FINAL REPORT

ON

PROJECT ON DEVELOPMENT OF HUMAN CAPACITY ON OPERATION OF WEATHER ANALYSIS AND FORECASTING IN THE PEOPLE'S REPUBLIC OF BANGLADESH

JANUARY 2014

JAPAN INTERNATIONAL COOPERATION AGENCY

CONSORTIUM OF
JAPAN WEATHER ASSOCIATION AND
INTERNATIONAL METEOROLOGICAL CONSULTANT INC.

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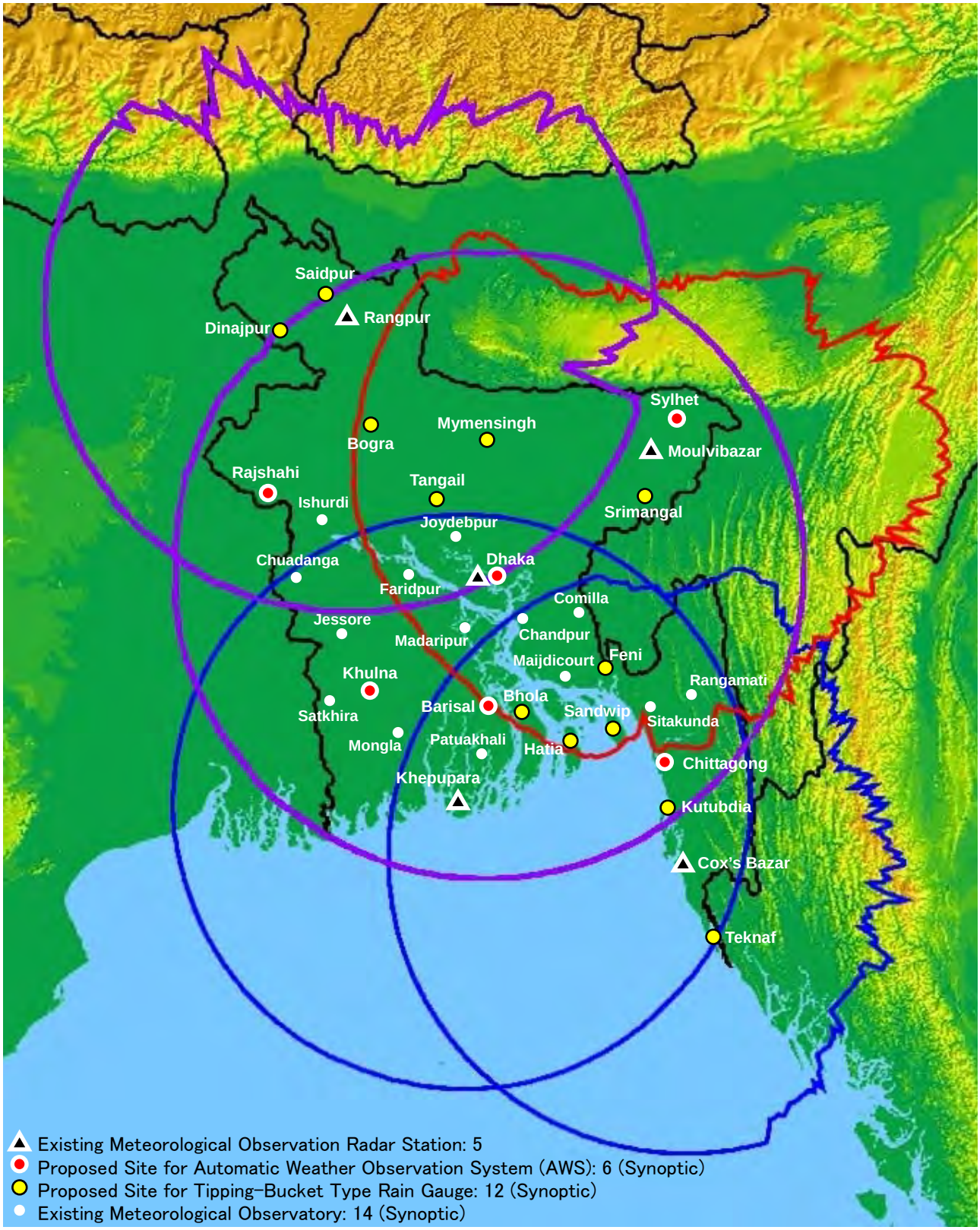


Location Map of the Project Sites

List of Abbreviations

AWS	:	Automatic Weather System
BDRCS	:	Bangladesh Red Crescent Society
BMD	:	Bangladesh Meteorological Department
BST	:	Bangladesh Standard Time
BTTB	:	Bangladesh Telegraph and Telephone Board
BWDB	:	Bangladesh Water Development Board
C/P	:	Counterpart
CPP	:	Cyclone Preparedness Programme
DMB	:	Disaster Management Bureau
DRR	:	Directorate of Relief and Rehabilitation
ECMWF	:	European Centre for Medium-Range Weather Forecasts
ECNEC	:	Executive Committee for National Economic Council
EDGE	:	Enhanced Data Rates for GSM Evolution
EOC	:	Emergency Operations Center
ERD	:	Economic Relation Division
FFWC	:	Flood Forecasting and Warning Centre
FY	:	Fiscal Year of Japan
GPS	:	Global Positioning System
GTS	:	Global Telecommunication System
IMDMCC	:	Inter-Ministerial Disaster Management Coordination Committee
JCC	:	Joint Coordinating Committee
JICA	:	Japan International Cooperation Agency
JMA	:	Japan Meteorological Agency
M/M	:	Minutes of Meetings

MDMR	:	Ministry of Disaster Management and Relief
MOA	:	Ministry of Agriculture
MOD	:	Ministry of Defence
MOE	:	Ministry of Environment
MOF	:	Ministry of Food
MOH	:	Ministry of Health
MOS	:	Model Output Statistics
NHM	:	(JMA) Non-Hydrostatic Model
NDMC	:	National Disaster Management Council
NOAA	:	National Oceanic and Atmospheric Administration
NWP	:	Numerical Weather Prediction
OJT	:	On-the-Job Training
PCM	:	Project Cycle Management
PDM	:	Project Design Matrix
PO	:	Plan of Operation
Pre-ECNEC	:	Pre-Executive Committee for National Economic Council
R/D	:	Record of Discussions
RIC	:	Regional Inspection Center
SAARC	:	South Asia Association for Regional Cooperation
SMS	:	Short Mail Message Service
SWC	:	Storm Warning Centre
TPP	:	Technical Project Proposal
UNDP	:	United Nations Development Programme
UNHCR	:	The Office of the United Nations High Commissioner for Refugees
VBA	:	Visual Basic for Applications
WMO	:	World Meteorological Organization

Exchange Rates of Currency assigned by JICA

Month	Japanese Yen / 1US$	Japanese Yen / 1 Bangladesh Taka
FY2009		
9	93.13	1.382
10	89.98	1.326
11	90.87	1.342
12	86.66	1.259
1	91.45	1.346
2	90.14	1.328
3	89.25	1.314
FY2010		
4	92.70	1.365
5	94.06	1.384
6	91.10	1.333
7	88.66	1.304
8	87.05	1.278
9	84.85	1.244
10	83.67	1.229
11	81.23	1.169
12	84.16	1.219
1	82.86	1.195
2	82.16	1.172
3	81.73	1.172
FY2011		
4	82.87	1.161
5	81.96	1.144
6	80.86	1.123
7	80.99	1.093
8	77.83	1.057
9	76.79	1.057
10	76.63	1.036
11	75.84	1.012
12	77.95	1.030
1	77.91	0.978
2	76.60	0.925
3	80.48	1.001

Month	Japanese Yen / 1US$	Japanese Yen / 1 Bangladesh Taka
FY2012		
4	82.50	1.025
5	81.07	1.007
6	79.26	0.984
7	79.45	0.987
8	78.31	0.975
9	78.63	0.979
10	77.68	0.969
11	79.65	0.998
12	82.11	1.027
1	85.81	1.087
2	91.04	1.166
3	91.84	1.184
FT2013		
4	94.19	1.227
5	97.84	1.278
6	101.03	1.323
7	98.07	1.282
8	98.10	1.280
9	98.04	1.287
10	98.29	1.289
11	98.25	1.292
12	102.19	1.338

Project on Development of Human Capacity on Operation of Weather Analysis and Forecasting in the People's Republic of Bangladesh
FINAL REPORT

Table of Contents

1. Outline of the Project (Background, Objective and Circumstance)

1.1 Background of the Project

Bangladesh is situated in a heavy rainfall and tropical cyclone prone region in the flood plains of the major rivers like the Ganges, the Brahmaputra and the Meghna with 20% of its landmass being flooded annually. During the pre-monsoon, monsoon, and post-monsoon seasons (March-November), it is constantly hammered by natural disasters such as tropical cyclones, storm surges, local severe storms, heavy rainfall, river erosion, major floods, flash floods, and their attendant landslides, and other forms of devastation every year. Bangladesh has long been associated with extreme vulnerability to natural disasters which are all responsible for its perpetual economic retardation. It experiences significant economic losses coupled with human anguish and sufferings generated especially by flood which is a perennial problem in this country. It has caused significant damage to agriculture, thereby, inflicting widespread poverty on the people of Bangladesh. These natural disasters have adversely affected the people's standard of living.

Moreover, with the accumulative unfavorable effects of global warming and climate change, this country, with its high population density, is likely to become more vulnerable to meteorological disasters and will, thus, encounter more intense floods, droughts and more severe and frequent tropical cyclones. During summer and the southwest monsoon season, intense rainfall in and around Bangladesh (with its large spatial and temporal variation - excessive rainfall at times and scanty sometimes) is responsible for the flash floods, floods and droughts that cause extensive damage to the infrastructure and agriculture of Bangladesh.

< Japanese Cooperation in the Field of Meteorology >

Japanese cooperation in the field of meteorology started in 1988 with the replacement of the two old cyclone surveillance radars located in the coastal belt of Bangladesh, more specifically at Cox's Bazar and Khepupara.

In the year 1994, Japan's Grant Aid took a more pragmatic approach by

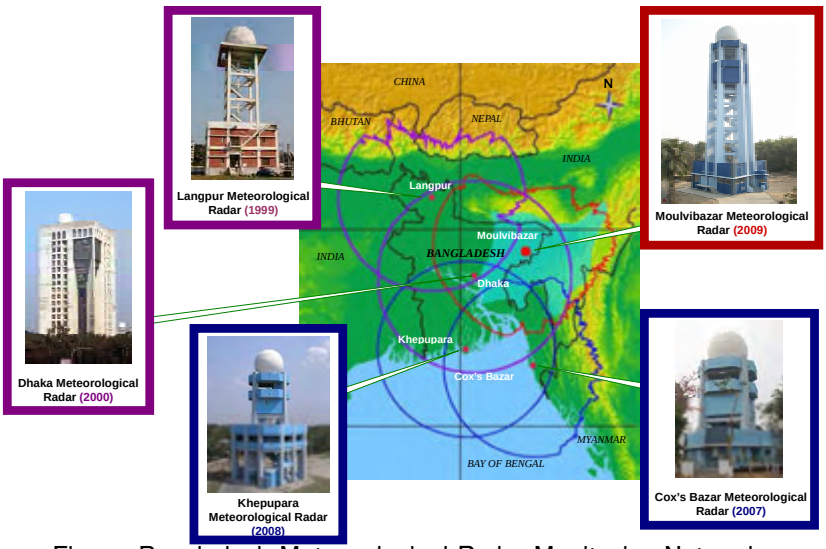


Figure: Bangladesh Meteorological Radar Monitoring Network

connecting the two coastal belt radars with the Storm Warning Center (SWC) of the Bangladesh Meteorological Department (BMD) through a micro-wave link for the real-time visualization of Radar images. Since then, and also with the subsequent increase in the amount of Japan's Grant Aid, a significant impact and improvement was seen in the cyclone forecasting and warning system as well as in the disaster management of Bangladesh which led to a considerable reduction in economic losses & human casualties.

In 1998-1999, through the Project for Strengthening of the Weather Warning Services related to Natural Disasters in Bangladesh, a massive upgrading of the BMD's overall operational capabilities were undertaken, namely, a new radar in Rangpur in the north-west part of Bangladesh for detecting severe thunderstorms was established, the old Dhaka Radar was replaced, Satellite Ground Receiving Stations were established, the BMD's Global Telecommunication Link was modernized, online weather presentation via TV was introduced, and a micro-wave link was established for the speedy transmission of hazardous weather information to the Honorable Prime Minister's Office, Zia International Airport and the Flood Forecasting & Warning Centre (FFWC). In order to improve the BMD's performance in the Aviation Sector, an Automatic Weather Observation System was also installed at the Zia International Airport under the Project.

During 2007-2009, Japan's Grant Aid has mainly given emphasis on the replacement of the two old radars, one at Cox's Bazar and the other at Khepupara, with Doppler Technology for improved tropical cyclone monitoring. In addition, another Doppler Radar at Moulvibazar has also been established which is equipped with improved precipitation monitoring facility for flash flood, flood forecasting and warning. During this period, due importance was also given to upgrade the GMS Satellite System to MTSAT and restore the existing WAN & LAN connection along with establishment of VSAT Links to connect all the radars for preparation of composite pictures at the SWC in Dhaka. Rainfall is an important component of the hydrological cycle and accurate rainfall estimates are necessary not only to improve the weather forecast, flood forecast and warning system but also to develop an understanding of the basic mechanisms of disaster management on which the warnings are based. With the help of observations from the newly operational Doppler Radar Systems, it would be possible to acquire accurate estimates of rainfall and its time of occurrence which will make possible the issuance of timely and advance flash flood and flood warning for disaster risk reduction, which, in turn, will considerably reduce the adverse impact of floods and flash floods on the socio-economic conditions of Bangladesh.

<Necessity of the Development of the Human Capacity of the BMD >

Significant damages resulting from meteorological disasters which frequently occur every year

still remains to be one of the major elements hampering the socio-economic development of Bangladesh in both a macro/micro-scale. The BMD has been incessantly receiving strong demand from both the public and the Government to upgrade its weather forecasting and warning systems. The current weather analysis and forecasting work done are mostly based on the subjective analysis of the weather forecasters and do not give forecasts which specify values of parameters (i.e. forecasted rainfall amount), places and forecast time. This situation makes it difficult for users to utilize the weather information from the BMD for their specific purpose.

More accurate and tailored weather forecasts need modern technologies of objective weather analysis such as radar rainfall analysis and numerical weather prediction (NWP), both of which are based on the computation of complex equations. These technologies will give values of parameters such as rainfall, temperature, wind, possibility of isolated heavy rain, etc. at particular places over the whole country.

The rainfall observation stations and the communication system of the BMD are not enough to detect and monitor local heavy rainfall on a real time basis. On the other hand, data from the meteorological radar systems provide real time data of location and intensity of water drops from the clouds. When the data is calibrated by actual rainfall data on the computers, it will immediately provide an estimated actual amount of local rainfall in high resolution in the covered areas of the meteorological radar systems provided under the grant aid projects of the Government of Japan. This rainfall data will help generate more accurate and timely flood forecasting without the need for huge investments for hundreds of rain gauge telemetry stations.

Numerical weather prediction (NWP), a kind of computer-based simulation model which mostly consists of physical equations, predicts future atmospheric conditions and gives quantitative data of air pressure, rainfall, temperature, etc. in high spatial and time resolution. The introduction of the NWP technique and its related methods is expected to drastically change the quality of weather forecasts of the BMD. However, a total NWP system needs a considerable amount of time for its development and investment for hardware. Therefore, it would be more feasible and prudent for the BMD to begin initially with basic skills trainings on the NWP system and the application of NWP products to weather forecasting.

Under such a background, the Bangladesh Government requested the Japan Government for the implementation of a technical cooperation project aimed at the improvement of the capability for weather observation, which is a base of weather analysis and forecasting duties, the improvement of observation accuracy through radar calibration with meteorological radar data and actual rainfall data, the establishment of medium and long range forecasting method by

introducing the Numerical Weather Prediction (NWP), the conduct of trend analysis of climate change through the utilization of accumulated climate data and the improvement of the capacity to promote these highly accurate information.

1.2 Objective of the Project

The objectives of the Project are as follows.

- Improvement of the capability for weather observation which is a base of weather analysis and forecasting duties;
- Improvement of observation accuracy through radar calibration with meteorological radar data and actual rainfall data;
- Establishment of medium and long range forecasting method by introducing the Numerical Weather Prediction (NWP);
- Conduct of trend analysis of climate change through the utilization of accumulated climate data; and,
- Improvement of the capacity to promote highly accurate information.

1.3 Circumstance of the Project

The implementation of this project follows the projects described in the table below.

The other meteorological projects that were implemented before the Project

Completion Year	Name of the Project	Major Maintenance Items
1988	The Project for Improvement of the Meteorological Radar Systems at Cox's Bazar and Khepupara	Cox's Bazar S-Band Radar Khepupara S-Band Radar
1994	The Project for Establishment of Microwave Link for Meteorology in the People's Republic of Bangladesh	Digital microwave lines
2000	Improvement of the Natural Disasters Weather Warning Project in the People's Republic of Bangladesh	Rangpur S-Band Radar Dhaka S-Band Radar
2007	The Project for the Improvement of the Meteorological Radar System at Cox's Bazar and Khepupara (1/2)	Cox's Bazar S-Band Radar
2008	The Project for the Improvement of the Meteorological Radar System at Cox's Bazar and Khepupara (2/2)	Khepupara S-Band Radar
2009	The Project for Establishment of the Meteorological Radar System at Moulvibazar in the People's Republic of Bangladesh	Moulvibazar S-Band Radar

This "Technical Cooperation Project for Development of Human Capacity on the Operation of Weather Analysis and Forecasting" was originally scheduled to be implemented for four years from October 2009 to December 2012. However, in the Final Evaluation conducted in July–September 2012, a one year extension of the project period has been proposed in order to guarantee the achievement of the project objectives and the sustainability of the outcomes. Due to the problems described in the table below, it was confirmed that the achievement of the project outcome and project objective would be difficult as several activities are affected by

these problems. Under such situation, the one year extension of the project period from January 2013 to December 2013 was decided upon on the basis of the recommendations of the Final Evaluation report and the result of extensive discussions with the Bangladesh Government.

Problems	Reason	Affected activities
Postponed procurement of the automatic rain gauge and the AWS (Automatic Weather Observation System AWS) for more than one year.	Delay of the completion of procedures by JICA and by the government of Bangladesh.	To install the six (6) AWSs and twelve (12) rain gauges at the eighteen existing meteorological observatories.
		To revise the field observation guidelines (including the AWS) in accordance with the latest WMO policy.
		To provide observation training for field observers based on the field observation guidelines and the data entry format.
		To conduct training on the data quality of observed data for forecasters.
		To prepare the operation and maintenance manuals for observation fields and instruments (including the AWS).
		To provide the training for field observers and instruments inspectors on the maintenance and control of observation fields and observation instruments (including the AWS).
		To compare the data obtained by the AWS and existing equipment and conduct quality control.
		To identify the radar ZR relation parameter for rainfall calculation in the observation range of 5 existing meteorological radar systems and optimize the parameter.
		To prepare correlation charts of rainfall data of radar and surface observations.
		To compose the rainfall composite picture of 5 existing meteorological radar systems optimized radar ZR relation parameter for rainfall calculation in SWC.
		To archive the observation data and conduct quality control.

2. ACTUAL INPUTS

2.1 Dispatch of JICA Expert Team

The following JICA experts that were involved in the Project for five (5) years in accordance with the schedule are attached hereunder.

Assigned Field	Name of Experts	Dispatch Schedule in This Fiscal Year	
Leader / Weather Forecasting & Warning Service and Organization Management	Yoshihisa UCHIDA	September 27, 2009 – October 11, 2009 December 20, 2009 – December 20, 2009 February 6, 2010 – February 23, 2010	1.70 M/M
		June 4, 2010 – June 18, 2010 September 13, 2010 – October 12, 2010 January 29, 2011 – February 18, 2011	2.20 M/M
		June 27. 2011 – July 13, 2011 September 9, 2011 – September 20, 2011 December 14, 2011 – December 31, 2011 January 23, 2012 – February 1, 2012 March 3, 2012 – March 17, 2012	2.40 M/M
		September5, 2012 – September20, 2012 November5, 2012 – November15, 2012 December 1, 2012 – December20, 2012	1.57 M/M
		March 29, 2013 – April 19, 2013 July 7, 2013 – July 18, 2013 October 19, 2013 – November1, 2013 December 10, 2013 – December 19, 2013	1.93 M/M
Assistant Leader / Weather Observation	Toshihide ENDO	December 20, 2009 – January 6, 2010 February 8, 2010 – February 23, 2010	1.13 M/M
		June 10, 2010 – June 27, 2010 September 18, 2010 – October 8, 2010 November 27, 2010 – December 11, 2010	1.80 M/M
		June 27, 2011 – July 31, 2011 September 08, 2011 – September 18, 2011 November 14, 2011 – January 26, 2012	4.00 M/M
		June 30, 2012 – July20, 2012	0.70 M/M
		March 29, 2013 – April 19, 2013 July 7, 2013 – July 19, 2013 September 23, 2013 – October 14, 2013 December 10, 2013 – December 18,2013	2.20 M/M
Weather Service Infrastructure	Kenji MORI	September 13, 2010 – October 8, 2010 October 24, 2010 – November 14, 2010	1.60 M/M
		December 19, 2011 – January 12, 2012 February 28, 2012 – March 14, 2012	1.37 M/M
Meteorological Radar Calibration	Takayuki OTSU	September 27, 2009 – October 9, 2009	0.43 M/M
		September 14, 2010 – September 28, 2010	0.50 M/M
		December 02, 2011 – December 16, 2011	0.50 M/M
		December 05, 2012 – December 22, 2012	0.60 M/M
		October 18, 2013 – November 1, 2013	0.50 M/M
Data Quality Control and Statistical Analysis	Takayuki MOTOYA	September 27, 2009 – October 11, 2009 December 1, 2009 – December 26, 2009 February 8, 2010 – February 23, 2010	1.90 M/M
		June 4, 2010 – June 24, 2010 September 18, 2010 – October 14, 2010 December 2, 2010 – December 16, 2010 February 4, 2011 – February 18, 2011	2.40 M/M
		June 27, 2011 – July 14, 2011 September 09, 2011 – September 23, 2011	2.67 M/M

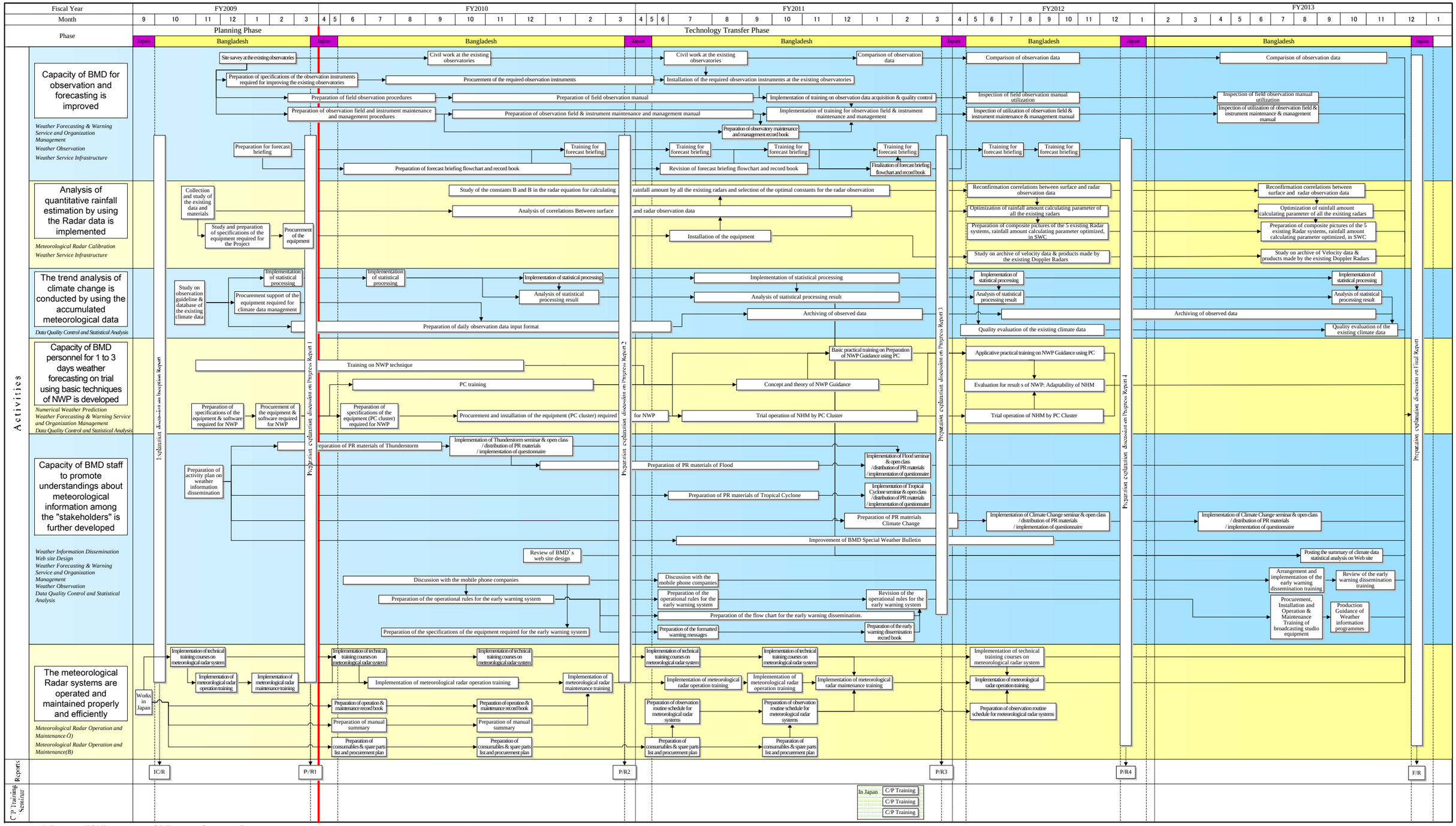
		December 2, 2011 – December 31, 2011 March 01, 2012 – March 17, 2012	
		August31, 2012 – September22, 2012 December4, 2012 – December 10, 2013 December26, 2012 – January 04, 2013	1.33 M/M
		March 29, 2013 April 19, 2013 May 14, 2013 – May 19, 2013 October 20, 2013 – November 2, 2013 November 14, 2013 – December 6, 2013	2.17 M/M
Web Site Design	Timothy Michael Kiddle	December 6, 2010 – December 23, 2010	0.60 M/M
		December 2, 2011 – December 19, 2011	0.60 M/M
Numerical Weather Prediction	Nobutaka NOGUCHI	September 27, 2009 – October 9, 2010 February 6, 2010 – February 8, 2010	1.10 M/M
		June 11, 2010 – June 26, 2010 September 21, 2010 – October 8, 2010 November 26, 2010 – December 16, 2010 January 29, 2011 – February 18, 2011	2.60 M/M
		June 27, 2011 – July 14, 2011 September 09, 2011 – September 29, 2011 December 2, 2011 – December 27, 2011 January 23, 2012 – February 4, 2012 March 1, 2012 – March 17, 2012	3.17 M/M
		September 5, 2012 – September 16, 2012 December 6, 2012 – January01, 2013	1.30 M/M
Weather Information Dissemination	Soshi IWATA	September 27, 2009 – October 9, 2009 December 1, 2009 – December 22, 2009 February 15, 2010 – February 27, 2010	1.60 M/M
		June 13, 2010 – July 3, 2010 September 14, 2010 – October 8, 2010 December 7, 2010 – December 21, 2010 January 22, 2011 – February 10, 2011	2.70 M/M
		June 27, 2011 – July 13, 2011 September 11, 2011 – October 5, 2011 December 06, 2011 – December 24, 2011 January 13, 2012 – February 04, 2012 February 28, 2012 – March 17, 2012	3.43 M/M
		September 13, 2012 – October 4, 2012 December 05, 2012 – December 20, 2012	1.27 M/M
		April 5, 2013 – April 19, 2013 October 1, 2013 – October 16, 2013 December 12, 2013 – December 20, 2013	1.33 M/M
Meteorological Radar Operation and Maintenance (J)	Takehiro YOSHIDA	September 27, 2009 – November 15, 2009	1.67 M/M
		June 4, 2010 – July 3, 2010 November 26, 2010 – December 25, 2010	2.00 M/M
		June 26, 2011 – July 22, 2011 October 13, 2011 – November 09, 2011	1.83 M/M
		October 30, 2012 – December 7, 2012	1.30 M/M
Meteorological Radar Operation and Maintenance (B)	Nasir Uddin Bhuiyan	September 29, 2009 – November 21, 2009 December 2, 2009 – February 20, 2010	4.50 M/M
		June 5, 2010 – July 28, 2010 September 14, 2010 – October 12, 2010 October 26, 2010 – November 12, 2010 November 27, 2010 – December 24, 2010 January 19, 2011 – February 17, 2011	5.30 M/M
		June 27, 2011 – July 31, 2011 September 10, 2012 – November 08, 2011 November 15, 2011 – December 30, 2011 February 16, 2012 – March 16, 2012	5.70 M/M
		July 1, 2012 – July18, 2012 November 1, 2012 – December 6, 2012	1.80 M/M

Operation & Maintenance for Studio Equipment	Nasir Uddin Bhuiyan	March 28, 2013 May 2, 2013	1.80 M/M
Meteorological Information Application and Promotion for Mass Media	Motoko KANOME		
Radar Observation Data Collection and Calibration	Takanari FUJII	September 22, 2012 – October6, 2012 December 08, 2012 – December 22, 2012	1.00 M/M
		July 5, 2013 – July 19, 2013 October 18, 2013 – November 1, 2013	1.00 M/M
Disaster Awareness Building (Project Coordinator)	Yosyiyuki YAGIRI	June 30, 2012 – July30, 2012 September 05, 2012 – January 05, 2013	5.13 M/M
		March 19, 2013 August 4, 2013 August 17, 2013 – August 26, 2013 December 3, 2013 – December19, 2013	5.53 M/M
Project Coordinator	Kazunori MURATA	December 20, 2009 – December 31, 2009	0.40 M/M
		September 27, 2010 – October 8, 2010	0.40 M/M
	Takanari FUJII	January 24, 2012 – February 4, 2012	0.40 M/M

2.1.1. Expert Dispatch Schedule

No.	Field	Name	Phase	1nd FY FY2009 9	10	11	12	1	2	3	2nd FY FY2010 4	5	6	7	8	9	10	11	12	1	2	3	3rd FY FY2011 4	5	6	7	8	9	10	11	12	1	2	3	4th FY FY2012 4	5	6	7	8	9	10	11	12	1	5th FY FY2013 2	3	4	5	6	7	8	9	10	11	12	1
				Activity Planning Phase							Technology Transfer Phase																																																						
1	Leader / Weather Forecasting & Warning Service and Organization Management	Yoshihisa UCHIDA		15			18		18		15			30					21				17			12			18	10	15					16		11	20				22			12			14	10										
2	Assistant Leader / Weather Observation	Toshihide ENDO					18		16		18			21			15						35		11			74						21								22			13		22			9									
3	Weather Service Infrastructure	Kenji MORI					29							26		22												25		14																														
4	Meteorological Radar Calibration	Takayuki OTSU		13										15														15									18												15									
5	Data Quality Control and Statistical Analysis	Takayuki MOTOYA		15			26		16				21			21		15		15				18		15		30			17					23		7	10				22		6				14	28								
6	Web Site Design	Timothy Michael Kiddle																	18									18																														
7	Numerical Weather Prediction	Nobutaka NOGUCHI		13					20		18			18		21			21				18		21			26	13	17					12			27																				
8	Weather Information Dissemination	Soshi IWATA		13			22		13		21			25			15		20				17		25			19	23	19					22			16				15						16		9								
9	Meteorological Radar Operation and Maintenance (J)	Takehiro YOSHIDA		50							30						30						27			28											39																					
10	The 1-4th fiscal year: Meteorological Radar Operation and Maintenance (B) The 5th fiscal year: Operation & Maintenance for Studio Equipment	Nasir Uddin Bhuiyan		54			81				54			29	18	28			30				35			60		46			30					18					36						36											
11	Meteorological Information Application and Promotion for Mass Media	Motoko KANOME																													19																										
12	Meteorological Radar Observation Data Collection & Calibration Technique	Takanari FUJII																																		15		15								15				15							
13	Disaster Awareness Building (Project Coordinator)	Yoshiyuki YAGIRI																																	31			123										139			10				17		

2.1.2. Flowchart



Italic type = JICA Expert C/P Training = Counterpart Training

FLOWCHART (Project)

2.1.3. Work Schedule

	1st FY							2nd FY											3rd FY											4rd FY											5rd FY										
	FY2009							FY2010											FY2011											FY2012											FY2013										
	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1
Capacity of BMD for observation and forecasting is improved																																																		
Site survey at the existing observatories																																																		
Preparation of specifications of the observation instruments required for improving the existing observatories																																																	
Procurement of the required observation instruments																																																	
Civil work at the existing observatories																																																	
Installation of the required observation instruments at the existing observatories																																																	
Preparation of field observation procedures																																																	
Preparation of field observation guideline																																																	
Implementation of training on observation & quality control																																																	
Inspection of field observation manual utilization																																																	
Training on quality control for observed data																																																	
Preparation of observation field and instrument maintenance and management procedures																																																	
Preparation of observatory maintenance and management record book																																																	
Preparation of observation field & instrument maintenance and management manual																																																	
Implementation of training for observation field & instrument maintenance and management																																																	
Inspection of utilization of observation field & instrument maintenance and management manual																																																	
Comparison of observation data																																																	
Training for forecast briefing																																																	
Preparation of forecast briefing flowchart and record book																																																	
Revision of forecast briefing flowchart and record book																																																	
Finalization of forecast briefing flowchart and record book																																																	
Analysis of quantitative rainfall estimation by using the Radar data is implemented																																																	
Collection and study of the existing data and materials																																																	
Study and preparation of specifications of the equipment required for the Project																																																	
Procurement and installation of the equipment																																																	
Optimization of rainfall amount calculating parameter of all the existing radars																																																	
Study on archive of velocity data & products made by the existing Doppler Radars																																																	
Analysis of correlations between surface and radar observation data																																																	
Study of the constants B and β in the radar equation for calculating rainfall amount by all the existing radars and selection of the optimal constants for the radar observation																																																	
Reconfirmation correlations between surface and radar observation data																																																	
The trend analysis of climate change is conducted by using the accumulated meteorological data																																																	
Preparation of daily observation data input format																																																	
Archiving of observed data																																																	
Implementation of statistical processing																																																	
Analysis of statistical processing result																																																	
Quality evaluation of the existing climate data																																																	
Study on observation guideline and database of the existing climate data																																																	
Procurement support of the equipment required for climate data management																																																	
Capacity of BMD personnel for 1 to 3 days weather forecasting on trial using basic techniques of NWP is developed																																																	
Preparation of specifications of the equipment & software required for NWP																																																	
Installation of the equipment & software required for NWP																																																	
Training on NWP technique																																																	
PC training																																																	
Trial operation of NHM by PC Cluster																																																	
Evaluation for Results of Numerical Weather Prediction: Adaptability of NWP																																																	
Concept and theory of NWP Guidance																																																	
Basic practical training onPreparation of NWP Guidance using PC																																																	
Applicative practical training on NWP Guidance using PC																																																	
Capacity of BMD staff to promote understandings about meteorological information among the "stakeholders" is further developed																																																	
Preparation of PR materials of Thunderstorm																																																	
Preparation of PR materials of Flood																																																	
Preparation of PR materials of Tropical Cyclone																																																	
Preparation of PR materials of Climate Change																																																	
Preparation of activity plan on weather information dissemination																																																	
Implementation of questionnaire																																																	
Implementation of Thunderstorm seminar & open class/ distribution of PR materials																																																	
Implementation of Flood seminar & open class/ distribution of PR materials																																																	
Implementation of Tropical Cyclone seminar & open class/ distribution of PR materials																																																	
Implementation of Climate Change seminar & open class/ distribution of PR materials																																																	
Improvement of BMD special weather bulletin																																																	
Procurement support of the equipment required for posting the climate data on Web site																																																	
Review of Web site design																																																	
Posting the summary of climate data statistical analysis on Web site																																																	
Discussion with the mobile phone companies																																																	
Preparation of the operational rules for the early warning system																																																	
Revision of the operational rules for the early warning system																																																	
Preparation of the specifications of the equipment required for the early warning system																																																	
Equipment installation, initial setting and basic performance are confirmed																																																	
Preparation of the flow chart for the early warning dissemination																																																	
Preparation of the formatted warning messages																																																	
Preparation of the early warning dissemination record book																																																	
Arrangement and implementation of the early warning dissemination training																																																	
Review of the early warning dissemination training																																																	
The meteorological Radar systems are operated and maintained properly and efficiently																																																	
Works in Japan																																																	
Implementation of technical training courses on meteorological radar system																																																	
Implementation of meteorological radar operation training																																																	
Implementation of meteorological radar maintenance training																																																	
Preparation of manual summary																																																	
Preparation of operation & maintenance record book																																																	
Preparation of consumables & spare parts list and procurement plan																																																	
Preparation of observation routine schedule for meteorological radar systems																																																	
Report and project evalution studies																																																	
Preparation of Inception Report (IC/R) Draft version																																																	
Preparation/ explanation/ discussion on Inception Report (IC/R)																																																
Preparation/ explanation/ discussion on Progress Report 1 (P/R1)																																																
Preparation/ explanation/ discussion on Progress Report 2 (P/R2)																																																
Preparation/ explanation/ discussion on Progress Report 3 (P/R3)																																																
Preparation/ explanation/ discussion on Final Report (F/R)																																																
Project evalution study by JICA																																																
Project evalution study by JICA																																																
Training in Japan (NWP basic training)																																																
Training in Japan (Meteorological information services)																																																
Training in Japan (Observation data management)																																																

2.2 Counterpart Training in Japan

2.2.1. Basic training on Numerical Weather Prediction (NWP)

Table: Summary of Training

Course Period	February 6, 2012 - March 3, 2012
Participants	1. Mr. Quamrul Hassan (Forecaster) 2. Mr. Md. Abdul Matin (Communication Engineer)
Course Objectives	To obtain basic techniques on the NHM (NWP model) for the preparation of 1-3 days weather forecasts.
Achievements of the Training	Improved understanding on the practical operation of the NHM (NWP model) which can be used in Bangladesh. Acquired deeper knowledge on the NHM (NWP model) through the training of researchers and engineers in a developed country.

Table: Training Schedule

		Training Places	Contents of Training
6	Mon		Travel: Dhaka - Bangkok (Stay)
7	Tue		Travel: Bangkok - Narita (Tokyo)
8	Wed	Tokyo International Center of JICA	Orientation/Briefing
9	Thu	JMA Head Office	Forecast Center, NWP Center, and Observation Field
10	Fri	Japan Weather Association (JWA)	Forecast section, Media section and Mobile web section
11	Sat		Day off
12	Sun		Day off
13	Mon	Yokohama Local Meteorological Observatory	Local Meteorological Observatory
		Tokyo Aviation Weather Service Center	Aviation Weather Service
14	Tue	Aerological Observatory	Aerological Observatory
		Meteorological Instruments Center	Meteorological Instruments Center
15	Wed	Japan Agency for Marine-Earth Science and Technology (JAMSTEC): Yokohama	Latest earth and marine science
16	Thu	National Research Institute for Earth Science and Disaster Prevention (NIED)	Advanced technology for disaster prevention X-band multi-parameter radar (MP-X)
17	Fri	Japan Aerospace Exploration Agency (JAXA): Hatoyama	Utilization of Observed Data of Tropical Rainfall Measuring Mission
18	Sat		Day off
19	Sun		Day off
20	Mon	Meteorological Research Institute (JMA-MRI)	Physical process of Non-Hydrostatic Model (NHM). Regional climate model
21	Tue	Meteorological Research Institute (JMA-MRI)	Setting of Surface Data, Boundary and Initial Condition for Bangladesh
22	Wed	Japan Weather Association (JWA)	Utilization of the NWP products
23	Thu	Japan Agency for Marine-Earth Science and Technology (JAMSTEC): Yokosuka	Marine observation equipment Latest ocean climate
24	Fri	Japan Aerospace Exploration Agency (JAXA): Tsukuba	Wide usage of meteorological satellite data/pictures
25	Sat		Day off
26	Sun		Day off
27	Mon	Meteorological Research Institute (JMA-MRI)	NHM forecast in Southeast Asia.
28	Tue	Japan Weather Association (JWA)	Visualization of Transmitted High Resolution Model Data Outline of Non Hydrostatic Model(NHM)
29	Wed	Japan Weather Association (JWA)	NHM operation
1	Thu	JICA	JICA Evaluation
2	Fri		Travel: Narita - Bangkok (Stay)
3	Sat		Travel: Bangkok - Dhaka

2.2.2. Weather Information Services

Table: Summary of Training

Course Period	February 6, 2012 - March 1, 2012
Participants	1. Mr. Md. Shameem Hassan Bhuiyan (Agro-meteorology division) 2. Ms. Taslima Imam (Training division)
Course Objectives	■ To obtain techniques on the preparation of visualized information which the general public easily understands. ■ To obtain techniques on the presentation of tropical cyclone visualized information to be disseminated through the media.
Achievements of the Training	■ Obtained the appropriate techniques on the presentation of tropical cyclone visualized information through the training in the JWA. ■ Recognized that visualized information is highly important to provide a more accurate, prompt and easily understandable weather information to users by visiting TV stations. ■ Learned about community-based weather services from the local newspaper company in Sendai, the disaster site of a tsunami. ■ Learned about the effective awareness building on disaster prevention by visiting the creative exhibition facilities where visitors can enjoy learning. ■ Obtained several fresh ideas about open classes that the BMD started last year by observing school education on global warming.

Table: Training Schedule

		Place of training	Contents of training
6	Mon		Travel: Dhaka - Bangkok (Stay)
7	Tue		Travel: Bangkok - Narita
8	Wed	Tokyo International Center, JICA	JICA briefing and orientation
9	Thu	Japan Meteorological Agency (JMA)	Forecast Center, NWP Center, and Observation Field
10	Fri	Japan Weather Association (JWA)	Forecast section, Media section and Mobile web section
11	Sat		Day off
12	Sun		Day off
13	Mon	Yokohama Local Meteorological Observatory	Local Meteorological Observatory
		Tokyo Aviation Weather Service Center	Aviation Weather Service
14	Tue	The Tokyo Rinkai Disaster Prevention Park	Disaster Prevention facility
		Fuji Television Network, Inc.	Weather information Program broadcasting by Private TV Center
15	Wed	Japan Broadcasting Corporation, NHK	Weather information Program broadcasting by Public TV Center
16	Thu	National Research Institute for Earth Science and Disaster Prevention (NIED)	Advanced technology for disaster prevention X-band multi-parameter radar (MP-X)
17	Fri	Travel: Tokyo - Sendai (Stay) Kahoku Shinpo in Sendai	Devastated Area by Huge Earthquake Local newspaper company
18	Sat	Miyagi prefecture Travel: Sendai - Tokyo	Devastated Area by Huge Earthquake Travel: Sendai - Tokyo
19	Sun		Day off
20	Mon	Life Safety Learning Center, Tokyo Fire Department	Disaster experience learning center (heavy rain and earthquake)
21	Tue	Japan Weather Association (JWA)	Presentation technique of tropical cyclone visualized information to be disseminated through mass media
22	Wed	National Museum of Emerging Science and Innovation	Effective and visualized exhibition method
23	Thu	Japan Agency for Marine-Earth Science and Technology (JAMSTEC): Yokosuka	Marine observation equipment Latest ocean climate
24	Fri	Weather Caster Network (Non-profit organization)	School education on global warming

25	Sat		Day off
26	Sun		Day off
27	Mon	Japan Weather Association (JWA)	Presentation technique at JWA studio.
28	Tue	Tokyo International Center, JICA	Evaluation meeting by JICA
29	Wed		Travel: Narita - Bangkok (Stay)
1	Thu		Travel: Bangkok - Dhaka

2.2.3. Observation Data Control

Table: Summary of Training

Course Period	February 6, 2012 - February 22, 2012
Participants	1. Mr. Md. Shadekul Alam (Forecaster at the Storm Warning Center) 2. Mr. Md. Ahmed Arif Rashid (Senior Mechanical Engineer)
Course Objectives	To improve acquisition/management techniques of meteorological data.
Achievements of the Training	▪ Expanded knowledge on the weather observation, data collection and data management methods in a developed country through the training in the JMA and the JWA. ▪ Obtained the necessary knowledge in order for the BMD to establish a meteorological data system and to guarantee data quality through the training at the Meteorological Instruments Center.

Table: Training Schedule

		Training Places	Contents of the training
6	Mon		Travel: Dhaka - Bangkok (Stay)
7	Tue		Travel: Bangkok - Narita (Tokyo)
8	Wed	Tokyo International Center of JICA	Orientation/Briefing
9	Thu	JMA Head Office	Forecast Center, NWP Center, and Observation Field
10	Fri	Japan Weather Association (JWA)	Forecast section, Media section and Mobile web section
11	Sat		Day off
12	Sun		Day off
13	Mon	Yokohama Local Meteorological Observatory	Local Meteorological Observatory
		Tokyo Aviation Weather Service Center	Aviation Weather Service
14	Tue	Aerological Observatory	Aerological Observatory
		Meteorological Instruments Center	Meteorological Instruments Center
15	Wed	Meteorological Instruments Center	Operation Check, Repair & Maintenance methods and Examination of Meteorological Instruments
16	Thu	National Research Institute for Earth Science and Disaster Prevention (NIED)	Advanced technology for disaster prevention X-band multi-parameter radar (MP-X)
17	Fri	Japan Aerospace Exploration Agency (JAXA): Hatoyama	Satellite data analysis technique
18	Sat		Day off
19	Sun		Day off
20	Mon	JICA	JICA Evaluation
21	Tue		Travelling: Narita - Bangkok (Stay)
22	Wed		Travelling: Bangkok - Dhaka

2.3 Provision of Equipment

The Equipment for the activities of each expert procured and provided to the BMD under the Project is listed in the following table.

Name of Equipment	Manufacturer	Model	Purpose	Q'ty	Installation Site	Inspection Date
FY2009 (1st FY)						
For Weather Forecasting & Warning Service and Organization Management						
Digital Visual Presenter	ELMO	P30S	For visual aid projector of document data, etc.	1	BMD Head Office	Feb. 5, 2010
Color LCD Type Monitor Display	PROLINK	PRO3201TW	For display of the weather information	3	BMD Head Office	Oct. 20, 2009
Desktop PC for Weather Briefing	HP Compaq	DC5800	For display, preparation and storage of the weather information	3	BMD Head Office	Oct. 20, 2009
For Meteorological Observation						
GPS measuring device	Garmin	GPSMAP60CSx	For site survey of latitude, longitude and altitude	1	BMD Head Office	Feb. 5, 2010
Altimeter	Brunton	ADC Summit		1	BMD Head Office	Feb. 5, 2010
For Meteorological Radar Calibration						
Desktop PC for Radar Calibration	HP Compaq	DC5800	For radar calibration	2	BMD Head Office	Oct. 20, 2009
Linux OS	Red Hat	Enterprise Linux 5	For radar calibration	2	BMD Head Office	Mar. 04, 2010
Rain Gauge and Data Logger	Delairco	-	For acquisition of rainfall data	12	Twelve (12) Existing Observatories 1) Saidpur 2) Dinajpur 3) Bogra 4) Mymensingh 5) Tangai 6) Srimangal 7) Chandpur 8) Mongla 9) Bhola 10) Sitakunda 11) Kutubdia 12) Teknaf	Mar. 15, 2010
Data Collection & Storage Unit	Delairco	-	For data collection & storage at the BMD Head Quarters	1	BMD Head Office	Mar. 15, 2010
Hard Disk for Data Storage	Buffalo	HD-PX500U2	For radar calibration data storage	2	BMD Head Office	Feb. 26, 2010
For Data Quality Control and Statistical Analysis						
Desktop PC for Data Quality Control and Statistical Analysis	HP Compaq	DC5800	For statistical analysis	2	BMD Head Office	Oct. 20, 2009
	HP Compaq	DX2810	For data quality control	1	BMD Head Office	Feb. 17, 2010
For Numerical Weather Prediction						
Laptop PC for Basic Training on NWP	Best Systems	BSC-LOW MM5NBV	For basic training on NWP	1	BMD Head Office	Mar. 12, 2010
For Weather Information Dissemination						
Laptop PC for Workshop	HP	6930P	For projection of the documents at the workshop	1	BMD Head Office	Oct. 20, 2009
Others						

UPS	APOLLO	1120F	For supplying back-up AC power to PC etc.	7 3	BMD Head Office	Oct. 20, 2009 Feb. 17, 2010
Color Inkjet Printer	HP	K7100	For printing the documents and materials	3	BMD Head Office	Oct. 20, 2009
	Cannon	PIXUS iP100		2		Nov. 27, 2009
Laser Pointer	KOKUYO	SASHI-82	For pointing table, figure, video, etc.	2	BMD Head Office	Sep. 24, 2009
Projector	Hitachi	RX80	For projecting table, figure, video, etc. to the screen	2	BMD Head Office	Oct. 13, 2009
Spare of a Valve for the projector	Hitachi	For RX80	For spare of a valve for the projector	8	BMD Head Office	Oct. 13, 2009
Copy Machine (including Scan)	Canon	IR-3225	For printing documents & materials	1	BMD Head Office	Oct. 13, 2009
Hard Disk for Data Storage	Buffalo	HD-PX500 U2	For data storage of the report, etc.	1	BMD Head Office	Nov. 18, 2009
FY2010 (2nd FY)						
For Numerical Weather Prediction						
PC Cluster for training on NWP	Delairco	-	For numerical analyses	1	BMD Head Office	Mar. 7, 2011
White Board	-	-	For training on NWP	1	BMD Head Office	Jun. 7, 2010
For Web Site Design						
USB Modem for training on Web Site design	Grameenphone	Internet modem	For Internet access by a PC for training	1	BMD Head Office	Dec. 10, 2010
Software for training on Web Site design	Adobe	Dreamweaver CS5	For web page edit	1	BMD Head Office	Dec. 8, 2010
Others						
Vacuum Cleaner	Panasonic	MC-CL481	For cleaning the equipment procured under the Project	1	BMD Head Office	Jun. 11, 2010
FY2011 (3rd FY)						
For Meteorological Observation						
Automatic Weather System (AWS)	Delairco	-	Weather Observation	6	Six (6) Synoptic Observation Station 1) Dhaka 2) Rajshahi 3) Sylhet 4) Barisal 5) Khulna 6) Chittagong	Nov. 01, 2011
Spare parts for AWS ■ 5103 Wind Speed and Direction Sensor: 2 ■ Temperature and Humidity Sensor: 1 ■ PTB330A Barometer:1 ■ RIM8050 Rain Gauge: 1 ■ CSD3 Solar Duration Sensor: 1 ■ SP LIte2 Solar Radiation Sensor: 1 ■ DLM Data Collection Unit: 1 ■ μDCP: 1 ■ Interface Board: 1 ■ Set 1008M/F Line Driver: 1 ■ SAM2W GPRS Modem: 1 ■ PS15M Solar Power Regulator: 1	Delairco	-	Maintenance of AWS	1	BMD Head Office	Mar. 19, 2012
Spare parts for Rain gauge	Delairco	-	Maintenance of	1	BMD Head Office	Mar. 19, 2012

■ Data Logger Board: 1 (Used for Bogla Station) ■ Sunguard 4.5A Solar Power Regulator: 1 ■ CELFXT009S GPRS Modem (Fastrak Extend): 1 (Used for MaijdiCourt Station) ■ CNPV-10M Solar Panel: 1 (Used for Joydebpur Station)			AWS and Rain gauge			
Vibration Battery Drill	Hitachi	DV18DBL(2LSCK)	Installation of Observation Equipment	1	BMD Head Office	Jun. 24, 2011
Safety Belt	Fujii Electric	Tsuyo Light TD-27		2	BMD Head Office	Oct. 4, 2011
Laminate Machine	LAMINATOR	YL-320	Courting of Meteorological Product	1	BMD Head Office	Jun. 30, 2011
For NWP						
Laptop PC for Guidance training	DELL	Inspiron N5110	Training for Guidance	3	BMD Head Office	Jul. 28, 2011
Anti-Virus Software	Kaspersky	Internet Security	Virus Protection for PC	3	BMD Head Office	Jun. 29, 2011
HDD Drive for Data Storage	BUFFALO	SHD-PE128G-WH	Storage for NWP Product	1	BMD Head Office	Jun. 24, 2011
HDD Drive for Data Storage	BUFFALO	HD-LBV3.0TU3		1	BMD Head Office	Jun. 24, 2011
For Weather Information Dissemination						
PC for Cyclone Trucking Bulletin Display	DELL	Vostro 460n	Cyclone Trucking Bulletin Display	1	BMD Head Office	Jan. 23, 2012
Generator	Walton	Zoom-1200	Implementation of Open Class and Seminar	1	BMD Head Office	Jan. 31, 2012
Electric Cable Drum	-	-		1	BMD Head Office	Jun. 29, 2011
Monitor Cable	-	-		1	BMD Head Office	
Portable Screen	-	-		1	BMD Head Office	Jun. 30, 2011
Accessories for Video	King	Fotopro C-4i		1	BMD Head Office	Jun. 23, 2011
	Transcend	TS16GSDHC10		4	BMD Head Office	Jun. 23, 2011
Graphic Software	CorelDRAW	GraphicsSuite X5	Production of Weather information Dissemination	1	BMD Head Office	Dec. 22, 2011
Video Camera	Panasonic	Panasonic		1	BMD Head Office	Mar. 15, 2012
For Meteorological Radar Operation and Maintenance						
AVR	Delixi	SVE3000	Operation and Maintenance of Meteorological	1	Rangpur Meteorological Radar Station	Jun. 29, 2011
Maintenance Parts for Antenna Controller Circuit Board	-	-		1		Jun. 24, 2011
Circuit breaker	Nikko Electric	NS102A-AC500V-75A- HC-LW		1		Feb. 7, 2012
FY2012(4th FY)						
Meteorological Information Programmes Recording Equipment (Audio-video and Studio Equipment)						
Live Editing Unit	NEWTEK	Tricaster 455	For producing weather information programmes in order to distribute it to TV centers and BMD Website via the Internet	1	BMD Head Office	Jan. 1, 2013
Live Recording Control Unit	NEWTEK	CS-450		1	BMD Head Office	Jan. 1, 2013
Data Storage External HDD	WESTERN DIGITAL	WDBY8L0020BBKNESN		1	BMD Head Office	Jan. 1, 2013
Live Text Editing programme	NEWTEK	LTX-10		1	BMD Head Office	Jan. 1, 2013
HD Camera Recorder	CANON	XF-300		1	BMD Head Office	Jan. 1, 2013
Ultra-Directional Microphone	Betterway	EM2800A		1	BMD Head Office	Jan. 1, 2013

Tripod for Camera	Libec	RH25		1	BMD Head Office	Jan. 1, 2013
Tiepin Microphone	SONY	ECMC115		2	BMD Head Office	Jan. 1, 2013
Monaural Mixer	YAMAHA	MG102		1	BMD Head Office	Jan. 1, 2013
Monitor for Caster (Dual Monitor Type)	FUJITSU	PD-LED185B		1	BMD Head Office	Jan. 1, 2013
Video Distribution Unit	KRAMER	VM-216H		1	BMD Head Office	Jan. 1, 2013
Monitor for Editing Work	DELL	U2711		2	BMD Head Office	Jan. 1, 2013
Uninterrupted Power Supply	APC	2kVA		1	BMD Head Office	Jan. 1, 2013
Automatic Voltage Regulator	MICRO	2kVA		1	BMD Head Office	Jan. 1, 2013
LED Lighting Set	NANGGUANG	CN600HS	For producing weather information programs in order to distribute it to TV center and BMD Website via the Internet	1	BMD Head Office	Jan. 1, 2013
Automatic Voltage Regulator	MICRO	2kVA		1	BMD Head Office	Jan. 1, 2013
Air Conditioning System	Fujitsu General	ASG-30	For keep the appropriate room temperature for broadcast studio	2	BMD Head Office	Jan. 1, 2013
For Weather Observation						
Battery Charger	ALPS Electric Instruments	SP1210TR	For maintenance of AWS and Rain Gauge	1	BMD Head Office	Jul. 9, 2012
Hexagon Shaft Drill Set	NACHI	COSET10		1	BMD Head Office	Jul. 9, 2012
Maintenance Terminal for AWS and Rain Gauge	FUJITSU	LH531		1	BMD Head Office	Jan. 2, 2013
For Radar Calibration						
External Hard Disk Drive	LaCie	LCH-MN2T U3/E	For archiving Radar Rainfall Data	1	BMD Head Office	Jul. 5, 2012
For Weather Information Dissemination						
Graphic Design Tool Kit (Software)	Adobe	Creative Suite 6	For implementation of Open Class/Seminar	1	BMD Head Office	Jan. 2, 2013
Megaphone	TOA	3W ER-1103		2	BMD Head Office	Jul. 4, 2012
External Hard Disk Drive	LaCie	LCH-MN2T U3/E	For archiving Outputs of Weather Dissemination Activities	1	BMD Head Office	Jul. 5, 2012
FY2013(5th FY)						
None						

2.4 List of Outputs

The reports ordered by JICA are listed in the following table.

Fiscal Year	Output	Submission Month
1st FY	INCEPTION REPORT	October 2009
	PROGRESS REPORT 1	March 2010
2nd FY	PROGRESS REPORT 2	March 2011
3rd FY	WORK PLAN 3	March 2012
	PROGRESS REPORT 3	March 2012
4th FY	WORK PLAN 4	July 2012
	PROGRESS REPORT 4	January 2013

5th FY	WORK PLAN 5	July 2013
	FINAL REPORT	January 2014

The outputs of the Project by each expert are listed in the following table.

PDM Output	Output prepared by the Project
Capacity of BMD for observation and forecasting is improved	Weather Observation Guideline
	Beaufort Scale
	Cloud Type Code
	Instrument Inspection/Maintenance, Automatic Weather Station (Rain Gauge)
	Instrument Inspection/Maintenance, Automatic Weather Station (AWS)
	Installation & Operation Manual (Meteorological Data Collection and Display Software)
	Maintenance & Calibration Manuals (Automatic Weather Station (AWS) Network
	Installation & Technical Manual (Rain Gauge System)
	Summary – Guide to Meteorological Instruments and Methods of Observation according to WMO Seventh Edition
	Quality Assurance and Management of Observing Systems according to WMO Seventh Edition
	Observation Equipment Layout Plan (Observation Field) First Class Observatory
	Observation Equipment Layout Plan (Observation Field) Agromet. Observatory
	AWS Layout Plan (Dhaka、Rajshahi、Sylhet、Barisal、Khulna、Chittagong)
	Standardized Specifications of Manual Observation Instruments
	Standardized Specifications of Automatic Weather System (AWS)
	Standardized Specifications of Automatic Rain Gauge
	Standardized Specifications of Data Receiving System
	Standardized Specifications of Communication Instrument
	Standardized Details of AWS Pole (Drawings for Manufacturing)
	Standardized Details of AWS Pole (Drawings for Foundation)
	Drawings for manufacturing furniture for briefing room equipment
	Forecast briefing flowchart
	Briefing flowchart for mass media BMD meteorological service regulation
	Forecast products by emergency management phase and location specificity
	Forecast briefing flowchart revised version
	BMD meteorological service regulation revised version
Quantitative rainfall estimation by using Doppler Radars is implemented	C-Shell scripts for use in BMD system to store IRIS product(RAIN1) files and to make figure of radar rainfall distribution from RAIN1 product files
	Source code(C language) files of radar data analysis for use in BMD system
	Source code(Fortran) files of rain-gauge data analysis and processing for B-Beta estimation for use in BMD system
	Excel template files for correlation analysis between radar and rain-gauge data, and for estimation of B-beta values
	Instruction on radar calibration for BMD radar system
	Presentation materials for lectures and trainings in this project
The trend analysis of climate change is conducted by using the accumulated meteorological data.	Comparison between BMD Formula and WMO Formula for Barometer Cistern Level Pressure
	Calculation of Atmospheric Pressure for Fixed-Cistern Type (Kew Type) Barometer
	Calculation of Atmospheric Pressure for Fortin Type Barometer
	Calculation of Relative Humidity and Dew Point Temperature
	Weather Observation Data Input Manual
	Daily Observation Data Input Sheet
	Changing Trend of Yearly Mean Temperature and Yearly Precipitation
Capacity of BMD personnel for 1 to 3 days weather forecasting on trial using basic techniques of Numerical Weather	Training Materials
	NO.1-Dynamics for Numerical Prediction
	NO.2-Dry Thermodynamics
	NO.3-Moist Thermodynamics
	NO.4-Isobaric Surface

Prediction (NWP) is developed.	NO.5-Richardson's Dream
	NO.6-Vorticity
	NO.7-Shallow Water Wave
	NO.8-Deep Sea Wave
	NO.9-Scale Analysis
	NO.10-Quasi-Geostrophic Equations
	NO.11-Theory of Quasi-Geostrophic Equations
	NO.12-Energy Conservation
	NO.13-Baroclinic Wave
	NO.14-Synoptic Wave
	NO.15-Overview of Mesoscale Phenomena
	NO.16-Mesoscale Equations
	NO.17-Introduction to the MM5
	NO.18-Map Projection
	NO.19-Equations of Map Factor
	NO.20-Introduction of JMA-Model
	NO.21-Numerical Methods
	NO.22-Differencing Technique
	NO.23-Introduction of EC Model
	NO.24-JMA-Nonhydrostatic Model Operation
	NO.25-NHM_Tutorial
	NO.26-Introduction to Linux
	NO.27-NHM-Installation
	NO.28-Running Training of NHM
	NO.29-Execution of NHM
	NO.30-Learning Fortran
	NO.31-Outline of NHM Main Program
	NO.32-Example of NHM
	NO.33-Reading of Main Program
	NO.34-Basic Equations of NHM
	NO.35-Reference Atmosphere
	NO.36-Terrain Coordinate
	NO.37-Time Integration
	NO.38-Practice of Preparation for NWP Execution
	No.39-Outline of Weather Guidance
	No.40-Production of Weather Guidance
	No.41-Practice on Weather Guidance
	No.42-MPI for parallel Calculation
	No.43-Practice of Restart
	No.44-Double Nesting
	No.45-Objective Analysis
	No.46-Data Processing for NWP
	No.47-Visualization of NuSDaS Data
	Installation of CentOS 5.5 (Linux OS)
	(JMA-NHM) Operation Manual for PC-Cluster
	PC-Cluster Operation Manual
Capacity of BMD staff to promote understandings about meteorological information among the "stakeholders" is further developed.	ANIMATION DVD
	Brochure "Save Yourself"
	Book "Weather Information"
	BMD Character
	Mascot of BMD Character
	Software for preparation of Visualized BMD Special Weather Bulletin
The meteorological Radar systems are operated and maintained properly and efficientl	SAFETY PRECAUTION
	Necessary of Periodic Maintenance of Radar System
	Techniques used in Doppler radar
	Maintenance Sheets
	Routine care of Computer System
	Routine Check Sheet for Radar System

2.5 REVISION OF THE PROJECT DESIGN MATRIX (PDM)

■1st Revision (October 2009)

The revision of certain items to make the descriptions of the PDM more concrete were proposed and approved at the Joint Coordinating Committee (JCC) conducted during the 2nd fiscal year.

