Democratic Socialist Republic of Sri Lanka
Telecommunications Regulatory Commission

Special Assistance for Project Implementation of Digitalization of Terrestrial Television Broadcasting Project in the Democratic Socialist Republic of Sri Lanka Final Report

August 2018

Japan International Cooperation Agency

Yachiyo Engineering Co., Ltd.

EI
JR
18-058

Democratic Socialist Republic of Sri Lanka
Telecommunications Regulatory Commission

Special Assistance for Project Implementation of Digitalization of Terrestrial Television Broadcasting Project in the Democratic Socialist Republic of Sri Lanka Final Report

August 2018

Japan International Cooperation Agency

Yachiyo Engineering Co., Ltd.

Contents

Figures

Tables

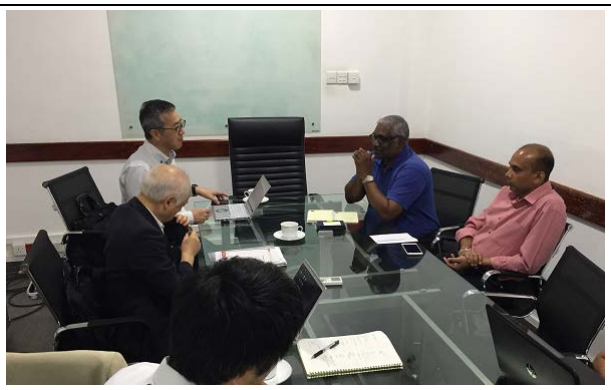
Acronyms

Acronym	Formal Name / Description
700 LTE	700 Long Term Evolution
ABNT NBR	Associação Brasileira de Normas Técnicas
APT	Asia-Pacific Telecommunity
ARIB	Association of Radio Industries and Businesses
ASO	Analogue Switch Off
BML	Broadcast Markup Language
DBNO	Digital Broadcasting Network Operator
DBNO Act	A law which will be prepared for DBNO
DiBEG	Digital Broadcasting Experts Group
digital dividend	Reuse of frequency bandwidths which will be vacant after ASO
DMC	Disaster Management Centre
DSO-HD	Digital Switch Over to High Definition
DSO-SD	Digital Switch Over to Standard Definition
DTMB	Digital Terrestrial Multimedia Broadcast
DTTB	Digital Terrestrial Television Broadcasting
DVB-T2	Digital Video Broadcasting – Terrestrial2
EFP	Electronic Field Production
ENG	Electronic News Gathering
EPG	Electric Program Guide
ERP	Effective Radiation Power
EWBS	Emergency Warning Broadcast System
Greater Colombo	A term which indicates Colombo city and its vicinity
HD	High Definition
IECD	Department of Import and Export Control
ISDB-T	Integrated Services Digital Broadcasting-Terrestrial
ITU	International Telecommunication Union
JICA	Japan International Cooperation Agency
Lotus Tower	The tower which will be the main transmitting station of DTTB in Sri Lanka
MCR	Master Control Room
MDM	Ministry of Disaster Management
MFMM	Ministry of Finance and Mass Media
MIC	Ministry of Internal Affairs and Communications of Japan

Acronym	Formal Name / Description
MOFA	Ministry of Foreign Affairs of Japan
MPRMM	Ministry of Parliamentary Reform and Mass Media
NOC	Network Operation Centre
Previous Survey	Feasibility Study on Digital Terrestrial Television Broadcasting Network Project (implemented by JICA in 2014)
SD	Standard Definition
SDSO	SD Digital Switch Off
STB	Set Top Box
STL	Studio to Transmitter Link
T1 Section	Top part of Lotus Tower at which antenna for DTTB will be installed
Tower Base	Ground part of Lotus Tower
Tower House	Middle part of Lotus Tower at which MCR and transmitter room will be installed
TRC	Telecommunications Regulatory Commission of Sri Lanka
UHF bandwidth	Ultra High Frequency bandwidth
VHF bandwidth	Very High Frequency bandwidth
Yen Loan Project	Digitalization of Terrestrial Television Broadcasting Project (Japanese ODA Loan agreed in 2014)

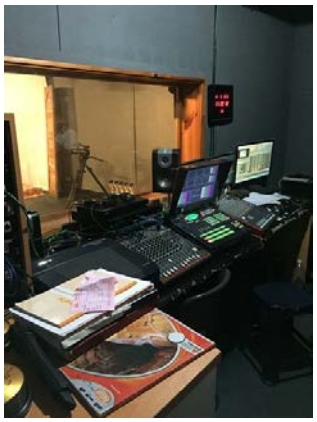
Picture of the survey

Meeting with relevant organizations / ISDB-T Technical Standards Seminar

<table>
<tr>
<td> 
Discussion with TRC about channel plan</td>
<td> 
Meeting with a private broadcaster (VIS Broadcasting)</td>
</tr>
<tr>
<td> 
Meeting with a telecommunication provider (Sri Lanka Telecom)</td>
<td> 

Presentation by JICA Survey Team at ISDB-T Technical Standards Seminar</td>
</tr>
<tr>
<td> 
Presentation by JICA Survey Team at ISDB-T Technical Standards Seminar</td>
<td> 
Attendants at ISDB-T Technical Standards Seminar (TRC, Sri Lankan broadcasters, MIC of Japan, JICA, etc.)</td>
</tr>
</table>

Facilities and equipment of private broadcasters

	
News studio floor (Art TV)	Master control facility (Art TV)
	
Camera at main hall (Buddhist TV)	Master control facility (Buddhist TV)
	
News studio floor (CSN)	Master control facility (CSN)

TV studio complex (Derana TV)

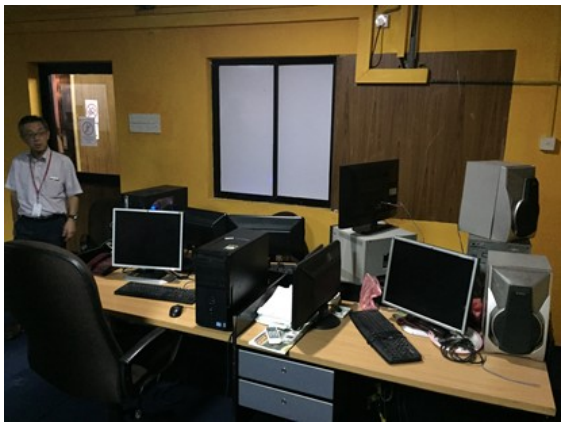
Control facility (Derana TV)

News studio floor (Derana TV)

Control facility (EAP)

News studio floor (EAP)

Master control facility (Hiru TV)

 TV studio floor (Hiru TV)	 TV studio floor (Hiru TV)
 Studio floor where cameras will be installed (Max TV)	 Video image editing room (Max TV)
 TV studio floor (MTV)	 Control facility (MTV)

External appearance (Rangiri TV)

Master control facility (Shradda TV)

TV studio floor (Shradda TV)

Radio master control facility (VIS Broadcasting)

News studio floor (Voice of Asia)

Master control facility (Voice of Asia)

Situation of Lotus Tower

 External appearance	 Top part of T1 Section
 Measurement working at T1 Section	 Measurement of holes for bolts at antenna installation part
 Antenna installation part	 Micro platform where parabolic antenna will be installed

	
Measurement of part for laying cables at Micro platform	Measurement of size of hole for carrying up antenna panels from Tower House to antenna mast
	
Fire prevention section in Tower House	Confirmation of route for laying cables at water storage floor in Tower House
	
Rooftop of Tower Base	Confirmation of route for carrying in cables in Tower Base

Site survey of existing antenna towers

Antenna tower in Jaffna

Antenna tower and station building in Vayuniya

Antenna tower in Kurunegala

Antenna tower in Hantana

	
Antenna Tower in Badulla	Antenna Tower in Elpitiya

Chapter 1 Background and outline of the survey

Chapter 1 Background and outline of the survey

1.1 Outline of migration into DTTB in Sri Lanka

In the Democratic Socialist Republic of Sri Lanka (hereinafter referred to as "Sri Lanka"), after the civil war ended in 2009, frequency usage has increased rapidly due to the spread of mobile phone and the Internet as well as significant increase in the number of TV and radio channels. Back in May 2006, at the International Telecommunication Union (hereinafter referred to as "ITU") meeting, it was agreed that migration into Digital Terrestrial Television Broadcasting (hereinafter referred to as "DTTB") would be implemented by 2015. In 2010, with the advice and support from ITU, the Roadmap for the Transition from Analogue to Digital Terrestrial Television Broadcasting in Sri Lanka (hereinafter referred to as "ITU Roadmap") was created. Discussions started on measures and means for effectively allocating frequencies for TV broadcasting which had been overcrowded.

The basic DTTB systems recognized by ITU as the international standards for DTTB are the Japanese DTTB standard developed in Japan, called Integrated Services Digital Broadcasting (hereinafter referred to as "ISDB-T"), the EU standard (including the first generation called Digital Video Broadcasting (hereinafter referred to as "DVB-T") and the second generation called "DVB-T2"), the American standard called Advanced Television Systems Committee, and the Chinese standard called Digital Terrestrial Multimedia Broadcast. The Government of Sri Lanka carefully examined which of these basic systems should be introduced to Sri Lanka and decided on the adoption of the ISDB-T system in 2014. Thereafter the Government of Sri Lanka concluded a Loan Agreement (hereinafter referred to as "L/A") with Japan International Cooperation Agency (hereinafter referred to as JICA) to receive assistance on the migration into DTTB through the Digitalization of Terrestrial Television Broadcasting Project (hereinafter referred to as "Yen Loan Project"). Loan amount of the said Yen Loan Project is 13.717 billion yen.

One determinant factor for adopting ISDB-T was that Emergency Warning Broadcast System (hereinafter referred to as "EWBS") was available as a characteristic feature of ISDB-T. Sri Lanka, an island country surrounded by the ocean like Japan, is susceptible to natural disasters such as sediment disasters, cyclones, tsunami, and tidal waves, which have given significant impacts on the economic and social activities of people. In recent years, heavy rain caused floods in 2009, 2011, and 2014 and a torrential downpour caused floods and landslides in the southwestern part of Sri Lanka in May 2017. Table 1.1-1 shows the disaster damage in Sri Lanka in recent years (2009 to 2017).

EWBS can transmit an early warning to viewers through broadcasting in collaboration with the agency regarding disaster management and is expected to contribute to disaster mitigation.

Table 1.1-1 Disaster damage in Sri Lanka in Recent Years (2009 to 2017)

Disaster type	Frequency of occurrence	Number of deaths	Number of persons injured	Number of disaster victims	Number of persons who lost home	Total number of disaster victims	Amount of damage (1000USD)
Flood	27	984	287	6,007,868	1,120,273	7,128,428	2,010,250
Storm	4	38	41	88,478	72,861	161,380	57,000
Landslide	3	241	0	1,467	330	1,797	0
Earthquake	1	35,399	23,176	516,130	480,000	1,019,306	1,316,500

Source: JICA Survey Team (reference: EM-DAT)

On the other hand, datacasting is another characteristic feature of ISDB-T. Datacasting can provide information unrelated to the programme being broadcast such as weather information, road information, and news anytime like the Internet. It also allows viewers to watch supplementary information related to dramas and sports programmes being broadcast. In Sri Lanka where Sinhalese, Tamil, and English are spoken, the supply of teletext service in multiple languages is an effective means, providing opportunities to create ideas of programme linkage using interactivity. Furthermore, ISDB-T with hierarchical transmission parameter setting has features that can provide High Definition (hereinafter referred to as "HD") broadcasting for stationary receivers and a service called one-segment broadcasting that can be received by mobile phones and terminals. These features of ISDB-T also provide DTTB viewers with an opportunity to discover new ways of TV viewing.

Sri Lanka sought to construct a DTTB platform to deal with severe shortage of frequencies for television and promote migration into DTTB at a coordinated and steady pace and thus realize migration into DTTB in the course of creating an ITU Roadmap mentioned earlier. Various measures to strongly promote migration into DTTB must be taken as quickly as possible because there are few business models for terrestrial broadcasting platforms in the world, the construction of a DTTB platform will diminish advantages of broadcasters that have expanded their broadcasting service areas on their own, and a measure for encouraging viewers to purchase DTTB receivers must be examined.

1.2 Background of dispatching JICA Survey Team

The Special Assistance for Project Implementation of Digitalization of Terrestrial Television Broadcasting Project in the Democratic Socialist Republic of Sri Lanka (hereinafter referred to as "This Survey") is aimed at conducting a survey for the implementation the Yen Loan Project on which the Governments of Sri Lanka and Japan has concluded an agreement for the reasons mentioned above and providing assistance to migration of the Sri Lankan television broadcasting from analogue broadcasting to DTTB. By now, the development of the DTTB platform (such as antennas, transmitters, and towers) should have gradually progressed but has not started yet because of a delay in the preparation on the Sri Lankan side. One reason for the delay is that no organisation responsible for the operation and maintenance of the DTTB platform has yet been founded. Since the Digital Broadcasting Network Operator (hereinafter referred to as "DBNO") to be founded by the Government of Sri Lanka will be a central organisation for DTTB management, it must be established carefully with the intentions of all the

broadcasters taken into account and therefore the foundation of it is taking time. Likewise, there is also a delay in the establishment of technical standards for transmitters and receivers, examination of the migration plan into DTTB (including establishment of a frequency plan), and construction of Lotus Tower from which radio waves of DBNO will be transmitted, resulting in a delay in the overall process of mitigation into DTTB. Therefore, the JICA Survey Team is required to conduct additional survey in Sri Lanka and discuss with the relevant organisations to make up for the delay in work and promote the migration into DTTB.

1.3 JICA Survey Team experts/members

A JICA Survey Team consisting of Japanese experts was formed to ensure smooth implementation of This Survey and execution of all the items described in the Terms of Reference without omission. Table 1.3-1 shows the roles of the experts.

Table 1.3-1 JICA Survey Team experts/members

No	Name	Position	Company	Role
1	Naoaki Nambu	Team Leader/ Broadcasting business planning	YEC	・Supervision of formulation of migration plan into DTTB, establishment of DBNO, formulation of technical standards for transmitter and receiver ・Collecting opinions of experts for maximizing project effectiveness
2	Yoshitaka Ikeda	Deputy Team Leader/ Financial planning (2)	YEC	・Supporting Team Leader and smooth operation for activities of JICA Survey Team ・Consideration on broadcasting business in Sri Lanka from a management and finance perspective
3	Izumi Takai	Financial Planning (1)	YEC	・Formulation of financial plan related to private broadcasting stations ・Estimation of the cost necessary for the operation of DBNO (DBNO usage fees and financial analysis)
4	Yoshiki Maruyama	Platform business planning/ Transmission design	YEC	・Examination of overall platform business (except finance and fund) ・Design of transmission link ・Preparation of channel plan
5	Yasuo Takahashi	Technical standards for transmitter-receiver	YEC	・Preparation of draft technical standards for transmitter and receiver ・Coordination with broadcasting stations in Sri Lanka and concerned organisations in Japan ・Examination on technical matters on platform
6	Satoshi Hamanaka	Transmitter and repeater equipment	YEC	・Overall transmitting system ・Examination on maintenance and update of equipment for transmitting system of DBNO ・Simulation for radio wave propagation for channel plan

No	Name	Position	Company	Role
7	Akira Saito	Transmitter and repeater equipment (2)	YEC	・Overall transmitting system ・Examination on maintenance and update of equipment for transmitting system of DBNO ・Simulation for radio wave propagation for channel plan
8	Osamu Nitta	Equipment of retransmitting station	YEC	・Examination on maintenance and update of transmission antenna equipment, antenna tower and station building ・Preparation of channel plan
9	Kazuhiko Harikae	Studio equipment (1)	YEC	・Survey on situation of equipment and facilities at private broadcasting stations ・Consideration on HD Roadmap and investment plan on investment
10	Kentaro Nakamura	Studio equipment (2)	YEC	・Survey on situation of equipment and facilities at private broadcasting stations ・Consideration on HD Roadmap and investment plan on investment
11	Keiya Fujiwara	Equipment procurement planning / Estimation (1)	YEC	・Coordination with Studio equipment (1) and (2) ・Procurement plan and estimation on maintenance and upgrade of equipment for DBNO
12	Takashi Mori	Equipment procurement planning / Estimation (2) / Operation coordination	YEC	・Coordination regarding all activities of JICA Survey Team
13	Keiko Uchiumi	Broadcasting business planning support	YEC	・Supporting Team Leader
14	Aya Haraguchi	Broadcasting business planning support (2) / Construction planning support of broadcast relay station	YEC	・Supporting Team Leader ・Supporting Equipment of retransmitting station
15	Hitomi Kotaka	Broadcasting business planning support (3)	YEC	・Supporting Team Leader ・Support of holding events such as ISDB-T Technical Standards Seminar

Source: JICA Survey Team

1.4 Survey schedule

Table 1.4-1 shows the periods of Work in Sri Lanka and work descriptions in This Survey.

Table 1.4-1 Description of Work in Sri Lanka

No.	Period	Description of work
1	From July to September, 2016	● Discussion on Inception Report ● Launch of the project office (such as procurement of equipment and local employment of workers) ● Check of execution schedule and technical drawings of Lotus Tower

No.	Period	Description of work
		● Check on status of migration of private broadcasters to HD broadcasting (MTV, EAP, CSN, Hiru TV, Voice of Asia, Art TV, Derana TV, and Rangiri TV) ● Hearing survey at banks on introduction of leases and microfinance for promoting purchase of receivers, conditions for granting of credit to broadcasters, etc. (Bank of Ceylon and People's Bank) ● Hearing survey at distributers of broadcasting equipment ● Discussion on necessity of minimum specifications with TRC ● Proposal of the first draft of channel plan to TRC ● Regular meeting among Japan International Cooperation Agency (hereinafter referred to as "JICA"), the Ministry of Internal Affairs and Communications (hereinafter referred to as "MIC"), the Ministry of Foreign Affairs and JICA Survey Team
2	Beginning of October, 2016	● Explanation on technical standards to TRC
3	From late October to December, 2016	● Verification survey on availability of towers (survey in Gongala, Nayabedda, Badulla, Namunukula, Madukanda, and Jaffna) ● Reception of a letter of consent on the use of Lotus Tower (from CEIEC to JICA Survey Team) ● Survey on the reserve status in the channel plan ● Analysis of investment plans of private broadcasters ● Pre-shipment inspection on the antenna mast of Lotus Tower in China ● Participation and presentation in MIC seminar ● Survey on legislation system related to broadcasting in Maldives
4	From January to February, 2017	● Study on DBNO usage fees ● Discussion on introduction of EWBS with TRC
5	Beginning of April, 2017	● Inspection on T1 Section of Lotus Tower ● Coordination with TRC for holding ISDB-T Technical Standards Seminar ● Survey on the occurrence of interference to 700MHz bandwidth microphones
6	From middle April to beginning of June, 2017	● Study on DBNO usage fees ● Producing draft of Guidelines for importers ● Survey and analysis on the use of the 700MHz band ● Examination of measures for receivers
7	Late June, 2017	● Support of holding of ISDB-T Technical Standards Seminar by TRC ● Acquisition of feedback on the migration plan into DTTB from TRC
8	From late August to beginning of September, 2017	● Discussion with Disaster Management Centre (hereinafter referred to as "DMC") and study on area codes of EWBS
9	October, 2017	● Submission of explanatory documents on EWBS to TRC ● Creation of a roadmap for migration into DTTB ● Inspection on Tower Mast of Lotus Tower
10	February, 2018	● Final discussion on the channel plan with TRC
11	May, 2018	● Attendance to Joint Working Group regarding DTTB and explanation about draft of Final Report to the Sri Lankan side

No.	Period	Description of work
		● Consideration on allocation of area codes to the list of area classification received from TRC, coordination with DiBEG, and finalization of draft on area codes
12	June, 2018	● Updating documents for EWBS explanation, and submission to TRC

Source: JICA Survey Team

1.5 Surveyed organisations

1.5.1 Governmental agencies

At the conclusion of L/A for the Yen Loan Project in 2004, the executing agency of the Yen Loan Project was the Ministry of Mass Media and Information, currently the Ministry of Finance and Mass Media. At present, however, the Government of Sri Lanka is advancing the internal process to change it to the Telecommunications Regulatory Commission of Sri Lanka (hereinafter referred to as "TRC").

Since the cooperation of the Ministry of Disaster Management (hereinafter referred to as "MDM") and DMC in charge of the operations of disaster management under the control of MDM is required, JICA Survey Team discussed with DMC on the operation of EWBS, a feature of ISDB-T. In particular, consent of both the agencies regarding disaster management is required for the area codes to be used in DTTB, which must be determined before the technical standards for DTTB are released.

Furthermore, as set top boxes (hereinafter referred to as "STBs") required for viewing of DTTB are more likely to be imported from other countries, rather than manufactured in Sri Lanka, JICA Survey Team discussed with the Import & Export Control Department (hereinafter referred to as "IECD"), Sri Lanka Standard Institution (hereinafter referred to as "SLSI") and other relevant governmental agencies in order to create import guidelines of the said products in compliance with the laws and regulations on import procedures of Sri Lanka.

Table 1.5-1 describes the above-mentioned government agencies.

Table 1.5-1 Governmental agencies with which discussion and hearing survey was conducted

No.	Governmental agency	Outline, etc.
1	TRC	A regulatory agency for communications and broadcasting and a regulatory organisation on the management of frequencies of a DTTB platform. TRC will be specified as the executing agency of the Yen Loan Project through cabinet decision in Sri Lanka.
2	DMC	Conduct disaster responses and disaster management in Sri Lanka, collaborate also with local and community disaster control organisations, formulate and execute a national disaster management plan and disaster-time execution plans and also conduct educational activities for disaster management.
3	IECD	Control import and export, create standards, and issues licences. Involved in the project on the import of STBs.
4	SLSI	An organisation that issue specification and standard compliance certificates for electronic equipment.

		(If TRC directly issue minimum specifications of STBs in a new system, the minimum specifications of STBs by SLSI are expected to be no longer required.)

Source: JICA Survey Team

1.5.2 Terrestrial broadcasting stations

In This Survey, hearing survey was conducted on the responses to migration into DTTB at the following terrestrial broadcasting stations. In this report, the broadcasting stations are called by the abbreviations listed in Table 1.5-2 for the sake of simplicity.

Table 1.5-2 Terrestrial broadcasting stations at which hearing survey was conducted

No.	Broadcasting station	Outline / situation
1.	Sri Lanka Rupavahini Corporation (hereinafter referred to as "SLRC")	SLRC, opened in 1982, received assistance from Japan in the past. They have coverage all over Sri Lanka with their UHF broadcast and own and operate Rupavahini in Sinhalese, Nethra TV in Tamil, and Channel Eye and NTV (currently off the air) in English. They received technical assistance of Japan until 2005.
2.	Independent Television Network (Pvt.) Ltd. (hereinafter referred to as "ITN")	Sri Lanka's first TV station founded in 1979. They were founded as a private broadcaster at the time but were transformed into an organisation in the Government of Sri Lanka in the same year. In 1992, the Ministry of Finance and Planning acquired all the shares of ITN to place them under state control. ITN's VHF and UHF broadcasts have coverage almost all over Sri Lanka. They own the ITN Channel in Sinhalese, Vasantham TV in Tamil, Prime TV in English, etc.
3	ART Television Broadcasting Company (Pvt.) Ltd. (hereinafter referred to as "Art TV")	A subsidiary of IWS Holdings, Art TV provide service in Greater Colombo and Kandy areas. They provide around-the-clock broadcasting, including 15 hours of relayed broadcasting of CNN International. Their base stations are in Colombo, Kandy, and Jaffna.
4	Buddhist Broadcasting Guarantee (Pvt.) Ltd. (hereinafter referred to as "Buddhist TV")	Buddhist TV receive contributions from individuals and the public and private sectors to raise its operating funds and are operated by a non-profit organisation. Their programmes are limited to those for dispersing Buddhist teachings.
5	Carlton Sports Network (Pvt.) Ltd. (hereinafter referred to as "CSN")	They have stopped broadcasting (since October 2016) due to a financial scandal revealed in January 2016. Due also to evasion of tax payment under the former administration, many of the broadcasting facilities were confiscated and the broadcaster is under dispute on the ownership of the facilities. Therefore, it is not clear whether they can restart broadcasting in the future. In preparation for restarting broadcasting, they are considering whether to shift from a sports channel to an all-round channel because it is financially difficult for the broadcaster to run a sports channel as their broadcasting rights to cricket games have expired. They are planning to provide various kinds of programmes such as news, children's programmes, educational programmes, and entertainment on the all-round channel.
6	Power House Ltd.	Derana TV are a relatively new broadcaster founded in 2005. About 400 staff members belong to them. It is a Sinhalese channel

No.	Broadcasting station	Outline / situation
	(hereinafter referred to as "Derana TV")	run by Power House Ltd. They broadcast mainly dramas, music shows, and variety programmes.
7	EAP Network (Pvt.) Ltd. (hereinafter referred to as "EAP")	A subsidiary of EAP Holdings. Opened in 1997, they own Swarnavahini, a channel for entertainment programmes, and ETV, a channel for programmes in English.
8	Asia Broadcasting Corporation Radio (Pvt.) Ltd. (hereinafter referred to as "Hiru TV")	Hiru TV, which started service in 2012, are the first broadcaster that covered all the land in Sri Lanka from the service start. They have transmitting stations in Gongala, Deniyaya, and Suriyakanda.
9	MGM Networks (Pvt.) Ltd. (hereinafter referred to as "Max TV")	Max TV provide service in Colombo and Kandy. They are planning to provide a wide range of services such as news, entertainment, sports, and religion programmes in Galle and Gammaduwa.
10	Maharaja Organization (Pvt.) Ltd. (hereinafter referred to as "MTV")	In 1992, MTV were founded by a joint corporation of Capital Maharaja, a financial giant in Sri Lanka, and Singapore Telecom. Their population coverage ratio is 85%. They run three channels, i.e., Sirasa TV in Sinhalese, Shakthi TV in Tamil, and MTV Sports in English.
11	Rangiri Sri Lanka Media Network (Pvt.) Ltd. (hereinafter referred to as "Rangiri TV")	Rangiri TV started Sri Lanka's first radio programme specialised in Buddhism in 2007 and are still providing Buddhist programmes both on radio and television. They are the only station that does not have a service area of analogue TV broadcasting in Colombo area. The broadcaster is in Dambulla. The programmes are mainly live broadcasting of preaching. Recently, they are providing a wide range of programmes on education for children, agriculture, history, technology, entertainment, etc. in addition to preaching.
12	Shraddha TV (hereinafter referred to as "Shraddha TV")	Shraddha TV are a broadcaster providing non-profit Buddhist channel with the operational expenses covered by contributions. They have already introduced new equipment for HD broadcasting and own six digital cameras according to the broadcaster. In addition to broadcasting, they are giving high priority to community services such as scholarships for students and contribution of food to hospitals.
13	Telshan Network (Pvt.) Ltd. (hereinafter referred to as "TNL")	TNL were founded in 1993 and provide programmes in English and Sinhalese in Colombo, Badulla, Kandy, Kurunegala, Matale, Nuwara Eliya and Ratnapura.
14	VIS Broadcasting (hereinafter referred to as "VIS Broadcasting")	They are broadcasting in Greater Colombo with assistance from China Central Television (hereinafter referred to as "CCTV"). All the programmes are distributed by CCTV via satellite. Its 2kW transmitters are made in China and programmes are broadcast in Chinese from Bambalapitiya in Colombo. Sky Media Network (Pvt.) Ltd., their parent company, are providing this TV broadcasting as well as FM radio broadcasting in four frequencies. Their own programmes are broadcast in FM.
15	Voice of Asia Network (Pvt.) Ltd.	Voice of Asia run two channels, *i.e.,* Siyatha TV in Sinhalese and Vamam in Tamil. They started Siyatha TV in 2009 and is

No.	Broadcasting station	Outline / situation
	(hereinafter referred to as "Voice of Asia")	operating a radio broadcasting station with the same name. It also owns a licence for cable television.

Source: JICA Survey Team

Table 1.5-3 Broadcasting-related companies at which hearing survey was conducted

No.	Company name	Outline
1.	SPM Electronic Engineering	An agent for purchasing studio equipment.
2.	BE Technology (Pvt.) LTD.	An agent for purchasing studio equipment. They have delivered goods to MTV, SLRC, ITN, and Derana TV.
3.	Solusys Consulting	An agent for purchasing studio equipment. They cover the introduction of equipment to service control with the support from the engineers of broadcasting equipment manufacturers.
4.	SIEDLES Pvt. Ltd.	An agent for purchasing studio equipment. They handle Sony products with cameras being main products. They have dealt with all the private broadcasters.
5.	Lanka Communication Services (Private) Limited	A telecommunication provider. Derana TV, EAP, and MTV are using Lankacom with full network access. The main business is the Internet service to companies and hotels with priority on IP transmission. They have the operation centre in the main office.
6.	Dish TV Lanka (Pvt.) Ltd.	A satellite broadcasting company. As the demand for satellite broadcasting is increasing, illegal STBs are being imported from India. There are 30,000 to 35,000 subscribing households under legitimate contracts. They started service only one year ago and is expanding the market share.
7.	Tos Lanka Co., (Pvt.) LTD.	A manufacturer of STBs. They are a manufacturing company based in the industrial area of Colombo and are exempted from import and export customs duties. They were initially founded to export products manufactured at low cost using cheap labour costs to Japan. At present, however, they are manufacturing small items that can be sold in large volumes for the Japanese market because the transportation cost is high. Twelve percent of their products are for the Sri Lankan market.
8.	Maspro Lanka (Private) Ltd.	Engaged in import and export of antennas and electronic parts, design and installation of television reception systems, and sale and installation of mast antenna television and CCTV equipment. Make proposals and provide solutions to the TV broadcasting industry.

Source: JICA Survey Team

Chapter 2 DBNO foundation support

Chapter 2 DBNO foundation support

2.1 Status of examination of government policies for DBNO foundation and private broadcasters' intention of participation

2.1.1 Status of examination of government policies

In Sri Lanka, the Digital Broadcasting Network Operator (hereinafter referred to as "DBNO") will be founded to run the DTTB platform. Whereas broadcasting stations have produced and broadcast TV programmes, DBNO will take over the broadcasting of all broadcasting stations, broadcasting their programmes on behalf of them. Therefore, the foundation of DBNO will eliminate the need of broadcasting stations to make direct investment in digital transmission equipment and promote coordinated smooth migration into DTTB of all stations. However, the foundation of DBNO is delayed and no specific discussion on the foundation has been held yet.

The Government of Sri Lanka assumes that the foundation of DBNO will be achieved in stages including examination of a business model, necessary revision of laws and regulations, securing of running costs, acquisition of necessary licences, securing of offices, and employment of staff.

Furthermore, the Government of Sri Lanka and stakeholders hope that DBNO must be founded as a neutral organisation to which no excess governmental restriction will be applied because DBNO will be used by broadcasting stations that should function as news media and the freedom of press must not be violated. Therefore, in consideration with cases worldwide, it will be necessary to define the legal standing and organisational form of a new, neutral, and independent public organisation to be founded, conduct a study on a business model suitable for the organisation, and ensure soundness and transparency of their business activities in compliance with the DBNO Act (a law stipulating the founding and operation of DBNO).

DBNO, as one of the broadcasting stations that provide terrestrial broadcasting services, must have a business licence (as stipulated in the DBNO Act) and a licence for frequency usage according to the existing laws of Sri Lanka in the broadcasting and telecommunication sector. A business licence can be issued when the DBNO Act takes effect. A licence for frequency usage must be issued according to the channel plan of DTTB. Although the JICA Survey Team is having discussion specifically on the matters concerning these licences with TRC that conducts radio wave supervision, TRC will not able to issue a licence for frequency usage to DBNO before a channel plan is approved.

On the other hand, the responsibility of DBNO for the operation of the DTTB network that extends over the entire country will be heavy because any failure of their facilities may make it suddenly impossible to view any of the broadcasting programmes. Furthermore, as a neutral organisation, DBNO must prevent any trouble from occurring only on the programmes of a certain broadcasting station. Therefore, it is the greatest responsibility of DBNO to ensure stable operation of their facilities and equipment. It is a must to secure staff and establish a management structure for the sustainable and stable operation of the facilities and equipment.

The Government of Sri Lanka established the DTTB Steering Committee (headed by the TRC chairperson and consisting of the secretaries and directors of the Ministry of Finance and Mass Media, Ministry of Telecommunication and Digital Infrastructure, Department of External Resources, Ministry

of National Policies and Economic Affairs, and TRC). The committee is to examine and prepare the policies on DBNO.

Table 2.1-1 lists the items to be examined on DBNO in the future.

Table 2.1-1 Topics to Be Examined on DBNO

Topic to be examined	Contents
Legal standing	DBNO Act must be enacted to found DBNO as a neutral and public organisation. The competent authority and affairs under the jurisdiction of DBNO shall be stipulated in the DBNO Act.
Organisational form	No decision has been made on whether to establish DBNO as a government-affiliated organisation, give them a corporate status as a special public corporation, or establish them as an ordinary company. If they become a special public corporation, specific examination will be required on whether the Government should have the management authority over them or acquire their shares and, in the latter case, whether limitations should be set on the acquisition of the shares. On the other hand, the private broadcasting stations, potential clients of DBNO, fear that the Government may intervene in the operation of DBNO and hope that they will be founded as a corporate organisation independent from the Government. (See Section 2.1.2 for details.) In other words, one of the following two systems is assumed to be adopted. i. A system that permits investment from private companies, and allocates a so-called "Golden Share" to the Government of Sri Lanka. The objective of the system is to prevent the private investment from having negative influence on the repayment of the Yen Loan Project, due to the deterioration of financial situations or change of the management policies of the companies. In addition, the system gives the Government certain authorities over important matters, *e.g.,* a power of veto to prevent buyout of DBNO from overseas. ii. A system in which DBNO shall be run as a business entity completely independent of the Government.
Business model	The most important element in examining the business model of DBNO is how to secure a financial resource required for the operation of DBNO. On the assumption that DBNO are a neutral organisation, the Government will make no or minimum monetary contribution to DBNO. Furthermore, the course of the examination of the business model will be influenced by whether the equipment and materials to be procured by the Government of Sri Lanka in the Yen Loan Project will be transferred to DBNO or not. First, baselines must be set on such matters as whether the Government and/or private sector shall be allowed to invest in DBNO and whether the operating revenue shall be fees paid by the broadcasting stations using services of DBNO, donations, or advertising revenues. Since donations and advertising revenues may be unreliable and may not be relied on for the stable operation of DBNO, they should have a highly reliable and stable financial resource sufficient to cover the expected operational expenses. The operation and maintenance expenses including the personnel fee, cost of electricity, communication network usage fees and maintenance expenses for towers and antennas will be the major expenditure items of DBNO. In addition, it will also be necessary to consider repayment of the Yen Loan Project. If the expenditure is to be covered by the usage fee revenue from the broadcasting

Topic to be examined	Contents
	stations, the fees must be affordable for them. Additional measures will be required for the expected increase in the expenditure in the period until the Analogue Switch Off (hereinafter referred to as "ASO"). (See Section 2.2.1 for details.)
Obtaining of licences	The revision of laws of Sri Lanka relevant to the migration into DTTB has not been specifically examined. However, it is assumed that matters concerning (1) licence for frequency use in DTTB, (2) Terrestrial Broadcast Distribution Service Licence (relevant to the operation of DBNO), (3) Digital Terrestrial Multiplexing Licence (which may be integrated into the licence (2)), and (4) Terrestrial Content Provider Licence must be examined in the revision. While DBNO must obtain the licences (1) to (3), the existing broadcasting stations that will broadcast through DBNO must obtain the licence (4). The revision of the existing laws and regulations for the inclusion of provisions on these licences must be made promptly in Sri Lanka. DBNO and the broadcasting stations will obtain the necessary licences after the revision has been completed.
Staffing	According to an estimate by the JICA Survey Team, the operation of DBNO will need an approximate total of 105 staff members (See Section 2.2.3). It is necessary to establish guidelines for recruitment and secure personnel with the required skills and experience. Since it is also related to securing the operating fund at the start of operation, it is necessary to prepare a personnel recruitment plan and spare sufficient time to promote recruitment of staff. It is also necessary to plan staff training, before the start of operation, on such subjects as handling of new equipment to be procured for the migration into DTTB.
Office building	Although examination is under way on a plan to establish the network operation centre of DBNO in Lotus Tower, no specific examination has been conducted regarding the location of the office for the operation and management of business activities. Although the amount of the loan to be provided in the Yen Loan Project includes the expense for constructing an office building, the budget for land acquisition must be raised by the Government of Sri Lanka. The Government must determine the location of the office building of DBNO before the detailed design by the consultant which will be employed by Yen Loan Project commences.

Source: JICA Survey Team

In December 2016, JICA Survey Team investigated the contents of legislation system related to DTTB in Maldives, which has adopted ISDB-T and is going ahead with the plan on establishment of DTTB platform and migration into DTTB. Through the investigation, JICA Survey Team collected items which should be regulated in legislation system such as the DBNO Act before starting DTTB in Sri Lanka, as shown below.

- "Usage of frequency for DTTB", "Transmission of DTTB programme" and "Multiplexing the signal of DTTB programme" need to be defined as factors which consist of DTTB service. It is also necessary to mention that DBNO will possess license of implementing those businesses and have responsibility for those stable operation.
- "Broadcast content provider" needs to be defined as a factor which consists of DTTB service. It is also necessary to mention that license for broadcast content provider is preferentially assigned to broadcasters which currently broadcast analogue programmes in case they apply for the license.
- Procedures which are necessary for broadcast content providers to start, suspend or terminate provision of DTTB programmes should be mentioned.

- Matters regarding license cancellation need to be written in legislation system. For example, the period until broadcasters, which have the license for broadcast content provider, actually start provision of DTTB programmes should be determined. The license will be revoked in case broadcasters do not provide programmes during the period.

2.1.2 Private broadcasters' intention of participation

In the hearing survey conducted at all the private broadcasters except TNL, JICA Survey Team confirmed their attitude to the participation in DBNO while explaining the concept of DBNO. Some broadcasters were positive about the participation, thinking about the advantages such as availability of nationwide broadcasting expected from it, whereas others were concerned about the participation. The Government have not yet made any official announcement about the migration into DTTB or explained to them about the policies on the migration into DTTB, timing of ASO, period of simultaneous broadcasting, relationship between the existing broadcasting stations and DBNO to be founded, and availability of a scheme of assistance to the broadcasters. This lack of appropriate communications between the Government and private broadcasters is the biggest reason for the concern of the broadcasters because they cannot make individual decisions about participation in DBNO without the information mentioned above. There are two points of serious concern of the private broadcasters regarding the foundation of DBNO: (1) Whether appropriate charges will be set for the use of DTTB platform and (2) whether DBNO will be founded as an organisation independent from and uninfluenced or minimally influenced by the Government.

Since the private broadcasters will have a heavier financial burden until ASO because the usage fee of DBNO will be added to the current expenses for analogue broadcasting, they are highly interested in the usage fee. Therefore, some kind of support to the private broadcasters, such as preferential tax measures and reduction in the usage fees, until ASO must be considered by the Government of Sri Lanka. Furthermore, some private broadcasters have misgivings that DBNO may be completely controlled by and its operation may be interfered with by the Government using its control over DBNO in such forms as intentionally interrupting broadcasting of specific programmes when they are inconvenient for the Government or during elections. In short, the private broadcasters think it desirable that DBNO to be founded is an organisation independent from the Government and financed partly with private capital provided by private investors.

Table 2.1-2 summarises the concerns of the private broadcasters and required actions for them.

Table 2.1-2 Concerns of the private broadcasters and required actions for them

Concerns of private broadcasters	Required action
Usage fee	Until ASO, the broadcasters will have a heavier burden because they must pay the DBNO usage fee in addition to the existing operational expenses of analogue broadcasting. Therefore, some kind of support to them, such as subsidising the usage fee, must be provided by the Government of Sri Lanka. After ASO, it is desirable that the usage fee is approximately equal to the operation and maintenance expenses of the broadcasters at present. To a broadcaster that has already built its own nationwide broadcasting network, a usage fee lower than its current operation and maintenance expenses will be offered to promote the use of DBNO of such a broadcaster. Since a broadcaster with a broadcasting area that covers not all but only part of the country is interested in the advantage of providing nationwide broadcasting without building a nationwide broadcasting network of its own, a fee setting should be adjusted according to the broadcasting service area after ASO to eliminate feelings of inequality among the users. However, as some broadcasters may not be able to respond to a sudden increase in financial burden, a lower fee will be set for regional broadcasting. The usage fee setting is discussed in detail in Section 2.2.4.
Organisational form	If the usage fees are lowered in consideration of increased burdens of the broadcasters until ASO, the operating fund of DBNO may run short at the start of the operation. Since it is desired to allow investment from private companies to alleviate such financial risk, a policy to allow the Government and private companies to own the shares of DBNO may be implemented. It can be expected that supervision on the operation of DBNO will be strengthened by joining of private sector as well as the Government. This policy seems quite feasible because some companies have expressed, albeit unofficially, their intention to make such investment. Even in this case, it is desirable to discuss Government's involvement in the operation of DBNO, *e.g.,* not as an executive but as an auditor. In this way, the direct involvement of the Government can be alleviated.

Source: JICA Survey Team

2.2 Organisational structure and staff plan of DBNO

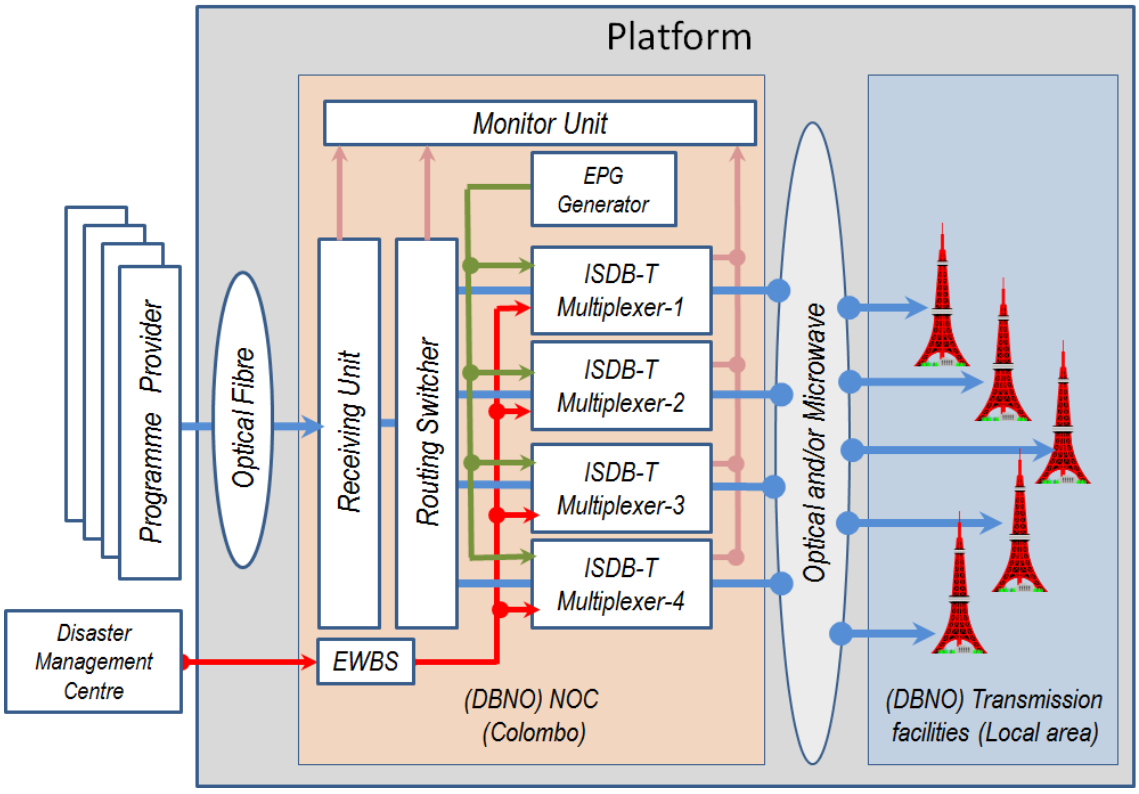
2.2.1 Service forms (forms of participation by private broadcasters, procurement of equipment, and operation method)

(1) Outline of business by DBNO

The DTTB platform business of DBNO under consideration by the Government of Sri Lanka is based on the content of Figure 2.2-1 that was confirmed in a JICA project, "Feasibility Study on Digital Terrestrial Television Broadcasting Network Project in Democratic Socialist Republic of Sri Lanka (hereinafter referred to as "Previous Survey")." In other words, the central business of DBNO shall be to operate the Network Operation Centre (hereinafter referred to as "NOC"), a facility for multiplexing programmes collected from the broadcasting stations in broadcasting channels, and the "transmission facilities" that convert signals received from NOC on which the programmes of the broadcasting stations are multiplexed into signals that can be viewed on ordinary receivers and transmit them. Whereas NOC shall be installed in Colombo, the transmission facilities shall be distributed to the transmitting stations in various regions. Furthermore, transmission links from NOC to transmitting stations are to be established with optical cables and microwave networks. Some of the transmission links are assumed to

be leased by networks of telecommunication providers. Since it will not be possible to provide the services without such links, they will be regarded as part of the platform.

Furthermore, DBNO will assume to have the roles such as issuing warnings via EWBS at the time of disaster in cooperation with DMC, and providing a call centre function to serve as an information desk to viewers and answer inquiries on DTTB from them. The broadcasting stations will pay usage fees for the platform of DBNO to DBNO, whereas DBNO will operate its business using the usage fees collected from the stations.



Source: "Feasibility Study on Digital Terrestrial Television Broadcasting Network Project in Democratic Socialist Republic of Sri Lanka" Final Report

Figure 2.2-1 Outline of platform business

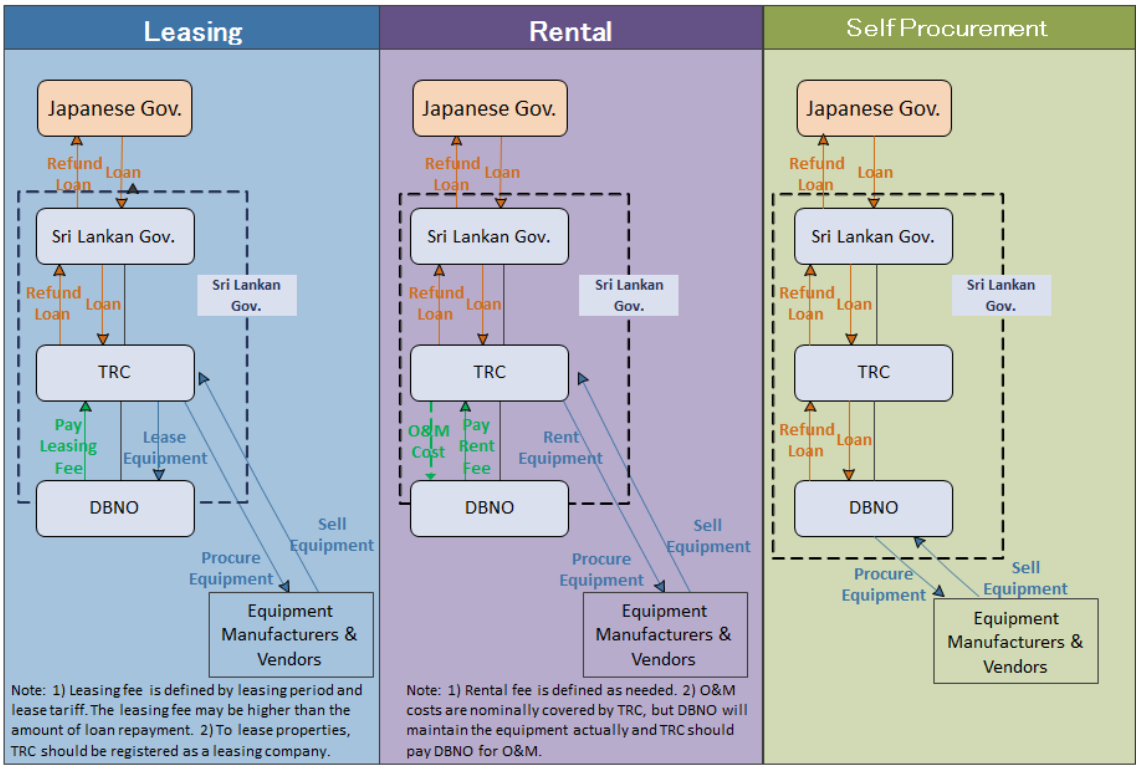
(2) Model for procurement of equipment

As described in Subsection (1) above, the operation and maintenance of the broadcasting equipment is a basic business of DBNO. The equipment to be operated by DBNO will be procured in the Yen Loan Project.

Although the Government of Sri Lanka have not yet examined a specific business model of DBNO, examination is under way on the use of part of usage fee revenue of DBNO for the repayment of the Yen Loan Project. Therefore, the DBNO usage fee will be influenced by how the DBNO equipment will be procured in the Yen Loan Project. This section describes models for procurement of equipment for

DBNO currently considered feasible to facilitate the said examination within the Government of Sri Lanka in the future.

There are the following three possible models for procurement of equipment regarding digital broadcasting of DBNO. In the Previous Survey, the case of rental was assumed. In This Survey, in addition to rental, JICA Survey Team considered other two models.. The followings are based on presumption that TRC will be the executing agency of Yen Loan Project. When the Government of Sri Lanka implement the Yen Loan Project, the Sri Lanka Ministry of Finance and Mass Media will receive the loan. TRC will receive relent loan from the Ministry of Finance and Mass Media and DBNO will be provided with a fund from TRC. There are three possible methods for this financing as described below. It will be necessary for Japanese side to carefully consider the implementation of relent loan within the existing ODA loan provision, while at the same time stance of Sri Lankan side should be clarified.



Source: JICA Survey Team

Figure 2.2-2 Models for the procurement of broadcasting equipment of DBNO

1) Lease

In this method, TRC, an executing agency, will procure the equipment and lease it to DBNO. Although the ownership of the equipment will belong to TRC, they may enter into a lease contract with DBNO so that the latter conduct maintenance of the equipment. In Sri Lanka, a company that conduct the lease business must be registered as a lease operator. Therefore, TRC must examine how to handle the matters concerning the licence for lease business.

2) Rental

In this method, TRC, an executing agency, will procure equipment and rent it to DBNO. This method is not so different from the lease method except that TRC will be responsible for the maintenance. In fact, TRC do not seem to have a capability to maintain equipment. Therefore, TRC will pays for the maintenance to DBNO, which will conduct the maintenance on behalf of TRC.

3) Self-procurement

In this method, DBNO will procure equipment directly from manufacturers and distributers with a fund borrowed from TRC. The flow of a fund is as follows: First, the Government of Sri Lanka will relend the loan provided in the Yen Loan Project to TRC, an executing agency of the Yen Loan Project, and TRC will relend the fund received from the Government to DBNO. DBNO will pay back the loan with the DBNO usage fees received from the broadcasting stations. The interest to be charged on this relending has not been discussed yet in Sri Lanka. There is a possibility that interest may be charged twice, when a loan is provided by the Ministry of Finance and Mass Media to TRC and by TRC to DBNO. Therefore, the DBNO usage fees may be higher than in the other models.

Since DBNO will procure equipment by themselves, the ownership of the equipment will belong to DBNO and, therefore, DBNO must carry out maintenance of the equipment by themselves. On the other hand, the fact that the ownership of the equipment belongs to DBNO complies with the intention of the private broadcasting stations that seek to minimize the involvement of the Government. However, it has been already organised that when implementing Yen Loan Project, the executing agency (Ministry of Mass Media and Information at the time of conclusion of the project) will own the equipment and facilities of DTTB and DBNO will lease the facilities from the Government and will be responsible for the operation and maintenance. As of This Survey, the organisation in charge of the operation and maintenance will also be supposed to play a main role of procurement of facilities and have the right of possession of those facilities in Yen Loan Project. The validity of roles of that organisation should be considered by Sri Lankan side again, involving the Government of Japan, because those are greatly different with that estimated at the time of conclusion of the project.

Table 2.2-1 Comparison of broadcasting equipment procurement models

Item	Leasing	Rental	Self-procurement
Equipment ownership	TRC	TRC	DBNO
Midterm cancellation	Not allowed (All the remaining lease charge must be paid in case of midterm cancellation.)	Allowed	-
Maintenance	DBNO	TRC	DBNO
Contract	DBNO	TRC	-
Licence	TRC needs to acquire licence for lease business.	Not required	Not required

Source: JICA Survey Team

2.2.2 Personnel plan of DBNO

In This Survey, JICA Survey Team conducted a hearing survey at the broadcasting stations regarding the validity of the personnel plan of DBNO created in the Previous Survey (see Table 2.2-2). , JICA Survey Team asked the interviewees to evaluate the validity of the organisational chart representing the planned organisational structure of DBNO consisting of the executives, administration, marketing, and engineering departments with a total of 105 staff members based on the current execution status of analogue broadcasting and number of staff members of the stations and arrived at a conclusion that this organisation structure would be sufficient to operate DBNO. In the future, the number of staff members may increase or decrease to some degree as the discussion on DBNO is deepened and the details of DBNO are determined in Sri Lanka. At present, it is hoped that this organisational structure will be used as the baseline of examination in Sri Lanka.

This personnel plan was used to calculate the personnel fee in the re-examination of DBNO operational expenses in Section 2.2.3.

Table 2.2-2 DBNO staff assignment (draft)

Department	Position	Division	Section	Main responsibilities	Staff (full-time)
1. Executives	Representative			Oversee all business execution in DBNO	1
	Management			Oversee administration department	1
	Marketing			Oversee marketing department	1
	Engineering			Oversee technical department	1
	Secretary			Assist and advise representative	1
	Total				5
2. Management	Director			Executive officer in charge of management serves concurrently	
		General affairs	General affairs	General affairs, external negotiation, personnel and salary management, PC systems	6
			Procurement management	Procurement and management of equipment	3
			Legal affairs	Legal affairs in general including contracts	1
		Finance	Funding	Financial planning, account, sale management	4
			Accounting	Bookkeeping, cost management, finical document preparation, accounting audit support	4

Department	Position	Division	Section	Main responsibilities	Staff (full-time)
	Total				18
3. Marketing	Director			Executive officer in charge of marketing serves concurrently	
		Marketing		Extension of customer base, customer support	2
		Call centre		Viewer support	8
		EPG creation department		EPG date collection, EPG creation	4
	Total				14
4. Engineering	Director			Executive officer in charge of engineering serves concurrently	
		Distribution		Input signal monitoring, multiplexing	20
		Transmission engineering			
			Transmission operation supervision	National Operation Centre (NOC)	20
			Metropolitan area	Operation and maintenance of transmission facilities and equipment	4
			Northern area	Maintenance of transmission facilities and equipment	4
			Western area and eastern area	Maintenance of transmission facilities and equipment	4
			Southern area	Maintenance of transmission facilities and equipment	4
			Central mountainous area	Maintenance of transmission facilities and equipment	4
		Technical management		Technical development, renewal plan, installation plan, licence management	8
	Total				68
Grand total					105

Source: "Feasibility Study on Digital Terrestrial Television Broadcasting Network Project in Democratic Socialist Republic of Sri Lanka" Final Report

It will be necessary to identify requirements for each position before the recruitment of DBNO staff and employ persons who meet the requirements. The posts of engineers should be filled by engineers loaned from broadcasting stations and those with experience in working in a broadcasting station. Such a method is to be used because engineers with a certain level of technical capabilities and experience will be

required at the foundation of DBNO as there is no time to foster new engineers and the actual operation is assumed to be started as soon as DBNO is founded and equipment is procured.

The equipment design of DBNO is being prepared based on the concept of manned monitoring at important transmitting stations and unmanned monitoring for transmitting stations that receive signals from a master station and broadcast them to their service areas. In the future, the manned monitoring will be replaced by unmanned monitoring in stages to reduce the operation and maintenance costs of transmitting stations. Some private broadcasting stations have already taken actions to prevent the increase in the number of personnel by, for example, outsourcing the operation and maintenance of regional transmitting stations to telecommunication providers. The reduction of personnel at transmitting stations has also been an issue to be solved for DBNO. It is too early to adopt unmanned operation at all the transmitting stations in Sri Lanka because of the need for emergency responses required by the current status of power infrastructures. However, the organisational structure must be designed in consideration of the adoption of the unmanned operation in future.

Note that it is fully possible to lower the failure risks such as transmitter stoppage if preventive maintenance is conducted thoroughly through periodical inspection.

In Sri Lanka, it is examined whether DBNO should operate a call centre. It is clear that, in the period before and after ASO, a huge number of inquiries will be received from people from the experience of Japan and other countries. Therefore, considering the number of households in Sri Lanka, it is desirable to acquire 100 or so call centre operators through outsourcing in this transition period to answer inquiries from people, based on the example in Japan.

2.2.3 Re-examination of DBNO operational expenses

(1) Re-examination and changes of components

The channel plan (which shows usable frequencies, effective radiation powers, etc. at each transmitting stations), an essence of the migration into DTTB, was examined in detail and proposed in the Previous Survey. However, a new frequency allocation was introduced in Sri Lanka later, making it necessary to review the channel plan. It became also necessary to re-examine the feasibility of using the existing antenna towers, which was confirmed in the Previous Survey, by including the existing antenna towers of private broadcasting stations and to review the components and project cost of the Yen Loan Project, operational expenses of DBNO, and DBNO usage fees based on the results of the re-examination to alleviate the burden of operational expenses of the broadcasting stations until ASO and facilitate the progress of the migration plan into DTTB.

The following describes the changes of the components of the Yen Loan Project according to the review results.

a. Review of the channel plan (See Section 4.2.1 for details.)

The Previous Survey assumed construction of 10 new towers, but This Survey assumes construction of six towers.

On the other hand, land expropriation of 5 sites assumed in the Previous Survey has been be changed to that of 4 sites in This Survey.

b. Review of the antenna configuration (See Section 4.2.5 for details.)

Due to the review of the channel plan, the antenna configuration in Gongala Station must be changed. As a result of changing the channel plan, interference will occur in the eastern and western parts of the coverage area of Gongola Station where the coverage area overlaps with those of Nayabedda and Elpitiya Stations, respectively. Until the expansion of the coverage area after ASO, the occurrence of the interference will be prevented by using the design including parabolic antennas, etc. that will only allow the station to cover a belt-shaped area in part of southwestern Sri Lanka. Therefore, parabolic antennas, etc. need to be added to the antenna configuration of the Previous Survey.

c. Review of the combiner to synthesize radio waves (See Section 4.2.3 for details)

Due to the change of the channel assignment status, the number of channels to be synthesized by a combiner to synthesize radio waves (hereinafter referred to as "combiner") needs to be changed. The Previous Survey adopted combiners that could synthesize four radio waves for digital broadcasting (or five radio waves for the existing sites that conducted analogue broadcasting).

Due to the re-examination of the channel assignment, however, channel repacking will be required for multiple sites in the future. Therefore, the combiners will be changed to those which can synthesize four channels for digital broadcasting and frequencies for channel repacking at the time of Digital Switch Over (hereinafter referred to as "DSO").

For Kokavil, furthermore, a combiner to synthesize five radio waves (synthesis of four channels for digital broadcasting and one channel for analogue broadcasting currently unused) has been selected. Note that this analogue channel is for the Tamil broadcasting planned by SLRC. Since one more radio wave for channel repacking needs to be added, a combiner to synthesize six radio waves will be required. For Jaffna and Vayuniya, too, as one more radio wave for repacking needs to be added, a combiner to synthesize five radio waves will be adopted.

Table 2.2-3 shows the required number of combiner-synthesized frequencies at the transmitting stations after the above-mentioned review. For the sites requiring seven or more synthesized frequencies such as Hunnasgiriya and Gongala, two combiners will be procured in the Yen Loan Project and one will be installed. The other combiner must be installed by DBNO at the stage of channel repacking. The reason why two combiners are to be procured for these four sites rather than a combiner that can synthesize seven or more radio waves is the total procurement cost can be decreased. If the combiner which can deal with more than seven radio waves is adopted, it will affect the specifications of other equipment such as transmitters, power supply facilities, and so on, which might result in the increase of cost.

For sites requiring less than seven synthesized radio waves, on the other hand, designs that allows one combiner to synthesize all the necessary channels will be adopted.

Table 2.2-3 Necessary number of synthesized frequencies for combiners

No.	Site of transmitting station	Number of synthesized frequencies		Configuration of device
		Previous Survey	This Survey	
1	Jaffna	4	5	Combiner to synthesize five radio waves
2	Kokavil	5	6	Combiner to synthesize six radio waves
3	Vayuniya	4	5	Combiner to synthesize five radio waves
4	Trincomalee	4	5	Combiner to synthesize five radio waves
5	Karagahatenna	4	6	Combiner to synthesize six radio waves
6	Kurunegala	4	6	Combiner to synthesize six radio waves
7	Colombo	4	5	Combiner to synthesize five radio waves
8	Yatiyantota	4	5	Combiner to synthesize five radio waves
9	Hunnasgiriya	5	9	Combiner to synthesize five radio waves＋combiner to synthesize four radio waves
10	Pidurutalagala	4	5	Combiner to synthesize five radio waves
11	Hantana	4	5	Combiner to synthesize five radio waves
12	Badulla	4	5	Combiner to synthesize five radio waves
13	Nayabedda	4	5	Combiner to synthesize five radio waves
14	Gongala	4	8	Combiner to synthesize four radio waves×2
15	Suriyakanda	4	8	Combiner to synthesize four radio waves×2
16	Elpitiya	4	8	Combiner to synthesize four radio waves×2

Source: JICA Survey Team

d. Review of transmission links (See Section 4.2.9 for details.)

Due to the change of the channel plan, the constitution of transmission links must be changed. Consequently, the components of the Yen Loan Project must be changed as described below.

The broadcast wave relay will no longer be required and links will be constructed with microwave TTL[1] and optical links provided by the telecommunication providers. Consequently, the total number of transmission/reception sets of microwave TTL equipment has been changed from 11 to 13 sets.

Furthermore, the Previous Survey adopted a policy of design in which space diversity was used to make up for the instability of signal propagation due to the transmission distance when transmission was conducted using microwave TTL over a distance of more than 40 km between the sites. Space diversity will be required for eight lines as defined in the initial plan.

e. Review of backup methods of transmitters

Due to the change of the configuration of transmission links, the backup methods of transmitters will be changed. In the initial plan, the presence of slave stations was related to the policy of design for backup. Since broadcast wave relay will not be conducted, however, the influence on communication from a master station to slave stations will not need to be considered and, therefore, the presence of slave stations will not influence the policy of design. Consequently, it seems appropriate to consider the backup method only by the output of transmitters.

Table 2.2-4 shows the outline, policy of design, and target stations of each backup method.

The change from the Previous Survey is found in the backup method used in Gongala. This change is made because the presence of slave stations does not influence the policy of design and, when classified by the transmitter output, it corresponds to a medium power station for which an appropriate backup method is the system with parallel PAs with duplicate exciters.

Furthermore, Primrose and Deniyaya have been changed to different sites, Kurunegala and Badulla respectively, due to the review of the channel plan.

Table 2.2-4 Backup method types and corresponding sites

Backup method	Outline	Policy of design	Site	
			Previous Survey	This Survey
N＋1	・ One set of transmitter exactly the same as the active transmitters is installed as backup. ・ When the PA unit breaks down or both the two pre-stage units break down, the channel is automatically changed over from the affected transmitter to the backup transmitter.	High power main station (3kW or more)	・ Colombo ・ Kokavil ・ Karagahatenna ・ Nayabedda ・ Gongala	・ Colombo ・ Kokavil ・ Karagahatenna ・ Nayabedda

[1] TTL: Stands for Transmitter to Transmitter Link and refers to a transmission link between transmitting relay stations.

Backup method	Outline	Policy of design	Site	
			Previous Survey	This Survey
	・ In the rare case where the PA units of two or more sets of transmitters break down, the second and later transmitters run in a reduced power operation.			
Fully redundant system	・ All the units from the input to output ends of a transmitter are made fully redundant. ・ From the viewpoint of redundancy, this system is the best solution. However, it requires large cost and installation space to make the PA units for high-power transmission fully redundant. (If a transmitting station for four channels/ programme transmission, as in the case of the current platform, is constructed with this system, a fairly large station building is required). ・ A gap filler transmitter with an output of 10 W or less often has a built-in PA unit in the exciter. The use of this type of transmitters alone makes a transmitting station fully redundant.	Small power station (50 W or less)	・ Pidurutalagala ・ Hantana ・ Primrose ・ Deniyaya	・ Pidurutalagala ・ Hantana ・ ***Kurunegala*** ・ ***Badulla***
System with parallel PAs with duplicate exciters	・ The exciters are made fully redundant, while PA units are in a parallel configuration. ・ Unlike the fully redundant system with two PA units, which have a high cost share, one PA unit is sufficient for this system. ・ However, if the number of PA units in a parallel configuration is small, output that each unit has to produce will be larger than that in a parallel configuration with a larger number of PAs Therefore, careful examination is required before determining the number of units in a parallel configuration.	Medium power station (500 W to 2kW)	・ Jaffna ・ Vayuniya ・ Trincomalee ・ Hunnasgiriya ・ Yatiyantota ・ Suriyakanda ・ Elpitiya	・ ***Gongala*** ・ Jaffna ・ Vayuniya ・ Trincomalee ・ Hunnasgiriya ・ Yatiyantota ・ Suriyakanda ・ Elpitiya

Legend: Underlined, italicized, or boldface text indicates changes made from the Previous Survey.

Source: JICA Survey Team

f. Review of the transmitter output (See Section 4.2.3 for details)

The transmitter output at Pidurutalagala designed at 300 W in the initial plan has been changed to 50 W due to the review of the channel plan.

g. Checking of the project cost of the Yen Loan Project

The total cost of Yen Loan Project was recalculated based on the above-mentioned changes of components. The recalculation was aimed at checking whether the project budget for the Yen Loan Project stated in the concluded L/A would be sufficient for implementing the project. Table 2.2-5 summarises the result of recalculation. Expenses for A-1.Antenna tower construction cost, B-1.d Transmitter (microwave link line type), and D-1 Compulsory land purchase cost changed. Meanwhile, each item needs to offset the difference by adjusting the associated preliminary expenses because total budget of the project is fixed. Consequently, the total project cost in Japanese yen is 17,437 million yen, staying same as that of Previous Survey.

Table 2.2-5 Result of recalculation of the total cost of Yen Loan Project

	Item	Before change		After change	
		Price (million)		Price (million)	
		Overseas procurement (JPY)	Local procurement (Rs.)	Overseas procurement (JPY)	Local procurement (Rs.)
A	Civil engineering cost (A-6)	60	2,095	60	***1,973***
1	Civil engineering 1 (DTTB platform construction)		1,372		***1,250***
a	Antenna tower construction cost		367		***245***
b	Station building construction cost		461		461
c	Electric facilities work cost		544		544
2	Civil engineering 2 (digital broadcasting centre)		525		525
a	Station building construction cost		350		350
b	Electric facilities work cost		175		175
3	Civil engineering cost (A1 + A2)		1,897		***1,775***
4	Civil engineering: Dispute Adjudication Board cost	60		60	
5	Civil engineering: Price escalation		198		198
6	Civil engineering cost including price escalation (A3 + A5)		2,095		***1,973***
B	Equipment and materials (B7)	8,904		***8,948***	

	Item	Before change		After change	
		Price (million)		Price (million)	
		Overseas procurement (JPY)	Local procurement (Rs.)	Overseas procurement (JPY)	Local procurement (Rs.)
1	Equipment and materials 1 (DTTB platform construction)	5,307		***5,351***	
a	Generators	135		135	
b	UHF antenna: Coaxial cable	410		***469***	
c	Transmitter (optical cable line type)	1,501		1,501	
d	Transmitter (microwave link line type)	2,122		***2,107***	
e	Microwave link line	54		54	
f	NOC equipment	472		472	
g	Private broadcaster interface equipment	366		366	
h	Gap filler	247		247	
2	Equipment and materials 2 (digital broadcasting centre)	2,948		2,948	
a	Generators	43		43	
b	Studio equipment	1,193		1,193	
c	Master control equipment	912		912	
d	OB Van	800		800	
3	Equipment and materials: total (B1 + B2)	8,255		***8,299***	
4	Sea transportation cost	79		79	
5	Equipment and materials: total including transportation cost (B3 + B4)	8,334		***8,378***	
6	Equipment and materials cost: Price escalation	570		570	
7	Equipment and materials cost: total including price escalation (B5 + B6)	8,904		***8,948***	
C	Consultant (C3)	1,415	898	1,415	898
1	Execution and construction supervising consultant cost	1,356	832	1,356	832
2	Consultant cost: Price escalation	59	66	59	66
3	Consultant cost: total including price escalation (C1 + C2)	1,415	898	1,415	898
D	Compulsory land purchase cost (D)	-	700	-	***560***
1	Compulsory land purchase cost		700		***560***
E	Reserve fund (E4)	967	324	***923***	***620***

	Item	Before change		After change	
		Price (million)		Price (million)	
		Overseas procurement (JPY)	Local procurement (Rs.)	Overseas procurement (JPY)	Local procurement (Rs.)
1	Equipment and materials and land construction: Reserve fund	896	209	***852***[*1]	***365***[*1]
2	Consultant: Reserve fund	71	45	71	45
3	Compulsory land purchase: Reserve fund		70		***210***[*1]
4	Reserve fund: total	967	324	***923***	***620***
F	Administrative cost (PMU) (F)	-	924	-	***908***
1	Administrative cost		924		***908***
G	Customs duties (G3)	2	2,752	2	***2,734***
1	Value-added tax	2	2,124	2	***2,106***
2	Import tax, etc.		628		628
H	Initial cost	28	-	28	-
1	Initial cost	28		28	
I	Interest during construction (I)	22	-	22	-
1	Interest during construction	21		21	
2	Consultant: Interest during construction	1		1	
J	Total by currency: JPY (A+B+C+E+G+H+I)/Rs. (A+C+D+E+F+G)	11,398	7,693	11,398	7,693
K	Amount in Sri Lanka rupee converted to JPY (JPY conversion rate: 0.785[*2])	6,039		6,039	
	Grand total in JPY	17,437		17,437	

Legend: Underlined, italicized, or boldface text indicates changes made from the Previous Survey.

*1: Since the related expenses fluctuated, thereby differences are offset by adjusting the corresponding preliminary expense.

*2: Rs. 1 = JPY 0.785 (The conversion rate used in the Previous Survey is used.)

Source: JICA Survey Team

(2) Recalculation of operational expenses

The operational expenses of DBNO were calculated in the Previous Survey. However, due to the above-mentioned changes of the components, the contents and amounts of the operational expenses calculated in the Previous Survey were reviewed.

They were divided into eight items and each of them was examined respectively.

Specifically, the expenses were divided into 1. Personnel fee, 2. Cost of electricity, 3. Repair and maintenance fee (maintenance work and procurement of goods, tower painting work and overhaul), 4.

Antenna tower rental fee, 5. Network connection fee, 6. Frequency licence, 7. Transmitters, and 8. Other expenses. of the above, 7. Transmitters is for the procurement of additional transmitters in the future. It was not included in the operational expenses of DBNO in the Previous Survey but was added in This Survey. Table 2.2-6 shows the changes made to the calculation of the operational expenses performed in the Previous Survey.

Table 2.2-6 Changes of the calculation of the operational expenses from the Previous Survey

Item	Changes made from the Previous Survey
1. Personnel fee	The salary structure of the DBNO staff was reviewed. For the operation of DBNO, it is essential to hire competent engineers. Therefore, the salary scale of engineers was set at a level equivalent to that of large-scale private broadcasters to attract competent engineers.
2. Cost of electricity	The cost of electricity was set at Rs. 26.8 per kWh in consideration of the data on the actual cost of electricity paid by the private broadcasters in addition to SLRC and ITN.
3. Repair and maintenance fee	No change
4. Antenna tower rental fee	Due to the change of the channel plan, the number of transmitting stations that will use the existing antenna tower has increased. Therefore, the rental fee has increased. Furthermore, the usage fee of Lotus Tower was added. However, TRC has not provided an assumed amount of the usage fee of Lotus Tower, so the amount was estimated from usage fee of station building and antenna tower in Badulla obtained from Etisalat.
5. Transmission link usage fee	Due to the change of the channel plan and the development of the optical network in Sri Lanka, the design of the transmission links was revised to a highly reliable one that mainly consists of optical links.
6. Frequency licence	Although there has been no change so far, TRC is considering revision of fees.
7. Transmitter	This is a new item added in This Survey. In Sri Lanka, the number of frequencies used for DTTB will increase from four to eight for the migration into HD. Consequently, each transmitting station will need four additional transmitters, which DBNO is assumed to procure. Therefore, the cost required for the procurement was calculated on the assumption that the procurement cost was to be saved from the operational expenses. The actual procurement operation can be conducted with a means other than saving fund before the procurement, *e.g.,* obtaining a loan from a bank. In this case, the amounts to be repaid, *i.e.,* the sum of the amount of loan used for the procurement and the interest of the loan, will be included in the operational expenses after the procurement.
8. Other expenses	Changed to 5% of the total amount of the above items 1 through 7.

Source: JICA Survey Team

The costs required for the operation of DBNO were recalculated in consideration of the changes made from the Previous Survey shown in Table 2.2-6. Table 2.2-7 shows the estimates of the operational expenses in 10 years in the future.

The repayment of the Yen Loan Project starting in 2024 is included in the operational expenses of DBNO. Since the repayment amounts for the Yen Loan Project will vary depending on the interest rate of the relending and the like from the Government of Sri Lanka, the actual amounts are not shown in this table.

(See Section 2.2.4 for the repayment amounts for the Yen Loan Project in consideration of the interest on relending.)

Table 2.2-7 DBNO operational expenses (2020 - 2029)

(Million Rs.)

	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
1. Personnel fee*	31	125	125	125	125	161	161	125	125	125
2. Cost of electricity	4	12	135	172	172	172	172	214	223	343
3. Repair and maintenance fee	0	3	3	5	5	5	12	12	12	12
4. Antenna tower rental fee	2	6	17	33	33	33	33	33	33	33
5. Transmission link usage fee	22	65	62	95	95	95	95	123	142	142
6. Frequency licence	0	0	2	2	2	2	2	3	3	5
7. Transmitter	0	145	145	145	145	145	-	-	-	-
8. Other expenses	3	18	24	29	29	31	24	26	27	33
Tax (12%)	7	45	62	73	73	77	60	64	68	83
Repayment for Yen Loan Project	-	-	-	-	Repayment amount will depend on the relending interest rate.					
Total	564	574	681	684	703	543	641	758	859	859

* Including outsourcing fee for call centre (in 2025 and 2016)

Source: JICA Survey Team

1) Personnel fee

The personnel fee was calculated according to the proposed staff assignment of DBNO shown in Section 2.2.2. The salary levels were raised to levels equivalent to those of the private broadcasting stations in consideration of the facts that DBNO will be founded as a neutral organisation, not a governmental agency, and that personnel from the private broadcasting stations will also be needed as the staff. The personnel fee must be considered for the staff of the call centre to be outsourced before and after ASO. (after 7 years from the start of Yen Loan Project)

Table 2.2-8 Calculation of personnel fee

(Rs.)

Department	Number of persons	Average salary amount (month)	Total salary amount (month)	Total salary amount (year)
Executive	5	550,000	2,750,000	-
Management (general and financial affairs)	18	51,667	930,000	
Marketing	14	45,000	630,000	
Engineering	68	65,000	4,420,000	
Total	105	83,143	8,730,000	124,839,000*

* The total salary amount per year includes the pension, welfare expense, overtime, 13th-month salary, etc.

Source: JICA Survey Team

2) Cost of electricity

The cost of electricity was calculated based on the output of transmitters of the transmitting stations, assuming a power conversion efficiency of 0.7 and operating time of 20 hours per day. Furthermore, the air conditioners are assumed to consume 20% of the power used by the transmitters. The cost of electricity was calculated at Rs. 26.8/kWh from the actual costs at SLRC and ITN acquired in the Previous Survey as well as the actual costs at the private broadcasters acquired in This Study. There are changes in the cost between fiscal years because it was calculated according to the DSO schedule. An approximate annual cost of Rs. 343 million will be required after all the transmitting stations have completed the Digital Switch Over to High Definition (hereinafter referred to as "DSO-HD").

3) Repair and maintenance fee

The repair and maintenance fee has remained the same as the one calculated in the Previous Survey. It consists of the costs of 1) maintenance work and procurement of goods, 2) tower painting work, 3) overhaul, and 4) equipment renewal.

4) Antenna tower rental fee

Table 2.2-9 is a list of the sites at which the existing antenna towers are to be used and owners and rental fees of the towers. The rental fees were calculated with the data obtained from the owners when JICA Survey Team interviewed them. Since the Digital Switch Over to Standard Definition (hereinafter referred to as "DSO-SD") would start from the Colombo area and gradually spread to local stations, only the use of Lotus Tower was assumed in the estimation of the tower rental fee in the initial stage of DSO-SD.

Table 2.2-9 Calculation of antenna tower rental fee

(Million Rs.)

No	Site name	Owner	Rental fee per year
1	Jaffna	Sri Lanka Telecom (hereinafter referred to as "SLT")	3.0
2	Kokavil	TRC	3.0
3	Vayuniya	TRC	3.0
4	Colombo (Lotus Tower)	TRC	6.0
5	Elpitiya	SLT	3.0
6	Kurunegala	SLT	3.0
7	Badulla	Etisalat	3.0
8	Karagahatenna	ITN	3.0
9	Hunnasgiriya	ITN	3.0
10	Hantana	SLT	3.0
	Total		33.0

Source: JICA Survey Team

5) Transmission link usage fee

Due to the change of the channel plan, the transmission link network of the DTTB platform was reorganised and the usage fees of the reorganised transmission links were calculated. There are two types

of transmission links that make up the DTTB platform: "programme collection links" to send programmes from broadcasters to DBNO and "programme distribution links" to distribute programmes from DBNO to transmitting stations. The monthly usage fee and initial cost were calculated for each of the two types of transmission links. There are two link types, optical fibre and microwave and it will be necessary in each type to prepare initial cost for its installation fee. DBNO usage fee was calculated based on that of optical fibre which is less expensive.

Table 2.2-10 Transmission link usage fees

(Million Rs.)

Item	Link type	Initial cost	Annual usage fee
Programme collection link (From broadcasters to DBNO)	Optical fibre	7	62
Programme distribution link (from DBNO to transmitting stations)	Optical fibre	4	33
	Microwave	121	52

Source: JICA Survey Team based on the information from SLT and LankaCom

6) Frequency licence

The frequency usage fees are set by TRC and calculated based on the altitude and transmission power of a transmitting station. There is a possibility that the tariff is revised during the migration into DTTB. The calculation was conducted in consideration of an increase in the number of frequencies to be used for transmitting a program from four to eight at DSO-HD.

7) Transmitters

Since DTTB will be started with four radio waves, transmitters used to transmit four radio waves will be procured in the Yen Loan Project. However, broadcasting using eight radio waves is conducted after DSO-HD (start of HD service) and the Sri Lanka side must procure additional transmitters. Therefore, the fund required to purchase the additional transmitters, which is Rs. 724.8 million (calculated from the market prices), must be raised as savings from the operational expenses by ASO.

As described earlier, the actual procurement operation may be conducted with loans from banks, etc. at the time of procurement instead of using savings.

2.2.4 Usage fees and financial analysis

In the migration into DTTB, it is the most important that all the broadcasting stations migrate into DTTB smoothly. Regarding the migration into DTTB, the broadcasting stations are troubled the most by two things: (1) Acquisition of the cost for procuring DTTB equipment and (2) Financing to make up for increases in the operational expense in the period of simultaneous broadcasting. Therefore, the DBNO usage fees must be carefully set. Setting too high a usage fee will put too much a burden on the broadcasting stations, possibly complicating ensuring of funds for the migration into DTTB. On the other hand, if too low a usage fee is set, DBNO will not be able to raise sufficient operational expenses to operate the platform stably, possibly causing troubles in all the broadcasting programmes and delaying the repayment for the Yen Loan Project.

The following sections describe analysis of expenditures and revenues and discussion on usage fees.

