Observational Issues of New Moon Sighting in Pakistan

Rehman, A.[1], M. S. Qureshi[2], N. Sadiq[3]

Abstract

Moon sighting issue in Pakistan is a socio-religious challenge as many religious events (Eid-ul-fitar, Eid-ul-Azha and Ramadan start after new Moon sighting) are directly related to it. The Islamic lunar date is determined by the first sighting of the new Moon which is considered more authentic in determining the start of new lunar month than the astronomical calculations. In Pakistan central Ruet-E-Hilal committee announces the beginning of new lunar month after taking reports from local Moon sighting witnesses. The main issue behind the concept of local Moon sighting is the reliability of the reports that claim to have seen the new Moon. So the study of local Moon sighting practices in Pakistan is necessary. In this study observation of new Moon recorded at meteorological observatories by using theodolite will be compared with the computed results of software's Moon calculator version6.0 and Accurate Times. The results show low accuracy in observational data of new Moon recorded at meteorological observatories. This is due to the lack of skill in handling instruments and inaccurate clocks. The error in altitude of recorded new Moon is due to inaccurate leveling of theodolite at the time of observation and error in recorded azimuth of Moon is due to inaccurate setting of azimuth with true north. To eliminate error in observational new Moon data recorded at observing stations, Astronomical Telescopes are suggested to be installed at Pakistan meteorological observatories. This work explores the related issues and indicates the short comings of the process of recordings of related data at the observatories.

Key Words: New Moon, Theodolite, Astronomical Telescope, Religious events.

Introduction

In Pakistan central Ruet e Hilal committee (an official committee) announces when to start the new lunar month on the basis of observation results provided by Pakistan meteorological department and evidences by members of Ruet e Hilal Committee and general public. In this regard central Ruet-E-Hilal committee holds meeting at Pakistan meteorological department camp office Karachi and sometimes in Islamabad or Lahore on 29th of each lunar month. Moon sighting data is collected at meteorological observatories located at different places in Pakistan. The advantage is that a large number of "observers" at meteorological observatories take part in the Moon sighting exercise and with it the probability of sighting the new Moon is increased. Moreover, most of these meteorological observatories are located in rural areas or in small cities where there is least industrial/traffic and light pollution, and it is highly probable that the observing conditions are better. Therefore in general these observations are considered to have a high degree of authenticity. The Meteorological observer has the responsibility to observe the new Moon at meteorological observatory and record time of sighting, altitude and azimuth of new Moon. New moon can be observed with naked eye, requiring the help of an optical instrument or new Moon cannot be observed at all. The altitude and azimuth of new Moon at meteorological observatory is recorded by using an instrument called theodolite. Theodolite is a precision telescope for measuring the azimuth and elevation of a pilot balloon at any instant for the purpose of obtaining upper wind direction and speed at different heights (U.S department of commerce weather bureau, 1942). In Pakistan theodolite is used officially to observe new Moon. The Earth's atmosphere consists of an infinite number of concentric shells of increasing density the near they are to the earth surface. Due to refraction theodolite cannot measure vertical angle accurately. The altitude measured of an object by using theodolite contains error (Hening Hmland, 2004). Therefore, for observers at Meteorological observatories it is difficult to see thin new Moon by using theodolite. The altitude is an

[1] sab.rehman@yahoo.com,
Pakistan Meteorological Department, Meteorological office, Jinnah International Airport, Karachi, Pakistan.
[2] Department of Mathematical Sciences, Institute of Business Administration, Karachi & Institute of space and Planetary Astrophysics, University of Karachi, Karachi 75270, Pakistan.
[3] Institute of Space and Planetary Astrophysics, University of Karachi, Karachi 75270, Pakistan.

important parameter for visibility of new Moon (Ozlem, 2014). According to Odeh (2006), the youngest Crescent seen by optical aid detection is at a topo centric age of 13 hrs. 14 min while the naked eye Crescent detected is at 15 hrs. 33 min (Odeh, M. S., 2006). During this study, no case is found in which observer claimed of sighting of new Moon by using theodolite and not by naked eye.

