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# DRAFT REGULATORY GUIDE

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## DRAFT REGULATORY GUIDE DG-1268

*(Proposed Revision 1 of Regulatory Guide 1.68.3, dated April 1982)*

# PREOPERATIONAL TESTING OF INSTRUMENT AND CONTROL AIR SYSTEMS

## A. INTRODUCTION

This regulatory guide describes methods and procedures the staff of the U.S. Nuclear Regulatory Commission (NRC) considers acceptable to implement preoperational testing of the instrument and control air systems (ICAS) in a commercial nuclear power plant.

Successful demonstration of the operability of the ICAS is one of the items required by Appendix A, "General Design Criteria for Nuclear Power Plants," of Title 10 of the *Code of Federal Regulations*, Part 50, "Domestic Licensing of Production and Utilization Facilities" (10 CFR Part 50) (Ref. 1) including, but not limited to:

- Criterion 1, "Quality Standards and Records;"
- Criterion 2, "Design Basis for Protection Against Natural Phenomena;"
- Criterion 5, "Sharing of Structures, Systems, and Components;"
- Criterion 13, "Instrumentation and Control;"
- Criterion 19, "Control Room;"
- Criterion 23, "Protection System Failure Modes;" and
- Criterion 55, "Reactor Coolant Pressure Boundary Penetrating Containment."

This guide also describes methods the NRC staff finds acceptable for the initial test program for ICAS systems, structures, and components (SSCs) in accordance with the regulations in 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants," Subpart B, "Standard Design Certifications," and Subpart C, "Combined Licenses" (Ref. 2).

Criterion XI, "Test Control" in 10 CFR 50, Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," requires, in part, that licensees establish a test program to assure that all testing required to demonstrate that structures, systems, and components will perform satisfactorily in service. It further requires that the test program be performed in accordance with written

test procedures which incorporate the requirements and acceptance limits contained in applicable design documents.

Additionally, 10 CFR 50.63, "Loss of All Alternating Current Power" requires necessary support systems to provide sufficient capacity and capability to ensure that the core is cooled and appropriate containment integrity is maintained for a specified length of time. The ICAS may provide compressed air or nitrogen to actuate or control equipment necessary for core cooling and decay heat removal or maintain containment integrity following a station blackout. Regulatory guide 1.155 provides additional guidance on a method acceptable to the staff for compliance with 10 CFR 50.63.

Throughout this guide, the term "air," as in "air-operated" or "air pressure," is equivalent to "air," "nitrogen," or, more generically, "pressurized gas." This guide is applicable to any pneumatic system that interacts with safety-related components. However, this is not applicable to hydrogen systems used for main generator cooling.

This guide describes methods and procedures acceptable to the NRC staff for demonstrating compliance with the Commission's regulations with respect to preoperational testing to verify that ICPS and the loads they supply will operate properly at normal system pressures and to ensure the operability of functions important to safety in the event that system pressure is lost, reduced below normal operating level, or increased above the design pressure of the pneumatic system components to the upstream safety valve accumulation pressure.

The NRC issues regulatory guides to describe to the public methods that the staff considers acceptable for use in implementing specific parts of the agency's regulations, to explain techniques that the staff uses in evaluating specific problems or postulated accidents, and to provide guidance to applicants. Regulatory guides are not substitutes for regulations and compliance with them is not required.

This regulatory guide contains information collection requirements covered by 10 CFR Part 50 and 10 CFR Part 52 that the Office of Management and Budget (OMB) approved under OMB control numbers 3150-0011 and 3150-0151, respectively. The NRC may neither conduct nor sponsor, and a person is not required to respond to, an information collection request or requirement unless the requesting document displays a currently valid OMB control number. Additionally, this regulatory guide is a rule as designated in the Congressional Review Act (5 U.S.C. 801–808). However, OMB has not found it to be a major rule as designated in the Congressional Review Act.

# B. DISCUSSION

**Reason for Change**

This guide is being revised to address new issues identified since the guide was originally issued. These include vibration testing of the ICAS components and systems, ICAS air-dryer testing to meet dew point design requirements, ICAS accumulator check valves and solenoid valves operating and testing experience, and an update to the Instrumentation, Systems, and Automation Society (ISA) Standard ISA S7.3, "Quality Standards for Instrument Air" for acceptable industry standards for oil, water and particle matter in ICAS. This revised guide contains information specific for testing both older plants and newer reactors licensed under both 10 CFR Parts 50 and 52.

