CAIS STANDARD MANUAL

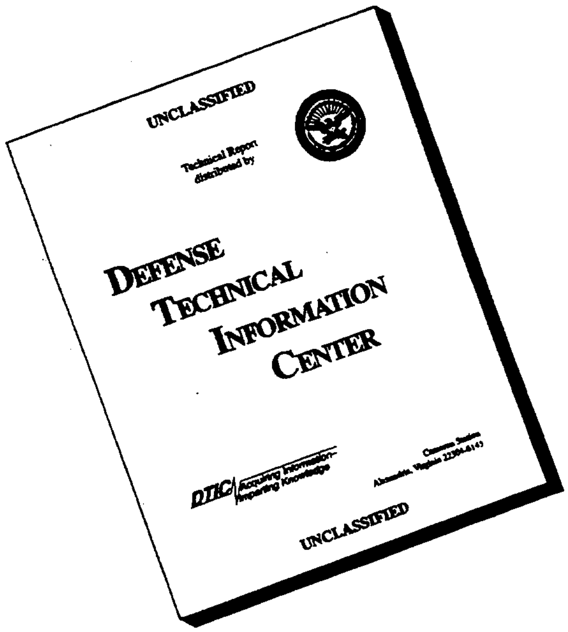
SYSTEM NO. 29
SITE ELECTRICAL

19960320 101

CAS PROJECT
CAIS MANUAL

Issued April 28, 1995

DISCLAIMER NOTICE



THIS DOCUMENT IS BEST QUALITY AVAILABLE. THE COPY FURNISHED TO DTIC CONTAINED A SIGNIFICANT NUMBER OF PAGES WHICH DO NOT REPRODUCE LEGIBLY.

8 Mar 96

MEMORANDUM FOR DTIC-OCP
ATTN: Ms. Lue Lynch
8725 John J. Kingman Road, Suite 0944
Fort Belvoir, VA 22060-6218

FROM: AL/EQ (STINFO)
139 Barnes Drive. Suite 2
Tyndall AFB FL 32403-5323

SUBJECT: Transmision of Technical Documents

1. As per telephone conversation with Andrew Poulis, EQ/TIC, the attached CAIS CTDS manuals are forwarded for accession, cataloging, and microconversions. Please forward the accession numbers to:

Andrew Poulis
AL/EQ/TIC
139 Barnes Drive. Suite 2
Tyndall AFB, FL 32403-5323

2. The Distribution statement should read as follows: Approved for Public Release: Distribution Unlimited.

3. If you have questions about these documents, please contact Andrew Poulis at DSN 523-6285.

Larry L. Testerman

LARRY L. TESTERMAN
Scientific and Technical
Information Program Manager

Atchs: Manuals

29 SITE ELECTRICAL

TABLE OF CONTENTS

29 SITE ELECTRICAL

PAGE

SUBSYSTEM 29.02 SUBSTATIONS

SUBSYSTEM 29.03 OVERHEAD MEDIUM VOLTAGE SYSTEM

SUBSYSTEM 29.04 UNDERGROUND MEDIUM VOLTAGE SYSTEM (601v TO 35kv)

29 SITE ELECTRICAL

PAGE

SUBSYSTEM 29.05 LOW VOLTAGE DISTRIBUTION SYSTEM 600v OR LESS

SUBSYSTEM 29.06 EXTERIOR LIGHTING SYSTEM

SUBSYSTEM 29.07 LIGHTNING PROTECTION/GROUNDING SYSTEM

29 SITE ELECTRICAL

PAGE

APPENDICES

29 SITE ELECTRICAL

ABSTRACT

GENERAL ORGANIZATION

At this installation the list of facilities to be surveyed, including infrastructure, will be addressed on the basis of 32 unique systems that form the CAIS Engineering Deficiency Standards and Inspection Methods document. Each system deals with a specific technical aspect of the facility to be surveyed. Within each system a further breakdown is made to subsystems, each having a related list of components. Detailed observations of the listed defects are provided so as to allow the entry of observed quantification data. A DOD CAIS manual is provided for each of the 32 systems with an internal organization as outlined below:

INSPECTOR'S GUIDE

I. General
   - A. Level I Inspection Method Description
   - B. Level II Inspection Method Description
   - C. Level III Inspection Method Description

II. General Inspection
   - A. Process. This section describes the process of the inspection activity.
   - B. Location. This section describes the procedure for locating the inspection units in the facility or infrastructure on this installation.

III. Inspector Qualifications
   This section notes the minimum qualifications for the person or persons performing the survey.

IV. Inspection Unit
   This section describes how the IU (Inspection Unit) is determined for the particular component being surveyed.

V. Unit Costs
   This section notes the nature of repair costs for this system.

VI. Standard Safety Requirements
   This section lists safety procedures and equipment required to implement a safe environment for the conduct of this survey.

VII. Standard Tools
   This section lists a set of standard tools required for the general conduct of this survey.

VIII. Special Tools and Equipment Requirements
   This section refers to special tools or equipment requirements endemic to the nature of the system being surveyed.

29 SITE ELECTRICAL

IX. Level II Inspection Method Keys
This section explains the use of keys as they relate to Level II Guide Sheets.

X. Level III Inspection Method Keys
This section explains the use of keys as they relate to Level III Guide Sheets.

XI. Replacement Cost
This section describes the nature and location of replacement cost data.

XII. Appendices
Appendix A. Provides a listing and definition of all abbreviations used both in the Standards and in the data base.

Appendix B. Provides a glossary of terms with their definitions as used in the Standard.

Appendix C. This section contains a listing of the average life cycle durations for each assembly* in the Standard.

* Assembly is a term describing the level at which replacement rather than repair occurs. This can be at the subsystem or component designation, depending on the system being surveyed.

SYSTEM TREE

The System Tree is a graphical representation of the Work Breakdown Structure, showing system, subsystem and component relationships for the Site Electrical System.

INSPECTION METHODS

Description
Describes the nature of what is to be condition surveyed.

Special Tool and Equipment Requirements
Lists any special tools required for this specific subsystem.

Special Safety Requirements
This section outlines any special safety measures or equipment required for this specific subsystem so as to maintain a safe environment and process in the conduct of the condition survey.

Component List
All components to be surveyed under this subsystem are listed here.

Related Subsystems
All other subsystems that have a survey relationship to this subsystem are listed here to help coordinate a complete and thorough condition assessment survey.

29 SITE ELECTRICAL

Standard Inspection Procedure

This statement indicates the various levels of survey effort required for this subsystem.

Components

The previously listed components of this subsystem are described with a survey procedure recommended on a component by component basis. For each component there is a listing of defects with each defect broken down into observations describing the nature and severity of the defective condition observed. The surveyor enters a quantification value for each defect/observation encountered in the field CAIS device (DCD) to record the result of his survey.

References

This page lists the reference sources from which the foregoing subsystem data was developed.

Guide Sheet Control Number

This section lists the key numbers that tie the written Level II and Level III guide sheets to specific components in this subsystem.

Level II and Level III Inspection Method Guide Sheets

This section contains the detailed descriptions of the Level II and III survey and inspection procedures for this subsystem.

29 SITE ELECTRICAL

INSPECTOR'S GUIDE

I. GENERAL

A. Level I Inspection Method

Level I Inspection Method for site electrical assets consist of a thorough inspection of electrical equipment. The following overhead and underground power distribution systems including lightning protection/grounding, site lighting and raceway systems located throughout the site and as described in the work breakdown structure. Site electrical standard inspection is essentially a walk-by inspection with observations and measurements. This standard inspection is essentially designed to be performed by one person and is to be made without changing the operational status of the electrical equipment. The inspector is not to operate the electrical equipment while performing a Level I Inspection Method, except in a case of an emergency.

B. Level II Inspection Method

Level II inspection is an extension of Level I inspection and performed concurrently with Level I inspection. The standard inspection is essentially designed to be performed by two persons due to the complexity of the survey and safety requirements. One will be a CAS certified electrical inspector and the other a local facility electrical maintenance man qualified for both low and medium voltage systems.

In some cases, the electrical equipment may not be operating or is partially or entirely enclosed. To perform a meaningful survey, the equipment is to be operated where possible and panels, where enclosed, and doors, are to be opened. Where possible the panels and doors will be opened without de-energizing the associated equipment. This standard inspection is essentially a walk-by inspection, with equipment operating and/or panels and doors opened, making meaningful observations and measurements possible.

The facility electrical maintenance man should coordinate with the facility manager as to what equipment can be operated during the time of the survey.

C. Level III Inspection Method

Defect/observation data from Level I and II inspections, of a given item, may indicate the requirement for a more in-depth inspection to analyze its condition. This type of inspection is to be performed by individual experts knowing the operation and problem areas of the item being inspected. Level III inspection guide sheets should indicate the type of specialized equipment, methods, and inspector required and the procedure this inspection is to follow.

29 SITE ELECTRICAL

II. GENERAL INSPECTION

A. Process

The work inspection is normally conducted at the component level. Figure 29.00-A provides the breakdown from system through component for the Site Electrical area.

The inspector will work through the Work Breakdown Structure (WBS) to conduct the inspection. At the component level the inspector will be provided a list of defects, each of which is described further as observations. These observations are described to various levels of severity as they relate to the effect on the life of the system. The quantification of each deficiency is identified by the inspector using the associated unit of measure. Once an observation is populated with a deficient quantity, the inspector will be requested to provide information on component type and location. The installation date or age of the component may be preloaded into the WBS for each asset from the Real Property Inventory List or site specific information. This can be overridden by the inspector, Site CAIS personnel, or Facility Manager.

B. Location

Level I and II inspections will be located by the inspector through a discrete entry into the Data Collection Device. The "IU" or component location will be derived from Facility-supplied segment numbering lists, maps or other I.D. numbering systems. For building associated "IU's" and components the Facility shall furnish plans annotated with room number schedules. In the case of non-room associated components, plans will be orientated with the top of each sheet being the north direction, so as to allow directional location and description. In the case where no maps, or plans are available the inspector shall enter a brief (65 character) description of location.

III. INSPECTOR QUALIFICATIONS

Minimum inspector qualifications, for the Site Electrical System, require a five year journeyman. Experience or familiarity in the areas of site electrical power system construction is desirable but not required. All of the survey requirements for this system can be accomplished by a single CAS surveyor, however safety and other considerations will require the inspector to work with local electrical maintenance personnel that are low and medium voltaged system qualified. CAS surveyors will be trained in the CAS system and its usage, and will be CAIS certified.

IV. INSPECTION UNIT (IU)

<u>Example:</u> *The IU is normally defined at the subsystem level. If the unit of measure at the subsystem level is each, then the IU is each. If the unit of measure is square feet or linear feet, the IU is determined by the identification of location (i.e., a deck level or quadrant).*

Occasionally the IU will occur at the component level. Where this occurs it will be noted in the component description.

IU's may include one occurrence of each component or multiple occurrence of a single component (e.g., multiple circuit breakers can occur in a substation, but only one

29 SITE ELECTRICAL

enclosure). Deficiency quantities are captured by the inspector for each occurrence within the discrete component (deficiency quantities are tied to each circuit breaker as a unique component, but the component Enclosure may have only one discrete unit since it is a continuous enclosure housing many circuit breakers).

For Example: The inspector locates 2 EA of hot bus connections in vertical cubicle No 1 of the enclosure. A quantity of "2" is recorded in the Field CAIS for the component enclosure located by the IU defined at the subsystem level as substation. As the inspection continues on the IU, the inspector finds another 1 EA hot bus connection in vertical cubicle No 2. This is recorded by editing the initial 2 EA to read 3 EA with a number of occurrence as two. The IU itself is the entire Enclosure, the discrete component is a single cubicle. As the inspector moves to a different component, such as transformer, multiple discrete components may exist. Deficiency quantities will be tied to each discrete component enclosure, which is in turn a component of the substation. So defects captured in the first cubicle will be linked together and distinguished from defects captured in the 2nd, 3rd, 4th ---cubicles.

For the above example, an occurrence is defined as a defect (or observation) which is detected within the inspector's line of vision. If the inspector has multiple defects (or observations) in an occurrence within the same discrete component, the inspector will quantify the observation that is considered most severe and identify the remaining quantity under the less severe observation for the discrete component.

For Example: 10 EA bus connections are running hot but of those, 7 EA are running 25°C or more above ambient temperature. The inspector will quantify 7 EA under "Bus connections 25°C or more above ambient" and 3 EA under "Bus connection 5° to 24°C above ambient.

V. UNIT COSTS

The unit cost that are applied to the quantities recorded for each observation are contained with in the Site CAIS as repair cost.

VI. STANDARD SAFETY REQUIREMENTS

The Master Safety Plan will be followed at all times during the inspection.

Inspector may utilize the following protective gear:
- Hard hat - to be worn in designated areas
- Safety glasses - to be worn in designated areas
- Safety shoes - to be worn during all inspections
- Ear plugs - to be worn in designated areas
- Knee pads - to be worn when crawling
- Gloves, electrically insulated - to be worn when working around live electrical components

29 SITE ELECTRICAL

VII. STANDARD TOOLS

Employee Identification Card - to be worn or carried during all inspections
Data Collection Device (DCD)
Battery pack for DCD
Flashlight
Tape measure - 25'
Tool bag
Screwdrivers with insulated handles -
  Phillips
  Straight slot
Insulated pliers

VIII. SPECIAL TOOLS AND EQUIPMENT REQUIREMENTS

At subsystem level, the deficiency standard has identified special tools and equipment required for the standard inspection of the associated components, which exceed the standard tools identified for the system. Level III Inspection Method Guide Sheets will address additional tools and equipment requirements that are specific to that particular method. Inspectors should review these sections in order to determine any special tool requirements for subsystems they are to inspect.

IX. LEVEL II INSPECTION METHOD KEYS

Certain observations will reference a Level II Inspection Method. The Facility Manager will be able to identify deficiencies where a Level II is flagged. The Level II Key at the observation level will refer to a specific Guide Sheet.

All Level II Guide Sheets are located at the end of each Subsystem section. A Guide Sheet Reference page precedes Level II and Level III Guide Sheets.

X. LEVEL III INSPECTION METHOD KEYS

Certain observations will reference a Level III Inspection Method. The Facility Manager will be able to identify deficiencies where a Level III is flagged. The Level III Key at the observation Level will refer to a specific guide sheet. These guide sheets may refer the Facility Manager to a more sophisticated and costly test method.

All Level III Guide Sheets are located at the end of each Subsystem section. A Guide Sheet Reference page precedes Level II and Level III Guide Sheets.

XI. REPLACEMENT COST

A replacement cost for each subsystem type will be contained within the cost estimating system in the Site CAIS.

29 SITE ELECTRICAL

XII. APPENDICES

Appendix A - Abbreviations

A summary and definition of abbreviations used in this system are contained in Appendix A which is located at the end of Site Electrical.

Appendix B - Glossary

A glossary of terms used in this system are contained in Appendix B which is located at the end of Site Electrical.

Appendix C - Life Cycles

A listing of the average life cycle durations for each assembly* in the Standard.

Note - Facility Manager's Guide

The following are included in the Facility Manager's Guide:

A table showing the required manhours to perform the standard inspection for this facility listed by Cat Code (three digit).

A listing of all Level III inspections with their estimated cost and time to perform. This list will include frequency of inspection for time driven Level III's.

* Assembly is a term describing the level at which replacement rather than repair occurs. This can be at the subsystem or component designation, depending on the system being surveyed.

29 SITE ELECTRICAL

Figure 29-A. WORK BREAKDOWN STRUCTURE

SYSTEM	SUB-SYSTEM	COMPONENT
29 SITE ELECTRICAL	29.01 Switchyards	29.01.01 Enclosures With Bus Bars
		29.01.02 Metering
		29.01.03 Surge (Lightning) Arresters
		29.01.04 Insulators
		29.01.05 Circuit Breakers (Medium Voltage)
		29.01.06 Disconnect Switches (Medium Voltage)
		29.01.07 Transformers
		29.01.08 Foundations
		29.01.09 Fencing
	29.02 Substations	29.02.01 Enclosures With Bus Bars
		29.02.02 Metering
		29.02.03 Surge (Lightning) Arresters
		29.02.04 Insulators
		29.02.05 Circuit Breakers (Medium Voltage)
		29.02.06 Circuit Breakers (Low Voltage)
		29.02.07 Disconnect Switches (Medium Voltage)
		29.02.08 Disconnect Switches (Low Voltage)
		29.02.09 Transformers
		29.02.10 Foundations
		29.02.11 Fencing
	29.03 Overhead Medium Voltage System	29.03.01 Disconnect Switches (Medium Voltage)
		29.03.02 Surge (Lightning) Arresters
		29.03.03 Insulators
		29.03.04 Transformers
		29.03.05 Power Regulators
		29.03.06 Steel Lattice Towers
		29.03.07 Poles
		29.03.08 Anchors and Guy Wires
		29.03.09 Foundations
	29.04 Underground Medium Voltage System (601 v to 35 kv)	29.04.01 Underground Electrical Utilities
		29.04.02 Handholes/Manholes
		29.04.03 Transformers
		29.04.04 Foundations

29 SITE ELECTRICAL

Figure 29-A. WORK BREAKDOWN STRUCTURE (Continued)

SYSTEM	SUB-SYSTEM	COMPONENT
29 SITE ELECTRICAL (Continued)	29.05 Low Voltage Distribution System 600v or Less	29.05.01 Circuit Breakers (Low Voltage)
		29.05.02 Disconnect Switches (Low Voltage)
		29.05.03 Transfer Switches
		29.05.04 Motor Starters/Contactors
		29.05.05 Transformers
		29.05.06 End Use Device Connections
	29.06 Exterior Lighting System	29.06.01 Lighting Fixtures - Fluorescent
		29.06.02 Lighting Fixtures - Incandescent
		29.06.03 Lighting Fixtures - High Intensity Discharge (HID)
		29.06.04 Lighting Controllers
		29.06.05 Poles
		29.06.06 Anchors and Guy Wires
		29.06.07 Foundations
	29.07 Lightning Protection/ Grounding System	29.07.01 Air Terminals
		29.07.02 Conductors (Bare)
		29.07.03 Bonding
		29.07.04 Conduit Systems
		29.07.05 Poles
		29.07.06 Anchors and Guy Wires
		29.07.07 Foundations

29.01 SWITCHYARDS

DESCRIPTION

Switchyard is a subsystem of the Site Electrical System. Switchyards receive power from power sources and distributes the power to its terminal points for distribution to remote distribution centers and/or end load devices. There are two types of switchyards, the single-fed and the double-fed units.

Single-fed switchyards receive power from a single power source. Power input to the switchyard is to its primary power switch. This primary power switch feeds the switchyard's feeder power switches that feeds the switchyard's terminal points.

Double-fed switchyards are similar to single-fed switchyards except the two incoming power sources feed individual power switches, each power source feeds its individual power switch. Each power switch can feed a separate section of the switchyard's distribution bus, or with the addition of a tie power switch, either power switch can feed both sections of the switchyard's distribution bus.

SPECIAL TOOL AND EQUIPMENT REQUIREMENTS

The following special tool, beyond the requirements listed in the Standard Tool Section shall be provided to perform the inspection of the Switchyard:

1. Infrared scanner, Raytek, Inc., #PM2EM-L2

SPECIAL SAFETY REQUIREMENTS

Interior compartments containing devices rated above 600v shall not be inspected by Level I / Level II inspectors. No other special safety requirements are needed for the inspection of the Switchyard beyond the requirements listed in the Master Safety Plan and System Safety Section.

COMPONENT LIST

- 29.01.01 ENCLOSURES WITH BUS BARS
- 29.01.02 METERING
- 29.01.03 SURGE (LIGHTNING) ARRESTERS
- 29.01.04 INSULATORS
- 29.01.05 CIRCUIT BREAKERS (MEDIUM VOLTAGE)
- 29.01.06 DISCONNECT SWITCHES (MEDIUM VOLTAGE)
- 29.01.07 TRANSFORMERS
- 29.01.08 FOUNDATIONS
- 29.01.09 FENCING

29.01 SWITCHYARDS

RELATED SUBSYSTEMS

Due to the related nature of the elements requiring inspection, the following should be reviewed for concurrent inspection activities.

10.06	RACEWAYS
29.07	LIGHTNING PROTECTION/GROUNDING SYSTEM

STANDARD INSPECTION PROCEDURE

Components require a Level I or Level II inspection as part of the basic inspection process. Other additional Level II inspection may be indicated or "triggered" by a Level I inspection and should be accomplished by the inspector at that time. Level III inspection may be indicated or "triggered" by a Level I or II inspection Defect/Observation and should be accomplished at the direction of the Facility Manager.

Inspection should be carried out in the order of presentation for the various components with associated defects and observations for each subsystem listed in the inspector's CAIS.

29.01 SWITCHYARDS

COMPONENTS

◆ 29.01.01 ENCLOSURES WITH BUS BARS

Enclosures with bus bars, their connections and structural steel that make up the enclosure, for motor control centers, panelboards, switchboards, switchyard and substations, includes doors and panels that are not part of any equipment mounted in the enclosure. Doors and panels not included in the enclosure inspection are those for circuit breakers, disconnect switches, combination starters, etc. which would be inspected as part of those components.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Corrosion:**			
Observation:			
a. Surface corrosion (no pitting evident). ***{Severity L}	SF		
b. Corrosion evidenced by pitting or blistering. ***{Severity M}	SF		
c. Corrosion evidenced by holes or loss of base metal. ***{Severity H}	SF		

Defect:

	UOM	LEVEL II KEY	LEVEL III KEY
*** Physical Damage:**			
Observation:			
a. Panel fastener loose, broken or missing. ***{Severity L}	EA		
b. Excessive dust, dirt or moisture accumulation. ***{Severity L}	EA	1	
c. Enclosure mounting loose, broken or missing. ***{Severity M}	EA		
d. Enclosure damaged (cannot be sealed). ***{Severity M}	EA		
e. Unused opening not covered. ***{Severity M}	EA		
f. Vent opening blocked. ***{Severity M}	EA		
g. Air filters dirty or missing. ***{Severity L}	EA	1	
h. Unit not grounded. ***{Severity H}	EA	1	

29.01 SWITCHYARDS

COMPONENTS (Continued)

◆ 29.01.01 ENCLOSURES WITH BUS BARS (Continued)

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
* **Hot Spots (Bus Bars Rated 600v or Less):**			
Observation:			
a. Bus connection 5° to 24°C above ambient. ***{Severity M}	EA	2	1
b. Bus connection 25°C or more above ambient. ***{Severity H}	EA	2	1

29.01 SWITCHYARDS

COMPONENTS (Continued)

◆ 29.01.02 METERING

Metering consists of devices used to measure voltage, current and Kilowatt Hour (KWH) usage at given locations. KWH metering may include measuring peak demand loads over a billing period on a continuous basis or a 24 hour on-peak / off-peak load basis. The KWH and peak demand loads are usually measured by a single meter unit.

Depending on voltage levels, voltage signal for metering purposes can be taken directly across lines or from potential transformers connected across lines being monitored.

Depending on voltage levels and maximum current flow, ampere signals for metering purposes can be taken from current flow through the meters or signals from either shunts or current transformers connected to the lines being metered.

Current and voltage readings at metering points can be taken with individual meters or selector switches can be used in conjunction with meters such that a single ampere or volt meter along with its individual selector switch can read the current or voltage at multi metering points.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Corrosion:**			
Observation:			
a. Surface corrosion (no pitting evident).	SF		
***{Severity L}			
b. Corrosion evidenced by pitting or blistering.	SF		
***{Severity M}			
c. Corrosion evidenced by holes or loss of base metal.	SF		
***{Severity H}			

Defect:

*** Physical Damage:**			
Observation:			
a. Enclosure mounting loose, broken or missing.	EA		
***{Severity L}			
b. Panel fastener loose, broken or missing.	EA		
***{Severity L}			

29.01 SWITCHYARDS

COMPONENTS (Continued)

◆ 29.01.02 METERING (Continued)

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
* **Physical Damage (Continued):**			
c. Enclosure damaged (cannot be sealed). ***{Severity M}	EA		
d. Glass broken or missing. ***{Severity M}	EA		
e. Selector switch broken or missing. ***{Severity M}	EA		
f. Unused opening not covered. ***{Severity M}	EA		
g. Meter broken. ***{Severity H}	EA		2

Defect:

* **Hot Spots:**			
Observation:			
a. Terminal 5° to 24°C above ambient. ***{Severity M}	EA	3	3
b. Terminal 25°C or more above ambient. ***{Severity H}	EA	3	3

29.01 SWITCHYARDS

COMPONENTS (Continued)

◆ 29.01.03 SURGE (LIGHTNING) ARRESTERS

Surge Arrester is a protective device for limiting surge voltages by discharging or bypassing surge current to ground. As soon as the surge voltage subsides to a low value the current to ground is quenched. The surge arrester is capable of repeating this function many times automatically without any outside input.

There are four basic arresters defined by industry standards; secondary, distribution, intermediate, and station type. These arresters utilize expulsion, silicone carbide valve element, or metal oxide valve element technology to consistently limit voltage surges to a known or controlled level.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Corrosion:**			
Observation:			
a. Corrosion evidenced by holes or loss of base metal.	SF		
***{Severity H}			

Defect:

*** Physical Damage:**			
Observation:			
a. Arrester chipped or cracked.	EA		
***{Severity M}			
b. Arrester broken or missing.	EA		
***{Severity H}			
c. Arrester mounting broken.	EA		
***{Severity H}			
d. Unit not grounded.	EA		
***{Severity H}			

29.01 SWITCHYARDS

COMPONENTS (Continued)

◆ 29.01.04 INSULATORS

Insulators are intended to give flexible or rigid support to electrical conductors or equipment and to electrically separate those conductors or equipment from ground or from other construction components, conductors, or equipment. An insulator can consist of one or more non-conducting parts to which metal fittings are permanently attached.

A variety of insulators are used in distribution applications including; pin insulators, suspension insulators, deadening insulators, line post insulators, station post insulators, spool insulators, and guy strain insulators.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Physical Damage:**			
Observation:			
a. Insulator chipped or cracked ***{Severity M}	EA		
b. Insulator broken or missing. ***{Severity H}	EA		
c. Insulator mounting broken ***{Severity H}	EA		
Defect:			
*** Hot Spots:**			
Observation:			
a. Terminal 5° to 24°C above ambient. ***{Severity M}	EA	4	4
b. Terminal 25°C or more above ambient. ***{Severity H}	EA	4	4

29.01 SWITCHYARDS

COMPONENTS (Continued)

◆ 29.01.05 CIRCUIT BREAKERS (MEDIUM VOLTAGE)

Circuit breakers (medium voltage) are devices used to disconnect loads rated from 601 volts to 35 kV. These type of breakers open and close a circuit when signaled from an outside source. These sources are current and voltage sensing devices such as relays and solid state devices with their associated potential and current transformers or by pushbuttons or selector switches that are manually operated.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Corrosion:**			
Observation:			
a. Surface corrosion (no pitting evident). ***{Severity L}	SF		
b. Corrosion evidenced by pitting or blistering. ***{Severity M}	SF		
c. Corrosion evidenced by holes or loss of base metal. ***{Severity H}	SF		

Defect:

*** Physical Damage:**			
Observation:			
a. Enclosure mounting loose, broken or missing. ***{Severity L}	EA		
b. Panel fastener loose, broken or missing. ***{Severity L}	EA		
c. Enclosure damaged (cannot be sealed). ***{Severity M}	EA		
d. Unused opening not covered. ***{Severity M}	EA		
e. Security devices missing or inoperable. ***{Severity H}	EA		
f. Door handle bent or inoperable. ***{Severity H}	EA		
g. Circuit breaker broken or damaged. ***{Severity H}	EA		
h. Pilot light damaged or inoperable. ***{Severity H}	EA		
i. Light monitoring breakers position not lit. ***{Severity H}	EA		

29.01 SWITCHYARDS

COMPONENTS (Continued)

◆ **29.01.05 CIRCUIT BREAKERS (MEDIUM VOLTAGE) (Continued)**

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
* **Oil Leak:**			
Observation:			
a. Oil on surface of tank (possible oil leak). ***{Severity L}	EA		9
b. Oil puddle under or around base of tank. ***{Severity H}	EA		9

Defect:

* **Hot Spots:**			
Observation:			
a. Terminal or breaker body 5 to 24°C above ambient. ***{Severity M}	EA	6	10
b. Terminal or breaker body 25°C or more above ambient. ***{Severity H}	EA	6	10

29.01 SWITCHYARDS

COMPONENTS (Continued)

◆ 29.01.06 DISCONNECT SWITCHES (MEDIUM VOLTAGE)

Fused cut-outs for the purpose of this inspection are considered disconnect switches. Disconnect switches (medium voltage) are devices used to disconnect loads rated from 601 volts to 35 kV from its source.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Corrosion:**			
Observation:			
a. Surface corrosion (no pitting evident). ***{Severity L}	SF		
b. Corrosion evidenced by pitting or blistering. ***{Severity M}	SF		
c. Corrosion evidenced by holes or loss of base metal. ***{Severity H}	SF		

Defect:

*** Physical Damage:**			
Observation:			
a. Enclosure mounting loose, broken or missing. ***{Severity L}	EA		
b. Panel fastener loose, broken or missing. ***{Severity L}	EA		
c. Enclosure damaged (cannot be sealed). ***{Severity M}	EA		
d. Unused opening not covered ***{Severity M}	EA		
e. Door handle bent or inoperable. ***{Severity H}	EA		
f. Security devices missing or inoperable. ***{Severity H}	EA		
g. Insulator damage. ***{Severity H}	EA		
h. Carbon tracking due to flashovers. ***{Severity H}	EA		
i. Discoloration of blades and contacts due to overheating. ***{Severity H}	EA		

29.01 SWITCHYARDS

COMPONENTS (Continued)

◆ 29.01.06 DISCONNECT SWITCHES (MEDIUM VOLTAGE) (Continued)

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
* **Hot Spots:**			
Observation:			
a. Terminal or switch body 5 to 24°C above ambient.	EA	7	11
***{Severity M}			
b. Terminal or switch body 25°C or more above ambient.	EA	7	11
***{Severity H}			

29.01 SWITCHYARDS

COMPONENTS (Continued)

◆ 29.01.07 TRANSFORMERS

Transformers are static electric devices consisting of a single winding or multiple coupled windings with or without a magnetic core. Power is transferred by electromagnetic induction from the input to the output circuit usually with changed values of voltages and currents.

Transformers have six types of functions: power transformers converts one voltage source to another voltage power source, isolation transformers shields the load side winding from the line side winding, reduced voltage starting transformers reduces the motor terminal voltage during the starting cycle, buck/boost transformers either raise or lower output voltage to accommodate the load, current transformers proportions a high current flow to a low current flow for instrumentation and control purpose and potential transformers proportions a high voltage potential to a low voltage potential for instrumentation and control purposes.

Transformers, other than current and potential transformers, smaller than 5 kVA single phase or 15 kVA multi phase will not be inspected. All current and potential transformers will be inspected.

Surge (lightning) arresters, insulators, foundations, poles and conductors bare will be inspected under separate components.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Corrosion:**			
Observation:			
a. Surface corrosion (no pitting evident).	SF		
***{Severity L}			
b. Corrosion evidenced by pitting or blistering.	SF		12
***{Severity M}			
c. Corrosion evidenced by holes or loss of base metal.	SF		12
***{Severity H}			

Defect:

*** Physical Damage:**			
Observation:			
a. Enclosure mounting loose, broken or missing.	EA		
***{Severity L}			
b. Panel fastener loose, broken or missing.	EA		
***{Severity L}			
c. Enclosure damaged (cannot be sealed).	EA		
***{Severity M}			
d. Air intake/exhaust ducts blocked.	EA		
***{Severity M}			

29.01 SWITCHYARDS

COMPONENTS (Continued)

◆ 29.01.07 TRANSFORMERS (Continued)

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Physical Damage (continued):**			
e. Air filter dirty or missing. ***{Severity M}	EA		
f. Unused opening not covered. ***{Severity M}	EA		
g. Loose or broken mounting bracket. ***{Severity M}	EA		
h. Cooling fan guard/blade broken or missing. ***{Severity H}	EA		
i. Unit not grounded. ***{Severity H}	EA		
j. Gauge or meter broken or missing. ***{Severity M}	EA		
k. Security lock missing or inoperable. ***{Severity H}	EA		

Defect:

*** Oil Leak:**

Observation:			
a. Oil on surface of tank (possible oil leak). ***{Severity L}	EA		13
b. Oil puddle under or around base of tank. ***{Severity H}	EA		13

Defect:

*** Hot Spots:**

Observation:			
a. Terminal 5° to 24°C above ambient. ***{Severity M}	EA	5	5
b. Terminal 25°C or more above ambient. ***{Severity H}	EA	5	5
c. Oil cooling fin blocked. ***{Severity H}	EA		14
d. Low oil level (less than 2" above fin). ***{Severity H}	EA		14

29.01 SWITCHYARDS

COMPONENTS (Continued)

◆ 29.01.08 FOUNDATIONS

Foundations consist of cast-in-place concrete footings and piers through which the loads of structures are transmitted to the earth. Anchor bolts are embedded in the concrete, to connect the structure or equipment to the foundation.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
* **Cracking:**			
Observation:			
a. Cracks between 1/16" and 1/4" wide. ***{Severity M}	LF		6
b. Disintegration of surface or cracks exceeding 2" depth. ***{Severity H}	LF		6

Defect:

* **Spalling:**			
Observation:			
a. Not more than 1" deep or 6" in diameter. ***{Severity L}	SF		
b. More than 1" in depth or 6" in dia., or 10% of surface area loss. ***{Severity H}	SF		
c. Disintegration of surface area, with corrosion of exposed rebar. ***{Severity H}	SF		7

Defect:

* **Scaling:**			
Observation:			
a. Surface loss of 1/2" to 1" deep, with coarse aggregates exposed. ***{Severity M}	SF		
b. Loss of surface exceeding 1" deep. ***{Severity H}	SF		
c. Exposure of reinforcing steel. ***{Severity H}	SF		7

Defect:

* **Reinforcing Steel Corrosion:**			
Observation:			
a. Rusting evident, cracks occurring along rebar. ***{Severity H}	LF		7

29.01 SWITCHYARDS

COMPONENTS (Continued)

◆ 29.01.09 FENCING

Fencing, serving as enclosures for electrical equipment, are constructed from metal material. Fencing includes posts, chain link material, security wires, gates and post foundations.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Corrosion:**			
Observation:			
a. Surface corrosion (no pitting evident).	SF		
***{Severity L}			
b. Corrosion evidenced by pitting or blistering.	SF		
***{Severity M}			
c. Corrosion evidenced by holes or loss of base metal.	LF		
***{Severity H}			

Defect:

*** Sagging/Cuts:**			
Observation:			
a. Loose or sagging security wire.	LF		
***{Severity M}			
b. Holes in fence material.	LF		
***{Severity H}			
c. Loose or sagging fence material.	LF		
***{Severity H}			
d. Broken or missing security wire.	LF		
***{Severity H}			

Defect:

*** Connections/Devices:**			
Observation:			
a. Loose bolts or wire fasteners.	EA		
***{Severity M}			
b. Loose or bent pipe posts, bracing and railing.	EA		
***{Severity H}			
c. Missing or broken hinges, latches, bolts and fasteners.	EA		
***{Severity H}			
d. Gate locking device missing or inoperable.	EA		
***{Severity H}			
e. High voltage danger sign missing or illegible.	EA		
***{Severity H}			

29.01 SWITCHYARDS

COMPONENTS (Continued)

◆ **29.01.09 FENCING (Continued)**

Defect:	**UOM**	**LEVEL II KEY**	**LEVEL III KEY**
*** Misalignment/Bowed Deflection:**			
Observation:			
a. Fence wall tilted between 2 - 3". ***{Severity L}	LF		
b. Fence wall tilted between 3"-6". ***{Severity M}	LF		
c. Binding gate. ***{Severity M}	EA		
d. Sagging gate. ***{Severity M}	EA		
e. Fence wall tilted more than 6". ***{Severity H}	LF		
f. Gate difficult or impossible to open. ***{Severity H}	EA		

Defect:

*** Erosion/Vegetation:**			
Observation:			
a. Soil erosion around posts or under fence wall. ***{Severity M}	SF		
b. Vines, trees or shrubs climbing over or growing into fence. ***{Severity M}	LF		
c. Post foundation exposed due to erosion. ***{Severity H}	SF		

Defect:

*** Grounding:**			
Observation:			
a. Ground connection missing. ***{Severity H}	EA		
b. Gate not grounded to fence. ***{Severity H}	EA		
c. Fence not grounded. ***{Severity H}	EA		

29.01 SWITCHYARDS

REFERENCES

1. DOE CAS Manual, Volume 9: 0.09, Electrical

2. National Fire Protection Association (NFPA 70B) *"Recommended Practice for Electrical Equipment Maintenance"*, 1990 Edition

3. MEANS *"Maintenance Standards"*, Roger W. Liska, PE, AK 1988

4. Iowa Administrative Code, Utilities [199], Chapter 25, Iowa Electrical Safety Code IAC 8/5/92

5. MEANS *"Facilities Maintenance & Repair Cost Data"*, 1994

6. *"Handbook of Building and Plant Maintenance Forms and Checklists"* by Roger W. Liska and Judith Morrison Liska

29.01 SWITCHYARDS

LEVEL II KEY	GUIDE SHEET CONTROL NUMBER
1	GS-II 29.01.01-1
2	GS-II 29.01.01-2
3	GS-II 29.01.02-3
4	GS-II 29.01.04-4
5	GS-II 29.01.07-5
6	GS-II 29.01.05-6
7	GS-II 29.01.06-7

LEVEL III KEY	GUIDE SHEET CONTROL NUMBER
1	GS-III 29.01.01-1
2	GS-III 29.01.02-2
3	GS-III 29.01.02-3
4	GS-III 29.01.04-4
5	GS-III 29.01.07-5
6	GS-III 29.01.08-6
7	GS-III 29.01.08-7
8*	GS-III 29.01-8*
9	GS-III 29.01.05-9
10	GS-III 29.01.05-10
11	GS-III 29.01.06-11
12	GS-III 29.01.07-12
13	GS-III 29.01.07-13
14	GS-III 29.01.07-14

* Indicates guide sheets which are not directly referenced by a Key. These are "triggered" by information beyond the inspection process such as time, age or repeated service calls.

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 1

COMPONENT: ENCLOSURES WITH BUS BARS
CONTROL NUMBER: GS-II 29.01.01-1

Application

This guide applies to the investigation of the inside of an enclosure, containing bare, energized, electrical parts.

