Telecommunications Authority of Trinidad and Tobago

Consultative Document

on

Technical Standards for Public Fixed Telecommunications Networks

(Second round)

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Abbreviations

ASTM	American Society for Testing and Materials
APS	automatic protection switching
IEC	International Electrotechnical Commission
HFC	hybrid fibre-coaxial
MSAN	multi-service access node
OGW	overhead ground wire
OTN	optical transport network
POI	point of interconnection
QoS	quality of service
SPD	surge protective device

1 Introduction

1.1 Rationale

The destructive forces of natural and man-made disasters may impair, damage or destroy telecommunications networks. Additionally, the demand for telecommunications services usually soars before, during and after disasters. Therefore, it is vital that operators design reliability and robustness into their networks. Further to this, the required reliability and robustness with respect to wired and wireless networks may be different.

In light of recent natural disasters and the resultant destruction of telecommunications networks in the Caribbean, the robustness of the national telecommunications infrastructure has become a critical issue. Compliance with appropriate technical standards will enable networks to better withstand the effects of natural and man-made disasters. The Telecommunications Authority of Trinidad and Tobago (the Authority) plays a central role in establishing such standards.

1.2 Purpose

This document, *Technical Standards for Public Fixed Telecommunications Networks in Trinidad and Tobago*, establishes technical standards to enhance the robustness of public fixed telecommunications networks in Trinidad and Tobago, in relation to:

i. making the facilities within public fixed telecommunications networks resilient against natural and man-made disasters.

ii. implementing redundancy into key aspects of public fixed telecommunications networks.

1.3 Background

Given the importance of public fixed telecommunications networks as a means of communication, it is vital that these networks be designed and deployed to be resilient against natural and man-made disasters.

The access network in public fixed telecommunications network infrastructures comprises outside plant facilities, such as aerial and underground cables, poles, manholes, underground ducts and cross-connect cabinets, as well as access network electronic devices such as multi-service access nodes (MSANs). Outside plant facilities, and MSANs in general, are in an external environment and, therefore, susceptible to disasters. Typical examples of disasters which affect the access network, include hurricanes/tropical storms, flooding, vehicular accidents and falling trees/branches.

The transport network infrastructure comprises fibre optic transmission systems and associated cables. It is susceptible to similar disasters that affect the access network, as well as disasters such as bush fires and power outages. These occurrences lead to service outages and other disruptions affecting large and small segments of the consumer population.

A point of POI is a critical part of a public fixed telecommunications network that requires a level of resilience and redundancy to mitigate susceptibility to catastrophic failure. Typical examples of disasters which affect POIs include power outages and earthquakes. Failures at POIs lead to the disruption of interconnection services between operators.

These key components of a public fixed telecommunications network should conform to appropriate technical standards to mitigate the effects of disasters. Additionally, the appropriate technical standards should be applicable to the various types of public fixed telecommunications networks.

1.4 Objectives

This document:

i. identifies the detrimental effects of natural and man-made disasters on the outside plant facilities of public fixed telecommunications networks.

ii. establishes technical standards:

    a) for outside plant facilities to withstand the effects of natural and man-made disasters.
    b) to enhance the resilience of active electronics within the access network of a public fixed telecommunications network.
    c) to enhance the resilience of the optical transport network within a public fixed telecommunications network. (N.B. Technical standards to enhance the

resilience of a microwave transport network will be established in a later document.)

d) to enhance the resilience of POIs within a public fixed telecommunications network.

1.5 Scope

This document does not deal with cybersecurity as a man-made disaster and its treatment to protect public fixed telecommunications networks. The Authority will undertake a separate consultation to address this issue in the context of network resilience.

Additionally, this document does not deal with quality of service (QoS) standards for public fixed telecommunications networks, nor does it deal with technical standards for public fixed wireless networks.

1.6 Relevant Legislation

The sections of the Telecommunications Act, Chap. 47:31 (the Act) which inform this document are:

Section (2)(1):

"In this Act –

"facility" means a physical component of a telecommunications network, other than terminal equipment, including wires, lines, terrestrial and submarine cables, wave guides, optics or other equipment or object connected therewith, used for the purpose of telecommunications and includes any post, pole, tower, standard, bracket, stay, strut, insulator, pipe, conduit, or similar thing used carrying, suspending, supporting or protecting the structure;"

Section (18)(1)(d):

"Subject to the provisions of this Act, the Authority may exercise such functions and powers as are imposed on it by this Act and in particular –

Establish national telecommunications industry standards and technical standards."

Section (25)(2)(a):

"In respect of a concessionaire's obligations pursuant to subsection (1), the Authority shall require a concessionaire to—

(a) comply with guidelines and standards established by the Authority to facilitate interconnection;"

Section (33)(1):

"In connection with the operation of a telecommunications network or the provision of a telecommunications service, a concessionaire may install or maintain a facility in or over a street or public ground or remove the facility therefrom and, for that purpose, may, in accordance with the development plan for the area and the provisions of the Highways Act and any other written law, carry out road works."

Section (33)(2)(d):

"Before carrying out any road works for the purposes specified in subsection (1), a concessionaire shall—

(d) notify the Authority of any intended road works and in the event of the failure to obtain the permission of a utility installation owner under paragraph (c), the Authority shall facilitate relief thereof."

