AT&T 760-400-102
Issue 1
May 1997

Standby AC Plant

Design Installation and Acceptance Criteria

Notice

Every effort was made to ensure that the information in this document was complete and accurate at the time of printing. However, information is subject to change.

Trademarks

AutoCAD is a trademark of Autodesk, Inc.
Dapper and Captor is a trademark of SKM System Analysis Inc.

Ordering Information

The ordering number for this document is 760-400-102. To order additional copies of this document, please contact:

Lucent Technologies, Inc.
Customer Information Center (CIC)
P.O. Box 19901
Indianapolis, IN 46219

Phone: 1-800-432-6600 or 1-317-352-0011

For more ordering information, see “How To Order Documentation” in the “About This Document” section.

Telephone Support

AT&T provides a telephone number for you to use to report errors or to ask questions about the information in this document. Please contact:

AT&T
Power Documentation Manager
30-MZB-40
1600 Osgood Street
N. Andover, MA 01845

Phone:	(800) 854-6228
FAX:	(508) 960-6851
AT&T Mail:	!powerdoc

How Are We Doing?

Document Title: _____

_____

Document Number: _____ Issue No. _____ Date: _____

AT&T welcomes your feedback on this document. Your comments can be of great value in helping us to improve our documentation.

1. Please rate the effectiveness of this document in the following areas:

	Excellent	Good	Fair	Poor	Not Applicable
Ease of Use					////////////////////////
Clarity					////////////////////////
Completeness					////////////////////////
Accuracy					////////////////////////
Organization					////////////////////////
Appearance					////////////////////////
Examples					////////////////////////
Illustration					
Overall Satisfaction					////////////////////////

2. Please check the ways you feel we could improve this document:

❒ Improve the overview/introduction
❒ Improve the table of contents
❒ Improve the organization
❒ Include more figures
❒ Add more examples
❒ Add more detail
❒ Make it more concise/brief
❒ Add more step-by-step procedures/tutorials
❒ Add more troubleshooting information
❒ Make it less technical
❒ Add more/better quick reference aids
❒ Improve the index

Please provide details for the suggested improvement. _____

_____

3. What did you like most about this document?

_____

_____

4. Feel free to write any comments below or on an attached sheet.

_____

_____

_____

If we may contact you concerning your comments, please complete the following:

Name: _____ Telephone Number: (_____)_____

Company/Organization: _____ Date: _____

Address: _____

When you have completed this form, pleased fold, tape, and return to address on back or
Fax to: (508) 960-6851.

---------- Do Not Cut — Fold Here And Tape ----------

Please
Place
Stamp
Here

AT&T
NSD Power and Infrastructure Development
Documentation Group
Documentation Manager
30-MZB-40
1600 Osgood Street
N. Andover, MA 01845

Contents

Contents

Contents

Contents

Contents

Contents

Contents

Contents

About This Document

Purpose

This Practice provides general as well as specific design criteria for the provisioning of new AC standby systems and modifications to existing systems. The purpose of this document is to establish standards and design criteria for the engineering, installation, and acceptance of standby AC power systems that support AT&T NCS facilities.

Intended Audiences

This document is intended for use by AT&T personnel responsible for the engineering, installation, and acceptance of standby AC power systems that support AT&T NCS facilities.

Reason for Reissue

This is the initial issue of this practice. Whenever this practice is reissued the reason for reissue will be found in this paragraph.

How to Use This Document

This Practice includes system design, layout, configuration, equipment design and selection, and quality assurance requirements for the standby AC power system.

The criteria developed in this Practice are not intended to supersede local or national code requirements but are intended to supplement these code requirements. Where this Practice is in conflict with accepted codes or industry standards, the stricter of the two shall be used. In unresolved conflicts, the order of precedence should be:

1. Code
2. Industry practice
3. This Practice.

Where this document is in conflict with other AT&T Practices with regard to design criteria for standby AC plant design, installation or acceptance, this document takes precedence.

The subjects in each chapter are organized as follows:

Chapter 1 **General** - provides an overview of AT&T network reliability criteria as well as a description of the objective of this Practice.

Chapter 2 **General Design Criteria**- provides a discussion of the Basis of Design and defines design parameters and assumptions required in design development.

Chapter 3 **Diesel Engines and Required Support Systems** - provides requirements for diesel engines used in standby AC plants.

Chapter 4 **Alternator** - provides design requirements for alternators.

Chapter 5 **Start Systems** - provides criteria for start systems used in standby AC plants.

Chapter 6 **Fuel Systems** - provides requirements for fuel and associated equipment.

Chapter 7 **Cooling System** - discusses cooling system requirements for use in a standby AC plant.

Chapter 8 **Engine-Generator Mounted Control Panel** - discusses the use of engine mounted control panels.

Chapter 9 **Floor Mounted Control Panel** - provides criteria for the use of floor mounted control panels.

Chapter 10 **Paralleling Switchboards** - provides requirements for paralleling switchboards.

Chapter 11 **Equipment and Accessories** - provides requirements for various equipment used in a standby AC plant such as electrical protective systems and alarms.

Chapter 12 **Turbines** - provides turbine assembly requirements.

Chapter 13 **Standby Plant Room Design Criteria** - provides criteria for standby AC rooms.

Chapter 14 **Exterior Engine Enclosures** - provides requirements for enclosures for externally mounted engines.

Chapter 15 **AC Standby Plant Test and Acceptance** - provides checklists to verify proper installation and working operation of a standby AC plant and supporting equipment.

Chapter 16 **Codes and Standards** - provides a list of codes and standards applicable to the material in this document.

Glossary defines various terms and acronyms used in this document.

Standards and Conventions

The chapters in this manual are separated by tabs. The title of each chapter is printed on the tab at the beginning of that chapter.

The following standards and conventions are used consistently throughout this document:

- Tables and figures are located as closely as practical to the point in the text where they are referenced
- Hardware labels and equipment stamping, when referenced in the text, are shown in boldface type
- Responses to actions or occurrences within the procedures (e.g., lighted or extinguished lamps, system alarms, etc.) are listed immediately following the action or occurrence that initiated them.

Admonishments

Admonishments are reminders that are used to assure the safety of personnel and to minimize service interruptions; loss of data; and damage to equipment, products, and software. There are three types of admonishments used in this document. The three types are identified and defined below in descending order of priority:

- **DANGER** indicates the presence of a hazard that **will** cause death or severe personal injury if the hazard is not avoided
- **WARNING** indicates the presence of a hazard that **can** cause death or severe personal injury if the hazard is not avoided
- **CAUTION** indicates the presence of a hazard that **wil**l or **can** cause minor personal injury or property damage if the hazard is not avoided.

Related Documentation

See Chapter 1, General, and Chapter 16, Codes and Standards for a list of related codes, standards and practices.

Training

For information about any training courses related to power systems, call NOET (Network Operation Education & Training) at 1-404-728-6100.

To register for a power course, contact your local training coordinator or call 1-800-NETRAIN (638-7246).

How to Order Documentation

Additional manuals are available from the Lucent Technologies Customer Information Center. Call the Customer Information Center and follow normal coding procedures to obtain additional copies of this manual. Copies can be obtained by calling, FAXing, or mailing orders as follows:

TOLL FREE:	**1-800-432-6600** (USA)
	1-800-255-1242 (Canada)
Toll:	**1-317-352-0011** (Worldwide)
FAX:	**1-317-322-6484**
MAIL:	Lucent Technologies, Inc. Customer Information Center Attn.: Customer Service Representative P.O. Box 19901 Indianapolis, IN 46219

Use the document numerical identifier and issue number (i.e., 760-400-102, Issue 1) when ordering this manual.

How to Comment on This Document

To suggest changes to the information in this document or to notify the authors of errors, please submit a comment form. The comment form is located at the beginning of this manual, immediately after the title page. If the comment form is missing, send your comments and recommendations to:

AT&T
Documentation Services District
ATTN: Documentation Manger
Room 30-MZB-40
1600 Osgood Street
N. Andover, MA 01845
attmail!powerdoc
I!powerdoc@att.mail.net

General

1

Contents

General

1

1.01 Purpose

This practice provides general as well as specific design criteria for the provisioning of new standby AC power systems and modifications to existing systems. The purpose of this document is to establish standards and design criteria for the engineering, installation, and acceptance of standby AC power systems that support AT&T NCS facilities. These criteria are established to provide the standby AC power system architectures recommended to meet the operational reliability objectives of the Infrastructure Segmentation Strategy, as outlined in section 1.03. For design criteria related to AC Power distribution systems, including automatic transfer schemes, refer to AT&T 760-400-101, AC Power Distribution Systems Design, Installation and Acceptance Criteria.

1.02 Scope

These design criteria cover all aspects of standby AC plant design including the engine, generator, fuel systems, starting systems, cooling systems, exhaust systems, controls, engine rooms, engine enclosures and acceptance criteria. Although the criteria are established to be used with new installations, they should also be used to assist in the design of modifications and retrofits to existing systems. Acceptance criteria, including factory testing and on-site testing requirements are included in Chapter 15.

NOTE:
This document shall not be used as the sole basis for major retrofits or redesign of existing systems. Other factors, such as commercial power reliability, maintenance costs, availability of spare parts, history of system failure, availability of funding, and criticality of network services supported must be considered and included in a detailed business plan. All approved standby AC projects for new installations, modifications, and retrofits shall conform to this practice, related documentation identified below and to documentation identified in Chapter 16, Codes and Standards.

1.03 Reliability Criteria - Infrastructure Segmentation Strategy

The overall objective for all NCS-managed Network locations is to provide a safe-secure-reliable infrastructure supporting the AT&T Network at a best-in-class cost. The Infrastructure Segmentation Strategy is a risk management plan that focuses on providing appropriate infrastructure reliability to segmented categories of Network offices or sites in a cost-effective manner. This strategy has been developed to guide the design and implementation of programs to improve the operational reliability of the NCS infrastructure. For further information on the Infrastructure Segmentation Strategy, refer to INFR-002 (part of AT&T 154-001-050).

The approximately 5,000 NCS Network offices and sites have been segmented into five categories based on the relative impact on the AT&T Network of a location-specific service outage. Greater infrastructure reliability objectives are assigned to the more critical office or site categories. While our goal should be to have virtually no service outages, practical experience tells us that we cannot reduce this probability to zero. The incremental costs of increasing our infrastructure reliability beyond certain levels may become unacceptable. The Segmentation Strategy proposes infrastructure reliability objectives appropriate for the Network service risk associated with each office or site category.

The Segmentation Strategy considered the infrastructure at each NCS office or site to be composed of three major functional systems: DC Power, AC Power, and HVAC. AC power systems are composed of AC power distribution systems and standby AC power systems. This practice addresses the standby AC power system architectures recommended to meet the operational reliability objectives of the Infrastructure Segmentation Strategy. AC power distribution system architecture recommendations are included in AT&T 760-400-101, AC Power Distribution Systems Design, Installation and Acceptance Criteria.

It is important to note that, in the case of new construction, these standards shall be employed. In the case of existing infrastructure, upgrades to bring offices/sites into compliance with these standards may be affected by variables such as capital availability, the relative reliability of commercial AC power at the office/site, or the availability of Network restoration facilities in the event of a failure of infrastructure or primary Network facilities.

Office/Site Category Reliability Objectives

Critical - Platinum Office

A Network service outage in any of these offices can have a catastrophic impact on Network operations and hence to the AT&T brand name. Subjective judgement is applied on the relative importance of the services provided from an office; that is, what customers would be affected by an outage and what the resulting impact would be. Each Critical-Platinum office should be configured and maintained to meet an infrastructure-related MTBF of 2000 years. The top 60 of the 145 Critical Offices have been placed in this category.

Critical - Gold Office

A Network service outage in any of these offices can have serious impact on Network operations and hence to the AT&T brand name. Each Critical-Gold office should be configured and maintained to meet an infrastructure-related MTBF of 1200 years. Critical offices not placed in the Platinum category have been assigned to the Gold office category.

Major Office

A Network service outage in any of these offices can have a major impact on some AT&T customers, however, the AT&T brand name impact may be minimal. Subjective judgement will be applied as to the relative importance of service provided from an office. Major offices will include significant Network switching locations not included in the above Critical Office categories. Each major office should be configured and maintained to meet an infrastructure related MTBF of 600 years. There are approximately 150 Major offices in the Network.

Node Office

A Network service outage in any of these offices can have a major impact on specific AT&T customers with an overall impact less than that of a Major Office. Nodes include all offices with significant terminating traffic not designated as Critical or Major. Each Node office should be configured and maintained to meet an infrastructure-related MTBF of 400 years. There are approximately 500 Node

offices in the Network, with a cumulative total of approximately 800 Critical, Major and Node Offices.

Site

Any other Network location not assigned to the Critical, Major or Node Office categories. Sub-categories within the definition of Site are to be developed for small POP's, lightwave regenerators and radio repeaters. Infrastructure reliability objectives for Sites are not established because of criteria that differ according to the Network restoration capability at each Site. Site operating characteristics will also differ based on various criteria such as commercial AC power reliability at the Site.

Standby AC Power System Architecture Recommendations

Critical-Platinum Office

- **Standby Engines** - N standby engines will be the standard for buildings with dual/diverse AC service feeds. N+1 engines are required in seismic zone 4 areas or when dual/diverse AC feeds are not available. All engines should be auto-start, auto-transfer, auto-parallel (when paralleling is required) and auto-transfer back to the commercial source.
  - — N = the number of standby engines required to support the building essential loads
  - — Physical separation or fire barriers between multiple engines will not be required.
  - — N + 1 engines will be required in buildings located in earthquake zone 4, even those equipped at present with dual AC feeds.
  - — Where dual AC power distribution systems exist within a building, and they are normally powered by separate engines, a flexible switching arrangement should be provided such that either distribution system may be supported by any engine. This may be accomplished by including tie breakers between sources and a load-shedding system (if required) or by tying the systems together and paralleling the engines.
  - — Where multiple engines are paralleled to support building loads, automatic load shedding and automatic restoration of loads should be applied to non-essential and priority 2 loads. Priority 1 loads should not be included in the automatic load shed plan.
  - — Buildings equipped with one standby engine or two engines, either of which has the capacity to support the entire building load, do not require automatic load shedding.

— Buildings equipped with separate distribution systems that are individually supported with N+1 standby engines will not require automatic load shedding.

- **Portable Engine Quick-Connect** - A quick-connect shall be provided in buildings that do not have dual/diverse AC service feeds and in buildings that have a high probability or past history of natural disasters such as hurricanes, tornados or earthquakes (zone 4 only). Buildings equipped with N+2 standby engines, except for those located in zone 4 seismic areas, will not require a portable engine quick-connect.
- **Single-Line Drawings** - Complete and accurate single-line drawings, riser diagrams and panel schedules are required. All drawings are to be built in Auto CAD Release 12 format per the AT&T Computer Aided Drafting Specification.
- **Studies** - Fault current studies, coordination studies, and load studies are required for all buildings. All deficiencies should be evaluated as to extent of risk and cost to upgrade. Life safety issues should be addressed as a special project or as part of other capital projects. All studies should be documented in software programs, such as Dapper® and Captor®. Hard copies of the studies should be maintained at each building.
- **AC Power for Other Redundant/Essential Equipment** - If two sources of AC power are available within the building, essential redundant equipment (i.e., fuel pumps, fan units, motor control centers, chillers. etc.) should be powered from separate diverse sources as far back into the AC distribution system as practical.

NOTE:
Critical redundant equipment served from one MCC which is provided AC power from diverse sources will be acceptable.

Critical - Gold Office

- **Standby Engines** - N standby engines will be the standard configuration for buildings which are equipped with dual/diverse AC service feeds. N+1 standby engines are required when one AC service feed is provided. All engines shall be auto-start, auto-transfer, auto-parallel (when paralleling is required), and auto-transfer back to the commercial source.
  - — N = the number of standby engines required to support the building essential loads.
  - — Physical separation or fire barriers between multiple engines will not be required.
  - — Where dual AC power distribution systems exist within a building and these systems are normally powered by separate engines, a flexible switching arrangement should be provided such that either

distribution system may be supported by any engine. This may be accomplished by provision of tie breakers between systems and a load-shedding system (if required) or by tying the systems together and paralleling the engines.

— Where multiple engines are paralleled, automatic load shedding and automatic restoration of loads should be applied to non-essential and Priority 2 (essential) loads. Priority 1 (essential) loads should not be included in the automatic load shed plan.

— Buildings equipped with one standby engine or buildings with two engines, either of which has the capacity to support the entire building load, will not require automatic load shedding.

— Buildings equipped with separate distribution systems that are individually supported with N+1 standby engines will not require automatic load shedding.

- **Portable Engine Quick-Connect -** Required in buildings which are not equipped with dual AC service feeds, and in buildings that have a high probability or past history of natural disasters such as hurricanes or earthquakes (zone 4 only). Buildings equipped with N+2 standby engines, except for those located in zone 4 seismic areas, will not require a portable engine quick-connect.
- **Single-Line Drawings** - Complete and accurate single-line drawings, riser diagrams and panel schedules are required. All drawings to be built in AutoCad Release 12 format per the AT&T Computer Aided Drafting Specification.
- **Studies** - Fault-current studies, coordination studies, and load studies are required for all buildings. All deficiencies should be evaluated as to risk and cost to upgrade. Life safety issues should be addressed as a special project or as part of other capital projects. All studies should be documented in software programs, such as Dapper® and Captor®. Hard copies of the studies should be maintained at each building.
- **AC Power for other Redundant/Essential Equipment** - If two sources of AC power are available within the building, essential redundant equipment (i.e., fuel pumps, fan units, motor control centers, chillers. etc.) should be powered from separate diverse sources as far back into the AC distribution system as practical.

NOTE:
Critical redundant equipment served from one MCC which is provided AC power from diverse sources will be acceptable.

Major Offices

- **Standby Engines** - N engines, auto-start and auto-transfer.
- **Portable Engine Quick Connect** - Provide hard-wired connection and disconnect.

Nodes

- **Standby Engines** - N Engines, auto-start and auto-transfer.
- **Portable Engine Quick Connect** - Provide hard-wired connection and disconnect.

Sites

- **Standby Engines** - Auto-start and auto-transfer on permanently installed engines.

  Radio - N engines.

  Lightguide - Standby AC power is provided by portable engines at a rate of 1 portable engine for every 3 regenerator sites. A permanently installed engine is not required but may be provided at sites which have had a documented service failure due to site inaccessibility, or which are not fully restorable by FASTAR or a SONET ring.

- **Portable Engine Quick Connect**

  Radio - provide hard-wired connection point and disconnect switch.

  Lightguide - Plug and receptacles with disconnect should be provided per Power and Infrastructure Standard ACPWR-002.

AC Power Notes

Automatic Transfer Switch (ATS)

When Automatic Transfer Switches (ATS) are used to transfer between commercial and standby sources, a hard manual bypass is required with posted step-by-step procedures.

Closed-transition (make-before-break) transfer switches may be used in new switchgear designs for critical (Platinum or Gold) building when a no-break transfer between two live sources is required due to special service conditions. The decision to use closed-transition transfer switches in the design of new switchgear should be considered based on the criticality of the location and services affected, as well as the inconvenience to building tenants and customers.

Programmable Logic Controllers

When Programmable Logic Controllers (PLCs) are used for critical AC power and engine controls, the design should be of modular construction, have the capability of field upgrades, should have the manufacturer's guarantee of evolutionary capability, and should be supported by the manufacturer for minimum of 7 years. All PLCs, regardless of function, should include a simple to use and activate manual override feature. When PLCs are used for the purpose of auto load-shed they should include an auto load-restore feature. The design for all PLCs used within the building should be of the same manufacturer and should be handled by a single engineering firm. Continuity of breaker and switchgear manufacturer should be maintained on a building basis (for detailed PLC design requirements, refer to AT&T 760-400-101, AC Power Distribution System Design, Installation and Acceptance Criteria).

Definitions

Automatic Load Shed - A mechanized system installed for the purpose of shedding non-essential and Priority 2 (essential) loads in order to maintain power to Priority 1 (essential) loads in the event of one or more standby engine failures.

N Standby Engines - The number of generators required to carry all building essential loads.

N+1 Standby Engines - A multiple standby engine configuration equipped with a single redundant standby generator for backup support of the other generators on site. The loss of any one generator should not limit the ability of the remaining generator or generators to support the building Priority 1 essential loads. In some locations this may require the automatic load shedding of building non-essential loads, and Priority 2 essential loads.

Non-essential Loads - Those AC loads which are not required to maintain service to telecommunications equipment. These loads may be included in an auto load-shed plan and will be the first loads to be shed.

Typical Non-essential loads:

1. Artificial load banks
2. Food/beverage service areas and equipment (cafeterias, kitchens, vending machine areas, etc.)
3. Non-essential office equipment (copiers, printers, terminals, etc.)
4. Non-essential lighting
5. AC panels and circuits supporting non-telecommunications equipment areas

6. HVAC fans which are dedicated to non-telecommunications equipment areas
7. Chillers and HVAC equipment which are dedicated to non-telecommunications equipment areas.

Priority 1 (Essential) Loads -Those AC loads which are required to maintain telecommunications service and the absolute minimum infrastructure loads required to support critical telecommunications equipment. They will also include critical security, environmental, fire protection, and alarm systems. These loads should not be part of an auto load-shed plan.

Typical Priority 1 (Essential) Loads:

1. Any AC operated equipment required to maintain proper operation of the standby AC system. The following list is representative of most standby AC systems but may not be all inclusive:
   - Engine fuel pumps -
     - storage tank to day tanks
     - Day tanks to engines
     - AC operated controls for fuel pumps
   - Engine fans -
     - remote radiator
     - room exhaust
     - combustion air
     - oil cooling fans
     - AC operated controls for fans
     - AC operated louvers and dampers required for combustion or cooling air flow
     - Engine coolant water pumps for remote radiators and heat exchangers
     - AC operated engine control and alarm systems
     - Engine start and control battery chargers
     - Engine air start systems (compressors, controls, etc.).
2. Chillers (except for spare or “+1” chillers, which are Priority 2 loads)
3. Fan units and airhandling equipment required for telecommunications equipment areas
4. HVAC controls
5. DC power plants supporting communication equipment

6. DC power plants supporting switchgear control battery
7. AC power for switchgear controls
8. AC power required for PLC operation
9. Office communication system (PBX)
10. AC power for building alarm systems
11. AC feeds for UPS systems
12. Elevators required by life safety codes
13. Building security systems
14. Fire alarm systems
15. AC pumps for the fire suppression stand pipe system
16. Emergency lighting systems
17. Sump pumps and sewage pumps.