1) Expenditures

The expenditures of DBNO are as shown in Section 2.2.3. Government of Sri Lanka is to relend the fund of Yen Loan Project to TRC, which consequently may cause interest. Therefore, the repayment amount for the Yen Loan Project will vary depending on the relending interest rate. Since the Government of Sri Lanka have not determined the interest rate on the relending to TRC for the Yen Loan Project for migration into DTTB, Table 2.2-11 shows the calculation results for the rates of 0%, 3%, 5%, and 7%.

Table 2.2-11 Repayment amount for Yen Loan Project

Relending interest rate (%)	Annual repayment amount (million Rs.)	Conditions
0	587	Calculated under the same conditions as the repayment for the Yen Loan Project: Interest of 0.1% (main part), 0.01% (consulting service), redemption period of 40 years, and deferment period of 10 years. Principal and interest equal repayment.
3	885	Calculated with these interest rates, redemption period of 40 years, and deferment period of 10 years. Principal and interest equal repayment.
5	1,135	
7	1,413	

Source: JICA Survey Team

2) Revenues

The revenues of DBNO will consist of usage fees collected from the broadcasters that broadcast using the DTTB platform. Although there is a possibility that a government budget may be allocated, it is assumed at present that no government budget will be allocated and that the usage fees will be the only revenue source because the business model of DBNO has not been examined by the Government of Sri Lanka yet.

3) Usage fee setting

Based on the expenditures and revenues described above, the usage fees of DBNO were calculated as shown in Table 2.2-12.

The fees of the services were calculated using the fee settings according to the ratios of data sizes used by services such as HD and SD broadcasting in a channel. JICA Survey Team assumed multiplexing operation of channels on four radio waves with six SD programmes, a datacasting programme, and a one-segment programme per channel before ASO. In this operation, the data usage ratios per service will be 90% for SD broadcasting (15% per programme), 7% for datacasting, and 3% for one-segment broadcasting. The fee settings are made according to these ratios. JICA Survey Team assumed multiplexing operation of channels on eight radio waves with three HD programmes, a datacasting programme, and a one-segment programme per channel after ASO. In this operation, the data usage

ratios per service are 90% for HD broadcasting (30% per programme), 7% for datacasting, and 3% for one-segment broadcasting.

Since DBNO are required to conduct financially independent business operation, the fee settings that will ensure a certain level of profit would be ideal. However, fee settings that ensure a minimum level of profit were used in This Study in consideration of the impact of the fee settings on the broadcasting stations and the public nature of the business of DBNO.

Since the fees will greatly vary depending on the interest rate of relending from the Government to TRC, it is hoped that the Government of Sri Lanka will set as low an interest rate as possible.

Table 2.2-12 Monthly usage fees of services (per programme)

(Million Rs.)

Timing	Interest rate of relending	HD broadcasting	SD broadcasting	Datacasting	One-segment broadcasting
Before ASO	0%	-	2.8	1.3	0.6
	3%	-	3.6	1.7	0.7
	5%	-	4.1	1.9	0.8
	7%	-	4.5	2.1	0.9
After ASO	0%	4.2	-	1.0	0.4
	3%	4.8	-	1.1	0.5
	5%	5.6	-	1.3	0.6
	7%	6.6	-	1.5	0.7

Source: JICA Survey Team

2.3 Examination of solvency of private broadcasters

This section verifies whether the DBNO usage fees calculated in Section 2.2.4 above can be paid by the participating broadcasting stations. The details of the financial statuses of the private broadcasting stations, in particular, have not been revealed so far. To make the future migration plan into DTTB feasible, it is necessary to check and analyse whether the private broadcasting stations have a revenue source to make necessary investments and expenditures in the future.

2.3.1 Revenue status of broadcasters in Sri Lanka

In Sri Lanka, most of the private broadcasting stations are unlisted companies and have not disclosed any financial statements or other financial documents. In the hearing survey conducted by us, all the broadcasters including small-scale stations and non-profit religious channels, except for CSN, which had suspended broadcasting, and Max TV, which were conducting test-broadcasting, responded that they had managed to make profit in recent years. The small-scale private broadcasters such as Art TV and Max TV, being subsidiaries of major corporate groups such as IWS Holdings and MGM group, are expected to have a stable financial basis. The religious channels, which cover operational expenses entirely with donations, obtain contributions sufficient for sound business management. Although it is

difficult to objectively evaluate the finance situation of a broadcaster which does not disclose the financial statements, their business situation can be estimated to a certain degree from the peripheral information that can be obtained.

In This Survey, JICA Survey Team obtained the financial statements of two state-run broadcasters (SLRC and ITN) and two private broadcasters conducting nationwide broadcasting as well as the future cash flow plan of one private broadcaster conducting regional broadcasting in multiple regions. For private broadcasters, commercial enterprises, the profit structure of the broadcasting industry in Sri Lanka is estimated based on the obtained financial statements of these broadcasters. The revenue status of religious broadcasters, non-profit enterprises, are examined mainly based on the individual hearing survey results because the financial statements or other financial data could not be obtained.

Table 2.3-1 shows the FY 2015 profit-and-loss statements of the four TV broadcasters obtained in This Survey. The figures of the current net income after income tax in the table reveals that the three broadcasters except SLRC gained a profit.

Table 2.3-1 Profit-and-loss statements of four TV broadcasters in Sri Lanka (FY 2015)

(Million Rs.)

	Nationwide broadcaster A	Nationwide broadcaster B	ITN	SLRC
Sales	2,566	1,157	2,434	149
Sales cost	-925	-703	-558	-217
Gross profit on sales	**1,640**	**454**	**1,876**	**-68**
Other operating revenue	65	24	58	39
Selling expense and administrative cost	-1,022	-332	-1,427	-156
Operating profit	**683**	**146**	**507**	**-122**
Financial expenses	-51	-8	80	-2
Current net income before income taxes	**632**	**137**	**587**	**-124**
Corporate tax/ corporate tax return, etc.	-198	-43	-154	3
Current net income after income taxes	**434**	**95**	**433**	**-121**

Source: Created by JICA Survey Team based on the financial statements of broadcasters

Table 2.3-2 shows the net income to sales ratios (Current net income before income taxes/Sales x 100) of the companies. Even the net income to sales ratio of Broadcaster B, which was the lowest among the three broadcasters except RLRC, which was in the red, was larger than 10%.

Table 2.3-2 Net income to sales ratios of four TV broadcasters in Sri Lanka (FY 2015)

	Nationwide broadcaster A	Nationwide broadcaster B	ITN	SLRC
Net income to sales ratio	24.6%	11.8%	24.1%	-83.2%

Source: Created by JICA Survey Team based on the financial statements of broadcasters

All the companies have sales that mostly consist of advertising revenues as seen in the ratios of advertising revenues in sales (including programme sales) shown below.

Table 2.3-3 Breakdown of sales of four TV broadcasters in Sri Lanka (FY 2015)

(Million Rs.)

	Nationwide broadcaster A	Nationwide broadcaster B	ITN	SLRC
Sales total	2,630	1,180	2,492	188
Amount of advertising revenue	*2,566*	*1,157*	*2,434*	*149*
Ratio of advertising revenue	*97.5%*	*98.0%*	*97.7%*	*79.3%*

Source: Created by JICA Survey Team based on the financial statements of broadcasters

The broadcasters except SLRC have advertising revenues that account for 95% or more of their sales. These ratios are exceedingly high when their revenue structures are compared with those of Japanese private broadcasters. It is apparent that the business management of the TV broadcasters of Sri Lanka tends to be largely dependent on the advertising revenue.

Consequently, it seems that the future trend of finance of the private broadcasters can be estimated to a certain degree if we analyse the advertising market of Sri Lanka.

The following section outlines the advertising market of Sri Lanka.

2.3.2 Scale of advertising market of Sri Lanka

The scale of the advertising market of Sri Lanka is on an expanding trend year by year. Table 2.3-4 shows the data on sales scales of advertising markets of print media, radio, and television from 2005 to 2012. The market scale of any of print media, radio, and television expanded until 2012. Although there is no overall data after this period, the television advertising market seems to have continued on an expanding trend after 2012 as the scale of television advertising market in 2016 reached Rs 52,593 million.

Table 2.3-4 Advertising market scale in Sri Lanka (2005 to 2012)

(Million Rs.)

Year	Print media	Radio	Television	Total
2005	3,086	3,763	7,337	14,186
2006	3,631	4,934	8,857	17,422
2007	4,299	5,827	10,891	21,017
2008	4,526	7,096	17,330	28,952
2009	3,724	8,227	20,848	32,799
2010	5,348	8,762	29,684	43,794
2011	6,937	9,810	33,538	50,285
2012	7,921	11,087	35,536	54,544

Source: SRL COSNet

Survey Research Lanka Pvt. Ltd. (SRL), a company in Colombo that collect and sell media-related data, have created a database on annual advertising fees by sponsor and broadcaster. Table 2.3-5 shows the data for 2016.

Table 2.3-5 Advertising revenues by broadcaster in Sri Lanka in 2016

(Rs.)

Broadcaster	Total annual advertising revenue from major clients
Company C	14,664,321,473
Company D	12,599,068,234
Company E	8,263,431,200
Company F	6,175,221,604
Company G	5,115,859,855
Company H	4,329,051,087
Company I	644,090,957
Company J	486,155,316
Company K	218,611,548
Company L	98,219,524
Total	**52,594,030,798**

Source: SRL

If these data cover all the advertising revenues of the broadcasters, their revenue amounts in 2016 can be estimated roughly on the assumption that the advertising revenues account for more than 90% of sales, as indicated in Table 2.3-3.

2.3.3 Religious broadcasters

In Sri Lanka, apart from the national broadcasting and private broadcasting stations, there are three broadcasting stations operated by Buddhist religious organisations. All of them are small-scale local broadcasters with transmitting stations at only one or two locations. Table 2.3-6 shows an outline of the religious broadcasting.

Table 2.3-6 Sri Lankan religious broadcasters

	Company M	Company N	Company O
No. transmitting stations	1	2	1
Service area	Matale District	Greater Colombo	Greater Colombo

Source: JICA Survey Team

A broadcaster operated by a religious organisation with donations is exempt from corporate and other taxes as it is considered a specified non-profit corporation. The above three stations meet all their

operational expenses with donations from their supporters and viewers. They are supposed to be able to purchase almost all the equipment for DTTB with donations.

However, since 2016 Company M has been operating on revenue from advertisements and sponsors, so they are no longer eligible for the favourable tax treatment. In an interview with Rangiri TV, JICA Survey Team learned that the operational expenses for TV broadcasts alone were about Rs three million per month and, when the TV advertising revenue was insufficient, they supplemented it with revenue from radio broadcasts and obtained short-term loans from a bank. This information suggests that at present it is difficult for the station to obtain sufficient revenue only from TV broadcasting advertisement to cover the operational expenses. The service area of the terrestrial broadcasts of Company M is only the Matale District of Sri Lanka, but their programmes can be viewed in the whole country through Dialog TV, a satellite broadcaster, and PEO TV, an IPTV operated by SLT.

Company N are the oldest religious TV channel, which have been operating since 2007. Their programmes can also be viewed via the satellite broadcast Dialogue TV and Dish TV and PEO TV, an IPTV. JICA Survey Team learned that their annual donation revenue was about Rs 200 million, which was sufficient to cover the operational expenses. The operation and maintenance costs including those for the equipment are about Rs 150 to 170 million per year.

Company O are the newest of the religious broadcasting stations, which were established in 2012. Company O also distribute its programmes via Dialog TV and PEO TV. According to the information obtained in an interview their annual donation revenue is about Rs 24 million. So far, they have managed to cover the operation and maintenance expenses with this revenue, but they have some concerns over insufficient funds.

2.3.4 Capacity to Pay DBNO Usage Charges

(1) Study of broadcasters' transmitting station operation and maintenance costs

After the migration into DTTB has been completed, the transmission facilities currently maintained by each broadcasting station will become unnecessary, so the operation and maintenance expenses for the transmission facilities borne by the stations will become unnecessary. The usage fee of transmission links between transmission stations and between the stations and studios and frequency license charge will also be unnecessary. The amount that broadcasting stations are currently paying for these expenses can be allocated to the DBNO usage charge after the complete migration into DTTB, so this amount can be considered to be the minimum amount that the stations can pay as the DBNO usage charge. Table 2.3-7 below shows the breakdown of the expenses that it is considered will no longer be necessary for the broadcasting stations to bear after the complete migration into DTTB. (In this document, the above expenses that will become unnecessary in the future are referred to as redundant expenses.)

Table 2.3-7 Redundant expenses after complete migration into DTTB

No	Item	Cost	
1	Transmitting station operation and maintenance fee	Cost of electricity	Transmitting station building (air-conditioning, etc.)
			Transmitters
		Other operation and maintenance costs	Transmitting station building and tower repair and maintenance
			Transmitters (periodic inspection costs)
		Antenna tower rental fee	
2	Transmission link usage fee	Usage fee	
3	Frequency license fee	Licence fee	

Source: JICA Survey Team

It was possible to estimate at a certain accuracy the annual costs for the items listed in Table 2.3-7 of three broadcasting companies from financial information including financial statements. Table 2.3-8 shows the estimated costs.

Table 2.3-8 Estimated annual expenses for broadcasters

Scale of broadcaster		**ITN**	**Company P, a nationwide broadcasting station**	**Company Q, a multiple area broadcaster**
No. transmitting stations		11 locations	9 locations	5 locations
Estimated annual cost (million Rs.)	Transmitting station operation and maintenance cost	114.0	48.0	70.0
	Network circuit charges	13.0	8.6	13.0
	Frequency license fee	0.8	4.4	2.0
	Total	**127.8**	**61.0**	**85.0**

Source: JICA Survey Team

JICA Survey Team were not able to obtain detailed data on small-scale broadcasters that broadcast in only limited areas, such as religious broadcasting stations, but obtained the information that at least Rs 12 million per year (Rs 1 million/month) were spent on the operation and maintenance of one transmitting station in the interview survey.

The transmitting station maintenance cost depends greatly on the number of the stations. The transmitting station operational expenses vary among broadcasting companies, but it is possible to estimate the expenses to a certain extent from the number of transmitting stations that each company has. Therefore, the redundant expenses were estimated from available information for broadcasters providing different scales of services, *i.e.* nationwide broadcasting, broadcasting to multiple areas, and broadcasting in a

limited area. Broadcasters having transmitting stations at one or two locations, three to eight locations and nine or more locations were classified as limited area broadcasters, multiple area broadcasters and nationwide broadcasting stations, respectively. Table 2.3-9 shows the results of estimating the redundant expenses according to scale. The estimates in the table are those envisaged as the approximate lower limits of the redundant expenses for each scale.

Table 2.3-9 Estimated redundant expenses according to the scale of the broadcaster

Scale of broadcaster		**Nationwide broadcasting stations**	**Multiple area broadcasters**	**Limited area broadcasters**
No. transmitting stations		9 or more locations	5-8 locations	1-4 locations
No. broadcasters in the scale category		7	2	5
Estimated annual cost (million Rs.)	Transmitting station operation and maintenance cost	96.6	45.9	12.0
	Transmission link usage fee	13.0	3.5	1.5
	Frequency license fee	0.7	0.3	0.06
	Total	**110.3**	**49.7**	**13.6**

Source: JICA Survey Team

Table 2.3-10 shows the annual DBNO usage fees set as stated in Section 2.2-4.

Table 2.3-10 DBNO usage fees

Interest rate of relending: 0% (Million Rs.)

	HD broadcast	SD broadcast	Datacasting	One-segment broadcast
Before ASO	-	33.6	15.6	7.2
After ASO	50.4	-	12.0	4.8

Source: JICA Survey Team

The usage fee for SD broadcast prior to ASO will be Rs. 33.6 million, which multiple area broadcasters and nationwide broadcasters can sufficiently pay with the redundant expenses, but the limited area broadcasters would be unable to pay this amount with the redundant expenses. The usage fee for HD broadcast after ASO will be Rs. 50.4 million, which is an amount that is somewhat difficult even for medium-scale broadcasters to pay. Meanwhile, for the nationwide broadcasters this DBNO usage fee will be a major reduction in cost compared with their present expense level.

(2) Study from the aspect of broadcasters' revenue

Table 2.3-5 "Advertising revenues by broadcaster in Sri Lanka in 2016" shows the current revenue of Sri Lankan private broadcasters. The revenue of religious broadcasters is as stated in Item 2.3.3 "Religious broadcasters." According to Table 2.3-5 the smallest advertising revenue is Rs. 98 million in

2016. After the commencement of digital broadcasting, all broadcasters can broadcast nationwide if they join DBNO, so there is a possibility that broadcasters that are currently broadcast limited area will benefit from a boost to their revenue including advertising revenue. The extent of this boost in revenue is unclear. At the nationwide broadcaster with the lowest advertising revenue at present, the revenue is Rs 644 million/year. If it is assumed that the net profit to sales percentage is about 10%, by reference to Table 2.3-2 "Net income to sales ratios of four TV broadcasters in Sri Lanka (FY 2015)", then the profit of a broadcasting station with revenue of Rs 644 million /year is estimated at Rs 64 million/year, which would enable payment of the usage fees of Rs 50.4 million /year for HD broadcasts after ASO.

It is considered that for religious broadcasters, which are the smallest, it would be difficult to pay the DBNO fees stated above from their annual revenue unless their revenue from donations greatly increases. Therefore, it is necessary to consider providing a certain amount of support for religious broadcasting. (See Section 6.8 "DBNO usage fee")

Chapter 3 Formulation of draft for technical standards for transmitter and receiver

Chapter 3 Formulation of draft for technical standards for transmitter and receiver

3.1 Formulation of Draft for technical standards for transmitter and receiver

3.1.1 Policy for creating technical standards

The draft technical standards for the ISDB-T-based DTTB system in Sri Lanka were formulated based on the following policies.

(1) The draft for technical standards developed in the ISDB-T international extension from 2006 onwards shall be introduced into Sri Lanka and assistance shall be provided for the adoption of the draft as the technical standards of Sri Lanka.
(2) The draft formulated by MIC of Japan and the Digital Broadcasting Experts Group (hereinafter referred to as DiBEG), the section responsible for DTTB in the Association of Radio Industries and Businesses (hereinafter referred to as ARIB), commissioned by MIC to formulate the draft shall be presented and explained to the Sri Lankan organisation responsible for the technical standards (TRC) and stakeholders and support shall be provided for the formulation of the technical standards by the Sri Lankan side.
(3) Support shall be provided for improving the technical standards to make them more suitable for Sri Lanka by responding to the questions and comments produced at the stage of formulation of the technical standards on the Sri Lankan side.

In other words, JICA Survey Team supported the preparation of the technical standards utilizing the existing technical standards to the maximum extent and including some standards specifically developed for specific circumstances of Sri Lanka so that the import of broadcast equipment, etc. from overseas could be facilitated and the availability of receivers, etc. that can be used by the viewers without inconvenience could be increased.
Note that DBNO and each broadcasting station will make specific DTTB system facility and operation plans based on the technical standards that are to be adopted in Sri Lanka.

3.1.2 Method of creation

The following is an explanation of the details of the method used at each stage of the preparation

(1) Creation of foundation of draft for technical standards

As stated previously the draft for technical standards was prepared mainly by MIC and DiBEG by reference to the technical standards in Japan and the countries adopting ISDB-T. Since 2012, MIC and ARIB-DiBEG have supported standardisation of DTTB in the countries adopting ISDB-T by preparing a draft for technical standards for each country and presenting it to the main regulatory authorities and stakeholders in the country concerned so that such a country could prepare ISDB-T technical standards that were suitable for it in a short period. In preparing the draft for technical standards for each country adopting ISDB-T, the basic policy

of taking into consideration the legal system and the cultural characteristics of the country has been used.

In accordance with this basic policy, JICA Survey Team have provided DiBEG with advice and information useful in reflecting circumstances in Sri Lanka in the formulation of the draft for technical standards to improve its accuracy.

1) Fundamental technical standards for reference

Formulation of technical standards for a new broadcast system requires much time and resources not only for formulating standards, but for developing and verifying hardware and operation know how, etc. Therefore, the draft for technical standards for use in Sri Lanka was prepared by the method of using the technical standards of the countries adopting ISDB-T that have already commenced commercial service of DTTB and have experience in operating the service as reference and modifying reference standards as required for the use in Sri Lanka.

The ISDB-T standards of Japan (hereafter referred to as the ARIB standards), which was the first to realize ISDB-T broadcast services, and those prepared by the Associação Brasilia de Normas Técnicas (hereinafter referred to as ABNT NBR), which had been the *de facto* South American ISDB-T standards, were used as reference of the draft for technical standards for Sri Lanka.

Table 3.1-1 shows the composition of these two technical standards.

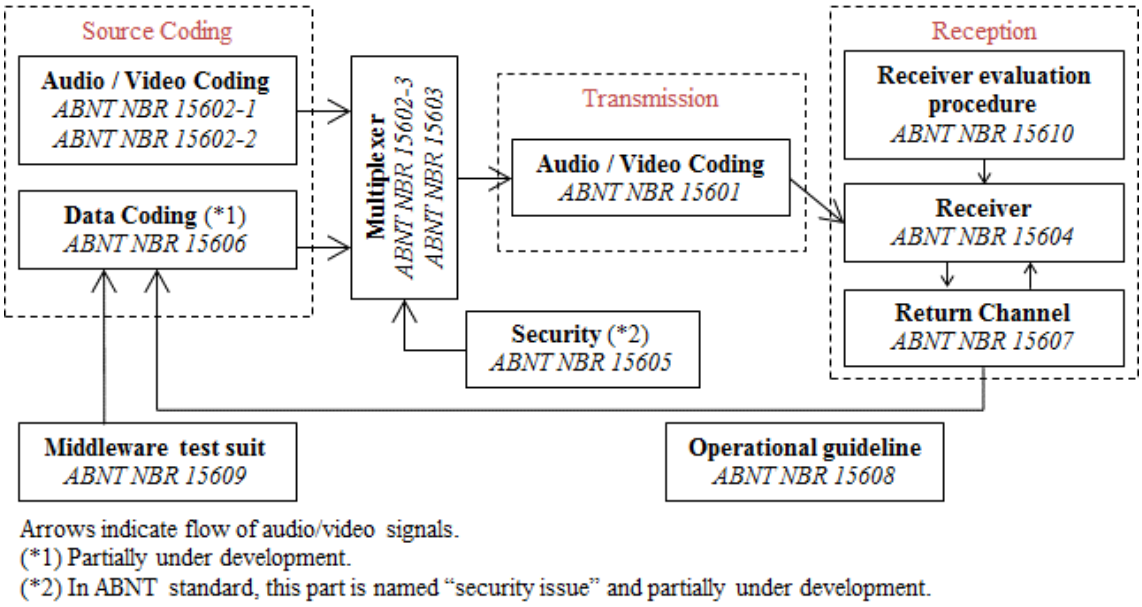
Table 3.1-1 Composition of the ARIB standards and the ABNT NBR and correspondence between them

Item	ARIB Standards	ABNT NBR
Transmission	ARIB STD- B31	***ABNT NBR 15601***
Video coding	ARIB STD- B32	***ABNT NBR 15602-1***
Audio coding	ARIB STD- B32	***ABNT NBR 15602-2***
Multiplexing	ARIB STD- B32	***ABNT NBR 15602-3***
Structure of service information	ARIB STD- B10	***ABNT NBR 15603-1***
Basic information of service information	ARIB STD- B10	***ABNT NBR 15603-2***
Extension information of service information	ARIB STD- B10	***ABNT NBR 15603-3***
Receivers	ARIB STD- B21	***ABNT NBR 15604***
Security issues	ARIB STD- B10,21,25	***ABNT NBR 15605***
Data Coding and transmission specification for digital broadcasting	***ARIB STD- B24***	ABNT NBR 15606
Interactive channel	ARIB STD- B21, B23, 24	***ABNT NBR 15607***
Operational Guideline	ARIB TR-B14	***ABNT NBR 15608***
EWBS	***ISDB-T Harmonization Document PART3: Emergency Warning Broadcast System (EWBS)***	

(Note) The individual standards used as the reference standards of the draft for technical standards in Sri Lanka are indicated with underlined, italic, and bold characters. Source: JICA Survey Team

The ABNT NBR is the standard based on the ARIB standards adapted for the use of new technologies and technologies developed in Brazil and to Brazil's unique cultural and legal environments. It was judged desirable to use the ABNT NBR as the reference standard of the technical standards in Sri Lanka as they have adopted a new technology of high-efficiency coding format (H.264). However, for the datacasting standard, it was judged that the ARIB standard (ARIB STD-B24) was advantageous in software development and creation and operation of contents. This is because it has compatibility with the next generation datacasting standard, HTML5, and is simpler and has been used more than the corresponding ANBR NBR standard. The individual standards used as the reference standards of the draft for technical standards in Sri Lanka are indicated in Table 3.1-1 with underlined, italic, and bold characters.

Figure 3.1-1 shows the correspondence between the individual standards in the ARIB and ABNT NBR to illustrate the relationship between these technical standards.



Source: JICA Survey Team

Figure 3.1-1 Correspondence between the individual standards used as the reference standards of the draft for technical standards in Sri Lanka

2) Modification to standards adapted to Sri Lanka

In order to formulate a draft for technical standards for Sri Lanka based on the ABNT NBR and ARIB standards mentioned above, it was necessary to modify these standards to make them adapted to the technical and cultural environments in which the Sri Lankan terrestrial broadcast services were provided.

The main points of the modification were as follows.

(a) Changes to the technical standards associated with changes of the transmission bandwidth

In Japan and Brazil the terrestrial broadcast bandwidth is 6MHz and the channel layout and numerical values for such parameters as the transmission parameters are prescribed in accordance with this bandwidth. On the other hand, for terrestrial analogue broadcasting system in Sri Lanka the PAL-B (bandwidth: 8MHz) was adopted, so it was necessary to change the channel layout and transmission parameters, etc., in the reference standard to those adapted to the 8MHz bandwidth. The main reference standard that was changed was "ABNT NBR 15601 (Transmission)."

(b) Changes to the technical standards associated with changes in the video standards

In Japan and Brazil, the 525/60 (NTSC and PAL-M) formats were adopted as the analogue TV broadcasting standards. On the other hand, in Sri Lanka the 625/50 (PAL-B) format was adopted. Standard TV (SDTV standard) in Digital broadcasting is compatible with the analogue TV broadcasting format taking into consideration interchangeability of transmission bandwidth and scan line format of display. Therefore, it was necessary to change the video

standards in the reference standard to those based on the 625/50 format. The main reference standard that was changed was "ABNT NBR 15602-1 (Video coding)."

(c) Change of languages used

It is necessary to amend the technical standards for DTTB to use the languages and characters used in the respective countries in the broadcasting. In Sri Lanka there are three official languages in use, Sinhalese, Tamil, and English, so it was necessary to change the relevant standards accordingly. The main reference standards that were modified were "ARIB STD B-24 (Datacasting)", and "ISDB-T Harmonization Document PART 3: Emergency Warning Broadcast System (EWBS)"[2].

(d) Changes to the standards relating to the above-mentioned changes and changes to items to be prescribed by each country

The changes mentioned in (a) to (c) necessitates partial modification of "ABNT NBR 15603 (Service information)" which prescribes descriptors, and "ARIB STD-B24 (Datacasting)" which deals with datacasting and captions. Also, items relating to each country's legal system and items that are uniquely prescribed in each country such as area codes must be changed.

Note that "ABNT NBR 15604 (Receiver)" and "ABNT NBR 15608 (Operational guideline)" are associated with all the prescribed items, so they must be modified on all of these change items.

The details of the changes outlined above have been incorporated into "(Draft) ISDB-T Standards of Sri Lanka (ver. 2.0)" prepared separately from this document. When a matter that is not prescribed in the standards arises, see the reference standards, *i.e.* the ARIB standards and ABNT NBR.

3.1.3 Comments from Sri Lankan side

(1) Comments from TRC

The details of the technical standards have been intermittently explained to the persons in charge of DTTB in TRC, the main government department responsible for the technical standards on the Sri Lankan side, as part of this survey that has been conducted since July 2016. However, although there were questions and answers regarding the content of the explanations, there were no comments relating to specific modifications or improvement to the draft for technical standards.

(2) Comments from stakeholders

On 23rd June 2017 "ISDB-T Technical Standards Seminar" was held in Colombo by TRC with support from us, to which stakeholders including relevant officials of the Government of Sri Lanka, broadcasting stations, telecommunications providers and companies manufacturing and selling broadcasting

[2]The ISDB-T Harmonization Document is controlled by the ISDB-T International Forum, so after formulating the relevant standards for Sri Lanka it is necessary to notify the Forum of the changes to modify the document.

equipment were invited. The objective of the seminar was to explain the contents of the draft for ISDB-T Technical standards and the draft of Technical Specification for STBs to the stakeholders including TRC, the sponsor of the seminar, to obtain comments on each draft from the stakeholders and to reflect these comments in the drafts.

Table 3.1-2 shows the results of the questionnaire survey of the participants at the ISDB-T Technical Standards Seminar and a summary of their comments, etc.

Table 3.1-2 The main comments and policies for the use of digital broadcasting obtained at the ISDB-T Technical standards Seminar

Topic	Outline of comments	Service	Result of answer to questionnaire		
			Scheduled to be used	Not scheduled to be used	No reply
Terrestrial digital service	Most of the participants are scheduled to provide the services indicated on the right	One-segment broadcast	76.0%	8.0%	16.0%
		Datacasting	64.0%	8.0%	28.0%
		Local broadcasts	76.0%	8.0%	16.0%

Topic	Outline of comments	Milestone	Questionnaire response result			
			Early	Appropriate	Late	No reply
Timing of milestones such as ASO and DSO	Most of the responses were that the timing of ASO and DSO-SD was appropriate, but for DSO-HD the percentages for appropriate and late were equal (suggesting their expectation for early commencement of HD broadcasts).	DSO-SD	0%	52.0%	28.0%	20.0%
		ASO	4%	68.0%	12.0%	16.0%
		DSO-HD	0%	40.0%	40.0%	20.0%

Topic	Outline of comments
EWBS	For emergency broadcasts and disaster broadcasts, it is more appropriate to use FM radio or community broadcasts than television. It is necessary to determine in detail the organisation issuing EWBS warnings and the powers of such organisation.
Others	Would like to know detailed technical information (OFDM, interleave, Single Frequency Network, etc.)

Source: JICA Survey Team

3.1.4 Characteristics of the draft for technical standards (summary)

The draft for technical standards proposed for Sri Lanka was prepared by modifying the individual reference technical standards indicated with underlined, italic, and bold characters in Table 3.1-1 described previously to make them adapted to the circumstances and environment in Sri Lanka as

described in Section 3.1.2 Item 2). Its details are provided in "(Draft) ISDB-T Standards of Sri Lanka (ver. 2.0)." The summary of the draft for technical standards is explained in the following.

(1) Transmission

The transmission parameters adopted in the 6MHz countries such as Japan and Brazil have been modified for the use at 8MHz bandwidth. "ABNT NBR 15601" was used as the reference standard.

Main parameters that have been changed are shown below.

- Symbol duration be 6/8 shorter than 6MHz/ch
- Bandwidth be 8/6 wider than 6MHz/ch
- IFFT sample clock be 8/6 faster than 6MHz/ch
- Transmission bitrate be 8/6 faster than 6MHz/ch
- Guard interval length be 6/8 shorter than 6MHz/ch
- Channels be set by every 8MHz and 1/7MHz frequency shift[3] not be used

Table 3.1-3 shows the changes of the system transmission parameters as representative examples of the change in specific transmission parameters.

For details of other changes to parameters relating to frequencies including segment parameters and parameters for transmission rates, channel frequencies and transmission spectrum mask, see "(Draft) ISDB-T Standards of Sri Lanka (ver. 2.0)" Annex 1.

[3] The 1/7 MHz shift in the central frequency was a measure to reduce interference to analogue TV broadcast on a lower adjacent frequency taken at the commencement of DTTB in Japan. This measure is not necessary for 8 MHz analog TV broadcasting.

Table 3.1-3 Main differences in transmission parameters between the draft Sri Lanka transmission standard and ABNT NBR 15601

Item (note)	Original (ABNT NBR 15601)	Modification for Sri Lanka
2. Segment width	6000/14 = 428.57 kHz	8000/14 = 571.43 kHz
3. Used bandwidth	5.575MHz (mode 1) 5.573MHz (mode 2) 5.572MHz (mode 3)	7.433MHz (mode 1) 7.431MHz (mode 2) 7.429MHz (mode 3)
6. Archive symbol duration	252 µs (mode 1) 504 µs (mode 2) 1 008 µs (mode 3)	189µs (mode 1) 378 µs (mode 2) 756 µs (mode 3)
7. Carrier spacing	Bws/108 = 3,968 kHz (mode 1) Bws/216 = 1,984 kHz (mode 2) Bws/432 = 0,992 kHz (mode 3)	Bws/108 = 5.291 kHz Bws/216 = 2.645 kHz Bws/432 = 1.322 kHz
8. Guard interval duration	63; 31,5; 15,75; 7,875 µs (mode 1) 126; 63; 31,5; 15,75 µs (mode 2) 252; 126; 63; 31,5 µs (mode 3)	47.25, 23.625, 11.8125, 5.90625 µs (mode 1) 94.5, 47.25, 23.625, 11.8125 µs (mode 2) 189, 94.5, 47.25, 23.625 µs (mode 3)
9. Overall symbol duration	315; 283,5; 267,75; 259,875 µs (mode 1) 628; 565; 533,5; 517,75 µs (mode 2) 1.260; 1 134; 1 071; 1.039,5 µs (mode 3)	236.25, 212.625, 200.8125, 194.90625 µs (mode 1) 472.5, 425.25, 401.625, 389.8125 µs (mode 2) 945, 850.5, 803.25, 779.625 µs (mode 3)

(Note) The main parameters selected from the parameters given in Table-1 of ABNT NBR15601 Section 6.1 are shown in the table above. The item numbers in the table are those used in ABNT NBR15601 Section 6.1.

Source: JICA Survey Team

(2) Video Coding / Audio Coding

The standard for video coding consists of (a) video format and (b) compression coding algorithm. There has been no change in (b) as the H.264 coding format adopted by the ABNT NBR standard is to be used in Sri Lanka. However, it was necessary to change the frame rate and the number of scan lines in the video format as the PAL-B format was used in Sri Lanka.

There has been no major change to the standard for audio coding.

"ABNT NBR 15602-1 (video)" and "ABNT NBR 15602-2 (audio)" were used as the reference standards for video and audio coding, respectively.

Table 3.1-4 and Table 3.1-5 show the main changes regarding video format. For details of the changes, see "(Draft) ISDB-T Standards of Sri Lanka (ver. 2.0)" Annex 2 and 3.

Table 3.1-4 Modifications from ABNT NBR15602-1

Item	Original (ABNT NBR 15602-1)	Modification for Sri Lanka
5.4 Parameters for video signals	NOTE: See ITU Recommendations BT.709-5 and BT.601-5 for additional information.	NOTE: Tables 5 to 14 and Figures 1 to 13 provide the parameters for 60 Hz field frequency. See ITU Recommendations BT.709-5 and BT.601-5 for the parameters for 50 Hz field frequency. Video coding parameters for Full-Segment services

Item	Original (ABNT NBR 15602-1)	Modification for Sri Lanka
		should meet the parameters indicated in Table A2-2.
8.3.1 General specifications	5 Hz, 10 Hz, 12 Hz, 15 Hz, 24 Hz, 30 Hz	5 Hz, 10 Hz, 12 Hz, 15 Hz, 24 Hz, 25 Hz, 30 Hz

Source: JICA Survey Team

Table 3.1-5 Video coding parameters for Full-Segment services

Number of pixels on the horizontal axis	Number of pixels on the vertical axis	Frame rate [Hz]	Scanning system	Aspect ratio	Profile and level
720	576	25	Interlaced	4:3 16:9	H.264|MPEG-4 AVC HP@L3
720	576	50	Progressive	16:9	H.264|MPEG-4 AVC HP@L3.1
1280	720	50	Progressive	16:9	H.264|MPEG-4 AVC HP@L4
1920	1080	25	Interlaced	16:9	H.264|MPEG-4 AVC HP@L4
1920	1080	25	Progressive	16:9	H.264|MPEG-4 AVC HP@L4

Source: JICA Survey Team

(3) Multiplexing & PSI/SI

MPEG-2 Systems, the reference standard for multiplexing in the ABNT NBR, have been incorporated into the Sri Lankan draft for technical standards without change, so there have been no changes to the reference standard. On the other hand, although there has been no change in the mechanism of transmission control in the reference standard for service information, there have been many changes in the service definitions associated with the changes to the transmission and video standard. "ABNT NBR 15602-3 (multiplexing)" and "ABNT NBR 15603(PSI/SI)" were used as the reference standards for multiplexing and PSI/SI, respectively. (See "(Draft) ISDB-T Standards of Sri Lanka (ver. 2.0)" Annex 4 and 5.)

(4) Receiver

It was necessary to change the receiver standard coupled with the changes to all the other standards. It was necessary to change the following specific points.

(a) Items, the description of which in reference standards must be changed

- In order to adopt Broadcast Markup Language (hereinafter referred to as BML) for data broadcasting, some items that are based on Ginga such as the remote-control key and the demodulator for data broadcasting shall be modified.
- As the analogue video format of Sri Lanka is PAL-B, those items prescribed for the PAL-M format shall be replaced by those for PAL-B.

- Changes associated with the change of the transmission bandwidth from 6MHz to 8MHz
- Changes required for broadcasting in the three languages

(b) Changes associated with country-specific industrial and cultural regulations, etc
- Change of receiver input connector (for consistency with industrial standards)
- Addition of safety standard (same as the above)
- Change of the IF signal regulation associated with the possibility of adopting a silicon tuner (reflecting the results of technological advancement)
- Elimination of items required by regulations specific to Brazil

"ABNT NBR 15604 (Receiver)" was used as the reference standard. (See "(Draft) ISDB-T Standards of Sri Lanka (ver. 2.0)" Annex 6.)

(5) Datacasting

The draft of a standard for datacasting system based on BML, which has been used successfully in Japan, has been presented to the Sri Lankan side. The datacasting standard is composed of the standards for (1) mono-media coding (video and static images, audio, texts, graphics, etc.), (2) coding of subtitles and superimposed texts, (3) multimedia coding based on BML, and (4) datacasting contents transmission format. The character code has been changed to UTF-8 to enable datacasting in English, Sinhalese, and Tamil for the development of a standard datacasting format in Sri Lanka, but in order to realize this system it is necessary to have consistency between the transmitter side and the receiver side. "ARIB STD-B24" was used as the reference standard. (See "(Draft) ISDB-T Standards of Sri Lanka (ver. 2.0)" Annex 8.)

(6) EWBS

The countries adopting ISDB-T have adopted EWBS. The area codes (including a country code) used for notifying areas that are subject to a warning are to be prescribed by each country. It is necessary to have discussions with disaster management organisation regarding setting of area codes. At present preparations are being made by TRC for discussions with MDM and DMC. It is desirable that these discussions with the disaster management organisations be held soon, as it is necessary to promptly determine the area codes for Sri Lanka and enter them in the ISDB-T Harmonization Document.
"ISDB-T Harmonization Document PART 3: Emergency Warning Broadcast System (EWBS)" was used as the reference standard.

(7) Operational Guidelines

Operational guidelines are a compilation of service guidelines used for carrying out broadcast services based on the ISDB-T standard prepared by each country adopting ISDB-T.
As a consequence, different guidelines were used as reference materials in different technical fields and the details of the amendments required for the application in Sri Lanka differ between technical fields. Therefore, the details of the amendments in each technical field are described in the following.

(a) Transmission

In addition to the changes described in (1), changes in the frequency bandwidth to be used (limited to UHF bandwidth only) and standard modulation system (adoption of QPSK), etc. have been added to the guidelines. "ABNT NBR 15608-1" was used as the reference standard. (See "(Draft) ISDB-T Standards of Sri Lanka (ver. 2.0)" Appendix 1.)

(b) Video Coding / Audio Coding

In addition to the changes described in (2), there is an addition to the guidelines indicating that the full segment coding parameters shall not be applied to the partial reception hierarchy. "ABNT NBR 15608-2" was used as the reference standard. (See "(Draft) ISDB-T Standards of Sri Lanka (ver. 2.0)" Appendix 2 and 3.)

(c) Multiplexing & PSI/SI

In addition to the changes described in (3), some of the items prescribing service information in the reference guidelines have been changed. "ABNT NBR 15608-3" was used as the reference standard. (See "(Draft) ISDB-T Standards of Sri Lanka (ver. 2.0)" Appendix 4 and 5.)

(d) Receiver

The guidelines regarding receivers are "ISDB-T HARMONIZATION DOCUMENT PART 1: HARDWARE."

(e) Datacasting

Changes have been made to the guidelines for datacasting based on the description in (5) above to make them compliant with the Sri Lankan standards, including those for the languages to be used. "ARIB TR-B14 VOL. 3" was used as the reference standard. See Appendix 8 of (Draft) ISDB-T Standards of Sri Lanka (ver. 2.0) for details of the changes made to TR-B-14.

(f) EWBS

JICA Survey Team has proposed the application of the standard described in (6) and the draft area codes prepared by them to the Sri Lankan side. "ISDB-T Harmonization Document PART 3: Emergency Warning Broadcast System (EWBS)" was used as the reference standard.

(g) Parameters for operation

In the draft for technical standards, a wide range of parameters are prescribed, so an example of parameter setting appropriate for the actual operation of DTTB has been shared with TRC and included in the guidelines. (See "(Draft) ISDB-T Standards of Sri Lanka (ver. 2.0)" Appendix 11.)

3.2 Formulation of draft of STB technical specifications

3.2.1 Policy for creating draft of STB technical specifications

The draft of Technical Specifications for STBs is a technical document that is required to ensure quality of imported STBs in countries that do not have sufficient domestic production capability for digital broadcasting receivers and must rely on imports. Among the Countries Adopting ISDB-1, Botswana was the first to prepare this document and it was applied as the guidelines for the import of STBs. In Botswana there is a legal obligation to perform minimum specification. The Government of Botswana intend to ensure the quality of imported products reliably by performing the minimum specification using the technical specifications mentioned above. It is anticipated that in Sri Lanka most of DTTB receivers will have to be imported. The simple minimum specification has been performed in the country. Therefore, JICA decided to prepare a draft of recommended STB technical specifications and submit it to the Sri Lankan side. The draft of recommended specifications complies with the requirements of TRC.
The following points were taken into consideration in its preparation.

(a) The draft of Technical Specifications for STBs submitted to the Government of Botswana is to be used as a reference in the preparation of the draft of Technical Specifications for STBs for Sri Lanka and the prepared draft is to be submitted to the Sri Lanka side. Support will be provided to the Sri Lankan side for its adoption as the guidelines for the simple minimum specification of STBs.
(b) A draft of recommended specifications formulated by MIC of Japan and DiBEG under commission from MIC based on the draft specifications for Botswana will be presented and an explanation on the draft will be provided to TRC and other stakeholders and support will be provided to the Sri Lankan side for the preparation of the recommended STB specifications.
(c) Support will be provided for the improvement of the technical standards to make them more suitable for Sri Lanka in response to questions and comments produced at the stage of the formulation of the recommended STB specification by the Sri Lankan side.

3.2.2 Method for creation

As stated previously, the draft STB specifications were mainly prepared by MIC and DiBEG mainly with reference to the draft of Technical Specifications for Botswana. In order to reflect the circumstances in Sri Lanka in the draft, JICA Survey Team provided them with appropriate advice and information to improve the accuracy of the draft of recommended specifications.

3.2.3 Comments from Sri Lankan side

(a) Comments from TRC

TRC have been performing the minimum specification of equipment for telecommunications including smartphones recently. The minimum specification has not been carried out for all the equipment for telecommunications and it seems to be carried out for wireless communication equipment and products in which new technologies are applied. TRC have not identified the products subject to the minimum specification because of the shortage of manpower. However, the person in charge of DTTB in TRC suggested that the simple minimum specification (a simple method for

verifying specifications of products using such information as product test results submitted by manufacturers, without testing sample products, etc.) would be performed on terrestrial digital receivers as new technologies are used in them. However, TRC have not made a final decision on the simple minimum specification of STBs.

Note that regardless of the requirement for the minimum specification, it is not possible to import foreign products into Sri Lanka without a permit from a regulatory authority. For the import of communication and broadcasting equipment, verification and approval from TRC is required.

Because of this situation, the recommended specifications will be useful when a staff of TRC in charge of DTTB decides whether to approve import of specific products even if it has been decided that the simple minimum specification will not be required for the import. Therefore, the preparation of the recommended specifications has commenced without waiting for a decision on whether the minimum specification of STBs should be performed.

The person in charge of DTTB in TRC had no specific comment on the draft of recommended specifications and expressed the necessity to present its contents at a seminar to be attended by the stakeholders and collect their comments on the draft.

(b) Comments from stakeholders

As stated in Section 3.1.3, at the "ISDB-T Technical Standards Seminar" held in Colombo on the 23rd June 2016, an outline of the draft of Technical Specifications for STBs was also explained.

Table 3.2-1 shows the results of the questionnaire survey regarding the draft STB specifications among the participants of the seminar and a summary of their comments. The policy on response to these comments is also indicated.

Table 3.2-1 The main comment regarding the recommended STB specifications obtained at the ISDB-T Technical Standards Seminar and policy to be used for responding to the comment

Comment	Policy on response to the comment
The latest standard for video compression, H.265, should be used, instead of H.264 adopted by ISDB-T.	After discussion with MIC and DiBEG-TF, it was concluded that existing draft was ideal because of the risk associated with the introduction of H.265.

Source: JICA Survey Team

(c) Characteristics of the draft of Technical Specifications for STBs (summary)

The draft of Technical Specifications for STBs proposed for Sri Lanka consists of (a) Operation Specifications Summary, (b) Technical Specification Summary, and (c) items that should be specified for commercial products, within the technical standards relating to STBs among the technical standards described in Section 3.1.4.

The following is the outline of the draft.

a. Summary of performance and functions

Table 3.2-2 summarises the performance and functions that ISDB-T STBs should have in the form of a table. It also describes their contents.

Table 3.2-2 Summary of the performance and functions stated in the STB specifications (original texts and outline explanation)

No	Feature	Description/functionality
1	On/Off button	Switches the STB power on or off
2	On Screen Display	Presents the channel programme number or Programme Guide on the screen
3	Electronic Programme Guide (EPG)	Lists the schedules, displays them on screen once operated
4	Auto Search	The unit will perform an automatic search for channels. (Manual search optional)
5	Signal Quality level indicator	Indicates signal strength and quality level (reception)
6	Video Output	PAL is the video signal for Sri Lanka and most analogue TV sets have PAL inputs
7	Languages	STB Operation Manual should be prepared in English. The manuals in Sinhalese and Tamil are optional
8	Remote Control Unit	Commands and executes the full STB functions.
9	Channels	The STB software shall have up to 100 programmes selectable at random as per user's requirement
10	Operation Manual	Clear and easy to understand with basic trouble shooting and pictorial illustrations.
11	Conditional Access (optional)	Optional and shall not prohibit viewers on free-to air DTT channels

Source: JICA Survey Team

b. Summary of technical standards

Table 3.2-3 shows the features relating to the ISDB-T technical standards in the STB specifications in a table form. The table also shows the specifications of the features.

Table 3.2-3 Summary of technical specifications for STB

No	Feature	Specification
1	RF Input Impedance	75 Ω
2	AC Mains Power supply	230 Vrms ± 20 V 50 Hz ± 2 Hz
3	Power plugs	Type G
4	Modulation	Comply with ITU-R BT.1306 System C
5	FEC on OFDM	Comply with ITU-R BT.1306 System C
6	Input signal	0 dBm to -78.4 dBm
7	Frequency	UHF (470-806MHz)
8	Signal Bandwidth	8MHz
9	Frequency off-set	125 kHz
10	Guard intervals	Comply with ITU-R BT.1306 System C
11	Carrier Noise Ratio	Comply with ITU-R BT.1306 System C
12	Interleaving	Comply with ITU-R BT.1306 System C
13	Video decoding	MPEG-4 (H.264)

No	Feature	Specification
14	CVBS Output	PAL: 625 Lines, 50 Hz, Video bandwidth: 5MHz
15	Aspect Ratio	4:3 and 16:9
16	Analogue Frame Rate	25 Hz
17	Conditional Access	Smart card/software applicable (optional)
18	RAM	128 Mbytes (DDRAM) 8 Mbytes Flash
19	Processor	≥ 300MHz
20	Digital conversion	MPEG-2 ISO/IEC 13818-1
21	Audio decoding	MPEG-4 AAC Sampling rate: 32 kHz, 44.1 kHz and 48 kHz (Dolby and other related approved audio decoding optional)
22	Serial Interface	RS 232 or USB
23	Audio mode	Single track/dual track/stereo
24	STB electronic Components	Comply with ITU-R BT.1306 System C

Source: JICA Survey Team

c. Matters to be prescribed for commercial products

Besides the above-mentioned performance, functions and technical specifications, detailed prescription for remote control, contents of display, input output interface, etc. is provided in the technical standards. For details see the separately prepared "(Draft) Technical Specification for Digital Terrestrial Set Top Box (Ver. 2.0)."

3.3 Producing draft of Guideline for importers

3.3.1 Policy for creating Guideline

The method of using a DTTB receiver or the method of purchasing a receiver such as an STB and connecting it to a television monitor can be used for viewing DTTB programmes. In Sri Lanka there are no companies manufacturing receivers for the current format of terrestrial TV broadcasts, so it is considered that most of DTTB receivers will have to be imported.

Sri Lanka imports most of the machinery, plastic products, electronic equipment, and electrical appliances. Meanwhile, the influx of counterfeit goods into Sri Lankan markets is a serious problem.

In a particular case where electrical appliances that do not comply with the Sri Lankan communications laws are available at low prices on the market, such appliances will develop problems such as faulty operation, which will create confusion in the public. In order to prevent the occurrence of such problems and confusion, comprehensive communication standards were set under the responsibility of TRC based on Article 25 of the Sri Lankan Communications Act as amended in 1996. The standards prescribe all the communication standards including those used for approval of equipment such as mobile phones and modems that are to be connected to public networks such as public wireless LAN services and mobile communication networks, control of frequency licences and frequency spectra, monitoring of communication services and approval of telephone charges and communication charges. The standards oblige TRC to perform the minimum specification of equipment for telecommunications to be sold in Sri Lanka and verify its normal operation the equipment in Sri Lanka.

In some of the countries from which Sri Lanka imports goods, legal restrictions on the control of manufacture of counterfeit goods may not function. This lack of restriction is one of the causes of the availability of counterfeit goods in Sri Lanka. Also, counterfeit goods are manufactured in neighbouring countries. Problems that can be caused by influx of counterfeit goods include damage to the brand image and price collapse. Most of the counterfeit goods are inferior products and the availability of such inferior counterfeit goods on the market will lead to damage to brand image of genuine goods. Also, counterfeit goods are usually cheaper than genuine goods, so the availability of such goods can result in collapse of prices. In the particular case of electrical appliances, unapproved counterfeit goods or pirated goods frequently do not operate properly and the availability of such goods on the market may cause confusion among the public.

In order to prevent the influx of counterfeit goods, it is considered that the most effective method to reduce the availability of counterfeit goods in Sri Lanka would be for the Government to prevent the influx of such goods in Sri Lanka. Therefore, Sri Lanka has mechanisms of import licencing and issuance of an import permit for each product to be imported after the verification of the quality of the product by the regulatory authority. The minimum specification can be considered a measure focused on eliminating counterfeit goods and inferior goods.

The purpose of preparing the draft Guidelines for Importers is to promote sales/purchase of DTTB receivers by enabling smooth import by importers of products to which the minimum specification has been issued in compliance with Sri Lankan laws and participation of many companies that are interested in exporting DTTB receivers to Sri Lanka in the market. The formal import procedures are described in the following section. The procedures require many documents to be prepared and approval to be received from multiple organisations. These complex import procedures could hinder the participation of companies that are not familiar with procedures in the import business. Clarifying the procedures for exporting products to Sri Lanka will improve the business environment for overseas manufacturers by enabling them to understand in advance the series of processes including product manufacture, acquisition of minimum specification, transport, customs clearance and sales and estimate the time required for their products to enter the market. Increasing the household penetration ratio of DTTB receivers to a sufficient level is an indispensable factor for the success of the migration into DTTB, which is a national project in the broadcasting and communication sector. Therefore, it is important to develop the import environment for DTTB receivers.

The policies for the preparation of the import guidelines based on the above-mentioned and other circumstances are as follows.

I. The guidelines will strictly adhere to the procedures for importing equipment for telecommunication and broadcasting implemented by TRC in accordance with laws currently in force in Sri Lanka
II. The guidelines will be compliant, in principle, with the concepts of “Route to Type Approval”, “Vendor Licence Procedure”, and “Route to Get Vendor Licence” for equipment for telecommunication shown on the TRC homepage

III. The guidelines will have manual-like elements on such matters as the processing of the import procedures and application procedures and forms as new imports from overseas are anticipated.

TRC have published general guidelines regarding equipment for telecommunications, etc. However, the guidelines only allow readers to understand the outline of the import procedures because of the lack of specific details. As the interest of foreign manufacturers of DTTB receivers that have not exported their products to Sri Lanka in exporting them to Sri Lanka may increase with the increase in the household penetration ratio of DTTB receivers, the draft of Guidelines for Importers of DTTB Receivers is expected to be useful for the exporters of DTTB receivers including these newcomers.

3.3.2 Organisations related to importing

Three government offices, TRC, IECD and Sri Lanka Customs, are involved in the import of STBs.
TRC have jurisdiction over all communications in Sri Lanka as well as radio wave supervision (including broadcasting). In the case of importing of receivers, they will check whether or not the equipment complies with Sri Lankan specifications based on documents submitted by manufacturers and importers and issue a certificate when they have found that the equipment complies with the requirements. In this way TRC certifies that the equipment operates normally in Sri Lanka. IECD examines the qualification of an importer. Qualified applicants will be issued with the Import Control Licence to certify they are officially qualified as an importer in accordance with the provisions of the regulations on import of Sri Lanka.
An STB type-approved by TRC will be imported by an importer licensed by IECD and distributed in the market of Sri Lanka after the taxes associated with its import have been collected by the Sri Lanka Customs. Table 3.3-1 shows the duties of these three organisations.

Table 3.3-1 Duties of the relevant organisations

	TRC	IECD	Sri Lanka Customs
Roles for importing DTTB receiver	● Issuance of minimum specification ● Issuance of vendor license	● Issuance of the Import Control License ● Collection of the license fees	● Collection of customs duties
Other roles	● Preparation of the regulations on customs duties ● Monitoring the activities of licensees ● Management of radio spectrum	● Formulation of the regulations on import and export ● Advice on the matters related to the regulations on import and export control ● Preparation of the standards for import and export of goods	● Prevention of the failure in collecting customs duties ● Measures to facilitate legitimate trade ● Collection of information on import and export ● Cooperation with other administrative organisations

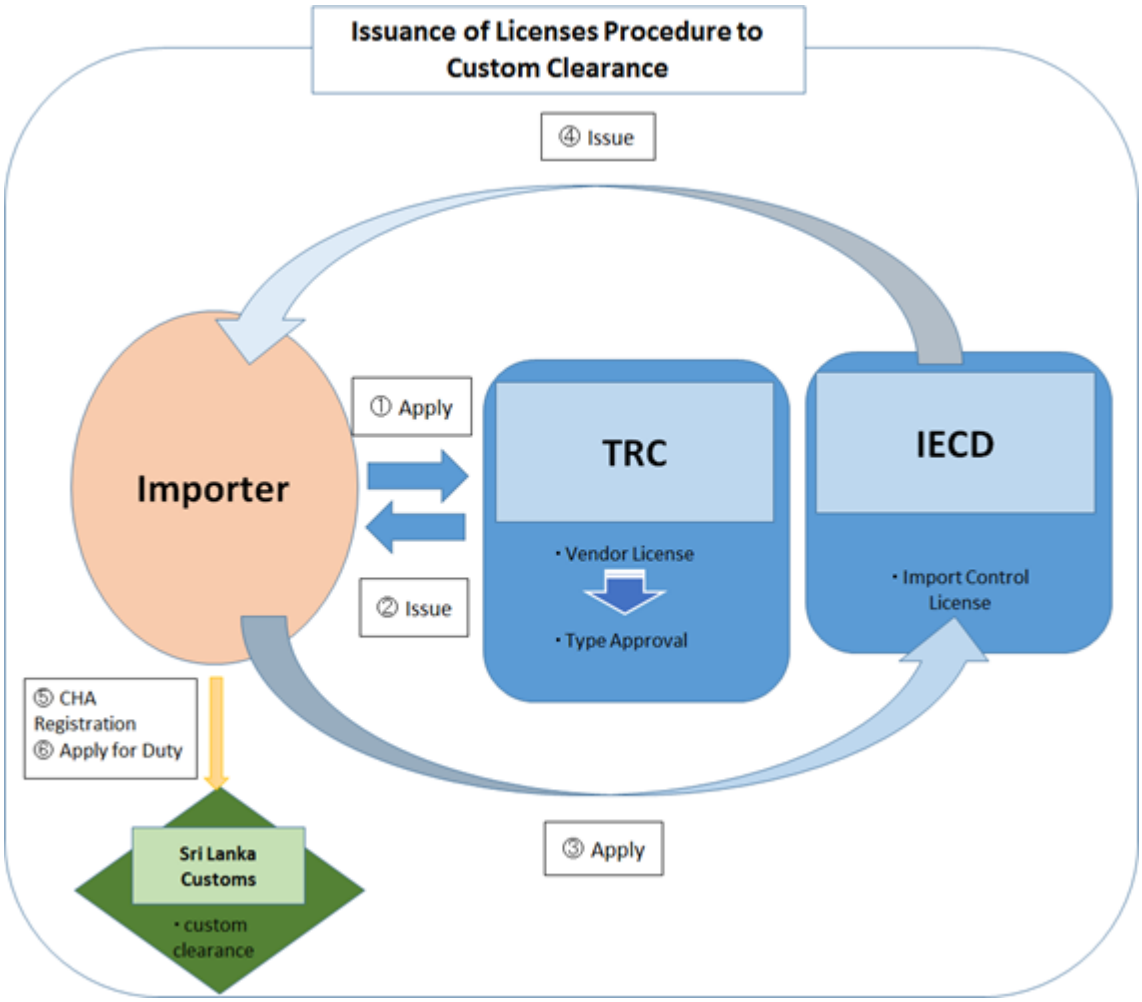
Source: Websites of TRC, IECD and Sri Lanka Customs, information compiled by JICA Survey Team

Figure 3.3-1 shows the relationships among the three organisations in the import of STBs.

TRC evaluates telecommunication equipment appropriately in accordance with the Telecommunications Act and issues the vendor license and certificate of type approval. IECD issues the Import Control License. The quality of the equipment is examined by TRC and qualifications of importers are examined by IECD. The Sri Lanka Customs collect customs duties and other taxes on import of telecommunication equipment to prevent loss from failure to collect customs duties and fraudulent activities.

Henceforth, it will be necessary that TRC formally approve the Guidelines for Importers and publish them on their homepage, etc., to increase the household penetration ratio of DTTB receivers.

For details see the draft of Guidelines for Importers.



Source: JICA Survey Team

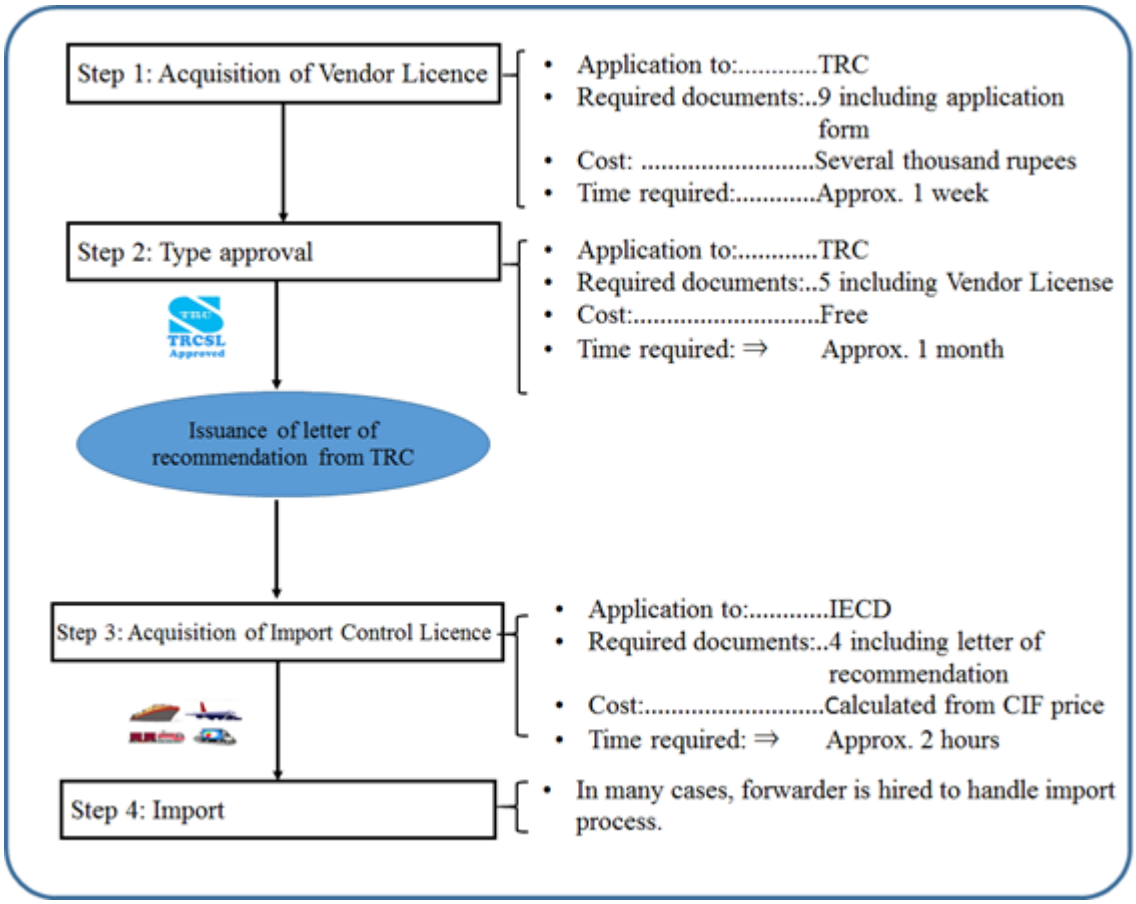
Figure 3.3-1 Procedures for the import of STBs and relationships among relevant organisations

3.3.3 Outline of procedures for importing

This section outlines the import procedures.

At the first stage of importing receivers, it is necessary to apply for the necessary licences, approval, importer registration, etc., to the aforementioned three organisations and obtain the licences, etc., from the relevant organisations. In other words, it is necessary to get the vendor licence and minimum

specification from TRC, import licence from IECD and certificate of registration as a customs agent from the Sri Lankan Customs and submit customs declaration to the Sri Lankan Customs.
Figure 3.3-2 shows the workflow for importing receivers and the details of applications for licenses, etc., to each organisation.



Source: JICA Survey Team

Figure 3.3-2 Workflow of importing STBs

The four steps shown in Figure 3.3-2 are explained in the following.

Step 1: The vendor licence is a licence that certifies that a holder of the licence is a qualified importer of specific goods. First, an importer applies to TRC for a vendor licence to import DTTB receivers and acquires a new license. The cost for the application is Rs several thousand (¥2,355 if the cost is Rs 3,000 and the conversion rate of Rs 1 = ¥0.75 obtained in the Previous Survey is used).

Step 2: The importer applies to TRC for the minimum specification of a receiver and obtain it from TRC. The minimum specification is a simple certification process, in which an applicant attaches the test results of a product to an application form submitted to TRC and TRC examines the test results to decide whether or not the details of the results comply with

the recommended specifications for receivers. There is a possibility that TRC may request submission of a small number of sample products, but a formal decision has not been made on this matter. The application is expected to be free of charge. It will take about a month for the specification to be issued. The minimum specification is a certificate that certifies that TRC has certified the compliance of equipment for telecommunication with the legal, technical, and safety requirements with its authority.

Step 3: When the vendor license and the minimum specification have been acquired, the importer can obtain a letter of recommendation required for obtaining an import licence from IECD from TRC. The import licence will be issued in a week of the application. The application fee will be invoiced later.

Step 4: Receivers will be imported. In most cases importers use specialist forwarders for the import because many tax-related matters including payment of customs duties are involved in the import procedures. An importer may ask a forwarder to carry out both the international transport and customs clearance.

The import procedures are complex, as mentioned above, and many documents must be submitted. Therefore, it is anticipated that time will be required in particular when importing receivers for the first time. Inadequate documentation or non-payment of customs duties may delay the delivery of imported products. Therefore, sufficient time should be allowed for these procedures.

Note that, according to the information obtained in an interview at IECD, the HS code (the item number in the import and export statistics used for classifying goods when importing or exporting cargo) of the receivers is "HS 8525.60: Transmission apparatus incorporating reception apparatus." Table 3.3-2 shows the current customs duty and tax rates in Sri Lanka for the product of this HS code. It will be necessary for importers to prepare a procurement plan with the payment of these customs duties and taxes at the time of the delivery taken into consideration.

Table 3.3-2 Customs duty and other tax rates for import of reception apparatus

HS Code	Description	Duty	VAT	PAL	NBT
8525.60	Transmission apparatus incorporating reception apparatus	15%	12%	5%	2%

Source: Prepared by JICA Survey Team based on materials of Sri Lanka Customs

Chapter 4 Formulation of migration plan into DTTB

Chapter 4 Formulation of migration plan into DTTB

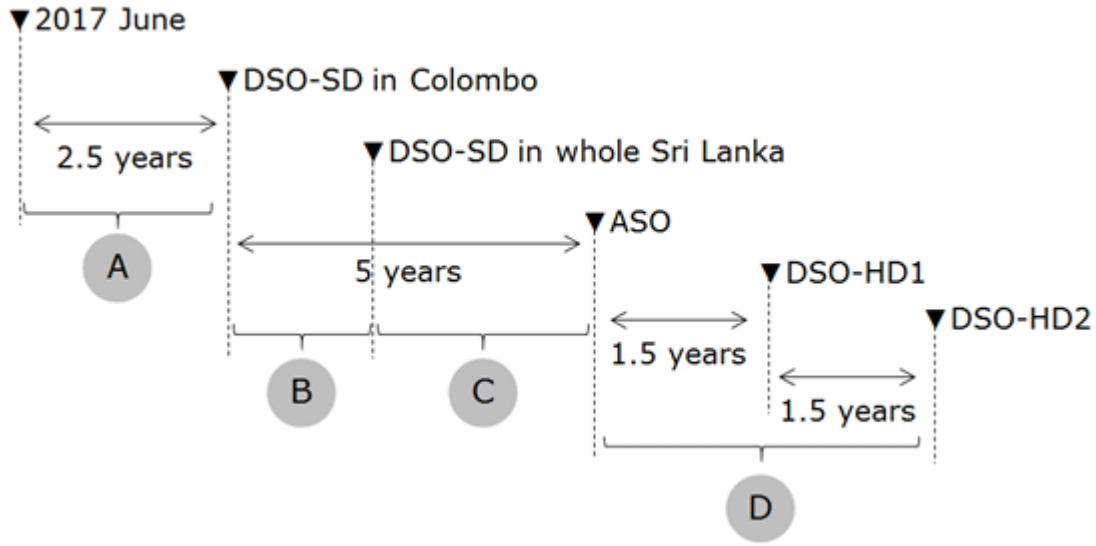
4.1 Overall process

4.1.1 Outline of migration plan into DTTB

There are various methods for migration into DTTB, which are selected in consideration with the situation of broadcasting stations' equipment development, government policy and so on, respectively. For example, in Japan, most broadcasting stations had started upgrade of studio equipment to HD while they provided analogue broadcasting. Provision of HD broadcasting was started just the same time as the start of DTTB. Therefore, the final goal of migration into DTTB in Japan was introduction of master control facility which could provide HD and multiplexing, as well as adaptation to DTTB of transmitting stations, relay stations and transmission link and thereafter ASO.

On the other hand, upgrade of studio equipment to HD has not progressed sufficiently in broadcasting stations in Sri Lanka. Therefore, migration into DTTB will be started in SD broadcasting at first, followed by ASO and upgrade of studio equipment and master control equipment at broadcasting stations. It will result in improvement of image quality of DTTB programmes in stages and Sri Lanka will receive benefit of migration into DTTB such as digital dividend before completion of upgrade to HD.

Figure 4.1-1 shows main milestones of migration into DTTB in Sri Lanka, with estimated period between each milestone.



Legend) DSO-SD: Digital Switch Over to Standard Definition
ASO: Analogue Switch Off
DSO-HD: Digital Switch Over in High Definition

Figure 4.1-1 Milestones of migration into DTTB

A to D in the figure above represent the assumed number of years required between major milestones. The start time shows the commencement of processes shown in "(draft) Roadmap for migration into DTTB." The roadmap was prepared on the premise that Sri Lankan side will start the selection of consultant for Yen Loan Project from August in 2018.

Period A shows the years necessary for the start of DTTB in Greater Colombo with SD quality. Preparation and installation of equipment for the start of DTTB will be assisted by Yen Loan Project, and it is estimated to take about 2 and half years from the selection of consultant. DSO-SD in Greater Colombo will be started in December 2019.

Period B shows the years from DSO-SD in Greater Colombo to DSO-SD in Sri Lanka nationwide, which is estimated to take 2 years. DSO-SD in the whole of Sri Lanka means the completion of Yen Loan Project.

The third stage will come as period C, which means the years from DSO-SD throughout Sri Lanka to ASO. Period C should be as short as possible in order to lessen expenses of broadcasting stations during the period of simultaneous broadcasting, in consideration with the idea of the Government of Sri Lanka and broadcasting stations as of Previous Survey. It is planned to take 5 years from DSO-SD in Greater Colombo to ASO, which is based on the concept that dissemination of DTTB receiver will be easy to promote in consideration with sentiment of Sri Lankan citizens, current situation of television receiver dissemination, coverage of existing analogue broadcasting network of broadcasting stations and penetration of satellite broadcasting and IPTV. Meanwhile, effective measures such as policy for dissemination of DTTB receivers will be necessary to be considered. TRC and related agencies of the Government of Sri Lanka are examining the policy.

The period D shown as the final stage represents the period of migration into HD after ASO in 2 steps. As of DSO-SD in the whole of Sri Lanka, DTTB platform operated by DBNO will provide 4 waves in each transmitting station for SD broadcasting, in which total 24 SD programmes will be broadcast. On the other hand, HD broadcasting needs twice the data capacity of SD, which means only a total of 12 programmes will be available in 4 waves. In order to provide 24 HD programmes, it will be necessary for transmitting stations to be upgraded for operation of 8 waves, which means additional 4 transmitters should be procured at each transmitting station. The upgrade of transmitting stations is planned to be implemented in stages considering financing; 24 SD programmes will be provided as of ASO. Thereafter SD programmes will decrease to 12 and 12 HD programmes will be provided in DSO-HD1. Finally the number of HD programmes will be 24 in DSO-HD2.

As stated above, it will take about at least 10 years to complete migration into DTTB in Sri Lanka. The details are indicated in “Draft of Roadmap for migration into DTTB.”

4.1.2 Work items in period A (until DSO-SD in Greater Colombo)

(1) Approval of ISDB-T technical standards and technical specification for receivers

The draft for technical standards stated in Chapter 3 needs to be approved soon. The area code of EWBS has to be decided through discussion among related agencies such as MDM and DMC and then draft for technical standards and technical specification for receivers should be finalised. DBNO will also be a main stakeholder, therefore comments and opinions should be collected from DBNO about technical standards and technical specification. Unless official publication of technical standards and technical specification are done, manufacturers will not be able to start producing equipment for Sri Lanka and tenderers will not be able to complete tender documents for DTTB platform equipment, which will be assisted by consultant of Yen Loan Project.

In the "Draft of Roadmap for migration into DTTB," period A will last until November 2019, when DSO-SD will start in Greater Colombo. In order to meet the deadline of DSO-SD, technical standards and technical specification need to be officially published.

(2) Establishment of DBNO

It is an urgent matter to establish DBNO which will operate DTTB platform. There will be a high possibility that legislative system should be formulated for DBNO in consideration with receiving fund as a highly-public organisation from the Government of Sri Lanka and operation of equipment procured through Yen Loan Project, etc. Preparation of legislative system requires a long period, therefore provisional organisation on behalf of DBNO has to be launched for determination regarding specification of equipment, procurement of DTTB platform and other practical work items. It is estimated to take about 1 and half years for completion of legislative system after launch of provisional organisation, thereafter DBNO will be established as official organisation before DSO-SD in Greater Colombo.

(3) Installation of transmitting equipment and facilities for DTTB in Greater Colombo

Transmitting equipment and facilities for digital broadcasting in Greater Colombo are planned to be installed in Lotus Tower which is currently under construction in Colombo. In parallel, NOC of DTTB platform will be installed and its operation will be started for multiplexing and transmitting programmes from broadcasting stations. Network communication lines between each broadcasting station and NOC should be developed as well.

This work item is planned to complete in October 2020 for DSO-SD in Greater Colombo.

(4) Development of network communication line for programme transmission between broadcasters and DBNO

Signals between the NOC and each broadcasting station will transmit programmes to the NOC via network of telecommunication providers and others. Therefore, it will be necessary for DBNO to ensure transmission link between MCR of broadcasting stations and NOC. The transmission link has to be completed and prepared for operation 1 month before DSO-SD in Greater Colombo at the latest.

(5) Consideration of EWBS operation regulations and preparation of EWBS operation plans

There are two major work items in order to operate EWBS, one of the features of ISDB-T. One is examination of EWBS operating system, other is formulation of specific operation plan for introducing EWBS. Cooperation with the disaster management institution is essential for EWBS operation, therefore operational guideline for EWBS should be formulated after examination based on legal grounds such as responsibility assignment of each institution. The guideline needs to be decided before the bidding on the procurement of equipment of Yen Loan Project is started because it may affect the location of EWBS equipment etc.

Meanwhile, it is desirable that the operation plan be specifically examined after the specification of the EWBS and peripheral equipment has been decided. Therefore, it should be decided before the start of

DTTB for Greater Colombo. Support through JICA's technical cooperation projects is being considered regarding the formulation of operation plans.

(6) Installation of provisional MCR for SD broadcasting at each broadcasting station

In addition to the current analogue broadcasting, broadcasters need to prepare temporary master control equipment for DTTB to transmit programmes to the NOC of the DBNO. Some broadcasters can easily prepare those pieces of equipment, others need to upgrade or change their broadcasting systems to ensure the same transmitting power as that of current master control. Furthermore, during the period of simultaneous broadcasting, broadcasters will have to develop other temporary master control equipment for SD broadcasting in DTTB in the case they hope to provide both analogue and digital broadcasting. These works have to be done by broadcasting stations before DSO-SD in Greater Colombo.

(7) Examination of policies for promotion of DTTB receiver penetration

Promotion to viewers about DTTB is one of the necessary work items before the start of DTTB. Dissemination of DTTB receivers will not proceed unless viewers understand the merits of migration into DTTB and what kind of equipment they need to purchase.

It will be necessary for the Government of Sri Lanka to consider the receiver dissemination policy, then start public dissemination activities and establish a call centre as a means of consultation for viewers. Setting up a call centre and establishing inquiry period from viewers before DTTB starts are expected to have an effect of preventing confusion among viewers. Therefore, it is desirable that the establishment of the call centre is completed one year before the start of DTTB.

(8) Test broadcasting

Test broadcasting includes processes such as adjusting the equipment with a colour bar etc. which is a test pattern of the image using designated channels for the period of a few months or half year, service broadcasting according to the actual programme contents when the timing of DSO-SD approaches, and preparation of DTTB. After the consultant of Yen Loan Project has been selected, test broadcasting of each transmitter will be planned when considering the detailed implementation process.

Table 4.1-1 shows the general procedures of test broadcasting.

Table 4.1-1 Procedure of test broadcasting

No.	Item	Measures
1	Licence for test broadcasting (including multi broadcasting licence)	Application for licence
2	Transmission of radio wave	Started from weak power, followed by gradual increase.
3	Avoidance of interference with existing analogue broadcasting station	Analogue broadcasting will be monitored 24/7. In case of the occurrence of interference, digital transmission will be lowered or stopped.
4	Measurement of radio wave	Measurement will assure that test broadcasting conforms to legislation regarding radio wave. Service area of digital broadcasting will be decided from the result of measurement.

Source: JICA Survey Team

4.1.3 Work items in period B (until DSO-SD in whole Sri Lanka)

(1) Start of operation of transmitting stations assisted by Yen Loan Project

Operation of transmitting stations at 15 sites except for Greater Colombo will be started using equipment and facilities which will be procured with the assistance of Yen Loan Project. DTTB will be started intermittently at 4 times in each site from February 2021, and period B will be completed at the same time as DSO-SD in November 2022.

(2) Ensuring transmission link from NOC to each transmitting station

Along with (1), transmission link from NOC to each transmitting station has to be ensured in order to provide programmes. DTTB programmes will be delivered to transmitting stations through the transmission link through the signals multiplexed at NOC. Transmission link has to be prepared for operation 1 month before start of each transmitting station mentioned in (1).

4.1.4 Work items in period C (ASO)

(1) Upgrade of broadcasting stations for HD broadcasting

The period of simultaneous broadcasting will be also a preparatory period of upgrade for HD broadcasting after ASO. Broadcasting stations must proceed with upgrading equipment for master control, TV studio and other peripheral equipment to HD by 2nd quarter of 2025. In case some broadcasting stations are late to upgrade equipment to HD broadcasting, broadcasting stations or NOC will have to upconvert signals to HD quality. However, in some broadcasters, programmes will be provided in SD image quality in spite of transmitting using HD signal, and there will be the risk of occurrence of difference in programme quality among broadcasters, which may result in decreasing the number of viewers of some programmes. Upgrading of equipment to HD broadcasting should be kept at a similar pace among broadcasters. However, it is difficult to make the pace mandatory because financial situation at each broadcasting station differs.

(2) Promotion of DTTB receiver penetration

Promotion of DTTB receiver penetration is the most important process after starting DTTB. ASO will be done based on the implementation conditions set in advance. In current policy for ASO in Sri Lanka, ASO will be implemented in areas where population coverage ratio of DTTB and household penetration ratio of receivers reach their goals. (Details are shown in 0). In case all areas satisfy the conditions, ASO is supposed to be implemented at the same time over the whole Sri Lanka. Appropriate and various activities should be done such as thorough promotion about DTTB receiver dissemination by the Government of Sri Lanka, appropriate and frequent update by DBNO about the progress of migration into DTTB, demonstration of DTTB receiver, public announcement in programmes by each broadcaster, holding campaigns related to migration into DTTB and so on. Activities mentioned above should be carried out not only in urban areas but also in rural areas because it is considered that many households do not recognize their own viewing environment well, especially in rural areas.

4.1.5 Work items in period D (migration into HD broadcasting)

(1) Consideration of analogue digital dividend

Among conventional frequency bandwidth used for analogue TV broadcasting, 700MHz bandwidth and VHF bandwidth will be available for other services when analogue TV broadcasting stops. Therefore, it will be necessary to determine what kind of services are allocated to those bandwidths, thereafter necessary technical standards for the services, followed by discussion about interference with broadcasting facilities and its countermeasures. After that, base stations for the corresponding services will be established. TRC is keeping in mind that 700MHz bandwidth will be used in mobile business, in accordance with the agreement of Asia Pacific Telecommunity (hereinafter referred to as "APT"). According to draft for technical standards in Sri Lanka, DTTB receivers would be available for 700MHz bandwidth at the beginning, there would be a risk that interference between mobile phone and DTTB receivers could occur in the case strength of radio wave is high, which may result in disturbance of screen. In order to avoid this kind of trouble, it will be necessary to consider countermeasures such as band elimination filter.

Meanwhile, in Japan and other countries implementing ASO, there are examples of using VHF for public radio and so on. In future, it is desirable to thoroughly examine needs within Sri Lanka and to consider services that can be used effectively.