Section (33)(9):

"The Authority shall require that, prior to carrying out road works, a concessionaire publish a description thereof in at least one daily newspaper."

Section (35):

"Where trees on private lands overhang or interfere with any facility or road works, a concessionaire shall, before cutting down, pruning or trimming the trees, obtain the consent of the owner or person in possession of the land."

Section (45):

(1) "Subject to the other provisions of this Act, concessionaires and licensees may implement such technical standards as they deem appropriate and which are in conformity with accepted international standards."

(2) "Not withstanding subsection (1), the Authority may identify, adopt or establish preferred technical standards."

1.7 Review Cycle

This document will be revised periodically to meet changing needs. The Authority will review the standards as necessary, and in consultation with stakeholders, to ensure that the document is guided by relevant international standards.

Questions or concerns regarding the maintenance of this document may be directed to the Authority via e-mail at consultation@tatt.org.tt.

1.8 Consultation Process

In accordance with its *Procedures for Consultation in the Telecommunications Sector of Trinidad and Tobago* (ver. 2.0, 2010), the Authority sought the views of the general public and industry stakeholders on the first draft of this document, published on February 15, 2019, with an initial closing date of March 15, 2019. The closing date was extended to April 12, 2019, following requests from stakeholders.

The comments and recommendations received from the first round of consultation, and the Authority's decisions on these comments and recommendations, have been compiled in the decisions on recommendations (DoRs) in Appendix I.

The following revisions to the first consultative document, based on the feedback captured in the DoRs, have been made in this version of the document:

i. A new section 1.5 entitled "Scope" has been added to the document.

ii. Section 1.6 (formerly section 1.5) of the document was amended to include parts of section 33 of the Act, as well as section 35 of the Act.
iii. The definition for "access network" in section 1.10 (formerly section 1.9) was amended.
iv. A definition for "firebreak" was included in section 1.10 (formerly section 1.9).
v. The definition for "local exchange" was deleted from section 1.10 (formerly section 1.9).
vi. A definition for "switch" was included in section 1.10 (formerly section 1.9).
vii. "Standard" was changed to "Mandatory Standard" in section 1.11 (formerly section 1.10).
viii. Definitions of mandatory and discretionary standards were amended in section 1.11 (formerly section 1.10) for clarification.
ix. "Technical standard(s)" in the boxes were changed to "Mandatory standard(s)"
x. The numbering of the mandatory standards, formerly technical standards, was adjusted.
xi. The numbering of the discretionary standards was adjusted.
xii. Changes to the list of outside plant facilities in the preamble of section 3
xiii. Changes to mandatory standards 1, 2 and 4, formerly technical standards 1, 2 and 4
xiv. Discretionary standard 1 has been changed to mandatory standard 5.
xv. Discretionary standard 1, formerly discretionary standard 2, has been amended.
xvi. Mandatory standards 8 and 9, formerly technical standards 7 and 8 respectively, have been amended.
xvii. Discretionary standard 3 has been changed to technical standard 11.
xviii. Former technical standard 10 has been removed.
xix. Mandatory standard 12 has been amended and included in section 3.1.1.2.
xx. Mandatory standard 16, formerly technical standard 13, has been amended.
xxi. Mandatory standard 19, formerly technical standard 16, has been amended.
xxii. Discretionary standards 5 and 6, formerly discretionary standards 7 and 8 respectively, have been amended.
xxiii. Discretionary standard 8, formerly discretionary standard 10, has been amended.
xxiv. Former discretionary standard 12 has been changed to mandatory standard 21.
xxv. Mandatory standard 23, formerly technical standard 19, has been amended.
xxvi. Discretionary standard 10, formerly discretionary standard 13, has been amended.
xxvii. The title of section 3.1.5 has been changed.
xxviii. Former technical standard 21 has been removed.
xxix. Mandatory standards 25, 26 and 27, formerly technical standards 22, 23 and 24 respectively, have been amended.
xxx. Former technical standard 25 has been removed.
xxxi. Former discretionary standard 15 has been changed to mandatory standard 28.
xxxii. A new mandatory standard 29 has been included in the document.

xxxiii. Discretionary standard 14, formerly discretionary standard 18, has been amended.
xxxiv. Mandatory standard 33, formerly technical standard 29, has been amended.
xxxv. Mandatory standard 38, formerly technical standard 34, has been amended.
xxxvi. Mandatory standard 39, formerly technical standard 35, has been amended.
xxxvii. Former technical standard 36 has been removed.
xxxviii. A new mandatory standard 40 has been included in the document.
xxxix. Mandatory standard 42, formerly technical standard 38, has been amended.
xl. Former discretionary standard 20 has been amended and renamed as mandatory standard 47.
xli. Editorial changes were made to the document.

1.9 Other Relevant Documents

Other relevant policies and regulations to be read along with the *Technical Standards for Public Fixed Telecommunications Networks in Trinidad and Tobago* include:

i. The Telecommunications Act, Chap. 47:31
ii. The *Authorisation Framework for the Telecommunications and Broadcasting Sectors of Trinidad and Tobago* (ver. 0.5)

1.10 Definitions

Access network: a system deployed between a suitable point on the core network and user premises, replacing part or the whole of the local line distribution network

Automatic protection switching: autonomous switching of a signal from a failed working trail/path to a protection trail/path, and subsequent restoration, using control signals ((ITU-T) Definition. Automatic Protection Switching 2004)

Firebreak: a strip of land clear of vegetation that is used to prevent the spread of bush fires

Man-made disaster: In the context of this document, this refers to an event caused by human activity, which negatively affects a small or large portion of a telecommunications network and, as a consequence, causes degradation or loss of service to a small or large number of consumers.

