

IEEE Recommended Practice to Improve Electrical Maintenance and Safety in the Cement Industry

Sponsor
**Cement Industry Committee
of the
IEEE Industry Applications Society**

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Abstract: Assists in the effective application of relays and other devices for the protection of shunt capacitors used in substations. It covers the protective considerations, along with recommended and alternate methods of protection for the most commonly used capacitor bank configurations. Capacitor bank design trade-offs are also discussed. This guide covers protection of filter tanks and very large EHV capacitor banks, but does not include a discussion of pole-mounted capacitor banks on distribution circuits or application of capacitors connected to rotating apparatus.

Keywords: Bank connections, bus voltage, capacitor units, delta-connected banks, equipment considerations, protection of banks, Y-banks, relaying methods.

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Foreword

(This Foreword is not a part of IEEE Std 625-1990, Recommended Practices to Improve Electrical Maintenance and Safety in the Cement Industry.)

The continuing efforts to improve safety and working conditions in the cement industry have made safety increasingly important to the management of every cement plant. Proliferating federal, state, and local laws have placed even greater stress on the need for a good maintenance and safety program. The Cement Industry Committee has analyzed many areas to which safety requirements pertain, and through the working groups, recommended practices have evolved for the industry.

Several years ago, the Safety Committee Working Group published its safety recommendations for the cement industry. At that time, no attempt was made to cover recommended maintenance practices in cement plants; the present document, however, combines both maintenance and safety practices. This approach was agreed on by the Maintenance and Safety Working Group and is based on the belief that sound maintenance practices go, of necessity, hand-in-hand with safety. As in the previous documents, IEEE Std 625-1979, the recommendations contained in this document are advisory and should be considered in that light. These recommendations have been agreed on by the Maintenance and Safety Working Group, but they will certainly be altered in the future to suit specific plant conditions. In general, however, it is hoped that these practices will provide sound, basic guidelines for the industry at the present time.

For these recommendations to be of maximum use to the cement industry, the users' comments are required. Comments should be concerned with areas not covered in this document, as well as with those requiring greater coverage in subsequent reports.

The working group wishes to acknowledge the guidance obtained from ANSI/NFPA No. 70-1990; National Electrical Code; Westinghouse Electric Corporations' "Maintenance Hints", and IEEE Cement Industry Standards, IEEE Std 277-1983, Recommended Practices for Cement Plant Power Distribution, and IEEE Std 499-1989, Recommended Practice for Cement Plant Electric Drives and Related Electrical Equipment.

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The final conditions for approval of this recommended practice were met on December 12, 1990. This recommended practice was conditionally approved by the IEEE Standards Board on December 6, 1990 and it had the following membership:

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IEEE Recommended Practices to Improve Electrical Maintenance and Safety in the Cement Industry

1. General

1.1 Purpose

The purpose of this recommended practice is to define and recommend practices for improving electrical maintenance and safety in the cement industry in order to promote the following:

- 1) Safety to personnel and equipment
- 2) Maximum equipment reliability with minimum loss of production
- 3) Reduced unscheduled maintenance and increased equipment life
- 4) Clarification of needs and conditions to reduce special engineering and chance of error in specification
- 5) Overall economy

1.2 Scope

These recommendations apply to all electrical equipment such as substations, power transformers, motor controls, generators, distribution systems, instruments, and storage batteries commonly used in cement plants. They are intended to be used as a guide and may be supplemented where special needs exist.

1.3 Objectives

It is urged that users and manufacturers cooperate with the working group to help formulate final recommendations that will ensure the use of proven equipment and methods. The ultimate objective is to establish recommendations that will assist in improving electrical maintenance and safety.

