3KEYMASTER™ Modeling Tools

High-Fidelity Modeling

Nuclear Power Products and Services

WSC, a legacy brand of Curtiss-Wright's Simulation Group, headquartered in Frederick, MD, is a global simulation and services company. Acquired by Curtiss-Wright in 2024, WSC is recognized for the quality and efficiency of their products and flexible team-oriented approach to serving its customers.

What are Modeling Tools?

As part of the overall 3KEYMASTER™ simulation platform, Curtiss-Wright provides a set of efficient, high-fidelity, graphical modeling tools to simulate common types of components and systems found in plants and machinery. These tools work with the 3KEYMASTER™ environment, share common features, and can be invoked together to increase their usability.

In addition to the modeling tools described within this document, we provide the following domain-specific modeling tools, described in other literature:

- 3KEYRELAP5-RTTM Thermal-hydraulic & Neutronic Modeling
- Distributed Control System (DCS) Solutions
- Fuel and Combustion Modeling Tool for thermal power plants

Modeling Tools Described in this Product Sheet

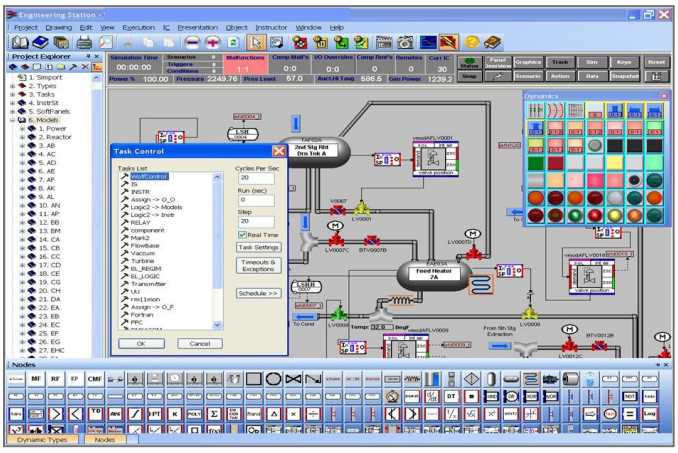
- Flow Network Tool
- Electrical Network Tool
- Logic and Control
- Relay Tool
- Component Tool and Library

Why Choose 3KEYMASTER™ Modeling Tools?

3KEYMASTER™ tools are all fully object-oriented, drag and drop, easy to use, and offer distinct advantages in both quality and speed.

Advantages

- Fast, on-line, graphics-based model construction, test, and re-engineering
- High-fidelity modeling embeds fundamental physical principles with robust numerical solution methods
  - These engineering grade models enable simulation assisted engineering (SAE)
- No programming knowledge required and no proprietary code generators
- Comprehensive coverage of common systems, equipment, and components
- Extendable to handle new types of systems
- Intuitive approach–easy to learn
- Models can be ported to other systems



3KEYMASTER™ Modeling Tools

Modeling Solutions

Shared Features of 3KEYMASTER™ Tools

Modeling with the 3KEYMASTER™ tools is performed using the Graphical Engineering Station (GES) that provides a canvas for the modeling page, and access to modeling tool objects that form the building blocks for model construction. The 3KEYMASTER™ modeling tools share common features that enhance usability and promote easy model integration.

Common Features across Modeling Tools

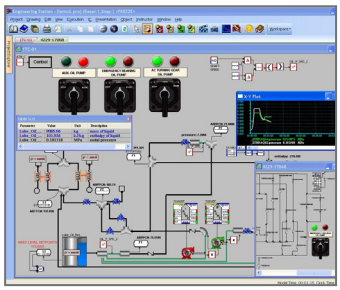
- ***Integrated user interface:*** models using different tools can be combined on the same modeling page
- ***Model construction using graphical objects:*** drag, drop, and connect
- Graphical connection rules enforce valid use of objects
- Objects linking across pages and tools for seamless integration
- ***Powerful visualization:*** multi-variable trend charts and tables
- Dynamic animation of model objects based on status and events
- Built-in standard component failure modes and incorporation of user-defined system-level malfunctions
- On-line and fast model updates with no manual recompile steps

Model Development & Organization

Modeling with 3KEYMASTER™ tools is performed using the 3KEYMASTER™ GES. This provides a canvas for the modeling page, and access to modeling tool objects, which form the model building blocks for model construction. The modeling pages are organized in a flexible user-defined file-structure, consisting of chapters and books.