Multi-service access node (MSAN): a platform which supports all the commonly deployed access technologies and services and acts as a gateway to a next generation network (NGN) core (Fujitsu n.d.)

Optical transport network: An optical transport network (OTN) comprises a set of optical network devices connected by optical fibre links. The OTN enables functions such as the transport, multiplexing, routing, management, supervision and survivability of optical channels carrying client signals ((ITU-T) Definition. Optical Transport Network 2004)

Point of interconnection (POI): a point on the interconnection provider's network where physical connection is allowed to any interconnecting concessionaire, to act as a gateway between networks, and enable the exchange of telecommunications services between networks (TATT 2006)

Public fixed telecommunications network: a system or any part thereof used for the provision of a public fixed (as distinct from mobile) telecommunications service

Switch: a telephone exchange in the public switched telecommunications network which directly routes calls between subscribers

1.11 Compliance Notation

Mandatory Standard	The concessionaire shall comply fully with the standard as specified.
Discretionary Standard	The concessionaire may comply with the standard as specified. There may exist valid reasons in particular circumstances where the specified standard cannot be implemented; in this regard, if the concessionaire chooses not to comply with the standard, the full implications of the case must be understood and carefully considered by the concessionaire.

2 Disasters

2.1 Natural Disasters

As part of the Caribbean, Trinidad and Tobago may experience any one of the following natural disasters:

i. **Hurricanes or strong winds**: A hurricane is a tropical cyclone that is generated over vast areas of warm water. Many hurricanes which affect the Caribbean region are formed in the Atlantic Ocean and, depending on the category of the hurricane, wind speeds can reach between 119 km/h and 250 km/h. Trinidad and Tobago, due to its location in relation to the equator, is not normally prone to hurricanes. The country, however, does experience tropical storms which cause damage to infrastructure.

ii. **Floods**: Flooding is the accumulation or overflow of a large amount of water over land which is normally dry (ODPM, Hazards - Flooding 2013). In Trinidad and Tobago, flooding normally occurs due to heavy rainfall during the rainy season from June to November. Deforestation and new developments in flood-prone areas have also exacerbated this problem. Many parts of the country are prone to flooding, including the capital city, Port of Spain.

iii. **Earthquakes:** An earthquake is the sudden shaking of the earth's crust caused by the shifting and unlocking of the tectonic plates that make up the earth's crust (ODPM, Hazards - Earthqauakes 2013). The strength of an earthquake is indicated by the Richter magnitude which ranges from 0 to 9 (weakest to strongest). In recent years, earthquakes that affected Trinidad and Tobago reached a magnitude of 6.9 on the Richter scale. But due to the short duration, the long distance from the epicenter and/or the depth from which the earthquakes originated, the effects have not been severe.

iv. **Bush fires**: Bush fires occur during the dry season, which in Trinidad and Tobago is normally between December and May. Bush fires tend to occur alongside highways as well as on hilly slopes where slash-and-burn farming methods are utilised. The devastation caused by bush fires can be substantial if the fires are not extinguished quickly.

v. **Landslides**: Heavy or prolonged rainfall causes soil to become saturated and heavy. On sloped areas where there is hardly any vegetation, the pull of gravity causes saturated soil to slide down hills and develop into landslides. In Trinidad and Tobago, the heavy showers during the rainy season, combined with deforestation due to bush fires, development and slash-and-burn farming, cause areas located on steep slopes or at the base of mountains to become prone to landslides.

vi. **Lightning strikes**: A lightning strike is an electrical discharge which can occur either within a cloud, from cloud to cloud, or from cloud to ground, and are common during thunderstorms which occur during the rainy season.

vii. **Tsunamis**: A tsunami is a series of ocean waves of extremely long wavelength caused by underwater seismic activity. Tsunami waves can reach up to several metres high and can cover large areas up to a hundred thousand square kilometres (ODPM n.d.). In the past, Trinidad and Tobago has experienced very minor tsunamis, resulting in minimal damage to coastal areas.

2.2 Man-Made Disasters

Man-made disasters that affect public fixed telecommunications networks are identified below:

i. **Destruction of underground ducts and cables by unauthorised or unplanned excavation:** Unauthorised or unplanned excavation occurs with roadworks that are carried out without the requisite notifications and/or approvals from relevant authorities. During such excavations, roadwork equipment may penetrate underground telecommunications ducts, causing damage to cables.

ii. **Destruction of aerial telecommunications cables by vehicles:** Outside plant aerial telecommunications cables run either along the side of the road or from one side of the road to the other. Aerial telecommunications cables with low ground heights that cross from one side of the road to the other lie in the path of vehicles with highly elevated loads, for example, containers, cement or music trucks and land-drilling rigs. The cables are, therefore, susceptible to being damaged.

iii. **Unauthorised burning of debris:** Flames caused by the burning of garbage and discarded items in residential areas may damage overhead aerial telecommunications cables.

