

# Fiber Optics Acceptance Test Procedures

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# General

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- Purpose** This practice standardizes and outlines GTE Telephone Operations Carrier Restoration Control Center (CRCC) procedures used in the Area operating units to test a Fiber Optic (FO) system prior to placing the system in-service.
- Filing Instructions** File this practice in numerical order in your GTE Telephone Operations Practices set.
- Forms** The form referenced in this practice is available at local stationery storerooms.
- Copyright and Responsibility** This practice was written by the Operations Department and published by the Telephone Operations Administrative Services Group. For more information about this practice contact the Senior Administrator - Maintenance - North Area.
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## Overview

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- Introduction** To ensure that the system meets GTE Telephone Operations' standards for quality service, perform a Fiber Optics Acceptance Test prior to placing the fiber optic system in-service.
- WARNING:** DO NOT LOOK **directly into the Fiber Optic cable. Laser light is invisible and may cause damage to your eyes.** Direct viewing **may not cause pain, but SERIOUS damage to the retina of the eye is possible.**

- Acronyms** The chart below lists the acronyms used in this practice:

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ACRONYM	MEANING
AC	Alternating Current
BER	Bit Error Rate
C O	Central Office
CRCC	Carrier Restoration Control Center
DNAS	Digital Network Administration Signal
DSX	Digital Signal Cross Connect
DS1	Digital Service Level One (1.544 mega bits)

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(continued)

## Overview, continued

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### Acronyms. continued

ACRONYM	MEANING
DS1C	Digital Service Level One "C" (3.152 mega bits)
DS2	Digital Service Level Two (6.132 mega bits)
DS3	Digital Service Level Three (144.738 mega bits)
ERO	Equipment Repair Order
FO	Fiber Optic
LED	Light Emitting Diode
MUX	Multiplexer
OTDR	Optical Time Domain Reflectometer
PC	Personal Computer
PCM	Pulse Code Modulation
PRBS	Pseudo Random Bit Stream
PWC	Printed Wiring Card
QRSS	Quasi-Random Signal Source
TSS	Technical Support Services

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## Departmental Responsibilities

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### Introduction

Several departments are responsible for performing the functions necessary to complete a fiber optic acceptance test. Those functions include the:

- Engineering.
- Installation.
- Acceptance.
- Turn-up of a fiber optic system.

### Engineering

The Engineering Department:

- Prepares work orders, associated specifications and documentation.
- Verifies and ensures latest version of equipment is ordered.
- Orders test equipment (as required).
- Orders special equipment, i.e., printers, PC's, tools and others (as required).
- Notifies CRCC when equipment has been ordered, proposed application and proposed test ready date.
- Notifies Manager-Technical Support Services and Manager-Maintenance Administration of first of a kind installation within their area of responsibility.

Engineering is responsible for providing sufficient maintenance spare parts according to manufacturer's recommended quantities.

**NOTE: The quantity of maintenance spares must be according to manufacturer's recommended quantities unless specifically indicated that GTE Engineering has determined another quantity to supply.**

# Departmental Responsibilities, continued

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## Network Construction and Engineering

The Network Construction and Engineering Department:

- Installs and inventories all equipment and facilities.
- Makes all fiber cross connects prior to end-to-end testing and acceptance.
- Updates prints and supporting documents.
- Follow-up on back ordered or missing material.
- Corrects any discrepancies noted by CRCC.
- Labels all equipment, bays, racks, frames, fuses, DSX jacks, etc.
- Notifies CRCC of start date of installation and when system is ready for acceptance.
- Turns over spare parts, test equipment, documentation, and other pertinent material to CRCC.
- Meets established time frame or keep CRCC updated as to the status (new time frame).
- Completes performance test(s) to ensure Fiber Optic (FO) system is fully operational.

## Carrier Restoration Control Center (CRCC)

The CRCC Department:

- Inventories all equipment according to GTE Engineering Specifications.
- Verifies labeling is complete and accurate.
- Signs acceptance form and return through established procedures noting any discrepancies.
- Maintains complete records of **all** FO systems, i.e., test records, route records, others as required.
- Verifies that access to accepted FO system is available from Remote Test/Monitor System, i.e., Hekimian, DNAS.
- Completes acceptance testing requirements.
- Tests all spare parts and test equipment for proper operation.
- Ensures FO system is fully operational.
- Turns FO system up for service.

The CRCC is responsible for providing adequate and proper storage for all maintenance spares.