Priority 2 (Essential) Loads - Those AC loads which are significant but are not absolutely required to maintain service to telecommunications equipment. These loads may be included in an auto load-shed plan and will be the last loads to be shed.

Typical Priority 2 (Essential) Loads:

1. Spare rectifiers (may be included in an auto load shed plan with a rectifier sequence controller)
2. Chillers (“+1” or spare chillers)
3. Elevators not required for life safety
4. General lighting for equipment areas.

Riser Diagram - A graphical block schematic of all AC electrical distribution and standby AC equipment on an elevation by building floor. All equipment will be represented with un-detailed blocks showing interconnections with other equipment.

Single-Line Drawings - a detailed graphical schematic of the AC distribution system from the AC service entrance to the loads, showing all distribution boards, breakers, panels, standby engines, transfer switches, motor control centers, and major equipment loads.

1.04 Related Documentation

This document incorporates information from the AT&T Practices listed below, which may be used as references for information not detailed in this practice. Where this document is in conflict with other AT&T Practices with reference to design standards for standby AC power installation, this document will take precedence. Conflicts shall be documented and reported to the Power and Infrastructure Standards Group.

154-103-101 Alarm Standards Manual

760-220-164 Storage Systems, Combustible Liquid Fuels - Design, Installation and Maintenance

760-400-101 AC Power Distribution System Design, Installation and Acceptance Criteria

760-200-050 Network Mechanical Systems Standards.

AT&T Computer Aided Drafting Specification dated 1/96 (for further details, refer to the AT&T NIR District, Mr. Larry Gilley, (404) 810-4391)

This document supersedes the following AT&T Practices:

760-640-150 Internal combustion Engines

790-100-659 Standby AC Plants General Design Requirements

790-100-662 Standby AC Plant Layout

802-006-150 Exhaust Line Size Requirements

802-006-180 Installation of Internal Combustion Engines Equipment Requirement

802-010-150 Ventilating Equipment Requirements for Engine Rooms

802-015-153 Engine Room Lighting

802-950-152 Method of Determining Motor Starting Capacity for Standby Engines

802-034-151 Paralleling and Load Management Equipment Design Requirements

802-034-152 Universal Engine Control Equipment Design Requirements

802-034-154 Microcomputer Generator Controller Design Requirements

General Design Criteria

2

Contents

General Design Criteria

2

2.01 General

The Standby AC System shall be designed to provide a reliable and cost effective back-up power source of sufficient capacity to power the required “essential” loads during all designed operating conditions.

The Standby AC System shall also provide voltage at the proper frequency to connected equipment within tolerances of equipment operating voltage and frequency during all design ranges of the electrical system.

The preferred standby AC plant shall be one or more auto-start and auto-transfer diesel generators. This design provides for fast start and transfer capability and meets the reliability standards required for AT&T NCS buildings. Gas turbines should be specified only where required by special circumstances such as commonality of equipment, floor loading, etc.

The finished unit shall comply in all respects with all applicable trade standards and all federal, state, county, and municipal ordinances, rules, and regulations, including compliance with noise criteria and seismic zoning.

All equipment shall be new and the current production of a national firm which manufactures/packages the diesel engine-generator set as a unit. The manufacturer/packager together with its authorized representative, shall have full responsibility for the performance of the diesel engine-generator set, control equipment and its accessories. All equipment shall have a minimum warranty, after acceptance by AT&T representatives, of one year on parts and labor.

The rating of the standby diesel engine-generator set at the stated ambient temperature and altitude shall be based on operation of the set when equipped with all operating accessories such as radiator fan, air cleaners, lubricating oil pump, fuel pump, jacket water pump, governor, generator, regulator, etc.

A building load study shall be performed to ensure proper sizing of the standby AC plant. The system shall be designed to accommodate future growth, but should also be designed within reasonable limits to avoid creation of a low-load condition and resulting degradation of engine performance.

2.02 Quality Assurance

The following procedures shall be employed to assure that standby AC plant design activities are carried out in a planned, controlled, orderly, and correct manner.

The design responsibilities, authorities, and interfaces among the contributing organizations (AT&T corporation., building owner, architect/engineer, equipment supplier, other contractors - both internal and external) shall be identified, and clearly delineated.

The AT&T Building Engineer shall be copied on any correspondence between project team members. This shall include written records on telephone conversations concerning project design decisions made during such conversations.

Exchange of technical information across external and internal interfaces shall be planned and coordinated and shall be sufficient to ensure that the contributing organization has complete and up-to-date information for the development of a appropriate design.

Coordination in the design of piping, mechanical equipment, and electrical equipment shall be done between all design team engineers. An overlay drawing showing piping and the standby plant equipment shall be submitted to the AT&T Building Engineer responsible for the project for review and approval prior to release of documents for construction.

Electrical equipment shall be located in accordance with NEC Article 110.

All wire and cable connections shall be made using UL® listed circumferential-crimp (compression) type solid copper long-barrel connectors. Tooling and dies used shall be UL® listed. The crimping tool or dies shall emboss the crimped connection in such a way that it may be easily identified that the correct tool or die for the connector was used. Lugs #1/0 and larger shall be connected with a two bolt tongue.

Voltages on mechanical and supplemental equipment shall be coordinated between all design team engineers prior to release of documents. Voltage coordination of all equipment shall also take place during the equipment submittals. This process shall continue through the design and installation of the plant.

Design documents such as calculations and drawings shall be prepared in a manner which reflects actual and existing or proposed conditions, and which clearly identifies which state (actual or proposed) the document purports to represent.

Appropriate design input for design documents shall be identified. For example:

- Basic functions of each item of equipment, system, and component
- Performance requirements such as load, capacity, rating, and protective device coordination
- Codes and standards including the applicable issue and/or date
- Design conditions such as short-circuit current and system voltage characteristics.

2.03 Documentation and Studies

Design documents shall be retained in each location easily accessible to potential users and shall be maintained in a condition that is usable to those personnel. Calculations and studies shall be maintained in a three ring binder or electronic media. Drawings shall be kept in order by date in a protective sleeve or electronic media.

As a minimum, the following design documents shall be developed and maintained current for the location with a copy maintained at the location:

- Single-line electrical drawings showing connections to standby AC plant system. These should include one copy protected by plastic lamination and posted in an area nearby the standby AC plant.
- Riser diagram showing floor location of standby plant and loads
- Piping and instrumentation drawings (P&ID's) showing schematic representations of the standby plant mechanical systems. These drawings shall enable one to quickly determine the overall system arrangement, interconnection, and operation of the major items of mechanical equipment. The P&ID's shall include instruments for control and indication, all valves, the basic control loops, drains, vents, backflow prevention, fill and sampling system connections, and connections to interconnecting fluid systems for makeup, overflow, recirculation, etc.

- System description including operation of the system
- Integrated wiring diagrams which include all wiring from termination point to termination point.

The following will be useful if site-maintained, but are not required:

- Electrical load calculation or analysis for standby AC plant(s)
- Short-circuit calculation or analysis
- Voltage profile calculation defining voltage levels throughout the AC system served by the standby plant
- Protective device coordination calculation with graphic representation demonstrating system served by standby plant(s).

The above mentioned studies and calculations shall be developed in accordance with the AT&T Computer Aided Drafting Specification dated 1/96. Identification of devices in these reports shall coordinate with that on the one-line diagram. Dapper® and Captor® engineering software shall be used. The load calculations shall also include switchboard, motor control center and panelboard schedules for each building. These reports shall be kept on file and updated with each standby plant modification. The design engineer on each project will be responsible for obtaining the latest calculations and studies and updating them with the new project parameters in a computer generated format.

All design drawings shall be produced per AT&T Computer Aided Drafting Specification. The system used shall be AutoCad®. The Design Engineer on each project will be responsible for obtaining the latest “as- built” drawings and updating them with the new project parameters.

Changes to design documents shall be controlled in such a manner that the most recent document is:

- Available for use at each location
- Appropriately identified as the most recent issue through the use of a sequential numbering system
- Appropriately marked to indicate where the change occurred, what the change was, and the reason for the change.

In-process approval of the design modification shall be performed by the AT&T Building Engineer.

As-built documents shall be produced within three months after final acceptance of the system/modifications by AT&T.

Training, operating, and maintenance procedures and manufacturer's drawings shall be submitted to the AT&T location being modified prior to final acceptance of system/modifications.

On-site training in the maintenance and operation of newly installed or modified systems shall be provided.

2.04 Mounting

The system shall have a skid base manufactured from heavy steel channel utilizing welded construction. The base shall be of sufficient size and mass to prevent damaging linear vibration for the entire speed range from 0-125% of rated speed. Vibration isolators shall be used between the skid base and the concrete foundation (above 400 kW and units located on upper floors) or between the engine-generator and the skid base (400 kW and below) to eliminate the transmission of vibration. Isolators shall be spring type with fully adjustable snubbers and synthetic rubber snubber inserts. They shall be provided with leveling adjustment. The isolation system shall have an efficiency of 90%.

2.05 Grounding

The engine-generator set shall be provided with an equipment grounding conductor sized per NEC 250-95 in the conduit or raceway that contains the phase leads from the generator enclosure provided for lead termination of phase leads.

Termination may be made on a bus bar or a ground stud electrically bonded to the cabinet or directly to an unpainted surface of the cabinet interior with two-hole copper circumferential compression-type terminal lugs. The cabinet shall be electrically connected to the set frame by direct bolting of non-painted, non-treated surfaces, or by a bonding strap of cross sectional area equal to that of the grounding conductor specified above, or equivalent, to provide ground continuity between the entire set and the equipment grounding conductors.

The control cabinet, meter cabinet/panel, generator and engine shall be bonded to the diesel generator metallic sub-base and/or skid. Fuel day tanks (if equipped), engine set base/skid, control cabinets, lube oil reservoir, start battery racks, and rectifiers shall be bonded to the central office ground with a stranded copper grounding conductor sized per NEC 250-95.

In addition to the above requirements, equipment grounding shall also be in compliance with AT&T Practice 803-500-150.

Such bonds shall be made with bare, stranded, ribbon-type conductors, designed and installed to withstand diesel generator set vibrations. Circumferential compression crimp-type connectors shall be used.

The neutral of the generator output shall not be grounded except through its unswitched connection to the commercial supply's neutral.

All grounding requirements of the NEC shall be strictly adhered to.

Ground-fault protection shall be provided (per NEC) and as indicated in sections 8.01, 9.02, and 10.02.

2.06 Spare Parts

Spare parts requirements are included in Chapter 15, AC Standby Plant Test and Acceptance.

2.07 Performance Testing

NOTE:
Entire system shall be on-site tested, end-to-end, to insure proper function of the system and all components

Factory testing as well as on-site testing requirements are covered in Chapter 15, AC Standby Plant Test and Acceptance.

2.08 Documentation

Documentation requirements are included in Chapter 15, AC Standby Plant Test and Acceptance.

Diesel Engines and Required Support Systems

3

Contents

Diesel Engines and Required Support Systems

3

3.01 General

Diesel engines are the preferred standby AC plant prime mover, and this document is compiled with this in mind. Each diesel engine assembly used in the standby AC plant shall be equipped with, but not be limited to the following support systems:

- Engine starting system
- Engine fuel system
- Engine cooling system
- Engine lubrication system
- Engine air intake system
- Engine exhaust system
- Engine speed control system
- Engine protection and shutdown systems
- Local/remote alarm capability
- Engine keep-warm system.

The diesel engine shall be:

- Two or four stroke per cycle, multi-cylinder
- Full diesel

- Turbocharged or non-turbocharged
- Vee or in-line
- Liquid cooled with a unit-mounted or remote radiator. (A unit-mounted radiator is preferred)
- Equipped with positive crankcase ventilation where required by local codes
- Maximum rpm of 1800
- Equipped with electric start or air start
- Equipped with a fully balanced crankshaft.
- Equipped with an automatic lube oil makeup system.

Additional requirements of the engine package:

- The diesel engine shall comply with requirements of SAE 1349, ISO 8528, part 2, EGSA 101P, and IEEE Standard 446-1987 as it applies to standby application.
- Harmful torsional vibration stresses shall not occur from 0 to 125% of rated synchronous speed.
- The engine rating and application shall be for standby duty. (The engine will deliver continuously under normal varying load factors for the duration of any power outage.)
- The diesel engine shall be capable of being both sequentially and block loaded, while maintaining the transient response requirements identified in section 4.03.
- The diesel engine start system shall be provided as outlined in Chapter 5.
- All equipment, as assembled units, shall operate without objectionable vibration, in the opinion of the design engineer, throughout the operating range. The supplier shall assume all additional shop, shipping and transportation expense or cost at the job site to reduce excessive vibration attributable to unbalance of any machine.
- Certified engine horsepower curves shall be submitted showing the manufacturer's approval of the engine rating for standby power application based on actual testing of a similar package. Special ratings or “maximum” ratings will not be acceptable.
- All engine support systems (cooling, lubrication, fuel, etc.) requiring electrical power shall be served from an essential bus. Redundant equipment shall have service from two separate sources.
- The engine shall be equipped with a block heater “keep-warm” system to aid in engine starting. The system shall be engineered and installed in compliance with the manufacturer’s recommended practices, and shall be equipped with proper valving for maintenance and repair of the system.

3.02 Exhaust System

The exhaust system shall be designed so that the exhaust gas is carried away from the generator set and dispersed into the atmosphere in such a way as to prevent recirculation to the engine cooling air and building air intake points.

The exhaust piping shall be run as directly as possible with the exhaust silencer as close to the engine as practical.

The exhaust openings shall be located in such a manner as to prevent restrictions by outside structures or adverse weather conditions. Exhaust pipes shall have a rain shield where required.

The system must be sized to insure that the exhaust system back pressure does not exceed the maximum limitations specified by the engine manufacturer. A fitting shall be provided on the engine exhaust manifold to permit back pressure measurements.

The exhaust system for each diesel engine shall consist of an exhaust connector with flange connections at both ends, and a silencer. Turbo units may be equipped with a suitable chamfered fitting with stainless steel clamp. Exhaust piping shall comply to NFPA 37, as well as any applicable local codes.

Exhaust pipes passing directly through combustible roofs, walls, or partitions, shall be guarded with metal ventilated thimbles to protect the combustible material from excessive temperatures.

The exhaust silencer classification used shall be based on site conditions and shall comply with the Occupational, Safety and Health Administration Code (OSHA), and local code requirements for noise levels.

All piping, flanges and gaskets in the exhaust system shall be rated for 1100 ˚F. All hardware, (i.e. bolts, washers, nuts, lock washers, etc.) shall be case-hardened or stainless steel rated at 1100 ˚F. The silencer and piping system shall be installed so that its weight is not supported by the engine.

Vibration isolation for the exhaust system shall be provided by the use of flexible stainless steel, convoluted-bellow-type sections. The pipe outlet connections shall be compatible with standard ASA-125 lb. pipe flange. The piping shall terminate in a rain cap, tee, or ell pointing downwind from the prevailing wind.

The interior exhaust pipe and silencer shall be insulated to reduce the heat release into the engine room.

The exhaust system shall be guarded or blanketed to prevent personal injury. All guards shall be easily removed with standard tools.

Valved extensions through insulation shall be provided for condensate drains on silencers and piping. These drains shall be extended for easy access by maintenance personnel.

The exhaust gas emission shall comply with all Federal, State, and Local Emission Codes in force at the location. Information on the content and capacity of exhaust gases emitted by the proposed engine at 1/4, 1/2, 3/4, and full-load shall be included in shop drawings.

If the silencer is to be exposed to an outside environment, it shall be specified as stainless steel.

3.03 Governor

The engine speed and load control system for the engine generator set shall consist of a suitable electric, isochronous governor. Smaller standby plants (60 kW or smaller where frequency is not critical) may use a mechanical governor with no more than a 3% droop. The governor shall maintain governed speed at rated frequency regardless of the kW load, and shall meet the following requirements:

- Stability: 0.25% maximum frequency variation at any constant load from no-load to full-load
- Regulation: 0.25% maximum frequency deviation at steady-state operation
- Transient: refer to Section 4.03 for transient response requirements

A manual speed adjusting control shall be provided on the engine control panel and at the remote control panel, if so equipped.

A separate overspeed device, independent of the governor, shall be provided to prevent engine runaway in the event of any failure which may render the governor inoperable.

3.04 Lubrication

The engine driven lubricating oil pump shall have sufficient capacity to ensure adequate lubrication of main bearings, crank pins, camshaft bearings, valve gear, rocker arms, and all other wearing parts.

Provide an automatic lube oil make-up system (REN® or equivalent) to automatically maintain proper oil level in the engine crankcase. The system shall be equipped with a reserve oil supply tank sized for the engine provided, based on the manufacturer's recommendation for oil consumption based on a 72-hour engine run. Provide a shut-off valve between the tank and float valve and a shut-

off valve between the float valve and oil pan. All flexible hoses shall be of the braided stainless type.

The system shall incorporate full-flow duplex filtration with a spring loaded, pressure-calibrated bypass valve to allow lubrication to continue in the event of unusually high filter restriction. The bypass valve must be an integral part of the engine filters or filter housings. On units with a rating of greater than 1000 kW, a local alarm will be generated if bypass occurs.

Threaded spin-on or canister type full-flow lubricating oil filters, located for easy servicing, shall be provided.

A valved oil pan drain extended past the engine rail with braided stainless hose and reusable fittings shall be provided.

A prelube oil system shall be used only when recommended by the manufacturer to reduce engine wear and improve starting time.

A lubrication oil pressure sensor shall be provided to pre-alarm on low oil pressure or low oil level. The sensor shall shut down the engine if the oil pressure falls below a manufacturer-determined safe level.

The engine shall be provided with an initial fill (including oil makeup tank) of manufacturer's recommended multi-viscosity lubricating oil.

Alternator

4

Contents

Alternator

4

4.01 General

Each alternator used in the standby AC plant shall be designed in accordance with NEMA MG-1 and ANSI C50.10.

The alternator shall have a continuous standby rating at rated speed, 0.8 power factor lagging, 3-phase, 60 Hz. The alternator shall have 12 leads (for applications under 500 kW) brought out to provide required essential load voltages (e.g. 120/208 V AC and/or 277/480 V AC). It shall be wye connected. The leads shall be reluggable and the output terminals shall be properly designated to identify the phase sequence. The neutral shall remain insulated from ground.

The alternator shall be a brushless, revolving field type, with a permanent magnet (PMG) or series boost exciter, and shall be coupled directly to the flywheel through a flexible driving disc for positive alignment. The housing shall bolt directly to the engine flywheel housing, and shall have a single ball-bearing support for the rotor. Units over 100 kW shall have 300% excitation support for 10 seconds. Units 100 kW and less shall have standard excitation. It is understood that a permanent magnet unit may not be available on alternators of smaller plants.

The alternator rotor shall withstand an overspeed condition of 25% above synchronous speed.

The alternator shall be capable of continuously delivering its rated output at any power factor from 1.0 to 0.8 lagging, at ±5% of rated voltage, and at 60 Hz, at

ambient temperatures from -20˚F to 105˚F (120˚F rating may be required in locations experiencing extremely high ambient temperatures) at altitudes up to 1500 feet above sea level. Engine de-rating data shall be submitted for higher altitudes.

The alternator, exciter, and regulator combination shall be capable of withstanding, without damage, application of any 2 second short circuit (either 3-phase, line-to-line, or line-to-neutral) at the alternator's terminals during operation at rated load, power factor, frequency, and voltage. Sustained short-circuit current shall not be less than 300% of the rated current for any of the short-circuit conditions. Each alternator, exciter, and regulator combination shall be capable of providing enough short-circuit drive to activate the protective relays. Additionally, the alternator short-circuit capability shall meet those delineated in ANSI Standards C50.10 and NEMA MG-1.

The deviation factor of the alternator open-circuit terminal voltage shall be below 6%. This deviation factor is determined by IEEE test code No.503, Paragraphs 1.190 and 1.191 for synchronous machines.

The alternator shall be self-ventilated, drip-proof construction.

The alternator shall be capable of starting, loading, and running without exceeding the temperature rises specified by NEMA MG-1 for a continuous standby AC alternator.

Output shall not deviate from a standard sine wave form more than ±5%. Total Harmonic Distortion (THD) shall be less than 5% aggregate and less than 3% for any single harmonic. Telephone Influence Factor (TIF) shall be less than 50, based on the 1961 weighting curve.

Windings

The windings shall be copper, designed for good wave shape and low noise level. Amortisseur windings shall be integral with the rotor-coil support. The rotor shaft bearing shall be shielded type with provisions for easy servicing. The bearings shall be designed for a minimum L-10 service life.

The insulation for the stator windings, the rotor windings, and for the exciter windings shall be Class H or Class F. The basic impulse level (BIL) of the insulation shall be a minimum of 7.5 kV.

The insulation system shall be 100 percent epoxy resin, vacuum and pressure impregnated into the windings to give specific temperature and environmental performance.

Winding pitch shall be a consideration and shall be coordinated by the AT&T engineer if the unit is to be operated in parallel with an existing unit. The

generated harmonic analysis for 3rd, 5th, and 7th harmonics shall be submitted for each unit.

Damper windings shall be provided for unbalanced loading conditions and shall be integral with the rotor coil support.

Connections

There shall be permanently mounted buses in the alternator terminal box with alternator leads pre-connected. Buses shall have provisions for connection of alternator leads to the alternator breaker. A terminal box of adequate size shall be provided to terminate conduit and cables. For engine mounted control panels bussing is not required.

All wire and cable connections shall be made using UL® listed “circumferential” crimp (compression) type solid copper long-barrel connectors. Tooling and dies used shall be UL® listed. The crimping tool or dies shall emboss the crimped connection in such a way that it may be easily identified that the correct tool or die for the connector was used. Lugs #1/0 and larger shall be connected with a two bolt tongue.

4.02 Voltage Regulation

The alternator shall be equipped with a continuously acting excitation system, consisting of a brushless rotary-type main exciter and a static voltage regulator. The exciter shall be capable of remote control in the case of a remote mounted control cabinet, to raise and lower the voltage. The exciter shall be capable of providing sustained fault current in excess of rated output current for selective tripping of downstream circuit breakers. The excitation system shall have the capability of minimizing voltage disturbances and maintaining the alternator output voltage within acceptable limits during the starting and acceleration of loads (see section 4.03, Transient Response).