iv. **Tree pruning:** The cutting of overhanging trees may result in branches falling on aerial telecommunications cables.

v. **Theft of copper aerial telecommunications cables:** Theft of copper aerial telecommunications cables occurs due to the high monetary value of copper.

vi. **Power outages**: Loss of electricity to facilities such as access nodes and buildings used to house network equipment

vii. **Cutting of cables**: The malicious cutting of cable infrastructure

viii. **Network traffic congestion**: The condition of a network where the immediate establishment of a new connection is impossible owing to the unavailability of network elements (Telecommunications 2000)

3 Technical Standards for Outside Plant Facilities

Outside plant facilities consist of cabling as well as the infrastructure hardware that supports the cables, including:

i. aerial cables (fibre and copper) and associated passive devices (splitters, couplers and joints)
ii. poles
iii. manholes
iv. underground ducts
v. underground cables (fibre and copper) and associated passive devices
vi. twisted pair copper and fibre cabinets, and pedestals (no active electronics)
vii. enclosures

3.1 Technical Standards to Mitigate the Effects of Natural Disasters

3.1.1 Technical Standards for Aerial Telecommunications Cables

3.1.1.1 Hurricanes or Strong Winds

Vibration on telecommunications cables due to strong winds causes abrasion to the elements of the cable and potentially a break in the cable. To reduce vibration, suppressers should be installed at the ends of cables located in areas which experience high winds. Cables with built-in strength members and suspension wires lashed to aerial cables both further reduce vibration.

Connections between aerial cables should be protected from rain by ensuring that the enclosures remain waterproof. This is accomplished by following the proper installation, operational and maintenance procedures.

Utility poles supporting heavy loads, such as electricity transformers, have a greater chance of breaking and falling during a hurricane than poles which do not support heavy loads. As far as practicable, aerial cables should not be connected to utility poles which support heavy loads.

Aerial cables could also become damaged if they are hit by falling branches or trees during hurricanes, so it is suggested that branches be kept clear of telecommunications cables.

To mitigate the effects of hurricanes and strong winds on aerial telecommunications cables, the following standards are applied.

Mandatory standards to mitigate the effects of hurricanes or strong winds on aerial telecommunications cables:

(1) Vibration dampers shall be installed between ends of aerial telecommunications cables and supporting structures in areas which experience high winds (ITU, L.89. Design of suspension wires, telecommunication poles and guy-lines for optical access networks 2012).

(2) Fibre optic cables shall either have a built-in strength member (element) or be lashed to a high-strength suspension/messenger wire (ITU, L.89. Design of suspension wires, telecommunication poles and guy-lines for optical access networks 2012). *For fibre optic last mile and drop cables to customer premises, such cables do not require a built-in strength member (element), nor is it required that they be lashed to a high-strength suspension/messenger wire, unless there is an unusually long cable span.*

(3) In coastal areas as well as industrial areas, suspension/messenger wires shall be made of an anticorrosive material (ITU, L.89. Design of suspension wires, telecommunication poles and guy-lines for optical access networks 2012).

(4) Enclosures used to house passive devices along telecommunications lines shall be, at a minimum, in accordance with international protection (IP) 55.

(5) Aerial telecommunications cables should, as far as practicable, not be connected to utility poles which support heavy loads (for example, transformers). The exception should only occur when there is no other suitable pole available and a substitute pole cannot be planted.

Discretionary standard to mitigate the effects of hurricanes or strong winds on aerial telecommunications cables:

(1) Aerial telecommunications cables should be kept clear of overhanging trees and branches. For trees located in private lands that overhang or interfere with aerial cables, operators should get consent from the landowner(s) before trimming overhanging branches.

3.1.1.2 Lightning Strikes

Copper or fibre optic aerial cables with metallic elements or strands can be affected by lightning. Fibre optic cables without metallic elements or strands are not affected by lightning.

Common ways of protecting aerial telecommunications cables from lightning strikes include: installation of an overhead ground wire (OGW) above the telecommunications cable with ample space between the conductor and the cable to prevent arcing; frequent grounding along the line of the telecommunications cable; grounding of metal strands along the line; and grounding of the cable at the point where the cable interfaces with a structure (ITU, ITU-T Recommendations - K.46. Protection of telecommunication lines using metallic symmetric conductors against lightning-induced surges 2012). There are standards employed for the grounding of aerial telecommunications cables. The common practice in Trinidad and Tobago is to utilise the following standard for grounding purposes: Trinidad and Tobago Electrical Wiring Code, Part 1: Low Voltage Installations (1st revision)-TTS 171: Part 1:2015. To mitigate the impact of lightning strikes on aerial telecommunications cables, the following standards are applied.

