



*Setting the Standard for Automation™*

# An Overview of the ISA112 SCADA Systems Management Lifecycle

Graham Nasby  
ISA112 committee co-chair

Wednesday, March 29, 2023


Standards  
Certification  
Education & Training  
Publishing  
Conferences & Exhibits

ISA Hamilton Section – Members Meeting – Hamilton, Ontario, Canada

# About the Speaker



**Graham Nasby, P.Eng., FS Eng., PMP, CAP, CISM, CISSP**

- 20+ years experience in operations, construction and automation sector
  - 1998-2005 IT Consultant – University of Guelph
  - 2005-2007 – controls specialist at various manufacturers
  - 2007-2010 Process Engineer – Cheme Engineering
  - 2010-2015 System Integrator & I/C Lead – Eramosa Engineering
  - 2015-2022 Water SCADA & Security Specialist – Guelph Water
  - 2022-present – Sr. Manager of OT Security Architecture – CN Rail
- 
- A professional headshot of Graham Nasby, a man with short dark hair, wearing a dark suit jacket, a white shirt, and a patterned tie. He is smiling slightly and looking directly at the camera.
- Co-chair of ISA112 SCADA Systems standards committee
  - Voting member of ISA101 HMI Design and ISA18 Alarm Management committees
  - Past Section President, Division Director, Technical VP within ISA at local, regional and society levels
  - Member of IEC/SCC TC65A “Industrial process measurement, control and automation”
  - Member of CSA P125 “Operational Technology: Functional Safety and Security”
  - Member of the OWWA Automation Committee since 2015, active in AWWA & WEF 2010-2022
  - Holder of Ontario Drinking Water Treatment Operator & Wastewater Treatment Operator licenses
- Sessional instructor at McMaster University (Hamilton, ON) and Conestoga College (Cambridge, ON)
  - Has published over 75 papers and articles on various OT, SCADA and industrial automation topics
  - Received ISA’s technical division leader of the year award in 2013
  - Received “Mid-Career Achievement Award” from his *alma mater* University of Guelph in 2014
  - Recipient of the ISA’s society-level Standards Leader of the Year Award in 2021
  - Contact: [graham.nasby@grahamnasby.com](mailto:graham.nasby@grahamnasby.com)

# I wanna be a Water Guy when I grow up!

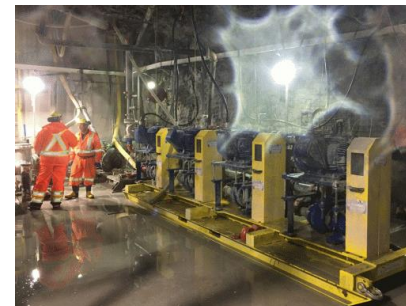


OK...  
Trains are  
cool too!



# An Overview of ISA112

- SCADA Refresher
- What is ISA112
- Goals of ISA112
- About the ISA112 Standards Committee
- Target Audience of ISA112
- How ISA112 defines “SCADA”
- Introduction to the ISA112 SCADA Management Lifecycle
  - Continuous Work Processes
  - (End-User) SCADA System Standards
  - Standardized Workflow for Projects
    - Design
    - Software Development
    - Hardware Build/Fabrication
    - Installation & Deployment
    - Commissioning
  - Operations & Maintenance



# What is SCADA?

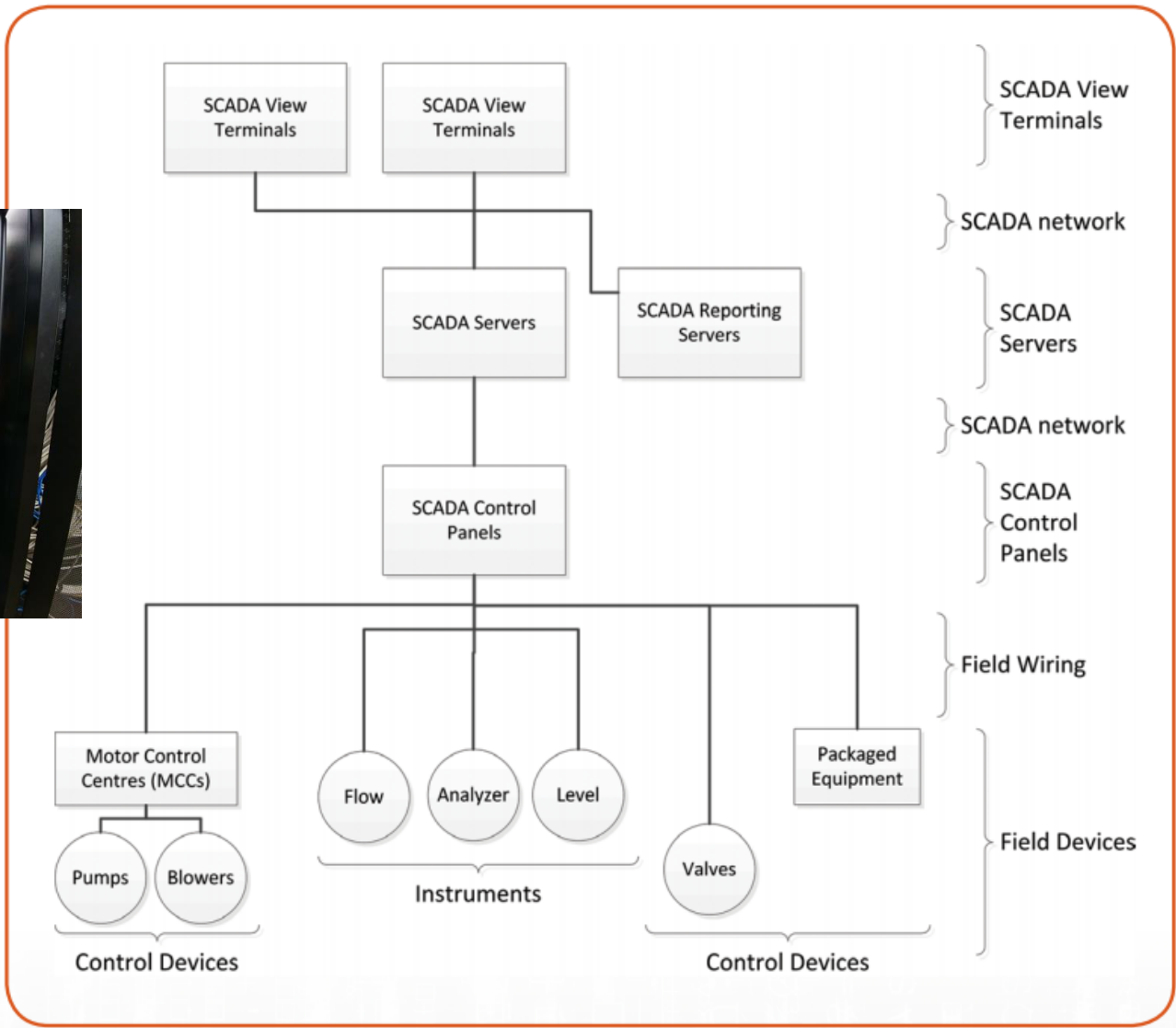
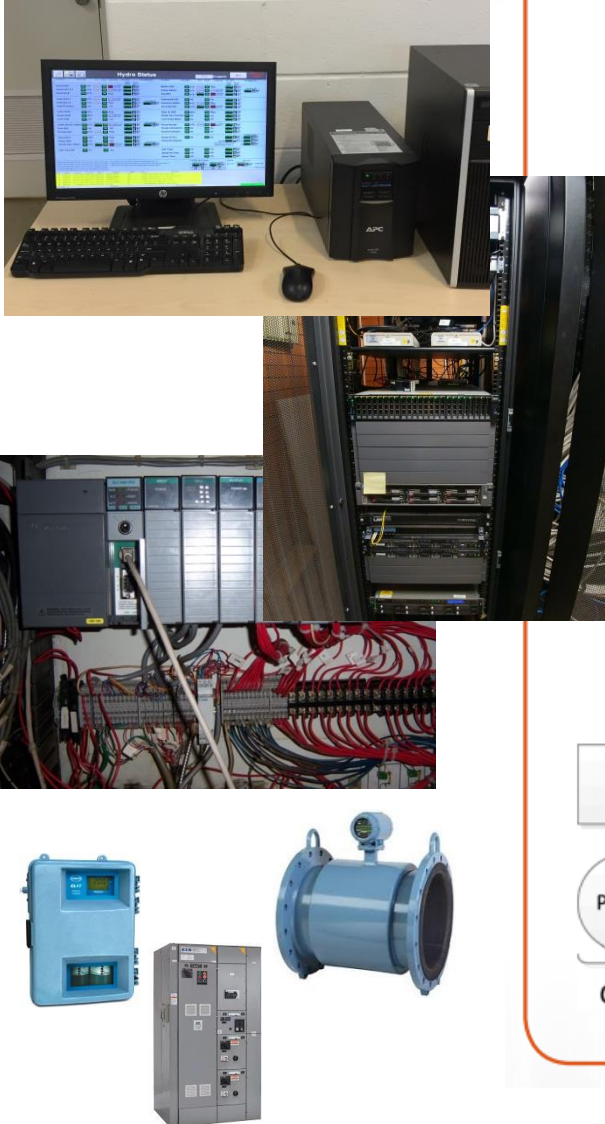