The reports of new Moon from observatories sent to Meteorological camp office Karachi are presented as claims to Ruet-E-Hilal committee. The central Ruet-E- Hilal committee also collect information from whole Pakistan about the claims of sighting the new Moon. The claims are judged on the basis of the Islamic laws. Once the claim(s) is justified scientifically and/or religiously the announcement is made about the sighting of new Moon. The Meteorological Assistant prepares Moon sighting report of every Islamic month on form number Met.C-66 (Issued by central Meteorological store Pakistan Meteorological Department) and sends for record to Regional Meteorological Centre.

The local Moon visibility conditions are obtained using astronomical computation based on some empirical models (B Schaefer. E., 1988; Ilyas, M., 1994; Yallop, BD., 2004; Caldwell, J. A.R. & Laney, C. D., 2001; Sultan, A. H., 2006; Qureshi, M .S. 2010) that lead to new Moon visibility curves that divide the world into three regions, one in which new Moon can be seen on particular evening, the other in which it cannot be seen and third in which new Moon can be seen by optical aid only. The sighting of the new Moon is difficult because of local sky condition but calculating the position of the new Moon is easy. Determining the birth of the new Moon is simple but to locate/observe i.e. an observer's physical capacity to identify the new Moon is a tricky matter. This capacity varies with the knowledge of the position of the new Moon in the sky, the sharpness of the eye-sight, acuity of vision, experience of the observer, the access to refined tools, the weather conditions, etc.

Religious Aspect

The practice of Moon sighting to celebrate religious events and for starting every new lunar month is old. There are numerous verses in Quran for the importance of Moon. The Some Quranic verses regarding the new Moon are: "They are but signs to mark fixed periods of time in (the affairs of) men and for pilgrimage" (Qur'an; 2; 189). Allah says: "And for the Moon, We have appointed mansion till she returns like an Old shriveled palm branch" (Yasin 36:39). This is important for religious events like the month and date of pilgrimage to Kaaba in Mecca; beginning and end of the fasting. There are many Ahadith in this respect among one of them is: "Do not start fasting until you see the Moon and do not celebrate Eid until you see the Moon. If the sky is cloudy, complete 30 days of Fasting" (Bukhari4:119, Muslim: 1080). There are numerous laws and duties which are based on Moon sighting for example to celebrate Eid, start and end of fasting are based on Moon sighting. The days of Hajj are decided by sighting the new Moon. The completion of a woman's iddat (period after divorce or death of husband after which she is allowed to re marry) is also calculated according to lunar days.

Data and Methodology

In this work 288 observations of new Moon recorded at six Meteorological observatories (i.e. Karachi, Hyderabad , Jiwani , Shaheed Benazirabad, Chhor & Jacobabad) by using theodolite in four years from 1428 A. H to 1431 A. H (Jan. 2007 to Nov.2010) are analyzed with computed results of software's Moon calculator version 6.0 (Manzur, A., 2001) and Accurate Times (Odeh, M.S., 2006). Although the advantage of new crescent visibility periodically vary from northern hemisphere to southern hemisphere, but currently it is with the southern hemisphere.(Caldwell, J. A.R. & Laney, C. D., 2001) Therefore, the southern parts of Pakistan are currently having better conditions of new crescent visibility. The stations selected for this study lie in southern parts of Pakistan and are in the range of good chances of Moon sighting.

