Please indicate your evaluation of PN1:007 (Revision B — November 1995). Attach extra sheets if needed.

1. How and when do you use this manual?
   - Read entire manual before attempting task
   - Read selected sections before attempting task
   - Read while attempting task
   - Attempt task first
   - Read as last resort

2. How well is the manual’s content organized? Please explain.
   - Excellent — parallels product’s operation, very usable
   - Good — representative of the product’s operation, usable
   - Average — usable but can be improved
   - Fair — not very usable, should be improved
   - Poor — not usable, must be improved
   - No Opinion

3. Is the manual’s content understandable and applicable to the product’s operation? Please explain.
   - Excellent — very easy to understand, very applicable
   - Good — easy to understand, applicable
   - Average — applicable but some sections not easy to understand
   - Fair — not very understandable/applicable, should be improved
   - Poor — not understandable/applicable, must be improved
   - No Opinion

   - Excellent — very easy to understand, extremely usable
   - Good — easy to understand, very usable
   - Average — fairly easy to understand, usable
   - Fair — not easy to understand, should be improved, not very usable
   - Poor — cannot understand, must be improved, totally unusable
   - No Opinion
5. Describe the amount of usable information in this manual including tables. Please explain.

- Too much information — not all required to perform task
- Proper amount provided — not too much nor too little
- Too little information — needed additional information to perform task
- No Opinion

6. How well is information cross-referenced in the manual’s individual sections and index? Please explain.

- Excellent — very easy to locate information, extremely usable
- Good — easy to locate information, very usable
- Average — fairly easy to locate information, usable
- Fair — not easy to locate information, should be improved, not very usable
- Poor — cannot locate information, must be improved, totally unusable
- Did Not Use
- No Opinion

7. How useful is the Glossary?

- Useful
- Useful but not complete/accurate
- Not Useful
- Did Not Use
- No Opinion

8. What is your overall impression of this manual? Please explain.

- Excellent — met all needs, extremely usable
- Good — met most of my needs, very usable
- Average — usable
- Fair — should be revised, not very usable
- Poor — must be revised, totally unusable
- No Opinion
Documentation Map

Lightning Protection Guidelines for Instrumentation Systems

This map shows manuals used to plan the installation of a PROVOX® Process Management System. The number, title, and binder location are shown for each document, identifying where specific information is located. See the descriptions on the back of this map for more information.
PROVOX documentation supports each stage of system development.

<table>
<thead>
<tr>
<th>System Development Stages</th>
<th>Document Type &amp; Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>System Design</td>
<td><strong>Configuration Engineering Manuals</strong></td>
</tr>
<tr>
<td></td>
<td>Configuration data-entry help for a product, including theory of operation for improved product use.</td>
</tr>
<tr>
<td></td>
<td><strong>Installation and User Manuals for Configuration Products</strong></td>
</tr>
<tr>
<td></td>
<td>Installation procedures, and operating methods and procedures for using the configuration software.</td>
</tr>
<tr>
<td></td>
<td><strong>Technical Reference Manuals</strong></td>
</tr>
<tr>
<td></td>
<td>Advanced user information for expanding the capability of the PROVOX system.</td>
</tr>
<tr>
<td></td>
<td><strong>System Manager’s Guide</strong></td>
</tr>
<tr>
<td></td>
<td>Expert users information for managing operating systems.</td>
</tr>
<tr>
<td>System Planning and Installation</td>
<td><strong>Installation Manuals</strong></td>
</tr>
<tr>
<td></td>
<td>Site preparation, including the environment, power, and grounding. Also, product signal wiring, cable connections, and hardware installation.</td>
</tr>
<tr>
<td>System Startup and Operation</td>
<td><strong>User Manuals</strong></td>
</tr>
<tr>
<td></td>
<td>Operating methods and procedures for a product, and software installation.</td>
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<tr>
<td></td>
<td><strong>Tutorials</strong></td>
</tr>
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<td>Structured training for operators.</td>
</tr>
<tr>
<td>Maintenance</td>
<td><strong>Maintenance Manuals</strong></td>
</tr>
<tr>
<td></td>
<td>Preventative maintenance, calibration, troubleshooting, and repair procedures.</td>
</tr>
</tbody>
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**Ordering Information** — To order additional manuals, contact your local sales representative, specifying the number, title, and quantity of each document required.
Lightning Protection Guidelines for Instrumentation Systems

