

Attachment

Backbone

- 1. Technical Specifications for Addis Ababa – Nazareth Optical Fiber Transmission Link (Backbone)**

(Total 46 Pages)

The Study on Telecommunications Development Plan, Ethiopia

**Technical Specifications
for
Addis Ababa – Nazareth Optical Fiber
Transmission Link
(Backbone)**

December , 2002

JICA STUDY TEAM

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Chapter 1 General

1. Introduction

This document provides Technical Specifications of the functional requirements and electrical and/or mechanical performance characteristics for the Fiber-optical Transmission Link (Backbone) between Addis Ababa and Nazareth in Ethiopia.

2. Configuration

The major facilities of the Optical Fiber Transmission Link (Addis Ababa-Nazareth) shall be comprised of the following subsystems and component:

Fiber-optic Transmission Link Subsystem

- (1) Digital Multiplex Subsystem
- (2) Distribution Frame Subsystem
- (3) Power supply Subsystem
- (4) Building and equipment room Drawing

3. Interface

3.1 Interface between the Existing Addis Ababa IR/ITE Transmission Equipment and This New Optical-Fiber Transmission Link.

- (1) Digital Interface : STM-1 of ITU Recommendation

3.2 Interface between the Existing SDH M/W links in Adama West M/W Rep. Station and This New Optical-Fiber Transmission Link.

- (1) Digital Interface : STM-1 of ITU Recommendation

3.3 Interface between the Existing Nazareth Transmission Equipment and This new Optical-Fiber Transmission Link.

- (1) Digital Interface : STM-1 of ITU Recommendation

Chapter 2 Technical Specification for the Fiber-optic Transmission Link

1. Fiber-optic Transmission Link Subsystem

1.1 General Information

(1) Transmission Route Plan

Transmission route plan of the Fiber-optic Transmission Link Subsystem is shown in Fig. 1.1.

For actual design, the Bidder shall confirm the route data on his responsibility in his site survey and design suitable system for making Fiber-optic link between Addis Ababa and Nazareth city via Debre Zeit and Adama West Rep. station.

The Bidder shall submit the anticipated total system Availability with theoretical calculation of system design.

1.2 Subsystem Configuration

Fiber-optic Transmission Link Subsystem shall be basically composed of following devices shown in Table 1.2-1 and Fig. 1.1.

Table 1-2-1 (1/2) Fiber-optic Transmission Link Subsystem

Item	Quantity		
	AA IR/ITE Station	AA Filwoha Station	AA Fefas Silk
The Fiber-optic (Distribution frame) LDF	Including OLT terminal	2(1+1*)	2(1+1*)
The Fiber-optic line terminal (OLT)	2 (1+1*)	N/A	N/A
	(Unit: 2.466Gbit/s STM-16)		
Materials for Civil Work and Cable Work of Fiber-optic System	1 Set		

* : Spare for back-up

Table 1.2-1 (2/2) Fiber-optic Transmission Link Subsystem

Item	Quantity		
	Debre Zeit Station	ADAMA West Rep. Station	Nazareth Station
The Fiber-optic (Distribution frame) LDF	Including OLT terminal	Including OLT terminal	Including OLT terminal
The Fiber-optic line terminal (OLT)	2 (1+1*)	2 (1+1*)	2 (1+1*)
	(Unit: 2.466Gbit/s STM-16)		
Materials for Civil Work and Cable Work of Fiber-optic System	1 Set		

* : Spare for back-up

1.2.1 The Fiber-optic Line Terminal (OLT) Shall Basically Consist of the Following Components.

- (1) Optical converter
- (2) Cable protection switch
- (3) Order-wire

1.2.2 Materials for Civil Work and Cable Installation Works of Fiber-optic Subsystem

All materials for civil work and cable installation work of Fiber-optic subsystem shall be provided enough quantity to install mentioned Fiber-optic Transmission Link Subsystem with the Bidder's supporting detailed installation plan.

1.2.2.1 Fiber-optic Cable Installation

As shown in Fig. 1.2-1, Fig. 1.2-2 (1/3), Fig. 1.2-2 (2/3), Fig. 1.2-2 (3/3) and 1.2-3, Table 1.2-2,

- (1) The new constructed duct system shall be used between AA IR/ITE and Nefas Silk via Filwoha (approximately 8km),
- (2) At Filwoha and Nefas Silk, Fiber-optic Cable for both directions shall be connected to Optic Line Distribution Frame (LDF),
- (3) The new constructed Aerial system by Concrete Pole (H=8m) shall be used between Nefas Silk and the city entrance of Nazareth (approximately 85.4km).
- (4) At Debre Zeit , Fiber-optic Aerial Cable for both direction shall be connected to Optic Line Distribution Frame (LDF) and the Fiber-optic line terminal (OLT) in order to repeat the Fiber-optic transmission link.
- (5) At ADAMA West, Fiber-optic Aerial Cable for both direction shall be connected to Optic Line Distribution Frame (LDF) and the Fiber-optic line terminal (OLT) in order to connect existing SDH Digital MW links.
- (6) At Nazareth, Fiber-optic Aerial Cable shall be connected to the new constructed Nazareth Duct system shall be used between City entrance of Nazareth and ETC Nazareth Primary center (approximately 2.6km). For the part of this duct system link (approximately 1.1 km long from the ETC Nazareth Primary Center shall be new adding sub-duct pipe construction), approximately 1.5 km long installation route is required the new duct system construction.

Table 1.2-2 Outline of the Cable Installation

	Installation Span	Installation Method	Distance
1	AA IR/ITE-Filwoha-Nefas Silk	Duct (new)	10 km
2	Nefas Silk- Nazareth(city entrance)	Aerial (new)	85.4 km
3	Nazareth city entrance- Existing Duct	Duct (new)	1.5 km
4	Existing Duct- Nazareth(P.C.)	Adding Sub Duct	1.1 km
	Total		98 Km

1.2.2.2 The Materials for Cable Work Shall be Basically Composed of the Following Components

- (1) Cable Termination Box and Accessories
- (2) Fiber-optic Cable
- (3) Jointing Kit
- (4) Sub-duct
- (5) Sealing materials
- (6) Others

1.2.2.3 The Materials for Civil Work

All necessary materials for civil work shall be prepared and provided in accordance with ETC's Technical Standard of Outside Plant.

1.2.3 OLT Installation Work

OLTs shall be installed in the AA IR/ITE (Master station), Debre Zeit (Repeater station) and ADAMA West MW Rep. Station (Repeater station) and Nazareth Primary Center (P.C.). All stations are connected serially by Fiber-optic cables of about 47 km long, 39 km and 14 km long, respectively. Fiber core of the cable is 24/125 μ m-step index type (ribbon type).

