

**APPENDIX C**

**INSTRUMENTATION AND CONTROLS DESIGN REVIEW GUIDANCE**

**(PROGRAMMATIC AND FACILITY)**

**TABLE OF CONTENTS**

1.0 PURPOSE AND SCOPE ..... 2

2.0 DEFINITIONS ..... 2

3.0 METHODOLOGY ..... 3

ATTACHMENT 1: CONTROL SYSTEM DESIGN CHECKLIST ..... 4

**RECORD OF REVISIONS**

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**CONTACT THE I&C STANDARDS POC**  
for upkeep, interpretation, and variance issues

Section D3060/F1050 App C	<a href="#">Instrumentation &amp; Controls POC/Committee</a>
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## 1.0 PURPOSE AND SCOPE

This appendix provides guidance for the conduct of design reviews of Instrumentation and Control (I&C) systems. The appendix provides the means to improve consistency, overall design, equipment specification, and lifecycle maintenance. It also provides guidance for addressing technology obsolescence.

## 2.0 DEFINITIONS

**Component Location Identifiers** – A labeling designation used to identify the location of a component. It generally consists of a combination of designations such as the component area, system, equipment type, and number.

**Control Philosophy** – A control system design approach that consists of: (1) establishing process control objectives (functional performance descriptions, process monitoring requirements, operational limits, etc.), (2) applying the most appropriate control techniques (ratio control, feed-forward control, cascade control, etc.), and (3) ensuring control system attributes (diversity, separation, isolation, redundancy, fault diagnostics, testability, etc.) are available for the reliable, efficient, and safe control of a facility / process.

**Engineering Standards Task Matrix** – An application matrix that provides for the selection of a minimum set of national codes and standards to be addressed for I&C systems. Refer to I&C Chapter, Section D3060/F1050, Subsection 3.4.

**Functional Classification** – A graded classification system used to determine the minimum requirements for Systems, Structures, and Components (SSCs) (e.g. design, operation, procurement, and maintenance requirements). The four Functional Classifications in order of precedence are ML-1 and/or SC, ML-2 and/or SS, ML-3, and ML-4.

**Instrument Range** – The region between the limits within which a quantity is measured, received, or transmitted, expressed by stating the lower and upper range values. It is often expressed as the difference between the upper and lower measurable limits.

**Instrument Scale** – The graduated series of marking on an instrument display, usually used in conjunction with a pointer to indicate a measured value.

**Instrument Sensitivity** – The smallest change in actual value of a measured quantity that will produce and observable change in an instrument's output.

**Measurement and Test Equipment (M&TE)** – Portable or fixed equipment used for acceptance, calibration, measurement, gauging, testing, and/or inspection of equipment in order to control or acquire data to verify conformance to specified requirements or for reference information (monitoring and data collection).

**Safety Significant Instrumented System** – An SS system or 29 CFR 1910.119 hazardous process independent protection layer that requires instrumentation, logic devices and final control elements to monitor and detect an SS event, and which will result in automatic or operator action that will bring the facility or process system to a safe state.

### 3.0 METHODOLOGY

- A. An attachment to this appendix (Attachment 1) provides a checklist that can be used to address the quality of an I&C system design. The questions are worded such that the desirable answer is “Yes”. It is, however, understood that not all questions are applicable to all I&C systems. The number of questions that are applicable and are answered “Yes” will be indicative of the quality of design.
  
- B. Maximum benefit is obtained when the attached checklist is used throughout the design phase. Completing the checklist at the beginning of a design task insures that the proper considerations are given and can reveal inconsistencies in the design approach. The checklist should be used during design reviews to assess the extent of progress in meeting the intent of the questions. For the final design review, the checklist provides a means to assess the completeness and quality of the system design.