**SCADA = Supervisory Control and Data Acquisition system**

# Not SCADA



# Typical SCADA Architecture



# What is ISA112?

- **ISA112** is a consensus-based technical standards committee **to promote best practices for SCADA systems** formed by the International Society of Automation in mid-2016
- Currently 300+ members with broad cross-section of roles, industries, and geographies
- **Committee Members:** software vendors, hardware vendors, end users, system integrators, consultants, distributors, and government from a wide variety of industries
- **Industry Sectors:** municipal water/wastewater, upstream oil/gas, pipelines, mining, power transmission/distribution, environmental monitoring, manufacturing, traffic control
- **Geographic Areas:** worldwide, with representation from Canada, USA, South America, Europe, Asia, Australia and beyond
- **Goal:** Develop a series of ISA standards and technical reports that provide guidance for system design, implementation, operation, and maintenance of SCADA systems for pipelines, water and wastewater, power, oil and gas, and other industries to support the overall integrity and reliability of these systems.



# Motivations & Drivers for ISA112

*Utilities, System Integrators, Consultants, Vendors, etc. are all asking for:*

- Need for common terminology for SCADA systems
- Specification for minimum SCADA hardware and software requirements
- Suggested I/O interfaces for interfacing with equipment
- Standardized Control Modes: Remote vs. Local, Auto vs. Manual, etc.
- Reference architectures for levels of control
- Guidance for applying other ISA standards to SCADA systems:
  - Cyber Security
  - Alarm Management
  - HMI Design
  - Data Storage
  - Designing robust, resilient and redundant systems

***A major goal of ISA112 is to provide a common framework that can be used for specifying, designing, pricing, building and maintaining SCADA systems***

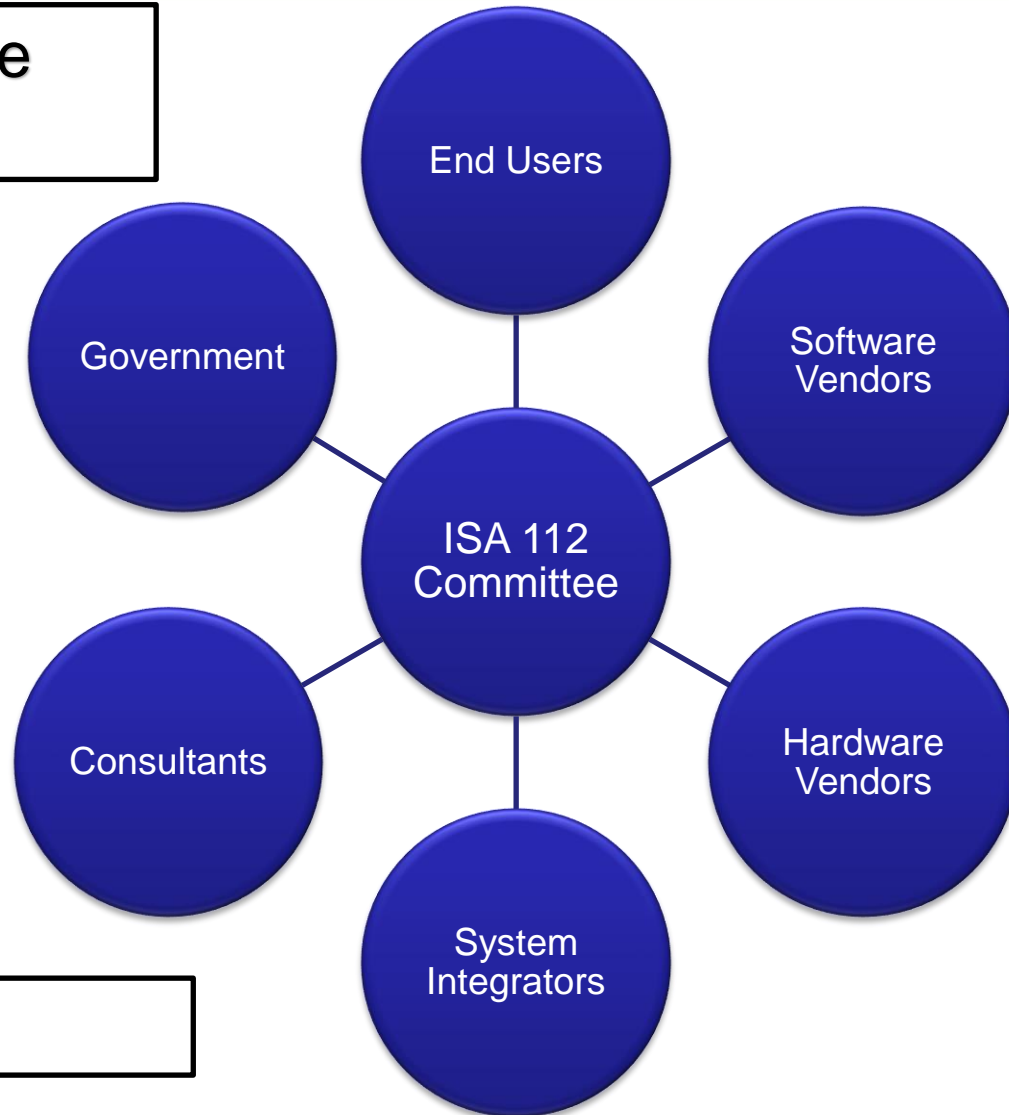
# What is ISA112 Audience?