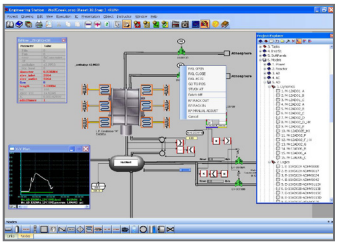
Object-Oriented Model Construction

- ***Model construction is performed using graphical objects:*** drag, drop, and connect
- ***Link and node objects are used to define network topology:*** e.g., piping, wiring, etc.
- ***Component objects are used to embed equipment within the network:*** e.g., valves, pumps, relay contacts, motors, etc.
- Graphical connection rules enforce valid use of objects
- Objects contain parameterization data fields
- Parameterization can be performed using on-screen graphical menus, or via export from 3KEYCATALOG, the centralized equipment catalog (see separate product sheet)
- Model integration achieved by connecting objects to reflect interconnections in the actual plant or equipment
- Flexibility is provided to change object icons using bit-map images. Allows flexibility to change look-and-feel to company specific standards or user preferences.
- ***Flexible organization of model pages: can be organized using system:*** subsystem organization of original plant or equipment



Integrated Tools Example (left)

Condenser Model (right)

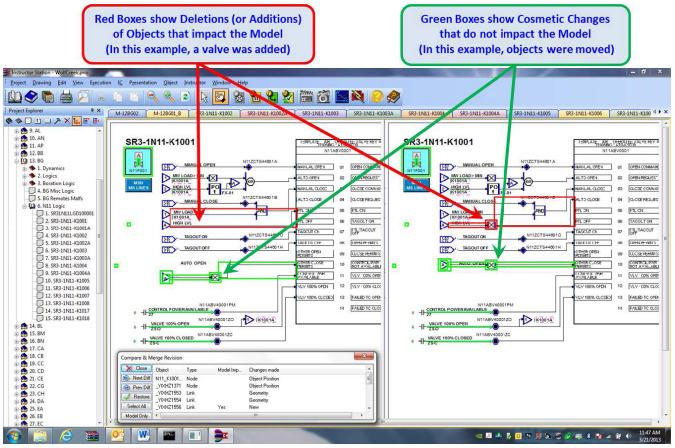


Model Execution & Test

3KEYMASTER™ modeling tools can fully utilize the powerful features provided by the 3KEYMASTER™ environment for model execution and test.

Model Execution & Test

- User-specified iteration rates for individual model tasks for numerical stability
- Every object has a standard set of parameters, all of which can be displayed
- Users can create multi-variable displays using tables and trend-charts for model testing
- Users can create event-triggers and alerts for monitoring specific model conditions
- Audit Trail provides model revision control allowing the modeler to compare a model with past revisions and restore them if desired

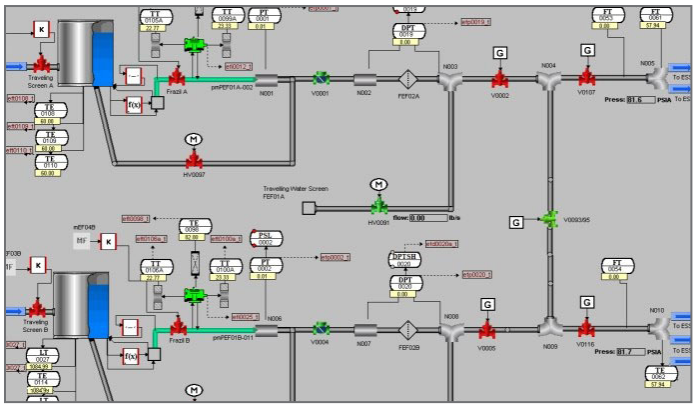


3KEYMASTER™ Audit Trail (Revision Control). Red boxes show revisions that impact the model, such as deletions or additions. Green boxes show editorial (or cosmetic) changes.