■2nd Revision (January 2010)

In order to maintain the logical relationship between the Output and the Activities of the PDM, to shift Activity 3.2 for Output 3 to Activity for Output 2 and to add "activity 4-3" to Output 4 were proposed at the terminal evaluation conducted by JICA in October 2009.
This proposal was approved at the JCC implemented during the 4th fiscal year.

The original PDM, 1st revised PDM (revised parts: blue color), and 2nd revised PDM (revised parts: red color) are attached hereunder.

The summary of the revised items in the PDM are indicated in the following table.

PROJECT DESIGN MATRIX (PDM) [Original]

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumption
Overall Goal Highly precise weather and climate information is utilized for Natural Disaster Management and contributed to the reduction of the Natural Disaster Losses.			
Project Purpose Weather information for natural disaster management is more strengthened in terms of time and quality through human capacity development and dissemination of weather information among the stakeholders are more broadened.	1. Quantitative rainfall information using rainfall calibration is provided. 2. More timely and precise forecasting and warning-delivery to organizations related to Natural Disaster Management and Mass Media are performed.	1. Report of the Project 2. Record of forecasting and warning Report of the Project Interview to organization elated to DM and Mass Media	State policy of weather services in the Government of Bangladesh remains unchanged
Outputs 1. Capacity of BMD for daily weather observation and forecasting is improved.	1-1 The training for observers / inspectors are implemented more than 6 times during the Project and 70% of participants understand the contents of the training. 1-2 More than 70% of the observers follow the revised observation guideline by end of the Project. 1-3 More than 70% of the inspectors follow the revised guideline for inspections by end of the Project.	1-1 Report of training for observers / inspectors Result of Questionnaire 1-2 Questionnaire and survey 1-3 Evaluation by expert Questionnaire	
2. Quantitative rainfall estimation by using Doppler Radars is effectively utilized for weather forecasting and warning.	2-1 Correlation between calibrated rainfall data and actual rainfall data is confirmed by December, 2010. 2-2 BMD can calculate the estimated rainfall data under the coverage area of 5 Radars by using the calibration method by December, 2011.	2-1 Calculated Correlation 2-2 Estimated rainfall data	
3. Climate data is utilized for the trend analysis of climate change.	3-1 Result of the Climate statistical analysis is shared with the SAARC Countries by December, 2010.	3-1 Result of statistical analysis Report of regional workshop	
4. Capacity of BMD personnel for weather forecasting using basic techniques of Numerical Weather Prediction (NWP) is established.	4-1 More than 5 personnel of BMD are capable of using the NWP basic technique by the end of the Project.	4-1 Evaluation by expert Questionnaire	
5. Capacity of BMD to promote understandings about weather and climate information in central/local governments, related organizations/agencies and end-user is improved..	5-1 The seminar / workshop are implemented more than 6 times during the Project and 70% of participants understand the contents of the training. 5-2 More than 2 categories of Booklets for target group (elementary school and people of affected area, etc) for promoting understandings of weather, climate and disaster are published and distrubuted during the Project.	5-1 Report of seminar / workshop Result of Questionnaire 5-2 Booklets	
6. Weather observation and monitoring equipment such as meteorological Radar system etc. are operated and maintained properly.	6-1 The training on O&M of Meteorological Radar are implemented more than 3 times during the Project and 70% of participants understand the contents of the training. 6-2 10 personnel of BMD are capable of efficient O&M of Meteorological Radar system by the end of the Project. 6-3 More than 70% of the personnel related to O&M of Meteorological Radar follow the guideline for O&M.	6-1 Report of the training Result of Questionnaire 6-2 Evaluation by expert 6-3 Report of the Project Questionnaire and survey	

Activities	Inputs		Pre-conditions
1-1 To conduct the training for observers on Meteorological Observation. 1-2 To revise the existing guideline on Meteorological Observation in accordance with latest WMO edition. To conduct the training for forecasters on data acquisition and quality control. 1-3 To have the daily briefing on every weather forecast among the forecasters. 1-4 To conduct the training for inspectors on inspection of the instruments. 1-5 To revise the existing guideline on inspection of the instruments and equipments in accordance with latest WMO edition. 2-1 To implement the Radar Calibration with existing Radar data and actual rainfall data in the observatories under coverage area of Cox's Bazar and Khepupara Radars. 2-2 To establish the correlation between actual rainfall and estimated rainfall. 2-3 To implement the Radar Calibration with existing Radar data and actual rainfall data in the observatories under coverage area of Moulavi bazar Radar. 2-4 To implement the Radar Calibration with existing Radar data and actual rainfall data in the observatories under coverage area of Dhaka and Rangpur Radars. 2-5 To evaluate the result of estimated rainfall data by the calibration method. 3-1 To develop the Quality Control System (automatic and human quality control) for identification of abnormal values. 3-2 To modify the Quality Control System. 3-3 To archive the climate data in the database developed in the Project. 3-4 To implement the statistical analysis of climate trend. 3-5 To organize the regional workshop on climate change. 4-1 To conduct the basic training on Numerical Weather Prediction (NWP). 4-2 To study for the applicability of NWP result calculated by other countries. 4-3 To examine the method of Guidance by using the result of study mentioned 4-2. 4-4 To develop the Meso Spectral Model (MSM) for NWP by using PC on trial. 5-1 To conduct the workshop for organizations and agencies related to disaster management. 5-2 To make the booklet for promoting the understandings of end-users of weather and climate information. 6-1 To conduct the training on operation and maintenance of Meteorological Radar System. 6-2 To review the guideline for maintenance of the equipments. 6-3 To review the guideline for operation of Meteorological Radar system. 6-4 To make the appropriate maintenance plan.	**(Bangladeshi Side)** 1. Provision of the project office for the project experts in BMD Head Office 2. Allocation of the required counterpart personnel 3. Provision of training spaces 4. Provision of installation spaces for the equipment to be procured under the Project 5. Security of the equipment for the Project 6. Operation and maintenance expenses of the equipment for the Project 7. Tax exemption, custom clearance and other procedures required for importing the equipment for the Project	**(Japan Side)** 1. Experts - Weather Observation - Weather Forecasting - Radar Calibration techniques - Climate data management - Statistical Analysis techniques - Numerical Weather Prediction - Weather Radar operation and maintenance 2. Equipment Supply 3. Provision of training in Japan	Trained observers continue working for BMD. Trained inspectors continue working for BMD. BMD personnel who acquired technique remain on duty. Meteorological Radar works without breaking. Budget required for maintenance allocates.

PROJECT DESIGN MATRIX (PDM) [revised-1]

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumption
Overall Goal Highly precise weather and climate information is utilized for natural disaster management which contributes to the reduction of the natural disaster losses.	Utilization of weather and climate information by organizations related to natural disaster management	Interview to the person in charge in organizations related to natural disaster management	
Project Purpose Weather information for natural disaster management is strengthened in terms of time and quality through human capacity development and dissemination of weather information among various stakeholders.	1. Rainfall data of the optimized radar ZR relation parameter for rainfall calculation being provided to FFWC. 2. Accurate and easily understandable forecasting and warning to organizations related to natural disaster management and Mass Media are timely issued.	1. Data distribution record 2. Weather forecasting and warning prepared by BMD for organizations related to natural disaster management and Mass Media	Weather data, forecasting and warning of BMD are utilized by organizations related to natural disaster management and Mass Media.
Outputs			
1. Capacity of BMD for observation and forecasting is improved.	1-1 Enable to acquire and archive accurate observed data: 6 existing meteorological observatories 1-2 Training for field observers and data inspectors on observed data acquisition and data quality control: 6 times 1-3 Briefing in SWC: at least 1 time/day	1-1 Database in BMD Head Office 1-2 Report of the Project 1-3 Briefing records	State policy of weather services in the Government of Bangladesh remains unchanged.
2. Quantitative rainfall estimation by using Doppler Radars is implemented.	2-1 Correlation of radar rainfall data observed by the optimized radar ZR relation parameter for rainfall calculation and surface observation being corroborated. 2-2 Binary data of rainfall intensity composite picture created by rainfall data of 5 existing radar systems optimized ZR relation parameter for radar rainfall calculation is distributed to FFWC.	2-1 Correlation chart of rainfall data of radar and surface observations 2-2 Computers in SWC	
3. Climate data is utilized for the trend analysis of climate change.	3-1 Summary of Climate statistical analysis is shared with the SAARC Countries.	3-1 BMD web page Regional Workshop of SAARC Countries opened	
4. Capacity of BMD personnel for 1 to 5 days weather forecasting using basic techniques of Numerical Weather Prediction (NWP) is established.	4-1 Enable to use the basic techniques of Numerical Weather Prediction (NWP): 5 staff of BMD	4-1 Report of the Project	
5. Understanding about weather and climate information among stakeholders related to natural disaster are deepened.	5-1 Implementation of seminars for stakeholders related to natural disaster: 8 times, 70% of the participants understood the contents 5-2 Booklets of weather, climate and natural disaster to be distributed to stakeholders related to natural disaster including elementary schools and residents in disaster affected area: 3	5-1 List of participants of seminar Questionnaires to the participants of seminar 5-2 Booklets	
6. Weather observation and monitoring equipment such as meteorological radar system etc. are operated and maintained properly.	6-1 Enable to implement regular maintenance and trouble shooting for the meteorological Doppler radar systems: 9 staff of BMD 6-2 Operation/maintenance manuals being utilized in each existing Meteorological Radar Station	6-1 Report of the Project 6-2 Record sheet of regular check	

Activities	Inputs		Pre-conditions
1-1 To rehabilitate the existing meteorological observatories in the targeted areas 1-2 To prepare the field observation guideline 1-3 To provide the training for field observers and data inspectors on observed data acquisition and data quality control 1-4 To prepare the operation and maintenance manuals for observation fields and instruments 1-5 To provide the training for field observers and instrument inspectors on maintenance and control of observation fields and observation instruments 1-6 To prepare the briefing flowchart and record 2-1 To procure and set up the required equipment for the training on optimization of radar ZR relation parameter for rainfall calculation 2-2 To prepare correlation charts of rainfall data of radar and surface observations in the observation range of 5 existing meteorological radar systems optimized radar ZR relation parameter for rainfall calculation 2-3 To compose the rainfall composite picture of 5 existing meteorological radar systems optimized radar ZR relation parameter for rainfall calculation in SWC 3-1 To develop daily observation data input sheet for easy statistical processing and data quality control of observed data 3-2 To conduct climate data statistical analysis 3-3 To publish the summarized result of climate data statistical analysis to BMD Web page 3-4 To conduct the workshop of South Asian Association for Regional Cooperation (SAARC) on Climate Change 4-1 To procure and set up the required equipment for the training on Numerical Weather Prediction (NWP) 4-2 To conduct the basic training on Numerical Weather Prediction (NWP) 4-3 To conduct the training on Numerical Weather Prediction (NWP) guidance 4-4 To operate the Meso Scale Model (MSM) by using PC (Linux) on trial base 5-1 To conduct the seminars for the stakeholders related to natural disaster 5-2 To prepare the booklets of weather, climate and natural disaster 6-1 To conduct the training on operation and maintenance of the meteorological radar systems 6-2 To prepare the operation and maintenance manuals for the meteorological radar system	**(Bangladeshi Side)** 1. Provision of the project office for the project experts in BMD Head Office 2. Allocation of the required counterpart personnel 3. Provision of training spaces 4. Provision of installation spaces for the equipment to be procured under the Project 5. Security of the equipment for the Project 6. Operation and maintenance expenses of the equipment for the Project 7. Tax exemption, custom clearance and other procedures required for importing the equipment for the Project	**(Japan Side)** 1. Dispatch of experts - Weather Forecasting & Warning Service and Organization Management - Weather Observation - Weather Service Infrastructure - Meteorological Radar Calibration - Data Quality Control and Statistical Analysis - Web Site Design - Numerical Weather Prediction - Weather Information Dissemination - Meteorological Radar Operation and Maintenance 2. Equipment Supply 3. Provision of training in Japan	To be able to obtain cooperation of organizations related to natural disaster management

PROJECT DESIGN MATRIX (PDM) [revised-2]

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumption
Overall Goal Natural disaster losses are reduced by the utilization of highly precise weather information.	Cases which prove that the utilization of BMD's weather information by organizations related to natural disaster management contributed to the natural disaster losses.	1. Interviews with SWC and the persons in charge in organizations related to natural disaster management 2. Case analysis by experts including the third party experts	
Project Purpose More accurate weather information is timely issued to the stakeholders of the natural disaster management.	1. Data from BMD Radar Systems optimized by radar ZR relation parameter for timely forecasting and warning is provided to FFWC 2. Accurate and easily-understanding forecast and warning including tropical cyclone are timely issued to the organizations related to natural disaster management and mass media.	1-1 Data distribution record at BMD 1-2 Data receiving record at FFWC 2-1 Weather forecast and warning prepared by BMD to natural disaster management organizations and mass media such as special weather bulletin 2-2 Interviews with the natural disaster management organizations and mass media	BMD's meteorological data and weather forecast and warning prepared by BMD is utilized by the natural disaster management organizations and mass media.
Outputs 1. Capacity of BMD for observation and forecasting is improved.	1-1 More than 80% of the hourly data such as surface temperature, humidity, wind direction, wind speed and precipitation are acquired at the six meteorological observatories with the AWSs. 1-2 Surface observations are conducted in each observatory by using the existing equipment in accordance with the observation guidelines which is developed by this Project. 1-3 Among the observers who attend the data quality control training, more than 70% of the participants understand the contents of the training. 1-4 Quality control is continuously conducted. 1-5 Briefing for understanding and sharing the meteorological situations is conducted at SWC at least once a day.	1-1 Database in BMD head office 1-2 Direct observation by experts including the third party experts 1-3 Achievement test 1-4 Observation records 1-5 Briefing records	State policy of weather services in the Government of Bangladesh remains unchanged. Trained BMD staff remain on the duty. Data transfer system between BMD and FFWC functions properly.

2 Analysis of quantitative rainfall estimation by using the Radar data is implemented	2-1 Correlation of radar rainfall data observed by the optimized radar ZR relation parameter for rainfall calculation and surface observation is corroborated	2-1 Correlation chart of rainfall data of radar and surface observations	
	2-2 Binary data of composite rainfall amount created by rainfall data of the five (5) existing radar systems optimized ZR relation parameter for radar rainfall calculation is composed	2-2 Binary data of composite rainfall amount created by rainfall data of the five (5) existing radar systems	
3. The trend analysis of climate change is conducted by using the accumulated meteorological data.	3-1 More than two (2) BMD staff can detect abnormal values and human error of the accumulated meteorological data through the computer program.	3-1 Analysis result of the data quality control program	
	3-2 Summary of climate statistical analysis is shared in the public.	3-2 BMD's website	
4. Capacity of BMD personnel for 1 to 3 days weather forecasting on trial using basic techniques of Numerical Weather Prediction (NWP) is developed.	4-1 More than five (5) staff of BMD can develop products and guidance by the Numerical Weather Prediction (NWP) model.	4-1 Report of the Project Outputs of the NWP	
5. Capacity of BMD staff to promote understandings about meteorological information among the "stakeholders" is further developed.	5-1 BMD staff's planning and presentation skills for disseminating meteorological information is improved.	5-1 PR materials Weather forecast (such as TV)/ daily and special weather bulletin	
	5-2 70% of the participants in the seminars/open-class (more than 8 times) understand the contents.	5-2 Questionnaires to the participants of seminar/open-class	
	5-3 Meteorological information on the BMD's website is user-friendly and updated.	5-3 BMD's website	
6. The meteorological Radar systems are operated and maintained properly and efficiently.	6-1 More than fifteen (15) BMD staff for the five Radar systems can implement regular maintenance and trouble shooting (except serious troubles which require assistance from HQ or manufacturer) for the meteorological radar systems.	6-1 Record sheet of regular check and trouble shooting Interview with the superintendents of each radar system	
	6-2 More than 80% of the BMD's staff in each existing meteorological radar station can operate and maintain the radar system in accordance with the operation/maintenance manual which is developed by this Project.	6-2 Direct observation by experts including the third party experts	
	6-3 Meteorological radar observation schedule is maintained based on the requirement of SWC.	6-3 Project report	
	6-4 Operation cost for the meteorological radar system in normal season is saved.	6-4 Operation cost for meteorological radar system in normal season (before and after the implementation of the radar observation routine schedule)	
7. Capacity of BMD for early warning dissemination is improved.		7.1. Record book of early warning dissemination	

Activities	Inputs		Pre-conditions
1-1 To install the six (6) AWSs and twelve (12) rain gauges at the eighteen existing meteorological observatories. 1-2 To revise the field observation guidelines (including AWS) in accordance with the latest WMO policy. 1-3 To provide the observation training for field observers based on the field observation guidelines and the data entry format (developed by Activity 3-1). 1-4 To conduct training on the data quality of observed data for forecasters 1-5 To prepare the operation and maintenance manuals for observation fields and instruments (including AWS). 1-6 To provide the training for field observers and instruments inspectors on maintenance and control of observation fields and observation instruments (including AWS). 1-7 To compare the data obtained by the AWS and existing equipment and conduct quality control 1-8 To prepare the briefing flowchart and record, and conduct briefing along with the flow chart. 2-1 To procure and set up the required equipment for the training on optimization of radar ZR relation parameter for rainfall calculation 2-2 To identify the radar ZR relation parameter for rainfall calculation in the observation range of 5 existing meteorological radar systems and optimize the parameter 2-3 To prepare correlation charts of rainfall data of radar and surface observations 2-4 To compose the rainfall composite picture of 5 existing meteorological radar systems optimized radar ZR relation parameter for rainfall calculation in SWC 3-1 To develop daily observation data input sheet for easy statistical processing and data quality control of observation data 3-2 To archive the observation data and conduct quality control 3-3 To conduct climate data statistical analysis by using the above data 4-1 To procure and set up the required equipment for the training on Numerical Weather Prediction (NWP) 4-2 To conduct the basic training on Numerical Weather Prediction (NWP) 4-3 To conduct the training on Numerical Weather Prediction (NWP) guidance 4-4 To operate the Meso Scale Model (MSM) by using PC (Linux) on trial base 5-1 To prepare PR materials of weather, climate and natural disaster 5-2 To conduct the seminars/open-class for the stakeholders 5-3 To upload and update meteorological information including summarized result of climate data statistical analysis on the BMD website 5-4 To disseminate meteorological information through media. 6-1 To prepare the operation and maintenance manuals for meteorological radar system 6-2 To conduct the training on operation and maintenance of the meteorological radar systems 6-3 To prepare the meteorological radar observation routine schedule in order to reduce the operation cost and implement it 7.1 To establish the early warning system utilized mobile phone services 7.2 To prepare the early weather warning official announcement system utilizing mobile phone service	**(Bangladeshi Side)** 1. Provision of the project office for the project experts in BMD Head Office 2. Allocation of the required counterpart personnel 3. Provision of training spaces 4. Provision of installation spaces for the equipment to be procured under the Project 5. Security of the equipment for the Project 6. Operation and maintenance expenses of the equipment for the Project 7. Tax exemption, custom clearance and other procedures required for importing the equipment for the Project	**(Japan Side)** 1. Dispatch of experts - Weather Forecasting & Warning Service and Organization Management - Weather Observation - Weather Service Infrastructure - Meteorological Radar Calibration - Data Quality Control and Statistical Analysis - Web Site Design - Numerical Weather Prediction - Weather Information Dissemination - Meteorological Radar Operation and Maintenance 2. Equipment Supply 3. Provision of training in Japan	Electricity is provided stably. Fuel unit cost does not drastically increase. Data transfer system (internet, phone, SSB, etc) works properly. **Pre-conditions** To be able to obtain cooperation of organizations related to natural disaster management.

3 ISSUES, IDEAS AND LESSONS LEARNED DURING PROJECT IMPLEMENTATION

Issues, ideas and lessons learned during Project Implementation are listed in the following table.

Output of PDM	Issues for the Project Implementation	Ideas of Solutions for the Issues/Recommendation to the BMD
Capacity of BMD for observation and forecasting is improved.	Due to the reduction of the budget, the appropriate procurement procedure and belated approval of the TPP by the Bangladesh Government as well as the procurement of the AWS was delayed. The following activities were postponed: ・Installation of the AWS ・Quality control of the observation data ・Implementation of trainings on observation data acquisition & quality control ・Implementation of trainings for observation field & instrument maintenance and management ・Preparation of observation field and instrument maintenance and management procedures ・Preparation of observation field & instrument maintenance and management manual	
Quantitative rainfall estimation by using Doppler Radars is implemented.	Sufficient observed data that could be used to make a comparison has not been obtained due to the delay in the procurement of the AWS and rain gauge.	
The trend analysis of climate change is conducted by using the accumulated meteorological data.	There was no substantial foundation for the BMD's conversion table for measuring barometric pressure, relative humidity and dew-point temperature. Observed data comparison table	BMD Standard Formulae were prepared according to the formulae specified in the WMO guidelines and the hypsometric formulae.
Capacity of BMD personnel for 1 to 3 days weather forecasting on trial using basic techniques of Numerical Weather Prediction (NWP) is developed.	None	None
Capacity of BMD staff to promote understandings about meteorological information among the "stakeholders" is further developed.	None	None
The meteorological Radar systems are operated and maintained properly and efficiently.	None	None

4 PROJECT OUTPUTS

The Progress of the Project Achievements at the end of the Project is indicated in the following table.

Progress of the Project Achievements

Project Purpose	Indicators	Achievements
Weather information for natural disaster management is strengthened in terms of time and quality through human capacity development and dissemination of weather information among various stakeholders.	1. Rainfall data of the optimized radar ZR relation parameter for rainfall calculation being provided to FFWC.	Optimized radar data was provided to the FFWC by the BMD.
	2. Accurate and easily-understanding forecast and warning including tropical cyclone are timely issued to the organizations related to natural disaster management and mass media.	The program for the preparation of Visualized BMD Special Weather Bulletins (for Cyclone Tracking, Storm Surge & Strong Wind Warning) was developed. The "Visualized BMD Weather Bulletin" was issued timely through TVs and the BMD web site, when cyclone "Mahasen" attacked Bangladesh in May 2013.
Output	**Activities**	**Achievements**
1. Capacity of BMD for observation and forecasting is improved.	1-1 More than 80% of the hourly data such as surface temperature, humidity, wind direction, wind speed and precipitation are acquired at the six meteorological observatories with the AWSs.	Hourly data such as surface temperature, humidity, wind direction, wind speed and precipitation have been acquired at the five meteorological observatories with the AWSs from July 2012.
	1-2 Surface observations are conducted in each observatory by using the existing equipment in accordance with the observation guidelines which is developed by this Project.	Training in accordance with the prepared field observation and observation instruments maintenance/management manuals was implemented.
	1-3 Among the observers who attend the data quality control training, more than 70% of the participants understand the contents of the training.	Training on quality control was implemented and all of the participants understood the contents of the training.
	1-4 Quality control is continuously conducted.	Observed data which deviated from the normal value range was detected by the "Observation Data Input Format." In addition, human errors such as the misreading of the conversion table were reduced.
	1-5 Briefing for understanding and sharing the meteorological situations is conducted at SWC at least once a day.	Weather Briefing is conducted at the briefing room which was newly constructed under the Project.

	Activities of PDM	Achievement Ratio	Achievements
	1-1 To install the six (6) AWSs and twelve (12) rain gauges at the eighteen existing meteorological observatories.	100%	6 AWSs were installed at the 6 existing synoptic meteorological observatories: 1) Dhaka 2) Rajshahi 3) Sylhet 4) Barisal 5) Khulna 6) Chittagong 12 Rain gauges were installed at the 12 existing synoptic meteorological observatories: 1) Saidpur 2) Dinajpur 3) Bogra 4) Mymensingh 5) Tangai 6) Srimangal 7) Chandpur 8) Mongla 9) Bhola 10) Sitakunda 11) Kutubdia 12) Teknaf The following drawings were prepared. ・Layout plan for the AWS pole ・Concrete foundation for the AWS pole ・10m height AWS pole (Manufacturing Drawings) ・Concrete foundation for the AWS pole (Shop Drawings) ・Standardized observation equipment layout plan for the synoptic meteorological observatory ・Standardized observation equipment layout plan for the agro-meteorological observatory. AWS specifications were also prepared.
	1-2 To revise the field observation guidelines (including AWS) in accordance with the latest WMO policy.	100%	Field observation procedures were prepared. Field observation guidelines were prepared. The training on observation data acquisition & quality control was implemented.
	1-3 To provide the observation training for field observers based on the field observation guidelines and the data entry format	100%	Training on observation data was implemented at a total of (x) synoptic meteorological observatories in Bangladesh.
	1-4 To provide the training for field observers on observed data acquisition and data quality control	100%	Data collected from the installed AWSs and rain gauges were compared with manually observed data. Based on the results of the comparison, a significant difference was not found.
	1-5 To prepare the operation and maintenance manuals for observation fields and instruments (including AWS).	100%	The following products were prepared. ・Drawings for the manufacturing of furniture for the briefing room equipment ・Forecast briefing flowchart ・Briefing flowchart for the mass media ・BMD meteorological service regulation ・Forecast products according to the emergency management phase and location specificity

	1-6 To provide the training for field observers and instruments inspectors on maintenance and control of observation fields and observation instruments (including AWS).	100%	Preparation of the field observation & instruments maintenance/management rules was conducted. Preparation of the observatory maintenance and management record book was conducted. Preparation of the field observation & instruments maintenance/management manual was conducted. Trainings for field observation & instruments maintenance/management were implemented.
	1-7 To compare the data obtained by the AWS and existing equipment and conduct quality control.	100%	Comparison between the data obtained using the AWSs and Rain Gauges installed under the Project and those obtained using manual observation was conducted.
	1-8 To prepare the briefing flowchart and record, and conduct briefing along with the flow chart.	100%	Training for forecast briefing has been implemented. The following products were prepared. ・Drawings for the manufacturing of furniture for briefing room equipment ・Forecast briefing flowchart ・Briefing flowchart for the mass media ・BMD meteorological service regulation ・Forecast products according to the emergency management phase and location specificity
Project Purpose	**Indicators**		**Achievements**
2. Quantitative rainfall estimation by using Doppler Radars is implemented.	2-1 Correlation of radar rainfall data observed by the optimized radar ZR relation parameter for rainfall calculation and surface observation being corroborated.		The training on the detailed procedures for analysis was implemented and the conduct of correlation analysis using observed data for this year was carried out as a test case.
	2-2 Binary data of rainfall intensity composite picture created by rainfall data of 5 existing radar systems optimized ZR relation parameter for radar rainfall calculation is distributed to FFWC.		The binary data of composite rainfall amount was created using rainfall data from the five (5) existing radar systems whose ZR relation parameters were optimized for radar rainfall calculation.
	Activities	**Achievement Ratio**	**Achievements**
	2-1 To procure and set up the required equipment for the training on optimization of radar ZR relation parameter for rainfall calculation.	100%	The rain gauges were installed at the 12 meteorological observatories: 1) Saidpur 2) Dinajpur 3) Bogra 4) Mymensingh 5) Tangai 6) Srimangal 7) Chandpur 8) Mongla 9) Bhola 10) Sitakunda 11) Kutubdia 12) Teknaf
	2-2 To prepare correlation charts of rainfall data of radar and surface observations in the observation range of 5 existing meteorological radar systems optimized radar ZR relation parameter for rainfall calculation.	100%	After the correlation analysis between the rainfall data from surface observation and the radar rainfall data obtained after increasing radar operation hours was done, the optimization of the radar ZR relation parameter of the 5 existing meteorological radar systems for rainfall calculation was implemented.

	2-3 To prepare correlation charts of rainfall data of radar and surface observations.	100%	The training on the detailed procedure for analysis was implemented. Correlation analysis using observed data from the installed rain gauges in the Project and the existing meteorological radar was conducted. C-shell script of the automatic data collection and the analysis programs for radar data (Analysis PC in the BMD) Training material about "Radar Calibration"
	2-4 To compose the rainfall composite picture of 5 existing meteorological radar systems optimized radar ZR relation parameter for rainfall calculation in SWC	100%	The plan to release additional products made from the new B and β values for testing purposes was adjusted.
Project Purpose	**Indicators**		**Achievements**
3. The trend analysis of climate change is conducted by using the accumulated meteorological data.	3-1 More than two (2) BMD staff can detect abnormal values and human error of the accumulated meteorological data through the computer program.		2 Counterparts can detect the value which deviated from the normal value range.
	3-2 Summary of climate statistical analysis is shared in the public.		Graphics showing the correlations and trends of annual precipitation and temperature for more than 30 years at the 6 existing synoptic observations (Dhaka, Rajshahi, Sylhet, Barisal, Khulna and Chittagong) were prepared.
	Activities	**Achievement Ratio**	**Achievements**
	3-1 To develop daily observation data input sheet for easy statistical processing and data quality control of observed data	100%	Observation data input sheet was developed. Formula for the automatic calculation by the Input Format was determined. ・Formula for Relative Humidity ・Formula for Dew Point Temperature ・Formula for the temperature correction value for the calculation of Station Level Pressure ・Formula for the gravity correction value for the calculation of Station Level Pressure ・Formula for the height correction value for the calculation of Mean Sea Level (MSL) Pressure Operation manual for the observation data input sheet was also prepared.
	3-2 To archive the observation data and conduct quality control	100%	Observation data of the AWS is archived automatically. Through a comparison of the data obtained by the AWS and those obtained using manual observation as well as the determination of the normal value range, data quality control was conducted.
	3-3 To conduct climate data statistical analysis by using the above data	100%	Statistical analysis (histogram preparation and calculation of correlation) of the climate data (rainfall and temperature) for more than 30 years at the 6 existing synoptic observations (Dhaka, Rajshahi, Sylhet, Barisal, Khulna and Chittagong) was executed.
Project Purpose	**Indicators**		**Achievements**
4. Capacity of BMD personnel for 1 to 3 days weather	4-1 Enable to use the basic techniques of Numerical Weather Prediction (NWP): 5 staff of BMD		More than 6 C/Ps of the BMD could develop products and guidance using the NWP model. The capacity of BMD personnel to conduct 1 to 3 days trial weather forecasting using basic techniques of the NWP was developed.

forecasting on trial using basic techniques of Numerical Weather Prediction (NWP) is developed.	**Activities**	**Achievement Ratio**	**Achievements**
	4-1 To procure and set up the required equipment for the training on Numerical Weather Prediction (NWP)	100%	Installation of the cluster computer procured for the training on the NWP at the SWC was completed. Installation of the required software/model into the cluster computer was also completed.
	4-2 To conduct the basic training on Numerical Weather Prediction (NWP)	100%	The basic training on the NWP was conducted. Training on computer operation for the NHM was conducted. Comparison between the NHM calculation result using the observation data of the tropical cyclone which landed in Bangladesh and the MTSAT imageries as well as the evaluation of the accuracy of the NHM calculation result were conducted.
	4-3 To conduct the training on Numerical Weather Prediction (NWP) guidance	100%	Lectures on the concept and theory of NWP Guidance were conducted. A 35 Grid Point Value (GPV) near the synoptic meteorological observation point in Bangladesh was selected. NWP forecast guidance for 1-3 days at the 35 points was prepared using a multiple regression analysis.
	4-4 To operate the Meso Scale Model (MSM) by using PC (Linux) on trial base	100%	The trial operation of the NHM using the cluster computer and laptop PCs for training was conducted.
Project Purpose	**Indicators**		**Achievements**
5. Capacity of BMD staff to promote understandings about meteorological information among the "stakeholders" is further developed.	5-1 BMD staff's planning and presentation skills for disseminating meteorological information is improved.		The BMD staff's planning and presentation skills for disseminating meteorological information have been improved.
	5-2 Implementation of seminars for stakeholders related to natural disaster: 8 times, 70% of the participants understood the contents		Seminars for stakeholders related to natural disaster management were implemented more than 8 times, and more than 70% of the participants understood the contents.
	5-3 Meteorological information on the BMD's website is user-friendly and updated.		Meteorological information on the BMD's website is user-friendly and updated.
	Activities	**Achievement Ratio**	**Achievements**
	5-1 To prepare PR materials of weather, climate and natural disaster	100%	Animated cartoon DVDs entitled “Save Yourself and Reduce Risk,” brochures and posters on the natural disasters which dealt damages and negative impacts to Bangladesh were prepared.
	5-2 To conduct the seminars/ open-class for the stakeholders	100%	Seminars/open classes for the stakeholders were implemented,
	5-3 To upload and update meteorological information including summarized result of climate data statistical analysis on the BMD website	100%	A hyperlink button to access the website of the animated cartoon entitled “Save Yourself and Reduce Risk” to allow users to download or display the cartoon was created on the BMD's website. BMD Special Weather Bulletins prepared under the Project for the Cyclone which attacked Bangladesh were uploaded on the BMD website and were regularly updated on time on the BMD website.
	5-4 To disseminate meteorological information through media.	100%	The Department of Disaster Management (DDM) under the Ministry of Disaster Management and Relief had expressed a dissenting view on the early warning dissemination done by the BMD. However, during a meeting among the DDM, BMD and JICA (including the project expert) on November 15, 2012, the DDM agreed on a “Positive Duplication” of the early warning dissemination system by the DDM and the BMD.

<table>
<tr><th>Project Purpose</th><th colspan="2">Indicators</th><th>Achievements</th></tr>
<tr><td rowspan="5">6.
Weather observation and monitoring equipment such as meteorological radar system etc. are operated and maintained properly.</td><td colspan="2">6-1
More than fifteen (15) BMD staff for the five Radar systems can implement regular maintenance and trouble shooting (except serious troubles which require assistance from HQ or manufacturer) for the meteorological radar systems.</td><td>1. In order to improve the technical skills of all radar staff at each radar station, 30 engineers in total joined an OJT on maintenance and measurement work of the radar system in FY2012 (Cox's Bazar: 9, Rangpur: 7, Khepupara: 7 and Moulvibazar: 7).
2. Maintenance work for the workstation of the Doppler Radar systems were carried out by two (2) engineers belonging to the National Meteorological Communication Centre and the BMD Head Office.
3. OJTs for new or transferred personnel were carried out by the skilled personnel of each radar station. All personnel except the mechanical staff was able to operate and shutdown the radar with accuracy.
4. Troubleshooting of the MOD UNIT was done by the personnel of the Moulvibazar radar station.
The unit was tested by the Experts and was confirmed to be in good operation.</td></tr>
<tr><td colspan="2">6-2
More than 80% of the BMD's staff in each existing meteorological radar station can operate and maintain the radar system in accordance with the operation/maintenance manual which is developed by this Project.</td><td>All of the BMD staff at each radar station operate and maintain the system in accordance with the operation/maintenance manual which was developed under the Project.</td></tr>
<tr><td colspan="2">6-3
Meteorological radar observation schedule is maintained based on the requirement of SWC.</td><td>Advice to the BMD on radar operation hours during the rainy season and the dry season.</td></tr>
<tr><td colspan="2">6-4
Operation cost for the meteorological radar system in normal season is saved.</td><td>Observation schedule for the meteorological radar was observed and maintained properly.</td></tr>
<tr><td colspan="3"><table>
<tr><th>Indicators</th><th>Achievement Ratio</th><th>Achievements</th></tr>
<tr><td>6-1
To prepare the operation and maintenance manuals for the meteorological radar system</td><td>100%</td><td>Technical training for the staff of five (5) radar stations on the fundamental skills and circuit diagram necessary for troubleshooting works of the meteorological radar system was conducted. (Radar stations: Dhaka, Rangpur, Cox's Bazar, Khepupara and Moulvibazar)
Training on radar operation procedures at three (3) Doppler meteorological radar stations (Cox's Bazar, Khepupara, and Moulvibazar) was conducted.
Training on maintenance works for the radar transmitter, receiver and Antenna System at 3 Doppler radar stations (Cox's Bazar, Khepupara and Moulvibazar) was conducted.
Main training was focused on:
1. Replacement and adjustment works of “Klystron.”
2. Measurement of the following items:
(1) Average transmitting power.
(2) Pulse width
(3) Pulse repetition frequency
(4) Radar receiver sensitivity check
(5) Receiver Linearity check
(6) Receiver Dynamic Range (Z CAL) check
(7) Sleep ring Cleaning
(8) Motor belt tension checking
(9) Meter reading of voltage and current
3. Practical Troubleshooting
After the preparation of the manual summary,
a portion of the manual summary (exchange and adjustment procedure of the transmitter) was revised and adapted to the C/P’s technical level.</td></tr>
</table></td></tr>
</table>

	6-2 To conduct the training on operation and maintenance of Meteorological Radar System.	100%	The operation & maintenance record book was used in the conduct of routine work. Instructions for the preparation of the radar spare parts consumables (ink cartridge and battery for the UPS) list were made.
	6-3 Operation cost for meteorological radar system in normal season (before and after the implementation of the radar observation routine schedule)	100%	Radar Observation Frequency was set as follows. 1. Radar observation: 6 times per day according to the WMO guidelines. 2. During cyclone/severe weather: 24 hours continuously. The review and establishment of the radar observation system of the BMD during the dry season were conducted.

5 Recommendations towards the achievement of the overall goal

Recommendations towards the achievement of the Overall Goal of the Project are described in the following table.

Overall Goal	
Highly precise weather and climate information is utilized for natural disaster management which contributes to the reduction of the natural disaster losses.	
PDM Output	Recommendations
Capacity of BMD for observation and forecasting is improved	• The development of more qualified technical personnel is indispensable. • Appropriate measures against any damage and/or loss of the equipment must be made. • Close communication and association with international institutions must be made as the governmental organization responsible for the mitigation of meteorological disasters. • Further research to increase the level of understanding/knowledge about meteorological disasters and its mechanisms along with other related meteorological phenomena must be conducted.
Quantitative rainfall estimation by using Doppler Radars is implemented.	• In order to obtain enough volume of radar rainfall data for the correlation analysis with rainfall data from surface observation, increasing radar operation hours is required. • In order to improve the accuracy of radar observation data, the periodic optimization of the radar ZR relation parameter (B and β) of the existing meteorological radar systems for rainfall calculation should be implemented.
The trend analysis of climate change is conducted by using the accumulated meteorological data.	• Standards and formulae specified by the World Meteorological Organization (WMO) must be complied with. • Formulae for Relative Humidity, Dew Point Temperature, temperature correction value for the calculation of Station Level Pressure, gravity correction value for the calculation of Station Level Pressure and height correction value for the calculation of the Mean Sea Level (MSL) Pressure made under the Project must be continuously utilized as the BMD's official formulae for observation data calculation.
Capacity of BMD personnel for 1 to 3 days weather forecasting on trial using basic techniques of Numerical Weather Prediction (NWP) is developed.	• Continuous recruitment of human resources for the next-generation. • Continuous trial operation of the Numerical Weather Prediction (NWP) model and the development of more qualified technical personnel through trainings and other related manpower development programs.
Capacity of BMD staff to promote understandings about meteorological information among the "stakeholders" is further developed.	Continuing educational activities for the general public in coordination with various related disaster management agencies and the mass media for a more effective natural disaster prevention and management strategy.
The meteorological Radar systems are operated and maintained properly and efficiently	In connection with equipment maintenance, consideration must be given to the following. • Recruitment of Electric Engineer/Staff (the existing vacant positions must be filled). • Internal technical training in the BMD. • Establishment of appropriate measures against system failure. • A fully documented maintenance system with proper document control. • Scheduled replacement of parts and overhauls.

6 THE RECORDS OF THE JOINT COORDINATING COMMITTEE

The Joint Coordinating Committees (JCCs) held at the BMD Head Office are indicated in the following table.

Date	Participants	Venue	Relevant Items discussed
October 7, 2009	JICA Bangladesh Office : 3 MOD : 1 ERD : 1 DMB : 1 FFWC : 1 BMD : 2 Experts : 5	BMD Head Office	・Approval of the Inception Report ・Approval of the PDM proposed by the Expert team
February 17, 2010	JICA Bangladesh Office: 0 ERD : 1 BMD : 2 Experts : 6	BMD Head Office	・Progress of the Project ・Postponement of the procurement schedule of the Cluster Computer and the AWS by JICA
February 15, 2011	JICA Bangladesh Office : 4 MOD : 1 ERD : 1 DMB : 1 BMD : 2 Expert : 1	BMD Head Office	・Report of the interim evaluation review ・Approval of the revised PDM proposed by the interim evaluation review study team
March 14, 2012	ICA Bangladesh Office : 2 ERD : 1 FFWC : 1 BMD : 2 Experts : 4	BMD Head Office	・Progress of the Project ・Training in Japan
September 20, 2012	JICA Bangladesh Office : 3 Project Evaluation Consultant : 2 ERD : 1 MOD : 1 BMD : 2 Experts : 2	BMD Head Office	・Progress of the Project ・Extension of the Project and activities to be implemented in the next year
December 17, 2013	JICA Bangladesh Office : 2 ERD : 1 DDM : 1 BMD : 2 Experts :4	JICA Bangladesh Office : 2	・Evaluation of the Project ・Handover of the equipment listed in the table "2-3 Provision of Equipment" mentioned before.

Annexes

1. Pictures of activities in each field

2. Major Outputs

Annex	Outputs
1	Weather Observation Guideline
2	Analysis Result based on Stored Radar and Raingauge Data
3	Instruction on radar calibration for BMD radar system
4	Calculation of Atmospheric Pressure for Fixed-Cistern Type (Kew Type) Barometer
5	Calculation of Atmospheric Pressure for Fortin Type Barometer
6	Calculation of Relative Humidity and Dew Point Temperature
7	Weather Observation Data Input Manual
8	Changing Trend of Yearly Mean Temperature and Yearly Precipitation
9	Installation of CentOS 5.5 (Linux OS)
10	PC-Cluster Operation Manual
11	(JMA-NHM) Operation Manual for PC-Cluster
12	Brochure "Save Yourself"
13	Book "Weather Information"
14	BMD Character
15	Mascot of BMD Character
16	Visualized BMD Special Weather Bulletin on May 16, 2013
17	Major Dissemination Activity of Animated Cartoon for Natural Disaster Awareness named "Save Yourself and Reduce Risk"
18	Result of Open Class Activity
19	SAFETY PRECAUTION
20	Necessary of Periodic Maintenance of Radar System
21	Techniques used in Doppler radar

3. Minutes of Meeting for the Joint Coordinating Committees (JCCs)

1. Pictures of the activities

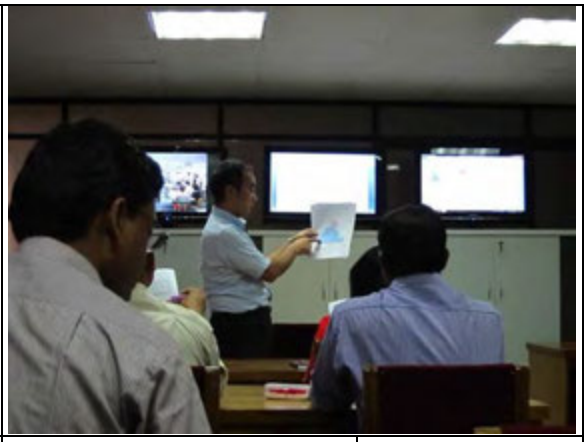
			
Basic Training on NWP at the BMD Head Office (Numerical Weather Prediction)	October 4, 2009	Technical Training Courses on Meteorological Radar System at the Dhaka Meteorological Radar Observation Station (Meteorological Radar Operation and Maintenance)	October 6, 2009
			
Performance Study of Current System Configuration and Operation Situation. at the BMD Head Office (Meteorological Radar Calibration)	October 6, 2009	Joint Coordinate Committee (JCC) at the BMD Head Office	October 7, 2009
			
Preparation of a Booklet (Draft version) at the BMD Head Office (Weather Information Dissemination)	December 6, 2009	Preparation of a Booklet (Draft version) at the BMD Head Office (Weather Information Dissemination)	December 17, 2009

			
PC Training for NWP at the BMD Head Office (Numerical Weather Prediction)	June, 2010	Basic Training on NWP at the BMD Head Office (Numerical Weather Prediction)	June, 2010
			
Preparation of a Booklet on Thunderstorm at the BMD Head Office (Weather Information Dissemination)	June, 2010	Open Class at a school in Tangail (Weather Information Dissemination)	September, 2010
			
Open Class at a school in Rangpur (Weather Information Dissemination)	September, 2010	Open Class at a school in Dhaka (Weather Information Dissemination)	September, 2010

			
Seminar on Thunderstorm at Tangail (Weather Information Dissemination)	October, 2010	Seminar on Thunderstorm at Rangpur (Weather Information Dissemination)	October, 2010
			
Lecture on the radar calibration at the BMD Head Office (Radar Calibration)	September, 2010	Completion of installation of concrete foundation for rain gauge at Sitakunda Meteorological Observatory (Weather Service Infrastructure)	October, 2010
			
Technical Training Courses on Meteorological Radar System at the Khepupara Meteorological Radar Observation Station (Meteorological Radar Operation and Maintenance)	December, 2010	Training on the manipulation of briefing equipment at the Briefing Room in the BMD Head Office (Weather Observation)	December, 2010

			
Meteorological Radar Maintenance Training at the Cox's Bazar Meteorological Radar Observation Station (Meteorological Radar Operation and Maintenance)	December, 2010	Training on Web Site Design at the BMD Head Office (Web Site Design)	December, 2010
			
Preparation of the Dhaka Seminar at the Seminar Room in the BMD Head Office (Weather Information Dissemination)	December, 2010	Dhaka Seminar at the Seminar Room in the BMD Head Office (Weather Information Dissemination)	February, 2011
			
Discussion with C/P on activities for Data Quality Control (Data Quality Control and Statistical Analysis) BMD Head Office	February, 2011	Joint Coordinate Committee (JCC) at the BMD Head Office	February, 2011

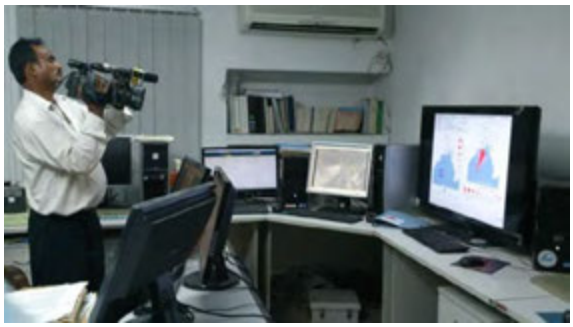
			
Function Test of Rain Gauge (BMD Head Office)	June, 2011	Initial Setup of PC Cluster (BMD Head Office)	July, 2011
			
Discussion about the animation story with C/P (BMD Head Office)	July, 2011	Operation Training of Meteorological Radar (Moulvibazar Meteorological Radar Station)	July, 2011
			
Maintenance Training of Meteorological Radar (Khepupara Meteorological Radar Station)	July, 2011	Installation of Rain Gauge (Bogra Observation Station)	July, 2011

			
Collection of Precipitation data and Function test （Tangail Observation Station）	September, 2011	Operation Training of Cyclone Trucking Display Program (BMD Head Office)	September, 2011
			
Weather Briefing Training （BMD Head Office）	September, 2011	Weather Briefing Training （BMD Head Office）	September, 2011
			
Cyclone Seminar （Khepupara）	September, 2011	Performance test of the equipment (Khepupara Meteorological Radar Station)	October, 2011

			
Installation of AWS (Khulna Observation Station)	December, 2011	The one scene of animation （Episode of Thunderstorm）	December, 2011
			
Operation Training of NWP with PC Cluster (BMD Head Office)	December, 2011	Showing animation story （Blue Bird School and College、Sylhet）	March, 2012
			
JCC （BMD Head Office）	March, 2012	Operation Training of NWP with PC Cluster (BMD Head Office)	March, 2012

			
Seminar for Mass Media “Weather information from BMD” （BMD Head Office）	March, 2012	Repair and Function Test of Rain Gauge (MaijdiCourt Observation Station)	September, 2012
			
Replacement of UPS (BMD Head Office)	September, 2012	Operation Training of NWP with PC (BMD Head Office)	September, 2012
			
JCC (BMD Head Office)	September, 2012	Seminar for BMD personnel (BMD Head Office)	October, 2012

			
Open Class (Sher-e-Bangla Boys High School, Dhaka)	October, 2012	Repair of RVP-8 by replaced HDD(Khepupara Meteorological Radar Station)	November, 2012
			
Performance check of Transmitter (Khepupara Meteorological Radar Station)	November, 2012	Operation Training of Radar Calibration (BMD Head Office)	December, 2012
			
Operation Training of Radar Calibrationwith PC (BMD Head Office)	December, 2012	Repair of Rain Gaugedamaged by flood (Bogra Observation Station)	December, 2012

			
News conference when the Cyclone Mohasen landing to Bangladesh (BMD Head Office)	May, 2013	News conference when the Cyclone Mohasen landing to Bangladesh (BMD Head Office)	May, 2013
			
1st Animation Cartoon Festival (Bangladesh Shishu Academy, Dhaka)	March, 2013	Training on Observation (MaijdiCcourt Observatory)	August, 2013
			
Training on Radar Calibration (BMD Head Office)	October, 2013	Weather Program Preparation Studio Training (BMD Head Office)	October, 2013

			
Weather Program Preparation Studio Training (BMD Head Office)	October, 2013	Weather Program Preparation Studio Training (BMD Head Office)	October, 2013
			
“Save Yourself” Campaign （Bashundara Shopping Mall）	December, 2013	“Save Yourself” Campaign （Bashundara Shopping Mall）	December, 2013
			
“Save Yourself” Campaign （Bashundara Shopping Mall）	December, 2013	JCC (JICA Bangladesh Office)	December, 2013

বাংলাদেশ আবহাওয়া অধিদপ্তর

আবহাওয়া পর্যবেক্ষণ নির্দেশিকা

FIELD OBSERVATION GUIDELINE

December 2010 (Ver. 1)

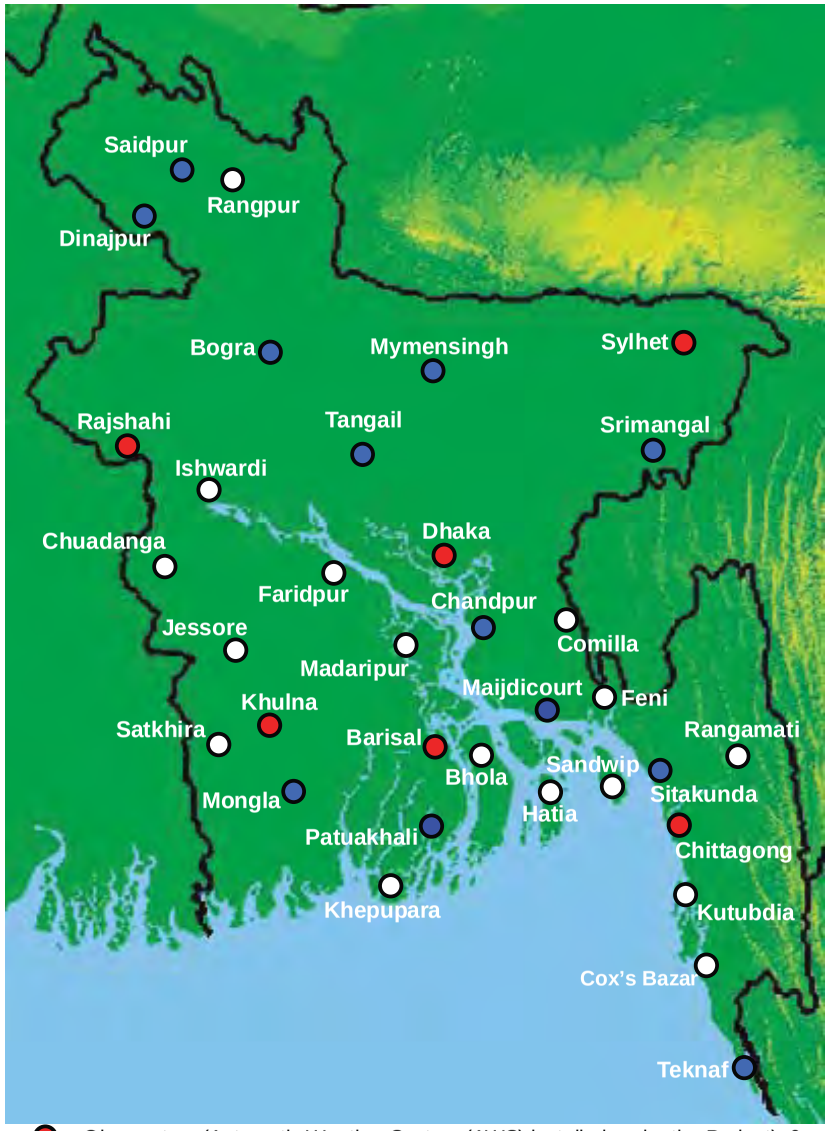
TECHNICAL COOPERATION PROJECT
FOR DEVELOPMENT OF HUMAN CAPACITY
ON OPERATION OF WEATHER ANALYSIS AND FORECASTING
IN THE PEOPLE'S REPUBLIC OF BANGLADESH

Japan International Cooperation Agency JICA

বিষয় বস্তু/সূচিপত্র
Contents

Information of the Synoptic Observatories in Bangladesh

Index	Observatory Name	Latitude	Longitude	Altitude	Calculated Station Gravity
41858	Saidpur	25º45´	88º55´	39 m	979.000 cm/s^2
41859	Rangpur	25º44´	89º14´	33 m	979.000 cm/s^2
41863	Dinajpur	25º39´	88º41´	36 m	978.994 cm/s^2
41883	Bogra	24º51´	89º22´	18 m	978.942 cm/s^2
41886	Mymensingh	24º43´	90º26´	18 m	978.933 cm/s^2
41891	Sylhet	24º54´	91º53´	34 m	978.942 cm/s^2
41895	Rajshahi	24º22´	88º42´	17 m	978.909 cm/s^2
41907	Ishwardi	24º08´	89º03´	13 m	978.894 cm/s^2
41909	Tangail	24º15´	89º56´	11 m	978.902 cm/s^2
41915	Srimangal	24º18´	91º44´	22 m	978.903 cm/s^2
41923	Dhaka	23º46´	90º23'	8 m	978.871 cm/s^2
41926	Chuadanga	23º39´	88º49´	12 m	978.862 cm/s^2
41929	Faridpur	23º36´	89º51´	8 m	978.859 cm/s^2
41933	Comilla	23º26´	91º11´	9 m	978.848 cm/s^2
41936	Jessore	23º11´	89º10´	6 m	978.832 cm/s^2
41939	Madaripur	23º10´	90º11´	7 m	978.831 cm/s^2
41941	Chandpur	23º16´	90º42´	6 m	978.838 cm/s^2
41943	Feni	23º02´	91º25´	6 m	978.822 cm/s^2
41946	Satkhira	22º43´	89º05´	4 m	978.803 cm/s^2
41947	Khulna	22º47´	89º32´	3 m	978.807 cm/s^2
41950	Barisal	22º45´	90º22´	3 m	978.805 cm/s^2
41951	Bhola	22º41´	90º39´	4 m	978.800 cm/s^2
41953	MaijdiCourt	22º52´	91º06´	5 m	978.812 cm/s^2
41958	Mongla	22º28´	89º36´	2 m	978.787 cm/s^2
41960	Patuakhali	22º20´	90º20´	2 m	978.778 cm/s^2
41963	Hatiya	22º26´	91º06´	2 m	978.784 cm/s^2
41964	Sandwip	22º29´	91º26´	2 m	978.788 cm/s^2
41965	Sitakunda	22º35´	91º42´	6 m	978.793 cm/s^2
41966	Rangamati	22º38´	92º12´	63 m	978.785 cm/s^2
41977	Chittagong (Ambagan)	22º21´	91º49´	33 m	978.773 cm/s^2
41978	Chittagong (Patenga)	22º16´	91º49´	4 m	978.774 cm/s^2
41984	Khepupara	21º59´	90º14´	2 m	978.756 cm/s^2
41989	Kutubdia	21º49´	91º51´	2 m	978.746 cm/s^2
41992	Cox's Bazar	21º26´	91º58´	2 m	978.722 cm/s^2
41998	Teknaf	20º52´	92º18´	5 m	978.687 cm/s^2



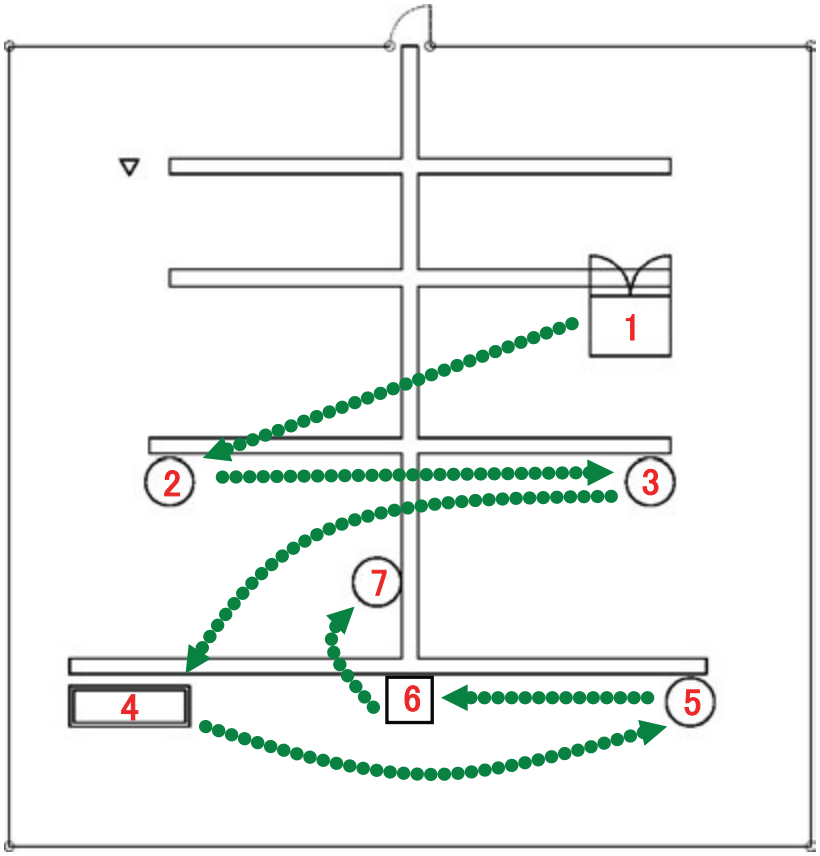
Observatory (Automatic Weather System (AWS) installed under the Project): 6
Observatory (Rain Gauge installed under the Project): 12
Observatory: 16