# Who is ISA 112?



Over 300 committee members



75 active authors

# Current Status of ISA112

Jun 2016	Committee approved by ISA
Aug 2016	Initial call for volunteers (40 members)
Sept 2016	First meeting held in Newport Beach, California, USA
Jan 2017	Committee co-chairs named -Graham Nasby, originally with Guelph Water Services, now with CN Rail (Guelph, Ontario, Canada) -Ian Verhappen, originally with CIMA+, now with Willow Glen Systems (Calgary, Alberta, Canada)
Apr 2017	Monthly conference calls begin
May 2017	Second meeting in Raleigh, North Carolina, USA Semi-annual face-to-face meetings start
May 2018	Development of ISA112 Lifecycle & Architecture diagrams begins, drafts distributed to early-adopters
Nov 2018	Draft Table of Contents Developed
2019-2020	Writing Phase begins. 75 active authors contributing.
July 2020	First release of Draft ISA112 Management Lifecycle Diagram at <a href="http://www.isa.org/isa112">www.isa.org/isa112</a> (free download)
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<b>2022-2023</b>	<b>Committee review/commenting rounds, going to final ballot in late 2023</b>
<b>Early 2024</b>	<b>Target publication date for Part 1: SCADA Management Lifecycle, Terminology &amp; Diagrams</b>
2025-2026	Target dates for Part 2: Lifecycle Implementation & Part 3: SCADA System Architecture

# Work so far on ISA112

- Defining what a “SCADA System” is, including industry-specific and regional variations
- ISA112 SCADA Model Architecture Diagram (1<sup>st</sup> draft)
- ISA112 SCADA Management Lifecycle Diagram (1<sup>st</sup> draft)
- Table of Contents (1<sup>st</sup> draft)
- ....and after much, much writing, review, and discussion...
- ISA112 SCADA Model Architecture Diagram (20 revisions later) – now posted at [www.isa.org/isa112/](http://www.isa.org/isa112/)
- ISA112 SCADA Management Lifecycle Diagram (38 revisions later) – now at [www.isa.org/isa112/](http://www.isa.org/isa112/)
- Table of Contents for a 3-part SCADA standard
  - Part 1 – SCADA Management Lifecycle, Terminology and Diagrams
  - Part 2 – SCADA Management Lifecycle Best Practices
  - Part 3 – SCADA Model Architecture Diagram Best Practices
- Approx 700 pages of technical content...now being distilled into the 3-part standard and technical reports
- The committee is now getting ready to begin formal comment cycles on Part 1, with the goal of publishing it in early 2024

# What is a SCADA System?

## ISA112 Definition

SCADA – Supervisory Control and Data Acquisition

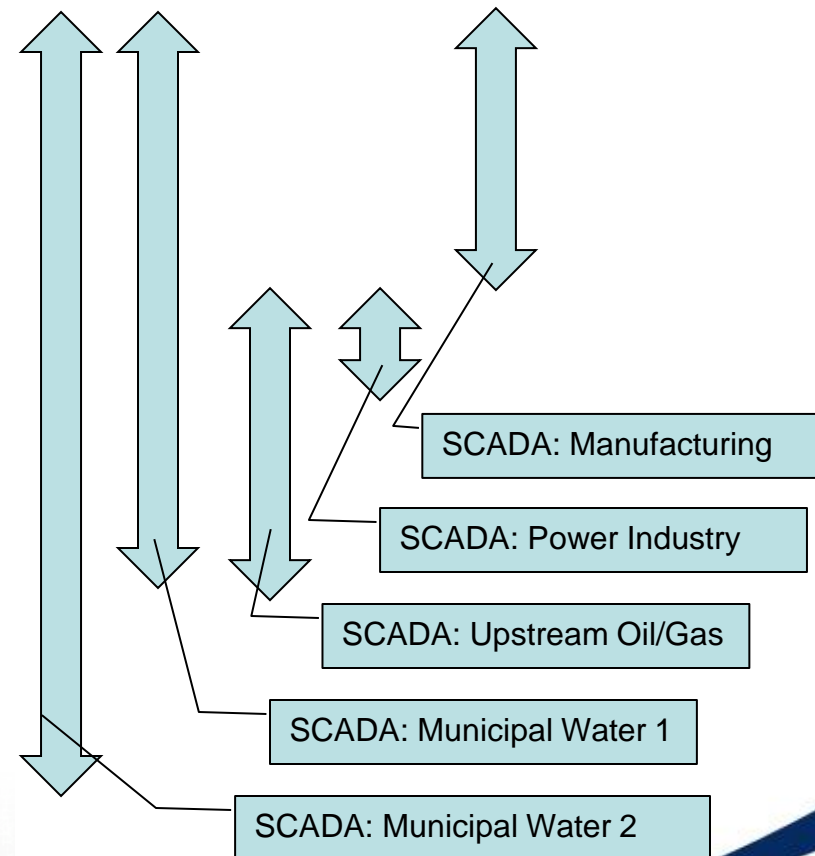
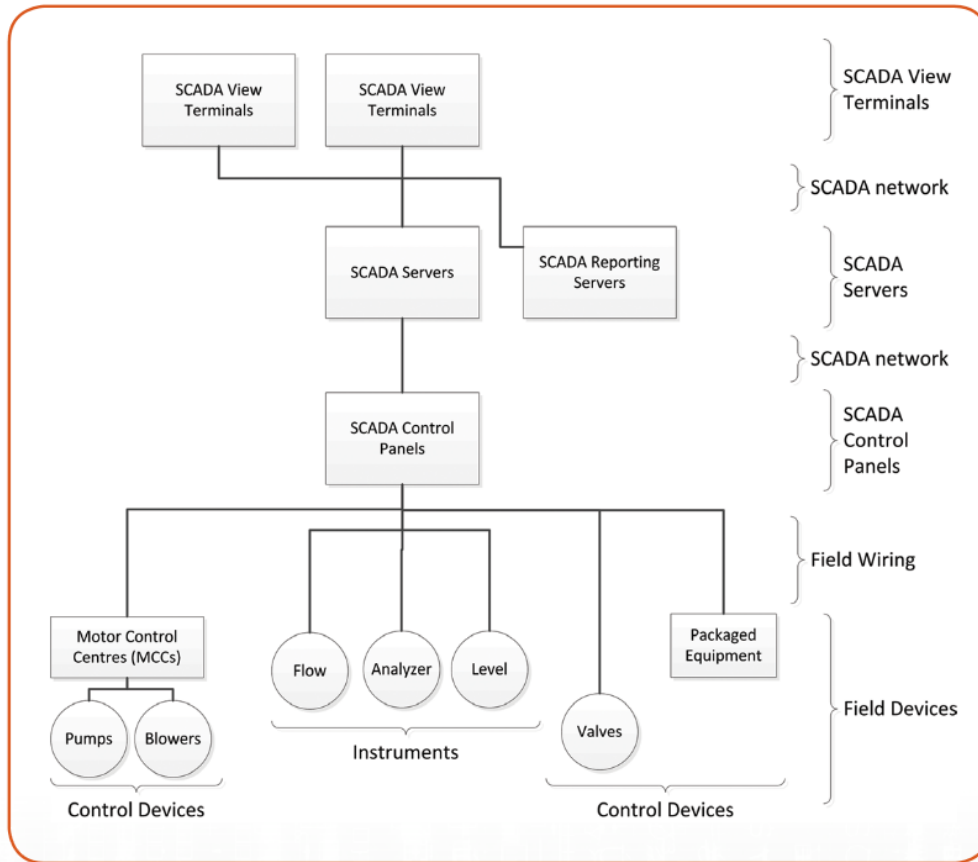
“SCADA = a system which is a combination of hardware and software used to send commands and acquire data for the purpose of monitoring and controlling.”

