Westinghouse Non-Proprietary Class 3

LTR-NRC-09-47 NP-Enclosure

Pre-Submittal Meeting – Plant Modeling Process: Supplement 3 to BISON Topical Report RPA 90-90-P-A (Non-Proprietary)

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Pre-Submittal Meeting
Plant Modeling Process: Supplement 3 to BISON Topical Report RPA 90-90-P-A

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Agenda

- Introductions (STP)
- Attendees (STP)
- Expected Outcomes (STP)
- BWR Code Overview (WEC)
- Topical Report Schedule (WEC)
- Objective of the Topical Report (WEC)
- Overview of SAFIR (WEC)
  - SAFIR Inputs and Outputs
  - Computer Interface
  - System Models
- SAFIR Validation and Verification Results (WEC)
- Desired uses of SAFIR (WEC)
- Future Actions and Meetings (WEC)

Introduction

- STP Team Attendees

- Scott Head	STPNOC
- Jeremy King	Westinghouse
- Ryan Stout	Westinghouse
- Ryan Lenahan	Westinghouse
- Mike Riggs	Westinghouse
- Thomas Lindqvist	Westinghouse
- Hakan Svensson	Westinghouse
- Kjell Bergman	Westinghouse
- Robert Quinn	Westinghouse
- Fumihiko Ishibashi	TANE
- Koichi Kondo	TANE

Introduction

- Desired Outcomes
  - Provide an update to the NRC on the plans for fuel related topical reports
  - Provide NRC reviewers with an understanding of the scope content of the SAFIR topical report
  - Receive feedback from NRC

Westinghouse BWR Code Overview

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LTR Schedule

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Changes introduced by ABWR and full-scope fuel related FSAR applications

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Supplement 3 to RPA 90-90-P-A

- Supplement 3 to RPA 90-90-P-A "BISON – One Dimensional Dynamic Analysis Code for Boiling Water Reactors"

- The main purpose of this Supplement is to license the process to model plant systems to support the removal of SER restriction 6 in RPA 90-90-P-A.

Objective of Supplement 3

- Provides a toolbox (SAFIR) to be used in the model development
- Provide a description of SAFIR components
- The process contains a verification and validation.
- Present plant measurements are used against SAFIR models for verification
- Models developed will be used for new and existing plants.
- Documentation follows Westinghouse standard procedures.

Topical Table of Contents

Topical Table of Contents (cont.)

Model Development Process

- Requirements
  - Desired functionality
  - Limitations and assumptions
  - Communication with adjacent systems
- Verification
  - Desired functionality will be verified
  - Co-function with adjacent models
- Validation when required
  - Complex models, i.e. models using controllers
  - Complete plant model

Use of SAFIR with Modeling Process

- SAFIR is a code package with a selection of standard components that can be used to model balance of plant responses, such as control systems.

What can SAFIR Model?

- SAFIR is a code package that through user input can be used to simulate almost any type of control system measurement system or logical functions.
- SAFIR can be used both for the simulation of digital systems control systems as well as analog systems.
- SAFIR was developed more than 20 years ago.
- SAFIR models have been used in Europe since mid 1990's.

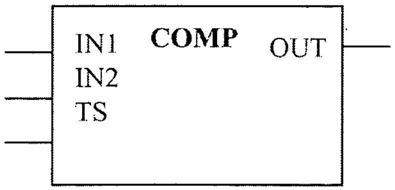
What can SAFIR Model? (cont'd)

The following type of elements are the bases for SAFIR:

- Components (basic components included in the source term)
- Instance (defines a component type)
- Models (combining basic and macro components to build systems)
- Signals (connecting components)

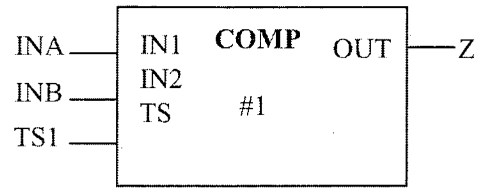
Components

- A component is a function that based on different inputs computes an algorithm and generates an output at a specific sampling time.
- Input and output are connected to "connectors"
- Consider the example of a component "COMP" that compares the input values IN1 and IN2 at each TS second and then generates the output OUT.



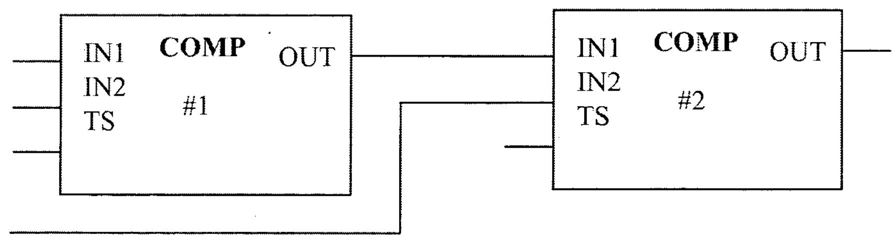
Instance or Identifier

- A component like COMP can be seen essentially as a component type.
- Each component that is part of a model is required to have a unique name defined as an instance.
- The instance defines the component type and well as which connectors are used and what signals or values that are associated with each connector.