বাংলাদেশ আবহাওয়া অধিদপ্তর

Technical Cooperation Project for Development of Human Capacity on Operation of Weather Analysis and Forecasting
in the People's Republic of Bangladesh 2009 - 2012

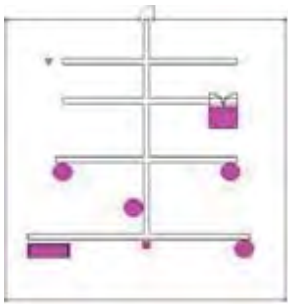
JICA

Reading Order of Meteorological Instruments in the Observation Field



1	Psychrometer (August) ***Dry & Wet Temperature***		2	Rain Gauge ***Precipitation***		5	Evaporation Pan ***Evaporation (Pan)***	
	Thermograph ***Temperature***		3	Rain Recorder ***Precipitation***			Wind Run Indicator ***Distant Wind***	
	Hygrograph ***Relative Humidity***		4	Soil Depth Thermometer ***Soil Temperature 5, 10, 20, 30 & 50 cm depth***		6	Pyranograph ***Solar Radiation***	
	Minimum & Maximum Thermometer ***Min. & Max. Temperature***					7	Sunshine Recorder ***Sunshine Duration***	

Observation Time Schedule

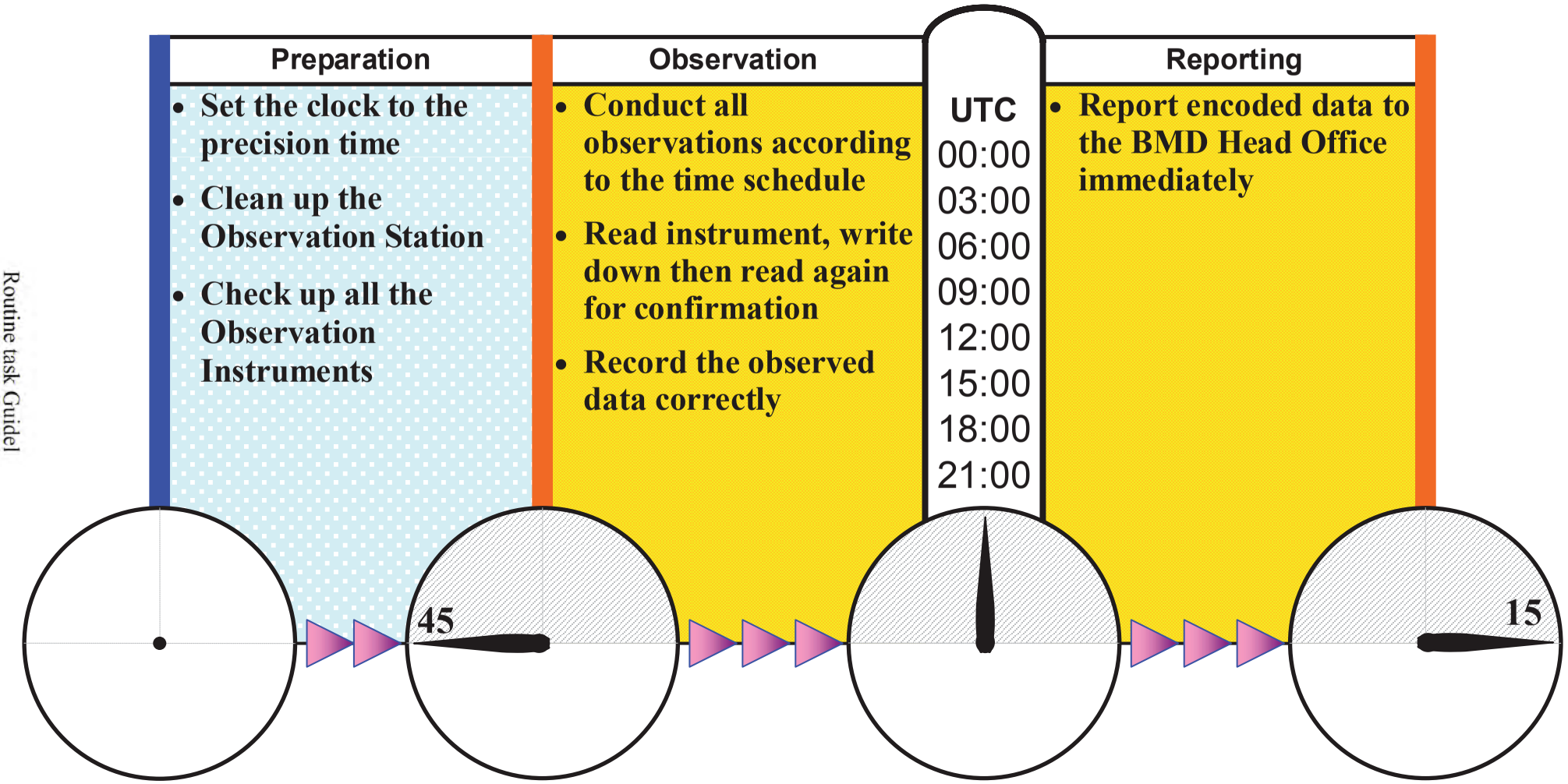
			UTC	00	03	06	09	12	15	18	21
Phenomenon	Visibility		km								
	Present Phenomenon										
	Cloud (Octas)										
	Cloud Types	CL CM CH									
	Height of Cloud Base		m								
 Wooden Shelter	Psychrometer		ºC								
	Thermograph		ºC								
	Hygrograph		%								
	Maximum Temperature		ºC								
	Maximum Temperature		ºC								
 Observation Field	Rain Gauge		mm								
	Rain Recorder		mm								
	Soil Depth Temperature		ºC								
	Evaporation (Pan)		mm								
	Distant Wind		km								
	Solar Radiation		W/m^2								
	Sunshine Recorder		hours								
 Observation Building	Barometer Temperature		ºC								
	Barometer Pressure		hPa								
	Barograph		hPa								
	Wind Direction										
	Wind Speed		m/s								

Observation Time Schedule

প্রাত্যাহিক কাজের/ নিত্য কর্মের নির্দেশিকা

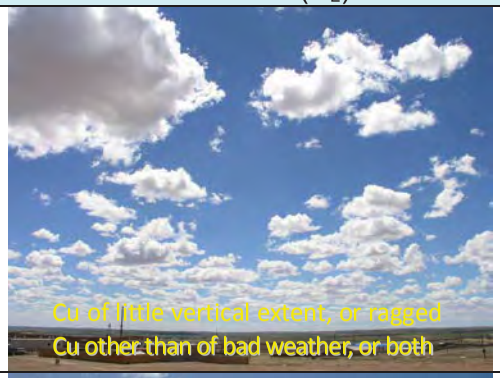
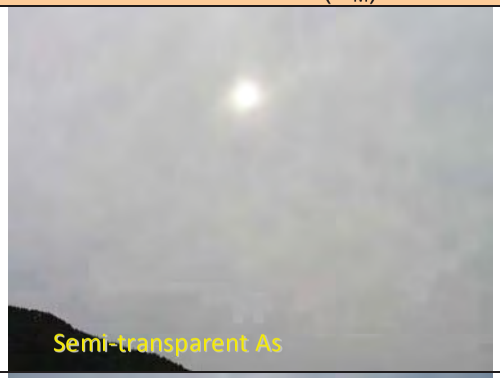
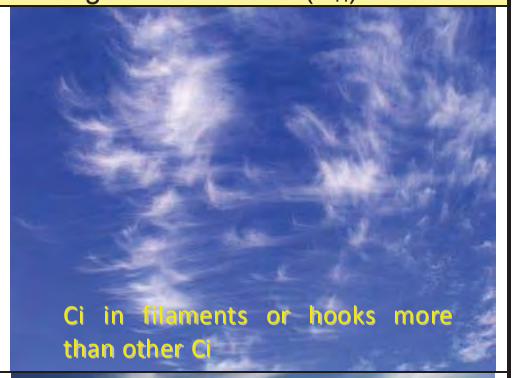
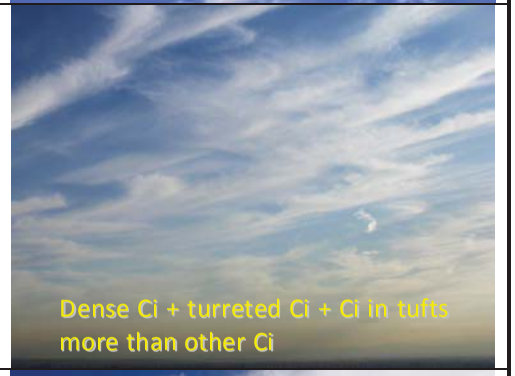
Bangladesh Meteorological Department

ROUTINE TASK GUIDELINE

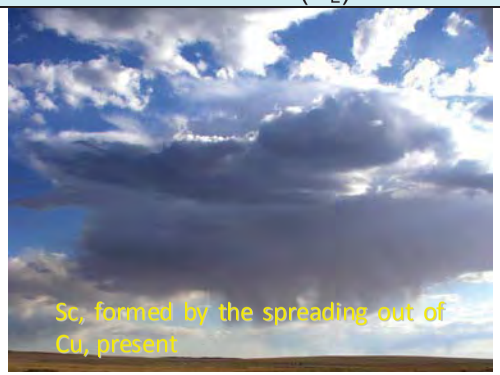
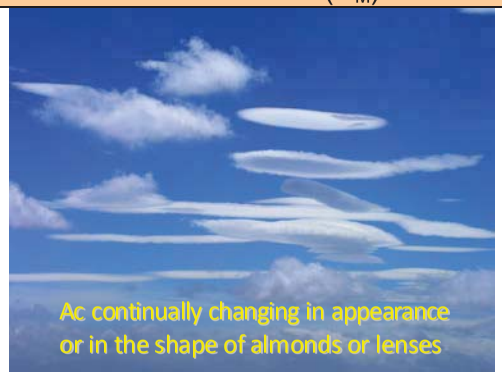
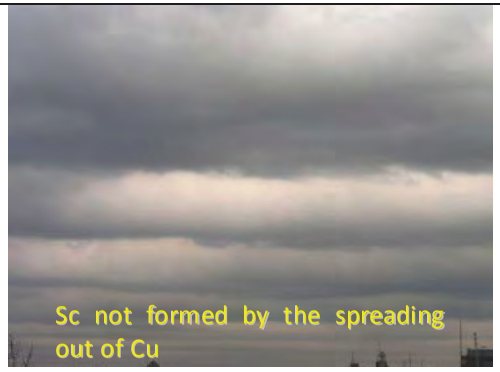
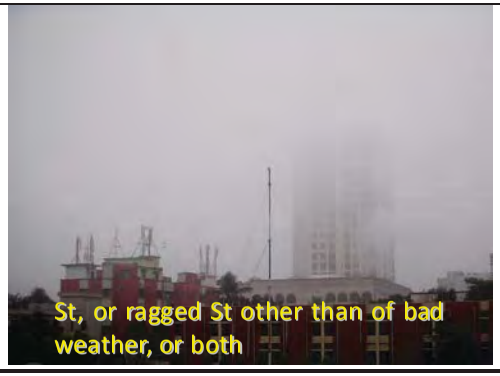
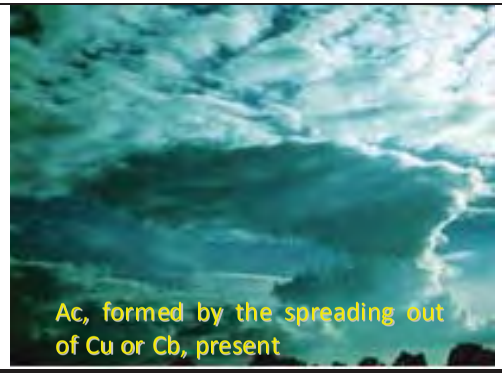


Routine task Guidel

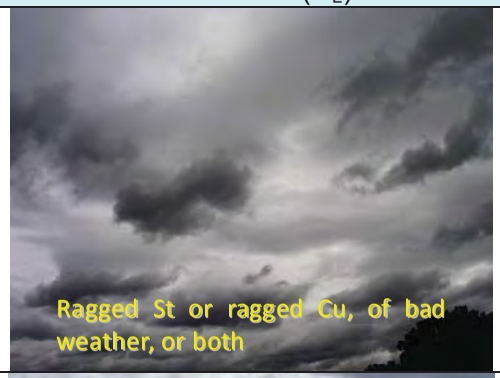
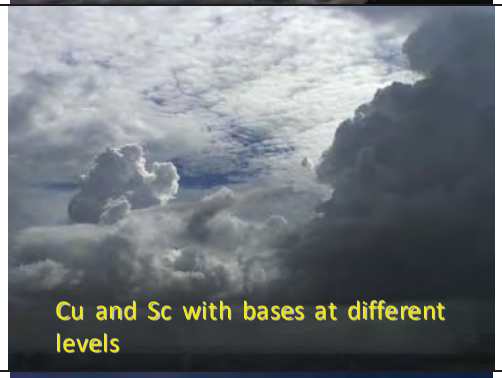
মেঘের ধরণ/ প্রকার ভেদের সংকেত / *Cloud Type Code*

Low Level Clouds (C_L)		Medium Level Clouds (C_M)		High Level Clouds (C_H)	
C_L-1		C_M-1		C_H-1	
C_L-2		C_M-2		C_H-2	
C_L-3		C_M-3		C_H-3	

মেঘের ধরণ/ প্রকার ভেদের সংকেত / *Cloud Type Code*

Low Level Clouds (C_L)		Medium Level Clouds (C_M)		High Level Clouds (C_H)	
C_L-4	 Sc, formed by the spreading out of Cu, present	C_M-4	 Ac continually changing in appearance or in the shape of almonds or lenses	C_H-4	 Ci invading the sky
C_L-5	 Sc not formed by the spreading out of Cu	C_M-5	 Ac invading the sky	C_H-5	 Cs not exceeding 45°
C_L-6	 St, or ragged St other than of bad weather, or both	C_M-6	 Ac, formed by the spreading out of Cu or Cb, present	C_H-6	 Cs exceeding 45°

মেঘের ধরণ/ প্রকার ভেদের সংকেত / *Cloud Type Code*

Low Level Clouds (C_L)		Medium Level Clouds (C_M)		High Level Clouds (C_H)	
C_L-7		C_M-7		C_H-7	
C_L-8		C_M-8		C_H-8	
C_L-9		C_M-9		C_H-9	

বিউফোর্ট স্কেল

Beaufort Scale

বিউফোর্ট নম্বর	স্থলভাগের অবস্থা		বায়ুর গতি কিঃমিঃ/ঘঃ (নটিক্যাল মাইল)
০	বাতাস নিস্তব্ধ/শান্ত। ধোঁয়া সরাসরি উপরের দিকে উঠবে।		<২ (< ১)
১	ধোঁয়ার দিক অনুসারে বাতাসের দিক নির্ধারণ করা যাবে। বায়ুমান যন্ত্রসমূহ স্থির থাকবে।		১-৫ (১-৩)
২	মুখমন্ডলে বাতাস অনুভূত হবে, পাতার শব্দ শোনা যাবে। বায়ুমান যন্ত্রসমূহ ঘুরতে থাকবে।		৬-১১ (৪-৬)
৩	পাতা ও ছোট ডালপালা নড়তে থাকবে। হাল্কা পতাকাগুলো উড়তে থাকবে।		১২-১৯ (৭-১০)
৪	ধূলা ও কাগজের টুকরা উড়তে থাকবে, ছোট ডালপালা দোল খাবে।		২০-২৯ (১১-১৬)
৫	ছোট ছোট গাছপালা দোল খেতে শুরু করবে। আবদ্ধ জলাশয়ে ছোট ছোট ঢেউয়ের সৃষ্টি হবে।		৩০-৩৯ (১৭-২১)
৬	বড় গাছের ডালপালা দোল খাবে। টানানো তারে শিসের শব্দ হবে। ছাতা ব্যবহার করা কষ্টকর হয়ে পড়বে।		৪০-৫০ (২২-২৭)
৭	বড় গাছ নড়তে থাকবে। বাতাসের বিপরীতে হাটা কষ্টকর হয়ে পড়বে।		৫১-৬১ (২৮-৩৩)
৮	বড় গাছের ডালাপালা ভেঙ্গে পড়বে। বাতাসের বিপরীতে হাঁটা অসম্ভব হয়ে পড়বে।		৬২-৭৪ (৩৪-৪০)
৯	অবকাঠামোর সামান্য ক্ষয়ক্ষতি ঘটবে।		৭৫-৮৭ (৪১-৪৭)
১০	দৃষ্টিসীমা কমে যাবে। বড় বড় গাছ উপড়ে পড়বে। অবকাঠামোর উলেখযোগ্য ক্ষয়ক্ষতি ঘটবে।		৮৮-১০১ (৪৮-৫৫)
১১	দৃষ্টিসীমা খুব কমে যাবে । ব্যাপক ক্ষয়ক্ষতি ঘটবে।		১০২-১১৭ (৫৬-৬৩)
১২	অবকাঠামোর উলেখযোগ্য ও ব্যাপক ক্ষয়ক্ষতি ঘটবে।		১১৮ এবং তার অধিক (৬৪ এবং তার অধিক)

WW PHENOMENON

(*Present Weather Symbols*)

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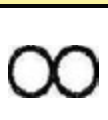
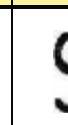
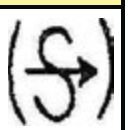
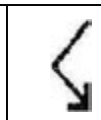
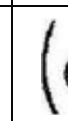
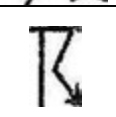
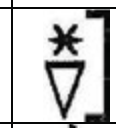
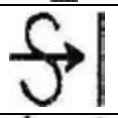
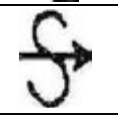
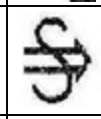
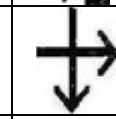
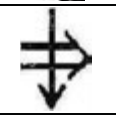
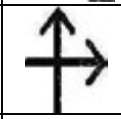
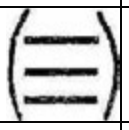
0										
1										
2										
3										
4										
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পর্যবেক্ষণ যন্ত্রপাতির আদর্শিক / তুল্যকরণ মান

Standardized Specifications of Manual Observation Instruments

No.	Instruments	Purpose	Specifications
1	Psychro-Evaporometer	To measure Surface Atmospheric Temperature and Relative Humidity.	Type: Psychrometer consisting of Unsheathed Liquid-in-Glass (Mercury) Thermometer for combination of dry- and wet-bulb temperature measurement by Natural Aspiration according to AUGUST Wall-Mount Type. Measuring and Application Range: -20ºC to +60ºC Accuracy: ±0.2ºC within the Total Range Division of Scale: 0.2ºC Mounting on the Inner Side of Shelter No electric power consumption Psychro-Evaporometer: Stand-alone type (not together with Maximum and Minimum Thermometer (Item No.2 and 3))
2	Maximum Thermometers	To measure Maximum Surface Atmospheric Temperature.	Type: Liquid-in-Glass (Mercury) unsheathed Thermometer with a thick wall where scale is marked directly, Wall-Mount Type. Measuring and Application Range: -20ºC to +60ºC Accuracy: ±0.2ºC Division of Scale: 0.2ºC No electric power consumption Maximum Thermometer: Stand-alone type (not together with Psychro-Evaporometer (Item No.1))
3	Minimum Thermometers	To measure Minimum Surface Atmospheric Temperature.	Type: Liquid-in-Glass (Alcohol) unsheathed Thermometer with a thick wall where scale is marked directly, Wall-Mount Type, Measuring and Application Range: -30ºC to +50ºC Accuracy: ±0.3ºC Division of Scale: 0.2ºC No electric power consumption Minimum Thermometer: Stand-alone type (not together with Psychro-Evaporometer (Item No.1))
4	Thermograph	To measure Surface Atmospheric Temperature.	Type: Bimetallic Thermograph with mechanical Clock Work Drum and Metallic Housing Measuring and Application Range: -10ºC to +50ºC Accuracy: ±0.5ºC Division of Scale: 0.5ºC Recording Period: Seven (7) days Housing: Metal Power Supply: Spiral Spring Clockwork Accuracy: ±60 seconds per day No electric power consumption Thermograph: Stand-alone type (not together with Hygrograph (Item No.5) and the Barograph (Item No.13))
5	Hygrograph	To measure relative Humidity of air	Type: Hygrograph Hair Grid made of natural hair with mechanical-driven Drum Measuring Range: 0% to 100% Accuracy: 2% Division of Scale: 1% Range of Application: -35ºC to +70ºC (Temperature), 0% to 100% (Relative Humidity) Recording Period: Seven (7) days Housing: Metal Power Supply: Spiral Spring Clockwork accuracy: ±60 seconds per day No electric power consumption Hygrograph: Stand-alone type (not together with Thermograph (Item No.4) and the Barograph (Item No.13))

No.	Instruments	Purpose	Specifications
6	Soil Surface Thermometer	To measure soil Surface Temperature.	Type: Liquid-in-Glass Thermometer, measuring on the ground Measuring Range: -30ºC to +50ºC Accuracy: ±0.3ºC Resolution: ≦0.2ºC Division of Scale: 0.2ºC No electric power consumption
7-1	Soil Depth Thermometer (5cm)	To measure Temperature at 5cm depth Underground in Soil.	Type: Bent type Liquid-in-Glass (Mercury) Thermometer, bent-stem 150º Measuring Range: -25ºC to +45ºC Accuracy: ±0.2ºC at 0ºC to +50ºC, ±0.4ºC at <0ºC Resolution: ≦0.2ºC Division of Scale: 0.2ºC Support Material made of (Stainless) Steel No electric power consumption
7-2	Soil Depth Thermometer (10cm)	To measure Temperature at 10cm depth Underground in Soil.	Type: Bent type Liquid-in-Glass (Mercury) Thermometer, bent-stem 150º Measuring Range: -20ºC to +40ºC Accuracy: ±0.2ºC at 0ºC to +50ºC, ±0.4ºC at <0ºC Resolution: ≦0.2ºC Division of Scale: 0.2ºC Support Material made of (Stainless) Steel No electric power consumption
7-3	Soil Depth Thermometer (20cm)	To measure Temperature at 20cm depth Underground in Soil.	Type: Bent type Liquid-in-Glass (Mercury) Thermometer, Bent-stem 150º Measuring Range: -15ºC to +35ºC Accuracy: ±0.2ºC at 0ºC to +50ºC, ±0.4ºC at <0ºC Resolution: ≦0.2ºC Division of Scale: 0.2ºC Support Material made of (Stainless) Steel No electric power consumption
7-4	Soil Depth Thermometer (50cm)	To measure Temperature at 50cm depth Underground in Soil.	Type: Straight type Liquid-in-Glass (Mercury) Thermometer Measuring Range: -10ºC to +30ºC Accuracy: ±0.3ºC at -10ºC to -5ºC, ±0.15ºC at -5ºC to 30ºC Resolution: ≦0.1ºC Division of Scale: 0.1ºC Case for Thermometer, Guide tube with cover cap and chain made of (stainless) Steel No electric power consumption
7-5	Soil Depth Thermometer (100cm)	To measure Temperature at 100cm depth Underground in Soil.	Type: Straight type Liquid-in-Glass (Mercury) Thermometer Measuring Range: -10ºC to +30ºC Accuracy: ±0.3ºC at -10ºC to -5ºC, ±0.15ºC at -5ºC to 30ºC Resolution: ≦0.1ºC Division of Scale: 0.1ºC Case for Thermometer, Guide tube with cover cap and chain made of (stainless) Steel No electric power consumption
7-6	Soil Drill	To install of Soil Depth Thermometers	
8-1	Rain Gauge	To measure Surface Precipitation.	Type: Rain Gauge according to Hellmann Measuring Range: Precipitation quantity 60mm Resolution/ Scale: 0.1mm (0 to 10mm) Range of Application: 0ºC to +60ºC Detachable Filtering Screen Collecting Surface Area Size: 200mm^2 or 314mm^2 Zinc Plate Housing Height: approximately 450mm Measuring Cylinder: for 10 mm precipitation quantity Materials for mounting on foundation No electric power consumption
8-2	Rainfall Recorder	To record Precipitation reading on Drum.	Type: Drum Recorder Measuring Range: 10mm at full scale of recording, Accuracy: 0.5mm/1minute Resolution and Division of Scale: 0.5mm Range of Application: 0°C to 60°C Detachable Filtering Screen Recording Period: One (1) day Power Supply: Spiral Spring Clockwork accuracy: ±60 seconds per day Collecting Surface Area Size: 200mm^2 or 314mm^2 Zinc Plate Housing Height: approximately 1,200mm Materials for Mounting on Foundation No electric power consumption

No.	Instruments	Purpose	Specifications
9-1	Wind Vane and Anemometer	To measure Surface Wind Direction and Wind Speed.	Type: Combination of single or double bladed Wind Vane and three-armed Cup Rotor Anemometer Measuring Range: 0-360º, 0-60m/s Accuracy: ±1% (Wind Direction), ±3% (Wind Speed) Resolution: 2.5º (Wind Direction), 0.1m/s (Wind Speed) Range of Application: 0ºC to +60ºC, Wind Speed 0m/s to 60m/s Starting Value: 1m/s Housing: Aluminum/Stainless Steel with grey color Input Power: Single Phase, AC220V, 50Hz with AC/DC power supply Galvanized Steel Traverse for φ50 mm top mast
9-2	Indicator for Wind Direction and Wind Speed	To display wind direction and wind speed by receiving electrical analog signals from the Wind Vane and the Anemometer (Item No.9-1).	Type: Desktop type analog wind indicator Measuring Range: 0-360º, 0-35m/s Accuracy: ±5º (Wind direction), ±2% (Wind speed) Resolution and Division of Scale: 10º (Wind direction), 1m/s (Wind speed) Metal Housing with durable coating Input Power: AC220V, 50Hz, Single Phase Power Supply Unit (If Power Supply Unit is required and installed outdoor, the Housing of the Power Supply Unit shall be weatherproof.) 2 Sensor Cable: 15m
9-3	Signal Cables for Wind Sensor	To connect between the Wind Vane and the Anemometer (Item No.9-1) and the Indicator (Item No.9-2)	Weatherproof Connectors
9-4	Power Cable with Flexible Conduit Pipe	To input commercial power for the Power Supply Unit of the Indicator (Item No.9-2), if necessary	Three (3)-wire, 1.5 sqmm, VCT, PVC insulated and sheathed table Length: depend upon the site condition Flexible Conduit Pipe: φ30mm Length: depend upon the site condition
9-5	AVR with surge absorber	To regulate input voltage	Capacity: 1kVA or more Input Power: AC 220V ±20%, single phase, 50Hz Output Power: AC 220V ±5%, single phase, 50Hz Surge Protection
9-6	Electric Extension Cord	To distribute commercial Power to the AVR (Item No.9-5)	Length: 5m Five (5) outlets
9-7	Tripod Self-standing Steel Tower with Anchor Legs and Base Plate	To mount the Wind Vane and the Anemometer (Item No.9-1).	Height: 10.5m from ground level Tower to be a three (3)-section: nine (9) m plus top mast of 1.5m. Wind Velocity : 45m/s (Maximum wind speed) at 10m high from the ground level Velocity Pressure for structural and foundation design: 200kgf/m^2 (approx. 2000N/m^2) Top Mast to consist of bracket to suit top of tower and pole of φ48mm to φ50 mm and 1.5meter length. Anchor Legs to be more than 650mm long with bearing angles. Steel Materials: Coated by hot-dip galvanizing after all sawing, drilling, punching, bending and other fabrication completed Weight of Zinc coating per square meter of actual surface ・For five (5)mm and heavier: average not less than 550g ・For steels under five (5)mm: not less than 450g For bolts and other threaded Work the coating weights: average 300g/m^2 Required Documents: Detailed design drawings for foundation including anchor Bolts and Base Plate, Structural calculation report, Assembling manuals Lightening Copper Rod, Copper cable Copper earthing rod (L=1,500mm) or Copper earthing plate 900x900mm, Cable fixer materials for mounting on foundation
9-8	Waterproof Box	To install the Indicator (Item No. 9-2), AVR (Item No.9-5) and Breaker	Type: FRP (Double roof type or with sunshield) Inside Heating Insulation Material (Foam polyurethane): t=20mm or more Fixers for Tripod (Item No.9-7): Mounting materials in weatherproof material Box Door Lever Type Handle, keyed lock and viewing window. Minimum Box Size: D250, H:500, W450 (mm) 3 Cable Glands (waterproof type) Non Fused Power Breaker: 5A with power outlets (x2) Shelf located in the middle of the box for mounting Indicator (Item 9-2)

No.	Instruments	Purpose	Specifications
10	Sunshine Recorder (Campbell Stocks)	To measure Sunshine Duration.	Type: Campbell-Stokes Application Area: 10 to 25º Latitude on northern hemisphere Measuring Range: Threshold 0.12kW/m^2 ±20% (WMO standard) Leveling: A circular bubble and adjustable feet for leveling Accessories: Paper card for one (1) year Spare Parts: one (1) glass sphere No electric power consumption
11	Evaporation Gauge	To measure Water Evaporation.	Type: Large-size Evaporation Pan Hook gauge for level measurement Measuring range: 0mm to 100mm Resolution: 0.2 mm Still Well for Evaporation Pan: Made of brass Evaporation Pan: Class A (1,200mm diameter, 250mm depth) Stainless steel or aluminum Materials for mounting on foundation Totalizing Anemometer Sensor: Three (3)-cup Starting Value: 1m/s Counter Type: Six (6)-digit mechanical indicator built in the Anemometer Resolution: 100m Materials: Aluminum Mounting Pipe: Diameter φ30mm Min-Max-floating Thermometer Measuring Range: -10ºC to +50ºC Accuracy: ± 1ºC Resolution: 0.5ºC No electric power consumption
12	Mercury Barometer	To measure surface air pressure.	Type: Mercury Barometer Measuring Range: 840hPa to 1,050 hPa -15ºC to +50ºC Accuracy: ± 0.25 hPa at 20ºC ± 1ºC Resolution: 0.1 hPa with venire (air pressure), 0.5ºC (temperature) Division of Scale: 1hPa (air pressure), 1ºC (temperature) Range of Application: 0m to 1,200m (altitude), -15ºC to +50ºC (temperature) Housing: Aluminum No electric power consumption
13	Barograph	To measure Surface Air Pressure and compare reading with that of Mercury Barometer.	Type: Aneroid Barograph Measuring Range: 945hPa to 1,050 hPa Accuracy: ±0.2 hPa Range of Application: -10ºC to +50ºC (temperature), 100m to 600m (altitude) Recording Period: Seven (7) days Housing: Metal Power Supply: Spiral spring Clockwork accuracy: ±60 seconds per day Overload Protection for transport to high altitude No electric power consumption Barograph: Stand-alone type (not together with Thermograph (Item No.4) and Hygrograph (Item No.5))
14	Mechanical Pyranograph	To measure global Solar Radiation	Type: Solar Radiation Meter and Mechanical Auto-Recorder (integrated into one weatherproof housing) Sensor: Black and White bimetallic strips Spectral Response: 0.3 to 3.0 microns Measuring Range: Approx. 1,300 W/m² Power Supply: Alkaline dry cell battery AA Clockwork Accuracy: ±60 seconds per day Recording Period: Seven (7) days Pen type: Cartridge Leveling: Adjustable feet and level Housing: Metal with white color, (with carrying handle and polycarbonate dome for solar radiation sensor)

Standardized Specifications of Automatic Weather System (AWS)

No.	Instruments	Purpose	Specifications
1	Wind Speed and Direction Sensor	To measure Surface Wind Direction and Wind Speed.	Type Wind speed : Propeller Wind direction : Vane Range Wind speed : 0.3 - 100m/s Wind direction : 0 - 360º Accuracy: Wind speed : ±0.3m/s or less (10m/s or less), ≤±1% or less (more than 10m/s) Wind direction : ±3º or less Threshold Wind speed : 1.1m/s Wind direction : 1.1m/s Operating Temperature : -10 - +50ºC Built-in Bearing : Replaceable by the end user without any special tool Materials : Rigid UV-stabilized thermoplastic (resistant to corrosion from sea air) or stainless steel Accessories : Galvanized Steel Tripod Tower Pole(*1) Mounting Bracket with galvanized U type bolt 120ϕ, Data Collection Unit Connecting Cable(s)
2	Temperature and Humidity Sensor with Radiation Shield	To measure Surface Atmospheric Temperature and Relative Humidity.	Temperature; Measuring Range : -10 - +50 ºC (Minimum Observation Range) Accuracy : ±0.2ºC or less (at 23 °C) Sensor Type : Platinum RTD Supply Voltage : 4 - 30V Sensing Element : Module Type Humidity; Measuring Range : 0 - 100%RH Accuracy : ±1.5%RH or less (at 23 °C) Stability : <1%RH per year Response Time : 10 seconds Supply Voltage : 4 - 30V Sensing Element : Module Type Radiation Shield : Naturally Aspirated Accessories : Galvanized Steel Tripod Tower Pole(*1) Mounting Bracket with galvanized U type bolt 120φ, Data Collection Unit Connecting Cable(s)
3	Barometer	To measure surface air pressure.	Internal pressure sensors : 1 Pressure range : 500 - 1100hPa Accuracy : ±0.10hPa or less (at +20 °C) Long-term stability : ±0.1hPa/year or less (at 500 - 1100hPa) Temperature range : -10 - +50ºC Supply voltage : 10 - 35VDC Serial I/O : RS232C, RS485/422 Resolution : 0.01hPa Accessories : System Enclosure Mounting Kit, Data Collection Unit Connecting Cable, External Pressure Port Tube.
4-1	Rain Gauge	To measure Surface Precipitation.	Type : Tipping Bucket Capacity : Unlimited Orifice : 8inch or 200mm Sensitivity : 0.5mm Accuracy : ±3% or less (380mm/hr or less), ±5% (500mm/hr or less) Contact rating : 50V AC/DC (0.5A non-inductive) Contact closure Timing : 100 milliseconds (nominal) Max. bounce time : 0.75 milliseconds Materials : Copper or Stainless Steel (Funnel and Housing) Accessories : Data Collection Unit Connecting Cable(s)(30m), Pedestal Mounting Kit with Level Adjustment Function.
4-2	Pedestal for Rain Gauge	To mount the Rain Gauge (Item No.4-1).	Material : Marine grade aluminum Total Height : 1m (Including Rain Gauge) with Leveling Adjustment
5	Sunshine Duration Sensor	To measure Sunshine Duration.	Spectral range : 400 – 1,100 nm Sunshine YES output : 1.0 ± 0.1V if direct irradiance more than 120 W/m2 Sunshine NO output : 0.0 to ± 0.1V if direct irradiance less than 120 W/m2 Accuracy : more than 90% in monthly total Power : 9 – 15VDC, 1W or less Accessories : Galvanized Steel Tripod Tower Mounting Bracket, Data Collection Unit Connecting Cable(s)

No.	Instruments	Purpose	Specifications
6	Sunshine Radiation Sensor	To measure Sunshine Radiation.	Spectral range : 400 – 1,100 nm Sensitivity : 100µV/W/m2 Response Time : less than 1sec Max. Irradiance : 2000 W/m2 Temperature Dependence : +0.15 %/ºC (typical) Operating Temperature : -10ºC – + 50ºC Directional Error : ± 5% at 80 deg Accessories : Galvanized Steel Tripod Tower Mounting Bracket, Data Collection Unit Connecting Cable(s)
7	Data Collection Unit	To collect observation data from each sensors and transmit the collected data to Data Receiving System at the BMD Head Office through GSM/GPRS Modem(Item No.8).	Analog Inputs Number of channels : 10 voltage inputs or more, 5 current inputs with 250Ω internal shunt resistor or more, 3 inputs for RTD or thermistor transducers or more Input ranges : 100mV, 1.0V, 2.0V, 5.0V Accuracy : 0.02% FS, 5V range (-10 - 65ºC) 0.1% FS for current measurements Digital Inputs/Outputs Frequency inputs : 3 counters, 16-bit Maximum count rate : 1.4KHz Serial Channels RS-232E ports : 4 ports or more, hardware and software handshaking baud rates 110bps to 115Kbps, Connecting and controlling capability of GSM/GPRS Modem Maintenance port: : RS-232 with external weatherproof connector for real-time data access and off-loading data memory RS-485port : 1 port with multi-drop capability, includes impedance termination Processor Functions Configuration parameters : Stored in non-volatile EEPROM Data memory : 1MB internal RAM Calendar clock : Comply with leap year, 2 times of day alarms, Accuracy ±30 sec/month, Synchronized with GPRS Data Management Function Interval of Data Calculation (Accumulation, Average, Total, Max./Min. etc.) : Configurable Data Transmission : Transmittable through GPS/GPRS Modem Transmitting Interval : Configurable Data layout in the Format : Customizable (GPRS/SMS) Input Voltage : Transmittable with Data Power Input voltage : +7 - +40VDC Operating current : less than 60mA (at 12VDC) Standby current : less than 0.6mA (at 12VDC) Input protection : Dual fuse surge protection, reverse polarity, and over-voltage Supply sources : AC or DC Power source Environmental Characteristics Operating temperature : -10 - +50ºC Humidity : 0 - 100%RH Vibration : 10 - 500Hz, to 2G (IEC-68-2-6) EMI and ESD protection : MIL-STD461,IEC 801 Construction Circuit boards : Surface mounted components, internal power & ground planes, and built-in EMI & ESD protection. Lightning protection : Minimum 3 stages of protection devices on all signal and power lines Waterproofing : IP66 Connections : Plug & Socket IP66 or higher Accessories : System Enclosure Mounting Kit, Power Cable(s) between Data Collection Unit and Regulator Appropriately connectable with all the required sensors and GSM/GPRS Modem indicated in this specification

No.	Instruments	Purpose	Specifications
8	GSM/GPRS Modem	To transmit the collected data to Data Receiving System at the BMD Head Office.	Type : GSM/GPRS dual band Modem Transmitting Power : 2W (GSM900), 1W (GSM1800) GPRS feature Class : Class10 Coding scheme : CS1 - CS4 Interfaces : RS232 (Sub-D15), Micro fit 4-pin for power, Sliding SIM holder Power Input voltage : 5.5V - 24VDC Operating current : less than 140mA (at 12VDC, GSM900) less than 100mA (at 12VDC, GSM1800) Standby current : less than 5mA (at 12VDC, GSM900/GSM1800) Environmental Characteristics Operating temperature : -10ºC - +50ºC Accessories : Antenna with Cable, Data Collection Unit Connecting Cable, System Enclosure Mounting Kit, Power cable(s) Appropriately connectable with Data Collection Unit indicated in this specifications
9	Power Supply System	To generate and supply electric power to AWS even during no sunshine	Solar Panel Voltage : 12V nominal Capacity : 30W or more Module Efficiency : 16.0% or higher Bird Protection : Spike type on the top side (Aluminum or Stainless Steel) Accessories : Aluminium Installation Kit for the installation on the enclosure roof (Incline 25deg., ±10deg. Adjustable), Regulator Connecting Cable(s) Regulator Capacity : more than 5A (12V) System Voltage : 12V Nominal Settings : Voltage at power charge commencement and completion Protection : Overload, Short Circuit, High Voltage, Reverse Polarity。 Accessories : Power System Enclosure Mounting Kit Battery Type : Sealed Maintenance Free Battery, designed for solar powered applications System Voltage : 12V Capacity : 60Ah or more Designed life time : More than 10years based upon 30% discharge cycles Accessories : Power System Enclosure Mounting Kit, Regulator Connecting Cable(s) Power System Enclosure Type : Free Standing Type Material : Fiber Reinforced Plastic International protection rating : IP66 Hinge : Stainless steel piano hinge Devices to be installed : Regulator and Battery in the Enclosure, Solar Panel on the Enclosure roof Accessories : Free Standing Pedestal (more than 60cm high from the ground to the bottom of the enclosure)
10	System Enclosure	To accommodate Data Collection Unit (Item No.7), GSM/GPRS Modem (Item No.8) and related devises.	Material : Fiber Reinforced Plastic International protection rating : IP66 Hinge : Stainless steel piano hinge Devices to be installed : Barometer, Data Collection Unit and GPRS Modem in the Enclosure Accessories : Galvanized Steel Pole Mounting Kit with two (2) galvanized U type bolts 120φ

No.	Instruments	Purpose	Specifications
11	Meteorological Data Display Unit	To display weather observation data.	Hardware: CPU : Intel Core2 Duo, 2GHz or equivalent Main memory (RAM) : 4GB or more Hard disk : 250GB x two (2) drives or more Monitor display : Color LCD TFT type, 19 inches or more, 1280×1024 or more Interface : 10BASE-T/100 BASE-TX, RS-232, USB DVD±R/W drive : one (1) drive Input Power : AC 220V (single phase, 50Hz) Software: O/S : Microsoft Windows XP, VISTA or 7 Office work software : Microsoft Office Ver.2007 or better Data collection and management software; - Data Display Function - Data Collecting and Storage Function - Data Collection Unit Control Function - Configuration and Customization for Data Management Function of Data Collection Unit Accessories : English Keyboard, Mouth, Data Collection Unit Connecting Cable(150m), Power cable(s)
12	1kVA UPS	To supplying stable electric power to Meteorological Data Display Unit (Item No.11).	Capacity : 1kVA or more Input power : AC 220V ±15% (single phase, 50Hz) Output power : AC 220V ±5% (single phase, 50Hz)。 Back up time : at least 5 minutes at full load Automatic Meteorological Data Display Unit Shutdown Function
13	Galvanized Steel Pole	To mount the Wind Speed and Direction Sensor (Item No.1), Temperature and Humidity Sensor with Radiation Shield (Item No.2), Sunshine Duration Sensor (Item No.5), Sunshine Radiation Sensor (Item No.6) and System Enclosure (Item No.10).	please see the attached drawings

Standardized Specifications of Automatic Rain Gauge

No.	Instruments	Purpose	Specifications
1	Rain Gauge	To measure Surface Precipitation.	Type : Tipping Bucket Capacity : Unlimited Orifice : 8inch or 200mm Sensitivity : 0.5mm Accuracy : ±3% or less (380mm/hr or less), ±5% (500mm/hr or less) Contact rating : 50V AC/DC (0.5A non-inductive) Contact closure Timing : 100 milliseconds (nominal) Max. bounce time : 0.75 milliseconds Materials : Copper or Stainless Steel (Funnel and Housing) Accessories : Data Collection Unit Connecting Cable(s)(30m), Pedestal Mounting Kit with Level Adjustment Function.
2	Data Collection Unit	To collect observation data from Rain Gauge and transmit the collected data to Data Receiving System at the BMD Head Office through GSM/GPRS Modem(Item No.3)	Digital Inputs Number of channels :3 or more Input Mode : High speed inputs for sine wave, square wave, or contact closure RS-232E ports : 2 or more for connection with GPRS Modem and maintenance purpose. baud rates 110bps to 115Kbps Processor Functions Data memory : 128KB internal RAM Calendar clock : Comply with leap year, 2 times of day alarms, Accuracy ≤±30 sec/month, Synchronized with GPS Power Input voltage : 7 - 40VDC Operating current : <55mA (at 12VDC) Standby current : <0.5mA (at 12VDC) Input protection : Dual fuse surge protection, reverse polarity, and over-voltage Environmental Characteristics Operating temperature : -10 - +85ºC Humidity : - 100%RH Construction Lightning protection : Minimum 3 stages of protection devices on all signal and power lines Waterproofing : IP66 Accessories : System Enclosure Mounting Kit, Power cable(s)
3	GSM/GPRS Modem	To transmit the collected data to Data Receiving System at the BMD Head Office.	Type : GSM/GPRS dual band Modem Transmitting Power : 2W (GSM900), 1W (GSM1800) GPRS feature Class : Class10 Coding scheme : CS1 - CS4 Interfaces : RS232 (Sub-D15), Micro fit 4-pin for power, Sliding SIM holder Power Input voltage : 5.5V - 24VDC Operating current : less than 140mA (at 12VDC, GSM900) less than 100mA (at 12VDC, GSM1800) Standby current : less than 5mA (at 12VDC, GSM900/GSM1800) Environmental Characteristics Operating temperature : -10ºC - +50ºC Accessories : Antenna with Cable, Data Collection Unit Connecting Cable, System Enclosure Mounting Kit, Power cable(s) Appropriately connectable with Data Collection Unit indicated in this specifications

No.	Instruments	Purpose	Specifications
4	Power Supply System	To generate and supply electric power to AWS even during no sunshine	Solar Panel Voltage : 40V nominal Capacity : 10W or more Module Efficiency : 16.0% or higher Accessories : Pedestal Mounting Kit, Regulator connecting Cable(s) Regulator Capacity : ≥5A (12V) System Voltage : 12V Solar Input Voltage : 40V Nominal Settings : Voltage at power charge commencement and completion Protection : Overload, Short Circuit, High Voltage, Reverse Polarity Accessories : System Enclosure Mounting Kit Battery Type : Sealed Maintenance Free Battery, designed for solar powered applications System Voltage : 12V Capacity : 7Ah or more Designed life time : More than 10years based upon 30% discharge cycles Accessories : System Enclosure Mounting Kit, Regulator connecting Cable(s)
5	System Enclosure	To accommodate Data Collection Unit (Item No.2), GPRS Modem (Item No.3) and related devises.	Material : Fiber Reinforced Plastic International protection rating : IP66 Hinge : Stainless steel piano hinge Devices to be installed : Data Collection Unit, GPRS Modem, Regulator, Battery Accessories : Pedestal Mounting Kit
6	Pedestal	To mount the Rain Gauge (Item No.1) and System Enclosure (Item No.5).	Material : Marine grade aluminum Total Height : 1m (Including Rain Gauge) with Leveling Adjustment
7	Digital Multi Meter	To measure electric current, Voltage and Resigtance	Measurement functions : AC Electric Current and Voltage : DC Electric Current, Voltage and Resistance

Standardized Specifications of Data Receiving System

No.	Instruments	Purpose	Specifications
1	Data Receiving Unit	To measure electric current, Voltage and Resigtance	Hardware: CPU : Intel Core2 Duo, 2GHz or equivalent Main memory (RAM) : 4GB or more Hard disk : 250GB x two (2) drives or more Monitor display : Color LCD type, 19 inches or more, 1280×1024 or more Interface : 10/100 BASE-T, RS-232, USB DVD-R/W drive : one (1) drive Input Power : AC 220V (single phase, 50Hz) Software: O/S : Microsoft Windows XP, VISTA or 7 Office work software : Microsoft Office Ver.2007 or better Data collection and management software; - Rainfall Data and AWS Data Collecting Function – (Periodical data and Event data) - Data Management and Storage Function - Data Display Function (Site-by-site basis, Multiple sites simultaneously, in table format) -Data Export Function
2	GSM/GPRS Modem	To transmit the collected data to Data Receiving System at the BMD Head Office.	Type : GSM/GPRS dual band Modem Transmitting Power : 2W (GSM900), 1W (GSM1800) GPRS feature Class : Class10 Coding scheme : CS1 - CS4 Interfaces : RS232 (Sub-D15), Micro fit 4-pin for power, Sliding SIM holder Power Input voltage : AC 220V (single phase, 50Hz) Operating current : less than 140mA (at 12VDC, GSM900) less than 100mA (at 12VDC, GSM1800) Standby current : less than 5mA (at 12VDC, GSM900/GSM1800) Environmental Characteristics Operating temperature : -10ºC - +50ºC Accessories : Antenna with Cable, Data Collection Unit Connecting Cable, System Enclosure Mounting Kit, Power cable(s) Appropriately connectable with Data Collection Unit indicated in this specifications
3	1kVA UPS	To supplying stable electric power to Meteorological Data Receiving Unit (Item No.1).	Capacity : 1kVA or more Input power : AC 220V ±15% (single phase, 50Hz) Output power : AC 220V ±5% (single phase, 50Hz)。 Back up time : at least 5 minutes at full load Automatic Meteorological Data Display Unit Shutdown Function

কাঠের আশ্রয়ের আদর্শ/ তুল্যকরণ মান

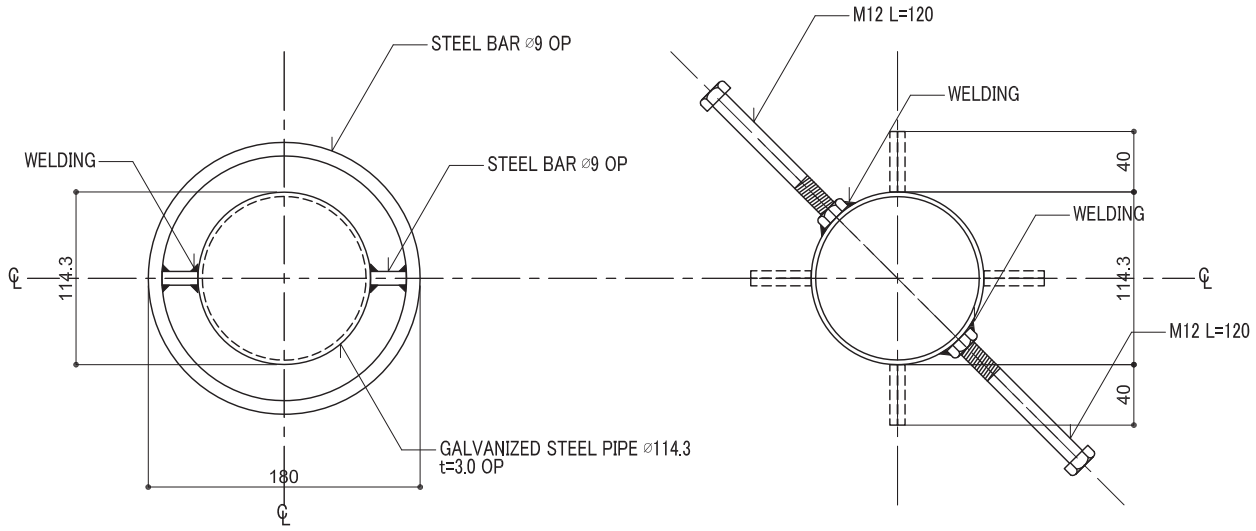
Standardized Specifications of Wooden Shelter

No.	Instruments	Purpose	Specifications
1	Wooden Shelter	To accommodate psychro-evaporometer, extreme maximum/minimum thermometers, thermograph and hygrograph.	Type: BMD Standard Large Instrument Shelter with four (4) legs made of wood and metal. Wooden Moisture Content: 20% or less Painting: Two (2) finish coats, white color Wood Screw: Stainless

যোগাযোগ যন্ত্রপাতির আদর্শ / তুল্যকরণ মান

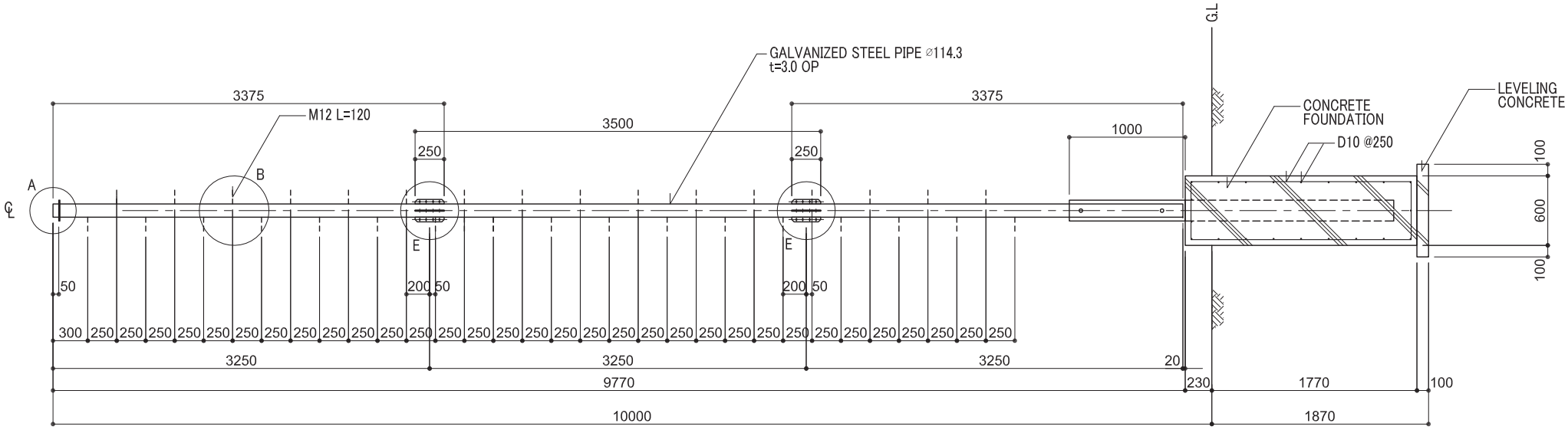
Standardized Specifications of Communication Instruments

No.	Instruments	Purpose	Specifications
1-1	HF SSB Transceiver Radio	To transmit meteorological data from observation stations to BMD Head Office.	Frequency Range : 2 to 10 MHz, Synthesized, Keypad tuning with detachable keypad for security. Operation : USB (J3E) pre programmed 6 channels with scan facility. BMD has permission to use only 4 channels. Channel 1: 9592 KHz(Under Test) Channel 2: 2505 KHz Channel 3: 3363 KHz Channel 4: 8814 KHz Channel 5: 7500 KHz(Under Test) Channel 6: 9460 KHz Power Output : 100 Watts PEP, reducible up to 60 Watts Indicator : LED Bar graph indicating relative power output and received signal strength, LED Bar ON Indicator, and Backlight. Display : LCD Display to show Channel Number and Frequency. Front Control Panel : Volume, Power On/Off, Channel Selector, Clarifier, Squelch, Microphone Socket etc. Rear Panel : AC and DC Power Supply, Antenna Connector, AC and DC Fuse etc. Power Supply : 220 Volts (AC) ± 10%, 50 Hz. Microphone : Desk Microphone or Fist/Handheld Microphone (600 Ω). Construction : Modular construction with plug in circuit boards for easy fault finding and quick servicing. Accessories : Automatic Antenna Tuner, Broadband Dipole Antenna, Lightning Arrester for each HF-SSB Transceiver set.
1-2	Dipole Antenna		Complete with 30m Coaxial Cable and Connector Frequency Range: 2 to 30MHz English Installation Manual
1-3	HF Antenna Pole		Type: DMH Standard made of Galvanized Steel The size, painting and methods of fabrication indicated in the drawings (Standardized Details of HF Pole for Observation Field). Painting: Two (2) Finish Coats, White Color



A DETAIL SCALE 1:5

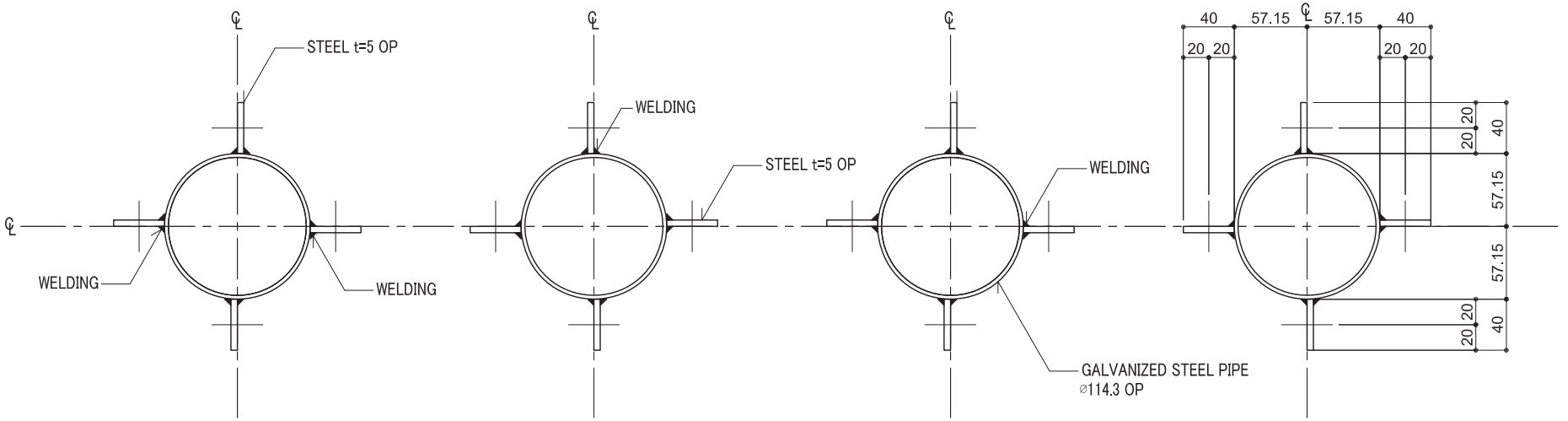
B DETAIL SCALE 1:5



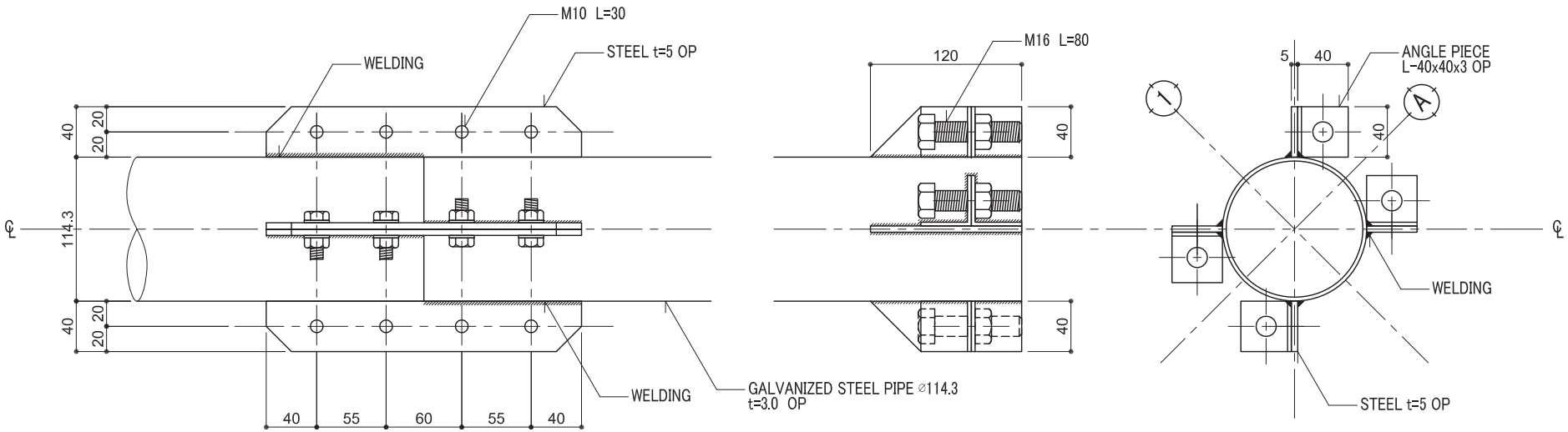
AWS POLE
ELEVATION/SECTION SCALE 1:50

※OP : OIL PAINT
(WHITE COLOR)