Special Safety Requirements

The following list of special safety requirements, beyond the requirements listed in the Master Safety Plan and System Safety Section, are to be observed in the performance of this inspection.

1. This inspection guide applies to enclosure compartments containing live electrical parts having a potential of 600 volts or less above ground. If the enclosure compartment contains circuitry of higher potential, do not use this inspection guide.

2. Any enclosure that is padlocked for safety reason is not to be opened unless okayed by the person having control of the key.

3. Inspector needs to carefully open, inspect the inside and close the enclosure without shutting down the equipment, and without creating a hazard to himself.

Inspection Actions

1. Open panels or doors carefully as required for doing the visual inspection.

2. Visually inspect for those physical damaged defects that are listed and tagged Level II Key No. as indicated above.

3. Close panels or doors carefully after the inspection is completed.

Recommended Inspection Frequency

Do a Level II inspection each time a Level I inspection indicates one is required.

References

1. Sverdrup Corporation

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 2

COMPONENT: ENCLOSURES WITH BUS BARS
CONTROL NUMBER: GS-II 29.01.01-2

Application

This guide applies to the investigation of the inside of an enclosure, containing bare, energized, electrical parts.

Special Safety Requirements

The following list of special safety requirements, beyond the requirements listed in the Master Safety Plan and System Safety Section, are to be observed in the performance of this inspection.

1. This inspection guide applies to enclosure compartments containing live electrical parts having a potential of 600 volts or less above ground. If the enclosure compartment contains circuitry of higher potential, do not use this inspection guide.

2. Any enclosure that is padlocked for safety reason is not to be opened unless okayed by the person having control of the key.

3. Inspector needs to carefully open, inspect the inside and close the enclosure without shutting down the equipment, and without creating a hazard to himself.

Inspection Actions

1. Open panels or doors carefully and to the degree required for scanning those devices being tested.

2. Make temperature measurements with an infrared scanner.

3. Measure the ambient temperature by measuring a spot on the inside of the enclosure that is least effected by any internal panel heat source.

4. Measure the temperature of the device specified.

5. Above-ambient temperature is calculated by subtracting the ambient temperature from the device temperature.

6. Record the results.

7. Close panels or doors carefully after the inspection is complete.

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 2 (Continued)

COMPONENT: ENCLOSURES WITH BUS BARS
CONTROL NUMBER: GS-II 29.01.01-2

Recommended Inspection Frequency

Do a Level II inspection each time a Level I inspection is made.

References

1. Maintenance Technology/September 1993; Write-up Title: *"Infrared Keeps All Systems Go"*

2. Raining - Agema Infrared Systems; *"Measurement of Excess Temperatures with Infrared Scanners"*

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 3

COMPONENT: METERING
CONTROL NUMBER: GS-II 29.01.02-3

Application

This guide applies to the investigation of the inside of an enclosure, containing bare, energized, electrical parts.

Special Safety Requirements

The following list of special safety requirements, beyond the requirements listed in the Master Safety Plan and System Safety Section, are to be observed in the performance of this inspection.

1. This inspection guide applies to enclosure compartments containing live electrical parts having a potential of 600 volts or less above ground. If the enclosure compartment contains circuitry of higher potential, do not use this inspection guide.

2. Any enclosure that is padlocked for safety reason is not to be opened unless okayed by the person having control of the key.

3. Inspector needs to carefully open, inspect the inside and close the enclosure without shutting down the equipment, and without creating a hazard to himself.

Inspection Actions

1. Open panels or doors carefully and to the degree required for scanning those devices being tested.

2. Make temperature measurements with an infrared scanner.

3. Measure the ambient temperature by measuring a spot on the inside of the enclosure that is least effected by any internal panel heat source.

4. Measure the temperature of the device specified.

5. Above-ambient temperature is calculated by subtracting the ambient temperature from the device temperature.

6. Record the results.

7. Close panels or doors carefully after the inspection is complete.

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 3 (Continued)

COMPONENT: METERING
CONTROL NUMBER: GS-II 29.01.02-3

Recommended Inspection Frequency

Do a Level II inspection each time a Level I inspection is made.

References

1. Maintenance Technology/September 1993; Write-up Title: *"Infrared Keeps All Systems Go"*

2. Raining - Agema Infrared Systems; *"Measurement of Excess Temperatures with Infrared Scanners"*

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 4

COMPONENT: INSULATORS
CONTROL NUMBER: GS-II 29.01.04-4

Application

This guide applies to the investigation of the inside of an enclosure, containing bare, energized, electrical parts.

Special Safety Requirements

The following list of special safety requirements, beyond the requirements listed in the Master Safety Plan and System Safety Section, are to be observed in the performance of this inspection.

1. This inspection guide applies to enclosure compartments containing live electrical parts having a potential of 600 volts or less above ground. If the enclosure compartment contains circuitry of higher potential, do not use this inspection guide.

2. Any enclosure that is padlocked for safety reason is not to be opened unless okayed by the person having control of the key.

3. Inspector needs to carefully open, inspect the inside and close the enclosure without shutting down the equipment, and without creating a hazard to himself.

Inspection Actions

1. Open panels or doors carefully and to the degree required for scanning those devices being tested.

2. Make temperature measurements with an infrared scanner.

3. Measure the ambient temperature by measuring a spot on the inside of the enclosure that is least effected by any internal panel heat source.

4. Measure the temperature of the device specified.

5. Above-ambient temperature is calculated by subtracting the ambient temperature from the device temperature.

6. Record the results.

7. Close panels or doors carefully after the inspection is complete.

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 4 (Continued)

COMPONENT: INSULATORS
CONTROL NUMBER: GS-II 29.01.04-4

Recommended Inspection Frequency

Do a Level II inspection each time a Level I inspection is made.

References

1. Maintenance Technology/September 1993; Write-up Title: *"Infrared Keeps All Systems Go"*

2. Raining - Agema Infrared Systems; *"Measurement of Excess Temperatures with Infrared Scanners"*

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 5

COMPONENT: TRANSFORMERS
CONTROL NUMBER: GS-II 29.01.07-5

Application

This guide applies to the investigation of the inside of an enclosure, containing bare, energized, electrical parts.

Special Safety Requirements

The following list of special safety requirements, beyond the requirements listed in the Master Safety Plan and System Safety Section, are to be observed in the performance of this inspection.

1. This inspection guide applies to enclosure compartments containing live electrical parts having a potential of 600 volts or less above ground. If the enclosure compartment contains circuitry of higher potential, do not use this inspection guide.

2. Any enclosure that is padlocked for safety reason is not to be opened unless okayed by the person having control of the key.

3. Inspector needs to carefully open, inspect the inside and close the enclosure without shutting down the equipment, and without creating a hazard to himself.

Inspection Actions

1. Open panels or doors carefully and to the degree required for scanning those devices being tested.

2. Make temperature measurements with an infrared scanner.

3. Measure the ambient temperature by measuring a spot on the inside of the enclosure that is least effected by any internal panel heat source.

4. Measure the temperature of the device specified.

5. Above-ambient temperature is calculated by subtracting the ambient temperature from the device temperature.

6. Record the results.

7. Close panels or doors carefully after the inspection is complete.

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 5 (Continued)

COMPONENT: TRANSFORMERS
CONTROL NUMBER: GS-II 29.01.07-5

Recommended Inspection Frequency

Do a Level II inspection each time a Level I inspection is made.

References

1. Maintenance Technology/September 1993; Write-up Title: *"Infrared Keeps All Systems Go"*

2. Raining - Agema Infrared Systems; *"Measurement of Excess Temperatures with Infrared Scanners"*

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 6

COMPONENT: CIRCUIT BREAKERS (MEDIUM VOLTAGE)
CONTROL NUMBER: GS-II 29.01.05-6

Application

This guide applies to the investigation of the inside of an enclosure, containing bare, energized, electrical parts.

Special Safety Requirements

The following list of special safety requirements, beyond the requirements listed in the Master Safety Plan and System Safety Section, are to be observed in the performance of this inspection.

1. This inspection guide applies to enclosures containing live electrical parts having a potential of 601 volts or more above ground.

2. Any enclosure that is padlocked for safety reason is not to be opened unless okayed by the person having control of the key.

3. Inspector needs to carefully open, inspect the inside and close the enclosure without shutting down the equipment, and without creating a hazard to himself.

Inspection Actions

1. Open panels or doors carefully as required for doing the visual inspection.

2. Visually inspect for those physical damaged defects that are listed and tagged Level II Key No. as indicated above.

3. Close panels or doors carefully after the inspection is completed.

Recommended Inspection Frequency

Do a Level II inspection each time a Level I inspection is performed on this equipment.

References

1. Sverdrup Corporation

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 7

COMPONENT: DISCONNECT SWITCHES (MEDIUM VOLTAGE)
CONTROL NUMBER: GS-II 29.01.06-7

Application

This guide applies to the investigation of the inside of an enclosure, containing bare, energized, electrical parts.

Special Safety Requirements

The following list of special safety requirements, beyond the requirements listed in the Master Safety Plan and System Safety Section, are to be observed in the performance of this inspection.

1. This inspection guide applies to enclosures containing live electrical parts having a potential of 601 volts or more above ground.

2. Any enclosure that is padlocked for safety reason is not to be opened unless okayed by the person having control of the key.

3. Inspector needs to carefully open, inspect the inside and close the enclosure without shutting down the equipment, and without creating a hazard to himself.

Inspection Actions

1. Open panels or doors carefully as required for doing the visual inspection.

2. Visually inspect for those physical damaged defects that are listed and tagged Level II Key No. as indicated above.

3. Close panels or doors carefully after the inspection is completed.

Recommended Inspection Frequency

Do a Level II inspection each time a Level I is performed on this equipment.

References

1. Sverdrup Corporation

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 1

COMPONENT: ENCLOSURES WITH BUS BARS
CONTROL NUMBER: GS-III 29.01.01-1

Application

This guide applies to the investigation of a hot terminal or device that is overheating from the flow of current through that terminal or device.

Special Safety Requirements

No special safety requirements are needed for the performance of this Level III inspection beyond those required in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Verify the findings of Level II inspection by using the Infrared Scanner and measuring the temperatures of the device and terminals. If the device or terminals are not hot as indicated by the findings of Level II inspection, check the current flow through the device or terminals. Heat generated is proportionate to the square of the current. If there is little or no current flow through the device or terminal at the time of measurement, there will be no significant amount of heat generated.

2. For terminal connections, verify the type of conductor being terminated. If the conductor is an aluminum conductor, look for evidence of cold flow or melt down of conductor.

3. If there is evidence of cold flow or melt down of the aluminum conductor, the conductor should either be replaced or shortened and reconnected. When making new aluminum conductor terminations a joint compound should be used.

4. If the terminal is loose it should be tightened. De-energize prior to attempting tightening of terminal connections.

5. If none of the above is the problem than there is an internal problem and an on-site analysis must be made to determine if additional inspections are to be made or the unit is to be replaced.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 1 (Continued)

COMPONENT: ENCLOSURES WITH BUS BARS
CONTROL NUMBER: GS-III 29.01.01-1

Special Tools and Equipment

The following is a list of special tools required beyond those listed in the Standard Tool Section.

1. Infrared Scanner, Raytek, Inc., #PM2EM-L2

2. Torque wrench

3. Digital Multimeter, Fluke #1TC676

Recommended Inspection Frequency

Do a Level III inspection when triggered by a Level II inspection.

References

1. Maintenance Technology/September 1993; Write-up Title: *"Infrared Keeps All Systems Go"*

2. Raining - Agema Infrared Systems; *"Measurement of Excess Temperatures with Infrared Scanners"*

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 2

COMPONENT: METERING
CONTROL NUMBER: GS-III 29.01.02-2

Application

This guide applies to the investigation of a broken meter that has received physical damage or is not operating.

Special Safety Requirements

No special safety requirements are needed for the performance of this Level III inspection beyond those required in the Master Safety Plan and System Safety Section.

Inspection Actions

1. For physically damaged units, inspect to verify if the unit is damaged to the point where it is no longer sealed from dust, water or insects entering the housing. If the seal is broken the housing should be replaced and the existing meter should be repaired or discarded.

2. If the meter is not operating, follow the following procedure:

   a. Check all fuses and replace those fuses that are blown.
   b. Check current transformers (CT) for output when power is being used. CT may be burnt out or overloaded. CT secondary circuit must not be opened or overloaded when current flows through the primary. Under the above operating conditions the CT could be destroyed.
   c. Check potential transformers (PT) for output when power is on. PT may not provide the proper voltage output.
   d. Check selector switches for proper operation and low contact resistance. If switch is malfunctioning it should be replaced.
   e. Check circuitry for proper connections. Any improper connection could cause damage to the meter, CT or PT. Damaged devices need to be repaired or replaced.
   f. Check all electrical terminals for loose connections and tighten those required.
   g. Check for broken and insulation-damaged conductors. Replace conductors as required.
   h. After the above items have been checked out, the necessary repairs and replacements have been made and the meter is still malfunctioning, the meter should be replaced and the original meter sent to the shop for repair or scrapping.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 2 (Continued)

COMPONENT: METERING
CONTROL NUMBER: GS-III 29.01.02-2

Special Tools and Equipment

The following is a list of special instruments required beyond those listed in the Standard Tool Section.

1. Digital Multimeter, Fluke #1TC67

Recommended Inspection Frequency

Do a Level III inspection only when triggered by a Level I inspection.

References

1. Sverdrup Corporation

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 3

COMPONENT: METERING
CONTROL NUMBER: GS-III 29.01.02-3

Application

This guide applies to the investigation of a hot terminal or device that is overheating from the flow of current through that terminal or device.

Special Safety Requirements

No special safety requirements are needed for the performance of this Level III inspection beyond those required in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Verify the findings of Level II inspection by using the Infrared Scanner and measuring the temperatures of the device and terminals. If the device or terminals are not hot as indicated by the findings of Level II inspection, check the current flow through the device or terminals. Heat generated is proportionate to the square of the current. If there is little or no current flow through the device or terminal at the time of measurement, there will be no significant amount of heat generated.

2. For terminal connections, verify the type of conductor being terminated. If the conductor is an aluminum conductor, look for evidence of cold flow or melt down of conductor.

3. If there is evidence of cold flow or melt down of the aluminum conductor, the conductor should either be replaced or shortened and reconnected. When making new aluminum conductor terminations a joint compound should be used.

4. If the terminal is loose it should be tightened. De-energize prior to attempting tightening of terminal connections.

5. If none of the above is the problem than there is an internal problem and an on-site analysis must be made to determine if additional inspections are to be made or the unit is to be replaced.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 3 (Continued)

COMPONENT: METERING
CONTROL NUMBER: GS-III 29.01.02-3

Special Tools and Equipment

The following is a list of special tools required beyond those listed in the Standard Tool Section.

1. Infrared Scanner, Raytek, Inc., #PM2EM-L2

2. Torque wrench

3. Digital Multimeter, Fluke #1TC676

Recommended Inspection Frequency

Do a Level III inspection when triggered by a Level II inspection.

References

1. Maintenance Technology/September 1993; Write-up Title: *"Infrared Keeps All Systems Go"*

2. Raining - Agema Infrared Systems; *"Measurement of Excess Temperatures with Infrared Scanners"*

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 4

COMPONENT: INSULATORS
CONTROL NUMBER: GS-III 29.01.04-4

Application

This guide applies to the investigation of a hot terminal or device that is overheating from the flow of current through that terminal or device.

Special Safety Requirements

No special safety requirements are needed for the performance of this Level III inspection beyond those required in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Verify the findings of Level II inspection by using the Infrared Scanner and measuring the temperatures of the device and terminals. If the device or terminals are not hot as indicated by the findings of Level II inspection, check the current flow through the device or terminals. Heat generated is proportionate to the square of the current. If there is little or no current flow through the device or terminal at the time of measurement, there will be no significant amount of heat generated.

2. For terminal connections, verify the type of conductor being terminated. If the conductor is an aluminum conductor, look for evidence of cold flow or melt down of conductor.

3. If there is evidence of cold flow or melt down of the aluminum conductor, the conductor should either be replaced or shortened and reconnected. When making new aluminum conductor terminations a joint compound should be used.

4. If the terminal is loose it should be tightened. De-energize prior to attempting tightening of terminal connections.

5. If none of the above is the problem than there is an internal problem and an on-site analysis must be made to determine if additional inspections are to be made or the unit is to be replaced.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 4 (Continued)

COMPONENT: INSULATORS
CONTROL NUMBER: GS-III 29.01.04-4

Special Tools and Equipment

The following is a list of special tools required beyond those listed in the Standard Tool Section.

1. Infrared Scanner, Raytek, Inc., #PM2EM-L2

2. Torque wrench

3. Digital Multimeter, Fluke #1TC676

Recommended Inspection Frequency

Do a Level III inspection when triggered by a Level II inspection.

References

1. Maintenance Technology/September 1993; Write-up Title: *"Infrared Keeps All Systems Go"*

2. Raining - Agema Infrared Systems; *"Measurement of Excess Temperatures with Infrared Scanners"*.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 5

COMPONENT: TRANSFORMERS
CONTROL NUMBER: GS-III 29.01.07-5

Application

This guide applies to the investigation of a hot terminal or device that is overheating from the flow of current through that terminal or device.

Special Safety Requirements

No special safety requirements are needed for the performance of this Level III inspection beyond those required in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Verify the findings of Level II inspection by using the Infrared Scanner and measuring the temperatures of the device and terminals. If the device or terminals are not hot as indicated by the findings of Level II inspection, check the current flow through the device or terminals. Heat generated is proportionate to the square of the current. If there is little or no current flow through the device or terminal at the time of measurement, there will be no significant amount of heat generated.

2. For terminal connections, verify the type of conductor being terminated. If the conductor is an aluminum conductor, look for evidence of cold flow or melt down of conductor.

3. If there is evidence of cold flow or melt down of the aluminum conductor, the conductor should either be replaced or shortened and reconnected. When making new aluminum conductor terminations a joint compound should be used.

4. If the terminal is loose it should be tightened. De-energize prior to attempting tightening of terminal connections.

5. If none of the above is the problem than there is an internal problem and an on-site analysis must be made to determine if additional inspections are to be made or the unit is to be replaced.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 5 (Continued)

COMPONENT: TRANSFORMERS
CONTROL NUMBER: GS-III 29.01.07-5

Special Tools and Equipment

The following is a list of special tools required beyond those listed in the Standard Tool Section.

1. Infrared Scanner, Raytek, Inc., #PM2EM-L2

2. Torque wrench

3. Digital Multimeter, Fluke #1TC676

Recommended Inspection Frequency

Do a Level III inspection when triggered by a Level II inspection.

References

1. Maintenance Technology/September 1993; Write-up Title: *"Infrared Keeps All Systems Go"*

2. Raining - Agema Infrared Systems; *"Measurement of Excess Temperatures with Infrared Scanners"*

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 6

COMPONENT: FOUNDATIONS
CONTROL NUMBER: GS-III 29.01.08-6

Application

This guide applies to the investigation of cracks in concrete.

Special Safety Requirements

No special safety requirements are needed for the performance of this Level III inspection beyond those required in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Utilize ultrasonic pulse velocity equipment to check for damage extent and loss of integrity.

Special Tools and Equipment

The following is a list of special tools required beyond those listed in the Standard Tool Section.

1. Ultrasonic pulse velocity test equipment, Krautkramer Branson #USK-6

Recommended Inspection Frequency

When triggered by a Level I or II defect/observation.

References

1. DOE, Vol. 2:0.02. *"Substructure Deficiency Standards and Inspection Methods Manual"*

2. MEANS *"Concrete Repair and Maintenance"*, Peter H. Emmons, 1994

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 7

COMPONENT: FOUNDATIONS
CONTROL NUMBER: GS-III 29.01.08-7

Application

This guide applies to the investigation of corrosion of reinforcing steel in concrete.

Special Safety Requirements

No special safety requirements are needed for the performance of this Level III inspection beyond those required in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Clean rust/discoloration.

2. Perform half-cell potential test to determine degree of corrosion of steel reinforcement.

Special Tools and Equipment

The following is a list of special tools required beyond those listed in the Standard Tool Section.

1. Half-cell test equipment.

Recommended Inspection Frequency

Whenever Level I or II defect/observation triggers this Level III procedure.

References

1. DOE, Vol. 2:0.02. *"Substructure Deficiency Standards and Inspection Methods Manual"*

2. MEANS *"Concrete Repair and Maintenance"*, Peter H. Emmons, 1994

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 8*

COMPONENT: SWITCHYARDS/SWITCHBOARDS
CONTROL NUMBER: GS-III 29.01-8*

Application

This guide applies to the inspection of switchyards and switchboards as a complete subsystem. This inspection, while a part of the Condition Assessment Survey, is triggered by information beyond the inspection process such as time, age, or repeated service calls.

Special Safety Requirements

Inspectors need to have complete control of the switchyard or switchboard while performing the inspection. During a portion of the inspection the switchyard or switchboard will be taken out of service. Therefore the inspection of the switchyard or switchboard will be scheduled accordingly to accommodate the inspection requirements. No other safety requirements are required for the performance of this Level III inspection beyond those required in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Locate switchyard or switchboard's maintenance log or records and review the following material:
   a. Date of the latest Short Circuit Analysis.
   b. Number of trips per protective device in the last 12 months of operation.
   c. Coordination study of protective device.
   d. Flash over problems.
   e. Scheduled checks for tightness of bus bars and terminal connections.
   f. Adequacy of maintenance logs or records.

2. Specify corrective action for problem areas:
   a. If there has not been a "Short Circuit Analysis" in the last 10 years or since the last incoming power source upgrade, a new study shall be made to determine the availability of short circuit current at various equipment locations.
   b. If a feeder circuit breaker trips or disconnect switch fuse blows more than twice a year, specify an Electrical Energy Analysis be made to verify the size of the existing circuit breakers or disconnect switches and their fuse rating. These units and any associated feeders having incorrect ratings should be changed out.
   c. If a back-up protective device trips or blows consistently before the equipment protective device trips or blows, specify a Protective Device Coordination Study be made for coordinating the characteristics of the protective device.
   d. If flash overs occur, investigate the problem and indicate the cause.
   e. If bus bar connections have not been tightened in the last 5 years, specify these connections be checked for proper tightness per manufacturers recommendation.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 8* (Continued)

COMPONENT: SWITCHYARDS/SWITCHBOARDS
CONTROL NUMBER: GS-III 29.01-8*

f. If some or all of the above information is not available from the maintenance logs or records, request that required records be kept.

3. Provide an inspection of the switchyard or switchboard and their components as specified by the equipment manufacturer. If there is no such recommendation, then provide an inspection as outlined in NFPA 70B *"Recommended Practices for Electrical Equipment Maintenance"*, latest edition.

Special Tools and Equipment

The following is a list of special tools and equipment required beyond those listed in the Standard Tool Section.

1. Infrared Scanner, Raytek Inc., #PM2EM-L2
2. Torque wrench
3. Refer to manufacturer maintenance guide for additional special tools required

Recommended Inspection Frequency

Follow manufacturer's recommendations for frequency of inspection of the switchyard/switchboard assembly for the first 3 years. If there is no manufacturer's recommendation than an annual inspection should be performed during this 3 year period. After the first 3 years of service, inspection frequency can be increased or decreased dictated by the past observations or experiences. When the number of service calls since the last inspection equals 4, the up-coming inspection should be performed immediately.

References

1. NFPA 70B, *"Recommended Practice for Electrical Equipment Maintenance"*, 1990 Edition

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 9

COMPONENT: CIRCUIT BREAKER (MEDIUM VOLTAGE)
CONTROL NUMBER: GS-III 29.01.05-9

Application

This guide applies to the investigation of oil leaks in the circuit breaker tank that has signs of oil on surface of the tank or an oil puddle under or around base of tank.

Special Safety Requirements

No special safety requirements are needed for the performance of this Level III inspection beyond those required in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Verify the findings of Level I inspection by finding the source of the oil. If the oil is coming from an external source no further inspection of the breaker is required. The external source should be identified and recommendations made to eliminate the contamination of the breaker.

2. If the oil source is coming from within the breaker, a determination should be made as how the oil is escaping.

3. If breaker repairs are made, oil analysis should be made after the repairs to determine if the oil is contaminated.

4. All contaminated oil should be removed and replaced with new oil.

Special Tools and Equipment

The following is a list of special tools required beyond those listed in the Standard Tool Section.

1. Brush

2. Non-flammable cleaning fluid

3. Wiping material

Recommended Inspection Frequency

Do a Level III inspection when triggered by a Level I inspection.

References

1. Sverdrup Corporation

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 10

COMPONENT: CIRCUIT BREAKERS (MEDIUM VOLTAGE)
CONTROL NUMBER: GS-III 29.01.05-10

Application

This guide applies to the investigation of a hot terminal or device that is overheating from the flow of current through that terminal or device.

Special Safety Requirements

No special safety requirements are needed for the performance of this Level III inspection beyond those required in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Verify the findings of Level II inspection by using the Infrared Scanner and measuring the temperatures of the device and terminals. If the device or terminals are not hot as indicated by the findings of Level II inspection, check the current flow through the device or terminals. Heat generated is proportionate to the square of the current. If there is little or no current flow through the device or terminal at the time of measurement, there will be no significant amount of heat generated.

2. For terminal connections, verify the type of conductor being terminated. If the conductor is an aluminum conductor, look for evidence of cold flow or melt down of conductor.

3. If there is evidence of cold flow or melt down of the aluminum conductor, the conductor should either be replaced or shortened and reconnected. When making new aluminum conductor terminations a joint compound should be used.

4. If the terminal is loose it should be tightened. De-energize prior to attempting tightening of terminal connections.

5. If none of the above is the problem than there is an internal problem and an on-site analysis must be made to determine if additional inspections are to be made or the unit is to be replaced.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 10 (Continued)

COMPONENT: CIRCUIT BREAKERS (MEDIUM VOLTAGE)
CONTROL NUMBER: GS-III 29.01.05-10

Special Tools and Equipment

The following is a list of special tools required beyond those listed in the Standard Tool Section.

1. Infrared Scanner, Raytek, Inc., #PM2EM-L2

2. Torque wrench

3. Digital Multimeter, Fluke #1TC676

Recommended Inspection Frequency

Do a Level III inspection when triggered by a Level II inspection.

References

1. Maintenance Technology/September 1993; Write-up Title: *"Infrared Keeps All Systems Go"*

2. Raining - Agema Infrared Systems; *"Measurement of Excess Temperatures with Infrared Scanners"*

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 11

COMPONENT: DISCONNECT SWITCHES (MEDIUM VOLTAGE)
CONTROL NUMBER: GS-III 29.01.06-11

Application

This guide applies to the investigation of a hot terminal or device that is overheating from the flow of current through that terminal or device.

Special Safety Requirements

No special safety requirements are needed for the performance of this Level III inspection beyond those required in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Verify the findings of Level II inspection by using the Infrared Scanner and measuring the temperatures of the device and terminals. If the device or terminals are not hot as indicated by the findings of Level II inspection, check the current flow through the device or terminals. Heat generated is proportionate to the square of the current. If there is little or no current flow through the device or terminal at the time of measurement, there will be no significant amount of heat generated.

2. For terminal connections, verify the type of conductor being terminated. If the conductor is an aluminum conductor, look for evidence of cold flow or melt down of conductor.

3. If there is evidence of cold flow or melt down of the aluminum conductor, the conductor should either be replaced or shortened and reconnected. When making new aluminum conductor terminations a joint compound should be used.

4. If the terminal is loose it should be tightened. De-energize prior to attempting tightening of terminal connections.

5. If none of the above is the problem than there is an internal problem and an on-site analysis must be made to determine if additional inspections are to be made or the unit is to be replaced.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 11 (Continued)

COMPONENT: DISCONNECT SWITCHES (MEDIUM VOLTAGE)
CONTROL NUMBER: GS-III 29.01.06-11

Special Tools and Equipment

The following is a list of special tools required beyond those listed in the Standard Tool Section.

1. Infrared Scanner, Raytek, Inc., #PM2EM-L2

2. Torque wrench

3. Digital Multimeter, Fluke #1TC676

Recommended Inspection Frequency

Do a Level III inspection when triggered by a Level II inspection.

References

1. Maintenance Technology/September 1993; Write-up Title: *"Infrared Keeps All Systems Go"*

2. Raining - Agema Infrared Systems; *"Measurement of Excess Temperatures with Infrared Scanners"*

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 12

COMPONENT: TRANSFORMER
CONTROL NUMBER: GS-III 29.01.07-12

Application

This guide applies to the investigation of 112.5 kVA transformers or larger that contain liquids used as electrical insulation and coolant.

Special Safety Requirements

No special safety requirements are needed for the performance of this Level III inspection beyond those required in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Verify the findings of Level I inspection concerning the corrosive condition of the tank containing the coolant and insulation liquid.

2. If the tank has corroded to the point where contaminated air could possibly pass through the tank wall an oil analysis should be performed.

3. If the liquid is contaminated, provide test to determine how the tank leaks.

4. Analyze the test results to determine whether the transformer can be repaired or must be replaced.

Special Tools and Equipment

The following is a list of special tools required beyond those listed in the Standard Tool Section.

1. Wire brush

2. Wrenches

3. Pressure gauge

4. Inert gas supply

Recommended Inspection Frequency

Do a Level III inspection when triggered by a Level I inspection.

References

1. Sverdrup Corporation

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 13

COMPONENT: TRANSFORMER
CONTROL NUMBER: GS-III 29.01.07-13

Application

This guide applies to the investigation of oil leaks in the transformer tank that has signs of oil on surface of the tank or an oil puddle under or around base of tank.

Special Safety Requirements

No special safety requirements are needed for the performance of this Level III inspection beyond those required in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Verify the findings of Level I inspection by finding the source of the oil. If the oil is coming from an external source no further inspection of the transformer is required. The external source should be identified and recommendations made to eliminate the contamination of the breaker.

2. If the oil source is coming from within the transformer, a determination should be made as how the oil is escaping.

3. If transformer repairs are made, oil analysis should be made after the repairs to determine if the oil is contaminated.

4. All contaminated oil should be removed and replaced with new oil.

Special Tools and Equipment

The following is a list of special tools required beyond those listed in the Standard Tool Section.

1. Brush

2. Non-flammable cleaning fluid

3. Wiping material

Recommended Inspection Frequency

Do a Level III inspection when triggered by a Level I inspection.

References

1. Sverdrup Corporation

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 14

COMPONENT: TRANSFORMER
CONTROL NUMBER: GS-III 29.01.07-14

Application

This guide applies to the investigation of 112.5 kVA transformers or larger that contain liquids used as electrical insulation and coolant.

Special Safety Requirements

No special safety requirements are needed for the performance of this Level III inspection beyond those required in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Verify the findings of Level I inspection concerning cooling fin blockage or low liquid level.

2. Do a liquid analysis test.

3. If liquid analysis test results are okay, add liquid to proper level requirements.

4. If fin blockage remains, have liquid removed and clear the fin blockage.

5. If liquid analysis test results show contaminates, have the liquid removed, the contaminates flushed out and new liquid added.

Special Tools and Equipment

The following is a list of special tools required beyond those listed in the Standard Tool Section.

1. Infrared scanner

2. Tools and sampling containers for taking liquid samples and transferring these samples to the lab.

3. Tools and liquid supplies for adding the appropriate liquid to the transformer tank.

Recommended Inspection Frequency

Do a Level III inspection when triggered by a Level I inspection.

References

1. Sverdrup Corporation

29.02 SUBSTATIONS

DESCRIPTION

Substation is a subsystem of the Site Electrical System. Substations receive power from high voltage power sources, transforms the incoming power to a lower voltage level and distributes the power to terminal points for distribution to remote distribution centers and/or end load devices. There are two types of substations, the single-ended and the double-ended units.

Single-ended substations receive power from a single power source. Power input to the substations is to a transformer located on one end of the substation. Power feed may connect directly to the primary (high voltage) side of the transformer or to a primary power switch that feeds the primary side of the transformer.

Double-ended substations receive power from two power sources. Power inputs to the substation are to two transformers, one located on each end of the substation. Power feed may connect directly to the primary (high voltage) side of the transformers or primary power switch that feed the primary side of the transformers.

Secondary bus in a single-ended substation is a continuous bus and the feeder power switches are fed from this bus. Secondary bus in a double-ended substation is divided in two sections and tied together by a tie power switch. Some of the feeder power switches are fed from one section of the bus and the remaining feeder power switches are fed from the other section.

In a single-ended substation the secondary bus feeding the terminal points is fed from one source, a single transformer. In a double-ended substation, if the tie power switch is closed, the secondary bus can be fed from either transformer or if the tie power switch is open each side of the secondary bus can be fed by the adjacent transformer.

SPECIAL TOOL AND EQUIPMENT REQUIREMENTS

The following special tool, beyond the requirements listed in the Standard Tool Section shall be provided to perform the inspection of the Substation:

1. Infrared scanner, Raytek, Inc., #PM2EM-L2

SPECIAL SAFETY REQUIREMENTS

Interior compartments containing devices rated above 600v shall not be inspected by Level I / Level II inspectors. No other special safety requirements are needed for the inspection of the Substation beyond the requirements listed in the Master Safety Plan and System Safety Section.

29.02 SUBSTATIONS

COMPONENT LIST

- ◆ 29.02.01 ENCLOSURES WITH BUS BARS
- ◆ 29.02.02 METERING
- ◆ 29.02.03 SURGE (LIGHTNING) ARRESTERS
- ◆ 29.02.04 INSULATORS
- ◆ 29.02.05 CIRCUIT BREAKERS (MEDIUM VOLTAGE)
- ◆ 29.02.06 CIRCUIT BREAKERS (LOW VOLTAGE)
- ◆ 29.02.07 DISCONNECT SWITCHES (MEDIUM VOLTAGE)
- ◆ 29.02.08 DISCONNECT SWITCHES (LOW VOLTAGE)
- ◆ 29.02.09 TRANSFORMERS
- ◆ 29.02.10 FOUNDATIONS
- ◆ 29.02.11 FENCING

RELATED SUBSYSTEMS

Due to the related nature of the elements requiring inspection, the following should be reviewed for concurrent inspection activities.

10.06 RACEWAYS
29.07 LIGHTNING PROTECTION/GROUNDING SYSTEM

STANDARD INSPECTION PROCEDURE

Components require a Level I or Level II inspection as part of the basic inspection process. Other additional Level II inspection may be indicated or "triggered" by a Level I inspection and should be accomplished by the inspector at that time. Level III inspection may be indicated or "triggered" by a Level I or II inspection Defect/Observation and should be accomplished at the direction of the Facility Manager.

Inspection should be carried out in the order of presentation for the various components with associated defects and observations for each subsystem listed in the inspector's CAIS.

29.02 SUBSTATIONS

COMPONENTS

◆ 29.02.01 ENCLOSURES WITH BUS BARS

Enclosures with bus bars, their connections and structural steel that make up the enclosure, for motor control centers, panelboards, switchboards, switchyard and substations, includes doors and panels that are not part of any equipment mounted in the enclosure. Doors and panels not included in the enclosure inspection are those for circuit breakers, disconnect switches, combination starters, etc. which would be inspected as part of those components.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
* **Corrosion:**			
Observation:			
a. Surface corrosion (no pitting evident). ***{Severity L}	SF		
b. Corrosion evidenced by pitting or blistering. ***{Severity M}	SF		
c. Corrosion evidenced by holes or loss of base metal. ***{Severity H}	SF		

Defect:

* **Physical Damage:**			
Observation:			
a. Panel fastener loose, broken or missing. ***{Severity L}	EA		
b. Excessive dust, dirt or moisture accumulation. ***{Severity L}	EA	1	
c. Enclosure mounting loose, broken or missing. ***{Severity M}	EA		
d. Enclosure damaged (cannot be sealed). ***{Severity M}	EA		
e. Unused opening not covered. ***{Severity M}	EA		
f. Vent opening blocked. ***{Severity M}	EA		
g. Air filters dirty or missing. ***{Severity L}	EA	1	
h. Unit not grounded. ***{Severity H}	EA	1	

29.02 SUBSTATIONS

COMPONENTS (Continued)

◆ 29.02.01 ENCLOSURES WITH BUS BARS (Continued)

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
* **Hot Spots:**			
Observation:			
a. Bus connection 5° to 24°C above ambient. ***{Severity M}	EA	2	1
b. Bus connection 25°C or more above ambient. ***{Severity H}	EA	2	1

29.02 SUBSTATIONS

COMPONENTS (Continued)

◆ 29.02.02 METERING

Metering consists of devices used to measure voltage, current and Kilowatt Hour (KWH) usage at given locations. KWH metering may include measuring peak demand loads over a billing period on a continuous basis or a 24 hour on-peak / off-peak load basis. The KWH and peak demand loads are usually measured by a single meter unit.

Depending on voltage levels, voltage signal for metering purposes can be taken directly across lines or from potential transformers connected across lines being monitored.

Depending on voltage levels and maximum current flow, ampere signals for metering purposes can be taken from current flow through the meters or signals from either shunts or current transformers connected to the lines being metered.

Current and voltage readings at metering points can be taken with individual meters or selector switches can be used in conjunction with meters such that a single ampere or volt meter along with its individual selector switch can read the current or voltage at multi metering points.

Defect:	**UOM**	**LEVEL II KEY**	**LEVEL III KEY**
*** Corrosion:**			
Observation:			
a. Surface corrosion (no pitting evident). ***{Severity L}	SF		
b. Corrosion evidenced by pitting or blistering. ***{Severity M}	SF		
c. Corrosion evidenced by holes or loss of base metal. ***{Severity H}	SF		

Defect:

*** Physical Damage:**			
Observation:			
a. Enclosure mounting loose, broken or missing. ***{Severity L}	EA		
b. Panel fastener loose, broken or missing. ***{Severity L}	EA		

29.02 SUBSTATIONS

COMPONENTS (Continued)

◆ 29.02.02 METERING (Continued)

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Physical Damage (Continued):**			
c. Enclosure damaged (cannot be sealed). ***{Severity M}	EA		
d. Glass broken or missing. ***{Severity M}	EA		
e. Selector switch broken or missing. ***{Severity M}	EA		
f. Unused opening not covered. ***{Severity M}	EA		
g. Meter broken. ***{Severity H}	EA		2

Defect:

*** Hot Spots:**			
Observation:			
a. Terminal 5° to 24°C above ambient. ***{Severity M}	EA	3	3
b. Terminal 25°C or more above ambient. ***{Severity H}	EA	3	3

29.02 SUBSTATIONS

COMPONENTS (Continued)

◆ 29.02.03 SURGE (LIGHTNING) ARRESTERS

Surge Arrester is a protective device for limiting surge voltages by discharging or bypassing surge current to ground. As soon as the surge voltage subsides to a low value the current to ground is quenched. The surge arrester is capable of repeating this function many times automatically without any outside input.