**Background**

The ICAS typically furnish pressurized air to a wide variety of equipment in nuclear power plants. The extent to which such air systems are used varies with the different designs of both the nuclear and the balance-of-plant portions of the facility. The ICAS also supply pressurized air to operate various loads, which may include components and systems that are required to perform safety-related and important-to-safety functions. These safety-related ICAS sections should be identified correctly and be capable of being isolated from the nonsafety-related components and systems.

Air systems supply diverse kinds of equipment, and loss of air or other system transients can have various effects that can challenge the operations staff's ability to respond. Therefore, it is important that licensees conduct testing to verify proper functioning during normal operation and to determine the effects of total loss, reduction, or increase of the pressure within the entire instrument and control pressurized-gas distribution system and portions of the system.

It is essential that testing verify that the system will respond appropriately to both normal operation of the plant and upset, faulted, or emergency conditions, with consideration given to (1) complete and sudden loss of pressure resulting from such postulated events as inadvertent valve operation in the supply system, severance of a system pipe, complete or partial loss of power, and component malfunction, (2) partial or gradual loss of system pressure to the entire distribution system or portions of the system as the result of such events, and (3) increases in pressure because of component malfunction or failure.

Air-operated valves and other air-operated components are normally designed to respond in a given manner (i.e., fail open, fail closed, or fail as is) if the instrument and control air supply is lost or its pressure is reduced or increased. Verification of system response to a loss-of-air-pressure event is an essential part of testing at the preoperational stage, when it can be accomplished with minimum risk to power plant equipment and personnel. Licensee should verify that air-operated components fail in their designated safe position upon loss of air and loss of electric power. Testing also provides a means for determining the adequacy of operating and emergency procedures for coping with a loss of air supply.

Preoperational testing of the ICAS after construction of the plant and installation of the system will help ensure that the air supply equipment (compressors and associated controls and backup air supplies) and the equipment provided to maintain the quality of air supplied (e.g., filters and dryers) will function within design requirements.

The applicant is responsible for developing a suitable preoperational test program for the ICAS. This includes preparing adequate procedures for carrying out the program, properly conducting the preoperational tests, and establishing the validity of the test results by adequate review and approval. If the test conditions do not reflect plant design conditions for flow, pressure, and differential pressure, the licensee should perform an analysis to demonstrate the adequacy of the test.

**Other Codes and Standards**

This regulatory guide endorses the use of one or more voluntary consensus codes or standards developed by external organizations. These codes or standards may contain references to other codes or standards. These references should be considered individually. If a referenced standard has been incorporated separately into NRC regulations, licensees and applicants must comply with that standard as set forth in the regulation. If the referenced standard has been endorsed in a regulatory guide, the standard constitutes a method acceptable to the NRC staff for meeting a regulatory requirement as described in the specific regulatory guide. If a referenced standard has been neither incorporated into

NRC regulations nor endorsed in a regulatory guide, licensees and applicants may consider and use the information in the referenced standard, if appropriately justified and consistent with current regulatory practice.

**Harmonization with International Standards**

The International Atomic Energy Agency (IAEA) has established a series of safety guides and standards constituting a high level of safety for protecting people and the environment. IAEA safety guides are international standards to help users striving to achieve high levels of safety. Pertinent to this regulatory guide, IAEA Safety Guide NS-G-1.3, "Instrumentation and Control Systems Important to Safety in Nuclear Power Plants" (Ref. 3), issued March 2002, addresses design considerations for the performance requirements, design reliability and in-service inspection of air systems in nuclear power plants. This regulatory guide incorporates similar design and preoperational testing guidelines and is consistent with the basics safety principles provided in IAEA Safety Guide NS-G-1.3.

# C. STAFF REGULATORY GUIDANCE

As part of the initial preoperational testing program, the system and loads should be tested as described below to verify that all components function properly at normal pressures and following possible pressure increases and that the systems respond as designed to a loss-of-air-pressure event. Also, licensees should perform testing similar to the initial preoperational testing after major modification or repair to the ICAS or portions thereof (e.g. where airflow-rate requirements are significantly altered or where opened systems are subject to contamination). For stations that use or may use service air systems to supply instrument air, all of the testing discussed in this guide also applies to the service air system. Only those portions of the service air system that cannot affect the instrument air system may be excluded from the recommendations of this guide.