The voltage regulator shall be of the solid-state type construction, powered from the PMG pilot exciter to maintain voltage within ±2% of nominal voltage from no load to full load, including a 2.5% variation in frequency and the effects of overheating. The voltage regulator shall be mounted in the engine alternator control cabinet (when cabinet is remote) or in the alternator mounted control panel.

When a separate and remote engine control cabinet is provided, a motorized potentiometer shall be provided for remote voltage adjustment.

4.03 Transient Response

Severe motor starting conditions shall be specified by the Building Engineer or the Consulting Engineer.

Upon load removal (0.8 power factor, full-load), there shall be a maximum of 2.5 seconds voltage recovery time.

The engine alternator shall be capable of accepting a one-step application of 100% of nameplate kW load at 0.8 power factor and recover to steady state conditions without disruption of power to the load. When the alternator is sequentially loaded with rated full load in three equal steps, the transient voltage drop at any step shall be limited such that the alternator voltage is not less than 75% of nominal voltage, and frequency is not less than 91% of nominal. In addition, the voltage at the alternator shall recover to within 90% of nominal voltage and the frequency to within 97% of nominal within 4 seconds after each sequential load application, or 60% of each step time interval (whichever is less).

During recovery from transients caused by step-load increases, step-load decreases, or resulting from 100% load rejection, the speed of the diesel alternator set shall not reach the overspeed shutdown set point.

Start Systems

5

Contents

Start Systems

5

5.01 General

All start systems shall be capable of starting the standby AC system either manually or automatically (auto starting without local attention).

5.02 Battery Start Systems

Batteries

The required battery for start applications is the nickel cadmium type storage battery, 12 V, 24 V, or 32 V (32 V for retrofit only). Together with rack and connections, the battery system shall be provided adjacent to the engine-generator unit for starting the unit. Starting batteries provided with the standby plant shall be of sufficient capacity to maintain cranking speed at or above the threshold speed recommended by the engine manufacturer through a cranking period of 60 seconds and at the design low ambient temperature for the site. Terminal voltage shall be no less than 1.0 volts per cell at the end of the cranking cycle. This shall be based on the lowest ambient temperature expected in the engine room or module for that site. (Recommend base temperature for sizing shall be 32˚F for most applications.)

The battery shall be a NiCad wet cell type as provided by Saft America Inc., the single source provider of NiCad batteries for AT&T NCS. Battery type shall be

Nife SPH except for the largest applications, which may use model SBH, if necessary. Specifications shall include reference to AT&T National Contract #GPA3177. If NIFE batteries are not available because of an out of stock condition, ALCAD is an acceptable alternative vendor.

The batteries shall be dedicated to each engine. (Shared start batteries will not be allowed.)

Cell Container

The cell container shall be made of high impact translucent polypropylene with clearly marked maximum and minimum electrolyte levels. All cell data such as battery type, manufacturer's name and electrolyte level marks shall be displayed clearly. The lid shall be thermally welded onto the cell container to eliminate any risk of electrolyte leakage. Gluing or chemical bonding is not acceptable.

Operating Temperatures

The battery shall be suitable for continuous operation within the temperature range of 0˚F to +105˚F, and able to operate adequately with occasional temperature excursions of up to +140˚F.

Vent Caps

Vent caps shall be flame arresting bayonet-type with flip-top for ease of maintenance.

Electrolyte

The electrolyte shall be an aqueous solution of potassium hydroxide with a specific gravity of approximately 1.20. Lithium hydroxide may be used as an additive. There shall be no need to change the electrolyte over the life of the battery.

Terminals

The positive and negative terminals shall be of threaded type. The positive terminal shall be identified by a red plastic disc at the base of the terminal.

Intercell Connections

Rigid connections shall be manufactured of nickel plated, high quality copper bar.

Flexible intercell connections shall be made out of copper cable with appropriate insulation. Nickel plated lead, or nickel plated steel are not acceptable for flexible or rigid connections. All connections shall be tight, clean, and coated with manufacturer's recommended coating.

Charger

A static-type dual rate float/equalize charger (10 ampere capacity minimum) with automatic and manual charge control shall be furnished to service and float the battery and maintain it fully charged. The actual size of the charger to be provided will be a function of engine cranking requirements and continuous DC control requirements. The charger shall be capable of restoring the batteries to a fully-charged state within eight hours after a complete duty-cycle discharge.

The charger shall have the following options as a minimum:

- Ammeter
- Voltmeter
- DC output failure contacts for alarms
- Indicating lamps showing unit operation
- High Volts (red) Low Volts (red)
- Rectifier Fail (red)
- AC Fail (red)
- Float Mode Status (green)
- High Rate Status (amber)
- Fused AC input and DC output.

The charger enclosure shall be properly treated per NEMA 1 requirements with chemical resistant epoxy coating.

Cable

The battery cables shall be welding-type cable, size #00 or #0000 depending on cranking requirements, shall use compression connectors and shall have physical protection.

Stands

Each battery shall be mounted on a freestanding steel rack protected with an alkaline resistant epoxy paint, or a freestanding polyester fiberglass type rack. Each cell row shall be elevated in steps so that the minimum electrolyte level mark is clearly visible on all cells from the front of the battery. Battery stands shall be grounded and anchored per AT&T 800-610-155, Earthquake and Disaster Bracing for Central Office Equipment-General Equipment Requirements, 803-500-150, Grounding Practices - Telecommunication Systems Grounding In New Buildings Housing Digital and/or Analog Telecommunication Equipment, General Equipment Requirements, as well as Engineering Information and the National Electric Safety Code,

5.03 Air Start System

For systems larger than 1,500 kW, an air start system shall be considered. The air start system shall consist of a minimum of two tanks, one main tank and one standby tank, with a capacity of at least four 10-second starts per engine, as determined by the engine manufacturer. The tanks shall be pressure tested in accordance with ASME standards.

The system shall have an air dryer to prevent condensation in the lines.

The tanks and compressor shall be located as close as practical to the engine. Air lines shall be sized per manufacturer's requirements and shall be physically guarded in areas where they are subject to damage.

Valves shall be provided to isolate the main tank from the spare tank.

Compressors

One AC compressor and one DC compressor shall be provided to recharge the air start tanks.

- — The AC compressor shall be capable of recharging the tanks within 10 minutes after a total duty-cycle discharge.
- — The DC compressor shall be capable of recharging the tanks within 30 minutes after a total duty-cycle discharge.

The AC-operated compressor shall be connected to an essential AC distribution panel served by the engine-generator bus as well as by the commercial power source.

The DC-operated compressor shall be connected to the -48 volt central office battery. The AT&T Power Engineer must be notified as to the size and load of the DC compressor to be added to the DC plant.

The two compressors may be started together or alternated on each starting cycle.

5.04 Diesel-Hydraulic Start System

A diesel-hydraulic start system may be used as a replacement for existing defective starting systems on gas turbine generators. The system shall consist of a diesel engine driving a hydraulic pump, a turbine engine-mounted hydraulic motor with overrunning clutch, and all associated equipment. The diesel engine shall be a complete unit requiring liquid fuel and a 24 V DC control and start battery power supply. Hydraulic oil shall be supplied from the turbine generator lube oil system.

The diesel-hydraulic start system shall provide “black-start” capability. The system shall allow the diesel engine to start, accelerate to rated speed, and accept load without the aid of AC power.

The hydraulic motor shall be mounted on the accessory gear housing to provide positive starting power to the engine. An overrunning clutch shall disengage the motor when the turbine engine reaches a self-sustaining speed.

Fuel Systems

6

Contents

Fuel Systems

6

6.01 Fuel Requirements

The engine shall be suitable for commercial Grade No. 2 diesel oil conforming to American Society for Testing and Materials (ASTM) standard D975.

In northern climates and locations that can have occasionally cold weather (0˚F or less) No. 1 diesel oil is the preferred fuel. Verify with the engine manufacturer that this will cause no problems with the engine or the warranty.

NOTE:
The use of No. 1 diesel oil will derate the capacity of the diesel engine, therefore a larger engine may be necessary to provide the same kW output.

On all units primary (a fuel/water separator) filtration shall be provided before the fuel transfer pump in addition to the final fuel filter located immediately upstream of the injector pump, to insure a supply of clean fuel to the injection system.

The primary fuel filter shall include a replaceable element conveniently located for servicing. Single filters shall be used for 200 kW units and below. The system shall be valved for bypass of the filter. Units above 200 kW shall have duplex primary filters with valves to isolate one filter at a time.

Provide a fuel heater when the fuel tank or lines are above ground and subject to sub-freezing temperatures.

Provide a fuel cup in the fuel system on the pressure side of the high lift pump and on the vacuum side of the boost or injector pump to aid in engine starting. A small petcock, intended for fuel sampling, shall be installed in the fuel cup line.

6.02 Fuel Piping

The preferred material for fuel lines is socket-welded black iron schedule 40 pipe or other material conforming to AT&T 760-220-164.

CAUTION:
Low-temperature soldered fittings shall not be allowed. All fuel piping shall conform to provisions of NFPA 30 and 37.

Stainless steel wire-reinforced flexible connections shall be used to connect fuel piping to the engine and other transition points. All flexible fuel lines shall be at least 12 inches in length and shall not be painted.

NOTE:
For further details on fuel storage and delivery refer to AT&T 760-220-164, Storage Systems, Combustible Liquid Fuels - Design, Installation, and Maintenance.

6.03 Fuel Pumping

When a day tank is not provided, the engine shall be equipped with a high-lift fuel pump, engine-driven, capable of lifting fuel against a 20-foot suction head. A rotary or lever operated, self-priming hand pump shall also be provided on the engine for the purpose of priming the engine fuel system in case of loss of prime. When a manual hand pump is provided it shall be a Gorman Rupp H03/4A4-H or equivalent.

6.04 Fuel Storage Tanks Above and Below Ground

For fuel storage standards refer to AT&T 760-220-164, Storage Systems, Combustible Liquid Fuels Design, Installation, and Maintenance and AT&T 760-220-165, Underground Storage Tanks for Combustible and Flammable Liquid Fuels - Removal and Abandonment.

6.05 Day Tanks

When designing the fuel oil delivery system it may be necessary to utilize day tanks. Listed below are conditions which may require the addition of a day tank to the fuel delivery system.

It is required that all engines be equipped with an engine-driven fuel pump capable of a 20-foot vertical lift, but because of excessively long pipe runs from the primary tank, the vertical lift of the engine fuel pump may be exceeded. If the engineered lift of the fuel system from the main tank to the engine exceeds 18 feet vertical lift, it is recommended that a day tank be utilized in the system.

When the engine injectors are below the level of the main fuel tank, a day tank must be utilized to remove the hydrostatic head on the injectors. This is a potentially dangerous situation and should be avoided if possible.

In the event use of a day tank is necessary, AT&T 760-220-164, Storage Systems - Combustible Liquid Fuels - Design, Installation and Maintenance will provide standards for such installations.

6.06 Fuel and Day Tank Alarms

Refer to Chapters 8, 9, and 10 of this practice for alarms required for fuel and day tank systems.

NOTE:
For more detailed information on day tank engineering and technical requirements, refer to AT&T 760-220-164, Storage System, Combustible Liquid Fuels - Design, Installation and Maintenance.

Cooling Systems

7

Contents

Cooling System

7

7.01 General

The engine cooling system must ensure that the engine manufacturer's maximum engine water outlet temperature is not exceeded when the generator set is operating at 100% load, with a 50% ethylene glycol or polypropylene glycol/water solution, at 105˚F ambient and at rated elevation for the installation.

A 120˚F ambient temperature rating for the radiator should be specified when necessary, (i.e. in the south and southwest).

NOTE:
Ambient is defined as the temperature of the cooling air as it enters the radiator.

Care should be taken in the design of the generator air flow system to insure that recirculation of the cooling air does not occur.

7.02 Engine Mounted Radiators

A radiator system mounted on the generator set is the preferred configuration. This configuration is more dependable and has few of the disadvantages of remote mounted units, such as confined space, additional piping, pumps, heat exchanger, and electric cooling fans.

The unit-mounted radiator shall be antifreeze protected and the cooling system shall consist of the following:

- Engine-driven water circulating pump
- Water temperature regulating valves
- Unit-mounted radiator with blower fan, equipped with more than 1 belt
- Radiator air discharge duct adapter
- Necessary pipe fittings and lagging
- Necessary valves and drain line to provide for easy access and maintenance
- Low coolant level pre-alarm and shutdown devices
- OSHA guards on all belts, pulleys and fan.

The engine-driven water circulating pump and cooling system shall be of adequate capacity to limit the temperature rise of the water through the engine to the engine manufacturer's specified limits when the diesel generator set is delivering full rated load at the specified ambient conditions and altitude.

The engine cooling water system shall be equipped with an engine-mounted, thermostatically controlled, AC electric immersion jacket water heater. Heater shall be sized per manufacturer's guidelines and supplied to match proper building voltage. Provide valves on the supply and discharge connections to the jacket water heater for servicing.

Provide a valved radiator drain with pipe extension and threaded connection at a location easily accessible to maintenance personnel.

All coolant hoses shall be of braided stainless or reinforced silicone rubber and shall not collapse under the most severe suction conditions. Coolant hoses shall not be painted. The radiator pressure cap shall meet the engine manufacturer's specifications for pressure. The temperature sensor shall be located in direct flow of coolant at engine jacket water discharge area. The cooling system shall be equipped with an internal sensing thermostatic valve to allow rapid engine warm up and regulated coolant flow. The set shall be equipped with a coolant recovery system that will prevent coolant overflow and spillage. The system should have a capacity of 20% of the total coolant capacity of the unit. When installed, the engine cooling system shall contain adequate ethylene glycol or polypropylene glycol antifreeze protection or inhibitor (Nalcool®) as specified by the consulting engineer.

7.03 Remote Radiators

When all engine-mounted radiator possibilities have been eliminated and site conditions warrant, the engine may be furnished with a remote radiator cooling system having sufficient capacity for cooling the engine-generator set when delivering full rated load at the specified ambient temperature and altitude. Each engine shall have its own dedicated system (i.e. radiator, pumps, piping, controls). The remote radiator unit shall be supplied with a radiator auxiliary pump (if required), and motor starter for the fan motor. When radiators are located on upper floors a hot well tank or heat exchanger shall be used to help reduce the hydraulic head on the engine.

7.04 Heat Exchanger

A heat exchanger may be used to aid the cooling system and to help reduce the hydraulic head on the engine when remote radiators are used. Heat exchangers should be sized to accommodate a heat rejection rate approximately 15 percent greater than the established engine heat rejection.

The heat exchanger should accommodate raw water temperature and flow adequate to cool the engine when operating at maximum anticipated load, with the temperature differential between jacket water in and out of the heat exchanger not exceeding approximately 20˚F (11˚C) and not less than 10˚F (6˚C). Temperature of the coolant entering the engine should not be below the recommended 180˚F (82˚C). Tubes and flexible fittings shall be sized to handle water head pressure.

Heat exchangers should always be located at a lower level than the coolant level in the surge tank. If possible the exchanger should be located several feet lower than the surge tank. The surge or expansion tank must be the highest level in the circuit, and must be located downstream from the heat exchanger. A heat exchanger system will require a surge tank in the jacket coolant circuit. When possible the heat exchanger should be floor mounted near the engine in a location free of vibration. Flexible fittings shall be used to connect the exchanger to the coolant circuit.

Engine-Generator Mounted Control Panel

8

Contents

Engine-Generator Mounted Control Panel

8

8.01 Engine Mounted Control Panel

An engine mounted control panel shall be used when possible for engines of 250 kW and less. If site conditions or set location warrant the use of a floor mounted control cabinet, refer to Chapter 9.

The engine control panel shall be wired-relay logic utilizing 10 ampere plug-in relays with pilot indication. Timers shall be 2% repeatable, and solid-state.

The panel shall meet the requirements listed below as well as those of the engine-generator manufacturer.

Analog control cabinet instruments shall have a maximum of 2% deviation from true with dial size of 2-1/2" minimum. All meters and gauges shall be clearly marked on their face with normal engine operating parameters. The control cabinet shall contain the following as a minimum:

- Operation selector switch (automatic, off/reset, manual, test) See details below
- Voltmeter (with appropriate scale)
- 7-position voltmeter selector switch
- Ammeter (with appropriate scale)
- 4-position ammeter selector switch
- Dial type frequency meter, 55-65 Hz

- Kilowatt meter (with appropriate scale)
- Elapsed time meter
- Frequency Control (in accordance with governor control below)
- Voltage Adjustment (in accordance with voltage control below)
- Emergency stop push-button (Refer to section 11.04)
- Cabinet heater with thermostat (for outside modules to prevent condensation)
- Alarm lamp test push-button
- Fuel pressure gauge (may be installed on the engine)
- DC Ammeter (for engines equipped with start battery generator)
- Power factor meter (only when unit is to be operated in parallel)
- Engine instrumentation
- Engine outlet coolant temperature
- Engine lube oil pressure.
- DC lighting for the panel (twist-timer activated; on outside modules only).

The engine shall shut down on occurrence of the following abnormal conditions:

- Overspeed
- High coolant temperature
- Overcrank
- Low engine coolant level*
- Low lube oil pressure
- Under-frequency
- Emergency stop
- Overvoltage.

* The low engine coolant level shutdown shall occur at a coolant level at which, should the engine start, coolant quantity would not be sufficient to allow proper operation of the coolant temperature sensing device.

Audible and visual indication of each condition will occur at the control panel.

Any shutdown will result in the following:

- Stop cranking of the engine or shut the set down
- Shunt trip the set circuit breaker

- Open up the path to the starting circuit
- Establish alarm circuits until control panel is manually reset
- Appropriate visual indicator shall be illuminated on the front panel.

All shut down devices shall be clearly labeled on the engine-generator set.

Breakers

Generator (less than 250 kW) breakers shall be molded-case, solid-state trip, rated for the appropriate voltage and symmetrical interrupting capacity. Provide adjustable solid-state/digital long-time-delay (LTD), short-time-delay (STD), ground (GRD) and instantaneous (INST.) trip elements with each breaker. Pickup/delay adjustments and ranges associated with these trips will be as follows: LTD pickup - (0.5 - 1.0) x sensor, four time delay bands; STD pickup - (2 - 9) x LTD pickup, three time bands (0.1 - 0.35) second with I^2t ramp; GRD pickup - (0.2 - 0.6) x sensor, three time bands (0.1 - 0.35) second with I^2t ramp; INST. pickup - (2 - 10) x sensor. Ground trip may be omitted when ground alarm is provided by a time overcurrent relay across the generator neutral current transformer. Provide trip indicators to show “overload”, “short-circuit” and “ground-fault” trip.

Selector Switch

The panel shall be equipped with a manual four-position selector switch, an alarm annunciator for alarms, and an audible alarm signal. (*The devices to accomplish functions below may be installed on or part of the automatic transfer switch or located in the engine control cabinet*). Position designations and functions shall be as follows:

- **Automatic**: In this position, the system shall be capable of receiving a power failure signal from voltage relays at the service entrance or in the transfer switch and then starting the engine-generator, and transferring the load from normal to standby. Upon return of commercial power, it shall be capable of re-transferring the load back to commercial power and shutting down the engine-generator, with the engine-generator available for the next power failure. The engine shall shut down after a cool down period of 5 minutes (adjustable) at full speed. All of the above shall be accomplished without personnel intervention. A green lamp shall indicate when the selector switch is in the “automatic” position.
- **Off/Reset**: The engine shall not be capable of starting and/or running. If the engine was shut down due to the operation of a protective device, the shutdown lockout circuit shall be reset when the switch is moved to this position. Any other type of malfunction will require clearing the cause of the malfunction before resetting the shutdown lockout. The “not in automatic”

lamp shall be lighted to indicate an off normal condition. If the engine is running when the switch is moved to this position, it shall immediately shut down.

- **Manual**: Initiates starting and running of the engine-generator without transferring the load. The manual mode shall bypass, and in no way be dependent upon an electronic or microprocessor based circuit in the control arrangement. All alarms and shutdowns shall remain operative in the manual mode.
- **Test**: This position shall be used to simulate a power failure condition. Closure of the power failure relay shall simulate a loss of power, start the engine, and signal a transfer of load to the engine. After a predetermined time, the engine control circuit shall signal a transfer of load back to commercial power, allow the engine to run at no load for a period of 5 minutes and then shut down the set.

Overlapping contacts shall be provided in control switches to allow switching positions of control switches between “Manual” and “Test” for smooth operation of system.

Auxiliary Equipment Controls

Auxiliary engine run contacts shall be provided for control of auxiliary systems required for the operation of the engine such as ventilation, fuel system, electric start, regulator and governor, pre-lube pumps, radiator fans, water pump, etc. Provide DC control battery contacts for operation of intake and exhaust air dampers. Provide a minimum of four (4) single-pole double-throw (SPDT) contacts.

The engine cool-down circuitry shall have a time delay function, adjustable 0-15 minutes, set at 5 minutes at full speed. Cool-down function shall automatically be bypassed for malfunction and manual or emergency shutdown.

Voltage and Speed Control

Provide a speed control on the front of the control cabinet (±10%) and a motorized “pot” for smooth manual speed control (80 second full travel) shall also be provided for all remote-mounted control cabinets.

A voltage regulator shall be provided. Provide a remote raise-lower control on the front door (±10%) and a motorized “pot” for smooth manual voltage control (80 second full travel) on remote-mounted cabinets. The “raise-lower” control shall be connected to operate only when engine is running.

Status and Alarm Annunciator

The status and alarm annunciator shall have the following alarm and status annunciators as a minimum:

Low Oil Pressure	Prealarm	Amber
Low Oil Pressure	Shut down	Red
High Water Temperature	Prealarm	Amber
High Water Temperature	Shut down	Red
Overcrank	Shut down	Red
Overspeed	Shut down	Red
Circuit Breaker Open	Alarm	Red
Controls not in Automatic	Alarm	Flashing Red
Engine Running	Status	White
Fuel in Containment Basin (day tank)*	Alarm	Amber
Over Voltage	Shut down	Red
Generator Bus Under Frequency Failure	Shut down	Red
Emergency Stop	Shut down	Red
Low Coolant Level - Radiator **	Prealarm	Amber
Low Coolant Level - Radiator **	Shut down	Red
Low Coolant Temperature	Alarm	Amber

* When equipped with a day tank.

** Low coolant level prealarm shall be activated only when coolant level is below any level attainable by normal expansion/contraction of the coolant due to temperature variation between ambient and operating temperatures. The low engine coolant level shutdown shall occur at a coolant level at which, should the engine start, coolant quantity would not be sufficient to allow proper operation of the coolant temperature sensing device.