(2) Expansion of operation channel for DTTB platform

As stated in 4.1.1 above, it will be necessary to increase the operation channel of DTTB platform in order to migrate DTTB from SD broadcasting to HD broadcasting. It is planned that the process after ASO will be divided into 2 stages, and 2 channels will be added at each stage, so that total 8 channels will be finally operated. Each stage is estimated to take 1 and half years considering procurement of fund for additional transmitters, which will result in a total of 3 years after ASO for completion of upgrading to HD. During the process of increasing HD channels to 8, programmes for SD and HD will be provided at the same time. Therefore, DBNO and broadcasting stations will have to reach an agreement in advance about which programmes will be firstly broadcast in HD quality.

4.1.6 Possibility of assistance from Japan

● Subsidiary project with Yen Loan Project

Preparation for technical cooperation which will be incidental to Yen Loan Project is proceeded. One is a project for promotion of migration into DTTB, such as establishment of call centre. It is assumed to assist formulation of comprehensive policy for dissemination and technical advice when implementing the policy. In addition, a project for capacity building on data casting programme is planned, including training for production of data casting programme and utilization of data casting, as well as capacity building for broadcasting in case of disaster occurrence.

● Assistance for dissemination of DTTB receivers

In order to smoothly proceed the migration into DTTB in Sri Lanka, dissemination of DTTB receivers is essential. "Verification Survey with the Private Sector for Disseminating Japanese Technologies for

Set Top Box and UHF Antenna of ISDB-T standard" is planned to start for dissemination and development of receivers. On the other hand, the Government of Sri Lanka requests further assistance on receivers from Japan. It is assumed for Japan to consider possibility for additional fund scheme, such as Counterpart Funds for distribution of receivers to households in poverty and public facilities. The Government of Sri Lanka is considering distributing receivers to its own citizens. In case Japanese side join the consideration, Sri Lanka and Japan need to continue cooperation for further consideration for dissemination of DTTB receivers.

Table 4.1-2 Estimated expense for dissemination of DTTB receivers

Category		Number	Expense for measures* (million yen)
Household in poverty		313,600	2,508.8
Public facility	School	9,471	75.8
	Hospital	1,085	8.7

*Calculated assuming one receiver costs 8,000 yen including antenna installation fee.
Source: Prepared by JICA Survey Team in reference with Department of Census and Statistics

4.2 Band Plan

4.2.1 Channel plan

The channel plan is one of the most important items of preparation toward start of DTTB. In the Previous Survey, a channel plan was prepared, but it needed to be reviewed because of the occurrence of newly assigned frequency as well as the cooperation from private broadcasting stations.
In the migration into DTTB in Sri Lanka, DSO-SD is planned to be done firstly in Greater Colombo, followed by other areas. In addition, UHF bandwidth is supposed to be allocated for DTTB in accordance with ITU recommendation. Currently in Sri Lanka, VHF bandwidth is allocated to analogue TV broadcasting. On the other hand, only UHF with short propagation distance will be used in DTTB. Sufficient care will need to be taken when establishing detailed plan.

In Sri Lanka, most radio waves are conveyed in land propagation. Field strength for reception of desired waves and interference waves at specific points attenuates according to the theory of radio wave propagation (ITU-R P.1546-4, Figure 9). However, the terrain of Sri Lanka has a higher elevation toward the centre of the country, therefore radio waves from a transmitting station in such a place (e.g., Pidurutalagala) reach far to a certain extent with strength. This fact causes interference between digital waves or between analogue wave and digital wave due to same channel and neighbouring channel.
Interference of same channel is the phenomenon that images do not appear on the screen of the receiver when field strength of an interference wave which is on the same channel of desired wave exceeds that of desired wave by certain amount. Interference of neighbouring channel is the phenomenon that images do not appear on the screen of the receiver when field strength of an interference wave which is on the neighbour channel of desired wave exceeds that of desired wave by certain amount. The JICA Survey Team collected information such as minimum field strength disclosed in ITU document, tolerance value of various types of interference,

situation of radio waves in Sri Lanka and standard values used in Japan, thereafter decided the standard value for simulation of radio wave propagation.

Table 4.2-1 shows the standard values.

Table 4.2-1 Standard values for simulation

No.	Name of standard value	Standard value	Explanation
1	Minimum Field Strength	51 dBμV/m	This value is set higher a little than ITU standard, 47.2dBμV/m, because performance of the local general receiving equipment is low in many cases.
2	Time rate for calculation of cover area	50%	This value is not 99% adopted in Japan, but the same value of analogue broadcasting, in consideration with certainty of broadcasting service required in Sri Lanka and the economics of system construction.
3	Time rate for calculation of interfered areas	1%	This value is the most stringent value which is also used in Japan, in consideration with preventing interference with existing analogue broadcasting and increasing the reliability of digital broadcasting. (It ranges from 1 to 10.)
4	Coverage rate of co-channel interference from digital to digital	20 dB	Same as the value of ITU-R BT.1368-13, Table 68.
5	Coverage rate of co-channel interference from digital to analogue	34 dB	Same as the most stringent value of ITU-R BT.1368-13, Table 78 Tropospheric, in order to prevent interference with existing analogue broadcasting.
6	Coverage rate of co-channel interference from analogue to digital	5 dB	Same as the value of ITU-R BT.1368-13, Table 72.
7	Coverage rate of adjacent channel from digital to analogue	-5 dB	Same as the most stringent value of ITU-R BT.1368-13, Table 79, Continuous, in order to prevent interference with existing analogue broadcasting.
8	Coverage rate of adjacent channel from analogue to digital	-32 dB	Same as the value of ITU-R BT.1368-13, Table 74.
9	Front-to-back rate of reception antenna	16 dB	The direction adjustment of the reception antenna is effective for avoidance of interference. ITU-R BT.419-3 is the reference as the standard of antenna characteristic, which is generally used in Sri Lanka.

Source: ITU

Taking the above into account, the policy plan for reviewing the channel plan is described below.

(1) Use of Existing Transmitting Stations

The construction of a new transmitting station requires a huge amount of time and money. The use of existing transmitting facilities is a very cost-effective way to establish a DTTB transmitting station. In addition, there is a high possibility that work such as logging, cutting, rounding, etc. for using new land will be unnecessary, which will lead to shortening construction work of transmitting stations. Therefore, the use of existing transmitting stations is highly recommended in order to plan developing DTTB network as early as possible.

(2) Consideration of Topographic Features

As radio waves travel in a straight line, topographic features such as mountains and hills can obstruct their path. The radio wave from a transmitting station may not reach certain areas behind mountains because of the obstruction by the mountains of the path of the radio wave. This kind of poor reception area can be improved by the installation of gap-fillers, consisting of low power transmitters and small transmitting antennas. In other words, taking into consideration the topographic features of Sri Lanka, it is difficult to cover the entire country with one or two large-output transmitting stations. It will be necessary to develop an efficient DTTB network by dividing the country into area blocks.

(3) Promotion of local broadcasting service

In the digital era, with access to a highly-developed Internet and mobile phone networks, diversification in TV programming is necessary for the acquisition of information and meets the needs of TV viewers. In general, national news broadcasts and programmes targeting a wide viewer base are to be provided nationwide. Meanwhile, broadcasts targeting individual municipalities and communities should be provided only to related areas. Multi-ethnic Sri Lanka, with its regionally diverse natural and social (industrial and economic) conditions, will need channel planning that incorporates special measures to promote the provision of community-based programmes in the near future.

It will be extremely difficult and cost a large amount of additional money to migrate from a broadcasting network which can only deal with uniform programme set nationwide to a network that can promote regional broadcasting. Meanwhile, a channel plan based on the policy of implementing regional broadcasting will realize not only provision of uniform programme nationwide but also effective equipment procurement by avoiding duplication. Therefore, the channel plan for DTTB is based on implementing regional broadcasting, in consideration with the situation of society in Sri Lanka and the flexibility of regional broadcasting.

4.2.2 Programme multiplexing and channel assignment

Programme multiplexing, which allows simultaneous transmission of multiple programmes on a single frequency, is a distinctive characteristic of DTTB. Programme multiplexing enables the effective use of frequencies. At present, as a large number of frequencies are allocated to analogue broadcasting, there are only a small number of vacant channels available for DTTB in Greater Colombo area. Therefore, programme multiplexing is a very effective technique during the period of simultaneous broadcasting when a large number of frequencies are required for the analogue and digital broadcasting. The JICA

Survey Team created a plan for frequency allocation considering the following points while supporting the creation of migration plan into DTTB.
From 4.2.3, the result of consideration for channel assignment for SD broadcasting is stated.

(1) Channel assignment during the period of simultaneous broadcasting

On the basis of the results of the subjective picture quality evaluation conducted in Previous Survey, the six-programme multiplexing system will be used in channel assignment plan. It is planned that all 24 licensed TV channels will be transited to DTTB. Therefore, four frequency bandwidths need to be assured at DTTB platform and each transmitting station during the period of simultaneous broadcasting.

(2) The way of thinking for operation of HD broadcasting

Multiplexing of HD programmes will start at the same time as when HD broadcasting starts. As data size of HD programme is bigger than SD, the number of programmes multiplexed in 1 channel will decrease to 3. Channel assignment plan for HD broadcasting is based on above.

(3) Blocks set for promoting regional broadcasting in future

7 blocks will be set to divide Sri Lanka for channel assignment based on geographical situation, in order to promote regional broadcasting in future, as stated in 4.2.1. It was especially focused on eliminating interference between neighbouring blocks when considering channel assignment for each block.

4.2.3 Revision of channel assignment for SD broadcasting

(1) Survey on existing antenna tower

In the Previous Survey, existing antenna towers of state-run broadcasting stations were investigated regarding the possibility of their usage for digital broadcasting. In This Survey, JICA Survey Team additionally investigated the possibility of usage of existing antenna towers owned by private broadcasters, after most of them agreed on cooperation with This Survey. The objective was to reduce the expenses on private broadcasting stations during the period of simultaneous broadcasting of DTTB.
The JICA Survey Team received lists of existing antenna towers from private broadcasting stations and telecommunication providers in advance. Thereafter antenna towers were extracted as the candidate of transmitting stations for DTTB in consideration with their locations. The Survey Team requested detailed information of the candidate towers from broadcasting stations and telecommunication providers who own those towers for further table top investigation (*). They visited the sites which were judged not to be difficult to be the transmitting station and looked into actual situations there.
Table 4.2-2 shows the list of existing antenna towers investigated in This Survey and the details of each tower are indicated further below.
(*) Table top investigation included image analysis using pictures of the towers, judgement of existence of space for installing additional antenna for DTTB, consideration on strength of the towers and so on.

Table 4.2-2 Outline for result of investigation regarding existing antenna tower

No.	Site of transmitting station	Owner of facility	Category of owner	Availability for DTTB	Situation of confirmation by owner
1	Kanduboda	Art TV	Private broadcasting station	Not available	N/A
2	Gongala	EAP	Private broadcasting station	Not available	N/A
3	Nayabedda	SLT	Governmental broadcasting station	Not available	N/A
4	Badulla	Etisalat	Private telecommunication provider	Available	Not answered
5	Namunukula	MTV	Private broadcasting station	Not available	N/A
6	Madukanda	Sri Lanka Air Force	Army	Not available	N/A
7	Jaffna	SLT	Governmental broadcasting station	Available	Not answered
8	Kurunegala	SLT	Governmental broadcasting station	Available	Not answered
9	Hantana	SLT	Governmental broadcasting station	Available	Not answered
10	Elpitiya	SLT	Governmental broadcasting station	Available	Not answered
11	Vayuniya	TRC	Governmental agency	Available	Not answered

Source: JICA Survey Team

(2) Detail of survey results

1) Kanduboda

The antenna tower in Kanduboda is used for analogue TV broadcasting provided by Art TV around Colombo. The JICA Survey Team implemented survey of this tower in order to compare with Lotus Tower. Table 4.2-3 shows detail of the survey result.

Table 4.2-3 Result of survey in Kanduboda

No.	Survey item	Result of survey
1	Location / Elevation	North latitude 6°58'40.72" East longitude 80° 0'54.04" Above sea level 96.9 m
2	Height of tower	65 m
3	Installation of antenna for DTTB	Possible
4	Place for installation of equipment for DTTB	No space for installation of equipment in existing transmitting station building. (Possible to construct additional building in the site)
5	Passage to station building	Large 4WD can reach transmitting station.
6	Transmission link	DBNO in Colombo and cable link network are necessary.
7	Coverage area (shown in green)	
8	Conclusion	Not available for transmitting station for DTTB. (1) Coverage area will be narrower than that of Lotus Tower (2) Occurrence of disturbance due to building in Colombo city area (3) Increase of operational cost due to additional cable link to connect to DBNO

Source: JICA Survey Team

2) Gongala

The antenna tower in Gongala is used for analogue TV broadcasting provided by EAP in south western part of Sri Lanka. Table 4.2-4 shows detail of the survey result.

Table 4.2-4 Result of survey in Gongala

No.	Survey item	Result of survey
1	Location / Elevation	North latitude 6°23'9.53" East longitude 80°39'14.43" Above sea level 1336 m
2	Height of tower	45 m
3	Installation of antenna for DTTB	Impossible
4	Place for installation of equipment for DTTB	No space for installation of equipment in existing transmitting station building and difficult to construct additional building in the site
5	Passage to station building	Road surface is bad and narrow. (1 hour from city area using 4WD)
6	Transmission link	Microwave link is prospected with Pidurutalagala (master station) and Suriyakanda (slave station)
7	Coverage area	Simulation was not implemented because of difficulty of additional antenna tower.
8	Conclusion	Not available for transmitting station for DTTB. - No space for installation of antenna for DTTB and antenna for microwave - No space for additional facilities for DTTB in site

Source: JICA Survey Team

3) Nayabedda

The antenna tower in Nayabedda is owned by SLT. EAP is renting rooms and the tower for analogue broadcasting. Table 4.2-5 shows detail of the survey result.

Table 4.2-5 Result of survey in Nayabedda

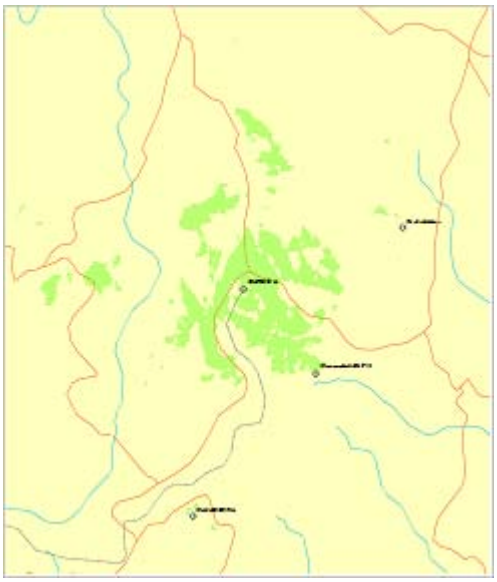
No.	Survey item	Result of survey
1	Location / Elevation	North latitude 6°48'14.83" East longitude 81° 0'55.78" Above sea level 1938 m
2	Height of tower	100 m
3	Installation of antenna for DTTB	Impossible
4	Place for installation of equipment for DTTB	No space for installation of equipment in existing transmitting station building and difficult to construct additional building in the site
5	Passage to station building	1 hour from Bandarawela station using 4WD through local street or road for plantation
6	Transmission link	Telecommunication is proposed with Pidurutalagala (master station) and Badulla (slave station)
7	Coverage area (shown in green)	
8	Conclusion	Not available for transmitting station for DTTB. (1) No space for installation of antenna for DTTB and antenna for microwave (2) No space for additional facilities for DTTB in site

Source: JICA Survey Team

4) Badulla

The antenna tower in Badulla is used for analogue TV broadcasting provided by EAP in Badulla city area. It is owned by Etisalat, and EAP rents the tower and the station building for operation of facilities. Antenna towers in neighbouring Pidurutalagala and Nayabedda will not cover Badulla city area from topographic situation. Therefore, JICA Survey Team investigated this tower as a candidate for gap filler station in order to cover Badulla city area. Table 4.2-6 shows detail of the survey result.

Table 4.2-6 Result of survey in Badulla

No	Survey item	Result of survey
1	Location/Elevation	North latitude 6°58'25.39" East longitude 81° 03'12.3" Above sea level 982 m
2	Height of tower	30 m
3	Installation of antenna for DTTB	Possible
4	Place for installation of equipment for DTTB	Vacant space for installation of equipment in existing transmitting station building and possible to construct additional building in the site
5	Passage to station building	Road surface is bad and narrow. (40 minutes from city area using 4WD)
6	Transmission link	Telecommunication is prospected with Pidurutalagala and Nayabedda. These 2 sites are available as master station of Badulla.
7	Coverage area (shown in green)	
8	Conclusion	It would be possible to cover the poor DTTB reception area which will appear between Pidurutalagala and Nayabedda. Besides, it was estimated to reduce the expenses regarding channel plan using existing tower and facilities. JICA Survey Team requested Etisalat and EAP to consider the possibility of the usage for DTTB, expense of its rental, etc.

Source: JICA Survey Team

5) Namunukula

The antenna tower in Namunukula is used for analogue TV broadcasting provided by MTV in south eastern area of Sri Lanka. Table 4.2-7 shows detail of the survey result.

Table 4.2-7 Result of survey in Namunukula

No	Survey item	Result of survey
1	Location / Elevation	North latitude 6°54'35.55" East longitude 81° 6'29.19" Above sea level 1677m
2	Height of tower	70 m
3	Installation of antenna for DTTB	Possible
4	Place for installation of equipment for DTTB	Vacant space for installation of equipment in existing transmitting station building and possible to construct additional building in the site
5	Passage to station building	Road surface is bad and narrow. (1 hour from city area using 4WD)
6	Transmission link	No prospect of telecommunication with Pidurutalagala (master station) and Badulla (slave station)
7	Coverage area (shown in green)	
8	Conclusion	Coverage area of this tower would be equivalent of that in Nayabedda and it was expected to reduce expenses regarding channel plan. On the other hand, JICA Survey Team judged this tower is not available for transmitting station for DTTB from the reasons below. (1) Difficulty of developing additional network due to existence of antenna tower of other broadcasting station between Namunukula and Pidurutalagala, which would be master station (2) No prospect of telecommunication from topographic perspective between Namunukula and Badulla, which would be slave station

Source: JICA Survey Team

6) Madukanda

This tower is located in the site of the Sri Lanka Air Force and used by Air Force and SLT. SLRC once used it as an analogue broadcasting station. Table 4.2-8 shows detail of the survey result.

Table 4.2-8 Result of survey in Madukanda

No	Survey item	Result of survey
1	Location / Elevation	North latitude 8°45'35.71" East longitude 80°32'46.65" Above sea level 177 m
2	Height of tower	65 m
3	Installation of antenna for DTTB	Impossible
4	Place for installation of equipment for DTTB	No space for installation of equipment in existing transmitting station building. (Possible to construct additional building in the site)
5	Passage to station building	30 minutes from city area using 4WD (Application for entry is necessary in advance because of military facility)
6	Transmission link	Telecommunication is prospected with Kokavil (master station)
7	Coverage area	Simulation was not implemented because of difficulty of additional antenna tower.
8	Conclusion	Coverage area of this tower would be enough for Vavuniya city area. On the other hand, JICA Survey Team judged this tower is not available for transmitting station for DTTB from the reasons below. (1) No space for installation of antenna for DTTB and antenna for microwave (2) Troublesome for entry into military facility in case of emergency

Source: JICA Survey Team

7) Jaffna

The antenna tower in Jaffna is owned by SLT. Table 4.2-9 shows detail of the survey result.

Table 4.2-9 Result of survey in Jaffna

No	Survey item	Result of survey
1	Location / Elevation	North latitude 09°39'55.76" East longitude 80°00'21.66" Above sea level 5 m
2	Height of tower	150 m
3	Installation of antenna for DTTB	Possible
4	Place for installation of equipment for DTTB	Possible to construct additional building in the site
5	Passage to station building	Located close to city area
6	Transmission link	Telecommunication is prospected with Kokavil (slave station)
7	Coverage area (shown in green)	
8	Conclusion	This antenna tower is available to provide DTTB in Jaffna area. JICA Survey Team requested SLT to consider the possibility of the usage for DTTB, expense of its rental, etc.

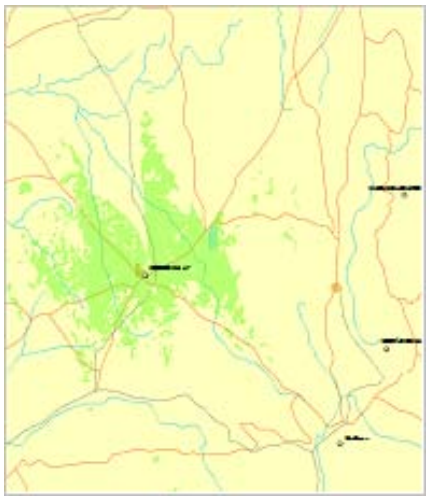
Source: JICA Survey Team

8) Kurunegala

Antenna tower in Kurunegala is used for analogue TV broadcasting provided by Hiru TV in Kurunegala city area. It is owned by SLT and Hiru TV rents the tower and the site.

Kurunegala city area does not receive analogue broadcasting waves from existing transmitting stations in Karagahatenna, Gammaduwa, Nuwara Eliya. In addition, from the result of simulation done by JICA Survey Team, digital transmitting station in Karagahatenna will not cover Kurunegala. Therefore, the JICA Survey Team investigated this tower as a candidate for gap filler station in order to cover Kurunegala city area. Table 4.2-10 shows detail of the survey result.

Table 4.2-10 Result of survey in Kurunegala

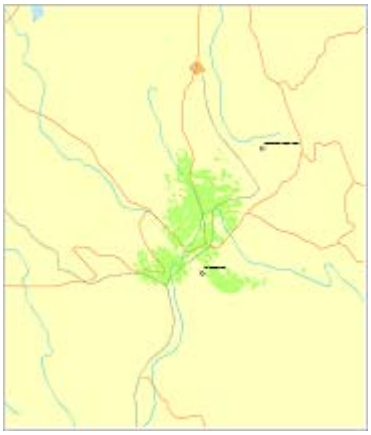
No.	Survey item	Result of survey
1	Location / Elevation	North latitude 7°29'4.38" East longitude 80°22'15.19" Above sea level 291 m
2	Height of tower	42 m
3	Installation of antenna for DTTB	Possible
4	Place for installation of equipment for DTTB	Vacant space for installation of equipment in existing transmitting station building and possible to construct additional building in the site
5	Passage to station building	40 minutes from city area using vehicle
6	Transmission link	Telecommunication is prospected with Karagahatenna (master station)
7	Coverage area (shown in green)	
8	Conclusion	It would be possible to cover the poor DTTB reception area in Kurunegala city area. Besides, it was estimated to reduce the expenses regarding channel plan using existing tower and facilities. Kurunegala JICA Survey Team requested SLT and Hiru TV to consider the possibility of the usage for DTTB, expense of its rental, etc.

Source: JICA Survey Team

9) Hantana

The antenna tower in Hantana is owned by SLT. SLRC rents the tower from SLT and uses SLRC's site and station building neighbouring the tower for analogue TV broadcasting. Table 4.2-11 shows detail of the survey result.

Table 4.2-11 Result of survey in Hantana

No.	Survey item	Result of survey
1	Location / Elevation	North latitude 7°15'31.25" East longitude 80°37'45.16" Above sea level 1045 m
2	Height of tower	70 m
3	Installation of antenna for DTTB	Possible
4	Place for installation of equipment for DTTB	Vacant space for installation of equipment in SLRC's transmitting station building and possible to construct additional building in the site of SLT
5	Passage to station building	30 minutes from city area using vehicle and 30 minutes on foot
6	Transmission link	Telecommunication is prospected with Hunnasgiriya (master station)
7	Coverage area (shown in green)	
8	Conclusion	This antenna tower is available to provide DTTB in Kandy area. JICA Survey Team requested SLT and SLRC to consider the possibility of the usage for DTTB, expense of its rental, etc.

Source: JICA Survey Team

10) Elpitiya

The antenna tower in Elpitiya is owned by SLT. (It is called Pathirajakanda by SLT.) Table 4.2-12 shows detail of the survey result.

Table 4.2-12 Result of survey in Elpitiya

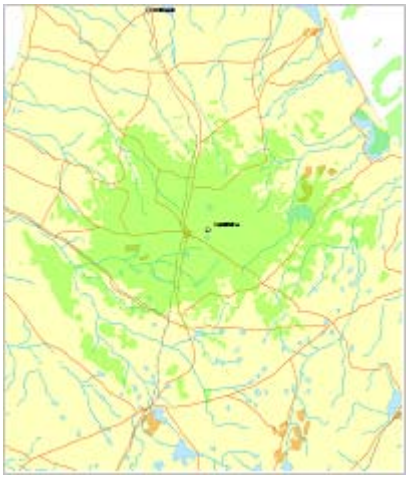
No.	Survey item	Result of survey
1	Location / Elevation	North latitude 6°15'33.20" East longitude 80° 8'39.00" Above sea level 33 m
2	Height of tower	80 m
3	Installation of antenna for DTTB	Possible
4	Place for installation of equipment for DTTB	Vacant space for installation of equipment in existing transmitting station building. (Impossible to construct additional building in the site)
5	Passage to station building	Located close to city area
6	Transmission link	Telecommunication is prospected with Gongala (master station)
7	Coverage area (shown in green)	
8	Conclusion	This antenna tower is available to provide DTTB in Elpitiya area. JICA Survey Team requested SLT to consider the possibility of the usage for DTTB, expense of its rental, etc.

Source: JICA Survey Team

11) Vayuniya

The antenna tower in Vavuniya is owned by TRC. Table 4.2-13 shows detail of the survey result.

Table 4.2-13 Result of survey in Vayuniya

No	Survey item	Result of survey
1	Location / Elevation	North latitude 8°46'1.23" East longitude 80°33'0.66" Above sea level 175 m
2	Height of tower	60 m
3	Installation of antenna for DTTB	Possible
4	Place for installation of equipment for DTTB	Vacant space for installation of equipment in existing transmitting station building. (Difficult to construct additional building in the site)
5	Passage to station building	30 minutes from city area using vehicle and 30 minutes on foot
6	Transmission link	Telecommunication is prospected with Kokavil (master station)
7	Coverage area (shown in green)	
8	Conclusion	This antenna tower is available to provide DTTB in Vayuniya area.

Source: JICA Survey Team

It will be finally judged whether these existing towers can be used or not, based on the result of survey above and consideration of the DSO plan and antenna system described later. (4.2.5 (9) shows the detail.)

(3) Planning for revision of SD channel assignment

Channel plan for SD broadcasting was revised in accordance with the result of investigation on existing antenna towers as well as additionally assigned channels for analogue broadcasting after Previous Survey. It is necessary to avoid the following 3 points.

i. Interference from existing analogue broadcasting waves to digital broadcasting waves
ii. Interference from digital broadcasting waves to other digital broadcasting waves
iii. Interference from digital broadcasting waves to existing analogue broadcasting waves

Digital signals are strong against interference, therefore in cases i) and ii), assignment of same channel will be relatively easy. On the other hand, in case iii), assignment of same channel will be restricted because analogue signals are not strong against interference compared to those of digital. In addition, viewers in Sri Lanka currently receive lower level (*) of field strength than the level regulated by ITU (65dBμv/m, ITU-R BT.417). It will result in the necessity of reducing reception level of digital broadcasting waves to some extent, and the difficulty of additional assignment of SD channels.

(*) TRC insists that more than 40dBμv/m is enough for the field strength for reception. However, that level will produce a very rough image quality on viewers' side as shown below. Meanwhile, there are some viewers who do not mind about the image if they just listen to the sound. When considering the detail of the policy for ASO, attention should be paid to which condition should be prioritized for its implementation.

Figure 4.2-1 Example of analogue images received through field strength of about 40dBμv/m

In consideration with above, JICA Survey Team reviewed SD channel assignment through the simulation on radio wave propagation in detail. Table 4.2-14 shows the plan for SD channel assignment. There are 2 stages for channel assignment; one is for the start of DTTB (DSO-SD) and the other is for channel repacking (replacing SD channels into other channels.)

As of Previous Survey, implementation of channel repacking would be necessary for only 1 channel of Colombo Transmitting Station. However, additional channels were assigned from that time, and channel repacking will be necessary in all 16 transmitting stations. Channels for DTTB are set from CH 21 to 48 in UHF bandwidth, based on agreement by APT. Meanwhile, number of channels will not be enough just after starting DTTB because the channels will be used in parallel with analogue channels. Therefore, frequency bandwidths which correspond to over CH 49 will also be used for DTTB, the same as current analogue broadcasting. Once some channels become vacant after ASO, those will be assigned for DTTB which will be using over CH 49 at that time.

Transmitting systems and antenna systems should not be affected much by channel repacking. Therefore, consideration should be taken that procurement of equipment will be proceeded in accordance with the situation of channel repacking. DTTB platform side will not be affected either from that consideration. In detail, operation of transmitter at lower power and change of radiation pattern of antenna system will

be done (as shown in 4.2.5 (8)). Table 4.2-14 also shows transmission power and necessity of modification of antenna pattern.

In addition, it will be necessary to implement promotion activities about what viewers need to do, because existing programmes will be provided through other channels after channel repacking. Viewers will have to set automatic channel setting of DTTB receiver just like at the time of purchasing. It will be necessary to support viewers appropriately through call centres and so on.

Table 4.2-14 SD channel assignment during period of simultaneous broadcasting

No	Site of transmitting station	Channels during DSO (SD)	Transmission power during simultaneous broadcasting (W)	Channels after repacking	Transmission power after repacking (W)	Modification of antenna pattern	SFN block number
1	Jaffna	41, 43, 44, 50	500	41, 43, 44, *47*	No changes	No need	1
2	Kokavil	41, 43, 44, 50	3000	41, 43, 44, *47*	No changes	No need	1
3	Vayuniya	41, 43, 44, 50	1000	41, 43, 44, *47*	No changes	No need	1
4	Trincomalee	33, 36, 38, 59	1000	33, *35*, 36, 38	No changes	No need	-
5	Karagahatenna	39, 40, 61, 62	3000	*34*, 40, 39, *42*	No changes	Necessary	6
6	Kurunegala	39, 40, 61, 62	10	*34*, 40, 39, *42*	No changes	No need	6
7	Colombo	41, 43, 44, 50	5000	41, 43, 44, *48*	No changes	Necessary	4
8	Yatiyantota	41, 43, 44, 50	1000	41, 43, 44, *48*	2000	Necessary	4
9	Hunnasgiriya	41, 43, 44, 50	1000	*33, 35, 36, 38*	No changes	Necessary	- (2 before ASO)
10	Pidurutalagala	41, 43, 44, 50	50	41, 43, 44, *48*	No changes	No need	2
11	Hantana	41, 43, 44, 50	10	41, 43, 44, *48*	No changes	No need	2
12	Badulla	41, 43, 44, 50	10	41, 43, 44, *48*	No changes	No need	5
13	Nayabedda	41, 43, 44, 50	3000	41, 43, 44, *48*	No changes	No need	5
14	Gongala	41, 43, 44, 50	250	*33, 34, 36, 38*	1000	Necessary	3
15	Suriyakanda	41, 43, 44, 50	250	*33, 34, 36, 38*	1000	Necessary	3
16	Elpitiya	41, 43, 44, 50	300	*33, 34, 36, 38*	No changes	Necessary	3

(*) SFN in Hunnasgiriya will be changed to MFN after ASO

Figure 4.2-2 shows block for channel assignment. “SFN block number” in the table above shows the block which will use the same channel. In 6 blocks, broadcasting network will be developed using Single Frequency Network (hereinafter referred to as SFN) in order to resolve lack of frequency bandwidth. Coverage area from transmitting station in Hunnasgiriya was adjusted for realizing SFN with Pidurutalagala and Hantana until ASO. Thereafter MFN will be developed using vacant channels which will appear after ASO. It will prevent occurrence of interference between the same frequency and lead to wider coverage area.

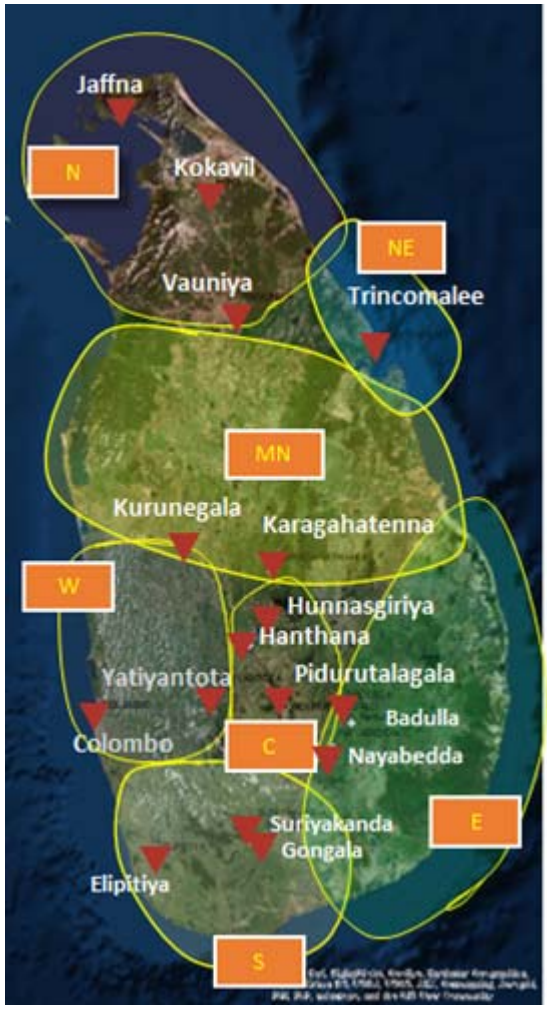


Figure 4.2-2 Blocks for channel assignment

Block	Major cities in the block
North (N)	Jaffna, Kilinochchi, Vayuniya, Mannar
North East (NE)	Trincomalee
Middle North (MN)	Anuradhapura, Matale, Dambulla, Kurunegala, Batticaloa, Polonnaruwa
West (W)	Colombo, Moratuwa, Negombo, Gampola, Homagama, Kalutara
Central (C)	Kandy, Nuwara Eliya, Badulla
East (E)	Hambantota, Kalmunai, Ampara
South (S)	Galle, Matara, Ratnapura

UHF bandwidth is supposed to be used for DTTB in Sri Lanka. Meanwhile, existing analogue TV broadcasting basically covers the whole nation using single wave in VHF bandwidth. It is difficult to realize channel assignment same as UHF bandwidth, because propagation distance of UHF is shorter than VHF. That is the reason of preparing blocks as above and transmitting stations in each block need to cover its area.

There are some merits for the migration into DTTB other than promotion of regional broadcasting. Comparison between nationwide broadcasting network using single wave and broadcasting in blocks is shown in Table 4.2-15.

Table 4.2-15 Comparison of nationwide broadcasting using single wave and broadcasting in blocks

Items	Nationwide broadcasting using single wave	Broadcasting in blocks
Regional broadcasting	Only nationwide broadcasting is available.	Regional broadcasting is available in maximum 7 blocks as well as limiting the blocks where certain programmes are provided.
Procurement of personnel and equipment	There will be the difficult case for procurement of many types of equipment and facilities and preparation for large amount of money.	Procurement will be easier by securing resources in stages.
Channel plan	Interference calculation becomes complicated and precise adjustment will be difficult.	Adjustment for interference avoidance becomes comparatively easy since interference calculation will be done for each block.
Relationship of installation schedule between transmitting stations	Delay in the process of a specific transmitting station affects the whole country.	Installation of transmitting stations can be carried out step by step, and it will be possible to avoid the influence on other areas.

Source: JICA Survey Team

4.2.4 DSO planning

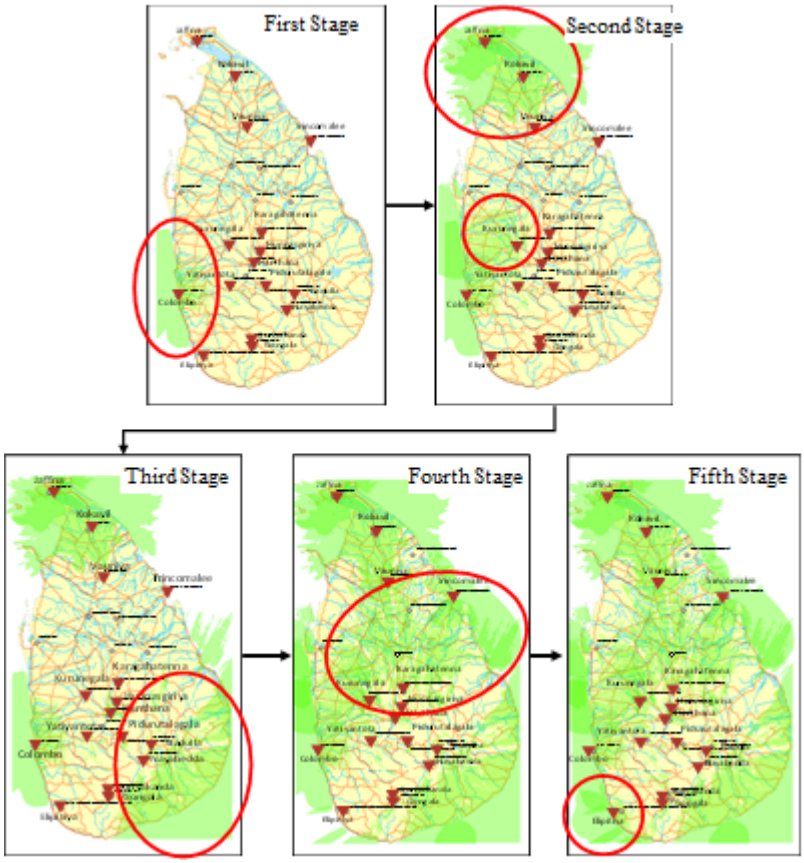
JICA Survey Team prepared the plan of DSO in Sri Lanka in consideration with blocks above and realization of smooth migration into nationwide DTTB in 5 stages for DSO-SD as shown below. Greater Colombo is planned to be the first area among 5 stages because it will be the most effective to firstly prioritize Colombo where a large population exists and dissemination of DTTB receiver is expected to greatly proceed. Then areas where major transmitting stations exist are prioritized to implement DSO-SD in consideration with network configurations of DTTB platform.

Table 4.2-16 DSO-SD planning in stages

	Sites of transmitting station	Population coverage ratio	Explanation
First stage	-Colombo (1kW)	21%	It is planned to install a transmitting system at Colombo Transmitting Station using 5kW transmitter, which will be produced by manufacturer who will receive orders from the Government of Sri Lanka. It is estimated to take 6 months for the production of 5kW transmitter after decision of supplier by tendering. Meanwhile, transmitting system using 1kW transmitter is expected to be available because suppliers usually stock that kind of equipment. Therefore, DTTB can be started earlier by transmitting system using 1kW transmitter at first in Greater Colombo, without waiting for production of 5kW transmitter. The method above makes sense because it is necessary to ascertain how radio waves propagate comparing with values of design during the earlier stage of DTTB. Generally, operation at lower power rather than regular power will be done to carefully confirm digital broadcasting does not interfere with existing analogue broadcasting. 1kW transmitter mentioned above will be relocated and used at another station after 5kW transmitter is installed at Colombo Transmitting Station.
Second stage	-Colombo (5kW) -Kokavil -Yatiyantota -Jaffna	41%	5kW transmitter will be installed instead of that of 1kW at Colombo Transmitting Station in February in 2021. This will enable covering the service area as planned. The strength of radio waves from the transmitter will be increased gradually based on the situation regarding occurrence of interference in order to expand the service area. In February in 2021, installation of equipment at transmitting stations in Kokavil, Yatiyantota and Jaffna will also be completed and radio wave transmission will start. In this stage, service area will be expanded mainly in northern and middle areas. Meanwhile, southward radio wave transmission needs to be weakened at Colombo Transmitting Station and Yatiyantota station in order to avoid interference with transmitting stations in southern area.
Third stage	-Pidurutalagala -Hunnasgiriya -Nayabedda	49%	Installation of equipment at transmitting stations will be completed in May 2021 in areas of third stage and radio waves transmission will start. South-eastern areas will also be covered at this stage and

	Sites of transmitting station	Population coverage ratio	Explanation
	-Hantana		population coverage rate will be 49%. Meanwhile, the strength of radio waves from the transmitter in Hunnasgiriya toward north-western needs to be kept weak until ASO in order to avoid interference with middle area.
Fourth stage	-Karagahatenna -Gongala -Trincomalee -Vayuniya	64%	Installation of equipment at transmitting stations will be completed in August 2021 in areas of fourth stage and radio waves transmission will start. Middle areas will also be covered at this stage and population coverage rate will reach 64%. Meanwhile, the strength of radio waves from the transmitter in Gongala toward Greater Colombo and south-eastern area needs to be kept weak until ASO in order to avoid interference. Frequency bandwidth of radio waves from transmitting stations in Karagahatenna and Trincomalee will be partly same as existing analogue broadcasting. Therefore, strength of electric field needs to be measured to confirm whether reception trouble to analogue broadcasting occur.
Fifth stage	-Suriyakanda -Elpitiya -Kurunegala -Badulla	68.9%	Installation of equipment at transmitting stations will be completed in November 2021 in areas of fifth stage and radio wave transmission will start. This is the final stage of DSO-SD and population coverage rate will be 68.9% by opening transmitting stations mainly in south and west areas. Meanwhile, the strength of radio waves from the transmitter in Suriyakanda and Elpitiya toward Greater Colombo and south-eastern area needs to be kept weak until ASO in order to avoid interference. If radio waves are transmitted at the same level as planned after ASO, population coverage rate will reach 84.2%.

Source: JICA Survey Team



Source: JICA Survey Team

Figure 4.2-3 Coverage areas at each stage of DSO-SD

4.2.5 Antenna system

In case existing facilities which are not informed or noticed appear and it becomes necessary to consider those usage, the channel plan needs to be changed to reconsider the channel assignment at each transmitting station. Many analogue broadcasting channels are currently allocated in Sri Lanka, therefore antenna patterns as well as avoidance of interference between existing analogue waves and digital waves have to be examined in detail

The following shows the consideration on appropriate antenna patterns at each transmitting station which will be opened through Yen Loan Project in order to proceed migration into DTTB based on channel assignment plan shown in 4.2.3.

(1) Design Policy

In general, the existing VHF analogue transmission antenna provides wide coverage area. Meanwhile, antenna configuration for the UHF digital broadcasting to be established requires optimal designs of antenna directivity for the creation of an optimal coverage area for each transmitting station for the minimization of the co-channel interference between stations in areas where the Single Frequency Network (hereinafter referred to as "SFN") broadcasting is carried out and for the prevention of interference caused by existence of different signals on the same frequency in the same area.

A broadband antenna system for the four-channel broadcasting in the UHF Band after the launch of DTTB (broadcasting of multiplexed 24 SD programmes on four frequencies) and the eight-channel HD broadcasting after ASO and DSO-HD (broadcasting of multiplexed 24 HD programmes on eight frequencies – in this basic design) will have to be designed. It is desirable to have small deviation in reception field strength between channels in the coverage area created by the antenna system, because big deviation will cause the risk to create channels which are available for some households but not for others. It is important to select an antenna with small deviation in directivity in a wide band range. Therefore, a 4L stacked loop antenna which is widely used in Japan will be adopted as the basic antenna. Use of products which allow inspection and maintenance of component parts which compose a transmitting antenna system including an antenna element is recommended for their long-term use. In this aspect, use of 4L stacked loop antennas is recommended because they have been used stably for a long period of time with a regular basis of internal inspection and repainting.

The antenna and main feeder system will be configured with the high power appropriate for the extended eight-channel operation in future. Combiner to be installed in the station buildings will be composed of suitable components which enable the eight-channel operation.

(2) Features of 4L Stacked Loop Antenna

The features of 4L stacked loop antenna to be adopted in the transmitting antenna system are as follows:

i. 4 loop antenna has four stacked loop elements (a type of directional antenna with vertical arrayed elements), and gain is high.
ii. Deviation of the radiation pattern of antenna unit and the composed some antenna units are small in the frequency range.
iii. Deviation of the gain is small in the above-mentioned frequency band.
iv. Because of its small deviation of radiation pattern and gain, the use of this type of antenna in multiple channels use makes it possible to have an identical coverage area.
v. Because the antenna cover is easily removable, the maintenance of the inside part of cover is easy.
vi. The wind pressure area is small; therefore, it is possible to reduce the wind load of an antenna mounting post and tower.

(3) Decision on Antenna radiation pattern

The interference between transmitter stations has to be minimized for DTTB. To satisfy this request, simulation on the synthetic horizontal and vertical directivity with simulation software was conducted repeatedly with different conditions, such as number of faces, directions and tilt angles of antenna panels and finally most appropriate condition was identified.

The channel planning began with the policy of using existing towers of broadcasting stations, however some interference between transmitter stations caused by long distance propagation from higher point to lower point may be estimated. Therefore, simulation on the directivity of antennas installed at transmitting stations in the mountains aiming at reduction of interference was conducted repeatedly with

different sets of conditions, including direction, tilt angle and power, of individual stations and the set of conditions which gave the best result was identified.

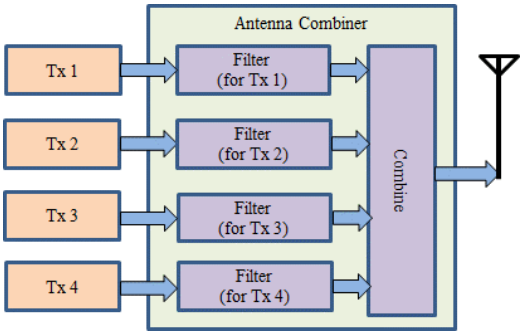
(4) Modification of design policy for combiner

1) Modification of design policy for combiner due to channel repacking

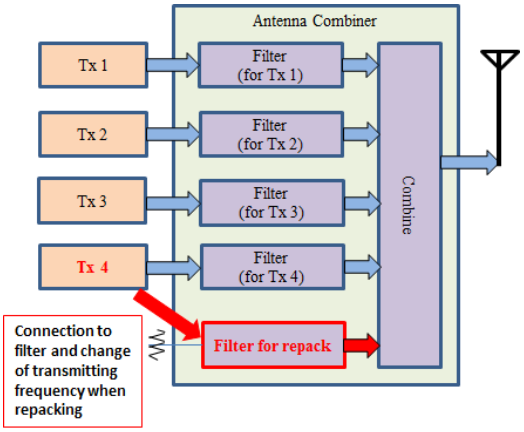
In the Previous Survey, design and cost estimation of combiner was implemented based on the premise of synthesizing 4 waves into 1.

During This Survey, it was revealed that situation of frequency usage changed and vacant frequency bandwidth corresponding to below CH 48 will not be enough. Therefore, in the channel plan of This Survey, CH 49 to 62 scheduled for future use by mobile phone etc. will be temporarily used for DTTB during the period of simultaneous broadcasting and those channels will be assigned below CH 48, which will become vacant after ASO. Along with assignment above, additional expense due to constitution of device and additional works of channel repacking will occur. When implementing channel repacking, each broadcasting station using concerned channel will have to stop its operation. Figure 4.2-4 shows the change of design policy for combiner in consideration with lowering additional expense and period of channel repacking.

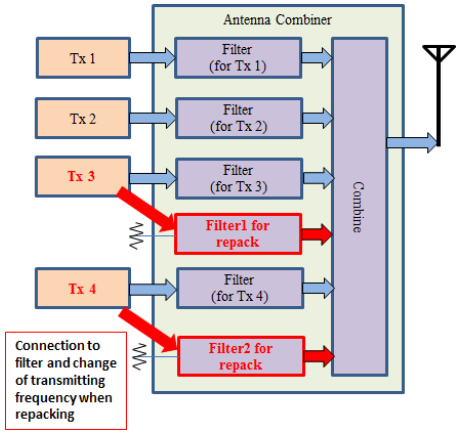
i) Policy as of Previous Survey/Station where repacking is not necessary



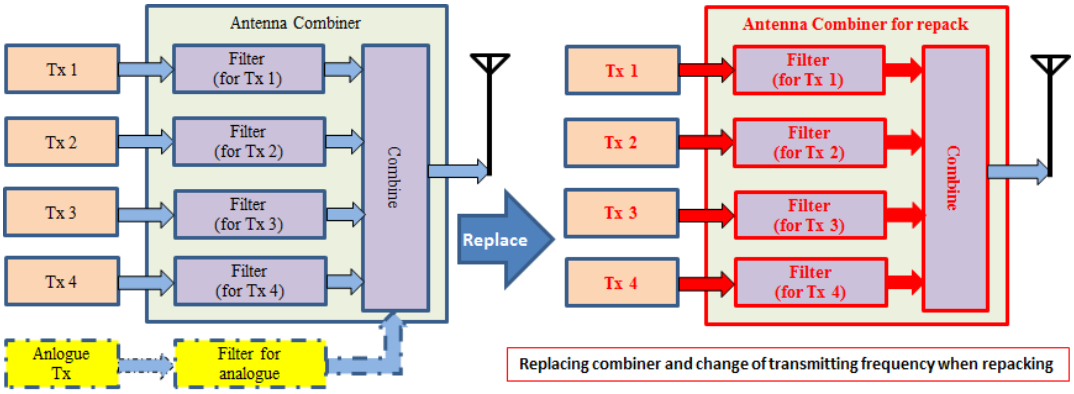
ii) 1 channel needs to be repacked



ii) 2 channels need to be repacked



iii) 3 or 4 channels are repacked



* Combining analogue transmitter is necessary in Hunnasgiriya where both analogue TV and digital TV will share existing transmitting facilities.

Source: JICA Survey Team

* Red indicates the part where replacement, modification of connection setting, change of frequency will be necessary.

Figure 4.2-4 Policy for design of combiner

Combiner for repacking is categorized; ①Combiner to synthesize five radio waves or six radio waves in case the number of repacking channel(s) is 1 or 2. (in Kokavil, 1 repacking and 1 analogue), and ② Replacing combiner in case the number of repacking channels is 3 or more.

In case ①, there is little increase in the loss of the combiner, it is not necessary to change the transmitter power etc. and it is possible to shorten the period of stop time for operation of transmitting stations by changing frequency of transmitter and connection setting of combiner. Therefore in the policy, integrated type combiner will be produced including channels in repacking stage after ASO.

In case ②, loss of signals due to increasing number of filters will happen, and it is necessary to increase the transmission power of the transmitter in order to compensate for the loss. As a result, it will be necessary to increase the size of the power amplifier, the capacity of the uninterruptible power supply (hereinafter referred to as "UPS"), the power of equipment for distribution and reception, and the air conditioning capacity. These will raise the electricity expense at the transmitting stations, followed by the reason of increasing operational expenses of DBNO.

Therefore, at each transmitting station, additional one combiner will be produced in order to use after repacking. Two types of combiners will be provisionally installed in advance and remove unnecessary one after repacking.

Some equipment which will be delivered at the time of DSO will become unnecessary after repacking and cannot be used as a spare item. Those will have to be kept long term or disposed of.

The input terminal of combiner which will be unnecessary after repacking or removing analogue TV set after ASO must be terminated.

(5) Decision on the Main Feeder Line System

The sizes of coaxial feeder cables were selected on the basis of the power capacity required for the transmission of eight signals in the future eight frequency antenna system.

Table 4.2-17 shows sizes of coaxial feeder cables appropriate for transmitters of different outputs.

Table 4.2-17 Transmitter Outputs and Sizes of Coaxial Feeder Cables

Transmitter output	Size of coaxial feeder cable
At or below 0.5kW (0.5kW x 8=4kW)	1-5/8"
1kW (1kWx8=8kW)	3"
2kW (2kWx8=16kW)	3-1/8"
3kW (3kWx8=24kW)	4-1/8" (3"x2) Note*)
5kW (5kWx8=40kW)	5"

Note*) Because of the difficulty in transporting 4-1/8" feeder cables in the mountains due to their large size, the power will be distributed through two lines of 3" feeder cables.

Source: JICA Survey Team

(6) Decision on Survival Wind Speed

Because the design wind speed for antenna towers for broadcasting antennas has not been defined clearly in Sri Lanka and the highest recorded maximum instantaneous wind speed in Sri Lanka is 206 km/h (≈

57.2 m/sec) recorded at the time of a cyclone, the survival wind speed used by Japanese broadcasting organisations will be used as the design standard. The deflection angle (an angle of the change in direction of an antenna caused by wind) of a transmitting antenna installed on a tower at the wind speed of 30 m/sec should be less than 0.5 degrees, in order not to cause fluctuation of field strength in the coverage area.

(7) Other Conditions and Design Specifications for Each Station

The result of the field study of the site of each station and the compositions and specifications of the transmitting antenna system used in the simulation of the coverage area are described in the following by transmitting station. For the setting of specification values, frequency of 650MHz and the common environmental conditions mentioned below were used.

Environmental conditions:
- Ambient temperature: -30 to 50 °C
- Relative humidity: maximum of 100%

1) Jaffna

JICA Survey Team has considered to install an antenna at the top of the 150 m tower of SLT in Jaffna located in the central part of the planned coverage area.

Four-stage two-face and two-stage two-face antenna array will be installed at the top of existing antenna tower to create an antenna system with a peanut-shaped horizontal radiation pattern similar in shape to the coverage area. A system configuration in which the ratio of power distributed to the upper and lower stages can be changed will be used to enable null-fill (to make a signal reach a point where it has not reached) of null points (places in the direction of a two-stage panel where signal cannot be received) on the vertical plane.

Filter part will have to combine total 5 waves due to channel repacking. Although it will cost a little, it will not lead to such a large cost increase.

Appendix 1 and 2 show specification of antenna system of transmitting station in Jaffna, diagram of horizontal radiation pattern and diagram of vertical radiation pattern.

2) Kokavil

An 8-stage 4-face analogue UHF antenna array of SLRC is installed on the 172m-high tower owned by TRC. Since this antenna has extra power capacity, the existing antenna will be converted to a multi-frequency analogue/digital antenna system with addition of a combiner for the use in a wide frequency range. The existing system uses vertically separated two-line feed system. It is possible to feed all power for the transmission of eight digital signals (3kW x 8) through a single feed line at the time of abnormality.

Filter part will have to combine total 6 waves due to channel repacking. Although it will cost a little, it will not lead to such a large cost increase.

Appendix 3 and 4 show specification of antenna system of transmitting station in Kokavil, diagram of horizontal radiation pattern and diagram of vertical radiation pattern.

3) Vayuniya

Vavuniya is located halfway between the edges of the coverage areas of Kokavil and Karagahatenna Transmitting Stations. A four-stage two-face and two-stage two-face antenna array has been selected as the basic design configuration for the prevention of interference with the coverage area of those two stations. This antenna will be installed in such a way that a peanut-shaped horizontal plane directionality with main lobes in the east-west direction is created. The JICA Survey Team requested installation of the antenna at the top of the tower of SLT. However, it was revealed that it was not possible to install the antenna at the top of the tower because of insufficient structural strength. Therefore, the Team conducted a study on installation of multi-face antenna array in the mid-section of the tower. The study showed that such a multi-face antenna array was not capable of transmitting signals on eight channels because the multi-face installation would make the usable frequency band narrow. Accordingly,, a new tower will be constructed on a lot nearby.

A vertically separated power feed system will be used, in order to eliminate the first null point (the first point at which the first null, or large dip in the field strength in the direction from the horizontal plane to the angle of depression, occurs) in the vertical radiation pattern in the direction of a panel with two elements in the four-stage two-face and two-stage two-face configuration.

Filter part will have to combine total 5 waves due to channel repacking. Although it will cost a little, it will not lead to such a large cost increase.

Appendix 5 and 6 show specification of antenna system of transmitting station in Vayuniya, diagram of horizontal radiation pattern and diagram of vertical radiation pattern.

4) Trincomalee

Trincomalee Transmitting Station is located in the eastern coastal area outside the coverage areas of Kokavil and Karagahatenna Transmitting Stations. The possibility of installing an antenna on the existing tower of SLT was examined. The examination revealed that there was no installation space on the tower because many parabolic antennas had been installed on it and the structural strength of the tower was not sufficient. Therefore, a 75m-high tower will be constructed on a lot in the north of the planned coverage area and an antenna will be installed at the top of the tower. (The lot is within the premises of a temple. The Survey Team has confirmed the positive attitude of the temple to the construction.)

The antenna array will have two faces, one facing to the south and the other to the northwest, and four stages in each direction. The coverage area to the southwest will be created as the composited radiation pattern between two direction antenna panels.

The premises of the temple, the candidate construction site of the new transmitting station, will be surveyed. Final confirmation of the design drawings of the tower and station building to be constructed and permission to use the land concerned will be required.

Filter part will have to combine total 5 waves due to channel repacking. Although it will cost a little, it will not lead to such a large cost increase.

Appendix 7 and 8 show specification of antenna system of transmitting station in Trincomalee, diagram of horizontal radiation pattern and diagram of vertical radiation pattern.

5) Karagahatenna

Karagahatenna Transmitting Station is located in the north of the mountainous area. As the plains to the east, west and north can be seen from the site of the station, the station at this site can create a large coverage area. Since there are mountains to the south direction which will obstruct propagation of the signal, a five-stage three-face directional antenna will be arranged at the right angles.

In order to suppress overshoot radio wave interference (a phenomenon that a radio wave propagates very far in a certain direction and causes interference where it has reached), the three-face antenna array will be installed in such a way that its directionality will be 35 degrees from the true north. The new antenna will be installed at the top of the existing 65m-high tower. The main feeder system will have power capacity of 24kW to allow extra capacity for the addition of transmitters in future. Although 4-1/8" cables satisfy the required power capacity, the packaging drum of a cable of this large size is so large that it is difficult to transport them to the site of the station. Therefore, two-line feeder system with 3" coaxial cables will be used instead. This is not an actual dual feeder system; two-way dividers will be installed on the outputs from the coaxial switch.

Until the ASO of neighbouring stations is completed, the directional pattern will be narrowed in order to prevent interference with the peripheral analogue stations and prevent radio waves from propagating widely.

Filter part will have to combine total 6 waves due to channel repacking. Although it will cost a little, it will not lead to such a large cost increase.

Appendix 9 and 10 show specification of antenna system of transmitting station in Karagahatenna, diagram of horizontal radiation pattern and diagram of vertical radiation pattern.

6) Hunnasgiriya

Hunnasgiriya is located in the mountains in the northeast of Kandy. Since Kandy area is covered by the station at the site, the eighth-stage three-face directional antenna facing to the north, south and west will be installed.

The analogue UHF antenna installed on the upper part of the existing stayed tower of ITN will be replaced by a digital/analogue multi-frequency antenna system. As only limited space is available for installation of antennas, 4 dipole antennas used in the existing system will be installed. Metal fitting at the antenna mount will also be replaced.

The tilt angles will be increased in order to prevent overshoot interference in the area outside the coverage area. There will be a need to study the effect of changes in the tilt angles on the existing analogue coverage area.

When ASO of the peripheral station is completed, all channels for DTTB will be changed for expansion of service area and tilt angle will be smaller in order to propagate radio waves to distant area. Combiner will be replaced in order to deal with total 9 waves due to channel repacking.

Appendix 11 and 12 show specification of antenna system of transmitting station in Hunnasgiriya, diagram of horizontal radiation pattern and diagram of vertical radiation pattern.

7) Yatiyantota

Yatiyantota Transmitting Station is located in the mountains east of Colombo and covers the Greater Colombo and surrounding areas. Since the Colombo Transmitting Station to be installed on the Lotus Tower will be the main transmitting station for the Greater Colombo, transmission westward toward Colombo from this station will be suppressed. A directional antenna will be composed with installation of three faces covering area in the north-south direction and part in the east.

There is no installation space on the sides of the existing 50m-high tower because the VHF antenna and the FM antenna are installed on the side and at the top of the tower. In the beginning, a plan to replace the FM antenna installed at the top with a digital UHF antenna and mounting the FM antenna on top of the UHF antenna was considered. However, a field reconnaissance revealed that many parabolic antennas were installed on the tower, that the structural strength of the tower was insufficient and that the tower was so dilapidated that it was difficult to reinforce it. Therefore, a 75m-high tower will be constructed at the halfway point between ITN tower and SLBC tower, which are in the same lot, and a digital UHF antenna will be installed at the top of the new tower. In this case, the new tower should be taller than the existing antennas to reduce the influence of the existing towers on the directionalities of the signal. The new tower will change the directionalities of the existing VHF and FM antennas slightly. However, since the change will be less than 1 dB, the tower has little influence on the coverage areas of those antennas.

Until channel repacking of neighbouring digital broadcasting stations is completed, the directional pattern will be narrowed in order to prevent interference with those digital stations. In addition, directional pattern will be broadened in order to propagate radio waves for satisfying the initial goal of service area.

Filter part will have to combine total 5 waves due to channel repacking. Although it will cost a little, it will not lead to such a large cost increase.

Appendix 13 and 14 show specification of antenna system of transmitting station in Yatiyantota, diagram of horizontal radiation pattern and diagram of vertical radiation pattern.

8) Nayabedda

Nayabedda is located in the mountains in the southeast. The coverage area of Nayabedda Transmitting Station will be in the south, east and southeast. Therefore, a directional antenna will be composed with installation of two faces, each consisting of six stages. A study was conducted on installation of antenna on the sides of the existing tower of ITN. As the drawings of the tower were not available, actual measurements of some of the steel members of the tower were taken. The measurements were used for the calculation of the structural strength of the tower. The result of the calculation revealed that the tower was not strong enough to install the new antenna system, because the wind load on the existing VHF omni-directional antenna was large. A candidate site for the installation of an antenna was sought in the neighbourhood.

The candidate site found is located along a road in a tea plantation approx. 200m south of the ITN tower. A 75m-high tower and a station building will be constructed on the site. The coverage area will be in the direction between northeast and southeast and the line of sight in the direction is good.

The main feeder system will have power capacity of 24kW to allow extra capacity for the addition of transmitters in future. Although 4-1/8" cables satisfy the required power capacity, the packaging drum of a cable of this large size is so large that it is difficult to transport them to the site of the station. Therefore, two-line feeder system with 3" coaxial cables will be used instead. This is not an actual dual feeder system; two-way dividers will be installed on the outputs from the coaxial switch.
Filter part will have to combine total 5 waves due to channel repacking. Although it will cost a little, it will not lead to such a large cost increase.
Appendix 15 and 16 show specification of antenna system of transmitting station in Nayabedda, diagram of horizontal radiation pattern and diagram of vertical radiation pattern.

9) Pidurutalagala

Pidurutalagala Transmitting Station is located in the highland on the highest mountain in Sri Lanka, Mt. Pidurutalagala (altitude of approx. 2,500m). Since its coverage area is in the mountains, a directional antenna will be composed with installation of two-stage one-face antenna array in the direction of Nuwara Eliya because it is difficult to prevent interference on peripheral area by increasing tilt angle on vertical plane.
In the beginning, installation of the antenna on the sides of the existing tower of SLRC was considered. However, as the condition of the tower (which was constructed in 1981) is dilapidated and it is difficult to reinforce it for a long-term use, a new tower will be constructed near the existing tower.
The only lot where a new tower can be constructed is a vacant lot by the side of the existing tower. A 75m-high tower, which is taller than the existing tower, will be constructed and a station building will be constructed in the space within the four legs of the tower. As the close proximity of the two towers will generate Candelabra Effect (branched dispersion of directionality), countermeasures will have to be developed.
Filter part will have to combine total 5 waves due to channel repacking. Although it will cost a little, it will not lead to such a large cost increase.
Appendix 17 and 18 show specification of antenna system of transmitting station in Pidurutalagala, diagram of horizontal radiation pattern and diagram of vertical radiation pattern.

10) Gongala

Gongala is located in the mountains in the south. The coverage area of the transmitting station at Gongala is the south and southwest. In order to reduce interference with Elpitiya Transmitting Station to be constructed, a directional antenna will be composed with installation of two faces, each with four stages, and one face with two stages. A study on the existing tower revealed that it did not have space to install a transmitting antenna. Therefore, the antenna will be installed at the top of a new 70m-high tower. Meanwhile the radar of the Meteorological Agency is in the proximity, the lot for the new tower should be acquired in coordination with the relevant organisation.
Until the ASO of neighbouring stations is completed, the directional pattern will be narrowed in order to prevent interference with the peripheral analogue stations. When ASO of the peripheral station is completed, all channels for DTTB will be changed for expansion of service area and directional pattern

will be broadened in order to propagate radio waves for satisfying the initial goal of service area. Combiner will be replaced in order to deal with total 8 waves due to channel repacking.
Appendix 19 and 20 show specification of antenna system of transmitting station in Gongala, diagram of horizontal radiation pattern and diagram of vertical radiation pattern.

11) Suriyakanda

Suriyakanda is located in the mountains in the south. As the transmitting station at the site will have the coverage area to the north and northwest, a directional antenna will be composed with installation of two faces each with four stages. In the beginning, installation of an antenna on the sides of the existing 75m-high tower of ITN was considered. However, because of the need for reinforcement for the insufficient structural strength of the tower and the difficulty in reinforcement because of the existence of the stays installed to prevent wind from causing vibration of the tower, though it is a self-standing four-legged tower, it has been decided to construct a new tower in the vicinity.
An area of flat land approx. 100m east of the tower of SLRC was selected as the candidate new tower construction site. The coverage area of the station will be in the north from the northwest to the northeast, the existing tower will not be an obstacle.
Until the ASO of neighbouring stations is completed, the directional pattern will be narrowed in order to prevent interference with the peripheral analogue stations. When ASO of the peripheral station is completed, all channels for DTTB will be changed for expansion of service area and directional pattern will be broadened in order to propagate radio waves for satisfying the initial goal of service area. Combiner will be replaced in order to deal with total 8 waves due to channel repacking.
Appendix 21 and 22 show specification of antenna system of transmitting station in Suriyakanda, diagram of horizontal radiation pattern and diagram of vertical radiation pattern.

12) Elpitiya

Since the coverage area of Elpitiya Transmitting Station is the southwest, antenna constitution and directionality will be; four-stage antenna array to north and south with maximum transmission power, two-stage antenna array to east mountain area, three-stage antenna array to west coastal area. There exists an 80m SLT tower in the vicinity and its top part is available.
As a large proportion of the coverage area of Elpitiya Transmitting Station is in the mountains, installation of gap-fillers for the increase in the population coverage in the coverage area should be considered in a separate project in future.
Until the ASO of neighbouring stations is completed, the directional pattern will be narrowed in order to prevent interference with the peripheral analogue stations. When ASO of the peripheral station is completed, all channels for DTTB will be changed for expansion of service area and directional pattern will be broadened in order to propagate radio waves for satisfying the initial goal of service area. Combiner will be replaced in order to deal with total 8 waves due to channel repacking.
Appendix 23 and 24 show specification of antenna system of transmitting station in Elpitiya, diagram of horizontal radiation pattern and diagram of vertical radiation pattern.

13) Colombo

An antenna configuration required to create a coverage area including the central part of the Greater Colombo will be used. The antenna system is to have directionality with main lobes in the directions of north, east and south and weaker signal in the direction of west, where the sea is, by having fewer faces on this direction. In order not to generate areas with weak field strength in the coverage area, null-fill in the vertical plane will be carried out. A 40kW antenna system of eight-stage three-face and four-stage one-face configuration will be used so that it will be possible to use the system in future when 5kW signals will be transmitted on eight channels simultaneously.

The antenna will be installed on a steel-pipe column for mounting antennas on the upper part of the 350m-high Lotus Tower, which is under construction. The dual feeding system will be used in the antenna system for redundancy. The Lotus Tower Project changed the design of the tower so that the transmitting antenna being designed by JICA Survey Team can be mounted on it after several technical consultations between the two parties. However, JICA Survey Team adopted the 4 dipole antenna system for the period of design changes takes too much to change the length for mounting gain tower of the 4 stacked Loop antenna system conclusion.

Until channel repacking of neighbouring digital broadcasting stations is completed, the directional pattern will be narrowed in order to prevent interference with those digital stations. In addition, directional pattern will be broadened in order to propagate radio waves for satisfying the initial goal of service area.

Filter part will have to combine total 5 waves due to channel repacking. Although it will cost a little, it will not lead to such a large cost increase.

Appendix 25 and 26 show specification of antenna system of Colombo Transmitting Station, diagram of horizontal radiation pattern and diagram of vertical radiation pattern.

14) Hantana

At the transmitting station in Hantana, a ring antenna will be installed as a gap filler station to cover south western part of Kandy. The antenna will be installed at 60m high on existing 70m antenna tower of SLT and will cover northern, western and eastern area of Hantana which cannot be covered from station in Hunnasgiriya.

Ring antenna does not affect antenna tower so much because of its light weight and low wind load. Depression angle will be bigger by the antenna consisting of four-stage. The constitution is four-stage and depression angle is large in order to reduce interference toward long distance. The constitution will be four-stage and depression angle will be large in order to reduce interference toward long distance area.

Filter part will have to combine total 5 waves due to channel repacking. Although it will cost a little, it will not lead to such a large cost increase.

Appendix 27 and 28 show specification of antenna system of transmitting station in Hantana, diagram of horizontal radiation pattern and diagram of vertical radiation pattern.

15) Kurunegala

At the transmitting station in Kurunegala, 4 dipole antenna will be installed on 2 sides on SLT tower located on Athugala rock in the centre of Kurunegala city area as a gap filler station to cover Kurunegala, which cannot be covered from the station in Karagahatenna. The antenna will be installed at 10m high of leg part on south western side of 42m tower and will cover northern, western and southern area.
Depression angle will be bigger by 4 dipole antenna consisting of one-stage two-face.
Filter part will have to combine total 6 waves due to channel repacking. Although it will cost a little, it will not lead to such a large cost increase.
Appendix 29 and 30 show specification of antenna system of transmitting station in Kurunegala, diagram of horizontal radiation pattern and diagram of vertical radiation pattern.

16) Badulla

At the transmitting station in Badulla, a ring antenna will be installed as a gap filler station to cover Badulla city area. The antenna will be installed at 18m high of existing 30m antenna tower of Etisalat and will cover northern, and eastern area of the station in Badulla.
Ring antenna does not affect antenna tower so much because of its light weight and low wind load. Depression angle will be bigger by the antenna consisting of two-stage two-face.
Filter part will have to combine total 5 waves due to channel repacking. Although it will cost a little, it will not lead to such a large cost increase.
Appendix 31 and 32 show specification of antenna system of transmitting station in Badulla, diagram of horizontal radiation pattern and diagram of vertical radiation pattern.

(8) Provisional antenna parameter until channel repacking

It will be necessary to implement channel repacking, which will move channels used from just after the start of DTTB into the ones vacant after ASO, in order to compensate for lack of frequency bandwidths, as stated in 4.2.3 (3). A digital wave will easily interfere with analogue waves or other digital waves until completion of channel repacking. Therefore, transmitter power should be reduced than that of its regular operation or range of digital wave propagation should be narrow by adjusting antenna pattern. That kind of measures will also be available after channel repacking and will not waste equipment procured in DTTB platform.
The following shows provisional antenna parameters until channel repacking. There are 6 transmitting stations which will be operated using provisional antenna patterns. Measures shown below will temporarily reduce coverage area by reducing propagation range of digital waves, however the coverage rates will become broader to its designated values by adjusting radiation pattern of the antennas soon after ASO.

1) Colombo

During DSO, field strength will be reduced by setting southward (259 degrees from the true north) antenna tilt at 3 degrees in order to avoid interference with Elpitiya. The angle is supposed to be changed to 0.5 degrees after ASO in order to cover areas at far distances.

Appendix 33 and 34 show provisional specification of antenna system of Colombo Transmitting Station, diagram of horizontal radiation pattern and diagram of vertical radiation pattern.

2) Yatiyantota

Southward waves from Yatiyantota (190 degrees from the true north) will produce interference with Elpitiya area, therefore its broadcasting area is supposed to be set only in a north western direction (340 degrees from the true North) using SFN with Colombo area. Soon after ASO, southern area will be covered by changing channels and adjusting antenna direction to include southern area. In the beginning, transmitter power is supposed to be set at 1kW, thereafter 2kW after ASO.

Appendix 35 and 36 show provisional specification of antenna system of transmitting station in Yatiyantota, diagram of horizontal radiation pattern and diagram of vertical radiation pattern.

3) Karagahatenna

Digital wave toward north western (300 degrees from the true north) from Karagahatenna will overlap the northern area of Yatiyantota. In order to avoid the overlap, antenna direction is supposed to be turned northward a little (320 degrees from the true north), which will lead to enhance efficiency of coverage area. In addition, antenna pattern will be changed for avoiding interference with analogue broadcasting waves from Nayabedda. Soon after ASO, service area will be expanded by changing channels and adjusting antenna direction.

Appendix 37 and 38 show provisional specification of antenna system of transmitting station in Karagahatenna, diagram of horizontal radiation pattern and diagram of vertical radiation pattern.

4) Elpitiya

Northern area of broadcasting from Elpitiya will cause interference with Colombo, therefore field strength to far distance should be reduced by setting northward (340 degrees from the true north) tilt angle at 2.5 degrees. After ASO, the angle will be set at 1 degree to increase field strength in order to expand service area.

Appendix 39 and 40 show provisional specification of antenna system of transmitting station in Elpitiya, diagram of horizontal radiation pattern and diagram of vertical radiation pattern.

5) Suriyakanda

North eastern area (50 degrees from the true north) of broadcasting from Suriyakanda will cause interference with Nayabedda, therefore radio waves must not propagate in that direction. In addition, radio waves toward north western area (320 degrees from the true north) will interfere with areas of Colombo and Yatiyantota, therefore tilt angle of antenna should be set at 4 degrees in order to reduce interference. Soon after ASO, channels should be changed, tilt angle be set at 1.5 degrees and transmission toward north eastern area be started, in order to ensure service area. In the beginning, transmitter power is supposed to be set at 250W, thereafter 1kW after ASO.

Appendix 41 and 42 show provisional specification of antenna system of transmitting station in Suriyakanda, diagram of horizontal radiation pattern and diagram of vertical radiation pattern.

6) Gongala

Eastern area (40 and 130 degrees from the true north) of broadcasting from Gongala will cause interference with Nayabedda, and western area (220 degrees from the true north) will cause interference with Elpitiya. Therefore, belt-shaped part of south western area should be covered by parabolic antenna (or equivalent with directional antenna), not by 4 stacked Loop antenna. The parabolic antenna will be installed on the side of the tower. Soon after ASO, channels will be changed and the parabolic antenna is supposed to be replaced by 4 stacked Loop antenna consisting of 3 planes in order to expand the service area. In the beginning, transmitter power is supposed to be set at 250W, thereafter 1kW after ASO.
Appendix 43 and 44 show provisional specification of antenna system of transmitting station in Gongala, diagram of horizontal radiation pattern and diagram of vertical radiation pattern.

7) Hunnasgiriya

Western area from Hunnasgiriya (245 degrees from the true north) will cause interference with Yatiyantota, and northern area (335 degrees from the true north) will cause interference with Vavuniya, therefore field strength should be reduced by setting tilt angle at 8 degrees. Soon after ASO, channels should be changed, tilt angle of western direction be set at 4.5 degrees and tilt angle of northern direction be set at 3.5, in order to ensure service area.
Appendix 44 and 45 show provisional specification of antenna system of transmitting station in Hunnasgiriya, diagram of horizontal radiation pattern and diagram of vertical radiation pattern.

(9) Remaining work items at transmitting stations

Table 4.2-18 summarizes issues at each transmitting station which are considered to be used for DTTB in future, based on the result above and the Previous Survey. It is hoped that these issues will be resolved before starting detailed design by consultant who will be employed in Yen Loan Project.

Table 4.2-18 Remaining work items at transmitting stations

No.	Site of transmitting station	Owner of existing facility	Antenna tower	Construction of antenna tower	Construction of station building	Renting of room for transmission facility	Ensuring space for generator	Land expropriation	Issue
1	Jaffna	SLT	Rent existing tower	No need	Necessary	No need	No need	No need	Confirmation of renting antenna tower of SLT and obtaining drawings of its top part for consideration of antenna installation. Measurement of candidate sites for construction of station building and selection of the site.
2	Kokavil	TRC	Rent existing tower	No need	Necessary for renovation	No need	Necessary	No need	Confirmation of renting antenna tower of TRC, confirmation of using existing transmission antenna and obtaining drawings of the tower and the inside part of building for consideration of antenna installation.
3	Vayuniya	TRC	Rent existing tower	No need	No need	Necessary	No need	No need	Confirmation of renting antenna tower of TRC and obtaining drawings of its top part and inside part of building for consideration of antenna installation.
4	Trincomalee	-	Newly construct	Necessary	Necessary	No need	No need	Necessary	Measurement of candidate sites for construction of antenna tower and station building and selection of the site. Lease agreement with the site owner.

No.	Site of transmitting station	Owner of existing facility	Antenna tower	Construction of antenna tower	Construction of station building	Renting of room for transmission facility	Ensuring space for generator	Land expropriation	Issue
5	Karagahatenna	-	Rent existing tower	Necessary for renovation	Necessary	No need	No need	No need	Strength calculation of ITN antenna tower. Measurement of candidate sites for construction of station building and selection of the site.
6	Kurunegala	SLT	Rent existing tower	No need	Necessary	No need	Necessary	No need	Confirmation of renting antenna tower of SLT. Obtaining drawings of the tower and the site for consideration of antenna installation.
7	Colombo	-	Newly construct	Necessary to be examined in Lotus Tower Project					Confirmation of completion of requested items through inspection by JICA Survey Team (details are shown in Chapter 5)
8	Yatiyantota	ITN	Newly construct	Necessary	Necessary	No need	No need	No need	Measurement of candidate sites for construction of antenna tower and station building and selection of the site
9	Hunnasgiriya	ITN	Rent existing tower	No need	Necessary	No need	No need	No need	Obtaining drawings of top part of ITN tower for consideration of antenna installation. Selection of location for construction of station building in the site.

No.	Site of transmitting station	Owner of existing facility	Antenna tower	Construction of antenna tower	Construction of station building	Renting of room for transmission facility	Ensuring space for generator	Land expropriation	Issue
10	Pidurutalagala	SLRC	Newly construct	Necessary	Necessary	No need	No need	No need	Measurement of candidate sites for construction of antenna tower and station building and selection of the site
11	Hantana	SLT (tower), SLRC (building)	Rent existing tower	No need	No need	Necessary (SLRC)	Necessary	No need	Confirmation of renting antenna tower of SLT and site for station building. Obtaining drawings of the tower, the site and inside part of the SLRC station building for consideration of antenna installation.
12	Badulla	Etisalat	Rent existing tower	No need	Necessary	No need	Necessary	No need	Confirmation of renting antenna tower of Etisalat. Obtaining drawings of the tower and the site for consideration of antenna installation.
13	Nayabedda	-	Newly construct	Necessary	Necessary	No need	No need	Necessary	Measurement of candidate sites for construction of antenna tower and station building and selection of the site
14	Gongala	-	Newly construct	Necessary	Necessary	No need	No need	Necessary	Measurement of candidate sites for construction of antenna tower and station building and selection of the site

No.	Site of transmitting station	Owner of existing facility	Antenna tower	Construction of antenna tower	Construction of station building	Renting of room for transmission facility	Ensuring space for generator	Land expropriation	Issue
15	Suriyakanda	-	Newly construct	Necessary	Necessary	No need	No need	Necessary	Measurement of candidate sites for construction of antenna tower and station building and selection of the site
16	Elpitiya	SLT	Rent existing tower	No need	No need	Necessary	Necessary	No need	Confirmation of renting antenna tower of SLT and obtaining drawings of top part of the tower, the site and inside part of the building for consideration of antenna installation.

Source: JICA Survey Team

4.2.6 ASO planning

It is supposed that ASO will have a bigger influence on viewers than starting DTTB. In case viewers have not purchased the DTTB receiver, they will not be able to see the TV broadcasting programmes which are available until the time of ASO. There will happen the case that viewers cannot watch programmes due to weak DTTB waves even though they have receivers.

ASO has to be carried out carefully due to its crucial social influence. It is essential to decide conditions for implementation of ASO and formulate regulations that ASO will not be done unless those conditions are accomplished. Initiatives by both public and private sector to meet conditions for implementation of ASO are required. It will be necessary to judge postpone ASO in case those conditions are not be accomplished.

The following shows the conditions for implementation of ASO, its procedure and rehearsal.

(1) Revision of conditions for implementing ASO

In the Previous Survey, DTTB receiver household penetration ratio and population coverage ratio were set as conditions for implementation of ASO, in order to reduce social impact of terrestrial broadcasting not being unavailable. These two index values are adopted in Japan and many countries where migration into DTTB is proceeded and can be regarded valid considering basis for judgement to minimize impact to viewers.