		DRAWING TITLE	SCALE	DRAWING No.
		STANDARDIZED DETAILS OF AWS POLE (1)	1:5 1:50	AWS - 1



E DETAIL SCALE 1:5

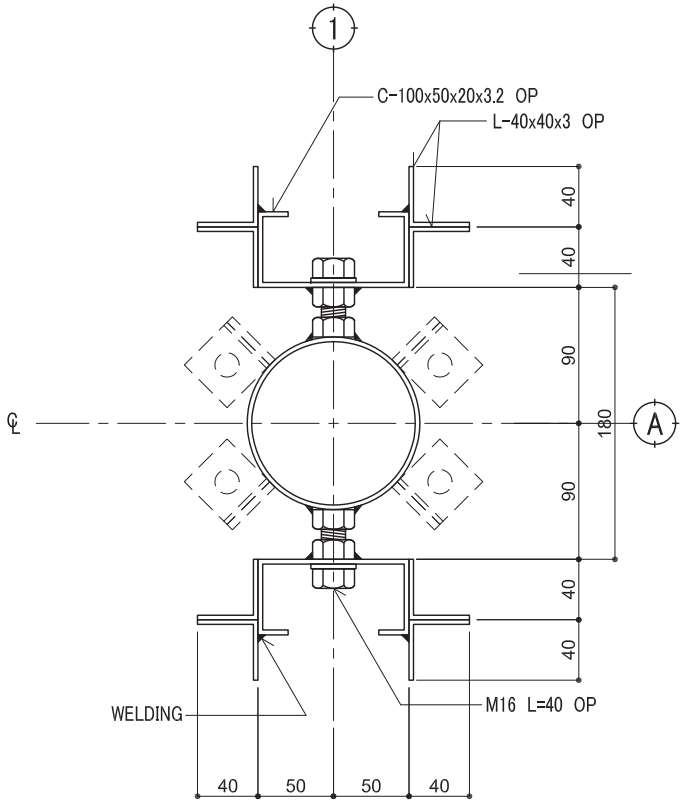


C DETAIL SCALE 1:5

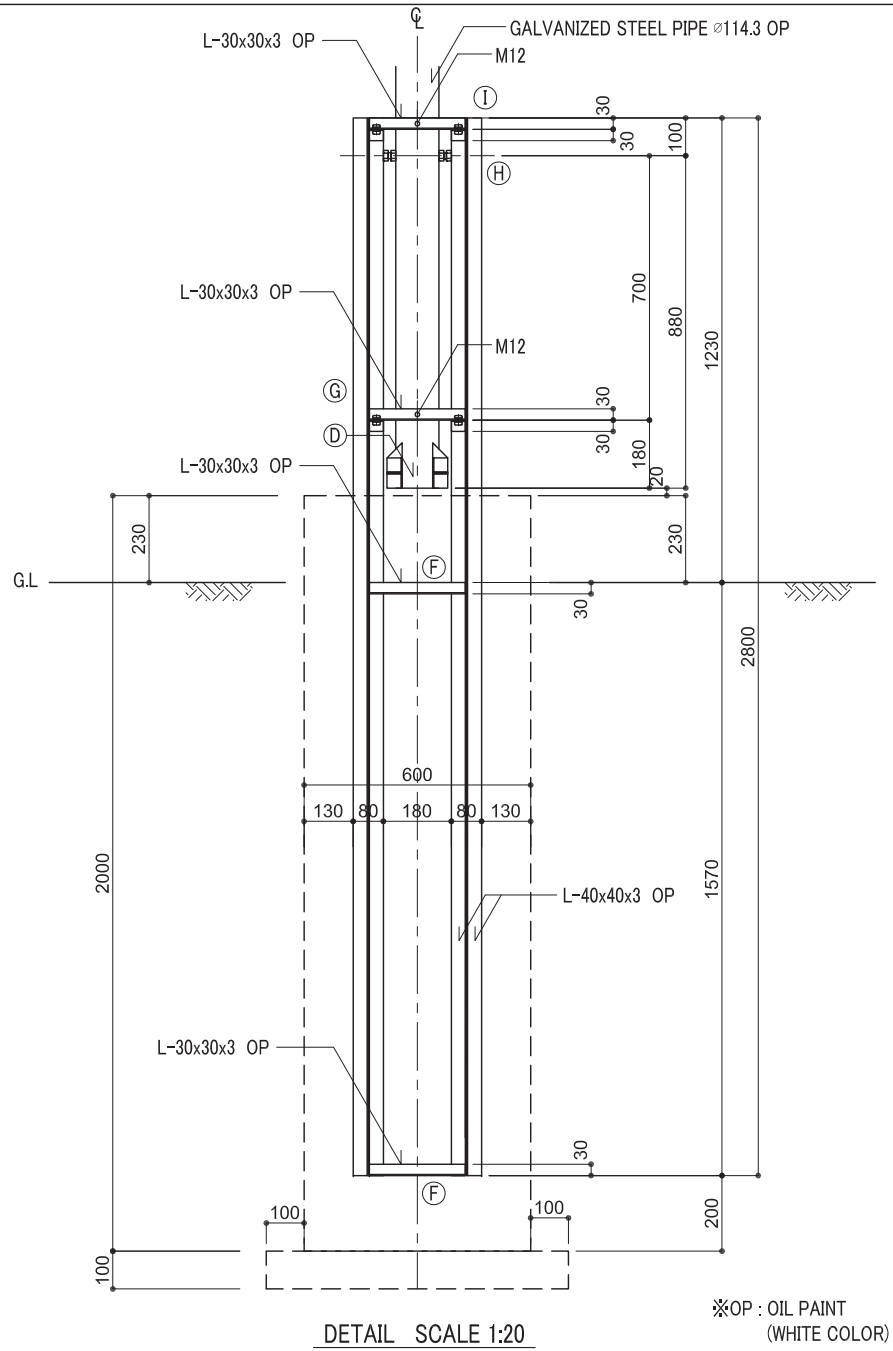
D DETAIL SCALE 1:5

※OP : OIL PAINT
(WHITE COLOR)

		DRAWING TITLE	SCALE	DRAWING No.
		STANDARDIZED DETAILS OF AWS POLE (2)	1:5	AWS - 2



H DETAIL SCALE 1:5



DETAIL SCALE 1:20

※OP : OIL PAINT
(WHITE COLOR)

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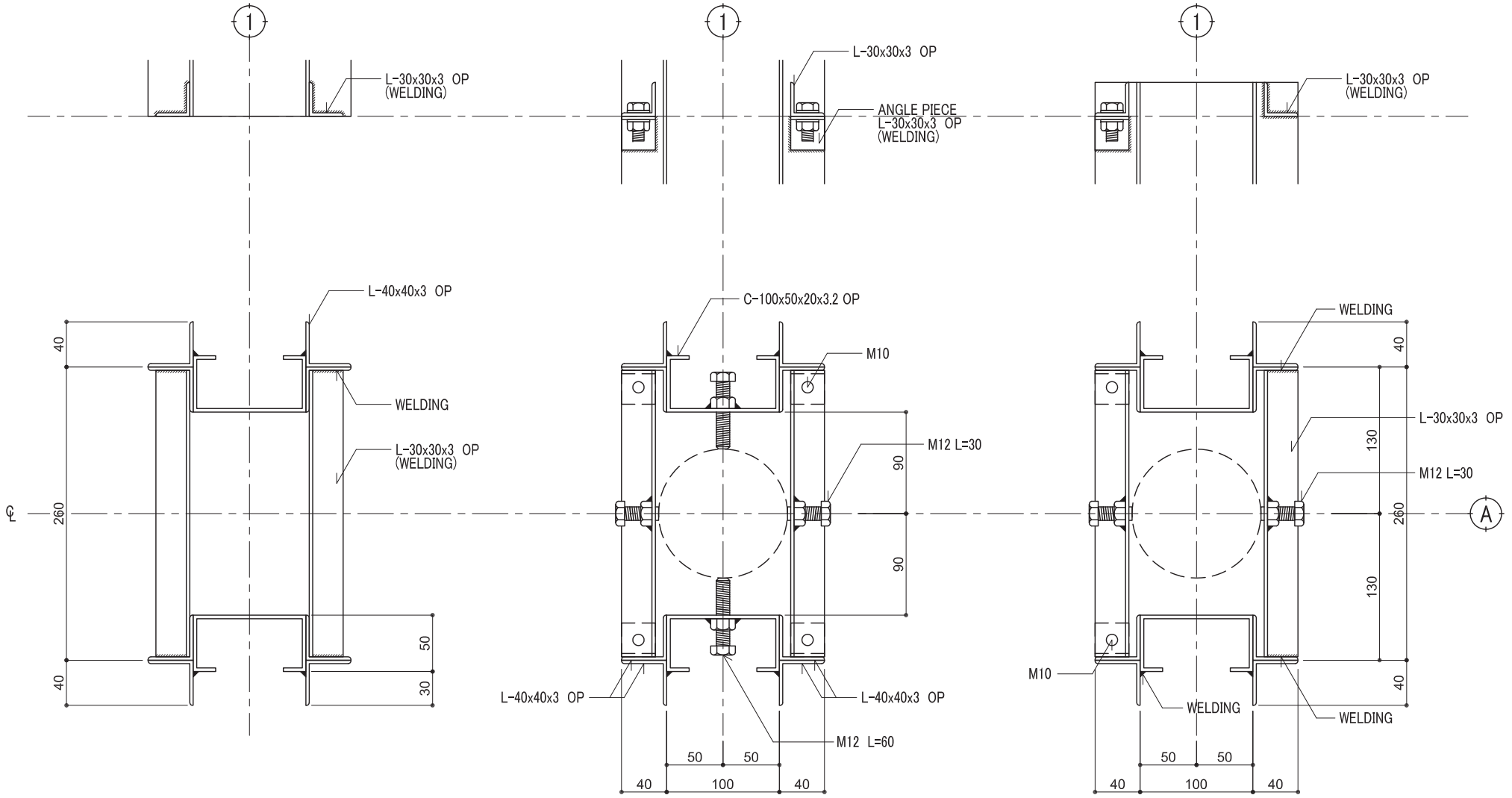
		STANDARDIZED DETAILS OF AWS POLE (3)	1:5 1:20	AWS - 3



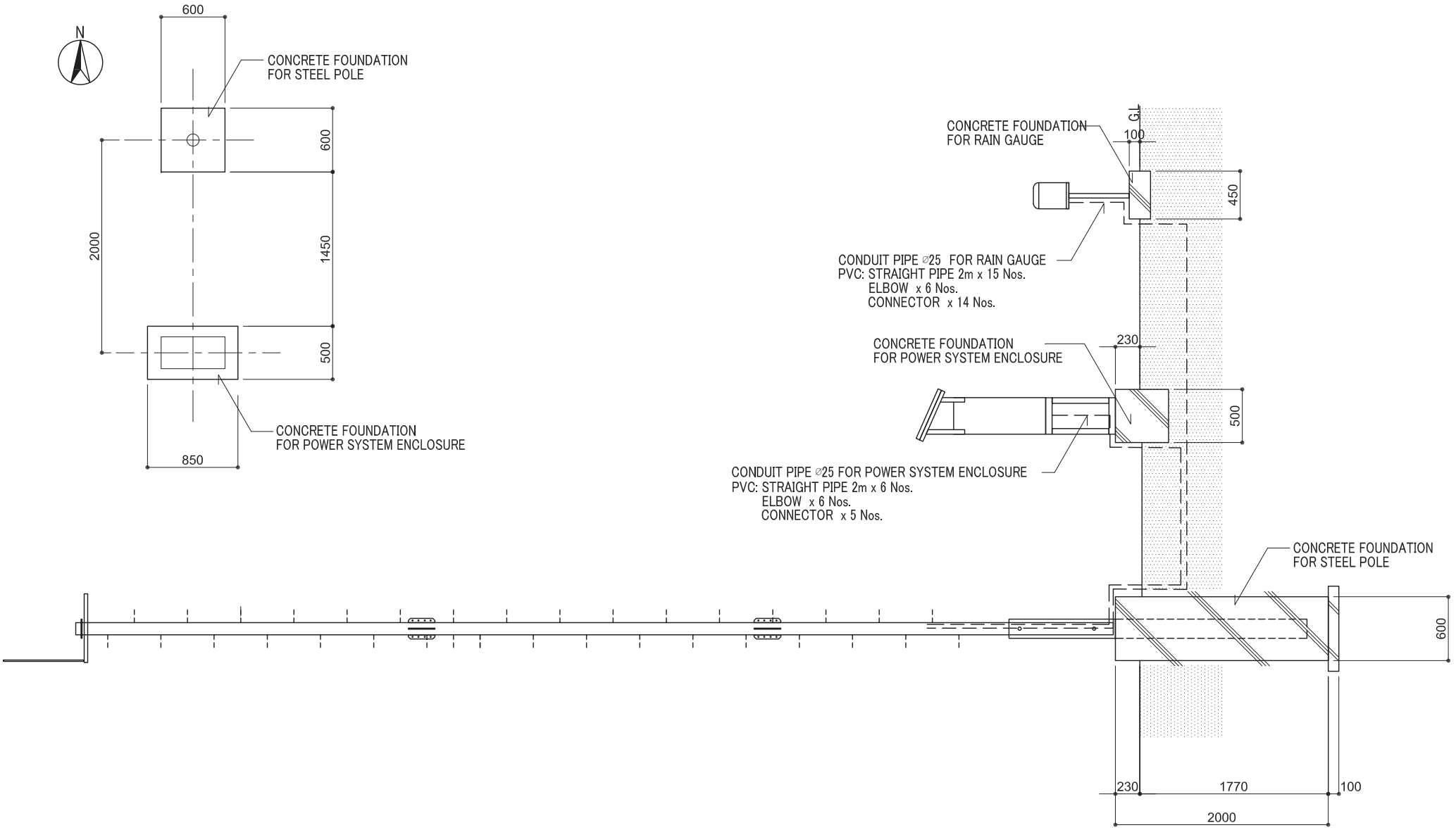
F DETAIL SCALE 1:5

G DETAIL SCALE 1:5

I DETAIL SCALE 1:5

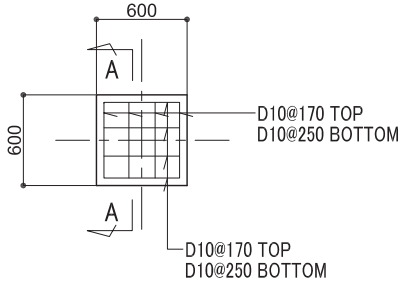
※OP : OIL PAINT
(WHITE COLOR)

		DRAWING TITLE	SCALE	DRAWING No.
		STANDARDIZED DETAILS OF AWS POLE (4)	1:5	AWS - 4

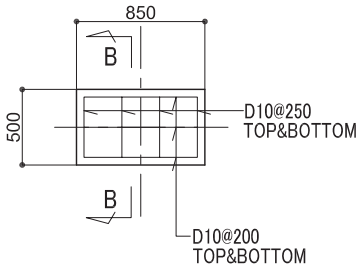


Steel Pole, Power System Enclosure and Rain Gauge
for Automatic Weather System

		DRAWING TITLE	SCALE	DRAWING No.
		STANDARDIZED DETAILS OF AWS POLE (5)	1:50	AWS - F - 1



PLAN



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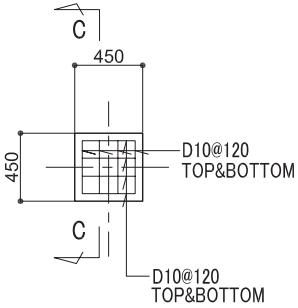

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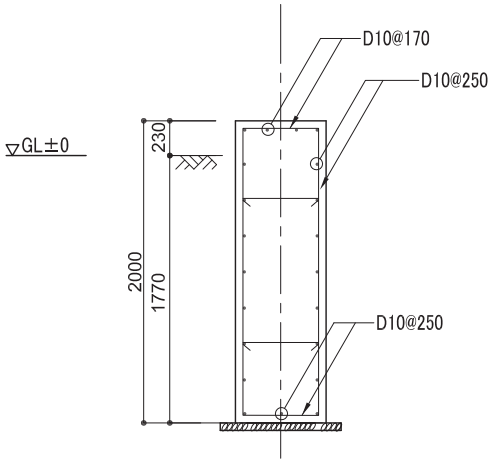
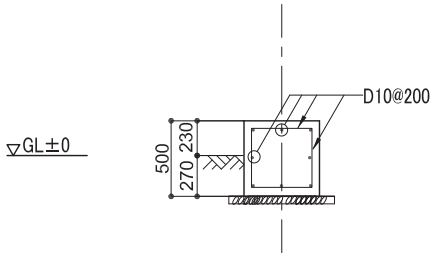
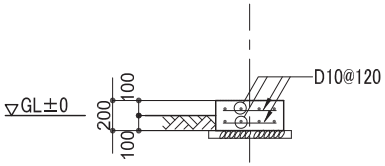


SECTION A–A



SECTION B–B



SECTION C–C

Foundation for Steel Pole

Foundation for Power System Enclosure

Foundation for Rain Gauge

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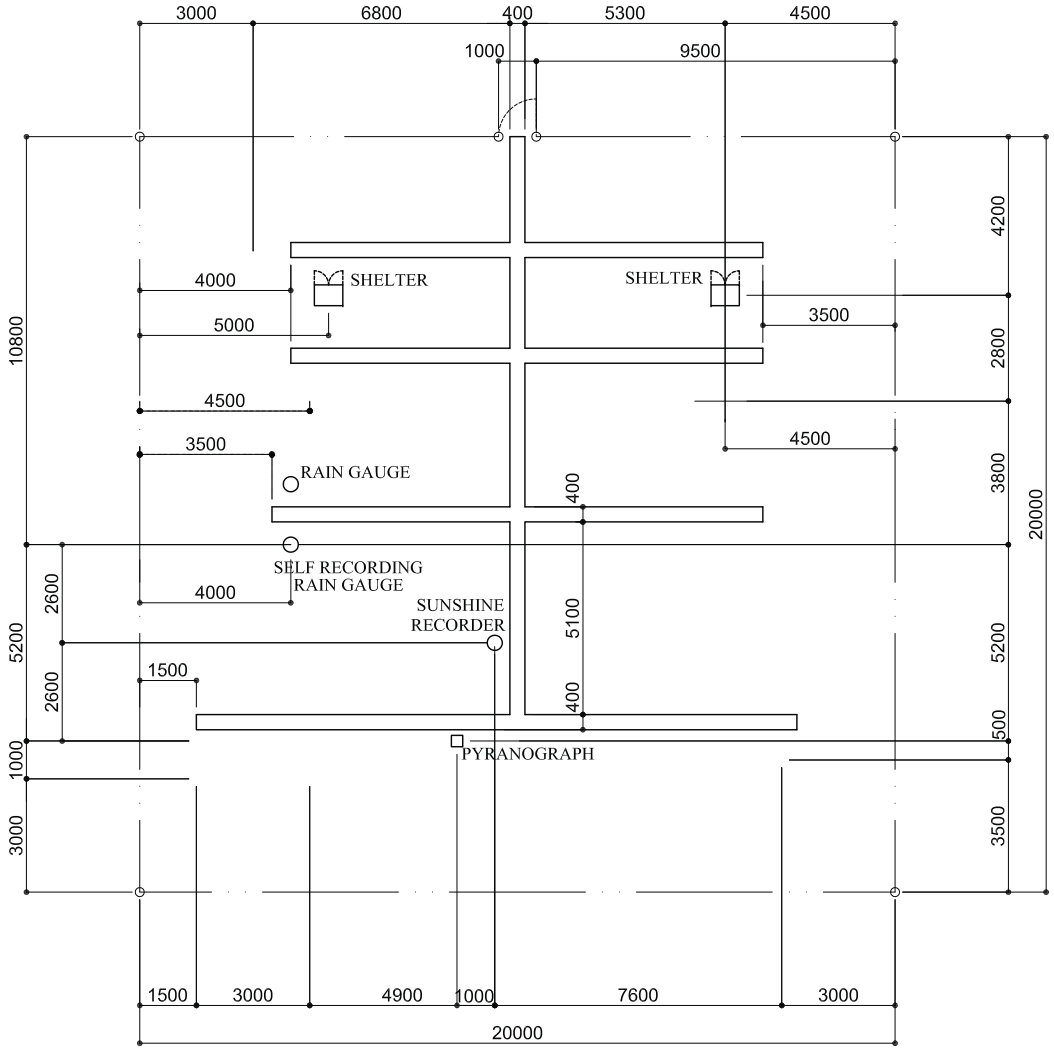
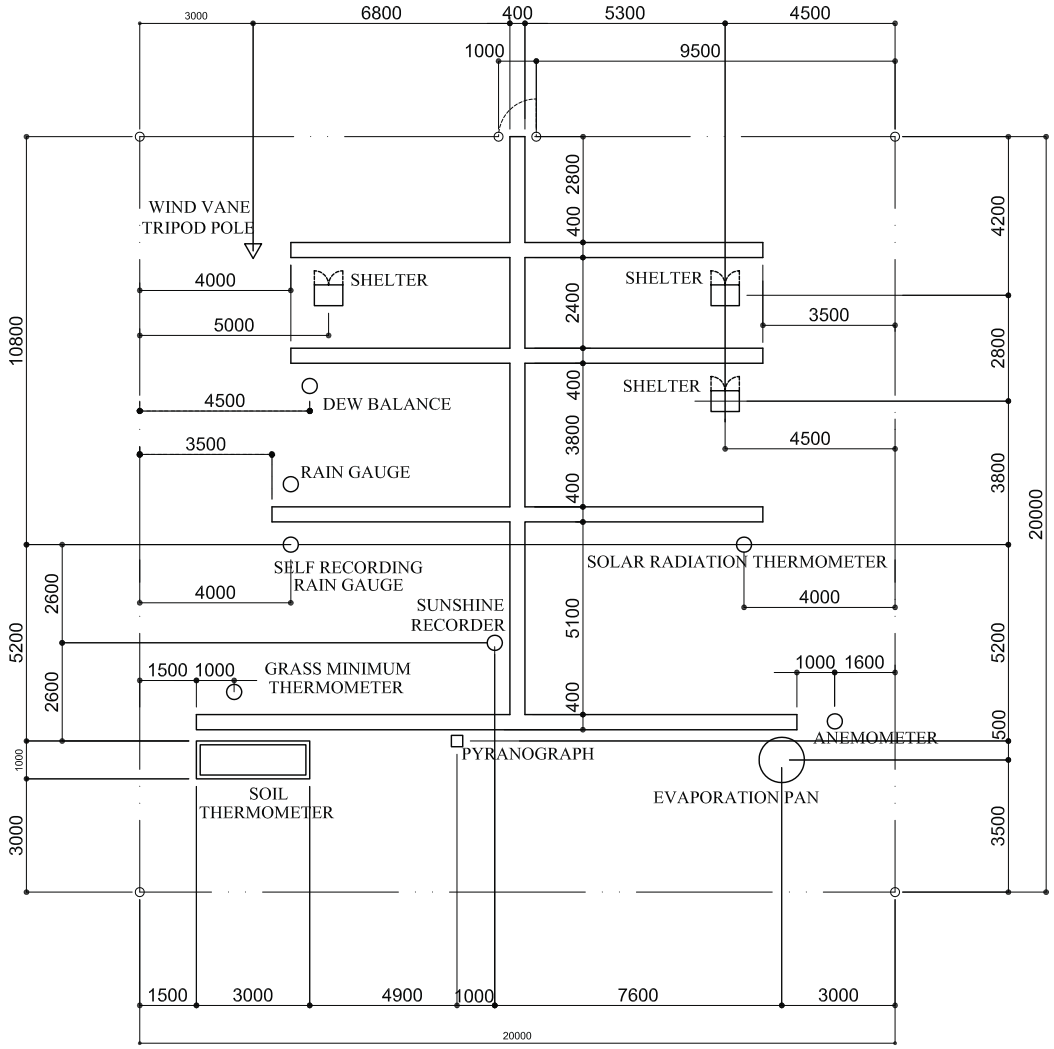
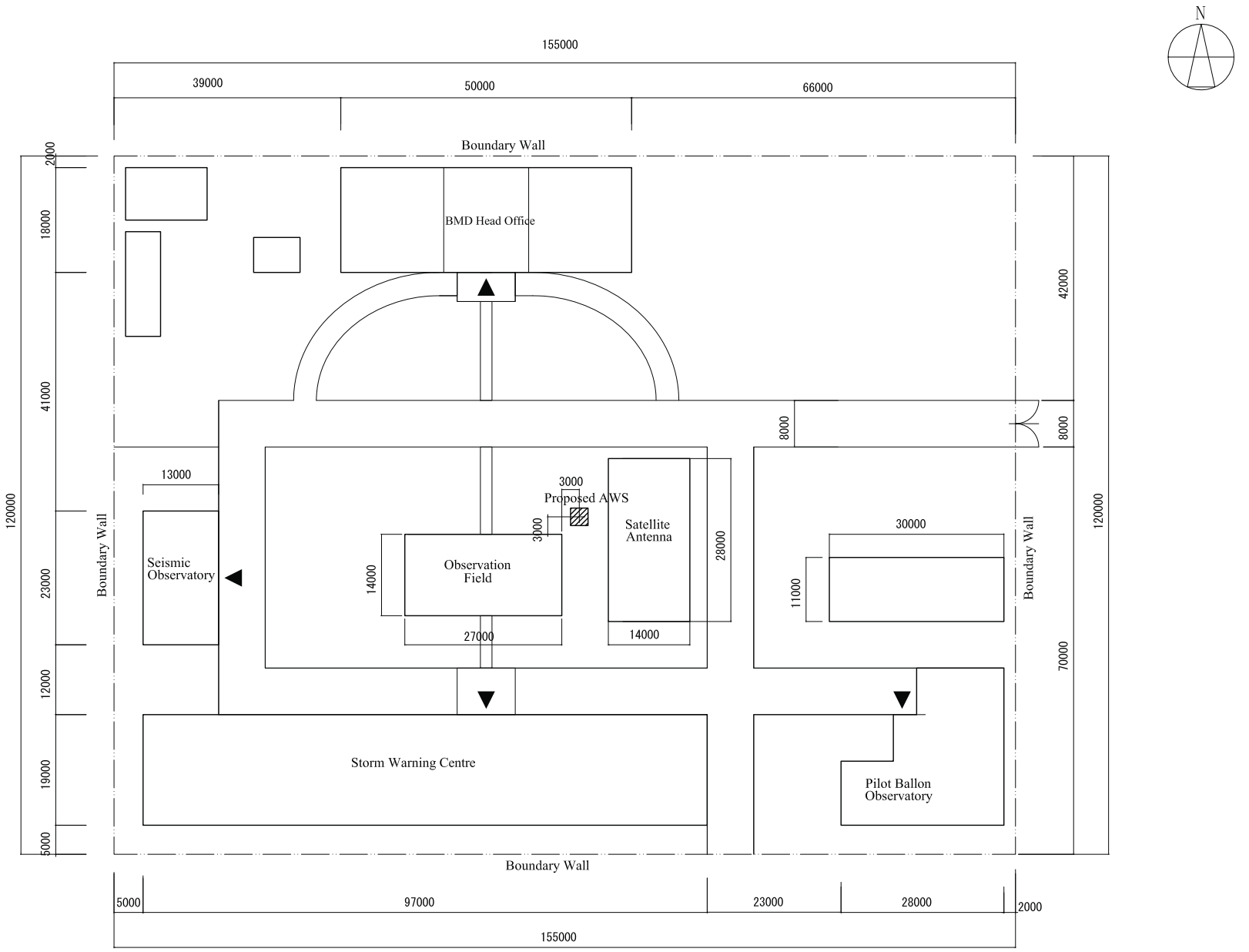
		STANDARDIZED DETAILS OF AWS POLE (6)	1:50	AWS - F - 2



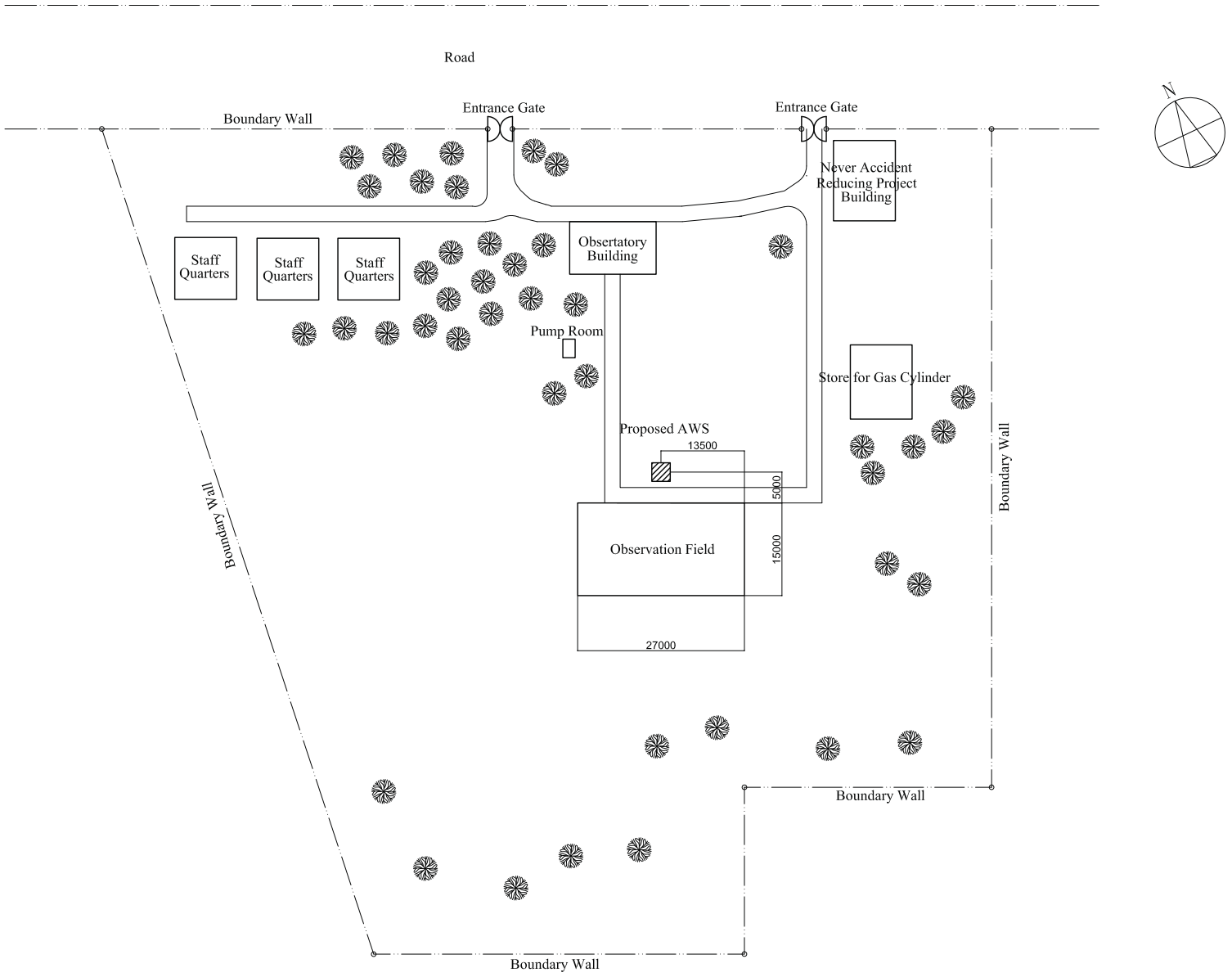
Bangladesh Meteorological Department Technical Cooperation Project for Development of Human Capacity on Operation of Weather Analysis and Forecasting	FIRST CLASS OBSERVATORY	DRAWING TITLE OBSERVATION EQUIPMENT LAYOUT PLAN (OBSERVATION FIELD)	SCALE 1:200	DRAWING No. -



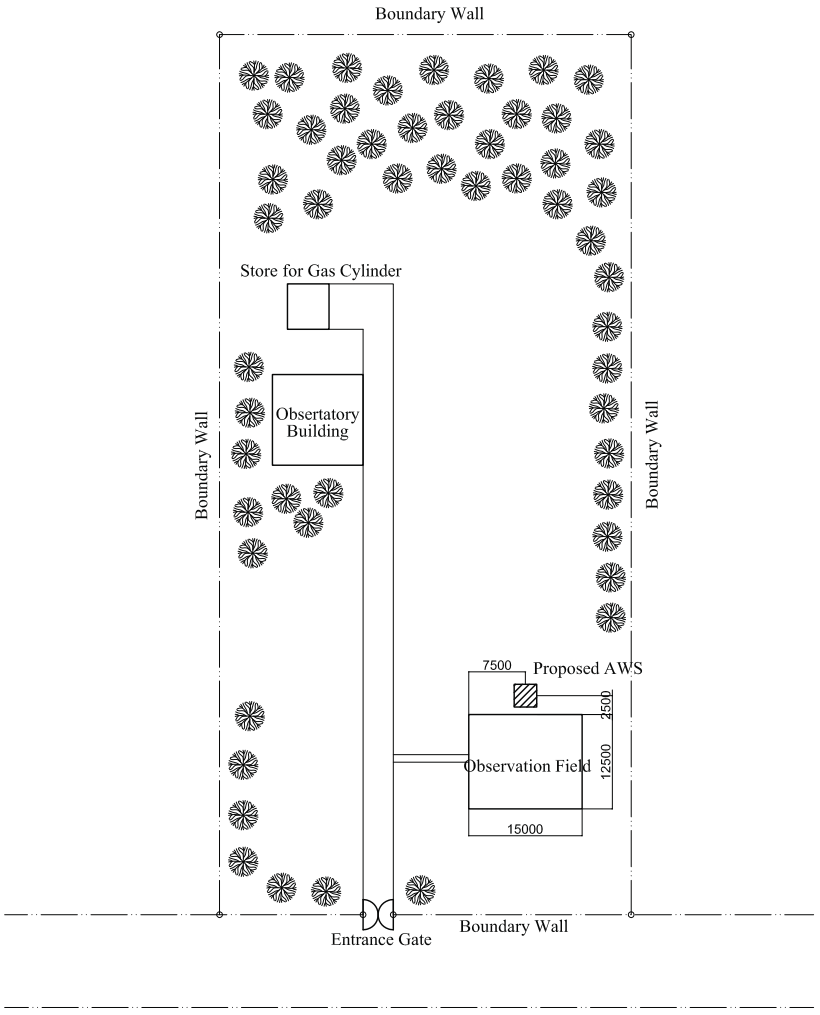
Bangladesh Meteorological Department Technical Cooperation Project for Development of Human Capacity on Operation of Weather Analysis and Forecasting	AGROMET OBSERVATORY	DRAWING TITLE OBSERVATION EQUIPMENT LAYOUT PLAN (OBSERVATION FIELD)	SCALE 1:200	DRAWING No. -

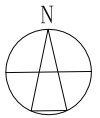


Bangladesh Meteorological Department Technical Cooperation Project for Development of Human Capacity on Operation of Weather Analysis and Forecasting	EXISTING DHAKA OBSERVATORY	DRAWING TITLE AWS LAYOUT PLAN	SCALE 1:1000	DRAWING No. -

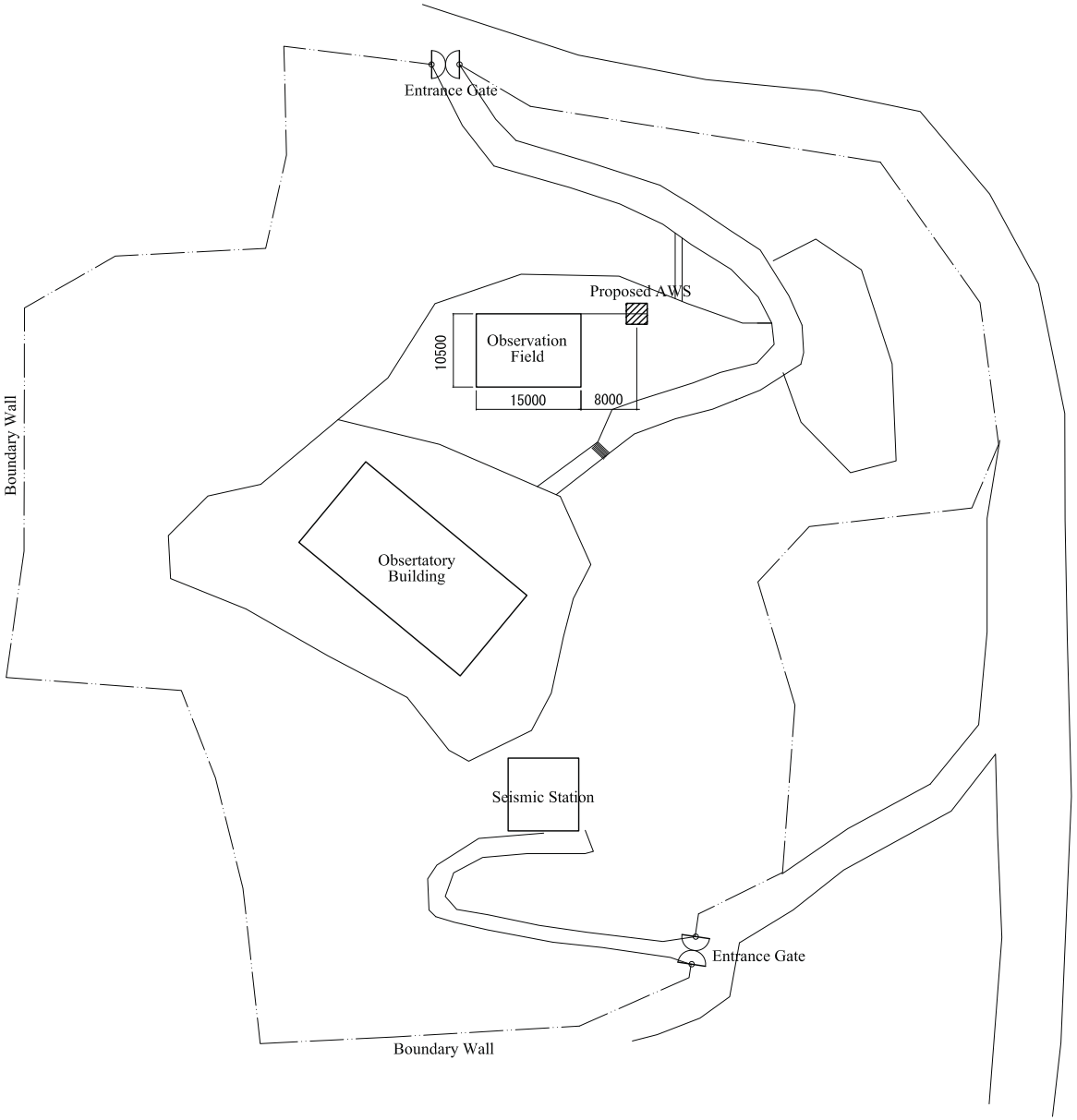


Bangladesh Meteorological Department Technical Cooperation Project for Development of Human Capacity on Operation of Weather Analysis and Forecasting	EXISTING BARISAL OBSERVATORY	DRAWING TITLE AWS LAYOUT PLAN	SCALE 1:1000	DRAWING No. -

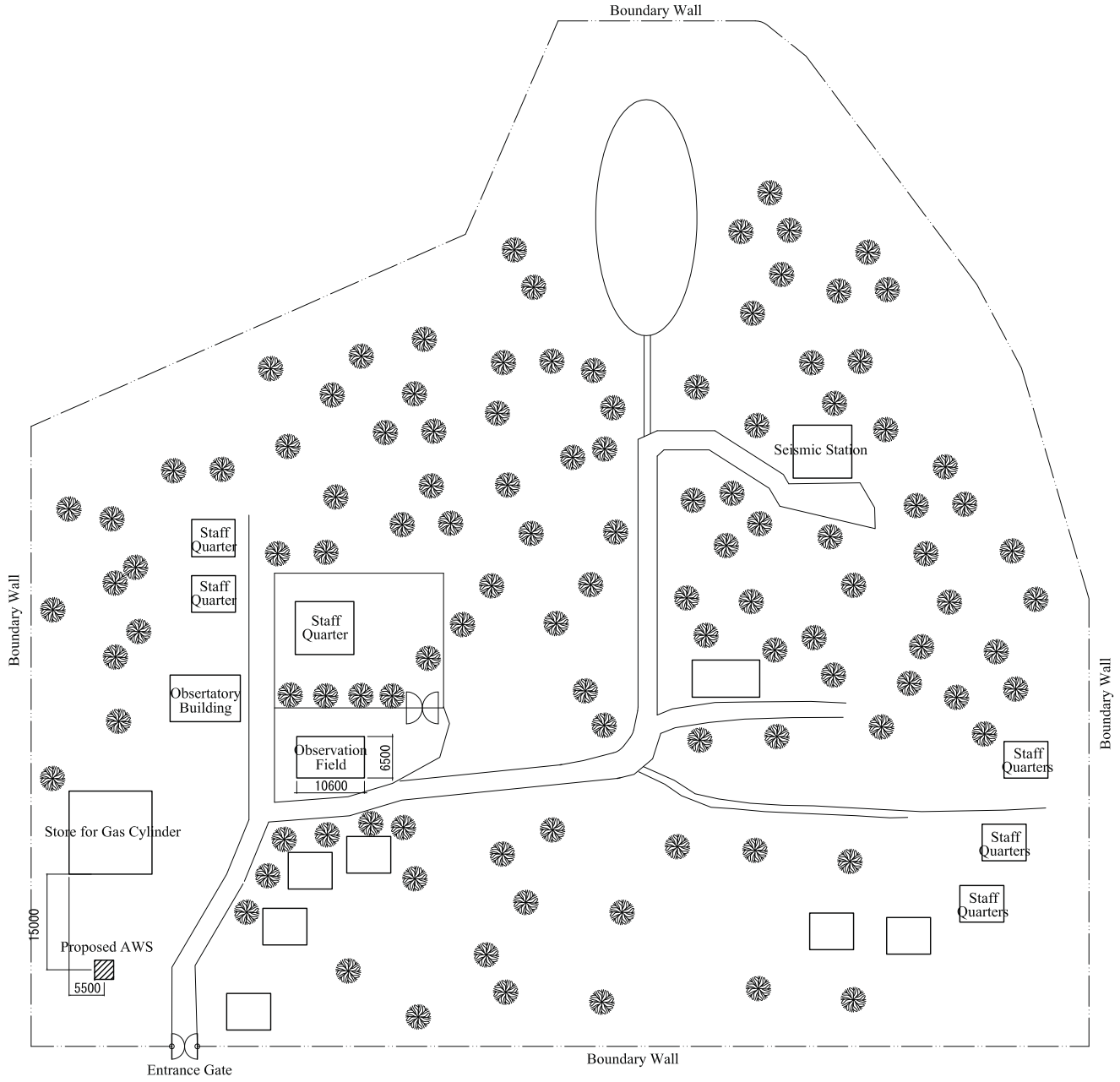




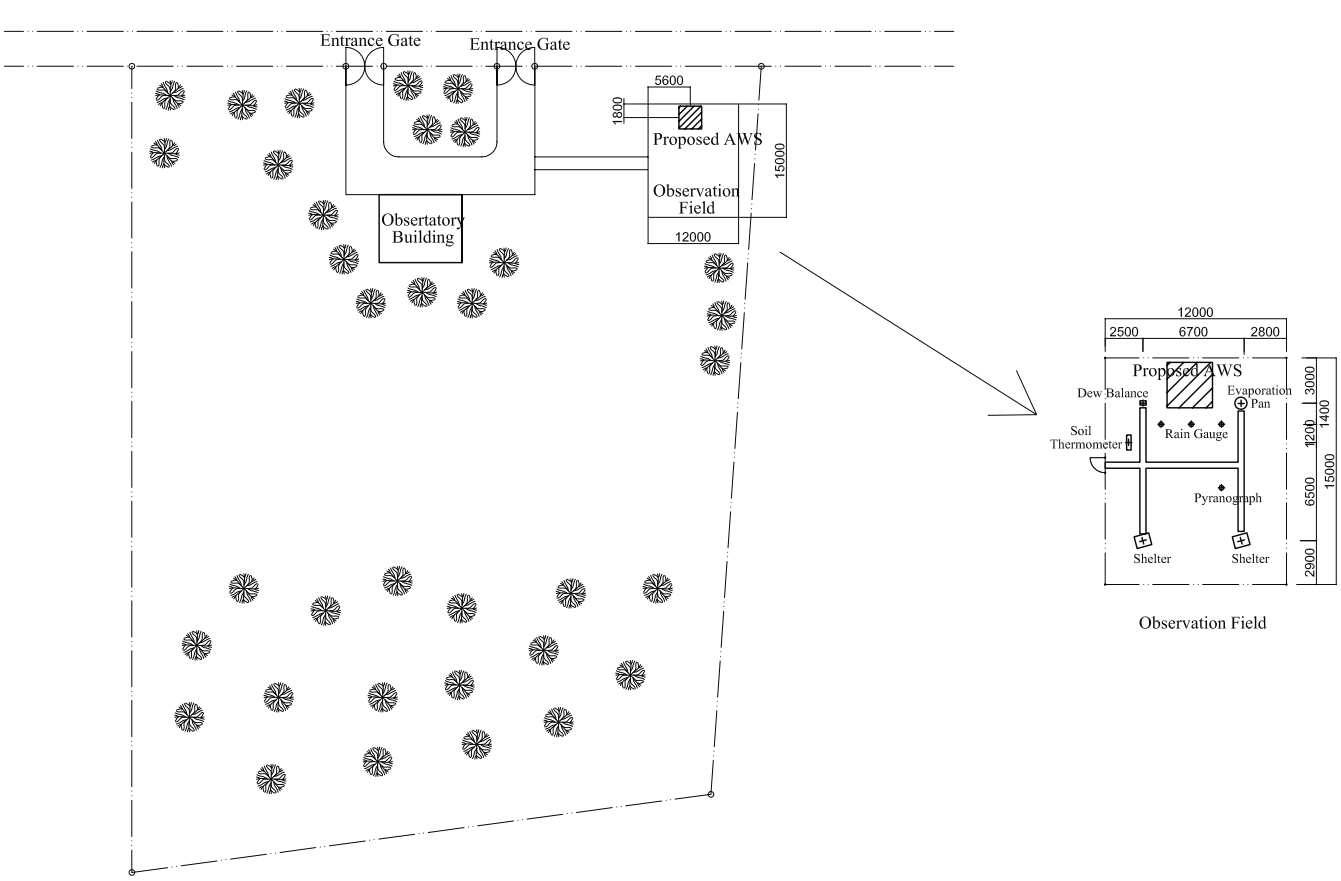
Bangladesh Meteorological Department Technical Cooperation Project for Development of Human Capacity on Operation of Weather Analysis and Forecasting	EXISTING KHULNA OBSERVATORY	DRAWING TITLE AWS LAYOUT PLAN	SCALE 1:1000	DRAWING No. -



Bangladesh Meteorological Department Technical Cooperation Project for Development of Human Capacity on Operation of Weather Analysis and Forecasting	EXISTING SYLHET OBSERVATORY	DRAWING TITLE AWS LAYOUT PLAN	SCALE 1:1000	DRAWING No. -



Bangladesh Meteorological Department Technical Cooperation Project for Development of Human Capacity on Operation of Weather Analysis and Forecasting	EXISTING CHITTAGONG OBSERVATORY	DRAWING TITLE AWS LAYOUT PLAN	SCALE 1:1000	DRAWING No. -

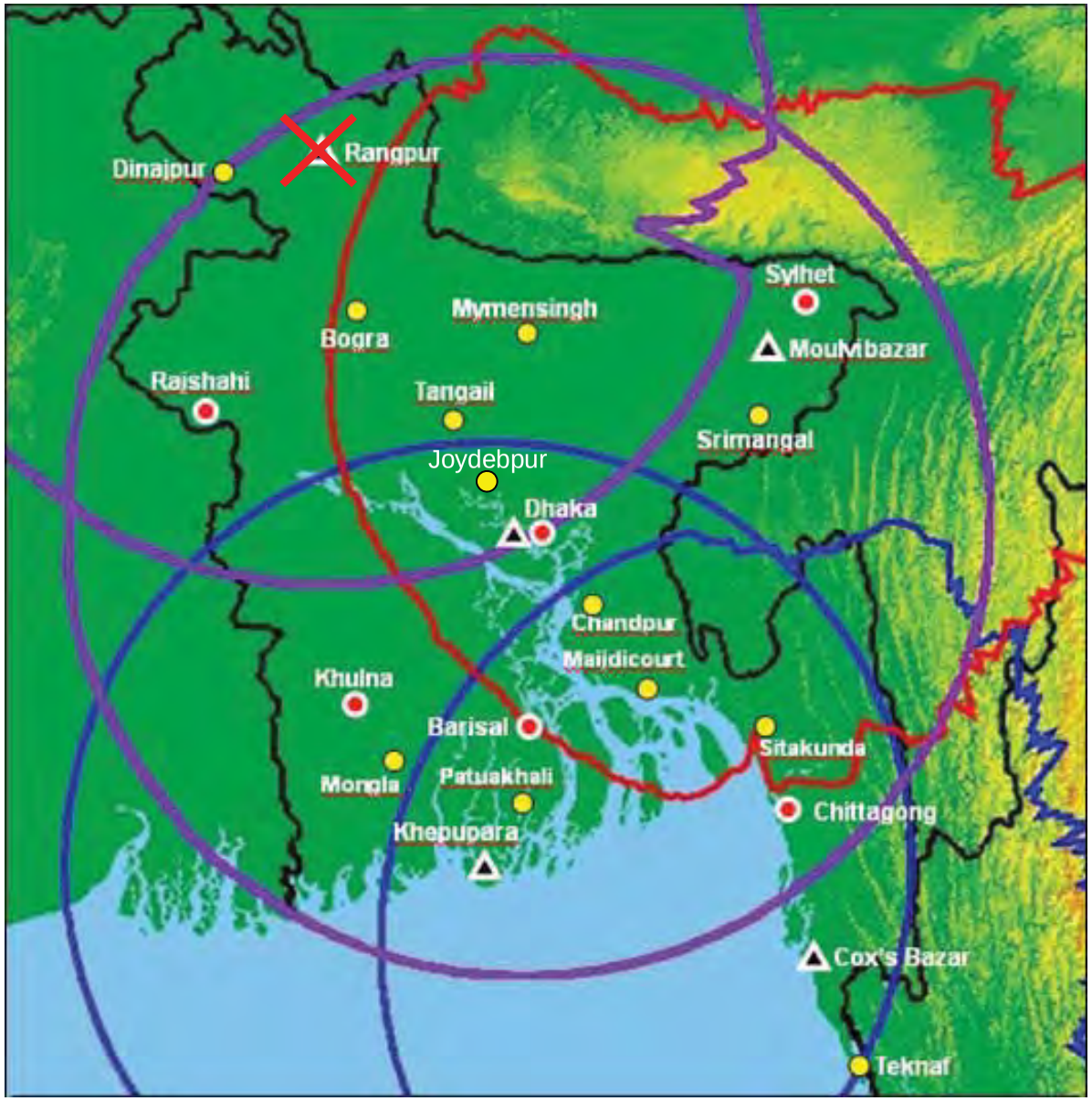


Bangladesh Meteorological Department Technical Cooperation Project for Development of Human Capacity on Operation of Weather Analysis and Forecasting	EXISTING RAJSHAHI OBSERVATORY	DRAWING TITLE AWS LAYOUT PLAN	SCALE 1:1000	DRAWING No. -

Analysis Result based on Stored Radar and Raingauge Data

- Verification of Radar Rainfall
- Calculation of parameter B and Beta

Location of radar, raingauge and AWS



- Radar: 5
- Raingauge: 12
- AWS: 6

Raingauge and AWS rainfall data are available in Weather Monitoring PC from last June.

-- Rangpur(Radar):
No observation.

(As of 23/Oct/2013)

Total observation hour coincidentally observed by radar and raingauge

Verification Period: 2012/6/1-2013/10/20（DHK,COX）
2012/6/1-2013/9/30（MLV,KHP）

Radar data and raingauge data have lots of gap each other, coincident observation hour is very short.

Maulvibazar radar is operated quite short time from 2012/6/1.

: More than 400km from the radar, or mountain shade

Radar / Raingauge	Rangpur Radar(*1)	Maulvibazar Radar	Dhaka Radar	Khepupara Radar	Cox's Bazar Radar
Dinajpur	N/A	0	12	0	Out of Range
Bogra	N/A	0	14	4	Out of Range
Mymensingh	N/A	1	**40**	20	5
Srimangal	N/A	2	36	17	18
Tangail	N/A	0	26	22	9
Joydebpur	N/A	0	**54**	9	17
Chandpur	N/A	2	34	**49**	39
Maijdicourt	N/A	0	17	21	25
Sitakunda	N/A	0	**41**	**45**	35
Mongla	N/A	0	**45**	**59**	**65**
Patuakhali	N/A	0	**51**	**65**	**62**
Teknaf	Out of Range	1	1	33	**59**
Sylhet	N/A	0	**58**	10	5
Rajshahi	N/A	0	25	3	Out of Range
Dhaka	N/A	0	**91**	21	30
Khulna	N/A	1	38	29	38
Barisal	N/A	0	**44**	**60**	**58**
Chittagong	Out of Range	1	**42**	**52**	**51**

(*1)Rangpur Radar: No operation.

(*2)Red bold number: Total hour more than 40 in white colored cell.

Correlation coefficient between the radar data and the raingauge data

CC was calculated by using data when both radar and raingauge observed rainfall.

In KHP and COX, CC in the cells of red bold number are mostly more than 0.6.

Number of data is still small, so it is desiable to operate each radar more frequently.

: More than 400km from the radar, or mountain shade

Raingauge \ Radar	Rangpur Radar(*1)	Maulvibazar Radar	Dhaka Radar	Khepupara Radar	Cox's Bazar Radar
Dinajpur	N/A	N/A	0.676	N/A	Out of Range
Bogra	N/A	N/A	−0.089	0.481	Out of Range
Mymensingh	N/A	N/A	**0.780**	0.475	0.059
Srimangal	N/A	N/A	0.152	−0.077	0.633
Tangail	N/A	N/A	0.798	0.356	−0.048
Joydebpur	N/A	N/A	**0.726**	0.802	0.545
Chandpur	N/A	N/A	0.801	**0.828**	0.774
Maijdicourt	N/A	N/A	0.823	0.797	0.820
Sitakunda	N/A	N/A	**0.531**	**0.755**	0.687
Mongla	N/A	N/A	**0.189**	**0.783**	**0.692**
Patuakhali	N/A	N/A	**0.610**	**0.845**	**0.744**
Teknaf	Out of Range	N/A	N/A	0.684	**0.849**
Sylhet	N/A	N/A	**0.450**	−0.192	−0.426
Rajshahi	N/A	N/A	0.707	0.327	Out of Range
Dhaka	N/A	N/A	**−0.183**	0.736	0.519
Khulna	N/A	N/A	0.395	0.293	0.433
Barisal	N/A	N/A	**0.605**	**0.683**	**0.641**
Chittagong	Out of Range	N/A	**0.248**	**0.710**	**0.497**

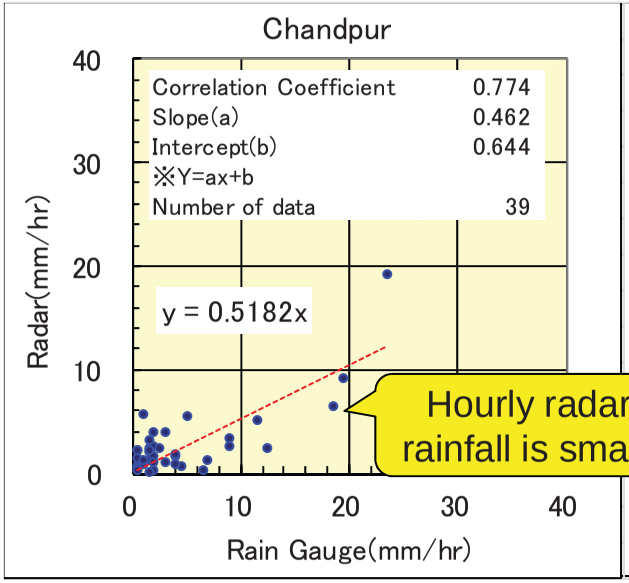
Formula for Correlation coefficient between the radar data and the raingauge data

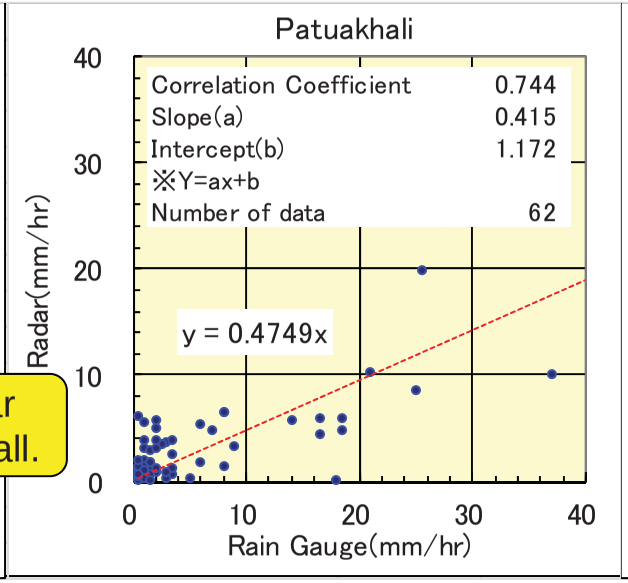
$$CC = \frac{\sum (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum (x_i - \bar{x})^2} \sqrt{\sum (y_i - \bar{y})^2}}$$

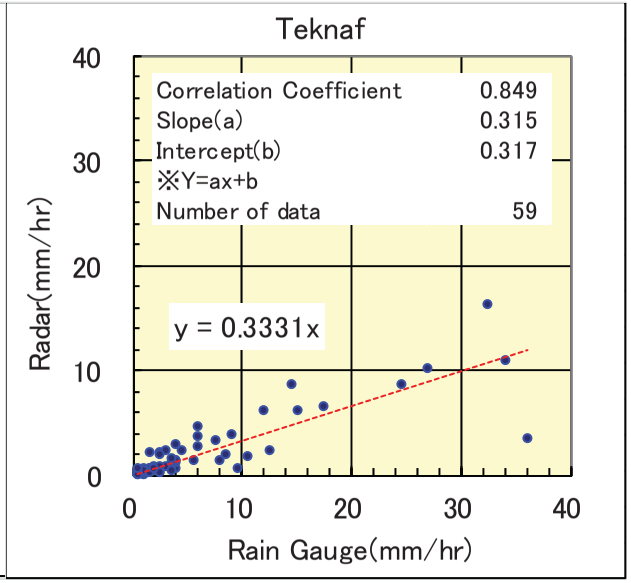
CC: correlation coefficient　　x: raingauge data(mm/h)

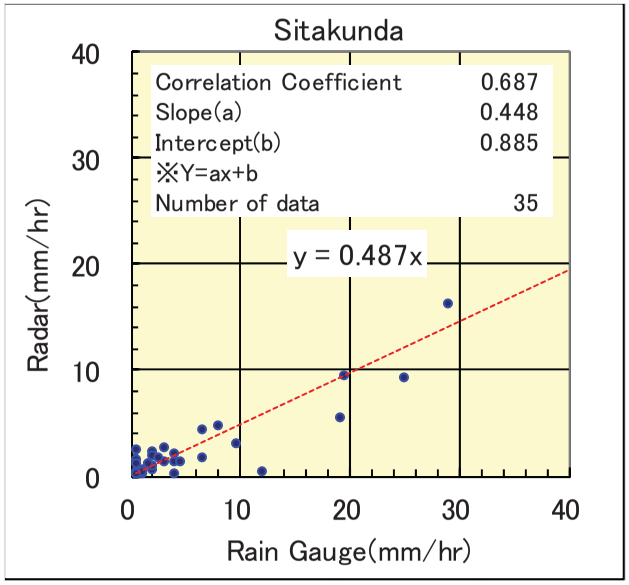
y: radar data(mm/h)　　$\bar{x}$, $\bar{y}$: avarage of x, y

Comparison of hourly rainfall between Cox's Bazar Radar and raingauges





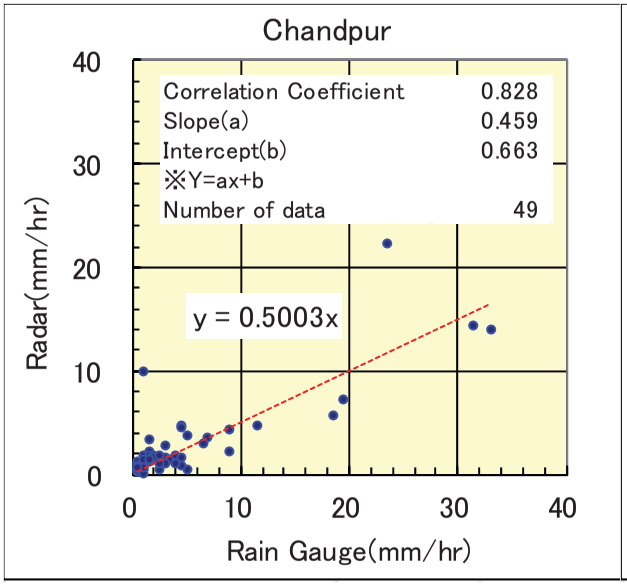


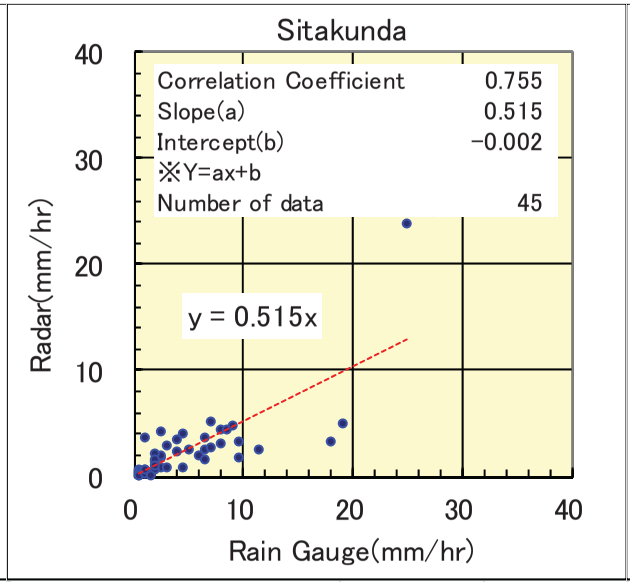


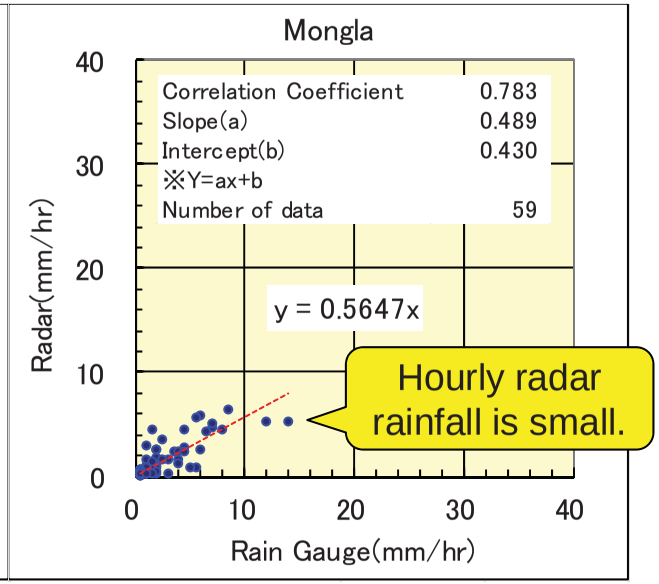
Radar rainfall is quite smaller than raingauge rainfall.
Correlation coefficient is more than 0.7 at some raingauge point.