The control circuit shall contain 24 volt (or 12 volt) alarm lamps energized by the engine protective devices. A 24 volt (or 12 volt) lamp (engine overcrank) shall be energized if the engine has not started by the end of the final cranking period.

All visual alarm indicators (not part of standard engine control) shall be LED type 24 V DC (or 12 V DC for 200 kW and less units), and labeled with appropriate identification as approved by the Building Engineer and OSWF.

All alarms shall be cabled to a terminal strip and mounted in a NEMA 1 enclosure. All alarm identification is to be stenciled on the terminal strip for ease of cross-connection to the building/remote alarm system(s). A drawing of the terminal strip and mounting information shall be furnished by the supplier to the owner's representative. It is the AT&T Building Engineer's responsibility to insure that all alarms are extended and connected to the office and remote alarm system per requirements in AT&T 154-103-101, Alarms Standards Manual.

In addition to lamps and dry SPDT contacts for the alarms listed above and in section 11.03, Alarms, the following options shall be provided:

- Alarm Horn (with alarm silence push-button equipped with automatic audible restoration)
- Automatic start control with adjustable cycle cranking
- Lamp Test
- Contacts to control auxiliary functions, (i.e., dampers, fans, etc. - a minimum of 4 sets of SPDT)
- Contacts for remote start (unmanned buildings)
- DC panel lighting with automatic reset.

Engine Cranking Sequence

The engine cranking sequence shall automatically initiate on receiving a signal from voltage relays at the service entrance or in the transfer switch(es). The engine shall start and accept the applicable load when the commercial service nominal voltage decays to 88%. Power shall be restored to the commercial service when all phases are at 95% of nominal voltage and 98% percent of rated frequency for a period of time to be determined by the system designer and controlled by an adjustable relay. Provide a cycle cranking timer to crank engine for 10 seconds with a ten second interrupt between cranking cycles until engine starts. If the engine fails to start within four cycles of 10-second cranking, the cranking shall discontinue and an overcrank alarm condition shall be signaled.

The engine shall not be capable of restart after a cranking period has been completed until the automatic start/stop switch has been reset by turning the switch to the off/reset position.

Floor Mounted Control Panel

9

Contents

Floor Mounted Control Panel

9

9.01 General Requirements

A floor mounted control cabinet shall be used for engines of 250 kW and larger where site conditions warrant, or if engine location warrants. Refer to Chapter 10 for paralleling switchgear.

All meters shall be analog, with an accuracy of 2%. The meters shall be rated for transformer service, with scales to match current and potential transformers. Current and potential transformer ratios shall be selected and coordinated to cause meter readings in the top 50% of the meter scale for nominal and rated values for ammeters, voltmeters, and kW meters.

All electromagnetic control relays shall be suitable and adequately rated for their intended service in the control system. Relays used in low-voltage, low-current DC control circuits shall have gold-flashed or bifurcated contacts to insure positive contact and shall be rated at 10 amperes minimum. All relays for control-circuit duty shall be plug-in type with retaining clips, transparent plastic covers and pilot or LED indication when operated.

Solid-state circuitry shall meet or exceed the Transient Over Voltage Withstand Test per NEMA ICSI-109 and the Surge Withstand Capability Tests (SWC) per IEEE 472-1974 (ANSI C37.90A-1974). In addition, where UL® Standards exist for components, devices, and/or assemblies, such standards shall apply.

9.02 Construction

The control panel shall be freestanding, front and rear accessible, with a voltage and fault current rating corresponding with the generators and AC distribution system.

The control panel shall be constructed with welded or bolted steel channel for a self-supporting frame. It shall be totally enclosed on the sides, top, and rear with 14 gauge (minimum) steel panels fastened to a heavy channel frame. Enclosing panels shall not be larger than 36" wide x 48" high with rolled edges. The entire switchboard shall be primed and painted with two coats of gray enamel or lacquer inside and outside. The board shall be mounted on a concrete pad by the installer in accordance with local requirements as well as requirements for the seismic zone in which the installation is located. The rear of the switchboard shall be hinged, and have full height doors with three point catch and lock. Doors over 24" wide shall be bi-parting. Insulated cable supports shall be provided to completely support conductors independent of breaker terminals.

Bussing

The bussing shall be made of 98%-conductivity copper with silver plated joints. The bussing shall be insulated and braced to withstand the short-circuit current available at the board at rated voltage. Overlap on all joints shall provide 100% of bus capacity. The bus joint connections shall be interleaved where multiple busses per run are required. Each joint is to have a minimum of two bolts per joint with flat and lock washers.

The phases shall be insulated from ground with a minimum 1" air space. Phase buses shall be insulated from other phases by a minimum 2" air space. The neutral bus shall be full-capacity and extend the entire length of the control board. The neutral bus shall penetrate the steel cubicle barriers with phase busses to prevent heating of barrier. A 1/4” X 3" copper ground bus shall extend the full length of the switchboard, bonded to each cubicle. The main bussing shall be constructed in a manner to allow for future extensions at end cubicles.

Breakers

Main generator breakers larger than 1600 amperes shall be power (air), draw-out solid-state-trip, rated for the appropriate voltage and symmetrical interrupting capacity. Provide adjustable solid-state/digital long-time-delay (LTD), short-time-delay (STD) and ground (GRD) trip elements with each breaker. Pickup/delay adjustments and ranges associated with these trips will be as follows: LTD pickup - (0.5 - 1.1) x sensor, four time delay bands; STD pickup - (2 - 9) x LTD pickup, three time bands (0.1 - 0.35) second with I^2t ramp; GRD pickup - (0.2 - 0.6) x

sensor, three time bands (0.1 - 0.35) second with I^2t ramp; Ground trip may be omitted when ground alarm is provided by a time overcurrent relay across the generator neutral current transformer. Provide trip indicators to show “overload” or “short-circuit” trips. Breakers are to have a stored energy (5 cycle maximum) closing and tripping mechanism.

Main generator breakers smaller than 1600 amperes shall be insulated case, draw-out, solid-state-trip rated for the appropriate voltage and symmetrical interrupting capacity. Provide adjustable solid-state/digital long-time-delay (LTD), short-time-delay (STD), ground (GRD) and high fixed instantaneous (INST.) over-ride trip elements with each breaker. Pickup/delay adjustments and ranges associated with these trips will be as follows: LTD pickup - (0.5 - 1.1) x sensor, four time delay bands; STD pickup - (2 - 9) x LTD pickup, three time bands (0.1 - 0.35) second with I^2t ramp; GRD pickup - (0.2 - 0.6) x sensor, three time bands (0.1 - 0.35) second with I^2t ramp; INST. - non-adjustable high fixed pickup to minimize the possibility of false trip due to INST. trip function. Ground trip may be omitted when ground alarm is provided by a time overcurrent relay across the generator neutral current transformer. Provide trip indicators to show “overload”, “short circuit” and “ground fault” trip. Breakers shall have a stored energy closing and tripping mechanism.

All motorized breakers shall utilize 48 V DC motors to charge stored energy springs and 48 V DC electric trip latches to open and close the breaker. Concurrence of the AT&T Power Engineer shall be obtained before imposing these loads on the -48 V power plant. The motor operated breakers shall be capable of manual tripping and capable of complete manual operation. An override switch for disabling control inputs from a remote location shall be provided at the breaker. Also provide an open/close control switch with pilot lights indicating breaker position for all motor operated breakers.

Control Power

Fused control power transformers shall be sized to supply all AC loads simultaneously. It is recommended that control power be supplied from the -48 volt Central Office battery plant. Provision of control power in that case should be coordinated with the AT&T Power Engineer.

The status of all control fuses shall be indicated on the front of the panel and the status circuitry shall have contacts for remote indication.

Status Indicating Lights

All status indicating lights shall be long-life DC LED type with colored lens cap.

9.03 Engine Start Panel

The engine start panel shall include the following as a minimum.

The engine starting control logic shall provide electrically isolated contacts for electronic governor control, electric fuel control, and common shutdown alarm annunciation.

The design drawings shall include the starting control logic for control of the engine generator. It is recommended that the control logic be 48 V DC supplied by the Central Office battery plant, with concurrence of the AT&T Power Engineer obtained before adding this to the load.

Engine cranking shall automatically initiate on receiving a signal from the voltage relays located at the service entrance or in the transfer switch(es). The engine shall start and accept the applicable load when the commercial service nominal voltage decays to 88%. Power shall be restored to the commercial service when all phases are at 95% of nominal voltage and 98% of rated frequency. Provide a cycle cranking timer to crank the engine for 10 seconds and interrupt cranking for 10 seconds until the engine starts. If the engine fails to start within four cycles of 10-second cranking, the cranking shall discontinue and an alarm condition is signaled (overcrank).

The engine shall not be capable of restart after a cranking period has been completed until the automatic start/stop switch has been reset by turning the switch to the off/reset position.

An idle cool-down timer (0-600 seconds) shall be provided.

The engine shall shut down on occurrence of the following abnormal conditions:

- Overspeed
- High coolant temperature
- Overcrank
- Low coolant level*
- High lube oil pressure
- Low oil pressure
- Under frequency
- Emergency stop
- Overvoltage.

* The low engine coolant level shutdown shall occur at a coolant level at which, should the engine start, coolant quantity would not be sufficient to allow proper operation of the coolant temperature sensing device.

To implement the shutdown condition, stop cranking of the engine or initiate the shutdown sequence, shunt trip the set circuit breaker, open up the path to the starting circuit, and establish alarm circuits until control panel is manually reset. All shutdown devices shall be clearly labeled on the engine-generator set.

Selector Switch

The panel shall be equipped with a manual four position selector switch, alarm annunciator for alarms, and audible alarm signal.

- **Automatic**: In this position, the system shall be capable of receiving a power failure signal from voltage relays at the service entrance or in the transfer switch and then starting the engine-generator, and transferring the load from normal to standby. Upon return of commercial power, it shall be capable of re-transferring the load back to commercial power and shutting down the engine-generator, with the engine-generator available for the next power failure. The engine shall shut down after a cool-down period of 5 minutes (adjustable) at full speed. All of the above shall be accomplished without personnel intervention. A green lamp shall indicate when the selector switch is in the “automatic” position.
- **Off/Reset**: The engine shall not be capable of starting and/or running. If the engine was shut down due to the operation of a protective device, the shut down lockout circuit shall be reset when the switch is moved to this position. Any other type of malfunction will require clearing the cause of the malfunction before resetting the shutdown lockout. The “not in automatic” lamp shall be lighted to indicate an off-normal condition. If the engine is running when the switch is moved to this position, it shall immediately initiate the shutdown sequence.
- **Manual**: Initiates starting of the engine-generator and running without transferring the load. The manual mode shall bypass, and in no way be dependent upon an electronic or microprocessor based circuit in the control arrangement. All alarms and shutdowns shall remain operative in the manual mode.
- **Test**: This position shall be used to simulate a power failure condition. Closure of the power failure relay shall simulate a loss of power, start the engine, and signal a transfer of load to the engine. After a predetermined time, the engine control circuit shall signal a transfer of load back to commercial power and allow the engine to run at no load for a period of 5 minutes and then shut down the set.

Overlapping contacts shall be provided in control switches to allow switching positions of control switches between “Manual” and “Test” for smooth operation of system.

Auxiliary Equipment Controls

Auxiliary engine run contacts shall be provided for control of auxiliary systems required for operation of the engine, such as ventilation, fuel system, electric start, regulator, governor, pre-lube pumps, radiator fans, water pump, etc. Provide normally-closed DC control battery contacts for operation of intake and exhaust air dampers. Provide a minimum of four (4) SPDT contacts.

The control cubicle shall have emergency stop switch (guarded red operator) mounted on it with plastic flip-up cap. Refer to section 11.04 for requirements on Emergency Stop Switches.

The engine cool-down circuitry shall have a time delay function, adjustable 0-15 minutes, set at 5 minutes at full speed. The cool-down function shall be automatically bypassed for malfunction and manual shutdown.

A manual reset lockout relay shall be provided to trip the generator and shut down the engine (when specified) for differential, reverse power, over/under voltage, and over/under frequency failures.

A status and alarm annunciator shall be provided on each control panel with alarm indications as determined by AT&T OSWF and Building Engineering. Alarms to be remotely surveilled shall be installed in accordance with the AT&T 154-103-101, the AT&T Alarm Standards Manual,

All metering shall be real-time, connected to PT's, CT's, and transducers.

Control Instruments and Devices

Control board instruments shall have ±2% accuracy with 4-1/2” dial. The following instruments shall be provided as a minimum:

- Three phase CT test block with shorting CT contacts and insertion tool mounted on front of the control panel in door.
- Voltmeter (with appropriate scale)
- 7-position voltmeter selector switch (positions to indicate phase/neutral and phase/phase voltage for each phase)
- Ammeter (with appropriate scale)
- 4-position ammeter selector switch

- Dial type frequency meter, 55-65 Hz
- Kilowatt meter (with appropriate scale)
- Elapsed time meter
- Power factor meter, 0.5 lag to 0.5 lead (on sets 200 kW and higher)
- Frequency Control (in accordance with governor control below)
- Voltage Adjustment (in accordance with voltage control below)
- Emergency stop push-button (Refer to section 11.04)
- Alarm lamp test push-button
- Fuel Pressure Gauge (may be installed on the engine)
- DC ammeter (for engines equipped with start battery generator)
- Engine instrumentation
- Engine outlet coolant temperature
- Engine lube oil pressure
- A fuel contamination indicator shall be mounted on the front panel to indicate the presence of contaminants such as water.
- Generator breaker shall be furnished with adjustable solid-state/digital ground fault detection having a pickup range of (0.2 - 0.6) x sensor, three time bands (0.1 - 0.35) second and I^2t ramp. This protection for the generator may be omitted when ground fault alarm between (100 - 1200) amps is provided by a time overcurrent relay across the generator neutral current transformer.
- A generator breaker manual control switch shall be provided.
- An under/over voltage relay shall be provided. The relay device shall be single phase sensing, phase-to-phase, AC 60 Hz; adjustable set point 75% - 100%; NC contact (closed without power applied); adjustable time delay; 48 V DC or 100/120 V AC power supply, one internally operated target, draw-out mounted.
- A power directional relay shall be provided on units to be used in a paralelling application. The relay device shall be single phase, line-to-line voltage sensing (or as required); one internal operated target; draw-out mounted.
- An over/under frequency relay shall be provided. The relay device shall be single phase sensing, one NO relay, adjustable inverse time delay, one internal operated target, two set points, draw-out mounted.
- A red annunciator light shall be provided to flash whenever the generator set mode selector is in any position other than automatic.

- It is recommended that, unless 120 V control power has been previously provided, control power for engine logic be derived from separate 48-volt direct wiring in each engine control panel, powered by the Central Office battery plant with concurrence of the AT&T Power Engineer.

9.04 Miscellaneous Equipment and Features

Provide for each ammeter a test block and necessary test plugs, switch current jacks, and power supply accessible in rear of control board for portable recording ammeters. All CT leads shall be terminated in “shorting type” terminals.

All timer required functions shall be solid-state, with timing lights, adjustable dials, and 0.2% repeatable. Battery voltage shall be used to drive all timers.

Mount all meters, switches and control devices on hinged doors. Provide 1/4” thick plexiglass barrier on rear of door to protect any exposed live connections.

Status and Alarm Annunciator

Furnish alarms with annunciators with manual resetting relays and common alarm horn, reset switch, and horn silence switch. The alarm horn shall be rated 95 dB at 4 feet. The “first in” alarm lamp should flash. Subsequent alarms should resound audible signals. Provide a lamp test switch. Alarm lights shall remain lighted until the alarm condition is corrected and controls are manually reset. All controls and alarms should operate on station battery voltage. Provide 1 SPDT auxiliary contact for each alarm indication, for connection to remote alarm indicators.

All visual alarm indicators shall be LED DC-powered type, and shall be labeled with appropriate identification.

The status and alarm annunciator shall have the following alarm and status annunciators as a minimum:

Low Oil Pressure	Prealarm	Amber
Low Oil Pressure	Shut down	Red
High Coolant Temperature	Prealarm	Amber
High Coolant Temperature	Shut down	Red
Overcrank	Shut down	Red

Low Oil Pressure	Prealarm	Amber
Overspeed	Shut down	Red
Circuit Breaker Open	Alarm	Red
Controls not in Automatic	Alarm	Flashing Red
Engine Running	Status	White
Low Fuel Day tank	Alarm	Amber
High Fuel Day tank	Alarm	Amber
Fuel in Containment Basin (day tank) *	Alarm	Amber
Over Voltage	Shut down	Red
Generator Bus Under Frequency Failure	Shut down	Red
Emergency Stop	Alarm	Red
Low Coolant Level - Radiator**	Prealarm	Amber
Low Coolant Level - Radiator**	Shutdown	Red
Low Coolant Temperature	Alarm	Amber
Battery Charger - Low DC /Output Failure ***	Alarm	Amber
High Start Air Pressure ***	Alarm	Red
Low Start Air Pressure ***	Alarm	Red

* When equipped with a day tank.

** Low coolant level prealarm shall be activated only when coolant level is below any level attainable by normal expansion/contraction of the coolant due to temperature variation between ambient and operating temperatures. The low engine coolant level shutdown shall occur at a coolant level at which, should the engine start, coolant quantity would not be sufficient to allow proper operation of the coolant temperature sensing device.

***To be used with the appropriate start system.

Control Wiring

All control wiring shall be color coded and laced in bundles of 20 wires maximum. All low-voltage electronic control circuit wiring must be shielded, and these shields must be properly grounded. Each wire shall be identified with permanent vinyl wire markers at every break (i.e. terminal strip, relay, control device, etc.). All

terminals shall be permanently identified with vinyl or bakelite markers. All devices shall be identified with bakelite nameplates located in a readable location and fastened with screws.

Wiring should be color coded as follows:

- White - CT leads
- Blue - DC control
- Red - AC control
- Yellow - source other than derived above
- Green - ground.

Labeling

Each switch and/or circuit breaker shall be provided with a bakelite nameplate, white with red core, engraved with 3/8” high letters to indicate usage and mounted with two screws. Master nameplates shall also be provided.

9.05 Instrument Transformers

Instrument transformers shall be provided for complete and proper operation of all instruments.

Current Transformers

Current transformers shall be bus-bar type with bolted connections or window type and have the following characteristics:

- BIL 10 kV
- Insulation Class 600 V
- Accuracy Class C-100 Minimum
- Ratio As required

Potential Transformers

Potential transformers shall have the following characteristics:

- Fused on primary incoming line with indicating current-limiting fuses

- Rated 600 volts and 10 kV
- Thermal volt ampere rating: 1000 (minimum) at 30˚C temperature rise above a 55˚C ambient temperature
- Secondary voltage as required for the devices to be connected
- Accuracy class for transformer: 0.3 at W, X, 0.6 at Y
- Provide six each spare PT primary fuses to be turned over to AT&T On-Site Work Force (OSWF).

Fuses and Wiring Connections

AC and control fuses shall be plug-in, neon indicating type, mounted in a relay compartment and labeled. DC control fuses shall be neon indicating, DC-rated firing circuit (48 V DC). Fuses shall be mounted on the inside of control cubicles in easily accessible and visible locations. All control fuses shall be equipped with visual alarm indications on the front of the control panel as well as audible alarm indications.

All wiring connections shall be made with compression, ring type terminals.

Factory Testing

Factory testing shall consist of the following as a minimum:

- Simulate all control and relay functions.
- Demonstrate complete operation, including electric breaker operation
- Perform high-potential insulation test per applicable standards.

Tests shall be in the presence of an AT&T authorized representative.

9.06 Installation

The control board shall be mounted on a 4" concrete pad and secured to the pad in accordance with the manufacturer’s recommendation and seismic requirements for the zone in which the installation is located. The pad shall be secured to the floor in accordance with the same standards.

Paralleling Switchboards

10

Contents

Paralleling Switchboards

10

10.01 General Requirements

This section pertains to floor mounted switchboards normally used for larger systems and paralleling of engine-generators.

All meters shall be digital or analog with an accuracy of 1%. The meters shall be rated for transformer service with scales to match current and potential transformers. Current and potential transformer ratios shall be selected and coordinated to cause meter readings in the top 50% of the meter scale for nominal and rated values for ammeters, voltmeters, and kW meters.

All electromagnetic control relays shall be suitable and adequately rated for their intended service in the control system. Relays used in low-voltage, low-current DC control circuits shall have gold flashed or bifurcated contacts to insure positive contact and shall be rated 10 amperes minimum. All relays for control circuit duty shall be plug-in type with retaining clips, transparent plastic covers and pilot light or LED indication when operated.

Repetitive accuracy for solid-state protective relays, devices, controls, and monitors shall not exceed values stated in supplier's specifications for AC powered devices over a voltage range of 70-110% of nominal, and for DC powered devices over a voltage range of 20-50 volts DC or 100-140 volts DC.

Repetitive accuracy shall be maintained across an operating temperature range of 0˚C to plus 60˚C with 5%-to-95% non-condensing humidity.

Solid-state circuitry shall meet or exceed the Transient Overvoltage Withstand Test per NEMA ICSI-109 and the Surge Withstand Capability Tests (SWC) per IEEE 472-1974 (ANSI C37.90A1974). In addition, where LTL Standards exist for components, devices and/or assemblies, such standards shall apply.

10.02 Construction

The switchboard shall be freestanding, front and rear accessible, with a voltage and fault current rating corresponding with the engine-generator's and AC distribution system.

The switchboard shall be constructed with welded or bolted steel channel for a self-supporting frame. It shall be totally enclosed on the sides, top, and rear with 14-gauge (minimum) steel panels fastened to heavy channel frame. Enclosing panels shall not be larger than 36" wide X 48" high with rolled edges. The entire switchboard shall be primed and painted with two coats of gray enamel or lacquer inside and outside. The board shall be mounted on 1/4" x 3" galvanized channel set flush in a concrete pad, and bolted to the channel. The rear of the switchboard shall be hinged and have full height doors with a three point catch and lock. Doors over 24" wide shall be bi-parting. Insulated cable supports shall be provided to completely support conductors independent of breaker terminals.

Each switchboard shall be designed to permit future additions, changes, or regrouping. Floor space allocation shall consider the addition of future sections and comply with NEC space requirements.