The Models (calculators) used for analyzing new Moon data in this study are selected as these models provide information concerning the position, age orientation, phase, appearance and visibility of the new Moon for any given date, time and location on Earth. These programs also calculates Islamic prayer times, sunrise, sunset, sun transit, beginning and end of twilight, Crescent visibility map for both ,new and old Crescents, Qiblah direction . These software's are used in scientific work (Odeh, M. S., 2004;Saiful &

Zainuddin,2012;Mohd Nawawi, M. S. A., M. Z., Zainuddin, N. Ahmed, M. abdul Niri, S. Man, R. Abdul Wahab, K. Ismail & N. H., A. Zaki, 2012; Utama, 2014) to determine Moon parameters namely Sun altitude, Moon altitude, Moon age relative altitude etc.

Nidhal Guessoum and Kiram Meziane (2001) in their study confront the 115 new Moon observations as decreed by the officials with the astronomical data and criteria of earliest visibility to the start and end of Ramadan and the starts of the month of Zilhij in Algeria between 1963 and 2000. In their work they use Interactive Computer Ephemeris (ICE) for comparison of observational new Moon data.

Throughout the history efforts have been made to develop models that predict when and where the new Moon will be seen first. Most of the early Models/Criteria are derived from the observations of the new Moon and some are based on theoretical consideration tested by observations. The calculation of Crescent visibility is a difficult method as it requires lengthy calculation and tables "Al Biruni (973-1048CE)".

The MoonCalc version 6.0 supports 13 astronomical criteria; Babylonian Criteria based on observational data, Age at sunset is greater than 24 hrs. & Lag is greater than 48 mins (Moon's lag time (Lag): the interval time between Sunset and Moonset). Muslim Astronomer Yaqub Ibn Tariq criterion depends on Moon lag and Moon altitude. Fotheringham in 1910, developed criteria that depends on observational data of Schmidt made at Athens over a period of 20 years .He plotted a scatter diagram of Moon's altitude at geometric Sunset verses relative azimuth which separate the visible Moons from the unsighted Moons. Maunder in 1911, used Schmidt's data together with a few more observations and drew the curve lower than Fotheringham. Indian/ Schoch used a slightly modified version of the Fotheringham and Maunder criteria. Bruin in 1977, published feature of a theoretical Moon sighting criterion based on new Moon width and Sun/Moon altitudes. Bruin used 0.5 minutes as the limiting crescent width MoonCalc uses limiting crescent width =0.25 minutes as suggested by Ilyas (1994). Ilyas (A, B, C) MoonCalc supports three best known crescent sighting criteria of Ilyas. (A) The first criteria is based on the Moon's relative altitude at Sunset and the Moon-Sun elongation at sunset. A curve depending on observational data was plotted on a graph of Moon's relative altitude at Sunset verses Sun-Moon elongation at Sunset. (B), Ilyas discovered second criterion after modification in the Babylonian system of Moonset Lag times. (C), Ilyas gave third criterion slight modification in his criteria (A) and depended on the relative altitude at Sunset and the difference in azimuth between the Sun and the Moon at sunset. Royal Greenwich observatory 67, created a series of information sheets which tabulated predicted thin Lunar Crescents .The calculations are based on the law that the best time and place for making the first new Moon sighting are when the Moon is upright above the Sun at the Sunset, so that their azimuth are equal and where the apparent altitude of the Moon at Sunset is 10 degrees. If the horizon is flat and the sky is clear, detection of new Moon should be possible just before the Sun reaches a geocentric altitude of -5 degrees. The principle as implemented in MoonCalc is helpful for finding the first place where the Crescent is likely to be visible. On a global scan, the principle does not show all areas west of the most primitive point where the new Moon will be seen.

