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IEEE Std 625-1990)

**IEEE Standards**

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

**IEEE Industry Applications Society**

Sponsored by the  
Cement Industry Committee



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

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

Approved 14 May 2001

**IEEE-SA Standards Board**

**Abstract:** These recommended practices are intended as a reference document for use by members of cement industry electrical maintenance departments. The procedures necessary for an efficient maintenance operation are summarized, and detailed information on maintenance procedures for many of the electrical devices more commonly found in the cement industry is provided.

**Keywords:** cement, control devices, electrostatic precipitator, equipment records, generators, grounding, instruments, lighting, maintenance, medium-voltage controllers, medium-voltage switchgear, motor control centers, motors, oil circuit breakers, power transformers, SCR controllers, secondary-unit substations, solid-state systems, spare parts, storage batteries

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## Introduction

(This introduction is not a part of IEEE Std 625-2001, IEEE Recommended Practices to Improve Electrical Maintenance and Safety in the Cement Industry.)

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 recommended practices, however, combine both maintenance and safety practices. This approach was agreed on by the Environmental, 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 recommended practices, IEEE Std 625-1979 and IEEE Std 625-1990, the recommendations contained here are advisory and should be considered in that light. The Environmental, Maintenance and Safety Working Group have agreed on these recommendations, but they recommend that they be revised in the future to suit specific plant conditions. In general, however, it is hoped that these practices can provide sound, basic guidelines for the industry at present.

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 these recommended practices, as well as with those requiring greater coverage in subsequent reports.

This document was revised by the Environmental, Maintenance and Safety Working Group of the Cement Industry Committee. The members of the working group were as follows:

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

## 1. Overview

### 1.1 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. This document is a companion document to IEEE Std 277-1994, IEEE Recommended Practice for Cement Plant Power Distribution [B1] and IEEE Std 499-1997, IEEE Recommended Practice for Cement Plant Electric Drives and Related Equipment [B3]<sup>1</sup>.

### 1.2 Purpose

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

- a) Safety to personnel and equipment
- b) Maximum equipment reliability with minimum loss of production
- c) Reduced unscheduled maintenance and increased equipment life
- d) Clarification of needs and conditions to reduce special engineering and chance of error in specification
- e) Overall economy

### 1.3 Objectives

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

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<sup>1</sup>The numbers in brackets correspond to those of the bibliography in Annex A.

## 2. References

These recommended practices shall be used in conjunction with the following publications. When the following specifications are superseded by an approved revision, the revision shall apply:

30 CFR Part 56: Safety and Health Standards—Surface Metal and Nonmetal Mines.<sup>2</sup>

NFPA No. 70-2002, National Electrical Code.<sup>3</sup>

NFPA 70B-1998, Electrical Equipment Maintenance.

NUREG 1556 Vol. 4-1998, Consolidated Guidance About Materials Licenses: Program-Specific Guidance About Fixed Gauge Licenses Nuclear Regulatory Commission (NRC).<sup>4</sup>

## 3. 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 a unique identification number. There are many numbering systems that can be used. A computer-compatible system is preferred to aid inventory and cost control. A simple system similar to many often used is described 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 and cost center. The motors and controllers for the same item usually carry the same basic number. The auxiliary equipment for the item, for example, an oil pump, can carry a suffix such as point one (.1), or can have a separate identification number. For example,

K-325 or      Kiln No. 3 Coal Mill  
25-325  
K-325.1 or    Kiln No. 3 Coal Mill Feeder  
25-325.1

The numbers for the auxiliary devices (e.g., 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

Electrical equipment servicing more than one item in the same department (e.g., 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

<sup>2</sup>CFR publications are available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402, USA (<http://www.access.gpo.gov>).

<sup>3</sup>NFPA publications are published by the National Fire Protection Association, Batterymarch Park, Quincy, MA 02269, USA (<http://www.nfpa.org/>).

<sup>4</sup>NUREG publications are available from the Superintendent of Documents, U.S. Government Printing Office, P.O. Box 37082, Washington, DC 20013-7082, USA (<http://www.access.gpo.gov/>).