Mandatory standards to mitigate the effects of lightning strikes on aerial telecommunications cables:

(6) Aerial telecommunications cables shall be grounded along the cable route (ITU, K.47. Protection of telecommunication lines against direct lightning flashes 2012).
(7) Surge protective devices (SPDs) shall be installed between the active conductors and the cable shield, with the shield connected directly to ground (ITU, K.47. Protection of telecommunication lines against direct lightning flashes 2012).
(8) At points where aerial telecommunications cables which have metallic elements enter or exit structures, the cables shall be grounded (ITU, K.47. Protection of telecommunication lines against direct lightning flashes 2012).
(9) OGWs shall be installed above aerial telecommunications cables (ITU, K.47. Protection of telecommunication lines against direct lightning flashes 2012). *For telecommunications cables that are either located below a T&TEC (electricity) bare cable or have ground heights that are below the height of adjacent electricity poles, the installation of an OGW is not required.*
(10) OGWs shall be connected to ground (ITU, K.47. Protection of telecommunication lines against direct lightning flashes 2012).
(11) Hybrid fibre-coaxial (HFC) aerial cables shall be grounded every 300 meters.
(12) Metal strands shall be grounded.
(13) Grounding of aerial telecommunications cables shall conform to the Trinidad and Tobago Electrical Wiring Code, Part 1: Low Voltage Installations (1st revision)-TTS 171: Part 1:2015.

3.1.1.3 Bush Fires

The heat generated from a bush fire may cause the sheath and the core of an aerial cable to melt. The trimming of underlying bushes to a low height reduces the chance of aerial cables being damaged by bush fires. Service providers should ensure that underlying bushes are trimmed to a low height. To mitigate the impact of bush fires on aerial telecommunications cables, the following standard is applied.

> ***Discretionary standard to mitigate the effects of bush fires on aerial telecommunications cables:***
>
> *(2) In areas where aerial telecommunications cables are deployed, underlying bush and vegetation should be trimmed to a low height.*

3.1.1.4 Tsunamis

Aerial telecommunications cables deployed within coastal areas are at risk of being damaged by tsunamis. Running cable routes at higher ground levels (as far as practicable) along coastal areas reduces the chance of aerial telecommunications cables being damaged by tsunamis. To mitigate the effects of tsunamis on aerial telecommunications cables, the following standard is applied.

> ***Discretionary standard to mitigate the effects of tsunamis on aerial telecommunications cables:***
>
> *(3) As far as practicable, cable routes in coastal areas should be run at higher ground levels* (ITU, L.92. Disaster management for outside plant facilities 2012).

3.1.2 Technical Standards for Telecommunications Poles

3.1.2.1 Hurricanes or Strong Winds

The use of guyed structures to keep telecommunications poles vertical and in place reduces the impact of hurricanes on poles. In rural areas, guyed structures comprising guyed wires and guyed anchors should be used. In urban areas where space is restricted, sidewalk guys should be used. To mitigate the effects of hurricanes and strong winds on telecommunications poles, the following standards are applied.

Mandatory standards to mitigate the effects of hurricanes or strong winds on telecommunications poles:

(14) In rural areas, guyed structures comprising guyed wires and guyed anchors shall be used to support telecommunications poles.
(15) For corner poles and terminal poles, guyed wires shall be used.
(16) In areas where wind conditions are at the highest, two guyed wires shall be attached to every second intermediate pole.
(17) Guyed anchors shall be used to attach guyed wires to the ground, as follows:
  - *i. Block-type guyed anchors shall be used in soft ground.*
  - *ii. Piton-type guyed anchors shall be used in soft ground which has other installations/anchors buried in the ground.*
  - *iii. Spikybolt-type guyed anchors shall be used for rocky/concrete surfaces.*

(18) In built-up areas, sidewalk guyed structures shall be used to support telecommunications poles.

3.1.2.2 Bush Fires

As wood is a combustible material, telecommunications poles made of wood are susceptible to being burnt and destroyed by bush fires. The construction of firebreaks around these poles, particularly those deployed in rural areas prone to bush fires, reduces the chance of poles being destroyed. To mitigate the effects of bush fires on telecommunications poles, the following standard is applied.

Discretionary standard to mitigate the effects of bush fires on telecommunications poles:

(4) Firebreaks should be constructed around the base of telecommunications poles, particularly those deployed in rural areas which are prone to bush fires (ITU, L.92. Disaster management for outside plant facilities 2012).

3.1.2.3 Earthquakes

Telecommunications poles have a great chance of falling during an earthquake if they are not buried deeply enough into the ground. The setting depth of a telecommunications pole is proportional to the length of the pole and should be, at a minimum, equal to 20% of the length of the pole. In soft ground, extra support should be given to the setting of the pole via pole anchors (ITU, Final report ITU-D Study group 2. Question 22 - 1/2. Utilization of telecommunications/ICTs for disaster preparedness, mitigation and response 2014). To mitigate the effects of earthquakes on the poles, the following standards are applied.

Mandatory standards to mitigate the effects of earthquakes on telecommunications poles:

(19) The setting depth of telecommunications poles shall be, at a minimum, 20% of the length of the pole.

(20) Pole anchors shall be used for the burial of telecommunications poles in soft ground.

3.1.2.4 Landslides

Telecommunications poles installed at the base of slopes that are prone to landslides have a high chance of falling if the severity of a landslide is great. The planting of telecommunications poles in areas prone to landslides should be avoided and the telecommunications cables should be installed in underground ducts buried in the roadway. To mitigate the effects of landslides on telecommunications poles, the following standards are applied.

Discretionary standards to mitigate the effects of landslides on telecommunications poles:

(5) Telecommunications poles should not be installed in areas which are known to be prone to landslides.

(6) If practicable, telecommunications cables should be run underground in ducts buried beneath roadways in areas which are known to be prone to landslides.