**Attachment 1: Control System Design Checklist**

**Obsolescence**

1. Is there a provision in the bid specification for migration to newer technologies?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
2. Does the supplier have a migration plan to newer technology covering the next 5 to 10 years?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
3. Is there a good balance between proven and new technology? (e.g., Equipment is not approaching obsolescence, but is not untested technology either.)	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
4. Are spare parts available as “off-the-shelf” items?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
5. Has the supplier provided a product support plan that covers at least five years following product delivery?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
6. Are there alternate sources available for the chosen components and are they compatible?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
7. Does the supplier have a good record of product support?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
8. Is the supplier considered to be a stable, viable supplier?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A

**Consistency**

1. Has the I&C system design been reviewed for consistency of design? (See five sub-questions below)	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
1.1 Can the system be operated and maintained without any significant additional site training for operations or maintenance personnel?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
1.2 Can existing facility procedures be utilized, or slightly modified in use, in order to operate the new control system?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
1.3 Can a common set of spare parts be used to maintain the proposed new system and exiting facility systems?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
1.4 In the event of multiple design groups or engineers, have difference segments of the new I&C system been designed so that the same control strategy is used	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
1.5 In the event of similar existing systems within the facility, has the new I&C system been designed so that it employs the same control strategy as the existing systems?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
2. Does the I&C system design support a uniform and consistent operating philosophy? (See four sub-questions below)	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
2.1 Are instruments that make similar measurements the same type of instruments? (e.g., all similar flows measured with the same type of flow meter?)	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A

2.2 Are alerts/alarms/interlocks for similar functions applied, prioritized, and handled in a consistent manner?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
2.3 Is process data being presented (display/engineering units/accuracy) in a consistent manner for similar applications?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
2.4 Is the instrument scale consistent with instruments that make similar measurements?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
3. Is the I&C system design consistent with the requirements established for the proposed functional classification?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
4. Have Component Location Identifiers (CLI) been assigned in a consistent manner with other similar systems in the facility?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
5. Are process displays consistent with applicable standards and existing conventions?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
6. Is the new I&C system equipment compatible with existing telecommunications equipment?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
7. Is the new I&C system compatible with existing systems with which it interfaces?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
8. Are databases (e.g., instrument index, I/O, alarm setpoint) established in the design consistent with existing databases?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A

**Technology**

1. Has control software been developed in accordance with the specified facility software requirements?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
2. Is the instrumentation the most appropriate for the type and range of measurement?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
3. Can the supplier provide an upgrade path for the I&C components to provide compatibility with fieldbus architecture if applicable?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
4. Does the I&C system utilize industry standard communication protocols instead of proprietary ones?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
5. Does the I&C system have the capability to easily add more I/O points or drops?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
6. Are on-line and/or self-diagnostics included in the system design?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
7. Does the system provide on-line help for operators and engineers?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
8. Can the system provide printouts of its configurations, logic, and executables for documentation purposes?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A

**Good Design Practice**

1. Is a control philosophy established for the facility?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
2. Are commercial “off-the-shelf” products being used to the maximum extent in the new design?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
3. Has energy efficiency been considered between design alternatives?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A

4. Has the heat load on the HVAC system resulting from the installation of additional equipment been taken into consideration?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
5. Has a human factors approach been applied in the design of operator workstations and any other Human Machine Interfaces?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
6. Have power sources been identified for electrical load studies?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
7. Has the system been designed to be fail-safe?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
8. Has the National Codes and Standards Task Matrix been reviewed for applicable I&C design standards for the proposed functional classification?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
9. Has the system been reviewed for security requirements established for computer-based control systems?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
10. Have all instruments been placed so that they meet guidelines for accessibility and proper operation?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
11. Have all instruments and actuators been sized to meet minimum, maximum, and nominal process operating conditions.	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
12. Has the instrument, instrument range, and instrument sensitivity been selected based on operational process sensitivity requirements?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
13. Has the design team agreed on the design standards that will be applied?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
14. Has space for expansion been provided if required for operation in the future?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
15. Are I&C materials of construction compatible with process materials and the operating environment?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
16. Has the system availability and reliability requirements been identified and met in the design?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
17. Has a life cycle cost analysis been performed and is the selected system competitive when compared to other designs?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
18. Has the supplier been qualified and placed on an approved supplier's list?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
19. Does the design specification include a factory acceptance test?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
20. Does the supplier specification require that the supplier be compliant with NQA-1 and that the supplier identify, in his proposal, all deliverables including lifecycle documentation?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
21. Has the appropriate design requirements been applied to ML-2 / Safety Significant instrumented systems?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
22. Has the control system design been reviewed to ensure it does not interfere with existing monitoring, alarm, and safety systems?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
23. Is the proper level of receipt inspection included in the purchasing documents?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
24. Is documentation for the application of DOE G 420.0 standards provided?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A

