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DRIVING THE FUTURE OF NUCLEAR TECHNOLOGY

Licensing Process for Upgrading I&C Systems at Non-power Production or Utilization Facilities (NPUFs)

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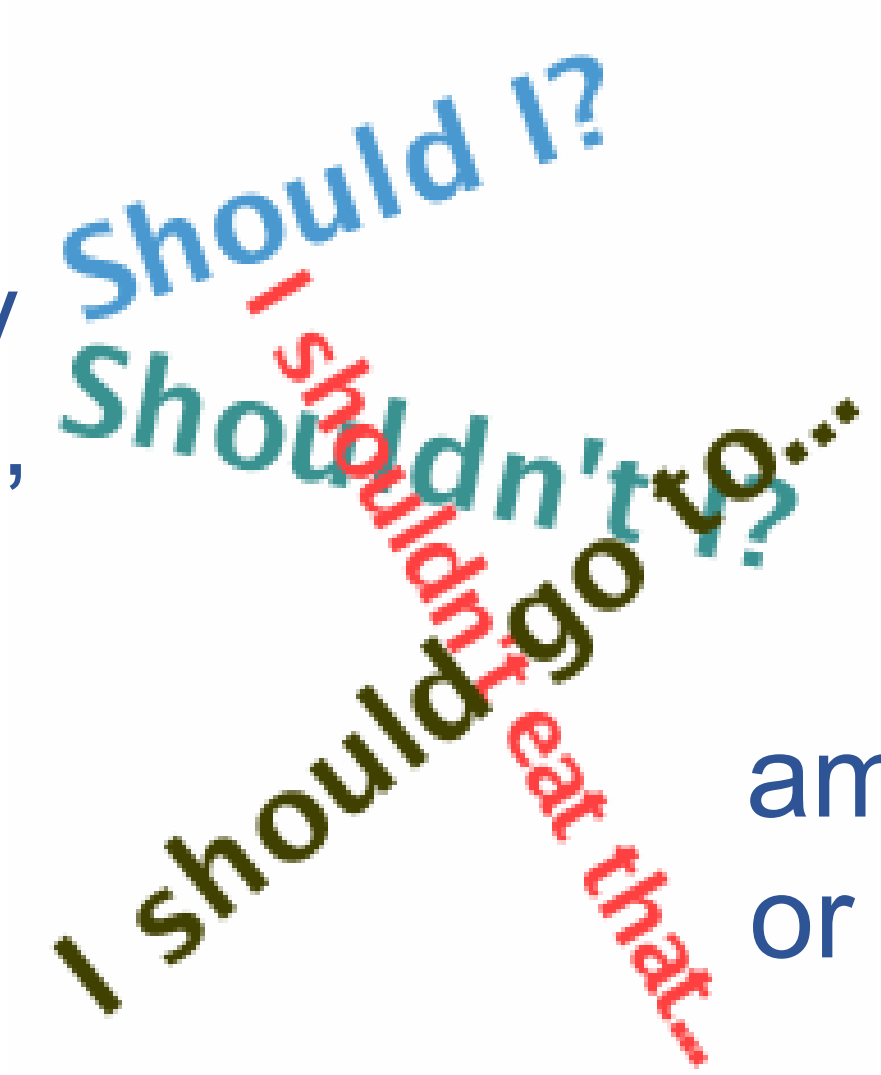
Introduction

- Nineteen of the 31 NRC-regulated non-power production or utilization facilities (NPUFs) are planning or already upgrading I&C systems
  - 3 license amendment requests
  - 2 new licensing applications
  - 14 performing or planning changes under 10 CFR 50.59
- The Research and Test Reactors Branch welcomes any opportunity to work with applicants on I&C upgrades
  - Committed to “Minimum Regulation” in the Atomic Energy Act, as amended (AEA)
    - Developed comprehensive NPUF guidance using graded approach
    - Holding workshops, public meetings, phase 0, and regulatory audits
    - Active in Agency’s Integrated Action Plan for Digital I&C
  - Encourage use of University Research Reactor Upgrades Infrastructure Support program*

* Part of the Scientific Infrastructure Support for Consolidated Innovative Nuclear Research

Digital upgrades

I want to upgrade my I&C system,



Is it an amendment or can I use 50.59?