3KEYMASTER™ Modeling Tools

Modeling Solutions

Flow Network Tool



Our FlowBase hydraulic network modeling tool provides a single, comprehensive tool for high-fidelity and detailed modeling across commonly occurring regimes, conditions, and system configurations.

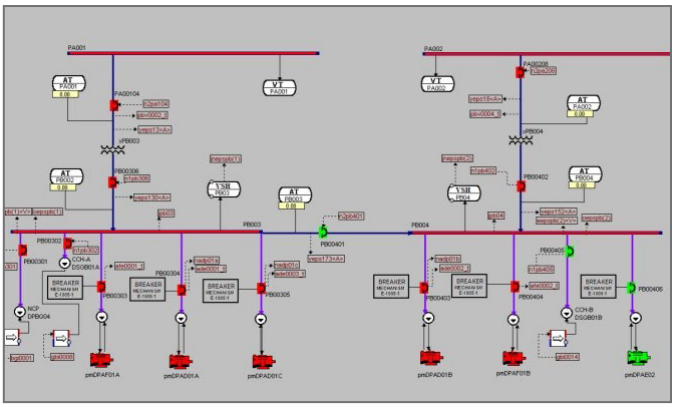
Flow Network Tool Features

- Fluid flow modeling, including incompressible, counter-current, and critical flow regimes; fluid heat transfer, combustion and reactions, and detailed solid wall heat transfer modeling.
- Fluid components: 2-phase (vapor & liquid), non-condensable gas, and transport of particulates, nuclides and contaminants
- All fluid systems are handled as user-defined, interfacing control volumes. Solid walls and metal components, such as shafts, use a user-defined mesh-model.
- Simultaneous solution of mass and energy conservation in control volumes, and force-momentum conservation across the network.
- Robust numerical solution method for convergence and stability; user alerts for unstable conditions based on control volume size, iteration rate, and flows.
- Accurate characteristics modeling for components such as pumps and nozzles, resistance factors, and volumes vs. elevations.

Flow Network Tool Applications

- Piped Fluid Networks–e.g., steam, water, gas, air, hydraulic and lube-oil systems
- Enclosed Spaces–e.g., containments and buildings
- Heat transfer equipment and fluid-flow machinery and components–e.g., steam generators, boilers, turbines, pumps, fans, valves, dampers, nozzles, accumulators, combustion equipment, various heat exchangers, etc.
- Detailed modeling of internal structures of machinery–e.g., shell and metal temperatures of turbines

Electrical Network Tool



The Electrical Network Tool provides an integrated solution to the active and passive elements of an electrical system. Using Kirchhoff's law, a series of simultaneous equations are solved for the network. Electrical network objects can be combined with relay tool and logic and control tool objects on the same modeling page to provide a complete view of electrical supply and logic for a piece of equipment.

Electrical Network Tool Features

- Complete modeling of electrical networks and components
- Robust numerical solutions of network simultaneous equations derived from Kirchhoff's laws
- Incorporation of Park's equations for synchronous machines; equivalent circuit model for generator and motor electrical characteristics
- Accurate transient network parameters response, including power quality and synchronization effects due to multiple generators, network islanding, and electrical disturbances or load changes