(DEFINITION ADOPTED BY ISA112 COMMITTEE AT MAY 5, 2017 MEETING IN RALEIGH, NORTH CAROLINA, USA)

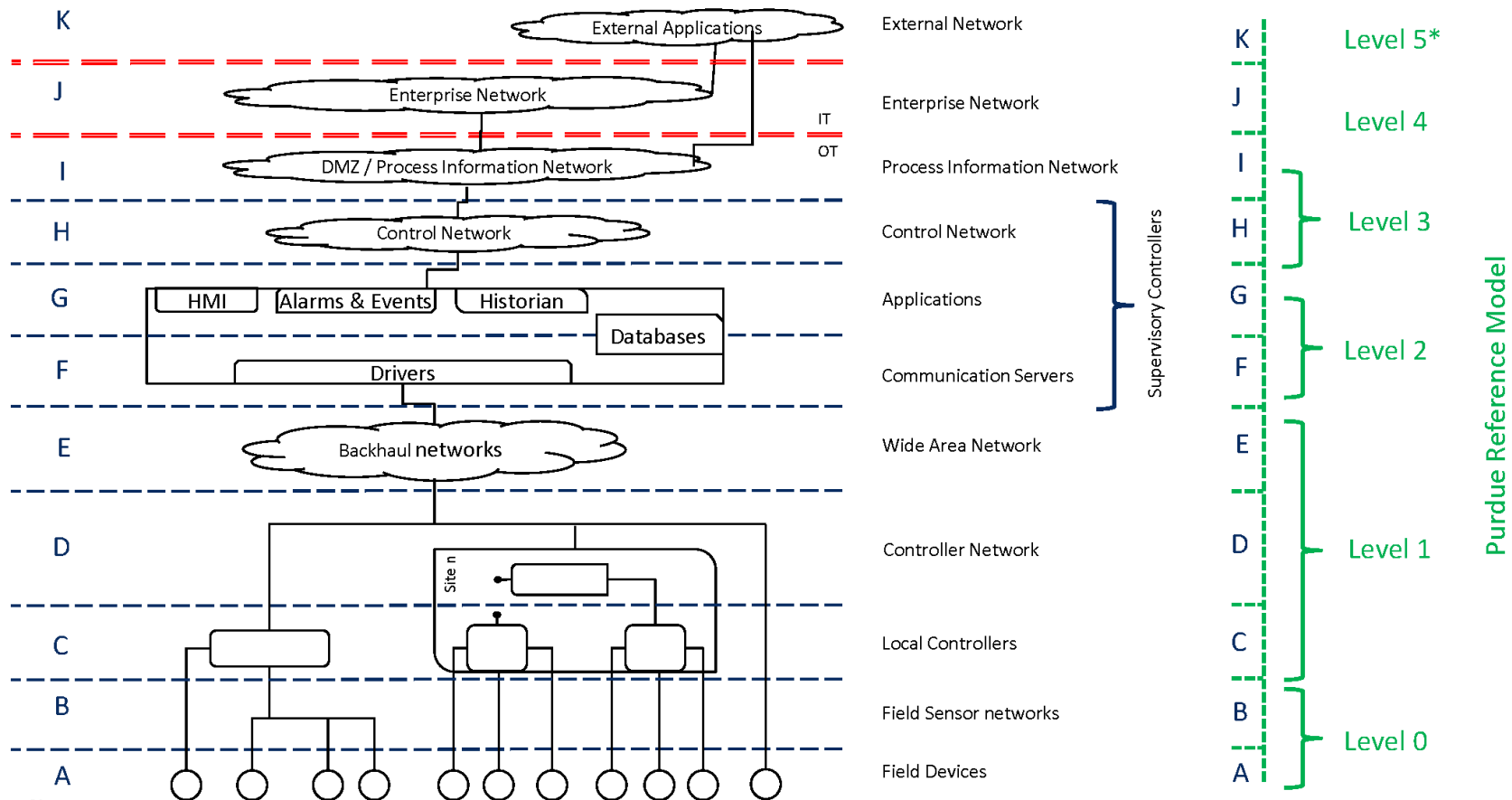
*Different Industries use the term “SCADA” to mean many different things that are specific to that individual industry. Each of these industries is correct in how it uses the term SCADA within its own context. We must be aware of this, and our definition and standard must be written so that it can be used by all industries.*

# Term “SCADA vs. Several Industries

- Examples of differing definitions of SCADA by industry
- Definitions can also vary by geographic area/country