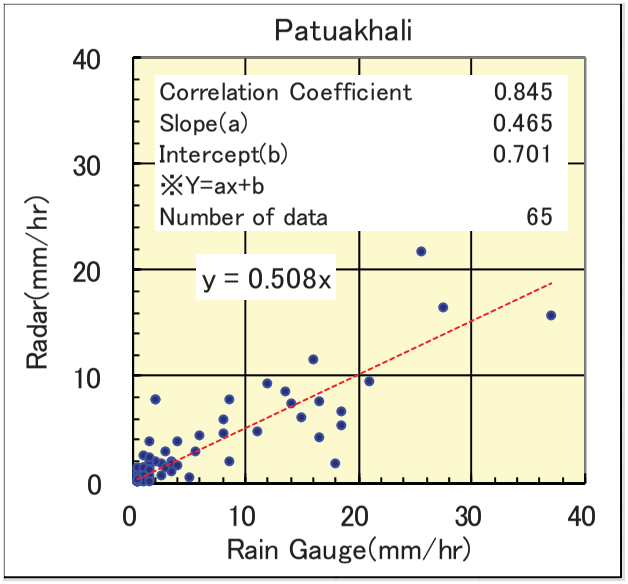
⇒Parameter B and Beta of COX radar should be optimized.

Comparison of hourly rainfall between Khepupara Radar and raingauges





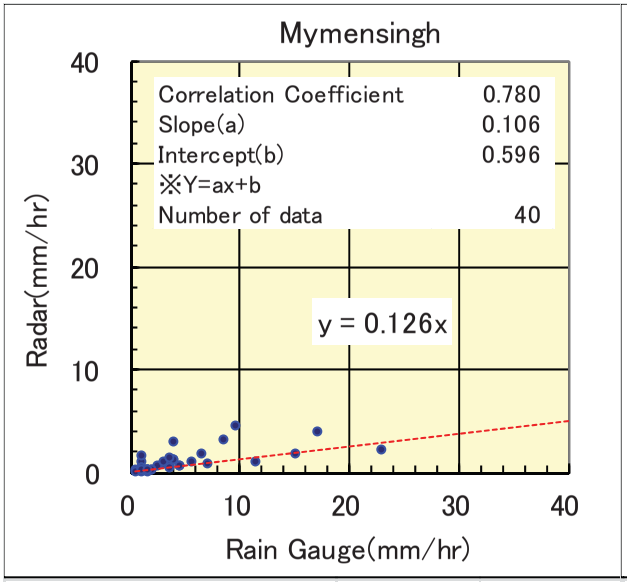


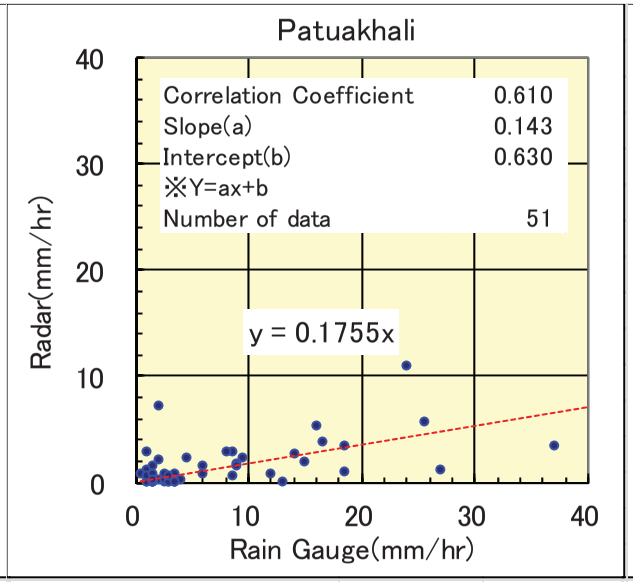


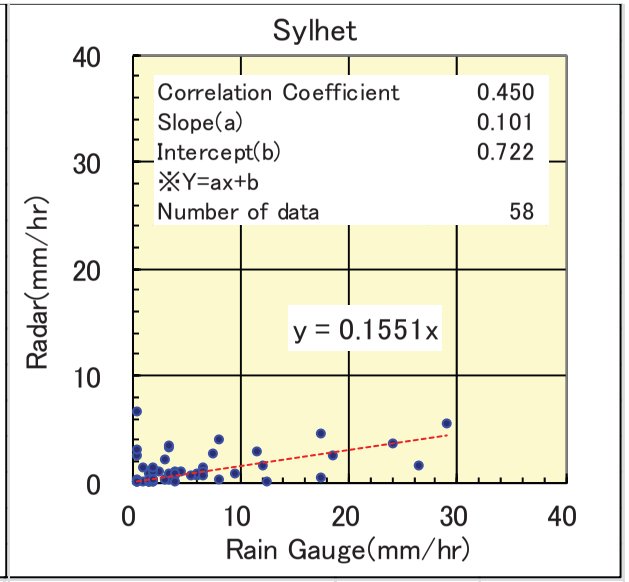
Correlation coefficient is more than 0.7 at most of raingauge point.
But radar rainfall is quite smaller than raingauge rainfall as COX radar.

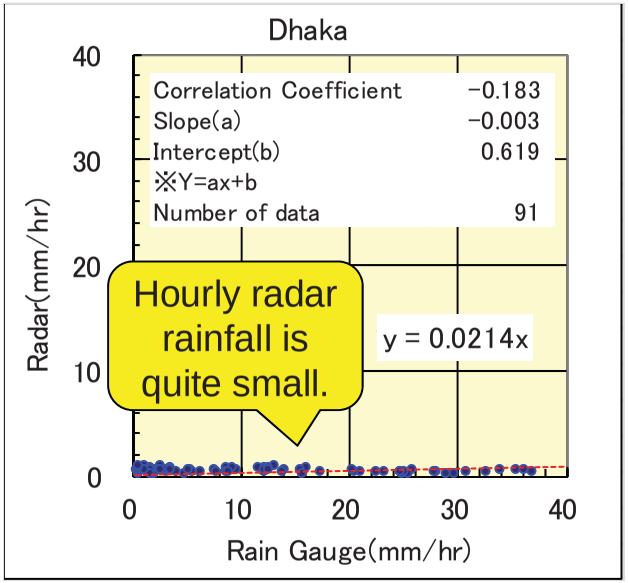
⇒Parameter B and Beta of KHP radar should be optimized.

Comparison of hourly rainfall between Dhaka Radar and raingauges









Dhaka radar rainfall is quite smaller than raingauge rainfall.
Moreover, Dhaka radar doesn't have good relationship with raingauge data at most raingauge point.

⇒ At DHK radar, parameter B and Beta cannot be calculated.

Choice of good relationship between radar and raingauge

COX radar

Verification Period: 2012/6/1-2013/10/20

RG/AWS station	CC （≧0.70）	Number （≧20）
Chandpur	0.77	39
Maidicourt	0.82	25
Patuakhali	0.74	62
Teknaf	0.85	59

KHP radar

Verification Period: 2012/6/1-2013/9/30

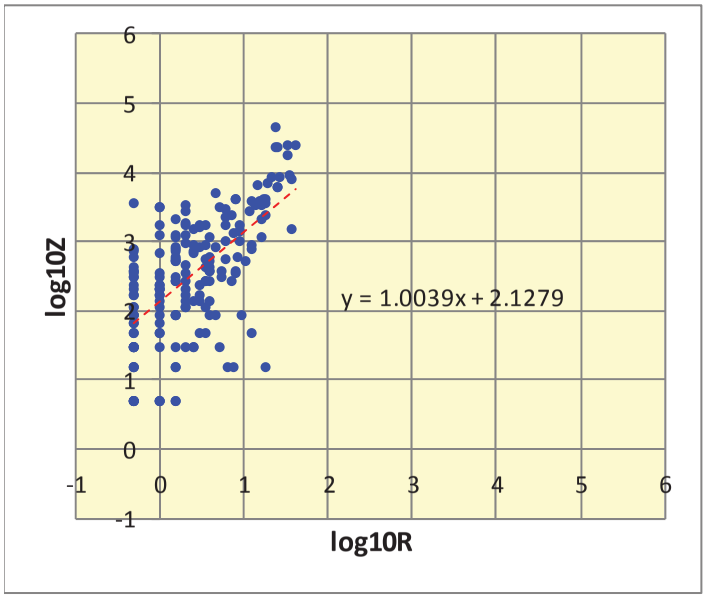
RG/AWS station	CC （≧0.70）	Number （≧20）
Chandpur	0.83	49
Maidicourt	0.80	21
Sitakunda	0.76	45
Mongla	0.78	59
Patuakhali	0.85	65
Dhaka	0.74	21
Chittagong	0.71	52

At COX and KHP radar, calculate B and Beta using radar and raingauge data at these point.

Result of B and Beta at COX and KHP radar

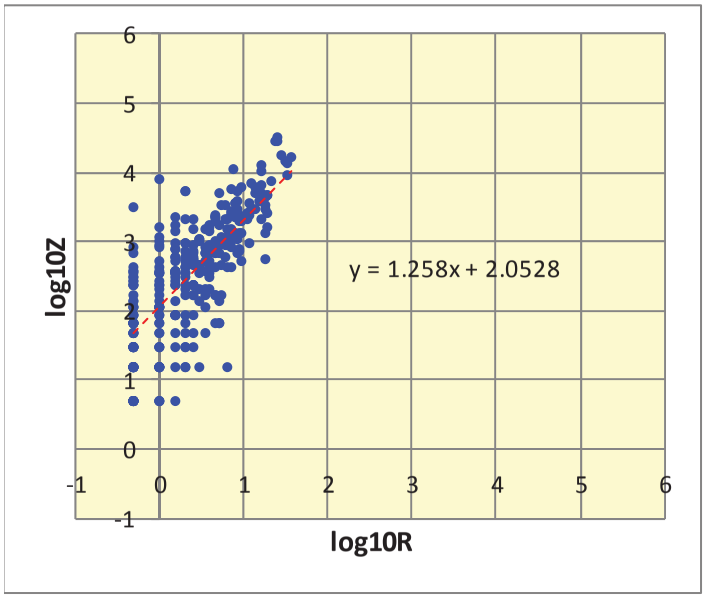
At COX and KHP, calculate log10Z and log10R with radar and raingauge data at above-mentioned point.

＜ ALL DATA of COX＞



Correlation Coefficien	0.620		
Slope(a)	1.004	New B=	134.2
Intercept(b)	2.128	New Beta=	1.00
※Y=ax+b			
Number of data	185		

＜ ALL DATA of KHP＞



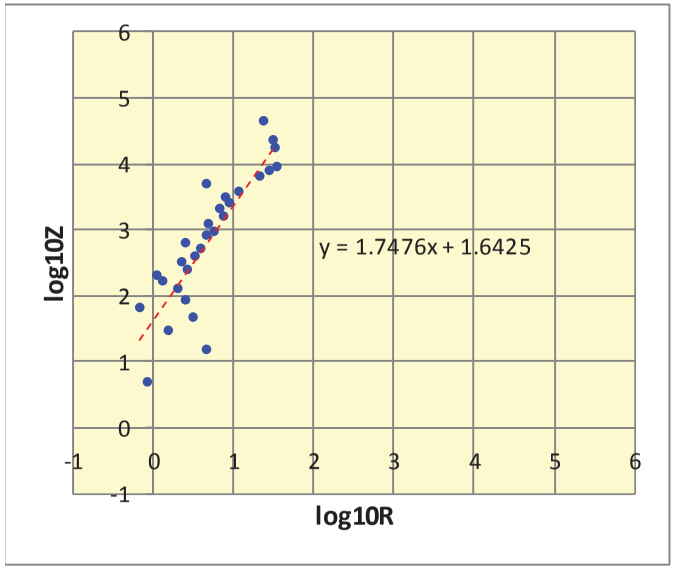
Correlation Coefficien	0.739		
Slope(a)	1.258	New B=	112.9
Intercept(b)	2.053	New Beta=	1.26
※Y=ax+b			
Number of data	312		

In the scattergram, dispersion is so wide that regression line doesn't make sense.

Result of B and Beta at COX and KHP radar

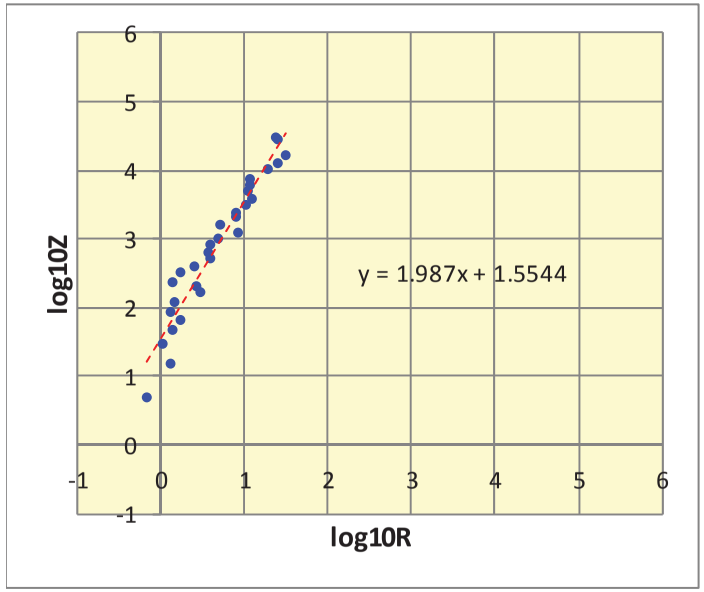
Averaged log10R and log10Z at each layer of log10Z indicated good relationship and B and Beta could be calculated.

＜ Stratification result for COX ＞



Correlation Coefficien	0.862
Slope(a)	1.748
Intercept(b)	1.642
※Y=ax+b	
Number of data	29
New B=	43.9
New Beta=	1.75

＜ Stratification result for KHP ＞

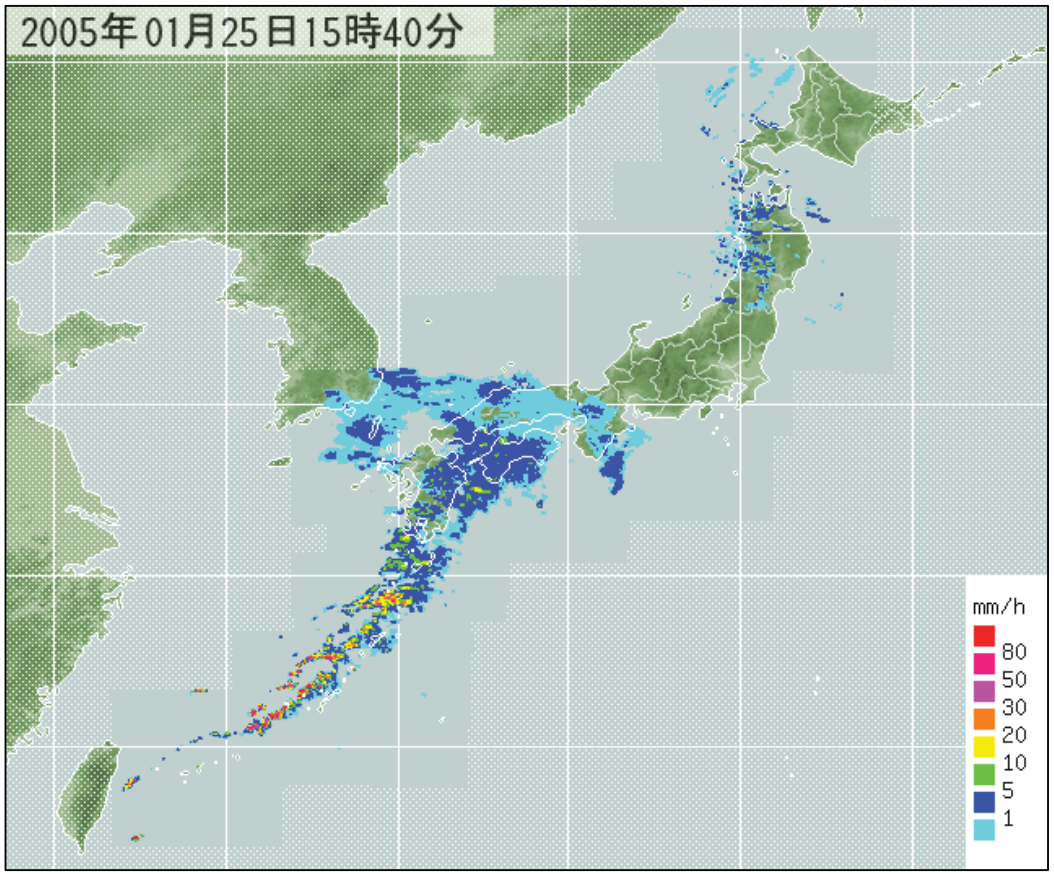


Correlation Coefficien	0.965
Slope(a)	1.987
Intercept(b)	1.554
※Y=ax+b	
Number of data	30
New B=	35.8
New Beta=	1.99

B and Beta value at COX and KHP are very close.
⇒Nationally-standardized parameter is configured as
B＝40, β＝1.9!!!

Radar Calibration

--- Overview and Plan in this Project ---



September 2010 at BMD

Takayuki Otsu
Disaster Prevention Section
Disaster Prevention Department
Japan Weather Association

Outline

- Overview of Radar Calibration
  ---What is “Radar Calibration” ?

- “Radar Calibration” in this project

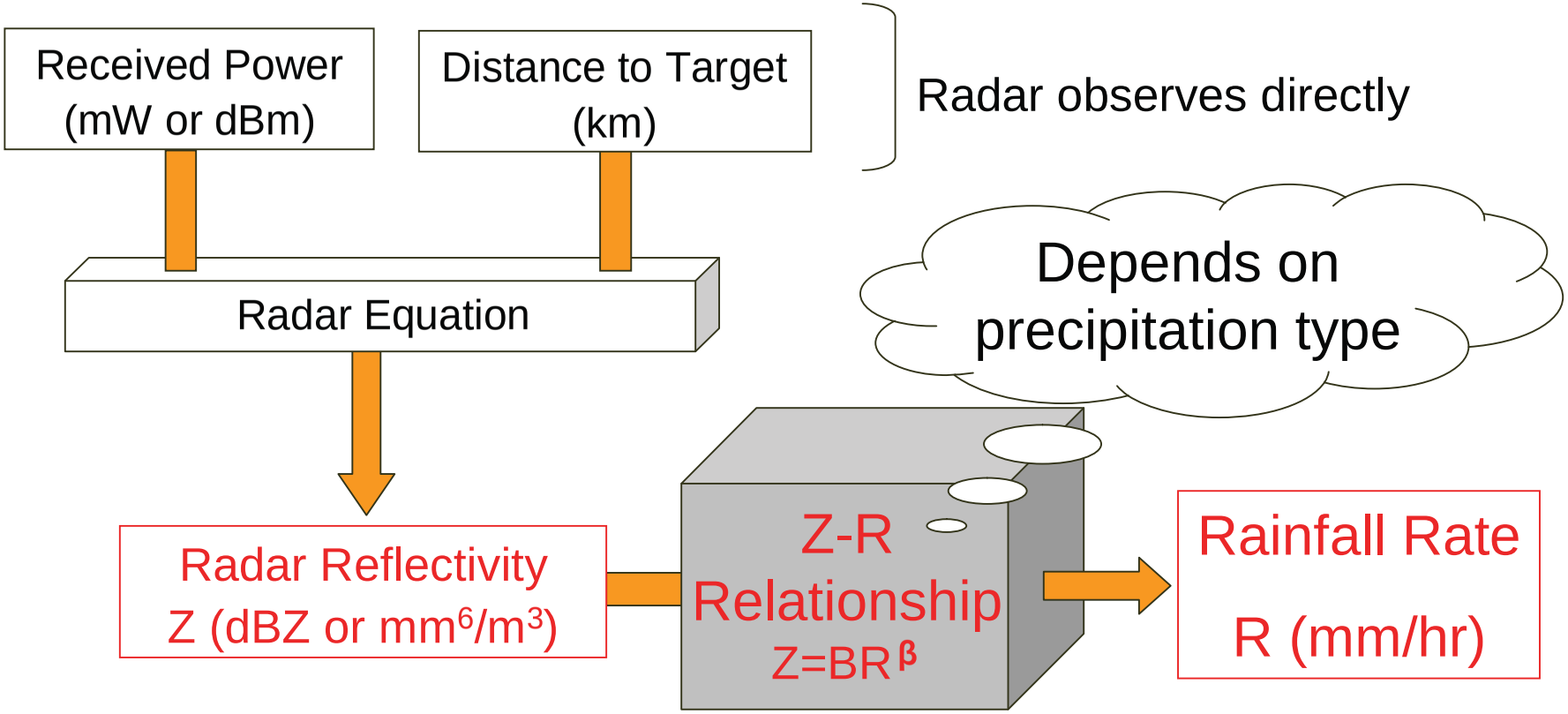
- Planned Schedule
  - Rough schedule until 2012
  - Work in 2010

- Review of radar theory
  - What is the radar reflectivity “Z”?
  - Detail of Z-R relationship

Overview of Radar Calibration

Why Radar Calibration is needed?

Radar can observe distribution of rainfall, but can not observe accurate rainfall rate.



Overview of Radar Calibration

What is the Z-R relationship?

rainfall rate is estimate from radar reflectivity using some assumption (B and beta).

$$Z=BR^{\beta}$$

Z: Radar Reflectivity Factor(mm^6/m^3)

R: Rainfall Rate(mm/hour)

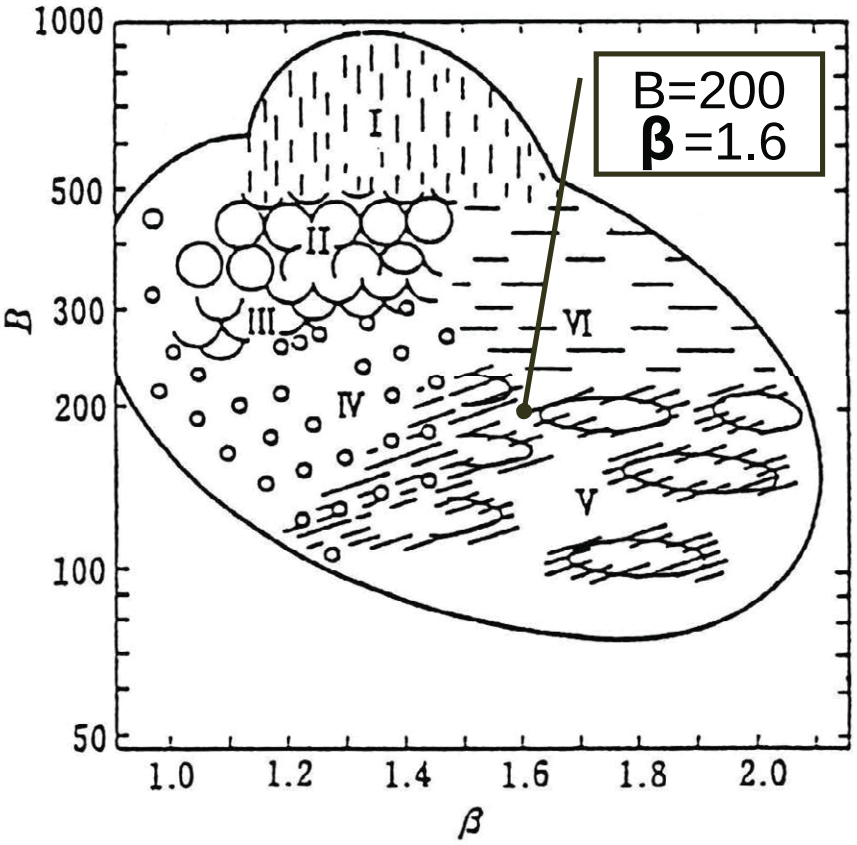
B, β: Constant but depending on drop size distribution

→ Assumption of B and β is needed

→ The detail will be explained later in “radar theory”

Overview of Radar Calibration

- Variation of Z-R relationship



Fujiwara,1965

I . Stratiform part of thunder storm or high convective echo in dry air

II .Heavy rain in the center of thunder storm or strong aggregated echo

III.Convective cells in the initiation or developing stage

IV.Small convective cells isolated or organized to line

V .Stratiform or weak,diffused echo

VI. Stratiform rain at dissipating stage of thunder storm

Overview of Radar Calibration

We need to check the relation between radar value and rain gauge value.

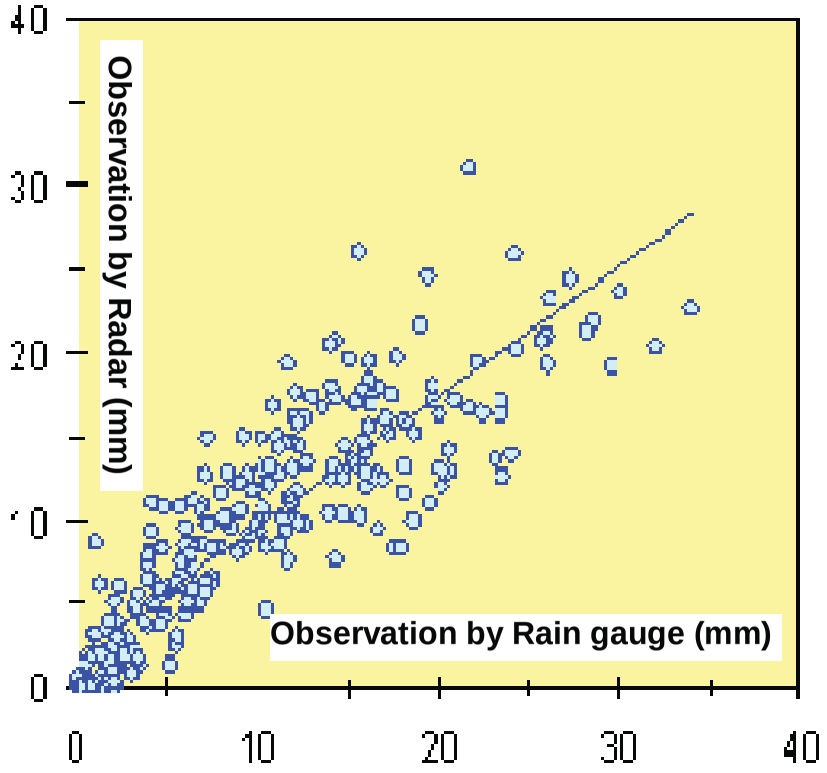
Compare Radar Value with Rain Gauge Data.

If there are large difference between radar and rain gauge, we would try to find more appropriate B and β value.

“Radar Calibration” in this project

- Checking the correlation between radar and rain gauge value to optimize rainfall value observed by radar.

- To optimize radar data, B and β value in BMD’s radar system would be modified, if necessary.



“Radar Calibration” in this project

How?

1. **Store radar data in Analysis PC.**
2. **Pick radar value over rain gauge.**
3. **Output picked radar value.**

Programs made by expert

4. **Collect data observed by rain gauge.**
5. **Compare radar value with rain gauge data**

Excel

“Radar Calibration” in this project

1. Store radar data in Analysis PC.

- Hourly rain accumulation(RAIN1) product files are created in “National Composite Processor”

  Old files are deleted automatically.

- Those files are copied to the analysis PC automatically in daily basis by FTP.

--- Detail ---

The C-shell script “/home/bmd/autoftp.csh” do it.

This script is invoked at 8:30 by “crontab”

“Radar Calibration” in this project

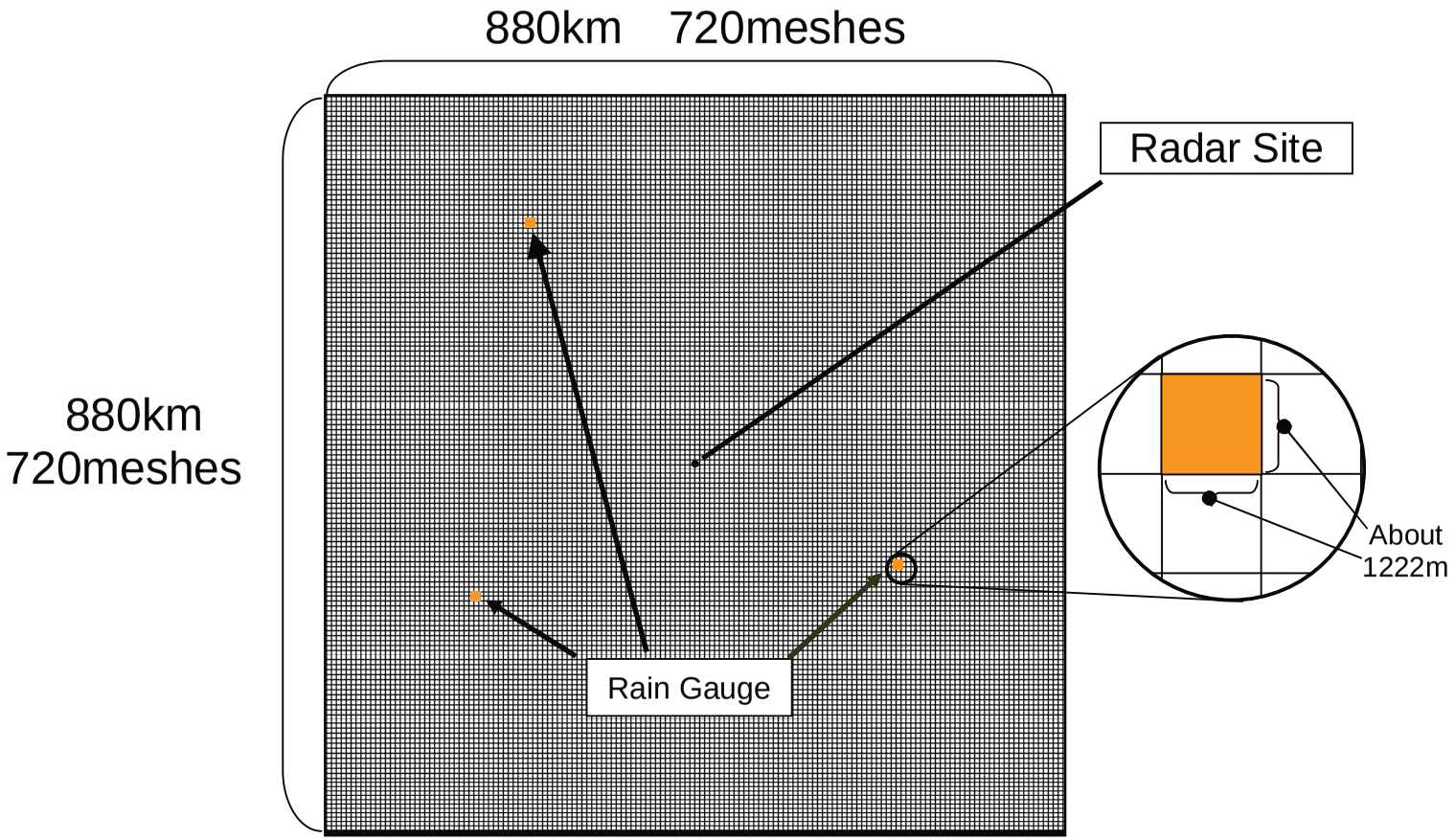
1. Store radar data in Analysis PC.

Analysis PC (in SWC)

“Radar Calibration” in this project

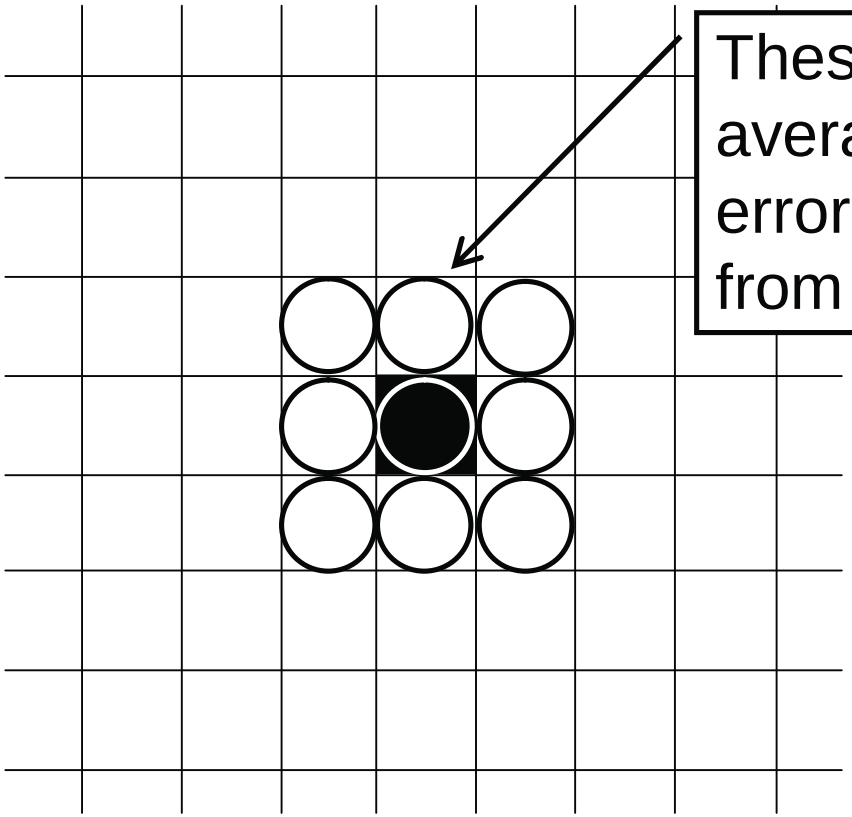
2.Pick radar value over rain gauge.

Conceptual structure of data



“Radar Calibration” in this project

2. Pick radar value over rain gauge.



These 9 meshes are picked and averaged to mitigate location error and advection of raindrops from neighboring mesh

■ Mesh on rain gauge station

3.Output picked radar value.

Radar value over rain gauge would be output as “csv format” to analyze using “Excel”

Example)

```
month,day,hour,rainfall
6,13,17,  3.3
6,13,18,  0.0
6,13,19,  0.0
6,13,20,  0.0
6,13,21,  5.0
6,13,22,14.2
6,13,23,12.0
6,14,0,25.4
      :
      :
```

Microsoft Excel can read this format which values are divided by comma.

“Radar Calibration” in this project

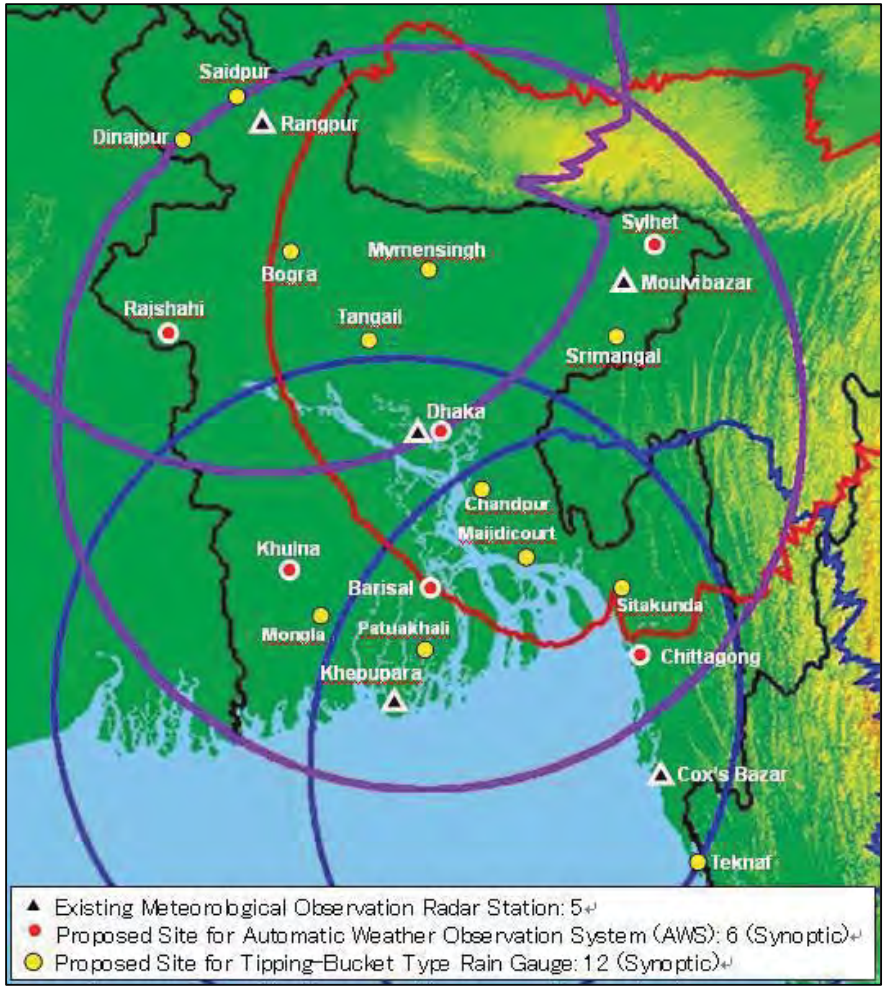
4.Collect data observed by rain gauge.

- **Hourly rain gauge data is necessary to compare with hourly radar data.**

- **Hourly rain gauge data would be collected after new automated rain gauges are installed.**

“Radar Calibration” in this project

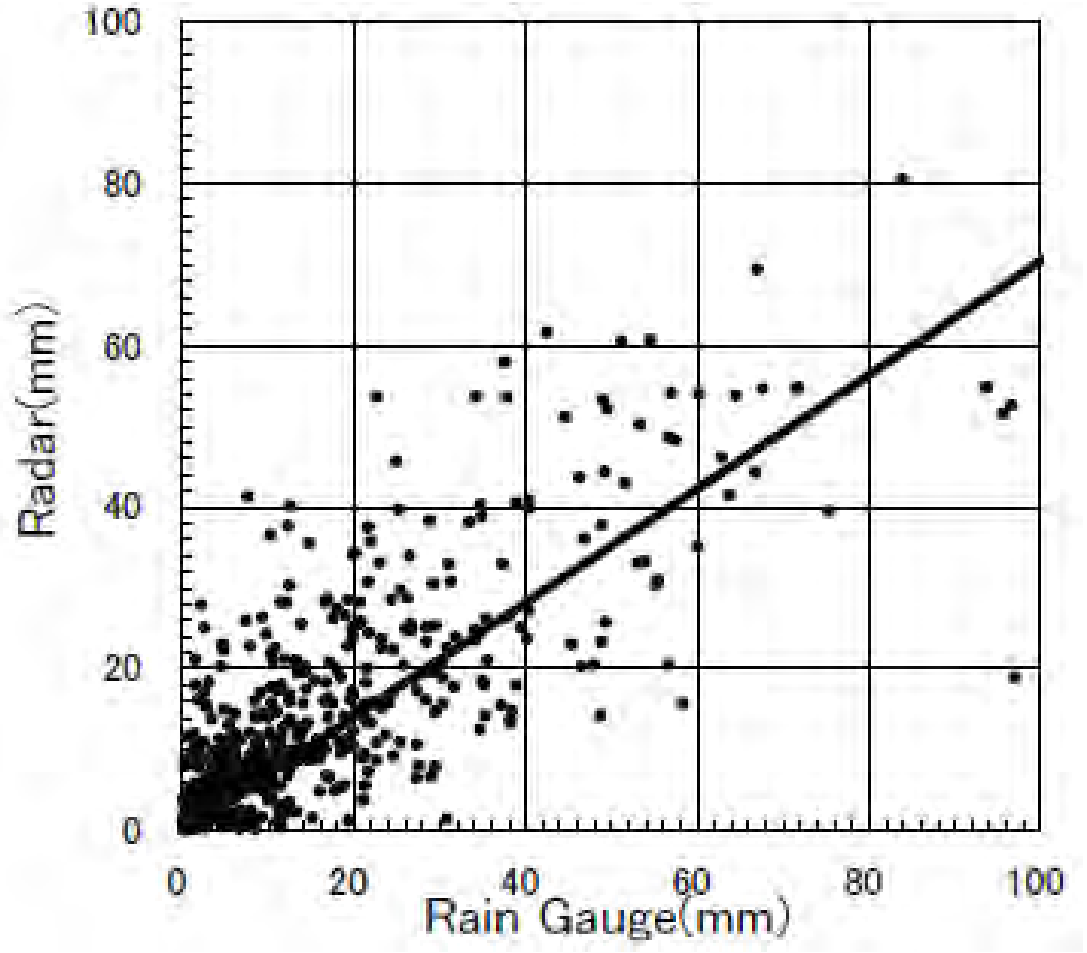
4.Collect data observed by rain gauge.



18 rain gauge station is planed

“Radar Calibration” in this project

5.Compare radar value with rain gauge data

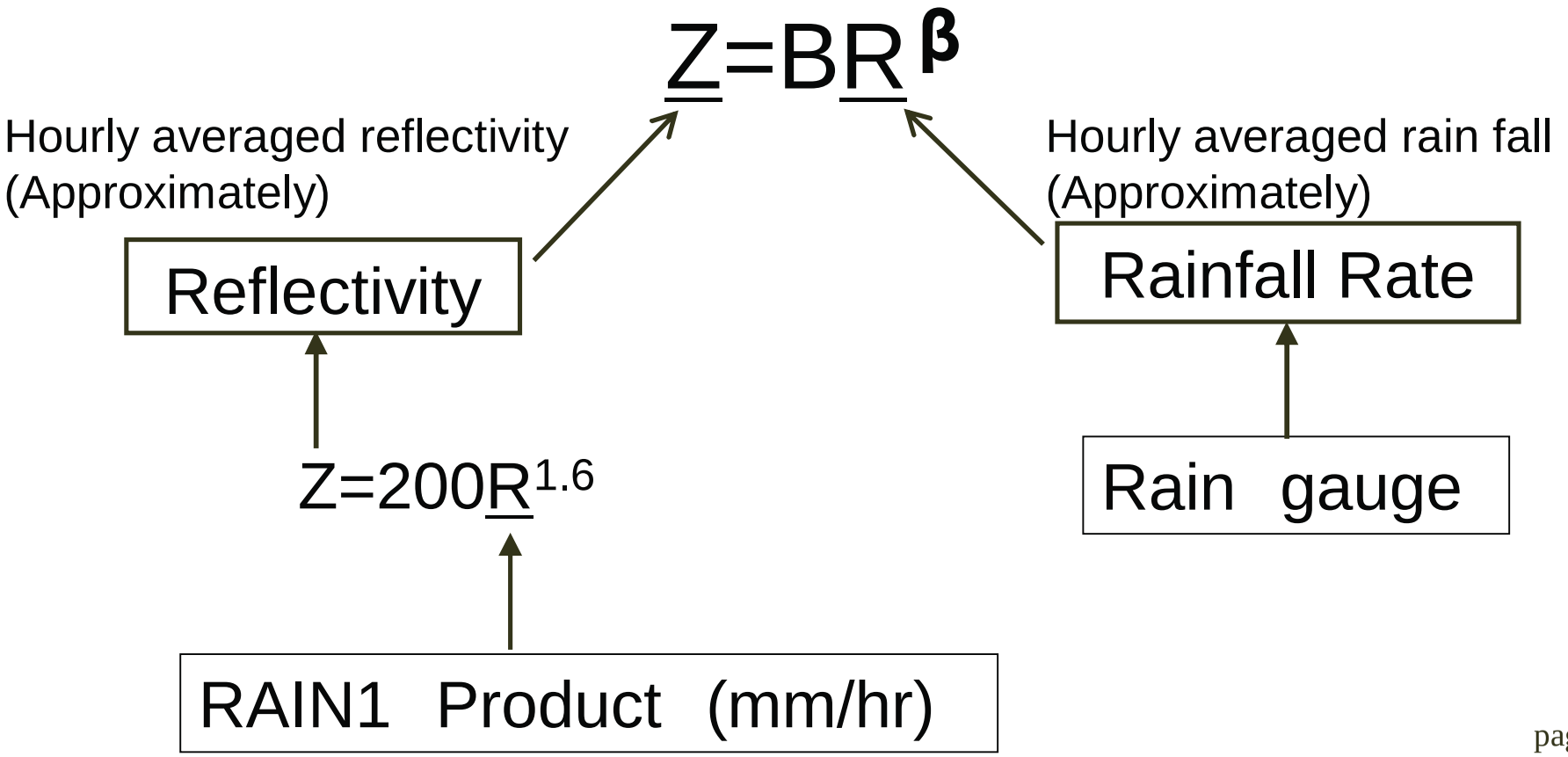


Microsoft Excel would be used for this analysis

“Radar Calibration” in this project

5.Compare radar value with rain gauge data --- Search for better B and β

B and β can be decided statistically (least square method)



Planned Schedule – Rough Schedule until 2012

2010

Automated rain gauges would be installed.

Expert will set up the "Analysis PC" and this PC will start to store radar data automatically.

2011

Expert will make the program and try to compare radar data with rain gauge data.

Expert and counterparts will discuss about the result and the way to analysis.

2012

Analysis and discussion would be Continued. We would try to make new RAIN1 product with new B and beta.

Planned Schedule – Schedule in 2010

2010

- **Introduction for overview of radar calibration.**
- **Checking the data format, radar system in BMD.**
- **Setting up the Analysis PC for radar calibration**
- **Start to make programs for analysis**
- **Start to Install rain gauge**

Review of radar theory

- Z-R relationship
  - What is the radar reflectivity “Z”?
  - Detail of Z-R relationship

How to estimate the rainfall rate from radar data

- Equation of Z-R relationship

$$Z = BR^{\beta}$$

Usually,
dBZ is used.

Z:Radar reflectivity factor(mm^6/m^3 NOT dBZ)

(or just called as “reflectivity”)

R:Rainfall rate(mm/hour)

B, β :Constant

Representative value:B=200, β =1.6

B:80~1000 β :1.0~2.0 (for rain)

Radar Reflectivity Factor “Z” –What is the “Z”?–

- Definition of “Z”

$$Z = \sum_{VOL} D^6 \quad (= \sum_{VOL} D_i^6) \quad (mm^6/m^3)$$

D_i:Diameter of each drops

$\sum_{VOL}$:Summation over $1m^3$(or unit volume)

Increasing the number of drop or diameter of drops make “Z” larger.

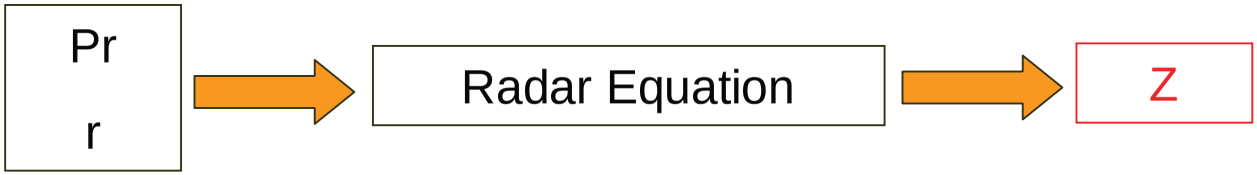
“Z” can be measured by weather radar.

Why is Z defined as “$Z = \sum D^6$”?

To discuss it,we need to return “Radar Equation”.

Radar Reflectivity Factor “Z” –What is the “Z”? –

- What is the “Radar Equation”?



Pr:Received power(mW or dBm)
r:Range from radar to target(km)
usually “dBm” is used as unit of “Pr”
These values can be directly measured by radar.

Z:Radar reflectivity factor
(mm^6/m^3 or dBZ)
usually “dBZ” is used as unit of “Z”

Usually “Z” is calculated by each radar system automatically.
We can get “Z” without caring about radar equation!
But it is useful for our understanding to discuss it.

Radar Reflectivity Factor “Z” –What is the “Z”? –

- Radar equation

$$\mathrm{Pr} = \frac{\pi^3 P_t G^2 \theta \phi h |K|^2}{2^{10} \log_e 2 \cdot \lambda^2 r^2} \sum_{vol} D_i^{\,6}$$

$$= \frac{\pi^3 P_t G^2 \theta \phi h |K|^2}{2^{10} \log_e 2 \cdot \lambda^2 r^2} Z$$

OBSERVED

Pr: Received power r: Range from radar to target

CONSTANT

Pt: Transmitted power G: Antenna gain **λ**: Wave length

θ φ: Beam width in horizontal and vertical direction

h: Pulse length $|K|^2$=0.930 for water (rain)

ESTIMATED

Σ D_i^6: Summation of the 6th power of droplet diameter

Σ D^6 is defined as reflectivity “Z”

Radar Reflectivity Factor “Z” –What is the “Z”? –

- Simplified radar equation

$$Pr = \frac{\pi^3 P_t G^2 \theta \phi h |K|^2}{2^{10} \log_e 2 \cdot \lambda^2 r^2} Z$$

$$= \frac{C|K|^2}{r^2} Z \quad \text{or} \quad = \frac{C}{r^2} Z$$

Where $$C = \frac{\pi^3 P_t G^2 \theta \phi h |K|^2}{2^{10} \log_e 2 \cdot \lambda^2} \quad \text{or} \quad = \frac{\pi^3 P_t G^2 \theta \phi h}{2^{10} \log_e 2 \cdot \lambda^2}$$

C is called “radar constant” because C is constant depending on each radar system.

It is easy way to calculate the radar equation.

Representation of “Z” value. –Why is the “dBZ” used? –

- Unit of “Z”

Usually Z is represented in the unit “dBZ” as following.

$$Z_{dBZ}=10\log_{10}Z \ (dBZ)$$

Take care!!

Z_{dBZ} is also called reflectivity!

The word “reflectivity” is used for Z_{dBZ} usually.

And it is also expressed as “Z”!

When you apply “Z”(dBZ) to Z-R relationship,you must convert Z(dBZ) to Z(mm^6/m^3).

$$Z = 10^{\frac{Z_{dBZ}}{10}} \ (mm^6/m^3)$$

Representation of “Z” value. –Why is the “dBZ” used? –

- Why is the unit “dBZ” used?

Reason 1

To shorten the range of “Z”

@Minimum: around $10^{-3}(mm^6/m^3)$

Ex.) fog or cloud droplet

Although normal weather radar can’t detect such small particles.

@Maximum:around 10^7 (mm^6/m^3)

Ex.) very large hail as large as softball

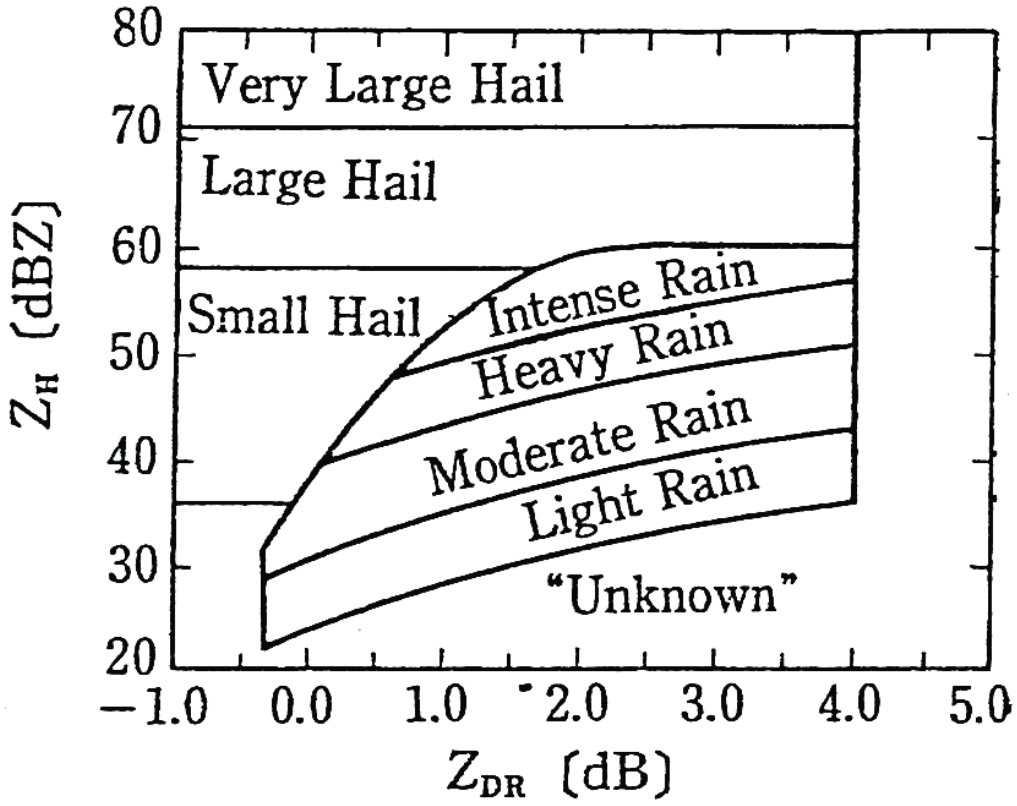
Although such hail is very rare…

In dBZ

Z ranging from –30dBZ to 70dBZ (10dBZ to 60dBZ will make sense in my experience.)

Representation of “Z” value. –Why is the “dBZ” used? –

- Example of the relation between reflectivity and precipitation type(Please neglect Z_{DR})



Lipschutz,Pratte and Smart,1986

Representation of “Z” value. –Why is the “dBZ” used? –

- Why is the unit “dBZ” used?

Reason 2

To treat the radar equation easily

radar equation using dBZ unit.

$$10\log Pr = 10\log C + 10\log r^{-2} + 10\log Z$$

Changing the unit of Pr from (mW) to (dBm)

$$Pr_{(dBm)} = 10\log Pr_{(mW)}$$

$$Z_{(dBZ)} = Pr_{(dBm)} - 10\log C + 20\log r$$

Usually,”dBm” is used for the unit of Pr rather than “mW”

Z-R Relationship

- First suggestion of Z-R relationship

Marshall et al.(1947) suggested the equation of Z-R relationship first.

$$Z=BR^{\beta}$$

Z:Radar reflectivity factor(mm^6/m^3)

R:Rainfall rate(mm/hour)

B, β :Constant

At that time,they showed B=190, β =1.72 empirically.

Marshall et al.,1947:Measurement of rainfall by radar. J. Meteor.,4,186-192

Z-R Relationship

- Coupling between Drop-size distribution and Z-R relationship

Marshall and Palmer(1948) showed that drop-size distribution can be represented by exponential distribution approximately.

$$N_D = N_0 \exp(-\Lambda D)$$

N_D:Number of droplets of diameter D(mm)

N_0:Constant they showed the value 0.08(cm^{-4}).

$\Lambda = 41R^{-0.21}$ R:Rainfall rate(mm/hour)

Drop-size distribution is only decided by rainfall rate.

$Z(\Sigma D^6)$ can be calculated from drop size distribution.

→ Z can be represented using only R(mm/hr)

Marshall and Palmer,1948:The distribution of raindrops with size. J. Meteor., 5,165-166.

Z-R Relationship

- Z-R Relationship in Marshall and Palmer(1948)

$$Z = \sum_{vol} D_i^{\,6} = \int D^6 N_D dD$$

$$= N_0 \Lambda^{-7} (7-1)!$$

$$= 296 R^{1.47}$$ Same form as $Z=BR^{\beta}$

If N_0 or Λ change,B and β also change.

In other words,

if drop-size distribution change, B and β also change.

And drop-size distribution depends on the type of precipitation.

Z-R Relationship

- Representative value of B and β

Marshall et al.(1955) suggested that moderate value of B and β.

B=200 β=1.6

Today these values are used as standard.

These value are useful for rough estimation of rainfall.

But we should remember that its variation is large.

In case of snow,following values are used as standard.

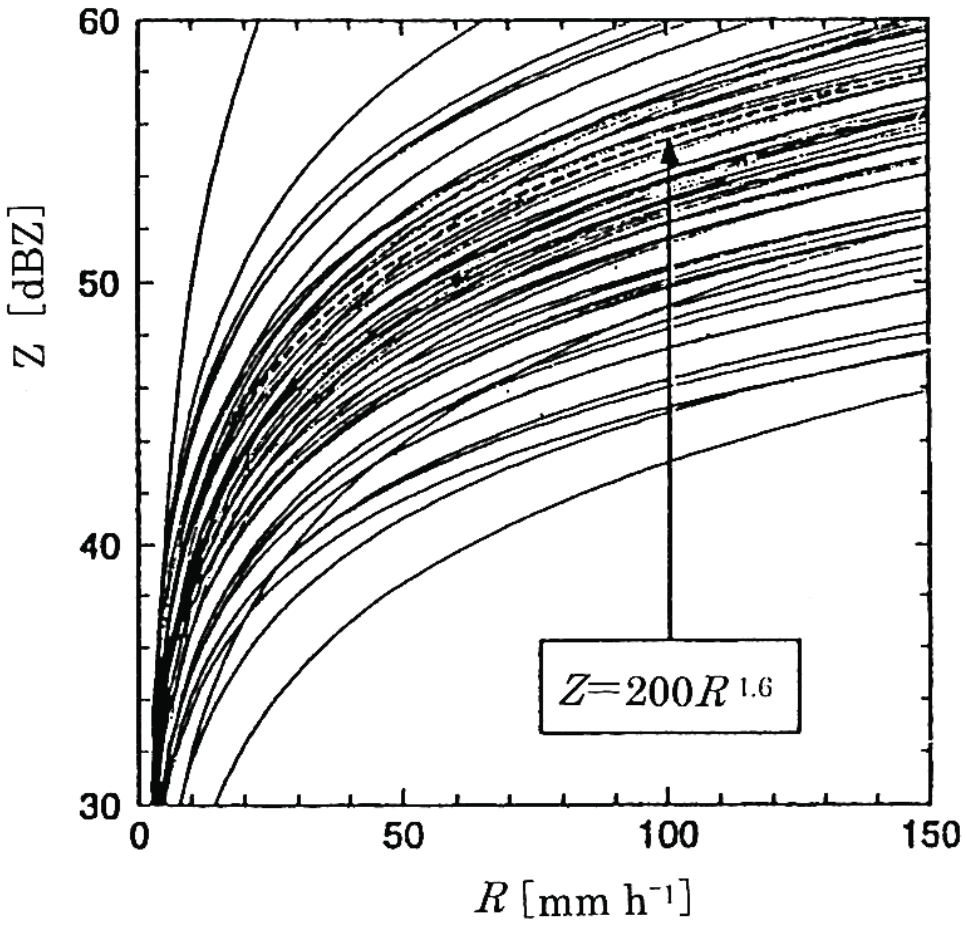
B=2000 β=2.0 Gunn and Marshall(1958)

Marshall et al.,1955:Advances in Radar Weather.Adv. Geophys.,2,1-56

Gunn and Marshall,1958:The distribution of size of aggregate snowflakes.J.Meteor.,15,452-466

Z-R Relationship

- Variation of Z-R relationship



Summary of Z-R relationship

- Rainfall rate can be estimated by Z-R relationship from radar reflectivity Z

- Because of variation of Z-R relationship,we can NOT get accurate rainfall rate from reflectivity only.

- Z-R relationship depends on drop-size distribution.And drop size distribution depends on type of precipitation.

Thank you!