**NOTE: The CRCC must not accept any system for service until adequate maintenance spares are provided.**

## Technical Support Services

The Technical Support Services Department:

- Provides second level of support.
- Works with CRCC on first of a kind installation.
- Conducts post acceptance meeting on first of a kind installation.
- Resolves technical problems and/or coordinates escalation to vendor/engineering.

# Departmental Responsibilities, continued

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## Maintenance Administration

The Maintenance Administration Department:

- Develops policies, practices and procedures.
- Works with CRCC and other GTE departments to establish appropriate spare parts stock.
- Works with GTE Training Department to establish appropriate training course availability.

## SUPPLY Department

The Supply Department:

- Ensures timely delivery of equipment to job site.
- Processes Material Request/Purchase Order.
- Keeps Network Construction updated as to status of material, i.e., back orders.
- Maintains an adequate stock of parts to support the CRCC in maintaining FO systems.

## Equipment Standardization Department (ESD)

The Equipment Standardization Department:

- Standardizes Fiber Optic systems for deployment throughout GTE.
- Arranges for field trial of new products.
- Standardizes vendor maintenance documentation package, i.e., acceptance test procedures, maintenance manuals.

## Planning

The Planning Department:

- Identifies need for installation of a FO system.
- Identifies quantity required to provide required customer service.
- Issues appropriate documentation to GTE Engineering to establish FO system.

# Preliminary Activities

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## Procedures

Prior to the start of functional acceptance testing, certain criteria must be met:

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STEP	ACTIVITY
1	Gather the following materials before starting the acceptance test: <ul style="list-style-type: none"><li>• Drawings.</li><li>• Equipment lists.</li><li>• Route layout/span design.</li><li>• Strapping options, etc.</li><li>• Manuals and publications, including:<ul style="list-style-type: none"><li>- Manufacturer's instruction manuals.</li><li>- Instruction manuals.</li><li>- Schematic diagrams.</li><li>- Flow charts.</li></ul></li></ul>

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(continued)

# Preliminary Activities, continued

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## Procedures, continued

STEP	ACTIVITY
2	<p>Provide one set of all applicable documentation per equipment location for initial installations. Subsequent installations of a later model or issue number must include all documentation directly related to the updated or changed equipment.</p> <p>Below is a minimum listing of records required by the CRCC:</p> <ul style="list-style-type: none"><li>• All DSX wiring assignment (bay/panel).</li><li>• Route layout/span design.</li><li>• System design card.</li><li>• Multiplexer records (assignments).</li><li>• Equipment documentation (manufacturer).</li><li>• List of related Work Orders.</li><li>• Budget "C" (capital) dollars allocated for acceptance testing.</li><li>• Floor plan.</li><li>• Bay and position assignment.</li><li>• Cable acceptance record.</li><li>• Fiber optic signature record.</li><li>• Wiring/Strapping options.</li></ul>
3	<p>Ensure that all test equipment is received, including necessary adaptors, cords and attenuators identified as required by the manufacturer.</p>
4	<p>Alternate test equipment designated as functionally equivalent by GTE Network Engineering may be substituted. Ensure test equipment is fully operational.</p>
5	<p>Inventory all spare parts, to ensure the quantity provided meets GTE standards.</p> <p><b>NOTE: The usual quantity provided is 10% spares per unit, up to a maximum of five per CO, with the remote spares included.</b></p> <p>This inventory does not include ERO's for failed modules in for repair, or for modules ordered but not received.</p>
6	<p>Modify all circuit boards required, including any and all identified modifications required by manufacturer and/or GTE Telephone Operations standards. Include a marked copy of the documentation identifying modifications.</p>
7	<p>Equipment connected end-to-end with no alarms indicated, includes A-Z systems where span facilities have been provided or assigned. Acceptance testing of the FO system is from DSX to DSX.</p>

## Records

All acceptance test results must be recorded and a file of the test results maintained by the CRCC.

**NOTE: Affix the transmit and receive margin levels to the system for future reference.**

# Preliminary Activities, continued

## Records, continued

The person conducting the acceptance test must record all acceptance test results and get the appropriate first level supervisor's approval.

Use the Fiber Optic Acceptance Form below for recording acceptance test results. Distribute the form according to the Distribution List shown on the bottom of the form.