Changes made under 10 CFR 50.59

- The licensee is responsible for the evaluation of a proposed modification implemented without prior NRC approval
  - The written evaluation must provide the bases for the determination that the change, test, or experiment does not require a license amendment
  - The 10 CFR 50.59 questions are answered in sufficient detail, that an independent third party can verify the judgements
- There is significant change in the arena of proposed 10 CFR 50.59 guidance for digital I&C
  - EPRI TR-102348 was replaced by NEI 01-01
  - NRC outlined 12 major concerns with guidance within NEI 01-01
  - NEI/industry plans to replace NEI 01-01 with two documents:
    - Digital licensing guidance (aka NEI 96-07, Appendix D)
    - Technical guidance for CCF (aka NEI 16-16)
  - RIS 2002-22, Supp. 1 published on qualitative assessments
  - Public meetings continue on the guidance documents under development

10 CFR 50.59(c)(2) questions*

i. *More than a minimal* increase in the frequency of occurrence of an accident previously evaluated in the FSAR
ii. increase in the likelihood of failure of SSCs to perform intended function as evaluated in the FSAR
iii. increase in the consequences of an accident previously evaluated in the FSAR
iv. increase in the consequences of a failure of SSCs to perform intended function as evaluated in the FSAR
v. possibility for an accident of a different type than any previously evaluated in the UFSAR
vi. possibility for a malfunction of an SSC important to safety with a different result
vii. a design basis limit for a fission product barrier described in the FSAR being exceeded or altered
viii. departure from a method of evaluation described in the FSAR in establishing the safety analyses

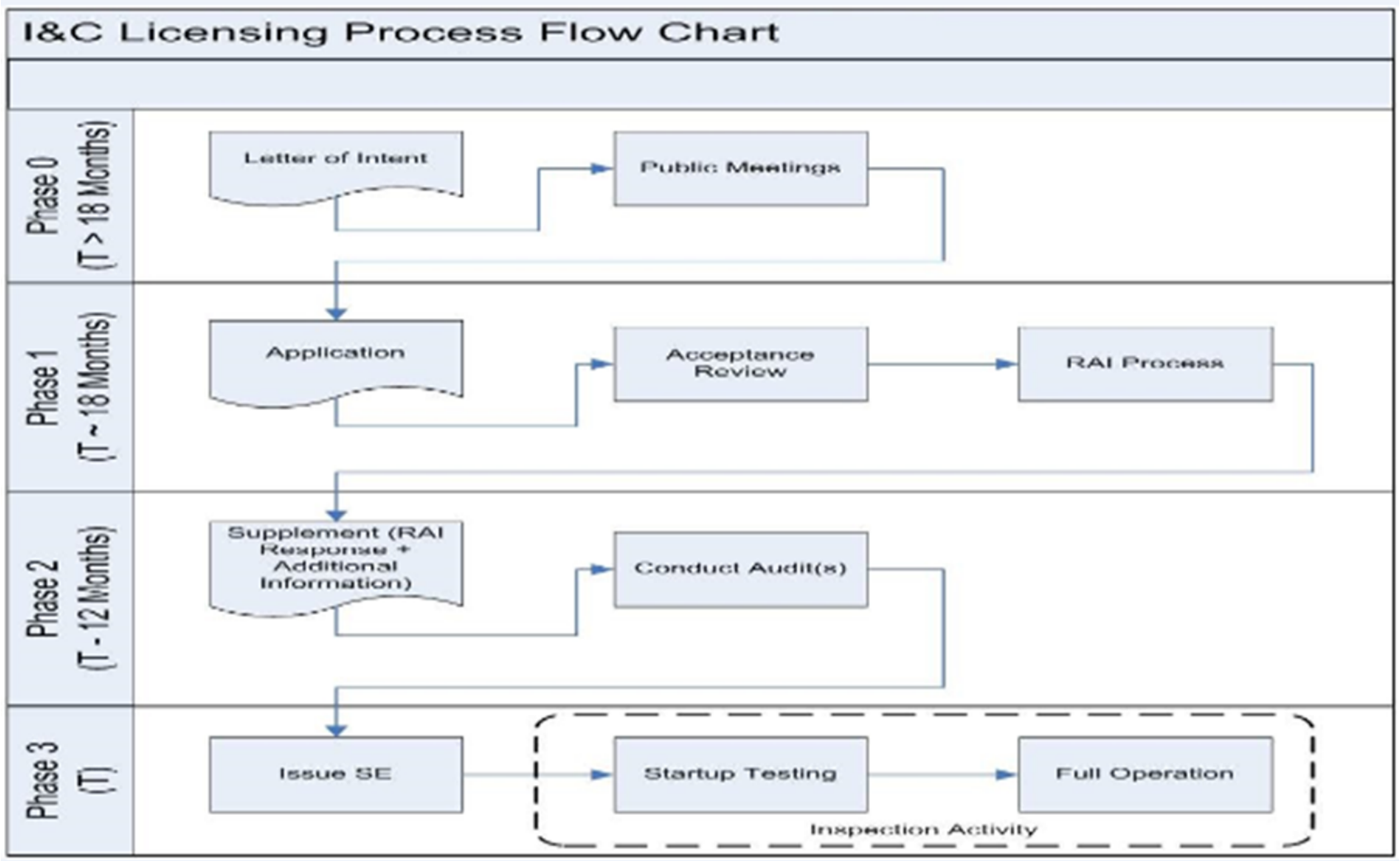
* Paraphrased to facilitate slide discussion, refer to Title 10 of the *Code of Federal Regulations*