# SCADA System Architecture



**Notes:**

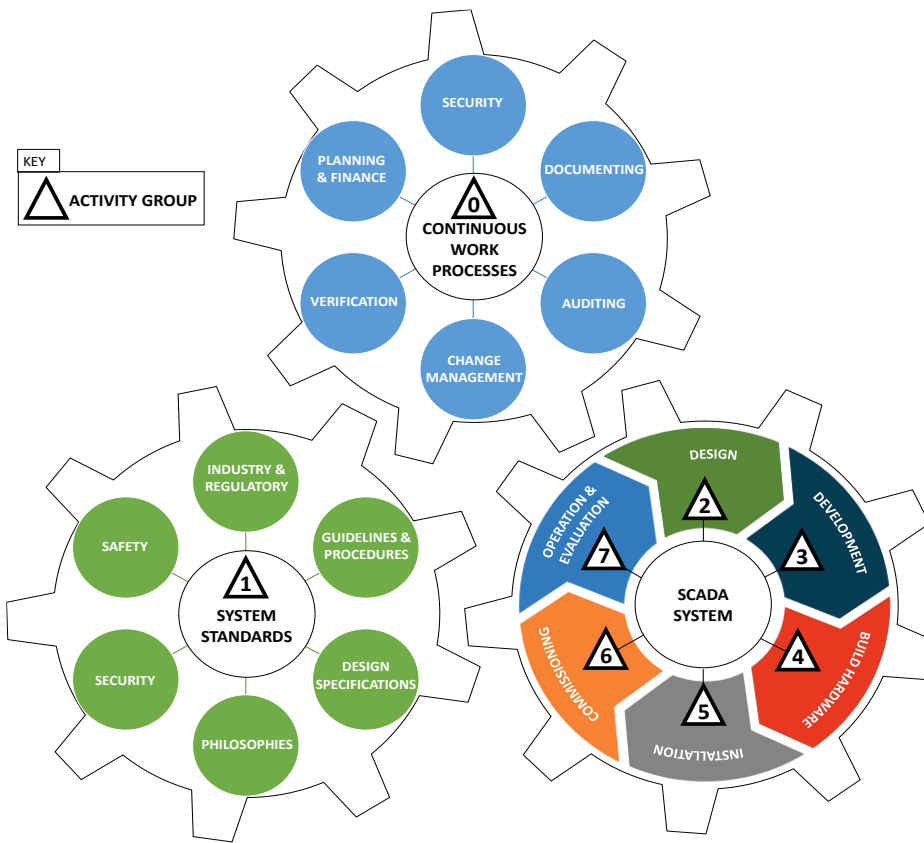
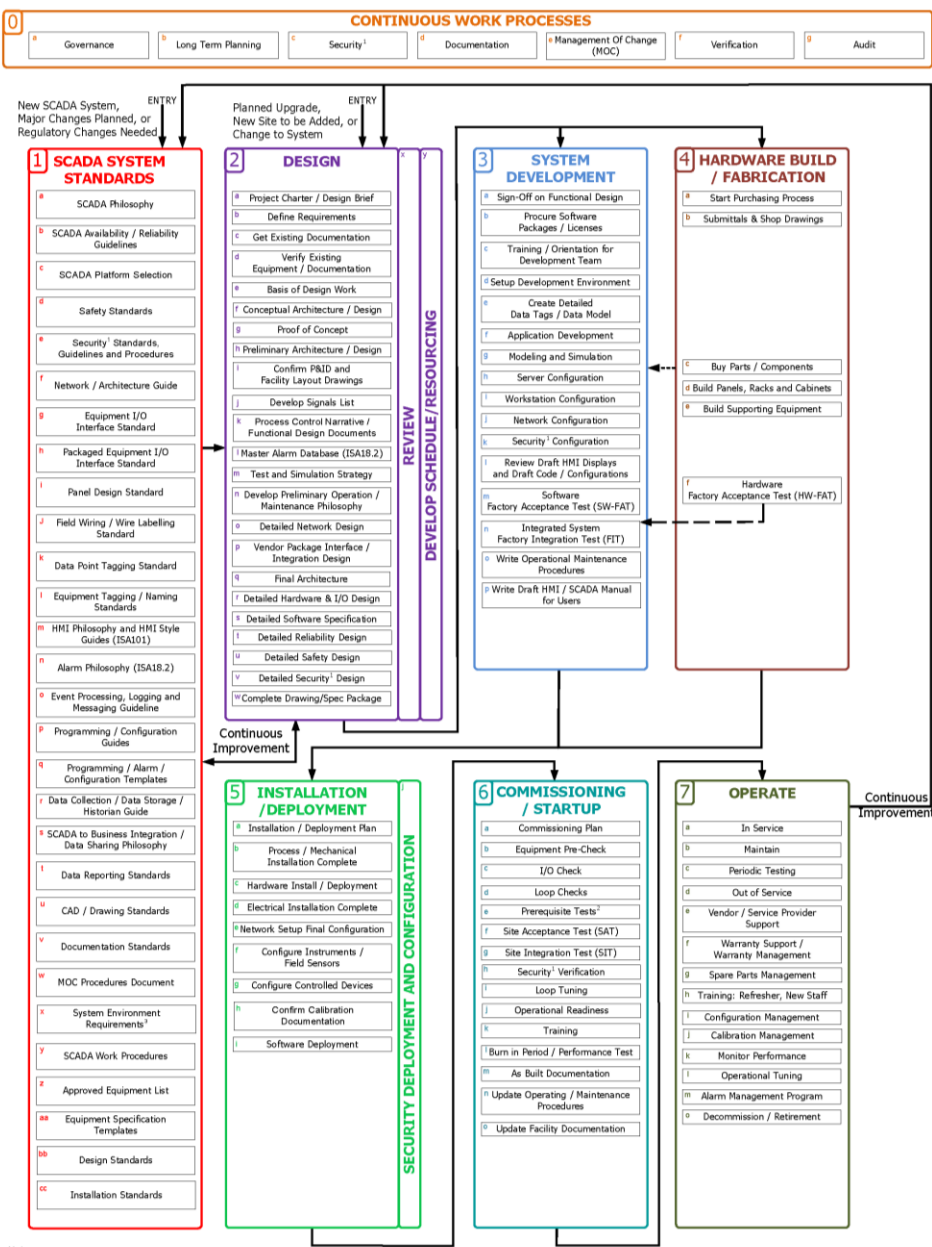
- 1 Letters are used to avoid potential conflict with ISA-95 and other "Layer" models.
- 2 Routers and Firewalls between layers as well as other system-specific servers, applications, and workstations are not shown.
- 3 Individual architectures may vary from the above general model. For example, if only local systems are used Level E may not be required
- 4 Communications for any remote-hosted external applications (Cloud) with lower levels must be done using extreme care.
- 5 The use of direct-connections for remote applications is strongly discouraged. Refer to ISA/IEC-62443 for guidance on an appropriate zone/conduit implementation.
- \* We show a Purdue Level 5. The true Purdue Model only has levels 0-4 because it did not anticipate external applications.

IT = Information Technology  
 OT = Operational Technology

Note: This is an interim working draft from the ISA112 SCADA Systems standards committee, as of 2022-01-26. (A previous version was posted on 2020-06-15). This diagram is still subject to change.