1.3 Functional Requirements of the Fiber-optic Line Terminal (OLT)

1.3.1 General

- (1) The equipment shall be capable of transmitting STM-16 (2.488Gbit/s) digital signal by means of light through Fiber-optic cable.
- (2) The equipment shall also be able to transmit those signals for supervisory and control purpose of the Fiber-optic link, two orderwires through the same cable.
- (3) Master Stations (AA IR/ITE and Nazareth P.C.) shall be able to monitor the following information from the Repeater station (Debre Zeit and ADAMA West MW Rep, Station) continuously and to detect the fault location:
 - a) Bit error rate
 - b) Laser diode bias current and laser diode current over the threshold
 - c) Loss of the optical receive signal
 - d) Loss of the optical transmit signal
- (4) Master Stations shall be able to transmit to the Repeater Station the reset command for laser diode switch-off function.
- (5) OLT in Master Stations shall display the following status of the link and equipment status at its own station and the Repeater Station.
 - a) Bit error rate
 - b) Laser diode bias current and laser diode current over the threshold

- c) Loss of the optical receive signal
 - d) Loss of the optical transmit signal
- (6) OLT in the Repeater Station shall display the following local status of the link and equipment in its own station.
- a) Bit error rate
 - b) Laser diode bias current and laser diode current over the threshold
 - c) Loss of the optical receive signal
 - d) Loss of the optical transmit signal
- (7) Information of the link and equipment are, at least, as follows;
- (a) Link status
 - Low transmit power,
 - Low receive level,
 - Loss of digital base-band signal at input point,
 - Excessive BER,
 - Loss of frame synchronization, etc.
 - (b) Equipment status
 - Cable protection switch alarm,
 - Failure of power supply, etc.

1.3.2 Cable Protection Switch

The cable protection switch shall be capable of switching automatically STM-16 (2.488 Gbit/s) Fiber-optic transmission line replacing a regular traffic channel by the protection channel when the regular channel becomes degraded.

1.3.2.1 General

- (1) Cable protection switch shall have the 1+1 switching arrangement of OLTs.
- (2) The switching shall be performed independently in each direction of transmission.

1.3.2.2 Operation Condition

- (1) Master Station shall have the capability to switch any direction manually.
- (2) The following, but not to be limited, fault conditions detected at OLT shall be able to activate automatic switchover to the protection channel.
 - a) Power failure
 - b) Loss of incoming optical line signal
 - c) Loss of line frame alignment
 - d) Abnormality of optical converter

1.3.2.3 Required Function

(1) Automatic Switch-over

- When the fault alarms above-mentioned are detected, the equipment shall automatically switchover the fault channel to the responding protection channel.
- Automatic switchover shall be inhibited if there is a fault condition in the protection channel.

(2) Manual Switch-over

- Any in operation channel shall be able to switchover to the reserved protection channel by manual operation at any terminal station.
- When manual switching is operated, automatic switching shall be disabled.

(3) Restoration

Traffic already switched to the protection channel shall be restored automatically and also manually. The bidder shall state the restoration condition. The hitless protection switching mechanism shall be fully described by the bidder.

(4) Forced Switching

In the event that both automatic and manual switchover cannot be operated due to the failure of the equipment, the equipment shall have function to switch-over by a specific manual command.

(5) Line Identification

Clear indication shall be given at the front of the equipment concerned as to which line is actually carrying traffic. The indication of the carrying traffic shall be visible.

1.3.3 Order-wire

One omnibus order-wire circuit shall be implemented for voice communications between the Master Station and the Repeater Station. It shall be terminated at a telephone set equipped in each station. Loud speaker shall be equipped at the appropriate position.

1.3.4 Power Unit for Fiber-Optic Transmission Link Subsystem

The Power Unit in AA IR/ITE Communications Center, Debre Zeit station station, ADAMA West MW Rep. station, Nazareth Primary center (P.C.) shall be equipped with each equipment for generating and supply necessary power to the equipment by receiving mains power from the Power Supply Subsystem specified in Section 4.

1.4 Electrical Performance Requirements of the Fiber-Optic Line Terminal (OLT)

1.4.1 General

The bidder shall provide the following information.

- (1) Power supply voltage and its acceptable variation range

- (2) Power consumption

1.4.2 Optical Converter

1.4.2.1 Interface Conditions

- (1) Interface requirement on the electric side and the optical side shall be in accordance with the prescription about STM-16 (2.488 Gbit/s) in ITU-T Rec. 'G.703' and 'G.707 and G.958' respectively.
- (2) Interface requirement on the optical side shall be as follows:
- (a) Wavelength : 1,310 nm in nominal
 - (b) Transmission mode : Single mode
- (3) The bidder shall state other conditions in detail of the interface in his Tender proposal.

1.4.2.2 Other Requirements

- (1) The bidder shall provide the following information.
- a) Optical output power with its stability
 - b) Optical source (Laser) with its life time
 - c) Receiver sensitivity
 - d) Receiver device
 - e) Type of optical connector
 - f) Bit rate and code format of optical interface
 - g) Link loss budget
 - h) Ambient Condition
 - Operation Temperature
 - Allowable Humidity

1.4.3 Orderwire

1.4.3.1 Interface Conditions

- (1) Voice frequency and data signal interface conditions of the order-wire shall be provided by the Bidder.
- (2) The channel interface of 64 kbit/s shall meet ITU-T Rec. V. 11 (RS-422)

1.4.3.2 Other Requirements

The bidder shall provide the following information.

- (1) Composition of orderwire system
- (2) Number and type of orderwire circuits

1.5 Fault Conditions and Consequent Actions

- (1) The equipment shall detect the existence of fault conditions on 2.488 Gbit/s optical and electrical line section, and perform consequent actions appropriate to the quick maintenance.
- (2) Fault conditions to be detected shall be, at least, as follows:
 - a) Power supply failure
 - b) Loss of incoming signal at 2.488 Gbit/s
 - c) Loss of incoming optical line signal
 - d) Loss of line frame alignment
 - e) Abnormality of optical transmitter
- (3) Maintenance alarm indication shall be immediately generated to indicate that the performance is below the acceptable standards and remedial actions are required locally.
- (4) In case of the detection of fault condition in the Fiber-optic cable or OLT, a signal shall be transmitted to the line protection switch to switch the transmission line carrying actual traffic to a pre-designed protection line.
- (5) Above important alarms (item 2) shall be extended to Operation and Control Desk of OCS installed in AA IR/ITE Communications Center and Nazareth Primary Center.
- (6) The bidder shall state in his Tender proposal the fault detection items and consequent actions in case of failure in the equipment and digital line at 2.488 G bit/s.

1.6 Technical Specification of Materials for Civil Works and Cable Work of Fiber-optic System

1.6.1 General

- (1) This specification covers technical requirements of all materials, consisting of Fiber-optic cable, junction cable facilities and their related civil facilities, used for the Fiber-optic system.
- (2) The materials not specified herein shall be in conformity with the relevant international standards and shall be approved by ETC prior to use.
- (3) Necessary tools, measuring equipment, vehicles and other mechanical aids for installation/construction of the cable work and civil works shall be provided by the Contractor.
- (4) All the outdoor materials shall be selected, designed and manufactured under sufficient consideration of being free from any corrosion caused by briny water and air as well as ordinary external environment.