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**Form # 90002199 – Fiber Optic Acceptance**

# Two Phase Acceptance Procedure

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## Visual Inspection

**WARNING:** DO NOT LOOK directly into the Fiber Optic cable. Laser light is invisible and may cause damage to your eyes. Direct viewing may not cause pain, but **SERIOUS** damage to the retina of the eye is possible.

Perform a visual inspection to ensure:

- Equipment placement - All equipment installed according to GTE Engineering specifications.
- PWC's placement - All PWC's installed according to GTE Engineering specifications.
- Wiring/Strapping options - All options are according to GTE Engineering specifications.
- Rating, placement, labeling of fuses.
- Correct fitting of connectors and optical pigtailed.
- Fiber signature record received including individual splice loss noted.
- Cable acceptance record received.
- Proper grounding.
- Other items as deemed necessary by the particular installation.
- All labeling completed:
  - All WARNING label(s) posted.

**NOTE:** Conduct a visual inspection at the regenerator site(s) if applicable.

## Performance Testing

Functional testing of Fiber Optic system includes (but is not limited to):

- Optical transmit power.
- Optical receive level, threshold sensitivity.
- Laser diode bias current.
- Power supply check.
- Redundancy check (automatic/manual).
- Bit Error Rate.
- Alarm operations (local/remote).
- Span diagnostic system (internal).
- Local/Remote loopback.
- Regenerator check.
- Portable generator test (if applicable).
- Others as related to specific manufacturer equipment specifications.

**NOTE:** Conduct all performance testing in accordance with the manufacturer's documentation. If test procedures/specifications are not stated, do **not** perform the test until TSS is notified and concurs with testing method/specifications.

Procedures for performing these tests are outlined on the following pages.

# Terminal and Equipment Testing Requirements

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**Test Equipment** Before performing an acceptance test(s), the following equipment is needed:

- DS-3 test set
- DS-1 test set
- Decade attenuators
- Digital multimeter
- Optical power meter
- Cleaning kit.
- Bit Error Rate test set
- Optical patch cords

**Standard “Burn-In”** Prior to acceptance testing, install and power up all FO systems for a minimum of 24 hours.

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**IF...**

**THEN.. .**

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During this 24 hour period there is a failure and repairs must be made

A second burn-in period begins after completing repairs.

**EXAMPLE: If Fiber Optic system has been installed and powered up for 20 hours and a failure of a transmit unit occurs. Replace the transmit unit and allow the system to stabilize for 24 hours before beginning the acceptance testing.**

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Any problems are encountered during acceptance test that requires a previously powered component, i.e., printed wiring card (PWC), or removal of power to the system, or any part of the system

After the problem is corrected:

1. Allow a minimum of eight (8) hours to elapse before proceeding with the acceptance testing. This will give the system time to stabilize.
2. Repeat all tests whose results may have been affected by the problem, then continue with remaining acceptance testing.

**NOTE: If in doubt, always Retest.**

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**Optical Transmit Power** Using an appropriate Optical Power test set and optical patch cords, measure and record the output of each optical transmitter installed. The level must be within the manufacturer’s specifications.

**Optical Receiver** Measure and record each optical receiver installed using:

- A Bit Error Rate (BER) test set.
- A Calibrated optical attenuator.
- An Optical power meter.
- An Optical patch cords.

The measured level must be a minimum of 6 dB from minimum GTE Engineering specification for each test conducted.

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# Terminal and Equipment Testing Requirements