Bussing

The bussing shall be made of 98%-conductivity copper with silver plated joints. The bussing shall be insulated and braced to withstand the short-circuit current available at the board at rated voltage. Overlap on all joints shall provide 100% of bus capacity. The bus joint connections shall be interleaved where multiple busses per run are required. Each joint is to have a minimum of two bolts per joint with flat and lock washers.

The phases shall be insulated from ground with a minimum 1" air space. Phase busses shall be insulated from other phases by a minimum 2" air space. The neutral bus shall be full-capacity and extend the entire length of the switchboard. The neutral bus shall penetrate the steel cubicle barriers with phase busses to prevent heating of barrier. A 1/4" x 3" copper ground bus shall extend the full length of the switchboard and be bonded to each cubicle. The main bussing shall be constructed in a manner to allow for future extensions at end cubicles.

Provisions for future devices in all switchboards shall include all studs, copper work and provisions for future mounting of a device without additional parts or changes in bus or structure. Bus and breaker provisions shall be made for all usable space.

Each section of the switchboard shall be separated with full-height and full-depth barriers. All barriers shall be 14 gage steel. Load bussing shall be braced from breakers to extend beyond all horizontal bussing to allow easy load-cable connections.

Breakers

Main generator breaker(s) and feeder breakers larger than 1600 amperes shall be power (air), draw-out, solid-state-trip, rated for the appropriate voltage and symmetrical interrupting capacity. Provide adjustable solid-state/digital long-time-delay (LTD), short-time-delay (STD) and ground (GRD) trip elements with each breaker. Pickup/delay adjustments and ranges associated with these trips will be as follows: LTD pickup - (0.5 - 1.1) x sensor, four time delay bands; STD pickup - (2 - 9) x LTD pickup, three time bands (0.1 - 0.35) second with I^2t ramp; GRD pickup - (0.2 - 0.6) x sensor, three time bands (0.1 - 0.35) second with I^2t ramp; Ground trip may be omitted when ground alarm is provided by a time overcurrent relay across the generator neutral current transformer. Provide trip indicators to show “overload” and “short circuit” trips. Breaker shall have stored energy (5 cycle maximum) closing and tripping mechanism.

Feeder breaker(s) smaller than 1600 amperes shall be insulated case, draw-out, solid-state-trip rated for the appropriate voltage and symmetrical interrupting capacity. Provide adjustable solid-state/digital long-time-delay (LTD), short-time-delay (STD), ground (GRD) and high fixed instantaneous (INST) over-ride trip elements with each breaker. Pickup/delay adjustments and ranges associated with these trips will be as follows: LTD pickup - (0.5 - 1.1) x sensor, four time delay bands; STD pickup - (2 - 9) x LTD pickup, three time bands (0.1 - 0.35) second with I^2t ramp; GRD pickup - (0.2 - 0.6) x sensor, three time bands (0.1 - 0.35) second with I^2t ramp; INST - non-adjustable high fixed pickup to minimize the possibility of false trip due to INST trip function. Provide trip indicators to show “overload”, “short-circuit” and “ground-fault” trip. Breaker shall have stored energy closing and tripping mechanism.

All motorized breakers shall utilize 48 V DC motors to charge stored energy springs and 48 V DC electric trip latches to open and close the breaker. Concurrence of the AT&T Power Engineer shall be obtained before imposing these loads on the -48 V power plant. The motor operated breakers shall be capable of manual tripping and capable of complete manual operation. An override switch for disabling control inputs from a remote location shall be provided at the breaker. Also provide an open/close control switch with pilot lights indicating breaker position for all motor operated breakers.

Control Power

Fused control power transformers, when used, shall be sized to supply all AC loads simultaneously. It is recommended that control power be supplied from the -48 volt Central Office battery plant. Provision of control power in that case should be coordinated with the AT&T Power Engineer.

The status of all control fuses shall be indicated on the front of the panel and the status circuitry shall have contacts for remote indication.

Labeling

A yellow mimic bus shall be provided on the front of the switchboards to indicate engine-generator supply connections. The mimic bus shall be colored hard bakelite strips anchored with brads. The minimum mimic bus size shall be 1/2” wide.

Each switch and/or circuit breaker shall be provided with a bakelite nameplate: white with a red core engraved with 3/8” high letters to indicate usage and mounted with two screws. Master nameplates shall also be provided.

Status Indicating Lights

All status indicating lights shall be long life 48 V DC LED-type with a colored lens cap.

10.03 Engine-Generator Control and Power Sections

Individual control and breaker sections shall be provided for each engine-generator set. The generator control panel, engine control panel, alarm and status indication, synchronizing switches, metering and meter selection switch, shall be furnished in isolated control sections.

A ground bus shall extend through the stationary structure, including the master cubicle. Each stationary unit shall be grounded directly to the ground bus.

10.04 Master Synchronizing, Control Section

The master control section shall have the following components to monitor and control automatic random-paralleling standby plants as a minimum:

- Generator synchronizer selector switch to manually parallel engines through synch-check relay.
- Digital bus frequency relay, to initiate load shedding at bus frequency decay to 58 Hz.
- Re-transfer mode selector switch (automatic - manual) with lighted push-button to initiate manual restoration. The push-button will light when utility service is stabilized.
- Three-phase test block connected to totaled or paralleled CT leads as applicable, with shorting CT contacts and insertion tool. Test block is to be mounted on the front of the control panel in the door.
- Synchroscope with 2-1/2” dial and an accuracy of 1%.

All metering shall be generated directly from CT’s, PT’s, or transducers. The PLC (programmable logic controller) shall not be used for totalizing or any meter readings. Meters shall be provided as follows:

- Utility (totalized) and generator bus wattmeters, digital, 1% accuracy. A totalizer shall be provided to combine metered loads from each main utility breaker (when required for multiple service entrances).
- Generator bus voltmeter and utility bus voltmeters, digital, with 1% accuracy.
- Generator bus ammeter and utility bus totalized ammeters, digital, 1% accuracy, and instantaneous scale. Necessary auxiliary current transformers and CT totalizer circuit shall be provided for proper reading.
- Voltmeter switches, 7-position.
- Ammeter switches, 4-position.
- Generator bus frequency meter, 55-65 Hz, digital, with 1% accuracy.
- Generator bus power factor meter, 0.5 lag to 0.5 lead, digital, 1% accuracy.
- Engine demand on-off selector switch. (Provide an engine demand monitor to automatically control the number of engines connected to the bus. Provide an off-on selector switch to select or de-select the automatic control).

A swing panel shall be provided with synchroscope, synchronizing lights, frequency meter, and bus voltmeter for manual synchronizing through the circuit breaker control switches, the synchroscope switches, synch-check relays, and the

frequency meter on the engine generator cubicle door. The swing panel shall be an integral part of the master cubicle door.

Provide transfer device control switches for manual control of the transfer devices.

Provide a system alarm and status panel with audible and visual indication annunciators.

Alarm and Status Annunciator

The master cubicle shall have the following alarm and status annunciators as a minimum: (The number of each will vary with the number of units serving the board.)

Engine Available	Status	White
Engine Fail	Alarm	Red
Tie Breaker Open (when applicable)	Alarm	Amber
Control Power Failure	Alarm	Red
Power Fail ATS	Alarm	Red
Power Return ATS	Status	Amber
Power Return Stable ATS	Status	Green
ATS - Manual	Alarm	Amber
Fail to Synchronize Engine	Alarm	Red
Control not in Automatic	Alarm	Red (Flashing)
Load Shed Bypass	Status	Amber
Generator Bus Under Frequency Failure	Alarm	Red
ATS Transferred to Standby	Status	Red
ATS Transferred to Normal	Status	Green
High Utility Demand	Status	White
Programmable Controller Failure	Alarm	Red
Generator Connected to Bus	Status	White
System Load Test	Status	White

System No Load Test	Status	White
Re-transfer Mode Automatic	Status	White
Re-transfer Mode Manual	Alarm	Amber

NOTE:
Refer to Section 9.04 for engine control cabinet alarm criteria.

Provide a three-position system test switch: “off line” (no-load test) will start and synchronize all engines under no load conditions; “on line” (load test) will start and synchronize all engines and take load; “normal” position returns system to standby condition. Switch shall be installed with “normal” position in the middle position.

Load shed control switches and indicators shall be provided with bypass-auto switches and white status indication lamps (one for each priority). Lamp shall be lit when switch is in bypass mode. Switches are to be mounted inside the master control cubicle and labeled.

Provide an automatic/manual control switch for manual operation of the paralleling generator breakers. Selector switch shall select the sources to be synchronized. Provide manual parallel breaker control switches (located on generator cubicles) to close generator breakers manually through the synch-check relay with automatic/manual switch in manual position.

Provide large (2”) phase synchronizing lights for use in manual breaker closing paralleling function.

Provide DC alarm horn (95 dB at 4 feet) to audibly enunciate all master and generator alarms. The system should include an alarm resound circuit for resound of the alarm after reset.

Provide an alarm on any control voltage failure, i.e., loss of converter, loss of DC bus, etc.

Provide an engine demand monitor to automatically control the number of engines connected to the bus. Provide an off/on selector switch to select or de-select the automatic control.

10.05 Programmable Logic Controller

When Programmable Logic Controllers (PLCs) are used for critical AC power and engine controls, the design shall be of modular construction, have the capability of field upgrades, shall have the manufacturer's guarantee of evolutionary capability, and shall be supported by the manufacturer for a minimum of 7 years. The design should be per AT&T 760-400-101, AC Power Distribution System Design, Installation and Acceptance Criteria. All PLCs regardless of function, shall include a manual override feature that is simple to use and activate. When PLCs are used for the purpose of auto load-shed they shall include an auto load-restore feature. The design for all PLCs used within the building should be by the same manufacturer and should be handled by a single engineering firm.

10.06 Remote Terminal Units

Programmable Controller Remote Terminal Units shall be used to provide monitoring and control of all standby engine systems related components.

Each RTU shall have a minimum of (4) four spare contact monitor points and (4) four spare contact control points.

10.07 Engine Demand Monitor Logic for Optimizing Engine to Bus Control

A monitor shall be furnished to analyze 3-phase loads on the system and signal when the load exceeds preset values (to be established based on standby plant capacity). The monitor should reset when the load drops below a preset value. A monitor shall be used to start and stop engines and to supply power to the specified parallel bus. Provide an on/off switch. This control may be provided in the PLC.

10.08 Engine Control Cubicles

The following components and circuitry shall be provided as a minimum for each engine control cubicle, completely wired and connected to provide automatic starting, stopping, monitoring and automatic parallel operation (when required) of engine generators.

An automatic active-synchronizing relay shall be used to control automatic synchronizing of engines to the parallel bus. Motor operated controls shall be used as required for control of the specified governors.

Each engine control shall have a synchronizing check-relay. Provide single-phase sensing; 120 V AC, 1 to 99 degree phase angle setting; line and bus voltage monitor, voltage difference with PC board mounted switches, a synch-check NO relay, and voltage monitor SPDT relay, time-delay adjustable 1-99 cycles and a 24 or 48 V DC power isolated sensing contact, draw-out mounted with “dead bus” feature. The synch-check relay shall be used for both manual and automatic synchronizing circuits.

Provide for manual paralleling through synch-check relay.

An electric governor control shall be provided. A remote speed control on the front door (±10%) and a motorized “pot” for smooth manual speed control (80 second full travel) shall also be provided.

A voltage regulator shall be provided. Provide a remote raise/lower control on the front door (±10%) and a motorized potentiometer for smooth manual voltage control (80 second full travel). The raise/lower control shall be connected to operate only when the engine is running. Provide cross-current compensation between generator regulators. The cross-current wiring shall be terminated through the tie breaker contacts for isolated generator operation.

Engine Start Panel

The engine start panel shall include the following as a minimum:

The engine starting control logic shall provide electrically isolated contacts for electronic governor control, electric fuel control and common shut down alarm annunciation. All relays shall be the same as, and interchangeable with, the relays used in the master synchronizing control section of board.

The design drawings shall include the starting control logic for the control of the engine generator. The control logic shall be 48 V DC unless 120 V has been previously provided.

Engine cranking shall automatically initiate on receiving a signal from voltage relays in the transfer switches. The engine shall start and accept the applicable load when the commercial service voltage decays to 80% of nominal. Power shall be restored to the commercial service when all phases are 95% of nominal voltage and 99% of rated frequency. Provide a cycle cranking timer to crank engine for 10 seconds and interrupt cranking for 10 seconds until engine starts. If the engine fails to start within four cycles of 10 second cranking, the cranking shall discontinue and an alarm condition shall be signaled (overcrank).

An idle warm-up timer (0-600 seconds) and a separate idle cool-down timer (0-600 seconds) shall be provided.

The engines shall shut down on occurrence of the following abnormal conditions:

- Overspeed
- Overcrank
- High coolant temperature
- Low water level
- Low oil pressure
- Under frequency
- Emergency stop
- Overvoltage.

To implement the shut down condition, stop cranking of the engine or shut the set down, shunt trip the set circuit breaker, open up the path to the starting circuit, and establish alarm circuits until the control panel is manually reset. All shut down devices shall be clearly labeled on the engine generator set.

Selector Switch

The panel shall be equipped with a manual four-position selector switch, an alarm annunciator for alarms, and an audible alarm signal.

- Automatic
- Off/Reset
- Manual
- Test

Automatic: the engine control shall be in readiness for fully automatic operation upon receipt of a start signal.

Off/Reset: The engine shall not be capable of starting and/or running. If the engine was shut down due to the operation of a protective device, the shutdown lockout circuit shall be reset when the switch is moved to this position. Any other type of malfunction will require clearing the cause of the malfunction before resetting the shutdown lockout. The “switch off normal” lamp shall be lighted to indicate an off-normal condition. If the engine is running when the switch is moved to this position, it shall immediately initiate the shutdown sequence.

Manual: the engine shall start and run as if a start signal were received, except it shall not be connected to the bus unless a start signal is received or manual controls are used. When returned to the automatic position, the engine shall initiate the shutdown sequence.

Test: This position shall be used to simulate a power failure condition. Closure of the power failure relay shall simulate a loss of power, start the engine, and signal a transfer of load to the engine. After a predetermined time, the engine control circuit shall signal a transfer of load back to commercial power and allow the engine to run at no load for a period of 5 minutes and then shut down the set.

Overlapping contacts shall be provided in control switches to allow switching positions of control switches between “Manual” and “Test” for smooth operation of system.

Auxiliary Engine Run Contacts

Auxiliary engine-run contacts shall be provided for control of auxiliary systems required for operation of the engine such as ventilation, fuel system, electric start, regulator, governor, prelube pumps, radiator fans, water pump, etc. Provide normally closed 48 VDC contacts for operation of intake and exhaust air dampers. Provide a minimum of eight (8) SPDT contacts. It is recommended that power for the contacts be provided from the Central Office battery plant with concurrence of the AT&T Power Engineer.

Synchronizing Selector Switch

A key-operated synchronizing mode selector switch shall be provided with permanently mounted instructions. The switch shall be located inside the control panel and have the following positions:

- **Permissive**: the governor controls shall be deactivated. However, the synchronizer can signal closing of the generator breaker.
- **Chec**k: the synchronizer shall be fully operational except it cannot close the generator breaker.
- **Off**: the synchronizer shall be turned off.
- **Run**: the synchronizer shall be in the fully operational, automatic mode.

The control cubicle shall have an emergency stop switch (guarded red operator) mounted on it with a plastic flip-up cap.

Refer to Section 11.04 for requirements on Emergency Stop Switches.

A multiple engine circuit interlock control shall be provided to prevent connection of multiple engines to the load bus simultaneously. Provide dead band time of two (2) seconds between activation of synchronizers.

Random access paralleling may be done with the PLC.

The engine cool-down circuit shall have a time delay function, adjustable 0-15 minutes, set at 5 minutes at full speed. The cool-down function shall automatically be bypassed for malfunction and manual shut down.

The panel shall have a failure-to-synchronize function, adjustable 0-300 seconds (set at 120 seconds) to initiate audible and visual alarms, but the function shall not terminate synchronizing attempts or shut down engine.

NOTE:
If synchronizing control panels are not colocated with engine control panels, refer to Section 9.04 for required engine alarms.

A manual reset lockout relay shall be provided to trip generator and shut down engine (when specified) for differential, reverse power, over/under voltage and over/under frequency failures.

A status and alarm annunciator shall be provided on each switchboard with alarm indications as determined by AT&T OSWF and Building Engineering.

Instrumentation

All metering shall be real-time, connected to PT's, CT's, and transducers. The PLC should not be used for meter calculations.

Switchboard instruments shall have ±1% accuracy with 2-1/2" minimum dial size. All meters and gauges shall be clearly marked on their face with the engine's normal operating parameters.

The following instruments shall be provided as a minimum:

- Three-phase CT test block with shorting CT contacts and insertion tool mounted on front of control panel in door
- Voltmeter (with appropriate scale)
- Ammeter (with appropriate scale)
- Dial type frequency meter, 55-65 Hz
- Kilowatt meter (with appropriate scale)
- 4-position Ammeter selector switch

- Elapsed time meter
- 7-position Voltmeter selector switch
- Power factor meter, 0.5 lag to 0.5 lead
- A fuel contamination indicator (to indicate presence of contaminants such as water) shall be mounted on front panel.

Generator breaker shall be furnished with adjustable solid-state/digital ground fault detection having a pickup range of (0.2 - 0.6) x sensor, three time bands (0.1 - 0.35) second and I^2t ramp. This protection for the generator may be omitted when ground fault alarm between (100 - 1200) amps is provided by a time overcurrent relay across the generator neutral current transformer.

A lockout on the radiator alarm for engine starting or stopping shall be provided.

A generator breaker manual control switch wired through the synch-check relay shall be provided.

Provide control logic for dead bus bypass of automatic synchronizer, random sequencing of generator sets on line, with sequential priority load-addition/load-shedding and audible alarm override of previously silenced alarm.

Relays

The generator shall be protected against motorization by using a reverse power relay. On sensing reverse power conditions, the control unit will initiate load shedding by opening the generator breaker of the failing unit. Provide 0.1 - 99 second adjustable time delay and internal target. The engine-generator shall not shut down upon activation of the relay.

An under/over voltage relay shall be provided. The relay device shall be single phase sensing, phase-to-phase; adjustable set point 75% - 100%; N.C. contact (closed without power applied); adjustable time delay; one internally operated target, draw-out mounted.

A power directional relay shall be provided. The relay device shall be single phase, line-to-line voltage sensing (or as required); 120 V AC power supply, one internal operated target; draw-out mounted.

An over/under frequency relay shall be provided. The relay device shall be single phase sensing, 120 V AC, 40-70 Hz, one N.O. relay, adjustable inverse time delay, one internal operated target, two set points, draw-out mounted.

Protective functions required during paralleling mode of operation can be incorporated into the generator multifunction digital protection package.

Master Control Switch

A master control switch shall be located on the master cubicle front door and allow the selection of automatic or manual operation. In the manual position all automatic synchronizing and PLC functions of the system control will be locked out, and the starting and stopping of engine-generators must be controlled from their engine operation selector switches.

If the switch is in the “Manual” position all automatic control functions of the engine-generator and priority controls will be locked out.

A red annunciator light shall be provided to flash whenever the engine-generator mode selector is in any position other than automatic.

Control power for engine logic should be derived from separate dual redundant 48 volt direct wiring in each engine control panel unless 120 V controls have been previously provided.

10.09 Miscellaneous Equipment and Features

Provide for each ammeter: test block and necessary test plugs, switch current jacks and power supply, accessible in rear of switchboard, for portable recording ammeters. All CT leads shall be terminated in “shorting type” terminals.

All timers requiring outside programmable controller functions shall be solid-state, with timing lights, adjustable dials, and 0.2% repeatable. Battery voltage shall be used to drive all timers. Mount all meters, switches, and control devices on hinged doors. Provide 1/4” thick plexiglass barrier on the rear of the door to protect any exposed live connections.

All key operated switches shall be pistol grip type, keyed alike, with 4 spare keys turned over to OSWF at acceptance.

Furnish annunciated alarms with manual resetting relays and a common alarm horn, reset switch and horn silence switch. The alarm horn shall be rated 95 dB at 4 feet. “First in” alarm shall flash. Subsequent alarms shall resound audible signals. Provide a lamp test switch. Alarm lights are to remain lighted until the alarm condition is corrected and controls are manually reset. All controls and alarms are operated on station battery voltage. Alarm annunciators are to consist of 0.86”H X 3”W lighted rectangles with dual LED lamps, with engraved alarm description. The annunciator shall have a black bezel. Provide for each alarm indication 1 SPDT auxiliary contact for connection to remote alarm indicators.

Auxiliary relays shall not flash if the module requires flashing. The annunciator shall have a split-relay/power supply panel mounted inside the control panel and window lamp panel mounted on the front door.

Control Wiring

All control wiring shall be color coded and laced in bundles of 12 wires maximum. Each wire shall be identified with permanent vinyl wire markers at every break (i.e. terminal strip, relay, control device, etc.). All terminals shall be permanently identified with vinyl or bakelite markers. All devices shall be identified with bakelite nameplates located in a readable location and fastened with screws.

Wiring should be color coded as follows:

- White - CT leads
- Blue - DC control
- Red - AC control
- Yellow - source other than derived above
- Green - frame ground.

10.10 Instrument Transformers

Instrument transformers shall be provided for complete and proper operation.

Current Transformer

Current transformers shall be bus-bar type with bolted connections or window type and have the following characteristics:

BIL	10 kV
Insulation Class	600 V
Accuracy Class	C-100 minimum
Ratio	As required

Potential Transformer

Potential transformers shall have the following characteristics:

- Fused on primary incoming line with indicating current limiting fuses.
- Rated 600 volts and 10 kV
- Thermal volt-ampere rating: 1000 (minimum) at 30˚C temperature rise above a 55˚C ambient temperature.
- Secondary voltage as required for the devices to be connected.
- Accuracy class for transformer: 0.3 at W, X; 0.6 at Y
- Provide six each spare PT primary fuses to be turned over to the OSWF.

Fuses and Wiring Connections

AC and control fuses shall be plug-in, neon indicating type, mounted in the relay compartment and labeled. DC control fuses shall be neon indicating DC rated firing circuit (48 V DC), Fuses shall be mounted on inside of control cubicles in an easily accessible and visible location. Provide audible and visual alarms external to the cabinet.

All wiring connections shall be made with compression, ring-type terminals.

Factory Test

Factory testing shall consist of the following as a minimum:

- Simulate all control and relay functions.
- Demonstrate complete operation including electric breaker operation
- Perform high potential insulation test per applicable standards.