1.6.2 Duct System Plan

Outline of the existing duct system of the Fiber-optic system is shown in Fig. 1.2-4 of this specification, as an example.

1.6.3 Materials for Cable Work

1.6.3.1 Cable Termination Box and Accessories

- (1) The Fiber-optic cable termination box (CTB) shall be equipped at the end of the Fiber-optic cable to terminate the cable.
- (2) The following accessories necessary for terminating the cable shall be provided included in the CTB.
 - (a) Adapter and attenuator
 - (b) Fiber-optic cord with connector to extend the Fiber-optic line to the Light Terminal Equipment (LTE)
 - (c) Cord protector

The bidder shall state details of the proposed CTB in his Tender proposal.

1.6.3.2 Fiber-optic Cable

1.6.3.2.1 Fiber-optic Cable

- (1) Number of Fiber-optics

One cable shall have at least twenty-four (24) Fiber-optics.

- (2) Type of Fiber-optic Cable

Type of Fiber Cable is consisting of Duct cable (Approximately 12.6 km) and Aerial cable (Approximately 12.6 km).

No.	Type of Fiber-Optic Cable	Quantity (Km)
1	Duct cable	12.6
2	Aerial cable	85.4

- (a) The cable shall have alternated helical slot for accommodating Fiber-optics and strength member for cable pulling firmly.
- (b) The Fiber-optic cable shall have laminated aluminum polyethylene sheath for conduit use (ribbon Type).
- (c) Each Fiber-optic shall be identified by color-coding.

1.6.3.2.2 Fiber-optic

- (1) Type

(a) Single mode Fiber-optic optimized for use at 1,310 nm-band shall be used.

- (2) Performance Characteristics

(a) The Fiber-optic shall meet ITU-T Rec. G.652.

- (b) The nominal value of the mode field diameter at 1,310 nm shall be within the range of 9 to $10\mu\text{m} \pm 10\%$.
- (c) The nominal value of the cladding diameter shall be $125\mu\text{m} \pm 2.4\%$.
- (d) The mode field concentricity error shall be less than $1\mu\text{m}$.
- (e) The cladding non-circularity shall be less than 2% .
- (f) The cut-off wavelength of a cabled fiber shall be less than 1,270 nm.
- (g) At the 1,300 nm wave-length region, the maximum attenuation shall be less than 0.5 dB/km, and the average attenuation shall be less than 0.4 dB/km.
- (h) The maximum value of the total chromatic dispersion at 1,300 nm wave-length region shall be less than $3.5\text{ ps}/(\text{km} \times \text{nm})$.
- (i) The attenuation variation with temperature shall be less than 0.1 dB/km in $-20^{\circ}\text{C} \sim +60^{\circ}\text{C}$.

(3) Structural Characteristics

- (a) Fiber-optic shall be of a multiple-layer coated. Multiple-layer coated Fiber-optic shall be composed of primary coating, buffer layer and secondary coating.
- (b) Coating materials for the multiple-layer coating shall be carefully chosen taking into account the following factors:
 - (i) Protection of fiber against breakage,
 - (ii) Stability of optical loss under various stresses,
 - (iii) Ease of handling,
 - (iv) Long term reliability, and
 - (v) Ease of jointing.
- (c) One or more Fiber-optics may be accommodated in one slot.

1.6.3.2.3 Strength Member

The strength member shall consist of stranded steel wires, shall be placed in the center of cable and shall withstand induced tensile loads within the permissible strain value.

1.6.3.2.4 Cable Sheath

- (1) Laminated Aluminum Polyethylene (LAP) sheath shall be used for conduit use cable.
- (2) The aluminum tape shall be electrically continuous and shall prevent ingress of moisture into cable.
- (3) The nominal thickness of LAP sheath including polyethylene coated aluminum tape shall be more than 2.0 mm.
- (4) The average thickness at four or more measured points shall not be less than 90 % of the nominal thickness.

1.6.3.2.5 Core Wrap

- (1) The cable core shall be completely covered with one or more layers of dielectric materials. The core wrap shall be applied with an overlap.
- (2) The core wrap shall provide a sufficient heat barrier so that adverse heat transfer does not damage optical fiber coatings during jacketing process.

1.6.3.2.6 Filling Compound

- (1) The interstices between Fiber-optics shall be solidly filled with compound.
- (2) The filling compound shall not corrode any material composing of the cable.
- (3) The filling compound shall not be oxidized and colored.

1.6.3.2.7 Length Mark

- (1) The length shall be marked at an interval of one-meter +1 % along the outer sheath of the cable. An asterisk shall also be marked just between length marks.
- (2) Sequential numbering to show cable length shall be employed for each cable in one piece.

1.6.3.2.8 Physical and Mechanical Requirements

- (1) Fiber-optic shall be resistant-tested at the specified stress level during manufacture. The strain level of resistant test for the Fiber-optics shall be higher than the standard value considering the weather condition of Ethiopia.
- (2) Allowable cable tensile load shall be determined to insure that all the materials of the cable elements behave within marginal elasticity. It shall not be less than 300 kg.
- (3) The bidder shall state details in relation to the following items;
 - (a) Fiber-optic cable:
 - (i) Tensile strength
 - (ii) Compressive strength
 - (iii) Bending strength
 - (b) Fiber-optic:
 - (i) Tensile strength
 - (ii) Breakage tensile strength
 - (iii) Bending strength
 - (iv) Screening method to be applied
 - (v) Lifetime of fiber estimated from breakage probability

1.6.3.2.9 Cable Pulling End

Cable pulling end may be prepared in factory at Contractor's own expense.

1.6.3.3 Jointing Kit

Though no jointing of the Fiber-optic cable is desirable, Contractor shall prepare necessary materials specified in this clause if he needs to joint the cables.

1.6.3.3.1 General

- (1) The jointing kit shall be composed of jointing materials and sheath closure for conduit use.
- (2) The jointing materials and sheath closure shall maintain proper physical, chemical and electrical properties to endure the weather condition of Ethiopia.

1.6.3.3.2 Jointing Materials for Fiber-optic

- (1) The jointing materials for Fiber-optic shall minimize deterioration of optical characteristics.
- (2) The jointing materials shall protect the uncoated Fiber-optics from mechanical damage, moisture and microbending loss.
- (3) The materials shall achieve ease of fiber jointing.