1.4 References

This document should be used in conjunction with the following publications:

[1] ANSI/NFPA No. 70-1990, National Electrical Code.¹

[2] MSHA 30 CFR parts 56 and 57, July 1, 1990.²

[3] NFPA 70B 1990, Electrical Equipment Maintenance³

2. Plant Equipment Numbers

In order to facilitate the maintenance procedures, spare-parts inventory, and the filing system of the manufacturer's information, it is important that each machine and piece of equipment be assigned an identification number. There are many numbering systems that can be used. Consider, for example, a computer-compatible system to aid inventory and cost control. A simple system is suggested here. The equipment numbers consist of a department letter or number as a prefix and a three-digit number assigned according to the material flow. The motors and controllers for the same item usually carry the same basic number. The auxiliary equipment for the item, an oil pump, for example, can carry a suffix such as point one (.1), or can have a separate identification number. For example:

K-325 or 25-325	Kiln No. 3 Coal Mill (suitable for computer entry)
K-325.1 or 25-325.1	Kiln No. 3 Coal Mill Feeder (suitable for computer entry)

The numbers for the auxiliary devices (for example, limit switches or pressure switches) could be the equipment numbers with a suffix such as LS or PS. For example:

K-326 LSO or Bucket gate open limit switch 25-325 LSO

¹ANSI/NFPA publications are available from the Sales Department, American National Standards Institute, 11 West 42nd St., 13th Floor, New York NY 10036 USA, or the National Fire Protection Association, 1 Batterymarch Park, PO Box 9101, Quincy, MA, 02269-9101 USA.

²MSHA documents are available from the Superintendent of Documents, US Government Printing Office, Washington, DC 20402, USA.

³NFPA publications are available from the National Fire Protection Association, 1 Batterymarch Park, PO Box 9101, Quincy, MA, 02269-9101 USA.

Table 1—Sample Spare-Parts List

Spare-Parts List			
Part in use	Description	Quantity Recommended	
		Max	Min
64	Scam panalarm division model 50-A1 plug-in relay, 120 V, 60 Hz	4	2
6	Scam panalarm division model 50-F1 flasher, 120 V, 60 Hz	2	2

Electrical equipment servicing more than one item in the same department (for example, control centers, secondary-unit substations, or operator's panels) can be identified with an abbreviated description and the department letter. For example:

CC "KIA"	Kiln No. 1 "A" Control Center
LC "K1"	Kiln No. 1 Load Center
OP "KI"	Kiln No. 1 Operator's Panel

Electrical equipment that is common to all departments (for example, power transformers or main switchgear) can be identified with abbreviated descriptions such as 10 MVA transformer or main 5 kV switchgear.

3. Equipment Manufacturer's Data

It is necessary to acquire from each manufacturer a complete data file of the specific equipment used in the plant. This will include a list of recommended spare parts, a set of drawings, operating instructions, part numbers for reordering replacement parts, trouble-shooting instructions, and suggested maintenance procedures. Practically all equipment manufacturers have this information available. This information is a definite prerequisite for a maintenance program. The manufacturer's data should include the following:

- 1) Drawings
 - a) Schematic and wiring diagrams
 - b) Operating description
 - c) Outline and installation drawings
 - d) Bill of material
- 2) Instructions
 - a) Handling and storage instructions
 - b) Installation instructions
 - c) Operating instructions
 - d) Trouble-shooting instructions
 - e) Maintenance procedures
- 3) Spare Parts
 - a) Part numbers
 - b) Recommended spare parts
 - c) Ordering information

This file will be set up for all electrical equipment, with every piece of information marked with the equipment identification numbers. This rule, in regard to setting up maintenance programs, should be followed even more strictly if the equipment is old or not in good condition.

The equipment manufacturer's data files should be indexed, both according to the identification numbers and general category for easy access. It is also recommended that the original documents be kept in the file room and that copies be made for outside use, as required.

4. Spare-Parts Inventory

Spare parts are an important part of any maintenance department. Good maintenance records will help to determine what and how many parts are needed.

An accurate spare-parts inventory should be kept and made available for maintenance repairmen at all times. The spare-parts quantities should be maintained, with minimum quantities set depending on the availability of each item.

A sample of a good spare-parts list is shown in Table 1.

Storage of spare parts with solid-state items should be per manufacturer recommendation as they may require a special environment.

Warehoused items should be periodically inspected for condensation in large equipment. Large motors should be periodically rotated to avoid buckling of rotor shaft, etc.

5. Maintenance Department

5.1 Maintenance Department Objectives

The basic objective of any maintenance department is to avoid unexpected production outages due to equipment breakdowns. The usual cause of breakdowns is neglect or prolonged periods of operation without preventive maintenance. The department interest should be focused on good preventive maintenance and the need for maximum utilization of time during normal shutdown.