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

#### 4. 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 should include a list of recommended spare parts, a set of drawings, operating instructions, part numbers for reordering replacement parts, troubleshooting instructions, and suggested maintenance procedures. Practically all equipment manufacturers have this information available. This information is a prerequisite for a maintenance program. Hard copy and CD-ROM files of the drawings and data are normally available, and can be provided in a software format suitable for plant use.

The manufacturer's data should include the following:

- a) Drawings
  - 1) Schematic and wiring diagrams
  - 2) Operating description
  - 3) Outline and installation drawings
  - 4) Bill of material
- b) Instructions
  - 1) Handling and storage instructions
  - 2) Installation instructions
  - 3) Operating instructions
  - 4) Troubleshooting instructions
  - 5) Maintenance procedures
  - 6) Technical support phone number
- c) Spare parts
  - 1) Part numbers
  - 2) Recommended spare parts
  - 3) Ordering information

This file should be set up for all electrical equipment, with every piece of information marked with the equipment identification numbers. This requirement is especially important 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.

#### 5. Spare-parts inventory

Spare parts are an important part of any maintenance department. Good maintenance records 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. Adequate quantities of spare parts should be maintained, with minimum quantities established depending on the availability of each item. A sample of a good spare-parts list is shown in Table 1.

**Table 1—Sample spare-parts list**

| Parts in use | Description                                                   | Quantity recommended |         |
|--------------|---------------------------------------------------------------|----------------------|---------|
|              |                                                               | Maximum              | Minimum |
| 64           | Scam panalarm division model 60-A1 plug-in relay, 120 V 60 Hz | 4                    | 2       |
| 6            | Scam panalarm division model 50-F1 flasher, 120 V, 60 Hz      | 2                    | 2       |

Spare parts with solid-state items should be stored according to the manufacturer's 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.

## 6. Maintenance department

### 6.1 General

#### 6.1.1 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 shutdowns.

#### 6.1.2 Maintenance department prime responsibilities

The prime responsibilities of any maintenance department are to

- Maintain equipment in satisfactory condition for safe continuous operation.
- Maintain equipment at peak operating efficiency at all times to avoid breakdowns.
- Reduce the downtime associated with breakdowns to a minimum.
- Control cost of maintenance.
- Perform work in a safe and efficient manner.
- Formulate and establish maintenance schedules based on equipment performance repair records and/or run time.
- Recommend and control spare-parts inventory requirements.
- Be a consultant to plant management when new equipment is being considered. Standardization of equipment, where possible, helps reduce spare-parts inventory requirements and simplifies maintenance work. After-sales support may be as important as technical specifications when selecting an equipment standard.
- Meet regularly with management and other departments to review long-range maintenance requirements.
- Continue to train and develop qualified maintenance electricians.
- Provide state-of-the-art training for qualified maintenance electricians.
- Maintain a computerized log of normal operating parameters and repair records for future reference.

- m) For repeated failures or unanticipated frequent maintenance, examine the equipment for installation misapplication. A failure analysis should be performed for any failure.
- n) Develop a close working relationship with equipment vendor/original equipment manufacturer (OEM). Establish a technical assistance contact. Identify reliable and reputable suppliers with good technical support. 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.

### 6.1.3 Maintenance electrician's basic qualifications

The basic qualifications for a maintenance electrician are that he or she

- a) Should be a certified electrician and physically and mentally fit to perform the job to which the maintenance electrician is assigned.
- b) Should obey all company safety rules.
- c) Should be able to read wiring diagrams and electrical equipment drawings.
- d) Should have a good knowledge of the location of electrical equipment and of tools used for electrical work.
- e) Should be able to install equipment and diagnose trouble on lighting, motors, motor controls, power circuits, and instrumentation.
- f) Should be able to locate and repair or replace electrical equipment as the situation merits.
- g) Should have hands-on experience troubleshooting programmable controllers, distributed control systems, drives, and digital and analog instrumentation.
- h) Should be able to follow schedules as prepared by the maintenance department, and perform the work in an efficient and workmanlike manner. It is also essential that he recognize the tasks in which he should seek assistance.
- i) Should cooperate with all employees, operators, and foremen at all times.
- j) Should be able and willing to learn.
- k) Should have a thorough working knowledge of the current National Electrical Codes, MSHA (Mine Safety and Health Administration) Standards, ANSI (American National Standards Institute), IEEE and NEMA (National Electrical Manufacturers Association) standards, and of local electrical codes where applicable.