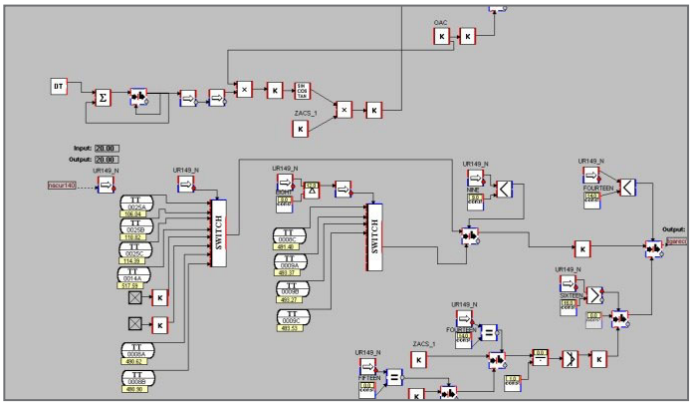
Electrical Network Tool Applications

- Power distribution networks and electrical circuits–e.g., electrical distribution in plants and machinery, T&D grids, isolated and stand-alone grids, multiple generator grids, ship and transportation systems grids, high voltage and low voltage networks, and electrical circuits
- Power generation and electrical systems machinery and components–e.g., switchgears, buses, transformers, generators, batteries, voltage regulators, and other circuit elements
- Electrical drives and motor

3KEYMASTER™ Modeling Tools

Modeling Solutions

Logic & Control Tool



The logic and control tool provided by Curtiss-Wright's Simulation Group can be used to accurately model any type of logic and control system. Strategies for efficient modeling of commercial DCS systems are described in the DCS Solutions brochure.

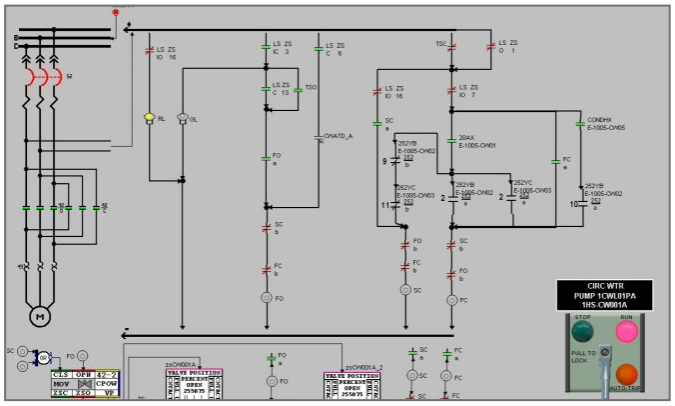
Logic & Control Tool Features

- One-to-one exact replica of control diagrams from source
- Robust solution method to solve control system topology based on multiple inputs and for multiple outputs
- Comprehensive library of common types of control system objects, including wires, sensors, comparators, power supplies, switches, gates, amplifiers, summers, actuators, indicators, M/A stations, controllers, etc.
- Modeling of control system transfer functions
- Extendable–can add new types of components

Logic & Control Tool Applications

- Any control system with continuous and discrete data control, including those with modulated analog signals
- Plant, process, industrial, and machinery control systems–e.g., reactor control, reactor protection, turbine control, feed

Relay Tool



The relay tool is used to model control of power to motive devices such as breakers for motors, that drive pumps, fans, and valves. These control circuits do not have modulated signals, but use relays to switch power on and off.

Relay Tool Features

- One-to-one replica of wiring diagrams from source–e.g., elementary diagrams
- Robust solution method to solve control system topology based on multiple inputs and for multiple outputs
- Comprehensive library of common types of control system objects, including wires, relays, switches, contacts, circuit breakers, power supplies, indicators, etc.
- Modeling of multi-contact switches and switch development diagrams

Relay Tool Applications

- Any control system which does not have modulated analog signals
- Control of motive power to actuators in plant, process, industrial and machinery control systems–e.g., plant elementary wiring diagrams

Component Tool & Library

The component library contains common types of components found in plant and equipment. The component tool provides the capability to create modeling objects for new types of plant and equipment components, which can then be added to the growing component library for reuse.

CONTACT INFORMATION: 7196 Crestwood Blvd., Suite 300, Frederick, MD, 21703 USA
simulation@curtisswright.com | +1.301.644.2500