1.6.3.3.3 Sheath Closure

- (1) The sheath closure shall consist of anti-corrosive materials suitable for conduit use.
- (2) The sheath closure shall have sufficient mechanical strength to withstand various stresses expected and be waterproof.
- (3) The sheath closure shall maintain mechanical continuity of strength member.
- (4) Filled type sheath closure shall be used for the jointing between duct cables. However, the space for the fiber storage in the sheath closure shall be unfilled. Filling compound shall be reenterable.

1.6.3.4 Sub-duct

Sub duct shall be prepared and provided.

- (1) Six pipes preformed sub-ducts shall be required.
- (2) Sub-duct shall be harmless to the Fiber-optic extending over a long-term.
- (3) The sub-duct shall have sufficient mechanical strength so that the deformation of sub-duct caused by various loads in duct is minimized.
- (4) The dimensions of sub-duct shall be determined from the relation between diameters of sub-duct, duct and Fiber-optic cable.
- (5) Pre-installed pulling rope shall be required for each sub-duct.

1.6.3.5 Sealing Materials

Sealing materials for the purpose of followings shall be required;

- (1) Sealing of vacant duct and sub-duct,
- (2) Sealing of gap between duct and sub-duct,
- (3) Sealing of gap between Fiber-optic cable and sub-duct.

1.6.4 Materials for Civil Works

All necessary materials for Civil Works shall be prepared and provided in accordance with ETC Technical Standard of Outside Plant.

1. BACK BONE

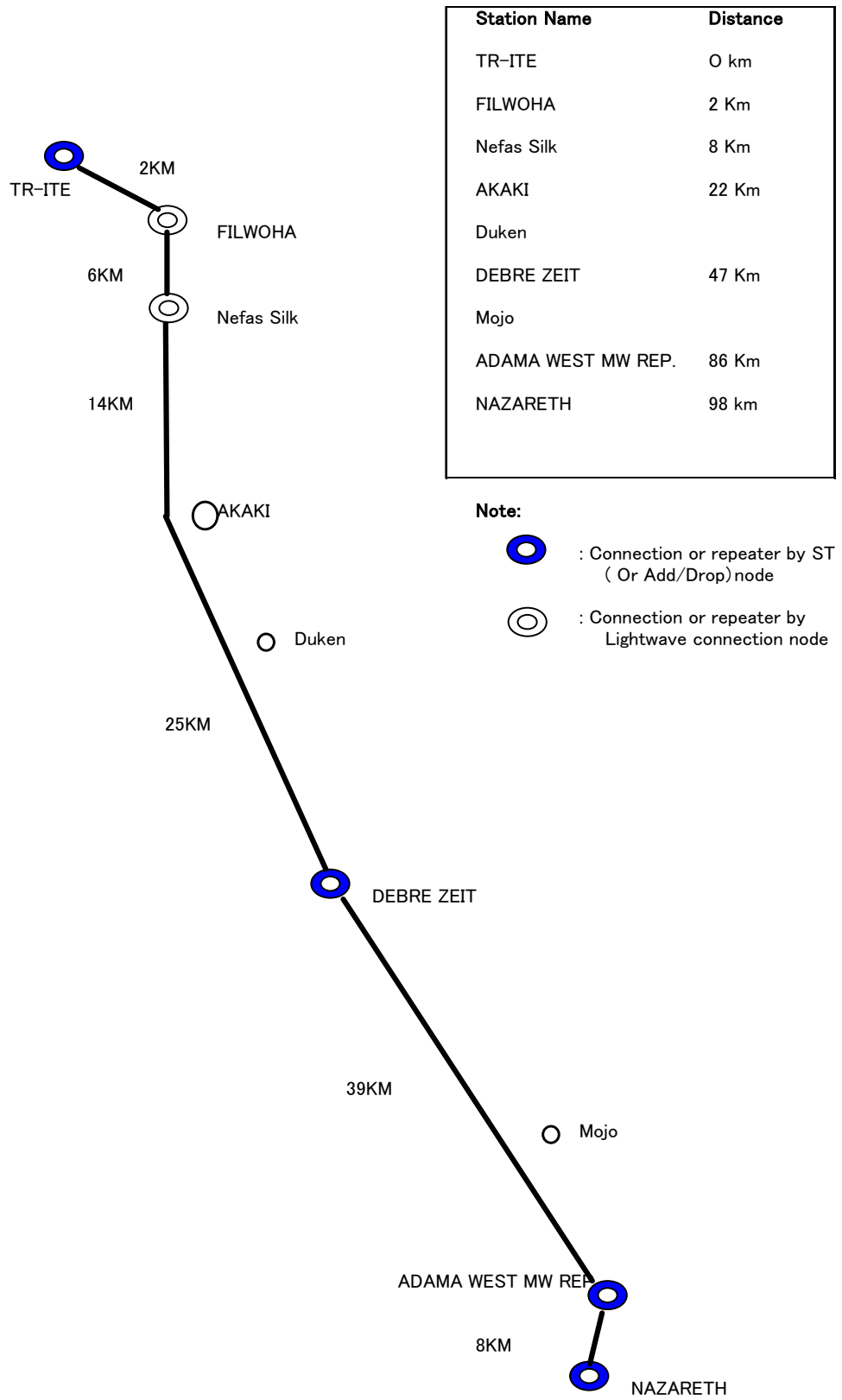


Fig. 1.1 Transmission Configuration of AA- Nazareth Optical Back-Bone



Fig. 1.2-1 Optical Fiber Laying Route (Addis Ababa)