There are four basic arresters defined by industry standards; secondary, distribution, intermediate, and station type. These arresters utilize expulsion, silicone carbide valve element, or metal oxide valve element technology to consistently limit voltage surges to a known or controlled level.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Corrosion:**			
Observation:			
a. Corrosion evidenced by holes or loss of base metal.	SF		
***{Severity H}			

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Physical Damage:**			
Observation:			
a. Arrester chipped or cracked.	EA		
***{Severity M}			
b. Arrester broken or missing.	EA		
***{Severity H}			
c. Arrester mounting broken.	EA		
***{Severity H}			
d. Unit not grounded.	EA		
***{Severity H}			

29.02 SUBSTATIONS

COMPONENTS (Continued)

◆ 29.02.04 INSULATORS

Insulators are intended to give flexible or rigid support to electrical conductors or equipment and to electrically separate those conductors or equipment from ground or from other construction components, conductors, or equipment. An insulator can consist of one or more non-conducting parts to which metal fittings are permanently attached.

A variety of insulators are used in distribution applications including; pin insulators, suspension insulators, deadening insulators, line post insulators, station post insulators, spool insulators, and guy strain insulators.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Physical Damage:**			
Observation:			
a. Insulator chipped or cracked ***{Severity M}	EA		
b. Insulator broken or missing. ***{Severity H}	EA		
c. Insulator mounting broken ***{Severity H}	EA		
Defect:			
*** Hot Spots:**			
Observation:			
a. Terminal 5° to 24°C above ambient. ***{Severity M}	EA	4	4
b. Terminal 25°C or more above ambient. ***{Severity H}	EA	4	4

29.02 SUBSTATIONS

COMPONENTS (Continued)

◆ 29.02.05 CIRCUIT BREAKERS (MEDIUM VOLTAGE)

Circuit breakers (medium voltage) are devices used to disconnect loads rated from 601 volts to 35 kV. These type of breakers open and close a circuit when signaled from an outside source. These sources are current and voltage sensing devices such as relays and solid state devices with their associated potential and current transformers or by pushbuttons or selector switches that are manually operated.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Corrosion:**			
Observation:			
a. Surface corrosion (no pitting evident).	SF		
***{Severity L}			
b. Corrosion evidenced by pitting or blistering.	SF		
***{Severity M}			
c. Corrosion evidenced by holes or loss of base metal.	SF		
***{Severity H}			

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Physical Damage:**			
Observation:			
a. Enclosure mounting loose, broken or missing.	EA		
***{Severity L}			
b. Panel fastener loose, broken or missing.	EA		
***{Severity L}			
c. Enclosure damaged (cannot be sealed).	EA		
***{Severity M}			
d. Unused opening not covered.	EA		
***{Severity M}			
e. Security devices missing or inoperable.	EA		
***{Severity H}			
f. Door handle bent or inoperable.	EA		
***{Severity H}			
g. Circuit breaker broken or damaged.	EA		
***{Severity H}			
h. Pilot light damaged or inoperable.	EA		
***{Severity H}			
i. Light monitoring breakers position not lit.	EA		
***{Severity H}			

29.02 SUBSTATIONS

COMPONENTS (Continued)

◆ 29.02.05 CIRCUIT BREAKERS (MEDIUM VOLTAGE) (Continued)

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Oil Leak:**			
Observation:			
a. Oil on surface of tank (possible oil leak). ***{Severity L}	EA		11
b. Oil puddle under or around base of tank. ***{Severity H}	EA		11

Defect:

	UOM	LEVEL II KEY	LEVEL III KEY
*** Hot Spots:**			
Observation:			
a. Terminal or breaker body 5 to 24°C above ambient. ***{Severity M}	EA	10	12
b. Terminal or breaker body 25°C or more above ambient. ***{Severity H}	EA	10	12

29.02 SUBSTATIONS

COMPONENTS (Continued)

◆ 29.02.06 CIRCUIT BREAKERS (LOW VOLTAGE)

Circuit breakers (low voltage) are devices used to disconnect loads rated 600 volts or less from its source. They contain built-in overcurrent and undervoltage devices to protect down stream conductors and equipment from overcurrent loads. These breakers can be operated automatically by built-in devices or by manually built-in toggle switches.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Corrosion:**			
Observation:			
a. Surface corrosion (no pitting evident). ***{Severity L}	SF		
b. Corrosion evidenced by pitting or blistering. ***{Severity M}	SF		
c. Corrosion evidenced by holes or loss of base metal. ***{Severity H}	SF		

Defect:

*** Physical Damage:**			
Observation:			
a. Enclosure mounting loose, broken or missing. ***{Severity L}	EA		
b. Panel fastener loose, broken or missing. ***{Severity L}	EA		
c. Enclosure damaged (cannot be sealed). ***{Severity M}	EA		
d. Unused opening not covered. ***{Severity M}	EA		
e. Door handle bent or inoperable. ***{Severity H}	EA		
f. Circuit breaker broken or damaged. ***{Severity H}	EA	5	
g. Security device missing or inoperable. ***{Severity H}	EA		

29.02 SUBSTATIONS

COMPONENTS (Continued)

◆ 29.02.06 CIRCUIT BREAKERS (LOW VOLTAGE) (Continued)

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
* **Hot Spots:**			
Observation:			
a. Terminal or breaker body 5° to 24°C above ambient. ***{Severity M}	EA	6	5
b. Terminal or breaker body 25°C or more above ambient. ***{Severity H}	EA	6	5

29.02 SUBSTATIONS

COMPONENTS (Continued)

◆ 29.02.07 DISCONNECT SWITCHES (MEDIUM VOLTAGE)

Fused cut-outs for the purpose of this inspection are considered disconnect switches. Disconnect switches (medium voltage) are devices used to disconnect loads rated from 601 volts to 35 kV from its source.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Corrosion:**			
Observation:			
a. Surface corrosion (no pitting evident). ***{Severity L}	SF		
b. Corrosion evidenced by pitting or blistering. ***{Severity M}	SF		
c. Corrosion evidenced by holes or loss of base metal. ***{Severity H}	SF		

Defect:

*** Physical Damage:**			
Observation:			
a. Enclosure mounting loose, broken or missing. ***{Severity L}	EA		
b. Panel fastener loose, broken or missing. ***{Severity L}	EA		
c. Enclosure damaged (cannot be sealed). ***{Severity M}	EA		
d. Unused opening not covered. ***{Severity M}	EA		
e. Door handle bent or inoperable. ***{Severity H}	EA		
f. Security devices missing or inoperable. ***{Severity H}	EA		
g. Insulator damage. ***{Severity H}	EA		
h. Carbon tracking due to flashovers. ***{Severity H}	EA		
i. Discoloration of blades and contacts due to overheating. ***{Severity H}	EA		

29.02 SUBSTATIONS

COMPONENTS (Continued)

◆ 29.02.07 DISCONNECT SWITCHES (MEDIUM VOLTAGE) (Continued)

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
* **Hot Spots:**			
Observation:			
a. Terminal or switch body 5 to 24°C above ambient.	EA	11	13
***{Severity M}			
b. Terminal or switch body 25°C or more above ambient.	EA	11	13
***{Severity H}			

29.02 SUBSTATIONS

COMPONENTS (Continued)

◆ 29.02.08 DISCONNECT SWITCHES (LOW VOLTAGE)

Disconnect switches (low voltage) are devices used to disconnect loads rated 600 volts or less from its source. Two types of disconnect switches are fused or non-fused. Disconnect switches are normally manually operated but could be electrically operated.

Disconnect switch with a fuse unit provides both overload and short circuit protection.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
* **Corrosion:**			
Observation:			
a. Surface corrosion (no pitting evident). ***{Severity L}	SF		
b. Corrosion evidenced by pitting or blistering. ***{Severity M}	SF		
c. Corrosion evidenced by holes or loss of base metal. ***{Severity H}	SF		

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
* **Physical Damage:**			
Observation:			
a. Enclosure mounting loose, broken or missing. ***{Severity L}	EA		
b. Panel fastener loose, broken or missing. ***{Severity L}	EA		
c. Enclosure damaged (cannot be sealed). ***{Severity M}	EA		
d. Door handle bent or inoperable. ***{Severity H}	EA		
e. Unused opening not covered. ***{Severity M}	EA		
f. Security devices missing or inoperable. ***{Severity H}	EA		
g. Carbon tracking due to flashovers. ***{Severity H}	EA	7	
h. Discoloration of blades and contacts due to overheating. ***{Severity H}	EA	7	

29.02 SUBSTATIONS

COMPONENTS (Continued)

◆ 29.02.08 DISCONNECT SWITCHES (LOW VOLTAGE) (Continued)

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
* **Hot Spots:**			
Observation:			
a. Terminal, blade end or fuse clip 5° to 24°C above ambient. ***{Severity M}	EA	8	6
b. Terminal, blade end or fuse clip 25°C or more above ambient. ***{Severity H}	EA	8	6

29.02 SUBSTATIONS

COMPONENTS (Continued)

◆ 29.02.09 TRANSFORMERS

Transformers are static electric devices consisting of a single winding or multiple coupled windings with or without a magnetic core. Power is transferred by electromagnetic induction from the input to the output circuit usually with changed values of voltages and currents.

Transformers have six types of functions: power transformers converts one voltage source to another voltage power source, isolation transformers shields the load side winding from the line side winding, reduced voltage starting transformers reduces the motor terminal voltage during the starting cycle, buck/boost transformers either raise or lower output voltage to accommodate the load, current transformers proportions a high current flow to a low current flow for instrumentation and control purpose and potential transformers proportions a high voltage potential to a low voltage potential for instrumentation and control purposes.

Transformers, other than current and potential transformers, smaller than 5 kVA single phase or 15 kVA multi phase will not be inspected. All current and potential transformers will be inspected.

Surge (lightning) arresters, insulators, foundations, poles and conductors bare will be inspected under separate components.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Corrosion:**			
Observation:			
a. Surface corrosion (no pitting evident). ***{Severity L}	SF		
b. Corrosion evidenced by pitting or blistering. ***{Severity M}	SF		14
c. Corrosion evidenced by holes or loss of base metal. ***{Severity H}	SF		14

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Physical Damage:**			
Observation:			
a. Enclosure mounting loose, broken or missing. ***{Severity L}	EA		
b. Panel fastener loose, broken or missing. ***{Severity L}	EA		
c. Enclosure damaged (cannot be sealed). ***{Severity M}	EA		
d. Air intake/exhaust ducts blocked. ***{Severity M}	EA		

29.02 SUBSTATIONS

COMPONENTS (Continued)

◆ 29.02.09 TRANSFORMERS (Continued)

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Physical Damage (continued):**			
e. Air filter dirty or missing. ***{Severity M}	EA		
f. Unused opening not covered. ***{Severity M}	EA		
g. Pole mounted transformer leads bare. ***{Severity M}	EA		
h. Cooling fan guard/blade broken or missing. ***{Severity H}	EA		
i. Unit not grounded. ***{Severity H}	EA		
j. Gauge or meter broken or missing. ***{Severity M}	EA		
k. Security lock missing or inoperable. ***{Severity H}	EA		

Defect:

*** Oil Leak:** Observation:			
a. Oil on surface of tank (possible oil leak). ***{Severity L}	EA		15
b. Oil puddle under or around base of tank. ***{Severity H}	EA		15

Defect:

*** Hot Spots:** Observation:			
a. Terminal 5° to 24°C above ambient. ***{Severity M}	EA	9	7
b. Terminal 25°C or more above ambient. ***{Severity H}	EA	9	7
c. Oil cooling fin blocked. ***{Severity H}	EA		16
d. Low oil level (less than 2" above fin). ***{Severity H}	EA		16

29.02 SUBSTATIONS

COMPONENTS (Continued)

◆ 29.02.10 FOUNDATIONS

Foundations consist of cast-in-place concrete footings and piers through which the loads of structures are transmitted to the earth. Anchor bolts are embedded in the concrete, to connect the structure or equipment to the foundation.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Cracking:**			
Observation:			
a. Cracks, between 1/16" and 1/4" wide. ***{Severity M}	LF		8
b. Disintegration of surface or cracks exceeding 2" depth. ***{Severity H}	LF		8
Defect:			
*** Spalling:**			
Observation:			
a. Not more than 1" deep or 6" in diameter. ***{Severity L}	SF		
b. More than 1" in depth or 6" in dia., or 10% of surface area loss. ***{Severity H}	SF		
c. Disintegration of surface area, with corrosion of exposed rebar. ***{Severity H}	SF		9
Defect:			
*** Scaling:**			
Observation:			
a. Surface loss of 1/2" to 1" deep, with coarse aggregates exposed. ***{Severity M}	SF		
b. Loss of surface exceeding 1" deep. ***{Severity H}	SF		
c. Exposure of reinforcing steel. ***{Severity H}	SF		9
Defect:			
*** Reinforcing Steel Corrosion:**			
Observation:			
a. Rusting evident, cracks occurring along rebar. ***{Severity H}	LF		9

29.02 SUBSTATIONS

COMPONENTS (Continued)

◆ 29.02.11 FENCING

Fencing, serving as enclosures for electrical equipment, are constructed from metal material. Fencing includes posts, chain link material, security wires, gates and post foundations.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
* **Corrosion:**			
Observation:			
a. Surface corrosion (no pitting evident). ***{Severity L}	SF		
b. Corrosion evidenced by pitting or blistering. ***{Severity M}	SF		
c. Corrosion evidenced by holes or loss of base metal. ***{Severity H}	EA		

Defect:

* **Sagging/Cuts:**			
Observation:			
a. Loose or sagging security wire. ***{Severity M}	LF		
b. Holes in fence material. ***{Severity H}	LF		
c. Loose or sagging fence material. ***{Severity H}	SF		
d. Broken or missing security wire. ***{Severity H}	LF		

Defect:

* **Connections/Devices:**			
Observation:			
a. Loose bolts or wire fasteners. ***{Severity M}	EA		
b. Loose or bent pipe posts, bracing and railing. ***{Severity H}	EA		
c. Missing or broken hinges, latches, bolts and fasteners. ***{Severity H}	EA		
d. Gate locking device missing or inoperable. ***{Severity H}	EA		
e. High voltage danger sign missing or illegible. ***{Severity H}	EA		

29.02 SUBSTATIONS

COMPONENTS (Continued)

◆ 29.02.11 FENCING (Continued)

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Misalignment/Bowed Deflection:**			
Observation:			
a. Fence wall tilted between 2" - 3". ***{Severity L}	LF		
b. Fence wall tilted between 3"-6". ***{Severity M}	LF		
c. Binding gate. ***{Severity M}	EA		
d. Sagging gate. ***{Severity M}	EA		
e. Fence wall tilted more than 6". ***{Severity H}	LF		
f. Gate difficult or impossible to open. ***{Severity H}	EA		

Defect:

*** Erosion/Vegetation:**			
Observation:			
a. Soil erosion around posts or under fence wall. ***{Severity M}	CY		
b. Vines, trees or shrubs climbing over or growing into fence. ***{Severity M}	LF		
c. Post foundation exposed due to erosion. ***{Severity H}	CY		

Defect:

*** Grounding:**			
Observation:			
a. Ground connection missing. ***{Severity H}	EA		
b. Gate not grounded to fence. ***{Severity H}	EA		
c. Fence not grounded. ***{Severity H}	EA		

29.02 SUBSTATIONS

REFERENCES

1. DOE CAS Manual, Volume 9: 0.09, Electrical

2. National Fire Protection Association (NFPA 70B) *"Recommended Practice for Electrical Equipment Maintenance"*, 1990 Edition

3. MEANS *"Maintenance Standards"*, Roger W. Liska, PE, AK 1988

4. Iowa Administrative Code, Utilities [199], Chapter 25, Iowa Electrical Safety Code IAC 8/5/92

5. MEANS *"Facilities Maintenance & Repair Cost Data"*, 1994

6. *"Handbook of Building and Plant Maintenance Forms and Checklists"* by Roger W. Liska and Judith Morrison Liska

29.02 SUBSTATIONS

LEVEL II KEY	GUIDE SHEET CONTROL NUMBER
1	GS-II 29.02.01-1
2	GS-II 29.02.01-2
3	GS-II 29.02.02-3
4	GS-II 29.02.04-4
5	GS-II 29.02.06-5
6	GS-II 29.02.06-6
7	GS-II 29.02.08-7
8	GS-II 29.02.08-8
9	GS-II 29.02.09-9
10	GS-II 29.02.05-10
11	GS-II 29.02.07-11

LEVEL III KEY	GUIDE SHEET CONTROL NUMBER
1	GS-III 29.02.01-1
2	GS-III 29.02.02-2
3	GS-III 29.02.02-3
4	GS-III 29.02.04-4
5	GS-III 29.02.06-5
6	GS-III 29.02.08-6
7	GS-III 29.02.09-7
8	GS-III 29.02.10-8
9	GS-III 29.02.10-9
10*	GS-III 29.02-10*
11	GS-III 29.02.05-11
12	GS-III 29.02.05-12
13	GS-III 29.02.07-13
14	GS-III 29.02.09-14
15	GS-III 29.02.09-15
16	GS-III 29.02.09-16

* Indicates guide sheets which are not directly referenced by a Key. These are "triggered" by information beyond the inspection process such as time, age or repeated service calls.

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 1

COMPONENT: ENCLOSURES WITH BUS BARS
CONTROL NUMBER: GS-II 29.02.01-1

Application

This guide applies to the investigation of the inside of an enclosure, containing bare, energized, electrical parts.

Special Safety Requirements

The following list of special safety requirements, beyond the requirements listed in the Master Safety Plan and System Safety Section, are to be observed in the performance of this inspection.

1. This inspection guide applies to enclosures containing live electrical parts having a potential of 600 volts or less above ground. If the enclosure contains circuitry of higher potential, do not use this inspection guide.

2. Any enclosure that is padlocked for safety reason is not to be opened unless okayed by the person having control of the key.

3. Inspector needs to carefully open, inspect the inside and close the enclosure without shutting down the equipment, and without creating a hazard to himself.

Inspection Actions

1. Open panels or doors carefully as required for doing the visual inspection.

2. Visually inspect for those physical damaged defects that are listed and tagged Level II Key No. as indicated above.

3. Close panels or doors carefully after the inspection is completed.

Recommended Inspection Frequency

Do a Level II inspection each time a Level I inspection indicates one is required.

References

1. Sverdrup Corporation

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 2

COMPONENT: ENCLOSURES WITH BUS BARS
CONTROL NUMBER: GS-II 29.02.01-2

Application

This guide applies to the investigation of the inside of an enclosure, containing bare, energized, electrical parts.

Special Safety Requirements

The following list of special safety requirements, beyond the requirements listed in the Master Safety Plan and System Safety Section, are to be observed in the performance of this inspection.

1. This inspection guide applies to enclosures containing live electrical parts having a potential of 600 volts or less above ground. If the enclosure contains circuitry of higher potential, do not use this inspection guide.

2. Any enclosure that is padlocked for safety reason is not to be opened unless okayed by the person having control of the key.

3. Inspector needs to carefully open, inspect the inside and close the enclosure without shutting down the equipment, and without creating a hazard to himself.

Inspection Actions

1. Open panels or doors carefully and to the degree required for scanning those devices being tested.

2. Make temperature measurements with an infrared scanner.

3. Measure the ambient temperature by measuring a spot on the inside of the enclosure that is least effected by any internal panel heat source.

4. Measure the temperature of the device specified.

5. Above-ambient temperature is calculated by subtracting the ambient temperature from the device temperature.

6. Record the results.

7. Close panels or doors carefully after the inspection is complete.

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 2 (Continued)

COMPONENT: ENCLOSURES WITH BUS BARS
CONTROL NUMBER: GS-II 29.02.01-2

Recommended Inspection Frequency

Do a Level II inspection each time a Level I inspection is made.

References

1. Maintenance Technology/September 1993; Write-up Title: *"Infrared Keeps All Systems Go"*

2. Raining - Agema Infrared Systems; *"Measurement of Excess Temperatures with Infrared Scanners"*

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 3

COMPONENT: METERING
CONTROL NUMBER: GS-II 29.02.02-3

Application

This guide applies to the investigation of the inside of an enclosure, containing bare, energized, electrical parts.

Special Safety Requirements

The following list of special safety requirements, beyond the requirements listed in the Master Safety Plan and System Safety Section, are to be observed in the performance of this inspection.

1. This inspection guide applies to enclosures containing live electrical parts having a potential of 600 volts or less above ground. If the enclosure contains circuitry of higher potential, do not use this inspection guide.

2. Any enclosure that is padlocked for safety reason is not to be opened unless okayed by the person having control of the key.

3. Inspector needs to carefully open, inspect the inside and close the enclosure without shutting down the equipment, and without creating a hazard to himself.

Inspection Actions

1. Open panels or doors carefully and to the degree required for scanning those devices being tested.

2. Make temperature measurements with an infrared scanner.

3. Measure the ambient temperature by measuring a spot on the inside of the enclosure that is least effected by any internal panel heat source.

4. Measure the temperature of the device specified.

5. Above-ambient temperature is calculated by subtracting the ambient temperature from the device temperature.

6. Record the results.

7. Close panels or doors carefully after the inspection is complete.

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 3 (Continued)

COMPONENT: METERING
CONTROL NUMBER: GS-II 29.02.02-3

Recommended Inspection Frequency

Do a Level II inspection each time a Level I inspection is made.

References

1. Maintenance Technology/September 1993; Write-up Title: *"Infrared Keeps All Systems Go"*

2. Raining - Agema Infrared Systems; *"Measurement of Excess Temperatures with Infrared Scanners"*

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 4

COMPONENT: INSULATORS
CONTROL NUMBER: GS-II 29.02.04-4

Application

This guide applies to the investigation of the inside of an enclosure, containing bare, energized, electrical parts.

Special Safety Requirements

The following list of special safety requirements, beyond the requirements listed in the Master Safety Plan and System Safety Section, are to be observed in the performance of this inspection.

1. This inspection guide applies to enclosures containing live electrical parts having a potential of 600 volts or less above ground. If the enclosure contains circuitry of higher potential, do not use this inspection guide.

2. Any enclosure that is padlocked for safety reason is not to be opened unless okayed by the person having control of the key.

3. Inspector needs to carefully open, inspect the inside and close the enclosure without shutting down the equipment, and without creating a hazard to himself.

Inspection Actions

1. Open panels or doors carefully and to the degree required for scanning those devices being tested.

2. Make temperature measurements with an infrared scanner.

3. Measure the ambient temperature by measuring a spot on the inside of the enclosure that is least effected by any internal panel heat source.

4. Measure the temperature of the device specified.

5. Above-ambient temperature is calculated by subtracting the ambient temperature from the device temperature.

6. Record the results.

7. Close panels or doors carefully after the inspection is complete.

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 4 (Continued)

COMPONENT: INSULATORS
CONTROL NUMBER: GS-II 29.02.04-4

Recommended Inspection Frequency

Do a Level II inspection each time a Level I inspection is made.

References

1. Maintenance Technology/September 1993; Write-up Title: *"Infrared Keeps All Systems Go"*

2. Raining - Agema Infrared Systems; *"Measurement of Excess Temperatures with Infrared Scanners"*

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 5

COMPONENT: CIRCUIT BREAKERS (LOW VOLTAGE)
CONTROL NUMBER: GS-II 29.02.06-5

Application

This guide applies to the investigation of the inside of an enclosure, containing bare, energized, electrical parts.

Special Safety Requirements

The following list of special safety requirements, beyond the requirements listed in the Master Safety Plan and System Safety Section, are to be observed in the performance of this inspection.

1. This inspection guide applies to enclosures containing live electrical parts having a potential of 600 volts or less above ground. If the enclosure contains circuitry of higher potential, do not use this inspection guide.

2. Any enclosure that is padlocked for safety reason is not to be opened unless okayed by the person having control of the key.

3. Inspector needs to carefully open, inspect the inside and close the enclosure without shutting down the equipment, and without creating a hazard to himself.

Inspection Actions

1. Open panels or doors carefully as required for doing the visual inspection.

2. Visually inspect for those physical damaged defects that are listed and tagged Level II Key No. as indicated above.

3. Close panels or doors carefully after the inspection is completed.

Recommended Inspection Frequency

Do a Level II inspection each time a Level I inspection indicates one is required.

References

1. Sverdrup Corporation

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 6

COMPONENT: CIRCUIT BREAKERS (LOW VOLTAGE)
CONTROL NUMBER: GS-II 29.02.06-6

Application

This guide applies to the investigation of the inside of an enclosure, containing bare, energized, electrical parts.

Special Safety Requirements

The following list of special safety requirements, beyond the requirements listed in the Master Safety Plan and System Safety Section, are to be observed in the performance of this inspection.

1. This inspection guide applies to enclosures containing live electrical parts having a potential of 600 volts or less above ground. If the enclosure contains circuitry of higher potential, do not use this inspection guide.

2. Any enclosure that is padlocked for safety reason is not to be opened unless okayed by the person having control of the key.

3. Inspector needs to carefully open, inspect the inside and close the enclosure without shutting down the equipment, and without creating a hazard to himself.

Inspection Actions

1. Open panels or doors carefully and to the degree required for scanning those devices being tested.

2. Make temperature measurements with an infrared scanner.

3. Measure the ambient temperature by measuring a spot on the inside of the enclosure that is least effected by any internal panel heat source.

4. Measure the temperature of the device specified.

5. Above-ambient temperature is calculated by subtracting the ambient temperature from the device temperature.

6. Record the results.

7. Close panels or doors carefully after the inspection is complete.

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 6 (Continued)

COMPONENT: CIRCUIT BREAKERS (LOW VOLTAGE)
CONTROL NUMBER: GS-II 29.02.06-6

Recommended Inspection Frequency

Do a Level II inspection each time a Level I inspection is made.

References

1. Maintenance Technology/September 1993; Write-up Title: *"Infrared Keeps All Systems Go"*

2. Raining - Agema Infrared Systems; *"Measurement of Excess Temperatures with Infrared Scanners"*

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 7

COMPONENT: DISCONNECT SWITCHES (LOW VOLTAGE)
CONTROL NUMBER: GS-II 29.02.08-7

Application

This guide applies to the investigation of the inside of an enclosure, containing bare, energized, electrical parts.

Special Safety Requirements

The following list of special safety requirements, beyond the requirements listed in the Master Safety Plan and System Safety Section, are to be observed in the performance of this inspection.

1. This inspection guide applies to enclosures containing live electrical parts having a potential of 600 volts or less above ground. If the enclosure contains circuitry of higher potential, do not use this inspection guide.

2. Any enclosure that is padlocked for safety reason is not to be opened unless okayed by the person having control of the key.

3. Inspector needs to carefully open, inspect the inside and close the enclosure without shutting down the equipment, and without creating a hazard to himself.

Inspection Actions

1. Open panels or doors carefully as required for doing the visual inspection.

2. Visually inspect for those physical damaged defects that are listed and tagged Level II Key No. as indicated above.

3. Close panels or doors carefully after the inspection is completed.

Recommended Inspection Frequency

Do a Level II inspection each time a Level I inspection indicates one is required.

References

1. Sverdrup Corporation

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 8

COMPONENT: DISCONNECT SWITCHES (LOW VOLTAGE)
CONTROL NUMBER: GS-II 29.02.08-8

Application

This guide applies to the investigation of the inside of an enclosure, containing bare, energized, electrical parts.

Special Safety Requirements

The following list of special safety requirements, beyond the requirements listed in the Master Safety Plan and System Safety Section, are to be observed in the performance of this inspection.

1. This inspection guide applies to enclosures containing live electrical parts having a potential of 600 volts or less above ground. If the enclosure contains circuitry of higher potential, do not use this inspection guide.

2. Any enclosure that is padlocked for safety reason is not to be opened unless okayed by the person having control of the key.

3. Inspector needs to carefully open, inspect the inside and close the enclosure without shutting down the equipment, and without creating a hazard to himself.

Inspection Actions

1. Open panels or doors carefully and to the degree required for scanning those devices being tested.

2. Make temperature measurements with an infrared scanner.

3. Measure the ambient temperature by measuring a spot on the inside of the enclosure that is least effected by any internal panel heat source.

4. Measure the temperature of the device specified.

5. Above-ambient temperature is calculated by subtracting the ambient temperature from the device temperature.

6. Record the results.

7. Close panels or doors carefully after the inspection is complete.

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 8 (Continued)

COMPONENT: DISCONNECT SWITCHES (LOW VOLTAGE)
CONTROL NUMBER: GS-II 29.02.08-8

Recommended Inspection Frequency

Do a Level II inspection each time a Level I inspection is made.

References

1. Maintenance Technology/September 1993; Write-up Title: *"Infrared Keeps All Systems Go"*

2. Raining - Agema Infrared Systems; *"Measurement of Excess Temperatures with Infrared Scanners"*

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 9

COMPONENT: TRANSFORMERS
CONTROL NUMBER: GS-II 29.02.09-9

Application

This guide applies to the investigation of the inside of an enclosure, containing bare, energized, electrical parts.

Special Safety Requirements

The following list of special safety requirements, beyond the requirements listed in the Master Safety Plan and System Safety Section, are to be observed in the performance of this inspection.

1. This inspection guide applies to enclosures containing live electrical parts having a potential of 600 volts or less above ground. If the enclosure contains circuitry of higher potential, do not use this inspection guide.

2. Any enclosure that is padlocked for safety reason is not to be opened unless okayed by the person having control of the key.

3. Inspector needs to carefully open, inspect the inside and close the enclosure without shutting down the equipment, and without creating a hazard to himself.

Inspection Actions

1. Open panels or doors carefully and to the degree required for scanning those devices being tested.

2. Make temperature measurements with an infrared scanner.

3. Measure the ambient temperature by measuring a spot on the inside of the enclosure that is least effected by any internal panel heat source.

4. Measure the temperature of the device specified.

5. Above-ambient temperature is calculated by subtracting the ambient temperature from the device temperature.

6. Record the results.

7. Close panels or doors carefully after the inspection is complete.

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 9 (Continued)

COMPONENT: TRANSFORMERS
CONTROL NUMBER: GS-II 29.02.09-9

Recommended Inspection Frequency

Do a Level II inspection each time a Level I inspection is made.

References

1. Maintenance Technology/September 1993; Write-up Title: *"Infrared Keeps All Systems Go"*

2. Raining - Agema Infrared Systems; *"Measurement of Excess Temperatures with Infrared Scanners"*

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 10

COMPONENT: CIRCUIT BREAKERS (MEDIUM VOLTAGE)
CONTROL NUMBER: GS-II 29.02.05-10

Application

This guide applies to the investigation of the inside of an enclosure, containing bare, energized, electrical parts.

Special Safety Requirements

The following list of special safety requirements, beyond the requirements listed in the Master Safety Plan and System Safety Section, are to be observed in the performance of this inspection.

1. This inspection guide applies to enclosures containing live electrical parts having a potential of 601 volts or more above ground.
2. Any enclosure that is padlocked for safety reason is not to be opened unless okayed by the person having control of the key.
3. Inspector needs to carefully open, inspect the inside and close the enclosure without shutting down the equipment, and without creating a hazard to himself.

Inspection Actions

1. Open panels or doors carefully as required for doing the visual inspection.
2. Visually inspect for those physical damaged defects that are listed and tagged Level II Key No. as indicated above.
3. Close panels or doors carefully after the inspection is completed.

Recommended Inspection Frequency

Do a Level II inspection each time a Level I inspection is performed on this equipment.

References

1. Sverdrup Corporation

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 11

COMPONENT: DISCONNECT SWITCHES (MEDIUM VOLTAGE)
CONTROL NUMBER: GS-II 29.02.07-11

Application

This guide applies to the investigation of the inside of an enclosure, containing bare, energized, electrical parts.

Special Safety Requirements

The following list of special safety requirements, beyond the requirements listed in the Master Safety Plan and System Safety Section, are to be observed in the performance of this inspection.

1. This inspection guide applies to enclosures containing live electrical parts having a potential of 601 volts or more above ground.

2. Any enclosure that is padlocked for safety reason is not to be opened unless okayed by the person having control of the key.

3. Inspector needs to carefully open, inspect the inside and close the enclosure without shutting down the equipment, and without creating a hazard to himself.

Inspection Actions

1. Open panels or doors carefully as required for doing the visual inspection.

2. Visually inspect for those physical damaged defects that are listed and tagged Level II Key No. as indicated above.

3. Close panels or doors carefully after the inspection is completed.

Recommended Inspection Frequency

Do a Level II inspection each time a Level I is performed on this equipment.

References

1. Sverdrup Corporation

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 1

COMPONENT: ENCLOSURES WITH BUS BARS
CONTROL NUMBER: GS-III 29.02.01-1

Application

This guide applies to the investigation of a hot terminal or device that is overheating from the flow of current through that terminal or device.

Special Safety Requirements

No special safety requirements are needed for the performance of this Level III inspection beyond those required in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Verify the findings of Level II inspection by using the Infrared Scanner and measuring the temperatures of the device and terminals. If the device or terminals are not hot as indicated by the findings of Level II inspection, check the current flow through the device or terminals. Heat generated is proportionate to the square of the current. If there is little or no current flow through the device or terminal at the time of measurement, there will be no significant amount of heat generated.

2. For terminal connections, verify the type of conductor being terminated. If the conductor is an aluminum conductor, look for evidence of cold flow or melt down of conductor.

3. If there is evidence of cold flow or melt down of the aluminum conductor, the conductor should either be replaced or shortened and reconnected. When making new aluminum conductor terminations a joint compound should be used.

4. If the terminal is loose it should be tightened. De-energize prior to attempting tightening of terminal connections.

5. If none of the above is the problem than there is an internal problem and an on-site analysis must be made to determine if additional inspections are to be made or the unit is to be replaced.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 1 (Continued)

COMPONENT: ENCLOSURES WITH BUS BARS
CONTROL NUMBER: GS-III 29.02.01-1

Special Tools and Equipment

The following is a list of special tools required beyond those listed in the Standard Tool Section.

1. Infrared Scanner, Raytek, Inc., #PM2EM-L2
2. Torque wrench
3. Digital Multimeter, Fluke #1TC676

Recommended Inspection Frequency

Do a Level III inspection when triggered by a Level II inspection.

References

1. Maintenance Technology/September 1993; Write-up Title: *"Infrared Keeps All Systems Go"*
2. Raining - Agema Infrared Systems; *"Measurement of Excess Temperatures with Infrared Scanners"*

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 2

COMPONENT: METERING
CONTROL NUMBER: GS-III 29.02.02-2

Application

This guide applies to the investigation of a broken meter that has received physical damage or is not operating.

Special Safety Requirements

No special safety requirements are needed for the performance of this Level III inspection beyond those required in the Master Safety Plan and System Safety Section.

Inspection Actions

1. For physically damaged units, inspect to verify if the unit is damaged to the point where it is no longer sealed from dust, water or insects entering the housing. If the seal is broken the housing should be replaced and the existing meter should be repaired or discarded.

2. If the meter is not operating, follow the following procedure:

   a. Check all fuses and replace those fuses that are blown.
   b. Check current transformers (CT) for output when power is being used. CT may be burnt out or overloaded. CT secondary circuit must not be opened or overloaded when current flows through the primary. Under the above operating conditions the CT could be destroyed.
   c. Check potential transformers (PT) for output when power is on. PT may not provide the proper voltage output.
   d. Check selector switches for proper operation and low contact resistance. If switch is malfunctioning it should be replaced.
   e. Check circuitry for proper connections. Any improper connection could cause damage to the meter, CT or PT. Damaged devices need to be repaired or replaced.
   f. Check all electrical terminals for loose connections and tighten those required.
   g. Check for broken and insulation-damaged conductors. Replace conductors as required.
   h. After the above items have been checked out, the necessary repairs and replacements have been made and the meter is still malfunctioning, the meter should be replaced and the original meter sent to the shop for repair or scrapping.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 2 (Continued)

COMPONENT: METERING
CONTROL NUMBER: GS-III 29.02.02-2

Special Tools and Equipment

The following is a list of special instruments required beyond those listed in the Standard Tool Section.

1. Digital Multimeter, Fluke #1TC67

Recommended Inspection Frequency

Do a Level III inspection only when triggered by a Level I inspection.

References

1. Sverdrup Corporation

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 3

COMPONENT: METERING
CONTROL NUMBER: GS-III 29.02.02-3

Application

This guide applies to the investigation of a hot terminal or device that is overheating from the flow of current through that terminal or device.

Special Safety Requirements

No special safety requirements are needed for the performance of this Level III inspection beyond those required in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Verify the findings of Level II inspection by using the Infrared Scanner and measuring the temperatures of the device and terminals. If the device or terminals are not hot as indicated by the findings of Level II inspection, check the current flow through the device or terminals. Heat generated is proportionate to the square of the current. If there is little or no current flow through the device or terminal at the time of measurement, there will be no significant amount of heat generated.

2. For terminal connections, verify the type of conductor being terminated. If the conductor is an aluminum conductor, look for evidence of cold flow or melt down of conductor.

3. If there is evidence of cold flow or melt down of the aluminum conductor, the conductor should either be replaced or shortened and reconnected. When making new aluminum conductor terminations a joint compound should be used.

4. If the terminal is loose it should be tightened. De-energize prior to attempting tightening of terminal connections.

5. If none of the above is the problem than there is an internal problem and an on-site analysis must be made to determine if additional inspections are to be made or the unit is to be replaced.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 3 (Continued)

COMPONENT: METERING
CONTROL NUMBER: GS-III 29.02.02-3

Special Tools and Equipment

The following is a list of special tools required beyond those listed in the Standard Tool Section.

1. Infrared Scanner, Raytek, Inc., #PM2EM-L2

2. Torque wrench

3. Digital Multimeter, Fluke #1TC676

Recommended Inspection Frequency

Do a Level III inspection when triggered by a Level II inspection.

References

1. Maintenance Technology/September 1993; Write-up Title: *"Infrared Keeps All Systems Go"*

2. Raining - Agema Infrared Systems; *"Measurement of Excess Temperatures with Infrared Scanners"*

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 4

COMPONENT: INSULATORS
CONTROL NUMBER: GS-III 29.02.04-4

Application

This guide applies to the investigation of a hot terminal or device that is overheating from the flow of current through that terminal or device.

Special Safety Requirements

No special safety requirements are needed for the performance of this Level III inspection beyond those required in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Verify the findings of Level II inspection by using the Infrared Scanner and measuring the temperatures of the device and terminals. If the device or terminals are not hot as indicated by the findings of Level II inspection, check the current flow through the device or terminals. Heat generated is proportionate to the square of the current. If there is little or no current flow through the device or terminal at the time of measurement, there will be no significant amount of heat generated.