3.1.3 Technical Standards for Telecommunications Manholes

3.1.3.1 Earthquakes

During an earthquake, the soil around a manhole may liquefy. Liquefication of the soil will cause the manhole to move or sink and, as a result, may cause the underground duct and cable connections housed within the manhole to break. Soil liquefaction countermeasures applied during the deployment of manholes reduces the chance of a manhole moving or sinking during an earthquake (ITU, L.92. Disaster management for outside plant facilities 2012). To mitigate the effects caused by earthquakes on manholes, the following standard is applied.

Discretionary standard to mitigate the effects of earthquakes on telecommunications manholes:

(7) Liquefaction countermeasures should be applied during the deployment of telecommunications manholes.

3.1.4 Technical Standards for Underground Ducts and Cables

3.1.4.1 Landslides

On hills where there is loose soil, rainfall may cause landslides, resulting in damage to underground ducts and cables buried within the soil. If practicable, underground ducts and cables should be buried under roadways in areas which are prone to landslides. Poles are more susceptible to landslides than ducts buried under roadways. To mitigate the effects caused by landslides on underground ducts and cables, the following standard is applied.

Discretionary standard to mitigate the effects of landslides on underground telecommunications ducts and cables:

(8) Underground ducts and cables should be buried under roadways in areas which are known to be prone to landslides.

3.1.4.2 Floods

In times of flooding, underground duct and cable connections housed within manholes become vulnerable to water. By making these ducts and cable connections waterproof, there is less likelihood of water penetrating the cables. To mitigate the effects of flooding on such ducts and cables, the following standards are applied.

Mandatory standard to mitigate the effects of floods on underground telecommunications ducts and cables:

(21) Joints connecting underground ducts and cables should be properly water sealed (ITU, L.92. Disaster management for outside plant facilities 2012).

Discretionary standard to mitigate the effects of floods on underground telecommunications ducts and cables:

(9) Excess gaps where underground ducts enter the manhole should be sealed using foam filler (ITU, L.92. Disaster management for outside plant facilities 2012).

3.1.4.3 Earthquakes

During an earthquake, underground ducts tend to move and flex due to the movement of the ground and, if the duct is too rigid, it can break. PVC or polyethylene (PE) duct sleeves and self-adjusting joints installed along the duct (where applicable), as well as at its ends, allows a certain amount of movement and rotation to be accommodated throughout the duct. To mitigate the effects caused by earthquakes on underground ducts and cables, the following standards are applied.

Mandatory standards to mitigate the effects of earthquakes on underground telecommunications ducts and cables:

(22) Extendable joints shall be used along the lengths of the ducts (where applicable) as well as at the ends (ITU, L.92. Disaster management for outside plant facilities 2012).

(23) Underground ducts made of either schedule 40 PVC, at a minimum, or high-density polyethylene (HDPE) shall be used.

(24) The standard specification of the PE conduit that shall be used is ASTM F2160 for solid-wall, high-density polyethylene (HDPE) conduits (ITU, Final report ITU-D Study group 2. Question 22 - 1/2. Utilization of telecommunications/ICTs for disaster preparedness, mitigation and response 2014).

3.1.4.4 Tsunamis

In Trinidad and Tobago, ducts and cables are normally strapped and run along the bottom of a bridge from one side to the other. A tsunami can cause the height and force of water entering river mouths to increase and this, in turn, may damage the conduit strapped to the bottom of the bridge. By running conduits under riverbeds or strapping them to the side of the bridge not facing the sea, depending on the type of bridge, the force of the water entering the river would be less detrimental to the conduits. To mitigate the effects of tsunamis on underground ducts and cables, the following standard is applied.

Discretionary standard to mitigate the effects of tsunamis on underground telecommunications ducts and cables:

(10) In coastal areas, conduits used to deploy telecommunications cables across bridges that are not constructed with reinforced steel or concrete should be run underneath riverbeds (ITU, L.92. Disaster management for outside plant facilities 2012). *Conduits used to deploy telecommunications cables across bridges constructed with reinforced steel and concrete should be attached to the side of the bridge that does not face the sea.*

3.1.5 Technical Standards for Passive Cross-Connect Cabinets and Pedestals

3.1.5.1 Floods

Cross-connect cabinets are generally installed low to the ground and, as a result, are susceptible to being submerged due to flooding. Water may penetrate under the sleeves of the telecommunications cables terminated in the cabinet, thereby causing line degradation. The installation of cross-connect cabinets at heights above flood lines, as well as outfitting the cabinets with waterproof doors, reduces the chance of cross-connect cabinets being submerged due to flooding. In areas that are prone to flooding, cross-connect cabinets should be installed on H-frames. Pedestals used to house passive devices like taps, nodes and couplers should be water sealed. To mitigate the damage caused by floods on passive cross-connect cabinets and pedestals, the following standards are applied.