South African Astronomical observatory (SAAO), criterion was proposed by Dr. John Caldwell and David Laney and based on published crescent sightings together with a few local sightings from Signal Hill. The principle depended upon topo centric Moon altitude at visible Sunset and the difference in azimuth at Sunset. Two lines are plotted on graph of altitude against relative azimuth. The new Moon is visible if above upper line, if between two lines then 'improbable', or not possible if below the two lines. Khalid Shoukat and the committee for crescent observation also derived criterion depended upon the topo centric altitude of the Moon (to the lower limb) at Sunset and the calculated new Moon width at sunset. According to this principle crescent will be visible, when altitude must be > 3.4 degree and (alt/12.7) + (crescent width in arc mint/1.2)>1. Yallop developed a criterion in 1997 from the Indian and Bruin criteria. It takes into account information from 295 published Moon sightings compiled by Shaefer and Doggett. This Criterion depends on a factor called 'q' which is resulting from the relative geometric altitude of the Moon (ARCV) and topo centric crescent width. This is the defaulting criterion used in MoonCalc. MoonCalc allows this criterion to be useful at Sunset or when the Sun is at -5 degree as well as at 'best time'. A complex theoretical sighting criterion based on the idea of Bruin has been developed by B.E Schaefer (1988). In this criterion

Schaefer takes into account haziness, ozone absorption, aerosol and Rayleigh scattering etc. To implement in MoonCalc this criterion has not been documented in sufficient detail.

Results and Discussions

The new Moon altitude and azimuth recorded at selected Meteorological observatories by using theodolite have been compared with the computed results of software Moon calculator version 6.0 and Accurate Times. Theodolite scales give the elevation and azimuth of any object with an accuracy of 0.1 degree (U.S department of commerce weather bureau, 1942). Therefore acceptable difference between calculated and recorded data range is considered ±1.0 degree, if the difference is greater than 1.0 degree and less than -1.0 then it is considered as error. The observation of new Moon at each pilot balloon observatory (P.B.O) is taken on 29th of each Islamic month (date issued by C.D.P.C Karachi Pakistan meteorological department); if new Moon is not sighted then its observations is taken on 30th of Islamic month, if new Moon is not sighted in first two dates (i.e. due to cloudy or Hazy weather), then Moon coordinates are recorded on third day (Met.C-66). The MoonCalc version 6.0 provides information of the new Moon for any given date, time and location on earth, while Accurate Times calculator give the same information of Moon for two days, after day of conjunction. Therefore, recorded observations on third day at observing stations cannot be computed with Accurate Times calculator.

The latitude, longitude, height of station above mean sea level and height of theodolite pillar is taken from Pakistan Meteorological department (Regional Meteorological centre Karachi).The position of new Moon at selected Meteorological observatories is calculated at topo centric by inserting information of observing place (i.e the latitude, longitude and height above mean sea level) in both software MoonCalc version 6.0 and Accurate Times. The coordinates of Crescent at each selected station calculated at the same time, at which observations of new Moon recorded by using theodolite. The recorded data of observing stations is summarized in tabular form. There are two types of tables for each station table 1 (a to e) and table 2 (a to e). In tables 1(a to e) recorded new Moon altitude are compared with computed altitude of software Moon calculator version6.0 and Accurate Times and in table 2 (a to e) the recorded azimuth are compared with computed azimuth of Moon calculator version6.0 and software Accurate Times. For convenience only those observations are summarized at which new Moon is sighted at meteorological observatory Jiwani and Chhor and new Moon recorded data of Shaheed Benazirabad are not tabulated. Each table consists of nine columns. In each table column1 contains serial number, column 2 contains first date issue by Pakistan meteorological department (C.D.P.C Karachi) of 29th of Islamic month and column 3 contains date at which new Moon sighted at observing station, fourth column represents time (UTC) of observation of Crescent at Meteorological observatories, fifth column contains altitude (A1) in table1 and azimuth (Z1) in table2 respectively of new Moon recorded by using theodolite. The altitude (A2) and (A3) of recorded new Moon computed with software Moon calculator version 6 and Accurate Times are presented in column 6 and 7, while in table2 these columns contains computed azimuth. In tables1 (a to e) column 8 and column 9 gives altitude difference (A2-A1) and (A3-A1) respectively, in table 2(a to e) these columns contains azimuth difference (Z2 - Z1) and (Z3-Z1) respectively. The results of observational new Moon data obtained in this study are given below.