Meanwhile, individual factors that will make DTTB unavailable include individual phenomena such as radio interference and building shadows, and countermeasures to deal with those factors will be necessary to be considered. Countermeasures for individual cases often become complex and compounded and similar troubles are derived from individual cases. Considering those concerns, it will be required to pay attention to the state of migration into DTTB and flexibly deal with it. Therefore, individual cases should be excluded from conditions for ASO implementation and it will be significant to consider not to slow down the progress of overall ASO processes.

JICA Survey Team virtually divided Sri Lanka into 3 areas from the perspective of implementing ASO, in consideration with current TV household penetration ratio, poverty rate and rate of dissemination of electric appliances. Each area follows the results of the Previous Survey which defined conditions for ASO implementation. On the other hand, values of population coverage ratio as of starting DTTB were changed due to change of channel plan. Along this revision, conditions for implementation of ASO are set as shown in Table 4.2-19.

The period until implementation of ASO is estimated to be 5 years from DSO-SD by Colombo Transmitting Station and 3 or 4 years from DSO-SD by other transmitting stations, by making use of various examples of ASO in Japan and other countries.

In the table below, values of proportion of households with DTTB receivers show the result of calculation for coverage population and coverage ratio in each area. These were obtained from overlapping cover area map through radio wave simulation of This Survey and population distribution map based on census of Sri Lanka.

Table 4.2-19 Conditions for implementation of ASO (comparison with Previous Survey)

No	Area	This Survey		Previous Survey	
		Proportion of households with DTTB receivers	Population coverage ratio	Proportion of households with DTTB receivers	Population coverage ratio
1	Greater Colombo	60%	***80%***	60%	85%
2	Northern area and eastern area	40%	70%	40%	70%
3	Kurunegala, Matale, Polonnaruwa, Ampara, Anuradhapura, Puttalam	***50%***	***70%***	-	-
4	Others	50%	***55%***	50%	70%

Legend: Changed points from Previous Survey are shown underlined, in italics and bold.
Source: JICA Survey Team

Reason for decrease of index values compared with that of Previous Survey is that service areas are set narrower for countermeasure of analogue broadcasting in the following areas; Greater Colombo (Colombo and Yatiyantota), southern area (Suriyakanda, Gongala, Elpitiya), Hunnasgiriya and in central mountain area (Pidurutalagala and Hantana). Greater Colombo, southern area and Hunnasgiriya are related to population coverage ratio of No. 1 in the table and central mountain area is related to No. 4.
At transmitting stations in Colombo and Yatiyantota, directionality of transmission antenna is supposed to be changed to its designated specification along with implementation of ASO and channel repacking. It will result in recovery of population coverage ratio in Greater Colombo to 85%, equivalent with its designated index value set in Previous Survey. In Suriyakanda, Gongala, Elpitiya and Hunnasgiriya as well, directionality of transmission antenna will be changed to recover the population coverage ratio to 70% in corresponding areas.
Impact on viewers that terrestrial TV waves cannot be received will be reduced by implementing channel repacking soon after ASO.

(2) Procedure of ASO implementation

It will be necessary to implement following channel repacking as soon as possible after implementing ASO as stated above (1).
Necessary work items of ASO are increase of transmission power at specific transmitting stations, change of antenna pattern and channel repacking.
As of the stage of DSO-SD, digital transmitters will be operated with less power than usual and antenna patterns will be adjusted to situations at that time, in order to avoid interference between radio waves of digital and analogue broadcasting and interference between radio waves among two or more digital broadcasts. Therefore, increase of transmitting power from transmitters and adjustment of antenna pattern will be necessary.

During this DSO-SD, frequency bandwidth which will be used for mobile phone business in future will be temporarily allocated to digital broadcasting to compensate for lack of frequency resource. It will be necessary to transfer the frequency bandwidth to the ranges prepared for digital broadcasting by executing channel repacking, which will lead to create vacant frequency bandwidth for mobile phone business in future.

Figure 4.2-5 shows the procedures of ASO. Blue circles indicate digital TV transmitting stations which will be installed during Yen Loan Project, red circles with solid line indicate analogue TV transmitting stations and red circles with wavy line indicate analogue TV transmitting stations where digital broadcasting stations will not be installed. Letters in each circle show abbreviation of each transmitting station and letters under each circle show necessary work items. There are some arrows connecting the circles. Each arrow indicates that work items at its end edge can be executed after those at its start edge are completed. In current plan, it is assumed that 5 stages are necessary to complete work items of ASO in the whole country.

In the 1st stage, ASO will be implemented at transmitting station in Pidurutalagala, followed by channel repacking in Pidurutalagala and Hantana. After that, channel repacking in Jaffna, Kokavil, Vavuniya and ASO in Hantana and Nuwara Eliya will be done.

In the 2nd stage, channel repacking and modification of radiation pattern of transmitting antenna will be implemented in Gongala, Suriyakanda and Elpitiya. After channel repacking in Gongala, ASO will be implemented in Gongala and Deniyaya. After channel repacking in Suriyakanda and Elpitiya, ASO will be done in Colombo, Suriyakanda and Ratnapura. ASO can be implemented also in Yatiyantota during this stage because radio wave of DTTB in Yatiyantota will not interfere with that of analogue TV broadcasting currently provided in VHF bandwidth. If provision of analogue broadcasting to viewers continues long, DTTB dissemination will be late. Therefore it is recommended to implement ASO in this stage in consideration with schedule of ASO and channel repacking at other transmitting stations.

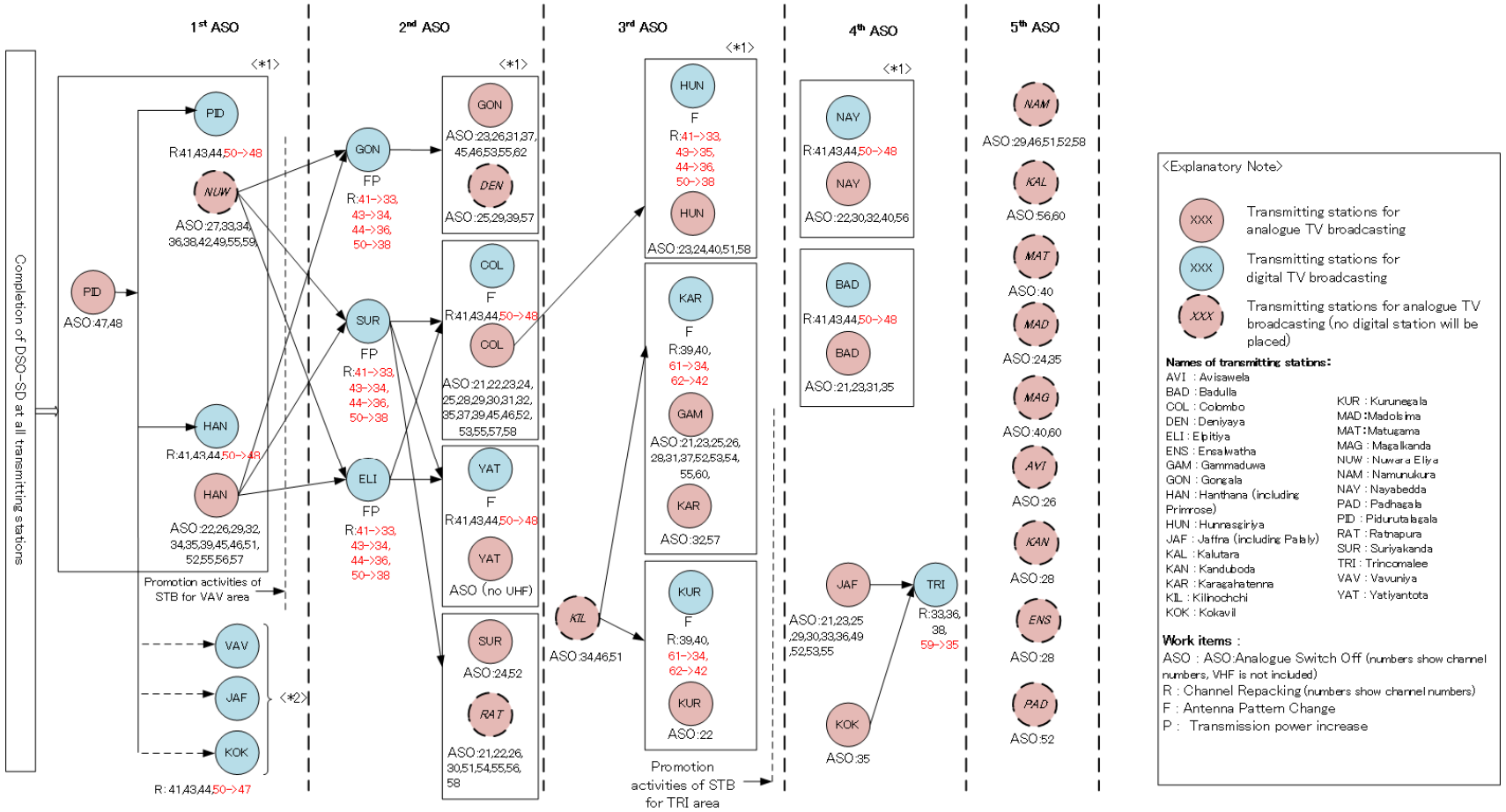
In the 3rd stage, ASO will be implemented in Kilinochchi, followed by channel repacking in Hunnasgiriya, Karagahatenna and Kurunegala. After that, ASO will be done in Hunnasgiriya, Gammaduwa, Karagahatenna and Kurunegala.

In the 4th stage, channel repacking and ASO will be implemented in Nayabedda and Badulla. In addition, ASO will be done in Jaffna and Kokavil, followed by channel repacking in Trincomalee.

In the last 5th stage, ASO will be implemented in remaining transmitting stations.

During the period of ASO, it will be necessary to implement channel repacking many times. On the other hand, it is expected that designated population coverage ratio can be ensured by promptly completing 5 stages mentioned above.

Figure 4.2-5 shows the detail of procedures for ASO implementation.



*1 : Work items at transmitting stations in same rectangle will be implemented at the same time
*2 : In 3 transmitting stations in northern area, 50 CH will be used before implementation of ASO in accordance with request of CSN.
*3 : ASO of master station and sub station will be implemented at the same time or master station will continuously keep transmitting analogue broadcasting until ASO of its sub station

Source: JICA Survey Team

Figure 4.2-5 Procedure of ASO implementation

(3) Implementation of rehearsal for ASO

Executing rehearsal of ASO by selecting one or more cities as pilot areas will be an effective method for preparation of smooth implementation of real ASO as well as verification of complex procedures of channel repacking. Even if certain failure occurs during rehearsal, the influence will be limited.

There are merits for organisations and viewers to make it easy to consider additional measures for real ASO while limiting its confusion. For example, clarification of ASO procedures and confirmation about situation of radio wave propagation and situation of receiver penetration will be possible during the rehearsal. It will also be information for making decisions to deal with issues such as contents of inquiry and response at call centres, number of operators, capacity of equipment of phone response and lack of promotion in advance.

The following shows conditions for selecting pilot areas of ASO rehearsal.

- Pilot areas should be the cities where interference among test digital broadcasting radio waves and analogue radio waves can be limited to minimum and the standard cities which are not peculiar compared with other cities.
- Rehearsal should be executed on the assumption that transmitters and other equipment have been installed and the penetration rate of receivers has reached its goal.
- Jaffna is recommended as candidate site for rehearsal considering geographic factor because it is located at the northern end of the country and the influence on the surroundings is limited. Badulla is also the site where influence is limited, but not recommended as much as Jaffna because of its low coverage area.

It will be necessary for the Government of Sri Lanka to consider the conditions for ASO rehearsal execution, select cities as pilot areas and finalise ASO plan.

4.2.7 Multiplexing for HD broadcasting programme

The frequency bandwidth for television broadcasting is used in analogue broadcasting in Sri Lanka, and there are almost no vacant channels. Although clear policy for multiplexing has not been shown yet from Sri Lanka, JICA Survey Team examined channel plan and technical matters on the premise that 6 SD programmes are multiplexed in 1 channel, considering image quality. In HD broadcasting, it is supposed that 3 programmes will be multiplexed in 1 channel and total number of channels should be increased to twice.

Parameters for transmission should be set before deciding the number of multiplexing programmes. It will be necessary to decide parameters for fixed reception (full-segment) and mobile reception (one-segment) in ISDB-T. In Previous Survey, high image quality broadcasting, endurance against interference as of SFN and error correction for reflected waves due to multipath propagation were examined to set parameters as shown in Table 4.2-20.

Table 4.2-20 Basic parameter for transmission

Form of reception	Item	Parameter
Fixed reception (Layer B)	Number of assigned segments	12
	Modulation	64QAM
	Convoluted coding rate	3/4
	Guard intervals	1/8
Mobile reception (Layer A)	Number of assigned segments	1
	Modulation	QPSK
	Convoluted coding rate	2/3
	Guard intervals	1/8

Source: JICA Survey Team

Data capacity that can be multiplexed per channel will be 22.90 Mbps. Data size of each service (HD broadcasting, SD broadcasting, Data casting and one-segment) will be decided using these parameters. JICA Survey Team examined data size considering smooth migration from SD to HD, making response speed of data casting not slow, providing requisite minimum image quality. Table 4.2-21 shows data size per 1 programme for each programme type. Based on this result, 6 SD programmes will be multiplexed in 1 channel, and 6 HD programmes in 1 channel.

Table 4.2-21 Data size per 1 programme (for each programme type)

Unit: Mbps/programme

Programme type	SD broadcasting	HD broadcasting
HD broadcasting		6.70 (×3 programmes)= 20.1
SD broadcasting	3.35 (×6 programmes)= 20.1	
Data casting	1.50 (×1 programme)	1.50 (×1 programme)
one-segment	0.45 (×1 programme)	0.45 (×1 programme)
Other control signal (PSI/SIEIT)	0.85	0.85
Total	22.90	22.90

Source: JICA Survey Team

Once DTTB is started in SD and a certain number of DTTB receivers spread to households, ASO will able to be implemented. After ASO, new channels will become vacant and available for digital broadcasting, which lead to realization of HD broadcasting.

4.2.8 Channel assignment for HD broadcasting

(1) Channel assignment for starting HD broadcasting service

It will be necessary to formulate channel assignment plan after DSO-HD on the premise that all broadcasters will carry out HD broadcasting. In some areas, especially around Colombo where most frequency bandwidths will be occupied, HD broadcasting cannot be provided during the period of simultaneous broadcasting. After ASO, enough bandwidth will be ensured available for all broadcasters to provide HD broadcasting. In channel plan for HD broadcasting, availability of frequency must be

considered including number of multiplexing programmes in 1 channel, digital dividend (*) for other businesses such as mobile phone. In addition, design for equipment procurement must considerate specifications for HD broadcasting. Especially, transmission antennas should be available for HD broadcasting as of procurement because those will be single point of transmitting radio waves.
(*) Utilizing frequency bandwidths used for analogue broadcasting to other services, after some of bandwidths become vacant through migration into DTTB.
Policy of channel assignment for HD broadcasting is shown as below.

i. The maximum number of multiplexed HD programmes per channel is 3.
ii. Channels for HD broadcasting are CH 21 to 48, based on APT agreement.
iii. Channels assigned at each transmitting station should be as adjacent as possible so that the frequency bandwidths of combiner of each station will not spread.
iv. Channel assignment for HD broadcasting will be implemented in two stages, in consideration with migration from SD service to HD service in stages, additional procurement of transmitters in DBNO to deal with 8 waves for HD broadcasting, and upgrade to HD earlier. (In case enough funds are affordable, channel assignment can be implemented at once.)
v. Making sure that empty channels are put together in same area and neighbouring areas as much as possible, considering the possibility of installation of gap filler[4] in future and utilizing frequency bandwidth for other services.

Channel assignment for HD broadcasting to DTTB platform operated by DBNO is shown in Table 4.2-22, based on the policy above. As stated in 4.2.7, the number of programmes multiplexed in one channel is 3, maximum 24 HD programmes will be available in accordance with the table below.

Table 4.2-22 Channel assignment for HD broadcasting

No	Site of transmitting station	Channel for HD broadcasting		Transmission power (W)	SFN
		First stage: from SD to HD during DSO-HD	Second stage: added as of DSO-HD		
1	Jaffna	41, 43, 44, 47	31, 32, 37, 45	500	1
2	Kokavil	41, 43, 44, 47	31, 32, 37, 45	3000	1
3	Vayuniya	41, 43, 44, 47	31, 32, 37, 45	1000	1
4	Trincomalee	33, 35, 36, 38	27, 28, 46, 48	1000	-
5	Karagahatenna	34, 40, 39, 42	23, 26, 29, 30	3000	6
6	Kurunegala	34, 40, 39, 42	23, 26, 29, 30	10	6
7	Colombo	41, 43, 44, 48	32, 37, 45, 46	5000	4

[4] Transmitter for covering gaps between broadcasting area where radio waves do not reach.

No	Site of transmitting station	Channel for HD broadcasting		Transmission power (W)	SFN
		First stage: from SD to HD during DSO-HD	Second stage: added as of DSO-HD		
8	Yatiyantota	41, 43, 44, 48	32, 37, 45, 46	2000	4
9	Hunnasgiriya	33, 35, 36, 38	24, 25, 27, 28	1000	-
10	Pidurutalagala	41, 43, 44, 48	32, 37, 45, 46	50	2
11	Hantana	41, 43, 44, 48	32, 37, 45, 46	10	2
12	Badulla	41, 43, 44, 48	32, 37, 45, 46	10	5
13	Nayabedda	41, 43, 44, 48	32, 37, 45, 46	3000	5
14	Gongala	33, 34, 36, 38	39, 40, 42, 47	1000	3
15	Suriyakanda	33, 34, 36, 38	39, 40, 42, 47	1000	3
16	Elpitiya	33, 34, 36, 38	39, 40, 42, 47	300	3

Source: JICA Survey Team

Based on Table 4.2-22, overall channel assignment from CH 21 to 62 is shown in Table 4.2-23. CH 49 or above will be used for other services after completing channel repacking. Furthermore, there will be just a few transmitting stations assigned CH 30 or below and those channels will be available for gap filler or other services.

Table 4.2-23 Overall channel assignment as of HD broadcasting

Area	No	Site	Channel																																			
			21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	・・・	59	60	61	62
N	1	Jaffna																																					
	2	Kokavil																																					
	3	Vavuniya																																					
NE	4	Trincomalee															After ASO																			Repack CH			
NC	5	Karagahatenna														After ASO								After ASO														Repack CH	Repack CH
	6	Kurunegala														After ASO								After ASO														Repack CH	Repack CH
W	7	Colombo																												After ASO		Repack CH							
	8	Yatiantota																												After ASO		Repack CH							
C	9	Hunnasgiriya													After ASO		After ASO	After ASO		After ASO			Repack CH		Repack CH	Repack CH						Repack CH							
	10	Pidurutalgala																												After ASO		Repack CH							
	11	Hanthana																												After ASO		Repack CH							
E	12	Badulla																												After ASO		Repack CH							
	13	Nayabedda																												After ASO		Repack CH							
S	14	Gongala													After ASO	After ASO		After ASO		After ASO			Repack CH		Repack CH	Repack CH						Repack CH							
	15	Suriyakanda													After ASO	After ASO		After ASO		After ASO			Repack CH		Repack CH	Repack CH						Repack CH							
	16	Elpitiya													After ASO	After ASO		After ASO		After ASO			Repack CH		Repack CH	Repack CH						Repack CH							
Number of sites for each digital channel			0	0	2	1	1	2	2	2	2	2	3	9	5	4	2	5	9	5	5	5	9	5	9	9	9	7	6	7									

<Legend>

Green: Channels which will be migrated from SD service to HD service.

Green and "After ASO": Channel repacking will be done after ASO, thereafter those channels will be migrated to HD service.

Orange and "Repack CH": Channels which will be changed during SD service after ASO.

Yellow: Channels which will not be used during SD. (Including the period of channel repacking)

Black: Channels which will be used newly after starting HD broadcasting.

<Area>

N: North, NE: North East, MN: Middle North, W: West, C: Central, E: East, S: South

Source: JICA Survey Team

4.2.9 Reconsideration on transmission link

The following shows review through This Survey regarding transmission link which is a component of DTTB platform considered in Previous Survey.

(1) Transmission link between each broadcaster and NOC

In Previous Survey, design policy for transmission link of TV programmes between each broadcaster and NOC was reported as below.

- TS signal, which is a transport stream type containing compressed and multiplexed image, sound, data, etc., will be adopted as transmission signal format. TS signals (except broadcast control signal) from each broadcaster will be multiplexed and conveyed from NOC to transmitting stations without reprocessing of programmes.
- IP transmission using optical network owned by telecommunication providers will be adopted as the type of transmission link, because broadcasters' studios are located inside or in the vicinity of Colombo. Transmission rate is prospected to be from 3 to 4 Mbps in case of SD broadcasting.
- Protect-type network route will be adopted as preparatory backup link.

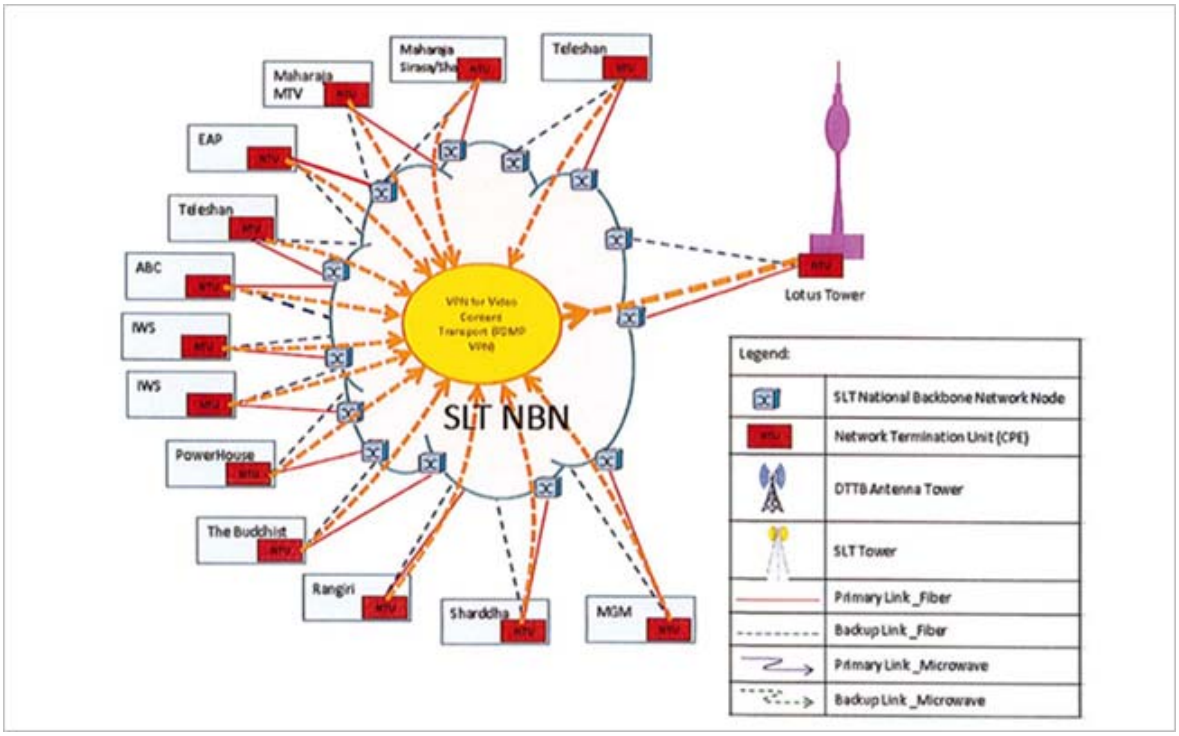
The policy above is basically followed also in This Survey. In addition, configuration of transmission link was reviewed from the perspective of reducing cost of equipment which will be procured by DBNO, suppressing operational expense of DBNO, and current situation on improvement of telecommunication links in Sri Lanka.

Telecommunication links have been improved in recent years in Sri Lanka, transmission rate is becoming faster in Colombo, and nationwide telecommunication network is under deployment. Figure 4.2-6 shows the result of detailed consideration on transmission link system, which was based on Previous Survey and confirmed with telecommunication providers.

National Backbone Network owned by telecommunication providers will be connected with each broadcaster using Primary link and Backup link, as shown in Figure 4.2-6. Connection points of Primary link and Backup link in National Backbone Network are on different nodes, which will enable route backup.

Some broadcasters plan to transmit 2 or more programmes. That will be dealt with by changing contracted bandwidth (shown in bitrate) according to number of programmes.

This survey concludes that transmission signal format, type of transmission link and backup method are not to be changed from the result of Previous Survey.



Source: SLT

Figure 4.2-6 Transmission link for programme transmission between each broadcaster and NOC

(2) Transmission link between NOC and each transmitting station

1) Result of review regarding development of transmission link network and issues in future

Table 4.2-24 shows the result of review regarding development of transmission link network which is originated from the perspective of preparing nationwide DTTB network in Sri Lanka in Previous Survey. Relationship among candidate sites for transmitting stations was also taken into consideration.

Table 4.2-24 Result of review regarding development of transmission link network

No.	Reviewed item	Result of Previous Survey	Result of review of This Survey
1	Type of transmission link	Network system of providers (optical fibre and microwave) + microwave line owned by DBNO + relaying of broadcasting waves	Network system of providers (optical fibre and microwave) + microwave line owned by DBNO
2	Transmission signal format (*1)	STM-1 (Multiplexing 4 TS signals for broadcasting)	IP transmission by TS signal of each broadcasting was also considered in addition to STM-1.
3	Network (*2)	Network consisting of 16 transmitting stations (including gap filler station)	Network consisting of 16 transmitting stations (*2)

(*1) Reference: 4.2.9 (2) 1) (a)

(*2) Reference: 4.2.9 (2) 2)

Policy items which became necessary after the review to be changed or added are described as below.

(a) Result of review regarding transmission signal format and issues in future

In Previous Survey, transmission signal format was suggested as shown in Table 4.2-25. In addition, interface system among NOC of DBNO, each transmitting station, and transmission link network operated by telecommunication providers was suggested as shown in Figure 4.2-7. The network adapter shown in the figure will be installed as equipment of DBNO in order to multiplex 4 broadcasting TS line systems and transmit the signals to transmission link through STM-1 network.

Table 4.2-25 Transmission standards for digital broadcasting signals in the broadcasting transmission network

No	Item	Standard	Remarks
1	Transmission signal	Broadcast TS (BTS) signal	
2	Transmission bit rate	43.34Mbps / 1 BTS signal(Note 1)	Standards for the 8MHz RF bandwidth
3	Standards for the interface used in the distribution network	Multiple BTS signals will be multiplexed and the multiplexed signal will be connected to a high-speed digital link.(Note 2)	
4	Usable communication network	STM-1 (155.2 Mbps)	
5	Standards for signals	DVB-ASI	

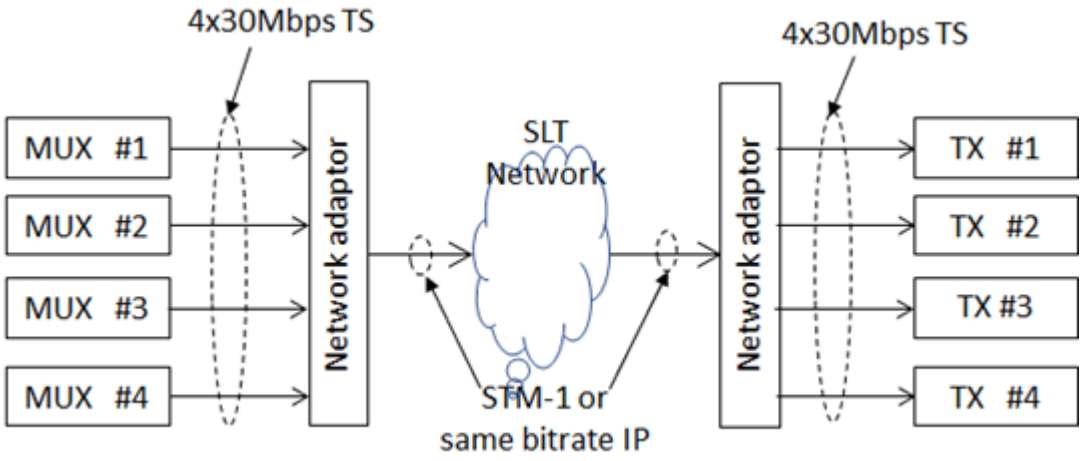
No	Item	Standard	Remarks
6	PSI/SI function	Rewriting of NIT and relevant data(Note 3)	

Source: "Feasibility Study on Digital Terrestrial Television Broadcasting Network Project in Democratic Socialist Republic of Sri Lanka" Final Report

(Note 1) Sample clock of 8MHz bandwidth ISDB-T signal (= 10.836MHz x 4)

(Note 2) BTS signals can be compressed (to approx. 29 Mbps in the 8MHz system) when they are multiplexed and transmitted. Therefore, the use of a compression/decompression system enables a maximum of four BTS signals (corresponding to four RF channels) to be transmitted via an STM-1 link.

(Note 3) As control information on broadcasting physical channels (frequencies) is included in the PSI/SI signal in a BTS signal, the information has to be replaced with information applicable to the broadcasting frequencies of the individual transmitting station.



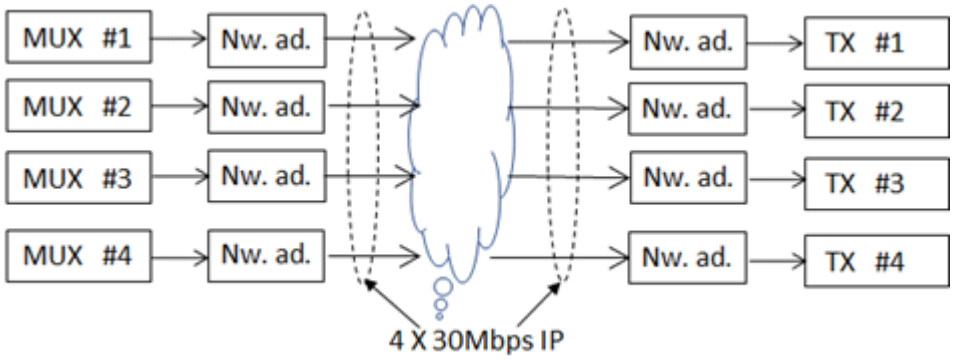
Source: JICA Survey Team

Figure 4.2-7 Interface between DBNO and telecommunication providers

The JICA Survey Team exchanged sufficient opinions with Sri Lankan telecommunication providers about network construction using the IP transmission method, in consideration with practical realization trend of IP transmission technology after Previous Survey. As a result, it was found feasible that interface system can connect with transmission link network using transmitting TS signal (or compressed TS signal) of each broadcasting as shown in Figure 4.2-8. In this case, Layer 2 IP-Multicast[5] and Layer 3 VLL (Virtual Leased Line)[6] are available as interface signal format.

[5] Communication method that transmits the same data all at once to multiple parties according to the IP protocol operated in 2nd layer (data link layer)

[6] Data communication method by virtual leased line operated in 3rd layer (network layer)



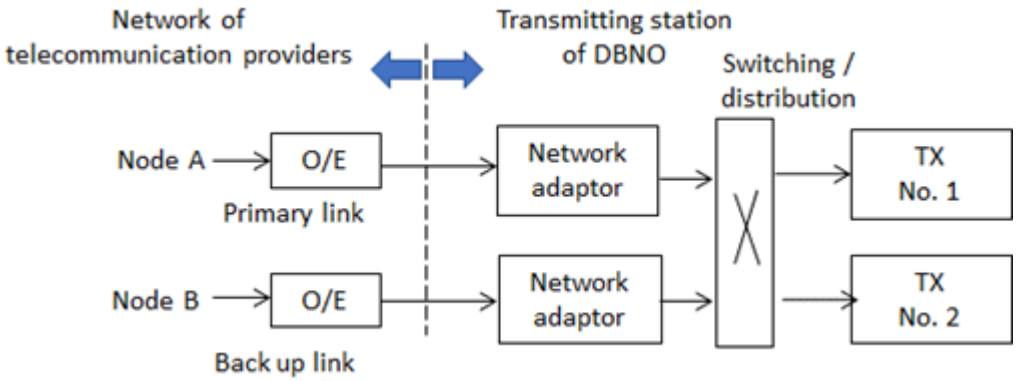
Source: JICA Survey Team

Figure 4.2-8 Interface between DBNO and telecommunication providers (Type in transmitting TS signal of each broadcasting)

It will be necessary to conduct detailed examination including equipment cost and operation cost when it comes to deciding which method should be selected from 3 interface systems (STM-1, Layer 2 IP-Multicast or Layer 3 VLL).

(b) Result of review regarding backup method and issues in future

Regarding the interface with transmission link of telecommunication providers, as indicated in Figure 4.2-9, backup method through bypass route will be available by setting interfaces of Primary link and Backup link on different nodes.



Source: JICA Survey Team

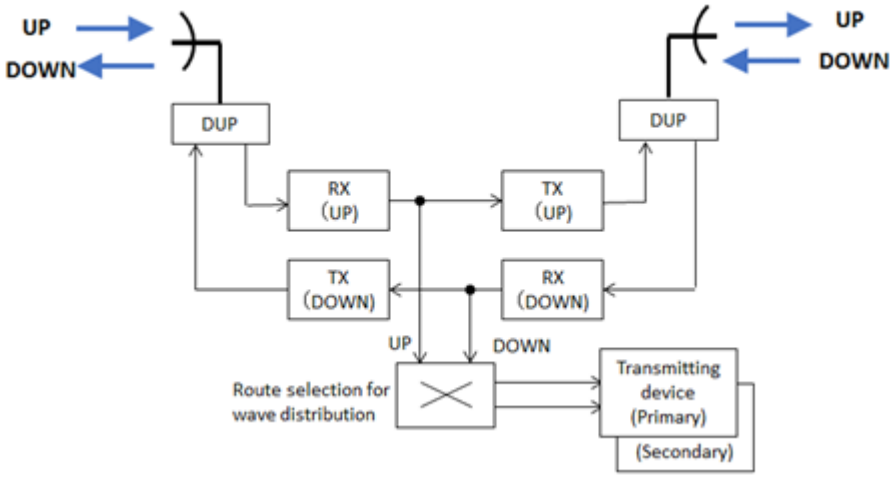
Figure 4.2-9 Interface between transmission link of telecommunication providers and transmitting station of DBNO

Delay time from NOC will be different in Primary line and Backup line because each signal is transmitted from independent nodes, as shown in the figure. Therefore, it is necessary to adjust the delay for the transmitting station constituting SFN, in order for signals to be in time for the specified transmission time in the network adapter which will be installed in transmitting stations of DBNO.

Methods such as time pulse (1 PPS)[7] supplied from a GPS device or the like can be used regarding delay time adjustment.
In addition, delay time fluctuation (jitter), which occurs when IP transmission method is adopted, can be absorbed by using the delay time adjustment function of the network adapter.

(c) Examination on development of backup route for microwave link owned by DBNO

In Previous Survey, microwave link which will be owned by DBNO was prospected to become a radial and star-shaped connection topology. In This Survey, transmission link was designed assuming redundancy of transmitters and receivers. Possibility of adopting methods for backup route for microwave link was also considered in parallel with backup route for communication link of telecommunication providers in This Survey. Figure 4.2-10 shows an example of device configuration for microwave link with backup route.



Source: JICA Survey Team

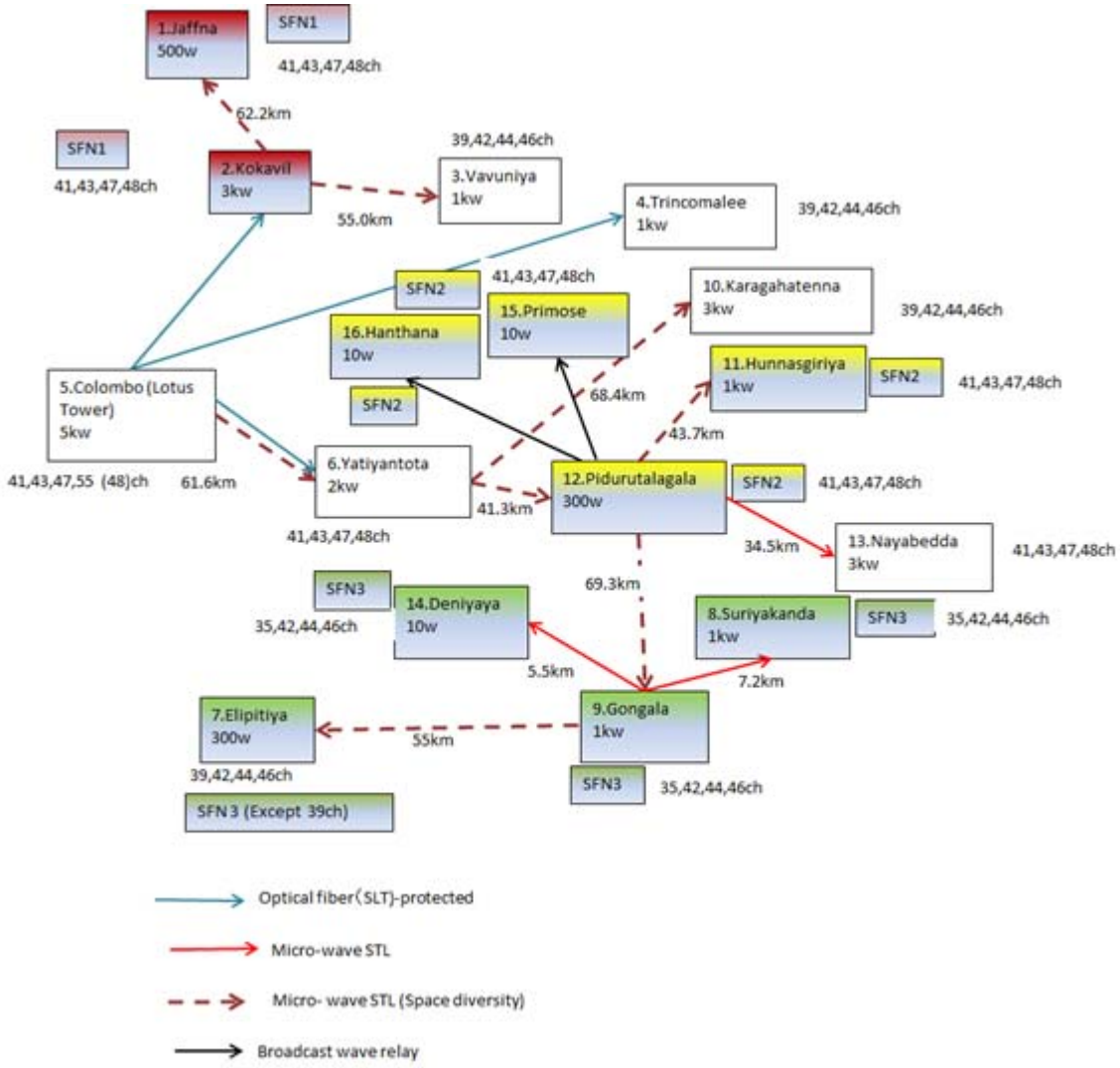
Figure 4.2-10 Example of device configuration for microwave link with backup route

As indicated in the figure above, transmitters obtain signals from each uplink and downlink and select them at the transmission device input. Therefore, it is possible to avoid trouble by acquiring signals from another route in case line disconnection occurs. Meanwhile, when route backup is operated, the number of lines is increased as compared with the star-shaped connection because it is necessary to make the microwave link network looping. Consequently, it will be necessary to trade-off between costs of facility and reliability of lines, followed by decision of the form of microwave link network owned by DBNO.
The equipment configuration of transmitter and receiver for microwave is the same as that of the case adopting active-standby system (2 transmitting systems and 2 receiving systems). The factor of cost increase comes from the increase of number of lines and complication of control unit for route selection.

[7] 1 Pulse Per Second (A signal that generates one pulse per second. A type of time calibration signal.)

2) Result of review regarding development of detailed transmission link and issues in future

In Previous Survey, it was suggested to constitute transmission link of DBNO using STM-1 transmission system through National Backbone Network owned by telecommunication providers and microwave link network of DBNO. The following shows outline of configuration of transmission link suggested in Previous Survey.



Source: "Feasibility Study on Digital Terrestrial Television Broadcasting Network Project in Democratic Socialist Republic of Sri Lanka" Final Report

Figure 4.2-11 Configuration of transmission link as of Previous Survey

In This Survey, the following points were reviewed in terms of developing transmission link network.

- Review regarding link parts which will be developed by telecommunication providers
- Review regarding transmission link network along with revising channel plan

Details of the points and issues in future are indicated below.

(a) Review regarding link parts which will be developed by telecommunication providers

In Previous Survey, transmission network to transmitting stations especially in the distant northern area and the north eastern area was examined, assuming usage of use of SLT's nationwide network (shown in the parts indicated as Optical fibre in Figure 4.2-11).

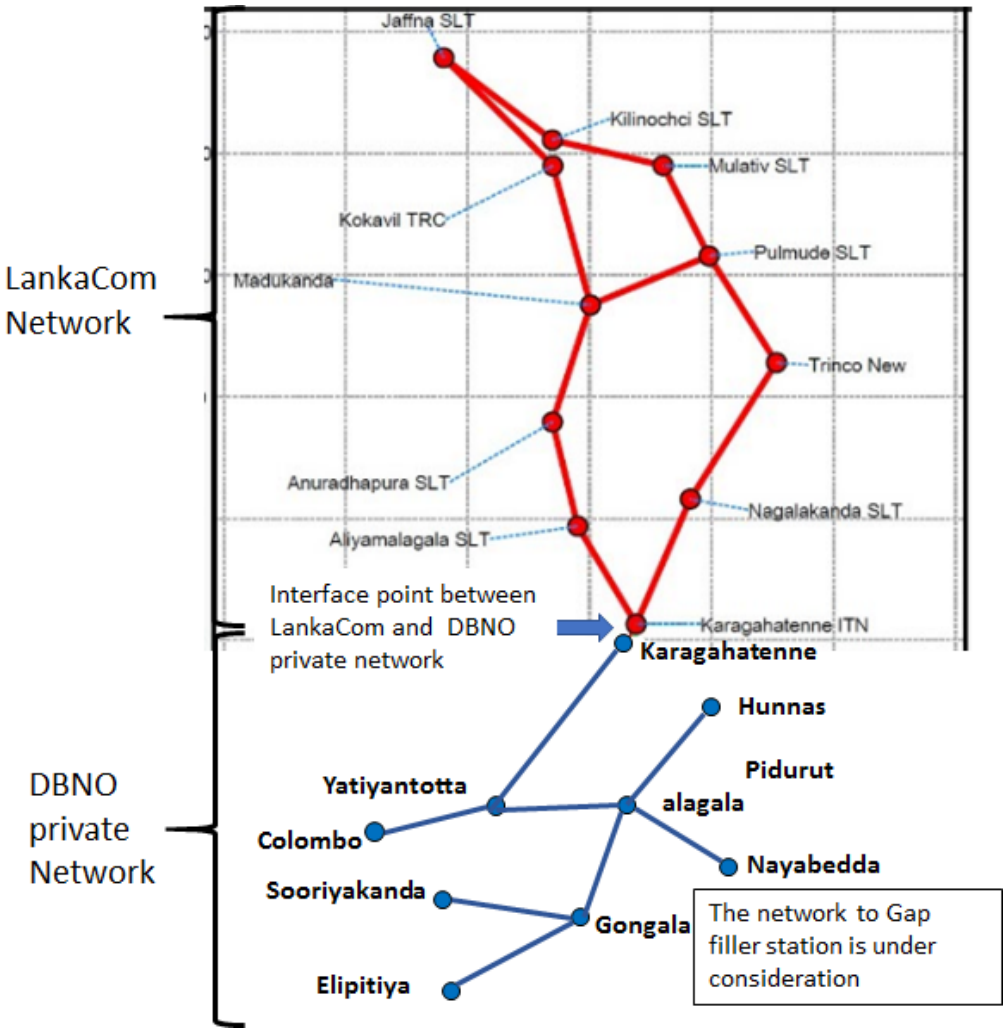
On top of that, in This Survey, it was necessary to discuss feasibility of development of network line and its usage fee with telecommunication providers which can provide the network shown in Figure 4.2-11, in order to calculate operational fee of DBNO. Therefore, the JICA Survey Team suggested draft of technical specification mentioned in 1) above to LankaCom, which mainly operates nationwide communication network for business.

LankaCom adopts a method of relaying nationwide on a microwave trunk line unlike SLT. It was suggested from LankaCom that a method of sharing towers of transmitting stations be used to prepare DBNO network.

It will be possible to constitute microwave relay stations with backup route as shown in Figure 4.2-11, because preliminary lines will be loop type using lines of LankaCom.

On the other hand, IP-Multicast method was suggested as transmission signal format from LankaCom. However, it is considered that interface system shown in Figure 4.2-9 can absorb jitter along with IP transmission. It is assumed that facilities such as optical cables connecting LankaCom and transmitting stations and terminated boxes will be installed by LankaCom at each site for transmission and relay.

Figure 4.2-12 shows the diagram of transmission link connecting transmitting stations in northern area and north eastern area using network of LankaCom.



Source: LankaCom

Figure 4.2-12 Transmission link consisting of microwave link of DBNO and LankaCom

(b) Review regarding transmission link network along with revising channel plan

Situation of frequency bandwidth usage in Sri Lanka has changed from the stage of Previous Survey in 2014. Therefore, channel plan was partly modified (as shown in 4.2.1) in consideration with interference between DTTB and analogue TV broadcasting or so. Along with that, it became necessary to review overall transmission link network.

Constitution of transmission link is different depending on the network link owned by each telecommunication provider. The following show each transmission link network.

i. Case of using transmission link network of SLT

In the case of using transmission link network of SLT, scope of delegation to telecommunication providers is not changed from Previous Survey. Design for network links owned by DBNO will be necessary to be changed along with modification of channel plan. Optical lines of SLT will be used for Kokavil, Trincomalee and Yatiyantota and microwave links of DBNO will be for other sites. It

will be necessary for DBNO to ensure frequency bandwidths for microwave links and operate and maintain necessary equipment.

Nationwide transmission link network using optical fibre link of SLT and microwave link of DBNO is shown below.

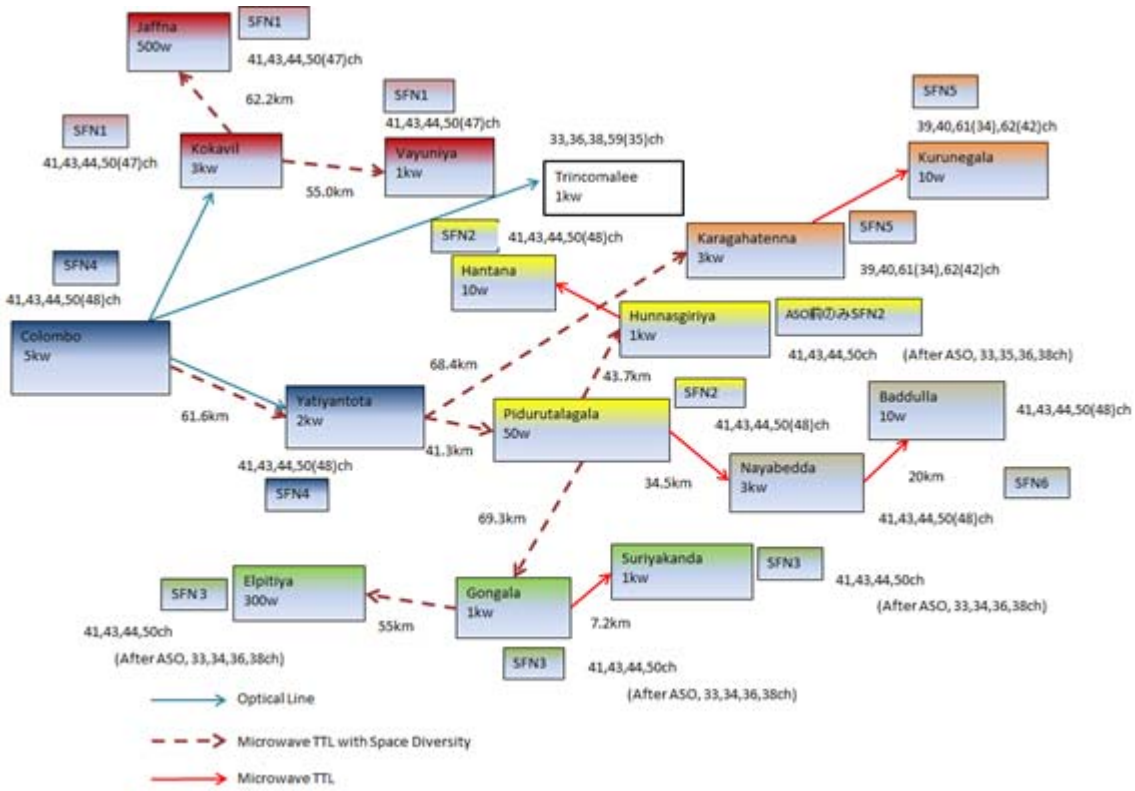


Figure 4.2-13 Case of using transmission link network of SLT

ii. Case of using transmission network link of LankaCom

In case of using transmission line network of LankaCom and cover transmitting stations in northern area and north eastern area, origin of network will be the transmitting station in Karagahatenna, unlike using communication line of SLT. In order to improve reliability of links between NOC of Colombo Transmitting Station and transmitting station in Karagahatenna, microwave TTL links will be prepared between Hunnasgiriya and Karagahatenna and backup route will consist of TTL links between Yatiyantota and Karagahatenna.

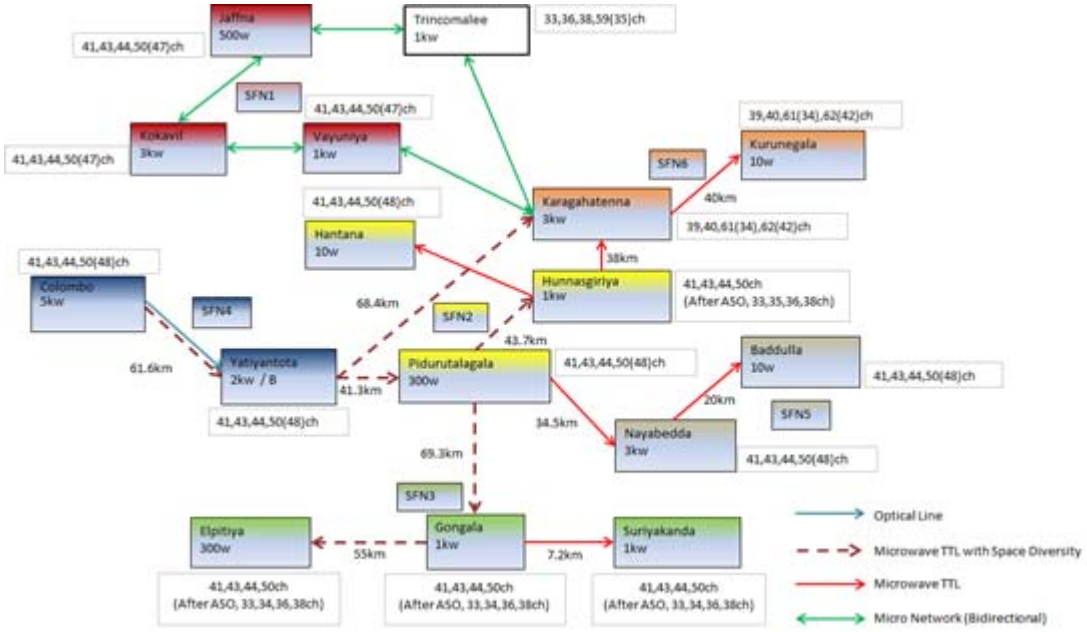


Figure 4.2-14 Case of using transmission link network of LankaCom

(3) Result of review on transmission link network and issues in future

1) Decision of transmission signal format in transmission link network

3 methods (STM-1, Layer 2 IP-Multicast and Layer 3 VLL) are considered to be chosen for transmission signal format as stated above. It will be necessary to decide the format in consideration with the following perspective.

- Transmission signal format should be common in network links operated by telecommunication providers and microwave links owned by DBNO. Consequently, it will be necessary to decide the transmission format when consultant of Yen Loan Project prepares tendering documents.
- Configuration of transmission link depends on the format. Therefore, it will be necessary to decide the format by comprehensively examining and comparing the difference in procurement cost of equipment, status of existing lines available at the time of introduction of equipment, and operation cost difference such as communication line usage fee for each transmission method.
- Operational test should be implemented in cooperation with telecommunication providers to evaluate practicality and safety on the lines.

2) Disclosure of algorithm for compression / decompression of broadcasting TS signal

Whether any of the three transmission formats is selected, the communication cost is proportional to the bandwidth. Therefore, it is preferable to use the compressed broadcast TS signal compressed by excluding invalid packets and the like from the broadcasting TS signal. On the other hand, transmission and reception of signals among multiple manufacturers are assumed because broadcasting TS signal will be the format at interface point between NOC and each transmission

station. Consequently in that case, it will be necessary to disclose compression algorithm and enable entry by multiple manufacturers.[8]

3) Confirmation of transmission network and SFN operation through transmitter

It will be necessary to manage delay time through transmission link network and transmitters, in order to ensure SFN. Especially as for network, there is a difference in the delay time between Primary line and Backup line and jitter and the like on the line. Therefore, it should be confirmed that SFN network will be operated stably in comprehensive test before starting its operation. These have to be dealt with at the time of preliminary examination and evaluation on transmission link network and equipment of each transmitting station (review on preliminary usage fee) during detailed design by consultant.

Thereafter processes such as selection of telecommunication providers, procurement of equipment in Yen Loan Project, preparation of tender documents and tendering for the procurement will be proceeded. The Government of Sri Lanka will conduct the selection of telecommunication providers and equipment for each transmitting station will be procured through Yen Loan Project. It should be considered that policy for procurement be modified as necessary based on the result of the comprehensive test.

4.2.10 Overall Band Plan

(1) Band Plan for frequency bandwidth

The Overall Band Plan of Sri Lanka is based on ITU recommendation or APT agreement. Merits of Overall Band Plan are creation of commonality on frequency usage plan with other countries technology to be used, which will lead to reduction of costs when developing new wireless communication infrastructure and opportunity for users to purchase equipment at reasonable price.

Frequency bandwidths currently assigned for analogue TV broadcasting in Sri Lanka are as follows. From CH 2 to 12 are allocated to bandwidths whose central frequencies are from 50.5MHz to 226.5MHz in 7MHz width. Broadcasting stations which VHF bandwidth is currently assigned are only state-run SLRC and ITN.

Table 4.2-26 Channel and VHF bandwidth for analogue broadcasting

CH	2	3	4	5	6	7	8	9	10	11	12
Central frequency (MHz)	50.5	57.5	64.5	177.5	184.5	191.5	198.5	205.5	212.5	219.5	226.5

Source: TRC

On the other hand, UHF bandwidth is allocated as TV broadcasting channel, from CH 21 to 62 whose central frequencies are from 474MHz to 802MHz in 8MHz width, as shown in the table below.

[8] Standards for digital broadcasting do not regulate compression method. Each manufacturer uses its own algorithm for broadcasting TS signal. Therefore, it will be necessary to disclose compression algorithm in advance in order to make it feasible to procure and adopt studio equipment and transmitters from different manufacturers.

Table 4.2-27 Channel and UHF bandwidth

CH	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Central frequency (MHz)	474	482	490	498	506	514	522	530	538	546	554	562	570	578	586	594	602	610	618	626

CH	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Central frequency (MHz)	634	642	650	658	666	674	682	690	698	706	714	722	730	738	746	754	762	770	778	786

CH	61	62
Central frequency (MHz)	794	802

Source: TRC

One of the merits of migration into DTTB is that TV broadcasting can be provided in less frequency bandwidths than analogue broadcasting. Meanwhile, use of International Mobile Telecommunications (hereinafter referred to as "IMT") is increasing rapidly and bandwidths for IMT are not enough. In order to deal with this situation, ITU is promoting policies of digital dividend which will ensure vacant bandwidths for IMT along with migration into DTTB.
Range of frequency bandwidth for IMT in Sri Lanka was also decided based on ITU recommendation and APT agreement. Bandwidths from 694MHz to 862MHz and corresponding channels will be disclosed to IMT, as shown in yellow in the following table.

Table 4.2-28 Frequency assigned for IMT

									IMT											
CH	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Central frequency (MHz)	634	642	650	658	666	674	682	690	698	706	714	722	730	738	746	754	762	770	778	786

	IMT								
CH	61	62	63	64	65	66	67	68	69
Central frequency (MHz)	794	802	810	818	826	834	842	850	858

Source: Recommendation from ITU and APT

From the situations above, from CH 21 to 48 in UHF bandwidth are available for DTTB in Sri Lanka. TRC, the governmental agency in charge of radio wave supervision, will follow APT agreement

especially in terms of services which will use frequency bandwidths corresponding those channels. TRC needs to consider policies and measures after migration into DTTB for usage of bandwidth over 700MHz which have been used for TV broadcasting.

VHF bandwidth (shown in Table 4.2-26) is supposed to be assigned not to digital broadcasting but other wireless communication method. Details are described in the following.

Table 4.2-29 Channel and digital broadcasting frequency bandwidth

CH	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Central frequency (MHz)	474	482	490	498	506	514	522	530	538	546	554	562	570	578	586	594	602	610	618	626

CH	41	42	43	44	45	46	47	48
Central frequency (MHz)	634	642	650	658	666	674	682	690

Source: JICA Survey Team

(2) Plan for analogue broadcasting digital dividend and necessary measures

Some frequency bandwidth in VHF and UHF will be vacant after ASO in Sri Lanka, based on agreements of ITU and APT. Table 4.2-30 shows the situation regarding those frequency bandwidths. Necessary digital dividend measures for VHF bandwidth and UHF bandwidth are shown below based on cases in Japan.

Table 4.2-30 Plan for analogue frequency digital dividend based on APT agreement

No	Frequency bandwidth (MHz)	Main use until ASO	Use after ASO
1	47 - 68	Analogue TV broadcasting (CH 2 - 4)	Broadcasting (fixed reception, mobile reception), etc.
2	174 - 209	Analogue TV broadcasting (CH 5 - 12)	Broadcasting (fixed reception, mobile reception), etc.
3	209 - 230		Broadcasting (fixed reception, mobile reception), aviation control, radio navigation, etc.
4	694 - 806	Analogue TV broadcasting (CH 49 - 62) and digital TV broadcasting	Mobile phone, etc.

Source: JICA Survey Team (based on APT recommendation and information of TRC)

(3) Digital dividend regarding VHF bandwidth

1) Outline

VHF bandwidth is supposed to be used for broadcasting, aviation control, radio navigation, etc. based on the APT agreement in Sri Lanka. Details for usage of each service have not been decided and remain issues to be considered in future.

2) Situation in Japan

In Japan, VHF has become to be used for services except TV broadcasting since ASO was implemented in 2011 (hereinafter referred to as analogue digital dividend). Table 4.2-31 shows the situation of analogue digital dividend in Japan as of March 2017.

Table 4.2-31 Situation of digital dividend in Japan

No	Frequency bandwidth (MHz)	Use as of March 2017	Business operator	Outline
1	90- 95	Supplementary FM broadcasting	Radio broadcasting stations	Contents of AM radio broadcasting in medium wave band are conveyed, in order to enhance the information transmission path in case of disaster, by 32 operators as of 2017.
2	95 - 108	i-dio	Multimedia Broadcasting Corporations in Tokyo, North Japan, Central Japan, Osaka, Chugoku and Shikoku, and Kyushu and Okinawa	i-dio conveys music, road information, information for daily life to portable receivers and car navigation equipment, as well as information for disaster prevention in case of emergency.
3	170 - 205	Public and general business (fixed reception)	-	It is used for administrative, disaster prevention work and so on.
4	205 - 222	(Vacant)	-	This bandwidth was used for multimedia broadcasting for smart phone terminals until June 2016.

Source: JICA Survey Team

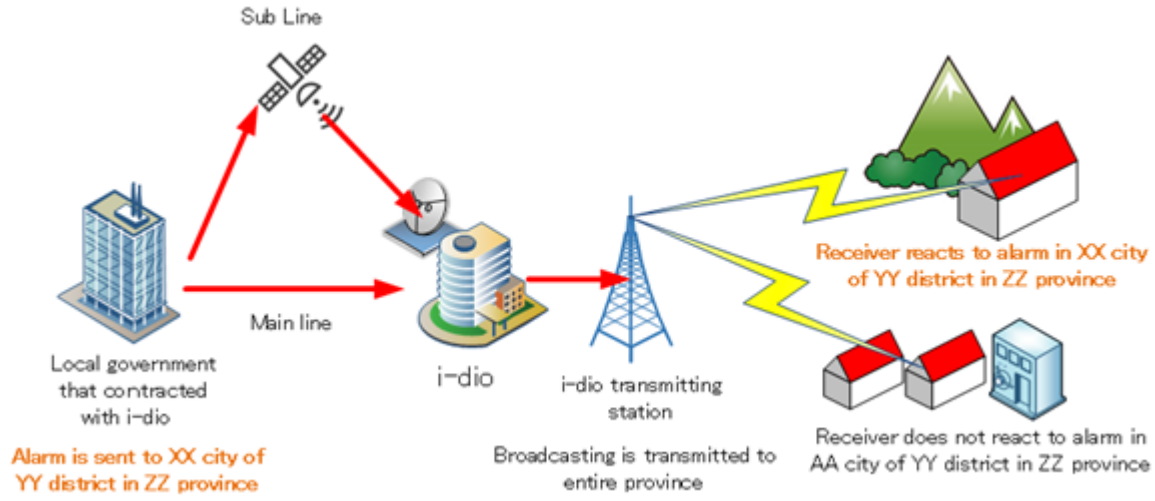
3) Technical standards for each usage method

① Technical standards of supplementary FM broadcasting were updated promptly without problems, as they are technically similar to FM radio broadcasting which was provided in bandwidths from 76 to 90MHz.

Receivers manufactured under the standard of analogue broadcasting can receive from 76 to 108MHz, therefore, there was no major change in technical standards. (Sound of analogue TV broadcasting in VHF bandwidth was perceptible by FM radio receiver.)

② i-dio adopts Integrated Services Digital Broadcasting for Terrestrial Sound Broadcasting (hereinafter referred to as "ISDB-Tsb"), which is a broadcasting method consisting of transmission bandwidth using 1 to 3 OFDM segments. Its main functions are broadcast of sound of higher quality than FM radio, simultaneous transmission of sound, text and small size movies, and emergency broadcasting the same as EWBS of ISDB-T. Emergency broadcasting is implemented as a service of municipal disaster prevention information media (hereinafter referred

to as “V-ALERT”) in contract with i-dio. Outline of V-ALERT is shown in Figure 4.2-15. Standard of receivers is indicated in ARIB STD-B30 (Standards for receivers of ISDB-Tsb), and corresponding portable receivers and car navigation systems are manufactured and sold.



Source: Homepage of i-dio

Figure 4.2-15 Outline of municipal disaster prevention information media

③ As for public and general business (fixed reception), method for usage of bandwidth from 170 to 205MHz was changed but no technical standards were prepared newly. An operator who hopes to use the bandwidths applies for radio wave type and transmission method suitable for that purpose, thereafter starts to use after receiving licence.

④ NOTTV was a broadcasting for mobile devices, with accumulating broadcast technology to ISDB-T and its technical standards were compiled as ISDB-T for mobile multimedia. NOTTV adopted ISDB-Tsb and its functions included broadcasting through higher quality image (720×480 dots and 30 frames per second) than one-segment, and accumulating broadcasting with furthermore high-quality image (high vision image of 1280×720). These were watched on smartphones etc. with subscription contract agreement. NOTTV started its service in 2012, however it was stopped in June 2016 because the number of subscribers was sluggish and it was not profitable. Currently in Japan, bandwidths from 205 to 222MHz are not used.

4) Preparation for each usage method, promotion activity and measures for reception

Table 4.2-32 shows promotion activity and measures for reception for each broadcasting method.

Table 4.2-32 Promotion activity for each method

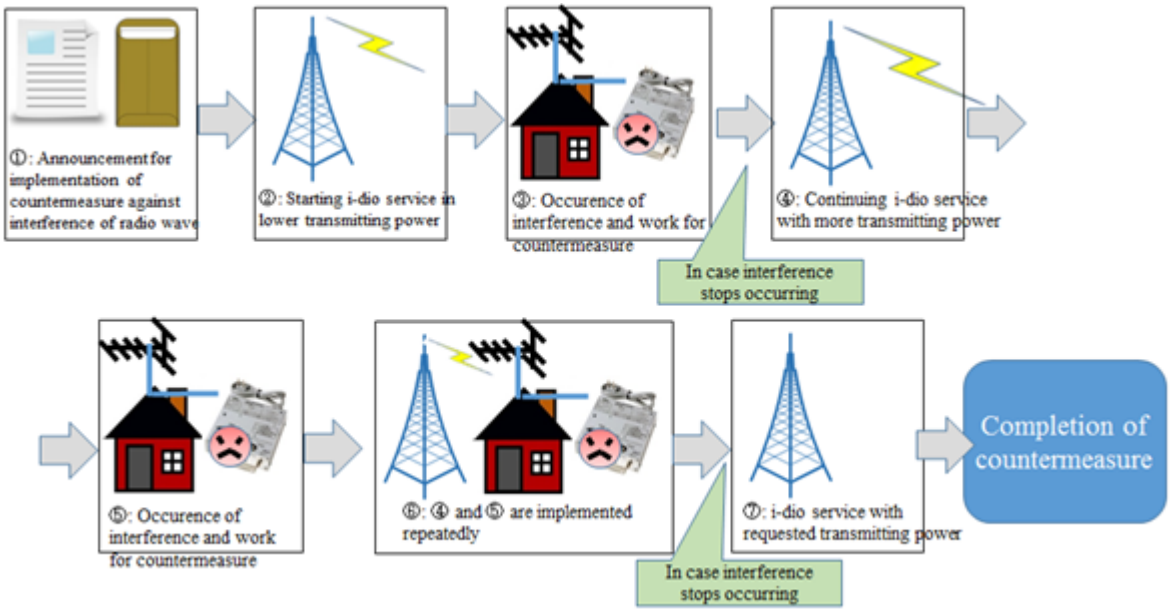
No	Broadcasting method	Activity for dissemination	Category	
			Assistance for replacement	Measures against interference for existing reception facility
1	Supplementary FM broadcasting	Commercial messages and websites by related operators	-	Small scale measures are implemented at the time of opening.
2	i-dio	Commercial messages and websites of related operators. (Implemented as a business related to maintenance of disaster prevention system.)	There will be a possibility of taking measures in case of maintenance of disaster prevention system. (No assistance for general business)	Method to avoid interference with instruments for landing system using bandwidths from 108 to 117.975MHz. Small scale measures are implemented at the time of opening.
3	Public and general business (fixed reception)	-	-	Small scale measures are implemented at the time of opening.
4	NOTTV	-	-	

Source: JICA Survey Team

When it comes to assistance on purchasing receivers of i-dio, there will be the case that receivers are distributed as replacements instead of wireless receivers for disaster warning on the occasion of implementing, deploying and updating disaster prevention system to local government contracting with V-ALERT.

The term “Small scale measures” of each broadcasting method means works for boosters for VHF / UHF bandwidth for TV reception that have been continuously used since analogue broadcasting. It was confirmed in laboratory experiment that those boosters cause malfunction due to excessive input of radio waves from each broadcasting system. There are 2 methods as countermeasures against interference; inserting filter to reduce radio waves of frequencies from each broadcasting system, and replacing existing booster with other one used for UHF bandwidth. It was found that the influence on society would be small when stakeholders discussed and analysed measures against interference. It was because replacement from boosters for VHF / UHF bandwidth to that for UHF bandwidth was in progress, and because areas where strength of radio waves reach the level of causing malfunction is limited only to a very narrow area around existing transmitting station. Therefore, a method different from countermeasure regarding digital dividend of UHF bandwidth, which is described below, was taken. This method is a general reception countermeasure which was taken when changing the method of radio waves usage in Japan.

Figure 4.2-16 and Table 4.2-33 show measures for reception and their expense.



Source: JICA Survey Team

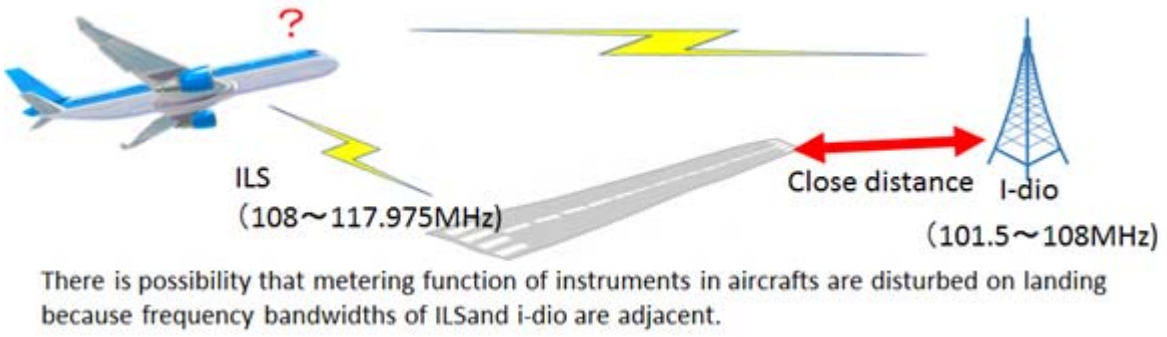
Figure 4.2-16 Conventional measures for reception

Table 4.2-33 Rough fee estimation of conventional measures for reception

No	Work item	Estimated fee	Remarks
1	Promotion activity	A few million yen	Posting to concerned region, announcement by public report, etc.
2	Measures for reception	About 30 thousand yen per facility	Implementation of countermeasure works on existing booster, assuming 2 experts on high place work.
3	Replacement of parts	About 20 thousand yen per facility	Replacing UHF booster as necessary

Source: JICA Survey Team

Countermeasures to avoid interference from i-dio to Instrument Landing System (hereinafter referred to as ILS), using bandwidth from 108 to 117.975MHz, took much time to be considered and implemented due to its big impact. Figure 4.2-17 shows the situation of interference.



Source: JICA Survey Team

Figure 4.2-17 Interference from i-dio to ILS

As the countermeasure against interference on the side of reception facilities, it is effective to some extent to insert filters to block radio waves of i-dio at the input end of all aircraft receivers which land on the target airfield using ILS. As for countermeasures against interference on the side of transmission, it is effective to reduce unnecessary transmissions toward outside of bandwidth, change transmission frequency (frequency bandwidths of i-dio are divided into two ranging from 95 to 101.5MHz and 101.5 to 108MHz), change the number of segments from 3 to 2, modify antenna pattern for transmission, and so on. On the other hand, countermeasures on reception side are not implemented because testing and approval of receiving equipment installed in aircraft and its renovation are required, which will cost a lot and take a long time. Currently, based on the distance between transmitting stations of i-dio and airports, countermeasures are taken by combining multiple measures on the side of transmission facility.

5) Summary

When it comes to digital dividend of VHF bandwidth, there will occur some effect on existing facilities no matter what kind of usage will be adopted. It will be necessary for Sri Lankan side to decide detailed measures regarding digital dividend, based on APT agreement.

(4) Digital dividend regarding UHF bandwidth digital dividend

1) Outline

In Sri Lanka, an intention to utilize frequency bandwidth centred on 700MHz bandwidth (from 694 to 806MHz) for mobile phone business (hereinafter referred to as 700 LTE) is shown from telecommunication providers, due to frequency shortage. TRC which has jurisdiction on management of frequency is also willing to decide Band Plan for frequency bandwidth according to APT agreement.

The JICA Survey Team investigated what kind of situation will happen when 700MHz bandwidth is used for 700 LTE in reference to reception countermeasure business implemented by Association of 700MHz Frequency Promotion of Japan (hereinafter referred to as 700afp). Table 4.2-34 shows the result.

Table 4.2-34 Estimated situation of interference related to 700 LTE in Sri Lanka

No	Facility	Related business operator	Result of survey	Countermeasure
1	Radio microphone	Owners of radio microphones	No interference because of different frequency bandwidth	-
2	Field Pickup Unit (FPU)	TV broadcasters	No interference because of different frequency bandwidth	-
3	TV set for receiving programmes	Viewers	Risk of interference with TV sets	Countermeasures to prevent interference will be necessary.
4	Cable television (CATV) facility	CATV operators	No facilities to be concerned for interference	-

Source: JICA Survey Team

In addition, there will the risk that interference between TV receiving equipment and 700 LTE will occur similarly to that in Japan. The JICA Survey Team investigated countermeasures regarding this point. Table 4.2-35 shows the result.

Table 4.2-35 Interference troubles on TV reception facilities and others caused by 700 LTE

No.	Equipment	Source of interference occurrence and mechanism for interference	
		Base station of mobile phone	Mobile phone
1	Booster (including facilities for detached house and common use facilities)	Saturation of amplifier or intermodulation disturbance caused by excessive input of 700 LTE radio wave	Disorder caused by input of 700 LTE radio wave
2	TV set for receiving programmes	・Disorder of pre amplifier operation caused by excessive input of 700 LTE radio wave ・Disorder caused by direct input of 700 LTE radio wave	Disorder caused by direct input of 700 LTE radio wave to enclosure
3	STB		
4	Mobile receiver		
5	Dongle		

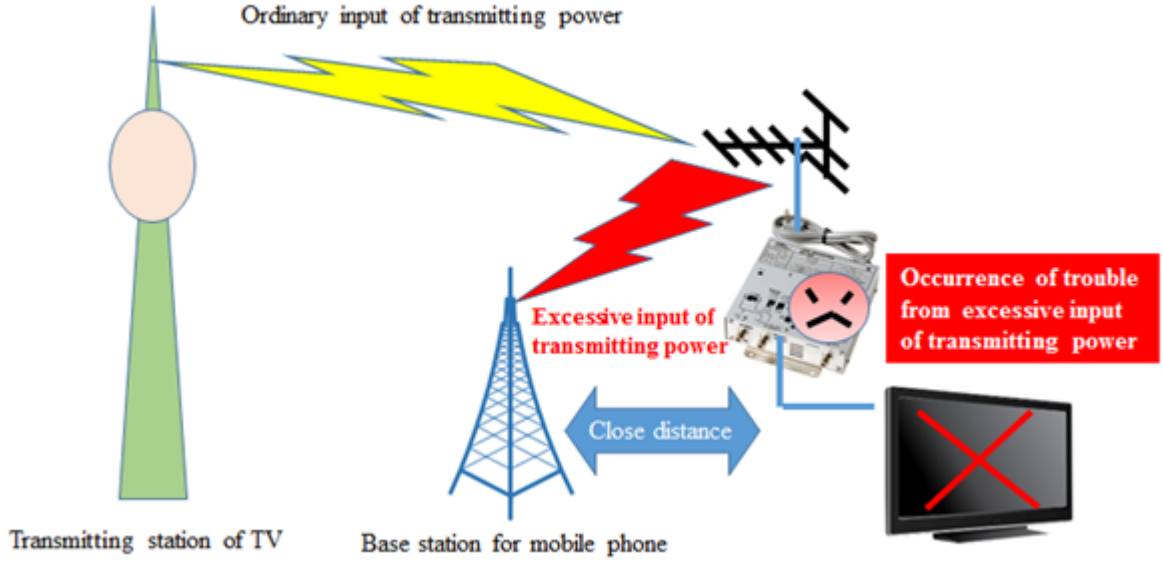
Source: JICA Survey Team

2) Cause of interference and countermeasures

Generally, TV receiving equipment consists of reception antenna and amplifier. Interference between TV receiving equipment and mobile phone comes from intermodulation generated in amplifier due to excessive input. Therefore, measures should be done for amplifier to prevent signal from new business such as mobile phone at facilities which receive UHF using amplifier. In detail, it will be necessary to take measures to insert a high band elimination filter targeting 700MHz or more in front of the amplifier, in order to ensure the amplifier is not saturated and not distorted. However, in Sri

Lanka, antennas integrated with amplifier are widely disseminated and it is physically impossible to directly insert high band elimination filter to antenna. In that case, measures such as replacing antenna should be taken.

The following shows an example of reception environment considered to have the high possibility of occurrence of interference.



Source: JICA Survey Team

Figure 4.2-18 Example of interference trouble caused by 700 LTE

As signal of 700MHz bandwidth can be received at existing TV reception equipment even after ASO, there will be the risk of occurrence of interference at that equipment once 700 LTE starts.

Comparison between distance from TV receiving facilities and TV transmitting station and that from TV receiving facilities and 700 LTE base station shows that the latter is shorter than the former in most cases. Therefore, disorder of receiving TV broadcasting may occur because radio waves from 700 LTE base stations are excessively input to TV receiving equipment in some cases. It is extremely significant to identify areas where such interference can occur when considering countermeasures for interference with 700 LTE.

3) Issues in future

Mechanism of interference caused by 700 LTE and countermeasures are described above. Some measures will have to be taken because the interference cannot be avoided due to the following.

① In some transmitting stations, TV reception facilities are required to cover broad area during simultaneous broadcasting and after ASO, when 700MHz or more bandwidth will be used.

② For the time being after the DTTB is started, there may be a possibility that receivers which are available for analogue and digital broadcasting and capable of receiving 700MHz bandwidth will be sold.

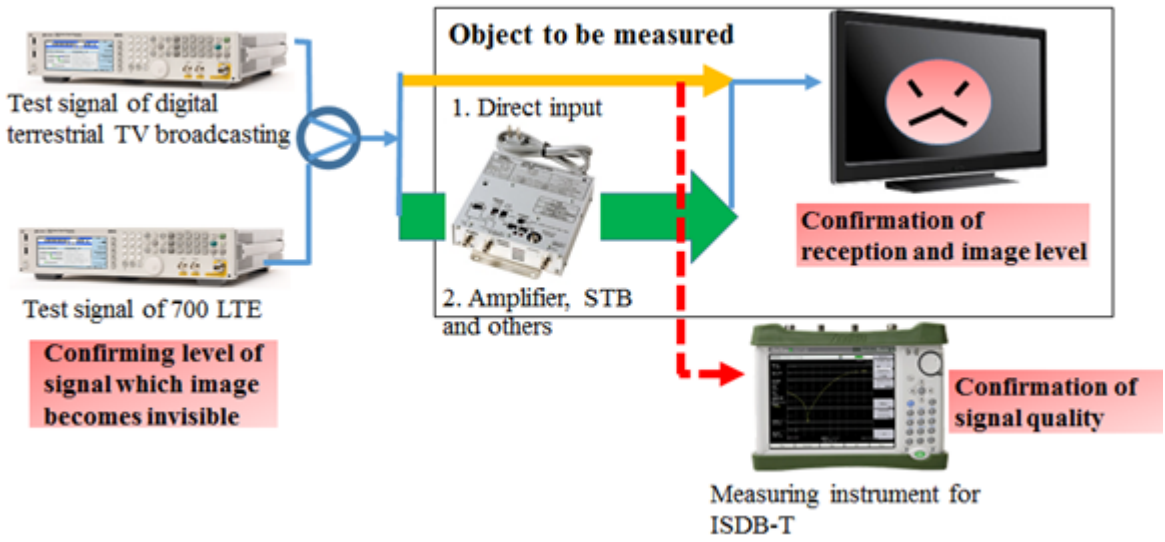
③ When 700MHz bandwidth becomes unnecessary to be received, relevant parts of technical standards will be revised and reception of that bandwidth will be stopped.

④ Amplifiers which have been used from analogue broadcasting, such as boosters capable of receiving 700MHz bandwidth, have the possibility to continue to be used after ASO.

Operators who will implement the measures should be specified, and the operators, DBNO and broadcasting stations need to cooperate in processing the measures. (In case of Japan, telecommunication providers play the role of the operator.)