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1 Introduction

This installation planning manual provides guidelines for protecting PROVOX® Process Management Systems from lightning damage. A direct strike can disrupt critical processes, start fires, damage buildings and equipment, and injure personnel. Near strikes, too, can disrupt critical processes and damage electronic circuitry, by inducing voltage in unprotected wiring. Therefore, adequate lightning protection is essential in a modern processing plant.

1.1 Intended Audience

Installation planning manuals are intended for use by plant engineering personnel, especially those charged with planning a control system installation.

1.2 CE Statement

If you intend to have your PROVOX system certified for compliance to appropriate European Union directives, the following CE statement is extremely important to your ability to achieve that compliance.

This manual describes installation and maintenance procedures for products which have been tested to be in compliance with appropriate CE directives. To maintain compliance, these products must be installed and maintained according to the procedures described in this manual. Failure to follow the procedures may compromise compliance.
1.3 Manual Conventions

This manual uses the following conventions:

- **Acronyms and Abbreviations** — Terms are spelled out the first time they appear in text. Thereafter, only the acronym or abbreviation is used.

- **Revision Control** — The title page lists the revision level and the printing date of this manual. When the manual is revised, the revision level and the printing date are changed.

- **References** — References to other Fisher-Rosemount Systems manuals include the name and catalog number for manuals.

1.4 Notes

Notes attract attention to essential information in this manual. The type of information included in a note is:

![Note]

Notes have this form and symbol. Notes contain installation, operation, or maintenance procedures, practices, conditions, statements, and so forth, that alert you to important information which may make your task easier or increase your understanding.

1.5 Related Documents

The planning manuals listed below provide further information for system installation planning:

- **PN1:002, Planning the Installation**
- **PN1:003, AC and DC Power and Ground Wiring**
- **PN1:004, Signal Wiring and Highway System Guidelines**
- **PN1:005, Preventing Electrostatic Damage**
- **PN1:006 Environmental Conditions for Instrumentation Systems**
- **PN1:008, Site Evaluation**
1.6 Reference Documents

The documents listed below provide further information for understanding lightning protection systems:


1.7 Excellence in Documentation

Our goal is to provide documents that meet your needs. Through surveys and interviews, we continually evaluate our documents as part of the broad Fisher-Rosemount Systems customer-support program. Various manuals are produced for different purposes and for readers with varying backgrounds and experience.

Please assist us in the evaluation of this manual by completing the reader evaluation form located at the front of the document. In addition, if you have any suggestions for specific pages, return a marked-up copy along with your survey.

2 Lightning Risk Determination

Two factors determine the level of protection required:

- Geographic location

- Process criticality

Lightning strikes occur more often in some areas than in others. Elevation, humidity, latitude, and normal weather patterns influence the frequency of lightning strikes in a particular geographic area. Therefore, the typical lightning storm patterns at your site will influence the extent of protection needed.

The other factor in determining appropriate lightning protection is process criticality. The more critical a process, the more important lightning protection is, even though the system may be in an area of low lightning occurrence. If any strike or near strike, no matter how unlikely, can cause loss of control of a critical process, severe financial loss, major equipment damage, or danger to personnel, a complete lightning protection system is appropriate.
3 Lightning Protection Systems

Lightning protection systems provide safe conduction paths to earth ground to minimize equipment damage and personal injury. A complete lightning protection system includes:

- Lightning rods
- Conductor system
- Grounding system
- Lightning arrestors and surge protectors

Lightning rods (also referred to as air terminals) intercept lightning discharges above a building or facility. The conductor system is a safe discharge path from the lightning rods to the grounding system. The grounding system lets the lightning discharge or dissipate safely. Lightning arrestors and surge protectors protect power lines, data highway cables, instrumentation wiring, and other such equipment from induced voltages. Together, these elements minimize lightning discharge damage.