Karachi

The Meteorological observing station (MOS) Karachi is located at latitude 24°54´ N and longitude 67° 08´E. Height of station above mean sea level is 22.1 meter (73 ft.) and height of theodolite pillar above mean sea level is 29.1 meter (Regional Meteorological Centre Karachi). The MOS Karachi is the oldest meteorological observatory of the region and was established in 1856 (Shamshad, 1988). The recorded and computed altitudes of new Moon at this observatory are analyzed in table 1(a) and in table 2(a) the azimuths has been taken in to account. At MOS Karachi 48 observations of new Moon were recorded during the period 1428 A. H to 1431 A. H.(Jan. 2007 to Nov. 2010) In five cases Moon was not sighted (MNS) due to cloudy and hazy weather or small altitude. In the 43 observations, altitudes of 18 and azimuths of 20 observations are consistent with calculated values of software Moon calculator version 6.0. The altitudes of 25 observations and azimuths of 23 observations are not consistent with calculated

values. The altitude of 18 claims and azimuth of 19 claims are consistent with software Accurate Times while in the remaining observations they are found to be in error. At this observing station10 observation on first date, 28 observations on second date and 5 observations on third are reported.

Hyderabad

The Meteorological observatory Hyderabad is located at latitude 25º23´N and longitude 68˚25´E. Height of the station above mean sea level is 39.04 m and height of theodolite pillar above mean sea level is 48.43m. The recorded and computed altitudes of new Moon at meteorological observatory Hyderabad are analyzed as shown in table 1(b) and 2(b). At Meteorological observatory Hyderabad 48 observations of new Moon are recorded by using theodolite during the period 1428 A. H to 1431 A. H (Jan.2007 to Nov.2010). In five cases Moon is not sighted due to cloudy/Hazy weather and in six cases new Moon sighted but time of sighting is not recorded by observer. In 37 observations altitude of 4 claims and azimuth of 18 claims are consistent with computed results of software Moon6 calculator while in 33 cases of altitude and 19 cases of azimuth are found to be in error. A total of 31 observations of new Moon are analyzed in view of computed results of software Accurate Times at this office. The altitude of 4 claims and azimuth of 18 claims are consistent with software Accurate Times while in 28 claims of altitude and 12 claims of azimuth are erroneous. At this station 8 observations on first date, 17 observations on second date and 7 observations on third day are recorded by using theodolite.

Jacobabad

The Meteorological observing station (MOS) Jacobabad is located at latitude 28 º18´N and longitude 68º 28´E, and height of station above mean sea level is 56.0 m. The recorded and computed altitudes and azimuths of new Moon at MOS Jacobabad are analyzed in table 1(c) and 2(c) .At this observatory two observations of new Moon are recorded but time of sighting are not recorded and in 6 cases new Moon is not sighted due to small altitude or cloudy/ Hazy weather. At this station out of 40 observations none of the azimuth value is consistent with calculated results of both software's (as shown in table 2(C)) and altitude of only 5 claims is consistent with calculated results of both software's while in the remaining observations they are found to be in error. At this station 10 observations on first date, 27 observations on second date and three observations on third date are recorded by using theodolite.

Jiwani

The meteorological observatory Jiwani is located at latitude 25º05´N and longitude 61˚4´E. Height of station above mean sea level is 56.0m. The recorded and computed altitudes of new Moon at meteorological observatory Jiwani are analyzed in table 1(d). In table 2(d) the azimuths are to be accounted. In recorded new Moon data altitude of 10 claims and azimuth of 9 claims are consistent with computed results while 19 claims of altitude and 20 claims of azimuth are found to be in error. In two cases observation of new Moon was made but time of sighting of Moon is not recorded by observer and in 17 cases Moon is not sighted at due to cloudy / Hazy weather .The altitude of 11 claims and azimuth of 8 claims are consistent with computed results of software Accurate Times while in 17 claims of altitude and in 20 cases of azimuth are erroneous. At this observing station 10 observations of new Moon have been reported on first date, 18 on second date and 3 observations on third date. In these dates output of both models gives new Moon easily visible by naked eye (as shown in table 1(d)) except observation no.25 which is not consistent with output of both models (discussed in table 3). In two cases (table 1 (d) S. No. 28 & 31) altitudes recorded by using theodolite consistent with calculated altitudes of Accurate Times and inconsistent with altitudes calculated with Moon6.0 Calc.