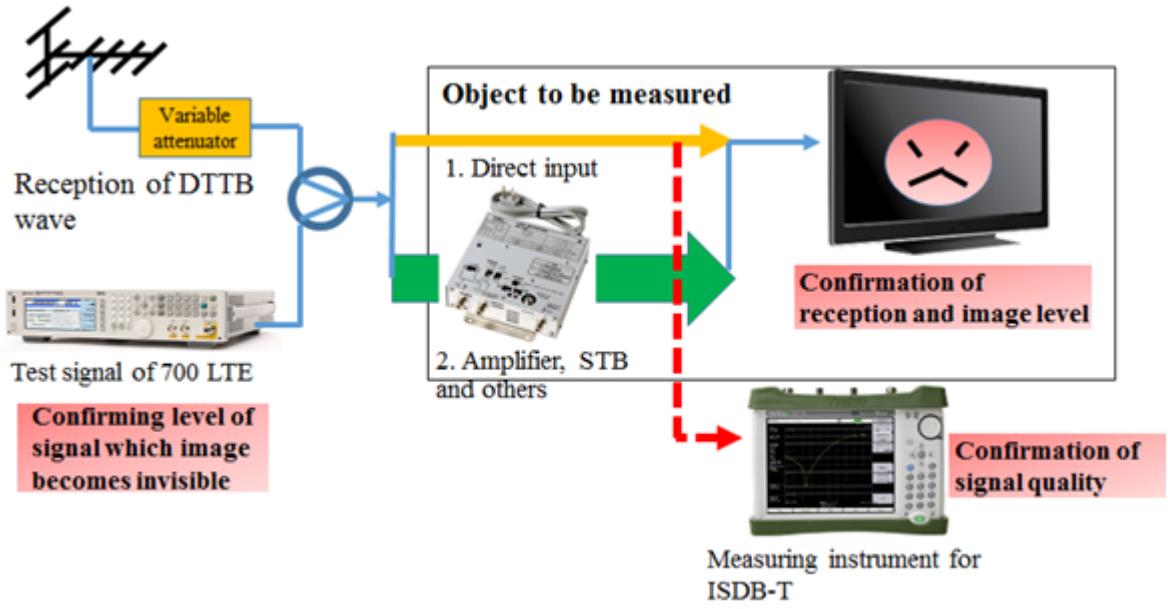
In addition, it will be necessary to consider the way how to measure the ratio at each facility (equipment) between desired DTTB wave and undesired 700 LTE wave. A method is available to clarify input level of 700 LTE which causes disorder on TV image, by having the facility (equipment) receive desired signal and undesired signal at the same time. From the result of this method and by utilizing radio wave propagation simulation, it will be possible to specify area where interference will occur to some extent.

The following show examples of test method.



Source: JICA Survey Team

Figure 4.2-19 Experiment for interference of signal input to antenna



Source: JICA Survey Team

Figure 4.2-20 Experiment for interference of direct signal input to equipment

4) Fee of countermeasure against interference

Result of 700afp business revealed that most of TV reception disorders by 700 LTE in Japan have occurred in amplifiers (including detached houses, common use equipment). It is estimated to be the similar case considering the situations in Sri Lanka.

Table 4.2-36 shows estimated unit prices regarding countermeasure for common parts against interference in Sri Lanka, based on procedures experienced in Japan, and Table 4.2-37 shows unit price of materials used for countermeasure.

Table 4.2-36 Unit price regarding countermeasure for common parts against interference

No	Item	Unit price (Rs.)	Unit	Quantity	Cost (Rs.)	Remarks
1	Workers	2,300	Person	1.0	2,300	Fee of ensuring two workers for two facilities per day. Unit price is assumed one-twentieth of the nationwide average monthly income based on census 2012.
2	Negotiation for countermeasure work	2,300	Person	6.0	13,800	Pre-negotiation for construction. Unit price is assumed one-twentieth of the nationwide average monthly income based on census 2012.
3	Vehicle	6,500	Set	0.5	3,250	One-half of the cost of arranging a construction vehicle for one day including fuel cost.
4	Fee for Loss of measuring instrument	700	Set	0.5	350	Rounding of fee for loss of measuring instrument for DTTB. (300 thousand yen for depreciation of digital level checker (LCV3). Operation of 200 days per year for 3 years)
5	Other parts	2,000	Set	1.0	2,000	Cables, waterproof processing tools, document preparation costs, etc.
6	Subtotal	-	-	-	21,700	

Source: JICA Survey Team

In the table above, it is assumed that workers will insert filter or exchange facility for reception at each place where reception antenna is installed. Promotion activities on digital dividend, explanation on expenses for working of measures, and arrangement of schedule will be implemented for regions where measures will be taken. It is considered the regions include the place where only CATV is watched and measures for digital dividend is not necessary, therefore those factors should be specified and excluded through negotiations. Roles of vehicle are transfer of workers, transportation of construction materials, etc. Vehicles are basically driven by workers themselves, meanwhile fee for vehicles for high place working will be counted separately. As for fee for loss of measuring instrument, a device equivalent to the digital level checker used widely in Japan (about 300 thousand yen) is forecast to be available. Other parts include materials such as cables, connectors, waterproof processing tools and so on and document preparation.

Total of these expenses per facility is expected to be 21.700 Rs. Actually, other expenses of other individual materials for working will be added up as necessary, as shown in Table 4.2-37.

Table 4.2-37 Unit price of materials for countermeasure against interference in Sri Lanka

No	Item	Unit price (Rs.)	Remarks
1	Filter for 700 LTE	7,000	Average price of current passage type filter

No	Item	Unit price (Rs.)	Remarks
2	Amplifier for detached house	17,000	Equivalent to SBF-33D of Sun Corporation
3	Amplifier for common use facilities	78,000	Equivalent to UF40M (DX antenna)

Source: JICA Survey Team

Though JICA Survey Team conducted investigation on actual status of amplifiers and the like, equipment which can be the basis foundation for measures of 700 LTE was not found in markets in Sri Lanka. Therefore, prices of that kind of equipment in Japan were included in the estimation for working of 700 LTE.

In general, a TV set consists of reception antenna and amplifier. Reception antenna widely used in Sri Lanka is integrated with amplifier, its directivity is not sharp, and amplifies a wide range of bandwidth (from VHF to UHF). Meanwhile, it is anticipated that reception antenna with sharp directivity (such as Yagi-Uda Antenna, ITU-R.BT419) and UHF bandwidth amplifier will be installed for DTTB in order to realize its stable reception. In that case, it will not be necessary to exchange existing antenna at the time of implementing countermeasure for digital dividend. Therefore, reception antenna is not included in the estimation for cost of materials of interference countermeasure.

Filters used for the countermeasure will be the ones which can suppress signal level of 700 LTE in order to avoid reception disorder of DTTB, as shown in Figure 4.2-18. Power supply for amplifier will be DC type because there is the case the power is supplied through coaxial cable where broadcasting waves are conveyed with direct current.

As for amplifier, equipment with prevention measures against interference from 700 LTE (hereinafter referred to as DH710) or its equivalent, which is recommended by the Japan Electronics and Information Technology Industries Association (JEITA), will be used for countermeasures. It will not be necessary to insert filters in case of using DH710. Amplifiers used in common use equipment (here means facilities which distribute TV broadcast waves to each room of housing complexes, commercial facilities and buildings) have high performance, different to detached houses.

Working of countermeasures against interference is supposed to be classified into 4 groups as shown in Table 4.2-38, considering its processes of implementing common work and thereafter usage of other materials. Based on Table 4.2-36 and Table 4.2-37, Rough estimation for working of countermeasures is shown in Table 4.2-38.

Table 4.2-38 Rough estimation for countermeasures against interference

No	Category	Cost (Rs.)	Detail
1	Confirmation and arrangement for works at detached houses and common use facilities	21,700	Works for common use parts
2	Inserting filters at facilities of detached houses and common use facilities	28,700	Works for common use parts and 700 LTE filters
3	Replacing amplifier at detached houses	38,700	Works for common use parts and amplifiers of detached houses
4	Replacing amplifier of common use facilities	99,700	Works for common use parts and amplifiers of common use facilities

Source: JICA Survey Team

Selling, general and administrative expenses and taxes are not included in each cost in the table above. Item No. 1 shows the cost which materials for countermeasures are not used and the cost for facilities of no necessity for implementing countermeasure. It is hoped that the latter case does not occur, therefore, necessity of countermeasure should be judged through negotiation and the actual work be executed. Meanwhile, as with the case of Japan, there will occur the situation that necessity cannot be judged through negotiation, or the case of judging that there is no need for countermeasures, even if it is not the defect of the parties or operators of countermeasure. Item No. 1 guarantees the minimum operating cost of workers in order to avoid the risk that workers cannot be secured in case of not defining that kind of cost. Items No. 2 and 3 show the case of the largest number of works occurring, based on analysing the performance of countermeasure in Japan.

Based on information above, Table 4.2-39 and Table 4.2-40 show examples of rough estimation for countermeasures against interference at detached houses and facilities sharing equipment for reception.

Table 4.2-39 Example of rough estimation for countermeasures against interference at detached houses

No	Item	Estimated quantity	Remarks
1	Number of detached houses	4,872,426	Based on Census 2010
2	Rate of TV dissemination	80%	Based on Census 2010
3	Probability of locating in areas where interference prevention measures are necessary	10%	Threshold of field strength for reception in Japan is 85dBμV/m. This percentage is equivalent with the area where field strength is estimated to be more than the

No	Item	Estimated quantity	Remarks
			threshold, based on calculation from the point of base station of mobile phone.
4	Number of houses where countermeasures will be implemented	389,794	8% of number of detached houses
5	Probability of implementing confirmation and negotiation with houses	10%	Based on countermeasure in Japan
6	Number of implementation of No. 5 above	38,979	10% of No. 4 (Round down after decimal point)
7	Fee for works per implementation at 1 house	Rs. 21,700	Based on Table 4.2-38
8	Subtotal 1 (Fee for items from 1 to 7)	**Rs. 845,844,300**	Result of multiplication of No. 6 and No. 7
9	Probability of inserting filters at facility of houses	80%	10% is added to percentage of that in Japan (Round down after decimal point)
10	Number of implementation of No. 9 above	311,835	80% of No. 4 (Round down after decimal point)
11	Fee for works per implementation at 1 house	28,700 Rs.	Based on Table 4.2-38
12	Subtotal 2 (Fee for items from 9 to 11)	**Rs. 8,949,670,240**	Result of multiplication of No. 10 and No. 11
13	Probability of replacing amplifier at detached house	10%	50% of probability in Japan (Round down after decimal point)
14	Number of implementation of No. 13 above	38,979	10% of No. 4 (Round down after decimal point)
15	Fee for works per implementation at 1 house	38,700	Based on Table 4.2-38
16	Subtotal 3 (Fee for items from 13 to 15)	**Rs. 1,508,487,300**	Result of multiplication of No. 14 and No. 15
17	Total (Sum of subtotal 1 to 3)	**Rs. 11,303,996,100**	Sum of No. 8, No. 12 and No. 16

Source: JICA Survey Team

Table 4.2-40 Example of rough estimation for countermeasures against interference at facilities sharing equipment for reception

No	Item	Estimated quantity	Remarks
1	Number of large buildings	335,314	Based on Census 2010
2	Rate of installation of common use facilities	84%	Result of survey in Colombo area
3	Probability of locating in areas where interference prevention measures are necessary	10%	Threshold of field strength for reception in Japan is 85dBμV/m. This percentage is equivalent with the area where field strength is estimated to be more than the threshold, based on calculation from the point of base station of mobile phone.
4	Number of buildings where countermeasures will be implemented	28,166	8% of number of large buildings
5	Probability of implementing confirmation and negotiation with owners of buildings	10%	Based on countermeasure in Japan
6	Number of implementation of No. 5 above	2,816	10% of No. 4 (Round down after decimal point)
7	Fee for works per implementation at 1 building	Rs. 21,700	Based on Table 4.2-38
8	Subtotal 1 (Fee for items from 1 to 7)	**Rs. 61,107,200**	Result of multiplication of No. 6 and No. 7
9	Probability of inserting filters at common use facility of building	80%	10% is added to percentage of that in Japan (Round down after decimal point)
10	Number of implementation of No. 9 above	22,533	80% of No. 4 (Round down after decimal point)
11	Fee for works per implementation at 1 building	Rs. 28,700	Based on Table 4.2-38
12	Subtotal 2 (Fee for items from 9 to 11)	**Rs. 646,697,100**	Result of multiplication of No. 10 and No. 11
13	Probability of replacing amplifier at building	10%	50% of probability in Japan (Round down after decimal point)
14	Number of implementation of No. 13 above	2,816	10% of No. 4 (Round down after decimal point)

No	Item	Estimated quantity	Remarks
15	Fee for works per implementation at 1 building	Rs. 99,700	Based on Table 4.2-38
16	Subtotal 3 (Fee for items from 13 to 15)	**Rs. 280,755,200**	Result of multiplication of No. 14 and No. 15
17	Total (Sum of subtotal 1 to 3)	**Rs. 988,559,500**	Sum of No. 8, No. 12 and No. 16

Source: JICA Survey Team

Overall expenses for countermeasures against interference in Sri Lanka, based on method in Japan, are expected to be about 12,293 million Rs. (Sum of 11,304 million Rs. for detached houses and 989 million Rs. for common use facilities)

5) Summary

In the case mobile phone service providers use UHF bandwidth, it is considered that the influence on existing television receiving equipment is very large, and the cost of measures will be enormous. In Sri Lanka, it will be necessary for TRC, TV broadcasting stations, manufacturing and sales companies of reception equipment and mobile phone service providers to consider usage of UHF bandwidth on mobile phone service and policies for measures (scale of countermeasure working, operators who will pay the cost) by 2024, when construction work for receiving radio wave is estimated to start in draft of Roadmap for migration into DTTB.

4.3 HD Roadmap

4.3.1 HD Roadmap for state-run broadcasting stations

Most of the broadcasting equipment of SLRC currently corresponds to only SD broadcasting. That will be upgraded to HD when equipment for digital TV centre is installed through Yen Loan Project. If selection of consultant for Yen Loan Project starts in August 2018, detailed design will be done by the consultant and equipment manufacturing, maritime transportation and installation work will be completed in early 2022. The operation of HD equipment is expected to be started in the latter half of 2024, which will make it possible to complete upgrade to HD before DSO-HD1 scheduled in 2027.

4.3.2 HD Roadmap for private broadcasting stations

The situation on upgrade of equipment to HD differs at each private broadcasting station as shown in 4.4. The JICA Survey Team recommended outline of upgrade plan of the equipment to broadcasting stations except Derana TV, Voice of Asia, Buddhist TV and Max TV, where upgrade to HD was already completed or was expected to close soon. The plan basically suggests that equipment upgrade will not concentrate on a single year but be proceeded in stages over a period of a few years. It is expected that all broadcasters will complete the upgrade before DSO-HD1 is scheduled to be implemented in 2027.

It is assumed that the following processes will be done regarding upgrade of broadcasting equipment.

A) Installation and update of facilities for filming HD images (camera, studio, outside broadcast van (hereinafter referred to as "OB Van") and so on)
B) Replacement of facilities for post-production of HD programmes
C) Replacement of facilities for archiving HD images
D) Replacement of facilities for routing of HD broadcasting
E) Replacement of Master Control Room (hereinafter referred to as MCR) for HD broadcasting

The order of these operations is categorized as follows depending on the situation of installation of facilities at each broadcasting station.

(1) Broadcasters which have not introduced MCR for HD broadcasting

Prioritizing update of facilities from A) to C) necessary for content production, such as filming of broadcasting materials and programme production. MTV and Shraddha TV correspond to this category.

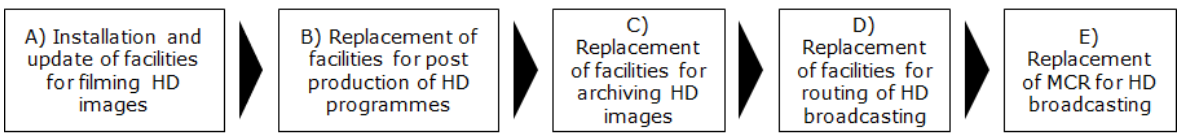


Figure 4.3-1 Flow of upgrade to HD at Broadcasters which have not introduced MCR for HD broadcasting

(2) Broadcasters which have installed MCR for HD broadcasting or started upgrade

Broadcasters where MCR for HD has already been installed or upgrading has started will introduce the system for filming and MCR in parallel. EAP, Hiru TV, Art TV, Derana TV, Voice of Asia, Buddhist TV, Rangiri TV, CSN, Max TV correspond to this category.

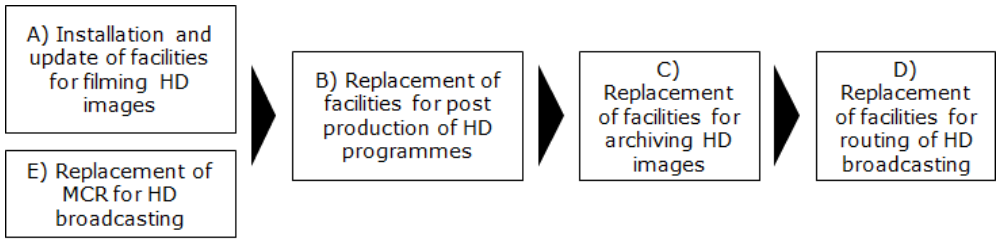


Figure 4.3-2 Flow of upgrade to HD at Broadcasters which have installed MCR for HD broadcasting or started upgrade

4.4 Proposed investment plan for upgrade of equipment to HD broadcasting

When it comes to broadcasting equipment for programme production of private broadcasting stations, some broadcasters have already upgraded most systems to HD, while others are still using SD equipment.

Many broadcasting stations assume procurement of fund from parent company of their group and/or banks as a means of upgrading equipment. Meanwhile, broadcasters providing religious programmes (hereinafter referred to as "religious broadcasters") intend to depend on donations as their fund continuously. (Exception: refer to 4.4.9)

The period between upgrade of studio broadcasting equipment at private broadcasting stations in Sri Lanka is from 5 to 10 years. Some broadcasters are using equipment beyond the expected lifetime, however, in general, upgrade to HD is proceeding sequentially. Studio broadcasting equipment which can be currently procured in the Sri Lankan market is supporting HD (including multi system for both HD and SD) or ultra high image quality of about 4,000 horizontal pixels (hereinafter referred to as "4K"), equivalent to four times the number of pixels for HD. Therefore, upgrade of broadcasting equipment related to studio is proceeding. It is expected that all Sri Lankan broadcasting stations will complete upgrade of their equipment to HD by 2022.

Migration into DTTB in Sri Lanka will be completed when upgrade of equipment to HD finishes. There is high possibility that upgrade at private broadcasting stations will depend on their financial situation. In case some broadcasters are late to accomplish the upgrade, the migration into DTTB will not be completed in the whole of Sri Lanka, which will lead to delay of getting benefit such as digital dividend.

The following from 4.3 to 4.4.13 shows situation of existing broadcasting facilities at private broadcasting stations, installation of equipment which needs to be upgraded to HD and rough estimation of expenses, and intention for investment and method for ensuring of funds. The objective is to confirm whether there are significant concerns for migration into DTTB in future.

Situations of each private broadcasting station are shown in the following (in alphabetical order). Regarding the equipment which needs maintenance for HD broadcasting in future, rough estimated price and the estimated introduction year are listed. Estimated price fluctuates by changing specifications with equipment having equivalent basic functions. Therefore, those prices are not based on quotation with detailed consideration about specification, but come from market price and example of actual introduction at broadcasters. The JICA Survey Team aimed at making those prices be the reference for consideration about how private broadcasting stations need to prepare their investment plans.

The JICA Survey Team also considered the schedule of upgrading equipment to HD broadcasting in accordance with draft of Roadmap for migration into DTTB. The roadmap is based on the assumption that selection of consultant for Yen Loan Project will be started in August 2018.

4.4.1 Art TV

(1) State of the existing broadcasting facilities

Art TV provide an English broadcasting service, mainly showing programmes made by US broadcasting service CNN. They cover Greater Colombo and areas around Kandy, Jaffna, and Hunnasgiriya. It is classified as a small or medium broadcasting station based on network scale. Art TV are not very active in producing programmes and their policy on business operation as a broadcasting station is not very clear.

On the other hand, the company gradually are upgrading their equipment to support HD broadcasting. The company has upgraded some of their news studio equipment and editing facilities and part of their MCR to HD. Art TV once announced that they would completely upgrade their MCR and line facilities by the end of 2017. However, it is not clear whether or not these upgrades have been completed.

Table 4.4-1 Situation regarding the upgrade of existing equipment for HD broadcasting (Art TV)

Facilities/equipment		Situation of update	Remarks
A	Facilities for filming HD images	Currently updating	Most equipment is not for HD broadcasting. (Cameras and other equipment have partially been replaced by those support HD broadcasting)
B	Facilities for post-production of HD programmes	Currently updating	
C	Facilities for archiving HD images	Not started	

Facilities/equipment		Situation of update	Remarks
D	Facilities for routing of HD broadcasting	Currently updating	Expected to complete upgrade to HD in 2017.
E	MCR for HD	Currently updating	Expected to complete upgrade to HD in 2017.

Legend: The alphabetical characters in the table indicate the categories of the equipment as described in 4.3.2.
Source: JICA Survey Team

(2) Condition of the equipment that needs to be upgraded to HD and estimates of expenses

Based on the company's business scale, the steps for the migration into HD were projected in three stages of three years. In the initial stage, the facilities for editing programmes will be upgraded to HD. Since the videos provided by CNN are already in HD, employing an HD editing system will enable HD broadcasting of CNN programmes. Then, the news studio equipment will be replaced with HD equipment, and finally, the video archiving facilities will be replaced. A total of approximately USD 200,000 in funding will be needed.

Table 4.4-2 Condition of facilities that need to be upgraded to HD and estimates of expenses (Art TV)

No	Facilities / equipment		Quantity	Estimated expenses (thousand USD)	Scheduled year of completion
1	A	Facilities for filming HD images (news studio equipment)	1 lot	79	2019
2	B	Facilities for post-production of HD programmes	1 lot	91	2018
3	C	Facilities for archiving HD images	1 lot	36	2020
Total				206	

(See Appendix 47 for breakdown of facilities/equipment and expenses)
Legend: The alphabetical characters in the table indicate the categories of the equipment as described in 4.3.2.
Source: JICA Survey Team

(3) Plans for investment and methods to secure funds

Funding for purchasing HD equipment is self-funding and the company sometimes receive funding from their parent company, IWS Holdings. Bank loans can also be considered. The creditworthiness of the loan is usually evaluated for the entire IWS Group, so the company are expected to receive loans without problems.

Appendix 54 shows the draft of the schedule for migration into HD proposed to Art TV in This Survey.

4.4.2 Buddhist TV

(1) State of the existing broadcasting facilities

Buddhist TV are a religious broadcasting station and classified as a small broadcasting station because they have only one transmitting station for terrestrial broadcasting in Greater Colombo. Their programmes can be viewed through a telecommunication provider Dialog TV, and Internet TV operated by SLT, to which the number of subscribers is estimated at approximately 1 to 2 million households. In addition, their programmes broadcast in countries around the world 24 hours a day through satellite links have many viewers other than the terrestrial broadcast recipients. The station also provides radio broadcasting and operate five FM transmission stations. The company started television service in 2007 and radio service in 2010.

All operational expenses are covered by donations. The revenue is approximately Rs. 200 million a year. As equipment maintenance costs Rs. 150 to 170 million a year, the station has to ask for additional donations whenever it plans to produce a new programme.

The company have three TV studio sets in Colombo and one in Kandy. They only record programmes in Kandy and send video tapes to Colombo to broadcast the programmes. The company have a total of 15 cameras in Colombo and Kandy and all of them are HD cameras. Three of them support 4K broadcasting. The company also have two studios for 4K broadcasting. Their video switchers and MCR have also been upgraded to support HD. Currently, programmes are down-converted to SD for broadcasting. The company also have five units of non-linear editing systems.

The company are purchasing more HD equipment and the upgrade of equipment to HD equipment is expected to be completed in the near future.

Table 4.4-3 Situation regarding the upgrade of existing equipment for HD broadcasting (Buddhist TV)

Facilities / equipment		Situation of update	Remarks
A	Facilities for filming HD images	Already updated	All 15 cameras are for HD broadcasting. (three of them support 4K)
B	Facilities for post-production of HD programmes	Currently updating	Expected to complete upgrade to HD in 2017.
C	Facilities for archiving HD images	Currently updating	Equipment that support 4K has been introduced and is used for archiving images of cultural heritage.
D	Facilities for routing of HD broadcasting	Currently updating	Expected to complete upgrade to HD in 2017.
E	MCR for HD	Currently updating	Expected to complete upgrade to HD in 2017.

Legend: The alphabetical characters in the table indicate the categories of the equipment as described in 4.3.2.
Source: JICA Survey Team

(2) Condition of the equipment that needs to be upgraded to HD and estimates of expenses

The company plan to launch new substations in Galle and Matara in the southern area of Sri Lanka, each of which is to be equipped with a studio with three cameras. A total of Rs. 4 million will be procured to accomplish this plan.

As of December 2016, Buddhist TV were promoting the replacement of equipment with HD equipment and expected to complete the update to HD in the first quarter of 2017.

(3) Plans for investment and methods to secure funds

The company usually purchase equipment with cash because banks charge high interest rates on loans. Therefore, the company reportedly have no debt. They purchased some equipment in monthly instalments over a four-year period in the past. The company plan to continue purchasing equipment with cash.

4.4.3 CSN

(1) State of the existing broadcasting facilities

CSN used to be a sports channel. Their broadcasting service has been suspended due to a court order and they currently only transmit test radio waves. A case of corruption in procurement of equipment led to the suspension of broadcasting. As this case is still in trial, the future of the company is uncertain.

CSN aim to resume broadcasting and plan to transform their channel from a sports channel to a news-oriented channel providing a wide variety of programmes in preparation for the resumption. They have a single channel broadcasting network and, therefore, are classified as a medium or small broadcasting station.

At present, only one camera out of a total of nine supports HD. CSN plan to install a TV studio as well as a news studio. They spent Rs. 25 million to purchase and installed a server-based broadcasting system. Although the company have installed video archiving facilities, ENG cameras, an editing system, MCR, etc., only the editing system and part of the MCR support HD broadcasting. The rest need to be upgraded in the future.

Table 4.4-4 Situation regarding the upgrade of existing equipment for HD broadcasting (CSN)

Facilities / equipment		Situation of update	Remarks
A	Facilities for filming HD images	Currently updating	Camera system has been partially upgraded for HD broadcasting.

Facilities / equipment		Situation of update	Remarks
B	Facilities for post-production of HD programmes	Currently updating	
C	Facilities for archiving HD images	Not started	
D	Facilities for routing of HD broadcasting	Not started	
E	MCR for HD	Already updated	

Legend: The alphabetical characters in the table indicate the categories of the equipment as described in 4.3.2.
Source: JICA Survey Team

(2) Condition of the equipment that needs to be upgraded to HD and estimates of expenses

Although it is uncertain whether CSN can restart broadcasting, the migration into HD of CSN by DSO-HD of DBNO can be performed in five stages as shown in the table below.

First of all, the TV studio will be upgraded to HD and the editing system will follow suit at a later date. Then, the news studio, video archiving facilities and routing facilities will be upgraded to HD in this order. With this schedule, the upgrading will be completed by DSO-HD. JICA Survey Team estimated the cost of the upgrade at USD 500,000, while CSN estimate it at Rs. 200 million, implying that CSN's estimate is approximately twice JICA Survey Team's estimates. It has not been possible to conclude that CSN's estimate is too much without knowledge of the contents and range of the upgrade considered by CSN in the estimation. It is necessary to continue monitoring if the broadcasting will be restarted.

Table 4.4-5 Condition of facilities that need to be upgraded to HD and estimates of expenses (CSN)

No	Facilities / equipment		Quantity	Estimated expenses (thousand USD)	Scheduled year of completion
1	A	Facilities for filming HD images (news studio equipment)	1 lot	155	2020
2	A	Facilities for filming HD images (TV studio equipment)	1 lot	205	2018
3	B	Facilities for post-production of HD programmes	1 lot	91	2019
4	C	Facilities for archiving HD images	1 lot	36	2021
5	D	Facilities for routing of HD broadcasting	1 lot	27	2022
Total				514	

(See Appendix 48 for breakdown of facilities/equipment and costs)
Legend: The alphabetical characters in the table indicate the categories of the equipment as described in 4.3.2.
Source: JICA Survey Team

(3) Plans for investment and methods to secure funds

Basically, CSN plan to take a bank loan to purchase HD equipment. Although CSN has purchased studio equipment with its own funds, the company borrowed money from a bank to purchase transmitters and other equipment. The company have not prepared a plan for the procurement of equipment. They have replaced their equipment when their financial situation allows it. Whether the company can restart broadcasting is more important than ensuring funds at the moment. It is assumed that CSN will raise funds after the company restarts broadcasting.

Appendix 55 shows the draft of the schedule of migration into HD proposed to CSN in This Survey.

4.4.4 Derana TV

(1) State of the existing broadcasting facilities

Derana TV is one of the popular broadcasting stations and is considered a large broadcasting station due to its large broadcasting networks. It is one of the typical broadcasting stations that attracts many viewers and gains advertising revenue through active production of programmes. While MTV and EAP are long-established stations, Hiru TV and Derana TV can be regarded as representatives of emerging forces. Derena TV have two channels, a 24-hour news channel and 18-hour entertainment channel. Although they purchase dramas from external production companies, the company basically produce other programmes on its own.

Derena TV have a studio complex in Nugegoda with six TV studios that have an 80 m x 100 m floor space. All of its equipment is HD equipment. However, they do not use a transmission link from the studio complex to the broadcasting centre in Colombo because, according to the company, the line usage fees are so expensive that it costs less to save recorded materials and programmes on a hard disk and take it to the broadcasting centre than to use the link. Most of studio broadcasting facilities in the broadcasting centre are those for HD broadcasting. Only part of the three news studios and two TV studios does not support HD broadcasting and all the other facilities can be used for HD broadcasting. They upgraded their switchers, ENG cameras, and other equipment to support HD over the past three to four years. They upgraded the fully-automated MCR to support HD spending approximately USD 8,000.

In addition, the broadcasting centre has ten non-linear editing systems, a 360-terabytes (hereinafter referred to as “TB”) server, 12 TB news server, and an OB Van equipped with eight SD cameras.

Table 4.4-6 Situation regarding the upgrade of existing equipment for HD broadcasting (Derana TV)

Facilities / equipment		Situation of update	Remarks
A	Facilities for filming HD images	Currently updating	There are three news studios and two TV studios. Some of the studio equipment does not support HD broadcasting.
B	Facilities for post-production of HD programmes	Already updated	
C	Facilities for archiving HD images	Already updated	
D	Facilities for routing of HD broadcasting	Already updated	
E	MCR for HD	Already updated	

Legend: The alphabetical characters in the table indicate the categories of the equipment as described in 4.3.2.
Source: JICA Survey Team

(2) Condition of the equipment that needs to be upgraded to HD and a rough estimate of expenses

As of December 2016, the company were already updating their equipment to that for HD broadcasting and the updating was expected to complete in the first quarter of 2017. Although the progress has not been confirmed, the company have already upgraded most equipment to HD and is ready to start HD broadcasting soon.

(3) Plans for investment and methods to secure funds

The company invested Rs. 150 million to make their studio equipment support HD in 2016. The company plan to take a bank loan to upgrade some of their cameras to support HD.

4.4.5 EAP

(1) State of the existing broadcasting facilities

When private broadcasting stations in Sri Lanka are classified by the scale of broadcasting networks[9], EAP would be classified as a large broadcasting station. However, since the existing studio building is outdated and small, it is difficult to continue using it after DSO-HD and install HD equipment. Therefore, EAP are planning to relocate the studio building to a suburb of Colombo. However, because of many unsettled issues associated with the uncertainty concerning the time of ASO until

[9] This is not classification based on defined criteria, but classification by the JICA Survey Team based on the findings in the interviews with the people involved in DTTB in Sri Lanka. The classification does not indicate the volume of operating revenue or financial situation.

which the period of simultaneous broadcasting lasts, the scale of investment required for the migration into DTTB, and the business model of DBNO, the company have been unable to determine the time of relocation.

For this reason, as shown in Table 4.4-7, only the MCR has been upgraded to support HD. EAP operate two studios: a news studio and a TV studio. Equipment required for filming HD images in these studio is being purchased. The time of the installation of the rest of equipment in the studios has not been decided yet.

Table 4.4-7 Situation regarding the upgrade of existing equipment for HD broadcasting (EAP)

Facilities / equipment		Situation of update	Remarks
A	Facilities for filming HD images	Currently updating	
B	Facilities for post-production of HD programmes	Not started	Six sets of non-linear editing systems for SD broadcasting are used. (three sets of an online editing system connected to a server, and three sets of an offline stand-alone system)
C	Facilities for archiving HD images	Not started	
D	Facilities for routing of HD broadcasting	Not started	
E	MCR for HD	Already updated	An automatic transmission system with a server ready for HD broadcasting has already been introduced.

Legend: The alphabetical characters in the table indicate the categories of the equipment as described in 4.3.2.

Source: JICA Survey Team

(2) Condition of the equipment that needs to be upgraded to HD and a rough estimate of expenses

EAP will need to procure various HD equipment in the future, for example, news and TV studio facilities, HD cameras for field reporting, editing system, video archiving facilities, and routing facilities.

First, the TV studio facilities will be upgraded to support HD. Then, equipment for field reporting, editing equipment, and routing facilities will be upgraded. This upgrading will enable the minimum required production and broadcasting of HD programmes. Then the news studio will be upgraded to support HD and finally the video archiving facilities will be upgraded to complete the migration to HD.

A total of a little more than USD 1.1 million will be invested in three stages of three years for the upgrading. Funds of approximately USD 330,000 to 380,000 will be required for the investment every year.

Table 4.4-8 Condition of facilities that need to be upgraded to HD and estimates of expenses (EAP)

No	Facilities / equipment		Quantity	Estimated expenses (thousand USD)	Scheduled year of completion
1	A	Facilities for filming HD images (news studio equipment)	1 lot	362	2020
2	A	Facilities for filming HD images (TV studio equipment)	1 lot	375	2018
3	A	Facilities for filming HD images (camera)	1 lot	27	2019
4	B	Facilities for post-production of HD programmes	1 lot	273	2019
5	C	Facilities for archiving HD images	1 lot	36	2021
6	D	Facilities for routing of HD broadcasting	1 lot	36	2019
Total				1,109	

(See Appendix 49 for breakdown of facilities/equipment and costs)

Legend: The alphabetical characters in the table indicate the categories of the equipment as described in 4.3.2.

Source: JICA Survey Team

(3) Plans for investment and methods to secure funds

Basically, the company plan to replace the existing studio broadcasting equipment with new HD equipment when they move to the new station building. In ordinary procurement, the company use its own funds or bank loans to procure equipment and it is expected to use both its own funds and bank loans for upgrading their equipment to support HD. The company plan to procure equipment and facilities when it is convenient for them without planning to receive loans from public institutions. Appendix 56 shows the draft of the schedule for migration into HD proposed to EAP in This Survey.

4.4.6 Hiru TV

(1) State of the existing broadcasting facilities

Hiru TV broadcast programmes on one channel and has a broadcasting network with 11 transmitting stations. It can be classified as a large broadcasting station according to the number of transmitting stations they operate. The company is currently considering adding one more channel. However, due to a lack of frequency, they are considering the possibility of using satellite broadcasting of Dialog TV.

Hiru TV has been actively upgrading its equipment to support HD and the necessary equipment is being installed or has already installed in every facility of the station. However, as the cameras in their studios are not of HD, most programmes are recorded in SD. The MCR has been basically upgraded to support

HD. Therefore, they can start operating HD broadcasting using the current equipment once they purchase a HD licence key.

Table 4.4-9 Situation regarding the upgrade of existing equipment for HD broadcasting (Hiru TV)

Facilities / equipment		Situation of update	Remarks
A	Facilities for filming HD images	Currently updating	Camera systems do not support HD broadcasting.
B	Facilities for post-production of HD programmes	Already updated	
C	Facilities for archiving HD images	Currently updating	
D	Facilities for routing of HD broadcasting	Already updated	
E	MCR for HD	Currently updating	Although MCR is currently operated for SD broadcasting, it can be switched to HD operation by purchasing an HD licence key.

Legend: The alphabetical characters in the table indicate the categories of the equipment as described in 4.3.2.
Source: JICA Survey Team

(2) Condition of the equipment that needs to be upgraded to HD and an estimate of expenses

As described above, most of the facilities and equipment support HD broadcasting. A total of USD 200,000 or so is required to upgrade the rest to support HD. Approximately 60% of this amount is for upgrading the TV studio to support HD. As Hiru TV is one of the most popular broadcasting stations in Sri Lanka at present, it is assumed that the company receive a considerable amount of advertising revenue. Therefore, the procurement mentioned below can most likely be carried out at one time.

Table 4.4-10 Condition of facilities that need to be upgraded to HD and estimates of expenses (HiruTV)

No	Facilities / equipment		Quantity	Estimated expenses (thousand USD)	Scheduled year of completion
1	A	Facilities for filming HD images (TV studio equipment)	1 lot	136	2018
2	C	Facilities for archiving HD images	1 lot	36	2018
3	E	MCR for HD	1 lot	45	2018
Total				217	

(See Appendix 50 for breakdown of facilities/equipment and costs)

Legend: The alphabetical characters in the table indicate the categories of the equipment as described in 4.3.2.
Source: JICA Survey Team

(3) Plans for investment and methods to secure funding

Hiru TV had invested approximately Rs. two billion in purchasing HD equipment as of the time of This Survey. The company plan to procure funds to purchase HD equipment using loans from their main bank and complete upgrading to HD by 2018. Appendix 57 shows the draft of the schedule of migration to HD proposed to Hiru TV in This Survey.

4.4.7 Max TV

(1) State of the existing broadcasting facilities

As of November 2016, new management of Max TV was preparing to restart broadcasting. They left the station building used under the former management, rented a new station building in Colombo City, and are installing equipment. They plan to restart operation with a set of TV studio and eventually have three or four studios. Their largest sponsor is SLT. The new management plans to run a comprehensive channel that consists of news, entertainment, sports, and religious programmes. Their broadcasting service area comprises the entire Western Province and, therefore, the company can be classified as a small broadcasting station.

Currently, Max TV is only performing test broadcasting. Equipment is now being installed in the new station building. The company are installing a set of studios for HD programmes equipped with a three cameras system and planning to hire approximately 50 production staff members. It is expected that the company will start installing equipment in full scale.

Table 4.4-11 Situation regarding the upgrade of existing equipment for HD broadcasting (Max TV)

Facilities/equipment		Situation of update	Remarks
A	Facilities for filming HD images	Currently updating	Broadcasting facilities equipped with three HD cameras are being installed.
B	Facilities for post-production of HD programmes	Currently updating	Expected to complete upgrade to HD in 2017.
C	Facilities for archiving HD images	Currently updating	Expected to complete upgrade to HD in 2017.
D	Facilities for routing of HD broadcasting	Currently updating	Expected to complete upgrade to HD in 2017.
E	MCR for HD	Currently updating	Expected to complete upgrade to HD in 2017.

Legend: The alphabetical characters in the table indicate the categories of the equipment as described in 4.3.2.
Source: JICA Survey Team

(2) Condition of the equipment that needs to be upgraded to HD and estimates of expenses

As of February 2017, the company had already started to the replacement with HD equipment and this process was expected to be completed in the third quarter of 2017. However, it is uncertain whether this process can be achieved as expected because of large uncertainty concerning their staff employment and fund raising. The status of management operations needs to be monitored continuously.

(3) Plans for investment and methods to secure funding

Although the company plan to purchase HD equipment with its own funds, it is not known whether they have a practical method for ensuring the funds.

4.4.8 MTV

(1) State of the existing broadcasting facilities

MTV have three channels and are classified as a large broadcasting station for their wide broadcasting network. They are also Sri Lanka's representative broadcasting station and very popular among viewers.

The company have two broadcasting facilities outside their head office in the suburb of Colombo. The facilities in the Pannipitiya Broadcasting Centre located in the inland east of Colombo city are somewhat old. The company also have the Stein Studio Complex in the south of Colombo. They have ten TV studios in total and six of them are operated in the studio complex. Some facilities in the Stein Studio Complex are equipped with SD-HD switchable cameras and switchers. However, all facilities including MRC in the Pannipitiya Broadcasting Centre are for SD broadcasting. MTV replace their studio equipment in an eight- to ten-year cycle. The currently used equipment does not support HD and is becoming outdated. The company own 27 cameras in total and all of its programmes are currently filmed and produced in SD.

In addition to these studio facilities, MTV own two OB Vans. Each OB Van is equipped with four HD cameras. However, all the other equipment on the vans is of SD and the entire system including equipment on OB Vans needs to be upgraded to support HD.

Although MTV operates three channels and have more facilities than other broadcasting companies, most of its existing facilities is for SD broadcasting as shown in Table 4.4-12. MTV cannot achieve full-HD operation unless the company upgrades these facilities and equipment to support HD.

Table 4.4-12 Situation regarding the upgrade of existing equipment for HD broadcasting (MTV)

Facilities / equipment		Situation of update	Remarks
A	Facilities for filming HD images	Currently updating	One of 10 production studios (in Stein Studio Complex) is available for HD broadcasting. 2 OB Vans has been upgraded for HD broadcasting.
B	Facilities for post-production of HD programmes	Not started	
C	Facilities for archiving HD images	Not started	
D	Facilities for routing of HD broadcasting	Not started	MCRs at Stein Studio Complex and Pannipitiya are connected with microwave cables and optical fibre cables (4.5 Mbps), which are used for live broadcasting.
E	MCR for HD	Not started	A MCR and 4 studios at the Pannipitiya Broadcasting Centre cannot be used for HD broadcasting.

Legend: The alphabetical characters in the table indicate the categories of the equipment as described in 4.3.2.
Source: JICA Survey Team

(2) Condition of the equipment that needs to be upgraded to HD and estimates of expenses

Since MTV have many facilities, the company need to upgrade some of production equipment and the routing facilities to those for HD broadcasting as soon as possible. The five TV studios and routing facilities will be upgraded to HD in the first year. Then, the OB Van systems and programme editing equipment will be upgraded. In the third stage, the four new studios will be upgraded, the video archiving facilities will be upgraded in the following year and, finally, the MCR will be upgraded to HD. It is assumed that the upgrade of MCR will be completed before the DBNO starts HD broadcasting in 2022. As the floor area of the current MCR is small, a space to install HD equipment for MCR needs to be created skilfully without interrupting the current SD broadcasting.

A total capital investment in this upgrade will be nearly USD 7.3 million, of which a little more than USD three million, USD 1.4 million, USD 1.8 million, nearly USD 36,000, and USD 800,000 will be spend in the first, second, third, fourth and fifth years, respectively. If the company do not have any financing problems, they should consider consolidating the fourth and fifth year in a year to complete the upgrade in four years.

When MTV considered upgrading all 27 of their cameras to HD in the past, they estimated the cost at USD 800,000, which is not much different from the estimate shown in the table below. MV must examine the specifications of equipment to be procured carefully because they need to raise much larger amount of fund for the upgrade than other broadcasting stations.

Table 4.4-13 Condition of facilities that need to be upgraded to HD and estimates of expenses (MTV)

No	Facilities / equipment		Quantity	Estimated expenses (thousand USD)	Expected year of completion
1	A	Facilities for filming HD images (news studio equipment)	4 lot	1,818	2020
2	A	Facilities for filming HD images (TV studio equipment)	5 lot	3,182	2018
3	A	Facilities for filming HD images (OB Van)	1 lot	1,145	2019
4	B	Facilities for post-production of HD programmes	1 lot	273	2019
5	C	Facilities for archiving HD images	1 lot	36	2021
6	D	Facilities for routing of HD broadcasting	1 lot	36	2018
7	E	MCR for HD	1 lot	773	2022
Total				7,263	

(See Appendix 51 for breakdown of facilities/equipment and costs)

Legend: The alphabetical characters in the table indicate the categories of the equipment as described in 4.3.2.

Source: JICA Survey Team

(3) Plans for investment and methods to secure funds

MTV intend to upgrade their broadcasting equipment to HD by replacing their existing equipment. So far, MTV basically have used loans from multiple banks and loans available within the Maharaja group for the procurement of equipment. The company sometimes use 12- to 24-month equipment leases as well. MTV plan to procure funds the upgrade in the same way.

Appendix 58 shows the draft of the schedule for migration into HD proposed to MTV in This Survey.

4.4.9 Rangiri TV

(1) State of the existing broadcasting facilities

Rangiri TV is a religious broadcasting station opened in Dambulla near the Sigiriya Rock in 2006. The station provides broadcasting 17.5 hours a day. In addition to preaching, the station airs a wide variety of programmes including educational programmes for children and agriculture, wildlife, history, science and technology, and entertainment programmes. They produce approximately 90%

of the programmes in house and purchase movies and some other programmes. They sometimes insert subtitles for movies and broadcast other movies in English without any subtitles.
Their broadcasting network is only capable of providing programmes in the area covered by their transmission station in Gammaduwa. Therefore, the company are classified as a small broadcasting station. Their programmes can be watched via the Internet TV of SLT.
The company have two TV studios and one of them is being equipped. Although most of their equipment is of HD, they are broadcasting programmes in SD. The studios are also equipped with virtual camera systems. Sections in the station are connected by a gigabyte network. The station is equipped with six sets of non-linear editing systems and a HD/SD switchable MCR. A broadcasting facilities server method is used and a large proportion of the equipment is new. The company have not installed video archiving facilities and they manage recorded programmes manually using a list on paper.
The total operational expenses of the broadcasting station are approximately Rs. three million for TV and radio services. The rent of the station building is not included in the operational expenses because the building is lent from a temple for free.

Table 4.4-14 Situation regarding the upgrade of existing equipment for HD broadcasting (Rangiri TV)

Facilities / equipment		Situation of update	Remarks
A	Facilities for filming HD images	Currently updating	Part of studio equipment cannot be used for HD broadcasting.
B	Facilities for post-production of HD programmes	Already updated	
C	Facilities for archiving HD images	Not started	
D	Facilities for routing of HD broadcasting	Already updated	
E	MCR for HD	Already updated	Signals are transmitted from a server system compatible with SD and HD broadcasting.

Legend: The alphabetical characters in the table indicate the categories of the equipment as described in 4.3.2.
Source: JICA Survey Team

(2) Condition of the equipment that needs to be upgraded to HD and a rough estimate of expenses
It is estimated that procurement of equipment required for the partially equipped studio will cost approximately USD 360,000. If the company purchase video archiving facilities not available in the station, approximately USD 36,000 of fund will be required in addition. Other than these, they do not need to replace their equipment as they have procured mostly HD equipment since their establishment.

Table 4.4-15 Condition of facilities that need to be upgraded to HD and estimates of expenses (Rangiri TV)

No		Facilities / equipment	Quantity	Estimated expenses (thousand USD)	Scheduled year of completion
1	A	Facilities for filming HD images (TV studio equipment)	1 lot	364	2018
2	C	Facilities for archiving HD images	1 lot	36	2019
Total				400	

(See Appendix 52 for breakdown of facilities/equipment and costs)

Legend: The alphabetical characters in the table indicate the categories of the equipment as described in 4.3.2.

Source: JICA Survey Team

(3) Plans for investment and methods to secure funds

They purchased equipment with donations received when they started broadcasting. They spent approximately Rs. 750 million for the purchase of radio and TV equipment and the construction of the building (including Rs. 250 million for the purchase of radio broadcasting equipment). They secured funds for the procurement of equipment with a letter of credit (hereinafter referred to as "LC").

Donation-based operations were abolished in January 2016 in accordance with a decision of the Steering Committee and the company started to earn funds from advertising and sponsorships. The company now pays corporate tax. When operating funds run short, the company takes short-term loans from banks and pays them back within two or three months.

Appendix 59 shows the draft of the schedule for migration into HD proposed to Rangiri TV in This Survey.

4.4.10 Shraddha TV

(1) State of the existing broadcasting facilities

Shraddha TV is a religious broadcasting station located in an eastern inland area, one hour away by car from Colombo. The station is operated with donations which total approximately Rs. 24 million a year. Their broadcasting service only covers Greater Colombo and, thus, they are classified as a small broadcasting station.

Even though their MCR and six cameras are of HD, they are unable to offer HD broadcasting because their software has not been updated. Their editing equipment and line facilities have also been updated to HD. Their studio equipment was flooded in July 2016. When JICA Survey Team interviewed them, they have collected donations and started working on recovering from the flood damage.

They have not installed video archiving facilities and most of the other equipment and facilities have been upgraded for HD broadcasting.

Table 4.4-16 Situation regarding the upgrade of existing equipment for HD broadcasting (Shraddha TV)

Facilities / equipment		Situation of update	Remarks
A	Facilities for filming HD images	Already updated	
B	Facilities for post-production of HD programmes	Already updated	
C	Facilities for archiving HD images	Not started	
D	Facilities for routing of HD broadcasting	Already updated	
E	MCR for HD	Not started	It will be necessary to pay for updating software to start HD broadcasting.

Legend: The alphabetical characters in the table indicate the categories of the equipment as described in 4.3.2.
Source: JICA Survey Team

(2) Condition of the equipment that needs to be upgraded to HD and estimates of expenses

If video archiving facilities need to be installed in the future, it is advisable to install HD video archiving facilities first and complete the upgrade to HD of the remaining equipment of MRC by 2021 in which DBNO will be ready to broadcast HD programmes. A total of USD 80,000 should be procured for this upgrade.

Table 4.4-17 Condition of the facilities that need to be upgraded to HD and estimates of expenses (Shraddha TV)

No	Facilities / equipment		Quantity	Estimated expenses (thousand USD)	Scheduled year of completion
1	C	Facilities for archiving HD images	1 lot	36	2019
2	E	MCR for HD	1 lot	45	2021
Total				81	

(See Appendix 53 for breakdown of facilities/equipment and costs)
Legend: The alphabetical characters in the table indicate the categories of the equipment as described in 4.3.2.
Source: JICA Survey Team

(3) Plans for investment and methods to secure funds

Shraddha TV is registered as a non-profit organisation. The cost of electricity and rent for the tower lent from SLT are practically their only major operational expenses. The rent for the tower is approximately Rs. 300,000 per month. The company is facing severe financial difficulties to pay this rent.

They mentioned that they had invested approximately Rs. 50 million to procure studio equipment. In principle, no tax will be charged on purchase of equipment, but value-added tax (hereinafter referred to as VAT) will applied to the equipment. The company plans to fund purchase of HD broadcasting equipment and facilities with donations.

Appendix 60 shows the draft of the schedule for migration into HD proposed to Shraddha TV in This Survey.

4.4.11 TNL

TNL broadcast programmes using one channel and have a broadcasting network including ten transmitting stations. For the coverage of this network, TNL can be classified as a medium-size broadcasting station.

As JICA Survey Team could not conduct an interview with them in This Survey, the status of operation of the station or activities for the migration into DTTB are not clear.

4.4.12 VIS Broadcasting

(1) State of the existing broadcasting facilities

VIS Broadcasting, with assistance from CCTV, broadcast CCTV's programmes in Colombo using their terrestrial analogue TV broadcasting network. All expenses to purchase transmitters and operation costs are provided by CCTV. The company do not provide nationwide broadcasting because there is no frequency available for television broadcasting in Sri Lanka. They use 3kW transmitters in a fully redundant configuration.

They also provide FM radio broadcasting as a member of the Sky Media Group.

(2) Condition of the equipment that needs to be upgraded to HD and a rough estimate of expenses

VIS Broadcasting have no equipment that needs to be upgraded to HD because they do not produce any programmes. The initial investment to establish the current operations was Rs. 10 million and the current monthly revenue is Rs. 1.8 million.

(3) Plans for investment and methods to secure funds

Expenses for the transmission facilities for terrestrial analogue TV broadcasting are paid in full by CCTV. For this reason, VIS Broadcasting think that they will need to produce their own programmes and broadcast them nationwide, if they decide to provide DTTB service.

4.4.13 Voice of Asia

(1) State of the existing broadcasting facilities

Voice of Asia provide broadcasting in Sinhalese and Tamil. The company use five and there transmitting stations for broadcasting in Sinhalese in Tamil, respectively, and can be classified as a medium-size broadcasting station. The company have already applied for licences for frequency usage for broadcasting in Tamil so that they can transmit programmes in Tamil from five locations like the programmes in Sinhalese. They have also applied for licences for frequency usage in Jaffna, Ratnapura, and Namupura in order to expand their broadcasting networks. The station broadcasts 17.5 hours a day.

The company have one TV studio and two news studios. However, news studios are so simple that it is difficult to produce sophisticated news programs there. The TV studio is equipped with four SD cameras. They use two SD cameras and three ENG cameras in the two news studios. They have three non-linear editing systems and one editing device both for computer graphics and general programmes. They have a material server and a transmission server both of which need to be replaced to provide HD broadcasting service.

The company is partially upgrading their equipment to support HD, spending approximately USD 0.5 million a year for the replacement of studio facilities. As the transmitters need to be replaced, the company has prepared an equivalent amount of funds to purchase them.

Table 4.4-18 Situation regarding the upgrade of existing equipment for HD broadcasting (Voice of Asia)

Facilities / equipment		Situation of update	Remarks
A	Facilities for filming HD images	Currently updating	Voice of Asia have one main and two news studios. Some of them are not ready for HD broadcasting.
B	Facilities for post-production of HD programmes	Currently updating	Expected to complete upgrade to HD in 2017.
C	Facilities for archiving HD images	Currently updating	Expected to complete upgrade to HD in 2017.
D	Facilities for routing of HD broadcasting	Currently updating	Expected to complete upgrade to HD in 2017.
E	MCR for HD	Already updated	

Legend: The alphabetical characters in the table indicate the categories of the equipment as described in 4.3.2.

Source: JICA Survey Team

(2) Condition of the equipment that needs to be upgraded to HD

As of April 2017, the company had already started to replace their equipment with HD equipment and the migration into HD was expected to be completed by the end of 2017. However, the progress of the replacement has not been confirmed. At the time of the survey in August 2016, the company planned to spend USD 4 to 5 million to upgrade their equipment to HD. However, their business situation seems to have changed and their progress cannot be confirmed.

(3) Plans for investment and methods to secure funds

According to the company, they replaced their equipment with HD equipment using USD 2 to 3 million bank loans. They plan to use bank loans as the main funding source for the purchase of equipment in the future while considering the use monthly instalment schemes offered by manufacturers.

4.4.14 Outline of HD broadcasting equipment

Some of the large broadcasters such as EAP and MTV for which the timing of equipment replacement will coincide with the migration into DTTB will conduct replacement of equipment for HD broadcasting in full scale. On the other hand, as newly-established broadcasters seem to have started installing new equipment, some or a large portion of their equipment is already of HD.

Many broadcasters plan to use bank loans or their own funds to finance purchase of HD equipment and facilities. Therefore, there is no necessity for a special financing scheme for private broadcasting stations.

Table 4.4-19 outlines the preparation for DSO-HD of the private broadcasting stations.

Table 4.4-19 Outline of the situation regarding HD broadcasting equipment of private broadcasting stations

No	Broadcaster	Date of Interview	Estimated year of completion for HD equipment installation	Total cost estimation for HD equipment installation (thousand USD)	Facilities for HD broadcasting						
					Filming			Post Production	Archive	Routing	MCR
					Studio	Camera	OB Van				
1	Art TV	09/12/2016	2020	206	SD★	HD	-	SD★	SD	(HD)	(HD)
2	Buddhist TV	15/12/2016	2017 Q1	0	HD	HD	HD	(HD)	(HD)	(HD)	(HD)
3	CSN	25/04/2017	2022	514	SD	HD	-	SD	SD	SD	HD
4	Derana TV	14/12/2016	2017 Q1	0	(HD)	HD	HD	HD	HD	HD	HD
5	EAP	07/12/2016	2021	1,109	SD★	SD	-	SD	SD	SD	HD
6	Hiru TV	20/12/2016	2019	217	SD★	HD	HD	HD	(HD)	HD	SD★
7	Max TV	02/02/2017	2017Q3	0	(HD)	(HD)	-	(HD)	(HD)	(HD)	(HD)
8	MTV	01/02/2017	2022	7,263	SD	HD	SD	SD	SD	SD★	SD
9	Rangiri TV	03/03/2016	2019	400	SD	HD	-	HD	SD	HD	HD
10	Shraddha TV	09/02/2017	2021	81	HD	HD	-	HD	SD	HD	SD
11	TNL	-	N/A	-	-	-	-	-	-	-	-
12	VIS Broadcasting	09/02/2018	-	-	-	-	-	-	-	-	-
13	Voice of Asia	24/04/2017	2017	0	(HD)	HD	-	(HD)	(HD)	(HD)	HD

< Legend >
HD: Already upgraded to HD system
(HD): Estimated to be upgraded to HD system within a few months from the date of interview
★: Partially upgraded to HD system

Chapter 5 Optimization for antenna mast of Lotus Tower

Chapter 5 Optimization for antenna mast of Lotus Tower

5.1 Outline of Lotus Tower

Lotus Tower is a building which the Government of Sri Lanka has been constructing in Colombo from 2012, with the fund assistance by China. The Project Consultant Unit (hereinafter referred to as PCU) under TRC is managing the project of Lotus Tower construction and overall planning. China National Electronics Import & Export Corporation (hereinafter referred to as CEIEC), a national company of China, is in charge of construction work and management of Lotus Tower.

The antenna mast (hereinafter referred to as Tower Mast) of Lotus Tower consists of six stages, which are called T1 section to T6 section in order from the top. At the highest top part of Lotus Tower, Tower Mast has been installed and transmitting antenna for DTTB will be installed on Tower Mast. Transmitter room and NOC as the main platform of DTTB will be operated in Lotus Tower. Transmitting station for Greater Colombo will also be established in Lotus Tower. It is also expected to function as common radio tower for radio broadcasting and wireless telecommunication for such as mobile phone. The transmission antenna for DTTB which will be procured by Yen Loan Project is supposed to be installed in T1 Section.

T3 Section to T6 Section are planned to be used as an antenna installation site for radio broadcasting and mobile phone, but concrete plans have not progressed and the usage objective has not become clear at present.

Transmitter room and NOC will be prepared in one of the floors in Tower House located just under Tower Mast. It is expected that parabolic antennas for transmitting microwave will be installed on the platform located about 20 meters under Tower House. In Tower Base on the ground, commercial facilities are planned to open from 2018.

Schematic view of Lotus Tower is shown below.

Source: JICA Survey Team

Figure 5.1-1 Schematic view of Lotus Tower

5.2 Points of change from original design

5.2.1 Outline of Tower Mast and T1 Section

Tower Mast is a structure about 90 meters tall overall and consists of 6 sections (T1 Section - T6 Section). Production of 6 sections has been done by CEIEC in China and all parts were transported to Lotus Tower in Colombo in February 2017. Afterwards, each section was connected, welded, hoisted up and installed at the top of Lotus Tower. Antenna panels (in total 28) are supposed to be installed at T1 Section of Tower Mast. Schematic view of Tower Mast is shown in Appendix 61.

5.2.2 Activities before starting survey in Sri Lanka

JICA Survey Team had obtained drawings of Tower Mast from TRC during Previous Survey and requested TRC to introduce designs and specifications suitable for UHF antenna. An agreement was formed between the Government of Sri Lanka and JICA.

A conference was held in advance among JICA, TRC, CEIEC and JICA Survey Team to discuss and share recognition regarding design of Lotus Tower. JICA Survey Team pointed out that drawings of T1 Section needed to be modified for installation of transmission antenna for DTTB and the indications were agreed with CEIEC. It was also confirmed that there is no liability for warranty on the design of the T1 section on the Japanese side. All work regarding T1 Section in This Survey was done based on this agreement.

5.2.3 Activities in Sri Lanka

After starting This Survey, JICA Survey Team had meetings with TRC and CEIEC to discuss details for design of T1 and T2 Section, such as position of inner ladders, laying feeder cables, angles for antenna installation and so on. JICA Survey Team each time prepared necessary drawings in order for technical confirmation to be done properly.

Requests from JICA Survey Team are shown below.

Table 5.2-1 Requested points regarding design of T1 Section from JICA Survey Team to CEIEC

No.	Point	Request
1	Rectangular steel pipe	Correcting drawing: size of pipes
2	Outer Ladder	Correcting drawing: position of installation of ladders and interval of ladders
3	Inner Ladder	Correcting drawing: position of installation of ladders
4	Space for laying feeder cables	Preparation of new drawing

Source: JICA Survey Team

TRC and CEIEC examined requested points above and TRC, CEIEC, JICA and JICA Survey Team reached an agreement about the drawing design revised by CEIEC.

Specifications of T1 Section as of the agreement are listed below and drawings are shown in Appendix 62 and 63.

Table 5.2-2 Specification of T1 Section

No.	Item	Dimension	Remarks
1	Height of Lotus Tower	350 m	Height from ground
2	Height of T1 Section	10.5 m	
3	External form of T1 Section	650 mm (Wall thickness of rectangular steel pipe: 30 mm	Including scaffold steps for outside work and inside work
4	Antenna model	4 dipole antenna	
5	Antenna panel	8.8.4.8	Number of antenna panel for each direction
6	Direction of antenna	79,169,259,349	Angle from true north
7	Kind of cables	HF-120D ×2 HF-20D ×28	Main feeder cable / Branch feeder cable
8	2 distributer	120D-77D (4:3) ×2	
9	6 distributer	77D-20D ×2	
10	8 distributer	77D-20D ×2	

Source: JICA Survey Team

5.3 Result of inspection on T1 Section implemented in China

From 17th to 22nd December 2016, JICA Survey Team implemented an inspection of T1 Section at CEIEC's factory in Langfang, China, as an opportunity of confirmation before transport to Colombo. The purpose of this inspection was to confirm whether the contents agreed in Table 5.2-2 were accurately reflected in the T1 section manufacturing as well as existence of trouble which were not be found from the drawings. This inspection was also implemented as the opportunity to correct the parts which might be able to be dealt with only in the factory before shipment.

In the presence of engineers of PCU as owner and staff of CEIEC, JICA Survey Team measured parts which were ready to be measured in T1 Section and confirmed whether manufacturing works were implemented within the tolerance range, based on the drawings.

JICA Survey Team judged that there was no problem concerning the height, the outer shape and the number of antenna stages of the T1 section. Meanwhile, JICA Survey Team pointed out that several points were different from those of the drawings and TRC and CEIEC confirmed to implement correction.

Table 5.3-1 shows requested points from JICA Survey Team. A picture of T1 Section as of the inspection is shown in Appendix 64.

Table 5.3-1 Requested points about manufacturing of T1 Section from JICA Survey Team to CEIEC

No.	Point	Request
1	Holes for installation of antennas	Expansion of size of hole/Correction of position of hole
2	Outer ladder	Production of ladder based on drawing (size of ladder and length of welded parts)
3	Inner ladder	Correction of position of ladder
4	Flat board	Removal of distortion

Source: JICA Survey Team

Along with above, JICA Survey Team has confirmed with TRC and CEIEC that inspection should be carried out again in Colombo before each part of Tower Mast would be assembled and installed at the top of the Lotus Tower. Tower Mast was transported from China to Colombo in February 2017.

5.4 Result of inspection on T1 Section implemented at Lotus Tower

JICA Survey Team conducted an inspection on Lotus Tower construction site in Colombo City from 6th to 7th April, 2017, to confirm the result of correction and its accuracy on the items pointed out in the preceding paragraph.

5.4.1 Points indicated by JICA Survey Team in previous inspection

JICA Survey Team measured the size and interval of holes for the antenna mounting on the surface of T1 section, the length of the welding part of the outer ladder, and the distance between the inner ladders. JICA Survey Team confirmed that these points were corrected based on the drawings and works such as cable laying can be carried out without problems.

On the other hand, the welding of the three parts constituting the TI section was incomplete. Therefore, at this time, it was not confirmed about intervals for antenna installation including the welded parts and the condition of weld bead. In this regard, TRC, CEIEC and JICA Survey Team agreed that the T1 section would be re-inspected after it was installed on top of the Lotus Tower.

5.4.2 Confirmed points and additionally indicated points by JICA Survey Team

At the time of the inspection, provisional pieces for hoisting Tower Mast were welded and was remained. JICA Survey Team pointed out that weld bead should not be left on the surface of the mast, which needs to be flat for installation of DTTB antennas, and requested that the provisional pieces would be cut and removed after welding work completed. TRC and CEIEC agreed to implement that work while ensuring enough strength of the mast.

JICA Survey Team measured the size of mounting frame on the steel platform of T1 section, which will fix the parts for supplying electricity. The size of holes of the frame were smaller (about φ17) than that of drawing (φ18), and CEIEC has rectified all holes. In addition, big weld beads were left on the mounting frame, and CEIEC has polished the surface of it to make it flat for setting antenna.

JICA Survey Team confirmed that enough space was secured for cable installation after measuring position and dimensions of branch cable outlet of T1 Section base. On the other hand, it was found

that scaffolding part of T1 Section would be set after installation of Tower Mast on top of Lotus Tower. Therefore, JICA Survey Team confirmed with TRC and CEIEC that at later date inspection should be implemented about shelves for fixing branch cables installed at the scaffolding part.
Details of the measurement and results are shown in Appendix 65.

5.5 Result of re-inspection on T1 Section and inspection on space for installation of cables

In September 2017 Tower Mast was installed at the top of the Lotus Tower, and JICA Survey Team conducted inspection regarding following points during the period from 2nd to 6th October, 2017.

5.5.1 Result of re-inspection on T1 Section

JICA Survey Team inspected the parts of T1 section that had not been completed, and confirmed that installation of transmission antenna for DTTB can be done without trouble. Inspected points and the result are shown below.

Table 5.5-1 Inspected points and the result after Tower Mast was installed

No.	Inspected part	Result	Judgement result
1	Welded part of T1 Section (Size of holes for installation of antennas and intervals between holes)	Same as the dimension in drawing	Allowable for installation of antennas of digital broadcasting.
2	Scaffold and outer ladder of T1 Section	Installed	
3	Rack for fixing branch cables at scaffold of T1 Section	Installed	
4	Direction of Tower Mast	Appropriate for installation of antennas	
5	Surface of part for antenna installation	Provisional pieces for hoisting Tower Mast have been cut and removed/ The surface of the mast is flat without weld bead	

Source: JICA Survey Team

5.5.2 Result of inspection on space for installation of cables in Lotus Tower

JICA Survey Team confirmed the following points regarding the laying of the main feeder cable for connecting the antenna and the transmitter for DTTB.

- Space for laying feeder cables from distributor at T1 Section to NOC and transmitter room
- Method of fixing feeder cables

The feeder cable connected from the transmitter to the transmission antenna is planned to be about 20 cm in diameter in order to provide enough power for HD broadcasting using 8 physical channels in future. That is because it will be difficult to replace feeder cable after completion of Lotus Tower. Cable laying routes must be carefully considered, including flow lines and spaces of workers in installation work, because it cannot bend flexibly. At the same time, confirmation of the cable laying route is very important from the viewpoint of securing the safety of high place work.

Several factors that might impede the laying of feeder cable were found during the inspection, therefore JICA Survey Team pointed out the factors to TRC and CEIEC and requested that correction works be carried out. It was also noted by JICA Survey Team also that it is technically difficult to use Lotus Tower as the main transmitting station for DTTB unless the correction works are completed. Requested points are shown below.

Table 5.5-2 Requested points regarding cable laying

No.	Issue	Floor / Position	Request	Document shown for request
1	Cable ladders have not been installed.	T6 Section (part of well curb)	Taking photos which show the interval (750 mm) of ladders and sharing those photos with JICA Survey Team for further inspection by the images.	Appendix 66
2	Size of bolts (φ8 mm) for mounting of feeder cables is small, therefore bolts are not tightened firmly enough.	T2 Section (inner part)	Replacing bolts into bigger ones (φ16 mm) and welding them.	Appendix 66

Source: JICA Survey Team

In parallel with above, JICA Survey Team examined work items assumed to be implemented for antenna installation in Yen Loan Project and requested TRC and CEIEC to deal with those items, followed by confirmation by TRC and CEIEC at wrap-up meeting of the inspection. Thereafter, request contents were shown on the drawings by JICA Survey Team to clarify the points and the drawings were shared with TRC via letter. Table 5.5-3 shows the requested points. (TRC has not officially answered to the letter as of March, 2018)

Table 5.5-3 Requested points assuming work items in Yen Loan Project

No.	Item	Floor / Position	Request	Document shown for request
1	Loading cable drum		Ensuring space on the ground or on the rooftop of Tower Base for installation of feeder cables and usage of tools such as winches. (Expected drum weighs 3 tons, diameter 4 m, length 3 m)	
		Ground	● Making door at the entrance of feeder shaft of the 1st floor should be removable. ● Ensuring enough space around outside of the main entrance of the Lotus Tower to install cables. ● Prohibiting entry around main entrance of the Tower when installing cables.	Appendix 67
		Rooftop of the Tower Base	● Expansion of the opening from the room of extra low voltage to feeder cable shaft (by removing block of frame of entrance). ● Ensuring space around outside of the main entrance of the Lotus Tower for crane truck (50 tons is expected) which will hoist drum onto the rooftop of the Tower Base. ● Prohibiting entry into the rooftop of the Tower Base when installing cables.	Appendix 68
2	Parabolic antenna for transmitting microwave	Microwave platform (187.5 m high)	● Ensuring route to install feeder cables from inside shaft to outside ● Preparing base frame to install anchor bolt for fixing antenna and waveguide[10]	Appendix 69
3	Outdoor units for transmitters and air conditioners	Microwave platform (195.5 m high)	Ensuring route to install feeder cables and water hoses from inside transmitters and air conditioners to outdoor units.	Appendix 70
4	Fire prevention compartment	2nd floor of Tower House (219.8 m high)	Confirmation of method to ensure fire prevention compartment until start of installation work of cables (Internet cable, waveguide, feeder cable, etc.)	Appendix 71
5	Size of the hole at the rooftop of the Tower House	Tower House (255.3 m high)	Ensuring the current size of the hole to pass through the rooftop of the Tower House for carrying transmitting antennas and other equipment.	Appendix 72
6	Base frame for fixing cables	Tower House (255.3 m high)	Reducing the height of the wall in the water tank room from 3.6 m to 1.5 m in order to use the wall as base frame for fixing cables.	Appendix 73
7	Water puddle	T1 Section	Removing water puddle from the base frame at scaffold.	Appendix 74

Source: JICA Survey Team

5.6 Summary of the result of inspection of Lotus Tower

Table 5.6-1 summarizes the status for the results of inspection regarding Lotus Tower including items the Sri Lankan side need to deal with in future.

[10] Metallic pipe used as a microwave transmission line

Table 5.6-1 Summary of the result of inspection of Lotus Tower

No.	Inspection points	Status	Remarks
1	Correction of drawings of T1 Section	Completed in September, 2016	Shown in Table 5.2-1 and Table 5.2-2
2	Situation about production of T1 Section before welding	Completed in April, 2017	Shown in Table 5.3-1 and 5.4
3	● Situation of T1 Section after its welding ● Situation of Tower Mast after its installation at the top of Lotus Tower	Completed in October, 2017	Shown in Table 5.5-1
4	Modification work for laying cables	Sri Lankan side should implement the work, which is necessary for cable laying.	Shown in Table 5.5-2
5	Assumed work items on the occasion of installation of antennas for digital broadcasting (including items below) ● Procurement of cable drum and other equipment for installation of feeder cables ● Selection of contractors for installation of antennas (Ensuring specialists who have experience of installation work of antennas and cables at high altitude)	Sri Lankan side should implement the work, which is necessary for using Lotus Tower as the main transmitting station of DTTB.	Shown in Table 5.5-3 It is recommended that installation work should be implemented under the guidance of Japanese experts of antenna tower.
6	Work items on transmitter room and NOC in Tower House ● Consideration and design for power receiving capacity and floor loading ● Installation of common equipment such as electric incoming panel board, distribution panel board, automatic voltage adjuster, uninterruptible power supply and so on	Sri Lankan side should implement the works.	

Source: JICA Survey Team

Among the above contents, "No.5. Size of the hole at the rooftop of the Tower House" of Table 5.5-3, in particular, may interfere with DTTB antenna installation work in future, therefore it must be dealt with reliably. In addition, it is desirable that No. 2, No. 3, and No. 6 of Table 5.5-2 and Table 5.5-3 to be done before the construction of Lotus Tower is completed. In case implementing those works after completion of construction of Lotus Tower, it will be troublesome on additional consideration on design contents and negotiation with tower owner about arrangement of work schedule. Consequently it is expected that construction cost and work period in Yen Loan Project will exceed than expected.

Chapter 6 Recommendations on Matters to be Implemented by the Government of Sri Lanka

Chapter 6 Recommendations on Matters to be Implemented by the Government of Sri Lanka

6.1 Finalisation and release of roadmap for migration into DTTB and ISDB-T technical standards

Migration into DTTB involves not only the relevant governmental agencies and broadcasting stations, but also business operators engaged in the replacement of receivers for viewers, the beneficiaries of broadcasting services, and the production, sale and distribution of DTTB receivers. In the case of Sri Lanka, it is highly likely that the digital dividend of frequencies freed up by migration into DTTB will be used by telecommunication providers, therefore they too will be impacted by migration into DTTB. In addition, business operators that develop, produce, sell and distribute products involved in telecommunications operations, companies that use telecommunications networks and the general public will also be affected.

Most countries that have migrated or are in the process of migrating into DTTB prepare a roadmap for migration into DTTB, share information and awareness of the problems involved adequately with the above-mentioned stakeholders and devote their efforts to successfully accomplishing migration as a national project.

The roadmap for migration into DTTB not only shows the timing of DSO and ASO, but also exhaustively covers the procedures for preparing laws, guidelines and standards, the time required for installing the equipment and facilities, the timing of public awareness activities aimed at viewers and other stakeholders, and discussion and implementation of measures to manage the digital dividend. The schedule is reviewed regularly or as appropriate, leading to smooth migration into DTTB overall while limiting the impact on other work.

Until now Sri Lanka had no roadmap for migration into DTTB. In interviews with the broadcasting stations, several commented that they were unable to set up concrete financial arrangements necessary for migration into DTTB, such as investment in high-definition equipment, because the timing of migration was uncertain. Despite the fact that Sri Lanka's plans lack total clarity, the JICA Survey Team has prepared a draft roadmap for Sri Lanka's migration into DTTB based on basic concepts. The Government of Sri Lanka must first build a framework for dealing with various issues flexibly and individually, and then finalise the roadmap for migration into DTTB and publicise it widely to the general public. As mentioned above, migration into DTTB will be advanced based on stakeholder consensus while revising the roadmap, so it is important that the Government manifests its current thinking as soon as possible and publicizes the roadmap for migration into DTTB. Release of the roadmap is the first step in full-scale migration into DTTB.

On the other hand, ISDB-T technical standards have already been drafted with assistance from relevant organisations on the Japanese side. Sri Lanka's area codes, which are closely involved in operation of the emergency warning broadcast system (EWBS), are currently under review. Technical standards are essential for the manufacture of transmitters and receivers, and manufacturers of broadcasting equipment and receivers will develop and manufacture products based on these standards. As the transmitters and receivers include those customized for Sri Lanka, specific product development is necessary.

As Sri Lanka has no companies that develop or manufacture broadcasting equipment, it basically relies on imports. Foreign companies do not necessarily develop or manufacture the products in question and they weigh profitability against business risk. Seeking a profit bearing in mind the costs incurred from the development stage, each manufacturer may naturally consider to what extent development is necessary by referring to the technical standards.

With no alternative but to rely on imports for part of its migration into DTTB, Sri Lanka must first publish ISDB-T technical standards as soon as possible in order to motivate overseas manufacturers to develop and produce the equipment. Publication will enable the Government of Sri Lanka to find companies that are interested in exporting to Sri Lanka and ensure enough time for development and manufacturing. In particular, as the spread of receivers will impact the timing of ASO, it is important that receivers are already manufactured for distribution to the market at the time of DSO. The area codes should be discussed with the relevant agencies and the technical standards released as soon as possible.

6.2 Legislation related to establishment of DBNO

When migration into DTTB with aid from ITU was first discussed, a DTTB platform to meet the shortage of frequencies was built by representatives from the Government of Sri Lanka and the broadcasting stations. As a result, the broadcasting stations came into line with each other and migration into DTTB was authorized. The various tasks and challenges involved in Sri Lanka's migration into DTTB are being considered and discussed based on the DTTB platform. Moreover, it was confirmed at the outset that a digital broadcasting network operator (DBNO) would be established as an independent and impartial organisation to manage the DTTB platform. Since then, however, no progress has been made in studying business models for DBNO nor have preparations been made for the establishment of DBNO.

Considering that DBNO will be an independent and impartial operator and that it will be financially supported under Yen Loan Project by the Government of Japan, the prevailing opinion is that DBNO will be a public organisation. Government regulations will be on a par with those governing ordinary broadcasters and its establishment is sought within the framework of ensuring its independence as a broadcasting station in order to guarantee reporting freedom. On the other hand, the establishment of DBNO will be made by public financial support under Yen Loan Project by the Government of Japan, so when establishing DBNO it is expected that the Act for Establishment of DBNO will be required unless it is established as an independent private business that is free from outside control.

DBNO must be established and operated based on a legal framework prior to DSO. The Government of Sri Lanka should start preparing the DBNO Act as soon as possible. The following basic items should be incorporated in the DBNO Act.

(1) Purpose of establishment of DBNO, business content, and laws and regulations governing business
(2) Voting rights of DBNO and guidelines on voting rights

(3) Method of electing members of the board of directors and management organisation, number of persons, term of office and possibility of reappointment
(4) Accountability to citizens and users, and method of accountability
(5) Financing guidelines, compliance with laws and ministerial ordinances, and guidelines on returning profits to users
(6) Regulatory guidelines on financing, including restrictions on foreign investment
(7) Obligation to disclose financial statements
(8) Obligation to undertake business and accounting audits, compliance with laws and ministerial ordinances, and obligation to release business and accounting audit reports
(9) Responsibilities to users and prohibited matters
(10) Guidelines on setting, approval and revision of usage fees

Based on the determined business model, attention will focus on the business content, voting rights and method of electing the board members, but discussion of exclusive ownership of broadcasting business and exclusive media ownership based on ownership of different kinds of media is also required. With regard to funds, consideration must be given to transparency, including audits if public funds are utilized. With regard to usage fees collected from users, consideration must be given, such as regulation using ministerial ordinance, in order to prevent arbitrary decisions by DBNO.
To enable rapid migration into DTTB, after DBNO has been established, instead of commencing procurement of platform equipment, it is desirable that work is performed by utilising the Project Management Unit (hereinafter referred to as PMU) of the Yen Loan Project as originally planned, or interim organisation which the Government of Sri Lanka will regard necessary and establish.

6.3 DBNO usage fees

In advance of the Government of Sri Lanka studying the DBNO business model, the JICA Survey Team performed a simulation of DBNO usage fees and in the process has raised the following two issues as items for discussion when the Government of Sri Lanka determines the fees.

(1) Measures for exemption from usage fees for religious corporations

Of the broadcasting stations expected to use DBNO following migration into DTTB, only Buddhist TV and Shraddha TV will continue to maintain their religious corporate status, but in view of the financial situation of the two broadcasting stations concerned which are run solely on donations, it is thought that they will find it difficult to pay the fees as currently set. If it is desirable that consideration be given to the continued existence of broadcasting stations run by religious corporations, measures for exemption from usage fees for religious corporations must be considered.

(2) Setting of fees by region

In the estimation of usage fees by the JICA Survey Team, the actual costs borne by most of the big broadcasting stations will be greatly reduced compared to their current operating expenses by transferring to DBNO. Conversely, the costs of small broadcasting stations will increase. While on

the one hand there are small broadcasting stations that belong to group companies and are able to invest ample resources through the parent company, there are also broadcasting stations that are in a very tight financial situation.

For small broadcasting stations that currently cover their service area from only one or two transmitting stations, if an equivalent service area can be obtained through DBNO, based on their current operating expenses, the usage fees must not be an amount that is difficult for them to bear. For this reason, it will be worthwhile to consider setting usage fees by region as shown in Table 6.3-1. The usage fees are assigned by the population coverage ratio of each region, with the regional fee for Greater Colombo higher than for other regions at Rs. 25.2 million. Most of the small broadcasting stations only serve Greater Colombo.

In light of the general state of the broadcasting industry in Sri Lanka at the present time, it will be effective to allow each broadcasting station to choose its service area based on its financial capacity. However, if the usage fees are set by region, DBNO's income will decline that much, therefore consideration must also be given to securing working capital and repaying the Yen Loan Project.