5.1.1 Maintenance Department Prime Responsibilities

- 1) Maintain equipment in satisfactory condition for safe operation.
- 2) Maintain equipment at peak operating efficiency at all times to avoid breakdowns.
- 3) Reduce to a minimum the downtime associated with breakdowns.
- 4) Control cost of maintenance.
- 5) Maintain safety and efficiency in performance of work.
- 6) Formulate and establish maintenance schedules based on equipment performance repair records.
- 7) Recommend and control spare-parts inventory requirements.
- 8) Be a consultant to plant management when new equipment is being considered.
- 9) Meet regularly with management and other departments to review long-range maintenance requirements.
- 10) Provide training to developed, qualified maintenance electricians.
- 11) Provide state-of-the-art training for qualified maintenance electricians.
- 12) Maintain a log of normal operating parameters and repair records for future reference.
- 13) For repeated failures or unanticipated frequent maintenance, examine the installation for equipment misapplication.

Careful planning and scheduling of manpower is an essential part of any maintenance department. Preventive maintenance requires many man hours with a minimum amount of downtime.

Reliability is built into equipment, but requires maintenance to keep it there. Occasional proof testing is a necessary function.

5.1.2 Maintenance Electrician's Basic Qualifications

- 1) Should be physically and mentally fit to perform the job to which the maintenance electrician is assigned.
- 2) Should obey all safety rules.
- 3) Should be able to read wiring diagrams and prints on electrical equipment.
- 4) Should have a good knowledge of the location of electrical equipment.
- 5) Should be able to install equipment and diagnose trouble on lighting, motors, motor controls, and power circuits.
- 6) Should be able to locate and repair electrical equipment and repair or replace as the situation merits.
- 7) Should have a good knowledge of tools used for electrical work. Should have proficiency in programmable controller trouble-shooting.
- 8) Should be able to follow schedules as prepared by the maintenance department.
- 9) Should cooperate with all employees, operators, and foremen at all times.
- 10) Should be able and willing to learn.
- 11) Should have thorough working knowledge of the current National Electrical Codes, MSHA Standards, and of local electrical codes where applicable.

5.2 Maintenance Schedules

The most important part of any maintenance schedule is to display at all times what equipment is due for servicing. The maintenance schedule should be posted in front of all maintenance and production personnel at all times. In order to prepare a preventive maintenance schedule, a complete list of equipment, by departments, should be made available.

Then, each unit of equipment should be analyzed to identify its characteristics of wear and its inherent weakness. It is very important that the maintenance schedules be prepared by the maintenance department and management, to take advantage of all scheduled shutdowns. The servicing intervals may not necessarily agree with the manufacturer's recommendation. These intervals depend on the operating conditions and environment.

All electrical equipment should be serviced including cables, motors, starters, SCR assemblies, transformers, etc. In order to accomplish this, the entire plant should be on the maintenance schedule and these schedules should be updated weekly and monthly. Maintenance schedules should be closely followed.

5.3 Maintenance Work Orders

The work order should give the date, priority, name of originator, cost, equipment to be worked on, and details of work to be done. This work order is then given to the maintenance planner and scheduler, and he gives it to the maintenance foreman. The maintenance foreman should review the work orders daily, determine whether a shutdown is necessary, and if a shutdown is needed, arrange with production. He should also check the spare parts required and their availability.

The work orders are then filed as:

- 1) Ready to go
- 2) Awaiting shutdown
- 3) Awaiting parts

A sample work order is shown in Fig 1.

Date	Priority	Originator	Charge	Foreman	Work Performed by	Date Completed (Checked and Authorized OK)
Equipment to be worked on				Job Estimate (Signature of Foreman)		
Work to be done (give details)				Work Performed - Major Materials		
Maintenance						

Figure 1—Sample Work Order

5.4 Maintenance Inspection and Repair Records

Good inspection and repair records are essential to any maintenance program. These records should indicate the nameplate data, purchase order data and number, and complete life history. The maintenance inspection and repair records should be in duplicate; each set of copies should be filed in separate parts of the plant to ensure that there is always one set available, in case the other is lost or damaged. A sample maintenance inspection and repair record is shown in Fig 2.