Although a lightning protection system intercepts, conducts and dissipates the main electrical discharge, it does not prevent possible secondary effects, such as spark-over in nearby large metal structures.

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**Note**

To minimize secondary effects of lightning strikes, make sure that all adjacent metal structures interconnect with and tie to the main conductor system. This construction maintains the same electrical potential throughout all structures in the vicinity.

---

3.1 Lightning Rods

Lightning rods intercept a discharge above a structure, and direct the discharge to a safe path. In particular, lightning rods minimize the possibility of fire. Lightning rods should be on structures, and parts of structures, most likely to be struck. Therefore, chimneys, ventilators, towers, and other such higher parts of buildings should have lightning rods. The parts of flat-roofed building most likely to be struck are the roof edges. A large plant site area needs a complete system of properly located lightning rods.
3.2 Conductor System

Once intercepted, a lightning discharge follows a low-impedance path to the earth (path of least resistance). Normally, the least resistant path is metal. A conductor system consists of one or more such metal paths. Each path must be continuous from the lightning rod to the ground. Paths must not have any sharp bends or loops. This ensures that the system provides the most direct path to earth for lightning discharge.

As illustrated in Figure 1, no bend should form an angle of less than 90 degrees, and no bend should have a radius less than 10X the diameter of the RG-6U cable used for the path (approximately 3 inches (76.2 mm). A non-ferrous metal such as copper or aluminum is the preferred material for the path, as it is not susceptible to the rust or corrosion of a ferrous metal.

![Figure 1 Minimum Conductor Bend Radius Requirements](image)

The impedance of a conductor system is inversely proportional to the number of separate discharge paths. Therefore, increasing the number of paths decreases the impedance. In a multi-path conductor system, the paths (wires) should form a cage around the structure. The steel framework of a structure can substitute for separate conductors, but smooth connection straps must span any sharp bends or other hindrance. Figure 2 shows a typical protection system with a conductor, grounded steel framework, and connection straps.
In metal structures, the conductor system can use the framing instead of separate conductor cables. In such cases, lightning rods should be electrically bonded to the top part of the framework, and ground terminals should be bonded to the bottom. Structures with electrically continuous metal exteriors may not require separate lightning rod and conductor systems, if the metal is at least 0.188 inch (4.76 mm) thick. The metal exterior itself can intercept lightning and conduct it to the ground.

### 3.3 Grounding System

Proper grounds are essential for effective lightning protection. Installation manual, *AC and DC Power and Ground Wiring*, PN1:003, includes a complete description of recommended plant grounding systems. Each ground connection, and each branch of each ground connection, should extend below, and at least 2 feet (0.61 m) away from, a building’s foundation walls. This construction minimizes wall damage.
3.4 Lightning Arrestors and Surge Protectors

Note

Lightning arrestors assist in the isolation of coaxial type highways, but strikes can still jump those systems. For the fullest protection, fiber optic links are recommended.

Lightning arrestors and surge protectors minimize current induced in the wiring of an instrumentation system. Induction can occur in two ways:

- A lightning discharge passing through the conductor system generates a transient magnetic field, which induces current in nearby wiring.

- As the grounding system dissipates a discharge in the earth, a step difference in potential develops in the earth itself. This difference induces current in underground instrumentation wiring.

Protection devices use three main types of circuits:

- Varistors

- Semiconductors (avalanche diodes)

- Gas discharge tubes

Varistors and semiconductors provide protection from lower current levels. Gas discharge tubes protect the system from high current and voltages levels. Most protection devices have a combination of these circuits.
4 Implementing Lightning Protection

When planning a protection system, carefully consider environmental conditions and plant requirements. To implement the system, follow these suggestions:

- Ground the building and plant site to a single ground system. If there is a remote or separated building at the plant site, isolate the signals, power, and communications systems of the remote building. Installation manual, *AC and DC Power and Ground Wiring*, PN1:003, contains additional plant grounding guidelines.