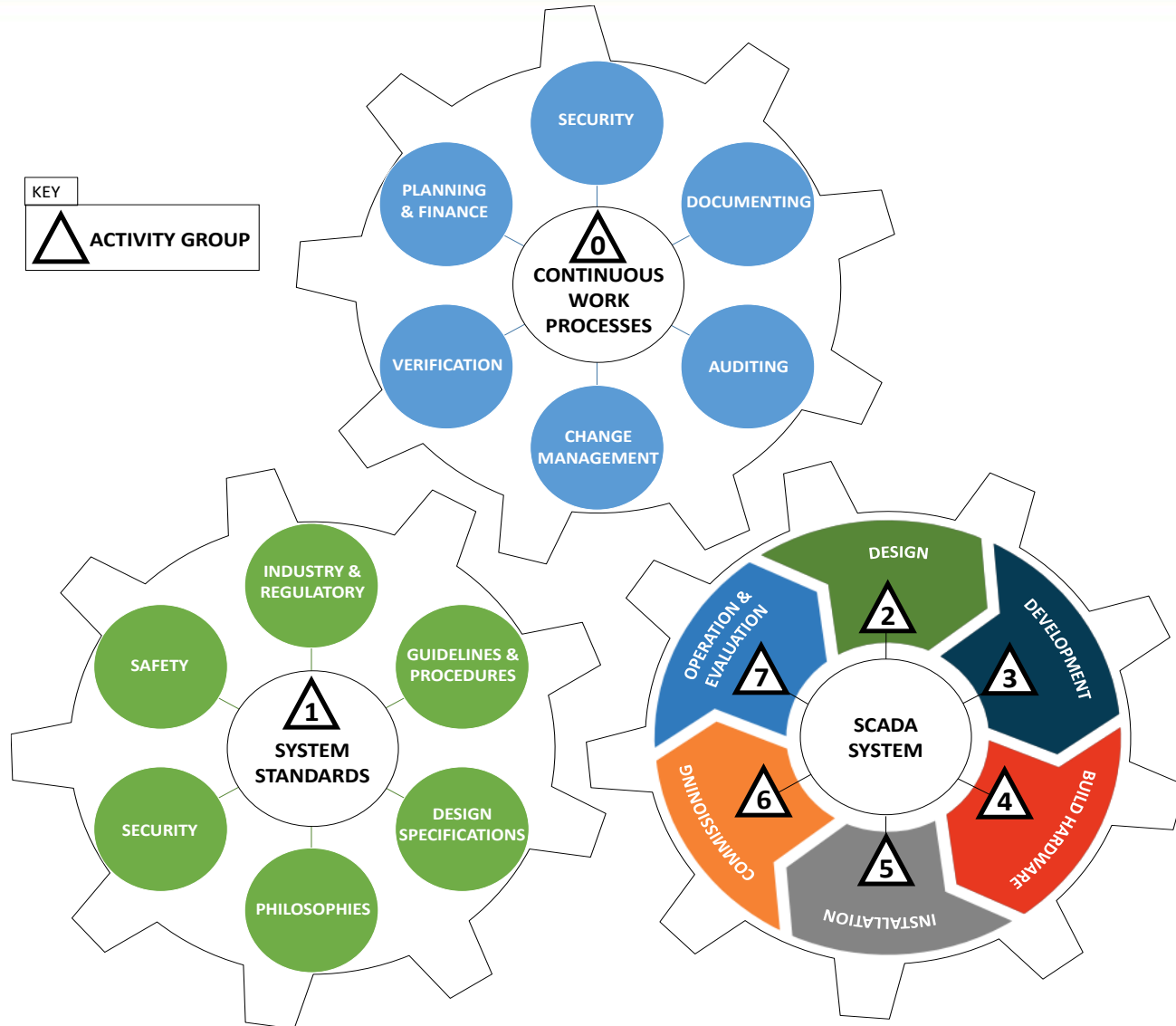


# SCADA Systems Lifecycle Diagram



Notes  
 1) Security includes physical security, operational security, and cybersecurity.  
 2) Prerequisite tests typically include both cold and hot commissioning or dry / wet commissioning as applicable.  
 3) System Environment Requirements can include separate systems for development, testing, training, production, backup, disaster recovery, digital twins, and other uses, as part of development and Management Of Change (MOC) procedures.

# SCADA Systems Lifecycle Diagram



# SCADA Lifecycle Activity Groups

- **Continuous Work Processes**

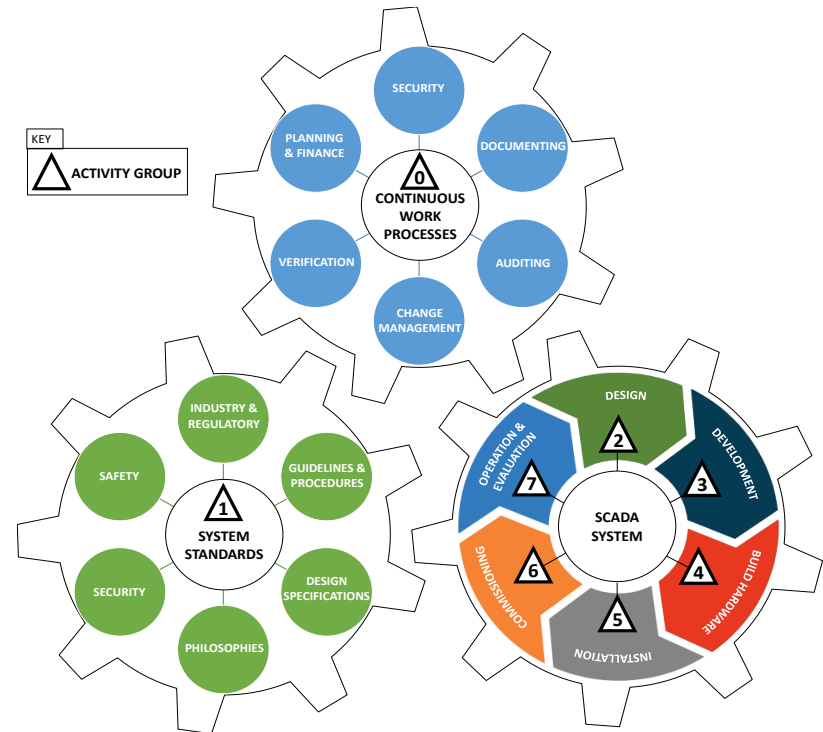
- Governance
- Long Term Planning
- Security
- Documentation
- Management of Change (MOC)
- Verification
- Audit

- **SCADA System Standards**

- **Design**
- **System Development (programming)**
- **Hardware Build / Fabrication**
- **Installation / Deployment**
- **Commissioning / Start-up**

- **Operate**

- Operations
- Maintenance
- Monitor Performance
- Operational Tuning
- Minor Improvements
- Alarm Management



# SCADA Continuous Work Processes

## CONTINUOUS WORK PROCESSES



**Governance** – defines who owns, uses, pays for, and maintains SCADA system  
 Requires a written SCADA Governance Policy doc endorsed by top management / board

**Long Term Planning** – Planning for 5, 10, 15, 20, 25+ year outlook  
 Some organizations may also use a SCADA Master Plan as part of their planning