Qualitative assessments

- Reference Regulatory Issues Summary (RIS) 2002-22, Supplement 1
- Examples of digital I&C modifications that licensees can likely implement without prior NRC approval using properly documented qualitative assessments*
  - replacement of analog relays (including timing relays) with digital relays
  - replacement of analog controls for safety related support systems such as chiller (heating, ventilation, and air conditioning) systems and lubricating oil coolers
  - replacement of analog controls for emergency diesel generator supporting systems and auxiliary systems such as voltage regulation
  - installation of circuit breakers that contain embedded digital devices
  - replacement of analog recorders and indicators with digital equivalent
  - digital upgrades to control systems that are not safety-related

* Assumes no interconnectivity across channels, systems, and trains; and their modification does not reduce the redundancy, diversity, separation, or independence of their SAR described design functions

Amendments per 10 CFR 50.90



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Examples of things to consider when upgrading to a digital system/component

- Recorder upgrade
- Stepper motor upgrade
- New pulse monitoring channels
- Broadcast or data storm
- Software design error

Recorder Upgrade

- An analog recorder is to be replaced with a new microprocessor-based recorder
- The recorder is used for various monitoring purposes, some of which are FSAR described design functions
- Information on new recorder shows:
  - Highly dependable (QA & testability)
  - Significant operating experience
  - Performance of design function unchanged
- At first glance it looks like this may “screen out” of a 50.59 review

Examples of what to consider in replacement of recorder

Engineering analysis shows the sampling and recording frequency are lower for the replacement than for the analog recorder and the related recording function replaces instantaneous readings with time-averaged readings!