- Use overhead cables when possible. The air around overhead cables acts as an insulator, so such cables are less susceptible to lightning induced voltage than are underground cables. Also, since overhead cables are not buried, they are less susceptible to step-potential induction in the earth than are underground cables. Ground both types of cables, including their conduits, pipe racking and cable trays.

- Install surge protectors on all cables running outside of buildings by:
  - Installing a protection device for power wiring at either the substation entrance (preferred), or at each piece of powered equipment.
  - Installing a protection device on each phone line coming into the building.
  - Installing a protection device on instrumentation wiring, if the structures are not all grounded to a plant-wide system. Or, the equipment is not designed to handle an induced voltage surge.

- For instrumentation system communication cables, install a surge protector in each building at the cable entry site. System communication cables are coaxial cables for data highways and control I/O busses.

---

**Note**

Install protected cables in grounded conduit or cable trays.

---

- When building a lightning protection system, use mechanically strong materials with physical properties which resist rust and corrosion.
For protecting data highways and control I/O busses, Type DH7091 Transient Protection Assemblies are available. Figure 3 through Figure 7 show the different methods and types of application for PROVOX cabinet grounding combinations. Refer to installation manual, AC and DC Power and Ground Wiring, PN1:003, for additional information on cabinet grounding.

The transient protection assemblies are grounded to the source of the signals that are being protected. For data highways, the ground is located within the cabinet area where the communications interface assemblies (CIA's and CIA II's) are located. For control I/O busses, the assemblies are grounded in the same area as the system cabinet ground. The ground can be at the cabinet level or remote I/O location, and connected to the cabinet ground system at any point from the cabinet back to the PROVOX Instrumentation Ground (PIG).

5 Inspection and Maintenance of Lightning Protection Systems

Building additions or structural repairs done without consideration for a lightning protection system can reduce the system’s effectiveness. Deterioration of or mechanical damage to the system itself may reduce its effectiveness in similar ways.

To prevent a loss of protection, evaluate all proposed structural changes for effects on the protection system, and ensure that no structural repairs inhibit system protection. Inspect the structure periodically, at least annually, for deterioration and mechanical damage. Thoroughly inspect and test the lightning protection system every five years.
Figure 3 Type DH7091 Transient Protection Assembly and User Supplied Mounting Plate
Notes:

1. Conductor used to connect the grounding electrode to the NEUTRAL Ground bond at the source of a separately derived instrumentation power system. (PER NEC 250.6)(CSA 22.1 Section 10)

2. Supplemental conductor used to connect the grounding electrode for the source of a separately derived instrumentation Power System, directly to the Plant Ground Grid System. This conductor is used to provide low impedance ground reference for EMI/RFI high frequency noise. (Per NEC 250.81/250.83) (CSA 22.1 Section 10)

3. Conductor used to provide a low impedance ground reference for the DC Power System (Logic, Transmitter, Output) and/or a Cabinet Ground for EMI/RFI high frequency noise protection of the instrumentation cabinets, file and wiring shields.

Figure 4  Cabinet Grounding and PROVOX Highway Protection in a Multi-Cabinet Grouping
Figure 5  Signal and Power Grounding, and PROVOX Highway Protection, in a Multi-Cabinet Grouping

Figure 6  Single Cabinet (DC Cabinet Grounding System)
A local ground bus (LGB) is required for each cabinet grouping of 8 or less.

A cabinet ground is required for each grouping of 8 or more.

**Notes:**

**GROUND WIRE SIZING CHART**

<table>
<thead>
<tr>
<th>Distance</th>
<th>Wire Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 25 feet</td>
<td>1/0 AWG</td>
</tr>
<tr>
<td>Up to 50 feet</td>
<td>2/0 AWG</td>
</tr>
<tr>
<td>Up to 200 feet</td>
<td>4/0 AWG</td>
</tr>
</tbody>
</table>

PRESTOFLEX Welding Cable is recommended.

**Figure 7**  Multiple Cabinet System Grounding and Transient Protection Assembly Placement
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