**Security** – ongoing Physical Security, Operational Security and Cyber Security measures

**Documentation** – keeping system documentation up to date for operations and maintenance

**Management of Change (MOC)** – managing / controlling / documenting system changes

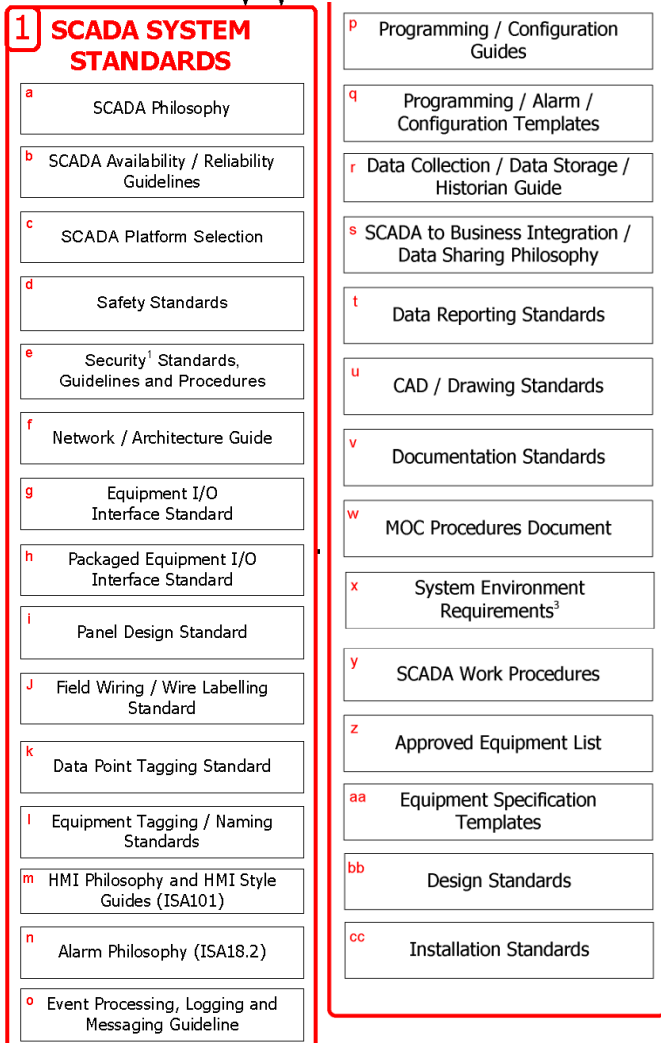
**Verification** – periodically checking that SCADA system is working the way it is documented

**Audit** – periodically checking that work processes are being followed and documented

# SCADA System Standards – End-User Specific Standards

New SCADA System,  
Major Changes Planned, or  
Regulatory Changes Needed

ENTRY



SCADA Philosophy Document  
SCADA Availability/Reliability Guideline  
SCADA Platform Selection

Safety Standards (for automatic shutdown systems)  
Security Standards, Guidelines and Procedures  
Network / Architecture Guide

Equipment I/O Interface Standard  
Packaged Equipment I/O Interface Standard  
Panel Design Standard  
Field Wiring / Wire Labelling Standard  
Data Point Tagging Standard  
Equipment Tagging / Naming Standards

HMI Philosophy and HMI Style Guides (ISA1010)  
Alarm Philosophy (ISA18.2)

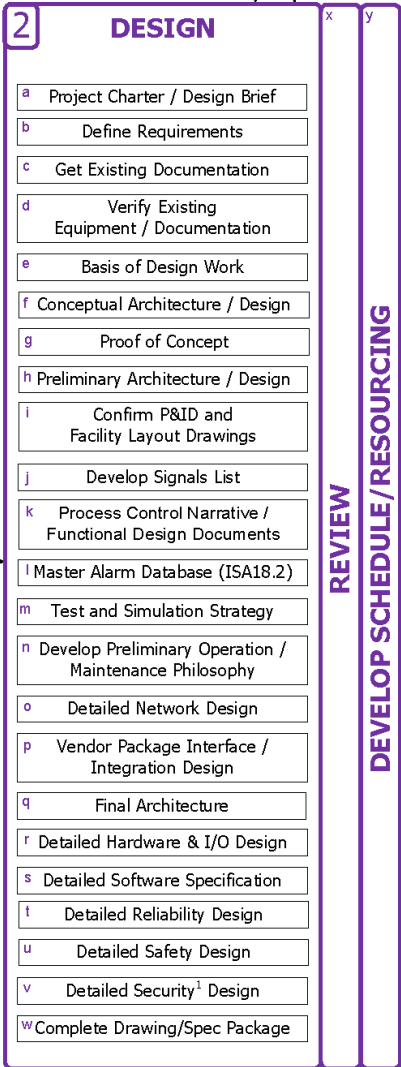
Event Processing, Logging and Messaging Guideline  
Programming / Configuration Guides  
Programming / Alarm / Configuration Templates  
SCADA to Business Integration / Data Sharing Philosophy  
Data Reporting Standards

CAD / Drawing Standards  
Documentation Standards  
MOC Procedures Document (Change Management)  
System Environment Requirements

SCADA Work Procedures  
Approved Equipment List  
Equipment Specification Templates  
Installation Standards

# SCADA Design Work Processes

Planned Upgrade,  
New Site to be Added, or  
Change to System



Project Charter / Design Brief  
Define Requirements

Get Existing Documentation  
Verify Existing Equipment/Documentation

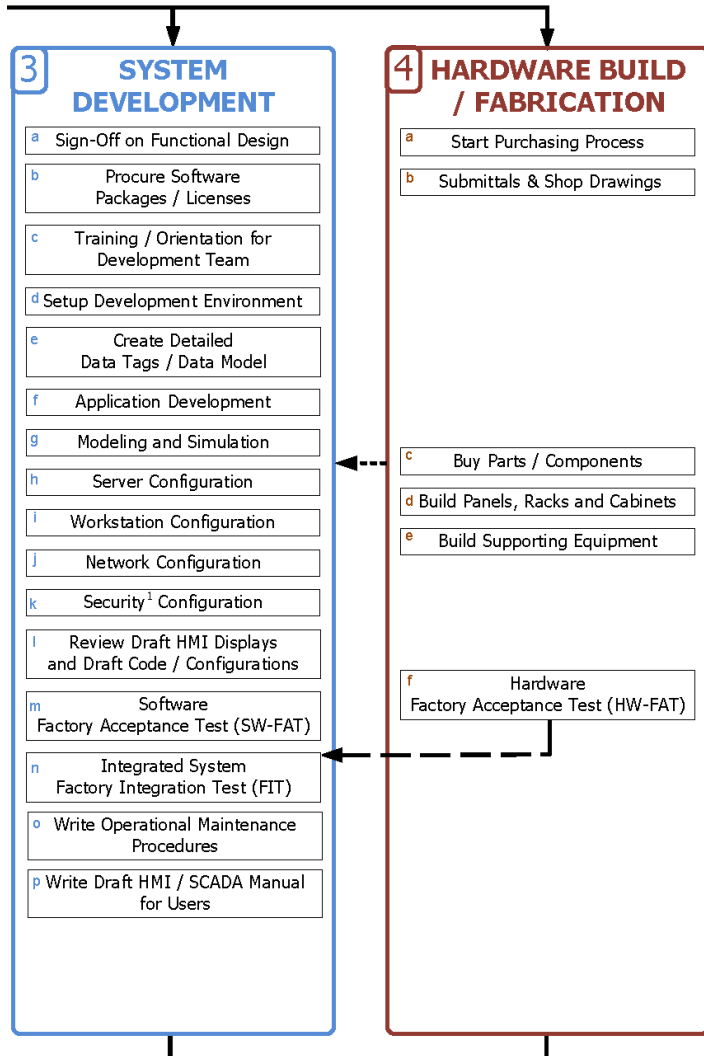
Basis of Design work  
Conceptual Architecture/Design  
Proof of Concept  
Preliminary Architecture/Design

Confirm P&ID's and Facility Layout Drawings  
Develop Signals List  
Process Control Narrative / Functional Design Documents  
Master Alarm Database (ISA18.2)  
Test and Simulation Strategy  
Develop Preliminary Operation / Maintenance Philosophy  
Detailed Network Design  
Vendor Package Interface/Integration Design  
Final Architecture