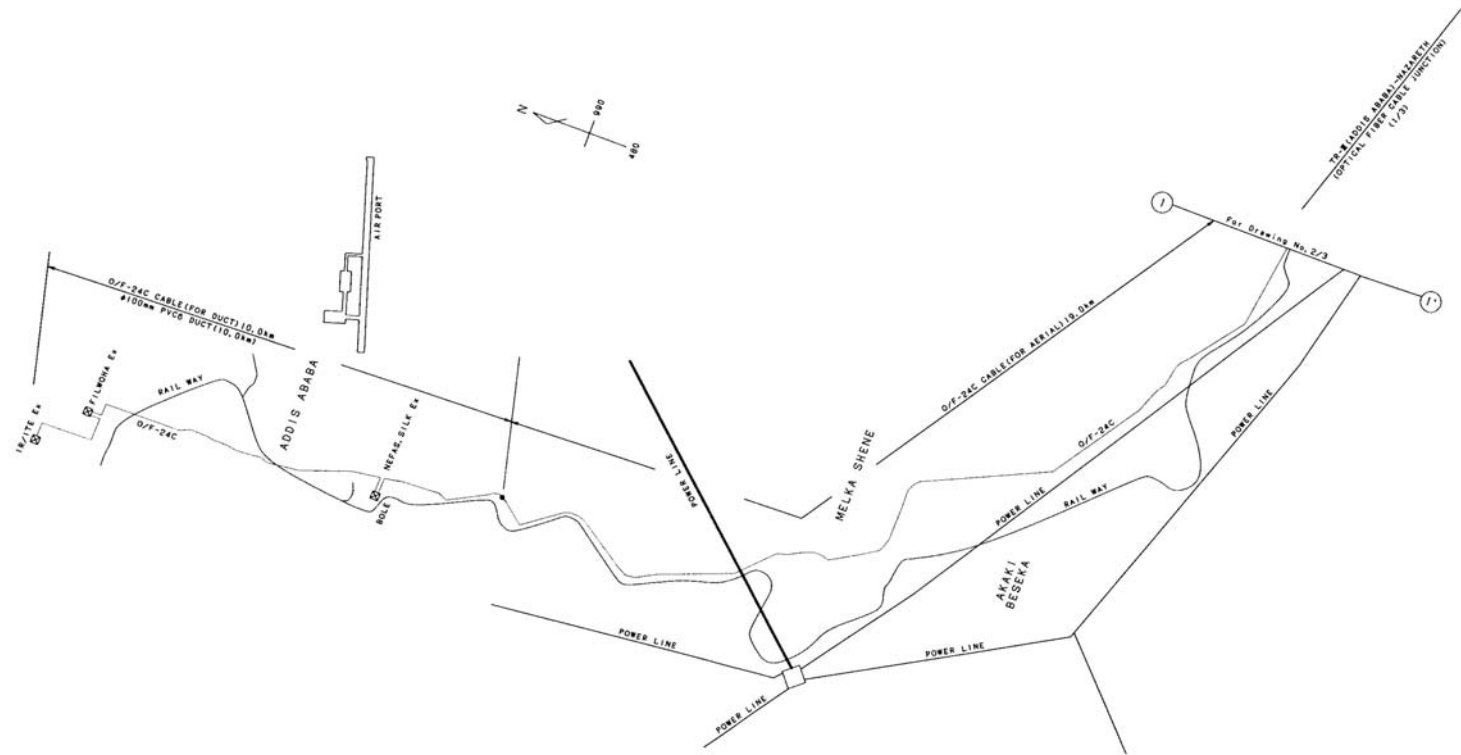


Figure 1.2-2 (1/3) Optical Fiber Laying Route (Addis Ababa-Nazareth/Outer City)

PREPARED BY	Coverage Area	Sheet No.
DSM	Sub-Station/Material/Project	1/1000
TCB	Type of Drawing	Scale 1:1000
CSB	Material Fiber Cable Meter Plan	Sheet No.
APPD	Task on Telecommunication Data	Drawing No.
DATE	JICA	14-002-001

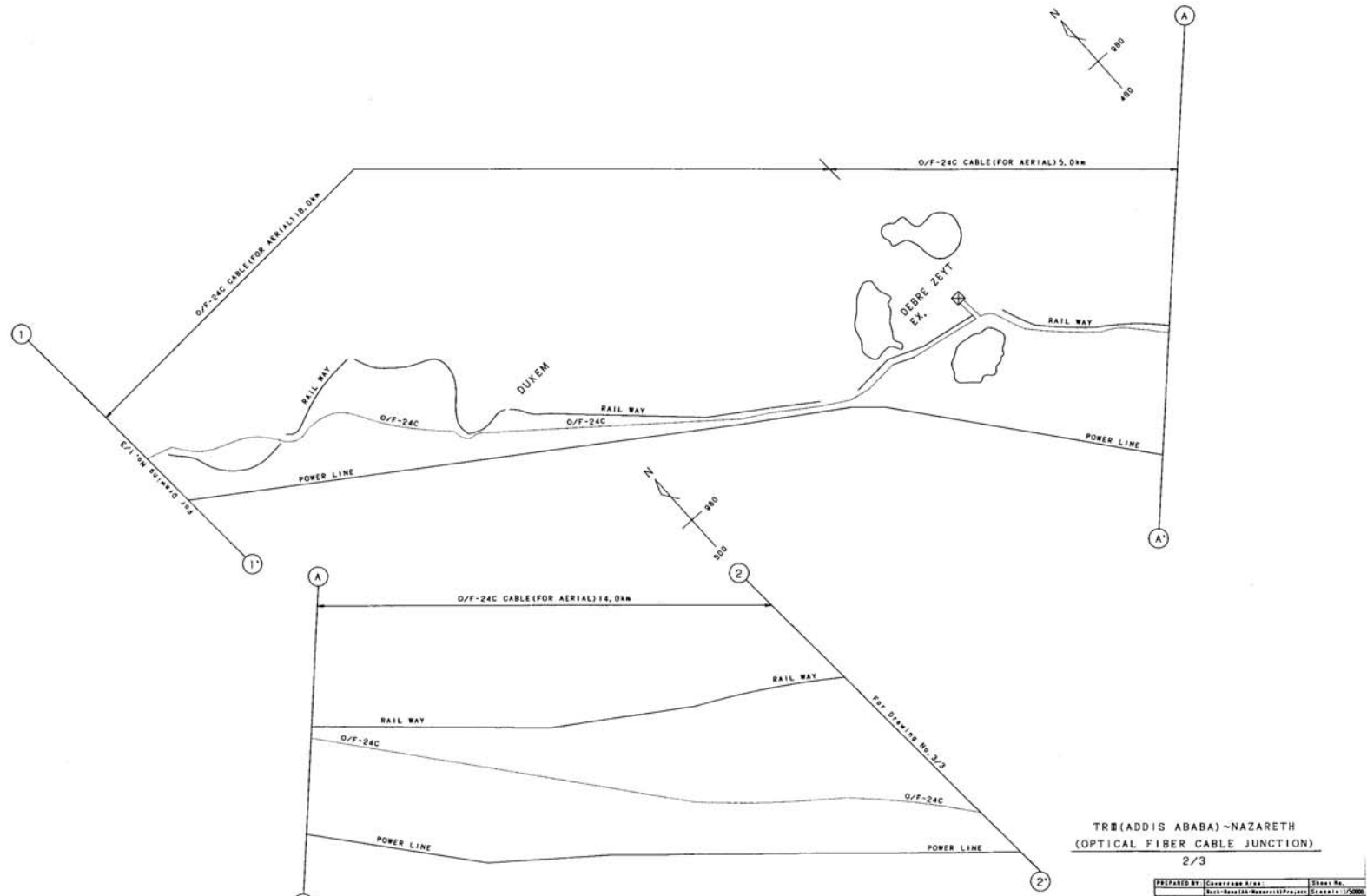


Figure 1.2-2 (2/3) Optical Fiber Laying Route (Addis Ababa-Nazareth/Outer City)