2. For terminal connections, verify the type of conductor being terminated. If the conductor is an aluminum conductor, look for evidence of cold flow or melt down of conductor.

3. If there is evidence of cold flow or melt down of the aluminum conductor, the conductor should either be replaced or shortened and reconnected. When making new aluminum conductor terminations a joint compound should be used.

4. If the terminal is loose it should be tightened. De-energize prior to attempting tightening of terminal connections.

5. If none of the above is the problem than there is an internal problem and an on-site analysis must be made to determine if additional inspections are to be made or the unit is to be replaced.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 4 (Continued)

COMPONENT: INSULATORS
CONTROL NUMBER: GS-III 29.02.04-4

Special Tools and Equipment

The following is a list of special tools required beyond those listed in the Standard Tool Section.

1. Infrared Scanner, Raytek, Inc., #PM2EM-L2
2. Torque wrench
3. Digital Multimeter, Fluke #1TC676

Recommended Inspection Frequency

Do a Level III inspection when triggered by a Level II inspection.

References

1. Maintenance Technology/September 1993; Write-up Title: *"Infrared Keeps All Systems Go"*
2. Raining - Agema Infrared Systems; *"Measurement of Excess Temperatures with Infrared Scanners"*

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 5

COMPONENT: CIRCUIT BREAKERS (LOW VOLTAGE)
CONTROL NUMBER: GS-III 29.02.06-5

Application

This guide applies to the investigation of a hot terminal or device that is overheating from the flow of current through that terminal or device.

Special Safety Requirements

No special safety requirements are needed for the performance of this Level III inspection beyond those required in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Verify the findings of Level II inspection by using the Infrared Scanner and measuring the temperatures of the device and terminals. If the device or terminals are not hot as indicated by the findings of Level II inspection, check the current flow through the device or terminals. Heat generated is proportionate to the square of the current. If there is little or no current flow through the device or terminal at the time of measurement, there will be no significant amount of heat generated.

2. For terminal connections, verify the type of conductor being terminated. If the conductor is an aluminum conductor, look for evidence of cold flow or melt down of conductor.

3. If there is evidence of cold flow or melt down of the aluminum conductor, the conductor should either be replaced or shortened and reconnected. When making new aluminum conductor terminations a joint compound should be used.

4. If the terminal is loose it should be tightened. De-energize prior to attempting tightening of terminal connections.

5. If none of the above is the problem than there is an internal problem and an on-site analysis must be made to determine if additional inspections are to be made or the unit is to be replaced.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 5 (Continued)

COMPONENT: CIRCUIT BREAKERS (LOW VOLTAGE)
CONTROL NUMBER: GS-III 29.02.06-5

Special Tools and Equipment

The following is a list of special tools required beyond those listed in the Standard Tool Section.

1. Infrared Scanner, Raytek, Inc., #PM2EM-L2

2. Torque wrench

3. Digital Multimeter, Fluke #1TC676

Recommended Inspection Frequency

Do a Level III inspection when triggered by a Level II inspection.

References

1. Maintenance Technology/September 1993; Write-up Title: *"Infrared Keeps All Systems Go"*

2. Raining - Agema Infrared Systems; *"Measurement of Excess Temperatures with Infrared Scanners"*

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 6

COMPONENT: DISCONNECT SWITCHES (LOW VOLTAGE)
CONTROL NUMBER: GS-III 29.02.08-6

Application

This guide applies to the investigation of a hot terminal or device that is overheating from the flow of current through that terminal or device.

Special Safety Requirements

No special safety requirements are needed for the performance of this Level III inspection beyond those required in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Verify the findings of Level II inspection by using the Infrared Scanner and measuring the temperatures of the device and terminals. If the device or terminals are not hot as indicated by the findings of Level II inspection, check the current flow through the device or terminals. Heat generated is proportionate to the square of the current. If there is little or no current flow through the device or terminal at the time of measurement, there will be no significant amount of heat generated.

2. For terminal connections, verify the type of conductor being terminated. If the conductor is an aluminum conductor, look for evidence of cold flow or melt down of conductor.

3. If there is evidence of cold flow or melt down of the aluminum conductor, the conductor should either be replaced or shortened and reconnected. When making new aluminum conductor terminations a joint compound should be used.

4. If the terminal is loose it should be tightened. De-energize prior to attempting tightening of terminal connections.

5. If none of the above is the problem than there is an internal problem and an on-site analysis must be made to determine if additional inspections are to be made or the unit is to be replaced.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 6 (Continued)

COMPONENT: DISCONNECT SWITCHES (LOW VOLTAGE)
CONTROL NUMBER: GS-III 29.02.08-6

Special Tools and Equipment

The following is a list of special tools required beyond those listed in the Standard Tool Section.

1. Infrared Scanner, Raytek, Inc., #PM2EM-L2

2. Torque wrench

3. Digital Multimeter, Fluke #1TC676

Recommended Inspection Frequency

Do a Level III inspection when triggered by a Level II inspection.

References

1. Maintenance Technology/September 1993; Write-up Title: *"Infrared Keeps All Systems Go"*

2. Raining - Agema Infrared Systems; *"Measurement of Excess Temperatures with Infrared Scanners"*

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 7

COMPONENT: TRANSFORMERS
CONTROL NUMBER: GS-III 29.02.09-7

Application

This guide applies to the investigation of a hot terminal or device that is overheating from the flow of current through that terminal or device.

Special Safety Requirements

No special safety requirements are needed for the performance of this Level III inspection beyond those required in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Verify the findings of Level II inspection by using the Infrared Scanner and measuring the temperatures of the device and terminals. If the device or terminals are not hot as indicated by the findings of Level II inspection, check the current flow through the device or terminals. Heat generated is proportionate to the square of the current. If there is little or no current flow through the device or terminal at the time of measurement, there will be no significant amount of heat generated.

2. For terminal connections, verify the type of conductor being terminated. If the conductor is an aluminum conductor, look for evidence of cold flow or melt down of conductor.

3. If there is evidence of cold flow or melt down of the aluminum conductor, the conductor should either be replaced or shortened and reconnected. When making new aluminum conductor terminations a joint compound should be used.

4. If the terminal is loose it should be tightened. De-energize prior to attempting tightening of terminal connections.

5. If none of the above is the problem than there is an internal problem and an on-site analysis must be made to determine if additional inspections are to be made or the unit is to be replaced.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 7 (Continued)

COMPONENT: TRANSFORMERS
CONTROL NUMBER: GS-III 29.02.09-7

Special Tools and Equipment

The following is a list of special tools required beyond those listed in the Standard Tool Section.

1. Infrared Scanner, Raytek, Inc., #PM2EM-L2
2. Torque wrench
3. Digital Multimeter, Fluke #1TC676

Recommended Inspection Frequency

Do a Level III inspection when triggered by a Level II inspection.

References

1. Maintenance Technology/September 1993; Write-up Title: *"Infrared Keeps All Systems Go"*
2. Raining - Agema Infrared Systems; *"Measurement of Excess Temperatures with Infrared Scanners."*

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 8

COMPONENT: FOUNDATIONS
CONTROL NUMBER: GS-III 29.02.10-8

Application

This guide applies to the investigation of cracks in concrete.

Special Safety Requirements

No special safety requirements are needed for the performance of this Level III inspection beyond those required in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Utilize ultrasonic pulse velocity equipment to check for damage extent and loss of integrity.

Special Tools and Equipment

The following is a list of special tools required beyond those listed in the Standard Tool Section.

1. Ultrasonic pulse velocity test equipment, Krautkramer Branson #USK-6

Recommended Inspection Frequency

When triggered by a Level I or II defect/observation.

References

1. DOE, Vol. 2:0.02. *"Substructure Deficiency Standards and Inspection Methods Manual"*

2. MEANS *"Concrete Repair and Maintenance"*, Peter H. Emmons, 1994

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 9

COMPONENT: FOUNDATIONS
CONTROL NUMBER: GS-III 29.02.10-9

Application

This guide applies to the investigation of corrosion of reinforcing steel in concrete.

Special Safety Requirements

No special safety requirements are needed for the performance of this Level III inspection beyond those required in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Clean rust/discoloration.

2. Perform half-cell potential test to determine degree of corrosion of steel reinforcement.

Special Tools and Equipment

The following is a list of special tools required beyond those listed in the Standard Tool Section.

1. Half-cell test equipment.

Recommended Inspection Frequency

Whenever Level I or II defect/observation triggers this Level III procedure.

References

1. DOE, Vol. 2:0.02. *"Substructure Deficiency Standards and Inspection Methods Manual"*

2. MEANS *"Concrete Repair and Maintenance"*, Peter H. Emmons, 1994

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 10*

COMPONENT: SUBSTATIONS
CONTROL NUMBER: GS-III 29.02-10*

Application

This guide applies to the inspection of a substation as a complete subsystem excluding the transformers. The transformers will be inspected under a separate procedure. This inspection, while a part of the Condition Assessment Survey, is triggered by information beyond the inspection process such as time, age, or repeated service calls.

Special Safety Requirements

Inspectors need to have complete control of the substation while performing the inspection. During a portion of the inspection the substation will be taken out of service. Therefore the inspection of the substation will be scheduled accordingly to accommodate the inspection requirements. No other safety requirements are required for the performance of this Level III inspection beyond those required in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Locate substation's maintenance log or records and review the following material:
   a. Date of the latest Short Circuit Analysis.
   b. Number of trips per protective device in the last 12 months of operation.
   c. Coordination study of protective device.
   d. Flash over problems.
   e. Scheduled checks for tightness of bus bars and terminal connections.
   f. Adequacy of maintenance logs or records.

2. Specify corrective action for problem areas:
   a. If there has not been a "Short Circuit Analysis" in the last 10 years or since the last incoming power source upgrade, a new study shall be made to determine the availability of short circuit current at various equipment locations.
   b. If a feeder circuit breaker trips or disconnect switch fuse blows more than twice a year, specify an Electrical Energy Analysis be made to verify the size of the existing circuit breakers or disconnect switches and their fuse rating. These units and any associated feeders having incorrect ratings should be changed out.
   c. If a back-up protective device trips or blows consistently before the equipment protective device trips or blows, specify a Protective Device Coordination Study be made for coordinating the characteristics of the protective device.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 10* (Continued)

COMPONENT: SUBSTATIONS
CONTROL NUMBER: GS-III 29.02-10*

d. If flash overs occur, investigate the problem and indicate the cause.
e. If bus bar connections have not been tightened in the last 5 years, specify these connections be checked for proper tightness per manufacturers recommendation.
f. If some or all of the above information is not available from the maintenance logs or records, request that required records be kept.

3. Provide an inspection of the substation and their components as specified by the equipment manufacturer. If there is no such recommendation, then provide an inspection as outlined in NFPA 70B *"Recommended Practices for Electrical Equipment Maintenance"*, current edition.

The following is a list of special tools and equipment required beyond those listed in the Standard Tool Section.

1. Infrared Scanner, Raytek Inc., #PM2EM-L2
2. Torque wrench
3. Refer to manufacturer maintenance guide for additional special tools required

Recommended Inspection Frequency

Follow manufacturers recommendations for frequency of inspection of the substation assembly for the 3 three years. If there is no manufacturer's recommendation than an annual inspection should be performed during this 3 year period. After the first 3 years of service, inspection frequency can be increased or decreased dictated by the past observations or experiences. When the number of service calls since the last inspection equals 4, the up-coming inspection should be performed immediately.

References

1. NFPA 70B, *"Recommended Practice for Electrical Equipment Maintenance"*, 1990 Edition

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 11

COMPONENT: CIRCUIT BREAKER (MEDIUM VOLTAGE)
CONTROL NUMBER: GS-III 29.02.05-11

Application

This guide applies to the investigation of oil leaks in the circuit breaker tank that has signs of oil on surface of the tank or an oil puddle under or around base of tank.

Special Safety Requirements

No special safety requirements are needed for the performance of this Level III inspection beyond those required in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Verify the findings of Level I inspection by finding the source of the oil. If the oil is coming from an external source no further inspection of the breaker is required. The external source should be identified and recommendations made to eliminate the contamination of the breaker.

2. If the oil source is coming from within the breaker, a determination should be made as how the oil is escaping.

3. If breaker repairs are made, oil analysis should be made after the repairs to determine if the oil is contaminated.

4. All contaminated oil should be removed and replaced with new oil.

Special Tools and Equipment

The following is a list of special tools required beyond those listed in the Standard Tool Section.

1. Brush

2. Non-flammable cleaning fluid

3. Wiping material

Recommended Inspection Frequency

Do a Level III inspection when triggered by a Level I inspection.

References

1. Sverdrup Corporation

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 12

COMPONENT: CIRCUIT BREAKERS (MEDIUM VOLTAGE)
CONTROL NUMBER: GS-III 29.02.05-12

Application

This guide applies to the investigation of a hot terminal or device that is overheating from the flow of current through that terminal or device.

Special Safety Requirements

No special safety requirements are needed for the performance of this Level III inspection beyond those required in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Verify the findings of Level II inspection by using the Infrared Scanner and measuring the temperatures of the device and terminals. If the device or terminals are not hot as indicated by the findings of Level II inspection, check the current flow through the device or terminals. Heat generated is proportionate to the square of the current. If there is little or no current flow through the device or terminal at the time of measurement, there will be no significant amount of heat generated.

2. For terminal connections, verify the type of conductor being terminated. If the conductor is an aluminum conductor, look for evidence of cold flow or melt down of conductor.

3. If there is evidence of cold flow or melt down of the aluminum conductor, the conductor should either be replaced or shortened and reconnected. When making new aluminum conductor terminations a joint compound should be used.

4. If the terminal is loose it should be tightened. De-energize prior to attempting tightening of terminal connections.

5. If none of the above is the problem than there is an internal problem and an on-site analysis must be made to determine if additional inspections are to be made or the unit is to be replaced.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 12 (Continued)

COMPONENT: CIRCUIT BREAKERS (MEDIUM VOLTAGE)
CONTROL NUMBER: GS-III 29.02.05-12

Special Tools and Equipment

The following is a list of special tools required beyond those listed in the Standard Tool Section.

1. Infrared Scanner, Raytek, Inc., #PM2EM-L2

2. Torque wrench

3. Digital Multimeter, Fluke #1TC676

Recommended Inspection Frequency

Do a Level III inspection when triggered by a Level II inspection.

References

1. Maintenance Technology/September 1993; Write-up Title: *"Infrared Keeps All Systems Go"*

2. Raining - Agema Infrared Systems; *"Measurement of Excess Temperatures with Infrared Scanners"*

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 13

COMPONENT: DISCONNECT SWITCHES (MEDIUM VOLTAGE)
CONTROL NUMBER: GS-III 29.02.07-13

Application

This guide applies to the investigation of a hot terminal or device that is overheating from the flow of current through that terminal or device.

Special Safety Requirements

No special safety requirements are needed for the performance of this Level III inspection beyond those required in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Verify the findings of Level II inspection by using the Infrared Scanner and measuring the temperatures of the device and terminals. If the device or terminals are not hot as indicated by the findings of Level II inspection, check the current flow through the device or terminals. Heat generated is proportionate to the square of the current. If there is little or no current flow through the device or terminal at the time of measurement, there will be no significant amount of heat generated.

2. For terminal connections, verify the type of conductor being terminated. If the conductor is an aluminum conductor, look for evidence of cold flow or melt down of conductor.

3. If there is evidence of cold flow or melt down of the aluminum conductor, the conductor should either be replaced or shortened and reconnected. When making new aluminum conductor terminations a joint compound should be used.

4. If the terminal is loose it should be tightened. De-energize prior to attempting tightening of terminal connections.

5. If none of the above is the problem than there is an internal problem and an on-site analysis must be made to determine if additional inspections are to be made or the unit is to be replaced.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 13 (Continued)

COMPONENT: DISCONNECT SWITCHES (MEDIUM VOLTAGE)
CONTROL NUMBER: GS-III 29.02.07-13

Special Tools and Equipment

The following is a list of special tools required beyond those listed in the Standard Tool Section.

1. Infrared Scanner, Raytek, Inc., #PM2EM-L2

2. Torque wrench

3. Digital Multimeter, Fluke #1TC676

Recommended Inspection Frequency

Do a Level III inspection when triggered by a Level II inspection.

References

1. Maintenance Technology/September 1993; Write-up Title: *"Infrared Keeps All Systems Go"*

2. Raining - Agema Infrared Systems; *"Measurement of Excess Temperatures with Infrared Scanners"*

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 14

COMPONENT: TRANSFORMER
CONTROL NUMBER: GS-III 29.02.09-14

Application

This guide applies to the investigation of 112.5 kVA transformers or larger that contain liquids used as electrical insulation and coolant.

Special Safety Requirements

No special safety requirements are needed for the performance of this Level III inspection beyond those required in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Verify the findings of Level I inspection concerning the corrosive condition of the tank containing the coolant and insulation liquid.

2. If the tank has corroded to the point where contaminated air could possibly pass through the tank wall an oil analysis should be performed.

3. If the liquid is contaminated, provide test to determine how the tank leaks.

4. Analyze the test results to determine whether the transformer can be repaired or must be replaced.

Special Tools and Equipment

The following is a list of special tools required beyond those listed in the Standard Tool Section.

1. Wire brush

2. Wrenches

3. Pressure gauge

4. Inert gas supply

Recommended Inspection Frequency

Do a Level III inspection when triggered by a Level I inspection.

References

1. Sverdrup Corporation

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 15

COMPONENT: TRANSFORMER
CONTROL NUMBER: GS-III 29.02.09-15

Application

This guide applies to the investigation of oil leaks in the transformer tank that has signs of oil on surface of the tank or an oil puddle under or around base of tank.

Special Safety Requirements

No special safety requirements are needed for the performance of this Level III inspection beyond those required in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Verify the findings of Level I inspection by finding the source of the oil. If the oil is coming from an external source no further inspection of the transformer is required. The external source should be identified and recommendations made to eliminate the contamination of the breaker.

2. If the oil source is coming from within the transformer, a determination should be made as how the oil is escaping.

3. If transformer repairs are made, oil analysis should be made after the repairs to determine if the oil is contaminated.

4. All contaminated oil should be removed and replaced with new oil.

Special Tools and Equipment

The following is a list of special tools required beyond those listed in the Standard Tool Section.

1. Brush

2. Non-flammable cleaning fluid

3. Wiping material

Recommended Inspection Frequency

Do a Level III inspection when triggered by a Level I inspection.

References

1. Sverdrup Corporation

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 16

COMPONENT: TRANSFORMER
CONTROL NUMBER: GS-III 29.02.09-16

Application

This guide applies to the investigation of 112.5 kVA transformers or larger that contain liquids used as electrical insulation and coolant.

Special Safety Requirements

No special safety requirements are needed for the performance of this Level III inspection beyond those required in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Verify the findings of Level I inspection concerning cooling fin blockage or low liquid level.
2. Do a liquid analysis test.
3. If liquid analysis test results are okay, add liquid to proper level requirements.
4. If fin blockage remains, have liquid removed and clear the fin blockage.
5. If liquid analysis test results show contaminates, have the liquid removed, the contaminates flushed out and new liquid added.

Special Tools and Equipment

The following is a list of special tools required beyond those listed in the Standard Tool Section.

1. Infrared scanner
2. Tools and sampling containers for taking liquid samples and transferring these samples to the lab.
3. Tools and liquid supplies for adding the appropriate liquid to the transformer tank.

Recommended Inspection Frequency

Do a Level III inspection when triggered by a Level I inspection.

References

1. Sverdrup Corporation

29.03 OVERHEAD MEDIUM VOLTAGE SYSTEM

DESCRIPTION

Overhead Medium Voltage System is a subsystem of Site Electrical System. Overhead medium voltage systems distribute electrical power from switchyards or substations to remote load centers via overhead lines supported on poles and towers. Voltage levels of the distribution systems vary from 2 kV to 35 kV. Cable carrying the electrical power is normally bare but could be insulated for the full voltage level of the distribution line.

SPECIAL TOOL AND EQUIPMENT REQUIREMENTS

The following list of special tools and equipment beyond the requirements listed in the Standard Tool Section, shall be developed to perform the inspection of the Overhead Medium Voltage System.

1. Binocular, 10 x 50 power
2. Infrared Scanner, Raytek, Inc., #PM2EM-L2
3. Ice Pick
4. Hammer

SPECIAL SAFETY REQUIREMENTS

Interior compartments containing devices above 600v shall be inspected by Level I / Level II inspectors. No other special safety requirements are needed for the inspection of the Overhead Medium Voltage System, beyond the requirements listed in the Master Safety Plan and System Safety Section.

COMPONENT LIST

- ◆ 29.03.01 DISCONNECT SWITCHES (MEDIUM VOLTAGE)
- ◆ 29.03.02 SURGE (LIGHTNING) ARRESTERS
- ◆ 29.03.03 INSULATORS
- ◆ 29.03.04 TRANSFORMERS
- ◆ 29.03.05 POWER REGULATORS
- ◆ 29.03.06 STEEL LATTICE TOWERS
- ◆ 29.03.07 POLES
- ◆ 29.03.08 ANCHORS AND GUY WIRES
- ◆ 29.03.09 FOUNDATIONS

RELATED SUBSYSTEMS

Due to the related nature of the elements requiring inspection, the following should be reviewed for concurrent inspection activities.

29.07 LIGHTNING PROTECTION / GROUNDING SYSTEM

29.03 OVERHEAD MEDIUM VOLTAGE SYSTEM

STANDARD INSPECTION PROCEDURE

Components require a Level I or Level II inspection as part of the basic inspection process. Other additional Level II inspection may be indicated or "triggered" by a Level I inspection and should be accomplished by the inspector at that time. Level III inspection may be indicated or "triggered" by a Level I or II inspection Defect/Observation and should be accomplished at the direction of the Facility Manager.

Inspection should be carried out in the order of presentation for the various components with associated defects and observations for each subsystem listed in the inspector's CAIS.

COMPONENTS

◆ 29.03.01 DISCONNECT SWITCHES (MEDIUM VOLTAGE)

Fused cut-outs for the purpose of this inspection are considered disconnect switches. Disconnect switches (medium voltage) are devices used to disconnect loads rated from 601 volts to 35 kV from its source.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Corrosion:**			
Observation:			
a. Surface corrosion (no pitting evident). ***{Severity L}	SF		
b. Corrosion evidenced by pitting or blistering. ***{Severity M}	SF		
c. Corrosion evidenced by holes or loss of base metal. ***{Severity H}	SF		

Defect:

*** Physical Damage:**			
Observation:			
a. Enclosure mounting loose, broken or missing. ***{Severity L}	EA		
b. Panel fastener loose, broken or missing. ***{Severity L}	EA		
c. Enclosure damaged (cannot be sealed). ***{Severity M}	EA		
d. Unused opening not covered. ***{Severity M}	EA		
e. Door handle bent or inoperable. ***{Severity H}	EA		
f. Security devices missing or inoperable. ***{Severity H}	EA		

29.03 OVERHEAD MEDIUM VOLTAGE SYSTEM

COMPONENTS

◆ **29.03.01 DISCONNECT SWITCHES (MEDIUM VOLTAGE) (Continued)**

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Physical Damage (Continued):**			
g. Insulator damage. ***{Severity H}	EA		
h. Carbon tracking due to flashovers. ***{Severity H}	EA		
i. Discoloration of blades and contacts due to overheating. ***{Severity H}	EA		

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Hot Spots:**			
Observation:			
a. Terminal or switch body 5 to 24°C above ambient. ***{Severity M}	EA	4	7
b. Terminal or switch body 25°C or more above ambient. ***{Severity H}	EA	4	7

29.03 OVERHEAD MEDIUM VOLTAGE SYSTEM

COMPONENTS (Continued)

◆ 29.03.02 SURGE (LIGHTNING) ARRESTERS

Surge Arrester is a protective device for limiting surge voltages by discharging or bypassing surge current to ground. As soon as the surge voltage subsides to a low value the current to ground is quenched. The surge arrester is capable of repeating this function many times automatically without any outside input.

There are four basic arresters defined by industry standards; secondary, distribution, intermediate, and station type. These arresters utilize expulsion, silicone carbide valve element, or metal oxide valve element technology to consistently limit voltage surges to a known or controlled level.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
* **Corrosion:**			
Observation:			
a. Corrosion evidenced by holes or loss of base metal.	SF		
***{Severity H}			

Defect:			
* **Physical Damage:**			
Observation:			
a. Arrester chipped or cracked.	EA		
***{Severity M}			
b. Arrester broken or missing.	EA		
***{Severity H}			
c. Arrester mounting broken.	EA		
***{Severity H}			
d. Unit not grounded.	EA		
***{Severity H}			

29.03 OVERHEAD MEDIUM VOLTAGE SYSTEM

COMPONENTS (Continued)

◆ 29.03.03 INSULATORS

Insulators are intended to give flexible or rigid support to electrical conductors or equipment and to electrically separate those conductors or equipment from ground or from other construction components, conductors, or equipment. An insulator can consist of one or more non-conducting parts to which metal fittings are permanently attached.

A variety of insulators are used in distribution applications including; pin insulators, suspension insulators, deadening insulators, line post insulators, station post insulators, spool insulators, and guy strain insulators.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Physical Damage:**			
Observation:			
a. Insulator chipped or cracked ***{Severity M}	EA		
b. Insulator broken or missing. ***{Severity H}	EA		
c. Insulator mounting broken ***{Severity H}	EA		
Defect:			
*** Hot Spots:**			
Observation:			
a. Terminal 5° to 24°C above ambient. ***{Severity M}	EA	1	1
b. Terminal 25°C or more above ambient. ***{Severity H}	EA	1	1

29.03 OVERHEAD MEDIUM VOLTAGE SYSTEM

COMPONENTS (Continued)

◆ 29.03.04 TRANSFORMERS

Transformers are static electric devices consisting of a single winding or multiple coupled windings with or without a magnetic core. Power is transferred by electromagnetic induction from the input to the output circuit usually with changed values of voltages and currents.

Transformers have six types of functions: power transformers converts one voltage source to another voltage power source, isolation transformers shields the load side winding from the line side winding, reduced voltage starting transformers reduces the motor terminal voltage during the starting cycle, buck/boost transformers either raise or lower output voltage to accommodate the load, current transformers proportions a high current flow to a low current flow for instrumentation and control purpose and potential transformers proportions a high voltage potential to a low voltage potential for instrumentation and control purposes.

Pole mounted transformers will not be inspected.

Surge (lightning) arresters, insulators, foundations, poles and conductors bare will be inspected under separate components.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Corrosion:**			
Observation:			
a. Surface corrosion (no pitting evident). ***{Severity L}	SF		
b. Corrosion evidenced by pitting or blistering. ***{Severity M}	SF		8
c. Corrosion evidenced by holes or loss of base metal. ***{Severity H}	SF		8

Defect:

*** Physical Damage:**			
Observation:			
a. Enclosure mounting loose, broken or missing. ***{Severity L}	EA		
b. Panel fastener loose, broken or missing. ***{Severity L}	EA		
c. Enclosure damaged (cannot be sealed). ***{Severity M}	EA		
d. Air intake/exhaust ducts blocked. ***{Severity M}	EA		

29.03 OVERHEAD MEDIUM VOLTAGE SYSTEM

COMPONENTS (Continued)

◆ 29.03.04 TRANSFORMERS (Continued)

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Physical Damage (continued):**			
e. Air filter dirty or missing. ***{Severity M}	EA		
f. Unused opening not covered. ***{Severity M}	EA		
g. Loose or broken mounting bracket. ***{Severity M}	EA		
h. Cooling fan guard/blade broken or missing. ***{Severity H}	EA		
i. Unit not grounded. ***{Severity H}	EA		
j. Gauge or meter broken or missing. ***{Severity M}	EA		
k. Security lock missing or inoperable. ***{Severity H}	EA		

Defect:

*** Oil Leak:**			
Observation:			
a. Oil on surface of tank (possible oil leak). ***{Severity L}	EA		9
b. Oil puddle under or around base of tank. ***{Severity H}	EA		9

Defect:

*** Hot Spots:**			
Observation:			
a. Terminal 5° to 24°C above ambient. ***{Severity M}	EA	2	2
b. Terminal 25°C or more above ambient. ***{Severity H}	EA	2	2
c. Oil cooling fin blocked. ***{Severity H}	EA		10
d. Low oil level (less than 2" above fin). ***{Severity H}	EA		10

29.03 OVERHEAD MEDIUM VOLTAGE SYSTEM

COMPONENTS (Continued)

◆ 29.03.05 POWER REGULATORS

Power regulators provide current, voltage, and power factor regulation to various types of equipment through the use of transformers, relays, filters, inverters, capacitors and various components that make up regulators.

Current regulators (dry or liquid) provide constant current output for fluctuating loads. Constant voltage regulators provide constant voltage output with fluctuating voltage inputs. Power factor regulators correct the power factors of loads to within a given range.

Pole mounted regulators will not be inspected.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Corrosion:**			
Observation:			
a. Surface corrosion (no pitting evident). ***{Severity L}	SF		
b. Corrosion evidenced by pitting or blistering. ***{Severity M}	SF		
c. Corrosion evidenced by holes or loss of base metal. ***{Severity H}	SF		

Defect:

*** Physical Damage:**			
Observation:			
a. Switch or pushbutton damaged or inoperative. ***{Severity M}	EA		
b. Panel fastener loose, broken or missing. ***{Severity L}	EA		
c. Ventilation obstructed. ***{Severity L}	EA		
d. Unit mounting loose, broken or missing. ***{Severity L}	EA		
e. Enclosure damaged (cannot be sealed). ***{Severity M}	EA		
f. Unused opening not covered. ***{Severity M}	EA		
g. Cover missing. ***{Severity M}	EA		
h. Unit not grounded. ***{Severity H}	EA	3	
i. Gauge or meter broken or missing. ***{Severity M}	EA		
j. Security lock missing or inoperable. ***{Severity H}	EA		

29.03 OVERHEAD MEDIUM VOLTAGE SYSTEM

COMPONENTS (Continued)

◆ 29.03.05 POWER REGULATORS (Continued)

Defect:

* **Overload:**

Observation:			
a. Constant current regulator KVA rating exceeded. ***{Severity H}	EA	5	11
b. Voltage regulator setting on maximum tap. ***{Severity H}	EA	5	11
c. Pow. fact. regulator correction below 0.9. ***{Severity H}	EA	5	11

Defect:

* **Oil Leak:**

Observation:			
a. Oil on surface of tank (possible oil leak). ***{Severity L}	EA		12
b. Oil puddle under or around base of tank. ***{Severity H}	EA		12

Defect:

* **Hot Spots:**

Observation:			
a. Terminal 5 to 24°C above ambient. ***{Severity M}	EA	6	13
b. Terminal 25°C or more above ambient. ***{Severity H}	EA	6	13

29.03 OVERHEAD MEDIUM VOLTAGE SYSTEM

COMPONENTS (Continued)

◆ 29.03.06 STEEL LATTICE TOWERS

There are two types of steel lattice towers; self-supporting and guyed. Lattice towers usually have three, four or more legs. These legs are interconnected by a frame work of formed metal bars to make a tower.

Legs of guyed towers converge to a single point at the base of the tower to form a single connection point to the foundation. Guy wires hold the guyed tower in an upright position. Self-supporting tower legs are supported by individual foundations.

These towers are used to support overhead power lines, microwave antennas, radar equipment, radio antennas, light fixtures, observation platforms and other loads that need to be supported above the surrounding area.

Steel lattice towers will be inspected from ground level.

Insulators and conductors (bare) shall be inspected under separate components.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Corrosion:**			
Observation:			
a. Surface corrosion (no pitting evident). ***{Severity L}	SF		
b. Corrosion evidenced by pitting or blistering. ***{Severity M}	SF		
c. Corrosion evidenced by holes or loss of base metal. ***{Severity H}	SF		

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Deformation of Gusset Plate:**			
Observation:			
a. Pack rust between gusset plate and member 1/32". ***{Severity L}	EA		3
b. Pack rust between gusset plate and member 1/16". ***{Severity M}	EA		3
c. Pack rust between gusset plate and member 1/8". ***{Severity H}	EA		3

29.03 OVERHEAD MEDIUM VOLTAGE SYSTEM

COMPONENTS (Continued)

◆ 29.03.06 STEEL LATTICE TOWERS (Continued)

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Fasteners (Bolts or Rivets):**			
Observation:			
a. Fastener loose. ***{Severity M}	EA		3
b. Fastener missing. ***{Severity H}	EA		3

Defect:

*** Steel Members:**			
Observation:			
a. Steel member bent. ***{Severity M}	EA		3
b. Steel member cracked, broken or missing. ***{Severity H}	EA		3

Defect:

*** Electrical:**			
Observation:			
a. Unit not grounded. ***{Severity H}	EA		

29.03 OVERHEAD MEDIUM VOLTAGE SYSTEM

COMPONENTS (Continued)

◆ 29.03.07 POLES

There are five basic types of poles; steel, aluminum, concrete, wood and fiberglass. They are mainly used to support lighting fixtures, overhead power lines, communication cables, traffic signals, antennas and radar equipment.

Poles mainly consist of pole bases, anchor bolts/nuts, base cover plates, transformer bases, mounting brackets, lighting fixture arms, cross arms, lowering devices and safety cage platforms.

Poles will be inspected from ground level.

Surge (lightning) arresters, disconnect switches, insulators and conductors (bare) shall be inspected under their separate component inspection.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Corrosion Damage to Steel Poles:**			
Observation:			
a. Surface corrosion (no pitting evident). ***{Severity L}	SF		
b. Corrosion evidenced by pitting or blistering. ***{Severity M}	SF		
c. Corrosion evidenced by holes or loss of base metal. ***{Severity H}	SF		

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Decay, Insect and Bird Damage to Wood Pole Structures:**			
Observation:			
a. Knothole decay. ***{Severity L}	EA		4
b. Wood colorated indicating wood decay. ***{Severity M}	SF		4
c. Holes made by birds. ***{Severity M}	EA		4
d. Fungi fruit indicating wood decay. ***{Severity H}	SF		4
e. Signs of parasite damage (carpenter ants and termites). ***{Severity H}	EA		4
f. Decay detected by hammer sounding near base of pole. ***{Severity H}	EA		4

29.03 OVERHEAD MEDIUM VOLTAGE SYSTEM

COMPONENTS (Continued)

◆ 29.03.07 POLES (Continued)

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Crack Damage to Concrete Poles:**			
Observation:			
a. Surface spalling more than 1" deep or 6" in diameter.	SF		
***{Severity L}			
b. Cracks greater than 1/16 inch wide.	LF		
***{Severity M}			

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Physical Damage:**			
Observation:			
a. Base plate broken or missing.	EA		
***{Severity L}			
b. Handhole coverplate broken or missing.	EA		
***{Severity L}			
c. Transformer base cover plate broken or missing.	EA		
***{Severity L}			
d. Wood pole 1" or less deep horizontal scar.	LF		
***{Severity L}			
e. Pole leaning (2 foot or more at top).	EA		
***{Severity M}			
f. Transformer base broken.	EA		
***{Severity M}			
g. Fixture mounting brackets bent or loosely mounted.	EA		
***{Severity M}			
h. Crossarm brackets/supports missing.	EA		
***{Severity M}			
i. Fiberglass pole damaged (opening in pole).	EA		
***{Severity M}			
j. Metal pole dented (more than 1" indentation).	EA		
***{Severity M}			

29.03 OVERHEAD MEDIUM VOLTAGE SYSTEM

COMPONENTS (Continued)

◆ **29.03.07 POLES (Continued)**

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Physical Damage (Continued):**			
k. Wood pole with 1" to 2-1/2" deep horizontal scar. ***{Severity M}	LF		
l. Anchor nut missing. ***{Severity H}	EA		
m. Hinged pole mechanism broken or damaged. ***{Severity H}	EA		
n. Cage platform broken or damaged. ***{Severity H}	EA		
o. Lighting fixture lowering device broken or damaged. ***{Severity H}	EA		
p. Wood pole more than 2-1/2" deep scar. ***{Severity H}	LF		
q. Wood pole splintered by lightning. ***{Severity H}	LF		
r. Pole not grounded. ***{Severity H}	EA		

29.03 OVERHEAD MEDIUM VOLTAGE SYSTEM

COMPONENTS (Continued)

◆ 29.03.08 ANCHORS AND GUY WIRES

Anchors occur as many different types with multiple variations of each type. Normally the anchors are underground except for the guy wire terminal attachment hardware. Excavation to inspect the underground portion of the anchor will destroy the integrity of the anchor being inspected. Only exposed section of the anchor will be inspected.

Guy wires connect the structure requiring support to an anchoring device. An anchoring device can either be an underground anchor or an above-ground device. Above-ground anchoring devices are either self-supporting or guyed structures.

Guy wires are steel stranded cables with either galvanized, copper or aluminum coating.

Anchoring system failure is indicated by either the top of the supported structure leaning away from the anchoring point or the supported structure intact but laying on the ground.