Detailed Hardware & I/O Design  
Detailed Software Specification  
Detailed Reliability Design (UPS's, redundant equipment)  
Detailed Safety Design (automatic shutdown systems)  
Detailed Security Design (check of security & cyber security details)

Complete Drawing/Spec Package (for group that will do building / programming)

# SCADA Programming & Hardware



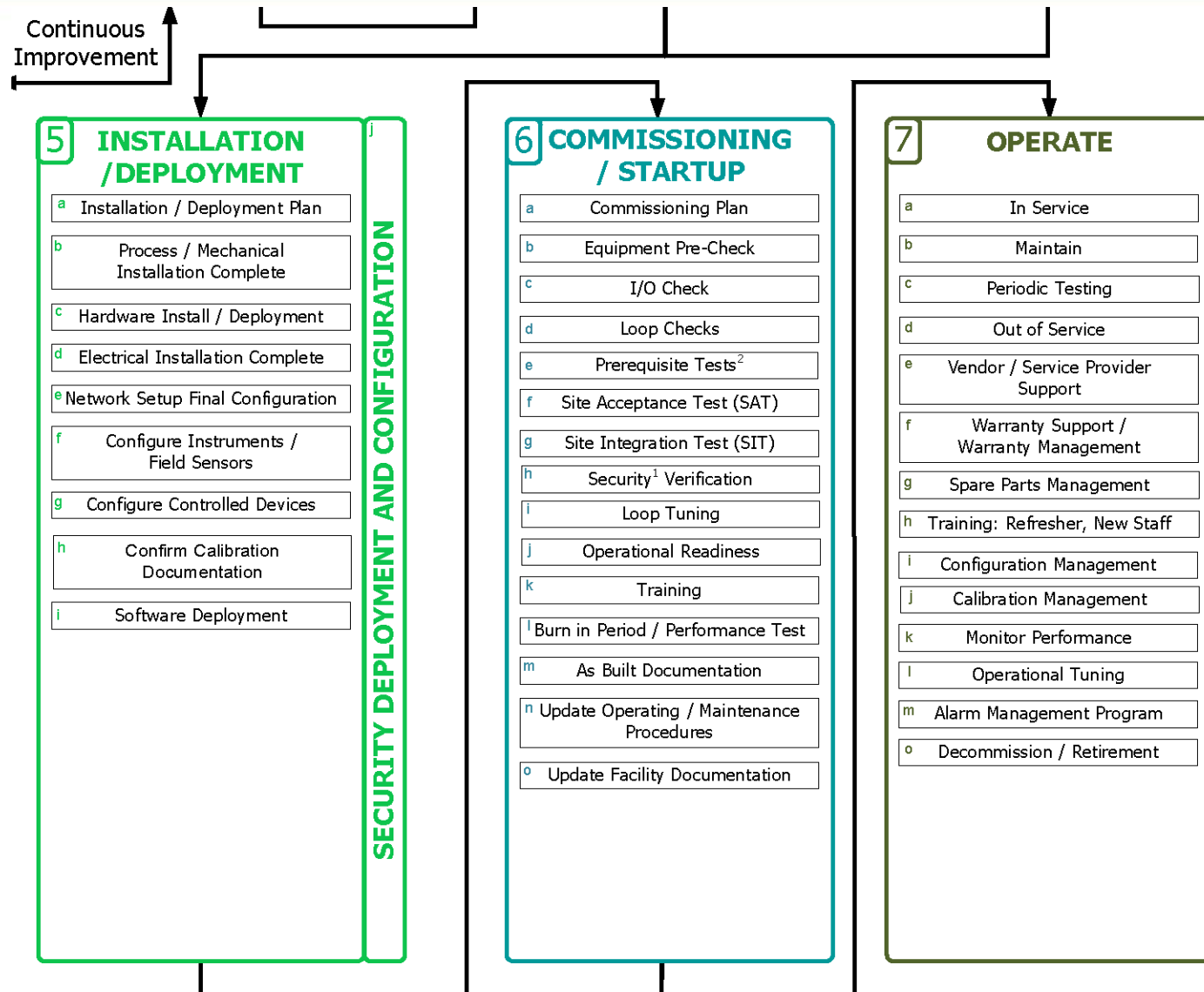
## System Development

- Sign-Off Functional Design Doc (Process Control Narrative)
- Procure Software Packages / Licences
- Training / Orientation for Software Development Team
- Setup Development Environment
- Create Detailed Data Tags / Data Model
- Application Development (PLC & HMI Programming)
- Modelling and Simulation (to enable testing as they program)
- Server Configuration
- Workstation Configuration
- Network Configuration
- Security Configuration (check all security settings are right)
- Review Draft HMI Screens and Draft Code / Configurations
- Software Factory Acceptance Test (SW-FAT)
- Integrated System Factory Integration Test (FIT)
- Write Operational Procedures (how to use the control system)
- Write Draft HMI / SADA Manual for Users
- Develop Software Training Materials

## Hardware Building / Fabrication (e.g., PLC panels & control consoles)

- Start Purchasing Process
- Shop Drawings / Submittals
- Buy Parts / Components
- Build Panels, Racks and Cabinets
- Build Supporting Equipment
- Hardware Factory Acceptance Test (HW-FAT)

# SCADA Install, Commission, Operate





# ISA112 Current Work Plan

Jun 2016	Committee approved by ISA
Aug 2016	Initial call for volunteers (40 members)
Sept 2016	First meeting held in Newport Beach, California, USA
Jan 2017	Committee co-chairs named -Graham Nasby, originally with Guelph Water Services, now with CN Rail (Guelph, Ontario, Canada) -Ian Verhappen, originally with CIMA+, now with Willow Glen Systems (Calgary, Alberta, Canada)
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# ISA112 Publications

- [www.isa.org/isa112](http://www.isa.org/isa112)
  - Freely available copy of ISA112 SCADA management lifecycle
  - Freely available copy of ISA112 SCADA model architecture
  - List of committee members, copies of presentations/articles, and other materials
- ISA112 upcoming publications
  - ISA112 Part 1– Terminology, Definitions & Lifecycle
  - ISA112 Part 2 – SCADA Systems Management Lifecycle
  - ISA112 Part 3 – SCADA Systems Model Architecture
- ISA112 Technical Reports
  - Titles and Topics TBD
  - To be focused on examples and best practices for “how” to implement SCADA systems
  - May be industry and/or application specific

# More Information on ISA112

- [www.isa.org/isa112/](http://www.isa.org/isa112/)
- Download the current ISA112 lifecycle & diagrams
- Contact the committee co-chairs
  - Graham Nasby  
[graham.nasby@grahamnashby.com](mailto:graham.nasby@grahamnashby.com)
  - Ian Verhappen  
[ian.verhappen@willowglensystems.com](mailto:ian.verhappen@willowglensystems.com)

*The ISA112 committee is still actively looking for volunteers from end-users, vendors, system integrators, consultants, utilities, and government entities to help with writing, editing, and reviewing content.*

*To join the committee or to get involved, feel free to contact Graham or Ian by email. If your organization would like to know more about ISA112, Graham can also give an online presentation on request.*