Calculation of Atmospheric Pressure
for Fixed-Cistern Type (Kew Type) Barometer

	Legend	
P_{BC}	**Barometer Cistern Level Pressure**	hPa
B	Observed Barometer Reading	hPa
C_i	Index Error Correction (provided by the Barometer Manufacturer)	
C_t	Temperature Correction	
C_g	Gravity Correction	
P'	Barometer Reading after the Correction for Index Error	
V	Total Volume of Mercury in the Fixed-Cistern Barometer	mm^3
A	Effective Cross-Sectional Area of the Cistern	mm^2
$1.24\frac{A}{V}$	Kew-Pattern Station Barometers it is taken to be *47* [hPa]. (This factor is dependent on the design of each individual instrument but for barometers of any particular pattern an average value can be used.)	
α	Cubic Thermal Expansion of Mercury ($\mu = 0.0001818$)	$^oC^{-1}$
β	Coefficient of Linear Thermal Expansion of the Scale ($\beta = 0.0000184$)	$^oC^{-1}$
η	Coefficient of Linear Thermal Expansion of the Cistern ($\eta = 0.000010$)	$^oC^{-1}$
t_B	Temperature indicated in the incidental Thermometer to Barometer in Celsius	^oC
T_B	Temperature indicated in the incidental Thermometer to Barometer in Kelvin T_B [K] = t_B [ºC] + *273.15*	K
P''	Barometer Reading reduced to Standard Temperature	
g_0	The standard Acceleration of Gravity ($g_0 = 9.80665$)	m/s^2
$g_{\varphi H}$	Local Acceleration of Gravity at the Station at Latitude φ and Elevation H above Sea Level	m/s^2
$g_{\varphi 0}$	Theoretical Value of Acceleration of Gravity at Mean Sea Level at Latitude φ	m/s^2
H	Elevation of the Station above Sea Level	m
H'	Absolute value in metres of the difference between the elevation of the Station (H) and the mean height of the actual surface of terrain included within a circle whose radius is about 150 km, centred at the Station ($\overline{H}$) $H' = \lvert H - \overline{H} \rvert$ (H' for a flatland like Bangladesh is assumed 0. [$H' = 0$].)	m
φ	Latitude of the Station in radians $\varphi = \theta^\circ \frac{\pi}{180}$	rad
θ	Latitude of the Station in degrees	º (degree)
P_s	**Station Level Pressure (at Elevation H)**	hPa
P_{MSL}	**Mean Sea Level Pressure**	hPa
P	Air/Atmospheric Pressure	Pa
ρ	Air Density	$kg\ m^{-3}$
z	Height	m
R	Gas Constant for Dry Air ($R = 287$)	$NmK^{-1}kg^{-1}$
T	Absolute Temperature T [K] = t [ºC] + 273.15	K
γ	Temperature Lapse Rate ($\gamma = 0.0065$: $0 \le z \le 11{,}000$ m)	$K\ m^{-1}$
h_{BC}	Barometer Cistern Height above Station Level	m
H_{BC}	Barometer Cistern Height above Mean Sea Level $H_{BC} = H + h_{BC}$	m

1. Barometer Cistern Level Pressure

1-1. Formula of Instrumental Errors, Temperature and Gravity Corrections

$$P_{BC} = B + C_i + C_t + C_g$$

1-1-1. Temperature Correction for Fixed-Cistern Type (Kew Type) Barometer

$$C_t = -P'(\alpha - \beta)t_B - \frac{4V}{3A}(\alpha - 3\eta)t_B$$

$$= -P'(0.0001818 - 0.0000184)t_B - \frac{V}{A} \times \frac{4}{3} \times (0.0001818 - 3 \times 0.000010)t_B$$ … substituted:

Constant: α, β and η

$$= -0.0001634\ P'\ t_B - 0.0002024\ \frac{V}{A}\ t_B$$

$$= -\left(0.0001634\ P' - 0.0002024\ \frac{V}{A}\right)t_B$$

$$\approx -\left(0.000163\ P' - 0.000163 \times 1.24\ \frac{V}{A}\right)t_B$$

$$= -0.000163 \times \left(P' + 1.24\ \frac{V}{A}\right)t_B$$

$$C_t = -0.000163 \times (P' + 47)t_b$$ … substituted: $1.24\frac{A}{V}$

$$P' = B + C_i$$

1-1-2. Gravity Correction

$$C_g = P''\left(\frac{g_{\phi H}}{g_0} - 1\right)$$

$$P'' = P' + C_t$$

$$g_{\phi H} = g_{\phi 0} - 0.000003086\ H + 0.000001118 \times (H - H')$$

$$g_{\phi 0} = 9.806\,20 \times (1 - 0.002\,644\,2\cos 2\phi + 0.000\,005\,8\cos^2 2\phi)$$

1-2. Calculation of Barometer Cistern Level Pressur

$$P_{BC} = B + C_i + C_t + C_g$$

$$= B + C_i + C_t + P''\left(\frac{g_{\phi H}}{g_0} - 1\right) \quad \text{… substituted: } C_g$$

$$= B + C_i + C_t + \left(P' + C_t\right)\left(\frac{g_{\phi H}}{g_0} - 1\right) \quad \text{… substituted: } P''$$

$$= B + C_i + C_t + \left(P_B + C_i + C_t\right)\left(\frac{g_{\phi H}}{g_0} - 1\right) \quad \text{… substituted: } P'$$

$$= \left(B + C_i + C_t\right)\left[1 + \left(\frac{g_{\phi H}}{g_0} - 1\right)\right]$$

$$= \left(B + C_i + C_t\right)\frac{g_{\phi H}}{g_0}$$

$$= \left[B + C_i - 0.000163 \times \left(P' + 47\right) t_B\right]\frac{g_{\phi H}}{g_0} \quad \text{… substituted: } C_t$$

$$= \left[B + C_i - 0.000163 \times \left(B + C_i + 47\right) t_B\right]\frac{g_{\phi H}}{g_0} \quad \text{… substituted: } P'$$

$$= \left[B + C_i - 0.000163 \times \left(B + C_i\right) t_B - 0.000163 \times 47 \times t_B\right]\frac{g_{\phi H}}{g_0}$$

$$= \left[\left(B + C_i\right)\left(1 - 0.000163\, t_B\right) - 0.007661\, t_B\right]\frac{g_{\phi H}}{g_0}$$

$$P_{BC} = \left[\left(B + C_i\right)\left(1 - 0.000163\, t_B\right) - 0.007661\, t_B\right]\frac{g_{\phi H}}{9.80665} \quad \text{… substituted: Constant: } \alpha, \beta \text{ and } g_0$$

2. Station Level Pressure

2-1. Hypsometric Formula

2-1-1. Formula of Hydrostatic Equilibrium

$$\partial P = -\rho g_0 \partial z$$

2-1-2. Ideal Gas Equation

$$P = \rho RT$$

$$\frac{P}{RT} = \frac{\rho RT}{RT} \quad \cdots\cdots \text{ divided by } RT$$

$$\rho = \frac{P}{RT} \quad \cdots\cdots \text{ substituted for } \underline{\textit{2-1-1 .Formula of Hydrostatic Equilibrium}}$$

$$\partial P = -\rho g_0 \partial z$$

$$= -\frac{P}{RT} g_0 \partial z$$

$$\frac{1}{P}\partial P = -\frac{1}{P}\frac{P}{RT} g_0 \partial z \quad \cdots\cdots \text{ divided by } P$$

$$\frac{1}{P}\partial P = -\frac{g_0}{R}\frac{1}{T}\partial z \quad \cdots\cdots \textbf{(A)}$$

2-1-3. Temperature Lapse Rate

$$\gamma = -\frac{\partial T}{\partial z}$$

$$= -\frac{T_B - T}{H_{BC} - z}$$

$$= \frac{T - T_B}{H_{BC} - z}$$

$$\gamma \left(H_{BC} - z\right) = T - T \quad \cdots\cdots \quad \text{multiplied by } \left(H_{BC} - z\right)$$

$$T - T_B = \gamma \left(H_{BC} - z\right)$$

$$T = T_B + \gamma \left(H_{BC} - z\right)$$

2-1-4. Hypsometric Formula

$$\frac{1}{P}\partial P = -\frac{g_0}{R}\frac{1}{T_B + \gamma\left(H_{BC} - z\right)}\partial z$$ ……substituted for "T" in Equation **(A)**

$$-\frac{1}{P}\partial P = \frac{g_0}{R}\frac{1}{T_B + \gamma\left(H_{BC} - z\right)}\partial z$$

$$-\int_{P_s}^{P_{BC}}\frac{1}{P}\partial P = \frac{g_0}{R}\int_{H}^{H_{BC}}\frac{1}{T_B + \gamma\left(H_{BC} - z\right)}\partial z$$ …… **(B)** ……integrated

$$-\int_{P_s}^{P_{BC}}\frac{1}{P}\partial P = \frac{g_0}{R}\int_{H}^{H_{BC}}\frac{1}{T_B + \gamma\left(H_{BC} - z\right)}\partial z$$ …… **(B)**

$$-\int_{P_s}^{P_{BC}}\frac{1}{P}\partial P = -\left[\ln P\right]_{P_s}^{P_{BC}}$$
$$= -\left[\ln\left(P_{BC}\right) - \ln\left(P_s\right)\right]$$
$$= \left[\ln\left(P_s\right) - \ln\left(P_{BC}\right)\right]$$
$$= \ln\frac{P_s}{P_{BC}}$$ …… **(C)**

$$-\int_{P_s}^{P_{BC}}\frac{1}{P}\partial P = \frac{g_0}{R}\int_{H}^{H_{BC}}\frac{1}{T_B + \gamma\left(H_{BC} - z\right)}\partial z$$ …… **(B)**

$$\frac{g_0}{R}\int_{H}^{H_{BC}}\frac{1}{T_B + \gamma\left(H_{BC} - z\right)}\partial z = \frac{g_0}{R}\left[-\frac{1}{\gamma}\ln\left[T_B + \gamma\left(H_{BC} - z\right)\right]\right]_{H}^{H_{BC}}$$
$$= -\frac{g_0}{\gamma R}\left\{\ln\left[T_B + \gamma\left(H_B - H_{BC}\right)\right] - \ln\left[T_B + \gamma\left(H_B - H\right)\right]\right\}$$
$$= -\frac{g_0}{\gamma R}\ln\frac{T_B}{T_B + \gamma\left(H_{BC} - H\right)}$$
$$= \ln\left[\frac{T_B}{T_B + \gamma\left(H_{BC} - H\right)}\right]^{-\frac{g_0}{\gamma R}}$$ …… **(D)**

(C) = **(D)**

$$\ln\frac{P_s}{P_{BC}} = \ln\left[\frac{T_B}{T_B + \gamma\left(H_{BC} - H\right)}\right]^{-\frac{g_0}{\gamma R}}$$

$$\frac{P_s}{P_{BC}} = \left[\frac{T_B}{T_B + \gamma\left(H_{BC} - H\right)}\right]^{-\frac{g_0}{\gamma R}}$$

$$P_s = P_{BC}\left[\frac{T_B}{T_B+\gamma\left(H_{BC}-H\right)}\right]^{-\frac{g_0}{\gamma R}}$$

$$= P_{BC}\left[1-1+\frac{T_B}{T_B+\gamma\left(H_{BC}-H\right)}\right]^{-\frac{g_0}{\gamma R}}$$

$$= P_{BC}\left[1-\frac{T_B+\gamma\left(H_{BC}-H\right)}{T_B+\gamma\left(H_{BC}-H\right)}+\frac{T_B}{T_B+\gamma\left(H_{BC}-H\right)}\right]^{-\frac{g_0}{\gamma R}}$$

$$= P_{BC}\left[1-\frac{\gamma\left(H_{BC}-H\right)}{T_B+\gamma\left(H_{BC}-H\right)}\right]^{-\frac{g_0}{\gamma R}}$$

$$= P_{BC}\left[1-\frac{\gamma\left(H_{BC}-H\right)}{t_B+273.15+\gamma\left(H_{BC}-H\right)}\right]^{-\frac{g_0}{\gamma R}}$$

..... Absolute Temperature "T_B" replaced with Celsius Temperature "t_B". $T_B = t_B + 273.15$

$$P_s = P_{BC}\left[1-\frac{0.0065\times\left(H_{BC}-H\right)}{t_B+273.15+0.0065\times\left(H_{BC}-H\right)}\right]^{-\frac{9.80665}{0.0065\times287}}$$

..... substituted: Constant: g_o, R and γ

$$= P_{BC}\left[1-\frac{0.0065\times\left(H_{BC}-H\right)}{t_B+273.15+0.0065\times\left(H_{BC}-H\right)}\right]^{-5.257}$$

2-2. Formula for Station Level Pressure

$$P_s = P_{BC}\left(1-\frac{0.0065\,h_{BC}}{t_B+273.15+0.0065\,h_{BC}}\right)^{-5.257}$$

..... (H_{BC} - H) replaced with h_{BC} $h_{BC} = H_{BC} - H$

3. Mean Sea Level Pressure

3-1. Hypsometric Formula

$$\frac{1}{P}\partial P = -\frac{g_0}{R}\frac{1}{T_B + \gamma\left(H_{BC} - z\right)}\partial z \quad \cdots\cdots\cdots\cdots \text{ substituted for "}T\text{" in Equation (A)}$$

$$-\frac{1}{P}\partial P = \frac{g_0}{R}\frac{1}{T_B + \gamma\left(H_{BC} - z\right)}\partial z$$

$$-\int_{P_{MSL}}^{P_B}\frac{1}{P}\partial P = \frac{g_0}{R}\int_0^{H_{BC}}\frac{1}{T_{BC} + \gamma\left(H_{BC} - z\right)}\partial z \quad \ldots\ldots \text{(E)} \quad \cdots\cdots\cdots \text{ integrated}$$

$$-\int_{P_{MSL}}^{P_B}\frac{1}{P}\partial P = \frac{g_0}{R}\int_0^{H_{BC}}\frac{1}{T_B + \gamma\left(H_{BC} - z\right)}\partial z \quad \ldots\ldots \text{(E)}$$

$$-\int_{P_{MSL}}^{P_B}\frac{1}{P}\partial P = -\left[\ln P\right]_{P_{MSL}}^{P_{BC}}$$
$$= -\left[\ln(P_{BC}) - \ln(P_{MSL})\right]$$
$$= \left[\ln(P_{MSL}) - \ln(P_{BC})\right]$$
$$= \ln\frac{P_{MSL}}{P_{BC}} \quad \ldots\ldots \text{(F)}$$

$$-\int_{P_{MSL}}^{P_B}\frac{1}{P}\partial P = \frac{g_0}{R}\int_0^{H_{BC}}\frac{1}{T_B + \gamma\left(H_{BC} - z\right)}\partial z \quad \ldots\ldots \text{(E)}$$

$$\frac{g_0}{R}\int_0^{H_{BC}}\frac{1}{T_B + \gamma\left(H_{BC} - z\right)}\partial z = \frac{g_0}{R}\left[-\frac{1}{\gamma}\ln\left[T_B + \gamma\left(H_{BC} - z\right)\right]\right]_0^{H_{BC}}$$
$$= -\frac{g_0}{\gamma R}\left\{\ln\left[T_B + \gamma\left(H_{BC} - H_{BC}\right)\right] - \ln\left[T_B + \gamma\left(H_{BC} - 0\right)\right]\right\}$$
$$= -\frac{g_0}{\gamma R}\ln\frac{T_B}{T_B + \gamma H_{BC}}$$
$$= \ln\left(\frac{T_B}{T_B + \gamma H_{BC}}\right)^{-\frac{g_0}{\gamma R}} \quad \ldots\ldots \text{(G)}$$

(F) = (G)

$$\ln\frac{P_{MSL}}{P_{BC}} = \ln\left(\frac{T_B}{T_B + \gamma H_{BC}}\right)^{-\frac{g_0}{\gamma R}}$$

$$\frac{P_{MSL}}{P_{BC}} = \left(\frac{T_B}{T_B + \gamma H_{BC}}\right)^{-\frac{g_0}{\gamma R}}$$

$$P_{MSL} = P_{BC}\left(\frac{T_B}{T_B + \gamma H_{BC}}\right)^{-\frac{g_0}{\gamma R}}$$

$$= P_{BC}\left(1-1+\frac{T_B}{T_B + \gamma H_{BC}}\right)^{-\frac{g_0}{\gamma R}}$$

$$= P_{BC}\left(1-\frac{T_B + \gamma H_{BC}}{T_B + \gamma H_{BC}}+\frac{T_B}{T_B + \gamma H_{BC}}\right)^{-\frac{g_0}{\gamma R}}$$

$$= P_{BC}\left(1-\frac{\gamma H_{BC}}{T_B + \gamma H_{BC}}\right)^{-\frac{g_0}{\gamma R}}$$

$$= P_{BC}\left(1-\frac{\gamma H_{BC}}{t_B + 273.15 + \gamma H_{BC}}\right)^{-\frac{g_0}{\gamma R}}$$

Absolute Temperature "T_B" replaced ..... with Celsius Temperature "t_B". $T_B = t_B + 273.15$

$$= P_{BC}\left[1-\frac{\gamma (H + h_{BC})}{t_B + 273.15 + \gamma (H + h_{BC})}\right]^{-\frac{g_0}{\gamma R}}$$

..... substituted: $H_{BC} = H + h_{BC}$

3-2.Formula for Mean Sea Level Pressure

$$P_{MSL} = P_{BC}\left[1-\frac{0.0065\times(H + h_{BC})}{t_B + 273.15 + 0.0065\times(H + h_{BC})}\right]^{-\frac{9.80665}{0.0065\times 287}}$$

..... substituted: Constant: g_o, R and γ

$$= P_{BC}\left[1-\frac{0.0065\times(H + h_{BC})}{t_B + 273.15 + 0.0065\times(H + h_{BC})}\right]^{-5.257}$$

Calculation of Atmospheric Pressure for Fortin Type Barometer

	Legend	
P_{BC}	**Barometer Cistern Level Pressure**	hPa
B	Observed Barometer Reading	hPa
C_i	Index Error Correction (provided by the Barometer Manufacturer)	
C_t	Temperature Correction	
C_g	Gravity Correction	
P'	Barometer Reading after the Correction for Index Error	
V	Total Volume of Mercury in the Fixed-Cistern Barometer	mm^3
A	Effective Cross-Sectional Area of the Cistern	mm^2
$1.24\frac{A}{V}$	Kew-Pattern Station Barometers it is taken to be *47* [hPa]. (This factor is dependent on the design of each individual instrument but for barometers of any particular pattern an average value can be used.)	
α	Cubic Thermal Expansion of Mercury ($\mu = 0.0001818$)	$^oC^{-1}$
β	Coefficient of Linear Thermal Expansion of the Scale ($\beta = 0.0000184$)	$^oC^{-1}$
η	Coefficient of Linear Thermal Expansion of the Cistern ($\eta = 0.000010$)	$^oC^{-1}$
t_B	Temperature indicated in the incidental Thermometer to Barometer in Celsius	^oC
T_B	Temperature indicated in the incidental Thermometer to Barometer in Kelvin T_B [K] = t_B [ºC] + *273.15*	K
P''	Barometer Reading reduced to Standard Temperature	
g_0	The standard Acceleration of Gravity ($g_0 = 9.80665$)	m/s^2
$g_{\varphi H}$	Local Acceleration of Gravity at the Station at Latitude φ and Elevation H above Sea Level	m/s^2
$g_{\varphi 0}$	Theoretical Value of Acceleration of Gravity at Mean Sea Level at Latitude φ	m/s^2
H	Elevation of the Station above Sea Level	m
H'	Absolute value in metres of the difference between the elevation of the Station (H) and the mean height of the actual surface of terrain included within a circle whose radius is about 150 km, centred at the Station ($\bar{H}$) $H' = \lvert H - \bar{H} \rvert$ (H' for a flatland like Bangladesh is assumed 0. [$H' = 0$].)	m
φ	Latitude of the Station in radians $\varphi = \theta° \frac{\pi}{180}$	rad
θ	Latitude of the Station in degrees	º (degree)
P_s	**Station Level Pressure (at Elevation H)**	hPa
P_{MSL}	**Mean Sea Level Pressure**	hPa
P	Air/Atmospheric Pressure	Pa
ρ	Air Density	$kg\ m^{-3}$
z	Height	m
R	Gas Constant for Dry Air ($R = 287$)	$NmK^{-1}kg^{-1}$
T	Absolute Temperature T [K] = t [ºC] + 273.15	K
γ	Temperature Lapse Rate ($\gamma = 0.0065$: $0 \le z \le 11{,}000$ m)	$K\ m^{-1}$
h_{BC}	Barometer Cistern Height above Station Level	m
H_{BC}	Barometer Cistern Height above Mean Sea Level $H_{BC} = H + h_{BC}$	m

1. Barometer Cistern Level Pressure

1-1. Formula of Instrumental Errors, Temperature and Gravity Corrections

$$P_{BC} = B + C_i + C_t + C_g$$

1-1-1. Temperature Correction for Fortin Type Barometer

(1) *for Fortin Type Barometer*

$$C_t = -P'(\alpha - \beta)t_B$$
$$= -P'(0.0001818 - 0.0000184)t_B \quad \text{… substituted: Constant: } \alpha \text{ and } \beta$$
$$= -P'\,0.0001634\,t_B$$
$$P' = B + C_i$$

1-1-2. Gravity Correction

$$C_g = P''\left(\frac{g_{\phi H}}{g_0} - 1\right)$$
$$P'' = P' + C_t$$
$$g_{\phi H} = g_{\phi 0} - 0.000\,003\,086\,H + 0.000\,001\,118 \times (H - H')$$
$$g_{\phi 0} = 9.806\,20 \times (1 - 0.002\,644\,2\cos 2\phi + 0.000\,005\,8\cos^2 2\phi)$$

1-2. Calculation of Barometer Cistern Level Pressure for Fortin Type Barometer

$$P_{BC} = B + C_i + C_t + C_g$$

$$= B + C_i + C_t + P''\left(\frac{g_{\phi H}}{g_0} - 1\right) \quad \text{… substituted: } C_g$$

$$= B + C_i + C_t + \left(P' + C_t\right)\left(\frac{g_{\phi H}}{g_0} - 1\right) \quad \text{… substituted: } P''$$

$$= B + C_i + C_t + \left(B + C_i + C_t\right)\left(\frac{g_{\phi H}}{g_0} - 1\right) \quad \text{… substituted: } P'$$

$$= \left(B + C_i + C_t\right)\left[1 + \left(\frac{g_{\phi H}}{g_0} - 1\right)\right]$$

$$= \left(B + C_i + C_t\right)\frac{g_{\phi H}}{g_0}$$

$$= \left[B + C_i - P'\left(\alpha - \beta\right)t_B\right]\frac{g_{\phi H}}{g_0} \quad \text{… substituted: } C_t$$

$$= \left[B + C_i - \left(P_b + C_i\right)\left(\alpha - \beta\right)t_B\right]\frac{g_{\phi H}}{g_0} \quad \text{… substituted: } P'$$

$$= \left(B + C_i\right)\left[1 - \left(\alpha - \beta\right)t_B\right]\frac{g_{\phi H}}{g_0}$$

$$P_{BC} = \left(B + C_i\right)\left[1 - \left(0.0001818 - 0.0000184\right)t_B\right]\frac{g_{\phi H}}{9.80665} \quad \text{… substituted: Constant } \alpha, \beta \text{ and } g_0$$

$$= \left(B + C_i\right)\left(1 - 0.0001634\, t_B\right)\frac{g_{\phi H}}{9.80665}$$

2. Station Level Pressure

2-1. Hypsometric Formula

2-1-1. Formula of Hydrostatic Equilibrium

$$\partial P = -\rho g_0 \partial z$$

2-1-2. Ideal Gas Equation

$$P = \rho RT$$

$$\frac{P}{RT} = \frac{\rho RT}{RT} \quad \cdots\cdots \text{ divided by } RT$$

$$\rho = \frac{P}{RT} \quad \cdots\cdots \text{ substituted for } \underline{\textit{2-1-1 .Formula of Hydrostatic Equilibrium}}$$

$$\partial P = -\rho g_0 \partial z$$

$$= -\frac{P}{RT} g_0 \partial z$$

$$\frac{1}{P}\partial P = -\frac{1}{P}\frac{P}{RT} g_0 \partial z \quad \cdots\cdots \text{ divided by } P$$

$$\frac{1}{P}\partial P = -\frac{g_0}{R}\frac{1}{T}\partial z \quad \cdots\cdots \textbf{(A)}$$

2-1-3. Temperature Lapse Rate

$$\gamma = -\frac{\partial T}{\partial z}$$

$$= -\frac{T_B - T}{H_{BC} - z}$$

$$= \frac{T - T_B}{H_{BC} - z}$$

$$\gamma \left(H_{BC} - z\right) = T - T_B \quad \cdots\cdots \text{ multiplied by } \left(H_{BC} - z\right)$$

$$T - T_B = \gamma \left(H_{BC} - z\right)$$

$$T = T_B + \gamma \left(H_{BC} - z\right)$$

2-1-4. Hypsometric Formula

$$\frac{1}{P}\partial P = -\frac{g_0}{R}\frac{1}{T_B + \gamma\left(H_{BC} - z\right)}\partial z$$ ..... substituted for "T" in Equation **(A)**

$$-\frac{1}{P}\partial P = \frac{g_0}{R}\frac{1}{T_B + \gamma\left(H_{BC} - z\right)}\partial z$$

$$-\int_{P_s}^{P_{BC}}\frac{1}{P}\partial P = \frac{g_0}{R}\int_{H}^{H_{BC}}\frac{1}{T_B + \gamma\left(H_{BC} - z\right)}\partial z$$ ..... **(B)** ..... integrated

$$-\int_{P_s}^{P_{BC}}\frac{1}{P}\partial P = \frac{g_0}{R}\int_{H}^{H_{BC}}\frac{1}{T_B + \gamma\left(H_{BC} - z\right)}\partial z$$ ..... **(B)**

$$\begin{aligned}-\int_{P_s}^{P_{BC}}\frac{1}{P}\partial P &= -\left[\ln P\right]_{P_s}^{P_{BC}} \\ &= -\left[\ln\left(P_{BC}\right) - \ln\left(P_s\right)\right] \\ &= \left[\ln\left(P_s\right) - \ln\left(P_{BC}\right)\right] \\ &= \ln\frac{P_s}{P_{BC}} \qquad \text{..... (C)}\end{aligned}$$

$$-\int_{P_s}^{P_{BC}}\frac{1}{P}\partial P = \frac{g_0}{R}\int_{H}^{H_{BC}}\frac{1}{T_B + \gamma\left(H_{BC} - z\right)}\partial z$$ ..... **(B)**

$$\begin{aligned}\frac{g_0}{R}\int_{H}^{H_{BC}}\frac{1}{T_B + \gamma\left(H_{BC} - z\right)}\partial z &= \frac{g_0}{R}\left[-\frac{1}{\gamma}\ln\left[T_B + \gamma\left(H_{BC} - z\right)\right]\right]_{H}^{H_{BC}} \\ &= -\frac{g_0}{\gamma R}\left\{\ln\left[T_B + \gamma\left(H_{BC} - H_{BC}\right)\right] - \ln\left[T_B + \gamma\left(H_{BC} - H\right)\right]\right\} \\ &= -\frac{g_0}{\gamma R}\ln\frac{T_B}{T_B + \gamma\left(H_{BC} - H\right)} \\ &= \ln\left[\frac{T_B}{T_B + \gamma\left(H_{BC} - H\right)}\right]^{-\frac{g_0}{\gamma R}} \qquad \text{..... (D)}\end{aligned}$$

(C) = (D)

$$\ln\frac{P_s}{P_{BC}} = \ln\left[\frac{T_B}{T_B + \gamma\left(H_{BC} - H\right)}\right]^{-\frac{g_0}{\gamma R}}$$

$$\frac{P_s}{P_{BC}} = \left[\frac{T_B}{T_B + \gamma\left(H_{BC} - H\right)}\right]^{-\frac{g_0}{\gamma R}}$$

$$P_s = P_{BC}\left[\frac{T_B}{T_B+\gamma\left(H_{BC}-H\right)}\right]^{-\frac{g_0}{\gamma R}}$$

$$= P_{BC}\left[1-1+\frac{T_B}{T_B+\gamma\left(H_{BC}-H\right)}\right]^{-\frac{g_0}{\gamma R}}$$

$$= P_{BC}\left[1-\frac{T_B+\gamma\left(H_{BC}-H\right)}{T_B+\gamma\left(H_{BC}-H\right)}+\frac{T_B}{T_B+\gamma\left(H_{BC}-H\right)}\right]^{-\frac{g_0}{\gamma R}}$$

$$= P_{BC}\left[1-\frac{\gamma\left(H_{BC}-H\right)}{T_B+\gamma\left(H_{BC}-H\right)}\right]^{-\frac{g_0}{\gamma R}}$$

$$= P_{BC}\left[1-\frac{\gamma\left(H_{BC}-H\right)}{t_B+273.15+\gamma\left(H_{BC}-H\right)}\right]^{-\frac{g_0}{\gamma R}}$$

..... Absolute Temperature "T_B" replaced with Celsius Temperature "t_B". $T_B = t_B + 273.15$

$$P_s = P_{BC}\left[1-\frac{0.0065\times\left(H_{BC}-H\right)}{t_B+273.15+0.0065\times\left(H_{BC}-H\right)}\right]^{-\frac{9.80665}{0.0065\times287}}$$

..... substituted: Constant: g_o, R and γ

$$= P_{BC}\left[1-\frac{0.0065\times\left(H_{BC}-H\right)}{t_B+273.15+0.0065\times\left(H_{BC}-H\right)}\right]^{-5.257}$$

2-2. Formula for Station Level Pressure

$$P_s = P_{BC}\left(1-\frac{0.0065\,h_{BC}}{t_B+273.15+0.0065\,h_{BC}}\right)^{-5.257}$$

..... (h_{BC} - H) replaced with h_{BC} $h_{BC} = H_{BC} - H$

3. Mean Sea Level Pressure

3-1. Hypsometric Formula

$$\frac{1}{P}\partial P = -\frac{g_0}{R}\frac{1}{T_B + \gamma\left(H_{BC} - z\right)}\partial z \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{ substituted for "}T\text{" in Equation (A)}$$

$$-\frac{1}{P}\partial P = \frac{g_0}{R}\frac{1}{T_B + \gamma\left(H_{BC} - z\right)}\partial z$$

$$-\int_{P_{MSL}}^{P_{BC}}\frac{1}{P}\partial P = \frac{g_0}{R}\int_0^{H_{BC}}\frac{1}{T_B + \gamma\left(H_{BC} - z\right)}\partial z \quad \ldots\ldots \text{(E)} \quad \ldots\ldots\ldots\text{integrated}$$

$$-\int_{P_{MSL}}^{P_{BC}}\frac{1}{P}\partial P = \frac{g_0}{R}\int_0^{H_{BC}}\frac{1}{T_B + \gamma\left(H_{BC} - z\right)}\partial z \quad \ldots\ldots \text{(E)}$$

$$-\int_{P_{MSL}}^{P_{BC}}\frac{1}{P}\partial P = -\left[\ln P\right]_{P_{MSL}}^{P_{BC}}$$
$$= -\left[\ln\left(P_{BC}\right) - \ln\left(P_{MSL}\right)\right]$$
$$= \left[\ln\left(P_{MSL}\right) - \ln\left(P_{BC}\right)\right]$$
$$= \ln\frac{P_{MSL}}{P_{BC}} \quad \ldots\ldots \text{(F)}$$

$$-\int_{P_{MSL}}^{P_{BC}}\frac{1}{P}\partial P = \frac{g_0}{R}\int_0^{H_{BC}}\frac{1}{T_B + \gamma\left(H_{BC} - z\right)}\partial z \quad \ldots\ldots \text{(E)}$$

$$\frac{g_0}{R}\int_0^{H_{BC}}\frac{1}{T_B + \gamma\left(H_{BC} - z\right)}\partial z = \frac{g_0}{R}\left[-\frac{1}{\gamma}\ln\left[T_B + \gamma\left(H_{BC} - z\right)\right]\right]_0^{H_{BC}}$$
$$= -\frac{g_0}{\gamma R}\left\{\ln\left[T_B + \gamma\left(H_{BC} - H_{BC}\right)\right] - \ln\left[T_B + \gamma\left(H_{BC} - 0\right)\right]\right\}$$
$$= -\frac{g_0}{\gamma R}\ln\frac{T_B}{T_B + \gamma H_{BC}}$$
$$= \ln\left(\frac{T_B}{T_B + \gamma H_{BC}}\right)^{-\frac{g_0}{\gamma R}} \quad \ldots\ldots \text{(G)}$$

(F) = (G)

$$\ln\frac{P_{MSL}}{P_{BC}} = \ln\left(\frac{T_B}{T_B + \gamma H_{BC}}\right)^{-\frac{g_0}{\gamma R}}$$

$$\frac{P_{MSL}}{P_{BC}} = \left(\frac{T_B}{T_B + \gamma H_{BC}}\right)^{-\frac{g_0}{\gamma R}}$$

$$P_{MSL} = P_{BC}\left(\frac{T_B}{T_B + \gamma H_{BC}}\right)^{-\frac{g_0}{\gamma R}}$$

$$= P_{BC}\left(1-1+\frac{T_B}{T_B + \gamma H_{BC}}\right)^{-\frac{g_0}{\gamma R}}$$

$$= P_{BC}\left(1-\frac{T_B + \gamma H_{BC}}{T_B + \gamma H_{BC}}+\frac{T_B}{T_B + \gamma H_{BC}}\right)^{-\frac{g_0}{\gamma R}}$$

$$= P_{BC}\left(1-\frac{\gamma H_{BC}}{T_B + \gamma H_{BC}}\right)^{-\frac{g_0}{\gamma R}}$$

$$= P_{BC}\left(1-\frac{\gamma H_{BC}}{t_B + 273.15 + \gamma H_{BC}}\right)^{-\frac{g_0}{\gamma R}}$$ ..... Absolute Temperature "T_B" replaced with Celsius Temperature "t_B". $T_B = t_B + 273.15$

$$= P_{BC}\left[1-\frac{\gamma (H + h_{BC})}{t_B + 273.15 + \gamma (H + h_{BC})}\right]^{-\frac{g_0}{\gamma R}}$$ ..... substituted: $H_B = H + h_B$

3-2. Formula for Mean Sea Level Pressure

$$P_{MSL} = P_{BC}\left[1-\frac{0.0065\times(H + h_{BC})}{t_B + 273.15 + 0.0065\times(H + h_{BC})}\right]^{-\frac{9.80665}{0.0065\times 287}}$$ ..... substituted: Constant: g_o, R and γ

$$= P_{BC}\left[1-\frac{0.0065\times(H + h_{BC})}{t_B + 273.15 + 0.0065\times(H + h_{BC})}\right]^{-5.257}$$

Calculation of Relative Humidity and Dew Point Temperature

Legend		
U	**Relative Humidity**	%
T_d	**Dew Point Temperature**	ºC
e	**Water Vapor Pressure**	hPa
$e_s(t)$	**Saturation Vapor Pressure at t [ºC]**	hPa
$e_s(t')$	**Saturation Vapor Pressure at t' [ºC]**	hPa
t	Dry Bulb Temperature	ºC
t'	Wet Bulb Temperature	ºC
A	Psychrometric Constant (*A = 0.0008:* Non Aspiration Type)	
a	Constant (*a = 7.5*)	
b	Constant (*b = 237.3*)	
P_s	Station Level Pressure	hPa

1. Relative Humidity

1-1. Water Vapor Pressure (Sprung Formula)

$$e = e_s(t') - P_s A(t - t')$$

1-2. Saturation Vapor Pressure (Tetens Formula)

$$e_s(t) = 6.1078 \times 10^{\frac{a\,t}{b+t}}$$

$$e_s(t') = 6.1078 \times 10^{\frac{a\,t'}{b+t'}}$$

1-3. Relative Humidity

$$U = \frac{e}{e_s(t)} \times 100$$

2. Dew Point Temperature

$$T_d = \frac{b}{\frac{a}{\log\frac{e}{6.1078}} - 1}$$

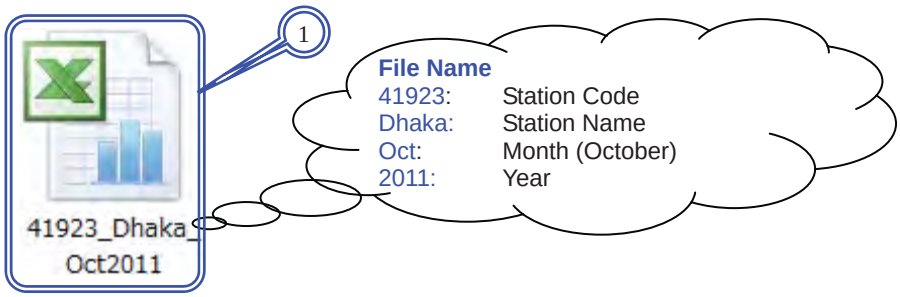
Weather Observation Data Input Manual

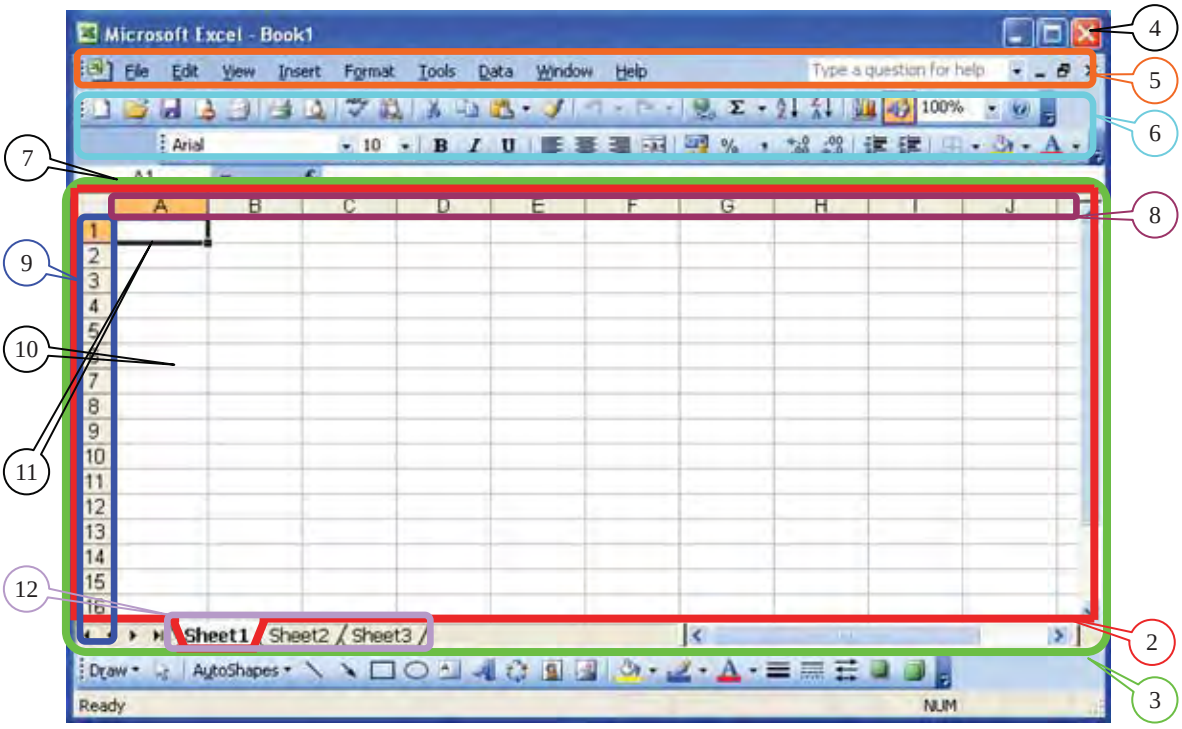
Software

OR

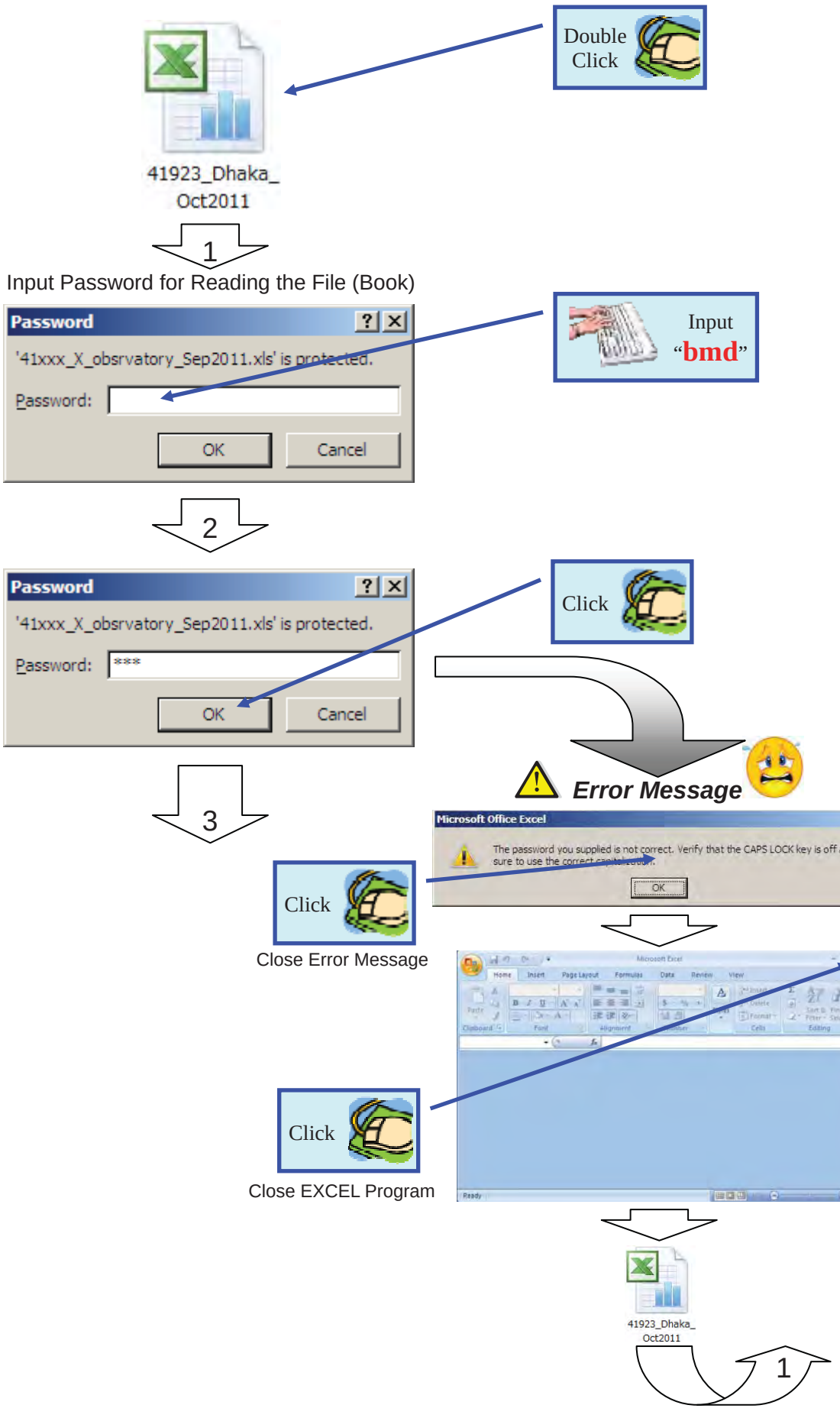
Legend

No.	Name
1	Icon
2	Worksheet
3	Book
4	Closing Button
5	Menu Bar
6	Tool Bar
7	Name Box
8	Row Number
9	Column Number
10	Cell
11	Active Cell
12	Sheet Tab





Procedures of Data Input File (Book) Open



3

Open Worksheet

Observation Date

Observation Time

Dhaka (41923)

October 07, 2011

Observation Time (UTC)

		00	03	06	09	12	15	18	21
Bar Pressure	Attached Thermometer (℃)								
	Bar as Read (mb)								
	Corrected for Index-Temp-Gravity (mb)								
	Height Correction (mb)								
	Station Level Pressure (mb)								
	Sea Level Reduction Constant (mb)								
	Sea Level Pressure (mb)								
	Altimeter setting (QNH)								
	24-Hour Pressure Change								
Thermometer As Read	Dry Bulb (℃)								
	Wet Bulb (℃)								
	Maximum (℃)								
	Minimum (℃)								
Thermometer Corrected	Dry Bulb (℃)								
	Wet Bulb (℃)								
	Maximum (℃)								
	Minimum (℃)								
Dew Point Temperature (℃)									
Relative Humidity (%)									
Squall	Force (KTS)								
	Direction (dq)								
	Time (qt)								
Horizontal Visibility (km)									
Misc. Meteors (Code)									
Weather	Past: W_1W_2								
	Present: WW								
Cloud Low	Form (Code)								
	Amount (Okta)								
	Direction (Code)								
	Height of Base (Code)								
Cloud Medium	Form (Code)								
	Amount (Okta)								
	Direction (Code)								
	Height of Base (Code)								
Cloud High	Form (Code)								
	Amount (Okta)								
	Direction (Code)								
	Height of Base (Code)								
Total Cloud Amount (Okta)									
Significant Cloud 1st Layer	Form (Code)								
	Amount (Okta)								
	Height of Base (Code)								
Significant Cloud 2nd Layer	Form (Code)								
	Amount (Okta)								
	Height of Base (Code)								
Significant Cloud 3rd Layer	Form (Code)								
	Amount (Okta)								
	Height of Base (Code)								
Significant Cloud 4th Layer	Form (Code)								
	Amount (Okta)								
	Height of Base (Code)								
Rainfall (mm)	Time of Start (HHMM)								
	Time of Ending (HHMM)								
	Since Previous Observation (At Intermediate Hours)								
	During Previous 6 Hours								
	Character Code								24
	24 hours Rainfall (mm)								
Wind	1st Anemometer Reading								
	2nd Anemometer Reading								
	Speed (KTS)								
	Direction								
Observer Name									

Calculated Data Input Area

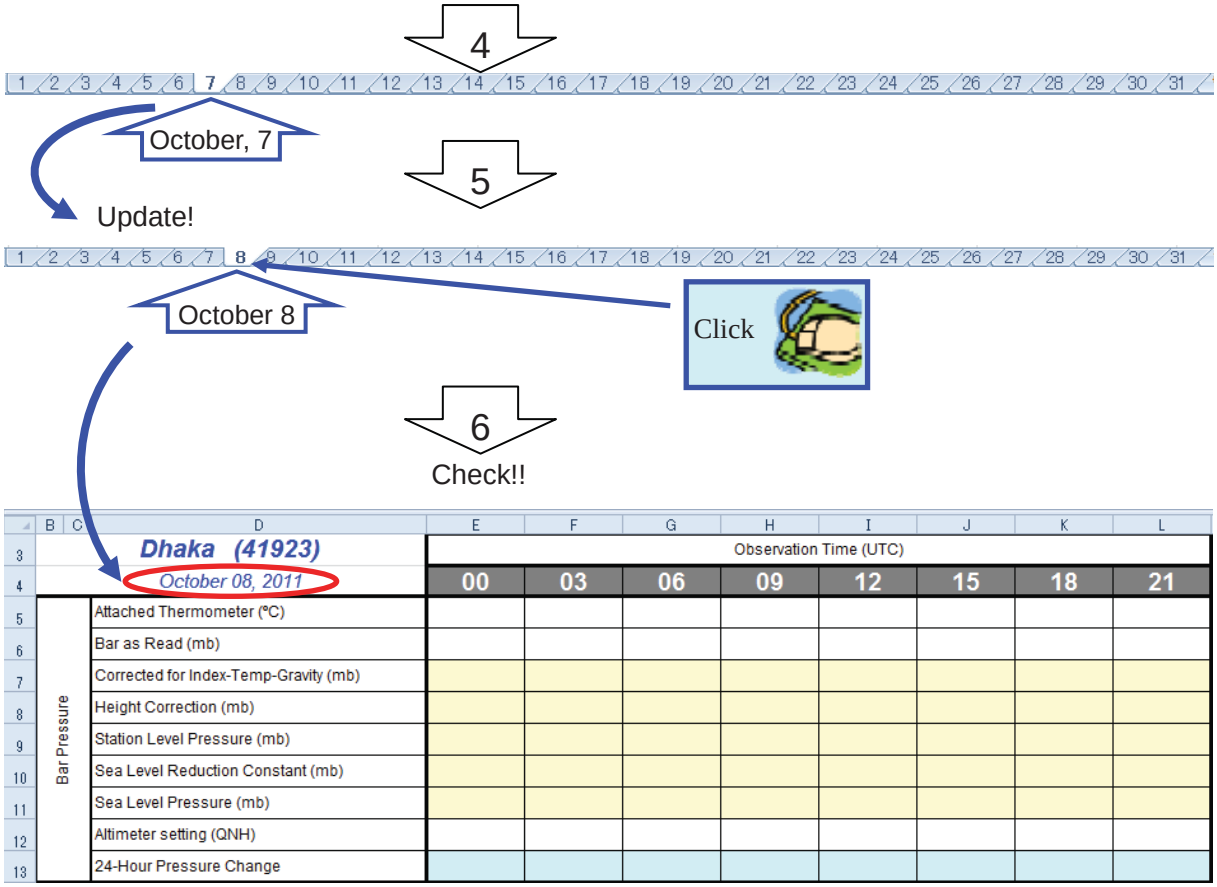
Observed Data Input Area

Calculated Data Input Area

Selection Area of Observer Name

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

4



	B	C	D	E	F	G	H	I	J	K	L
3			Dhaka (41923)	Observation Time (UTC)							
4			October 08, 2011	00	03	06	09	12	15	18	21
5	Bar Pressure		Attached Thermometer (°C)								
6			Bar as Read (mb)								
7			Corrected for Index-Temp-Gravity (mb)								
8			Height Correction (mb)								
9			Station Level Pressure (mb)								
10			Sea Level Reduction Constant (mb)								
11			Sea Level Pressure (mb)								
12			Altimeter setting (QNH)								
13			24-Hour Pressure Change								

Observed Data (in the Observation Building)

Barometer Temperature
Barometer Pressure

		Dhaka (41923)	Observation Time (UTC)							
		October 08, 2011	00	03	06	09	12	15	18	21
Bar Pressure		Attached Thermometer (°C)								
		Bar as Read (mb)								
		Corrected for Index-Temp-Gravity (mb)								
		Height Correction (mb)								
		Station Level Pressure (mb)								
		Sea Level Reduction Constant (mb)								
		Sea Level Pressure (mb)								
		Altimeter setting (QNH)								
		24-Hour Pressure Change								

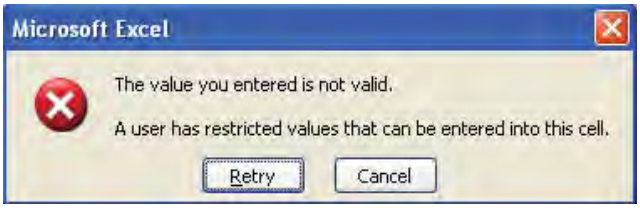
1

		Dhaka (41923)	00
		October 08, 2011	
Bar Pressure		Attached Thermometer (°C)	
		Bar as Read (mb)	
		Corrected for Index-Temp-Gravity (mb)	
		Height Correction (mb)	
		Station Level Pressure (mb)	
		Sea Level Reduction Constant (mb)	
		Sea Level Pressure (mb)	
		Altimeter setting (QNH)	
		24-Hour Pressure Change	

Click

Input Observed Data

Error Message



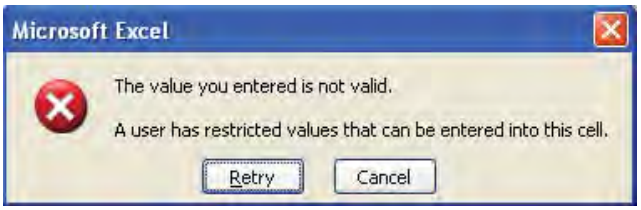
2

Report to BMD Head Office

2

	B	C	D	E
3			**Dhaka (41923)**	
4			*October 08, 2011*	00
5	Bar Pressure		Attached Thermometer (°C)	20.0
6			Bar as Read (mb)	
7			Corrected for Index-Temp-Gravity (mb)	
8			Height Correction (mb)	
9			Station Level Pressure (mb)	
10			Sea Level Reduction Constant (mb)	
11			Sea Level Pressure (mb)	
12			Altimeter setting (QNH)	
13			24-Hour Pressure Change	

Error Message



2

	B	C	D	E
3			**Dhaka (41923)**	
4			*October 08, 2011*	00
5	Bar Pressure		Attached Thermometer (°C)	20.0
6			Bar as Read (mb)	1,000.0
7			Corrected for Index-Temp-Gravity (mb)	-5.24
8			Height Correction (mb)	0.86
9			Station Level Pressure (mb)	**995.6**
10			Sea Level Reduction Constant (mb)	0.93
11			Sea Level Pressure (mb)	**996.5**
12			Altimeter setting (QNH)	
13			24-Hour Pressure Change	±0

Automatic Input!!

3

OK!

Observed Data (in the Observation Field)

Dry Bulb Temperature
Wet Bulb Temperature
Maximum Temperature
Minimum Temperature

			Dhaka (41923)	Observation Time (UTC)							
			October 08, 2011	00	03	06	09	12	15	18	21
Thermometer	As Read		Dry Bulb (°C)								
			Wet Bulb (°C)								
			Maximum (°C)								
			Minimum (°C)								
	Corrected		Dry Bulb (°C)								
			Wet Bulb (°C)								
			Maximum (°C)								
			Minimum (°C)								
Dew Point Temperature (°C)											
Relative Humidity (%)											

1

			Dhaka (41923)	00
			October 08, 2011	
Thermometer	As Read		Dry Bulb (°C)	
			Wet Bulb (°C)	
			Maximum (°C)	
			Minimum (°C)	
	Corrected		Dry Bulb (°C)	
			Wet Bulb (°C)	
			Maximum (°C)	
			Minimum (°C)	
Dew Point Temperature (°C)				
Relative Humidity (%)				

Click

Input Observed Data

Error Message

Microsoft Excel

The value you entered is not valid.

A user has restricted values that can be entered into this cell.

Retry Cancel

2

			Dhaka (41923)	00
			October 08, 2011	
Thermometer	As Read		Dry Bulb (°C)	26
			Wet Bulb (°C)	24
			Maximum (°C)	28
			Minimum (°C)	22
	Corrected		Dry Bulb (°C)	26.0
			Wet Bulb (°C)	24.0
			Maximum (°C)	28.0
			Minimum (°C)	22.0
Dew Point Temperature (°C)				23.1
Relative Humidity (%)				84

Report to BMD Head Office

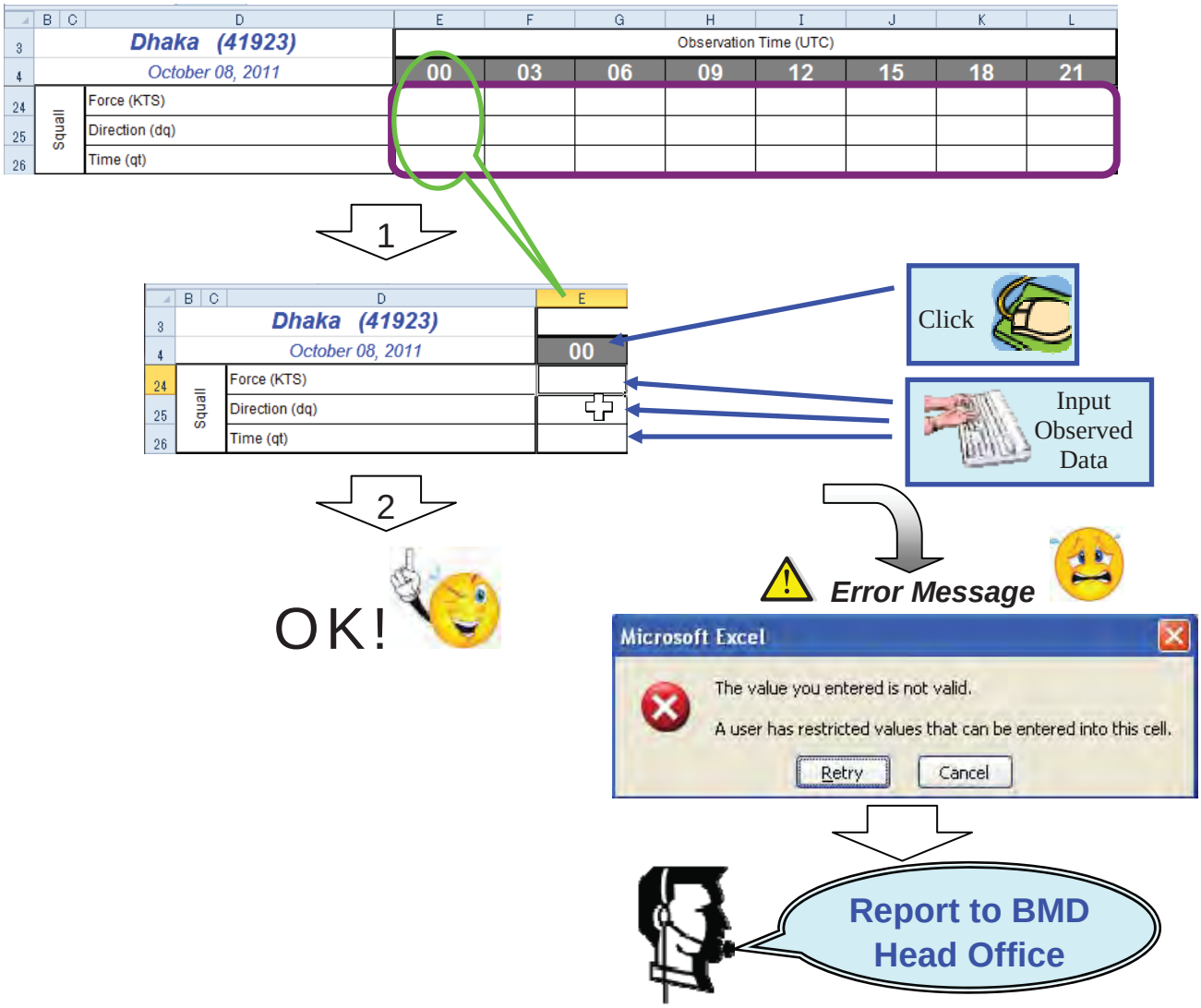
Automatic Input!!

3

OK!

Observed Data (in the Observation Field)

Squall (Force, Direction and Time)



Observed Data (in the Observation Field)

Horizontal Visibility
Misc. Meteors

	B C	D	E	F	G	H	I	J	K	L
3		***Dhaka (41923)***	Observation Time (UTC)							
4		*October 08, 2011*	00	03	06	09	12	15	18	21
27		Horizontal Visibility (km)								
28		Misc. Meteors (Code)								

1

	B C	D	E
3		***Dhaka (41923)***	
4		*October 08, 2011*	00
27		Horizontal Visibility (km)	
28		Misc. Meteors (Code)	

Click 

 Input Observed Data

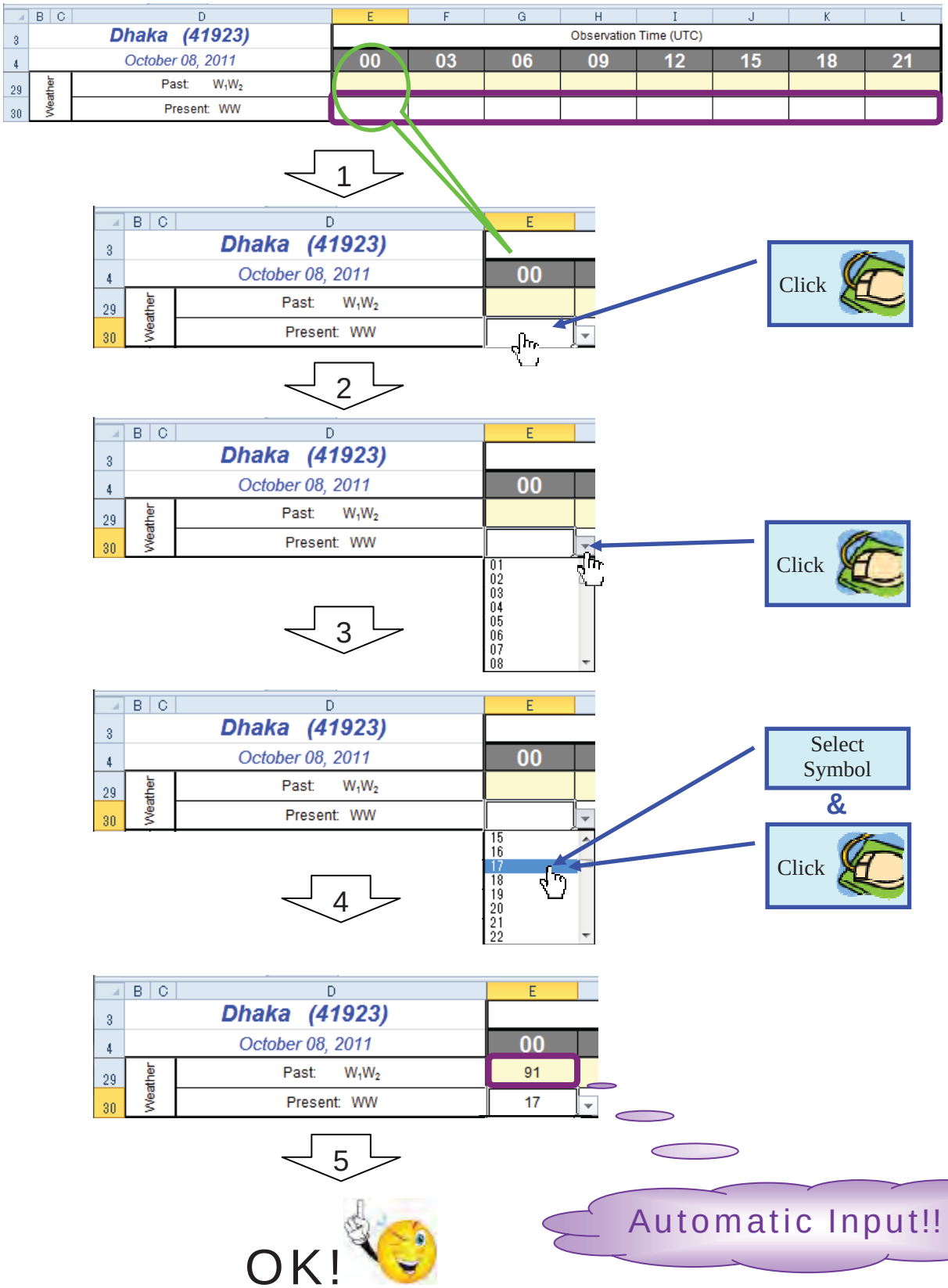
2

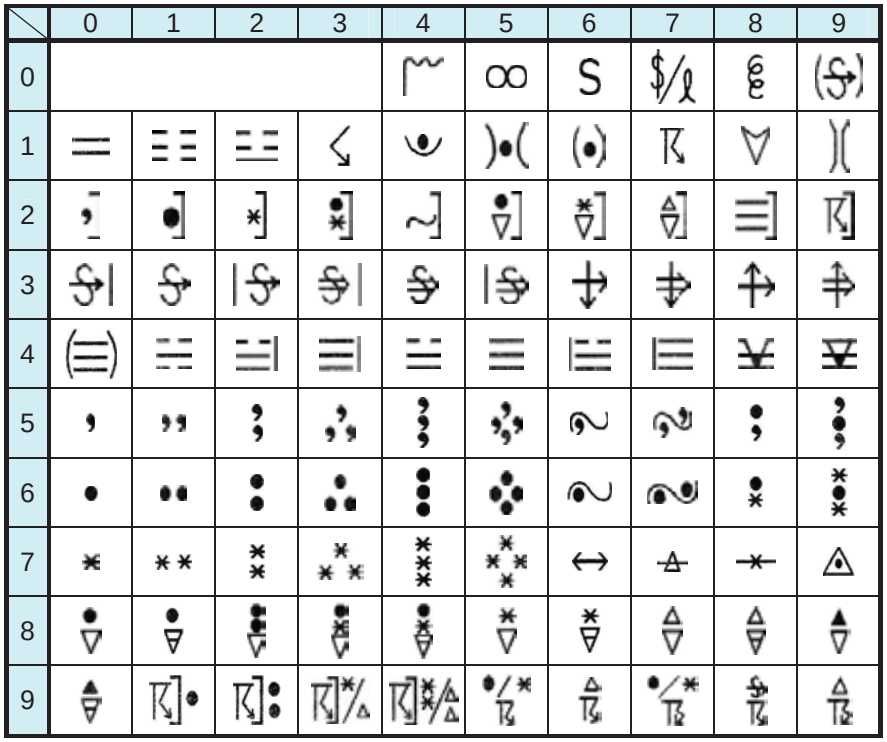
OK! 