Insulators will be inspected under a separate component.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
* **Corrosion:**			
Observation:			
a. Surface corrosion (no pitting evident). ***{Severity L}	LF		
b. Corrosion evidenced by pitting or blistering. ***{Severity M}	LF		
c. Corrosion evidenced by holes or loss of base metal. ***{Severity H}	LF		

Defect:

* **Physical Damage:**			
Observation:			
a. Guy wire guard missing or detached. ***{Severity L}	EA		
b. Guy wire strand broken. ***{Severity M}	EA		
c. Vegetation growth on guy wire. ***{Severity M}	EA		
d. Clamping hardware fasteners loose or missing. ***{Severity H}	EA		
e. Guy wire broken. ***{Severity H}	EA		
f. Anchor creep (pole leaning away from anchor). ***{Severity H}	EA		
g. Guy (strain) insulator damaged. ***{Severity H}	EA		
h. Clamping hardware missing. ***{Severity H}	EA		

29.03 OVERHEAD MEDIUM VOLTAGE SYSTEM

COMPONENTS (Continued)

◆ 29.03.09 FOUNDATIONS

Foundations consist of cast-in-place concrete footings and piers through which the loads of structures are transmitted to the earth. Anchor bolts are embedded in the concrete, to connect the structure or equipment to the foundation.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Cracking:**			
Observation:			
a. Cracks, between 1/16" and 1/4" wide. ***{Severity M}	LF		5
b. Disintegration of surface or cracks exceeding depth of 2". ***{Severity H}	LF		5
Defect:			
*** Spalling:**			
Observation:			
a. Not more than 1" deep or 6" in diameter. ***{Severity L}	SF		
b. More than 1" in depth or 6" in dia., or 10% of surface area loss. ***{Severity H}	SF		
c. Disintegration of surface area, with corrosion of exposed rebar. ***{Severity H}	SF		6
Defect:			
*** Scaling:**			
Observation:			
a. Surface loss of 1/2" to 1" deep, with coarse aggregates exposed. ***{Severity M}	SF		
b. Loss of surface exceeding 1" deep. ***{Severity H}	SF		
c. Exposure of reinforcing steel. ***{Severity H}	SF		6
Defect:			
*** Reinforcing Steel Corrosion:**			
Observation:			
a. Rusting evident, cracks occurring along rebar. ***{Severity H}	LF		6

29.03 OVERHEAD MEDIUM VOLTAGE SYSTEM

REFERENCES

1. DOE CAS Manual, Volume 9: 0.09, Electrical

2. DOE, Volume 2: 0.02 Substructure Deficiency Standards and Inspection Method Manual

3. National Fire Protection Association (NFPA 70B) *"Recommended Practice for Electrical Equipment Maintenance"*, 1990 Edition

4. Iowa Administrative Code, Utilities [199], Chapter 25, Iowa Electrical Safety Code IAC 8/5/92

5. MEANS "Concrete Repair and Maintenance", Peter H. Emmons, 1994

6. MEANS *"Facilities Maintenance & Repair Cost Data"*, 1994

29.03 OVERHEAD MEDIUM VOLTAGE SYSTEM

LEVEL II KEY	GUIDE SHEET CONTROL NUMBER
1	GS-II 29.03.03-1
2	GS-II 29.03.04-2
3	GS-II 29.03.05-3
4	GS-II 29.03.01-4
5	GS-II 29.03.05-5
6	GS-II 29.03.05-6

LEVEL III KEY	GUIDE SHEET CONTROL NUMBER
1	GS-III 29.03.03-1
2	GS-III 29.03.04-2
3	GS-III 29.03.06-3
4	GS-III 29.03.07-4
5	GS-III 29.03.09-5
6	GS-III 29.03.09-6
7	GS-III 29.03.01-7
8	GS-III 29.03.04-8
9	GS-III 29.03.04-9
10	GS-III 29.03.04-10
11	GS-III 29.03.05-11
12	GS-III 29.03.05-12
13	GS-III 29.03.05-13

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 1

COMPONENT: INSULATORS
CONTROL NUMBER: GS-II 29.03.03-1

Application

This guide applies to the investigation of the inside of an enclosure, containing bare, energized, electrical parts.

Special Safety Requirements

The following list of special safety requirements, beyond the requirements listed in the Master Safety Plan and System Safety Section, are to be observed in the performance of this inspection.

1. This inspection guide applies to enclosure compartments containing live electrical parts having a potential of 600 volts or less above ground. If the enclosure compartment contains circuitry of higher potential, do not use this inspection guide.

2. Any enclosure that is padlocked for safety reason is not to be opened unless okayed by the person having control of the key.

3. Inspector needs to carefully open, inspect the inside and close the enclosure without shutting down the equipment, and without creating a hazard to himself.

Inspection Actions

1. Open panels or doors carefully and to the degree required for scanning those devices being tested.

2. Make temperature measurements with an infrared scanner.

3. Measure the ambient temperature by measuring a spot on the inside of the enclosure that is least effected by any internal panel heat source.

4. Measure the temperature of the device specified.

5. Above-ambient temperature is calculated by subtracting the ambient temperature from the device temperature.

6. Record the results.

7. Close panels or doors carefully after the inspection is complete.

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 1 (Continued)

COMPONENT: INSULATORS
CONTROL NUMBER: GS-II 29.03.03-1

Recommended Inspection Frequency

Do a Level II inspection each time a Level I inspection is made.

References

1. Maintenance Technology/September 1993; Write-up Title: *"Infrared Keeps All Systems Go"*

2. Raining - Agema Infrared Systems; *"Measurement of Excess Temperatures with Infrared Scanners"*

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 2

COMPONENT: TRANSFORMERS
CONTROL NUMBER: GS-II 29.03.04-2

Application

This guide applies to the investigation of the inside of an enclosure, containing bare, energized, electrical parts.

Special Safety Requirements

The following list of special safety requirements, beyond the requirements listed in the Master Safety Plan and System Safety Section, are to be observed in the performance of this inspection.

1. This inspection guide applies to enclosure compartments containing live electrical parts having a potential of 600 volts or less above ground. If the enclosure compartment contains circuitry of higher potential, do not use this inspection guide.

2. Any enclosure that is padlocked for safety reason is not to be opened unless okayed by the person having control of the key.

3. Inspector needs to carefully open, inspect the inside and close the enclosure without shutting down the equipment, and without creating a hazard to himself.

Inspection Actions

1. Open panels or doors carefully and to the degree required for scanning those devices being tested.

2. Make temperature measurements with an infrared scanner.

3. Measure the ambient temperature by measuring a spot on the inside of the enclosure that is least effected by any internal panel heat source.

4. Measure the temperature of the device specified.

5. Above-ambient temperature is calculated by subtracting the ambient temperature from the device temperature.

6. Record the results.

7. Close panels or doors carefully after the inspection is complete.

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 2 (Continued)

COMPONENT: TRANSFORMERS
CONTROL NUMBER: GS-II 29.03.04-2

Recommended Inspection Frequency

Do a Level II inspection each time a Level I inspection is made.

References

1. Maintenance Technology/September 1993; Write-up Title: *"Infrared Keeps All Systems Go"*

2. Raining - Agema Infrared Systems; *"Measurement of Excess Temperatures with Infrared Scanners"*

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 3

COMPONENT: POWER REGULATORS
CONTROL NUMBER: GS-II 29.03.05-3

Application

This guide applies to the investigation of the inside of an enclosure, containing bare, energized, electrical parts.

Special Safety Requirements

The following list of special safety requirements, beyond the requirements listed in the Master Safety Plan and System Safety Section, are to be observed in the performance of this inspection.

1. This inspection guide applies to enclosures containing live electrical parts having a potential of 600 volts or less above ground. If the enclosure contains circuitry of higher potential, do not use this inspection guide.

2. Any enclosure that is padlocked for safety reason is not to be opened unless okayed by the person having control of the key.

3. Inspector needs to carefully open, inspect the inside and close the enclosure without shutting down the equipment, and without creating a hazard to himself.

Inspection Actions

1. Open panels or doors carefully as required for doing the visual inspection.

2. Visually inspect for those physical damaged defects that are listed and tagged Level II Key No. as indicated above.

3. Close panels or doors carefully after the inspection is completed.

Recommended Inspection Frequency

Do a Level II inspection each time a Level I inspection indicates one is required.

References

1. Sverdrup Corporation

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 4

COMPONENT: DISCONNECT SWITCHES (MEDIUM VOLTAGE)
CONTROL NUMBER: GS-II 29.03.01-4

Application

This guide applies to the investigation of the inside of an enclosure, containing bare, energized, electrical parts.

Special Safety Requirements

The following list of special safety requirements, beyond the requirements listed in the Master Safety Plan and System Safety Section, are to be observed in the performance of this inspection.

1. This inspection guide applies to enclosures containing live electrical parts having a potential of 601 volts or more above ground.

2. Any enclosure that is padlocked for safety reason is not to be opened unless okayed by the person having control of the key.

3. Inspector needs to carefully open, inspect the inside and close the enclosure without shutting down the equipment, and without creating a hazard to himself.

Inspection Actions

1. Open panels or doors carefully as required for doing the visual inspection.

2. Visually inspect for those physical damaged defects that are listed and tagged Level II Key No. as indicated above.

3. Close panels or doors carefully after the inspection is completed.

Recommended Inspection Frequency

Do a Level II inspection each time a Level I is performed on this equipment.

References

1. Sverdrup Corporation

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 5

COMPONENT: POWER REGULATORS
CONTROL NUMBER: GS-II 29.03.05-5

Application

This guide applies to the investigation of the inside of an enclosure, containing bare, energized, electrical parts.

Special Safety Requirements

The following list of special safety requirements, beyond the requirements listed in the Master Safety Plan and System Safety Section, are to be observed in the performance of this inspection.

1. This inspection guide applies to enclosures containing live electrical parts having a potential of up to 35 kV.

2. Any enclosure that is padlocked for safety reason is not to be opened unless okayed by the person having control of the key.

3. Inspector needs to carefully open, inspect the inside and close the enclosure without shutting down the equipment, and without creating a hazard to himself.

Inspection Actions

1. Open panels or doors carefully as required for doing the physical inspection.

2. Take power readings and inspect tap settings that are listed and tagged Level II Key No. as indicated above.

3. Close panels or doors carefully after the inspection is completed.

Recommended Inspection Frequency

Do a Level II inspection each time a Level I inspection is performed on this equipment.

References

1. Sverdrup Corporation

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 6

COMPONENT: POWER REGULATORS
CONTROL NUMBER: GS-II 29.03.05-6

Application

This guide applies to the investigation of the inside of an enclosure, containing bare, energized, electrical parts.

Special Safety Requirements

The following list of special safety requirements, beyond the requirements listed in the Master Safety Plan and System Safety Section, are to be observed in the performance of this inspection.

1. This inspection guide applies to enclosures containing live electrical parts having a potential of up to 35 kV above ground.

2. Any enclosure that is padlocked for safety reason is not to be opened unless okayed by the person having control of the key.

3. Inspector needs to carefully open, inspect the inside and close the enclosure without shutting down the equipment, and without creating a hazard to himself.

Inspection Actions

1. Open panels or doors carefully as required for doing the visual inspection.

2. Visually inspect for those physical damaged defects that are listed and tagged Level II Key No. as indicated above.

3. Close panels or doors carefully after the inspection is completed.

Recommended Inspection Frequency

Do a Level II inspection each time a Level I is performed on this equipment.

References

1. Sverdrup Corporation

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 1

COMPONENT: INSULATORS
CONTROL NUMBER: GS-III 29.03.03-1

Application

This guide applies to the investigation of a hot terminal or device that is overheating from the flow of current through that terminal or device.

Special Safety Requirements

No special safety requirements are needed for the performance of this Level III inspection beyond those required in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Verify the findings of Level II inspection by using the Infrared Scanner and measuring the temperatures of the device and terminals. If the device or terminals are not hot as indicated by the findings of Level II inspection, check the current flow through the device or terminals. Heat generated is proportionate to the square of the current. If there is little or no current flow through the device or terminal at the time of measurement, there will be no significant amount of heat generated.

2. For terminal connections, verify the type of conductor being terminated. If the conductor is an aluminum conductor, look for evidence of cold flow or melt down of conductor.

3. If there is evidence of cold flow or melt down of the aluminum conductor, the conductor should either be replaced or shortened and reconnected. When making new aluminum conductor terminations a joint compound should be used.

4. If the terminal is loose it should be tightened. De-energize prior to attempting tightening of terminal connections.

5. If none of the above is the problem than there is an internal problem and an on-site analysis must be made to determine if additional inspections are to be made or the unit is to be replaced.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 1 (Continued)

COMPONENT: INSULATORS
CONTROL NUMBER: GS-III 29.03.03-1

Special Tools and Equipment

The following is a list of special tools required beyond those listed in the Standard Tool Section.

1. Infrared Scanner, Raytek, Inc., #PM2EM-L2
2. Torque wrench
3. Digital Multimeter, Fluke #1TC676

Recommended Inspection Frequency

Do a Level III inspection when triggered by a Level II inspection.

References

1. Maintenance Technology/September 1993; Write-up Title: *"Infrared Keeps All Systems Go"*
2. Raining - Agema Infrared Systems; *"Measurement of Excess Temperatures with Infrared Scanners"*

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 2

COMPONENT: TRANSFORMERS
CONTROL NUMBER: GS-III 29.03.04-2

Application

This guide applies to the investigation of a hot terminal or device that is overheating from the flow of current through that terminal or device.

Special Safety Requirements

No special safety requirements are needed for the performance of this Level III inspection beyond those required in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Verify the findings of Level II inspection by using the Infrared Scanner and measuring the temperatures of the device and terminals. If the device or terminals are not hot as indicated by the findings of Level II inspection, check the current flow through the device or terminals. Heat generated is proportionate to the square of the current. If there is little or no current flow through the device or terminal at the time of measurement, there will be no significant amount of heat generated.

2. For terminal connections, verify the type of conductor being terminated. If the conductor is an aluminum conductor, look for evidence of cold flow or melt down of conductor.

3. If there is evidence of cold flow or melt down of the aluminum conductor, the conductor should either be replaced or shortened and reconnected. When making new aluminum conductor terminations a joint compound should be used.

4. If the terminal is loose it should be tightened. De-energize prior to attempting tightening of terminal connections.

5. If none of the above is the problem than there is an internal problem and an on-site analysis must be made to determine if additional inspections are to be made or the unit is to be replaced.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 2 (Continued)

COMPONENT: TRANSFORMERS
CONTROL NUMBER: GS-III 29.03.04-2

Special Tools and Equipment

The following is a list of special tools required beyond those listed in the Standard Tool Section.

1. Infrared Scanner, Raytek, Inc., #PM2EM-L2

2. Torque wrench

3. Digital Multimeter, Fluke #1TC676

Recommended Inspection Frequency

Do a Level III inspection when triggered by a Level II inspection.

References

1. Maintenance Technology/September 1993; Write-up Title: *"Infrared Keeps All Systems Go"*

2. Raining - Agema Infrared Systems; *"Measurement of Excess Temperatures with Infrared Scanners"*

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 3

COMPONENT: STEEL LATTICE TOWERS
CONTROL NUMBER: GS-III 29.03.06-3

Application

This guide determines the extent of defects recorded in Level I inspection of steel lattice towers. This Level III inspection is performed to evaluate the observed defect and to develop maintenance or remedial measures required to monitor, control or correct the existing deficiencies.

Special Safety Requirements

No special safety requirements are needed for the performance of the Level III inspection beyond those required in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Prior to making a field inspection of the observed defect, review all past inspection records concerning the steel lattice tower.
2. Perform inspection of observed defects that triggered this Level III inspection.
3. Make an assessment of the importance of the individual observed defects and indicate whether continued observation, maintenance, or remedial work is required.
4. Prepare cost estimate for doing the required maintenance or remedial repair work, as applicable.

Special Tools & Equipment Requirements

Grinder or sand blasting equipment
Industry required testing equipment needed to perform the advanced investigation method chosen

Recommended Inspection Frequency

Do a Level III inspection when triggered by a Level I inspection.

References

1. Bridges Inspector's Training Manual/90 by U.S. Department of Transportation

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 4

COMPONENT: POLES
CONTROL NUMBER: GS-III 29.03.07-4

Application

This guide applies to the investigation of decay in wood poles.

Special Safety Requirements

No special safety requirements are needed for the performance of this Level III inspection beyond those required in the Master Safety Plan and System Safety Section.

Inspection Actions

Observation inspection will detect above ground grade decay and parasite infestation only. If there is above ground grade deterioration there may be greater deterioration at 6 to 9 inches below grade.

1. Remove backfill from around the poles to a depth of 9 inches.

2. Probe, with ice pick, for decay material or parasite infestation in the exposed areas above and below the grade. Probing should be made in suspected areas from 9" below ground grade to top of pole, including bird damaged areas.

3. Remove all located decay or parasite damage material.

4. Provide written descriptions of the material damage, giving depths and volumes of each effected area.

5. Structural Engineer shall study the finding to determine if:
   a. Poles should be treated only to prevent further damage in these areas.

   b. Poles should be treated to prevent further damage and reinforced by a C truss reinforcement method or by other applicable means.

   c. Poles has been damaged beyond repair and must be replaced.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 4 (Continued)

COMPONENT: POLES
CONTROL NUMBER: GS-III 29.03.07-4

Special Tools and Equipment

The following is a list of special tools required beyond those listed in the Standard Tool Section.

1. D Handle Shovel
2. Wood Chisel
3. Ice pick
4. Binocular, 10 x 50 power

Recommended Inspection Frequency

Whenever Level I or Level II defect/observation triggers this Level III procedure.

References

1. Electrical World, March 1991, Vol 205, No. 3
2. NAVFAC MO-322, Vol II, January 1993

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 5

COMPONENT: FOUNDATIONS
CONTROL NUMBER: GS-III 29.03.09-5

Application

This guide applies to the investigation of cracks in concrete.

Special Safety Requirements

No special safety requirements are needed for the performance of this Level III inspection beyond those required in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Utilize ultrasonic pulse velocity equipment to check for damage extent and loss of integrity.

Special Tools and Equipment

The following is a list of special tools required beyond those listed in the Standard Tool Section.

1. Ultrasonic pulse velocity test equipment, Krautkramer Branson #USK-6

Recommended Inspection Frequency

When triggered by a Level I or II defect/observation.

References

1. DOE, Vol. 2:0.02. *"Substructure Deficiency Standards and Inspection Methods Manual"*

2. MEANS *"Concrete Repair and Maintenance"*, Peter H. Emmons, 1994

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 6

COMPONENT: FOUNDATIONS
CONTROL NUMBER: GS-III 29.03.09-6

Application

This guide applies to the investigation of corrosion of reinforcing steel in concrete.

Special Safety Requirements

No special safety requirements are needed for the performance of this Level III inspection beyond those required in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Clean rust/discoloration.

2. Perform half-cell potential test to determine degree of corrosion of steel reinforcement.

Special Tools and Equipment

The following is a list of special tools required beyond those listed in the Standard Tool Section.

1. Half-cell test equipment.

Recommended Inspection Frequency

Whenever Level I or II defect/observation triggers this Level III procedure.

References

1. DOE, Vol. 2:0.02. *"Substructure Deficiency Standards and Inspection Methods Manual"*

2. MEANS *"Concrete Repair and Maintenance"*, Peter H. Emmons, 1994

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 7

COMPONENT: DISCONNECT SWITCHES (MEDIUM VOLTAGE)
CONTROL NUMBER: GS-III 29.03.01-7

Application

This guide applies to the investigation of a hot terminal or device that is overheating from the flow of current through that terminal or device.

Special Safety Requirements

No special safety requirements are needed for the performance of this Level III inspection beyond those required in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Verify the findings of Level II inspection by using the Infrared Scanner and measuring the temperatures of the device and terminals. If the device or terminals are not hot as indicated by the findings of Level II inspection, check the current flow through the device or terminals. Heat generated is proportionate to the square of the current. If there is little or no current flow through the device or terminal at the time of measurement, there will be no significant amount of heat generated.

2. For terminal connections, verify the type of conductor being terminated. If the conductor is an aluminum conductor, look for evidence of cold flow or melt down of conductor.

3. If there is evidence of cold flow or melt down of the aluminum conductor, the conductor should either be replaced or shortened and reconnected. When making new aluminum conductor terminations a joint compound should be used.

4. If the terminal is loose it should be tightened. De-energize prior to attempting tightening of terminal connections.

5. If none of the above is the problem than there is an internal problem and an on-site analysis must be made to determine if additional inspections are to be made or the unit is to be replaced.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 7 (Continued)

COMPONENT: DISCONNECT SWITCHES (MEDIUM VOLTAGE)
CONTROL NUMBER: GS-III 29.03.01-7

Special Tools and Equipment

The following is a list of special tools required beyond those listed in the Standard Tool Section.

1. Infrared Scanner, Raytek, Inc., #PM2EM-L2
2. Torque wrench
3. Digital Multimeter, Fluke #1TC676

Recommended Inspection Frequency

Do a Level III inspection when triggered by a Level II inspection.

References

1. Maintenance Technology/September 1993; Write-up Title: *"Infrared Keeps All Systems Go"*
2. Raining - Agema Infrared Systems; *"Measurement of Excess Temperatures with Infrared Scanners"*

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 8

COMPONENT: TRANSFORMER
CONTROL NUMBER: GS-III 29.03.04-8

Application

This guide applies to the investigation of 112.5 kVA transformers or larger that contain liquids used as electrical insulation and coolant.

Special Safety Requirements

No special safety requirements are needed for the performance of this Level III inspection beyond those required in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Verify the findings of Level I inspection concerning the corrosive condition of the tank containing the coolant and insulation liquid.

2. If the tank has corroded to the point where contaminated air could possibly pass through the tank wall an oil analysis should be performed.

3. If the liquid is contaminated, provide test to determine how the tank leaks.

4. Analyze the test results to determine whether the transformer can be repaired or must be replaced.

Special Tools and Equipment

The following is a list of special tools required beyond those listed in the Standard Tool Section.

1. Wire brush

2. Wrenches

3. Pressure gauge

4. Inert gas supply

Recommended Inspection Frequency

Do a Level III inspection when triggered by a Level I inspection.

References

1. Sverdrup Corporation

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 9

COMPONENT: TRANSFORMER
CONTROL NUMBER: GS-III 29.03.04-9

Application

This guide applies to the investigation of oil leaks in the transformer tank that has signs of oil on surface of the tank or an oil puddle under or around base of tank.

Special Safety Requirements

No special safety requirements are needed for the performance of this Level III inspection beyond those required in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Verify the findings of Level I inspection by finding the source of the oil. If the oil is coming from an external source no further inspection of the transformer is required. The external source should be identified and recommendations made to eliminate the contamination of the breaker.

2. If the oil source is coming from within the transformer, a determination should be made as how the oil is escaping.

3. If transformer repairs are made, oil analysis should be made after the repairs to determine if the oil is contaminated.

4. All contaminated oil should be removed and replaced with new oil.

Special Tools and Equipment

The following is a list of special tools required beyond those listed in the Standard Tool Section.

1. Brush

2. Non-flammable cleaning fluid

3. Wiping material

Recommended Inspection Frequency

Do a Level III inspection when triggered by a Level I inspection.

References

1. Sverdrup Corporation

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 10

COMPONENT: TRANSFORMER
CONTROL NUMBER: GS-III 29.03.04-10

Application

This guide applies to the investigation of 112.5 kVA transformers or larger that contain liquids used as electrical insulation and coolant.

Special Safety Requirements

No special safety requirements are needed for the performance of this Level III inspection beyond those required in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Verify the findings of Level I inspection concerning cooling fin blockage or low liquid level.

2. Do a liquid analysis test.

3. If liquid analysis test results are okay, add liquid to proper level requirements.

4. If fin blockage remains, have liquid removed and clear the fin blockage.

5. If liquid analysis test results show contaminates, have the liquid removed, the contaminates flushed out and new liquid added.

Special Tools and Equipment

The following is a list of special tools required beyond those listed in the Standard Tool Section.

1. Infrared scanner

2. Tools and sampling containers for taking liquid samples and transferring these samples to the lab.

3. Tools and liquid supplies for adding the appropriate liquid to the transformer tank.

Recommended Inspection Frequency

Do a Level III inspection when triggered by a Level I inspection.

References

1. Sverdrup Corporation

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 11

COMPONENT: POWER REGULATOR
CONTROL NUMBER: GS-III 29.03.05-11

Application

This guide applies to the investigation of power regulators that are overloaded.

Special Safety Requirements

No special safety requirements are needed for the performance of this Level III inspection beyond those required in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Verify the findings of Level I inspection concerning overloading of the regulator.

2. For constant current regulator, determine if part of the load being supplied is no longer needed and should be shed, is it practical to transfer the load to another constant current regulator or if the constant current regulator needs to be replaced with a larger unit.

3. For voltage regulator, determine if the supply to the regulator can be upgraded by changing the taps on the upstream transformer, increase the size of any overloaded supply cable, part of the load no longer needs to be connected to the regulator and should be shed or if the voltage regulator needs to be replaced with a larger unit.

4. For power factor regulator, determine if the power factor of one or more of the larger loads could be corrected by adding individual capacitors that are switched with the load or if the power factor regulator needs to be replaced or modified.

Special Tools and Equipment

The following is a list of special tools required beyond those listed in the Standard Tool Section.

1. Voltmeter
2. Ampmeter
3. Power factor meter
4. Watthour meter

Recommended Inspection Frequency

Do a Level III inspection when triggered by a Level I inspection.

References

1. Sverdrup Corporation

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 12

COMPONENT: POWER REGULATOR
CONTROL NUMBER: GS-III 29.03.05-12

Application

This guide applies to the investigation of oil leaks in the power regulator tank that has signs of oil on surface of the tank or an oil puddle under or around base of tank.

Special Safety Requirements

No special safety requirements are needed for the performance of this Level III inspection beyond those required in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Verify the findings of Level I inspection by finding the source of the oil. If the oil is coming from an external source no further inspection of the power regulator is required. The external source should be identified and recommendations made to eliminate the contamination of the breaker.

2. If the oil source is coming from within the power regulator, a determination should be made as how the oil is escaping.

3. If power regulator repairs are made, oil analysis should be made after the repairs to determine if the oil is contaminated.

4. All contaminated oil should be removed and replaced with new oil.

Special Tools and Equipment

The following is a list of special tools required beyond those listed in the Standard Tool Section.

1. Brush

2. Non-flammable cleaning fluid

3. Wiping material

Recommended Inspection Frequency

Do a Level III inspection when triggered by a Level I inspection.

References

1. Sverdrup Corporation

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 13

COMPONENT: POWER REGULATORS
CONTROL NUMBER: GS-III 29.03.05-13

Application

This guide applies to the investigation of a hot terminal or device that is overheating from the flow of current through that terminal or device.

Special Safety Requirements

No special safety requirements are needed for the performance of this Level III inspection beyond those required in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Verify the findings of Level II inspection by using the Infrared Scanner and measuring the temperatures of the device and terminals. If the device or terminals are not hot as indicated by the findings of Level II inspection, check the current flow through the device or terminals. Heat generated is proportionate to the square of the current. If there is little or no current flow through the device or terminal at the time of measurement, there will be no significant amount of heat generated.

2. For terminal connections, verify the type of conductor being terminated. If the conductor is an aluminum conductor, look for evidence of cold flow or melt down of conductor.

3. If there is evidence of cold flow or melt down of the aluminum conductor, the conductor should either be replaced or shortened and reconnected. When making new aluminum conductor terminations a joint compound should be used.

4. If the terminal is loose it should be tightened. De-energize prior to attempting tightening of terminal connections.

5. If none of the above is the problem than there is an internal problem and an on-site analysis must be made to determine if additional inspections are to be made or the unit is to be replaced.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 13 (Continued)

COMPONENT: POWER REGULATORS
CONTROL NUMBER: GS-III 29.03.05-13

Special Tools and Equipment

The following is a list of special tools required beyond those listed in the Standard Tool Section.

1. Infrared Scanner, Raytek, Inc., #PM2EM-L2

2. Torque wrench

3. Digital Multimeter, Fluke #1TC676

Recommended Inspection Frequency

Do a Level III inspection when triggered by a Level II inspection.

References

1. Maintenance Technology/September 1993; Write-up Title: *"Infrared Keeps All Systems Go"*

2. Raining - Agema Infrared Systems; *"Measurement of Excess Temperatures with Infrared Scanners"*

29.04 UNDERGROUND MEDIUM VOLTAGE SYSTEM (601 V TO 35 kV)

DESCRIPTION

Underground Medium Voltage System is a subsystem of the Site Electrical System. This system has a voltage rating range from 601 volts to 35 kV and distributes electrical power from a single source to one or more end use devices.

SPECIAL TOOL AND EQUIPMENT REQUIREMENTS

The following special tool, beyond the requirements listed in the Standard Tool Section, shall be provided to perform the inspection of the Underground Medium Voltage System.

1. Infrared scanner, Raytek, Inc., #PM2EM-L2

SPECIAL SAFETY REQUIREMENTS

No special safety requirements are needed for the inspection of the Overhead Medium Voltage System, beyond the requirements listed in the Master Safety Plan and System Safety Section.

COMPONENT LIST

- ◆ 29.04.01 UNDERGROUND ELECTRICAL UTILITIES
- ◆ 29.04.02 HANDHOLES/MANHOLES
- ◆ 29.04.03 TRANSFORMERS
- ◆ 29.04.04 FOUNDATIONS

RELATED SUBSYSTEMS

Due to the related nature of the elements requiring inspection, the following should be reviewed for concurrent inspection activities.

10.01	SERVICE ENTRANCE, 600V OR LESS
29.03	OVERHEAD MEDIUM VOLTAGE SYSTEM
29.07	LIGHTNING PROTECTION / GROUNDING SYSTEM

STANDARD INSPECTION PROCEDURE

Components require a Level I or Level II inspection as part of the basic inspection process. Other additional Level II inspection may be indicated or "triggered" by a Level I inspection and should be accomplished by the inspector at that time. Level III inspection may be indicated or "triggered" by a Level I or II inspection Defect/Observation and should be accomplished at the direction of the Facility Manager.

Inspection should be carried out in the order of presentation for the various components with associated defects and observations for each subsystem listed in the inspector's CAIS.

29.04 UNDERGROUND MEDIUM VOLTAGE SYSTEM (601 V TO 35 kV)

COMPONENTS

◆ 29.04.01 UNDERGROUND ELECTRICAL UTILITIES

Underground electrical utilities consist of direct buried cables, cables in direct buried ducts, cables in ductbanks and cables in underground cable trenches.

Direct buried cables and cables in direct buried ducts should be marked with ground level markers in such a manner that their entire location can be readily identified.

Surge arresters will be inspected under a separate component.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Markers:**			
Observation:			
a. 51 to 100 feet of route section not marked.	LF		
***{Severity L}			
b. 101 to 150 feet of route section not marked.	LF		
***{Severity M}			
c. 151 feet or more of route section not marked.	LF		
***{Severity H}			

Defect:

*** Erosion:**			
Observation:			
a. Ground erosion which may reduce ground cover or cause damage.	LF		
***{Severity H}			

29.04 UNDERGROUND MEDIUM VOLTAGE SYSTEM (601 V TO 35 kV)

COMPONENTS (Continued)

◆ 29.04.02 HANDHOLES / MANHOLES

Handholes and manholes are underground enclosures that serve as splice, junction and pull points for cables routed in duct and ductbank raceway systems, and for direct buried cables.

Handholes are underground enclosures which workmen can reach into, but are not large enough to enter. Depth of handholes are normally less than four feet deep.

Manholes are underground enclosures large enough for a man to enter and work in so as to make cable splices and routings. Depth of manhole, less entrance chamber, is normally more than six feet deep.

Handhole enclosure material is either metal, composite material or concrete.

Manhole enclosure material is either composite material or concrete.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
* **Enclosure Damage:**			
Observation:			
a. 10% or less of coverplate seat missing. ***{Severity H}	EA		
b. More than 10% of coverplate seat missing. ***{Severity H}	EA		
c. Coverplate broken or missing. ***{Severity H}	EA		
d. Structure cracks, 1/16" or wider. ***{Severity H}	LF		

29.04 UNDERGROUND MEDIUM VOLTAGE SYSTEM (601 V TO 35 kV)

COMPONENTS (Continued)

◆ 29.04.03 TRANSFORMERS

Transformers are static electric devices consisting of a single winding or multiple coupled windings with or without a magnetic core. Power is transferred by electromagnetic induction from the input to the output circuit usually with changed values of voltages and currents.

Transformers have six types of functions: power transformers converts one voltage source to another voltage power source, isolation transformers shields the load side winding from the line side winding, reduced voltage starting transformers reduces the motor terminal voltage during the starting cycle, buck/boost transformers either raise or lower output voltage to accommodate the load, current transformers proportions a high current flow to a low current flow for instrumentation and control purpose and potential transformers proportions a high voltage potential to a low voltage potential for instrumentation and control purposes.

Transformers, other than current and potential transformers, smaller than 5 kVA single phase or 15 kVA multi phase will not be inspected. All current and potential transformers will be inspected.

Surge (lightning) arresters, insulators, foundations, poles and conductors bare will be inspected under separate components.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Corrosion:**			
Observation:			
a. Surface corrosion (no pitting evident). ***{Severity L}	SF		
b. Corrosion evidenced by pitting or blistering. ***{Severity M}	SF		5
c. Corrosion evidenced by holes or loss of base metal. ***{Severity H}	SF		5

Defect:

*** Physical Damage:**			
Observation:			
a. Enclosure mounting loose, broken or missing. ***{Severity L}	EA		
b. Panel fastener loose, broken or missing. ***{Severity L}	EA		
c. Enclosure damaged (cannot be sealed). ***{Severity M}	EA		
d. Air intake/exhaust ducts blocked. ***{Severity M}	EA		

29.04 UNDERGROUND MEDIUM VOLTAGE SYSTEM (601 V TO 35 kV)

COMPONENTS (Continued)

◆ **29.04.03 TRANSFORMERS (Continued)**

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Physical Damage (continued):**			
e. Air filter dirty or missing. ***{Severity M}	EA		
f. Unused opening not covered. ***{Severity M}	EA		
g. Loose or broken mounting bracket. ***{Severity M}	EA		
h. Cooling fan guard/blade broken or missing. ***{Severity H}	EA		
i. Unit not grounded. ***{Severity H}	EA		
j. Gauge or meter broken or missing. ***{Severity M}	EA		
k. Security lock missing or inoperable. ***{Severity H}	EA		

Defect:

*** Oil Leak:**			
Observation:			
a. Oil on surface of tank (possible oil leak). ***{Severity L}	EA		6
b. Oil puddle under or around base of tank. ***{Severity H}	EA		6

Defect:

*** Hot Spots:**			
Observation:			
a. Terminal 5° to 24°C above ambient. ***{Severity M}	EA	1	1
b. Terminal 25°C or more above ambient. ***{Severity H}	EA	1	1
c. Oil cooling fin blocked. ***{Severity H}	EA		7
d. Low oil level (less than 2" above fin). ***{Severity H}	EA		7

29.04 UNDERGROUND MEDIUM VOLTAGE SYSTEM (601 V TO 35 kV)

COMPONENTS (Continued)

◆ 29.04.04 FOUNDATIONS

Foundations consist of cast-in-place concrete footings and piers through which the loads of structures are transmitted to the earth. Anchor bolts are embedded in the concrete, to connect the structure or equipment to the foundation.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Cracking:**			
Observation:			
a. Cracks, between 1/16" and 1/4" wide. ***{Severity M}	LF		2
b. Disintegration of surface or cracks exceeding 2" depth. ***{Severity H}	LF		2

Defect:

*** Spalling:**			
Observation:			
a. Not more than 1" deep or 6" in diameter. ***{Severity L}	SF		
b. More than 1" in depth or 6" in dia., or 10% of surface area loss. ***{Severity H}	SF		
c. Disintegration of surface area, with corrosion of exposed rebar. ***{Severity H}	SF		3

Defect:

*** Scaling:**			
Observation:			
a. Surface loss of 1/2" to 1" deep, with coarse aggregates exposed. ***{Severity M}	SF		
b. Loss of surface exceeding 1" deep. ***{Severity H}	SF		
c. Exposure of reinforcing steel. ***{Severity H}	SF		3

Defect:

*** Reinforcing Steel Corrosion:**			
Observation:			
a. Rusting evident, cracks occurring along rebar. ***{Severity H}	LF		3

29.04 UNDERGROUND MEDIUM VOLTAGE SYSTEM (601 V TO 35 kV)

REFERENCES

1. DOE CAS Manual, Volume 9: 0.09, Electrical

2. DOE, Volume 2: 0.02 Substructure Deficiency Standards and Inspection Method Manual

3. National Fire Protection Association (NFPA 70B) *"Recommended Practice for Electrical Equipment Maintenance"*, 1990 Edition

4. Iowa Administrative Code, Utilities [199], Chapter 25, Iowa Electrical Safety Code IAC 8/5/92

5. MEANS "Concrete Repair and Maintenance", Peter H. Emmons, 1994

6. MEANS *"Facilities Maintenance & Repair Cost Data"*, 1994

29.04 UNDERGROUND MEDIUM VOLTAGE SYSTEM (601 V TO 35 kV)

LEVEL II KEY	GUIDE SHEET CONTROL NUMBER
1	GS-II 29.04.03-1

LEVEL III KEY	GUIDE SHEET CONTROL NUMBER
1	GS-III 29.04.03-1
2	GS-III 29.04.04-2
3	GS-III 29.04.04-3
4*	GS-III 29.04.01-4*
5	GS-III 29.04.03-5
6	GS-III 29.04.03-6
7	GS-III 29.04.03-7

* Indicates guide sheets which are not directly referenced by a Key. These are "triggered" by information beyond the inspection process such as time, age or repeated service calls.

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 1

COMPONENT: TRANSFORMERS
CONTROL NUMBER: GS-II 29.04.03-1

Application

This guide applies to the investigation of the inside of an enclosure, containing bare, energized, electrical parts.

Special Safety Requirements

The following list of special safety requirements, beyond the requirements listed in the Master Safety Plan and System Safety Section, are to be observed in the performance of this inspection.

1. This inspection guide applies to enclosure compartments containing live electrical parts having a potential of 600 volts or less above ground. If the enclosure compartment contains circuitry of higher potential, do not use this inspection guide.

2. Any enclosure that is padlocked for safety reason is not to be opened unless okayed by the person having control of the key.

3. Inspector needs to carefully open, inspect the inside and close the enclosure without shutting down the equipment, and without creating a hazard to himself.

Inspection Actions

1. Open panels or doors carefully and to the degree required for scanning those devices being tested.

2. Make temperature measurements with an infrared scanner.

3. Measure the ambient temperature by measuring a spot on the inside of the enclosure that is least effected by any internal panel heat source.

4. Measure the temperature of the device specified.

5. Above-ambient temperature is calculated by subtracting the ambient temperature from the device temperature.

6. Record the results.

7. Close panels or doors carefully after the inspection is complete.

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 1 (Continued)

COMPONENT: TRANSFORMERS
CONTROL NUMBER: GS-II 29.04.03-1

Recommended Inspection Frequency

Do a Level II inspection each time a Level I inspection is made.

References

1. Maintenance Technology/September 1993; Write-up Title: *"Infrared Keeps All Systems Go"*

2. Raining - Agema Infrared Systems; *"Measurement of Excess Temperatures with Infrared Scanners"*

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 1

COMPONENT: TRANSFORMERS
CONTROL NUMBER: GS-III 29.04.03-1

Application

This guide applies to the investigation of a hot terminal or device that is overheating from the flow of current through that terminal or device.

Special Safety Requirements

No special safety requirements are needed for the performance of this Level III inspection beyond those required in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Verify the findings of Level II inspection by using the Infrared Scanner and measuring the temperatures of the device and terminals. If the device or terminals are not hot as indicated by the findings of Level II inspection, check the current flow through the device or terminals. Heat generated is proportionate to the square of the current. If there is little or no current flow through the device or terminal at the time of measurement, there will be no significant amount of heat generated.

2. For terminal connections, verify the type of conductor being terminated. If the conductor is an aluminum conductor, look for evidence of cold flow or melt down of conductor.