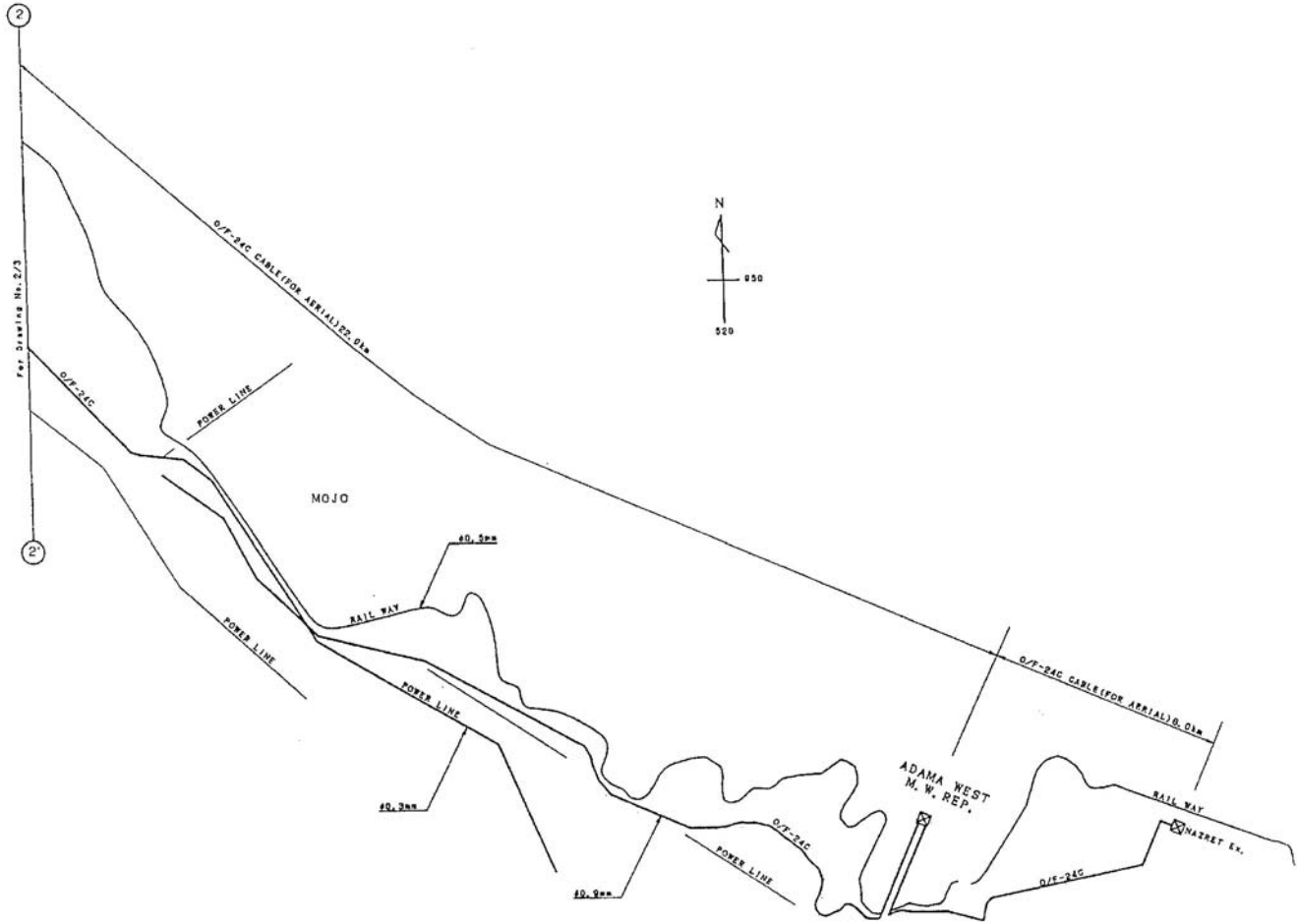


Figure 1.2-2 (3/3) Optical Fiber Laying Route (Addis Ababa-Nazareth/Outer City)

PREPARED BY	Checked and Approved	Sheet No.
DESIGNED BY	Drawn	Scale
DATE	Project Title	Project No.
APPVED BY	Project Manager	Project Name
DATE	Project Location	Project Status

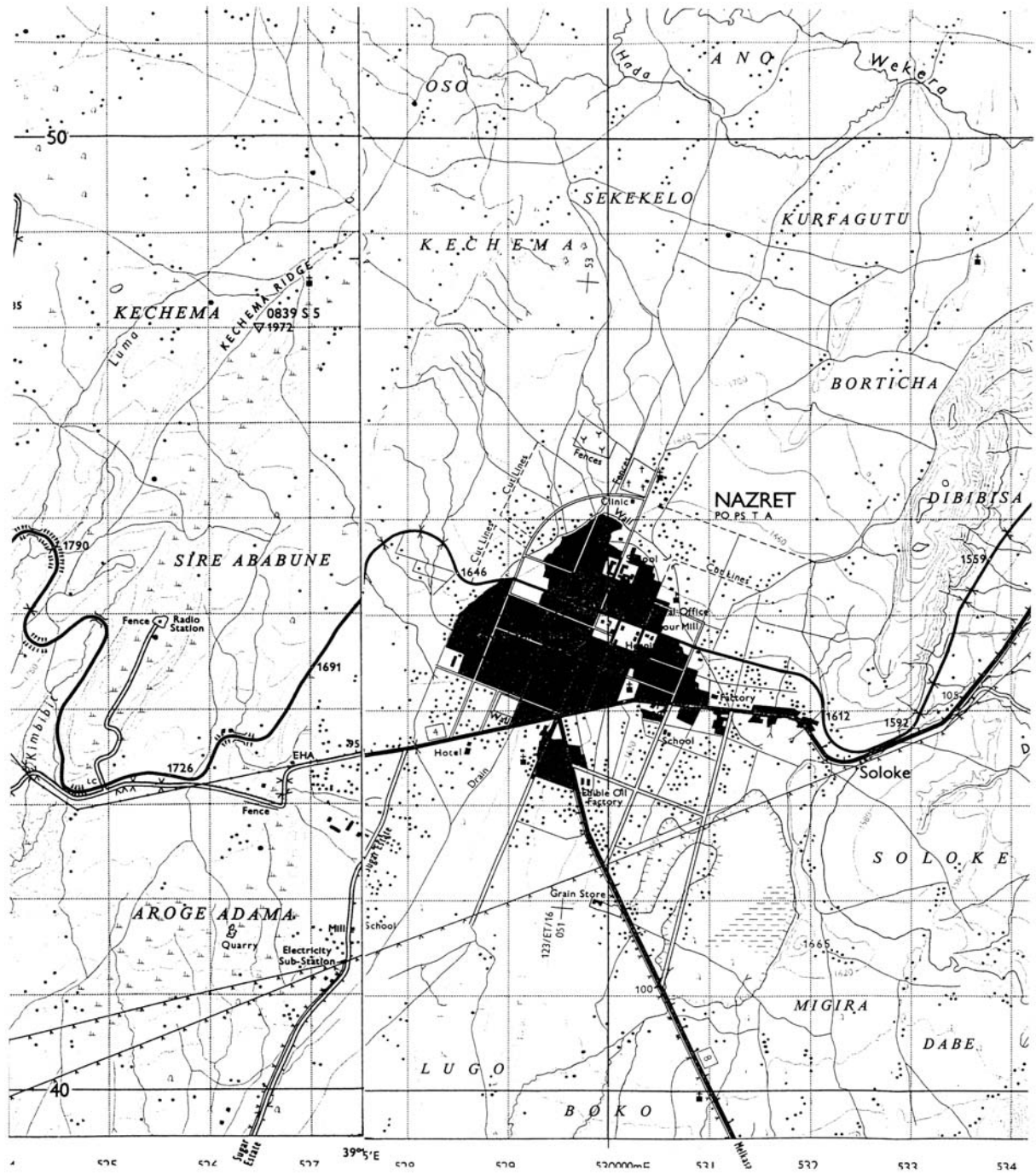


Fig. 1.2-3 Optical-Fiber Laying Route (Nazareth)