## 6.2 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 prepared.

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 coordinated between 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, circuit breakers and starters, electronic control assemblies for adjustable speed drives, transformers, instruments, 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 to accomplish the maximum plant production.

### 6.3 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. The work order is then given to the maintenance planner and scheduler, which is then given to the maintenance foreman. The maintenance foreman should review the work orders daily, and determine whether a shutdown is necessary. If a shutdown is needed, he should arrange it with production. He should also check the spare parts required and their availability. The work orders are then filed as

- a) Ready to go
- b) Awaiting shutdown
- c) Awaiting parts

### 6.4 Maintenance inspection and repair records

Good inspection and repair records are essential to the success of 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 either in duplicate, with each set filed in separate locations of the plant, or computerized with a backup record on tape or CD-ROM. A sample maintenance inspection and repair record is shown in Figure 1.

| Inspection and Repair Record Card |             |                                |         |            |           |           |
|-----------------------------------|-------------|--------------------------------|---------|------------|-----------|-----------|
| Item No.                          | Make        | Purchase Order No.<br>Part No. |         |            | Location  |           |
| Horsepower                        | RPM         | Volts                          | Amperes | Type       | Frame No. | Class     |
| Phase                             | Form        | Temperature                    | Hertz   | Serial No. | Model No. | Enclosure |
| Brushes                           | Lubrication | Date Initial                   |         |            |           |           |
| Quantity                          |             |                                |         |            |           |           |
| Size                              |             |                                |         |            |           |           |
| Catalog No.                       |             |                                |         |            |           |           |
| Bearings                          |             |                                |         |            |           |           |
| Non-Shaft End                     |             |                                |         |            |           |           |
| Shaft End                         |             |                                |         |            |           |           |
|                                   |             |                                |         |            |           |           |
|                                   |             |                                |         |            |           |           |
|                                   |             |                                |         |            |           |           |
|                                   |             |                                |         |            |           |           |
|                                   |             |                                |         |            |           |           |

Figure 1—Sample maintenance inspection and repair record card

### 6.5 Repair and maintenance cost records

The repair and maintenance costs for each piece of electrical equipment should be kept at all times and maintained indefinitely. These records can facilitate the decision as to whether to replace or repair the

equipment after a number of years of service. These cost records also help when purchasing new equipment.

## **7. Equipment maintenance**

### **7.1 Oil circuit breakers**

#### **7.1.1 Maintenance**

Thorough maintenance of circuit breakers is very important and necessary to obtain the best service and performance.

#### **7.1.2 Reports**

Thorough reports with data on circuit breakers help the maintenance person determine when to plan a maintenance inspection.

#### **7.1.3 Filing**

A complete and accessible filing system should be maintained, accumulating all information pertinent to all types and sizes of circuit breakers. Also, instruction books, drawings, and spare-parts manuals supplied with the equipment should be kept on file and available for use. As the equipment ages, these books and drawings become more difficult to replace.

#### **7.1.4 Organization and planning**

The work to be done should be carefully planned, either by the supervisor or qualified assistants, and all potential hazards recognized and called to the work crew's attention.

#### **7.1.5 Safety precautions**

Safety devices should be examined before they are used to be sure they are in working condition. Nothing should be taken for granted.

#### **7.1.6 Maintenance inspection determination**

The following factors determine when a circuit breaker should be inspected:

- a) Interval of time, since the last inspection (1 year maximum).
- b) Number of switching and testing operations.
- c) Number of fault operations.
- d) Location and severity of faults.
- e) Cleanliness of the environment surrounding the breaker.
- f) Accumulated experience of the breaker characteristics and duty.