3. If there is evidence of cold flow or melt down of the aluminum conductor, the conductor should either be replaced or shortened and reconnected. When making new aluminum conductor terminations a joint compound should be used.

4. If the terminal is loose it should be tightened. De-energize prior to attempting tightening of terminal connections.

5. If none of the above is the problem than there is an internal problem and an on-site analysis must be made to determine if additional inspections are to be made or the unit is to be replaced.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 1 (Continued)

COMPONENT: TRANSFORMERS
CONTROL NUMBER: GS-III 29.04.03-1

Special Tools and Equipment

The following is a list of special tools required beyond those listed in the Standard Tool Section.

1. Infrared Scanner, Raytek, Inc., #PM2EM-L2

2. Torque wrench

3. Digital Multimeter, Fluke #1TC676

Recommended Inspection Frequency

Do a Level III inspection when triggered by a Level II inspection.

References

1. Maintenance Technology/September 1993; Write-up Title: *"Infrared Keeps All Systems Go"*

2. Raining - Agema Infrared Systems; *"Measurement of Excess Temperatures with Infrared Scanners"*

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 2

COMPONENT: FOUNDATIONS
CONTROL NUMBER: GS-III 29.04.04-2

Application

This guide applies to the investigation of cracks in concrete.

Special Safety Requirements

No special safety requirements are needed for the performance of this Level III inspection beyond those required in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Utilize ultrasonic pulse velocity equipment to check for damage extent and loss of integrity.

Special Tools and Equipment

The following is a list of special tools required beyond those listed in the Standard Tool Section.

1. Ultrasonic pulse velocity test equipment, Krautkramer Branson #USK-6

Recommended Inspection Frequency

When triggered by a Level I or II defect/observation.

References

1. DOE, Vol. 2:0.02. *"Substructure Deficiency Standards and Inspection Methods Manual"*

2. MEANS *"Concrete Repair and Maintenance"*, Peter H. Emmons, 1994

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 3

COMPONENT: FOUNDATIONS
CONTROL NUMBER: GS-III 29.04.04-3

Application

This guide applies to the investigation of corrosion of reinforcing steel in concrete.

Special Safety Requirements

No special safety requirements are needed for the performance of this Level III inspection beyond those required in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Clean rust/discoloration.

2. Perform half-cell potential test to determine degree of corrosion of steel reinforcement.

Special Tools and Equipment

The following is a list of special tools required beyond those listed in the Standard Tool Section.

1. Half-cell test equipment.

Recommended Inspection Frequency

Whenever Level I or II defect/observation triggers this Level III procedure.

References

1. DOE, Vol. 2:0.02. *"Substructure Deficiency Standards and Inspection Methods Manual"*

2. MEANS *"Concrete Repair and Maintenance"*, Peter H. Emmons, 1994

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 4*

COMPONENT: UNDERGROUND ELECTRICAL UTILITIES
CONTROL NUMBER: GS-III 29.04.01-4*

Application

This guide applies to underground electrical utilities' component and covers the inspection of underground handholes, manholes and power cables. This inspection, while it is part of the Condition Assessment Survey, is triggered by information beyond the inspection process such as time, age, or repeated service calls.

Special Safety Requirements

Inspectors need to have complete control of the underground utility while performing the inspection. During a portion of the inspection the underground utility will be taken out of service. Therefore the inspection of the underground utility will be scheduled accordingly to accommodate the inspection requirements. No other safety requirements are required for the performance of this Level III inspection beyond those required in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Locate the Underground Electrical Utilities maintenance log or records and review this material concerning the following:
   a. Dates when these inspections have been performed and frequency between these tests.
   b. Type of failure, if any, such as terminal or insulation failure.

2. Specify corrective action for problem areas:
   a. If inspections are not performed at scheduled intervals, a schedule should be established.
   b. If excessive problems occur between inspections, time between inspections should be shortened.

3. Handhole/Manhole Checkout:
   a. Handholes and manholes are to be pumped dry and cleaned out by removing the dirt, mud and debris.
   b. Check for defects in cable support devices including cable brackets and clamps.
   c. Check for damages to and continuity of cable shield and equipment grounding circuits.
   d. Check for sharp cable bends, excessive cable tension and cable movement.
   e. Check cables for insulation swelling and soft spots.
   f. Check cable splices for physical deterioration and signs of corona and tracking.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 4* (Continued)

COMPONENT: UNDERGROUND ELECTRICAL UTILITIES
CONTROL NUMBER: GS-III 29.04.01-4*

Inspection Actions (Continued):

4. Conduct megger and highpot testing as specified by the cable manufacturer. If there is no such recommendation, then provide these tests as outlined in NFPA 70B "*Recommended Practices for Electrical Maintenance*", latest edition.

5. After the power cables are tested as required above, connect, energize and check all terminals for hot spots and retorque as required.

Special Tools and Equipment

The following is a list of special tools and equipment required beyond those listed in the Standard Tool Section.

1. Infrared Scanner, Raytek Inc., #PM2EM-L2
2. Megger Insulation Analyzer, Biddle Bulletin 21-22, #218700; 115V, 60 Hz
3. High Voltage DC High-Pot, 70 kV, DC Test Set, Biddle Bulletin 22-60/160a #220070; 120V, 60 Hz
4. Refer to manufacturer troubleshooting guide for additional special tools required.

Recommended Inspection Frequency

Follow manufacturers' recommendations for frequency of inspection of power cables. If there is no manufacturer's recommendation, then an inspection for underground cables should be performed every ten years until the cable is 30 years old. After 30 years of life, the cable should be inspected every 5 years. Cables in dry protective areas should be inspected only when triggered by a visual inspection, repeated service calls, or catastrophic occurrences such as flood or fire.

References

1. NFPA 70B, *"Recommended Practice for Electrical Equipment Maintenance", 1990 Edition*

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 5

COMPONENT: TRANSFORMER
CONTROL NUMBER: GS-III 29.04.03-5

Application

This guide applies to the investigation of 112.5 kVA transformers or larger that contain liquids used as electrical insulation and coolant.

Special Safety Requirements

No special safety requirements are needed for the performance of this Level III inspection beyond those required in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Verify the findings of Level I inspection concerning the corrosive condition of the tank containing the coolant and insulation liquid.
2. If the tank has corroded to the point where contaminated air could possibly pass through the tank wall an oil analysis should be performed.
3. If the liquid is contaminated, provide test to determine how the tank leaks.
4. Analyze the test results to determine whether the transformer can be repaired or must be replaced.

Special Tools and Equipment

The following is a list of special tools required beyond those listed in the Standard Tool Section.

1. Wire brush
2. Wrenches
3. Pressure gauge
4. Inert gas supply

Recommended Inspection Frequency

Do a Level III inspection when triggered by a Level I inspection.

References

1. Sverdrup Corporation

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 6

COMPONENT: TRANSFORMER
CONTROL NUMBER: GS-III 29.04.03-6

Application

This guide applies to the investigation of oil leaks in the transformer tank that has signs of oil on surface of the tank or an oil puddle under or around base of tank.

Special Safety Requirements

No special safety requirements are needed for the performance of this Level III inspection beyond those required in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Verify the findings of Level I inspection by finding the source of the oil. If the oil is coming from an external source no further inspection of the transformer is required. The external source should be identified and recommendations made to eliminate the contamination of the breaker.

2. If the oil source is coming from within the transformer, a determination should be made as how the oil is escaping.

3. If transformer repairs are made, oil analysis should be made after the repairs to determine if the oil is contaminated.

4. All contaminated oil should be removed and replaced with new oil.

Special Tools and Equipment

The following is a list of special tools required beyond those listed in the Standard Tool Section.

1. Brush

2. Non-flammable cleaning fluid

3. Wiping material

Recommended Inspection Frequency

Do a Level III inspection when triggered by a Level I inspection.

References

1. Sverdrup Corporation

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 7

COMPONENT: TRANSFORMER
CONTROL NUMBER: GS-III 29.04.03-7

Application

This guide applies to the investigation of 112.5 kVA transformers or larger that contain liquids used as electrical insulation and coolant.

Special Safety Requirements

No special safety requirements are needed for the performance of this Level III inspection beyond those required in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Verify the findings of Level I inspection concerning cooling fin blockage or low liquid level.
2. Do a liquid analysis test.
3. If liquid analysis test results are okay, add liquid to proper level requirements.
4. If fin blockage remains, have liquid removed and clear the fin blockage.
5. If liquid analysis test results show contaminates, have the liquid removed, the contaminates flushed out and new liquid added.

Special Tools and Equipment

The following is a list of special tools required beyond those listed in the Standard Tool Section.

1. Infrared scanner
2. Tools and sampling containers for taking liquid samples and transferring these samples to the lab.
3. Tools and liquid supplies for adding the appropriate liquid to the transformer tank.

Recommended Inspection Frequency

Do a Level III inspection when triggered by a Level I inspection.

References

1. Sverdrup Corporation

29.05 LOW VOLTAGE DISTRIBUTION SYSTEM, 600V OR LESS

DESCRIPTION

Low Voltage Distribution System is a subsystem of Site Electrical system. Low Voltage Distribution System consist of electrical devices and interconnecting conductors required to distribute the electrical power from where it enters the building to the end use devices located throughout the building. The Low Voltage Distribution System will condition the power and change the voltage level as required by the individual end use devices.

SPECIAL TOOL AND EQUIPMENT REQUIREMENTS

The following special tool, beyond the requirements listed in the Standard Tool Section shall be provided to perform the inspection of the Low Voltage Subsystem:

1. Infrared scanner, Raytek, Inc. #PM2EM-L2

SPECIAL SAFETY REQUIREMENTS

No special safety requirements are needed for the inspection of Low Voltage Distribution Subsystem beyond the requirements listed in the Master Safety Plan and System Safety Section.

COMPONENT LIST

- ◆ 29.05.01 CIRCUIT BREAKERS (LOW VOLTAGE)
- ◆ 29.05.02 DISCONNECT SWITCHES (LOW VOLTAGE)
- ◆ 29.05.03 TRANSFER SWITCHES
- ◆ 29.05.04 MOTOR STARTERS/CONTACTORS
- ◆ 29.05.05 TRANSFORMERS
- ◆ 29.05.06 END USE DEVICE CONNECTIONS

RELATED SUBSYSTEMS

Due to the related nature of the elements requiring inspection, the following should be reviewed for concurrent inspection activities.

10.04	CONTROL UNITS
10.06	RACEWAYS
29.04	UNDERGROUND MEDIUM VOLTAGE SYSTEM (601V TO 35kV) (UNDERGROUND ELECTRICAL UTILITIES)

STANDARD INSPECTION PROCEDURE

Components require a Level I or Level II inspection as part of the basic inspection process. Other additional Level II inspection may be indicated or "triggered" by a Level I inspection and should be accomplished by the inspector at that time. Level III inspection may be indicated or "triggered" by a Level I or II inspection Defect/Observation and should be accomplished at the direction of the Facility Manager.

Inspection should be carried out in the order of presentation for the various components with associated defects and observations for each subsystem listed in the inspector's CAIS.

29.05 LOW VOLTAGE DISTRIBUTION SYSTEM, 600V OR LESS

COMPONENTS

◆ 29.05.01 CIRCUIT BREAKERS (LOW VOLTAGE)

Circuit breakers (low voltage) are devices used to disconnect loads rated 600 volts or less from its source. They contain built-in overcurrent and undervoltage devices to protect down stream conductors and equipment from overcurrent loads. These breakers can be operated automatically by built-in devices or by manually built-in toggle switches.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Corrosion:**			
Observation:			
a. Surface corrosion (no pitting evident). ***{Severity L}	SF		
b. Corrosion evidenced by pitting or blistering. ***{Severity M}	SF		
c. Corrosion evidenced by holes or loss of base metal. ***{Severity H}	SF		

Defect:

	UOM	LEVEL II KEY	LEVEL III KEY
*** Physical Damage:**			
Observation:			
a. Enclosure mounting loose, broken or missing. ***{Severity L}	EA		
b. Panel fastener loose, broken or missing. ***{Severity L}	EA		
c. Enclosure damaged (cannot be sealed). ***{Severity M}	EA		
d. Unused opening not covered. ***{Severity M}	EA		
e. Door handle bent or inoperative. ***{Severity H}	EA		
f. Circuit breaker broken or damaged. ***{Severity H}	EA	1	
g. Security devices missing or inoperable. ***{Severity H}	EA		

29.05 LOW VOLTAGE DISTRIBUTION SYSTEM, 600V OR LESS

COMPONENTS (Continued)

◆ 29.05.01 CIRCUIT BREAKERS (LOW VOLTAGE) (Continued)

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Hot Spots:**			
Observation:			
a. Terminal or breaker body 5° to 24°C above ambient. ***{Severity M}	EA	2	1
b. Terminal or breaker body 25°C or more above ambient. ***{Severity H}	EA	2	1

29.05 LOW VOLTAGE DISTRIBUTION SYSTEM, 600V OR LESS

COMPONENTS (Continued)

◆ 29.05.02 DISCONNECT SWITCHES (LOW VOLTAGE)

Disconnect switches (low voltage) are devices used to disconnect loads rated 600 volts or less from its source. Two types of disconnect switches are fused or non-fused. Disconnect switches are normally manually operated but could be electrically operated.

Disconnect switch with a fuse unit provides both overload and short circuit protection.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Corrosion:**			
Observation:			
a. Surface corrosion (no pitting evident). ***{Severity L}	SF		
b. Corrosion evidenced by pitting or blistering. ***{Severity M}	SF		
c. Corrosion evidenced by holes or loss of base metal. ***{Severity H}	SF		

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Physical Damage:**			
Observation:			
a. Enclosure mounting loose, broken or missing. ***{Severity L}	EA		
b. Panel fastener loose, broken or missing. ***{Severity L}	EA		
c. Enclosure damaged (cannot be sealed). ***{Severity M}	EA		
d. Door handle bent or inoperative. ***{Severity H}	EA		
e. Unused opening not covered. ***{Severity M}	EA		
f. Security device missing or inoperative. ***{Severity H}	EA		
g. Carbon tracking due to flashovers. ***{Severity H}	EA	3	
h. Discoloration of blades and contacts due to overheating. ***{Severity H}	EA	3	

29.05 LOW VOLTAGE DISTRIBUTION SYSTEM, 600V OR LESS

COMPONENTS (Continued)

◆ 29.05.02 DISCONNECT SWITCHES (LOW VOLTAGE) (Continued)

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
* **Hot Spots:**			
Observation:			
a. Terminal blade end or fuse clip 5° to 24°C above ambient. ***{Severity M}	EA	4	2
b. Terminal blade end of fuse clip 25°C or more above ambient. ***{Severity H}	EA	4	2

29.05 LOW VOLTAGE DISTRIBUTION SYSTEM, 600V OR LESS

COMPONENTS (Continued)

◆ 29.05.03 TRANSFER SWITCHES

Transfer switch has two power inputs, each from a separate power source and a single output to feed a given load. The purpose of the switch is to provide a means of transferring the load from one power source to another without remaking manual connections.

Transfer switches can be manually operated or both manually and automatically operated.

Transfer switches may be mounted independently or in substations, switchboards or motor control centers.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Corrosion:**			
Observation:			
a. Surface corrosion (no pitting evident). ***{Severity L}	SF		
b. Corrosion evidenced by pitting or blistering. ***{Severity M}	SF		
c. Corrosion evidenced by holes or loss of base metal. ***{Severity H}	SF		

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Physical Damage:**			
Observation:			
a. Enclosure mounting loose, broken or missing. ***{Severity L}	EA		
b. Panel fastener loose, broken or missing. ***{Severity L}	EA		
c. Pilot light damaged or inoperable. ***{Severity L}	EA		
d. Interior not clean or moisture free ***{Severity L}	EA	5	
e. Enclosure damaged (cannot be sealed). ***{Severity M}	EA		
f. Unused opening not covered. ***{Severity M}	EA		
g. Handle bent or inoperable. ***{Severity H}	EA		

29.05 LOW VOLTAGE DISTRIBUTION SYSTEM, 600V OR LESS

COMPONENTS (Continued)

◆ **29.05.03 TRANSFER SWITCHES (Continued)**

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
* **Physical Damage (continued):**			
h. Security device missing or inoperable. ***{Severity H}	EA		
i. Carbon tracking due to flashovers. ***{Severity H}	EA	5	
j. Discoloration of blades and contacts due to overheating. ***{Severity H}	EA	5	
k. Unit not grounded. ***{Severity H}	EA	5	

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
* **Hot Spots:**			
Observation:			
a. Terminal 5° to 24°C above ambient. ***{Severity M}	EA	6	3
b. Terminal 25°C or more above ambient. ***{Severity H}	EA	6	3

29.05 LOW VOLTAGE DISTRIBUTION SYSTEM, 600V OR LESS

COMPONENTS (Continued)

◆ 29.05.04 MOTOR STARTERS/ CONTACTORS

Motor starters are devices housed in an enclosure and used for controlling electrical motors. These devices consist of the following: disconnect switches, circuit breakers, contactors, control transformers, fuses, various types of relays, pushbuttons, selector switches, pilot lights, metering devices, etc. Required components depend on the complexity of the motor control function. Control functions provided by motor starters are; starting, accelerating, reversing rotation, cycling, jogging and stopping electrical motors. The complexity of control functions depends on the operational requirements the motors are to fulfill.

Magnetic and auxiliary contactors are used to switch lighting and heating loads, capacitors, transformers and electric motors where overload protection is separately provided. Contactors can be used as accessories to various pieces of equipment such as disconnect switches, circuit breakers, light controls or operate alone with its own accessories.

Circuit breakers and disconnect switches located in motor starters will be inspected under a separate component. The motor starter housing and devices therein will be inspected by this standard.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
* **Corrosion:**			
Observation:			
a. Surface corrosion (no pitting evident).	SF		
***{Severity L}			
b. Corrosion evidenced by pitting or blistering.	SF		
***{Severity M}			
c. Corrosion evidenced by holes or loss of base metal.	SF		
***{Severity H}			

Defect:

* **Physical Damage:**			
Observation:			
a. Enclosure mounting loose, broken or missing.	EA		
***{Severity L}			
b. Pilot light damaged or inoperable.	EA		
***{Severity L}			
c. Metering device loose or damaged.	EA		
***{Severity L}			

29.05 LOW VOLTAGE DISTRIBUTION SYSTEM, 600V OR LESS

COMPONENTS (Continued)

◆ 29.05.04 MOTOR STARTERS/ CONTACTORS (Continued)

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Physical Damage (Continued):**			
d. Panel fastener loose, broken or missing. ***{Severity L}	EA		
e. Interior not clean or moisture-free. ***{Severity L}	EA	7	
f. Enclosure damaged (cannot be sealed). ***{Severity M}	EA		
g. Control device loose or damaged. ***{Severity M}	EA		
h. Unused opening not covered. ***{Severity M}	EA		
i. Door handle bent or inoperable. ***{Severity H}	EA		
j. Security devices missing or inoperable. ***{Severity H}	EA		
k. Unit not grounded. ***{Severity H}	EA	7	
l. Switch or pushbutton damaged or broken. ***{Severity M}	EA		

Defect:

*** Hot Spots:**			
Observation:			
a. Terminal 5° to 24°C above ambient. ***{Severity M}	EA	8	4
b. Terminal 25°C or more above ambient. ***{Severity H}	EA	8	4

29.05 LOW VOLTAGE DISTRIBUTION SYSTEM, 600V OR LESS

COMPONENTS (Continued)

◆ 29.05.05 TRANSFORMERS

Transformers are static electric devices consisting of a single winding or multiple coupled windings with or without a magnetic core. Power is transferred by electromagnetic induction from the input to the output circuit usually with changed values of voltages and currents.

Transformers have six types of functions: power transformers converts one voltage source to another voltage power source, isolation transformers shields the load side winding from the line side winding, reduced voltage starting transformers reduces the motor terminal voltage during the starting cycle, buck/boost transformers either raise or lower output voltage to accommodate the load, current transformers proportions a high current flow to a low current flow for instrumentation and control purpose and potential transformers proportions a high voltage potential to a low voltage potential for instrumentation and control purposes.

Transformers, other than current and potential transformers, smaller than 5 kVA single phase or 15 kVA multi phase will not be inspected. All current and potential transformers will be inspected.

Surge (lightning) arresters, insulators, foundations, poles and conductors bare will be inspected under separate components.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Corrosion:**			
Observation:			
a. Surface corrosion (no pitting evident). ***{Severity L}	SF		
b. Corrosion evidenced by pitting or blistering. ***{Severity M}	SF		7
c. Corrosion evidenced by holes or loss of base metal. ***{Severity H}	SF		7

Defect:

Defect	UOM	LEVEL II KEY	LEVEL III KEY
*** Physical Damage:**			
Observation:			
a. Enclosure mounting loose, broken or missing. ***{Severity L}	EA		
b. Panel fastener loose, broken or missing. ***{Severity L}	EA		
c. Enclosure damaged (cannot be sealed). ***{Severity M}	EA		
d. Air intake/exhaust ducts blocked. ***{Severity M}	EA		

29.05 LOW VOLTAGE DISTRIBUTION SYSTEM, 600V OR LESS

COMPONENTS (Continued)

◆ 29.04.03 TRANSFORMERS (Continued)

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Physical Damage (continued):**			
e. Air filter dirty or missing. ***{Severity M}	EA		
f. Unused opening not covered. ***{Severity M}	EA		
g. Loose or broken mounting bracket. ***{Severity M}	EA		
h. Cooling fan guard/blade broken or missing. ***{Severity H}	EA		
i. Unit not grounded. ***{Severity H}	EA		
j. Gauge or meter broken or missing. ***{Severity M}	EA		
k. Security lock missing or inoperable. ***{Severity H}	EA		

Defect:

*** Oil Leak:**	UOM	LEVEL II KEY	LEVEL III KEY
Observation:			
a. Oil on surface of tank (possible oil leak). ***{Severity L}	EA		8
b. Oil puddle under or around base of tank. ***{Severity H}	EA		8

Defect:

*** Hot Spots:**	UOM	LEVEL II KEY	LEVEL III KEY
Observation:			
a. Terminal 5° to 24°C above ambient. ***{Severity M}	EA	9	5
b. Terminal 25°C or more above ambient. ***{Severity H}	EA	9	5
c. Oil cooling fin blocked. ***{Severity H}	EA		9
d. Low oil level (less than 2" above fin). ***{Severity H}	EA		9

29.05 LOW VOLTAGE DISTRIBUTION SYSTEM, 600V OR LESS

COMPONENTS (Continued)

◆ 29.05.06 END USE DEVICE CONNECTIONS

End use devices use electrical power. These end use devices are electric unit heaters, welding receptacles, electric water heaters, electric kitchen appliances, etc.

Inspection of the end use devices will cover the termination of the incoming conductors. The remainder of the inspection of the end use devices are covered in other sections.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Physical Damage:**			
Observation:			
a. Excessive dust, dirt or moisture accumulation. ***{Severity L}	EA	10	
b. Conductor insulation damaged or carbon tracked. ***{Severity M}	EA	10	
c. Two or more conductor strands broken. ***{Severity H}	EA	10	
d. Unit not grounded. ***{Severity H}	EA	10	

Defect:

*** Hot Spots:**			
Observation:			
a. Terminal 5° to 24°C above ambient. ***{Severity M}	EA	11	6
b. Terminal 25°C or more above ambient. ***{Severity H}	EA	11	6

29.05 LOW VOLTAGE DISTRIBUTION SYSTEM, 600V OR LESS

REFERENCES

1. DOE CAS Manual, Volume 9: 0.09, Electrical

2. National Fire Protection Association (NFPA 70B) *"Recommended Practice for Electrical Equipment Maintenance"*, 1990 Edition

3. American Electrician's Handbook, Twelfth Edition, Terrell Croft/Wilford Summers - Editors, McGraw-Hill, Inc. Publishers

4. *"Handbook of Building and Plant Maintenance Forms and Checklists"* by Roger W. Liska and Judith Morrison Liska

5. MEANS *"Facilities Maintenance & Repair Cost Data"*, 1994

29.05 LOW VOLTAGE DISTRIBUTION SYSTEM, 600V OR LESS

LEVEL II KEY	GUIDE SHEET CONTROL NUMBER
1	GS-II 29.05.01-1
2	GS-II 29.05.01-2
3	GS-II 29.05.02-3
4	GS-II 29.05.02-4
5	GS-II 29.05.03-5
6	GS-II 29.05.03-6
7	GS-II 29.05.04-7
8	GS-II 29.05.04-8
9	GS-II 29.05.05-9
10	GS-II 29.05.06-10
11	GS-II 29.05.06-11

LEVEL III KEY	GUIDE SHEET CONTROL NUMBER
1	GS-III 29.05.01-1
2	GS-III 29.05.02-2
3	GS-III 29.05.03-3
4	GS-III 29.05.04-4
5	GS-III 29.05.05-5
6	GS-III 29.05.06-6
7	GS-III 29.05.05-7
8	GS-III 29.05.05-8
9	GS-III 29.05.05-9

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 1

COMPONENT: CIRCUIT BREAKERS (LOW VOLTAGE)
CONTROL NUMBER: GS-II 29.05.01-1

Application

This guide applies to the investigation of the inside of an enclosure, containing bare, energized, electrical parts.

Special Safety Requirements

The following list of special safety requirements, beyond the requirements listed in the Master Safety Plan and System Safety Section, are to be observed in the performance of this inspection.

1. This inspection guide applies to enclosures containing live electrical parts having a potential of 600 volts or less above ground. If the enclosure contains circuitry of higher potential, do not use this inspection guide.

2. Any enclosure that is padlocked for safety reason is not to be opened unless okayed by the person having control of the key.

3. Inspector needs to carefully open, inspect the inside and close the enclosure without shutting down the equipment, and without creating a hazard to himself.

Inspection Actions

1. Open panels or doors carefully as required for doing the visual inspection.

2. Visually inspect for those physical damaged defects that are listed and tagged Level II Key No. as indicated above.

3. Close panels or doors carefully after the inspection is completed.

Recommended Inspection Frequency

Do a Level II inspection each time a Level I inspection indicates one is required.

References

1. Sverdrup Corporation

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 2

COMPONENT: CIRCUIT BREAKERS (LOW VOLTAGE)
CONTROL NUMBER: GS-II 29.05.01-2

Application

This guide applies to the investigation of the inside of an enclosure, containing bare, energized, electrical parts.

Special Safety Requirements

The following list of special safety requirements, beyond the requirements listed in the Master Safety Plan and System Safety Section, are to be observed in the performance of this inspection.

1. This inspection guide applies to enclosures containing live electrical parts having a potential of 600 volts or less above ground. If the enclosure contains circuitry of higher potential, do not use this inspection guide.

2. Any enclosure that is padlocked for safety reason is not to be opened unless okayed by the person having control of the key.

3. Inspector needs to carefully open, inspect the inside and close the enclosure without shutting down the equipment, and without creating a hazard to himself.

Inspection Actions

1. Open panels or doors carefully and to the degree required for scanning those devices being tested.

2. Make temperature measurements with an infrared scanner.

3. Measure the ambient temperature by measuring a spot on the inside of the enclosure that is least effected by any internal panel heat source.

4. Measure the temperature of the device specified.

5. Above-ambient temperature is calculated by subtracting the ambient temperature from the device temperature.

6. Record the results.

7. Close panels or doors carefully after the inspection is complete.

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 2 (Continued)

COMPONENT: CIRCUIT BREAKERS (LOW VOLTAGE)
CONTROL NUMBER: GS-II 29.05.01-2

Recommended Inspection Frequency

Do a Level II inspection each time a Level I inspection is made.

References

1. Maintenance Technology/September 1993; Write-up Title: *"Infrared Keeps All Systems Go"*

2. Raining - Agema Infrared Systems; *"Measurement of Excess Temperatures with Infrared Scanners"*

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 3

COMPONENT: DISCONNECT SWITCHES (LOW VOLTAGE)
CONTROL NUMBER: GS-II 29.05.02-3

Application

This guide applies to the investigation of the inside of an enclosure, containing bare, energized, electrical parts.

Special Safety Requirements

The following list of special safety requirements, beyond the requirements listed in the Master Safety Plan and System Safety Section, are to be observed in the performance of this inspection.

1. This inspection guide applies to enclosures containing live electrical parts having a potential of 600 volts or less above ground. If the enclosure contains circuitry of higher potential, do not use this inspection guide.

2. Any enclosure that is padlocked for safety reason is not to be opened unless okayed by the person having control of the key.

3. Inspector needs to carefully open, inspect the inside and close the enclosure without shutting down the equipment, and without creating a hazard to himself.

Inspection Actions

1. Open panels or doors carefully as required for doing the visual inspection.

2. Visually inspect for those physical damaged defects that are listed and tagged Level II Key No. as indicated above.

3. Close panels or doors carefully after the inspection is completed.

Recommended Inspection Frequency

Do a Level II inspection each time a Level I inspection indicates one is required.

References

1. Sverdrup Corporation

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 4

COMPONENT: DISCONNECT SWITCHES (LOW VOLTAGE)
CONTROL NUMBER: GS-II 29.05.02-4

Application

This guide applies to the investigation of the inside of an enclosure, containing bare, energized, electrical parts.

Special Safety Requirements

The following list of special safety requirements, beyond the requirements listed in the Master Safety Plan and System Safety Section, are to be observed in the performance of this inspection.

1. This inspection guide applies to enclosures containing live electrical parts having a potential of 600 volts or less above ground. If the enclosure contains circuitry of higher potential, do not use this inspection guide.

2. Any enclosure that is padlocked for safety reason is not to be opened unless okayed by the person having control of the key.

3. Inspector needs to carefully open, inspect the inside and close the enclosure without shutting down the equipment, and without creating a hazard to himself.

Inspection Actions

1. Open panels or doors carefully and to the degree required for scanning those devices being tested.

2. Make temperature measurements with an infrared scanner.

3. Measure the ambient temperature by measuring a spot on the inside of the enclosure that is least effected by any internal panel heat source.

4. Measure the temperature of the device specified.

5. Above-ambient temperature is calculated by subtracting the ambient temperature from the device temperature.

6. Record the results.

7. Close panels or doors carefully after the inspection is complete.

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 4 (Continued)

COMPONENT: DISCONNECT SWITCHES (LOW VOLTAGE)
CONTROL NUMBER: GS-II 29.05.02-4

Recommended Inspection Frequency

Do a Level II inspection each time a Level I inspection is made.

References

1. Maintenance Technology/September 1993; Write-up Title: *"Infrared Keeps All Systems Go"*

2. Raining - Agema Infrared Systems; *"Measurement of Excess Temperatures with Infrared Scanners"*

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 5

COMPONENT: TRANSFER SWITCHES
CONTROL NUMBER: GS-II 29.05.03-5

Application

This guide applies to the investigation of the inside of an enclosure, containing bare, energized, electrical parts.

Special Safety Requirements

The following list of special safety requirements, beyond the requirements listed in the Master Safety Plan and System Safety Section, are to be observed in the performance of this inspection.

1. This inspection guide applies to enclosures containing live electrical parts having a potential of 600 volts or less above ground. If the enclosure contains circuitry of higher potential, do not use this inspection guide.

2. Any enclosure that is padlocked for safety reason is not to be opened unless okayed by the person having control of the key.

3. Inspector needs to carefully open, inspect the inside and close the enclosure without shutting down the equipment, and without creating a hazard to himself.

Inspection Actions

1. Open panels or doors carefully as required for doing the visual inspection.

2. Visually inspect for those physical damaged defects that are listed and tagged Level II Key No. as indicated above.

3. Close panels or doors carefully after the inspection is completed.

Recommended Inspection Frequency

Do a Level II inspection each time a Level I inspection indicates one is required.

References

1. Sverdrup Corporation

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 6

COMPONENT: TRANSFER SWITCHES
CONTROL NUMBER: GS-II 29.05.03-6

Application

This guide applies to the investigation of the inside of an enclosure, containing bare, energized, electrical parts.

Special Safety Requirements

The following list of special safety requirements, beyond the requirements listed in the Master Safety Plan and System Safety Section, are to be observed in the performance of this inspection.

1. This inspection guide applies to enclosures containing live electrical parts having a potential of 600 volts or less above ground. If the enclosure contains circuitry of higher potential, do not use this inspection guide.

2. Any enclosure that is padlocked for safety reason is not to be opened unless okayed by the person having control of the key.

3. Inspector needs to carefully open, inspect the inside and close the enclosure without shutting down the equipment, and without creating a hazard to himself.

Inspection Actions

1. Open panels or doors carefully and to the degree required for scanning those devices being tested.

2. Make temperature measurements with an infrared scanner.

3. Measure the ambient temperature by measuring a spot on the inside of the enclosure that is least effected by any internal panel heat source.

4. Measure the temperature of the device specified.

5. Above-ambient temperature is calculated by subtracting the ambient temperature from the device temperature.

6. Record the results.

7. Close panels or doors carefully after the inspection is complete.

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 6 (Continued)

COMPONENT: TRANSFER SWITCHES
CONTROL NUMBER: GS-II 29.05.03-6

Recommended Inspection Frequency

Do a Level II inspection each time a Level I inspection is made.

References

1. Maintenance Technology/September 1993; Write-up Title: *"Infrared Keeps All Systems Go"*

2. Raining - Agema Infrared Systems; *"Measurement of Excess Temperatures with Infrared Scanners"*

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 7

COMPONENT: MOTOR STARTERS/CONTACTORS
CONTROL NUMBER: GS-II 29.05.04-7

Application

This guide applies to the investigation of the inside of an enclosure, containing bare, energized, electrical parts.

Special Safety Requirements

The following list of special safety requirements, beyond the requirements listed in the Master Safety Plan and System Safety Section, are to be observed in the performance of this inspection.

1. This inspection guide applies to enclosures containing live electrical parts having a potential of 600 volts or less above ground. If the enclosure contains circuitry of higher potential, do not use this inspection guide.

2. Any enclosure that is padlocked for safety reason is not to be opened unless okayed by the person having control of the key.

3. Inspector needs to carefully open, inspect the inside and close the enclosure without shutting down the equipment, and without creating a hazard to himself.

Inspection Actions

1. Open panels or doors carefully as required for doing the visual inspection.

2. Visually inspect for those physical damaged defects that are listed and tagged Level II Key No. as indicated above.

3. Close panels or doors carefully after the inspection is completed.

Recommended Inspection Frequency

Do a Level II inspection each time a Level I inspection indicates one is required.

References

1. Sverdrup Corporation

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 8

COMPONENT: MOTOR STARTERS/CONTACTORS
CONTROL NUMBER: GS-II 29.05.04-8

Application

This guide applies to the investigation of the inside of an enclosure, containing bare, energized, electrical parts.

Special Safety Requirements

The following list of special safety requirements, beyond the requirements listed in the Master Safety Plan and System Safety Section, are to be observed in the performance of this inspection.

1. This inspection guide applies to enclosures containing live electrical parts having a potential of 600 volts or less above ground. If the enclosure contains circuitry of higher potential, do not use this inspection guide.

2. Any enclosure that is padlocked for safety reason is not to be opened unless okayed by the person having control of the key.

3. Inspector needs to carefully open, inspect the inside and close the enclosure without shutting down the equipment, and without creating a hazard to himself.

Inspection Actions

1. Open panels or doors carefully and to the degree required for scanning those devices being tested.

2. Make temperature measurements with an infrared scanner.

3. Measure the ambient temperature by measuring a spot on the inside of the enclosure that is least effected by any internal panel heat source.

4. Measure the temperature of the device specified.

5. Above-ambient temperature is calculated by subtracting the ambient temperature from the device temperature.

6. Record the results.

7. Close panels or doors carefully after the inspection is complete.

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 8 (Continued)

COMPONENT: MOTOR STARTERS/CONTACTORS
CONTROL NUMBER: GS-II 29.05.04-8

Recommended Inspection Frequency

Do a Level II inspection each time a Level I inspection is made.

References

1. Maintenance Technology/September 1993; Write-up Title: *"Infrared Keeps All Systems Go"*

2. Raining - Agema Infrared Systems; *"Measurement of Excess Temperatures with Infrared Scanners"*

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 9

COMPONENT: TRANSFORMERS
CONTROL NUMBER: GS-II 29.05.05-9

Application

This guide applies to the investigation of the inside of an enclosure, containing bare, energized, electrical parts.

Special Safety Requirements

The following list of special safety requirements, beyond the requirements listed in the Master Safety Plan and System Safety Section, are to be observed in the performance of this inspection.

1. This inspection guide applies to enclosure compartments containing live electrical parts having a potential of 600 volts or less above ground. If the enclosure compartment contains circuitry of higher potential, do not use this inspection guide.

2. Any enclosure that is padlocked for safety reason is not to be opened unless okayed by the person having control of the key.

3. Inspector needs to carefully open, inspect the inside and close the enclosure without shutting down the equipment, and without creating a hazard to himself.

Inspection Actions

1. Open panels or doors carefully and to the degree required for scanning those devices being tested.

2. Make temperature measurements with an infrared scanner.

3. Measure the ambient temperature by measuring a spot on the inside of the enclosure that is least effected by any internal panel heat source.

4. Measure the temperature of the device specified.

5. Above-ambient temperature is calculated by subtracting the ambient temperature from the device temperature.

6. Record the results.

7. Close panels or doors carefully after the inspection is complete.

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 9 (Continued)

COMPONENT: TRANSFORMERS
CONTROL NUMBER: GS-II 29.05.05-9

Recommended Inspection Frequency

Do a Level II inspection each time a Level I inspection is made.

References

1. Maintenance Technology/September 1993; Write-up Title: *"Infrared Keeps All Systems Go"*

2. Raining - Agema Infrared Systems; *"Measurement of Excess Temperatures with Infrared Scanners"*

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 10

COMPONENT: END USE DEVICE CONNECTIONS
CONTROL NUMBER: GS-II 29.05.06-10

Application

This guide applies to the investigation of the inside of an enclosure, containing bare, energized, electrical parts.

Special Safety Requirements

The following list of special safety requirements, beyond the requirements listed in the Master Safety Plan and System Safety Section, are to be observed in the performance of this inspection.

1. This inspection guide applies to enclosures containing live electrical parts having a potential of 600 volts or less above ground. If the enclosure contains circuitry of higher potential, do not use this inspection guide.
2. Any enclosure that is padlocked for safety reason is not to be opened unless okayed by the person having control of the key.
3. Inspector needs to carefully open, inspect the inside and close the enclosure without shutting down the equipment, and without creating a hazard to himself.

Inspection Actions

1. Open panels or doors carefully as required for doing the visual inspection.
2. Visually inspect for those physical damaged defects that are listed and tagged Level II Key No. as indicated above.
3. Close panels or doors carefully after the inspection is completed.