Error Message 

Observed Data (in the Observation Field)

Present Weather




0 1 2 3 4 5 6 7 8 9
0
1
2
3
4
5
6
7
8
9

Observed Data (in the Observation Field)

Cloud Type Code
Amount, etc.

				Dhaka (41923)		Observation Time (UTC)			
				October 08, 2011	00	03	06	09	12	15	18	21
Cloud	Low		Form (Code)									
			Amount (Okta)									
			Direction (Code)									
			Height of Base (Code)									
	Medium		Form (Code)									
			Amount (Okta)									
			Direction (Code)									
			Height of Base (Code)									
	High		Form (Code)									
			Amount (Okta)									
			Direction (Code)									
			Height of Base (Code)									
			Total Cloud Amount (Okta)									

1

		Dhaka (41923)	
		October 08, 2011	00
Low		Form (Code)	
		Amount (Okta)	
		Direction (Code)	
		Height of Base (Code)	

Click 

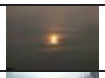
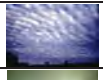
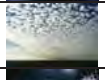
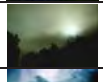
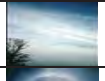
2

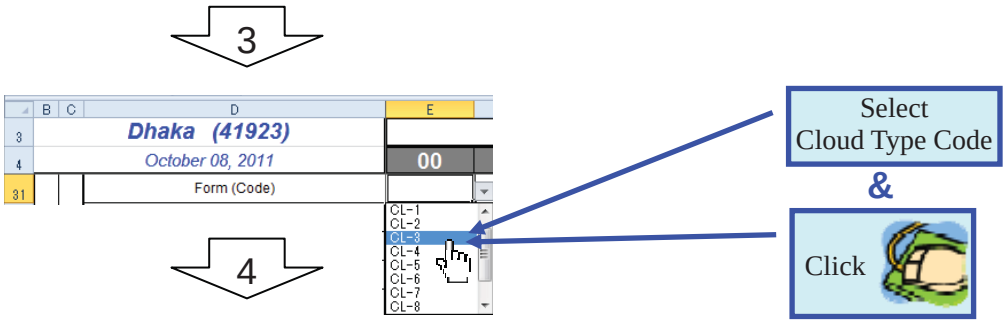
		Dhaka (41923)	
		October 08, 2011	00
		Form (Code)	

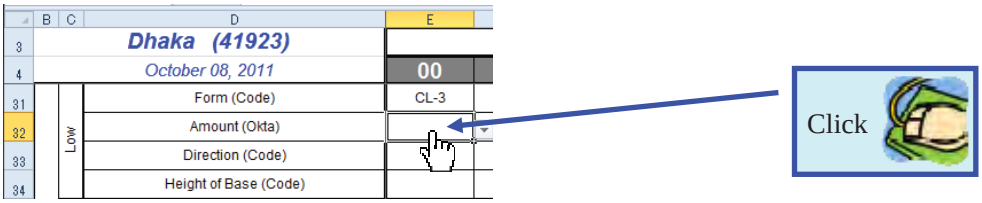
CL-0
CL-1
CL-2
CL-3
CL-4
CL-5
CL-6
CL-7

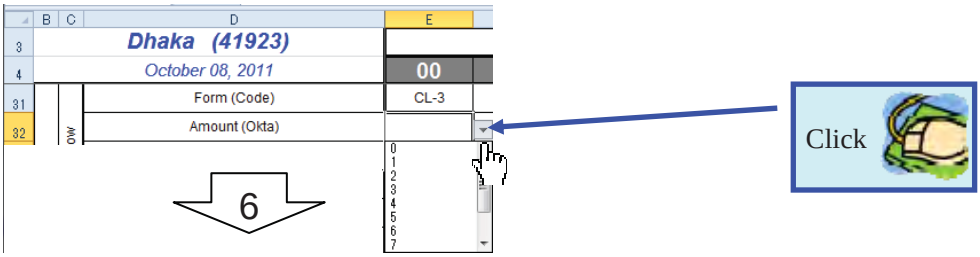
Click 

3

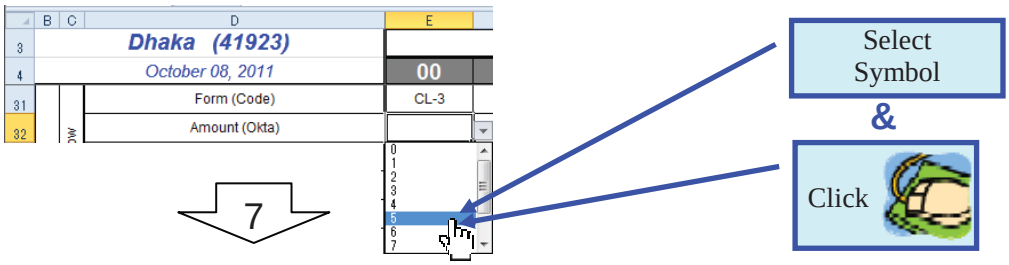
Cloud Type Coad			
	C_L	C_M	C_H
1			
2			
3			
4			
5			
6			
7			
8			
9			







No.	Symbol	Name	Amount of cloud
0		None	None
1		1 okta or less, but no zero	1/8
2		2 oktas	2/8
3		3 oktas	3/8
4		4 oktas	4/8
5		5 oktas	5/8
6		6 oktas	6/8
7		7 oktas or more, but not 8 oktas	7/8
8		8 oktas	8/8
9		Sky obscured, or cloud amount cannot be estimated	
/		No measurement made	



7

	B	C	D	E
3			Dhaka (41923)	
4			October 08, 2011	00
31			Form (Code)	CL-3
32		Low	Amount (Okta)	5
33			Direction (Code)	
34			Height of Base (Code)	

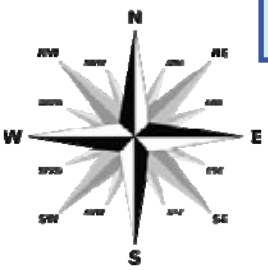
Click

8

	B	C	D	E
3			Dhaka (41923)	
4			October 08, 2011	00
31			Form (Code)	CL-3
32		Low	Amount (Okta)	5
33			Direction (Code)	
34			Height of Base (Code)	

N
NNE
NE
ENE
E
ESE
SE
SSE

Click



9

	B	C	D	E
3			Dhaka (41923)	
4			October 08, 2011	00
31			Form (Code)	CL-3
32		Low	Amount (Okta)	5
33			Direction (Code)	E
34			Height of Base (Code)	

N
NNE
NE
ENE
E
ESE
SE
SSE

Select Symbol

&

Click

8

	B	C	D	E
3			Dhaka (41923)	
4			October 08, 2011	00
31			Form (Code)	CL-3
32		Low	Amount (Okta)	5
33			Direction (Code)	E
34			Height of Base (Code)	

Click

Input Observed Data

9

Error Message

Report to BMD Head Office

9

	B	C	D	E
3			Dhaka (41923)	
4			October 08, 2011	00
31	Cloud	Low	Form (Code)	CL-3
32			Amount (Okta)	5
33			Direction (Code)	E
34			Height of Base (Code)	100
35		Medium	Form (Code)	
36			Amount (Okta)	
37			Direction (Code)	
38			Height of Base (Code)	
39		High	Form (Code)	
40			Amount (Okta)	
41			Direction (Code)	
42			Height of Base (Code)	
43			Total Cloud Amount (Okta)	

Select Cloud Type Code

Select Symbol


Input Observed Data

Select Cloud Type Code

Select Symbol


Input Observed Data

10

	B	C	D	E
3			Dhaka (41923)	
4			October 08, 2011	00
31	Cloud	Low	Form (Code)	CL-3
32			Amount (Okta)	5
33			Direction (Code)	E
34			Height of Base (Code)	100
35		Medium	Form (Code)	CM-3
36			Amount (Okta)	5
37			Direction (Code)	E
38			Height of Base (Code)	100
39		High	Form (Code)	CH-3
40			Amount (Okta)	5
41			Direction (Code)	E
42			Height of Base (Code)	100
43			Total Cloud Amount (Okta)	

Click

11

	B	C	D	E
3			Dhaka (41923)	
4			October 08, 2011	00
31	Cloud	Low	Form (Code)	CL-3
32			Amount (Okta)	5
33			Direction (Code)	E
34			Height of Base (Code)	100
35		Medium	Form (Code)	CM-3
36			Amount (Okta)	5
37			Direction (Code)	E
38			Height of Base (Code)	100
39		High	Form (Code)	CH-3
40			Amount (Okta)	5
41			Direction (Code)	E
42			Height of Base (Code)	100
43			Total Cloud Amount (Okta)	

0
1
2
3
4
5
6
7

Click

12

12

	B	C	D	E
3			Dhaka (41923)	
4			October 08, 2011	00
31	Cloud	Low	Form (Code)	CL-3
32			Amount (Okta)	5
33			Direction (Code)	E
34			Height of Base (Code)	100
35		Medium	Form (Code)	CM-3
36			Amount (Okta)	5
37			Direction (Code)	E
38			Height of Base (Code)	100
39		High	Form (Code)	CH-3
40			Amount (Okta)	5
41			Direction (Code)	E
42			Height of Base (Code)	100
43			Total Cloud Amount (Okta)	

0 1 2 3 4 5 6 7

Select Symbol

&

Click 

13

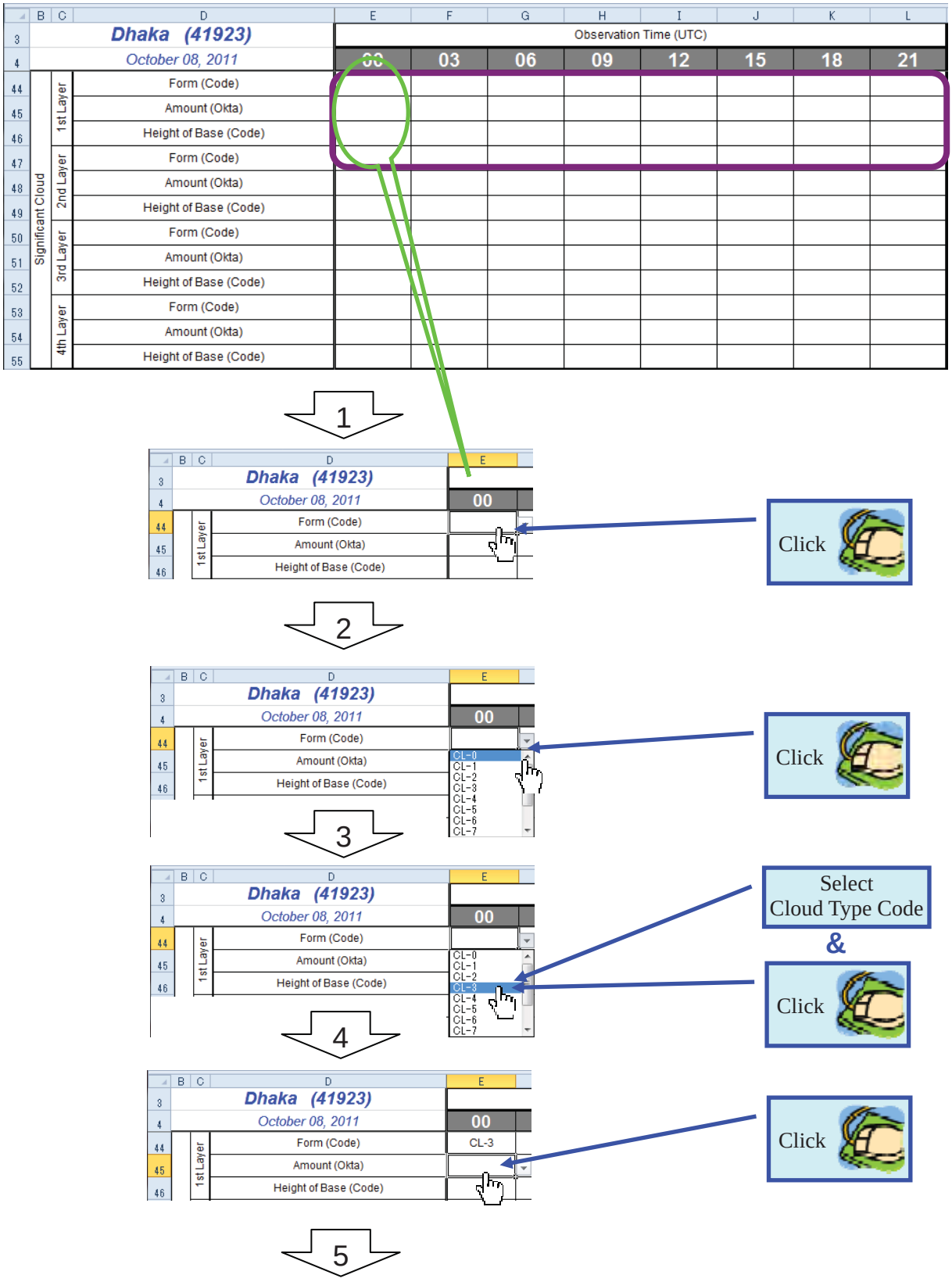
	B	C	D	E
3			Dhaka (41923)	
4			October 08, 2011	00
31	Cloud	Low	Form (Code)	CL-3
32			Amount (Okta)	5
33			Direction (Code)	E
34			Height of Base (Code)	100
35		Medium	Form (Code)	CM-3
36			Amount (Okta)	5
37			Direction (Code)	E
38			Height of Base (Code)	100
39		High	Form (Code)	CH-3
40			Amount (Okta)	5
41			Direction (Code)	E
42			Height of Base (Code)	100
43			Total Cloud Amount (Okta)	6

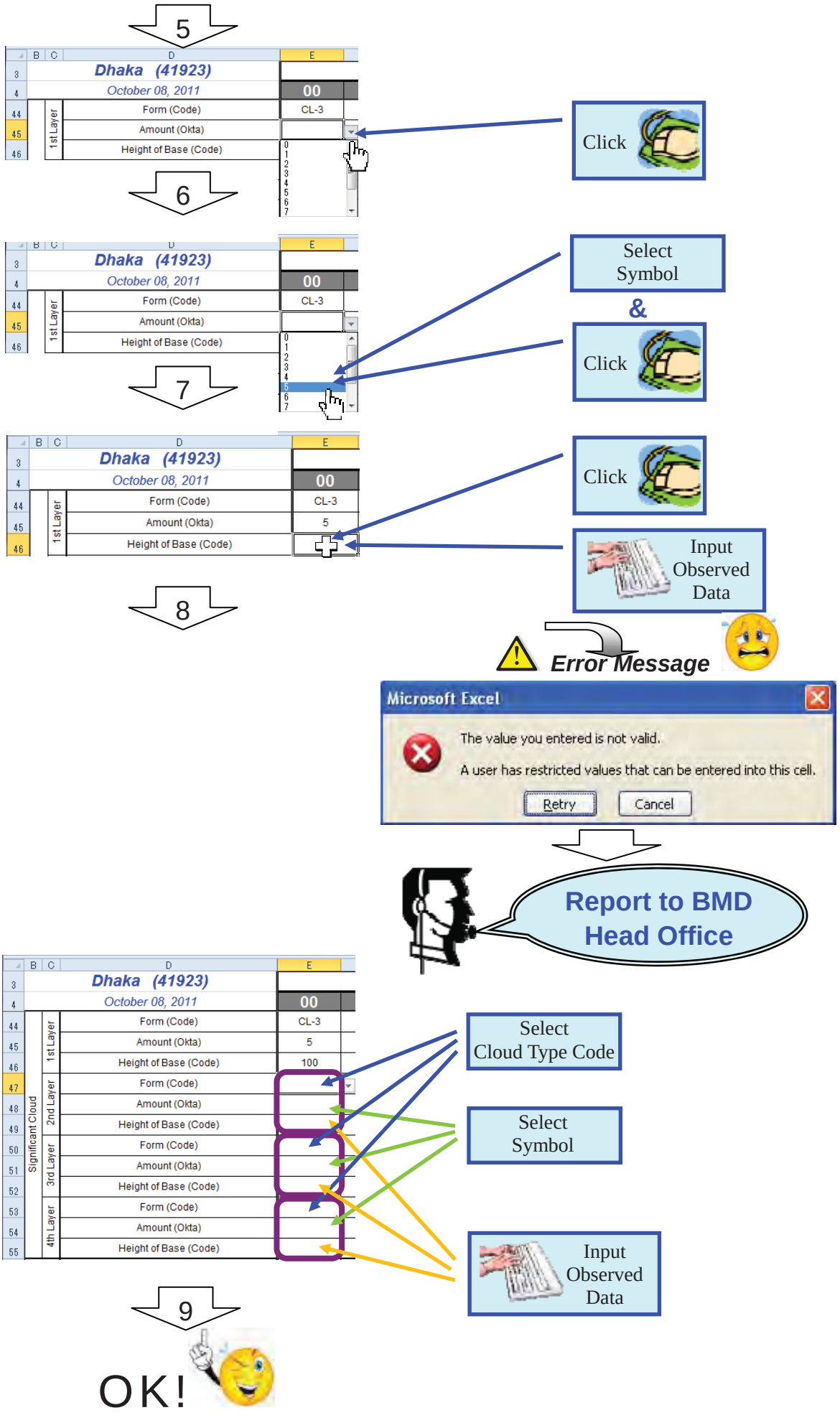
14

OK! 

Observed Data (in the Observation Field)

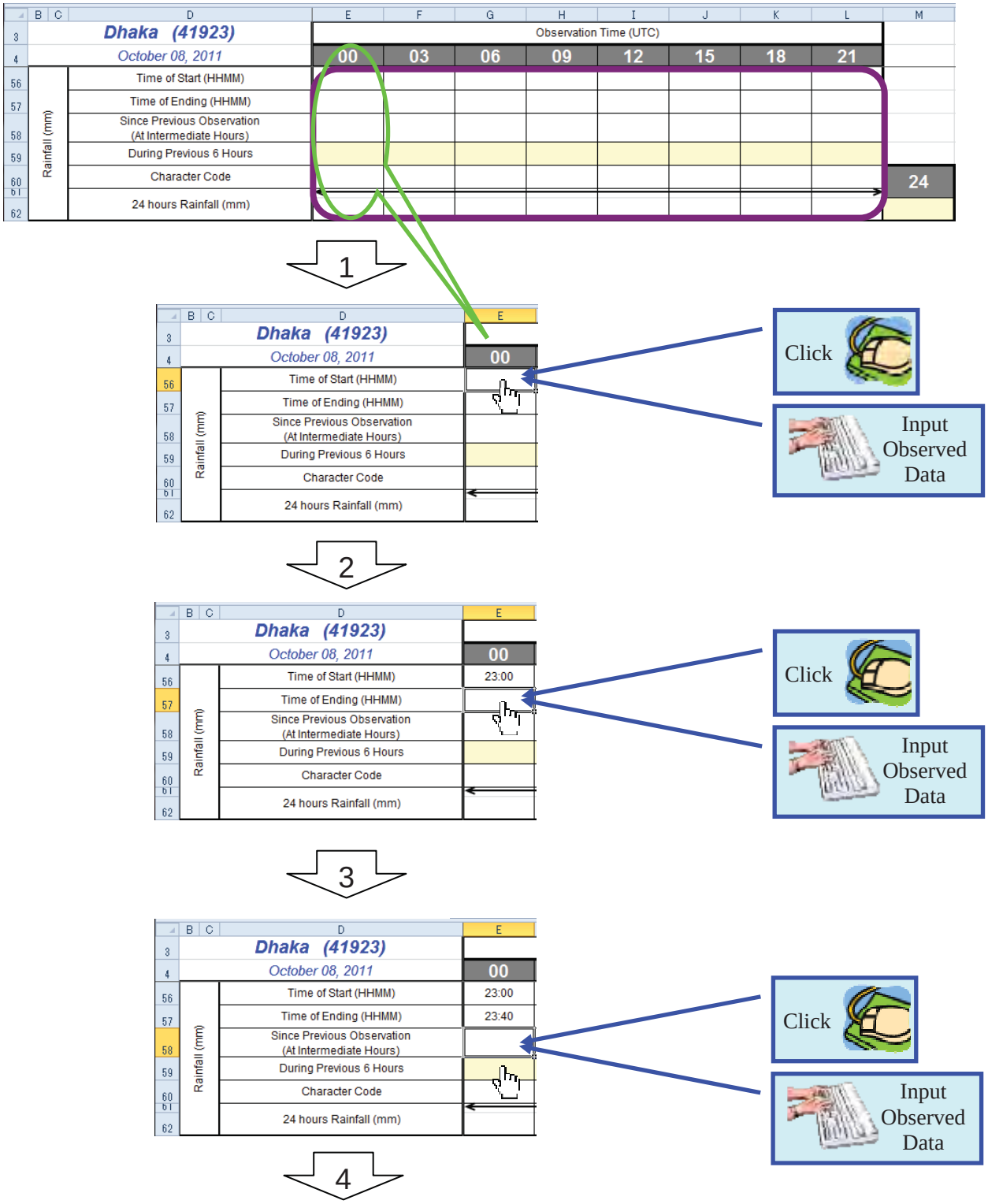
Significant Cloud




5
Dhaka (41923)
October 08, 2011
00
Form (Code)
CL-3
Amount (Okta)
Height of Base (Code)
1st Layer
Click
6
Select Symbol
&
Click
7
Click
Input Observed Data
8
Error Message
Microsoft Excel
The value you entered is not valid.
A user has restricted values that can be entered into this cell.
Retry
Cancel
Report to BMD Head Office
Significant Cloud
2nd Layer
3rd Layer
4th Layer
Select Cloud Type Code
Select Symbol
Input Observed Data
9
OK!

Observed Data (in the Observation Field)

Precipitation



4

	B	C	D	E
3			Dhaka (41923)	
4			October 08, 2011	00
56	Rainfall (mm)		Time of Start (HHMM)	23:00
57			Time of Ending (HHMM)	23:40
58			Since Previous Observation (At Intermediate Hours)	10
59			During Previous 6 Hours	15
60			Character Code	
61				
62			24 hours Rainfall (mm)	

Automatic Input!!

5

	B	C	D	E
3			Dhaka (41923)	
4			October 08, 2011	00
56	Rainfall (mm)		Time of Start (HHMM)	23:00
57			Time of Ending (HHMM)	23:40
58			Since Previous Observation (At Intermediate Hours)	10
59			During Previous 6 Hours	15
60			Character Code	
61				
62			24 hours Rainfall (mm)	

Click 

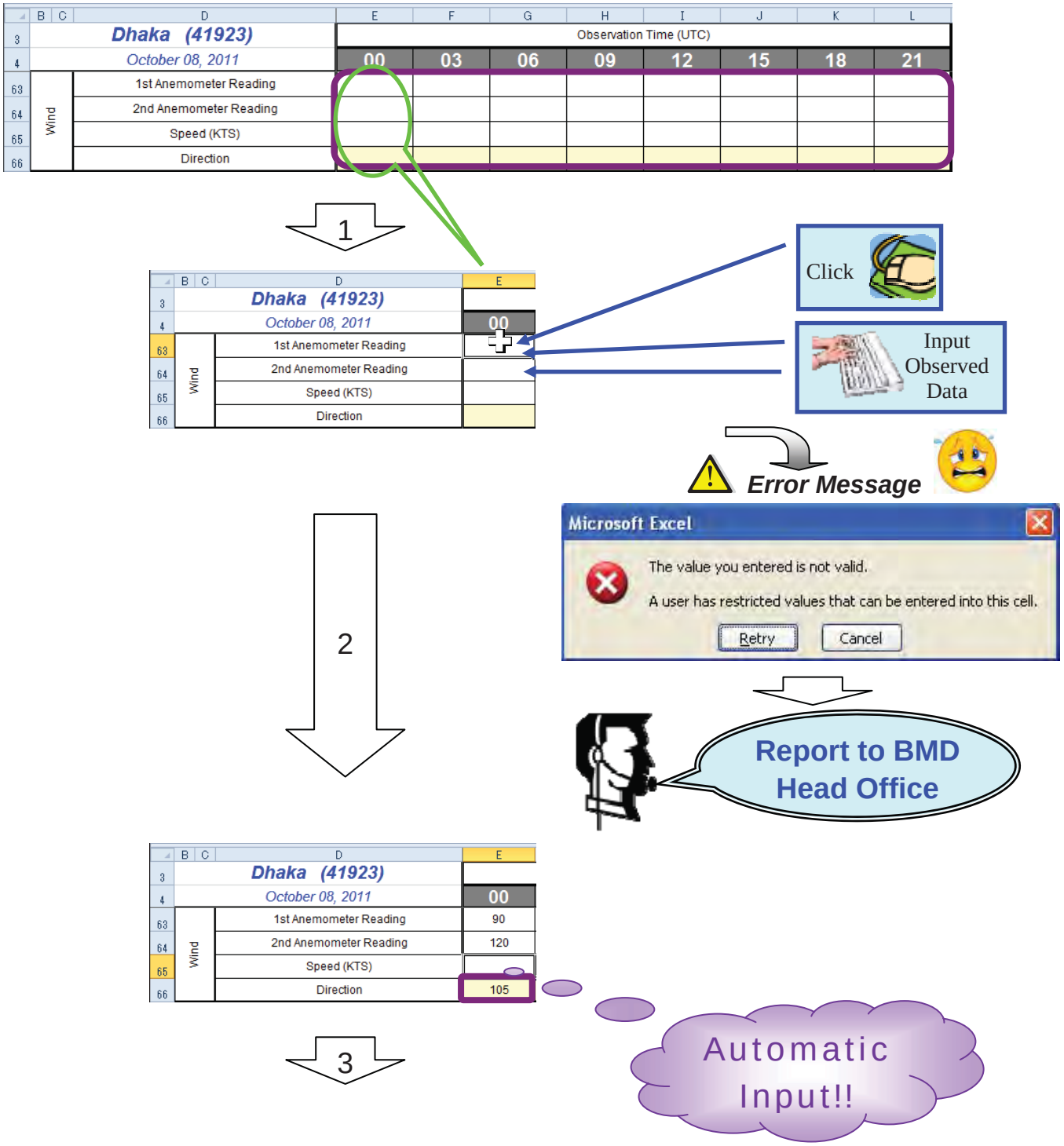
 Input Observed Data

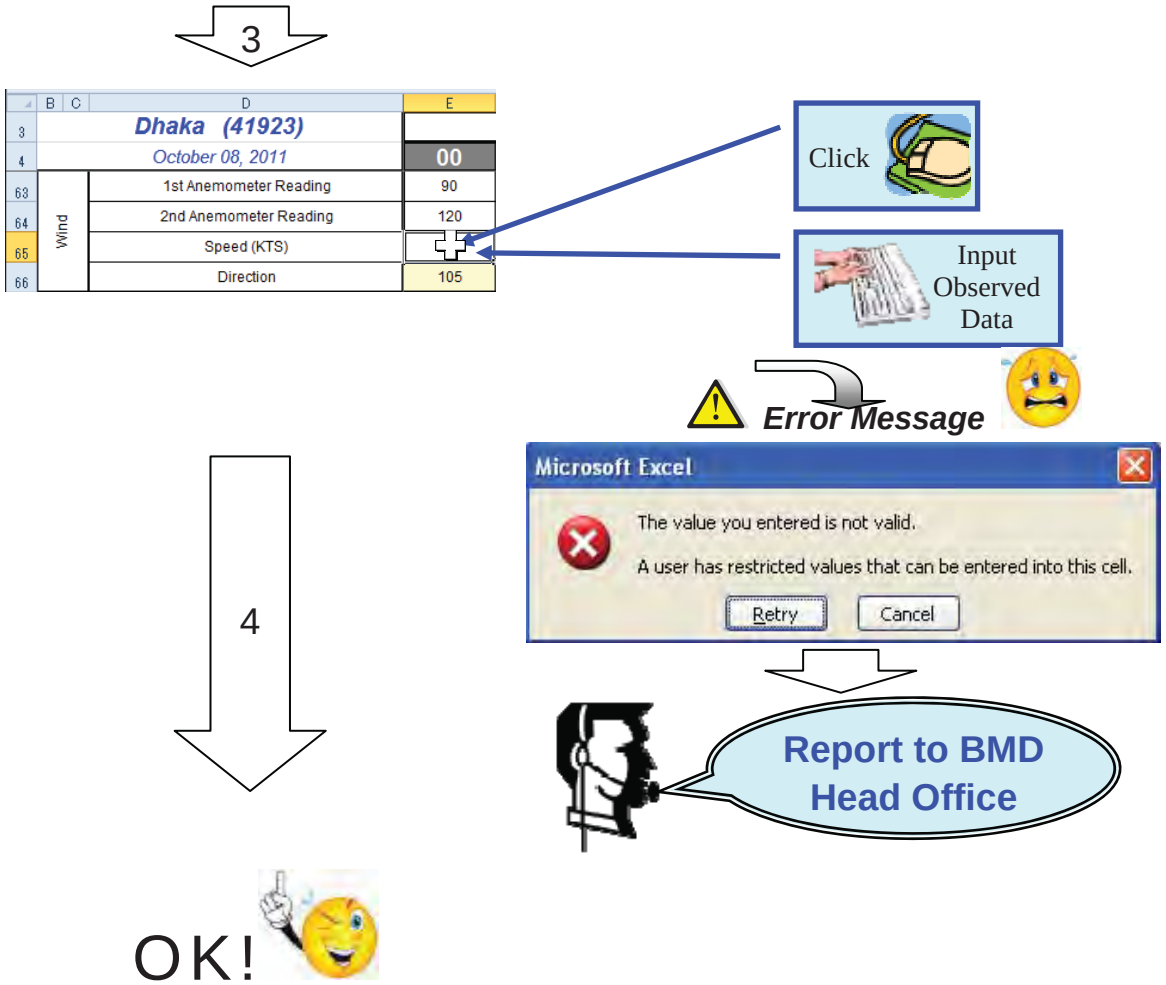
6

OK! 

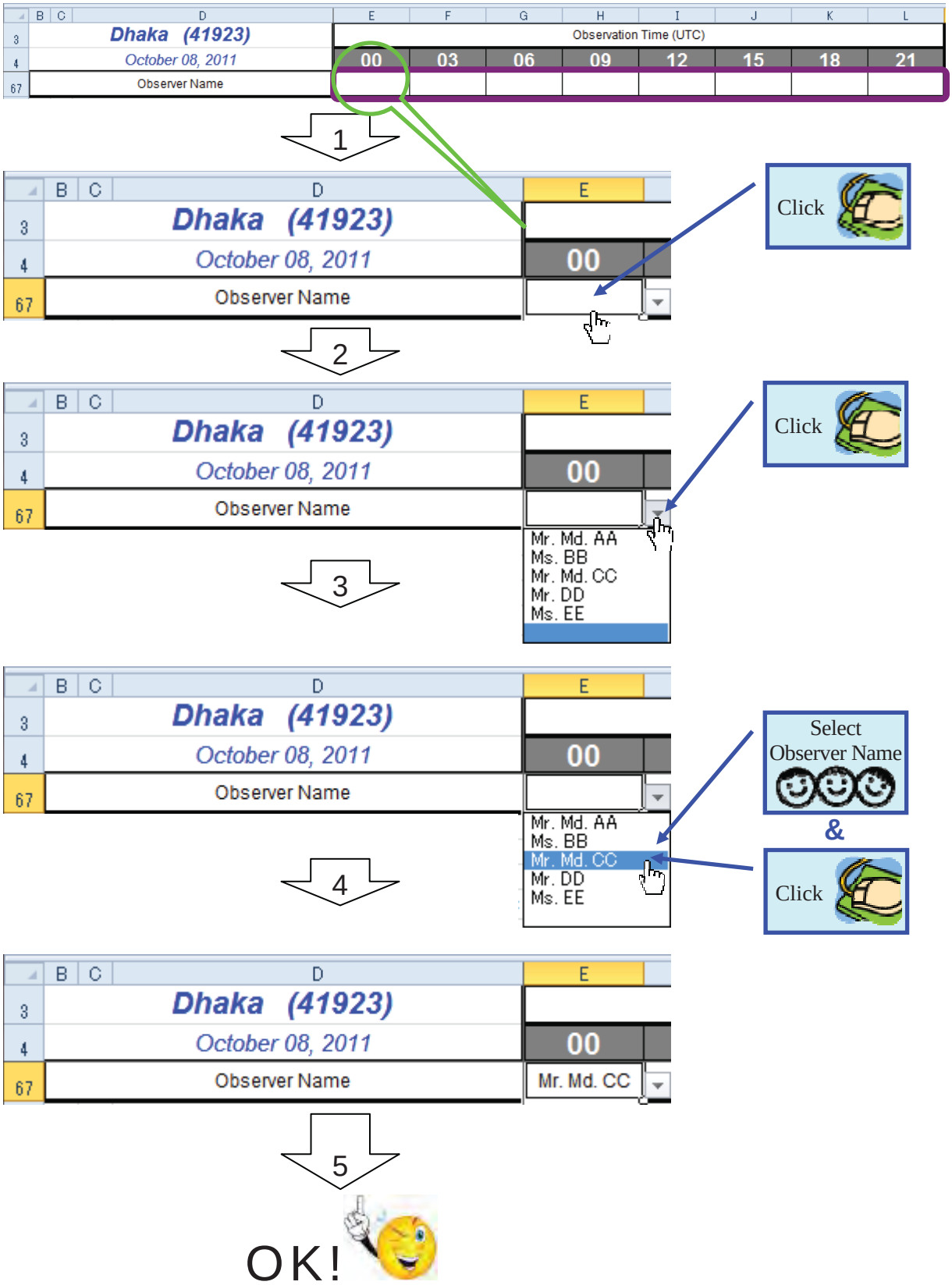
Observed Data (Observation Building)

Wind Speed
Wind Direction

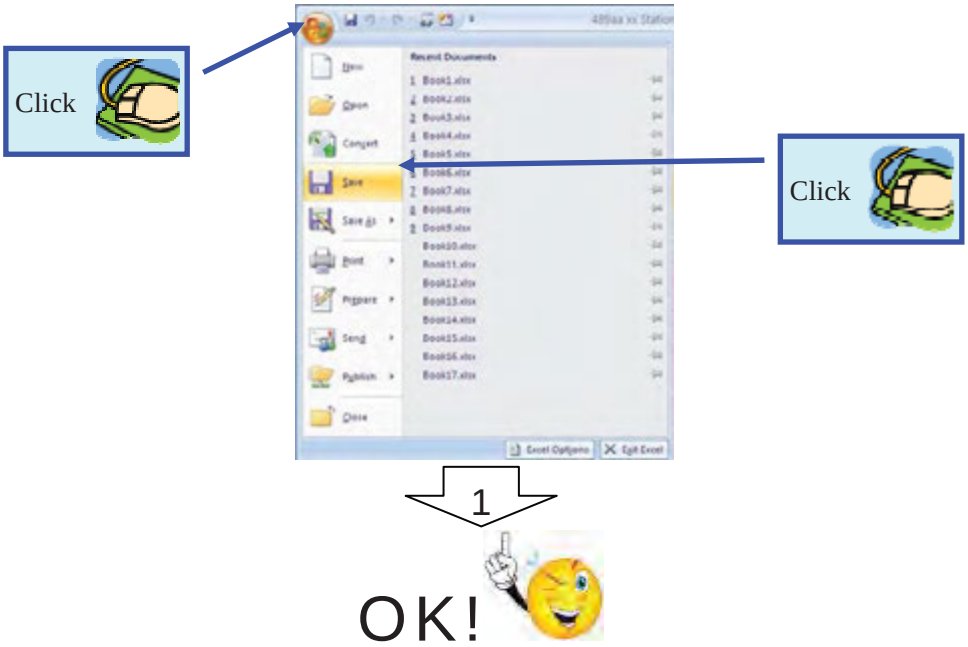



3
Dhaka (41923)
October 08, 2011
00
Wind
1st Anemometer Reading
90
2nd Anemometer Reading
120
Speed (KTS)
Direction
105
Click
Input Observed Data
Error Message
Microsoft Excel
The value you entered is not valid.
A user has restricted values that can be entered into this cell.
Retry
Cancel
4
Report to BMD Head Office
OK!

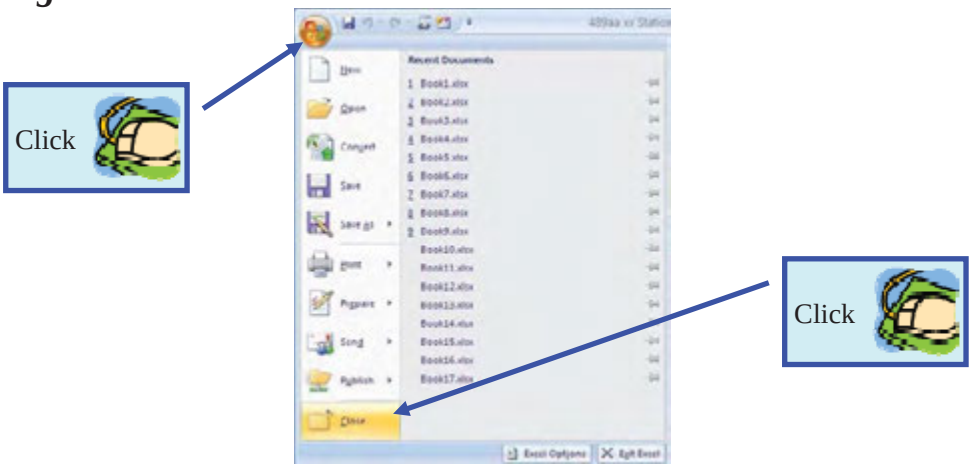
Observer Name

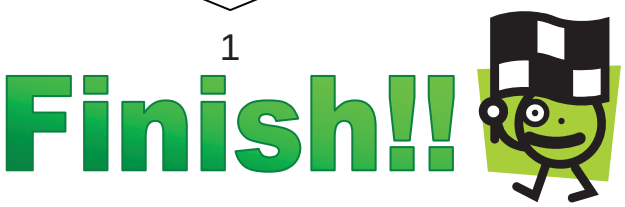


Data Saving

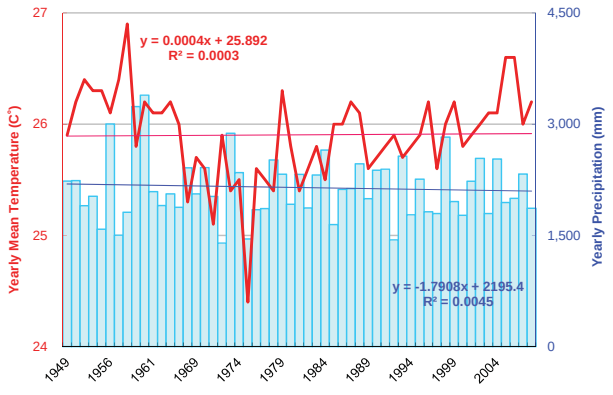


File Closing

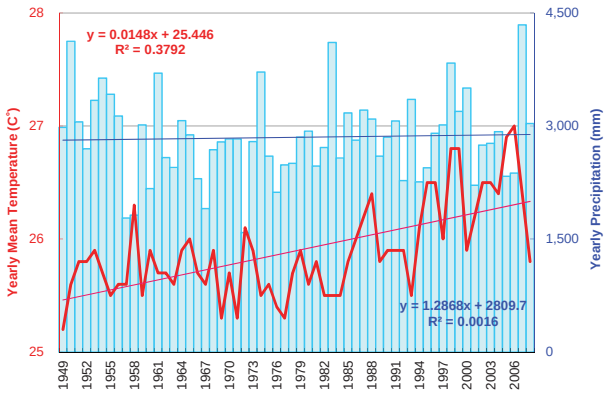




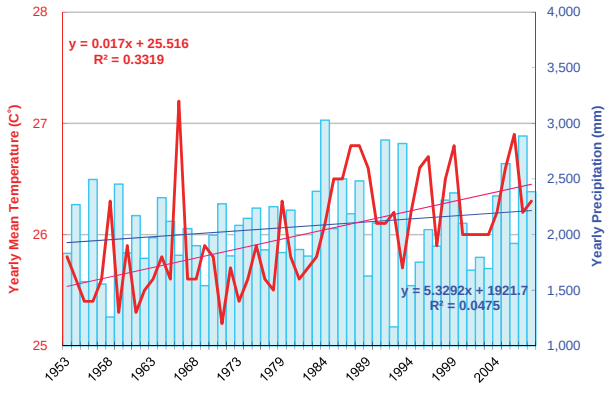
Changing Trend of Yearly Mean Temperature and Yearly Precipitation



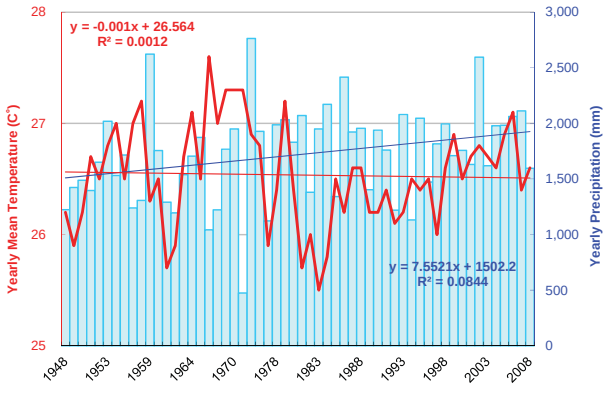
Barisal



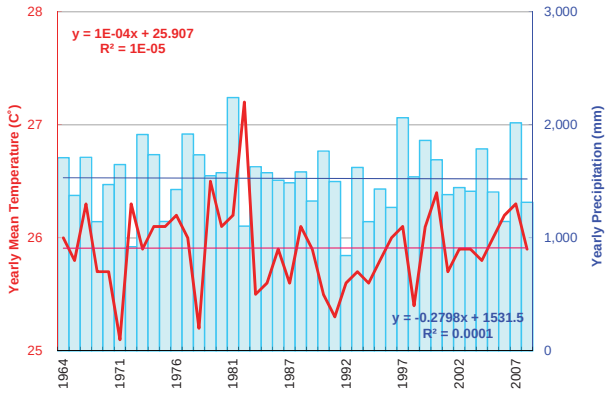
Chittagong



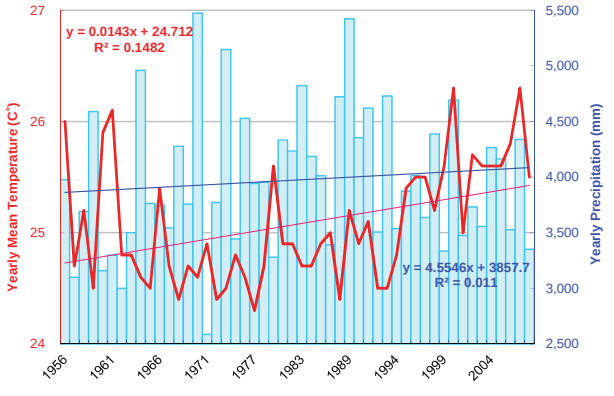
Dhaka



Khulna



Rajshahi



Sylhet

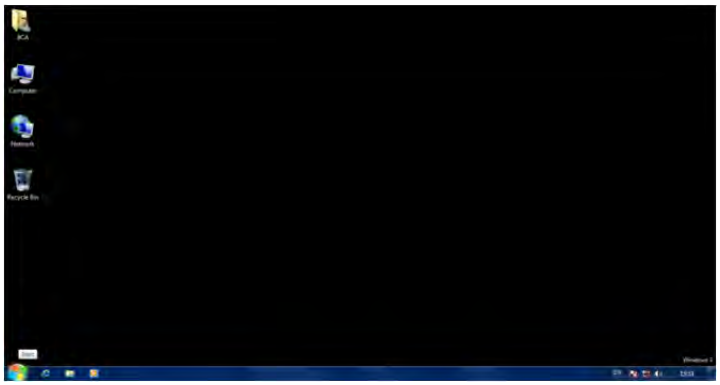
(BMD Manual Observation Data)

Installation of CentOS 5.5 (Linux OS)

1. HARD DISK PARTITIONING BY WINDOWS 7

Click

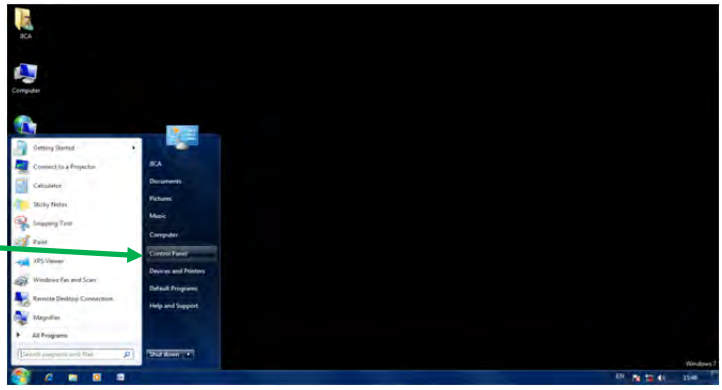
“ ”



1

Click

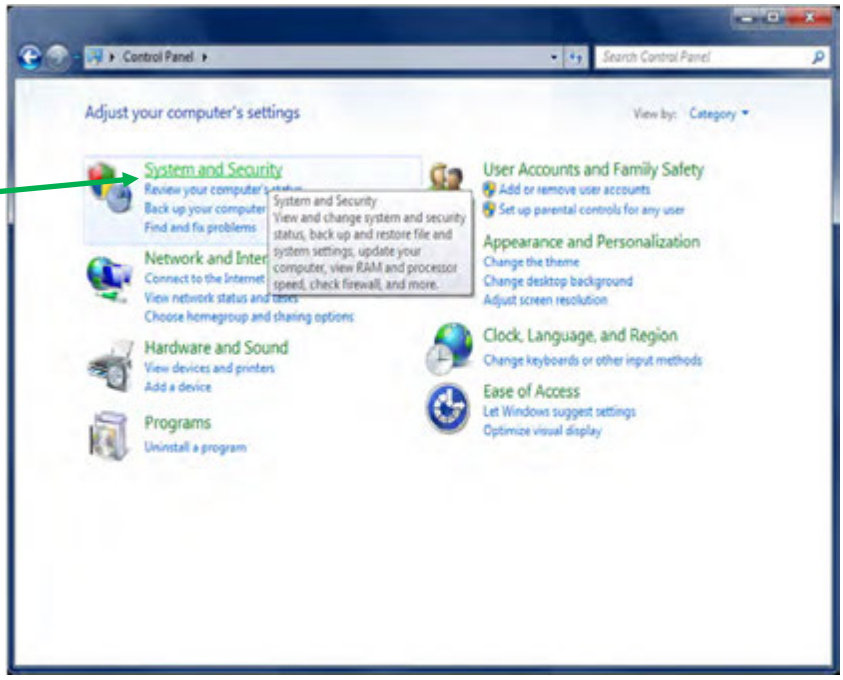
“Control Panel”



2

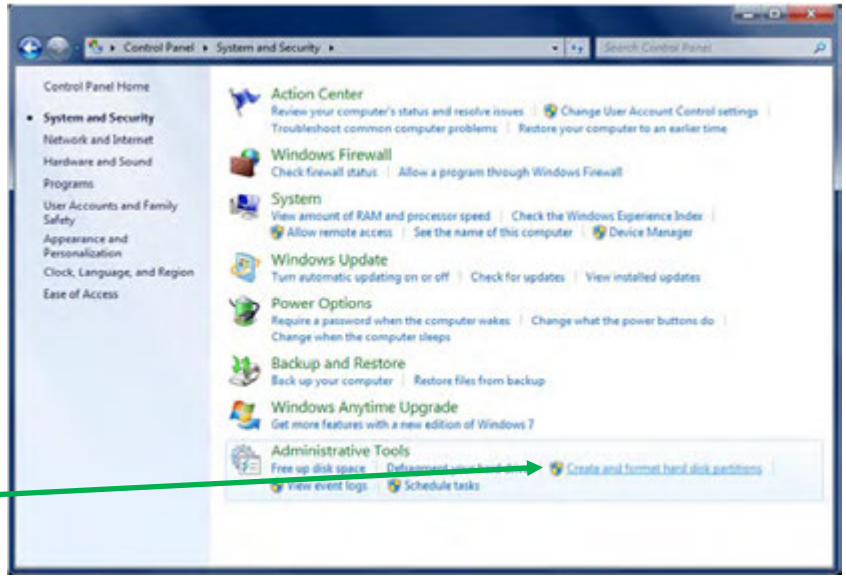
Click

“System and Security”



3

3

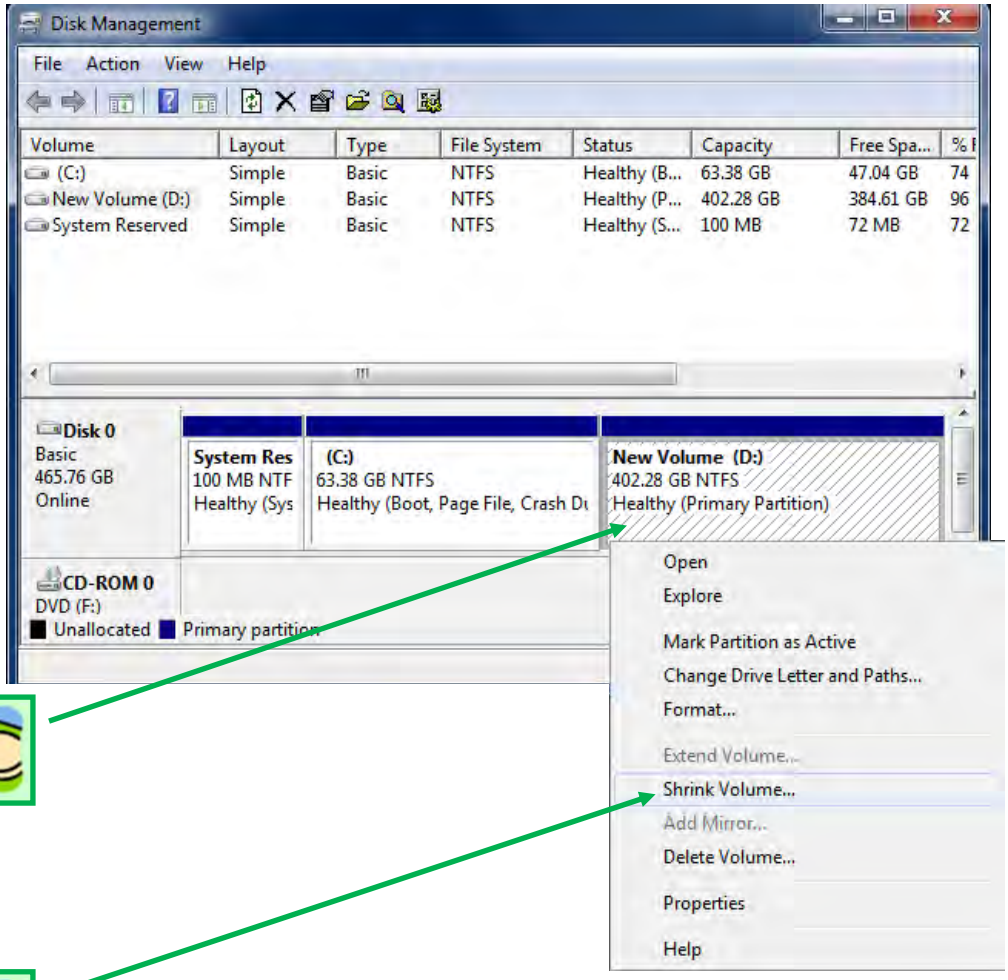


Click

"Create and format hard disk partitions"

4

Partition a Hard Disk Volume!



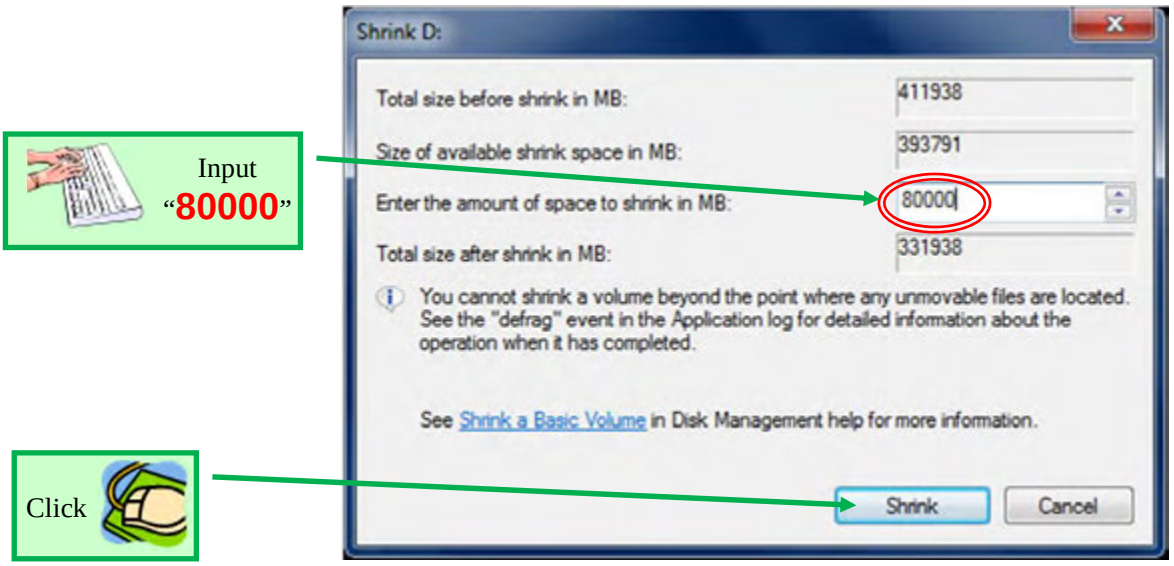
Click *Right button*

Click

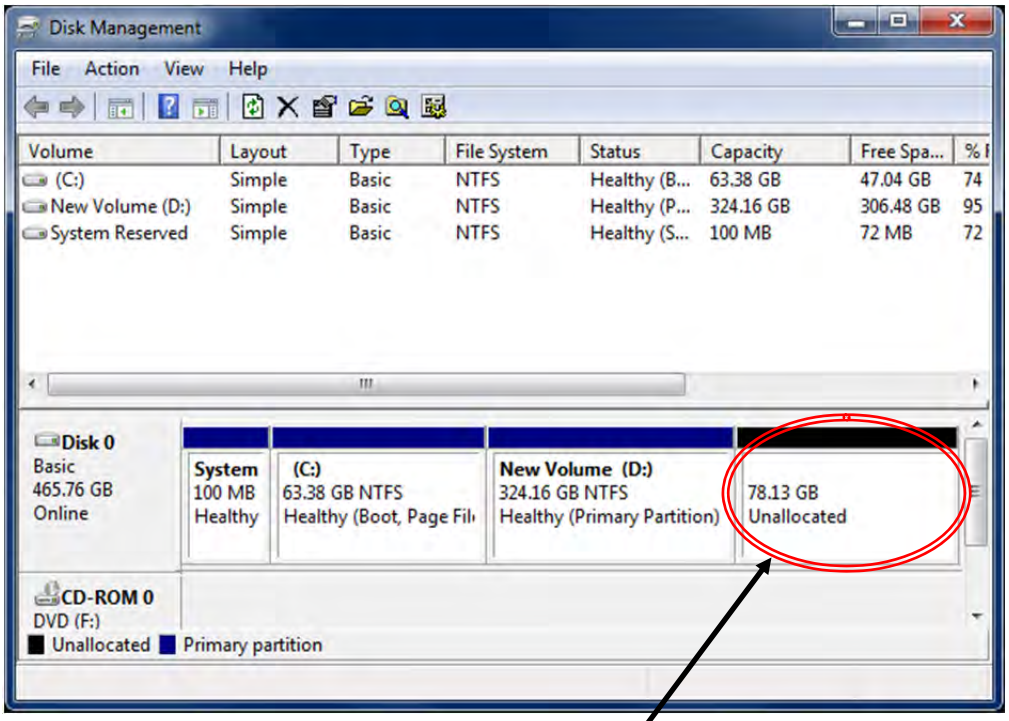
"Shrink Volume…"

5

5



6



The Linux OS will be installed in this volume.

7

OK!

2. INSTALLATION OF CentOS 5.5

Insert Installation Disk!

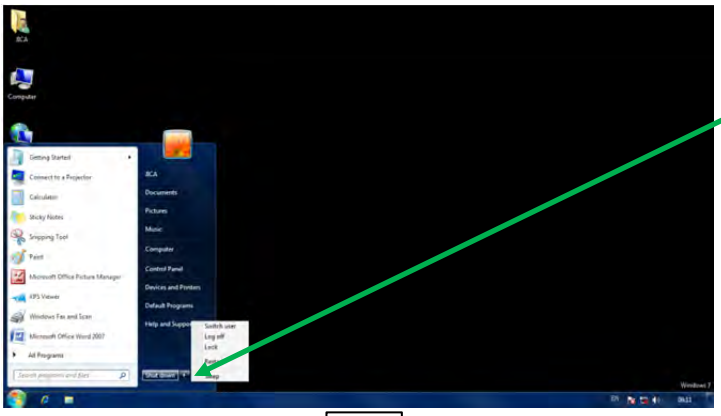
CentOS Installation Disk

1

Click

“ ”

2

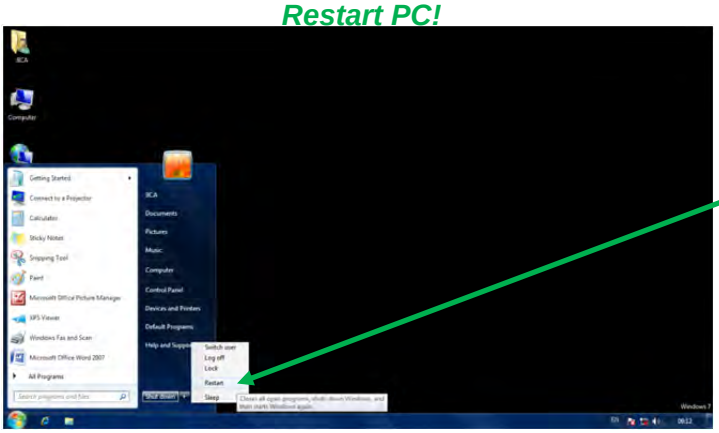


Click

“ ”

3

Restart PC!