**Maintenance**

1. Has instrumentation been modularized where possible for low maintenance and repair costs?	<input type="checkbox"/> <b>Yes</b>	<input type="checkbox"/> <b>No</b>	<input type="checkbox"/> <b>N/A</b>
2. Does the purchase requisition require the vendor to supply specification sheets in hard and electronic copy?	<input type="checkbox"/> <b>Yes</b>	<input type="checkbox"/> <b>No</b>	<input type="checkbox"/> <b>N/A</b>
3. Does the design allow for maintenance to be conducted with minimum or no impact to plant operation?	<input type="checkbox"/> <b>Yes</b>	<input type="checkbox"/> <b>No</b>	<input type="checkbox"/> <b>N/A</b>
4. Does the purchase requisition require the vendor to supply calibration certification, M&TE requirements, and procedures for any unique or special instruments?	<input type="checkbox"/> <b>Yes</b>	<input type="checkbox"/> <b>No</b>	<input type="checkbox"/> <b>N/A</b>
5. Has the Procurement Department’s controlled product list been reviewed to ensure no suspect materials are being used as critical components?	<input type="checkbox"/> <b>Yes</b>	<input type="checkbox"/> <b>No</b>	<input type="checkbox"/> <b>N/A</b>
6. Are appropriate features available for calibrating / testing?	<input type="checkbox"/> <b>Yes</b>	<input type="checkbox"/> <b>No</b>	<input type="checkbox"/> <b>N/A</b>
7. Are items accessible and oriented for support by construction and maintenance?	<input type="checkbox"/> <b>Yes</b>	<input type="checkbox"/> <b>No</b>	<input type="checkbox"/> <b>N/A</b>
8. Can the system be maintained without special calibration equipment or procedures?	<input type="checkbox"/> <b>Yes</b>	<input type="checkbox"/> <b>No</b>	<input type="checkbox"/> <b>N/A</b>
9. Has weather protection been provided where necessary?	<input type="checkbox"/> <b>Yes</b>	<input type="checkbox"/> <b>No</b>	<input type="checkbox"/> <b>N/A</b>
10. Has the I&C system design taken into consideration ALARA issues for maintenance and operational personnel?	<input type="checkbox"/> <b>Yes</b>	<input type="checkbox"/> <b>No</b>	<input type="checkbox"/> <b>N/A</b>
11. Does the supplier offer training for maintenance personnel on its I&C components if necessary?	<input type="checkbox"/> <b>Yes</b>	<input type="checkbox"/> <b>No</b>	<input type="checkbox"/> <b>N/A</b>
12. Does the I&C system design incorporate features to limit system susceptibility to electrical noise, ground loops, static electricity, lightning strikes and electrical surges?	<input type="checkbox"/> <b>Yes</b>	<input type="checkbox"/> <b>No</b>	<input type="checkbox"/> <b>N/A</b>
13. Has the supplier demonstrated a good quality assurance program and a quality product? (e.g., Records do not indicate quality concerns with the supplier’s products)	<input type="checkbox"/> <b>Yes</b>	<input type="checkbox"/> <b>No</b>	<input type="checkbox"/> <b>N/A</b>