Almost all the broadcasting stations, including the small stations, recognize the attractions of nationwide broadcasting, and if ways of gradually expanding their service areas after migration into DTTB can also be taken into consideration, their options will be all the greater.

Table 6.3-1 DBNO usage fees by region based on population coverage ratio

(Rs. 1 million)

Broadcasting region	Fee by region
Sri Lanka	55.2
Jaffna, Kokavil, Vayuniya	3.4
Trincomalee	1.0
Kurunegala, Karagahatenna	6.9
Colombo, Yatiyantota	25.2
Hunnasgiriya, Primrose, Pidurutalagala	1.8
Badulla, Namunukula	7.8
Suriyakanda, Elpitiya, Gongala	9.2

Source: JICA Survey Team

6.4 Guidelines on issuance of digital terrestrial broadcasting licenses

The guidelines on issuance of digital terrestrial broadcasting licenses cover the criteria on which licenses for digital terrestrial broadcasting are issued. In most countries that have migrated into DTTB, priority is basically given to existing terrestrial broadcasters that are able to migrate to digital terrestrial broadcasting. This is based on the perspective of protecting viewers who watch the programmes of existing broadcasting stations, the possibility of many new players entering the field, managing the broadcasting facilities and assets owned by existing broadcasting stations, and providing employment protection for employees engaged in current broadcast business such as broadcasting stations.

Firstly, Sri Lanka has no clear guidelines on priority accompanying migration into DTTB. Priority is not granted infinitely. In most cases, it depends on confirmation of whether or not migration into DTTB is feasible and is based on approval of appropriate business plans. In addition, priority does not prevent new entry into the field. As long as channels can be assigned, new entry is allowed in order to increase the benefits to the beneficiaries.

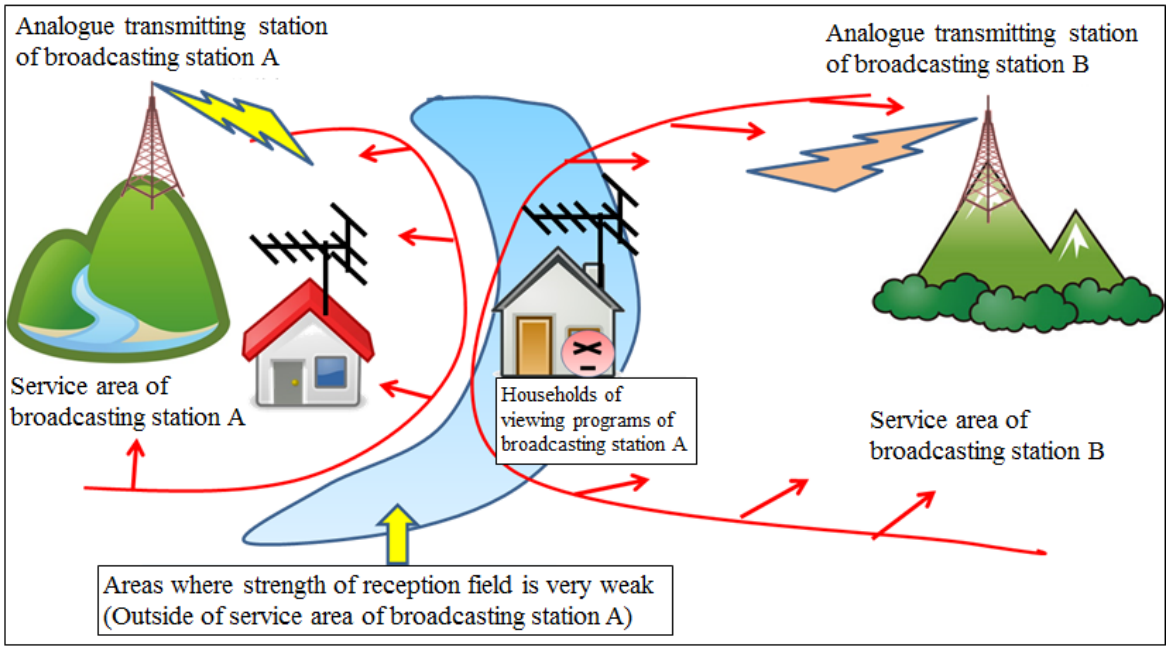
Until now terrestrial broadcasting stations in Sri Lanka required a broadcasting station licence and a broadcast channel license for radio wave emissions. In future, the latter broadcast channel licence will be assigned to DBNO, but the license for broadcasters using DBNO is vague. For this reason, a new license will be required for digital terrestrial programme providers to provide DTTB through DBNO. The Government of Sri Lanka must clarify the qualifications of digital terrestrial programme providers and ensure that the necessary licenses can be issued without delay.

If the Government of Sri Lanka basically adheres to the previous basic framework with regard to broadcasting stations, digital terrestrial programme providers will be roughly on a par with current broadcasting stations, but it is reasonable to expect that operation and maintenance of the transmission and relay equipment will not be included. If it is necessary to review the positioning, social contribution, responsibilities and role of the broadcasting sector anew, this may not be the case. However, as a new review will prompt a shake-up of the broadcasting industry and implementation at the same time as migration into DTTB may cause confusion, the matter needs to be handled with care.

6.5 Appropriate radio wave supervision

Until now, there existed no clear definition of a broadcasting service area for analogue terrestrial broadcasting in Sri Lanka. Normally, as in the example of Japan, the definition of a broadcasting service area should be created by the broadcasting stations, transmitter and receiver manufacturers and radio wave supervising organisations based on ITU minimum field strength standards and issued as a ministerial ordinance. In Sri Lanka, however, as there is no definition of a service area, each broadcasting station asserts its service areas groundlessly. On the other hand, the Telecommunications Regulatory Commission of Sri Lanka (TRC), which is responsible for radio wave supervision, has no clear grasp of service area or regulations regarding such.

The problem of interference between multiple analogue broadcasting signals currently exists in Sri Lanka. Interference is caused by two or more broadcasting signals in the area concerned, and the signal that causes the interference is distinguished from the signal that is subjected to interference. When interference occurs, normally some kind of response is required of the side that emitted the later radio wave. However, it is possible for Broadcaster B to obtain a broadcasting service area outside the service area of Broadcaster A that started broadcasting first. At this time, even if Broadcaster A's programs cannot be viewed by viewers in Broadcaster B's service area, basically it is recognized as Broadcaster B's service area and in general no measures are required. This situation is shown in Figure 6.5-1.



Source: JICA Survey Team

Figure 6.5-1 Interference outside analogue broadcasting coverage area

However, as Sri Lanka has no clear definition of a service area, when such a situation arises, no clear technical decision can be reached and occasionally cases end up in court.

The TRC even considers areas with an analogue field strength of around 40 dBμV/m to be service areas, but it was confirmed by the results of "field strength measurements across Sri Lanka" carried out in the Previous Survey that, in most cases, no images are displayed on the TV screen at a field strength of 40 dBμV/m. In nearly all cases, viewers in Sri Lanka fit a booster to their exterior antenna to watch TV, but as there is little but noise at 40 dBμV/m, even when amplified, it is difficult to get TV images that are clear enough to be able to tell what the programme is.

A major cause of this creation of an environment where areas with considerably low reception fields are designated as service areas is the lack of a clear definition of a broadcasting service area.

It is strongly desired that this inappropriate method of radio wave supervision is reviewed at the time of migration into DTTB and changed to an appropriate method. In the DTTB channel plan mentioned in section 4.2, the service area is set at 51 dBμV/m, with a margin added, based on the ITU standard minimum field strength of 47.2 dBμV/m. In future, if new channels other than those mentioned in section 4.2 are assigned, it will be necessary to discuss a solution to radio wave interference with the relevant parties on technical grounds based on service area rules.

For this reason, first of all, to ensure appropriate radio wave supervision in digital broadcasting, it is necessary for the TRC to issue various rules as a ministerial ordinance, such as the minimum field strength of service areas and various interference protection ratios for co-channel interference and adjacent channel interference. Without these, there is the risk of not being able to solve radio wave interference problems that may arise with newcomers to the business.

This inappropriate method of radio wave supervision has created frequency shortages, especially in Greater Colombo. Appropriate radio wave supervision will boost development of the broadcasting sector, narrow the digital divide between urban and rural areas and provide the foundation for building a rich and sound broadcasting culture. Migration into DTTB is an excellent opportunity to optimize radio wave supervision, introduce policies to avoid political channel assignment and implement fair and open radio wave administration.

6.6 System review of EWBS operation

EWBS (Emergency Warning Broadcast System), an important feature of the ISDB-T system, is expected to play an important role in Sri Lanka where natural disasters occur frequently. EWBS can communicate warnings to viewers rapidly by broadcasts through collaboration with disaster monitoring agencies, and with the ISDB-T system, mobile phones and mobile band receivers can receive warnings by broadcasts even outdoors. With the recent development of mobile phones, warnings can be received through the mobile phone Short Message Service (SMS). The merits of receiving warnings through broadcasts are assumed to be that there is no risk of not being able to receive a warning due to sudden deterioration of the communication situation as a result of excessive communications within a certain area (as long as broadcast waves can be received, there is no dependence on the communication situation), the broadcasting station will continue to provide follow-up reports, and following the warnings, reliable information can be obtained.

As the broadcasting stations are not disaster monitoring organisations or disaster management organisations, collaboration with disaster-related organisations is essential for operation of EWBS. Rules must be systematically created on who activates EWBS warnings and how. As it is assumed that creation of such rules will affect the specifications of the equipment to be procured by DBNO, in order to promote migration into DTTB, the Government of Sri Lanka should establish an EWBS system review committee including disaster-related organisations as soon as possible.

6.7 Consideration of Policy on dissemination of receivers, support for viewers and measures for disadvantaged groups

If the DTTB population coverage ratio and dissemination of DTTB receivers are taken as the requirements for implementing ASO as in most countries, since the Yen Loan Project will lead to achievement of the goal for DTTB coverage if the project is appropriately implemented, dissemination of receivers and the implementation of ASO are the issues facing the Government of Sri Lanka.

Measures to motivate viewers to replace their receivers are necessary for dissemination of the receivers.

Motivation includes, for example, direct giving-back plans for viewers, such as VAT reduction within a certain period and reward points. Digital terrestrial broadcasting has a value-added service, but examples in Japan and other countries of adding some kind of incentive for viewers to replace the TV receiver that they have been using up till then with a new one or to have to buy a set-top box (STB) have been shown to boost the spread of receivers.

Such direct giving-back measures are not the only motivation. Viewers are also motivated by ample provision of information, such as PR regarding the DTTB migration schedule, information on when DTTB will be available in each area and what kind of products it will be necessary to buy.

For this to happen, it is important to create and implement PR measures aimed at viewers. At the same time, it will also be effective to set up a call centre to answer questions and inquiries from viewers about migration into DTTB and enable viewers to easily seek advice.

Support for the creation of PR plans, including measures for dissemination of receivers and support for establishment of a call centre by a JICA technical cooperation project, has already been considered based on a request from the Government of Sri Lanka. As mentioned in section 6.1, it is necessary to publicise the roadmap for migration into DTTB and consider measures for dissemination of receivers and PR plans as soon as possible based on the roadmap.

In addition, it is also necessary to consider support measures for households where viewing may be difficult because of migration into DTTB, such as measures for difficult viewing areas and measures for poor households. First of all, individuals should be encouraged to replace their receivers by fully explaining the merits of migration into DTTB to viewers and obtaining people's understanding of the need for migration. Then, feasible support must be considered for residents in difficult viewing areas and for poor households. The Government of Sri Lanka must organise its thinking, including carefully examining the risks that could hinder ASO and considering a government response in the event that the risks cannot be removed by individual response. Measures to support receiver replacement by all viewers is unlikely to be a feasible step and migration into DTTB must be advanced while confronting the issue of people's understanding. The merit of the digital dividend for ordinary people is not just greater convenience for mobile phone users, and it is desirable to consider ways of giving back the economic benefits generated by the digital dividend. The Government of Sri Lanka must organise its thinking as soon as possible, such as asking people to bear direct costs by utilising these economic benefits to promote substantial information and communication policies.

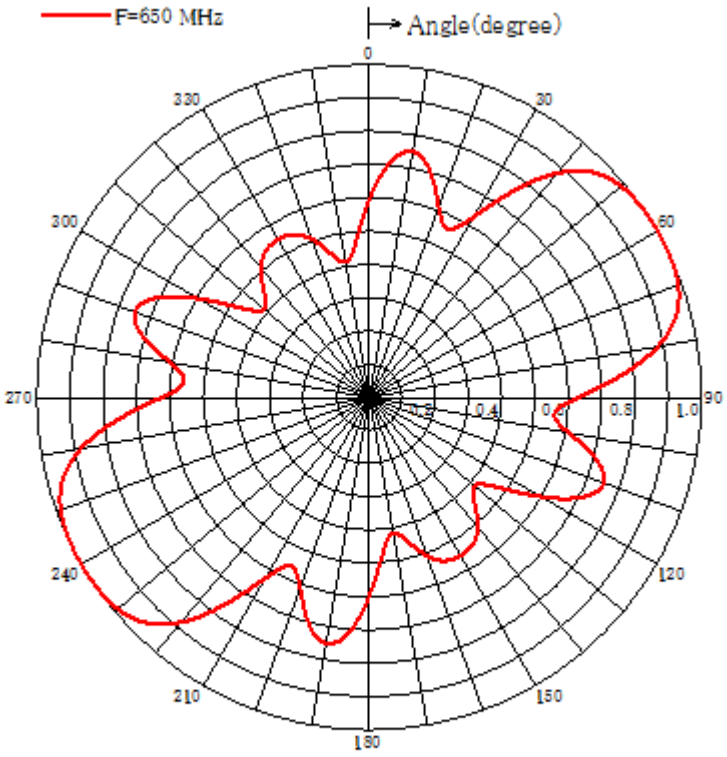
Appendix

Appendix

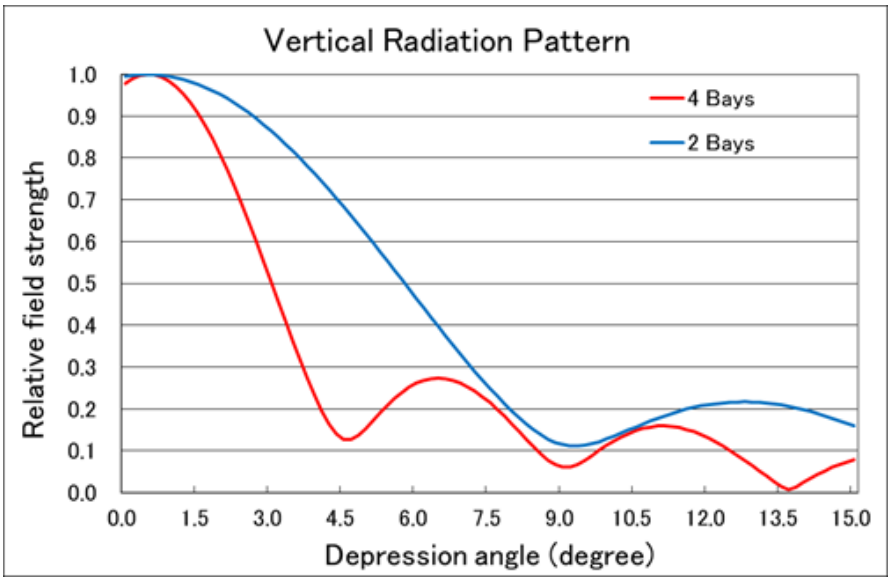
1. Specification of antenna system (Jaffna)

Item	Specifications	Remarks
Location: Latitude Longitude	N:09˚39'56" E:80˚00'21"	Location of the SLT tower
Tower for antenna installation	At the top of an existing 150 m-high tower	
Antenna configuration Directions of the antenna Numbers of stages in the antenna	4-stage 2-face, 2-stage 2-face 60, 150, 240, 330 (degree) 4, 2, 4, 2	 Clockwise from the due north Number of stages in each direction
<Specifications of the antenna> Type of the antenna panel Polarization Gain of an antenna panel Gain of the antenna system Voltage standing wave ratio Tilt angle Null fill-in Power capacity Size and length of main feeder cable Dehydrator Combiner Coaxial switch Coaxial dummy load	 4L stacked-loop antenna Horizontal polarization 11.0 dBd or above 11.6 dBd or above 1.10 or below 0.5 degree for each face 10 % or above 5 kW or above Air dielectric coaxial cable 1-5/8“, 185m 1 unit For transmission of 500W signals on four frequencies Three terminals、1-5/8“ 4kW	 Including the loss of branching coaxial cables From the outdoor distributor Within the channel in use Angle of depression from the horizontal plane First null point
Transmitter output	500W	

2. Diagram of horizontal and vertical radiation pattern (Jaffna)



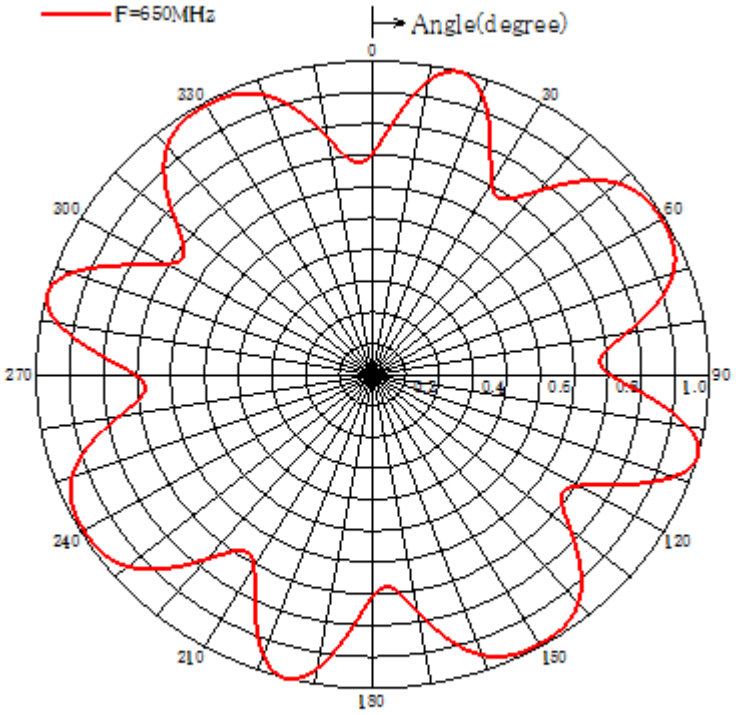
Antenna Radiation Pattern
UHF 4 Loop Antenna 4 Faces (4.2.4.2)



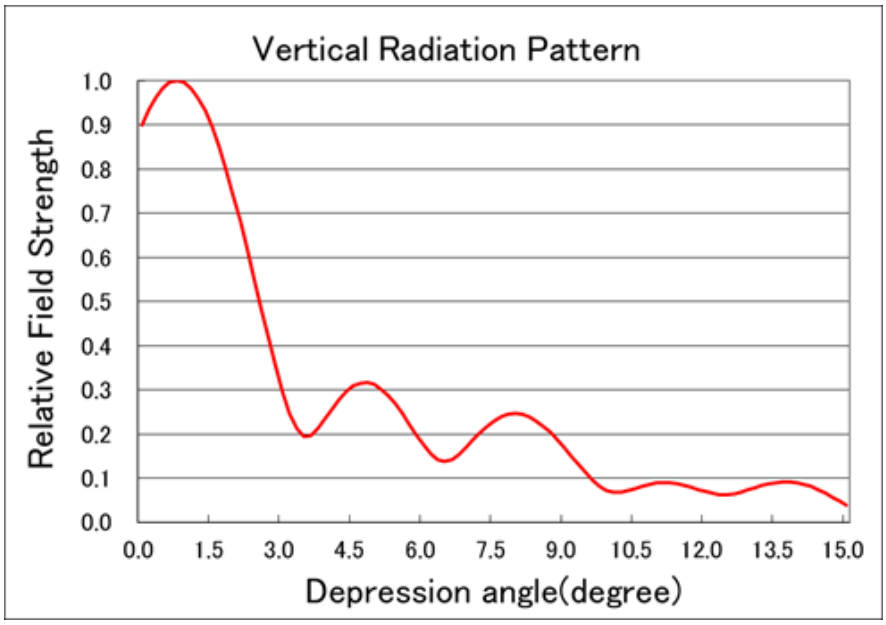
3. Specification of antenna system (Kokavil)

Item	Specifications	Remarks
Location: Latitude Longitude	N: 09˚16'11" E: 80˚24'29"	
Antenna configuration Directions of the antenna Numbers of stages in the antenna	8-stage 4-face 60, 150, 240, 330 (degree) 8, 8, 8, 8	 Clockwise from the due north Number of stages in each direction
<Specifications of the antenna> Type of the antenna panel Polarization Gain of an antenna panel Power capacity Size of main feeder cable Input terminal	 4 dipole antenna Horizontal polarization 12.9 dBd 24 kW / line Air dielectric coaxial cable HCA495 EIA 3-1/8”	 600MHz Input of 8 x 3kW at the time of abnormality Vertically separated two-line feed system
New equipment to be installed Combiner (on five frequencies) Coaxial switch Coaxial dummy load	For transmission of 3kW digital signals on four frequencies and 3kW analogue signals on one frequency Three terminals, 3-1/8“ 24kW	

4. Diagram of horizontal and vertical radiation pattern (Kokavil)



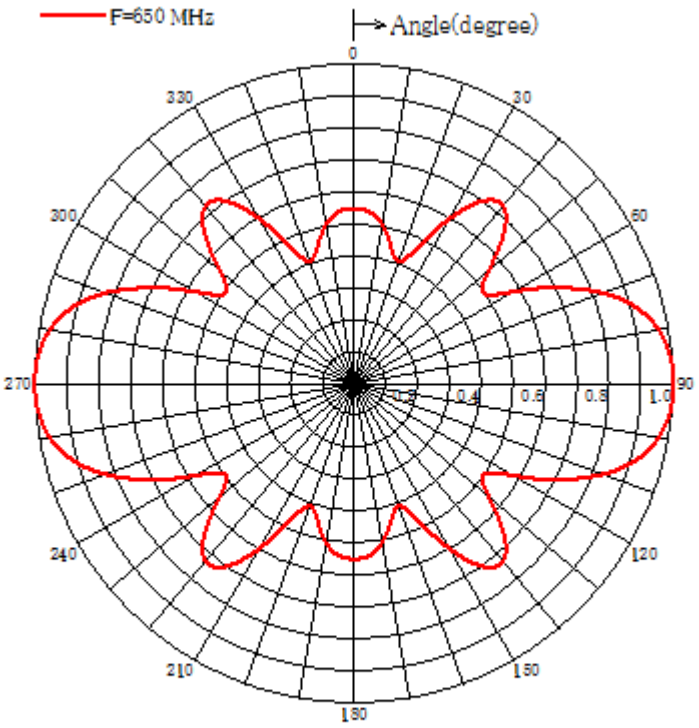
Antenna Radiation Pattern
UHF 4 Dipole Antenna 4 Faces



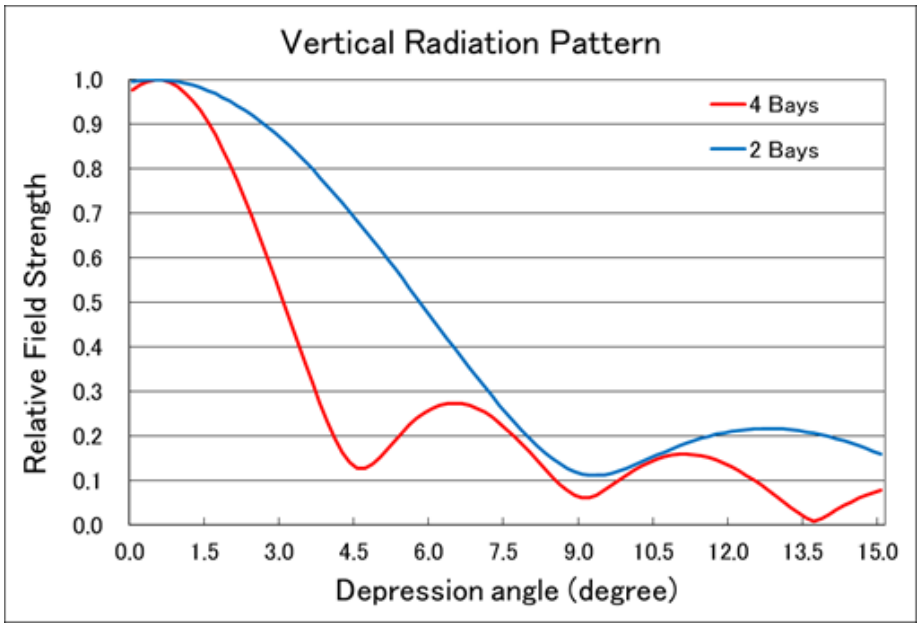
5. Specification of antenna system (Vayuniya)

Item	Specifications	Remarks
Location: Latitude Longitude	N: 08˚46'1.23" E:80˚33'0.66"	Location of the SLT tower
Tower for antenna installation	At the top of an existing 60 m-high tower	
Antenna configuration	4-stage 2-face, 2-stage 2-face	
Directions of the antenna	0, 90, 180, 270 (degree)	Clockwise from the due north
Numbers of stages in the antenna	2, 4, 2, 4	Number of stages in each direction
<Specifications of the antenna>		
Type of the antenna panel	4L stacked-loop antenna	
Polarization	Horizontal polarization	
Gain of an antenna panel	11.0 dBd or above	Including the loss of branching coaxial cables
Gain of the antenna system	11.6 dBd or above	From the outdoor distributor
Voltage standing wave ratio	1.10 or below	Within the channel in use
Tilt angle	0.5 degree for each face	Angle of depression from the horizontal plane
Null fill-in	10 % or above	First null point
Power capacity	10 kW or above	
Size and length of main feeder cable	Air dielectric coaxial cable 3“, 100m	
Dehydrator	1 unit	
Combiner	For transmission of 1kW signals on four frequencies	
Coaxial switch	Three terminals, 1-5/8“	
Coaxial dummy load	8kW	
Transmitter output	1kW	

6. Diagram of horizontal and vertical radiation pattern (Vayuniya)



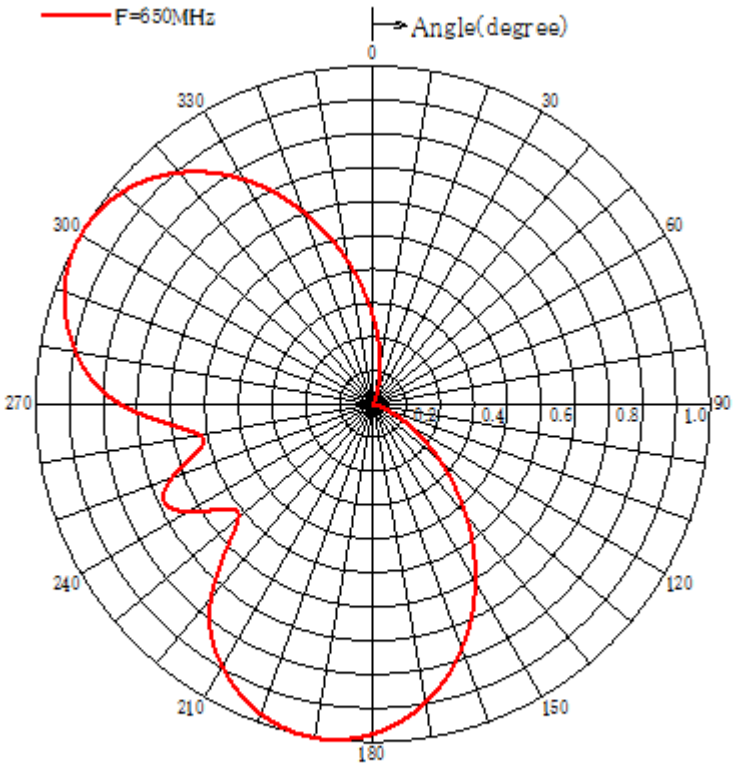
Antenna Radiation Pattern
UHF 4 Loop Antenna 4 Faces (2.4.2.4)



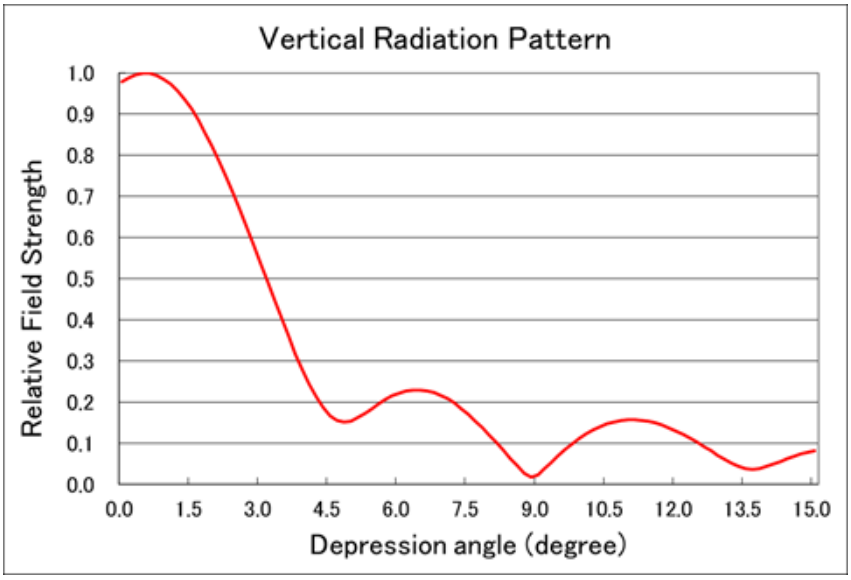
7. Specification of antenna system (Trincomalee)

Item	Specifications	Remarks
Location: Latitude Longitude	N : 8°35'20.19" E : 81°12'48.49"	
Tower for antenna installation	At the top of a new 75m-high tower	
Antenna configuration	4-stage 2-face	
Directions of the antenna	190, 300 (degree)	Clockwise from the due north
Numbers of stages in the antenna	4, 4	Number of stages in each direction
<Specifications of the antenna>		
Type of the antenna panel	4L stacked-loop antenna	
Polarization	Horizontal polarization	
Gain of an antenna panel	11.0 dBd or above	Including the loss of branching coaxial cables
Gain of the antenna system	13.8 dBd or above	From the outdoor distributor
Voltage standing wave ratio	1.10 or below	Within the channel in use
Tilt angle	0.5 degree for each face	Angle of depression from the horizontal plane
Null fill-in	10 % or above	First null point
Power capacity	10 kW or above	
Size and length of main feeder cable	Air dielectric coaxial cable 3“, 100m	
Dehydrator	1 unit	
Combiner	For transmission of 1kW signals on four frequencies	
Coaxial switch	Three terminals, 1-5/8“	
Coaxial dummy load	8kW	
Transmitter output	1kW	

8. Diagram of horizontal and vertical radiation pattern (Trincomalee)



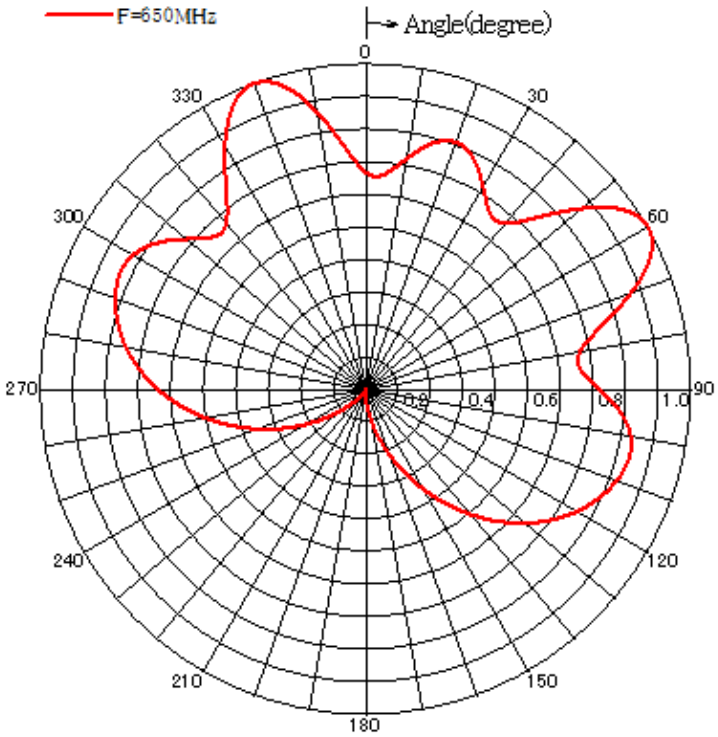
Antenna Radiation Pattern
UHF 4 Loop Antenna 2 Faces (4.4)



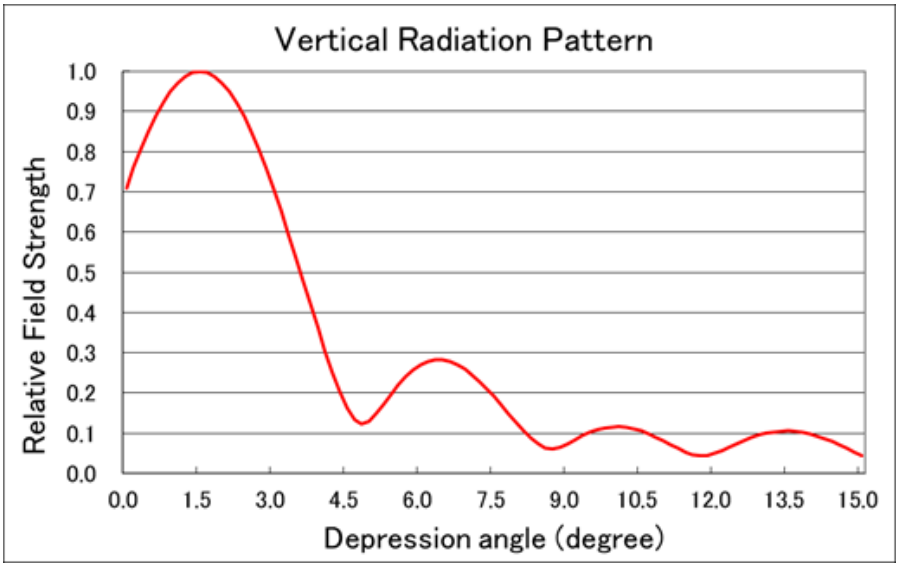
9. Specification of antenna system (Karagahatenna)

Item	Specifications	Remarks
Location: Latitude Longitude	N:07˚35'28.47" E:80˚42'49.02"	
Tower for antenna installation	At the top of an existing 65m-high tower	
Antenna configuration	6-stage 3-face	
Directions of the antenna	20, 100, 300 (degree)	Clockwise from the due north
Numbers of stages in the antenna	5, 5, 5	Number of stages in each direction
<Specifications of the antenna>		
Type of the antenna panel	4L stacked-loop antenna	
Polarization	Horizontal polarization	
Gain of an antenna panel	11.0 dBd or above	Including the loss of branching coaxial cables
Gain of the antenna system	13.9 dBd or above	From the outdoor distributor
Voltage standing wave ratio	1.10 or below	Within the channel in use
Tilt angle	1.5 degree for each face	Angle of depression from the horizontal plane
Null fill-in	10 % or above	First null point
Power capacity	14 kW or above	
Size and length of main feeder cable	Air dielectric coaxial cable 3“, 85mx2	
Dehydrator	1 unit	Two terminals at the outlet
Combiner	For transmission of 3kW signals on four frequencies	
Coaxial switch	Three terminals、3-1/8“	
Coaxial dummy load	24kW	
Transmitter output	3kW	

10. Diagram of horizontal and vertical radiation pattern (Karagahatenna)



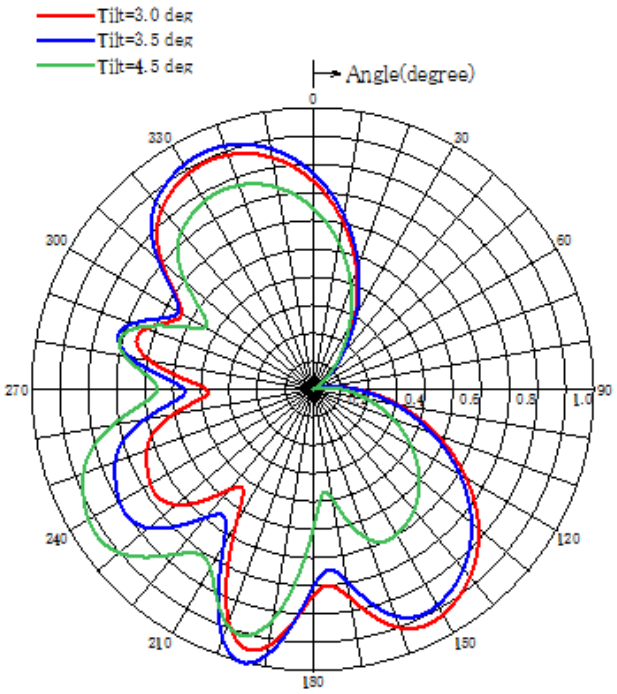
Antenna Radiation Pattern
UHF 4 Loop Antenna 3 Faces (5.5.5)



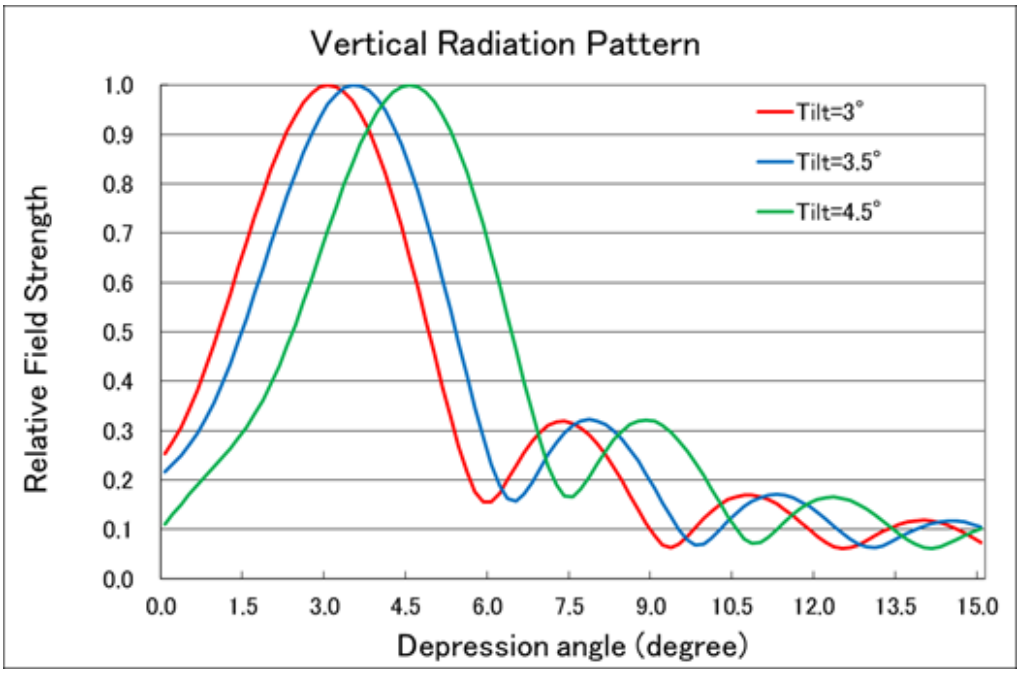
11. Specification of antenna system (Hunnasgiriya)

Item	Specifications	Remarks
Location: Latitude Longitude	N:07˚23'12.99" E:80˚41'25.86"	
Tower for antenna installation	Upper part of an existing 75m-high tower	Stayed tower
Antenna configuration Directions of the antenna Numbers of stages in the antenna	8-stage 3-face 155, 245, 335 (degree) 8, 8, 8	 Clockwise from the due north Number of stages in each direction
<Specifications of the antenna> Type of the antenna panel Polarization Gain of an antenna panel Gain of the antenna system Voltage standing wave ratio Tilt angle Null fill-in Power capacity Size and length of main feeder cable Dehydrator Combiner Coaxial switch Coaxial dummy load	 4 dipole antenna Horizontal polarization 10.5 dBd or above 13.6 dBd or above 1.10 or below 3.0, 4.5, 3.5 (degree) 10 % or above 10 kW or above Air dielectric coaxial cable 3“, 85m 1 unit For transmission of 2kW x 1 analogue signals and 1kW x 4 digital signals on five frequencies Three terminals, 3-1/8“ 8kW	 From the outdoor distributor Within the channel in use Angle of depression from the horizontal plane First null point
Transmitter output	Digital 1kW Analogue 2kW	

12. Diagram of horizontal and vertical radiation pattern (Hunnasgiriya)



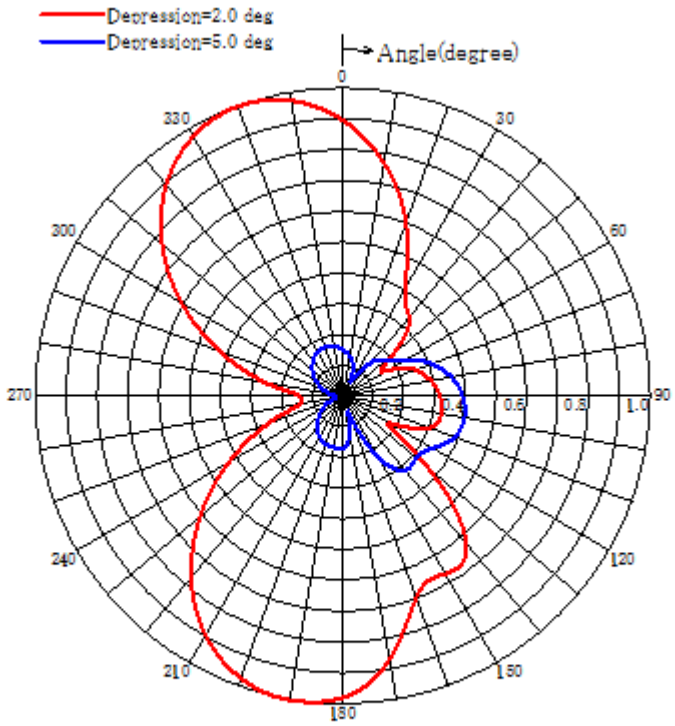
Antenna Radiation Pattern
UHF 4 Dipole Antenna 3 Faces (8.8.8)



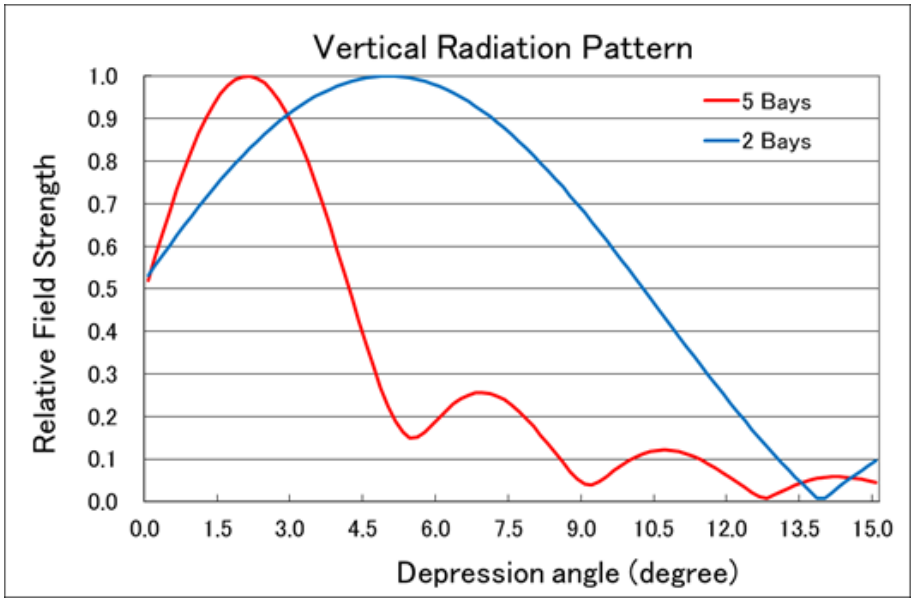
13. Specification of antenna system (Yatiyantota)

Item	Specifications	Remarks
Location: Latitude Longitude	N: 07˚02'44.63" E:80˚24'08.73"	Location of the ITN tower
Tower for antenna installation	At the top of a new 75m-high tower	
Antenna configuration	5-stage 2-face, 2-stage 1-face	
Directions of the antenna	100, 190, 340 (degree)	Clockwise from the due north
Numbers of stages in the antenna	2, 5, 5	Number of stages in each direction
<Specifications of the antenna>		
Type of the antenna panel	4L stacked-loop antenna	
Polarization	Horizontal polarization	
Gain of an antenna panel	11.0 dBd or above	Including the loss of branching coaxial cables
Gain of the antenna system	13.8 dBd or above	From the outdoor distributor
Voltage standing wave ratio	1.10 or below	Within the channel in use
Tilt angle	5, 2, 2 (degree)	Angle of depression from the horizontal plane
Null fill-in	10 % or above	First null point (0% for 2-stage)
Power capacity	16 kW or above	
Size and length of main feeder cable	Air dielectric coaxial cable 3-1/8“, 100m	
Dehydrator	1 unit	
Combiner	For transmission of 2kW signals on four frequencies	
Coaxial switch	Three terminals, 3-1/8“	
Coaxial dummy load	8kW	
Transmitter output	2kW	

14. Diagram of horizontal and vertical radiation pattern (Yatiyantota)



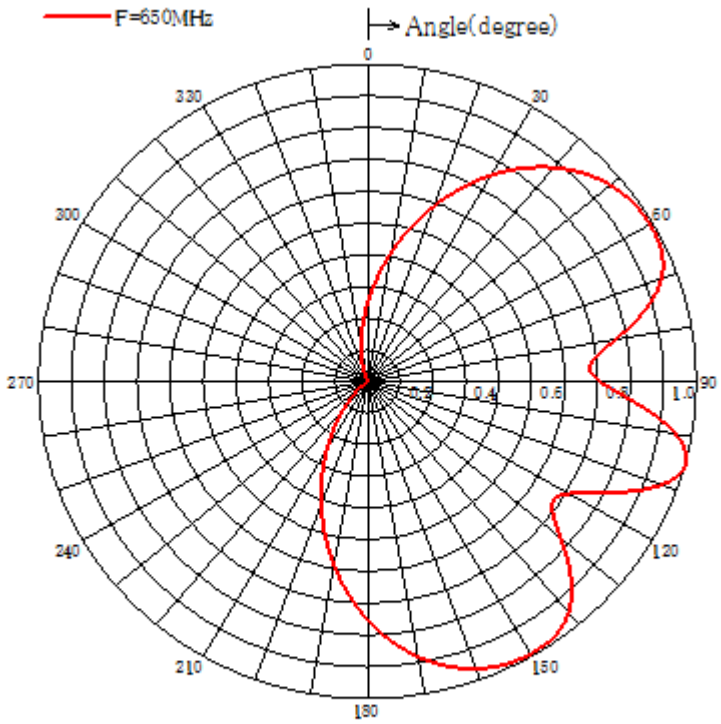
Antenna Radiation Pattern
UHF 4 Loop Antenna 3 Faces (2.5.5)



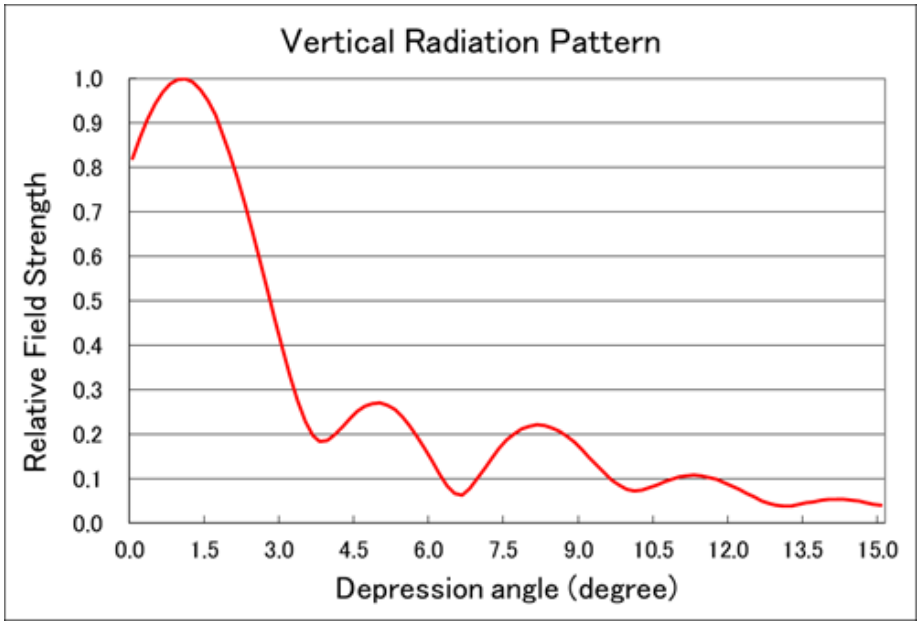
15. Specification of antenna system (Nayabedda)

Item	Specifications	Remarks
Location: Latitude Longitude	N: 06˚48'15" E:81˚01'02"	
Tower for antenna installation	At the top of a new 75m-high tower	
Antenna configuration	6-stage 2-face	
Directions of the antenna	60, 150 (degree)	Clockwise from the due north
Numbers of stages in the antenna	6, 6	Number of stages in each direction
<Specifications of the antenna>		
Type of the antenna panel	4L stacked-loop antenna	
Polarization	Horizontal polarization	
Gain of an antenna panel	11.0 dBd or above	Including the loss of branching coaxial cables
Gain of the antenna system	15.3 dBd or above	From the outdoor distributor
Voltage standing wave ratio	1.10 or below	Within the channel in use
Tilt angle	1 degree for each face	Angle of depression from the horizontal plane
Null fill-in	10 % or above	First null point
Power capacity	24 kW or above	
Size and length of main feeder cable	Air dielectric coaxial cable 3“, 100m x 2	
Dehydrator	1 unit	Two terminals at the outlet
Combiner	For transmission of 3kW signals on four frequencies	
Coaxial switch	Three terminals, 3-1/8“	
Coaxial dummy load	24kW	
Transmitter output	3kW	

16. Diagram of horizontal and vertical radiation pattern (Nayabedda)



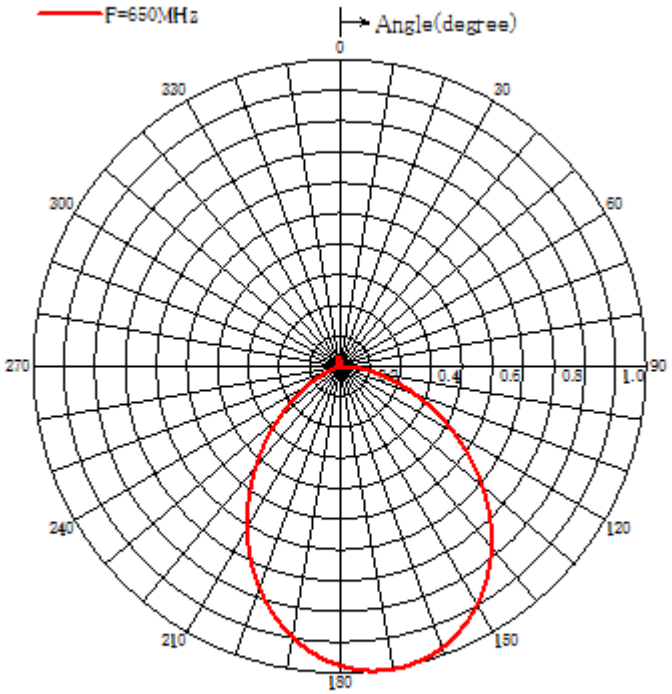
Antenna Radiation Pattern
UHF 4 Dipole Antenna 2 Faces (6.6)



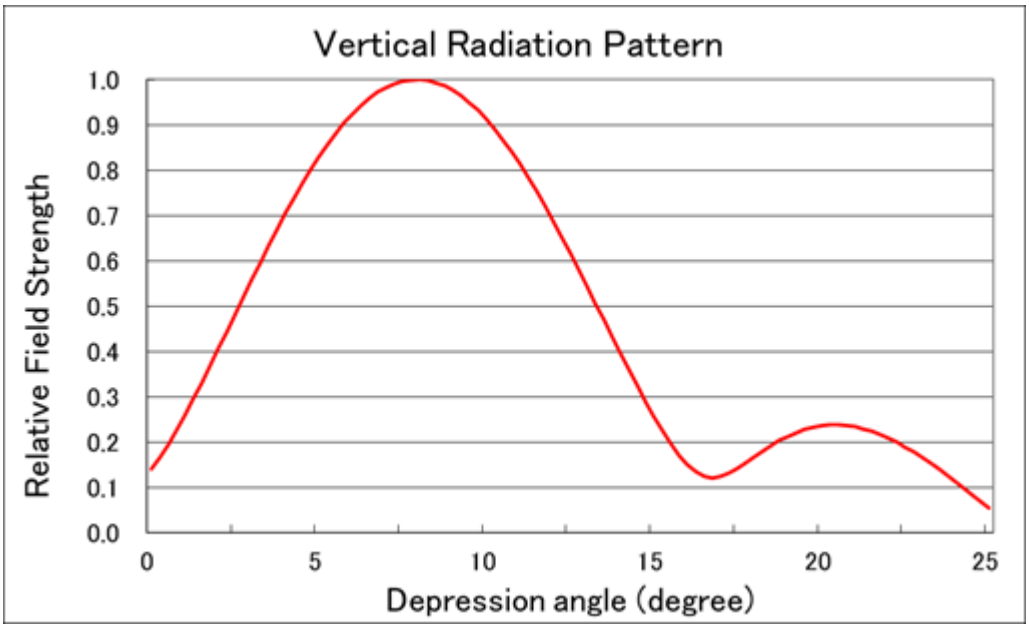
17. Specification of antenna system (Pidurutalagala)

Item	Specifications	Remarks
Location: Latitude Longitude	N: 07˚00'01" E:80˚46'26"	Location of the SLRC tower
Tower for antenna installation	At the top of a new 75m-high tower	
Antenna configuration	2-stage 1-face	
Directions of the antenna	170 (degree)	Clockwise from the due north
Numbers of stages in the antenna	2	Number of stages in each direction
<Specifications of the antenna>		
Type of the antenna panel	4L stacked-loop antenna	
Polarization	Horizontal polarization	
Gain of an antenna panel	11.0 dBd or above	Including the loss of branching coaxial cables
Gain of the antenna system	13.8 dBd or above	From the outdoor distributor
Voltage standing wave ratio	1.10 or below	Within the channel in use
Tilt angle	8 (degree)	Angle of depression from the horizontal plane
Null fill-in	10 % or above	First null point
Power capacity	0.4 kW or above	
Size and length of main feeder cable	Air dielectric coaxial cable 1-5/8“, 100m	
Dehydrator	1 unit	
Combiner	For transmission of 0.05kW signals on four frequencies	
Coaxial switch	Three terminals, 7/8“ or equivalent	
Coaxial dummy load	0.4kW	
Transmitter output	0.05kW	

18. Diagram of horizontal and vertical radiation pattern (Pidurutalagala)



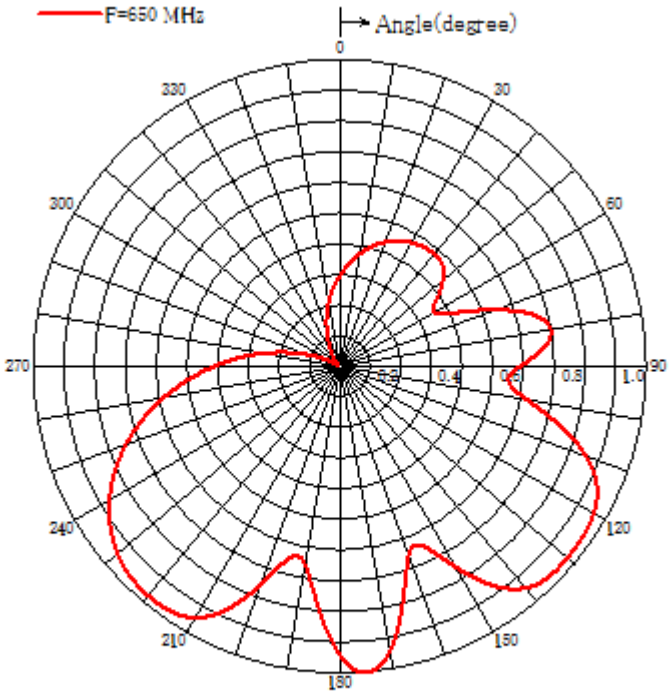
Antenna Radiation Pattern
UHF 4 Loop Antenna 1 Face (2)



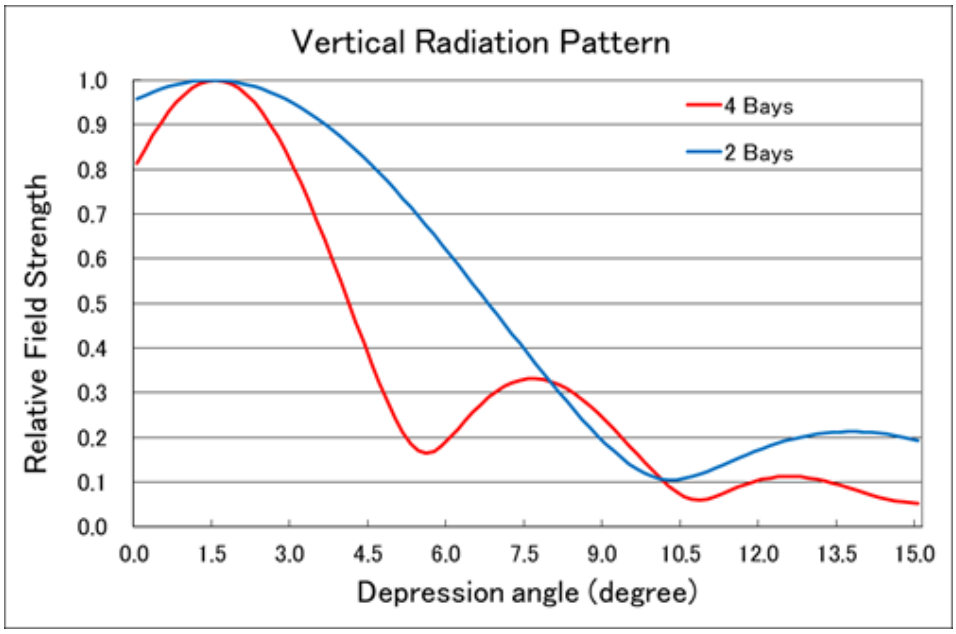
19. Specification of antenna system (Gongala)

Item	Specifications	Remarks
Location: Latitude Longitude	N: 06˚23'09" E:80˚39'02"	
Tower for antenna installation	At the top of a new 75m-high tower	
Antenna configuration	4-stage 2-face, 2-stage 1-face	
Directions of the antenna	40, 130, 220 (degree)	Clockwise from the due north
Numbers of stages in the antenna	2, 4, 4	Number of stages in each direction
<Specifications of the antenna>		
Type of the antenna panel	4L stacked-loop antenna	
Polarization	Horizontal polarization	
Gain of an antenna panel	11.0 dBd or above	Including the loss of branching coaxial cables
Gain of the antenna system	12.8 dBd or above	From the outdoor distributor
Voltage standing wave ratio	1.10 or below	Within the channel in use
Tilt angle	1.5 degree for each face	Angle of depression from the horizontal plane
Null fill-in	10 % or above	First null point
Power capacity	10 kW or above	
Size and length of main feeder cable	Air dielectric coaxial cable 3“, 100m	
Dehydrator	1 unit	
Combiner	For transmission of 1kW signals on four frequencies	
Coaxial switch	Three terminals, 3-1/8“	
Coaxial dummy load	8kW	
Transmitter output	1kW	

20. Diagram of horizontal and vertical radiation pattern (Gongala)



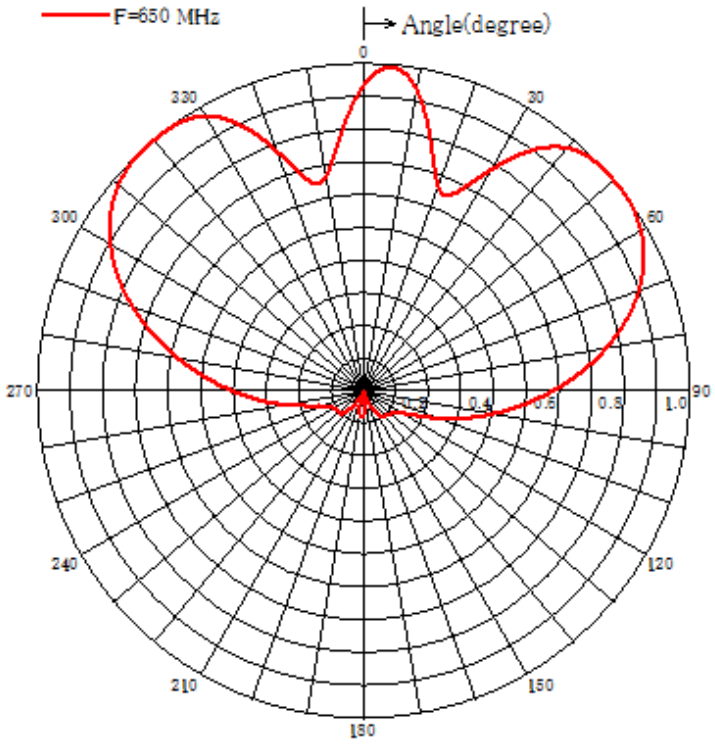
Antenna Radiation Pattern
UHF 4 Loop Antenna 3 Faces (2.4.4)



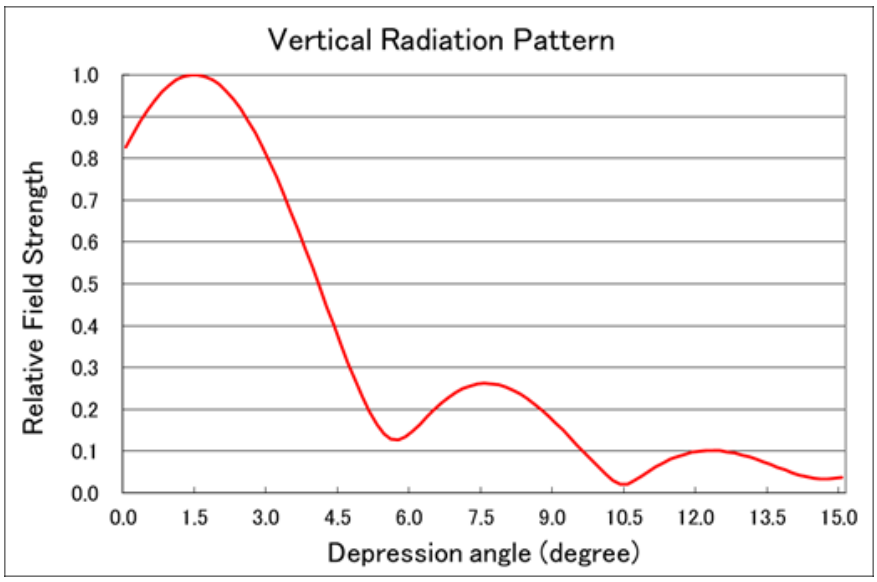
21. Specification of antenna system (Suriyakanda)

Item	Specifications	Remarks
Location: Latitude Longitude	N:06˚26'25" E:80˚36'54"	Location of the ITN tower
Tower for antenna installation	At the top of a new 75m-high tower	
Antenna configuration	4-stage 2-face	
Directions of the antenna	50, 320 (degree)	Clockwise from the due north
Numbers of stages in the antenna	4, 4	Number of stages in each direction
<Specifications of the antenna>		
Type of the antenna panel	4L stacked-loop antenna	
Polarization	Horizontal polarization	
Gain of an antenna panel	11.0 dBd or above	Including the loss of branching coaxial cables
Gain of the antenna system	13.8 dBd or above	From the outdoor distributor
Voltage standing wave ratio	1.10 or below	Within the channel in use
Tilt angle	1.5 degree for each face	Angle of depression from the horizontal plane
Null fill-in	10 % or above	First null point
Power capacity	8 kW or above	
Size and length of main feeder cable	Air dielectric coaxial cable 3“, 100m	
Dehydrator	1 unit	
Combiner	For transmission of 1kW signals on four frequencies	
Coaxial switch	Three terminals, 3-1/8“	
Coaxial dummy load	8kW	
Transmitter output	1kW	

22. Diagram of horizontal and vertical radiation pattern (Suriyakanda)



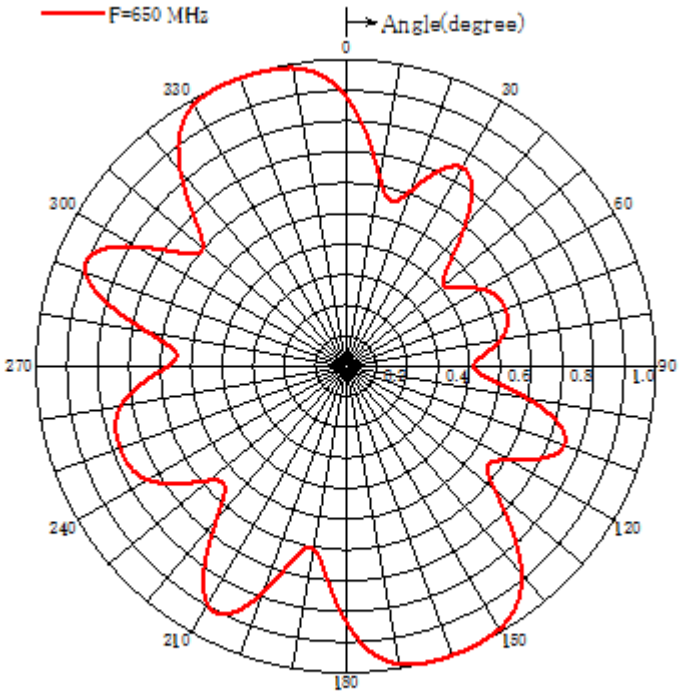
Antenna Radiation Pattern
UHF 4 Loop Antenna 2 Faces (4.4)



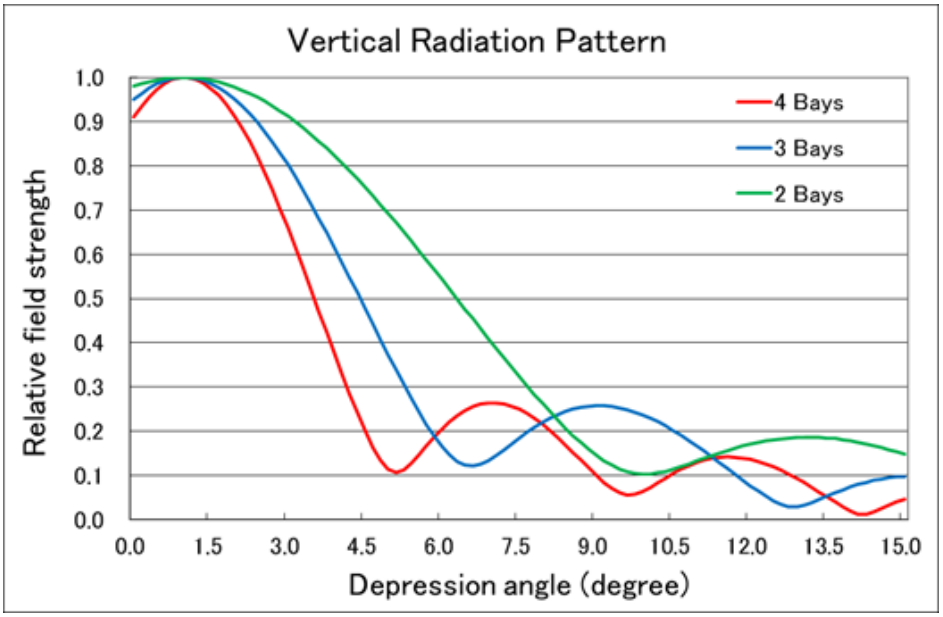
23. Specification of antenna system (Elpitiya)

Item	Specifications	Remarks
Location: Latitude Longitude	N: 06˚15’33.2” E:80˚08’39”	
Tower for antenna installation	At the top of a new 80m-high tower	
Antenna configuration	4-stage 4-face	
Directions of the antenna	70, 160, 250, 340(degree)	Clockwise from the due north
Numbers of stages in the antenna	2, 4, 3, 4	Number of stages in each direction
<Specifications of the antenna>		
Type of the antenna panel	4L stacked-loop antenna	
Polarization	Horizontal polarization	
Gain of an antenna panel	11.0 dBd or above	Including the loss of branching coaxial cables
Gain of the antenna system	11.6 dBd or above	From the outdoor distributor
Voltage standing wave ratio	1.10 or below	Within the channel in use
Tilt angle	1 degree for each face	Angle of depression from the horizontal plane
Null fill-in	10 % or above	First null point
Power capacity	5 kW or above	
Size and length of main feeder cable	Air dielectric coaxial cable 1-5/8“, 100m	
Dehydrator	1 unit	
Combiner	For transmission of 300W signals on four frequencies	
Coaxial switch	Three terminals, 1-5/8“	
Coaxial dummy load	3kW	
Transmitter output	300W	

24. Diagram of horizontal and vertical radiation pattern (Elpitiya)



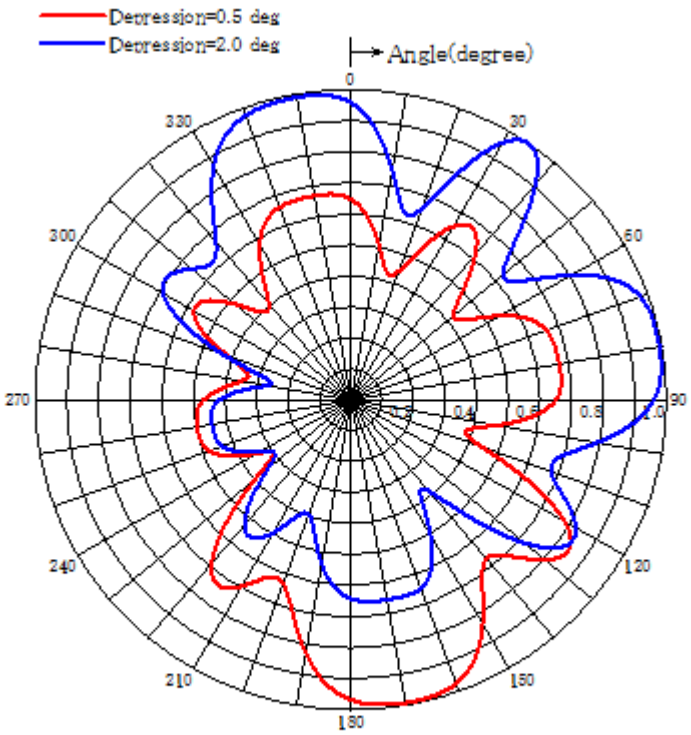
Antenna Radiation Pattern
UHF 4 Loop Antenna 4 Faces (2.4.3.4)



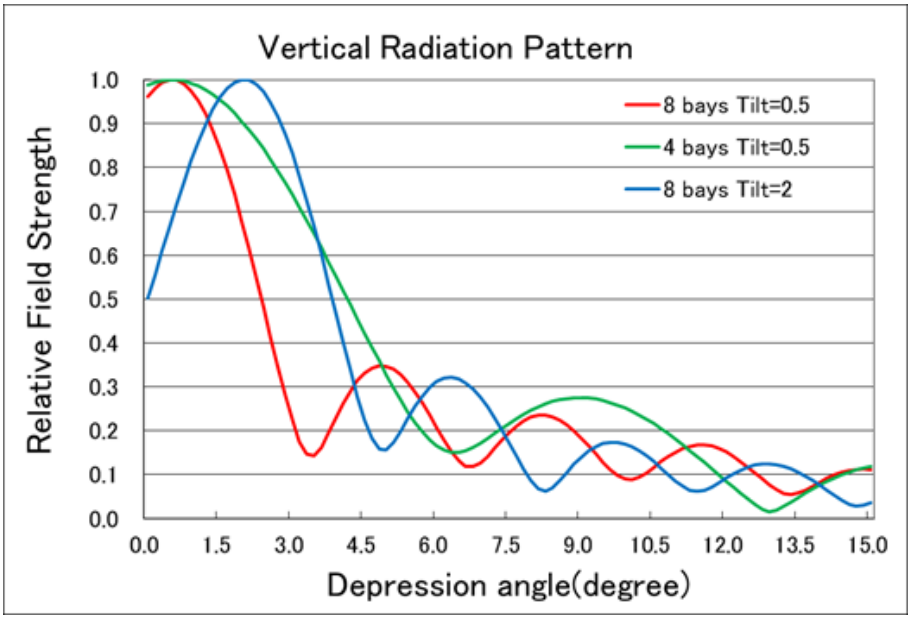
25. Specification of antenna system (Colombo)

Item	Specifications	Remarks
Location: Latitude Longitude	N: 06˚ 55’45” E: 79˚51'27"	
Tower for antenna installation	At the top of a 350m-high tower	Lotus Tower
Antenna configuration	8-stage 3-face, 4-stage 1-face	
Directions of the antenna	79, 169, 259, 349(degree)	Clockwise from the due north
Numbers of stages in the antenna	8, 8, 4, 8	Number of stages in each direction
<Specifications of the antenna>		
Type of the antenna panel	4 dipole antenna	
Polarization	Horizontal polarization	
Gain of an antenna panel	10.5 dBd or above	Including the loss of branching coaxial cables
Gain of the antenna system	13.2 dBd or above	From the outdoor distributor
Voltage standing wave ratio	1.10 or below	Within the channel in use
Tilt angle	2.0, 0.5, 0.5, 2.0 (degree)	Angle of depression from the horizontal plane
Null fill-in	10 % or above	First null point
Power capacity	40 kW or above	
Size and length of main feeder cable	Air dielectric coaxial cable 5“, 150m x 2	Two-line feed system
Dehydrator	2 units	
Combiner	For transmission of 5kW signals on four frequencies	
Coaxial switch	Seven terminals, 5“	
Coaxial dummy load	40kW	
Transmitter output	5kW	

26. Diagram of horizontal and vertical radiation pattern (Colombo)



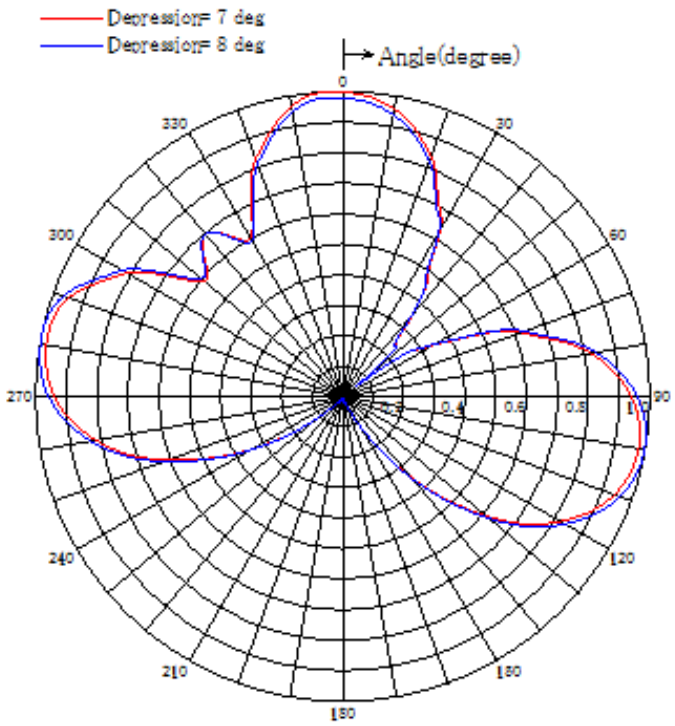
Antenna Radiation Pattern
UHF 4 Dipole Antenna 4 Faces (8.8.4.8)



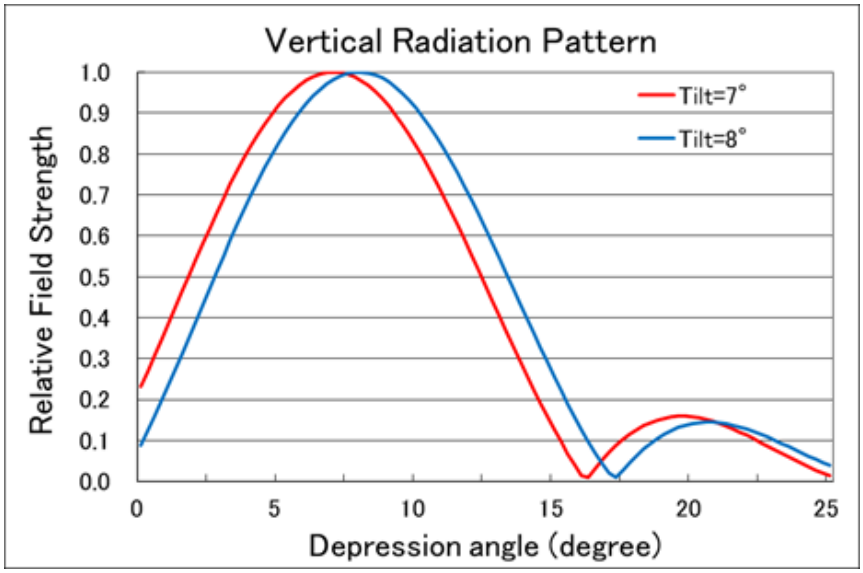
27. Specification of antenna system (Hantana)

Item	Specifications	Remarks
Location: Latitude Longitude	N: 07˚15'31" E:80˚37'46"	
Tower for antenna installation	At the side of an existing 70m-high tower	
Antenna configuration	4-stage 3-face	
Directions of the antenna	0, 100, 280(degree)	Clockwise from the due north
Numbers of stages in the antenna	4, 4, 4	Number of stages in each direction
<Specifications of the antenna>		
Type of the antenna panel	8-element ring antenna	
Polarization	Horizontal polarization	
Gain of an antenna panel	9.0 dBd or above	Including the loss of branching coaxial cables
Gain of the antenna system	10.0 dBd or above	From the outdoor distributor
Voltage standing wave ratio	1.15 or below	Within the channel in use
Tilt angle	7, 8, 8 (degree)	Angle of depression from the horizontal plane
Null fill-in	0 % or above	First null point
Power capacity	0.8 kW or above	
Size and length of main feeder cable	Air dielectric coaxial cable 7/8“, 90m	
Dehydrator	1 unit	
Combiner	For transmission of 10W signals on four frequencies	
Coaxial switch	Three terminals、7/8“	
Coaxial dummy load	0.1kW	
Transmitter output	10W	

28. Diagram of horizontal and vertical radiation pattern (Hantana)



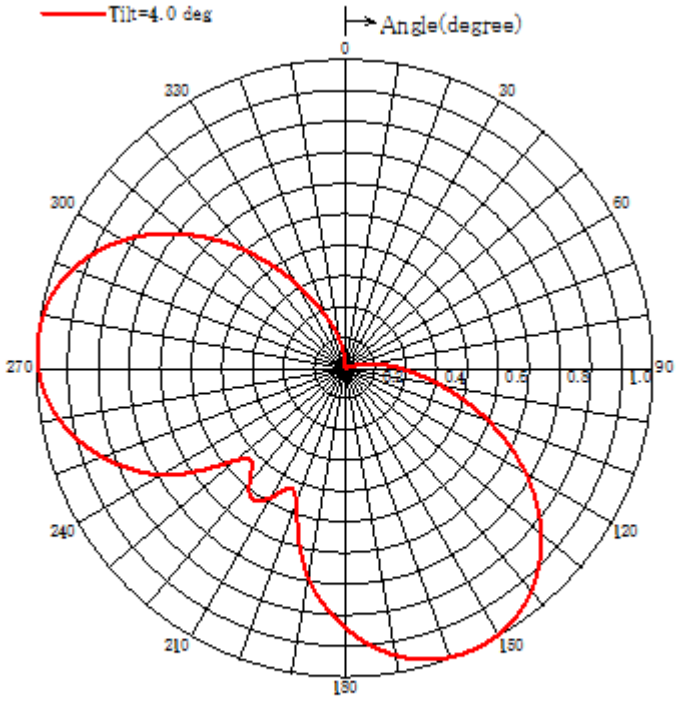
Antenna Radiation Pattern
UHF Ring Antenna 3 Faces (4.4.4)



