

# MANUAL

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## FORCE Software Requirements Specification and Traceability Matrix

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# Contents

1	Introduction .....	7
1.1	Other Design Documentation .....	7
1.2	Dependencies and Limitations .....	7
2	References .....	9
3	Definitions and Acronyms .....	10
3.1	Definitions .....	10
3.2	Acronyms .....	10
3.3	System Operations .....	11
3.3.1	Human System Integration Requirements .....	11
3.3.2	Maintainability .....	11
3.3.3	Human System Integration Requirements .....	12
3.4	Information Management .....	12
4	Verification .....	13
5	FORCE:SYSTEM REQUIREMENTS .....	14
5.1	Requirements Traceability Matrix .....	14
5.1.1	Minimum Requirements .....	14



# 1 Introduction

The Framework for Optimization of Resources and Economics is a collection of software tools, models, and datasets acquired and developed under the Integrated Energy Systems (IES) program to enable analysis of technical and economic viability of myriad IES configurations. FORCE is the consolidating interface and data repository for all the IES toolsets ranging from macrotechnoeconomic analysis to transient process modeling and experimental validation for integrated energy systems. This document is aimed to report and explain the HYBRID software requirements. In addition, it reports the traceability matrix between software requirements and requirement tests (tests that testify the software is compliant with respect its own requirements).

## 1.1 Other Design Documentation

Also available within the repository is the FORCE User manual within the “docs” folder. This user manual gives a detailed explanation of the installation process, system dependencies alongside links upon which where to find them, and an explanation of the use cases within the repository.

## 1.2 Dependencies and Limitations

The software should be designed with the fewest possible constraints. The only primary constraint is:

1. Python 3 – <https://docs.conda.io/en/latest/miniconda.html>

However, enhanced capabilities will require the installation of the aforementioned plugins (HYBRID, HERON, RAVEN, TEAL) which have the dependencies shown below.

### **RAVEN**

1. Visual Studio Community Edition – Link Available on the raven github
2. Raven specific python library set. – Available through the install process.

### **HERON, TEAL**

1. Risk Analysis and Virtual ENvironment (RAVEN) – <https://raven.inl.gov/SitePages/Software%20Infrastructure.aspx>

## **HYBRID**

1. Commercial Modelica platform Dymola – <https://www.3ds.com/products-services/catia/products/dymola/latest-release/>



## 2 References

- ASME NQA 1 2008 with the NQA-1a-2009 addenda, “Quality Assurance Requirements for Nuclear Facility Applications,” First Edition, August 31, 2009.
- ISO/IEC/IEEE 24765:2010(E), “Systems and software engineering Vocabulary,” First Edition, December 15, 2010.
- LWP 13620, “Managing Information Technology Assets”

## 3 Definitions and Acronyms

### 3.1 Definitions

- **Baseline.** A specification or product (e.g., project plan, maintenance and operations [M&O] plan, requirements, or design) that has been formally reviewed and agreed upon, that thereafter serves as the basis for use and further development, and that can be changed only by using an approved change control process. [ASME NQA-1-2008 with the NQA-1a-2009 addenda edited]
- **Validation.** Confirmation, through the provision of objective evidence (e.g., acceptance test), that the requirements for a specific intended use or application have been fulfilled. [ISO/IEC/IEEE 24765:2010(E) edited]
- **Verification.**
  - The process of evaluating a system or component to determine whether the products of a given development phase satisfy the conditions imposed at the start of that phase.
  - Formal proof of program correctness (e.g., requirements, design, implementation reviews, system tests). [ISO/IEC/IEEE 24765:2010(E) edited]

### 3.2 Acronyms

**API** Application Programming Interfaces

**ANL** Argonne National Laboratory

**ARMA** Auto-Regressive Moving Average

**DOE** Department of Energy

**FMI** Functional Mock-up Interface

**FMU** Functional Mock-up Unit

**HERON** Heuristic Energy Resource Optimization Network

**IES** Integrated Energy Systems

**INL** Idaho National Laboratory

**NHES** Nuclear-Renewable Hybrid Energy Systems

**IT** Information Technology

**ORNL** Oak Ridge National Laboratory

**M&O** Maintenance and Operations

**NQA** Nuclear Quality Assurance

**POSIX** Portable Operating System Interface

**QA** Quality Assurance

**RAVEN** Risk Analysis and Virtual ENvironment

**SDD** System Design Description

**TEAL** Tool for Economic Analysis

**TRANSFORM** Transient Simulation Framework of Reconfigurable Modules

**XML** eXtensible Markup Language

### **3.3 System Operations**

#### **3.3.1 Human System Integration Requirements**

The command line interface shall support the ability to toggle any supported coloring schemes on or off pursuant to section 508 of the Rehabilitation Act of 1973.

#### **3.3.2 Maintainability**

- The latest working version (defined as the version that passes all tests in the current regression test suite) shall be publicly available at all times through the repository host provider.
- Flaws identified in the system shall be reported and tracked in a ticket or issue based system. The technical lead or any COB member will determine the severity and priority of all reported issues. The technical lead will assign resources at his or her discretion to resolve identified issues.
- The software maintainers will entertain all proposed changes to the system in a timely manner (within two business days).
- The FORCE framework in its entirety is made publicly available under the Apache version 2.0 license.

### **3.3.3 Human System Integration Requirements**

The regression test suite will cover at least 80% of all models at all times. The results of the regression tests will be stored in the Continuous Integration System.

## **3.4 Information Management**

The FORCE framework in its entirety is made publicly available on an appropriate repository hosting site (e.g. GitHub). Backups and security services will be provided by the hosting service.

## **4 Verification**

The regression test suite shall employ several verification tests of the correct mechanical executions of the models and workflows reported in this repository.

## 5 FORCE:SYSTEM REQUIREMENTS

### 5.1 Requirements Traceability Matrix

This section contains all of the requirements, requirements' description, and requirement test cases. The requirement tests are automatically tested for each CR (Change Request) by the CIS (Continuous Integration System).

#### 5.1.1 Minimum Requirements

Requirment ID	Requirment Descrip- tion	Test(s)
R-M-1	Dymola 2020x or higher	1)K. Frick, A. Alfonsi, C. Rabiti, "HYBRID User Manual", INL/MIS-20-60624
R-M-2	Visual Studio 2017 or higher with associated 64-bit Intel Compiler	1)K. Frick, A. Alfonsi, C. Rabiti, "HYBRID User Manual", INL/MIS-20-60624
R-M-3	Python 3 or higher to be able to execute RAVEN-based work-flows	1)K. Frick, A. Alfonsi, C. Rabiti, "HYBRID User Manual", INL/MIS-20-60624

Minimum Requirements