1. The test program for the ICAS and associated equipment should include the applicable prerequisite checks, verifications, and tests provided in RG 1.68, "Initial Test Programs for Water-Cooled Nuclear Power Plants" (Ref. 4).

2. During testing, the impacts of vibration on instrument air lines should be evaluated and the connection of supports for air lines should be verified. The test program should ensure that any seismic requirements for the air systems or components are met.

3. The test program should verify that air system components perform as expected in accordance with all design-basis events, including a loss of normal instrument air. Testing should also verify the component position upon loss of instrument air. If components realign or protective or automatic functions occur, testing should ensure that the pressure at which the action occurs is in accordance with the design and is reflected in the operating procedures (if appropriate).

4. Compressors, aftercoolers, oil separator units, air receivers, and pressure-reducing stations, should be tested to verify proper operation at the system minimum and maximum demand conditions according to the system design. The operation of compressor unloaders, automatic and manual start and stop circuits of standby compressors, high- and low-pressure alarms, pressure indicators, and temperature indicators should be checked. Compressor operation at worst case environmental conditions (i.e., temperature, humidity) should be verified either by test or analysis. Relief valve capacity and settings should be verified.

5. Air dryer units should be tested for proper functioning, and the units should be operated through several regeneration cycles in accordance with manufacturers' recommendations. Acceptable operation at the maximum and minimum flow rates should be verified. The dewpoint should be verified in accordance with system design requirements and dryer manufacturer specifications. The appropriate differential pressures and proper operation of pressure switches, high- and low pressure alarms, safety and relief valves, bypass valves, and alarms and resets should be verified.

6. The test program should cycle the operability of all accumulator check valves and solenoid-operated valves required to operate the power-operated relief valves.

7. Testing should evaluate whether the failure of a single solenoid or other component can impact redundant safety-related or important to safety components or trains.

8. The test program should verify that the ICAS will meet system design specifications relating to the flow, pressure, and temperature of the compressed gas during the worst case demand on the system. It may be necessary to simulate transient demands at various portions of the system to demonstrate that the most remote portion of the system still meets specifications.

9. Tests should be conducted to demonstrate that plant equipment designated by design to be supplied by the ICAS is not being supplied by other compressed-gas supplies (such as service air) that may have less restrictive air quality requirements.

10. Appropriate measurements or observations should be established to verify that the total air demand at normal steady-state, accident, loss of offsite power, station blackout, or other transient conditions, including leakage from the system, is in accordance with the design.

11. The ability of the system to meet the quality requirements of the system design should be verified. In NUREG-0800, Section 9.3.1, "Compressed Air System," (Ref. 5) the NRC staff identified ANSI/ISA S7.3 R1981, "Quality Standard for Instrument Air," (Ref. 6) as an acceptable standard with respect to oil, water, and particulate matter contained in ICAS air. The quality should be verified by analyzing the air at the end of each feeder line using continuous flow techniques or by analyzing a discrete sample. The maximum particle size should be 3 microns for all components serviced by ICAS.

12. Licensees should verify by test, if applicable, the redundant components and air supplies provided in the facility design to meet the single-failure criterion for a given safety function.

13. Testing should verify that air actuators cycle air-operated valves within design specifications and time limits. Air actuators that control valves position should also be tested at the highest process fluid differential pressure they will experience with the lowest design air pressure.

14. Testing should verify that the air-operated or air-powered loads that are a part of (or support the operation of) portions of the facility important to safety respond in accordance with design to a loss of air pressure. Testing should be sufficiently comprehensive to determine the response of loads to complete loss of system pressure, both sudden and gradual, and to partial reductions in system pressure. Testing should verify that valves which use multiple air connections (e.g., 206.7 kilopascals (kPa) (30 psig) to pilot and 689.3 kpa (100 psig) to positioner or booster relay) respond safely to all failure modes, if failure of less than all air supply sources is credible. The tests should verify the adequacy of design requirements relating to system pressures at which supplied loads change state (e.g., fail open, fail closed, fail as is, fail upscale, fail downscale, or

fail to perform other required functions). The licensee should specify the time frame that the accumulators need to maintain a minimum pressure under accident conditions.