Recommended Inspection Frequency

Do a Level II inspection each time a Level I inspection indicates one is required.

References

1. Sverdrup Corporation

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 11

COMPONENT: END USE DEVICE CONNECTIONS
CONTROL NUMBER: GS-II 29.05.06-11

Application

This guide applies to the investigation of the inside of an enclosure, containing bare, energized, electrical parts.

Special Safety Requirements

The following list of special safety requirements, beyond the requirements listed in the Master Safety Plan and System Safety Section, are to be observed in the performance of this inspection.

1. This inspection guide applies to enclosures containing live electrical parts having a potential of 600 volts or less above ground. If the enclosure contains circuitry of higher potential, do not use this inspection guide.

2. Any enclosure that is padlocked for safety reason is not to be opened unless okayed by the person having control of the key.

3. Inspector needs to carefully open, inspect the inside and close the enclosure without shutting down the equipment, and without creating a hazard to himself.

Inspection Actions

1. Open panels or doors carefully and to the degree required for scanning those devices being tested.

2. Make temperature measurements with an infrared scanner.

3. Measure the ambient temperature by measuring a spot on the inside of the enclosure that is least effected by any internal panel heat source.

4. Measure the temperature of the device specified.

5. Above-ambient temperature is calculated by subtracting the ambient temperature from the device temperature.

6. Record the results.

7. Close panels or doors carefully after the inspection is complete.

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 11 (Continued)

COMPONENT: END USE DEVICE CONNECTIONS
CONTROL NUMBER: GS-II 29.05.06-11

Recommended Inspection Frequency

Do a Level II inspection each time a Level I inspection is made.

References

1. Maintenance Technology/September 1993; Write-up Title: *"Infrared Keeps All Systems Go"*

2. Raining - Agema Infrared Systems; *"Measurement of Excess Temperatures with Infrared Scanners"*

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 1

COMPONENT: CIRCUIT BREAKERS (LOW VOLTAGE)
CONTROL NUMBER: GS-III 29.05.01-1

Application

This guide applies to the investigation of a hot terminal or device that is overheating from the flow of current through that terminal or device.

Special Safety Requirements

No special safety requirements are needed for the performance of this Level III inspection beyond those required in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Verify the findings of Level II inspection by using the Infrared Scanner and measuring the temperatures of the device and terminals. If the device or terminals are not hot as indicated by the findings of Level II inspection, check the current flow through the device or terminals. Heat generated is proportionate to the square of the current. If there is little or no current flow through the device or terminal at the time of measurement, there will be no significant amount of heat generated.

2. For terminal connections, verify the type of conductor being terminated. If the conductor is an aluminum conductor, look for evidence of cold flow or melt down of conductor.

3. If there is evidence of cold flow or melt down of the aluminum conductor, the conductor should either be replaced or shortened and reconnected. When making new aluminum conductor terminations a joint compound should be used.

4. If the terminal is loose it should be tightened. De-energize prior to attempting tightening of terminal connections.

5. If none of the above is the problem than there is an internal problem and an on-site analysis must be made to determine if additional inspections are to be made or the unit is to be replaced.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 1 (Continued)

COMPONENT: CIRCUIT BREAKERS (LOW VOLTAGE)
CONTROL NUMBER: GS-III 29.05.01-1

Special Tools and Equipment

The following is a list of special tools required beyond those listed in the Standard Tool Section.

1. Infrared Scanner, Raytek, Inc., #PM2EM-L2

2. Torque wrench

3. Digital Multimeter, Fluke #1TC676

Recommended Inspection Frequency

Do a Level III inspection when triggered by a Level II inspection.

References

1. Maintenance Technology/September 1993; Write-up Title: *"Infrared Keeps All Systems Go"*

2. Raining - Agema Infrared Systems; *"Measurement of Excess Temperatures with Infrared Scanners"*

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 2

COMPONENT: DISCONNECT SWITCHES (LOW VOLTAGE)
CONTROL NUMBER: GS-III 29.05.02-2

Application

This guide applies to the investigation of a hot terminal or device that is overheating from the flow of current through that terminal or device.

Special Safety Requirements

No special safety requirements are needed for the performance of this Level III inspection beyond those required in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Verify the findings of Level II inspection by using the Infrared Scanner and measuring the temperatures of the device and terminals. If the device or terminals are not hot as indicated by the findings of Level II inspection, check the current flow through the device or terminals. Heat generated is proportionate to the square of the current. If there is little or no current flow through the device or terminal at the time of measurement, there will be no significant amount of heat generated.

2. For terminal connections, verify the type of conductor being terminated. If the conductor is an aluminum conductor, look for evidence of cold flow or melt down of conductor.

3. If there is evidence of cold flow or melt down of the aluminum conductor, the conductor should either be replaced or shortened and reconnected. When making new aluminum conductor terminations a joint compound should be used.

4. If the terminal is loose it should be tightened. De-energize prior to attempting tightening of terminal connections.

5. If none of the above is the problem than there is an internal problem and an on-site analysis must be made to determine if additional inspections are to be made or the unit is to be replaced.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 2 (Continued)

COMPONENT: DISCONNECT SWITCHES (LOW VOLTAGE)
CONTROL NUMBER: GS-III 29.05.02-2

Special Tools and Equipment

The following is a list of special tools required beyond those listed in the Standard Tool Section.

1. Infrared Scanner, Raytek, Inc., #PM2EM-L2

2. Torque wrench

3. Digital Multimeter, Fluke #1TC676

Recommended Inspection Frequency

Do a Level III inspection when triggered by a Level II inspection.

References

1. Maintenance Technology/September 1993; Write-up Title: *"Infrared Keeps All Systems Go"*

2. Raining - Agema Infrared Systems; *"Measurement of Excess Temperatures with Infrared Scanners"*

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 3

COMPONENT: TRANSFER SWITCHES
CONTROL NUMBER: GS-III 29.05.03-3

Application

This guide applies to the investigation of a hot terminal or device that is overheating from the flow of current through that terminal or device.

Special Safety Requirements

No special safety requirements are needed for the performance of this Level III inspection beyond those required in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Verify the findings of Level II inspection by using the Infrared Scanner and measuring the temperatures of the device and terminals. If the device or terminals are not hot as indicated by the findings of Level II inspection, check the current flow through the device or terminals. Heat generated is proportionate to the square of the current. If there is little or no current flow through the device or terminal at the time of measurement, there will be no significant amount of heat generated.

2. For terminal connections, verify the type of conductor being terminated. If the conductor is an aluminum conductor, look for evidence of cold flow or melt down of conductor.

3. If there is evidence of cold flow or melt down of the aluminum conductor, the conductor should either be replaced or shortened and reconnected. When making new aluminum conductor terminations a joint compound should be used.

4. If the terminal is loose it should be tightened. De-energize prior to attempting tightening of terminal connections.

5. If none of the above is the problem than there is an internal problem and an on-site analysis must be made to determine if additional inspections are to be made or the unit is to be replaced.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 3 (Continued)

COMPONENT: TRANSFER SWITCHES
CONTROL NUMBER: GS-III 29.05.03-3

Special Tools and Equipment

The following is a list of special tools required beyond those listed in the Standard Tool Section.

1. Infrared Scanner, Raytek, Inc., #PM2EM-L2
2. Torque wrench
3. Digital Multimeter, Fluke #1TC676

Recommended Inspection Frequency

Do a Level III inspection when triggered by a Level II inspection.

References

1. Maintenance Technology/September 1993; Write-up Title: *"Infrared Keeps All Systems Go"*
2. Raining - Agema Infrared Systems; *"Measurement of Excess Temperatures with Infrared Scanners"*

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 4

COMPONENT: MOTOR STARTERS/CONTACTORS
CONTROL NUMBER: GS-III 29.05.04-4

Application

This guide applies to the investigation of a hot terminal or device that is overheating from the flow of current through that terminal or device.

Special Safety Requirements

No special safety requirements are needed for the performance of this Level III inspection beyond those required in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Verify the findings of Level II inspection by using the Infrared Scanner and measuring the temperatures of the device and terminals. If the device or terminals are not hot as indicated by the findings of Level II inspection, check the current flow through the device or terminals. Heat generated is proportionate to the square of the current. If there is little or no current flow through the device or terminal at the time of measurement, there will be no significant amount of heat generated.

2. For terminal connections, verify the type of conductor being terminated. If the conductor is an aluminum conductor, look for evidence of cold flow or melt down of conductor.

3. If there is evidence of cold flow or melt down of the aluminum conductor, the conductor should either be replaced or shortened and reconnected. When making new aluminum conductor terminations a joint compound should be used.

4. If the terminal is loose it should be tightened. De-energize prior to attempting tightening of terminal connections.

5. If none of the above is the problem than there is an internal problem and an on-site analysis must be made to determine if additional inspections are to be made or the unit is to be replaced.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 4 (Continued)

COMPONENT: MOTOR STARTERS/CONTACTORS
CONTROL NUMBER: GS-III 29.05.04-4

Special Tools and Equipment

The following is a list of special tools required beyond those listed in the Standard Tool Section.

1. Infrared Scanner, Raytek, Inc., #PM2EM-L2
2. Torque wrench
3. Digital Multimeter, Fluke #1TC676

Recommended Inspection Frequency

Do a Level III inspection when triggered by a Level II inspection.

References

1. Maintenance Technology/September 1993; Write-up Title: *"Infrared Keeps All Systems Go"*
2. Raining - Agema Infrared Systems; *"Measurement of Excess Temperatures with Infrared Scanners"*

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 5

COMPONENT: TRANSFORMERS
CONTROL NUMBER: GS-III 29.05.05-5

Application

This guide applies to the investigation of a hot terminal or device that is overheating from the flow of current through that terminal or device.

Special Safety Requirements

No special safety requirements are needed for the performance of this Level III inspection beyond those required in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Verify the findings of Level II inspection by using the Infrared Scanner and measuring the temperatures of the device and terminals. If the device or terminals are not hot as indicated by the findings of Level II inspection, check the current flow through the device or terminals. Heat generated is proportionate to the square of the current. If there is little or no current flow through the device or terminal at the time of measurement, there will be no significant amount of heat generated.

2. For terminal connections, verify the type of conductor being terminated. If the conductor is an aluminum conductor, look for evidence of cold flow or melt down of conductor.

3. If there is evidence of cold flow or melt down of the aluminum conductor, the conductor should either be replaced or shortened and reconnected. When making new aluminum conductor terminations a joint compound should be used.

4. If the terminal is loose it should be tightened. De-energize prior to attempting tightening of terminal connections.

5. If none of the above is the problem than there is an internal problem and an on-site analysis must be made to determine if additional inspections are to be made or the unit is to be replaced.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 5 (Continued)

COMPONENT: TRANSFORMERS
CONTROL NUMBER: GS-III 29.05.05-5

Special Tools and Equipment

The following is a list of special tools required beyond those listed in the Standard Tool Section.

1. Infrared Scanner, Raytek, Inc., #PM2EM-L2
2. Torque wrench
3. Digital Multimeter, Fluke #1TC676

Recommended Inspection Frequency

Do a Level III inspection when triggered by a Level II inspection.

References

1. Maintenance Technology/September 1993; Write-up Title: *"Infrared Keeps All Systems Go"*
2. Raining - Agema Infrared Systems; *"Measurement of Excess Temperatures with Infrared Scanners"*

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 6

COMPONENT: END USE DEVICE CONNECTIONS
CONTROL NUMBER: GS-III 29.05.06-6

Application

This guide applies to the investigation of a hot terminal or device that is overheating from the flow of current through that terminal or device.

Special Safety Requirements

No special safety requirements are needed for the performance of this Level III inspection beyond those required in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Verify the findings of Level II inspection by using the Infrared Scanner and measuring the temperatures of the device and terminals. If the device or terminals are not hot as indicated by the findings of Level II inspection, check the current flow through the device or terminals. Heat generated is proportionate to the square of the current. If there is little or no current flow through the device or terminal at the time of measurement, there will be no significant amount of heat generated.

2. For terminal connections, verify the type of conductor being terminated. If the conductor is an aluminum conductor, look for evidence of cold flow or melt down of conductor.

3. If there is evidence of cold flow or melt down of the aluminum conductor, the conductor should either be replaced or shortened and reconnected. When making new aluminum conductor terminations a joint compound should be used.

4. If the terminal is loose it should be tightened. De-energize prior to attempting tightening of terminal connections.

5. If none of the above is the problem than there is an internal problem and an on-site analysis must be made to determine if additional inspections are to be made or the unit is to be replaced.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 6 (Continued)

COMPONENT: END USE DEVICE CONNECTIONS
CONTROL NUMBER: GS-III 29.05.06-6

Special Tools and Equipment

The following is a list of special tools required beyond those listed in the Standard Tool Section.

1. Infrared Scanner, Raytek, Inc., #PM2EM-L2

2. Torque wrench

3. Digital Multimeter, Fluke #1TC676

Recommended Inspection Frequency

Do a Level III inspection when triggered by a Level II inspection.

References

1. Maintenance Technology/September 1993; Write-up Title: *"Infrared Keeps All Systems Go"*

2. Raining - Agema Infrared Systems; *"Measurement of Excess Temperatures with Infrared Scanners"*

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 7

COMPONENT: TRANSFORMER
CONTROL NUMBER: GS-III 29.05.05-7

Application

This guide applies to the investigation of 112.5 kVA transformers or larger that contain liquids used as electrical insulation and coolant.

Special Safety Requirements

No special safety requirements are needed for the performance of this Level III inspection beyond those required in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Verify the findings of Level I inspection concerning the corrosive condition of the tank containing the coolant and insulation liquid.
2. If the tank has corroded to the point where contaminated air could possibly pass through the tank wall an oil analysis should be performed.
3. If the liquid is contaminated, provide test to determine how the tank leaks.
4. Analyze the test results to determine whether the transformer can be repaired or must be replaced.

Special Tools and Equipment

The following is a list of special tools required beyond those listed in the Standard Tool Section.

1. Wire brush
2. Wrenches
3. Pressure gauge
4. Inert gas supply

Recommended Inspection Frequency

Do a Level III inspection when triggered by a Level I inspection.

References

1. Sverdrup Corporation

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 8

COMPONENT: TRANSFORMER
CONTROL NUMBER: GS-III 29.05.05-8

Application

This guide applies to the investigation of oil leaks in the transformer tank that has signs of oil on surface of the tank or an oil puddle under or around base of tank.

Special Safety Requirements

No special safety requirements are needed for the performance of this Level III inspection beyond those required in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Verify the findings of Level I inspection by finding the source of the oil. If the oil is coming from an external source no further inspection of the transformer is required. The external source should be identified and recommendations made to eliminate the contamination of the breaker.

2. If the oil source is coming from within the transformer, a determination should be made as how the oil is escaping.

3. If transformer repairs are made, oil analysis should be made after the repairs to determine if the oil is contaminated.

4. All contaminated oil should be removed and replaced with new oil.

Special Tools and Equipment

The following is a list of special tools required beyond those listed in the Standard Tool Section.

1. Brush

2. Non-flammable cleaning fluid

3. Wiping material

Recommended Inspection Frequency

Do a Level III inspection when triggered by a Level I inspection.

References

1. Sverdrup Corporation

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 9

COMPONENT: TRANSFORMER
CONTROL NUMBER: GS-III 29.05.05-9

Application

This guide applies to the investigation of 112.5 kVA transformers or larger that contain liquids used as electrical insulation and coolant.

Special Safety Requirements

No special safety requirements are needed for the performance of this Level III inspection beyond those required in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Verify the findings of Level I inspection concerning cooling fin blockage or low liquid level.

2. Do a liquid analysis test.

3. If liquid analysis test results are okay, add liquid to proper level requirements.

4. If fin blockage remains, have liquid removed and clear the fin blockage.

5. If liquid analysis test results show contaminates, have the liquid removed, the contaminates flushed out and new liquid added.

Special Tools and Equipment

The following is a list of special tools required beyond those listed in the Standard Tool Section.

1. Infrared scanner

2. Tools and sampling containers for taking liquid samples and transferring these samples to the lab.

3. Tools and liquid supplies for adding the appropriate liquid to the transformer tank.

Recommended Inspection Frequency

Do a Level III inspection when triggered by a Level I inspection.

References

1. Sverdrup Corporation

29.06 EXTERIOR LIGHTING SYSTEM

DESCRIPTION

Exterior Lighting is a subsystem of the Site Electrical System. Lighting consists of various types, sizes and shapes of lighting fixtures together with a wide range of lamp sources combined with a large variety of light controllers and poles.

SPECIAL TOOL AND EQUIPMENT REQUIREMENTS

The following list of special tools and equipment beyond the requirements listed in the Standard Tool Section, shall be provided to perform the inspection of the Exterior Lighting System.

1. Binocular, 10 x 50 power
2. Ice Pick
3. Hammer

SPECIAL SAFETY REQUIREMENTS

No special safety requirements are needed for the inspection of the exterior lighting system, beyond the requirements listed in the Master Safety Plan and System Safety Section.

COMPONENT LIST

- ◆ 29.06.01 LIGHTING FIXTURES - FLUORESCENT
- ◆ 29.06.02 LIGHTING FIXTURES - INCANDESCENT
- ◆ 29.06.03 LIGHTING FIXTURES - HIGH INTENSITY DISCHARGE (HID)
- ◆ 29.06.04 LIGHTING CONTROLLERS
- ◆ 29.06.05 POLES
- ◆ 29.06.06 ANCHOR AND GUYWIRES
- ◆ 29.06.07 FOUNDATIONS

RELATED SUBSYSTEMS

Due to the related nature of the elements requiring inspection, the following should be reviewed for concurrent inspection activities.

10.06 RACEWAYS
29.07 LIGHTNING PROTECTION/GROUNDING SYSTEM

STANDARD INSPECTION PROCEDURE

Components require a Level I or Level II inspection as part of the basic inspection process. Other additional Level II inspection may be indicated or "triggered" by a Level I inspection and should be accomplished by the inspector at that time. Level III inspection may be indicated or "triggered" by a Level I or II inspection Defect/Observation and should be accomplished at the direction of the Facility Manager.

Inspection should be carried out in the order of presentation for the various components with associated defects and observations for each subsystem listed in the inspector's CAIS.

29.06 EXTERIOR LIGHTING SYSTEM

COMPONENTS

◆ 29.06.01 LIGHTING FIXTURES - FLUORESCENT

Lighting fixtures, also known as luminaires, are devices that transform electrical energy to energy in the visible spectrum.

Fluorescent lighting fixture assemblies consist of housing, ballasts, lamps, lens, reflectors, sockets and emergency battery packs.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
* **Corrosion:**			
Observation:			
a. Surface corrosion (no pitting evident).	SF		
***{Severity L}			
b. Corrosion evidenced by pitting or blistering.	SF		
***{Severity M}			
c. Corrosion evidenced by holes or loss of base metal.	SF		
***{Severity H}			

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
* **Physical Damage:**			
Observation:			
a. Fixture lens door broken or missing.	EA		
***{Severity L}			
b. Dirty or discolored lens.	EA		
***{Severity L}			
c. Battery test switch broken or missing.	EA		
***{Severity L}			
d. Fixture not adequately secured.	EA		
***{Severity M}			
e. Lighting lens broken or missing.	EA		
***{Severity M}			
f. Socket broken or missing.	EA		
***{Severity M}			
g. Fixture inoperable.	EA	1	1
***{Severity M}			
h. Bad ballast (noisy).	EA		
***{Severity M}			
i. Lamp missing.	EA		
***{Severity M}			
j. Fixture housing damaged or missing.	EA		
***{Severity H}			
k. Interior not moisture-free.	EA		
***{Severity H}			

29.06 EXTERIOR LIGHTING SYSTEM

COMPONENTS (Continued)

◆ 29.06.02 LIGHTING FIXTURES - INCANDESCENT

Lighting fixtures, also known as luminaires, are devices that transform electrical energy to energy in the visible spectrum.

Incandescent lighting fixture assemblies consist of housing, lamps, lens, reflectors, sockets and baffles.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Corrosion:**			
Observation:			
a. Surface corrosion (no pitting evident). ***{Severity L}	SF		
b. Corrosion evidenced by pitting or blistering. ***{Severity M}	SF		
c. Corrosion evidenced by holes or loss of base metal. ***{Severity H}	SF		

Defect:

*** Physical Damage:**			
Observation:			
a. Fixture lens door broken or missing. ***{Severity L}	EA		
b. Dirty or discolored lens. ***{Severity L}	EA		
c. Fixture not adequately secured. ***{Severity M}	EA		
d. Lighting lens broken or missing. ***{Severity M}	EA		
e. Safety guard/louver broken or missing. ***{Severity M}	EA		
f. Reflector broken or missing. ***{Severity M}	EA		
g. Socket broken or missing. ***{Severity M}	EA		
h. Fixture inoperable. ***{Severity M}	EA	2	2
i. Lamps missing. ***{Severity M}	EA		
j. Lighting baffle burned, broken or missing. ***{Severity M}	EA		
k. Fixture housing damaged or missing. ***{Severity H}	EA		
l. Interior not moisture-free. ***{Severity H}	EA		

29.06 EXTERIOR LIGHTING SYSTEM

COMPONENTS (Continued)

◆ 29.06.03 LIGHTING FIXTURES - HIGH INTENSITY DISCHARGE (HID)

Lighting fixtures, also known as luminaires, are devices that transform electrical energy to energy in the visible spectrum.

HID Lighting fixture assemblies consist of housing, ballasts, lamps, lens, reflectors and sockets.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Corrosion:**			
Observation:			
a. Surface corrosion (no pitting evident). ***{Severity L}	SF		
b. Corrosion evidenced by pitting or blistering. ***{Severity M}	SF		
c. Corrosion evidenced by holes or loss of base metal. ***{Severity H}	SF		

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Physical Damage:**			
Observation:			
a. Fixture lens door broken or missing. ***{Severity L}	EA		
b. Dirty or discolored lens. ***{Severity L}	EA		
c. Fixture not adequately secured. ***{Severity M}	EA		
d. Lighting lens broken or missing. or missing. ***{Severity M}	EA		
e. Reflector broken or missing. ***{Severity M}	EA		
f. Socket broken or missing. ***{Severity M}	EA		
g. Safety guard/louver broken or missing. ***{Severity M}	EA		
h. Fixture inoperable ***{Severity M}	EA	3	3
i. Bad ballast (noisy). ***{Severity M}	EA		
j. Lamp missing. ***{Severity M}	EA		
k. Fixture housing damaged or missing. ***{Severity H}	EA		
l. Interior not moisture-free. ***{Severity H}	EA		

29.06 EXTERIOR LIGHTING SYSTEM

COMPONENTS (Continued)

◆ 29.06.04 LIGHTING CONTROLLERS

Lighting controllers turn the lighting fixtures on/off and in some instances control the brightness of the lights. Controllers consist of on/off switches, dimmers, contactors, motion/occupancy sensors, photocells and time clocks.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Corrosion:**			
Observation:			
a. Surface corrosion (no pitting evident). ***{Severity L}	SF		
b. Corrosion evidenced by pitting or blistering. ***{Severity M}	SF		
c. Corrosion evidenced by holes or loss of base metal. ***{Severity H}	SF		

Defect:

*** Physical Damage:**			
Observation:			
a. Enclosure mounting loose, broken or missing. ***{Severity L}	EA		
b. Discolored switch. ***{Severity L}	EA		
c. Noisy dimmer. ***{Severity L}	EA		
d. Motion/occupancy sensor inoperative. ***{Severity L}	EA	4	4
e. Motion/occupancy sensor housing broken. ***{Severity L}	EA		
f. Photocell housing broken. ***{Severity L}	EA		
g. Time clock mechanism broken. ***{Severity L}	EA		
h. Enclosure damaged (cannot be sealed). ***{Severity M}	EA		
i. Unused opening not covered. ***{Severity M}	EA		
j. Switch cover plate broken or missing. ***{Severity H}	EA		
k. On/off switch handle broken. ***{Severity H}	EA		
l. Dimmer switch broken. ***{Severity H}	EA		

29.06 EXTERIOR LIGHTING SYSTEM

COMPONENTS (Continued)

◆ 29.06.05 POLES

There are five basic types of poles; steel, aluminum, concrete, wood and fiberglass. They are mainly used to support lighting fixtures, overhead power lines, communication cables, traffic signals, antennas and radar equipment.

Poles mainly consist of pole bases, anchor bolts/nuts, base cover plates, transformer bases, mounting brackets, lighting fixture arms, cross arms, lowering devices and safety cage platforms.

Poles will be inspected from ground level.

Surge (lightning) arresters, disconnect switches, insulators and conductors (bare) shall be inspected under their separate component inspection.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
* **Corrosion Damage to Steel Poles:**			
Observation:			
a. Surface corrosion (no pitting evident). ***{Severity L}	SF		
b. Corrosion evidenced by pitting or blistering. ***{Severity M}	SF		
c. Corrosion evidenced by holes or loss of base metal. ***{Severity H}	SF		

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
* **Decay, Insect and Bird Damage to Wood Pole Structures:**			
Observation:			
a. Knothole decay. ***{Severity L}	EA		5
b. Wood colorated indicating wood decay. ***{Severity M}	SF		5
c. Holes made by birds. ***{Severity M}	EA		5
d. Fungi fruit indicating wood decay. ***{Severity H}	SF		5
e. Signs of parasite damage (carpenter ants and termites). ***{Severity H}	EA		5
f. Decay detected by hammer sounding near base of pole. ***{Severity H}	EA		5

29.06 EXTERIOR LIGHTING SYSTEM

COMPONENTS (Continued)

◆ 29.06.05 POLES (Continued)

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Crack Damage to Concrete Poles:**			
Observation:			
a. Surface spalling more than 1" deep or 6" in diameter.	SF		
***{Severity L}			
b. Cracks greater than 1/16 inch wide.	LF		
***{Severity M}			

Defect:

*** Physical Damage:**			
Observation:			
a. Base plate broken or missing.	EA		
***{Severity L}			
b. Handhole coverplate broken or missing.	EA		
***{Severity L}			
c. Transformer base cover plate broken or missing.	EA		
***{Severity L}			
d. Wood pole 1" or less deep horizontal scar.	LF		
***{Severity L}			
e. Pole leaning (2 foot or more at top).	EA		
***{Severity M}			
f. Transformer base broken.	EA		
***{Severity M}			
g. Fixture mounting brackets bent or loosely mounted.	EA		
***{Severity M}			
h. Crossarm brackets/supports missing.	EA		
***{Severity M}			
i. Fiberglass pole damaged (opening in pole).	EA		
***{Severity M}			
j. Metal pole dented (more than 1" indentation).	EA		
***{Severity M}			

29.06 EXTERIOR LIGHTING SYSTEM

COMPONENTS (Continued)

◆ 29.06.05 POLES (Continued)

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Physical Damage (Continued):**			
k. Wood pole with 1" to 2-1/2" deep horizontal scar. ***{Severity M}	LF		
l. Anchor nut missing. ***{Severity H}	EA		
m. Hinged pole mechanism broken or damaged. ***{Severity H}	EA		
n. Cage platform broken or damaged. ***{Severity H}	EA		
o. Lighting fixture lowering device broken or damaged. ***{Severity H}	EA		
p. Wood pole more than 2-1/2" deep scar. ***{Severity H}	LF		
q. Wood pole splintered by lightning. ***{Severity H}	LF		
r. Pole not grounded. ***{Severity H}	EA		

29.06 EXTERIOR LIGHTING SYSTEM

COMPONENTS (Continued)

◆ 29.06.06 ANCHORS AND GUY WIRES

Anchors occur as many different types with multiple variations of each type. Normally the anchors are underground except for the guy wire terminal attachment hardware. Excavation to inspect the underground portion of the anchor will destroy the integrity of the anchor being inspected. Only exposed section of the anchor will be inspected.

Guy wires connect the structure requiring support to an anchoring device. An anchoring device can either be an underground anchor or an above-ground device. Above-ground anchoring devices are either self-supporting or guyed structures.

Guy wires are steel stranded cables with either galvanized, copper or aluminum coating.

Anchoring system failure is indicated by either the top of the supported structure leaning away from the anchoring point or the supported structure intact but laying on the ground.

Insulators will be inspected under a separate component.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Corrosion:**			
Observation:			
a. Surface corrosion (no pitting evident).	LF		
***{Severity L}			
b. Corrosion evidenced by pitting or blistering.	LF		
***{Severity M}			
c. Corrosion evidenced by holes or loss of base metal.	LF		
***{Severity H}			

Defect:

	UOM		
*** Physical Damage:**			
Observation:			
a. Guy wire guard missing or detached.	EA		
***{Severity L}			
b. Guy wire strand broken.	EA		
***{Severity M}			
c. Vegetation growth on guy wire.	EA		
***{Severity M}			
d. Clamping hardware fasteners loose or missing.	EA		
***{Severity H}			

29.06 EXTERIOR LIGHTING SYSTEM

COMPONENTS (Continued)

◆ 29.06.06 ANCHORS AND GUY WIRES (Continued)

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Physical Damage (Continued):**			
e. Guy wire broken. ***{Severity H}	EA		
f. Anchor creep (pole leaning away from anchor). ***{Severity H}	EA		
g. Guy (strain) insulator damaged. ***{Severity H}	EA		
h. Clamping hardware missing. ***{Severity H}	EA		

29.06 EXTERIOR LIGHTING SYSTEM

COMPONENTS (Continued)

◆ 29.06.07 FOUNDATIONS

Foundations consist of cast-in-place concrete footings and piers through which the loads of structures are transmitted to the earth. Anchor bolts are embedded in the concrete, to connect the structure or equipment to the foundation.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Cracking:**			
Observation:			
a. Cracks, between 1/16" and 1/4" wide. ***{Severity M}	LF		6
b. Disintegration of surface or cracks exceeding 2 depth. ***{Severity H}	LF		6
Defect:			
*** Spalling:**			
Observation:			
a. Not more than 1" deep or 6" in diameter. ***{Severity L}	SF		
b. More than 1" in depth or 6" in dia., or 10% of surface area loss. ***{Severity H}	SF		
c. Disintegration of surface area, with corrosion of exposed rebar. ***{Severity H}	SF		7
Defect:			
*** Scaling:**			
Observation:			
a. Surface loss of 1/2" to 1" deep, with coarse aggregates exposed. ***{Severity M}	SF		
b. Loss of surface exceeding 1" deep. ***{Severity H}	SF		
c. Exposure of reinforcing steel. ***{Severity H}	SF		7
Defect:			
*** Reinforcing Steel Corrosion:**			
Observation:			
a. Rusting evident, cracks occurring along rebar. ***{Severity H}	LF		7

29.06 EXTERIOR LIGHTING SYSTEM

REFERENCES

1. DOE CAS Manual, Volume 9: 0.09, Electrical

2. DOE, Volume 2: 0.02 Substructure Deficiency Standards and Inspection Method Manual

3. National Fire Protection Association (NFPA 70B) *"Recommended Practice for Electrical Equipment Maintenance"*, 1990 Edition

4. *"Handbook of Building and Plant Maintenance Forms and Checklists"* by Roger W. Liska and Judith Morrison Liska

5. MEANS *"Concrete Repair and Maintenance"*, Peter H. Emmons, 1994

6. MEANS *"Facilities Maintenance & Repair Cost Data"*, 1994

29.06 EXTERIOR LIGHTING SYSTEM

LEVEL II KEY	GUIDE SHEET CONTROL NUMBER
1	GS-II 29.06.01-1
2	GS-II 29.06.02-2
3	GS-II 29.06.03-3
4	GS-II 29.06.04-4

LEVEL III KEY	GUIDE SHEET CONTROL NUMBER
1	GS-III 29.06.01-1
2	GS-III 29.06.02-2
3	GS-III 29.06.03-3
4	GS-III 29.06.04-4
5	GS-III 29.06.05-5
6	GS-III 29.06.07-6
7	GS-III 29.06.07-7

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 1

COMPONENT: LIGHTING FIXTURES - FLUORESCENT
CONTROL NUMBER: GS-II 29.06.01-1

Application

This guide applies to lighting fixtures and motion/occupancy sensors that are inoperative.

Special Safety Requirements

No special safety requirements are needed for the performance of the Level II inspection beyond those required in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Verify if the branch circuit disconnecting means is in the "on" operation.

2. Verify if the light controller is in the "on" mode.

Recommended Inspection Frequency

Do a Level II inspection each time a Level I inspection indicates one is required.

References

1. *"Handbook of Building and Plant Maintenance Forms and Checklists"* by Roger W. Liska and Judith Morrison Liska

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 2

COMPONENT: LIGHTING FIXTURES - INCANDESCENT
CONTROL NUMBER: GS-II 29.06.02-2

Application

This guide applies to lighting fixtures and motion/occupancy sensors that are inoperative.

Special Safety Requirements

No special safety requirements are needed for the performance of the Level II inspection beyond those required in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Verify if the branch circuit disconnecting means is in the "on" operation.

2. Verify if the light controller is in the "on" mode.

Recommended Inspection Frequency

Do a Level II inspection each time a Level I inspection indicates one is required.

References

1. *"Handbook of Building and Plant Maintenance Forms and Checklists"* by Roger W. Liska and Judith Morrison Liska

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 3

COMPONENT: LIGHTING FIXTURES - HIGH INTENSITY DISCHARGE (HID)
CONTROL NUMBER: GS-II 29.06.03-3

Application

This guide applies to lighting fixtures and motion/occupancy sensors that are inoperative.

Special Safety Requirements

No special safety requirements are needed for the performance of the Level II inspection beyond those required in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Verify if the branch circuit disconnecting means is in the "on" operation.

2. Verify if the light controller is in the "on" mode.

Recommended Inspection Frequency

Do a Level II inspection each time a Level I inspection indicates one is required.

References

1. *"Handbook of Building and Plant Maintenance Forms and Checklists"* by Roger W. Liska and Judith Morrison Liska

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 4

COMPONENT: LIGHTING CONTROLLERS
CONTROL NUMBER: GS-II 29.06.04-4

Application

This guide applies to lighting fixtures and motion/occupancy sensors that are inoperative.

Special Safety Requirements

No special safety requirements are needed for the performance of the Level II inspection beyond those required in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Verify if the branch circuit disconnecting means is in the "on" operation.

2. Verify if the light controller is in the "on" mode.

Recommended Inspection Frequency

Do a Level II inspection each time a Level I inspection indicates one is required.

References

1. *"Handbook of Building and Plant Maintenance Forms and Checklists"* by Roger W. Liska and Judith Morrison Liska

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 1

COMPONENT: LIGHTING FIXTURES - FLUORESCENT
CONTROL NUMBER: GS-III 29.06.01-1

Application

This guide applies to lighting fixtures that are inoperative.

Special Safety Requirements

No special safety requirements are needed for the performance of this Level III inspection beyond those required in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Determine if there is voltage at the fixture and at the lamp(s).

2. Replace the lamp(s) in the lighting fixture.

3. Replace the ballast in the lighting fixture.

Special Tools and Equipment

The following is a list of special tools required beyond those listed in the Standard Tool Section.

1. Digital Multimeter, Fluke #1TC67

2. 6' Fiberglass Step Ladder

Recommended Inspection Frequency

Do a Level III inspection only when triggered by a Level I inspection.

References

1. *"Handbook of Building and Plant Maintenance, Forms and Checklists"* by Roger W. Liska and Judith Morrison Liska.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 2

COMPONENT: LIGHTING FIXTURES - INCANDESCENT
CONTROL NUMBER: GS-III 29.06.02-2

Application

This guide applies to lighting fixtures that are inoperative.

Special Safety Requirements

No special safety requirements are needed for the performance of this Level III inspection beyond those required in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Determine if there is voltage at the fixture and at the lamp(s).

2. Replace the lamp(s) in the lighting fixture.

3. Replace the ballast in the lighting fixture.

Special Tools and Equipment

The following is a list of special tools required beyond those listed in the Standard Tool Section.

1. Digital Multimeter, Fluke #1TC67

2. 6' Fiberglass Step Ladder

Recommended Inspection Frequency

Do a Level III inspection only when triggered by a Level I inspection.

References

1. *"Handbook of Building and Plant Maintenance, Forms and Checklists"* by Roger W. Liska and Judith Morrison Liska.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 3

COMPONENT: LIGHTING FIXTURES - HIGH INTENSITY DISCHARGE (HID)
CONTROL NUMBER: GS-III 29.06.03-3

Application

This guide applies to lighting fixtures that are inoperative.

Special Safety Requirements

No special safety requirements are needed for the performance of this Level III inspection beyond those required in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Determine if there is voltage at the fixture and at the lamp(s).

2. Replace the lamp(s) in the lighting fixture.

3. Replace the ballast in the lighting fixture.

Special Tools and Equipment

The following is a list of special tools required beyond those listed in the Standard Tool Section.

1. Digital Multimeter, Fluke #1TC67

2. 6' Fiberglass Step Ladder

Recommended Inspection Frequency

Do a Level III inspection only when triggered by a Level I inspection.

References

1. *"Handbook of Building and Plant Maintenance, Forms and Checklists"* by Roger W. Liska and Judith Morrison Liska.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 4

COMPONENT: LIGHTING CONTROLLERS
CONTROL NUMBER: GS-III 29.06.04-4

Application

This guide applies to motion/occupancy sensors that are inoperative.

Special Safety Requirements

No special safety requirements are needed for the performance of this Level III inspection beyond those required in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Verify that the manual switch is in the "on" position.
2. Activate the manual by-pass switch.
3. Determine if there is voltage at the motion/occupancy sensor.
4. Replace the motion/occupancy sensor.

Special Tools and Equipment

1. Digital multimeter, Fluke #1TC67
2. 6' fiberglass step ladder

Recommended Inspection Frequency

Do a Level III inspection only when triggered by a Level II inspection.

References

1. *"Handbook of Building and Plant Maintenance, Forms and Checklists"* by Roger W. Liska and Judith Morrison Liska

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 5

COMPONENT: POLES
CONTROL NUMBER: GS-III 29.06.05-5

Application

This guide applies to the investigation of decay in wood poles.

Special Safety Requirements

No special safety requirements are needed for the performance of this Level III inspection beyond those required in the Master Safety Plan and System Safety Section.

Inspection Actions

Observation inspection will detect above ground grade decay and parasite infestation only. If there is above ground grade deterioration there may be greater deterioration at 6 to 9 inches below grade.

1. Remove backfill from around the poles to a depth of 9 inches.

2. Probe, with ice pick, for decay material or parasite infestation in the exposed areas above and below the grade. Probing should be made in suspected areas from 9" below ground grade to top of pole, including bird damaged areas.