Chhor

The meteorological observatory Chhor is located at latitude 25º31´N and longitude 69˚47´E. Height of station above mean sea level is 4.22m.The recorded and computed altitudes of new Moon at this station are analyzed in table 1(e). In table 2(e) the recorded azimuths are compared with computed azimuths of software. At this observatory out of 48 observations in 35 cases new Moon is not sighted due to cloudy/Hazy weather or small altitude. In 13 observations altitude of 5 claims and azimuth of 9 claims

are consistent with the computed results of both software and in remaining observations they are found to be in error. At this observing station 10 observations of new Moon are reported on first date and three observations on second date. In 4 cases output of both models consistent on first date and in 01 case output is consistent on second date and in other observations both models output give new Moon easily visible with naked eye except observations no.7& 8 (discussed in table 3) in which output of both models give new Moon lie below horizon as shown in table 1(e).

Shaheed Benazirabad

The new Moon data recorded at Meteorological observatory Shaheed Benazirabad, is also analyzed but for convenience results of this station are not shown in tables form. However results obtained at this station are described here. At MOS Shaheed Benazirabad, in two cases observation of new Moon has been done but time of sighting was not recorded and in 9 cases Moon is not sighted due to cloudy/ Hazy weather. At this observatory out of 37 observations altitude of 14 claims and Azimuth of 7 claims are consistent with computed results of software moon6 calculator while in remaining observations errors have been found. The altitudes in 11 observations and azimuths in 5 observations are consistent with computed results of software Accurate Times while in remaining observations were found to be in error. At this observing station 10 observation of new Moon have been reported on first date, 24 on second date and 5 observations on third date

Negative Observations

There are some negative observations are also reported from Meteorological observatories as shown in table 3. They are negative in the sense that the recorded altitude at the recorded time is positive (crescent above horizon) but the computations for the recorded time shows that the new Moon is below horizon. In this table column1 contains station name, column 2 give name of Islamic month and year, column 3 and column 4 give the date and time sighting of new Moon in UTC (denoted by Z) respectively, columns5 contains new Moon set time at Meteorological observatory of date at which claim of new Moon was done, column 6 gives the altitude of new Moon recorded at meteorological observatory and column7 give the altitude calculated by using software Accurate Times on the same date and time at which new Moon was seen at observatory.

- At Meteorological observatory station Karachi new Moon for month of Shawwal 1429 A. H, on second date 01/10/2008 at time 1430 Z was claimed with altitude 10.0 degree, as represented in Sr. No. 22 table 1(a). But Moonset time dated at Karachi was 1419 Z as shown in table 3. According to Jang newspaper dated 01 October, 2008.The central Ruet-E- Hilal committee receives testimonies (shahadat) of sighting of new Moon from different parts of country on evening 30/9/2008. The central Ruet-E- Hilal committee received claims from some areas of Khyber Pakhtunkhwa; Pindi khaip and Daira Ismail khan. The Peshawar zonal Ruet-E-Hilal committee also received seven claims of sighting of new Moon. The nine D.C.O of Khyber Pakhtunkhwa included Bunir, Laki Murwat, Mardan and Kark verified claims of sighting of new Moon. The central Ruet-E-Hilal Committee also received Moon sighting reports from Talhar areas (District Badin). Khatib of Talhar mosques verified the claims of sighting of new Moon. The central Ruet-E- Hilal committee decided to celebrate Eid-ul -fitr on 01 October 2008. The new Moon was sighted on 1/10/2008 as reported from observing station Hyderabad and Jiwani (consistent with Model results) as shown in table 1(b) &1(d). The reason of negative observation is that the observer clock was not consistent with local zone time.
- At Meteorological observatory Shaheed Benazirabad new Moon for month of Shawwal 1429 A. H was claimed with altitude 10.5 degree at 1442 Z on dated 1/10/2008 (second date) but new Moon set time on that date was 1411 Z . The new Moon was sighted on 1/10/2008 as reported from observing station Hyderabad and Jiwani (consistent with Model results) as shown in table 1(b) &1(d). The observer clock was not consistent with local zone time (or other human error i.e. recorded wrong time). Another claim was also done at Meteorological observatory Shaheed