15. Testing should also verify that the backup supplies for the protected loads supplied by the system (e.g., accumulators and backup bottled gas supplies) will maintain sufficient air pressure to permit these loads to perform their design function. (If the design includes multiple cycles, ensure that the backup capacity is sufficient.)

16. As part of the testing in Regulatory Position 13 above, licensees should also perform loss-of-air-supply tests on all branches of the instrument and control air system simultaneously, if practicable, or on the largest number of branches of the system that can be adequately managed. For each test, the valves to be tested should be placed in their normal operating positions, and the rest of the plant should be maintained in as close to normal position as is practicable. (Note that not all valves can be placed in the required normal operating position because of operating procedure requirements or personnel or equipment safety factors.) Licensees should perform the following tests:

    a) Shut off the ICAS in a manner that would simulate a sudden air pipe break, and verify that the affected components respond properly.

    b) Repeat Test 15(a), but shut the ICAS off very slowly to simulate a gradual loss of pressure.

17. Plant components requiring large quantities of instrument and control compressed gas for operation (such as large valve operators) should be operated simultaneously while the system is operating at normal steady-state conditions (unless it can be shown that simultaneous operation is prohibited by interlock or appropriate procedure) to verify that pressure transients in the distribution system do not exceed acceptable values or result in unexpected actuations.

18. Functional testing of ICASs important to safety should be performed to ensure that credible failures resulting in an increase in the supply system pressure will not cause loss of operability.

19. Where applicable, test ICAS containment isolation functions and/or isolation of the ICAS safety related functions (i.e., safety related backup air accumulators) from ICAS non safety related functions.

## D. IMPLEMENTATION

The purpose of this section is to provide information on how applicants and licensees[1] may use this guide and information regarding the NRC's plans for using this regulatory guide. In addition, it describes how the NRC staff complies with the Backfit Rule (10 CFR 50.109) and any applicable finality provisions in 10 CFR Part 52.

[1] In this section, "licensees" refers to licensees of nuclear power plants under 10 CFR Parts 50 and 52; and the term "applicants," refers to applicants for licenses and permits for (or relating to) nuclear power plants under 10 CFR Parts 50 and 52, and applicants for standard design approvals and standard design certifications under 10 CFR Part 52.

**Use by Applicants and Licensees**

Applicants and licensees may voluntarily[2] use the guidance in this document to demonstrate compliance with the underlying NRC regulations. Methods or solutions that differ from those described in this regulatory guide may be deemed acceptable if they provide sufficient basis and information for the NRC staff to verify that the proposed alternative demonstrates compliance with the appropriate NRC regulations. Current licensees may continue to use guidance the NRC found acceptable for complying with the identified regulations as long as their current licensing basis remains unchanged. The acceptable guidance may be a previous version of this regulatory guide.

Licensees may use the information in this regulatory guide for actions which do not require NRC review and approval such as changes to a facility design under 10 CFR 50.59. Licensees may use the information in this regulatory guide or applicable parts to resolve regulatory or inspection issues.

**Use by NRC Staff**

During regulatory discussions on plant specific operational issues, the staff may discuss with licensees, various actions consistent with staff positions in this regulatory guide, as one acceptable means of meeting the underlying NRC regulatory requirement. Such discussions would not ordinarily be considered backfitting even if prior versions of this regulatory guide are part of the licensing basis of the facility. However, unless this regulatory guide is part of the licensing basis for a facility, the staff may not represent to the licensee that the licensee's failure to comply with the positions in this regulatory guide constitutes a violation.

If an existing licensee voluntarily seeks a license amendment or change and (1) the NRC staff's consideration of the request involves a regulatory issue directly relevant to this new or revised regulatory guide and (2) the specific subject matter of this regulatory guide is an essential consideration in the staff's determination of the acceptability of the licensee's request, then the staff may request that the licensee either follow the guidance in this regulatory guide or provide an equivalent alternative process that demonstrates compliance with the underlying NRC regulatory requirements. This is not considered backfitting as defined in 10 CFR 50.109(a)(1) or a violation of any of the issue finality provisions in 10 CFR Part 52.