Tests shall be in the presence of the AT&T authorized representative.

10.11 Installation

The control board shall be mounted on a 4" concrete pad and secured to the pad in accordance with manufacturer's recommendations as well as seismic requirements for the zone in which the installation is located. The pad shall be secured to the floor in accordance with the same standards.

Provide a 24" X 1/8" thick rubber, insulating operator mat across the rear of the entire switchgear lineup. The mat shall be designed to lay without curling on ends and installed without adhesive.

Equipment and Accessories

11

Contents

Equipment and Accessories

11

11.01 Electrical Protective Systems

Medium Voltage Standby AC Plant Protection

The primary-phase fault protection for each standby AC plant shall be a 3-phase percentage differential relay. The backup protection shall consist of three single-phase, voltage restrained, time-overcurrent relays.

The backup overcurrent relays shall be set to clear a bus fault with reasonable speed and coordinate with the breaker protection for the largest load connected to the essential distribution system.

A field ground relay shall provide protection for a sustained ground at the generator field. A reverse-power relay and loss-of-field relay shall also be provided.

A negative-sequence relay shall be provided to detect the negative-sequence component of the phase current in the stator winding. This relay shall be set within the continuous negative-sequence rating and the I^2t values obtained from the generator manufacturer.

The standby generator supply neutral shall be low resistance grounded for 4,160 V generators. Ground-fault protection shall be provided by a time-overcurrent relay in the generator neutral connection to a current-limiting resistor. Refer to AT&T 760-400-500, Building Electrical System Ground Fault Protection.

Any time the standby AC plants are paralleled with the utility source, a synch-check relay shall be provided to minimize the risk of operator error.

The percentage differential, voltage-restrained overcurrent, reverse power, loss-of-field, negative-sequence, and ground-overcurrent relays shall energize a lockout relay which shall shut down the generator, and trip the standby AC plant generator breaker. Voltage and frequency relays shall be provided to allow the generator breaker to close when the voltage reaches 95% of nominal, and frequency reaches 59 Hz.

Multifunctional digital protection package which incorporates most of the protective functions outlined above should be considered for new facilities.

Existing Facilities

Multifunctional digital relays now available incorporate most of the protective functions described above and can be considered for use in existing facilities.

Low Voltage Standby AC Plant Generator Protection

The following guidelines shall be the minimum protection required for units to be operated in parallel, or units to be paralleled with the utility.

The primary phase-fault protection for each standby generator shall be a 3-phase percentage-differential relay. The backup protection shall consist of three single-phase, voltage-restrained, inverse time-overcurrent relays.

The backup overcurrent relays shall be set to clear a bus fault and coordinate with the breaker protection for the largest load connected to the essential distribution system.

A field ground relay shall provide protection for a sustained ground at the generator field. A reverse-power relay and loss-of-field relay shall also be provided.

A negative-sequence relay shall be provided to detect the negative-sequence component of the phase current in the stator winding. This relay shall be set within the continuous negative-sequence rating and I^2t values obtained from the generator manufacturer.

The standby generator supply neutral shall be solidly grounded ahead of the system disconnect or overcurrent device for 480 V generators. Ground-fault protection shall be provided by a time-overcurrent relay connected across a current transformer in the generator neutral. Refer to AT&T 760-400-500, Building Electrical System Ground-Fault Protection.

Any time the standby AC plants are paralleled with the utility source, a synch-check relay shall be provided to minimize the risk of operator or equipment error.

The percentage differential, voltage-restrained overcurrent, field-ground, reverse-power, loss-of-field, negative-sequence, and ground-overcurrent relays shall energize the lockout relay which shall shut down the standby generator, and trip the standby generator breaker. A voltage relay and frequency relay shall be provided to allow the standby generator breaker to close when the voltage reaches 95% of nominal, and frequency reaches 59 Hz.

Multifunctional digital protection package which incorporates most of the protective functions outlined above should be considered for new facilities.

Existing Facilities

Multifunctional digital relays now available incorporate most of the protective functions described above and can be considered for use in existing facilities.

For 480/277 V standby sources, tripping from ground-fault protection can be eliminated, but indication for such faults should be provided.

Electrical Protective Systems

Generators rated at 480 V and below shall be solidly grounded. Generators rated at 4,160 V shall be low-resistance grounded. The stator frame shall be provided with two unpainted copper ground pads, diametrically opposed in location, for the ground connections. Each pad shall be drilled and tapped for a standard NEMA two-hole connection. Generators are to be grounded per article 250 of NEC and in compliance with AT&T Practice 802-001-198.

11.02 Instrumentation and Controls

Each standby AC plant shall be provided with local instrumentation and control systems suitable for manual start-up and shutdown, and for monitoring and control during operation.

Local mechanical and electrical instrumentation shall be provided for each standby AC plant power source to monitor the variables required for successful operation. The systems monitored shall include the starting, cooling, lubricating, fuel supply, excitation, voltage regulation, and control power.

The design of the local instrumentation and control systems shall ensure resistance of these systems against the environmental conditions in which they

will operate, particularly with regard to temperature, vibration, moisture, and contamination of electrical contacts.

Remote indication shall be provided in the Building Command Center to indicate engine operation and engine trouble. Controls shall be provided to start, synchronize, load, stop, and run the generator. Refer to alarms listed in this section. Alarm points shall be as per the latest edition of AT&T 154-103-101, Alarm Standards Manual.

All gauges shall be a minimum of 2" diameter, with ±2% accuracy at full scale. Gauges shall be red-lined with normal operating ranges.

11.03 Alarms

Local alarms shall be as listed for each type of control panel in Chapters 8, 9, and 10 and shall be in accordance with AT&T 154-103-101, Alarm Standards Manual.

Remote alarms transmitted to the NCC shall also be in accordance with AT&T 154-103-101, Alarm Standards Manual.

11.04 Remote Emergency Stop Switches

Remote emergency stop switches shall be provided on each control cabinet. These switches, when actuated, will shut the set down, shunt trip the set circuit breaker, open up the path to the starting circuit, and establish alarm circuits. In addition, a manually operated device shall be mounted on the engine which, when actuated, will activate the emergency shutdown device, and open up the path to the starting circuit.

Remote emergency stop switches shall also be located outside each interior exit from the standby plant room. Emergency stop switches shall be located immediately inside each exterior exit.

The switches shall be mounted between 42" and 48" above finished floor depending on building conditions. Each switch shall be equipped with a flip-up cover and clearly labeled to prevent accidental activation.

11.05 Load-Shedding

If at any time the AC standby plant system(s) malfunction(s) the control system shall be capable of shedding loads to keep the AC standby plant up and running.

The shedable loads shall be placed into load priority blocks. The order of priority shall be established by the AT&T Building Engineer, OSWF, and affected Business Units in accordance with the definitions and examples given below.

Definitions

Priority 1 Essential Loads - loads which are required to maintain telecommunications service, and the absolute minimum infrastructure required to support critical telecommunications equipment. These will also include critical security, environmental, and fire protection systems, and any AC-operated alarm systems. These loads shall not be a part of an auto load-shed plan.

Priority 2 Essential Loads - loads which are significant but are not absolutely required to maintain service to telecommunications equipment. These loads may be included in an auto load-shed plan and will be the last to be shed.

Nonessential Loads - loads which are not required to maintain service to telecommunications equipment. These loads may be included in an auto load-shed plan and will be the first to be shed.

NOTE:
Examples of Priority 1 Essential, Priority 2 Essential and Nonessential loads are detailed in section 1.03, Reliability Criteria - Infrastructure Segmentation Strategy, Definitions.

NOTE:
Essential redundant equipment or equipment with A and B power feeds shall be provided with AC power from separate breakers or fuses from separate sources when available.

Turbines

12

Contents

Turbines

12

12.01 General

Refer to the applicable sections for information not covered in this section for standby plants.

Each turbine assembly used in the standby AC plant shall be fitted with but not limited to:

- Turbine starting system
- Turbine cooling system
- Fuel oil system
- Inlet system
- Exhaust system
- Turbine speed and control system
- Protection system.

The units shall be suitable for idle periods up to four weeks under specified conditions without requiring any special maintenance procedures.

The assembled unit,(i.e., turbine, generator, exciter) shall be designed and constructed to comply with the vibration and critical speed requirements of API 616.

The turbine shall be capable of being sequentially loaded.

A lateral and torsional critical speed analysis of the combined driver/driven equipment system shall be provided.

Castings used for any part shall meet the requirements of MSS S55. The use of gray cast iron shall not be permitted. Modular or ductile cast iron shall be used.

The turbine casing shall be designed with allowable hoop-stress values in accordance with Section VIII of the ASME Code as specified in API 616.

Inlet silencers shall be included to attenuate sounds emitting from the compressor.

Exhaust silencers shall be included to attenuate sounds emitting from the turbine exhaust.

A water-wash system including a mixing tank, solvent storage tank, piping, valving, instruments, and a permanently mounted water-wash spray manifold shall be provided.

The starting system shall be fully automatic.

12.02 Fuel Oil and Lubrication

The main fuel oil pump shall be full capacity, driven off the turbine. If an engine pump is not available, separate full capacity AC and DC motor driven pumps shall be provided.

The fuel oil system shall further include:

- Necessary valves
- Duplex fuel oil filters before and after the pumps
- Piping
- Regulating device
- Metering device
- Instrumentation
- Pressure switches
- Indicators
- Automatic control system.

The system shall have lube oil mist precipitators per manufacturer's guidelines.

The lubrication shall be accomplished by a continuous flow of oil supplied by a system consisting of:

- Main oil circulating pump
- Separate emergency DC-motor-driven oil pump
- Delivery pipes
- Return pipes
- Reservoir
- Oil coolers
- Pressure gauges and thermometers
- Duplex oil filters
- All necessary oil piping to and from oil cooler

The oil reservoir shall be furnished complete with:

- Level indicator
- High and low level alarm switches
- Drain
- Overflow
- Inspection port valves
- Piping.

The reservoir shall provide a minimum of 5 minutes retention time.

Duplicate oil coolers each for 100% capacity shall be provided.

An electric lube oil immersion heater shall be provided for turbines in environments having ambient temperatures ranging below 50˚F. The lube oil tank heater shall be thermostatically operated.

The turbine shall be suitable for burning No. 2 diesel oil, although No. 1 diesel is the preferred fuel.

A fuel oil day tank, one for each system, having a minimum capacity of 2.5 hours full-load operation shall be provided.

A reserve fuel oil tank having a minimum capacity of 3 days full-load operation for each essential bus shall be provided.

A closed lube oil cooling system shall be employed using extended surface, finned-tube, air-cooled radiators, and fans. The radiator shall utilize admiralty tubes with copper fins.

The lubricating and fuel oil systems shall be designed to minimize fire hazards due to leakage of vapors or fluids caused by physical damage, vibration, or piping failures.

The piping system shall be designed to minimize local heating from external sources and adequately braced to withstand vibration.

The unit shall be furnished with an automatic control system suitable for sequencing the unit for all operating modes.

12.03 Ventilation

Combustion air for turbines shall be ducted directly from the building exterior to the turbine set. Combustion air should be directed from the coolest source possible. The inlet duct should be as short as possible to eliminate inlet restrictions. This type of duct shall not have shutters at the combustion air intake building opening. However, louvers or a protective hood are needed to keep snow and rain out the inlet duct. A 1/2” mesh bird screen shall also be installed. Where it is not possible to duct combustion air, the building wall opening for the combustion air inlet should have two position dampers to prevent unnecessary lowering of engine-room temperature during cold weather when the set is not running. Where combustion air inlets are located near grade, an air filtration arrangement shall be included with sufficient stages of filtration to clean the air of dust and road salt to the extent necessary to prevent engine damage due to salt and particulate ingestion. This filtration should be accomplished with a minimum loss of performance.

Standby Plant Room Design Criteria

13

Contents

Standby Plant Room Design Criteria

13

13.01 Lighting

Lighting in the standby AC plant rooms shall be evenly distributed, avoiding obstructions, to produce a maintained lighting level of 35 footcandles on all sides of the plant and control equipment. All lighting in these rooms shall be served from an essential bus.

All rooms housing standby AC plants shall also be equipped with DC emergency lighting, either self-contained or powered by a remote battery plant. In addition to normal egress lighting, a light level of 15 foot-candles shall be maintained on the face of the switchgear and control panels, with a DC light placed on each side of the standby plant.

13.02 Ventilation

The intake air and ventilation system for diesels must supply air for combustion, radiator cooling, and air to remove the heat released by the engine-generator, silencer, and exhaust pipe. Heat removal for other internal loads (fan and pump heat release), building transmission, and engine jacket heat release shall also be provided. Radiator fans are normally large enough to cool the radiator and remove some of the peripheral systems heat load. If the fan capacity is not sufficient to handle the engine room heat load or if the system is equipped with a remote radiator system, an auxiliary fan(s) shall be installed. The silencer and exhaust pipe shall be insulated to enable reduction of the size of the auxiliary fan.

All inlet and outlet openings shall be equipped with fixed louvers or screens. Two-position dampers should be used in cold or dusty environments. When used, the damper controls shall be properly interfaced with the engine, and designed to fail in the open position.

Acoustical treatments to inlet and exhaust openings shall be provided at locations where sound attenuation is required.

13.03 Fire Protection

Fire safety for standby engines shall comply with AT&T 760-610-925, Fire Safety - Standby Engines.

13.04 Environmental

The standby AC plant shall be capable of operating at its design capacity under the site ambient conditions of temperature, humidity, and altitude. The normal operating temperature range for diesels is 40˚F to 110˚F. For this reason additional cold starting devices should be specified. Electrical equipment areas subject to flooding from above or adjacent areas or located below grade shall be protected from flood damage by the use of a floor drain system. Floor drains for standby AC plant rooms shall be provided with oil separators.

13.05 Seismic and Structural

The baseplate for the diesel, generator, and air inlet system shall be welded structural steel fabrication. The engine generator shall be mounted on a common subbase with its respective engine driver.

Additional criteria for mounting and supporting shall be in accordance with manufacturer's requirements and AT&T 810-610-155, Earthquake and Disaster Bracing for Central Office Equipment General Equipment Requirements.

13.06 Plant Room Configuration

Plant layouts shall be in accordance with manufacturer's recommendations, leaving appropriate access for growth and maintenance. The plant shall not be located near “growth” walls to prevent relocation in the event of a building addition. The plant shall be located in an area protected from external hazards (i.e., corrosion, flooding, etc.).

Exterior Engine Enclosures

14

Contents

Exterior Engine Enclosures

14

14.01 Enclosures (Non Walk-In)

The enclosure shall be designed to fit over the standby plant set, and be designed to provide weather resistance and easy maintenance access to the set.

The enclosure shall consist of a roof, underframe, two (2) side walls, and two (2) end walls. The interior of the enclosure shall be designed to permit normal maintenance of the set without enclosure removal. Large doors on the sides and rear of the module are to be provided with retainers and locks to allow easy access for maintenance. For extraordinary maintenance, the enclosure shall be designed with lifting rings and anchor fittings to permit lift-off removal of the enclosure.

Enclosure structural members shall be constructed of ASTM A36 steel or 6061-T6 aluminum alloy. Joining of the various structural members shall be done by welding. Each structural member shall be primed and painted with a high grade primer and an automotive type enamel. The structure shall be capable of withstanding the highest level of winds as listed by the ANSI Basic Wind Speed Map for the contiguous United States.

The exterior surface of the enclosure and accesses shall be manufactured of aluminum panels with a minimum thickness of 0.63 inches (14 Gauge). All exterior panels of the roof shall be weather sealed. The exterior top and bottom perimeter of the enclosure shall be protected by a 3" wide by 0.25" thick aluminum rub rails.

Air intake shall be via a fixed louver system of sufficient size to allow proper cooling and combustion air flow as specified by the manufacturer. Air exhaust from the radiator shall be via a gravity or motor operated louver. Provide 10 gage, 1/2” x 1/2” screen on the interior of fixed intake louvers.

All hardware for doors, silencer supports, and roof penetrations shall be stainless steel.

At any point where the frame and surface panels of dissimilar metal are designed to touch, a gasket of sufficient type and size shall be permanently affixed to prevent dissimilar (bimetallic) corrosion.

The roof frame shall be designed to have sufficient structural bracing to support those components (i.e. silencers, etc.) scheduled to be placed on or supported by the roof. The roof shall be capable of supporting a live load of 50 pounds/square foot. The roof shall be designed with sufficient pitch to permit normal water shed. The enclosure shall be capable of withstanding a rain test equal to 4 inches per hour.

Fixed louvers shall be used as dictated by the engine air flow. The fixed louvers shall be of all-aluminum construction and hinged to an aluminized steel frame incorporating an internal locking pin for security.

In addition to the genset, internal installation design requirements shall include but are not limited to the following:

- Main breaker panel (Properly sized for distribution to all AC operated equipment within the module)
- Engine block heater
- Battery charger
- Duplex work receptacle (20A, 125V, 2P, 3W)
- Generator heater (required for humid environments)
- Fuel oil heater (required in cold climates)
- Space heater (cold climate only).

Enclosures shall have 12 or 24 V DC lights, pre-wired, switched with a twist-timer and connected to the cranking batteries.

The operating characteristics of the nicad batteries allow for operation in cold climates. A battery heater shall not be required or recommended by the manufacturer.

Enclosures shall be provided with one 10-pound, carbon dioxide, portable bottle type fire extinguisher, wall mounted within the enclosure.

All enclosures shall be equipped with silencer supports and brackets along with rain collar and cap as required.

14.02 Walk-In Enclosures

The enclosure shall be designed to fit over the generator set, provide weather resistance, and allow for easy maintenance of the generator set. The enclosure shall be mounted on to the concrete pad and sealed to prevent leakage under the walls.

A minimum of two (2) doors shall be provided. The interior of the enclosure shall be designed to permit normal maintenance of the generator set without enclosure removal. For extraordinary maintenance, the enclosure shall be designed with lifting rings and anchor fittings to permit lift-off removal of the enclosure.

Enclosure structural members shall be constructed of ASTM A36 steel or 6061-T6 aluminum alloy. Joining of the various structural members shall be done by welding. Each structural member shall be primed and painted with a high grade primer and an automotive type enamel. The structure shall be capable of withstanding the highest level of winds as listed by the ANSI Basic Wind Speed Map for the contiguous United States.

The exterior surface of the enclosure and accesses shall be manufactured of aluminum panels with a minimum thickness of 0.63 inches (14 Gauge). All exterior panels of the roof shall be weather sealed. The exterior top and bottom perimeter of the enclosure shall be protected by a 3" wide by 0.25" thick aluminum rub rails.

At any point where the frame and surface panels of dissimilar metal are designed to touch, a gasket of sufficient type and size shall be permanently affixed to prevent dissimilar (bimetallic) corrosion.

The roof frame shall be designed to have sufficient structural bracing to support those components (i.e. silencers, etc.) scheduled to be placed on or supported by the roof. The roof shall be capable of supporting a live load of 50 pounds/square foot. The roof shall be designed with sufficient pitch to permit normal water shed. The enclosure shall be capable of withstanding a rain test equal to 4 inches per hour.

Intake air shall be via a motor operated louver system of sufficient size to allow proper cooling and combustion air flow as specified by the standby plant manufacturer. Exhaust air from radiator shall be via a gravity louver. Provide 10 gage 1/2” x 1/2” screen on interior of fixed intake louvers. A means of ice removal shall be provided in areas where icing of the louvers may occur.

All hardware for doors, muffler supports, and roof penetrations shall be stainless steel.

In addition to the genset, internal installation design requirements shall include but are not limited to the following:

- Main breaker panel (Properly sized for distribution to all AC operated equipment within the module)
- Engine block heater
- Battery charger
- Duplex work receptacle (20A, 125V, 2P, 3W)
- Generator heater (required for humid environments)
- Fuel oil heater (required in cold climates).

Enclosures shall have 12 or 24 V DC lights pre-wired and switched with a no-lock-on timer and connected to the cranking batteries. Fluorescent AC vapor tight fixtures shall be provided with a switch at the main personnel door and connected to the distribution panel board.

Enclosures shall be provided with two 10-pound carbon dioxide portable bottle type fire extinguishers wall mounted within enclosure.

The electrical design package shall ensure that suitable lighting, light switches, and receptacles are wired to a properly sized distribution panel. Suppliers shall submit layout, circuit design, etc., for review.

All electrical components shall be UL listed and installed in accordance with the latest edition of the National Electric Code.

AC Standby Plant Test and Acceptance

15

Contents

AC Standby Plant Test and Acceptance

15

15.01 General

This checklist is designed to be used by the building engineers, local consultants, and AT&T OSWF. All of the checkpoints can be verified by visual inspection, or from manufacturers manuals, drawings, and specifications. The Operational Testing portion of this acceptance checklist is designed to verify working operation of the Standby AC plant and supporting equipment.

Once the final acceptance of the work has been completed, the completed checklists shall be filed in the building engineering project file.

The checklist blocks are defined as follows:

[Y]	This item has been completed and meets requirements.
[N]	This item does not meet requirements.
[NA]	This item does not apply to this project.

15.02 Miscellaneous Requirements Checklist

[Y] [N] [NA] 1. Verify that all engine-generator support systems and auxiliary equipment requiring electrical power are served from an essential bus, and that redundant equipment is fed from two separate sources.

[Y] [N] [NA] 2. Verify that all connections are tight, properly crimped, wrapped, soldered, and/or torqued and are free of excessive heat.

[Y] [N] [NA] 3. Verify that the physical arrangement provides sufficient clearance from all obstacles. Ensure that equipment doors open fully and all maintenance activities can be performed unrestricted.

[Y] [N] [NA] 4. Verify that insulation protection has been provided on cable rack straps, stringers, threaded rods, auxiliary framing cables, and all other metallic objects where power cables make contact with sharp surfaces.

[Y] [N] [NA] 5. Verify that all flexible conduit has been supported at a minimum of every 4-1/2 feet.

[Y] [N] [NA] 6. Verify that task lighting (connected to the essential bus) has been provided in the key areas of the engine room and general power plant area. Lighting should be maintained at a level of 35 foot-candles, ensuring maintenance activities may be performed in a safe unrestricted manner.

[Y] [N] [NA] 7. Verify that DC emergency lighting meeting requirements in Chapter 13 is provided for safe access and egress to support systems and operating areas of the engine-generator.

[Y] [N] [NA] 8. Verify that all AC breakers, disconnects, switch and fuse units, etc., are capable of being “locked out” to prevent the load from being energized.