(ETC will add the Specifications in this Page)

Fig. 1.2-4 Outline of the Existing Duct ETC System of the Fiber-Optic System

2. Digital Multiplex Subsystem

2.1 Subsystem Configuration

Digital Multiplex Subsystem shall be basically composed of following devices shown in Table 2.1-1.

Table 2.1-1 Digital Multiplex Subsystem

Item	Quantity					
	AA IR/ITE	Debere Zeit Station		ADAMA West MW Rep.		Nazareth P.C.
(1) STM-16 Digital Multiplex Equipment A	1	1	1	1	1	1
	(Unit: 2.488 Gbit/s)					
(2) 155M Digital Multiplex Equipment B	0	1	1	0	0	0
(3) 155M Digital Multiplex Equipment C	2	0	0	0	0	2
	(Unit: 155M Bit/s)					

Type A and Type B shall be provided for Digital Microwave Connecting Link and Type C shall be provided for Fiber-optic Transmission Link.

- (1) STM-16 Digital Multiplex Equipment A :
16 X STM-1 (155 Mbit/s)
- (2) 155M Digital Multiplex Equipment B :
63 X C-12 (2.048 Mbit/s)
- (3) 155M Digital Multiplex Equipment C :
21 X C-12 (2.048 Mbit/s) + 2 X C-3 (34.368 Mbit/s)

2.2 Functional Requirements

2.2.1 STM-16 Digital Multiplex Equipment

- (1) This equipment shall be a system developed as Synchronous Digital Hierarchy (SDH) products.
- (2) This equipment shall be synchronized to any of the following timing sources:
 - (a) STM-16 line signal
 - (b) STM-1 tributary signal (155 Mbit/s)
 - (c) STM-1 and/or 2048 kHz G.703 external synchronization signal
 - (d) Framed STM-1 and/or 2048 kbit/s G.703 external synchronization signal
 - (e) Internal oscillator

The priority order and the quantity level of the synchronization sources shall be configurable.

The quality level of selected timing source shall be sent to the remote side by using section overhead byte (Z1).

The current timing sources shall be considered as the failure when either of the following conditions is reported with an alarm:

- (a) Loss of signal
- (b) Alarm Indication Signal (AIS)
- (c) Loss of frame
- (d) Excessive bit error rate

If the current timing source fails, this equipment shall automatically choose the lower order priority timing source which is not failed according to timing source selection algorithm.

- (a) STM-1 external synchronization signal
- (b) 2048 kHz G.703 external synchronization signal
- (c) Framed 2048 kbit/s G.703 external synchronization signal

- (3) This equipment shall multiplex STM-1 (155.52 Mbit/s) synchronous signals and output a synchronous STM-16 (2.488 Gbit/s) signal. (Note: The total capacity of these signals is not to exceed 1 x STM-16 signal.)
- (4) This equipment shall accommodate STM-16 (2.488 Gbit/s) signals at the aggregate interface and STM-1 (155.52 Mbit/s) signals at its tributary interface.
- (5) A highly reliable transmission path shall be ensured by built-in protection features utilized in this equipment.

When a line or unit failure occurs in this equipment, Protection switching shall be carried out to avoid service interruption. Switching shall automatically be carried out within less than 5 msec after the failure is detected.

This function shall perform protection switching for STM-1 tributary signals and STM-16 electrical tributary and aggregate line signals.

- (6) Built-in VC level digital Cross-connect capabilities (**Cross Connect Function**)

STM-16 Digital Multiplex Equipment shall be built in the VC level digital Cross-connect capabilities in STM-1 Level.

- Required Cross connect Level: STM-1 equivalent (VC-4)/ (155Mbit/s)
- Required Cross connect Capacity: 16 x STM-1 equivalent (VC-4)

- (7) Management functions such as surveillance, performance monitoring, provisioning, and security management shall be controlled and monitored from the Operation and Control Desk of OCS installed in AA IR/ITE and Nazareth Primary Center (P.C.).

2.2.2 155M Digital Multiplex Equipment

(1) This equipment shall be a system developed as Synchronous Digital Hierarchy (SDH) products.

(2) This equipment shall be synchronized to any of the following timing sources:

- (a) STM-1 line signal
- (b) G.703 tributary signal (2.048 Mbit/s)
- (c) 2048 kHz G.703 external synchronization signal
- (d) Framed 2048 kbit/s G.703 external synchronization signal
- (e) Internal oscillator

The priority order and the quantity level of the synchronization sources shall be configurable.

The quality level of selected timing source shall be sent to the remote side by using section overhead byte (Z1).

The current timing sources shall be considered as the failure when either of the following conditions is reported with an alarm:

- (a) Loss of signal
- (b) Alarm Indication Signal (AIS)
- (c) Loss of frame
- (d) Excessive bit error rate

If the current timing source fails, this equipment shall automatically choose the lower order priority timing source which is not failed according to timing source selection algorithm.

- (a) 2048 kHz G.703 external synchronization signal
- (b) Framed 2048 kbit/s G.703 external synchronization signal

(3) This equipment shall multiplex 2.048 Mbit/s, 34.368 Mbit/s or a combination of 2.048 Mbit/s and 34.368 Mbit/s plesiochronous signals and output a synchronous STM-1 (155.52 Mbit/s) signal. (Note: The total capacity of these signals is not to exceed 1 x STM-1 signal.)

(4) This equipment shall accommodate STM-1 (155.52 Mbit/s) signals at the aggregate interface and either 2M (2.048 Mbit/s) or 34M (34.368 Mbit/s) signals at its tributary interface. The multiplexing paths used by this equipment is shown in Fig. 2.1-1.

(5) A highly reliable transmission path shall be ensured by built-in protection features utilized in this equipment.

When a line or unit failure occurs in this equipment, Protection switching shall be carried out to avoid service interruption. Switching shall automatically be carried out within less than 5 msec after the failure is detected.

