 2012 NuScale Power, LLC

NuScale Power™

PART 4

Application of DSS to the NuScale IST – Single-Phase Natural Circulation

DRAFT

© 2012 NuScale Power, LLC

[[

]]3(a)-(c)

DRAFT

Proprietary Class 2
© 2012 NuScale Power, LLC

NuScale Power™

[[

]]3(a)-(c)

DRAFT

Proprietary Class 2
© 2012 NuScale Power, LLC

NuScale Power™

[[

]]3(a)-(c)

DRAFT

Proprietary Class 2
© 2012 NuScale Power, LLC

NuScale Power™

[[

]]3(a)-(c)

DRAFT

Proprietary Class 2
© 2012 NuScale Power, LLC

NuScale Power™

[[

]]3(a)-(c)

DRAFT

Proprietary Class 2
© 2012 NuScale Power, LLC

NuScale Power™

[[

]]3(a)-(c)

DRAFT

Proprietary Class 2
© 2012 NuScale Power, LLC

[[

]]3(a)-(c)

DRAFT

Proprietary Class 2
© 2012 NuScale Power, LLC

NuScale Power™

- DSS Methodology is being applied to the design of NuScale IST and SET facilities.
- As part of its pre-engagement activities with NRC, NuScale is seeking feedback on its scaling methodology topical report.
  - Dynamical System Scaling (DSS) Methodology, NP-TR-1010-867, Revision 1 was issued to NRC on February 2011.
- Provided an overview of the Dynamical System Scaling Methodology
  - Part 1: [[ ]]3(a) (b)
  - Part 2: Dynamical System Scaling (DSS) – Integral System Scaling
  - Part 3: Application of the DSS Methodology to the Evaluation Model Development and Assessment Process (EMDAP) described in NRC Regulatory Guide 1.203.
  - Part 4: Application to Single-Phase Natural Circulation

DRAFT
Proprietary Class 2
© 2012 NuScale Power, LLC
NuScale Power™

NuScale Power™

1100 NE Circle Blvd., Suite 350
Corvallis , OR 97330
541-207-3931

http://www.nuscalepower.com

DRAFT

© 2012 NuScale Power, LLC