The NRC staff does not intend or approve any imposition or backfitting of the guidance in this regulatory guide. The NRC staff does not expect any existing licensee to use or commit to using the guidance in this regulatory guide, unless the licensee makes a change to its licensing basis. The NRC staff does not expect or plan to request licensees to voluntarily adopt this regulatory guide to resolve a generic regulatory issue. The NRC staff does not expect or plan to initiate NRC regulatory action which would require the use of this regulatory guide. Examples of such unplanned NRC regulatory actions include issuance of an order requiring the use of the regulatory guide, requests for information under 10 CFR 50.54(f) as to whether a licensee intends to commit to use of this regulatory guide, generic communication, or promulgation of a rule requiring the use of this regulatory guide without further backfit consideration.

Additionally, an existing applicant may be required to adhere to new rules, orders, or guidance if 10 CFR 50.109(a)(3) applies.

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[2] In this section, "voluntary" and "voluntarily" means that the licensee is seeking the action of its own accord, without the force of a legally binding requirement or an NRC representation of further licensing or enforcement action.

**Conclusion**

This regulatory guide is not being imposed upon current licensees and may be voluntarily used by existing licensees. In addition, this regulatory guide is issued in conformance with all applicable internal NRC policies and procedures governing backfitting. Accordingly, the NRC staff issuance of this regulatory guide is not considered backfitting, as defined in 10 CFR 50.109(a)(1), nor is it deemed to be in conflict with any of the issue finality provisions in 10 CFR Part 52.

If a licensee believes that the NRC is either using this regulatory guide or requesting or requiring the licensee to implement the methods or processes in this regulatory guide in a manner inconsistent with the discussion in this Implementation section, then the licensee may file a backfit appeal with the NRC in accordance with the guidance in NUREG-1409 and NRC Management Directive 8.4.

# GLOSSARY OF ACRONYMS

ANSI — American National Standards Institute

CFR—Code of Federal Regulations

ICAS—Instrument and Control Air Systems

ISA—International Society of Automation

NRC—Nuclear Regulatory Commission

OMB—Office of Management and Budget

RG—Regulatory Guide

SSCs—Structures, Systems and Components

# REFERENCES[3]


1. 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," U.S. Nuclear Regulatory Commission, Washington, D.C.

2. 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants," U.S. Nuclear Regulatory Commission, Washington, D.C.

3. International Atomic Energy Agency (IAEA) Safety Standard No. NS-G-1.3, "Instrumentation and Control Systems Important to Safety in Nuclear Power Plants," issued March 2002, International Atomic Energy Agency, Vienna, Austria, 2004.[4]

4. Regulatory Guide 1.68, "Initial Test Programs for Water-Cooled Nuclear Power Plants," Revision 3, U.S. Nuclear Regulatory Commission, Washington, D.C.

5. NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition," Chapter 9.3.1, "Compressed Air System," Revision 2, March 2007, U.S. Nuclear Regulatory Commission, Washington, D.C.

6. ANSI/ISA S7.3-R1981, "Quality Standards for Instrument Air," American National Standards Institute, International Society of Automation, Washington, D.C.[5]


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[3] Publicly available NRC published documents are available electronically through the NRC Library on the NRC's public Web site at http://www.nrc.gov/reading-rm/doc-collections/. The documents can also be viewed online or printed for a fee in the NRC's Public Document Room (PDR) at 11555 Rockville Pike, Rockville, MD; the mailing address is USNRC PDR, Washington, DC 20555; telephone (301) 415-4737 or (800) 397-4209; fax (301) 415-3548; and e-mail pdr.resource@nrc.gov.

[4] Copies of International Atomic Energy Agency (IAEA) documents may be obtained through their Web site: WWW.IAEA.Org/ or by writing the International Atomic Energy Agency P.O. Box 100 Wagramer Strasse 5, A-1400 Vienna, Austria. Telephone (+431) 2600-0, Fax (+431) 2600-7, or E-Mail at Official.Mail@IAEA.Org

[5] Copies of American National Standards Institute (ANSI) standards may be purchased from ANSI, 1819 L Street, NW., Washington, DC 20036, on their Web site at http://webstore.ansi.org/; telephone (202) 293-8020; fax (202) 293-9287; or e-mail storemanager@ansi.org.

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