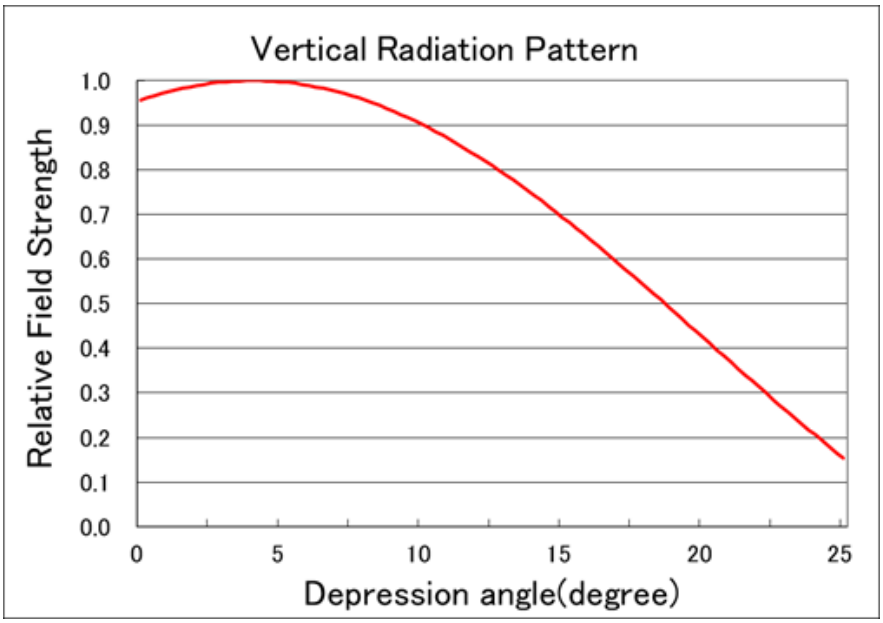
29. Specification of antenna system (Kurunegala)

Item	Specifications	Remarks
Location: Latitude Longitude	N: 07˚29'04" E:80˚22'15"	
Tower for antenna installation	At the side of an existing 42m-high tower	
Antenna configuration	1-stage 2-face	
Directions of the antenna	135, 255(degree)	Clockwise from the due north
Numbers of stages in the antenna	1, 1	Number of stages in each direction
<Specifications of the antenna>		
Type of the antenna panel	4 dipole antenna	
Polarization	Horizontal polarization	
Gain of an antenna panel	10.5 dBd or above	Including the loss of branching coaxial cables
Gain of the antenna system	7.3 dBd or above	From the outdoor distributor
Voltage standing wave ratio	1.15 or below	Within the channel in use
Tilt angle	4 (degree)	Angle of depression from the horizontal plane
Null fill-in	0 % or above	First null point
Power capacity	0.1 kW or above	
Size and length of main feeder cable	Air dielectric coaxial cable 7/8“, 25m	
Dehydrator	1 unit	
Combiner	For transmission of 10W signals on four frequencies	
Coaxial switch	Three terminals, 1-5/8“	
Coaxial dummy load	0.1kW	
Transmitter output	10W	

30. Diagram of horizontal and vertical radiation pattern (Kurunegala)



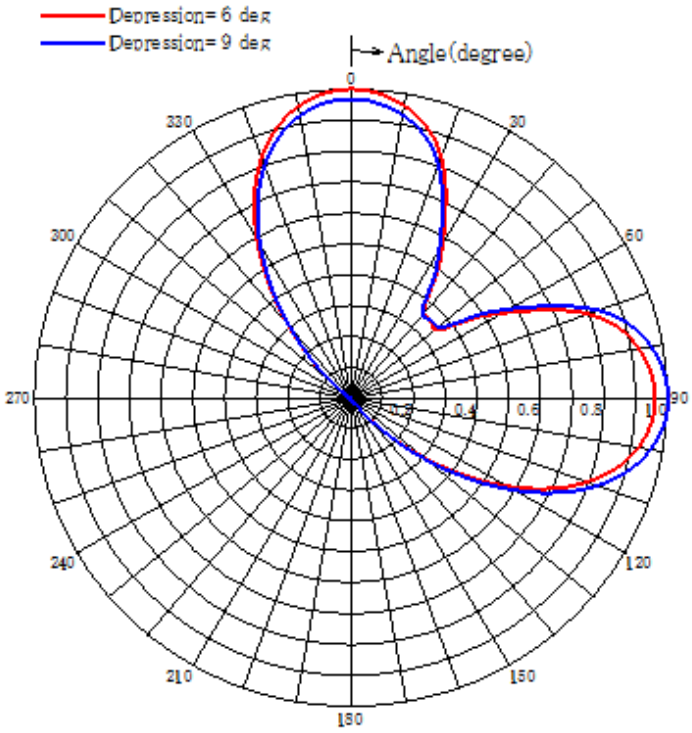
Antenna Radiation Pattern
UHF 4 Dipole Antenna 2 Faces (1.1)



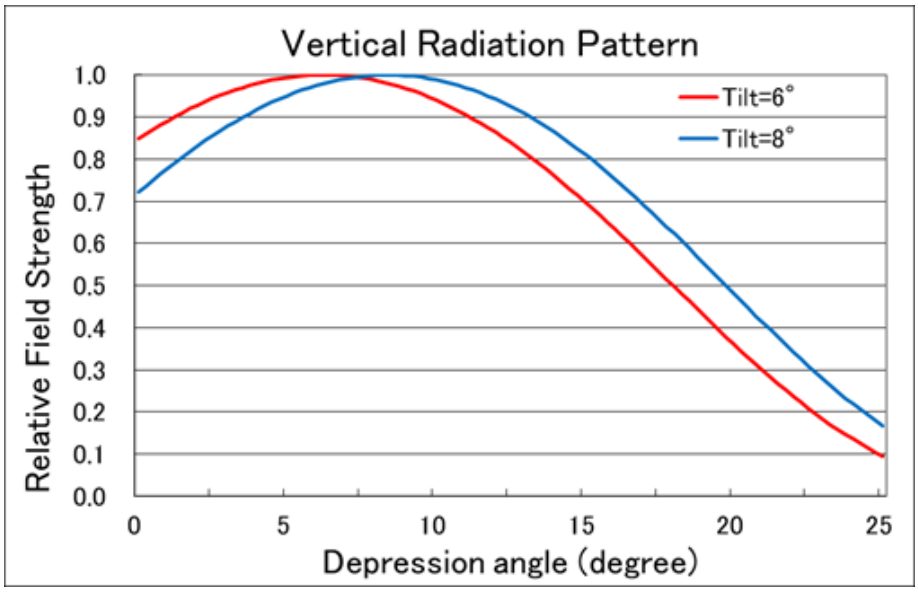
31. Specification of antenna system (Baddulla)

Item	Specifications	Remarks
Location: Latitude Longitude	N: 06˚58'25" E:81˚03'12"	
Tower for antenna installation	At the side of an existing 30m-high tower	
Antenna configuration	2-stage 2-face	
Directions of the antenna	0, 90 (degree)	Clockwise from the due north
Numbers of stages in the antenna	2, 2	Number of stages in each direction
<Specifications of the antenna>		
Type of the antenna panel	8-element ring antenna	
Polarization	Horizontal polarization	
Gain of an antenna panel	9.0 dBd or above	Including the loss of branching coaxial cables
Gain of the antenna system	9.0 dBd or above	From the outdoor distributor
Voltage standing wave ratio	1.15 or below	Within the channel in use
Tilt angle	6, 9 (degree)	Angle of depression from the horizontal plane
Null fill-in	0 % or above	First null point
Power capacity	0.1 kW or above	
Size and length of main feeder cable	Air dielectric coaxial cable 7/8“, 35m	
Dehydrator	1 unit	
Combiner	For transmission of 10W signals on four frequencies	
Coaxial switch	Three terminals, 7/8“	
Coaxial dummy load	0.1kW	
Transmitter output	10W	

32. Diagram of horizontal and vertical radiation pattern (Baddulla)



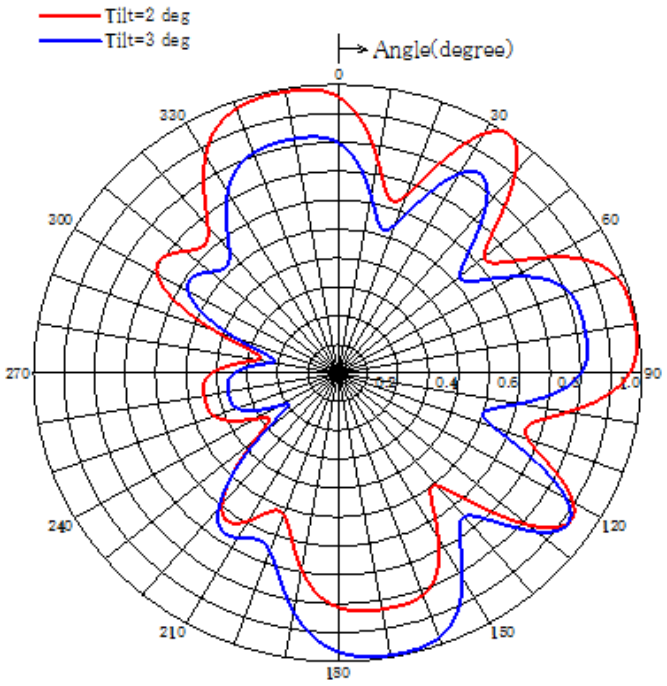
Antenna Radiation Pattern
UHF Ring Antenna 2 Faces (2.2)



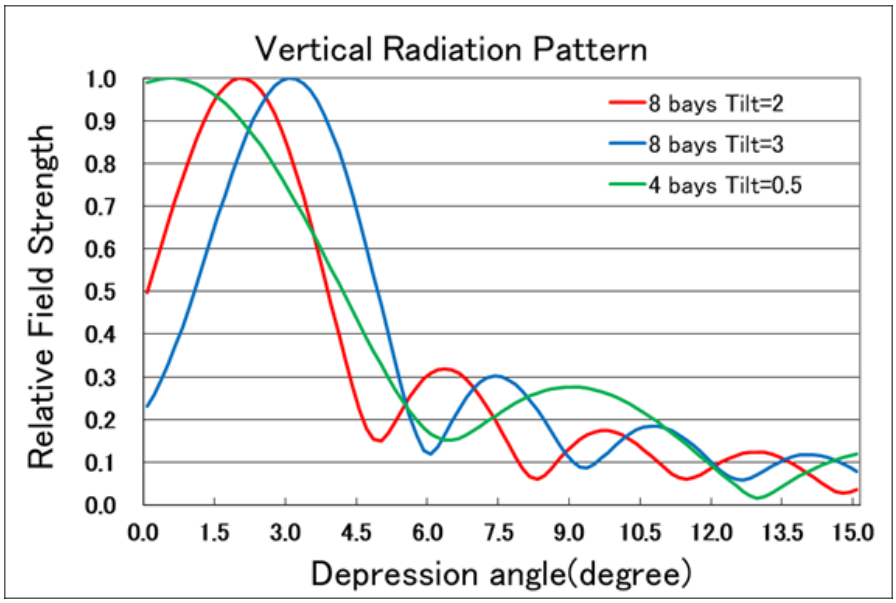
33. Provisional specification of antenna system (Colombo)

Item	Specifications	Remarks
Location: Latitude Longitude	N: 06˚ 55'45" E: 79˚51'27"	
Tower for antenna installation	At the top of 350m-high tower	Lotus Tower
Antenna configuration	8-stage 3-face, 4-stage 1-face	
Directions of the antenna	79, 169, 259, 349(degree)	Clockwise from the due north
Numbers of stages in the antenna	8, 8, 4, 8	Number of stages in each direction
<Specifications of the antenna>		
Type of the antenna panel	4 dipole antenna	
Polarization	Horizontal polarization	
Gain of an antenna panel	10.5 dBd or above	Including the loss of branching coaxial cables
Gain of the antenna system	13.2 dBd or above	From the outdoor distributor
Voltage standing wave ratio	1.10 or below	Within the channel in use
Tilt angle	2.0, 3.0, 0.5, 2.0 (degree)	Angle of depression from the horizontal plane
Null fill-in	10 % or above	First null point
Power capacity	40 kW or above	
Size and length of main feeder cable	Air dielectric coaxial cable 5", 150m x 2	Two-line feed system
Dehydrator	2 units	
Combiner	For transmission of 5kW signals on four frequencies	
Coaxial switch	Seven terminals, 5"	
Coaxial dummy load	40kW	
Transmitter output	5kW	

34. Provisional diagram of horizontal and vertical radiation pattern (Colombo)



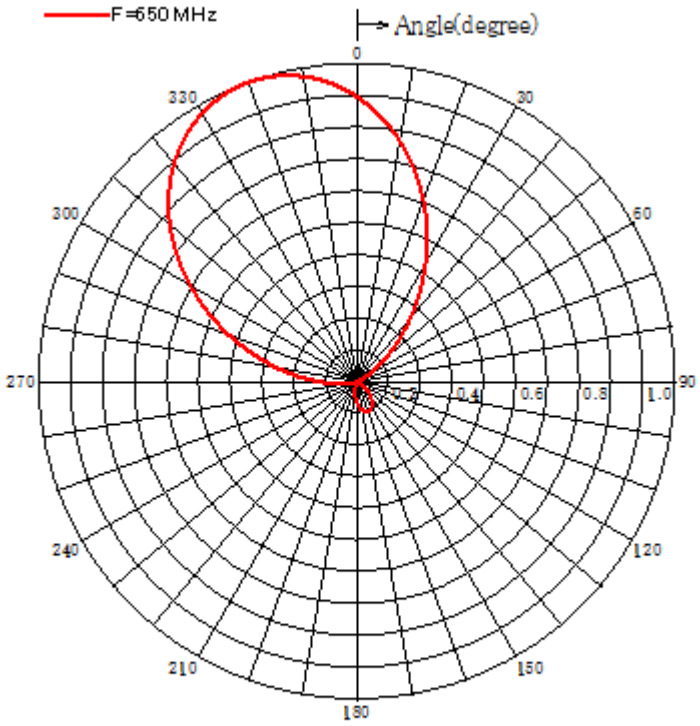
Antenna Radiation Pattern
UHF 4 dipole Antenna 4 Faces (8.8.4.8)



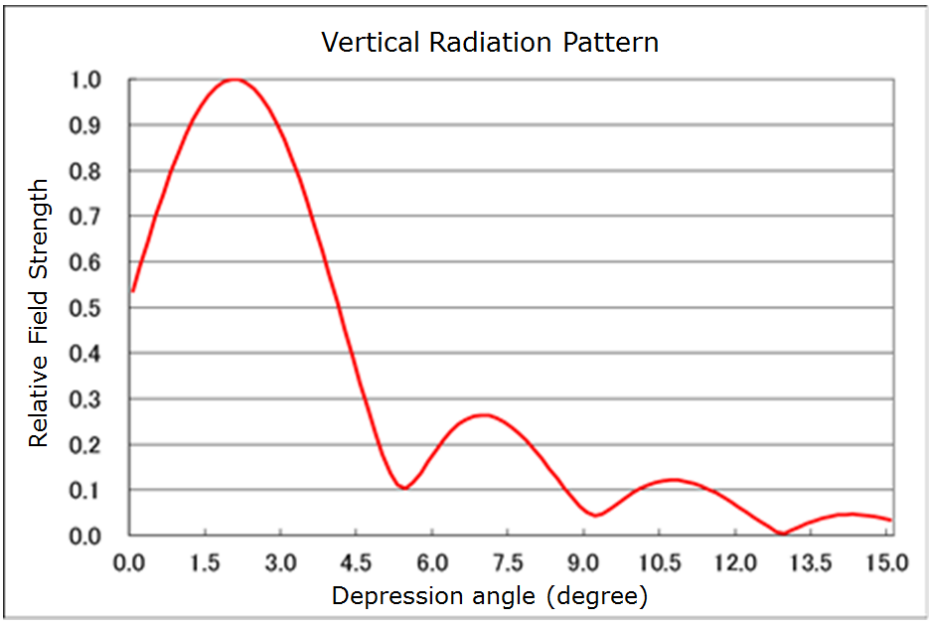
35. Provisional specification of antenna system (Yatiyantota)

Item	Specifications	Remarks
Location: Latitude Longitude	N: 07˚02'44.63" E:80˚24'08.73"	ITN 鉄塔位置
Tower for antenna installation	At the side of a new 75m-high tower	
Antenna configuration	5-stage 1-face	
Directions of the antenna	340 (degree)	Clockwise from the due north
Numbers of stages in the antenna	5	Number of stages in each direction
<Specifications of the antenna>		
Type of the antenna panel	4L stacked-loop antenna	
Polarization	Horizontal polarization	
Gain of an antenna panel	11.0 dBd or above	Including the loss of branching coaxial cables
Gain of the antenna system	17.7 dBd or above	From the outdoor distributor
Voltage standing wave ratio	1.10 or below	Within the channel in use
Tilt angle	2 (degree)	Angle of depression from the horizontal plane
Null fill-in	10 % or above	First null point (0% for 2-stage)
Power capacity	16 kW or above	
Size and length of main feeder cable	Air dielectric coaxial cable 3-1/8“, 100m	
Dehydrator	1 unit	
Combiner	For transmission of 2kW signals on four frequencies	
Coaxial switch	Three terminals, 3-1/8“	
Coaxial dummy load	8kW	
Transmitter output	0.5kW	

36. Provisional diagram of horizontal and vertical radiation pattern (Yatiyantota)



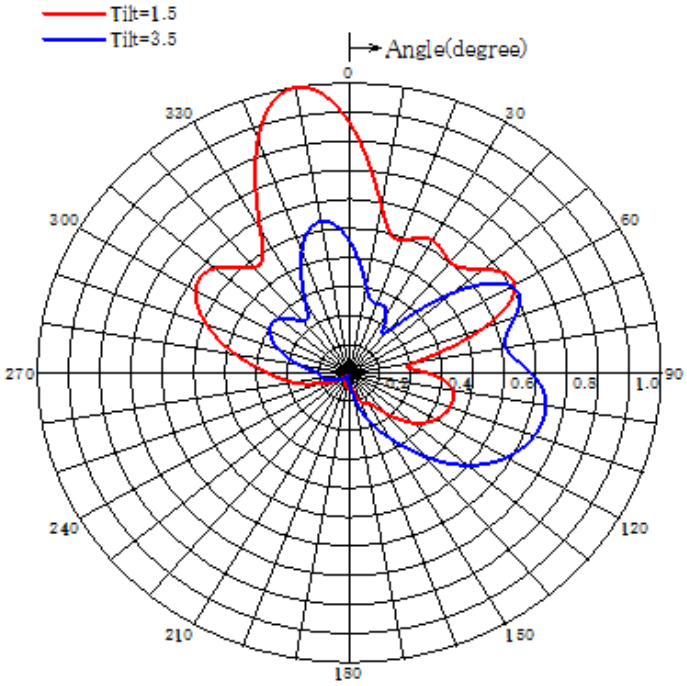
Antenna Radiation Pattern
UHF 4 Loop Antenna 1 Face (5)



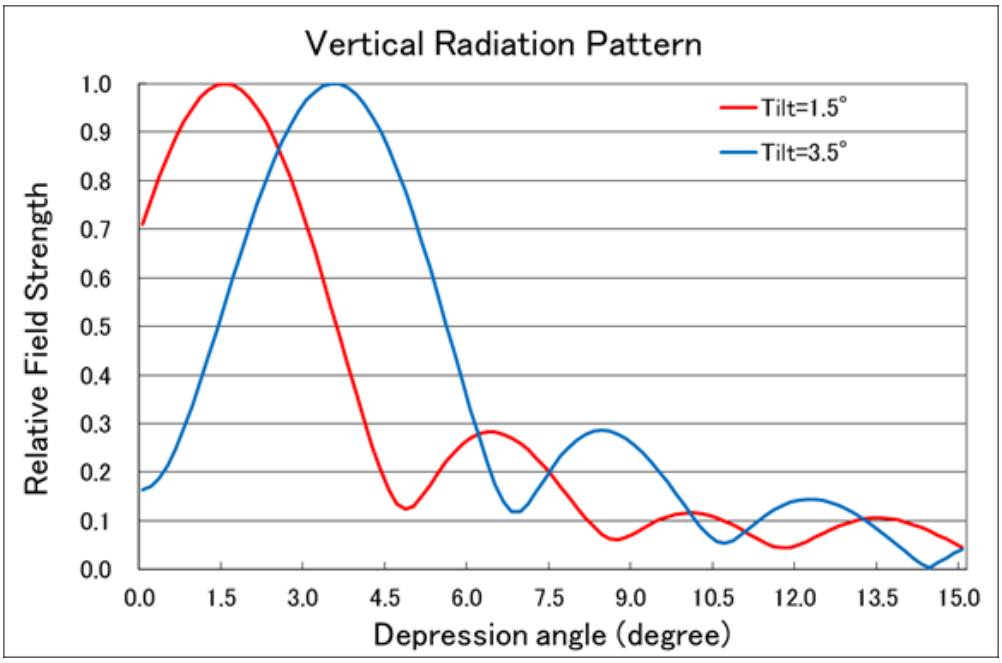
37. Provisional specification of antenna system (Karagahatenna)

Item	Specifications	Remarks
Location: Latitude Longitude	N:07˚35'28.47" E:80˚42'49.02"	
Tower for antenna installation	At the side of an existing 65m-high tower	
Antenna configuration	6-stage 3-face	
Directions of the antenna	20, 100, 320 (degree)	Clockwise from the due north
Numbers of stages in the antenna	5, 5, 5	Number of stages in each direction
<Specifications of the antenna>		
Type of the antenna panel	4L stacked-loop antenna	
Polarization	Horizontal polarization	
Gain of an antenna panel	11.0 dBd or above	Including the loss of branching coaxial cables
Gain of the antenna system	16.0 dBd or above	From the outdoor distributor
Voltage standing wave ratio	1.10 or below	Within the channel in use
Tilt angle	1.5 degrees for each face	Angle of depression from the horizontal plane
Null fill-in	10 % or above	First null point
Power capacity	14 kW or above	
Size and length of main feeder cable	Air dielectric coaxial cable 3“, 85m x 2	
Dehydrator	1 unit	Two terminals at the outlet
Combiner	For transmission of 3kW signals on four frequencies	
Coaxial switch	Three terminals, 3-1/8“	
Coaxial dummy load	24kW	
Transmitter output	3kW	

38. Provisional diagram of horizontal and vertical radiation pattern (Karagahatenna)



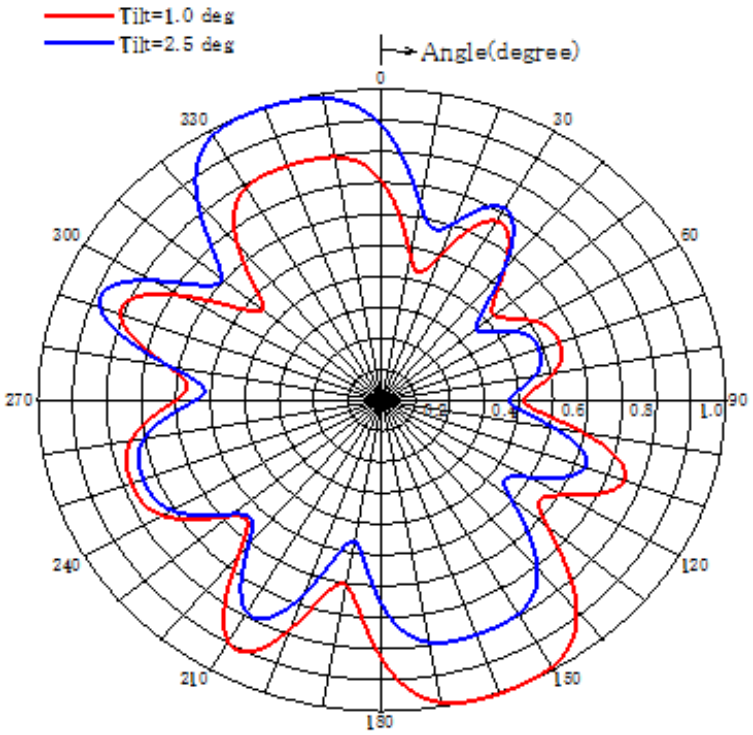
Antenna Radiation Pattern
UHF 4 Loop Antenna 3 feces (5.5.5)



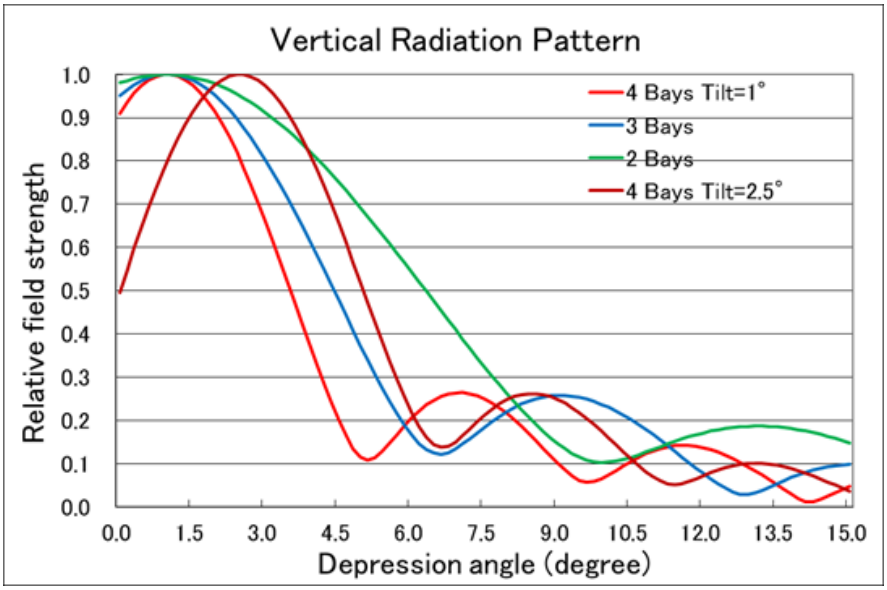
39. Provisional specification of antenna system (Elpitiya)

Item	Specifications	Remarks
Location: Latitude Longitude	N: 06˚17'26" E:80˚09'26"	
Tower for antenna installation	At the top of a new 75m-high tower	
Antenna configuration	4-stage 4-face	
Directions of the antenna	70, 160, 250, 340(degree)	Clockwise from the due north
Numbers of stages in the antenna	2, 4, 3, 4	Number of stages in each direction
<Specifications of the antenna>		
Type of the antenna panel	4L stacked-loop antenna	
Polarization	Horizontal polarization	
Gain of an antenna panel	11.0 dBd or above	Including the loss of branching coaxial cables
Gain of the antenna system	11.6 dBd or above	From the outdoor distributor
Voltage standing wave ratio	1.10 or below	Within the channel in use
Tilt angle	1, 1, 1, 2.5 (degree)	Angle of depression from the horizontal plane
Null fill-in	10 % or above	First null point
Power capacity	5 kW or above	
Size and length of main feeder cable	Air dielectric coaxial cable 1-5/8“, 100m	
Dehydrator	1 unit	
Combiner	For transmission of 300W signals on four frequencies	
Coaxial switch	Three terminals, 1-5/8“	
Coaxial dummy load	3kW	
Transmitter output	300W	

40. Provisional diagram of horizontal and vertical radiation pattern (Elpitiya)



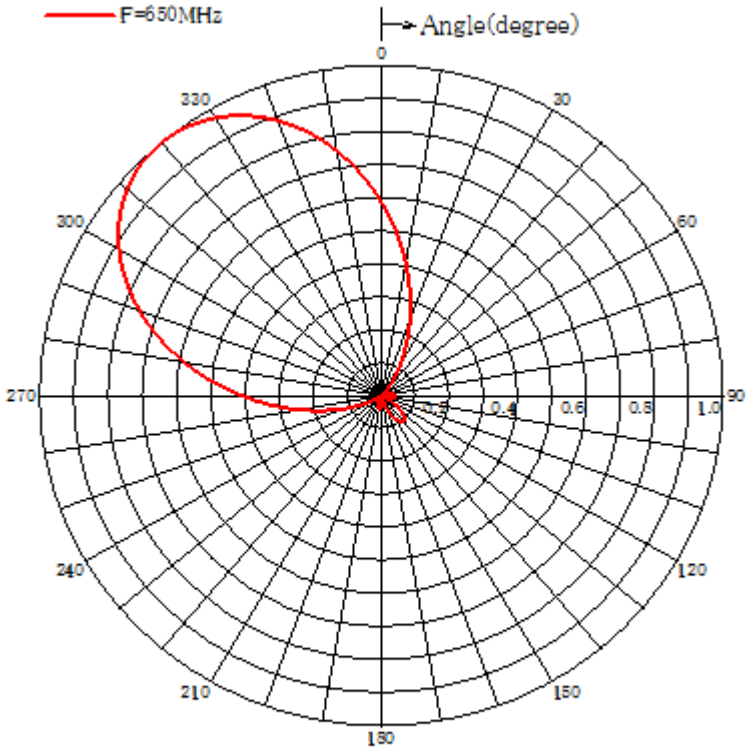
Antenna Radiation Pattern
UHF 4 Loop Antenna 4 Faces (2.4.3.4)



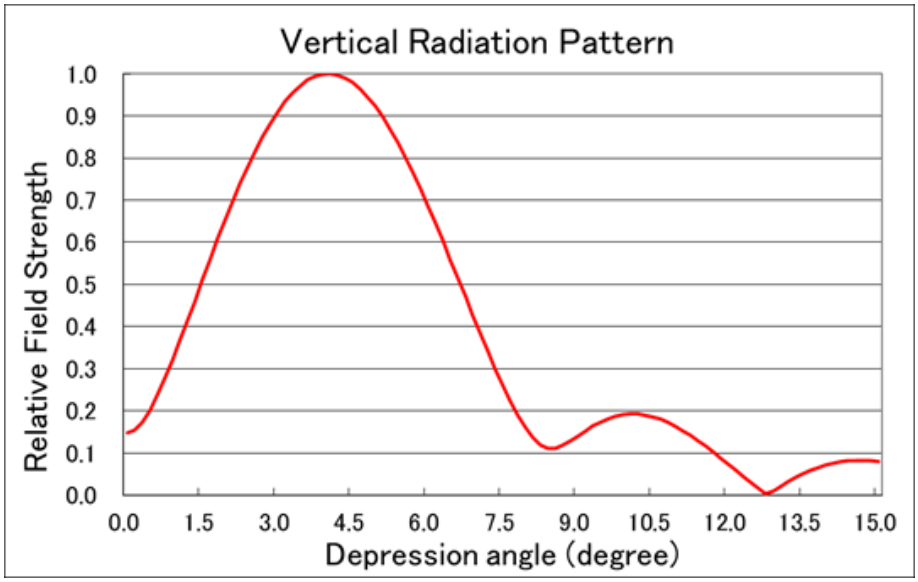
41. Provisional specification of antenna system (Suriyakanda)

Item	Specifications	Remarks
Location: Latitude Longitude	N:06˚26'25" E:80˚36'54"	ITN 鉄塔位置
Tower for antenna installation	At the top of a new 75m-high tower	
Antenna configuration	4-stage 1-face	
Directions of the antenna	320 (degree)	Clockwise from the due north
Numbers of stages in the antenna	4	Number of stages in each direction
<Specifications of the antenna>		
Type of the antenna panel	4L stacked-loop antenna	
Polarization	Horizontal polarization	
Gain of an antenna panel	11.0 dBd or above	Including the loss of branching coaxial cables
Gain of the antenna system	16.8 dBd or above	From the outdoor distributor
Voltage standing wave ratio	1.10 or below	Within the channel in use
Tilt angle	4 (degree)	Angle of depression from the horizontal plane
Null fill-in	10 % or above	First null point
Power capacity	8 kW or above	
Size and length of main feeder cable	Air dielectric coaxial cable 3“, 100m	
Dehydrator	1 unit	
Combiner	For transmission of 1kW signals on four frequencies	
Coaxial switch	Three terminals, 3-1/8“	
Coaxial dummy load	8kW	
Transmitter output	0.2kW	

42. Provisional diagram of horizontal and vertical radiation pattern (Suriyakanda)



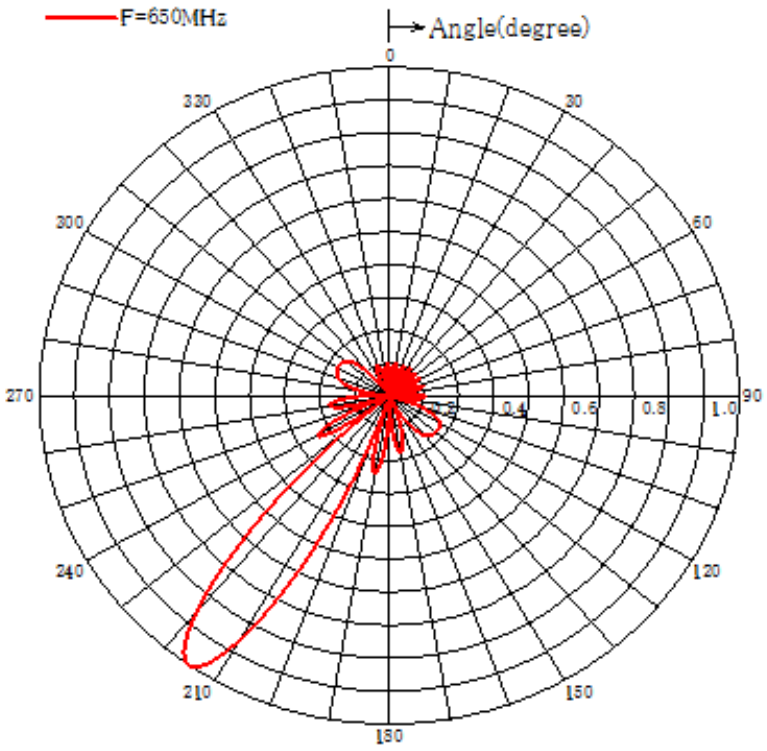
Antenna Radiation Pattern
UHF 4 Loop Antenna 1 Face (4)



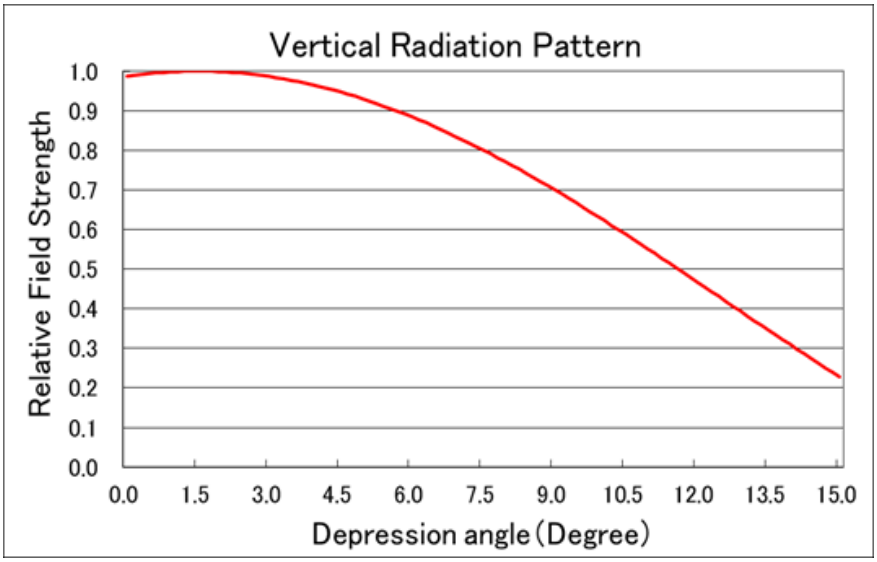
43. Provisional specification of antenna system (Gongala)

Item	Specifications	Remarks
Location: Latitude Longitude	N: 06˚23'09" E:80˚39'02"	
Tower for antenna installation	At the side of a new 75m-high tower	
Antenna configuration Directions of the antenna Numbers of stages in the antenna	24GU x 1 215 (degree) 1	 Clockwise from the due north Number of stages in each direction
<Specifications of the antenna> Type of the antenna panel Polarization Gain of an antenna panel Gain of the antenna system Voltage standing wave ratio Tilt angle Null fill-in Power capacity Size and length of main feeder cable Dehydrator Combiner Coaxial switch Coaxial dummy load	 2.4m-grid parabolic antenna Horizontal polarization 19.35 dBd or above 17.1 dBd or above 1.10 or below 1.5 (degree) 0 % or above 1 kW or above Air dielectric coaxial cable 3“, 100m 1 unit For transmission of 1kW signals on four frequencies Three terminals, 3-1/8“ 8kW	 Including the loss of branching coaxial cables From the outdoor distributor Within the channel in use Angle of depression from the horizontal plane First null point
Transmitter output	1kW	

44. Provisional diagram of horizontal and vertical radiation pattern (Gongala)



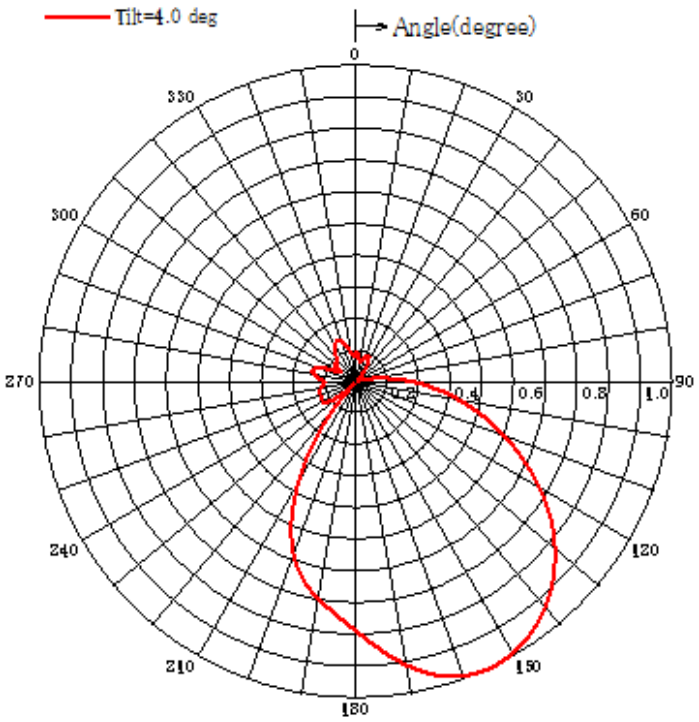
Antenna Radiation Pattern
UHF 2.4m Parabolic Antenna 1 Face



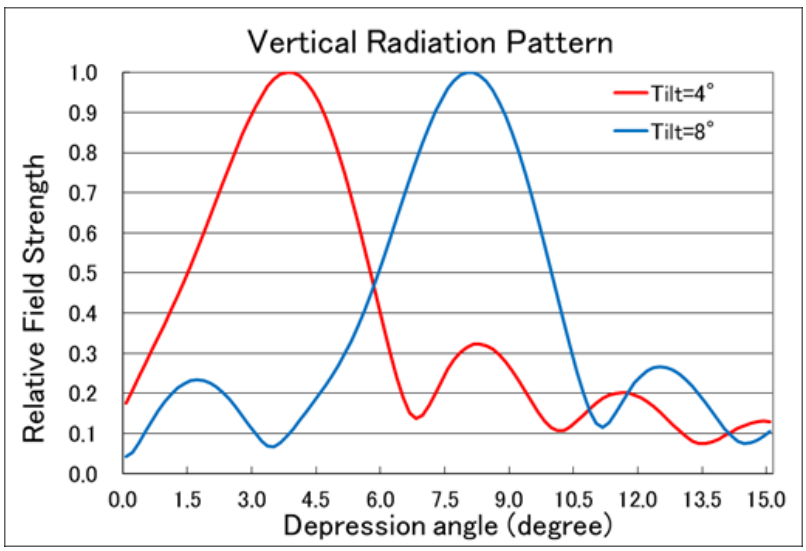
45. Provisional specification of antenna system (Hunnasgiriya)

Item	Specifications	Remarks
Location: Latitude Longitude	N:07˚23'12.99" E:80˚41'25.86"	
Tower for antenna installation	Upper part of an existing 75m-high tower	Stayed tower
Antenna configuration	8-stage 3-face	
Directions of the antenna	155, 245, 335 (degree)	Clockwise from the due north
Numbers of stages in the antenna	8, 8, 8	Number of stages in each direction
<Specifications of the antenna>		
Type of the antenna panel	4 dipole antenna	
Polarization	Horizontal polarization	
Gain of an antenna panel	10.5 dBd or above	
Gain of the antenna system	13.6 dBd or above	From the outdoor distributor
Voltage standing wave ratio	1.10 or below	Within the channel in use
Tilt angle	3.0, 4.5, 3.5 (degree)	Angle of depression from the horizontal plane
Null fill-in	10 % or above	First null point
Power capacity	10 kW or above	
Size and length of main feeder cable	Air dielectric coaxial cable 3“, 85m	
Dehydrator	1 unit	
Combiner	For transmission of 2kW x 1 analogue signals and 1kW x 4 digital signals on five frequencies	
Coaxial switch	Three terminals, 3-1/8“	
Coaxial dummy load	8kW	
Transmitter output	Digital 1kW Analogue 2kW	

46. Provisional diagram of horizontal and vertical radiation pattern (Hunnasgiriya)



Antenna Radiation Pattern
UHF 4 Dipole Antenna 3 Faces (8.8.8)



47. Detail of expense for upgrading broadcasting equipment to HD at Art TV

	Description	Q'té		System Price Rough Estimation (K USD)
3	News Studio System	1	lot	79
3.2	Digital Video System	1	lot	45
3.3	Character Generator System	1	lot	18
3.4	Digital Audio System	1	lot	9
3.7	Sync System	1	lot	6
7	Post Production Server / News Production Server System	1	lot	91
7.1	Ingest Device	1	lot	14
7.2	Postproduction Server	1	lot	55
7.5	System Management Server	1	lot	14
7.6	File I/O interface	1	lot	9
8	Archive System	1	lot	36
8.1	Archive Management Server	1	lot	27
8.2	Cataloging Terminal	1	lot	5
8.5	Archive Media	1	lot	5
				Total (K USD)
				206

48. Detail of expense for upgrading broadcasting equipment to HD at CSN

	Description	Q'té		System Price Rough Estimation (K USD)
2	HD-SDI Embedded Audio Routing System	1	lot	27
2.1	HD-SDI Embedded Audio Router	1	lot	18
2.2	Control Panels	1	lot	9
3	News Studio System	1	lot	155
3.1	Digital Camera System	1	lot	18
3.2	Digital Video System	1	lot	45
3.3	Character Generator System	1	lot	18
3.4	Digital Audio System	1	lot	9
3.7	Sync System	1	lot	6
3.8	Monitoring System (A/V)	1	lot	55
3.1	On-Air Light and Tally System	1	lot	3
4	Production Studio System	1	lot	205
4.1	Digital Camera System	1	lot	45
4.2	Digital Video System	1	lot	45
4.3	Character Generator System	1	lot	18
4.4	Digital Audio System	1	lot	9
4.6	Sync System	1	lot	6
4.7	Monitoring System (A/V)	1	lot	64
4.8	Intercom System	1	lot	14
4.9	On-Air Light and Tally System	1	lot	3
7	Post Production Server / News Production Server System	1	lot	91
7.1	Ingest Device	1	lot	14
7.2	Postproduction Server	1	lot	55
7.5	System Management Server	1	lot	14
7.6	File I/O interface	1	lot	9
8	Archive System	1	lot	36
8.1	Archive Management Server	1	lot	27
8.2	Cataloging Terminal	1	lot	5
8.5	Archive Media	1	lot	5
				Total (K USD)
				514

49. Detail of expense for upgrading broadcasting equipment to HD at EAP

	Description	Q'té		System Price Rough Estimation (K USD)
2	HD-SDI Embedded Audio Routing System	1	lot	36
2.1	HD-SDI Embedded Audio Router	1	lot	27
2.2	Control Panels	1	lot	9
3	News Studio System	1	lot	362
3.1	Digital Camera System	1	lot	136
3.2	Digital Video System	1	lot	73
3.3	Character Generator System	1	lot	27
3.4	Digital Audio System	1	lot	16
3.7	Sync System	1	lot	9
3.8	Monitoring System (A/V)	1	lot	73
3.9	Intercom System	1	lot	18
3.1	On-Air Light and Tally System	1	lot	9
4	Production Studio System	1	lot	375
4.1	Digital Camera System	1	lot	136
4.2	Digital Video System	1	lot	73
4.3	Character Generator System	1	lot	27
4.4	Digital Audio System	1	lot	16
4.6	Sync System	1	lot	9
4.7	Monitoring System (A/V)	1	lot	82
4.8	Intercom System	1	lot	23
4.9	On-Air Light and Tally System	1	lot	9
5	ENG/EFP System	1	lot	27
5.1	HD Portable Camcorder	1	lot	14
5.2	Monitoring System	1	lot	14
7	Post Production Server / News Production Server System	1	lot	273
7.1	Ingest Device	1	lot	18
7.2	Postproduction Server	1	lot	109
7.3	News Production server system	1	lot	55
7.4	Graphics and Studio playout server system	1	lot	55
7.5	System Management Server	1	lot	18
7.6	File I/O interface	1	lot	18
8	Archive System	1	lot	36
8.1	Archive Management Server	1	lot	27
8.2	Cataloging Terminal	1	lot	5
8.5	Archive Media	1	lot	5
				Total (K USD)
				1109

50. Detail of expense for upgrading broadcasting equipment to HD at Hiru TV

	Description	Q'té		System Price Rough Estimation (K USD)
1	Master Control Room	1	lot	45
4	Production Studio System	1	lot	136
4.1	Digital Camera System	1	lot	136
8	Archive System	1	lot	36
8.1	Archive Management Server	1	lot	27
8.2	Cataloging Terminal	1	lot	5
8.5	Archive Media	1	lot	5
				Total (K USD)
				217

51. Detail of expense for upgrading broadcasting equipment to HD at MTV

	Description	Q'té		System Price Rough Estimation (K USD)
1	Master Control Room	1	lot	773
1.1	Integrated Control systemwith Playout Automation System	1	lot	164
1.2	Playout Server	1	lot	273
1.3	Character Generator	1	set	36
1.4	Network system peripherals	1	set	18
1.5	Baseband Video System peripherals	1	set	27
1.6	Test Signal Generator	1	set	9
1.7	Sync Signal System	1	lot	36
1.8	Monitor System (A/V)	1	lot	91
1.9	Room to Room Intercom System	1	lot	45
1.10	Master Clock	1	set	18
1.11	OA Tally System	1	lot	36
1.12	Alarm Monitoring System	1	lot	18
2	HD-SDI Embedded Audio Routing System	1	lot	36
2.1	HD-SDI Embedded Audio Router	1	lot	27
2.2	Control Panels	1	lot	9
3	News Studio System	4	lot	1818
3.1	Digital Camera System	1	lot	211
3.2	Digital Video System	1	lot	91
3.3	Character Generator System	1	lot	27
3.4	Digital Audio System	1	lot	16
3.7	Sync System	1	lot	9
3.8	Monitoring System (A/V)	1	lot	73
3.9	Intercom System	1	lot	18
3.1	On-Air Light and Tally System	1	lot	9
4	Production Studio System	5	lot	3182
4.1	Digital Camera System	1	lot	397
4.2	Digital Video System	1	lot	73
4.3	Character Generator System	1	lot	27
4.4	Digital Audio System	1	lot	16
4.6	Sync System	1	lot	9
4.7	Monitoring System (A/V)	1	lot	82
4.8	Intercom System	1	lot	23
4.9	On-Air Light and Tally System	1	lot	9
6	OB VAN	1	lot	1145
6.1	Digital Camera System	1	lot	455
6.2	Digital Video System	1	lot	182
6.3	Character Generator System	1	lot	36
6.4	Digital Audio System	1	lot	182
6.6	Sync System	1	lot	18
6.7	Monitoring System (A/V)	1	lot	91
6.8	Intercom System	1	lot	45
6.9	OB VAN with Engine Generator	1	lot	136
7	Post Production Server / News Production Server System	1	lot	273
7.1	Ingest Device	1	lot	18
7.2	Postproduction Server	1	lot	109
7.3	News Production server system	1	lot	55
7.4	Graphics and Studio playout server system	1	lot	55
7.5	System Management Server	1	lot	18
7.6	File I/O interface	1	lot	18
8	Archive System	1	lot	36
8.1	Archive Management Server	1	lot	27
8.2	Cataloging Terminal	1	lot	5
8.5	Archive Media	1	lot	5
				Total (K USD)
				7263

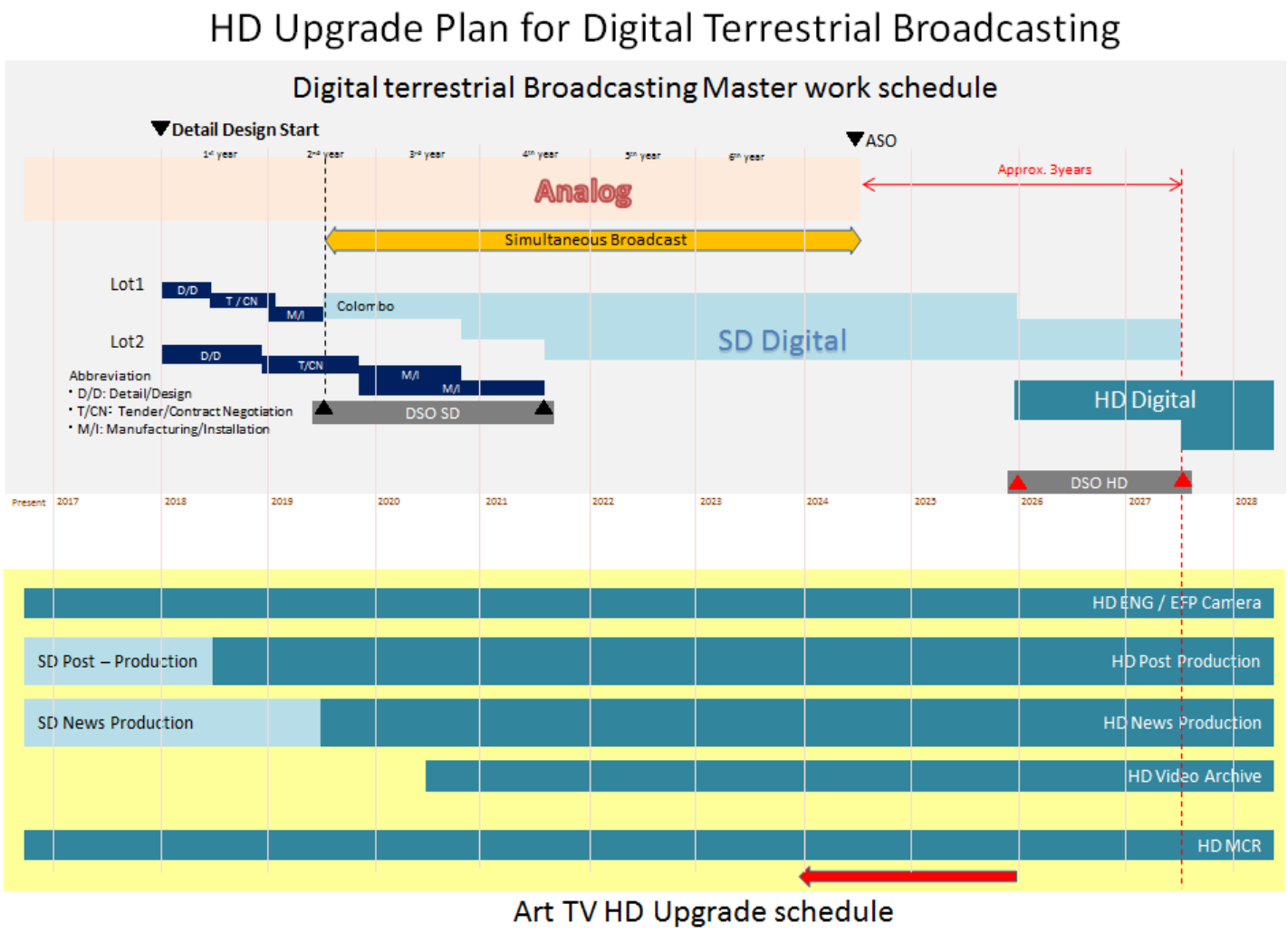
52. Detail of expense for upgrading broadcasting equipment to HD at Rangiri TV

	Description	Q'té		System Price Rough Estimation (K USD)
4	Production Studio System	1	lot	364
4.1	Digital Camera System	1	lot	364
8	Archive System	1	lot	36
8.1	Archive Management Server	1	lot	27
8.2	Cataloging Terminal	1	lot	5
8.5	Archive Media	1	lot	5
				Total (K USD)
				400

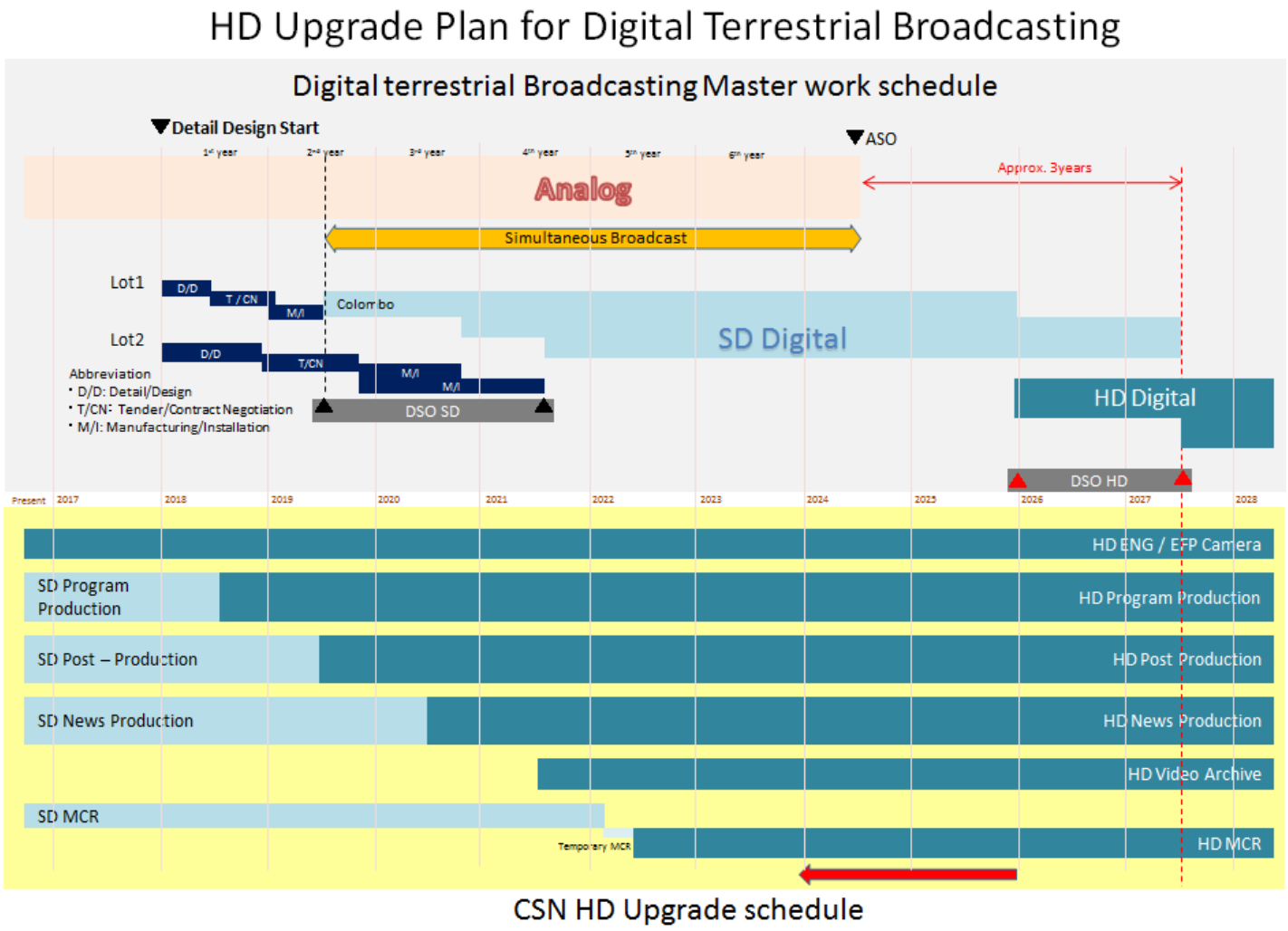
53. Detail of expense for upgrading broadcasting equipment to HD at Shraddha TV

	Description	Q'té		System Price Rough Estimation (K USD)
1	Master Control Room	1	lot	45
8	Archive System	1	lot	36
8.1	Archive Management Server	1	lot	27
8.2	Cataloging Terminal	1	lot	5
8.5	Archive Media	1	lot	5
				Total (K USD)
				81

54. Schedule for upgrading broadcasting equipment to HD at Art TV

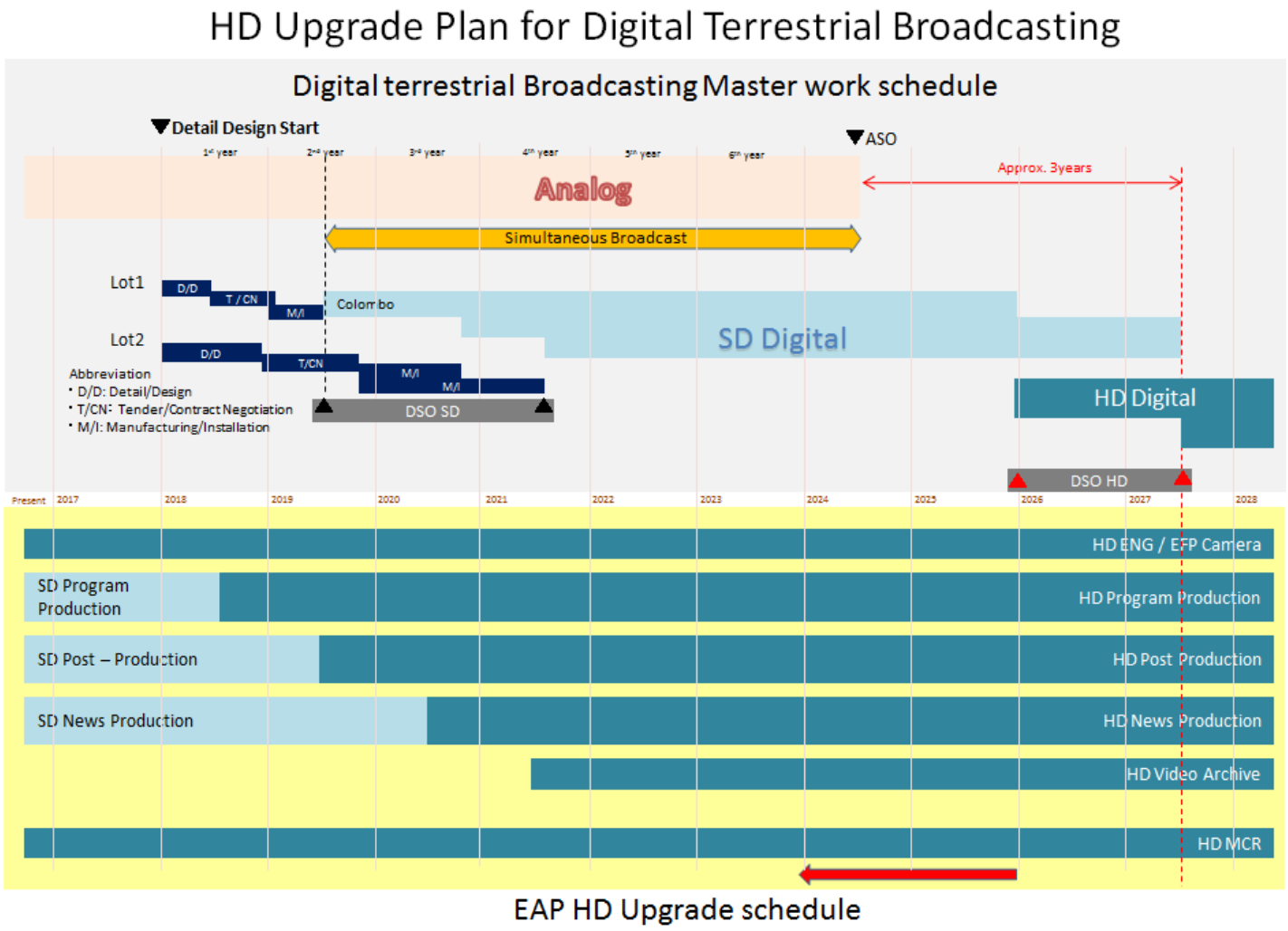


55. Schedule for upgrading broadcasting equipment to HD at CSN



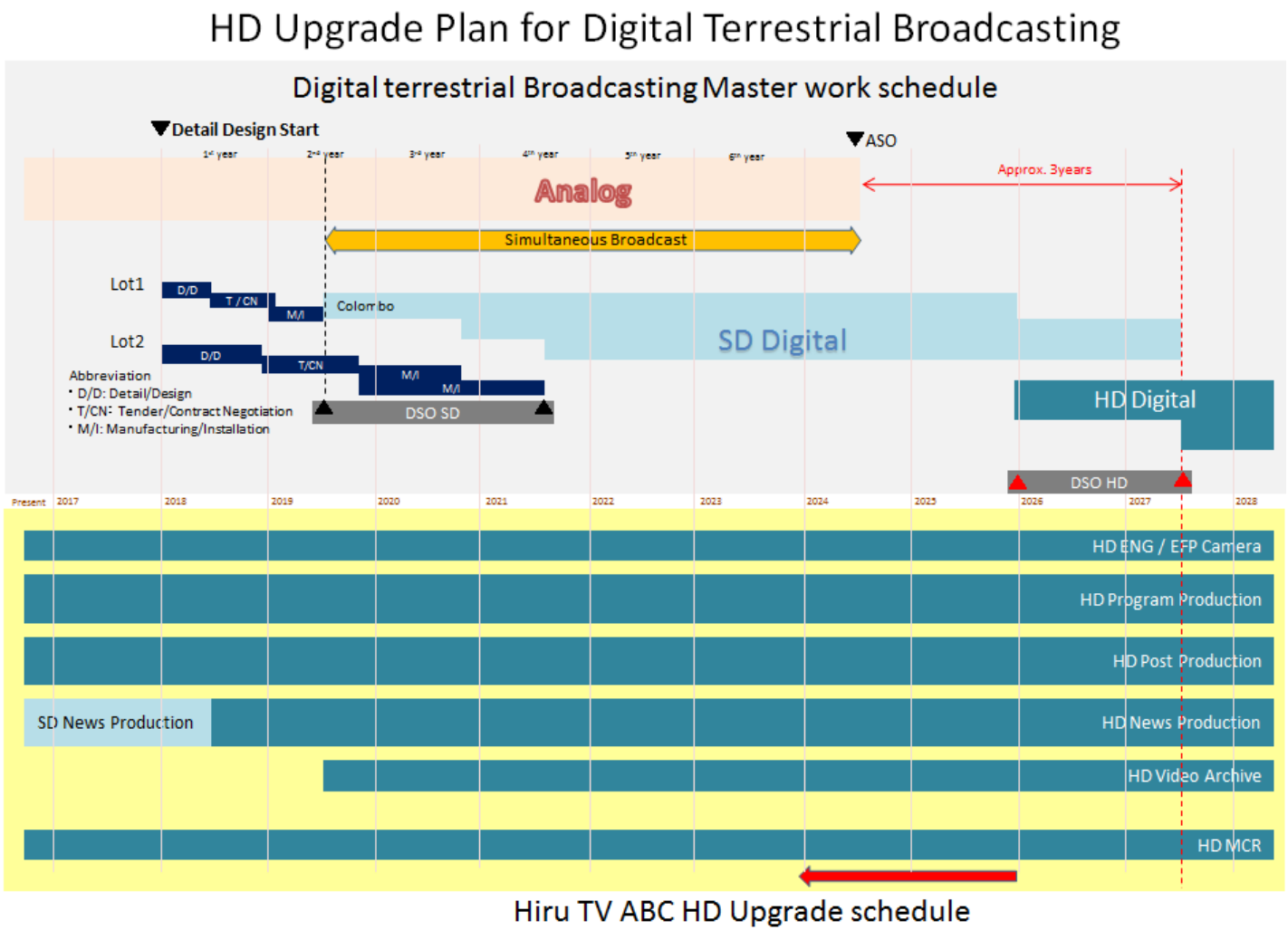
CSN HD Upgrade schedule

56. Schedule for upgrading broadcasting equipment to HD at EAP



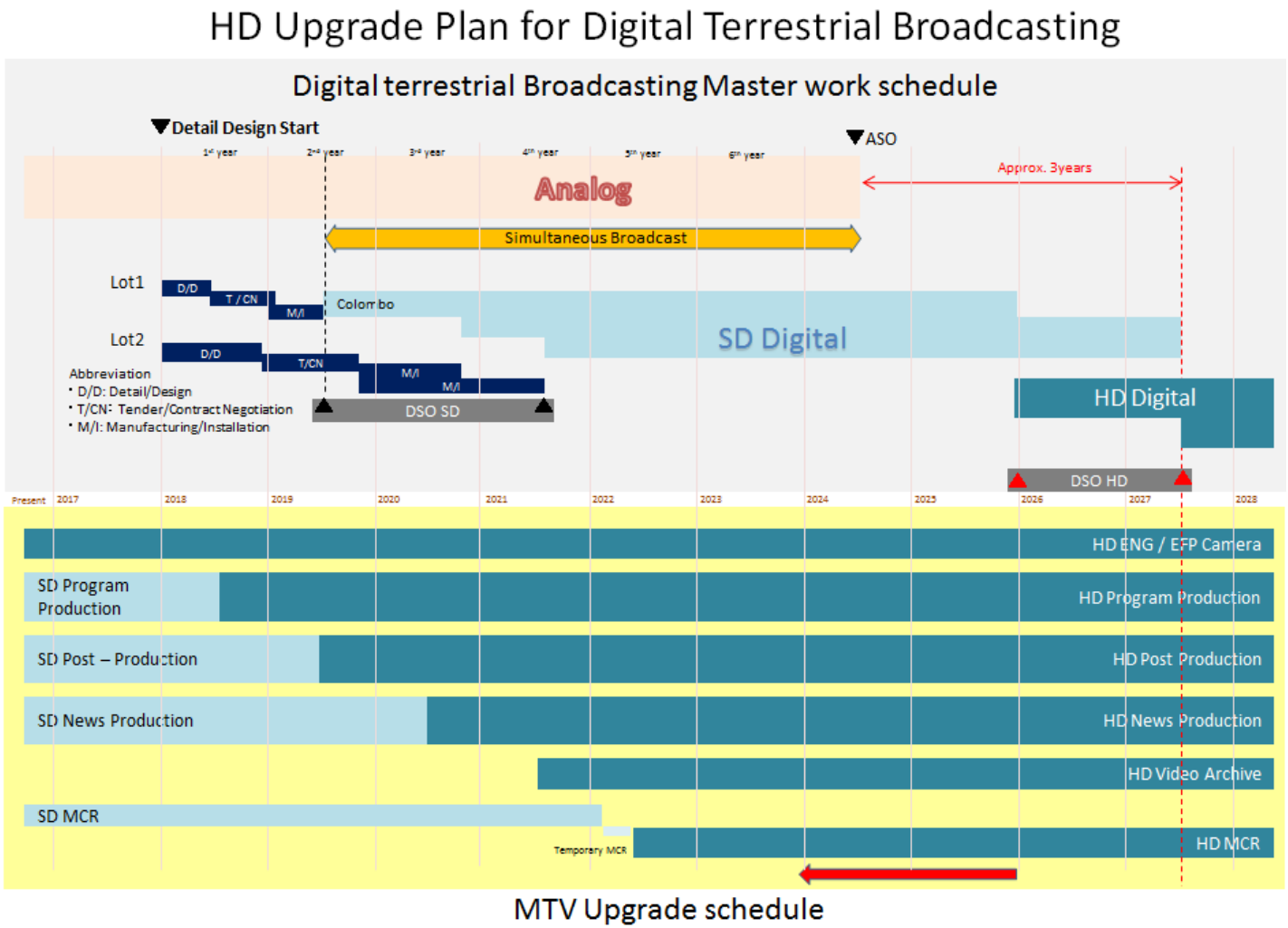
EAP HD Upgrade schedule

57. Schedule for upgrading broadcasting equipment to HD at Hiru TV



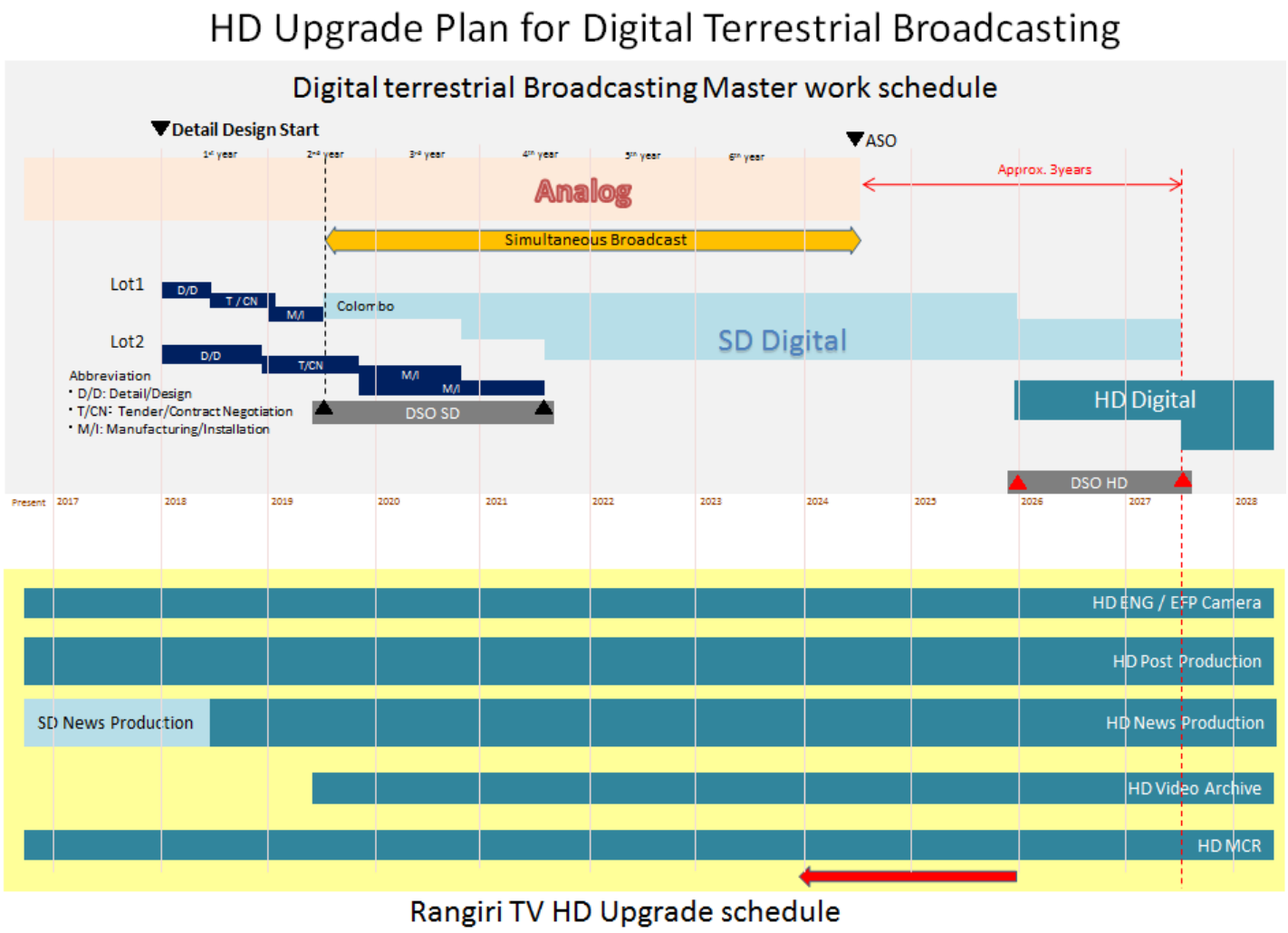
Hiru TV ABC HD Upgrade schedule

58. Schedule for upgrading broadcasting equipment to HD at MTV



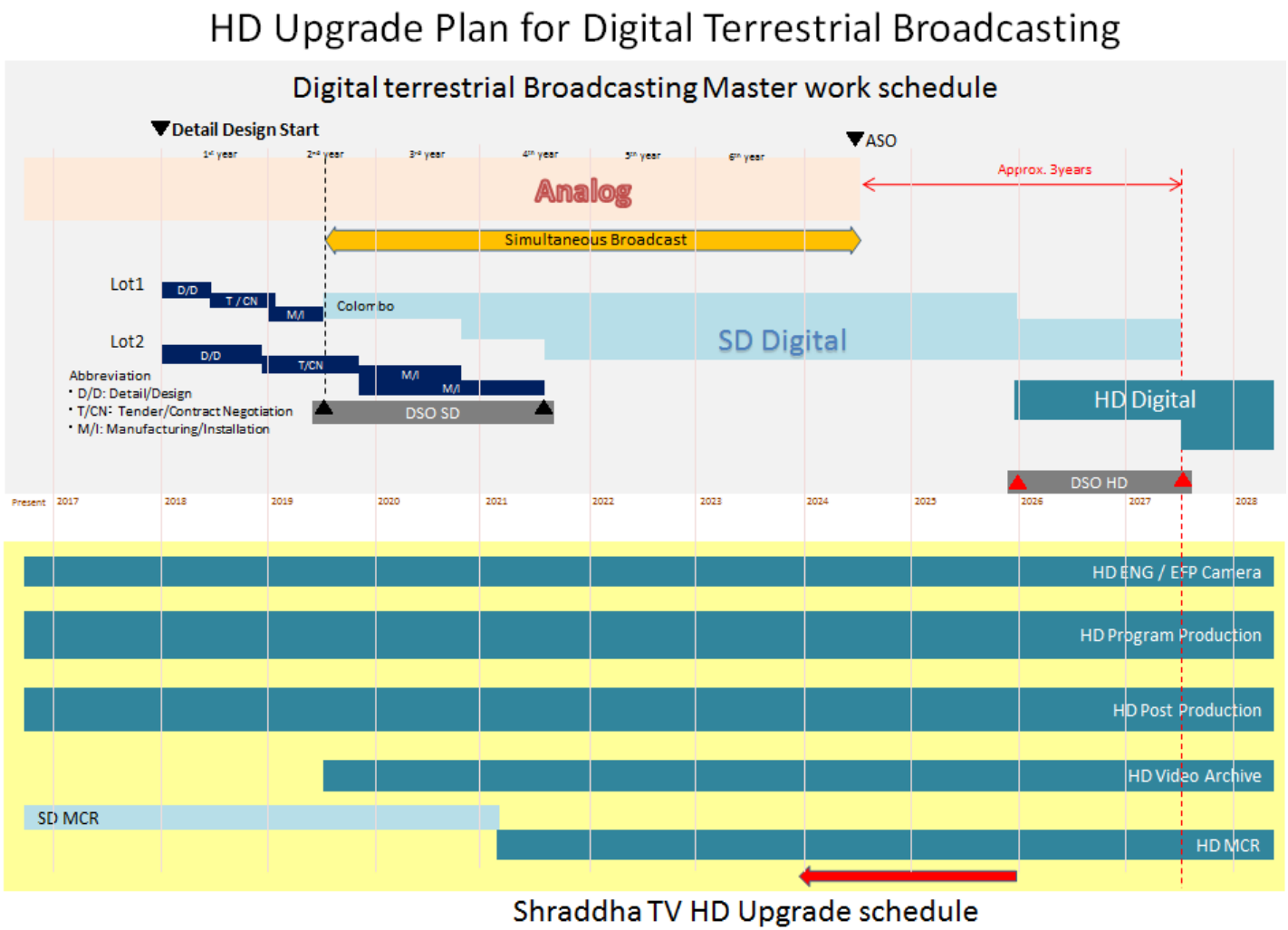
MTV Upgrade schedule

59. Schedule for upgrading broadcasting equipment to HD at Rangiri TV

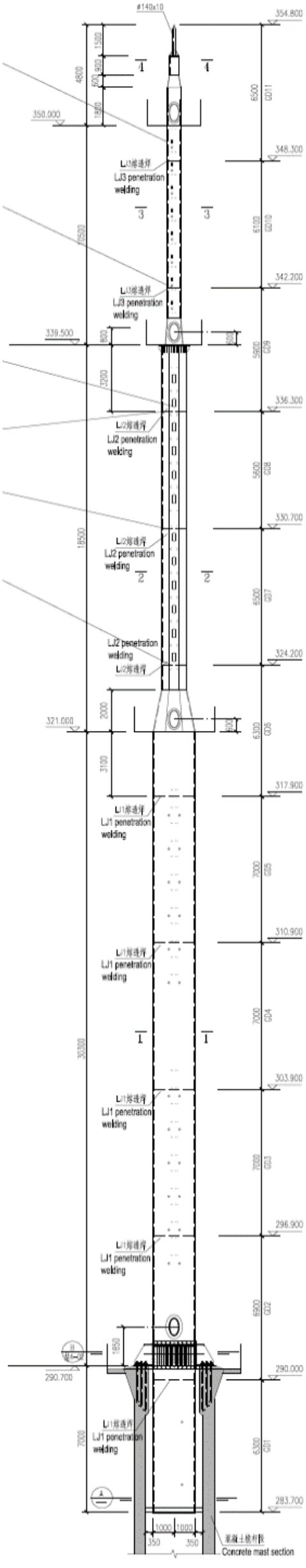


Rangiri TV HD Upgrade schedule

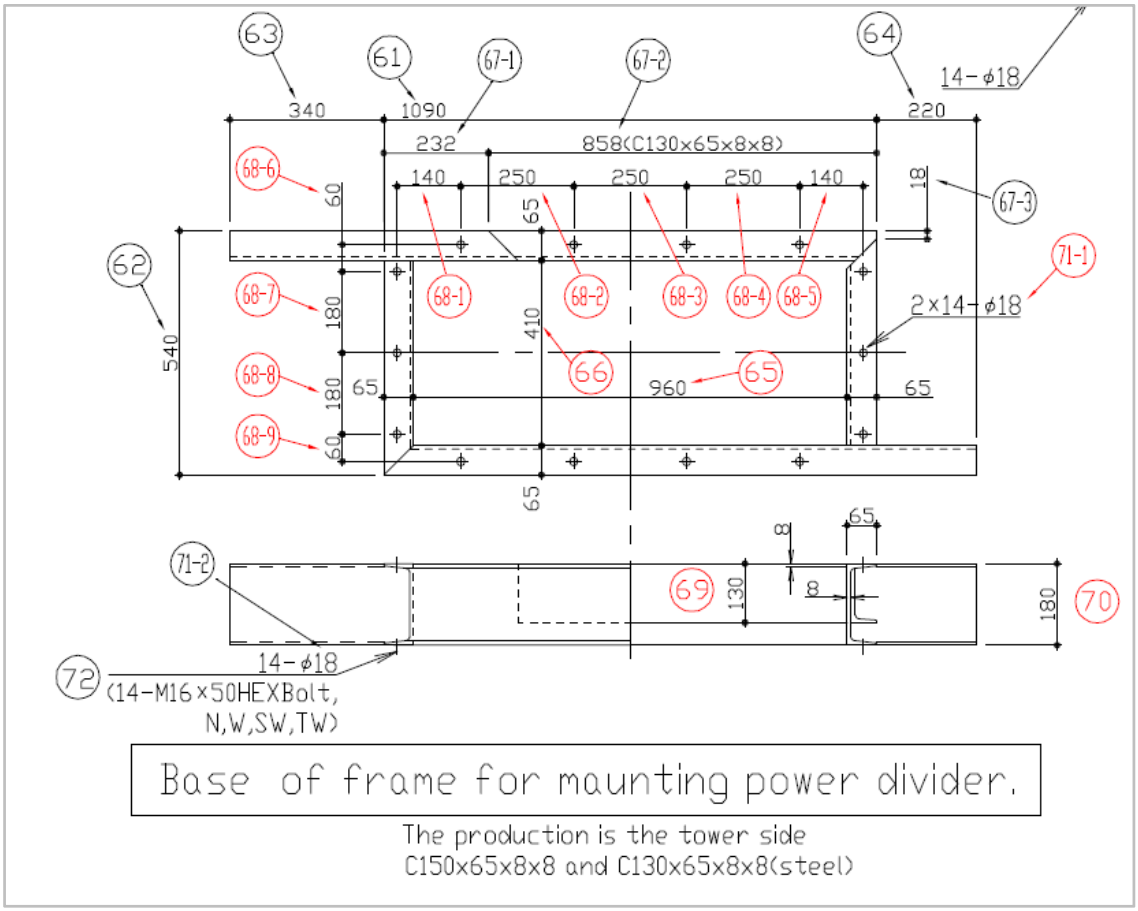
60. Schedule for upgrading broadcasting equipment to HD at Shraddha TV