3. Remove all located decay or parasite damage material.

4. Provide written descriptions of the material damage, giving depths and volumes of each effected area.

5. Structural Engineer shall study the finding to determine if:
   a. Poles should be treated only to prevent further damage in these areas.

   b. Poles should be treated to prevent further damage and reinforced by a C truss reinforcement method or by other applicable means.

   c. Poles has been damaged beyond repair and must be replaced.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 5 (Continued)

COMPONENT: POLES
CONTROL NUMBER: GS-III 29.06.05-5

Special Tools and Equipment

The following is a list of special tools required beyond those listed in the Standard Tool Section.

1. D Handle Shovel

2. Wood Chisel

3. Ice pick

4. Binocular, 10 x 50 power

Recommended Inspection Frequency

Whenever Level I or Level II defect/observation triggers this Level III procedure.

References

1. Electrical World, March 1991, Vol 205, No. 3

2. NAVFAC MO-322, Vol II, January 1993

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 6

COMPONENT: FOUNDATIONS
CONTROL NUMBER: GS-III 29.06.07-6

Application

This guide applies to the investigation of cracks in concrete.

Special Safety Requirements

No special safety requirements are needed for the performance of this Level III inspection beyond those required in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Utilize ultrasonic pulse velocity equipment to check for damage extent and loss of integrity.

Special Tools and Equipment

The following is a list of special tools required beyond those listed in the Standard Tool Section.

1. Ultrasonic pulse velocity test equipment, Krautkramer Branson #USK-6

Recommended Inspection Frequency

When triggered by a Level I or II defect/observation.

References

1. DOE, Vol. 2:0.02. *"Substructure Deficiency Standards and Inspection Methods Manual"*

2. MEANS *"Concrete Repair and Maintenance"*, Peter H. Emmons, 1994

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 7

COMPONENT: FOUNDATIONS
CONTROL NUMBER: GS-III 29.06.07-7

Application

This guide applies to the investigation of corrosion of reinforcing steel in concrete.

Special Safety Requirements

No special safety requirements are needed for the performance of this Level III inspection beyond those required in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Clean rust/discoloration.

2. Perform half-cell potential test to determine degree of corrosion of steel reinforcement.

Special Tools and Equipment

The following is a list of special tools required beyond those listed in the Standard Tool Section.

1. Half-cell test equipment.

Recommended Inspection Frequency

Whenever Level I or II defect/observation triggers this Level III procedure.

References

1. DOE, Vol. 2:0.02. *"Substructure Deficiency Standards and Inspection Methods Manual"*

2. MEANS *"Concrete Repair and Maintenance"*, Peter H. Emmons, 1994

29.07 LIGHTNING PROTECTION/GROUNDING SYSTEM

DESCRIPTION

Lightning Protection/Grounding System is a subsystem of the Site Electrical System. Lightning Protection is a complete system of air terminals, conductors, ground terminals, interconnecting conductors and other connectors or fittings required to complete the system.

A lightning protection system provides a means by which a lightning discharge can enter or leave the earth without resulting damage or loss to life and property. Types of systems used are integral, overhead wire, mast-type, or faraday cage systems.

SPECIAL TOOL AND EQUIPMENT REQUIREMENTS

The following list of special tools and equipment beyond the requirements listed in the Standard Tool Section, shall be provided to perform the inspection of the Lightning Protection/Grounding System.

1. Binocular, 10 x 50 power
2. Ice Pick
3. Hammer

SPECIAL SAFETY REQUIREMENTS

No special safety requirements are needed for the inspection of lightning protection, beyond the requirements listed in the Master Safety Plan and System Safety Section.

COMPONENT LIST

- ◆ 29.07.01 AIR TERMINALS
- ◆ 29.07.02 CONDUCTORS (BARE)
- ◆ 29.07.03 BONDING
- ◆ 29.07.04 CONDUIT SYSTEMS
- ◆ 29.07.05 POLES
- ◆ 29.07.06 ANCHORS AND GUY WIRES
- ◆ 29.07.07 FOUNDATIONS

RELATED SUBSYSTEMS

Due to the related nature of the elements requiring inspection, the following should be reviewed for concurrent inspection activities.

10.06 RACEWAYS

29.07 LIGHTNING PROTECTION/GROUNDING SYSTEM

STANDARD INSPECTION PROCEDURE

Components require a Level I or Level II inspection as part of the basic inspection process. Other additional Level II inspection may be indicated or "triggered" by a Level I inspection and should be accomplished by the inspector at that time. Level III inspection may be indicated or "triggered" by a Level I or II inspection Defect/Observation and should be accomplished at the direction of the Facility Manager.

Inspection should be carried out in the order of presentation for the various components with associated defects and observations for each subsystem listed in the inspector's CAIS.

COMPONENTS

◆ 29.07.01 AIR TERMINALS

Air terminal is the topmost component of lightning protection systems and is intended to intercept lightning flashes. An air terminal is attached to a mounting base for mounting on buildings or poles.

There are nickel-tipped solid copper or nickel-tipped aluminum terminal types. The variety of base types used include flat, hinged, ridge and parapet type.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
* **Physical Damage:**			
Observation:			
a. Loose base/air terminal mounting. ***{Severity L}	EA		
b. Air terminal/cable base cracked or broken. ***{Severity M}	EA		
c. Air terminal bent, cracked or broken. ***{Severity M}	EA		
d. Air terminal missing. ***{Severity H}	EA		
e. Conductor not secured to mounting base. ***{Severity H}	EA		
f. Holes or loss of base metal. ***{Severity H}	EA		

29.07 LIGHTNING PROTECTION/GROUNDING SYSTEM

COMPONENTS (Continued)

◆ 29.07.02 CONDUCTORS (BARE)

Bare conductors include conductors used for equipment grounding, structure grounding, lightning protection system and electrode grounding system.

Bare conductor is a wire or combination of wires not insulated from one another, suitable for carrying an electric current.

Conductors are either copper or aluminum.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Physical Damage:**			
Observation:			
a. One conductor strand broken. ***{Severity L}	EA		
b. Two or more conductor strands broken. ***{Severity M }	EA		
c. Conductor severed. ***{Severity H}	LF		
d. Conductor not secured. ***{Severity H}	LF		
e. Conductor not terminated. ***{Severity H}	EA		

29.07 LIGHTNING PROTECTION/GROUNDING SYSTEM

COMPONENTS (Continued)

◆ 29.07.03 BONDING

Bonding provides an electrical connection between an electrically conductive object and a component of a lightning protection or grounding system that is intended to significantly reduce potential differences created by lightning currents. Bonding also provides electrical continuity and the capacity to conduct safely any imposed fault or static voltage induced currents.

Static electric charges and electric currents from lightning can cause stray currents to flow in tanks, tank trucks, pipelines, hose nozzles, raceways and other equipment. Such equipment must be properly bonded throughout each system and properly grounded in order to prevent such stray currents and charges from producing arcs (sparking) and causing serious personnel shocks, explosion hazards and fires.

Types of bonding methods are fusion weld, pressure connectors, and clamps.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Corrosion:**			
Observation:			
a. Surface corrosion (no pitting evident).	EA		
***{Severity L}			
b. Corrosion evidenced by pitting or blistering.	EA		
***{Severity M}			
c. Corrosion evidenced by holes or loss of base metal.	EA		
***{Severity H}			

Defect:

	UOM	LEVEL II KEY	LEVEL III KEY
*** Physical Damage:**			
Observation:			
a. Bond cracked or chipped.	EA		
***{Severity L}			
b. Improper bond material used.	EA		
***{Severity L}			
c. Bond melted or burnt.	EA		
***{Severity H}			
d. Loose connections.	EA		
***{Severity H }			
e. Bond missing.	EA		
***{Severity H }			

29.07 LIGHTNING PROTECTION/GROUNDING SYSTEM

COMPONENTS (Continued)

◆ 29.07.04 CONDUIT SYSTEMS

Conduits are part of the electrical system that support and protect conductors. This system includes conduits, conduit bodies, pull boxes, junction boxes, outlet boxes and their supports.

Types of conduits commonly used are: Intermediate Metal Conduit, Rigid Metal Conduit, Rigid Nonmetallic Conduit, Electric Metallic Conduit, Flexible Metallic Tubing, Flexible Metal Conduit, Liquidtight Flexible Metal Conduit, Liquidtight Flexible Nonmetallic Conduit, Surface Metal Raceways, and Surface Nonmetallic Raceways. (Power Poles and Plugmold/wiremold are considered surface raceway.)

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Corrosion:**			
Observation:			
a. Surface corrosion (no pitting evident).	LF		
***{Severity L}			
b. Corrosion evidenced by pitting or blistering.	LF		
***{Severity M}			
c. Corrosion evidenced by holes or loss of base metal.	LF		
***{Severity H}			

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Physical Damage:**			
Observation:			
a. Conduit bent.	LF		
***{Severity L}			
b. Conduit sagging.	LF		
***{Severity L}			
c. Conduit support loose or missing.	EA		
***{Severity L}			
d. Box gasketing missing.	EA	1	
***{Severity L}			
e. Box damaged.	EA		
***{Severity L }			
f. Box cover fastener loose or missing.	EA		
***{Severity L}			
g. Box support loose or missing.	EA		
***{Severity L}			
h. Plugmold/wiremold support loose or missing.	EA		
***{Severity L}			

29.07 LIGHTNING PROTECTION/GROUNDING SYSTEM

COMPONENTS (Continued)

◆ 29.07.04 CONDUIT SYSTEMS (Continued)

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Physical Damage (Continued):**			
i. Unused opening not covered or plugged. ***{Severity M}	EA		
j. Cover plates missing. ***{Severity M}	EA		
k. Plugmold/wiremold damaged. ***{Severity M}	LF		
l. Conduit separation (wire exposed). ***{Severity H}	EA		
m. Conduit not bonded. ***{Severity H}	EA		

29.07 LIGHTNING PROTECTION/GROUNDING SYSTEM

COMPONENTS (Continued)

◆ 29.07.05 POLES

There are five basic types of poles; steel, aluminum, concrete, wood and fiberglass. They are mainly used to support lighting fixtures, overhead power lines, communication cables, traffic signals, antennas and radar equipment.

Poles mainly consist of pole bases, anchor bolts/nuts, base cover plates, transformer bases, mounting brackets, lighting fixture arms, cross arms, lowering devices and safety cage platforms.

Poles will be inspected from ground level.

Surge (lightning) arresters, disconnect switches, insulators and conductors (bare) shall be inspected under their separate component inspection.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Corrosion Damage to Steel Poles:**			
Observation:			
a. Surface corrosion (no pitting evident).	SF		
***{Severity L}			
b. Corrosion evidenced by pitting or blistering.	SF		
***{Severity M}			
c. Corrosion evidenced by holes or loss of base metal.	SF		
***{Severity H}			

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Decay, Insect and Bird Damage to Wood Pole Structures:**			
Observation:			
a. Knothole decay.	EA		1
***{Severity L}			
b. Wood colorated indicating wood decay.	SF		1
***{Severity M}			
c. Holes made by birds.	EA		1
***{Severity M}			
d. Fungi fruit indicating wood decay.	SF		1
***{Severity H}			
e. Signs of parasite damage (carpenter ants and termites).	EA		1
***{Severity H}			
f. Decay detected by hammer sounding near base of pole.	EA		1
***{Severity H}			

29.07 LIGHTNING PROTECTION/GROUNDING SYSTEM

COMPONENTS (Continued)

◆ **29.07.05 POLES (Continued)**

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Crack Damage to Concrete Poles:**			
Observation:			
a. Surface spalling more than 1" deep or 6" in diameter.	SF		
***{Severity L}			
b. Cracks greater than 1/16 inch wide.	LF		
***{Severity M}			

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Physical Damage:**			
Observation:			
a. Base plate broken or missing.	EA		
***{Severity L}			
b. Handhole coverplate broken or missing.	EA		
***{Severity L}			
c. Transformer base cover plate broken or missing.	EA		
***{Severity L}			
d. Wood pole 1" or less deep horizontal scar.	LF		
***{Severity L}			
e. Pole leaning (2 foot or more at top).	EA		
***{Severity M}			
f. Transformer base broken.	EA		
***{Severity M}			
g. Fixture mounting brackets bent or loosely mounted.	EA		
***{Severity M}			
h. Crossarm brackets/supports missing.	EA		
***{Severity M}			
i. Fiberglass pole damaged (opening in pole).	EA		
***{Severity M}			
j. Metal pole dented (more than 1" indentation).	EA		
***{Severity M}			

29.07 LIGHTNING PROTECTION/GROUNDING SYSTEM

COMPONENTS (Continued)

◆ 29.07.05 POLES (Continued)

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Physical Damage (Continued):**			
k. Wood pole with 1" to 2-1/2" deep horizontal scar. ***{Severity M}	LF		
l. Anchor nut missing. ***{Severity H}	EA		
m. Hinged pole mechanism broken or damaged. ***{Severity H}	EA		
n. Cage platform broken or damaged. ***{Severity H}	EA		
o. Lighting fixture lowering device broken or damaged. ***{Severity H}	EA		
p. Wood pole more than 2-1/2" deep scar. ***{Severity H}	LF		
q. Wood pole splintered by lightning. ***{Severity H}	LF		
r. Pole not grounded. ***{Severity H}	EA		

29.07 LIGHTNING PROTECTION/GROUNDING SYSTEM

COMPONENTS (Continued)

◆ 29.07.06 ANCHORS AND GUY WIRES

Anchors occur as many different types with multiple variations of each type. Normally the anchors are underground except for the guy wire terminal attachment hardware. Excavation to inspect the underground portion of the anchor will destroy the integrity of the anchor being inspected. Only exposed section of the anchor will be inspected.

Guy wires connect the structure requiring support to an anchoring device. An anchoring device can either be an underground anchor or an above-ground device. Above-ground anchoring devices are either self-supporting or guyed structures.

Guy wires are steel stranded cables with either galvanized, copper or aluminum coating.

Anchoring system failure is indicated by either the top of the supported structure leaning away from the anchoring point or the supported structure intact but laying on the ground.

Insulators will be inspected under a separate component.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Corrosion:**			
Observation:			
a. Surface corrosion (no pitting evident). ***{Severity L}	LF		
b. Corrosion evidenced by pitting or blistering. ***{Severity M}	LF		
c. Corrosion evidenced by holes or loss of base metal. ***{Severity H}	LF		

Defect:

*** Physical Damage:**			
Observation:			
a. Guy wire guard missing or detached. ***{Severity L}	EA		
b. Guy wire strand broken. ***{Severity M}	EA		
c. Vegetation growth on guy wire. ***{Severity M}	EA		
d. Clamping hardware fasteners loose or missing. ***{Severity H}	EA		

29.07 LIGHTNING PROTECTION/GROUNDING SYSTEM

COMPONENTS (Continued)

◆ 29.07.06 ANCHORS AND GUY WIRES (Continued)

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
* **Physical Damage (Continued):**			
e. Guy wire broken. ***{Severity H}	EA		
f. Anchor creep (pole leaning away from anchor). ***{Severity H}	EA		
g. Guy (strain) insulator damaged. ***{Severity H}	EA		
h. Clamping hardware missing. ***{Severity H}	EA		

29.07 LIGHTNING PROTECTION/GROUNDING SYSTEM

COMPONENTS (Continued)

◆ 29.07.07 FOUNDATIONS

Foundations consist of cast-in-place concrete footings and piers through which the loads of structures are transmitted to the earth. Anchor bolts are embedded in the concrete, to connect the structure or equipment to the foundation.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Cracking:**			
Observation:			
a. Cracks, between 1/16" and 1/4" wide. ***{Severity M}	LF		2
b. Disintegration of surface or cracks exceeding 2" depth. ***{Severity H}	LF		2

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Spalling:**			
Observation:			
a. Not more than 1" deep or 6" in diameter. ***{Severity L}	SF		
b. More than 1" in depth or 6" in dia., or 10% of surface area loss. ***{Severity H}	SF		
c. Disintegration of surface area, with corrosion of exposed rebar. ***{Severity H}	SF		3

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Scaling:**			
Observation:			
a. Surface loss of 1/2" to 1" deep, with coarse aggregates exposed. ***{Severity M}	SF		
b. Loss of surface exceeding 1" deep. ***{Severity H}	SF		
c. Exposure of reinforcing steel. ***{Severity H}	SF		3

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Reinforcing Steel Corrosion:**			
Observation:			
a. Rusting evident, cracks occurring along rebar. ***{Severity H}	LF		3

29.07 LIGHTNING PROTECTION/GROUNDING SYSTEM

REFERENCES

1. DOE CAS Manual, Volume 9: 0.09, Electrical

2. DOE, Volume 2: 0.02 Substructure Deficiency Standards and Inspection Method Manual

3. NFPA780 - 1992 Lightning Protection Code

4. National Fire Protection Association (NFPA 70B) *"Recommended Practice for Electrical Equipment Maintenance"*, 1990 Edition

5. MEANS *"Concrete Repair and Maintenance"*, Peter H. Emmons, 1994

6. MEANS *"Facilities Maintenance & Repair Cost Data"*, 1994

29.07 LIGHTNING PROTECTION/GROUNDING SYSTEM

LEVEL II KEY	GUIDE SHEET CONTROL NUMBER
1	GS-II 29.07.04-1

LEVEL III KEY	GUIDE SHEET CONTROL NUMBER
1	GS-III 29.07.05-1
2	GS-III 29.07.07-2
3	GS-III 29.07.07-3
4*	GS-III 29.07-4*
5*	GS-III 29.07-5*

* Indicates guide sheets which are not directly referenced by a Key. These are "triggered" by information beyond the inspection process such as time, age or repeated service calls.

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 1

COMPONENT: CONDUIT SYSTEMS
CONTROL NUMBER: GS-II 29.07.04-1

Application

This guide applies to the investigation of the inside of an enclosure, containing bare, energized, electrical parts.

Special Safety Requirements

The following list of special safety requirements, beyond the requirements listed in the Master Safety Plan and System Safety Section, are to be observed in the performance of this inspection.

1. This inspection guide applies to enclosures containing live electrical parts having a potential of 600 volts or less above ground. If the enclosure contains circuitry of higher potential, do not use this inspection guide.

2. Any enclosure that is padlocked for safety reason is not to be opened unless okayed by the person having control of the key.

3. Inspector needs to carefully open, inspect the inside and close the enclosure without shutting down the equipment, and without creating a hazard to himself.

Inspection Actions

1. Open panels or doors carefully as required for doing the visual inspection.

2. Visually inspect for those physical damaged defects that are listed and tagged Level II Key No. as indicated above.

3. Close panels or doors carefully after the inspection is completed.

Recommended Inspection Frequency

Do a Level II inspection each time a Level I inspection indicates one is required.

References

1. Sverdrup Corporation

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 1

COMPONENT: POLES
CONTROL NUMBER: GS-III 29.07.05-1

Application

This guide applies to the investigation of decay in wood poles.

Special Safety Requirements

No special safety requirements are needed for the performance of this Level III inspection beyond those required in the Master Safety Plan and System Safety Section.

Inspection Actions

Observation inspection will detect above ground grade decay and parasite infestation only. If there is above ground grade deterioration there may be greater deterioration at 6 to 9 inches below grade.

1. Remove backfill from around the poles to a depth of 9 inches.
2. Probe, with ice pick, for decay material or parasite infestation in the exposed areas above and below the grade. Probing should be made in suspected areas from 9" below ground grade to top of pole, including bird damaged areas.
3. Remove all located decay or parasite damage material.
4. Provide written descriptions of the material damage, giving depths and volumes of each effected area.
5. Structural Engineer shall study the finding to determine if:
   a. Poles should be treated only to prevent further damage in these areas.

   b. Poles should be treated to prevent further damage and reinforced by a C truss reinforcement method or by other applicable means.

   c. Poles has been damaged beyond repair and must be replaced.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 1 (Continued)

COMPONENT: POLES
CONTROL NUMBER: GS-III 29.07.05-1

Special Tools and Equipment

The following is a list of special tools required beyond those listed in the Standard Tool Section.

1. D Handle Shovel
2. Wood Chisel
3. Ice pick
4. Binocular, 10 x 50 power

Recommended Inspection Frequency

Whenever Level I or Level II defect/observation triggers this Level III procedure.

References

1. Electrical World, March 1991, Vol 205, No. 3
2. NAVFAC MO-322, Vol II, January 1993

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 2

COMPONENT: FOUNDATIONS
CONTROL NUMBER: GS-III 29.07.07-2

Application

This guide applies to the investigation of cracks in concrete.

Special Safety Requirements

No special safety requirements are needed for the performance of this Level III inspection beyond those required in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Utilize ultrasonic pulse velocity equipment to check for damage extent and loss of integrity.

Special Tools and Equipment

The following is a list of special tools required beyond those listed in the Standard Tool Section.

1. Ultrasonic pulse velocity test equipment, Krautkramer Branson #USK-6

Recommended Inspection Frequency

When triggered by a Level I or II defect/observation.

References

1. DOE, Vol. 2:0.02. *"Substructure Deficiency Standards and Inspection Methods Manual"*

2. MEANS *"Concrete Repair and Maintenance"*, Peter H. Emmons, 1994

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 3

COMPONENT: FOUNDATIONS
CONTROL NUMBER: GS-III 29.07.07-3

Application

This guide applies to the investigation of corrosion of reinforcing steel in concrete.

Special Safety Requirements

No special safety requirements are needed for the performance of this Level III inspection beyond those required in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Clean rust/discoloration.

2. Perform half-cell potential test to determine degree of corrosion of steel reinforcement.

Special Tools and Equipment

The following is a list of special tools required beyond those listed in the Standard Tool Section.

1. Half-cell test equipment.

Recommended Inspection Frequency

Whenever Level I or II defect/observation triggers this Level III procedure.

References

1. DOE, Vol. 2:0.02. *"Substructure Deficiency Standards and Inspection Methods Manual"*

2. MEANS *"Concrete Repair and Maintenance"*, Peter H. Emmons, 1994

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 4*

COMPONENT: LIGHTNING PROTECTION SYSTEM
CONTROL NUMBER: GS-III 29.07-4*

Application

This guide applies to the investigation of possible deterioration of a lightning protection system due to age, alteration to the protected structure or lightning discharge to the system.

Special Safety Requirements

No special safety requirements are needed for the performance of this Level III inspection beyond those required in the Master Safety Plan and System Safety Section.

Inspection Actions

In addition to the Level I inspection method performed on the lighting protection system, testing on the system should be performed. This includes:

1. Review inspection guides or forms for conducting inspections of lightning protection systems. These guides should contain sufficient information to guide the inspector through the inspection process so that he or she may document all areas of importance relating the methods of installation, the type and condition of system components, test methods, and the proper recording of the test data obtained.

2. Perform tests to verify continuity of those parts of the system that were concealed (built in) during the initial installation and that are not now available for visual inspection.

3. Conduct ground resistance tests of the ground termination system and its individual ground electrodes if adequate disconnecting means have been provided. These test results should be compared with previous, or original, results or current accepted values, or both, for the soil conditions involved. If it is found that the test values differ substantially from previous values obtained under the same test procedures, additional investigations should be made to determine the reason for the difference.

4. Perform continuity tests to determine if suitable equipotential bonding has been established for any new services or constructions that have been added to the interior of the structure since the last inspection.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 4* (Continued)

SUBSYSTEM: LIGHTNING PROTECTION SYSTEM
CONTROL NUMBER: GS-III 29.07-4*

Special Tools and Equipment

The following is a list of special instruments required beyond those listed in the Standard Tool Section.

1. Ground resistance tester, Biddle #250260

2. Digital multimeter, Fluke #1TC67

Recommended Inspection Frequency

1. The interval between inspection should be determined by such factors as:

   a. Classification of structure or area protected.
   b. Level of protection afforded by the system.
   c. Immediate environment (corrosive atmospheres).
   d. Materials from which components are made.
   e. The type of surface to which the lightning protection components are attached.

2. In addition to the above, a lightning protection system should be inspected whenever any alterations or repairs are made to a protected structure as well as following any known lightning discharge to the system.

3. It is recommended that lightning protection systems be visually inspected at least annually. In some areas where severe climatic changes occur it may be advisable to visually inspect systems semiannually or following extreme changes in ambient temperatures. Complete, in-depth inspections of all systems should be completed every three to five years. It is recommended that critical systems be so inspected every one to three years depending on occupancy or the environment in which the protected structure is located.

4. In most geographical areas, and especially in areas that experience extreme seasonal changes in temperature and rainfall, it is advisable to stagger inspections so that earth resistance measurements, for example, are made in the hot, dry months as well as the cool, wet months. Such staggering of inspections and testing is important is assessing the effectiveness of the lightning protection system during the various seasons throughout the year.

References

1. NFPA 780-1992 *"Lightning Protection Code"*

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 5*

COMPONENT: GROUNDING SYSTEM
CONTROL NUMBER: GS-III 29.07-5*

Application

This guide applies to the investigation of possible deterioration of a grounding system due to age, alteration or ground fault discharge to the system.

Special Safety Requirements

No special safety requirements are needed for the performance of this Level III inspection beyond those required in the Master Safety Plan and System Safety Section.

Inspection Actions

In addition to the Level I inspection method performed on the grounding system, testing on the system should be performed. This includes:

1. Review inspection guides or forms for conducting inspections of the grounding system. These guides should contain sufficient information to guide the inspector through the inspection process so that he or she may document all areas of importance relating the methods of installation, the type and condition of system components, test methods, and the proper recording of the test data obtained.

2. Terminal connections and bonding jumpers shall be checked under the individual components.

3. Checking the grounding system to determine the adequacy of the equipment ground involves inspection of connections that is supplemented by an impedance test to enable an evaluation of those parts of the system not accessible for inspection.

4. Where metal raceway is used as the equipment grounding path, couplings, bushings, setscrews, and locknuts shall be checked to see that they are tight and properly seated. Raceway shall be examined for rigid mounting and secured joints.

5. Perform tests to verify continuity of those parts of the system that are concealed and that are not available for visual inspection.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 5* (Continued)

SUBSYSTEM:	GROUNDING SYSTEM
CONTROL NUMBER:	GS-III 29.07-5*

Inspection Actions (Continued)

6. Conduct ground resistance tests of the ground termination system and its individual ground electrodes if adequate disconnecting means have been provided. These test results should be compared with previous, or original, results or current accepted values, or both, for the soil conditions involved. If it is found that the test values differ substantially from previous values obtained under the same test procedures, additional investigations should be made to determine the reason for the difference.

7. Perform continuity tests to determine if suitable equipotential bonding has been established for any new services or constructions that have been added to the interior of the structure since the last inspection.

Special Tools and Equipment

The following is a list of special instruments required beyond those listed in the Standard Tool Section.

1. Ground resistance tester, Biddle #250260

2. Digital multimeter, Fluke #1TC67

Recommended Inspection Frequency

1. A grounding system should be inspected whenever any alterations or repairs are made to a structure as well as following any known ground fault discharge to the system.

2. Complete, in-depth inspections of a system should be completed every ten years. It is recommended that critical systems be inspected every four years.

References

1. NFPA 70B *"Recommended Practice for Electrical Equipment Maintenance"* 1990 Edition

2. *"Handbook of Building and Plant Maintenance, Forms and Checklists"* by Roger W. Liska and Judith Morrison Liska

3. MEANS *"Facilities Maintenance & Repair Cost Data"* 1994

APPENDIX A

ABBREVIATIONS

ADF	Asset Determinant Factor
A/E	Architect-Engineer
AFM	U.S. Air Force Manual
ALUM	Aluminum
ALUMINZ	Aluminized
Amp	Ampere
ANSI	American National Standards Institute
AVG	Average
AWG	American Wire Gauge
BKRS	Breakers
BLDG	Building
BOCA	Building Official Code Association
BRNZ	Bronze
°C	Degrees Centigrade (Celsius)
CAIS	Condition Assessment Inspection Survey
CAS	Condition Assessment Survey
CIRC	Circuit
COE	U.S. Army Corps of Engineers
COR	Contracting Officer Representative
CSI	Construction Specification Institute
CT	Current Transformer
DBL	Double
DC	Direct Current

APPENDIX A

DCD	Data Collection Device
DEG	Degrees
DIA	Diameter
DISCONN	Disconnect
DIST	Distribution
DM	NAVFAC Design Manual
DOD	U.S. Department of Defense
DOE	U.S. Department of Energy
DR	Door
DS/IM	Deficiency Standard/Inspection Method
EA	Each
EM	U.S. Army Engineering Manual
EMS	Energy Management System
EPA	U.S. Environmental Protection Agency
Est	Estimated
EXPLO-SIONPRF	Explosion proof
°F	Degrees Fahrenheit
FLR	Floor
Ft	Foot, feet
FVNR	Full Voltage, Non-Reversing
FVR	Full Voltage, Reversing
Galv	Galvanized
GS	Guide Sheet
H	High

APPENDIX A

HID	High Intensity Discharge
HOA	Hand-Off-Automatic
HP	Horsepower
HR	Hour
HVAC	Heating, Ventilating, and Air-Conditioning
Hz	Hertz, frequency
IEEE	Institute of Electrical and Electronic Engineers
IES	Illumination Engineering Society
ITIM	Intrusive Test and Inspection Method
INDUS	Industrial
IU	Inspection Unit
KA	Kiloampere
KV	Kilovolt
kVA	kiloVolt Ampere
kVAR	Kilovar
kW	kiloWatt
kWh	kiloWatt hour
L	Low
LF	Linear Feet
M	Medium
MCC	Motor Control Center
Mfg	Manufacturing
Mfr	Manufacturer
MC	Major Command/Major Claimant

APPENDIX A

MCC	Motor Control Center
Mhz	Megahertz
MN	Minimum
MTD	Mounted
MVA	Million-Volt-Amps
MYMARP	Multi-Year Maintenance and Repair Plan
NAVFAC	Naval Facilities Engineering command
NDT	Non-Destructive Testing
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NSTIM	Non-Standard Testing and Inspection Method
OD	Outside Dimension
OSHA	Occupational Safety and Health Administration
P or PH	Phase
PB	Pushbutton
PCB	Polychlorinated biphenyls
PL	Pilotlight
PNL	Panel
PNLBD	Panelboard
PT	Potential Transformer
PVC	Polyvinyl Chloride
PWR	Power
QA	Quality Assurance
RAINPRR	Rain Proof

APPENDIX A

Reqd	Required
RPFM	Real Property and Facilities Management (U.S. DOE)
RPIS	Real Property Inventory System (U.S. DOE)
RV	Reduced Voltage
RVA	Reduced Voltage Autotransformer
RVRes	Reduced Voltage Reactor
SF	Square feet
SIM	Standard Inspection Method
SQ	Square
SS	Stainless Steel
SW	Switch
SWTCHBD	Switch Board
SZ	Size
TM	U.S. Army technical manual
TR	DOD technical report
UL	Underwriters Laboratory
UOM	Unit of Measure
UPS	Uninterruptible Power Supply
USCE	U.S. Army Corps of Engineers
V	Volt
VAC	Voltage, Alternating Current
VDC	Voltage, Direct Current
W	Watt
W/	With

APPENDIX A

WATERPRF	Water Proof
WBS	Work Breakdown Structure
XFRM	Transformer
XTRA	Extra
Yrs	Years
2S1W	Two Speed, single winding
2S2W	Two Speed, two winding
2MC	Two Magnetic Contractors
°F	Degrees Fahrenheit
°C	Degrees Centigrade (Celsius)
<	Less Than
%	Percent

APPENDIX B

GLOSSARY

Accessible	Capable of being removed or exposed without damaging the building structure or finish, or not permanently closed in by the structure or finish of the building (as applied to wiring methods).
Bonding	The permanent joining of metallic parts to form an electrically conductive path which will assure electrical continuity and the capacity to conduct safely any current likely to be imposed.
Branch Circuit	The circuit conductors between the final overcurrent device and the outlet(s).
Buildings	A structure which stands alone or which is cut off from adjoining structures by fine walls with all openings therein protected by approved fine doors.
Circuit Breakers	A device designed to open and close a circuit by nonautomatic means and to open the circuit automatically on a predetermined overcurrent without damage to itself when properly applied within its rating.
Device	A unit of an electrical system which is intended to carry but not utilize electric energy.
Enclosure	The case of housing of apparatus, or the fence, or walls which will prevent persons from accidentally contacting energized parts.
Equipment	A general term including material, fittings, devices, appliances, fixtures, apparatus, and the like used as a part of, or in connection with, an electrical installation.
Feeder	All circuit conductors between the service equipment of the source of a separately derived system and the final branch circuit overcurrent device.
Fitting	An accessory such as a locknut, bushing, or other part of a wiring system that is intended primarily to perform a mechanical rather than an electrical function.
Outlet	A point on the wiring system at which current is taken to supply utilization equipment.
Overcurrent	Any current in excess of the rated current of equipment or the ampacity of a conductor. It may result from overload, short circuit, or ground fault.

APPENDIX B

Overload	Operation of equipment in excess of normal, full-load rating, or of a conductor in excess of rated ampacity which, when it persists for a sufficient length of time, would cause damage or dangerous overheating. A fault, such as a short circuit or ground fault is not an overload.
Panelboard	A single panel or group of panel units designed for assembly in the form of a single panel; including bases, automatic overcurrent devices, and with or without switched for the control of light, heat, or power circuits; designed to be placed in a cabinet or cutout box placed in or against a wall of partition and accessible only from the front.
Raceway	An enclosed channel designed expressly for holding wires, cable, or busbars, with additional functions as permitted. Raceways may be of metal or insulating material, and the term includes rigid metal conduit, rigid nonmetallic conduit, intermediate metal conduit, liquid tight flexible conduit, flexible metallic conduit, electrical nonmetallic conduit, electrical metallic conduit, underfloor raceways, cellular concrete floor raceways, cellular metal floor raceways, surface raceways, wireways, and busyways.
Service Drop	The overhead conductors that extend from the last pole or other aerial support to and including the splices, if any, connecting to the service-entrance conductors at the building or other structure.
Service Entrance Conductors	The service conductors between the terminals of the service equipment and point usually outside the building, clear of building walls, where joined by tap or splice to the service drop or the service conductors between the terminals of the service equipment and the point of connection to the service lateral. The service conductors may be individual insulated conductors or in the form of a cable. The insulation will be appropriate to the environmental application.
Service Entrance Equipment	The necessary equipment, usually consisting of a circuit breaker or switch and fuses, and their accessories, located near the point of entrance of supply conductors to a building or other structure, or an otherwise defined area, and intended to constitute the main control and means of cutoff of the supply.

APPENDIX B

Service Lateral	The underground service conductors between the street main, including any risers at a pole or other structure or from transformers, and the first point of connection to the service entrance conductors in a terminal box or meter or the enclosure with adequate space, inside or outside the building wall. Where there is no terminal box, meter, or other enclosure with adequate space, the point of connection will be considered to be the point of entrance of the service conductors into the building.
Switchboard	A large single panel, frame, or assembly of panels on which are mounted, on the face or back or both, switches, overcurrent and other protective devices, buses, and usually instruments. Switchboards are generally accessible from the rear as well as from the front and are not intended to be installed in cabinets.
Utilization Equipment	Equipment which utilizes electric energy for mechanical, chemical, heating, lighting, or similar purposes.

APPENDIX C

LIFE CYCLE

29 SITE ELECTRICAL SYSTEM

29.01 SWITCHYARDS

Enclosures with Bus Bars	20 YRS
Meters	20 YRS
Surge (Lightning) Arresters	60 YRS
Insulators	60 YRS
Circuit Breakers	50 YRS
Disconnect Switches	25 YRS
Transformers	30 YRS
Foundations	50 YRS
Fencing	30 YRS

Source:
MEANS Facilities Maintenance & Repair Cost Data, 1994
AASHTO - AGC - ARTBA Joint Committee
Task Force 32 Report
Joslyn Corporation

29.02 SUBSTATIONS

Enclosures with Bus Bars	20 YRS
Meters	20 YRS
Surge (Lightning) Arresters	60 YRS
Insulators	60 YRS
Circuit Breakers	50 YRS
Disconnect Switches	25 YRS
Transformers	30 YRS
Foundations	50 YRS
Fencing	30 YRS

Source:
MEANS Facilities Maintenance & Repair Cost Data, 1994
AASHTO - AGC - ARTBA Joint Committee
Task Force 32 Report
Joslyn Corporation

APPENDIX C

29.03 OVERHEAD MEDIUM VOLTAGE SYSTEM

Disconnect Switches	25 YRS
Surge (Lightning) Arresters	20 YRS
Insulators	60 YRS
Transformers	30 YRS
Power Regulators	18 YRS
Steel Lattice Towers	50 YRS
Wood, Steel, aluminum, concrete & fiberglass poles	50 YRS
Anchors and Guy Wires	50 YRS
Foundations	50 YRS

Source:
MEANS Facilities Maintenance & Repair Cost Data, 1994
Illinois Power Company
AASHTO - AGC - ARTBA Joint Committee, Task Force 32 Report
Joslyn Corporation

29.04 UNDERGROUND MEDIUM VOLTAGE SYSTEM (601 V TO 35 kV

Underground Electrical Utilities	50 YRS
Handholes/Manholes	50 YRS
Transformers	30 YRS
Foundations	50 YRS

Source:
MEANS Facilities Maintenance & Repair Cost Data, 1994
AASHTO - AGC - ARTBA Joint Committee, Task Force 32 Report

29.05 LOW VOLTAGE DISTRIBUTION SYSTEM, 600V OR LESS

Circuit Breakers	50 YRS
Disconnect Switches	25 YRS
Transfer Switches	18 YRS
Motor Starters/Contactors	18 YRS
Transformers	30 YRS

Source:
MEANS Facilities Maintenance and Repair Cost Data, 1994

APPENDIX C

29.06 EXTERIOR LIGHTING SYSTEM

Lighting Fixtures	20 YRS
Lighting Controllers	15 YRS
Wood Poles	50 YRS
Steel, Aluminum, Concrete and Fiberglass Poles	50 YRS
Anchor and Guy Wires	50 YRS
Foundations	50 YRS

Source:
MEANS Facilities Maintenance & Repair Cost Data, 1994
Illinois Power Company
AASHTO-AGC-ARTBA Joint Committee, Task Force 32 Report

29.07 LIGHTNING PROTECTION/GROUNDING SYSTEM

Air Terminals	25 YRS
Conductors (Bare)	50 YRS
Bonding	50 YRS
Conduit Systems	50 YRS
Wood Poles	50 YRS
Steel, Aluminum, Concrete and Fiberglass Poles	50 YRS
Anchors and Guy Wires	50 YRS
Foundations	50 YRS

Source:
MEANS Facilities Maintenance & Repair Cost Data, 1994
Illinois Power Company
AASHTO-AGC-ARTBA Joint Committee, Task Force 32 Report