This function shall perform protection switching for 2M, 34M tributary signals and STM-1 electrical tributary and aggregate line signals.

- (6) Management functions such as surveillance, performance monitoring, provisioning, and security management shall be controlled and monitored from the Operation and Control Desk of OCS installed in AA IR/ITE Communications Center and Nazareth Primary center.

2.2.3 Power Unit for 155M Digital Multiplex Subsystem

The Power Unit in AA IR/ITE Communications Center, Deber Zeit station, ADAMA West MW Rep. station and Nazareth Primary center shall be equipped with each equipment for generating and supply necessary power to the equipment by receiving mains power from the Power Supply Subsystem specified in Section 4.

2.2.4 Alarm/Status indication, Monitor and Control

2.2.4.1 Alarm/Status indication, Monitor and Control (STM-16)

- (1) STM-16 Digital Multiplex Equipment shall detect the existence of faulty conditions on digital sections at 2.488 Gbit/s, 155.52 Mbit/s and perform consequent actions in conformance with ITU-T Rec. G. 751 paragraph 2 and 3.
- (2) Above important alarms (item 2.2.1) shall be extended to Operation and Control Desk of OCS installed in AA IR/ITE Communications Center and Nazareth Primary center.
- (3) Racks shall be provided with adequate testing and monitoring facilities for conducting routine operation and maintenance.

2.2.4.2 Alarm/Status indication, Monitor and Control (STM-1)

- (1) 155M Digital Multiplex Equipment shall detect the existence of faulty conditions on digital sections at 155.52 Mbit/s, 34.368 Mbit/s and 2.048 Mbit/s, and perform consequent actions in conformance with ITU-T Rec. G. 751 paragraph 2 and 3.
- (2) Above important alarms (item 3.2.1.2) shall be extended to Operation and Control Desk of OCS installed in AA IR/ITE Communications Center and Nazareth Primary center.
- (3) Racks shall be provided with adequate testing and monitoring facilities for conducting routine operation and maintenance.

2.3 Electric Performance Requirements

2.3.1 STM-16 Digital Multiplex Equipment

(1) System Parameters

- a) Transmission Capacity : STM-16
- b) Service Capacity : 16 X STM-1 (155.52 Mbit/s)
 - (i) STM-16 Digital Multiplex Equipment A :
16 X STM-1 (155.52 Mbit/s)
- c) Bit Error Rate : $< 1 \times 10^{-10}$
- d) Type of Tributary Interface : STM-1 (155.52 Mbit/s)

(2) Interfaces

- a) STM-16 Interface (Electrical) :
 - (i) Bit rate : 2.488 Gbit/s
 - (ii) Impedance : 75 ohms unbalanced
 - (iii) Code : CMI (Code Mark Inversion)
 - (iv) Pulse waveform : Rec. ITU-T Table 11/G.703, Fig. 24/G.703 and Fig. 25/G.703
- b) 155.52 M Interface :
 - (i) Bit rate : 155.52 Mbit/s
 - (ii) Impedance : 75 ohms unbalanced
 - (iii) Code : CMI (Code Mark Inversion)
 - (iv) Pulse waveform : Rec. ITU-T Table 8/G.703, Fig. 17/G.703

- (3) Performance Requirements : ITU-T Rec. G. 751

2.3.2 155M Digital Multiplex Equipment

(1) System Parameters

- a) Transmission Capacity : STM-1
- b) Service Capacity : 63 X C-12 (2.048 Mbit/s) or
3 X C-3 (34.368 Mbit/s)
Note: 21 X C-12 can be replaced with one C-3
 - (i) 155M Digital Multiplex Equipment B :
63 X C-12 (2.048 Mbit/s)
 - (ii) 155M Digital Multiplex Equipment C :
21 X C-12 (2.048 Mbit/s) + 2 X C-3 (34.368 Mbit/s)
- c) Multiplexing Scheme : C-12 --> TU-12 --> AU-4 or
C-3 --> TU-3 --> AU-4

- d) Bit Error Rate : < 1 X 10⁻¹⁰
- e) Type of Tributary Interface : 2.048 Mbit/s, 34.368 Mbit/s
- f) TSI Level : VC-12 level (for C-12)
VC-3 level (for C-3)

(2) Interfaces

a) STM-1 Interface (Electrical) :

- (i) Bit rate : 155.520 Mbit/s
- (ii) Impedance : 75 ohms unbalanced
- (iii) Code : CMI (Code Mark Inversion)
- (iv) Pulse waveform : Rec. ITU-T Table 11/G.703, Fig. 24/G.703 and Fig. 25/G.703

b) 34M Interface :

- (i) Bit rate : 4.368 Mbit/s ± 20 ppm
- (ii) Impedance : 75 ohms unbalanced
- (iii) Code : HDB3 (High Density Bipolar 3)
- (iv) Pulse waveform : Rec. ITU-T Table 8/G.703, Fig. 17/G.703

c) 2M Interface :

- (i) Bit rate : 2.048 Mbit/s ± 50 ppm
- (ii) Impedance : 75 ohms unbalanced
- (iii) Code : HDB3 (High Density Bipolar 3)
- (iv) Pulse waveform : Rec. ITU-T Table 6/G.703, Fig. 15/G.703

(3) Performance Requirements : ITU-T Rec. G. 751

2.3.3 Power Units for Digital Multiplex Subsystem

- (1) STM-16 Digital Multiplex Equipment : Shall be proposed
- (2) 155M Digital Multiplex Equipment : Shall be proposed

3. Distribution Frame Subsystem (DDF)

3.1 Subsystem Configuration

Distribution Frame Subsystem shall be basically composed of devices shown in Table 3.1-1.

Table 3.1-1 Distribution Frame Subsystem

Item	Quantity					
	AA IR/ITE Station	AA Filwoha Station	AA Nefas Silk Station	Debre Zeit Station	Adama West M/W Rep.	Nazareth Primary Center
Digital Distribution Frame (DDF)	1 Set	1 Set	1 Set	1 Set	1 Set	1 Set

3.2 Functional Requirements

3.2.1 Digital Distribution Frame

- (1) This DF shall provide cross-connect points for digital signals (DDF). The terminal panel mounted in a frame shall be used as a distributor for making the connections and rerouting transmission paths, over which 2M or 34M or 155M or 2.488 G PCM signals are cross-connected using jumper wires or cords.
- (2) Each distribution circuits of the panel shall be provided with U-link plugs or jumper cords for bridging or terminating the circuit.
- (3) The Contractor shall furnish the following types of DFs.

2M-DF, 34M-DF, 155M-DF (STM-1-DF) , STM-16-DF

- (4) Bidder shall provide following information of the proposed DDFs and provide enough quantity to implement all systems specified in this Document.
 - Dimensions of DDFs
 - Drawings of terminal blocks
 - Cable terminating capacity
 - Description and quantities of parts, accessories and spares