> ***Mandatory standards to mitigate the effects of floods on passive cross-connect cabinets and pedestals:***
>
> *(25) Passive cross-connect cabinets shall be outfitted with waterproof doors.*
> *(26) In areas that are prone to flooding, passive cross-connect cabinets shall be installed on H frames at a sufficient height above known floodwater levels. Concrete pads may be utilised as an alternative, once the topography of the area allows for the same height advantage as an H frame.*
> *(27) For pedestals, protection against dust and resistance to water shall be applied, at a minimum, in accordance with international protection (IP) 68.*

3.1.5.2 Tsunamis

Within coastal areas, passive cross-connect cabinets are susceptible to damage by tsunamis. The installation of passive cross-connect cabinets at higher ground (where practicable), or on H frames along coastal areas, reduces the chance of passive cross-connect cabinets being damaged by tsunamis. To mitigate the effects of tsunamis on passive cross-connect cabinets, the following standard is applied.

Discretionary standard to mitigate the effects of tsunamis on passive cross-connect cabinets:

(11) In coastal areas, passive cross-connect cabinets should be installed at higher ground (where practicable) or on H frames at a sufficient height above the ground.

3.2 Technical Standards to Mitigate the Effects of Man-Made Disasters

3.2.1 Technical Standards for Underground Ducts and Cables

Concrete encasements constructed below the ground surface to cover the tops of underground ducts reduces the chance of damage caused to underground ducts and cables during unauthorised or unplanned excavations. These concrete encasements should be implemented for underground ducts which are buried less than 30 inches below the surface (United States Department of Agriculture 2002). To prevent damage to underground telecommunications ducts and cables by unauthorised or unplanned excavations, the following standards are applied.

Mandatory standards to mitigate the damage caused to underground ducts and cables by unauthorised or unplanned excavations:

(28) For underground ducts which are buried less than 30 inches below street level, concrete encasements covering the top of the duct shall be constructed.

(29) Caution tape shall be placed on top of concrete encasements constructed to cover underground ducts.

3.2.2 Technical Standards for Aerial Telecommunications Cables

3.2.2.1 Destruction by Vehicles

Aerial telecommunications cables may become damaged if they come in contact with high vehicles. The height of aerial cables from the ground, inclusive of sag, should be a minimum of 15 feet, five inches, where practicable, to allow sufficient clearance for high vehicles. To mitigate the damage caused by vehicles to aerial telecommunications cables, the following standard is applied.

Discretionary standard to mitigate the damage caused by high vehicles to aerial telecommunications cables:

(12) Where practicable, the minimum ground height of aerial telecommunications cables running across roads (inclusive of sag) should be 15 feet, five inches (15 ft 5 in) (Coldrocks n.d.).

3.2.2.2 Unauthorised Burning of Debris

The burning of debris or rubbish on roadsides may result in damage to low-hanging aerial telecommunications cables. The ground height of aerial cables running along the sides of roads should be a minimum of 15 feet, five inches, to reduce the possibility of damage to aerial telecommunications cables from burning debris. To mitigate the damaging effects to aerial telecommunications cables caused by the burning of debris, the following standard is applied.

Discretionary standard to mitigate the damage to aerial telecommunications cables caused by the burning of debris:

(13) Minimum ground height of aerial telecommunications cables running along the sides of roadways (inclusive of sag) should be 15 feet, five inches (Coldrocks n.d.).

3.2.2.3 Tree Pruning

The trimming of tree branches hanging over aerial telecommunications cables may result in cables being damaged if falling branches hit them. Tree branches located near aerial telecommunications cables should be trimmed by personnel or contractors authorised by the operators, thereby reducing the probability of damage to aerial cables caused by falling branches. To mitigate the damage caused by tree pruning to aerial telecommunications cables, the following standard is applied.

Discretionary standard to mitigate the damage caused by tree pruning on aerial telecommunications cables:

(14) Aerial telecommunication cables should be kept clear of overhanging trees and branches. For trees located in private lands that overhang or interfere with aerial cables, operators should get consent from the landowner(s) before trimming overhanging branches.

3.2.2.4 Theft of Copper Aerial Telecommunications Cables

There have been a significant number of instances where copper aerial telecommunications cables have been cut and stolen. In areas prone to such theft, these cables should, as far as practicable, be run in underground ducts. To mitigate the theft of copper aerial telecommunications cables, the following standard is applied.

Discretionary standard to mitigate the theft of copper aerial telecommunications cables:

(15) In areas prone to theft of copper aerial telecommunications cables, these cables should, as far as practicable, be run in underground ducts.

4 Technical Standards to Enhance the Resilience of the Access Network (Active Electronic Devices)

Active access network devices such as MSANs are located either in controlled buildings or in outdoor cabinets. Outdoor cabinets used to house MSANs should be designed with consideration being made to the following elements: environmental protection and related sealing requirements, mechanical protection, thermal management, electrical powering (ITU, L.70. Managing active electronics in the outside plant 2007), and protection against theft. To enhance the resilience of access network active electronic devices such as MSANs, the following standards are applied.

Mandatory standards to enhance the resilience of access network active electronic devices:

(30) For outdoor cabinets used to house multi-service access nodes (MSANs), protection against dust and resistance against jets of water shall be applied, at a minimum, in accordance with international protection (IP) 55 of the specification IEC 60529 (ITU, L.70. Managing active electronics in the outside plant 2007).

(31) Outside cabinets used to house MSANs shall be able to withstand 20.00 joules of impact energy, in accordance with IK code 10 of the specification IEC 62262 (ITU, L.70. Managing active electronics in the outside plant 2007).

(32) The temperature within the structure used to house MSANs shall always be within the operational temperature range of the equipment (ITU, L.70. Managing active electronics in the outside plant 2007).