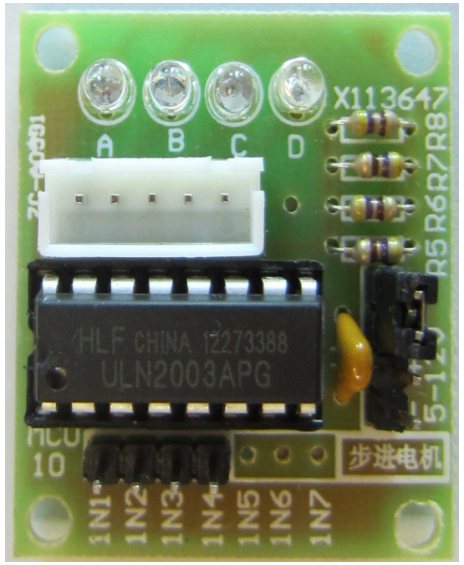
HSI Considerations

- Physical interface examples
  - Physical interaction
    - use of a touch screen in place of push-buttons, switches or knobs
  - Number/type of parameters
    - Information overload
  - Information presentation
    - Parameter change (e.g., “%” change vs. seconds)
  - Operator response time
    - e.g., additional steps necessary to call up the appropriate display and operate the “soft” control

Other Considerations

- Should also analyze any additional features for the new recorder, such as
  - Networking interface
  - Remote control capability
  - USB ports (*intrusion protection)*
  - Built-in or self-test diagnostics
  - Environmental qualification
    - temperature, pressure, humidity
    - Electromagnetic compatibility

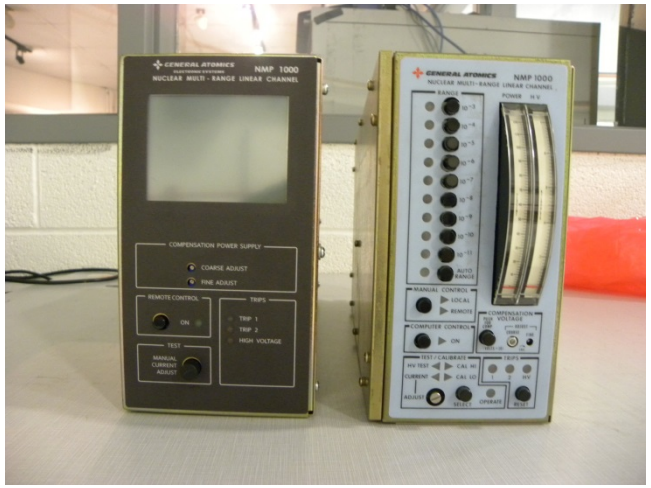
Rod drive replacement



Which one would you rather have?

- Stepper motor and optical encoder for rod position encoded digital signal actuates rod bottom indication for rod full-in / full-out
- A programmable logic controller (PLC) interface provides a “soft” means to select and control rods with digital position indication to thousandths
- XYZ vendor is reputable with established manufacturing and quality processes
- PLC software and programming is done by the manufacturer but integrated and tested by XYZ vendor

50.59 or LAR?



"The current NMP-1000 architecture (ca. 2013) is very similar to all previous NMP units…changes enable the use of modern, obtainable components with surface-mount technology, and a touch-screen display…" --GA description document

Reality - The new NMP-1000 has a microprocessor and an LCD interface!

Broadcast or Data Storm

- Operator manually inserted a reactor scram for loss of both recirculation pumps
  - variable frequency drive (VFD) controllers were non-responsive due to unrelated demineralizer pump controller failure
  - Controller is dual redundant programmable logic controller (PLC) connected to the same Ethernet-based computer network as the VFD
- Excessive data packet traffic on network caused delayed response to new command and lockup
  - As designed, data packets were transmitted to every device connected to the network.
  - Receiving devices had to examine each data packet to determine which ones were addressed to them and to ignore those that were not
  - The control network produced more traffic than the PLC and VFD controllers could handle

Software Design Error

Software Design:

- A trip channel was designed to trip if a sensor was detected to be failed out of range
- Use of two sets of instruments and multiplexors (primary and secondary)
- Out of range sensor failure
  - If the primary sensor failed the trip channel switched over to secondary sensor
  - Out of range on secondary sensor value reverts to “last stored good value”
- CCF of all sensors of one type would result in continuous use of “last good value”
  - The software requirements specifications erroneously included the requirement for use of the last valid sensor data when a sensor fails while the functional requirements specifications required an automatic trip

Questions

thank you

* Publically available via NRC Agencywide Document Access and Management System (ADAMS) Accession No. ML18166A323

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