Click

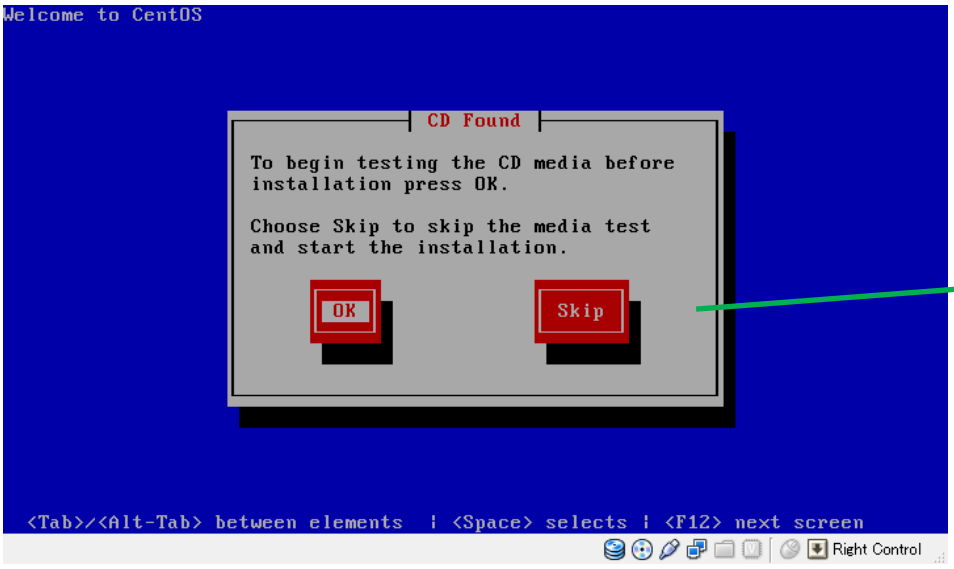
“Restart”

4

4

Enter

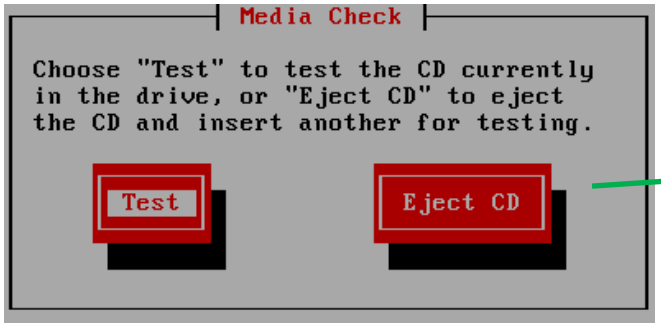
5



Enter

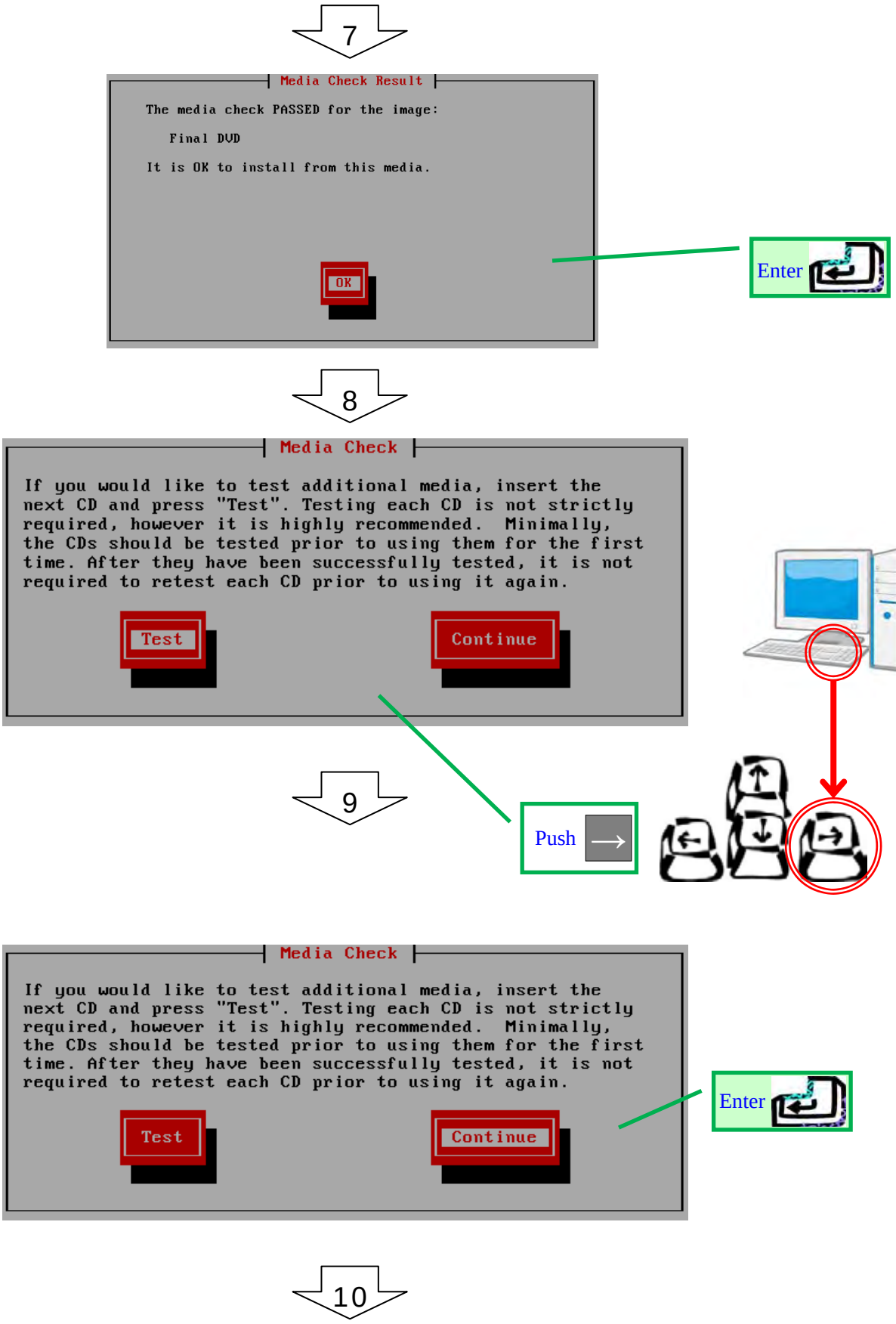
6

Check Installation Disk!



Enter

7

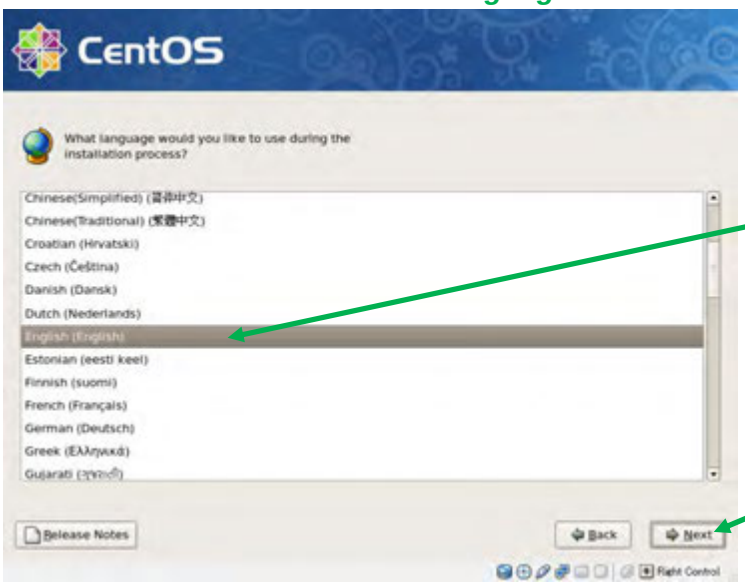

7
Media Check Result
The media check PASSED for the image:
Final DVD
It is OK to install from this media.
OK
Enter
8
Media Check
If you would like to test additional media, insert the next CD and press "Test". Testing each CD is not strictly required, however it is highly recommended. Minimally, the CDs should be tested prior to using them for the first time. After they have been successfully tested, it is not required to retest each CD prior to using it again.
Test
Continue
9
Push
Media Check
If you would like to test additional media, insert the next CD and press "Test". Testing each CD is not strictly required, however it is highly recommended. Minimally, the CDs should be tested prior to using them for the first time. After they have been successfully tested, it is not required to retest each CD prior to using it again.
Test
Continue
Enter
10

10

Click 

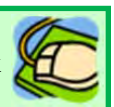
11

Select Language!



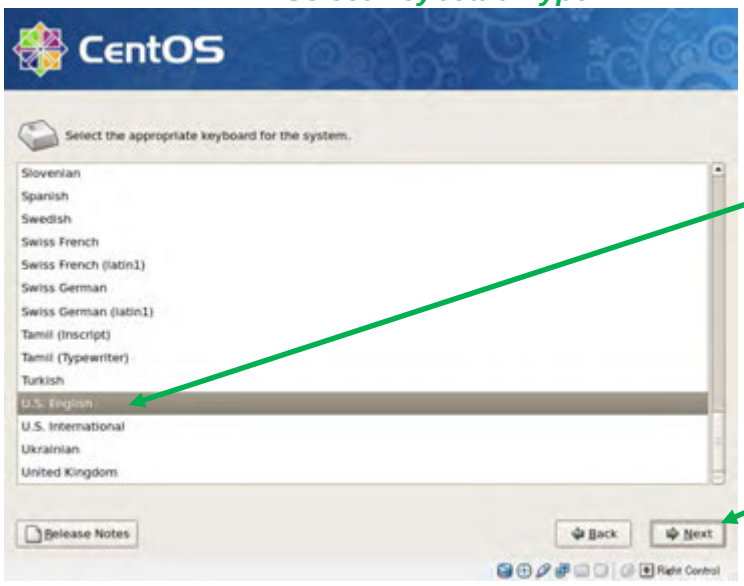
Click 

“English (English)”

Click 

12

Select Keyboard Type!



Click 

“U.S. English”

Click 

13

13

Click 

14

Select Installation Space!

Click 

"Use free space on selected drives and create default layout "

15

Confirm!

Click 

16

16

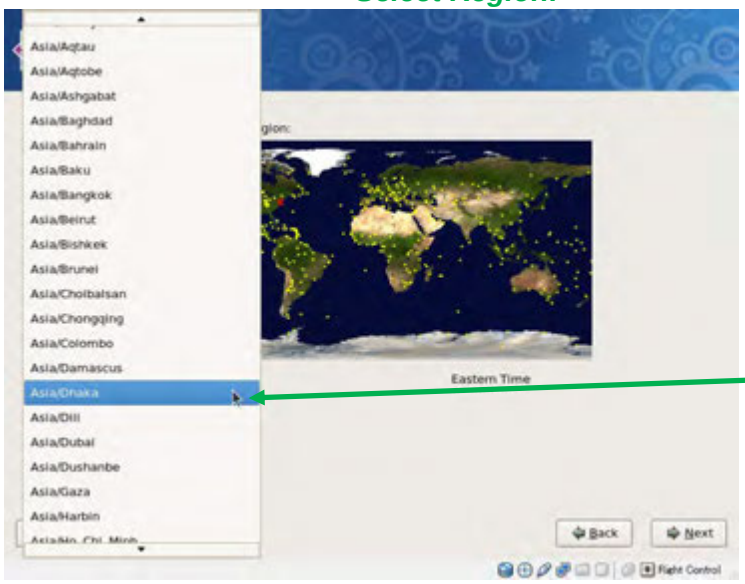
Click 

17

Click 

18

Select Region!



Click 

“Asia/Dhaka”

19

19

Confirm!

Click 

20

 Input "**initial0**"

21

 Input "**initial0**"

22

22

Click 

23

Click 

24

Click 

25

25

Reboot!

Click 

26

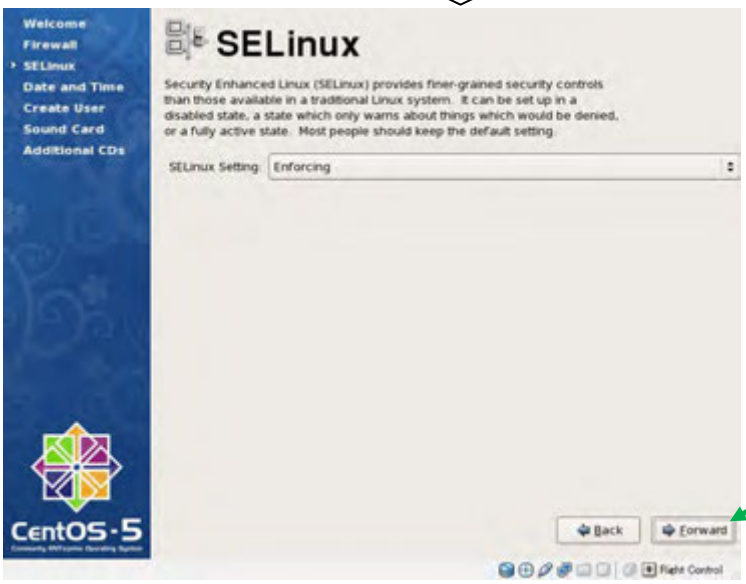
Click 

27

27

Click 

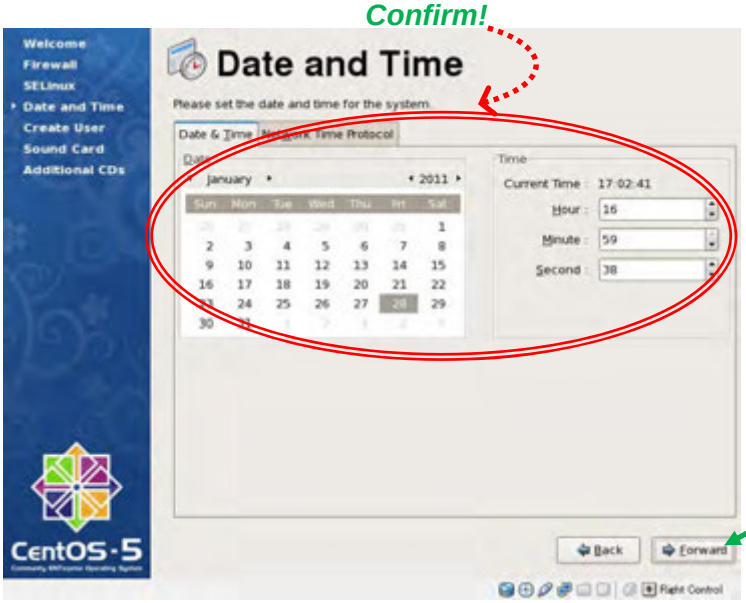
28



Click 

29

Confirm!



Click 

30

30

Input
"**bmd_01**"

31

Input
"**BMD**"

32

Input
"**jicaproject**"

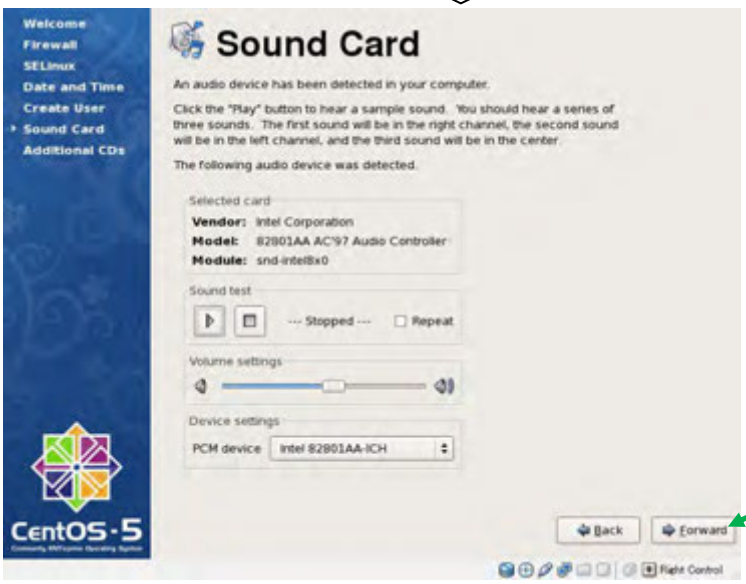
Input
"**jicaproject**"

33

33

Click 

34



Click 

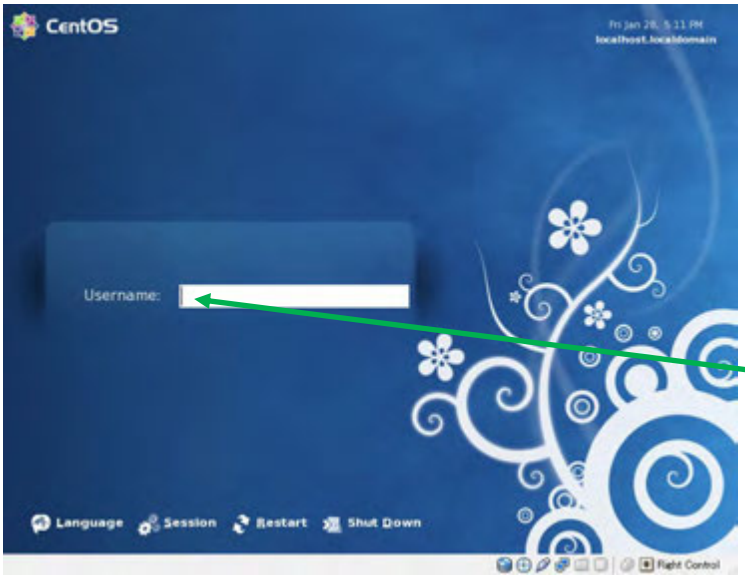
35

Click 

36 OK!

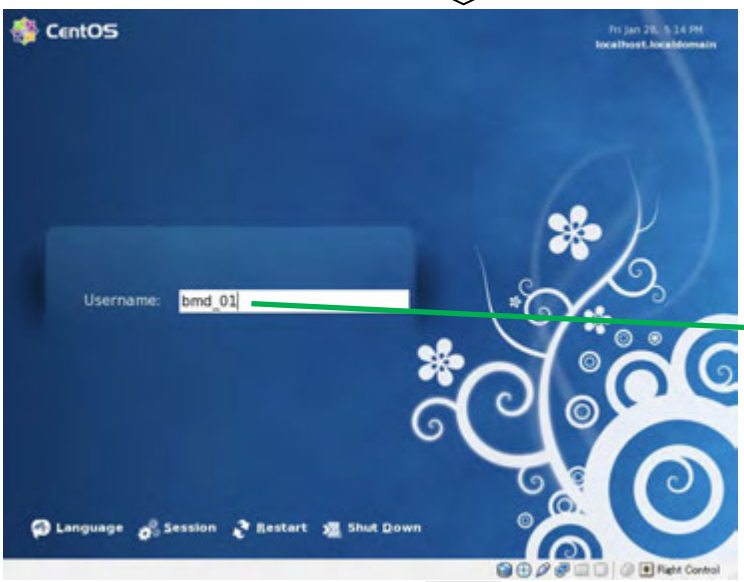
3. BASIC OPERATION

3.1. LOG IN



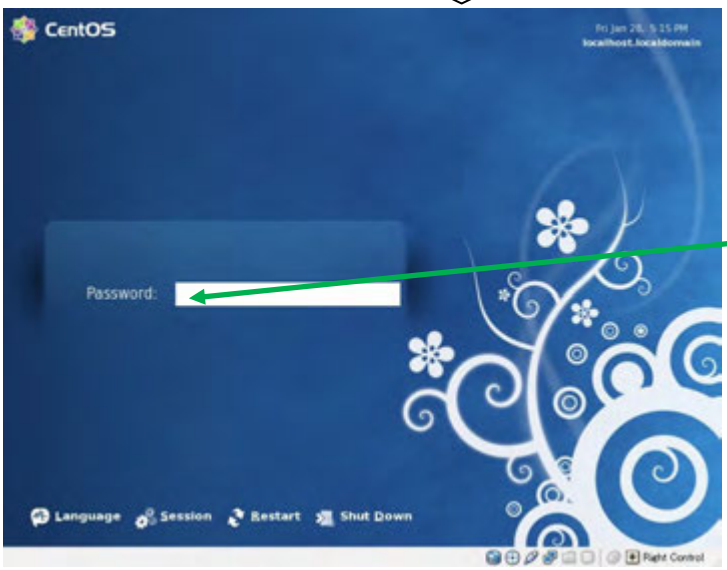
Input "**bmd_01**"

1



Enter

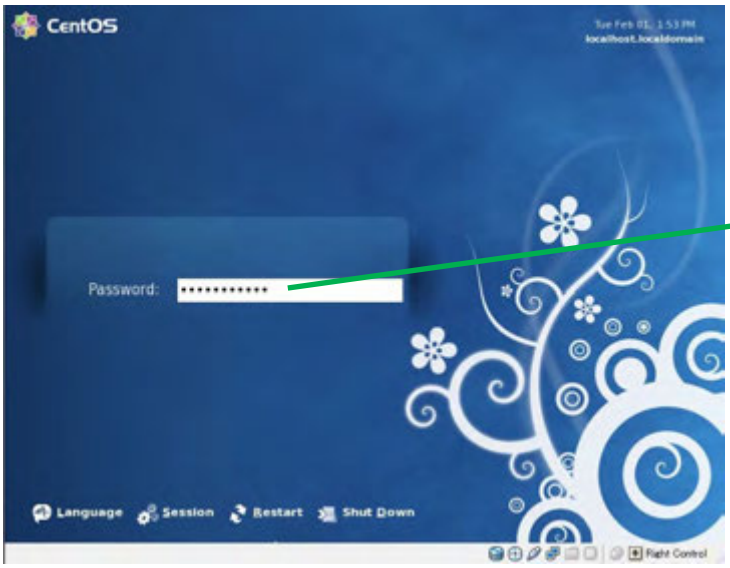
2



Input "**jicaproject**"

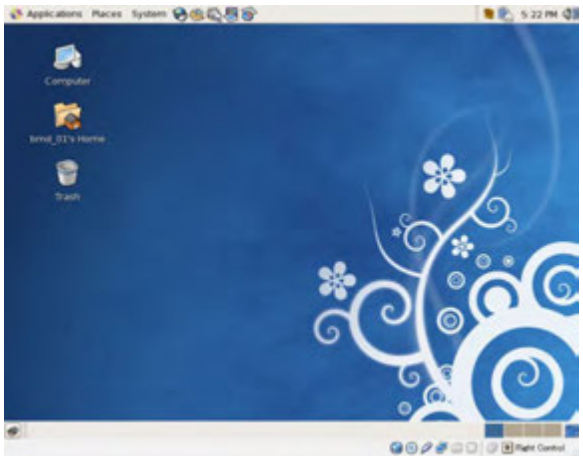
3

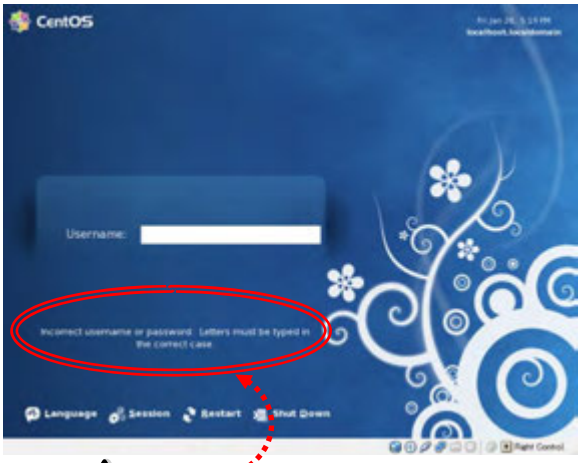
3



Enter

4





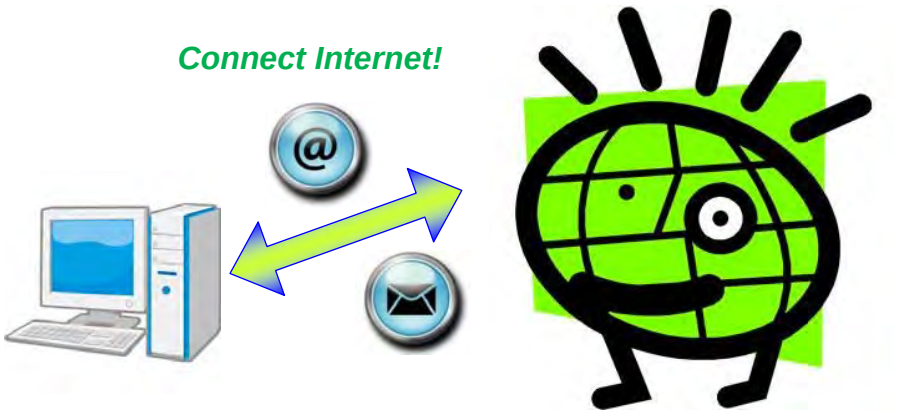
Error Message

1

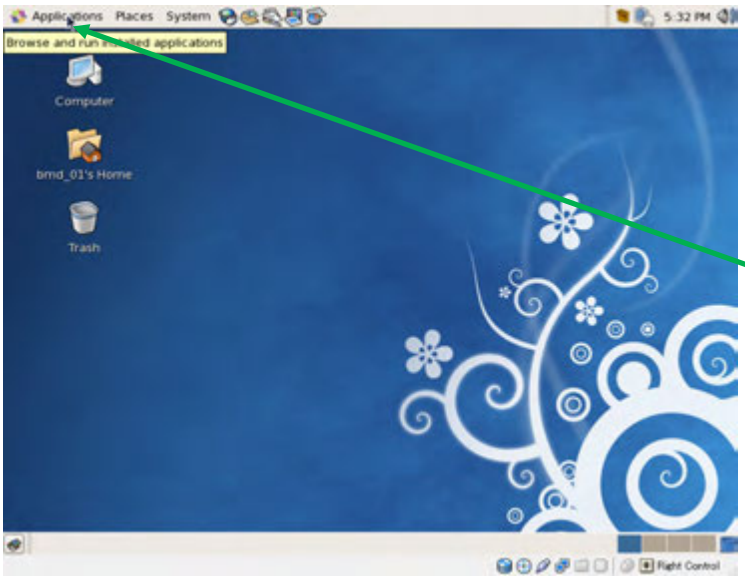
5

OK!

3.2. UPDATING

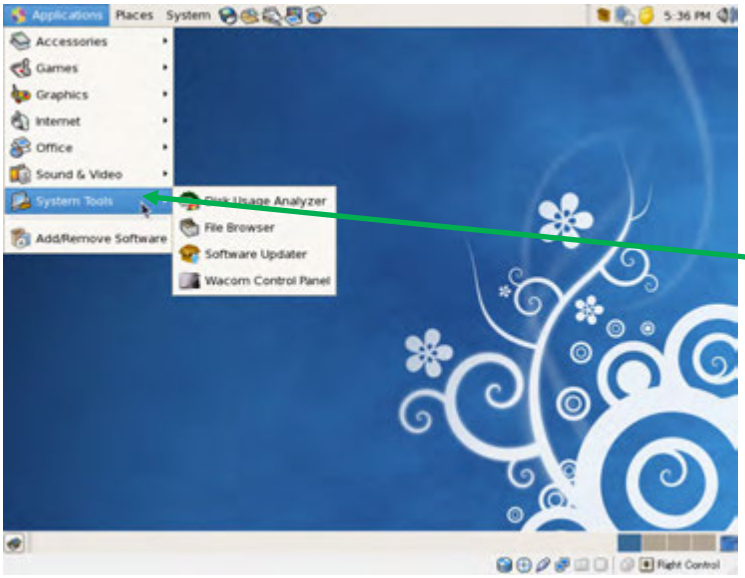


1



Click 
"Applications"

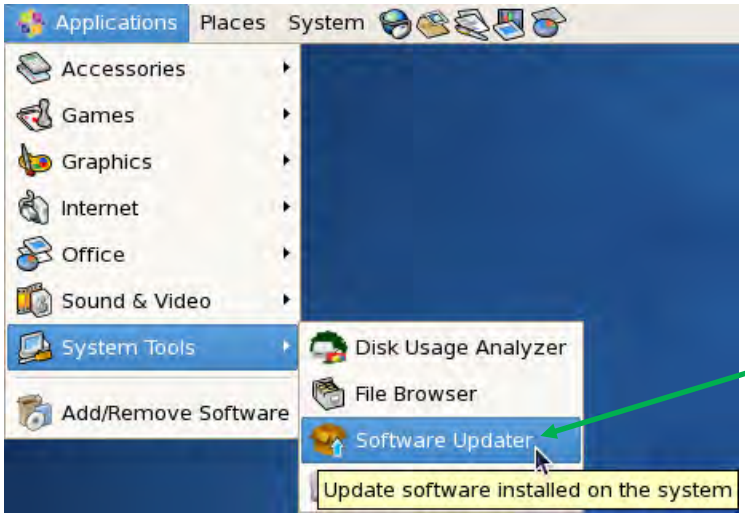
2



Click 
"System tools"

3

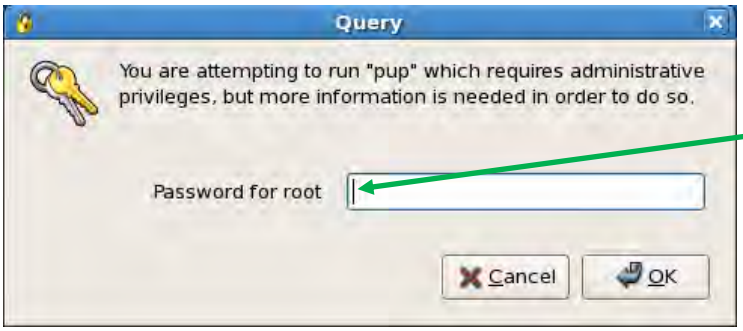
3



Click 

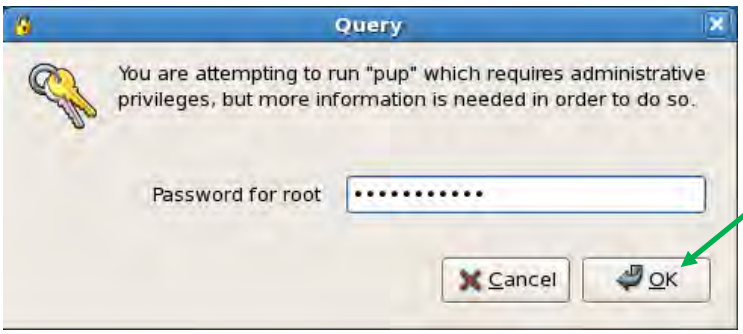
"Software Updater"

4



Input "**initial0**"

5



Click 

6

6

Click 

7

Click 

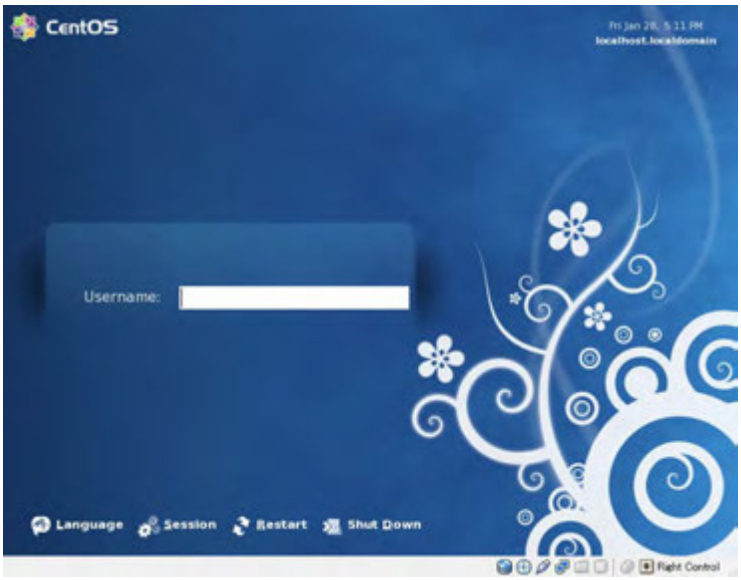
8

Reboot!

Click 

9

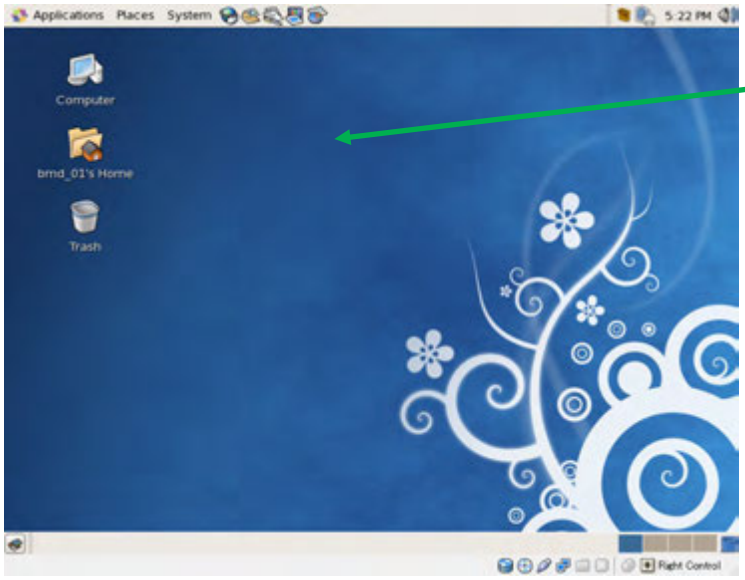
9


CentOS
Fri Jan 28, 5:11 PM
localhost.localdomain
Username:
Language
Session
Restart
Shut Down
Right Control

10

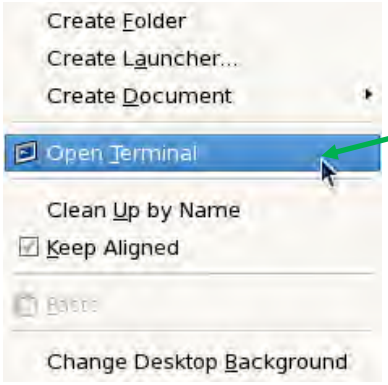
OK!

3.3. TERMINAL OPEN



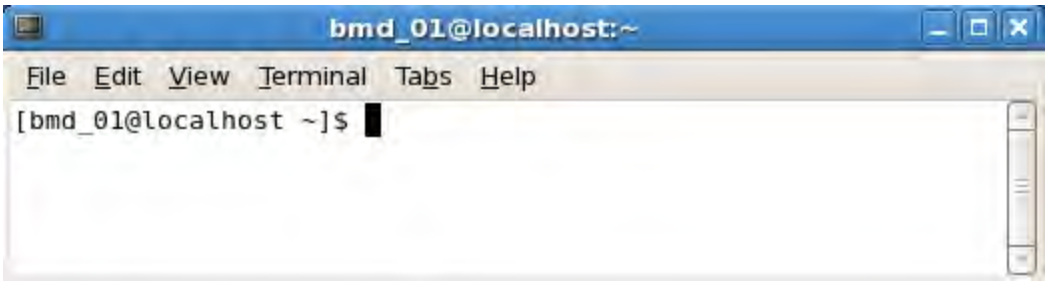
Click *Right Button*

1



Click

3



4

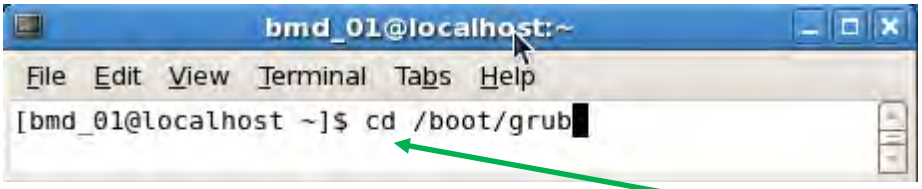
OK!

3.4. BOOT MENU SETTING (FOR WINDOWS DEFAULT)

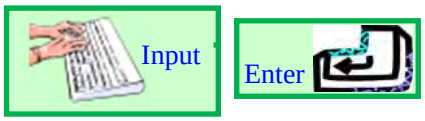
Open Terminal!

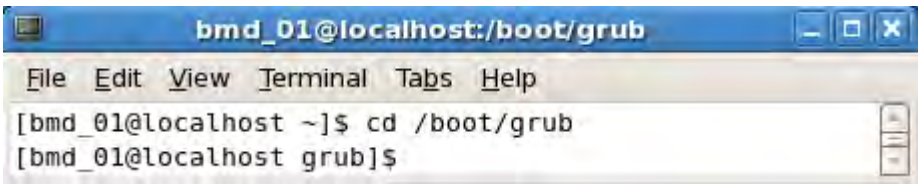
1

Change Directory!

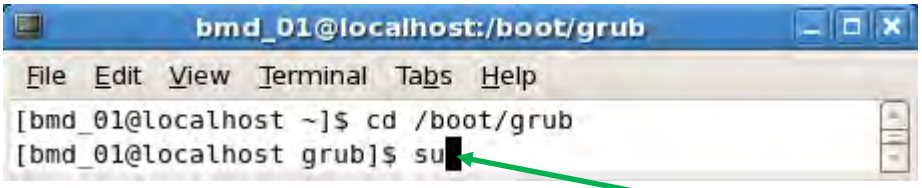


2

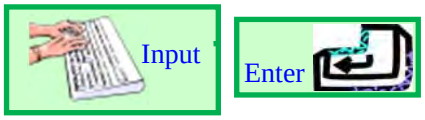


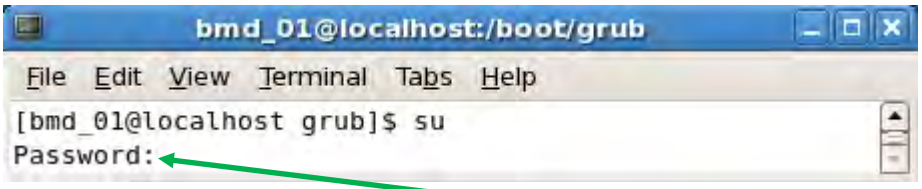


3

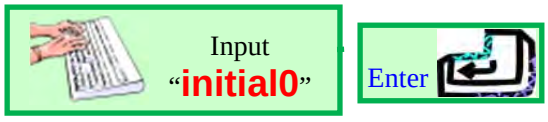


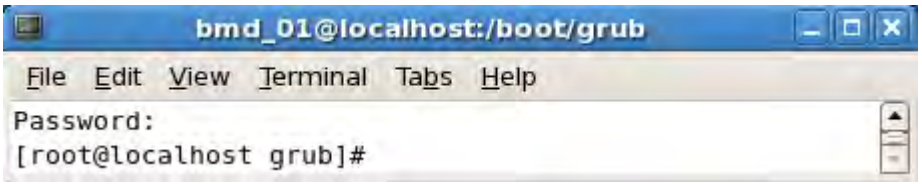
4





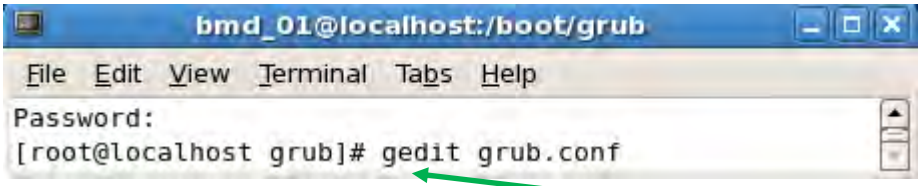
5





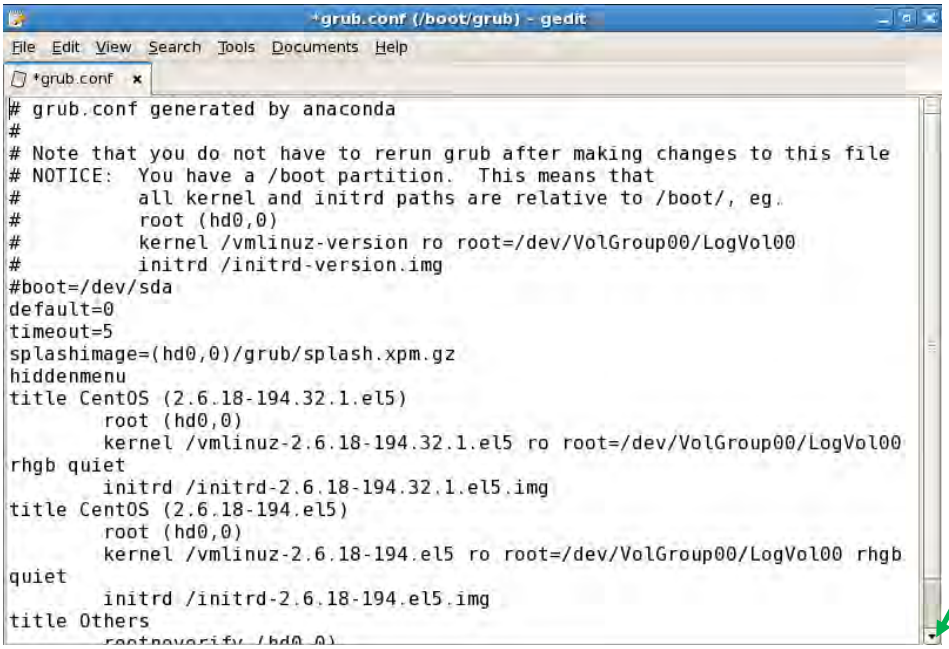
6

6



7

Edit Boot Menu!



Scroll

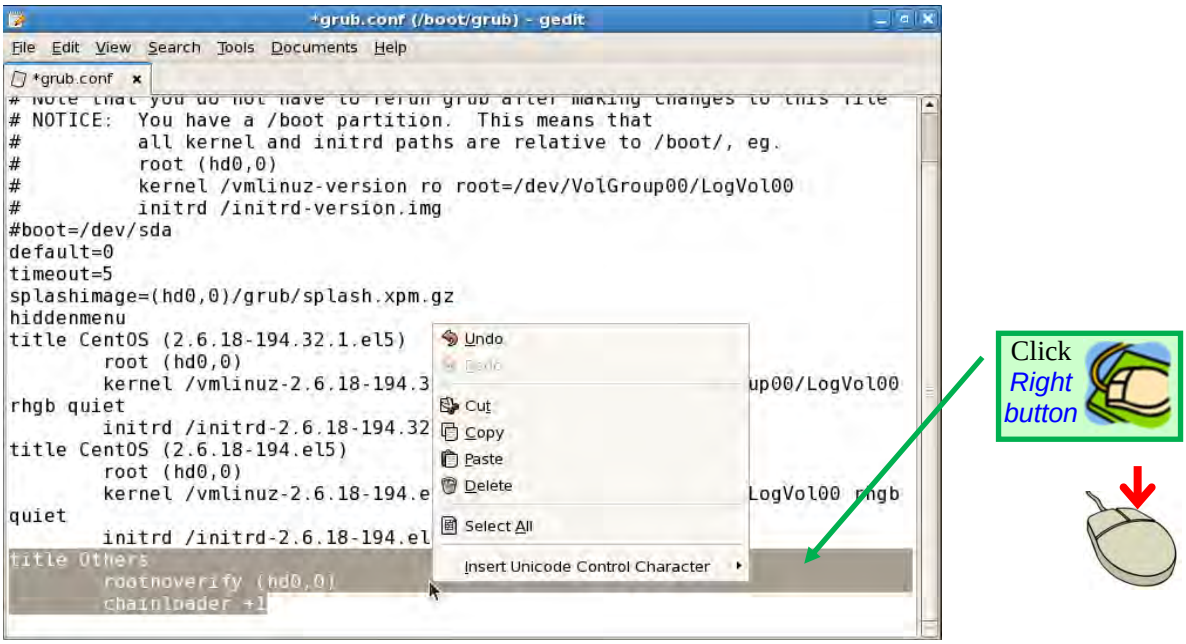
8

9

9


*grub.conf (/boot/grub) - gedit
File Edit View Search Tools Documents Help
*grub.conf
NOTICE: You have a /boot partition. This means that
all kernel and initrd paths are relative to /boot/, eg.
root (hd0,0)
kernel /vmlinuz-version ro root=/dev/VolGroup00/LogVol00
initrd /initrd-version.img
#boot=/dev/sda
default=0
timeout=5
splashimage=(hd0,0)/grub/splash.xpm.gz
hiddenmenu
title CentOS (2.6.18-194.32.1.el5)
root (hd0,0)
kernel /vmlinuz-2.6.18-194.32.1.el5 ro root=/dev/VolGroup00/LogVol00
rhgb quiet
initrd /initrd-2.6.18-194.32.1.el5.img
title CentOS (2.6.18-194.el5)
root (hd0,0)
kernel /vmlinuz-2.6.18-194.el5 ro root=/dev/VolGroup00/LogVol00 rhgb
quiet
initrd /initrd-2.6.18-194.el5.img
title Others
rootnoverify (hd0,0)
chainloader +1
Select

10

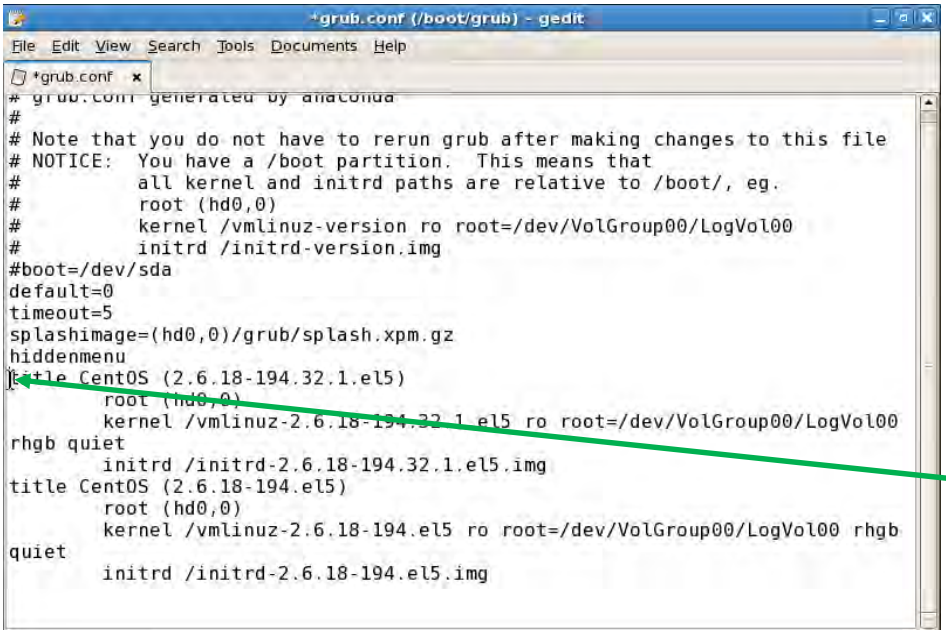

*grub.conf (/boot/grub) - gedit
File Edit View Search Tools Documents Help
*grub.conf
NOTICE: You have a /boot partition. This means that
all kernel and initrd paths are relative to /boot/, eg.
root (hd0,0)
kernel /vmlinuz-version ro root=/dev/VolGroup00/LogVol00
initrd /initrd-version.img
#boot=/dev/sda
default=0
timeout=5
splashimage=(hd0,0)/grub/splash.xpm.gz
hiddenmenu
title CentOS (2.6.18-194.32.1.el5)
root (hd0,0)
rhgb quiet
title CentOS (2.6.18-194.el5)
root (hd0,0)
quiet
title Others
rootnoverify (hd0,0)
chainloader +1
Undo
Redo
Cut
Copy
Paste
Delete
Select All
Insert Unicode Control Character
Click
Right
button

11


Undo
Redo
Cut
Copy
Paste
Delete
Select All
Insert Unicode Control Character
Click
"Cut"

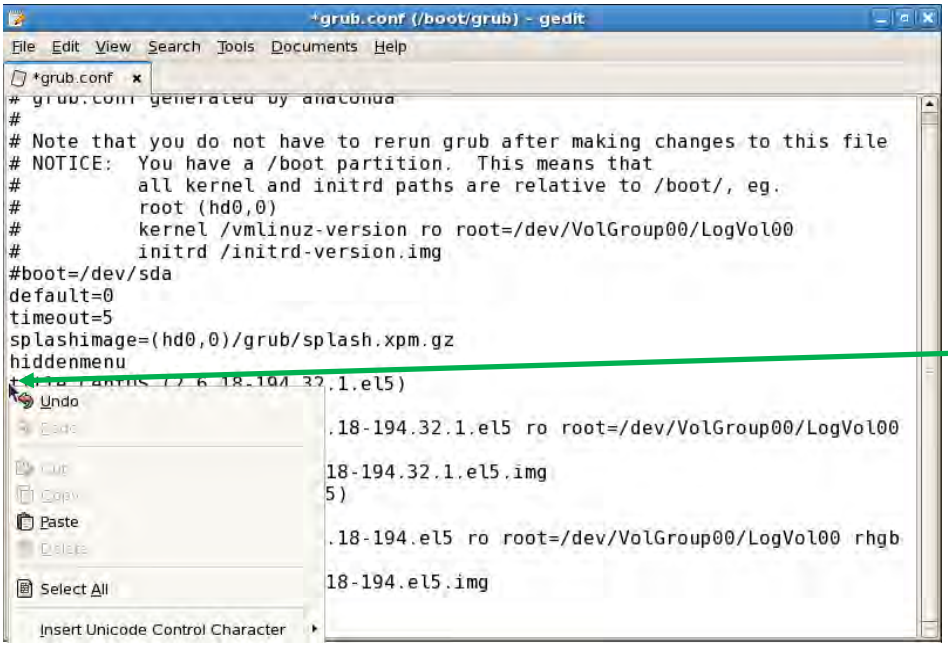
12

12



Click

13



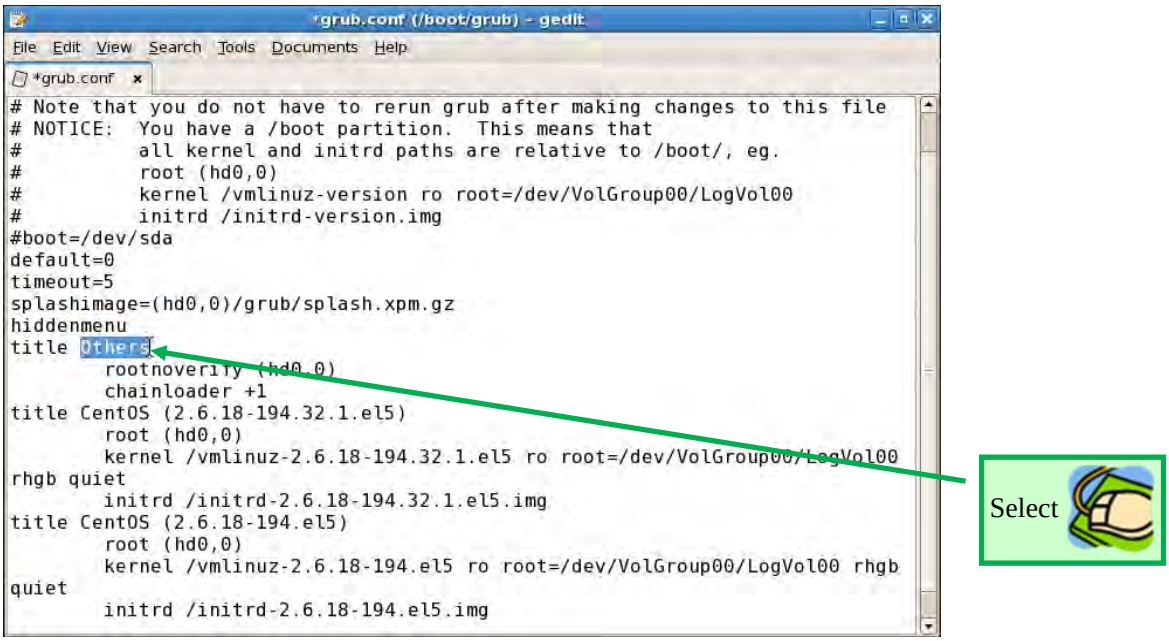
Click *Right button*

14

Click **"Paste"**

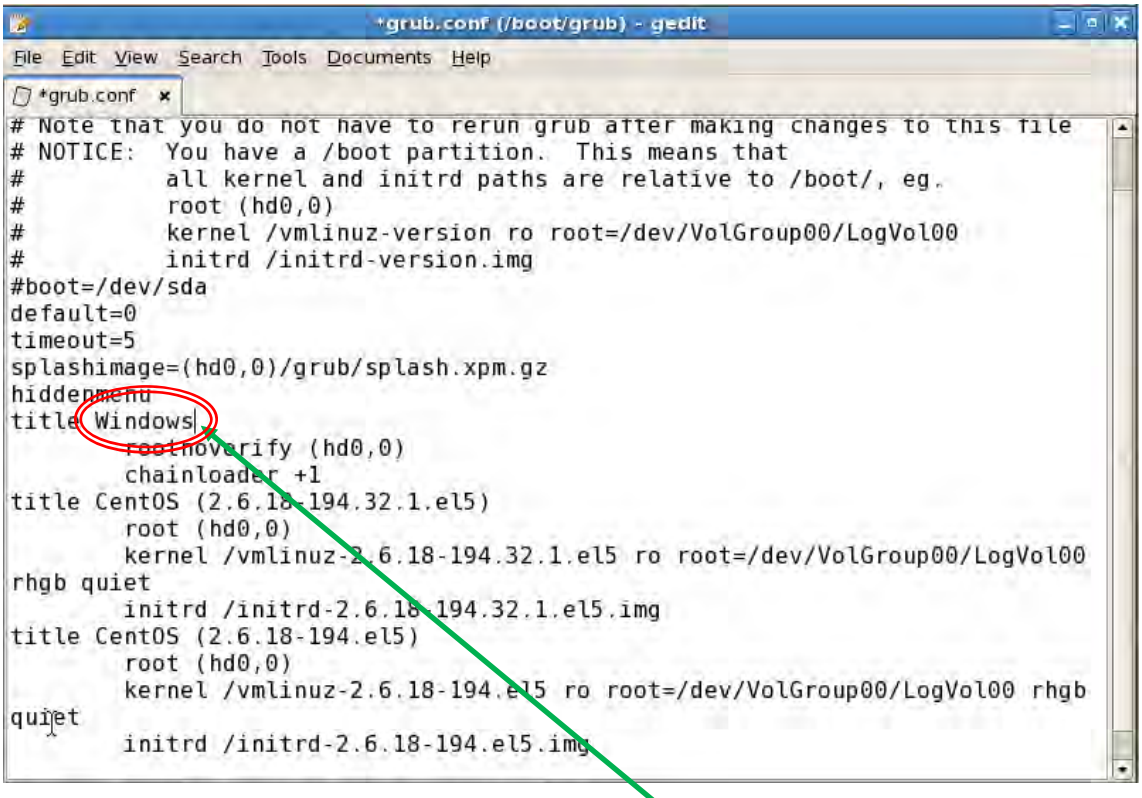
15

15



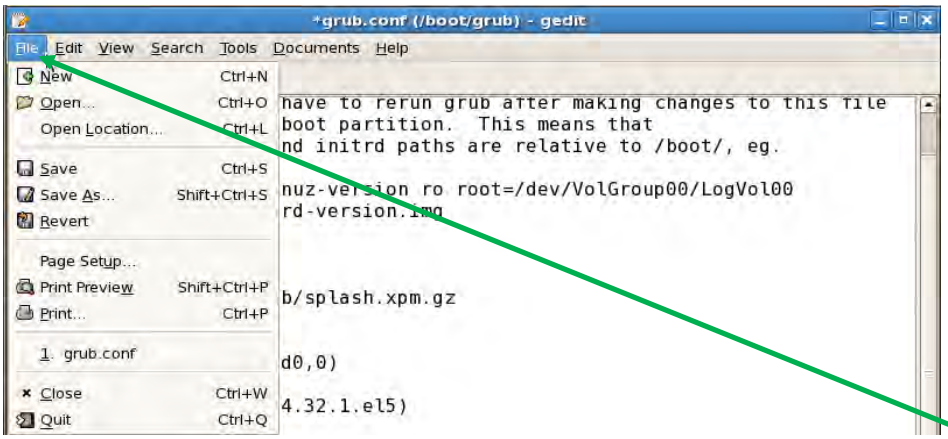
16

Input!



17

17



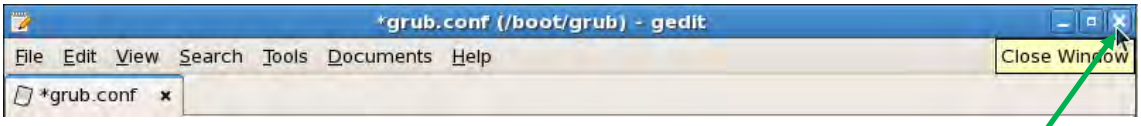
Click

18

Click

“Save”

19

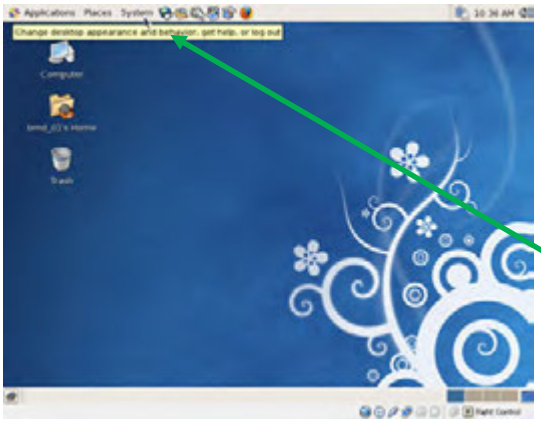


20

OK!

Click

3.5. LOG OUT

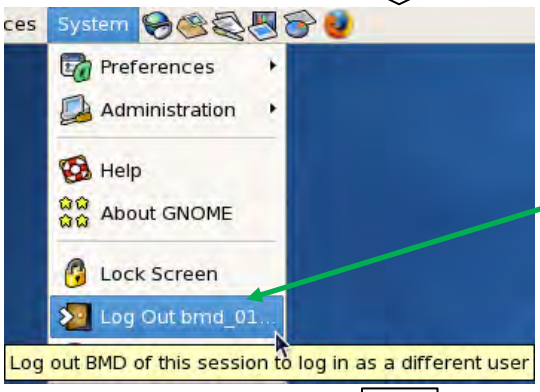


Click

“System”

1

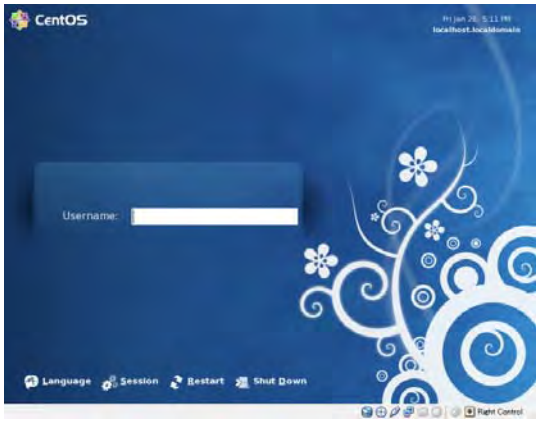
2



Click

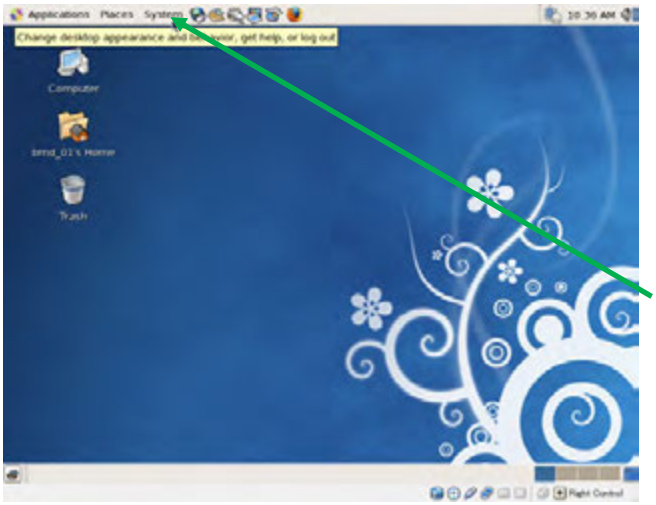
“Log Out (user name)…”

3



4 OK!

3.6. SHUT DOWN

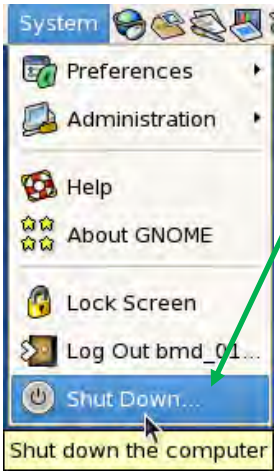


Click

“System”

1

2



Click

“Shut Down…”

3

OK!