(33) Each building or outdoor cabinet used to house MSANs shall be wired to accommodate back-up power (ITU, L.70. Managing active electronics in the outside plant 2007).

(34) Outdoor cabinets used to house MSANs shall be properly secured.

(35) Back-up power generators shall, without refueling, have the capability of supporting full equipment load and building ancillary services load, for a period of eight to 12 hours, to buildings which house MSANs.

(36) A supply of fuel capable of running standby generators (if deployed) for one week shall be on site at buildings which house MSANs.

(37) Back-up power batteries or fuel cell technology shall have the capability of supporting full equipment load for a minimum period of six hours to outdoor cabinets which house MSANs.

5 Technical Standards for Optical Transport Networks

Technical standards to enhance the resilience of optical transport networks (OTNs) are outlined in this section.

5.1 Technical Standards to Implement Redundancy

The most common mode of redundancy deployed in OTNs is ring topology. If there is a break in one of the spans of the ring, the signal is transmitted through the opposite direction of the ring to the destination node. In a single fibre ring topology, two separate breaks in the fibre within different spans of the ring may prevent a signal from reaching its destination node. By utilising a second fibre within the ring to act as a protective fibre, signals can be switched from the broken fibre to the protective one, using automatic protection switching (APS) to reach the destination node (ITU 2014). Microwave systems may also be used to provide redundancy, once full restoration of traffic can be achieved. To implement redundancy within OTNs, the following standards are applied.

Mandatory standards to implement redundancy in optical transport networks (OTNs):

(38) For a national, major or minor territorial public fixed telecommunications network, a ring topology or a point-to-point fibre link with redundant electronics and physically diverse paths shall be deployed within OTNs.

(39) APS shall be deployed within an OTN ring or a point-to-point fibre link.

(40) Where a microwave system is deployed to provide redundancy, full restoration of traffic shall be required.

5.2 Technical Standards to Withstand the Effects of Natural and Man-Made Disasters

OTN devices are generally housed in either a building or shelter. Structures used to house OTN devices should be constructed to withstand the effects of hurricanes and earthquakes, as well as be resilient against man-made disasters, such as power outages and malicious damage to cable infrastructure connected to the structure or equipment. To mitigate the effects of natural and man-made disasters on OTN nodes, the following standards are applied.

Mandatory standards to mitigate the effects of both natural and man-made disasters on optical transport network (OTN) nodes:

(41) Buildings that house OTN nodes shall comply with internationally recognised building codes adopted in Trinidad and Tobago.

(42) Shelters that house OTN nodes shall be designed to withstand hurricanes up to Category 4.

(43) Shelters housing OTN nodes shall be designed to withstand earthquakes up to a magnitude of 7 on the Richter scale.

(44) Structures that house OTN nodes shall be constructed with two physically separate cable entrances.

(45) Structures housing OTN nodes shall be equipped with stand-by power facilities and batteries.

(46) Stand-by power facilities shall have the following features:

- *I. Automatic load transfer*
- *II. Capability of supporting full equipment and building ancillary service loads for a period of one week without refueling*

(47) Opposite sides of the OTN ring topology shall be run on opposite sides of the road (as long as there is adequate road reserve) in areas where there is no readily available diverse physical path.

6 Technical Standards for Points of Interconnection or Switches

Technical standards to enhance the resilience of POIs are applied in this section.

6.1 Technical Standards to Implement Redundancy

In the past, technical issues at a POI have caused disruption in the telecommunications services between the operators served by that POI. A second POI acting as a redundant POI eliminates or significantly reduces the duration of the disruption of inter-operator traffic. To mitigate the effects caused by technical failures at a POI, the following standard is applied.

Mandatory standard to implement redundancy to points of interconnection (POIs):

(48) Public fixed telecommunications operators from whom interconnection services are requested shall have two separate POIs.

6.2 Technical Standards to Withstand the Effects of Natural and Man-Made Disasters

POI equipment is normally housed in local exchanges, trunk exchanges, or international exchanges belonging to the corresponding operator(s). Considering the vital need for telecommunications services between operators in times of emergency, buildings which house POIs should be constructed to be resilient against both natural disasters, such as hurricanes and earthquakes, and man-made disasters such as power outages.

In times of natural and man-made disasters, telecommunications networks become congested, causing overloading of the switching network. Features such as congestion detection and traffic control functionality within the switching network, and emergency voice call prioritisation should be applied to control network congestion (ITU 2017).

To mitigate the effects of natural and man-made disasters on buildings used to house POIs, the following standards are applied.

Mandatory standards to mitigate the effects of natural and man-made disasters on buildings used to house points of interconnection (POIs):

(49) Buildings which house POIs shall comply with internationally recognized building codes adopted in Trinidad and Tobago.

(50) Switches shall be installed with congestion detection and traffic control functionality.

(51) Switches shall have the functionality to prioritise calls to emergency services.

(52) Buildings that house POIs shall have stand-by power facilities.

(53) Stand-by power facilities shall have the following features:

- *I. Automatic load transfer feature*
- *II. Capability of supporting full equipment and building ancillary service loads for a period of one week without refueling*

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8 Appendix I: Decisions on Recommendations (DoRs) Matrix for First Consultation Round

Matrix is attached separately.