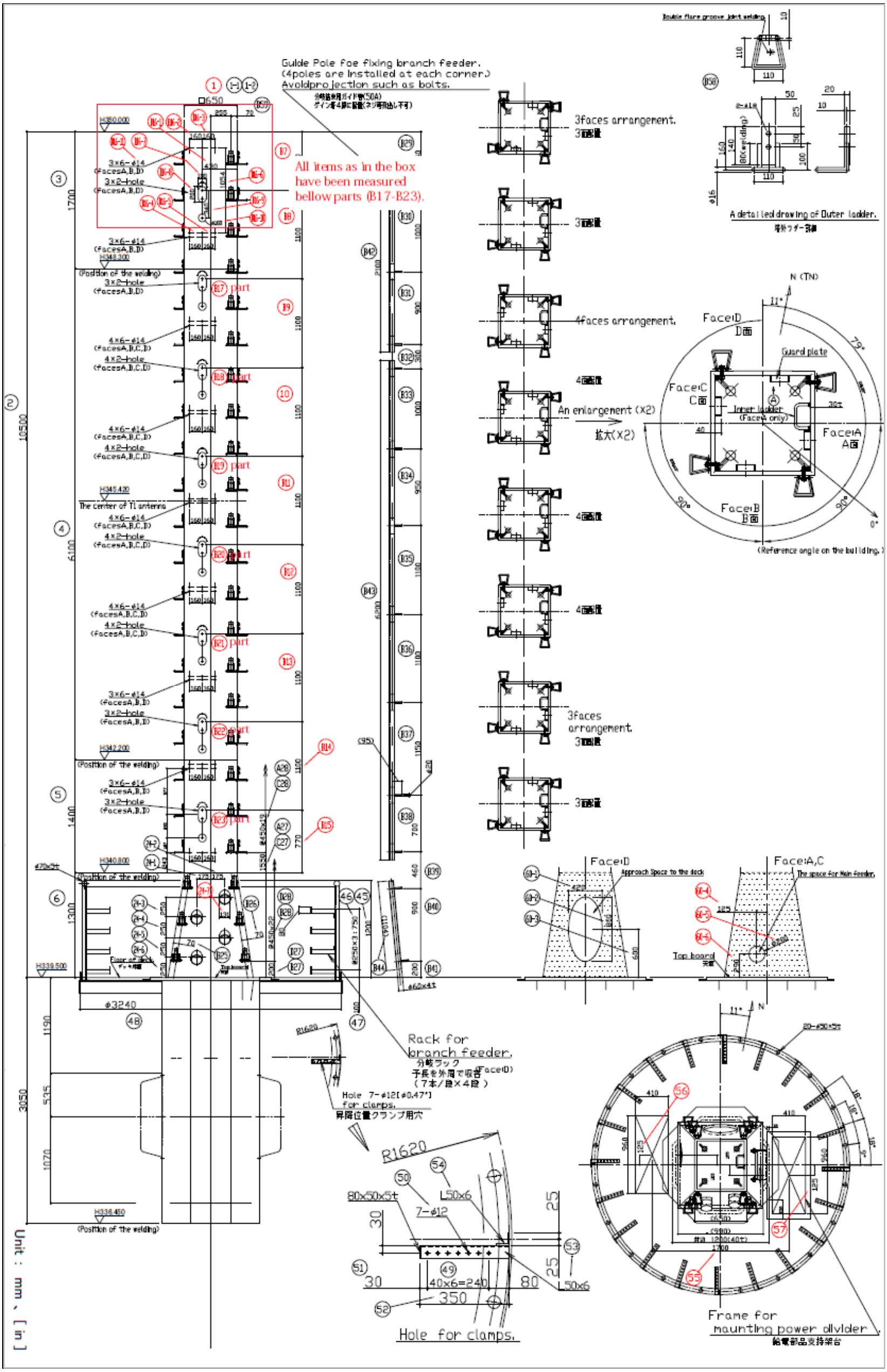
61. Drawing of Tower Mast



62. Drawing of T1 Section as of agreement of design change (foundation part)



63. Drawing of T1 Section as of agreement of design change



64. Photo of T1 Section as of inspection in China

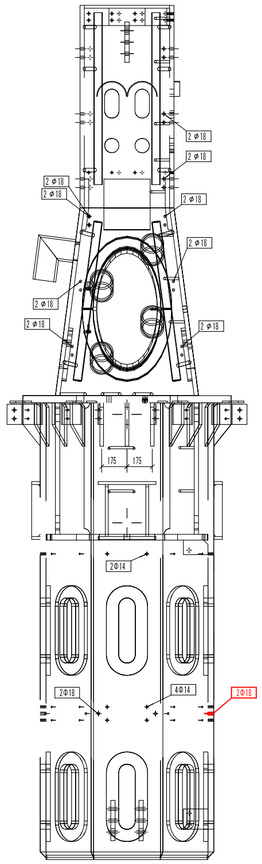
65. Result of measurement of T1 Section (before welding)

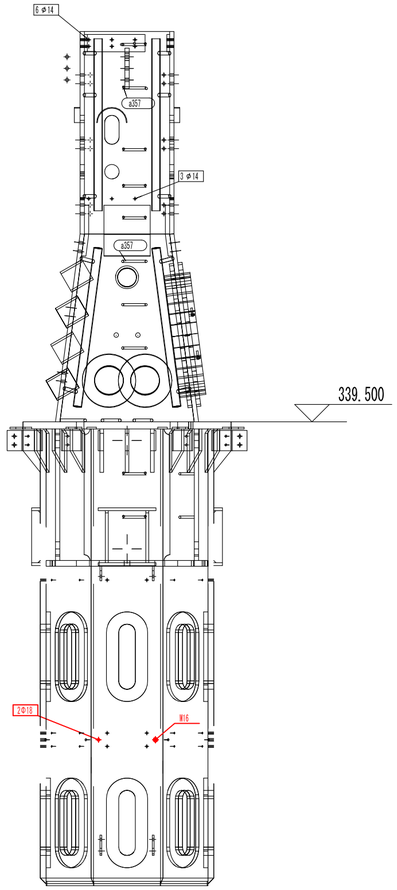
Colombo Lotus Tower Tower frame for T1 antennas

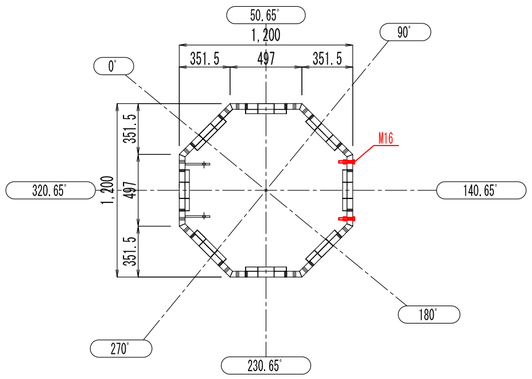
Inspection results

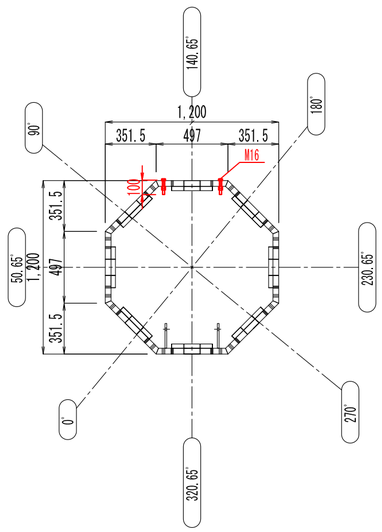
No.	Item	Dimension	Tolerance	12/19 Result				12/20 Result				4/6-7 Result			
				A	B	C	D	A	B	C	D	A	B	C	D
B7	Center of Antenna(First bay from top of tower)	730	728～732	730.0											
B8	Center of Antenna(2nd bay from top of tower)	1100	1097～1103												1,100.0
B9	Center of Antenna(3rd bay from top of tower)	1100	1097～1103												1,099.0
B10	Center of Antenna(4th bay from top of tower)	1100	1097～1103												1,100.0
B11	Center of Antenna(5th bay from top of tower)	1100	1097～1103												1,100.0
B12	Center of Antenna(6th bay from top of tower)	1100	1097～1103												1,100.0
B13	Center of Antenna(7th bay from top of tower)	1100	1097～1103												
B14	Center of Antenna(8th bay from top of tower)	1100	1097～1103												
B15	Center of Antenna(First(8th) bay from bottom of tower)	770	768～772												
B16-1	1st bay/Center of mounting antenna(eccentricity)	430	428～432	429.0											
B16-2	1st bay/Space between holes for mounting antenna(upper-left)	160	158.8～161.2	160.5	160.0	-	160.0								
B16-3	1st bay/Space between holes for mounting antenna(upper-right)	160	158.8～161.2	160.5	160.0	-	158.0				160.0				
B16-4	1st bay/Space between holes for mounting antenna(bottom-left)	160	158.8～161.2	159.0	160.0		159.0								
B16-5	1st bay/Space between holes for mounting antenna(bottom-right)	160	158.8～161.2	160.5	161.0		161.0								
B16-6	1st bay/Space between holes for mounting antenna(top-bottom)	1054	1051～1057	1,056.0	1,056.0	-	Hole required				1,055.0				
B16-7	1st bay/Width of electricity supply point hole	100	99.2～100.8	96.4	97.5	-	98.0	96.7	98.0		97.6	100.1	100.8		100.5
B16-8	1st bay/Length of electricity supply point hole	200	198.8～201.2	200.1	200.0	-	200.7								
B16-9	1st bay/Position of bracket fixing hole	340	338.8～341.2	366.0	341.3	-	341.8	341.0							
B16-10	1st bay/Diameter of bracket fixing hole	100	99.2～100.8	97.0	97.5	-	98.0	98.0	99.0		98.0	101.5	100.0		101.0
B16-11	1st bay/Diameter of mounting antenna bolt	14	13.5～14.5	14.0	14.2	-	14.0				14.0				
B17-2	2nd bay/Space between holes for mounting antenna(upper-left)	160	158.8～161.2	162.0	160.0	-	160.0	161.0							
B17-3	2nd bay/Space between holes for mounting antenna(upper-right)	160	158.8～161.2	162.0	161.0	-	160.0	161.0							
B17-4	2nd bay/Space between holes for mounting antenna(bottom-left)	160	158.8～161.2	160.0	160.0	-	160.0								
B17-5	2nd bay/Space between holes for mounting antenna(bottom-right)	160	158.8～161.2	160.0	160.0	-	160.0								
B17-6	2nd bay/Space between holes for mounting antenna(top-bottom)	1054	1051～1057	-	1,054.0	-	1,053.0								
B17-7	2nd bay/Width of electricity supply point hole	100	99.2～100.8	97.0	97.0	-	99.0	94.0	96.5			100.2	100.7		
B17-8	2nd bay/Length of electricity supply point hole	200	198.8～201.2	202.0	201.0	-	203.0				204.0				
B17-9	2nd bay/Position of bracket fixing hole	340	338.8～341.2	343.0	340.3	-	339.3								
B17-10	2nd bay/Diameter of bracket fixing hole	100	99.2～100.8	95.6	97.0	-	100.0	96.8	96.0			100.1	100.3		
B17-11	2nd bay/Diameter of mounting antenna bolt	14	13.5～14.5	13.9	14.0	-	14.0								
B18-2	3rd bay/Space between holes for mounting antenna(upper-left)	160	158.8～161.2	160.0	160.0	160.0	160.0								
B18-3	3rd bay/Space between holes for mounting antenna(upper-right)	160	158.8～161.2	160.0	160.0	160.0	160.0								
B18-4	3rd bay/Space between holes for mounting antenna(bottom-left)	160	158.8～161.2	160.0	160.0	160.0	159.0								
B18-5	3rd bay/Space between holes for mounting antenna(bottom-right)	160	158.8～161.2	160.0	160.0	160.0	160.0								
B18-6	3rd bay/Space between holes for mounting antenna(top-bottom)	1054	1051～1057	1,055.0	1,056.0	1,054.0	1,053.0								
B18-7	3rd bay/Width of electricity supply point hole	100	99.2～100.8	98.0	99.0	100.0	100.0	100.0							
B18-8	3rd bay/Length of electricity supply point hole	200	198.8～201.2	202.0	201.0	200.0	200.0	200.0							
B18-9	3rd bay/Position of bracket fixing hole	340	338.8～341.2	342.5	339.3	339.0	338.5								
B18-10	3rd bay/Diameter of bracket fixing hole	100	99.2～100.8	98.0	97.0	98.0	99.0	98.0	98.0	98.0	99.0	100.3	101.4	100.5	100.1
B18-11	3rd bay/Diameter of mounting antenna bolt	14	13.5～14.5	14.0	14.0	14.0	14.0								
B19-2	4th bay/Space between holes for mounting antenna(upper-left)	160	158.8～161.2	160.0	160.0	160.0	159.0								
B19-3	4th bay/Space between holes for mounting antenna(upper-right)	160	158.8～161.2	160.0	160.0	160.0	160.0								
B19-4	4th bay/Space between holes for mounting antenna(bottom-left)	160	158.8～161.2	160.0	159.0	160.0	160.0								
B19-5	4th bay/Space between holes for mounting antenna(bottom-right)	160	158.8～161.2	160.0	160.0	160.0	160.0								
B19-6	4th bay/Space between holes for mounting antenna(top-bottom)	1054	1051～1057	1,060.0	1,054.0	1,056.0	1,055.0	1,055.0							
B19-7	4th bay/Width of electricity supply point hole	100	99.2～100.8	97.5	98.0	100.0	100.0	98.0	99.0			100.1	100.9		
B19-8	4th bay/Length of electricity supply point hole	200	198.8～201.2	202.0	199.0	198.0	200.0	201.0		201.0					
B19-9	4th bay/Position of bracket fixing hole	340	338.8～341.2	339.8	336.8	339.5	339.0								
B19-10	4th bay/Diameter of bracket fixing hole	100	99.2～100.8	98.0	97.0	98.0	100.0	96.0	99.0	96.0		100.0	100.3	100.0	
B19-11	4th bay/Diameter of mounting antenna bolt	14	13.5～14.5	14.0	14.0	14.2	14.3								
B20-2	5th bay/Space between holes for mounting antenna(upper-left)	160	158.8～161.2	160.0	159.0	160.0	160.0								
B20-3	5th bay/Space between holes for mounting antenna(upper-right)	160	158.8～161.2	160.0	160.0	160.0	160.0								
B20-4	5th bay/Space between holes for mounting antenna(bottom-left)	160	158.8～161.2	160.0	161.0	160.0	160.0								
B20-5	5th bay/Space between holes for mounting antenna(bottom-right)	160	158.8～161.2	160.0	161.0	160.0	160.0								
B20-6	5th bay/Space between holes for mounting antenna(top-bottom)	1054	1051～1057	1,054.0	1,054.0	1,055.0	1,055.0								
B20-7	5th bay/Width of electricity supply point hole	100	99.2～100.8	97.0	99.0	100.0	100.0	99.0				100.4			
B20-8	5th bay/Length of electricity supply point hole	200	198.8～201.2	202.0	200.0	198.0	200.0	202.0		ok					
B20-9	5th bay/Position of bracket fixing hole	340	338.8～341.2	337.0	339.5	340.0	339.0								
B20-10	5th bay/Diameter of bracket fixing hole	100	99.2～100.8	97.0	97.0	97.0	98.0	97.0	102.0	98.0	98.0	100.2	100.2	100.8	101.2
B20-11	5th bay/Diameter of mounting antenna bolt	14	13.5～14.5	13.9	14.1	14.2	14.2								
B21-2	6th bay/Space between holes for mounting antenna(upper-left)	160	158.8～161.2	160.0	161.0	160.0	160.0								
B21-3	6th bay/Space between holes for mounting antenna(upper-right)	160	158.8～161.2	160.0	161.0	160.0	160.0								
B21-4	6th bay/Space between holes for mounting antenna(bottom-left)	160	158.8～161.2	162.0	161.0	160.0	161.0	166.0				160.8			
B21-5	6th bay/Space between holes for mounting antenna(bottom-right)	160	158.8～161.2	159.5	160.0	160.0	160.0								
B21-6	6th bay/Space between holes for mounting antenna(top-bottom)	1054	1051～1057	1,054.0	1,054.0	1,054.0	1,054.0								
B21-7	6th bay/Width of electricity supply point hole	100	99.2～100.8	97.0	99.0	100.0	100.0	100.0							
B21-8	6th bay/Length of electricity supply point hole	200	198.8～201.2	202.0	201.0	200.0	200.0	201.0							
B21-9	6th bay/Position of bracket fixing hole	340	338.8～341.2	341.0	337.3	339.8	339.5								
B21-10	6th bay/Diameter of bracket fixing hole	100	99.2～100.8	97.0	97.0	96.5	97.0	98.0	99.0	110.0	98.0	100.2	100.0		101.0
B21-11	6th bay/Diameter of mounting antenna bolt	14	13.5～14.5	14.0	14.3	14.2	14.2								
B22-2	7th bay/Space between holes for mounting antenna(upper-left)	160	158.8～161.2	162.0	161.0	160.0	161.0	160.0							
B22-3	7th bay/Space between holes for mounting antenna(upper-right)	160	158.8～161.2	159.5	160.0	160.0	160.0								
B22-4	7th bay/Space between holes for mounting antenna(bottom-left)	160	158.8～161.2	160.0	160.0	160.0	160.0								
B22-5	7th bay/Space between holes for mounting antenna(bottom-right)	160	158.8～161.2	160.0	160.0	160.0	160.0								
B22-6	7th bay/Space between holes for mounting antenna(top-bottom)	1054	1051～1057												
B22-7	7th bay/Width of electricity supply point hole	100	99.2～100.8	97.0	100.0	-	100.0	99.0				100.8			
B22-8	7th bay/Length of electricity supply point hole	200	198.8～201.2	202.0	201.0	-	200.0	203.0							
B22-9	7th bay/Position of bracket fixing hole	340	338.8～341.2	338.0	338.8	-	339.5								
B22-10	7th bay/Diameter of bracket fixing hole	100	99.2～100.8	97.0	98.0	-	97.0	98.0	100.0			100.3			
B22-11	7th bay/Diameter of mounting antenna bolt	14	13.5～14.5	14.0	14.1	13.9	14.2								
B23-2	8th bay/Space between holes for mounting antenna(upper-left)	160	158.8～161.2	160.0	160.0	160.0	160.0								
B23-3	8th bay/Space between holes for mounting antenna(upper-right)	160	158.8～161.2	160.0	160.0	160.0	160.0								
B23-4	8th bay/Space between holes for mounting antenna(bottom-left)	160	158.8～161.2	160.0	160.0	160.0	160.0								
B23-5	8th bay/Space between holes for mounting antenna(bottom-right)	160	158.8～161.2	161.0	160.0	160.0	160.0								
B23-6	8th bay/Space between holes for mounting antenna(top-bottom)	1054	1051～1057	1,055.0	1,055.0	1,056.0	1,055.0								
B23-7	8th bay/Width of electricity supply point hole	100	99.2～100.8	98.0	100.0	-	100.0	100.0					100.3		100.7
B23-8	8th bay/Length of electricity supply point hole	200	198.8～201.2	202.0	200.0	-	200.0	204.0							
B23-9	8th bay/Position of bracket fixing hole	340	338.8～341.2	342.5	340.0	-	337.5								
B23-10	8th bay/Diameter of bracket fixing hole	100	99.2～100.8	98.0	98.0	-	97.0	101.0	98.0		99.0		101.4		100.4
B23-11	8th bay/Diameter of mounting antenna bolt	14	13.5～14.5	14.0	14.0	14.3	14.0								
24-1	Hole for branching cable (Left)	175	173.8～176.2										502.0		
24-2	Hole for branching cable (Right)	175	173.8～176.2												
24-3	Hole for branching cable (Upper)	250	248.8～251.2												
24-4	Hole for branching cable (Center)	250	248.8～251.2										504.0		
24-5	Hole for branching cable (Lower)	250	248.8～251.2												
24-6	Hole for branching cable (from Deck)	250	248.8～251.2												
24-7	Hole Diameter (4 directions)	131	129.8～132.2										130.1		
60-4	Position of hole (from center line to left)	125	69.2～70.8												
60-5	Diameter of main feeder hole	200	69.2～70.8												
60-6	Position of hole (from base)	290	198.8～201.2												

66. Requested points regarding cable laying

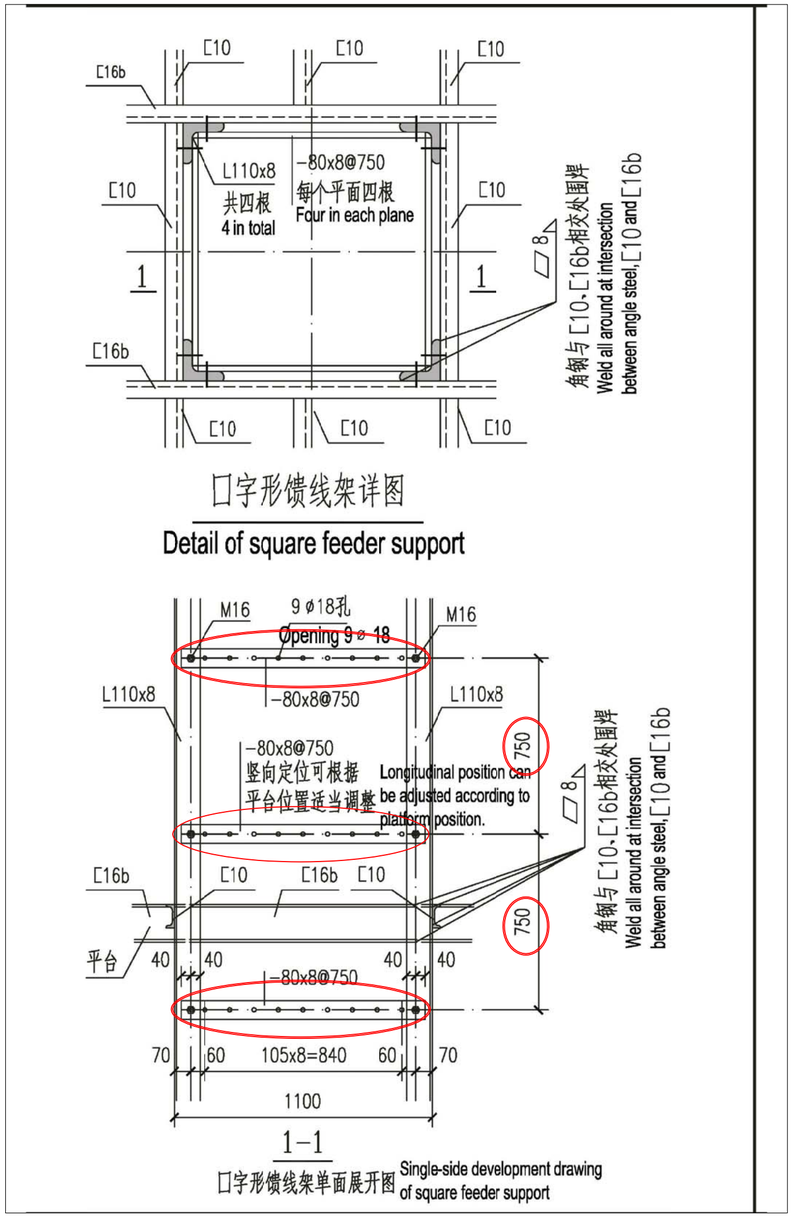






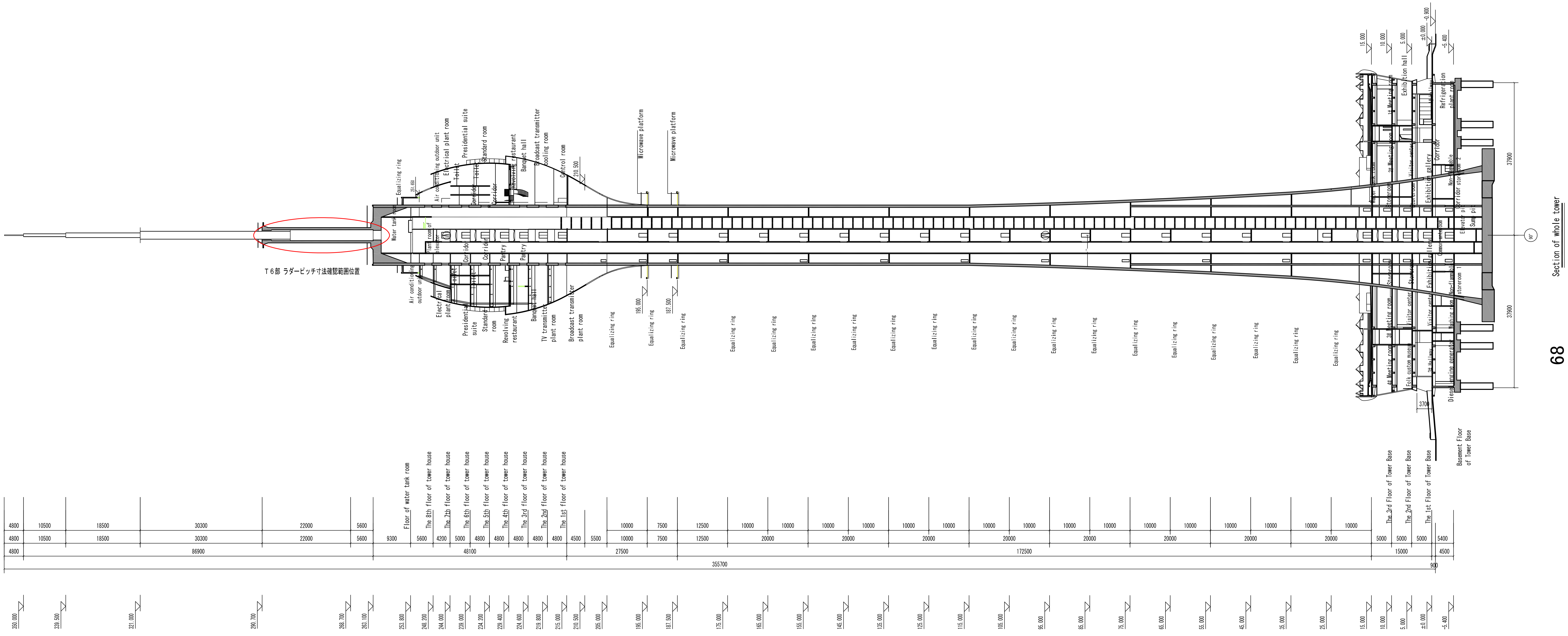


T２部 必要ボルト位置



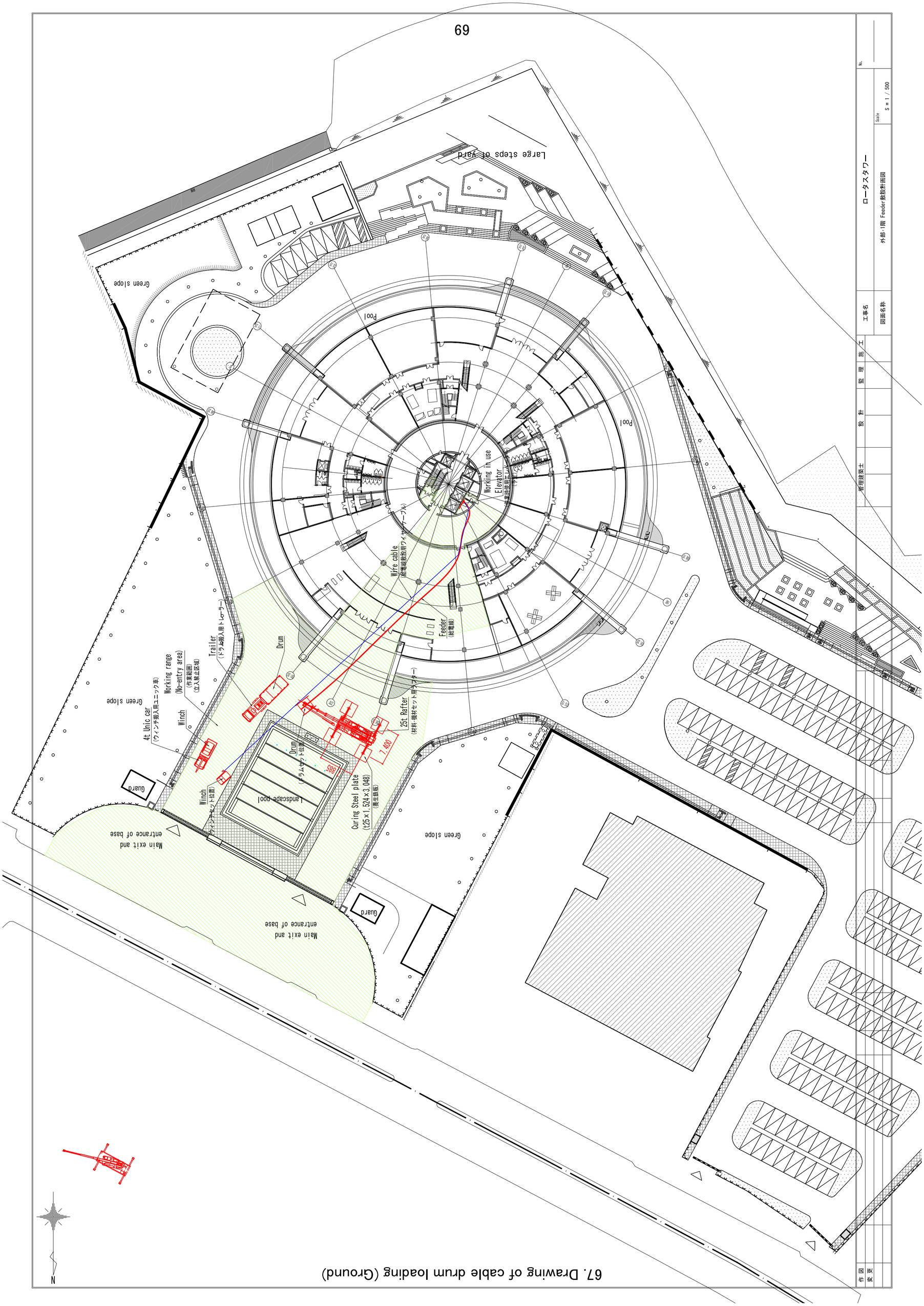
T６部 ラダーピッチ確認寸法

作図									管理建築士		設計		監理	施工	工事名	ロータスタワー	No.
変更															図面名称	T2･T6 確認位置図	Scale S = 1 / 30



作 図	管理建築士	設 計	監 理	施 工
変 更				

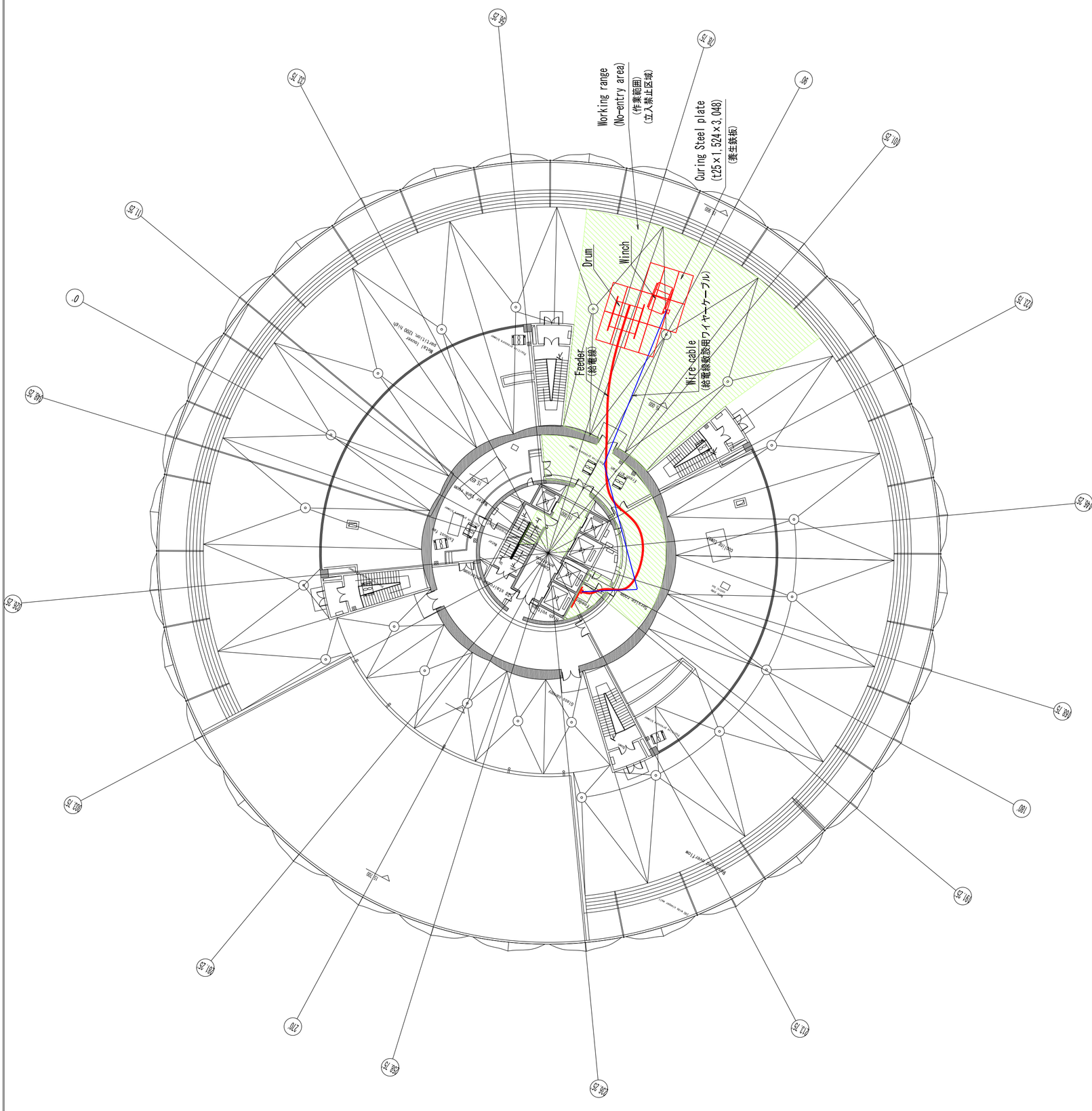
工事名	ロータスタワー		No.
図面名称	T６部 ラダーピッチ寸法確認範囲位置	Scale S = 1 / 700	



67. Drawing of cable drum loading (Ground)

作図								
査図								

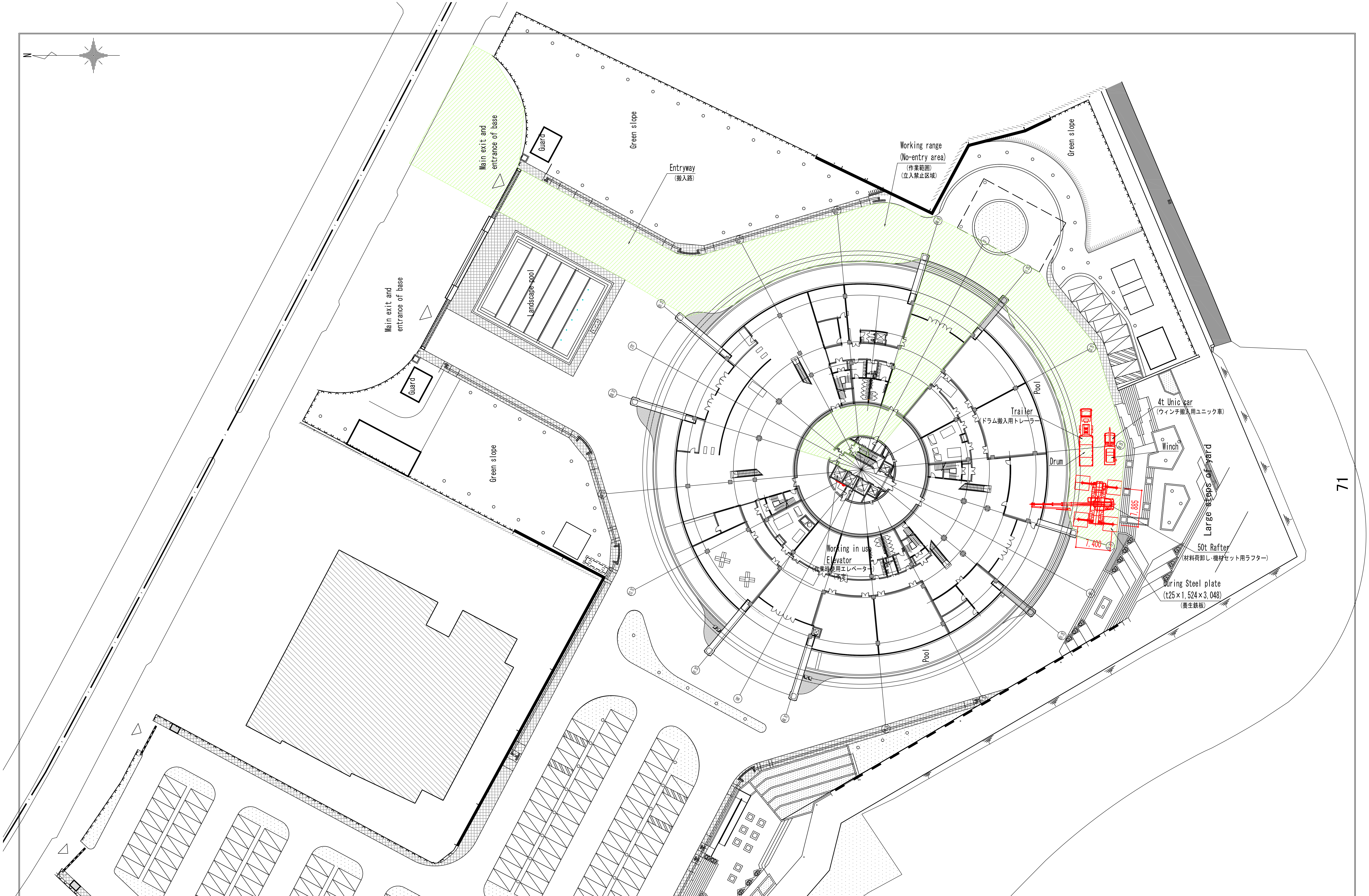
管理建築士	設計	監理	施工	工事名	ロータスタワー		No.	
				図面名称	外部・1階 Feeder敷設計画図	Scale S = 1 / 500		



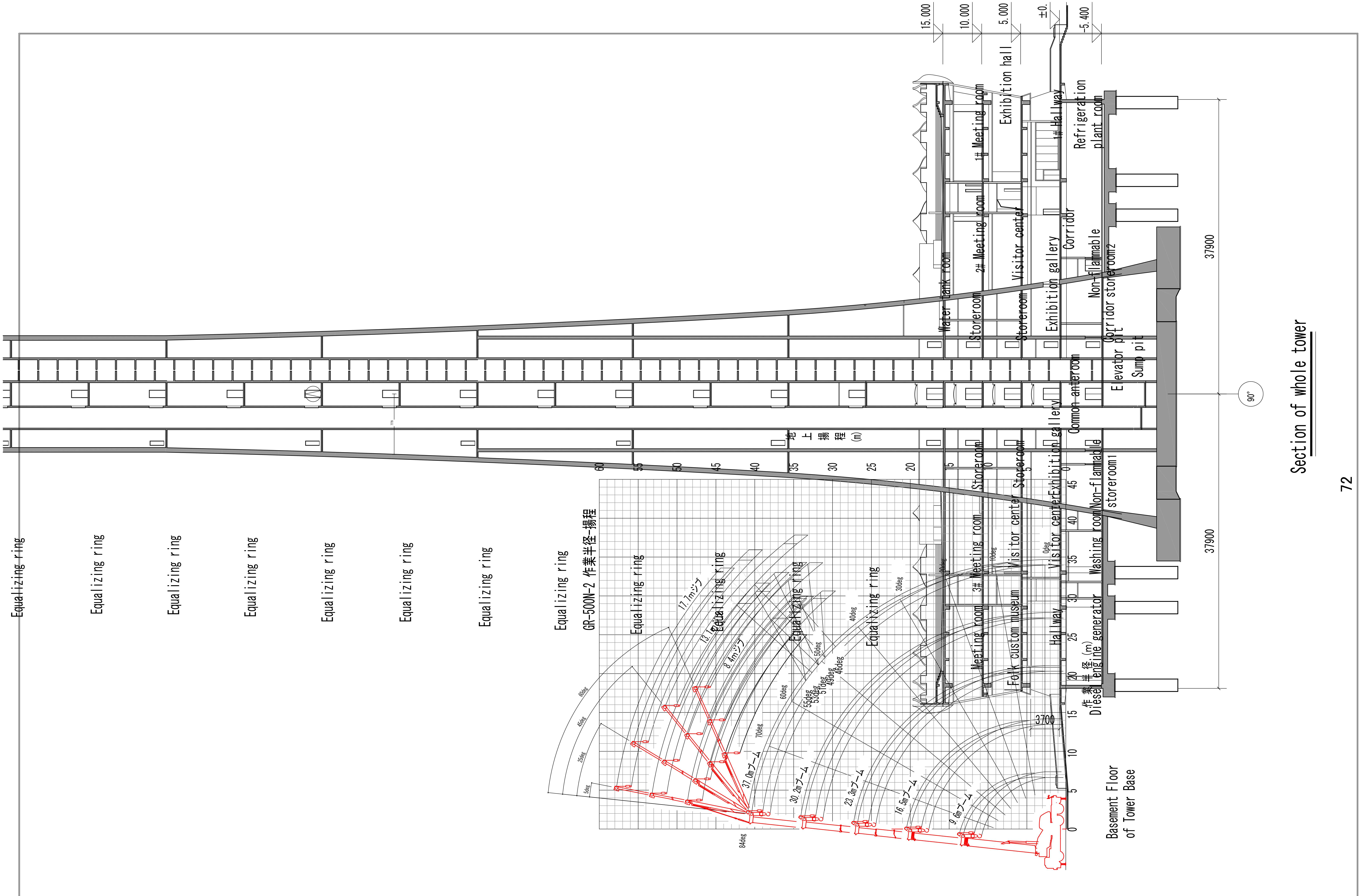
68. Drawing of cable drum loading (Tower Base)

管理建築士	設計	監理	施工	工事名	ロータスタワー		No.
				図面名称	4F屋上 Feeder敷設計画図	Scale S = 1 / 300	

作図 査図

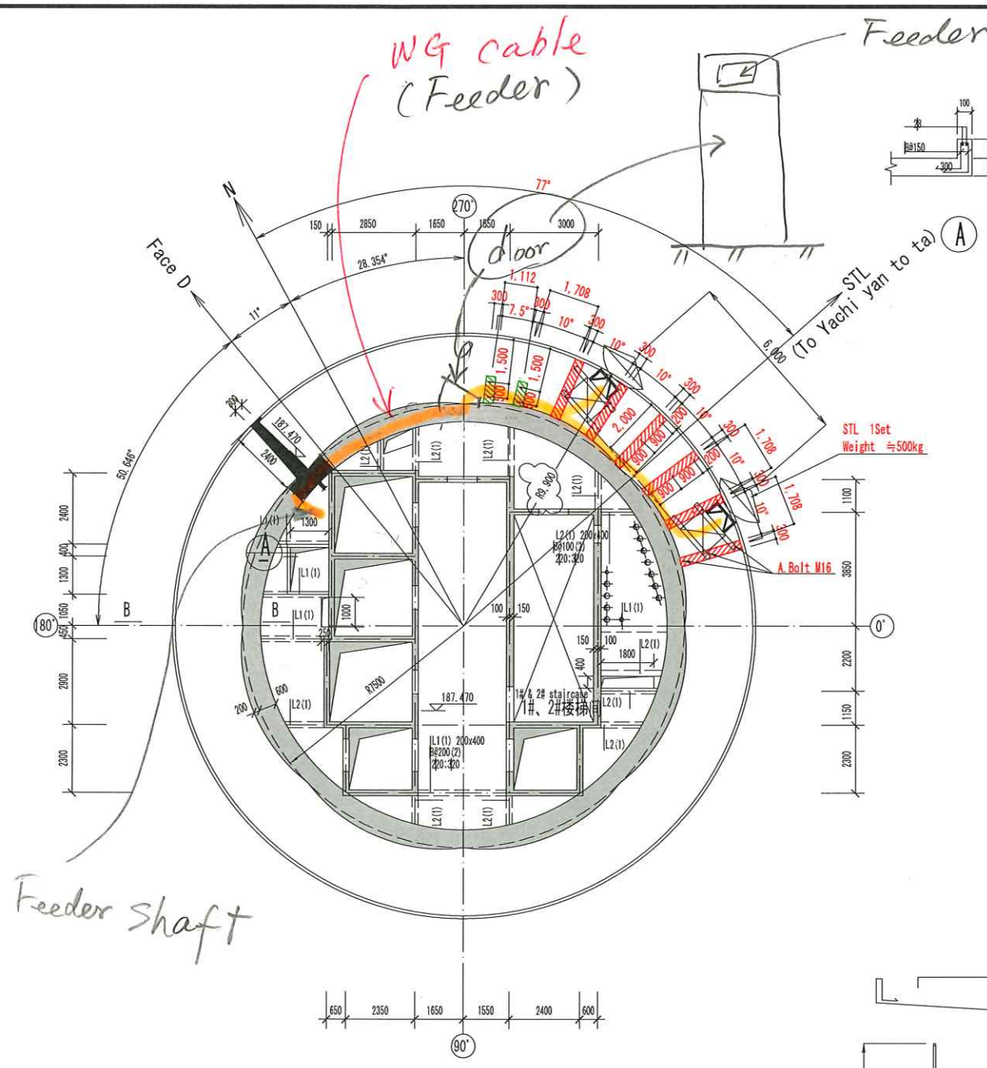


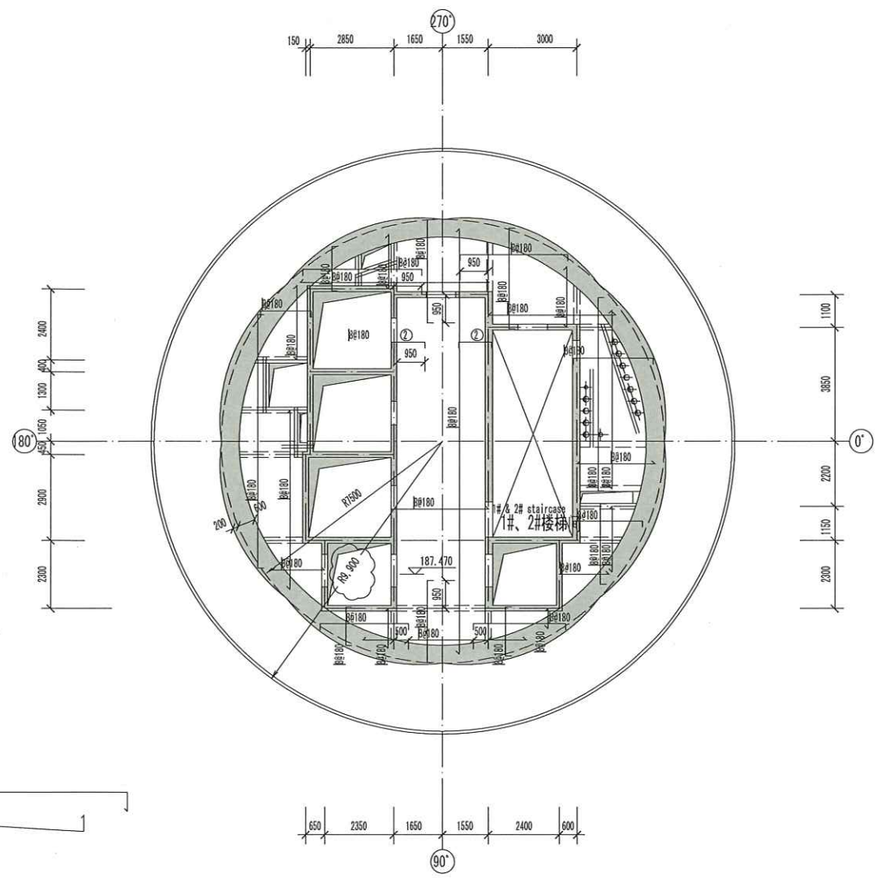
作図		管理建築士	設計	監理	施工	工事名	ロータスタワー	No.
変更						図面名称	4F屋上 Feeder敷設時1階機器配置計画図	Scale S = 1 / 500



作図				
変更				

管理建築士	設計	監理	施工	工事名	ロータスタワー	No.
				図面名称	4F屋上 荷上げ検討図	Scale S = 1 / 300

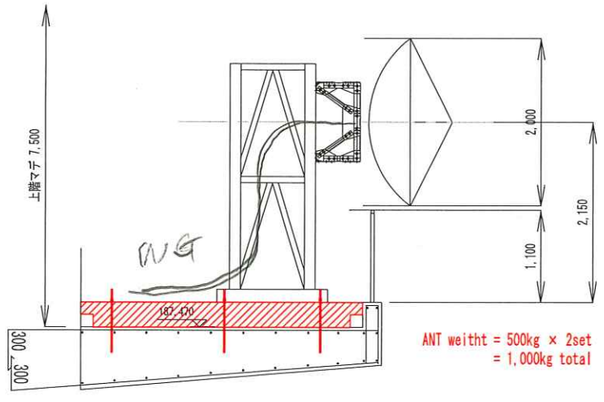




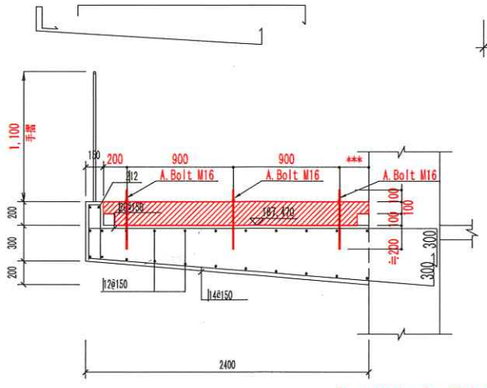
187.500m塔身结构平面图 uctural plan of 187.5 00m tower body

1. 本层板顶标高187.470。
2. 除特殊注明外，板厚均为130mm。
3. 微波天线的支架预埋件，待微波天线最终确定后另详。

1. Slab top elevation is 187.470 m in this floor.
2. Unless otherwise specified, slab thickness is 130mm.
3. Support embedded parts of microwave antennas are to be described in details after the antennas are determined.

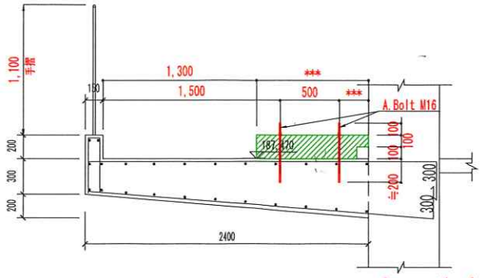


ANT weitht = 500kg × 2set
= 1,000kg total



Cross section for STL base

B-B



Cross section for WG ladder

187.500m塔身楼板配筋图 Floor reinforcement drawing of 187.5 00m tower body

1. 本层板顶标高187.470。
2. 除特殊注明外，板厚均为130mm。

1. Slab top elevation is 187.470 m in this floor.
2. Unless otherwise specified, slab thickness is 130mm.

说明：

1. 梁、板混凝土强度等级为C35。
2. 除图中注明外，梁居轴线中布置。
3. 除图中注明外，板洞边加筋均为每侧2Φ14(下铁)，钢筋伸入支座40d或伸过洞边600。
4. 板钢筋遇洞口或降板处截断弯折锚固；本图中未表示不大于300x300（或不大于⌀300）的板洞，楼板钢筋尽量绕洞而行。
5. 除悬挑板外，其余130mm厚板的分布筋为Φ8@250。

Note:

1. Concrete strength grade is C35 for beam and slab.
2. Unless otherwise specified in the drawing, beams are centered on the axis.
3. Unless otherwise specified in the drawing, 2 14 dReinforcements (lower iron) are added for slab opening edge, reinforcements stretch 40d into the base or 600 beyond the opening edge.
4. Slab reinforcements are cut, bent and anchored at the opening or slab lowering position. For slab openings not greater than 300x300 (or not greater than ⌀300) and not shown in this drawing, floor reinforcement should be laid around the opening if possible.
5. Except cantilever slab, distributing reinforcement of other 130mm thick slabs is Φ8@250. ⊕

FL=187.5

REV 修订	DATE 日期	DRAWN 绘图	CHKD 复核	APPR 批准人

EMPLOYER

TELECOMMUNICATION REGULATORY COMMISSION OF SRI LANKA (TRCSL)

PROJECT CONSULTANCY UNIT
Faculty of Architecture
UNIVERSITY OF MORATUWA

Reviewed Approved

DESIGN & BUILT CONTRACTOR

中国电子进出口总公司
China National Electronics Import & Export Corp

航天长征国际贸易有限公司
AEROSPACE LONG-MARCH INTERNATIONAL TRADE CO.,LTD

DESIGN

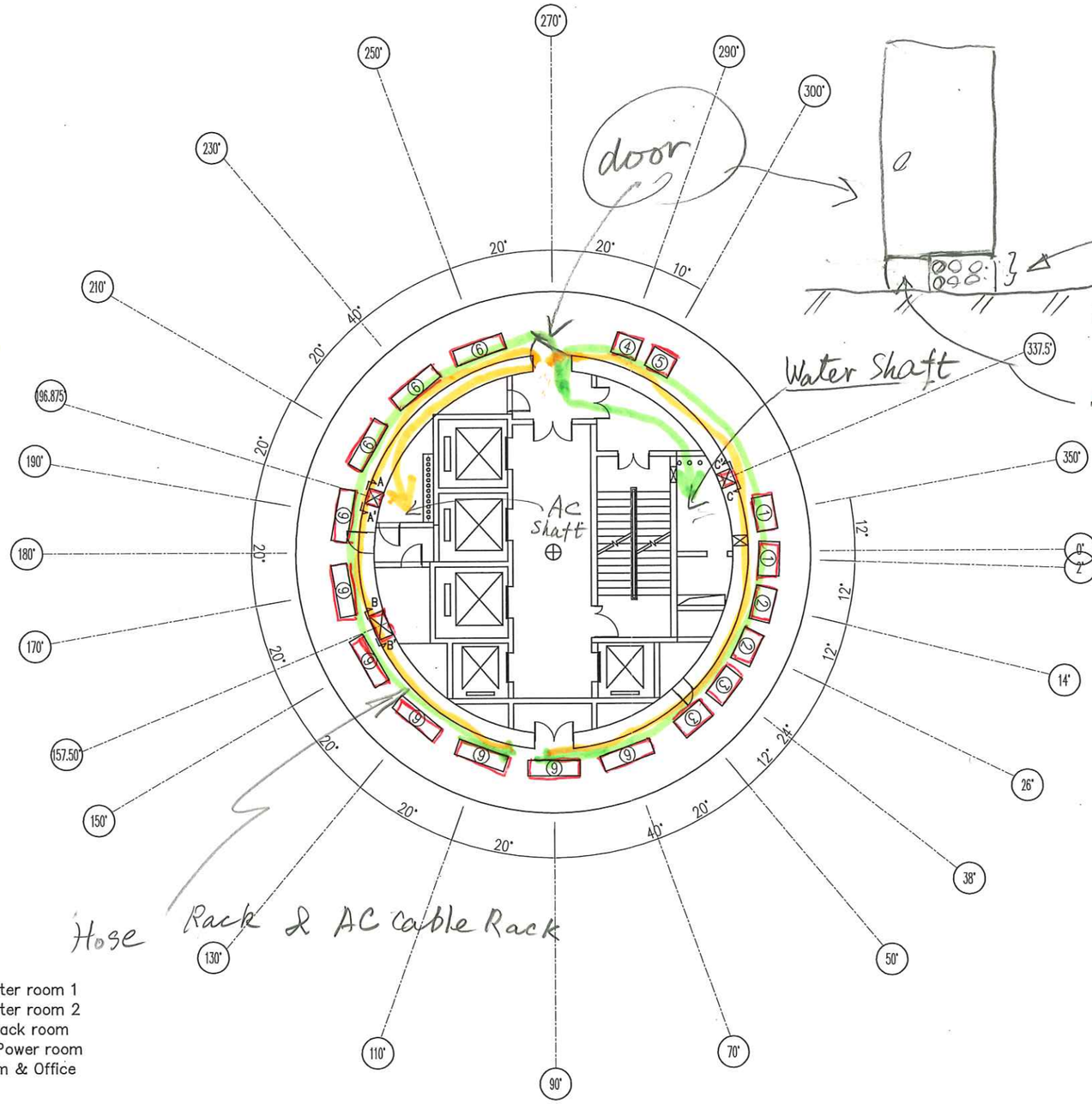
中华人民共和国中广电广播电影电视设计研究院
RADIO FILM & TELEVISION DESIGN & RESEARCH INSTITUTE, P.R.C

资质证书号 :A111010337
CERTIFICATE NO.: A111010337

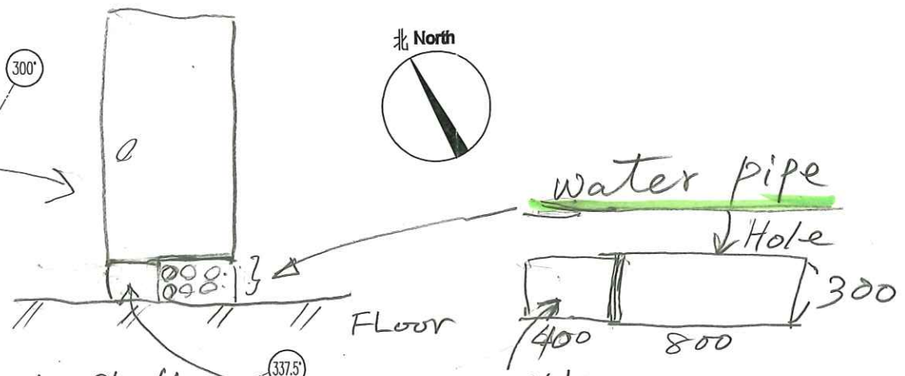
工程名称 PROJECT NAME	斯里兰卡科伦坡莲花电视塔工程 Colombo Lotus Tower Project in the Democratic Socialist Republic of Sri Lanka		
分项名称 SUB-PROJECT NAME	塔身 tower body	设计代号 DESIGN NO.	11008
设计阶段 DESIGN STAGE	施 construction drawing	比 例 SCALE	
项目负责人	PROJECT MANAGER	张红印	
专业负责人	DISCIPLINE CHIEF	袁建东	
审 定	APPROVED BY	袁建东	
审 核	VERIFIED BY	张红印	
校 对	CHECKED BY	马 蓉	
设 计	DESIGNED BY	胡 玮	
图 名 DRAWING NAME	187.500m塔身结构平面图 Structural plan of 187.500m tower body		
图 号 SERIAL NO.	结1-023 Structure11-023	版本号 VERSION NO.	01
		日 期 DATE	2013.02

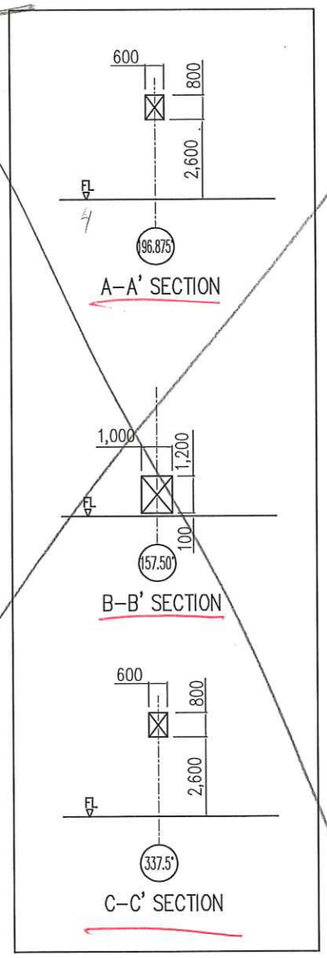
FL=195

70. Drawing of Tower House (Microwave platform, at 195.5m high)

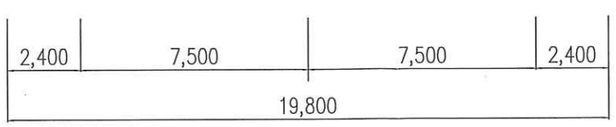


Hose Rack & AC cable Rack





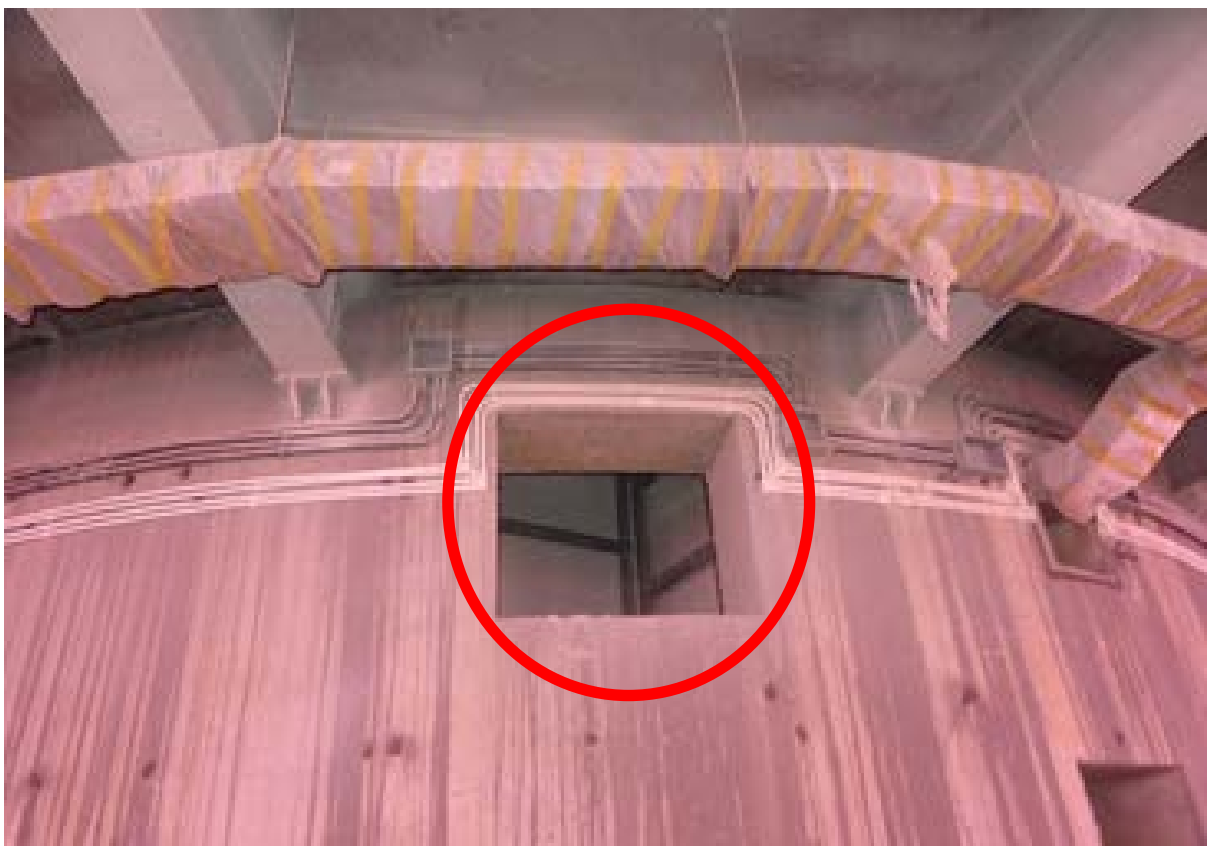
Item	Description
Microwave Platform FL 195.000	
①	Heat Exchanger for Cooler of Transmitter room 1
②	Heat Exchanger for Cooler of Transmitter room 2
③	Heat Exchanger for Cooler of Master Rack room
④	Heat Exchanger for Cooler of Electric Power room
⑤	Heat Exchanger for Cooler of NOC room & Office
⑥	Heat Exchanger for Transmitter



Incase of Liquid cooling system Transmitter
PLAN 1:200

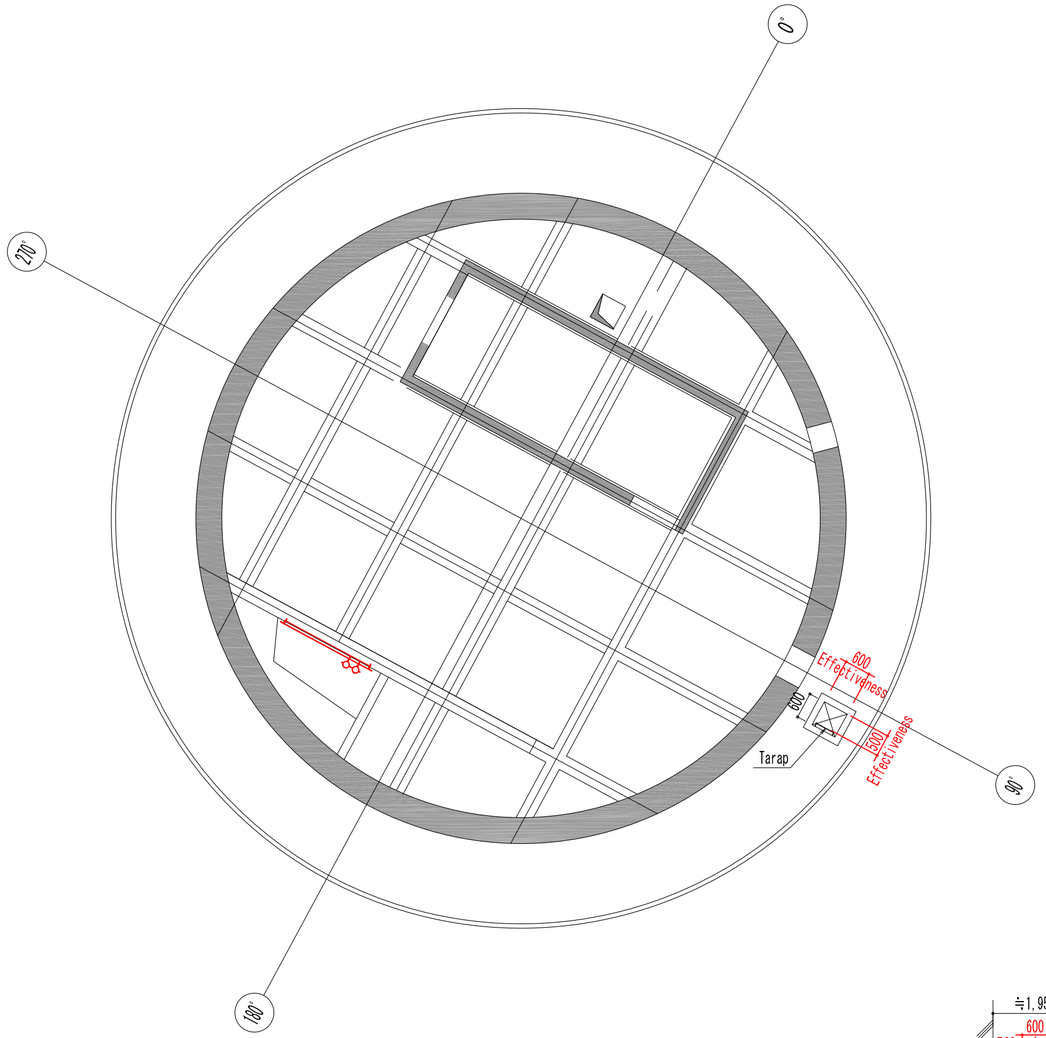
Case 1

71. Photo of Tower House (Fire prevention compartment)

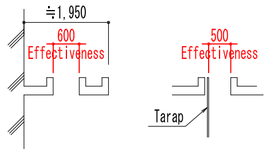


2nd floor of Tower House (219.8 m high)

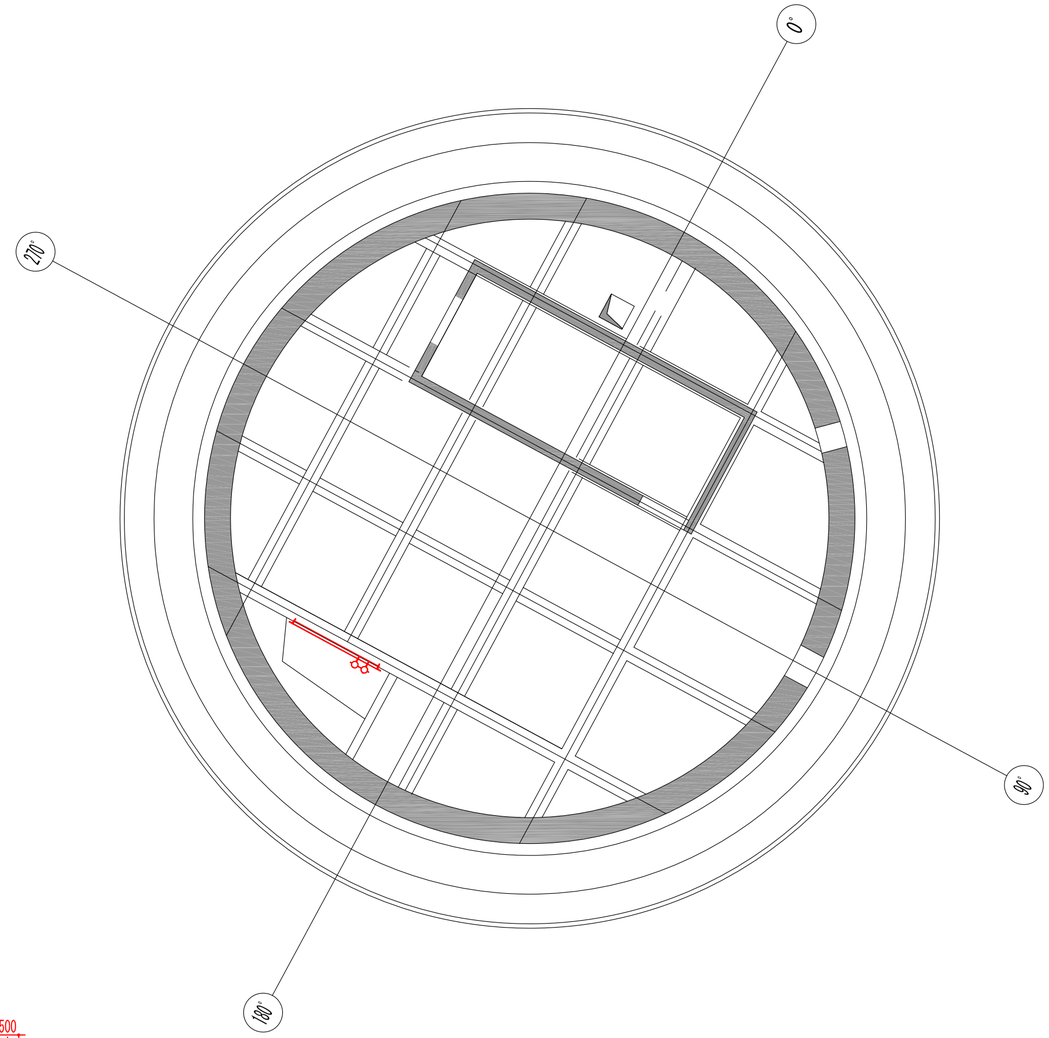
72. Drawing of Tower House (Size of the hole for carrying in equipment, at 253.3m high)



Structural plan of 257.200m high



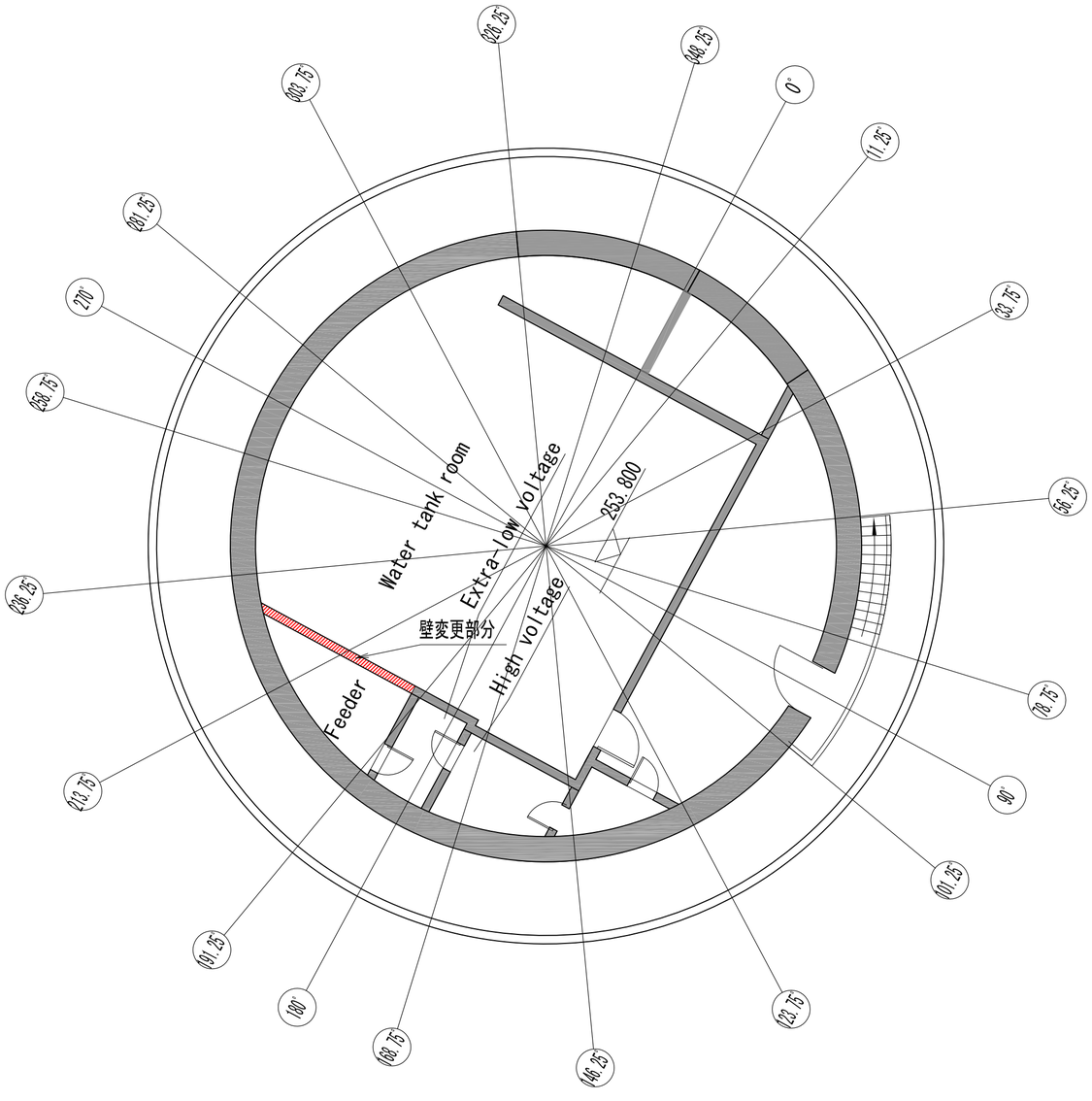
cross section



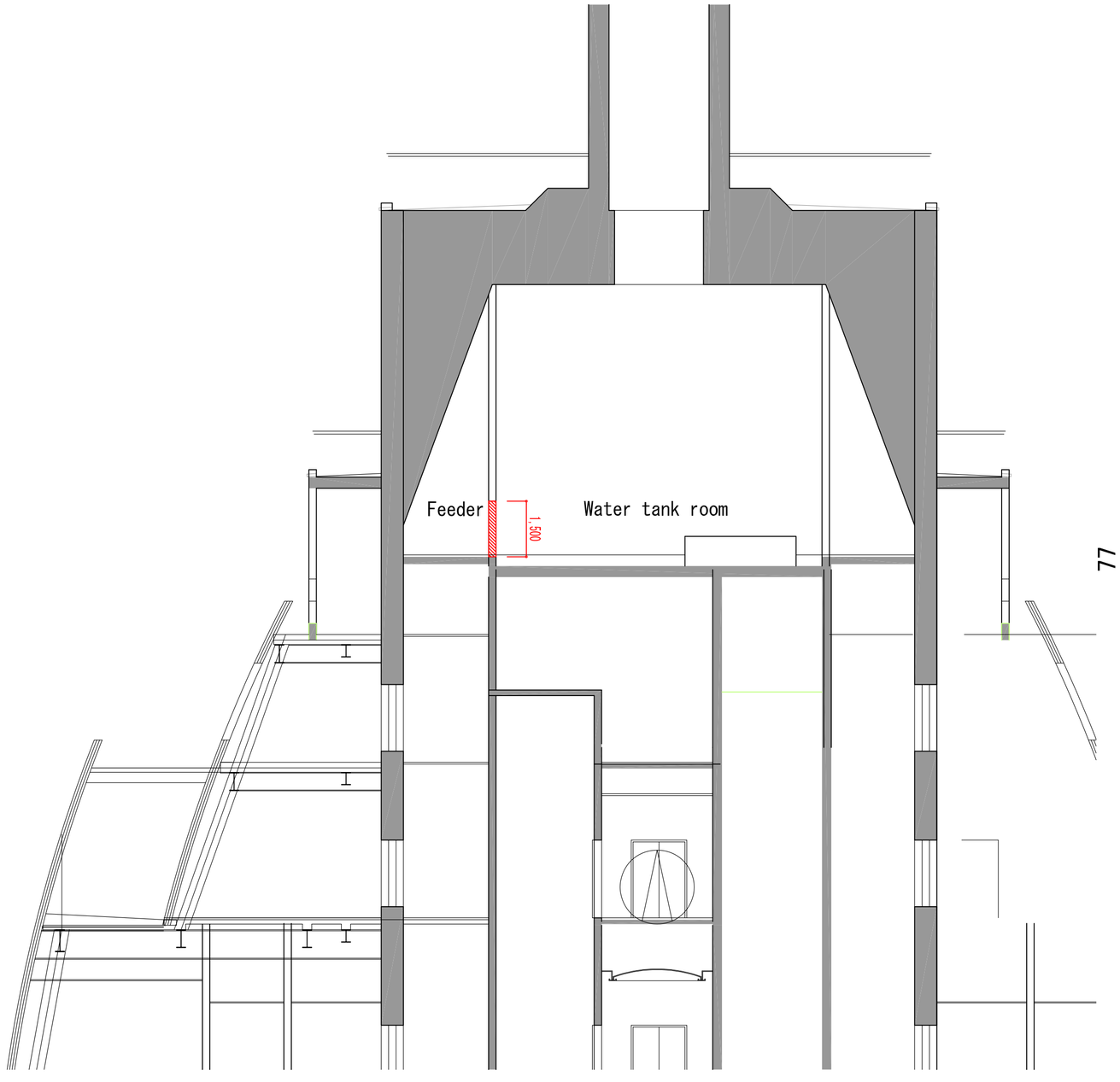
Structural plan of 257.200m high

作図									管理建築士		設計		監理	施工	工事名	ロータスタワー	No. 100
変更															図面名称	********	Scale S = 1 / 100	意匠

73. Drawing of Tower House (Base frame for fixing cables, at 253.3m high)



Structural plan of 253.800m high



77

作図									管理建築士		設計		監理	施工	工事名	ロータスタワー	No. 100
変更															図面名称	H253.8部ラダー用壁	Scale S = 1 / 100	意匠

Base frame at scaffold of T1 Section