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<b>Power Supply</b>	<p>Using a digital Multimeter, verify power supply voltage is within manufacturer's and GTE Engineering's specifications.</p> <p>Check redundancy to ensure proper operation according to manufacturer's guidelines.</p>
<b>Redundancy Check</b>	<p>Perform this test ONLY upon initial installation of a Fiber Optic system.</p> <ul style="list-style-type: none"><li>• Verify automatic/manual switching.</li><li>• Check restoration of all redundant features to ensure proper operation.</li><li>• Check and verify that the feature occurred within GTE Engineering specifications.</li></ul> <p><b>WARNING: Verify that there are no alarms at either terminal while conducting redundancy checks.</b></p> <p>This test must include the maximum capacity of the system. At the conclusion of this test, verify that there are no alarms- at either terminal and the system is operating on the main channel.</p>
<b>Bit Error Rate</b>	<p>Conduct the bit error rate tests listed below, if the required equipment is available:</p> <ul style="list-style-type: none"><li>• <math>2 \times 10^{-9}</math></li><li>• <math>2 \times 10^{-10}</math></li><li>• <math>2 \times 10^{-15}</math></li><li>• <math>2 \times 10^{-20}</math></li><li>• <math>2 \times 10^{-23}</math></li></ul> <p>Using PRBS test signal, the system should run error free for a 24 hour test period. If the system does not run error free, refer to the Trouble Resolution section, page 11, for procedures to take.</p>
<b>Alarm Operation</b>	<p>Simulate alarm conditions in accordance with manufacturer's guidelines and verify that:</p> <ul style="list-style-type: none"><li>• The alarm is properly received at both terminals.</li><li>• Local office alarms operate.</li><li>• Remote test/monitor system records alarm.</li></ul>
<b>Span Diagnostic</b>	<p>If equipped, test the span diagnostic system for proper operation as outlined in the manufacturer's manual. A minimum of one fault must be simulated to ensure proper operation.</p>
<b>Local/Remote Loopback</b>	<p>Perform tests as outlined in manufacturer's manual(s). To ensure loopback has occurred:</p> <ul style="list-style-type: none"><li>• Transmit QRSS from the transmit portion of the FO system and receive at the receive portion of the FO system.</li><li>• Do <i>not</i> depend on LED indications that a loopback has occurred.</li></ul>
<b>Regenerator</b>	<p>Perform all tests required by manufacturer's and GTE Engineering's specifications to ensure proper operation of all regenerators.</p> <ol style="list-style-type: none"><li>1. Shut off AC power to the regenerator and ensure that the batteries take over the load.</li><li>2. Hook up portable generator according to manufacturer's specifications. Shut off AC power to the regenerator and ensure the portable generator maintains service for a minimum of one (1) hour.</li></ol> <p><b>WARNING: Battery and portable generator tests must not be performed on Central Office located regenerators or other locations that may disrupt existing service.</b></p>

# Terminal and Equipment Testing Requirements, continued

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## Laser Diode

1. Use a digital multimeter to perform a laser diode test. Ensure measured reading is within manufacturer's specified limits.
2. Perform this test using manufacturer's specifications and guidelines.

## Trouble Resolution

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### Procedures

For trouble resolution follow the procedures outlined below:

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#### IF...

#### THEN...

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Acceptance test measurement(s) exceeds GTE Engineering/Manufacturer's specifications, the system is not acceptable to be placed in service

The following steps must be taken:

1. Terminal
  - Ensure test equipment is operating properly and calibrated.
  - Verify terminal configuration, i.e., shelf, position, etc.
  - Inspect PWC's.
  - Inspect connectors.
2. End-to-End
  - Ensure test equipment is operating properly and calibrated.
  - Have the fiber in question checked with an OTDR for defects.
  - Have CO connector/pigtail checked and replaced if defective.
  - Inspect the CO connector and clean it thoroughly using appropriate cleaning material.
  - Analyze splice losses with an OTDR to determine if resplicing to achieve lower splice losses would bring the end-to-end loss within the allowable limit.

**NOTE: Allow an average overall loss of .25 dB. See Network Engineering specifications for individual splice loss parameters (refer to Responsibilities section - Engineering responsibilities).**

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The above corrective action fails to resolve the incorrect measurement

Notify your local supervision.

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Local management is unable to identify/resolve the problem

Escalate to second level technical support. Technical Support Services will coordinate the problem resolution with GTE Engineering or manufacturer, as required.

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# Multiplexer Acceptance

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## Multiplexer MUX

For a new installation, refer to the manufacturer's procedures when conducting acceptance tests.

As each new MUX is added to an already existing Fiber Optic system, perform an acceptance test for the digital rate being installed, i.e., if any DS-3 system is added to the initial FO system.

1. Perform a complete acceptance per manufacturer's documentation **for all** new equipment added including all associated multiplex equipment down to the lowest level in the digital hierarchy equipped.
2. Once acceptance has been completed, do not perform the acceptance for the higher level digital rates when systems are added.
3. As PCM systems (DS 1, DS1C, or DS2) are added to a previously accepted FO system, i.e., the end-to-end test will be performed at the rate being added.

For example, a DS1 system would require end-to-end acceptance testing at DS 1 requirements. Do not perform acceptance at the higher digital rates since that acceptance was performed previously.

4. All redundancy checks must include higher levels of DS1, and DS2.

**WARNING: All redundancy tests performed on additions must be completed during the maintenance window because an outage may occur.**