[Y] [N] [NA] 9. Verify that all electrical and grounding conductors of sufficient size are terminated using two-hole bolted circumferential compression-type connectors. No mechanical type connectors are allowed.

[Y] [N] [NA] 10. Verify that the equipment layout agrees with the AT&T Central Office Planning (COP) development plan or that COP has agreed to as-built layout.

[Y] [N] [NA] 11. Verify that fault-current and coordination studies have been completed.

[Y] [N] [NA] 12. Verify that all electrical, mechanical, and architectural drawings have been developed in AutoCad Release 12, per the AT&T Computer Aided Drafting Specification.

[Y] [N] [NA] 13. Verify that all equipment is properly anchored to the floor. In earthquake zones, verify the earthquake bracing has been provided where required.

Comments:

15.03 Diesel Engines and Required Support Systems Checklist

Exhaust Systems

Verify that the exhaust system is designed such that:

[Y] [N] [NA] 1. Exhaust gas is carried away from engine cooling and building air intake points to prevent recirculation.

[Y] [N] [NA] 2. Exhaust system back pressure (measured at a manometer plug installed at or near the engine exhaust manifold outlet) does not exceed maximum specifications provided by the manufacturer.

[Y] [N] [NA] 3. Exhaust pipes passing through combustible roofs, walls, or partitions are guarded with metal ventilated thimbles to protect the combustible material from excessive temperatures.

[Y] [N] [NA] 4. Silencer classification complies (based on site conditions) with OSHA and local code requirements for noise levels.

[Y] [N] [NA] 5. The silencer and piping weight are not supported by the engine.

[Y] [N] [NA] 6. Vibration isolation is provided by flexible stainless steel, convoluted bellow type sections and that the sections have been installed without distortion.

[Y] [N] [NA] 7. Piping terminates in a rain cap, tee, or ell pointing away from the prevailing wind and shielded from the rain.

[Y] [N] [NA] 8. Interior exhaust piping and silencer is insulated and guarded to reduce interior heat release, and prevent personal injury. (Flexible bellows shall not be insulated.)

[Y] [N] [NA] 9. Exhaust gas emission complies with all federal, state, and local emission codes.

[Y] [N] [NA] 10. The exhaust system has a condensation drain and drain piping extended to the floor for easy access.

[Y] [N] [NA] 11. The exhaust openings are located so as to not be restricted by outside structures or weather conditions (i.e., above the snow line).

[Y] [N] [NA] 12. In the case of multiple engine sets sharing the same exhaust system, verify that the system connections are properly valved to prevent heated exhaust gases from reaching engines that are not in operation.

Comments:

Engine Lubricating Oil System

Verify that the engine lubrication system is designed such that:

[Y] [N] [NA] 1. An automatic lube oil make-up system maintains proper oil level in the engine crankcase.

[Y] [N] [NA] 2. A full-flow duplex filter is provided, equipped with a spring-loaded, pressure-calibrated bypass valve.

[Y] [N] [NA] 3. Lubricating oil filters are threaded, spin-on or canister type full flow filters located for convenient servicing.

[Y] [N] [NA] 4. A valved oil pan drain is extended to the engine rail for servicing.

[Y] [N] [NA] 5. A lubrication oil pressure sensor is provided to pre-alarm on low oil pressure or low oil level, and will provide alarms and shut down the engine if the oil pressure falls below safe levels.

Comments:

Equipment Mounting and Grounding

[Y] [N] [NA] 1. Verify that all grounding cables are connected using two-hole bolted circumferential-crimp type connectors. No mechanical type connectors are allowed.

[Y] [N] [NA] 2. Verify that all equipment is anchored to the floor, and that all mounting and supports are in accordance with manufacturer's requirements and AT&T 810-610-155, Earthquake and Disaster Bracing for Central Office General Equipment Requirements.

[Y] [N] [NA] 3. Verify that the Standby AC plant is mounted on a welded, heavy steel skid base.

[Y] [N] [NA] 4. Verify that Standby AC plants above 400 kW (or units located on upper floors) have vibration isolators between the skid base and the concrete foundation.

[Y] [N] [NA] 5. Verify that Standby AC plants below 400 kW have vibration isolators between the engine-generator and the skid base, or vibration isolators between the skid base and the concrete foundation.

[Y] [N] [NA] 6. Verify that the generator frame is grounded, and that the equipment ground wire is sized per NEC 250-95.

[Y] [N] [NA] 7. Verify that the control cabinet, meter cabinet/panel, generator, engine and skid base are bonded together (using bare, stranded, ribbon type conductors) using two hole, copper, crimp type connectors.

[Y] [N] [NA] 8. Verify that day tanks (if equipped), engine skid base, metallic start battery racks, rectifiers, lube oil tank, etc., are bonded to the central office ground with No. 2 AWG stranded copper grounding conductor using two hole bolted circumferential-crimp type connectors.

[Y] [N] [NA] 9. Verify that the neutral of the generator output is not grounded except through its un-switched connection to the commercial supply's neutral.

[Y] [N] [NA] 10. Verify that ground fault protection is provided for all engine sets above 800 Amps.

[Y] [N] [NA] 11. Verify that all equipment connected to the engine is isolated from vibration. (i.e., fuel and exhaust piping, cooling system connections, control cabinet, AC panels, etc.)

[Y] [N] [NA] 12. Verify that each conduit is equipped with a green wire ground per NEC requirements.

[Y] [N] [NA] 13. When insulated cables of colors other than green are used as grounding conductors, verify that they are identified as grounding conductors with green tape at both ends per NEC standards.

[Y] [N] [NA] 14. Verify that neutral conductors are isolated from ground in all distribution cabinets and boards.

[Y] [N] [NA] 15. Verify that transformers are properly grounded.

[Y] [N] [NA] 16. Verify that all Central Office grounding conductors are properly labeled with their destination on both ends.

Comments:

Generator

[Y] [N] [NA] 1. Verify that the engine-generator has a standby rating (per requirements) at rated engine speed, 0.8 power factor lagging, 3-phase, and 60 Hz.

[Y] [N] [NA] 2. Verify that all generator connections are made using a UL-listed circumferential-crimp (compression) type solid copper long-barrel two-hole lug connectors.

Comments:

Cooling System

[Y] [N] [NA] 1. Verify that the cooling system is equipped with low water pre-alarm and shut down devices.

[Y] [N] [NA] 2. Verify that the engine cooling system is equipped with a thermostatically controlled AC immersion-jacket water heater sized per manufacturers guidelines.

[Y] [N] [NA] 3. Verify that the valved radiator drain is in a location easily accessible to maintenance personnel.

[Y] [N] [NA] 4. Verify that all coolant hoses are made of unpainted reinforced silicone rubber.

[Y] [N] [NA] 5. Verify that the cooling system has the appropriate coolant for the climate.

[Y] [N] [NA] 6. Verify that the radiator/cooling system has the appropriate ambient rating for site conditions.

[Y] [N] [NA] 7. Verify that electric fan motors are fed from a separate essential power source.

Comments:

15.04 Start and Control Systems Checklist

Electric Start and Control Systems

[Y] [N] [NA] 1. Verify that the engine start batteries and control batteries are located as close as practical to the engine, in a protected environment. The preferred location is adjacent to the engine-generator base at the starter motor.

[Y] [N] [NA] 2. Verify that start battery and control battery cables are physically guarded from contact with sharp objects and properly sized, and that all start battery connections are tight.

[Y] [N] [NA] 3. Verify that the engine start batteries are Nickel Cadmium type with explosion resistant vent caps.

[Y] [N] [NA] 4. Verify that the engine start batteries are dedicated “one system per engine”.

[Y] [N] [NA] 5. Verify that the start battery and control battery charger is a static type dual rate (float/equalize) charger with automatic and manual high rate charge control.

[Y] [N] [NA] 6. Verify that the start battery and control battery charger is capable of fully re-charging the engine start batteries within 8 hours after a full duty-cycle discharge.

[Y] [N] [NA] 7. Verify that the start battery and control battery charger contains the following options (minimum):

- Ammeter
- Voltmeter
- DC output failure contacts (for alarms)
- Indicating lamps and alarms showing unit operation (AC on, High DC Voltage, and Low DC Voltage
- Fused AC input and DC output.

[Y] [N] [NA] 8. Verify that all meters and measurement devices are calibrated and properly adjusted.

[Y] [N] [NA] 9. Verify that the charger case is properly grounded.

[Y] [N] [NA] 10. Verify operation of all local and remote alarms.

Comments:

Air Start Systems (if equipped)

[Y] [N] [NA] 1. Verify that air start systems contain an air dryer to prevent condensation in the lines.

[Y] [N] [NA] 2. Verify that air start systems are located as close to the engine as practical.

[Y] [N] [NA] 3. Verify that air start systems are sized per manufacturers' requirements.

[Y] [N] [NA] 4. Verify that air start systems contain a minimum of two air tanks and are equipped with isolation valves between the main tank and the spare tank.

[Y] [N] [NA] 5. Verify that (at least) one AC and one DC compressor are available to (jointly or alternately) recharge the air start tanks.

[Y] [N] [NA] 6. Verify installation and function of condensate drain.

[Y] [N] [NA] 7. Verify that the AC compressor is capable of recharging the tanks within 10 minutes after a total discharge.

[Y] [N] [NA] 8. Verify that the AC compressor is connected to an essential AC distribution panel (fed by commercial and standby AC power).

[Y] [N] [NA] 9. Verify that the DC compressor is capable of recharging the tanks within 30 minutes after a total discharge.

[Y] [N] [NA] 10. Verify that the DC compressor is connected to the -48 Volt Central Office battery.

[Y] [N] [NA] 11. Verify that the air start system is equipped with low and high pressure alarms.

Comments:

15.05 Fuel Checklist

Fuel Systems

[Y] [N] [NA] 1. Verify (by calculations and full load test) that the capacity of all fuel piping and pumps is adequate to supply sufficient fuel to the engine at full load.

[Y] [N] [NA] 2. Verify from manufacturers data that the engine is capable of using commercial Grade No. 2 diesel oil (No. 1 diesel fuel if the engine is subject to a seasonally cold environment).

CAUTION:
The use of No. 1 diesel fuel will de-rate the engine operating capacity, therefore, a larger engine may be necessary to provide the same kW output.

[Y] [N] [NA] 3. Verify that a fuel/water separator-filter is provided (in addition to the normal fuel filter).

[Y] [N] [NA] 4. Verify that a fuel heater is provided (if fuel tank or fuel lines are subject to freezing temperatures).

[Y] [N] [NA] 5. Verify that when day tanks are not provided the engine is equipped with a high-lift fuel pump capable of lifting fuel against a 20 foot suction head.

[Y] [N] [NA] 6. Verify that fuel piping is constructed of black-iron schedule 40 pipe or other material conforming to AT&T 760-220-164 and NFPA 30.

[Y] [N] [NA] 7. Verify that fuel piping contains fusible link fire isolation valves in the supply connections.

[Y] [N] [NA] 8. Verify that fuel piping contains anti-siphon or automatic flow shut-off devices to prevent leaks.

[Y] [N] [NA] 9. Verify that fuel piping includes appropriate flow prevention devices to ensure that no continuous flow of fuel occurs to the engine or day tank when not in operation.

[Y] [N] [NA] 10. Verify that fuel piping uses stainless steel wire reinforced flexible connections at all transition points.

[Y] [N] [NA] 11. Verify that a rotary or lever operated manual fuel pump is provided on the engine for the purpose of priming.

[Y] [N] [NA] 12. Verify that there is a remote means for shutting off the standby engine fuel supply.

[Y] [N] [NA] 13. Verify that the entire fuel piping system has been properly pressure tested and is free from leaks.

Comments:

Day Tanks

[Y] [N] [NA] 1. Verify that the day tank pumps are provided in accordance with AT&T practice 760-220-164.

NOTE:
A manual pump may not be appropriate when day tanks are located on an upper floor. A DC pump may be substituted in this situation.

[Y] [N] [NA] 2. Verify that the day tank pump controls have “high level” pump shut-off and alarm.

[Y] [N] [NA] 3. Verify that the day tank outlet piping is below the level of the engine injectors or combustor.

[Y] [N] [NA] 4. If the day tank is designed to be on an upper floor, verify that the interconnecting piping is located within a containment pipe.

[Y] [N] [NA] 5. Verify that secondary containment encloses the fuel piping in areas where telephone or electrical equipment is placed.

[Y] [N] [NA] 6. Verify that day tank construction includes a 110% containment basin with a float switch (with alarm and shutdown features) located near the bottom of the basin to indicate presence of fuel.

[Y] [N] [NA] 7. Verify the day tank fuel return pipe operation. The fuel return pipe should be sized at 1.5 times the day tank fuel feed pipe, contain no valves or obstructions, and be designed to direct fuel oil back to the primary tank in the event of an overfill condition.

[Y] [N] [NA] 8. Verify that the day tank is properly vented outside of the building at an elevation of 12 ft. minimum above grade and at least 4 feet above the highest point in the fuel system. (See NFPA 30).

[Y] [N] [NA] 9. Verify that day tanks are sized to provide 2.5 hours of fuel to all connected generators at full load. Aggregate capacity of the unenclosed tanks supplying one engine should not exceed 660 gallons, with aggregate capacity of **all** unenclosed day and supply tanks in one building not to exceed 1320 gallons.

[Y] [N] [NA] 10. Verify that float switches operate normally.

[Y] [N] [NA] 11. Verify that all alarms and shutdown features are working properly.

Comments:

Main Fuel Tank

For fuel storage standards refer to AT&T 760-220-164, Storage Systems, Combustible Liquid Fuels Design, Installation, and Maintenance.

[Y] [N] [NA] 1. If the main fuel tank is above the day tank, verify that the pumping system is located above the main tank or has an anti-siphon shut-off to avoid gravity feed.

[Y] [N] [NA] 2. Verify that the main tank has access for water removal.

[Y] [N] [NA] 3. Verify that a gauge is provided that indicates the quantity of fuel in the main tank.

[Y] [N] [NA] 4. Verify that there is a low fuel level alarm. (set for 24-hour supply)

[Y] [N] [NA] 5. Verify that the tank has sufficient capacity to provide fuel for a 72-hour full-load engine run when only 3/4 full.

[Y] [N] [NA] 6. Verify that the main tank is properly vented. (See NFPA 37)

[Y] [N] [NA] 7. Verify that fuel piping is constructed of black iron, schedule 40 pipe or other material conforming to AT&T 760-220-164 and NFPA 30.

[Y] [N] [NA] 8. If any filters (other than furnished as part of the engine-generator set) are used, verify that they are on the pressure (output) side of auxiliary pumps and are alarmed for excessive pressure drop.

[Y] [N] [NA] 9. Verify that all connections to the engine-generator set are made via flexible, stainless-steel reinforced connectors.

[Y] [N] [NA] 10. In the case of multiple engine-generator sets, verify that each set has a dedicated fuel line.

[Y] [N] [NA] 11. Verify that all “fixed” fuel system piping is properly supported and isolated from any vibrations.

Comments:

15.06 Control Panels Checklist

Engine Mounted Control Panel

[Y] [N] [NA] 1. Verify that the control cabinet contains operation selector switch (automatic, off/reset, manual, test).

[Y] [N] [NA] 2. Verify that the control cabinet contains voltmeter equipped with a 7-position selector switch.

[Y] [N] [NA] 3. Verify that the control cabinet contains ammeter equipped with a 4-position selector switch.

[Y] [N] [NA] 4. Verify that the control cabinet contains frequency meter (55-65 Hz).

[Y] [N] [NA] 5. Verify that the control cabinet contains kilowatt meter.

[Y] [N] [NA] 6. Verify that the control cabinet contains frequency-control-adjustment rheostat.

[Y] [N] [NA] 7. Verify that the control cabinet contains voltage-adjustment rheostat.

[Y] [N] [NA] 8. Verify that the control cabinet contains emergency stop push-button.

[Y] [N] [NA] 9. Verify that the control cabinet contains cabinet heater with thermostat to prevent condensation (for outside units).

[Y] [N] [NA] 10. Verify that the control cabinet contains alarm lamp test push-button.

[Y] [N] [NA] 11. Verify that the control cabinet contains power factor meter (if unit is to be operated in parallel).

[Y] [N] [NA] 12. Verify that the control cabinet contains engine-running hour meter.

Engine instrumentation (may be located on the engine or control panel) should include:

[Y] [N] [NA] 13. fuel pressure gauge

[Y] [N] [NA] 14. engine outlet coolant temperature

[Y] [N] [NA] 15. engine lube oil pressure

[Y] [N] [NA] 16. Verify that the status and alarm annunciator panel contains the alarms as identified in Chapter 8.

[Y] [N] [NA] 17. Verify that alarm horn and silence push-button with auto-reset option is provided.

[Y] [N] [NA] 18. Verify that automatic start control with cycle cranking option is provided.

[Y] [N] [NA] 19. Verify that contacts to control auxiliary functions (i.e., dampers, fans, etc. - minimum 4 sets) option is provided.

[Y] [N] [NA] 20. Verify that contacts for remote start (unmanned locations) option is provided.

Emergency shutdown requiring a manual reset (on the control panel) on any of the following abnormal conditions (minimum):

[Y] [N] [NA] 21. overspeed

[Y] [N] [NA] 22. high coolant temperature

[Y] [N] [NA] 23. overcrank

[Y] [N] [NA] 24. low water level

[Y] [N] [NA] 25. low oil pressure

[Y] [N] [NA] 26. under frequency

[Y] [N] [NA] 27. generator overvoltage

[Y] [N] [NA] 28. emergency stop push-button activation

[Y] [N] [NA] 29. Verify that all alarm indicators and controls are properly labeled.

[Y] [N] [NA] 30. Verify that all control fuses indicate or alarm to an easily visible location on the outside of the cabinet.

[Y] [N] [NA] 31. Verify that clearly marked remote stop switches are provided on each control cabinet, outside each interior exit, and inside each exterior exit.

[Y] [N] [NA] 32. Verify that all local and remote alarms are properly installed and working for all components per AT&T 154-103-101, Alarm Standards Manual.

Comments:

Floor Mounted Control Panel

Verify that floor mounted control boards are:

[Y] [N] [NA] 1. front and rear accessible.

[Y] [N] [NA] 2. rated in correspondence with the generators and AC distribution system.

Verify that the bussing is:

[Y] [N] [NA] 3. insulated and braced to withstand the short circuit current available at rated voltage.

[Y] [N] [NA] 4. insulated with a minimum 2" air space between phase conductors.

Verify that main generator breakers (> 1600 A):

[Y] [N] [NA] 5. are power (stored energy), draw-out, solid-state-trip rated for the appropriate voltage and interrupting capacity.

[Y] [N] [NA] 6. are adjustable for short/long time delay and short/long time pickup for each pole.

[Y] [N] [NA] 7. contain zero-sequence or residual ground fault alarms with adjustable pickup and time delay.

[Y] [N] [NA] 8. contain trip indicators that show “overload,” and “short circuit” trips.

Verify that main generator breakers (< 1600 A):

[Y] [N] [NA] 9. are insulated case, draw-out, solid state trip rated for the appropriate voltage and symmetrical interrupting capacity.

[Y] [N] [NA] 10. are adjustable for instantaneous pickup, short/long time delay, and short/long time pickup for each pole.

[Y] [N] [NA] 11. contain zero-sequence or residual ground fault alarms with adjustable pickup and time delay.

[Y] [N] [NA] 12. contain trip indicators that show “overload,” “short circuit,” and “ground fault,” trips.

[Y] [N] [NA] 13. Verify that auxiliary engine run contacts are provided for control of auxiliary systems required for operation (i.e., ventilation, fuel system, regulator, fans, water pump, etc.)

[Y] [N] [NA] 14. Verify that all metering is “real time” (connected to PT's, CT's, and transducers.)

Verify that the control board contains the following (as a minimum):

[Y] [N] [NA] 15. three phase CT test block with shorting CT contacts and insertion tool.

[Y] [N] [NA] 16. voltmeter equipped with a 7-position selector switch

[Y] [N] [NA] 17. ammeter equipped with a 4-position selector switch

[Y] [N] [NA] 18. frequency meter, 55-65 Hz

[Y] [N] [NA] 19. kilowatt meter

[Y] [N] [NA] 20. elapsed time meter

[Y] [N] [NA] 21. engine running hour meter

[Y] [N] [NA] 22. power factor meter, 0.5 lag to 0.5 lead (units > 200 kW)

[Y] [N] [NA] 23. operation selector switch (automatic, off/reset, manual, test)

[Y] [N] [NA] 24. voltage adjustment rheostat

[Y] [N] [NA] 25. frequency adjustment rheostat

[Y] [N] [NA] 26. emergency stop push-button

[Y] [N] [NA] 27. lamp test push-button

[Y] [N] [NA] 28. alarm horn and silence push button with auto reset

NOTE:
The following instrumentation should be located on the engine:

[Y] [N] [NA] 29. engine outlet coolant temperature

[Y] [N] [NA] 30. engine lubricating oil pressure

[Y] [N] [NA] 31. fuel pressure

Verify that the following miscellaneous equipment and features are provided:

Emergency shutdown requiring a manual reset (on the control panel) on any of the following abnormal conditions (minimum):

[Y] [N] [NA] 32. overspeed

[Y] [N] [NA] 33. high coolant temperature

[Y] [N] [NA] 34. overcrank

[Y] [N] [NA] 35. low water level

[Y] [N] [NA] 36. low oil pressure

[Y] [N] [NA] 37. under frequency

[Y] [N] [NA] 38. generator over-voltage

[Y] [N] [NA] 39. emergency stop push-button activation

[Y] [N] [NA] 40. Verify that the status and alarm annunciator panel contains the alarms as identified in Chapter 9.

[Y] [N] [NA] 41. Verify that all control wiring is color coded and laced in bundles (20 wire maximum).

[Y] [N] [NA] 42. Verify that all circuit breakers, alarm indicators, and controls are properly labeled.

[Y] [N] [NA] 43. Verify that all control fuses indicate or alarm to an easily visible location on the outside of the cabinet.

[Y] [N] [NA] 44. Verify that clearly marked emergency stop switches are provided on each control cabinet, outside each interior exit, and inside each exterior exit.

[Y] [N] [NA] 45. Verify that all local and remote alarms are properly installed and working for all components per AT&T 154-103-101, Alarm Standards Manual.

Comments:

Paralleling Switchboards

For dedicated floor or engine mounted control panels that include paralleling controls and alarms, refer for additional information to the floor and engine mounted control panel sections.