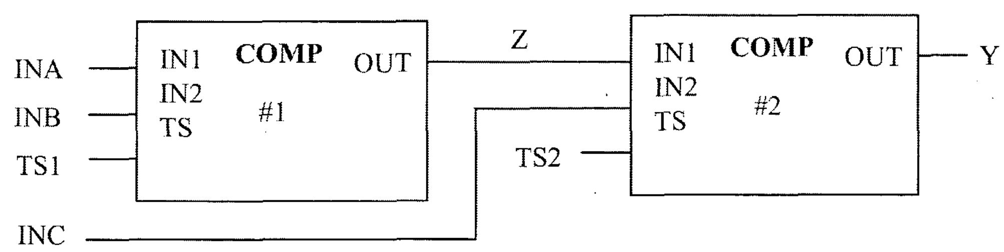
Model

- A model is a combination of at least two components.
- Consider the COMP component from the definition earlier and imagine two COMP components put together.
- We need to have different names of the two components to be able to distinguish between them.



Signal

- A signal is a variable that can change with time.
- Signals are used to connect components into models, as well as connections between models.
- Signals also serve as the connection between components/models and the transient code.



Different Types of Signals

- An **input signal** is connected to one or several component(s) input. It may be changed by the user and is not connected to an output of a component.
- An **output signal** is connected to exactly one component output and will be calculated by the component.
- An **internal signal** connects between one components output and another components input. These signals are local in a model and will not interact with other models.
- A **global signal** is an input or output signal that does not connect components within a model. These signals are usable by other models for interaction.

Initialization of Signals

- SAFIR automatically assigns values to model output signals for the steady-state solution based on known input signals and the standard component response.

- Generally the output of a component changes only by changing the input signal(s).

- There are however some exceptions. These exceptions are components that do not have a clear steady-state relationship between input and output if the history is unknown.

Initialization of Signals (cont'd)

Components with an unclear initial output are typically:

- Set/reset switches where last set or reset is not known (not initialized) so the output is unknown in the steady state solution.
- All types of components that contain historical information, e.g. integrating control components, may have a different steady state solution than zero as output.
- Components that feed back the output to an input

Sampling Time

All components can have their own sampling time.

- Digital control system components within a model can have individual sampling times.
  - For such a model the component sampling shall be that of the real plant component.

- For an analog system there is no sampling time. But, the transient code itself is digital so this determines the requirement for the component sampling time.
  - For such a model the sampling time shall not be longer than the transient code time step.

Currently Available Components

- The LTR will provide a short description of close to 40 different components of different types.
- This includes control components, mathematical components, logical components and different types of noise components.
- Example of the Integrator component description.

Function	Description	Input	Output
INT	Integrator INT (INTegrator) is used to give an integration effect. The output signal can be limited to limit values specified by input MIN and MAX. The balancing function permits the output signal to follow an external reference and permits a bumpless return to the normal function. The main property when controlling is that the output signal retains its value when the input signal IN(t) = 0.	IN, K, TI, TS, MIN, MAX, F, CF	Transfer function G(s) = K • (1 +1/(sTI)) OUT(t) = K(t) • TS/TI(t) • IN(t) + OUT(t-TS)

SAFIR Component V&V Process

- The addition of a component to SAFIR follows the Westinghouse standard quality assurance processes both for the implementation, the verification and a possible validation.

- Verification consists of one or more comparisons with:
  - Theoretical solution
  - Another method of solution
  - Code to code comparison

- An example of a component verification will be presented in the LTR

SAFIR Model V&V Process

- The creation of a SAFIR model for a specific plant and function follows the Westinghouse standard quality assurance processes both for the verification and a possible validation.

- This process is almost identical with the verification and validation of a component with the exception that no software upgrades are involved since models are built entirely through code inputs.

- In the LTR two different applications of the V&V process will be presented:

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Turbine Controller Model

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Turbine Controller Model Examples

- In the LTR 10 different verifications and 1 validation against plant data will be shown.

- In this presentation we will show:
  - Verification of the step in neutron flux up to 130%
  - Validation for a Load Rejection transient

Verification: Step in Neutron Flux up to 130%

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Verification: Step in Neutron Flux up to 130% (cont'd)

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Validation Using a Load Rejection Transient

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Validation of Load Rejection

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Validation of Load Rejection (cont'd)

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Validation From Start Up Tests

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Validation From Start Up Test Example

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Summary

- The LTR will present the Westinghouse control system modeling process including some examples:
  - Present the toolbox SAFIR that is used in the process.
  - Verification and Validation of SAFIR components.
  - Verification and Validation of plant system models.
  - Documentation according to Westinghouse procedures.
- The purpose is to license the PROCESS that uses SAFIR

Questions and Feedback