All applicable items covered in the section for floor mounted control panels should be verified in addition to the requirements listed below:

[Y] [N] [NA] 1. Verify that all electromagnetic relays are plug-in type, with transparent covers and LED indication when operated.

[Y] [N] [NA] 2. Verify that the bussing is insulated and braced to withstand the available short-circuit current.

[Y] [N] [NA] 3. Verify that the bussing joints are mated with a minimum of 50% overlap.

[Y] [N] [NA] 4. Verify that the bussing is interleaved where multiple busses per run are required.

[Y] [N] [NA] 5. Verify that the bussing is bolted with a minimum of two bolts per joint with flat and lock washers.

[Y] [N] [NA] 6. Verify that each section of the switchboard is separated by a full 14 gauge steel barrier.

[Y] [N] [NA] 7. Verify that all control fuses are indicated on the front of the panel, and have contacts for remote indication.

[Y] [N] [NA] 8. Verify that a mimic bus is provided on the front of all switchboards.

[Y] [N] [NA] 9. Verify that separate control and breaker sections are provided for each engine generator set.

[Y] [N] [NA] 10. Verify that the master control section has generator synchronizer selector switch (to manually parallel engines).

[Y] [N] [NA] 11. Verify that the master control section has digital bus frequency relay (to initiate load shedding at a frequency decay of 58 Hz).

[Y] [N] [NA] 12. Verify that the master control section has re-transfer mode selector switch (automatic - manual) with lighted push-button.

[Y] [N] [NA] 13. Verify that the master control section has three-phase test block.

[Y] [N] [NA] 14. Verify that the master control section has synchroscope with 4 1/2" dial (accurate to 1%).

[Y] [N] [NA] 15. Verify that utility and generator wattmeters are present and that indications are generated directly from CT's, PT's, or transducers.

[Y] [N] [NA] 16. Verify that utility and generator voltmeters are present and that indications are generated directly from CT's, PT's, or transducers.

[Y] [N] [NA] 17. Verify that utility and generator ammeters are present and that indications are generated directly from CT's, PT's, or transducers.

[Y] [N] [NA] 18. Verify that 7-position voltmeter switches are present and that indications are generated directly from CT's, PT's, or transducers.

[Y] [N] [NA] 19. Verify that 4-position ammeter switches are present and that indications are generated directly from CT's, PT's, or transducers.

[Y] [N] [NA] 20. Verify that bus frequency meter is present and that indications are generated directly from CT's, PT's, or transducers.

[Y] [N] [NA] 21. Verify that bus power factor meter is present and that indications are generated directly from CT's, PT's, or transducers.

[Y] [N] [NA] 22. Verify that engine demand on-off selector switch is present and that indications are generated directly from CT's, PT's, or transducers.

[Y] [N] [NA] 23. Verify the presence of swing panel with synchroscope, synchronizing lights, frequency meter, and bus voltmeter for manual synchronization is present and that indications are generated directly from CT's, PT's, or transducers.

[Y] [N] [NA] 24. Verify the presence of manual control of transfer devices is present and that indications are generated directly from CT's, PT's, or transducers.

[Y] [N] [NA] 25. Verify the presence of alarm and status panel with audible and visual indication annunciator as identified in Chapter 10.

[Y] [N] [NA] 26. Verify that the master cubicle contains the alarm and status annunciators as identified in Chapter 10.

[Y] [N] [NA] 27. Verify that clearly marked remote stop switches are provided on each control cabinet, outside each interior exit, and inside each exterior exit.

[Y] [N] [NA] 28. Verify that all local and remote alarms are properly installed and working for all components per AT&T 154-103-101, Alarm Standards Manual.

Comments:

15.07 Engine Room and Exterior Engine Enclosure Checklist

Standby Engine Room Design Criteria

[Y] [N] [NA] 1. Verify that AC lighting (fed from an essential AC bus) is evenly distributed on all sides of the plant and control equipment.

[Y] [N] [NA] 2. Verify that emergency DC lighting is evenly distributed on all sides of the plant and control equipment to allow safe access and egress to the area.

[Y] [N] [NA] 3. Verify that new rooms are protected with a pre-action automatic sprinkler system (including the day tank area.)

[Y] [N] [NA] 4. Verify that day tanks exceeding 600 gallons (aggregate) are separated from the engine generator by a 3-hour fire-rated enclosure that contains an automatic fire suppression system.

[Y] [N] [NA] 5. Verify that standby AC plant areas are equipped with heat detectors and UV/IR-plus smoke detectors.

[Y] [N] [NA] 6. Verify that a thermostatically controlled room exhaust fan is provided (powered from the essential bus), and will operate at an appropriate temperature (typically 90^{o} F).

[Y] [N] [NA] 7. Verify that the engine radiator or enclosure exhaust is ducted to an exhaust opening.

[Y] [N] [NA] 8. Verify that properly controlled shutters are used where cold and dusty environments are present.

[Y] [N] [NA] 9. If filters are used, verify that they are installed for ease of maintenance and replacement.

[Y] [N] [NA] 10. Verify that air inlet openings are located so as to not be restricted by outside structures or weather conditions (i.e., are they above the snow line).

[Y] [N] [NA] 11. Verify that air inlet openings are sufficiently separated so as to prevent recirculation.

Comments:

Exterior Engine Enclosures

[Y] [N] [NA] 1. Verify that all enclosures are designed and equipped with the following:

- main breaker panel (sized for AC equipment within the enclosure)
- duplex work receptacle (20 A, 125 V, 2-Phase, 3-wire)
- generator heater, engine control panel heater, or room heater
- wall mounted carbon dioxide portable bottle type fire extinguishers.

[Y] [N] [NA] 2. Verify that walk-in enclosures contain 24 V DC operating lights, pre-wired and connected to the engine crank batteries, in addition to fluorescent AC lights, switched at the main personnel door.

Comments:

15.08 Operational Testing Checklist

Factory Testing

Before the equipment is installed, a factory test and log of the diesel engine-generator set, showing a minimum of 4 hours testing at 100 percent rated load (at worst case site ambient temperature) shall be submitted to the purchaser. Factory test data and recording sheets are to be available for comparisons during the on-site acceptance test. Load testing for larger units and units being paralleled shall have a 0.8 power factor lagging continuously.

All engine safety features shall be tested for operation and calibrated prior to the load test.

All control and relay functions shall be tested for proper operation.

A high potential test of the generator shall be performed.

All tests shall be conducted under the worst ambient temperature expected at the site. The actual radiators to be installed shall be used.

The following engine run data shall be recorded at 15 minute intervals:

- Time
- kW output
- Output voltage
- Amperes
- rpm
- Input water temperature
- Output water temperature
- Input oil temperature
- Fuel pressure
- Oil pressure
- Ambient temperature
- Radiator inlet air temperature if different than ambient.

All test sheets will be furnished to the owner at the completion of the test. The supplier shall contact the AT&T Building Engineer for scheduling and coordination of the factory test. AT&T personnel or an AT&T representative shall have the

opportunity to witness the test. Normal preliminary diesel engine and generator tests shall have been performed before unit assembly.

Site Testing

Prior to acceptance of the standby AC plant installation, an entire system test including an 8-hour load test shall be performed. If, for any reason, the 8-hour load test is terminated, the entire 8-hour test shall be restarted until satisfactory results are obtained.

The 8-hour test shall include one half-hour at half-load, one half-hour at three-quarters load, and 7 hours at full load.

The contractor shall provide qualified personnel, load banks, test equipment, cable, etc. for this system test.

Prior to the load test, the following verifications should be performed:

- Verification of the proper operation of all safety shutdowns.
- Verification of all alarms (local and remote).
- Verification of all control functions (automatic and manual).
- If the system is equipped with automatic load shed and restore, the system shall be tested for proper operation.

The system test shall include the following:

- During the 8-hour load test, the ability of the standby AC plant to accept one-step loads shall be verified at one-half, three-quarter and full loads. Voltage and frequency transient response shall be recorded and verified as meeting the specification.
- During the entire load test the following data shall be recorded at 15 minute intervals.
    - — Time
    - — kW
    - — Amperes
    - — Voltage
    - — Frequency
    - — Input water temperature
    - — Output water temperature
    - — Oil temperature

- — Oil pressure
- — Fuel pressure
- — Exhaust back-pressure
- — Ambient temperature
- — Radiator inlet air temperature
- — Oil, coolant or fuel leakage

The following tests of the day tank fuel system shall be performed prior to acceptance:

- Verify the proper operation of the duplex pumps and the pump controller (manual and automatic).
- Verify the following day tank alarms:
  - — high fuel level
  - — low fuel level
  - — fuel in containment basin

Verify proper operation of all motor-controlled louvers, shutters and ventilation fans.

Upon completion of the load test, verification of the standby systems' ability to accept building essential load on a simulated commercial AC failure, and provide automatic return to the commercial source shall be performed. The system shall run for one hour under building load.

Verify that the entire AC standby system is accurately documented by drawings such as single line diagrams, riser diagram, and P&ID mechanical system drawings built in AutoCad Release 12 per the AT&T Computer Aided Drafting Specification.

All test sheets shall be furnished to the owner at the completion of the tests. AT&T personnel or AT&T representatives including On-Site Work Force representation shall be present to witness all tests.

15.09 Documentation and Manuals Checklist

Documentation

Upon completion of the project, two complete operation and maintenance manuals shall be provided to the customer. The manuals shall contain the following information.

- Wiring diagrams of all interconnecting control systems
- Wiring diagrams for alarm interface
- Recommended maintenance procedures and intervals for all equipment
- Ordering information for spare parts
- Warranty documentation
- Technical data sheets for all equipment
- Complete interconnection diagrams which indicate all components of the system
- Complete operating instructions
- Troubleshooting guidelines

In addition to the normal paper copies of the diagrams, an AutoCad electronic file shall be submitted for each diagram.

Verify that the following minimum operating documents are available on-site:

[Y] [N] [NA] 1. Verify that a safety shutdown list is provided on the set and in the generator maintenance manual. Verify that the appropriate safety controls have been provided based on the shutdown list.

[Y] [N] [NA] 2. Verify that engine-generator test records, lubrication, fuel and start battery records are available and satisfactory.

[Y] [N] [NA] 3. Verify that “engine operating instructions” are posted near the unit and provide clearly defined, step-by-step procedures for starting, running and stopping the engine.

[Y] [N] [NA] 4. Verify that “AC Load-Shedding” plan is in place (if needed).

[Y] [N] [NA] 5. Verify that lockout/tagout procedures in place for the AC switchgear and distribution.

[Y] [N] [NA] 6. Verify that logbook for commercial power contain power company emergency contacts.

[Y] [N] [NA] 7. Verify that logbook for commercial power contain AC switchgear maintenance and trouble logs.

[Y] [N] [NA] 8. Verify that logbook for commercial power contain trouble log for commercial AC power.

[Y] [N] [NA] 9. Verify that logbook for commercial power contain AC load management plan.

[Y] [N] [NA] 10. Verify that logbook for commercial power contain emergency contacts for electrical contractors, switchgear maintenance, technical support.

[Y] [N] [NA] 11. Verify that logbook for commercial power contain AC switchgear inspection routine. (see CAMS SJI 770-075 through 770-088)

[Y] [N] [NA] 12. Verify that readings of commercial AC voltages are posted on the main AC switchgear. (see CAMS SJI 155-703)

[Y] [N] [NA] 13. Verify that the portable engine hook-up plan for the building includes where to obtain a portable engine.

[Y] [N] [NA] 14. Verify that the portable engine hook-up plan for the building includes an electrical contractor, if required.

[Y] [N] [NA] 15. Verify that the portable engine hook-up plan for the building includes instructions on providing a fuel supply.

[Y] [N] [NA] 16. Verify that the portable engine hook-up plan for the building includes a parking location for the engine.

[Y] [N] [NA] 17. Verify that the portable engine hook-up plan for the building includes a cable path for portable generator cables.

[Y] [N] [NA] 18. Verify that the portable engine hook-up plan for the building includes where to hook up the cables.

[Y] [N] [NA] 19. Verify that the portable engine hook-up plan for the building includes the size of engine required.

[Y] [N] [NA] 20. Verify that the portable engine hook-up plan for the building includes a load shed plan, if necessary.

Comments:

As Built Drawings and Specifications

[Y] [N] [NA] 1. Verify that as-built drawings of the AC switchgear and distribution system are on-site.

[Y] [N] [NA] 2. Verify that the AC single-line diagram is posted near the AC switchgear.

[Y] [N] [NA] 3. Verify that the as-built AC single-line diagram (submitted per section 2.03) contains standby engine tie-in.

[Y] [N] [NA] 4. Verify that the as-built AC single-line diagram (submitted per section 2.03) contains portable engine tie-in.

[Y] [N] [NA] 5. Verify that the as-built AC single-line diagram (submitted per section 2.03) contains breaker sizes and trip settings.

[Y] [N] [NA] 6. Verify that the as-built AC single-line diagram (submitted per section 2.03) contains breaker designations.

[Y] [N] [NA] 7. Verify that the as-built AC single-line diagram (submitted per section 2.03) contains indication of essential and non-essential loads.

[Y] [N] [NA] 8. Verify that the as-built AC single-line diagram (submitted per section 2.03) contains location of AC panels.

[Y] [N] [NA] 9. Verify that the as-built AC single-line diagram (submitted per section 2.03) contains interlock devices.

[Y] [N] [NA] 10. Verify that the as-built AC single-line diagram (submitted per section 2.03) contains conduit and cable sizes.

[Y] [N] [NA] 11. Verify that as-built construction drawings have been completed and submitted to the Building Engineer per section 2.03.

[Y] [N] [NA] 12. Verify that instruction manuals, shop drawings, switchgear test results, etc. are available for maintenance use.

[Y] [N] [NA] 13. Verify that all equipment test results have been submitted and approved.

Comments:

Operation and Maintenance Manuals

Upon completion of each AC standby plant installation, an operational and maintenance manual must be compiled for each system and its support equipment. The manuals shall include wiring diagrams, technical data sheets and ordering information on replacement parts, for the plant and all auxiliary equipment.

All diagrams shall include the following information as a minimum:

- Complete interconnection diagrams which indicate all components of the system.
- Complete diagrams of the internal wiring for each of the items of equipment.
- The diagrams shall have terminals identified to facilitate installation, operation, and maintenance.

All operating instructions shall include the following information as a minimum:

- Manufacturer's operating instructions for each piece of equipment furnished.
- Specific operating instructions for each portion of the system which involves multiple items of equipment.

- Instructions for charging, start-up, control or sequencing of operation, phase of seasonal variations, shut-down, safety and similar operations.
- Engine operating instructions shall be posted near the unit and provide clearly defined, step-by-step procedures for starting, running, and stopping the engine.
- Troubleshooting guidelines

All maintenance manuals shall include the following information as a minimum:

- Emergency instructions including addresses and telephone numbers for service sources.
- Procedures for all required periodic system maintenance.
- Manufacturer's maintenance data, including complete parts lists, partial detailed parts drawings, etc. for each operational item in each system.
- Wiring and control diagrams for all systems.
- Troubleshooting guidelines
- Manufacturer's product warranties and guarantee relating to the system and equipment items in the system.
- Complete shop drawings related to the entire system.

Each maintenance manual shall be bound in vinyl-covered, 3-ring binders, with pocket-folders for folded drawings. The manual shall have an index with tabs for each section.

15.10 Parts and Service Checklist

The standby AC plant set supplier shall be an authorized dealer for the unit provided, and shall be factory trained and authorized to provide service and parts for both the diesel engine and generator at any time during the day or night. Parts stock shall be maintained for the diesel engine-generator by the supplier of the package. A description of the services and parts support capability shall be included with submittal information as covered in Chapter 2 of this document.

Spare Parts

Verify that the following spare parts are provided on-site at the completion of the project.

- 1 of each type of belt
- 1 of each type of hose with clamp
- 1 of each type of air filter
- 1 of each type of plug in relay and timer
- 6 of each type of fuse
- 6 of each type of lamp
- 3 of each type of oil filter
- 3 of each type of fuel filter

Codes and Standards

16

The diesel engines, combustion turbines, and generators shall conform to the requirements of, and be suitable for, application in accordance with:

- Diesel Engines
  - — ANSI/AFBMA-9 - Load Ratings and Fatigue Life for Ball Bearings
  - — ANSI/AFBMA-11 - Load Ratings and Fatigue Life for Roller Bearings
  - — ASME B31.1 - Power Piping Code
  - — NFPA-30 - Flammable and Combustible Liquids Code
  - — NFPA-37 - Installation and use of Stationary Combustion Engines and Gas Turbines
  - — UL-80 - Steel Inside Tanks for Oil Burner Fuel
  - — DEMA - Diesel Engine Manufacturers Association
  - — National Electric Code

The combustion turbines shall conform to the requirements of, and be suitable for, application in accordance with:

- Combustion Turbines
  - — ANSI B16.5 - Steel Pipe Flanges and Flanged Fittings
  - — ANSI B16.11 - Forged Steel Fittings, Socket Welding and Threaded
  - — ANSI B31.1 - Power Piping Code

- — API 615 - Mechanical Drive Steam Turbines for General Refinery Service
- — ANSI/AFBMA9 - Load Ratings and Fatigue Life for Ball Bearings
- — ANSI/AFBMA11 - Load Ratings and Fatigue Life for Roller Bearings
- — NFPA 37 - Installation and use of Stationary Combustion Engines and Gas Turbines
- — National Electric Code

The engine generators shall conform to the requirements of, and be suitable for, application in accordance with:

- Generators
  - — ANSI/AFBMA-9 - Load Ratings and Fatigue Life for Ball Bearings.
  - — ANSI/AFBMA-11 - Load Ratings and Fatigue Life for Roller Bearings
  - — ANSI C50.10 - General Requirements for Synchronous Machines
  - — ANSI C50.12 - Requirements for Salient Pole Synchronous Generation and Condensers
  - — ANSI S1.4 - Sound Level Meters
  - — ANSI S1.6 - Preferred Frequencies and Band Numbers for Acoustical Measurements
  - — ANSI S1.11 - Octave, Half Octave, and Third Octave Band Filter Sets
  - — IEEE 85 - Test Procedures for Airborne Noise Measurement on Rotating Electric Machinery
  - — IEEE 112 - Standard Test Procedure for Polyphase Induction Motors and Generators
  - — IEEE 115 - Test Procedure for Synchronous Machines
  - — NEMA MG-1 - NEMA Standards for Motors and Generators
  - — NFPA 37 - Standard for the Installation and Use of Stationary Combustion Engines and Gas
- Turbines
  - — NFPA 110 - Emergency and Standby Power Systems
  - — UL 80 - Steel Inside Tanks for Burner Fuel
  - — National Electric Code
- Related AT&T Practices on Standby Plants:
  - — Engine Fuel Storage - 065-320-301

— Alarm Standards Manual - 154-103-101

— Earthquake Design Loads - 760-200-023

— Storage Systems, Combustible Liquid Fuels, Design, Installation, and Maintenance - 760-220-164

Glossary

GL

AC Standby Plant

A generator set driven by a prime mover, either a diesel engine or a combustion gas turbine. The backup power source consisting of one or more generating sets, suitable controls, transfer equipment, a fuel supply, auxiliary equipment such as fuel tanks and pumps, starting batteries and ventilation systems for handling exhaust gasses and intake air and silencers.

Combustible Material

Material capable of undergoing a chemical process involving oxidation sufficient to produce light and heat.

Commercial Power

AC power provided by the local electric utility.

Commercial Power Failure

A condition occurring when the commercial power source is interrupted or goes below a specified voltage or frequency limit.

Connected Load

The sum of the continuous ratings of the power-consuming apparatus connected to the system.

Current Transformer (CT)

An instrument transformer inserted in a power circuit for metering or controlling the line current.

Diesel Engine

An internal combustion engine in which the fuel is injected into compressed air and ignited entirely by the heat resulting from the compression of the air supplied for combustion.

Diverse Loads

Multiple similar loads which may or may not be redundant.

Electrical Protective Systems

Those systems furnishing protection for equipment and personnel which are considered to be the grounding, lightning protection and surge protective device systems.

Engine-Generator (Standby)

Used to generate standby AC power to sustain the essential load during commercial power failure. The generator may be powered by a gas turbine, diesel, or gasoline engine.

Essential Bus

The electrical buses (switchgear and switchboards) which supply the essential loads.

Essential Loads

Electrical loads which, because of their criticality to operation of telecommunications equipment, are backed up by a standby power system. Essential loads support network equipment and can tolerate only short periods of downtime (see 11.05 for examples).

Fault Current

The maximum current flow for all AC sources that would be available under the worst short-circuit conditions.

Gas Turbine Engine

A rotary prime mover in which air is compressed, heated and then expanded to produce useful power.

Generator

Converts mechanical energy to electrical energy.

Governor

A device used to control a prime mover's (engine's) speed.

Load Shedding

Automatic removal of low-priority loads from a generating system when total load exceeds the available generator capacity, due to either an increase in high-priority loads or the loss of one or more engine-generators.

Main Bus

The electrical buses (switchgear and/or switchboards) which supply the nonessential loads as well as the essential busses. In some cases called a nonessential bus.

Non-Combustible

A material which, in the form in which it is used and under conditions anticipated, will not ignite, burn, support combustion, or release flammable vapors when subject to fire or heat.

Non-Essential Bus

The electrical buses (switchgear and/or switchboards) which supply the nonessential loads as well as the essential buses. In some cases called the main bus.

Non-Essential Loads

Electrical loads which, because of their lack of criticality, do not require a standby AC plant power supply.

Paralleling

The procedure used to connect two or more synchronized alternators in parallel.

Priority Loads

In systems where load management schemes are used, a priority is assigned to each load. Loads with the highest priority are powered first and shed last.

Redundant Parallel Operation

A parallel connection of two or more (n) power supplies, with the total power required by the load equal to or less than the power capabilities of (n-1) of the power supplies.

Starting Battery

A source of reserve energy used for cranking the electric starting motor of an engine-generator set.

Synchronism

The state in which two or more generators have the same voltage, the same frequency, the same phase sequence, and their voltages in phase.

Synchroscope

An instrument that provides a visual indication of proper time for closing the switch when synchronizing generators are connected in parallel to the load.

Transfer Switch

A switch designed so that it will disconnect the load from one power source and reconnect it to another source. The switch may be automatic or manual.

Voltage Dip

The instantaneous reduction in generator voltage, resulting from an increase in load, before the voltage regulator begins to correct it.