Benazirabad for the month of Shawwal 1430 A. H on 20/9/2009 (29th date of Islamic month Shawwal) at 1440 Z. However, Moon was set at 1413 Z as shown in table 3.The new Moon was sighted in Jiwani on this date as shown in table 1(d) observation number 24.

- At MOS Jacobabad new Moon for month of Shawwal 1429 A. H was claimed with altitude 01.5 degree at 1416 Z dated 01/10/2008 as represented in table No.1 (c) Sr. no.22.But new Moon on that date was set at 1408 Z at Jacobabad. At this office another claim of new Moon for month of Shawwal 1430 A. H was also done on dated 20/9/2009 at 1435 Z as shown in table 1(c) observation no. 34 but Moon was set at Jacobabad on that dated at1412 Z as represented in table 3. The new Moon was sighted in Pakistan on both dates as described above. At this observing station observer clock time was inconsistent with local zone time.
- The new Moon for month of Jamadiussani 1430 A. H was claimed at Meteorological office Jiwani on 25/05/2009 at 1615 Z with altitude 04.5 degree as shown in table 1(d) Sr. No.20. But new Moon set time on that dated at Jiwani was1555 Z. The new Moon was sighted on this date in Pakistan (Jang Newspaper, 26/5/2009; C.D.P.C Meteorological office Karachi). The observer clock was not consistent with local zone time at this observing station (or observer recorded wrong time).
- The new Moon for month of Jamadiussani 1430 A. H was claimed at Meteorological office Chhor on 25/05/2009 at 1535 Z with altitude 10.2 degree as shown in table 1(e) Sr. No.7 but Moon was set at 1519 Z at Chhor. The Moon was sighted on this date in Pakistan as described above. At this observing station another claimed was also done for month of Shawwal 1430 A. H on 20/09/2009 at time 1533 Z with altitude 6.8 degree as shown in table 1(e) sr.8 but new Moon was set at 1409 Z at this office. The new Moon was sighted on this date at Jiwani shown in table 1(d) Sr.No.24.The observer clock was not consistent on these dates with local zone time at this station.

The error in altitude of recorded new Moon (observational data) occurred due to inaccurate leveling of theodolite and error in recorded azimuth occurred due to inaccurate setting of theodolite azimuth with true north at the time of observation. The other reason may be inaccurately determined datum point of theodolite, which is determined at the time of establishment of Meteorological observatory. The zero percent azimuth consistency of new Moon data with the computed results of both calculators at Meteorological observatory Jacobabad shows that the datum points of such observatories should be checked. An observing location at higher elevation generally atmosphere expected to be free from dust, haze and aerosol pollution. These conditions reduce the light scattered in the sky and the visibility restrictions of new Moon due to the high elevation of the site above sea level are improved (Mikhakk. J. S., Asaad, A. S, 1995).The air density continually decline with increasing height above sea level .The refraction be smaller, diminishing the sky brightness, as Moon illumination is not affected, the contrast will be higher, favoring the visibility of new Moon (Ozlem, 2014).The meteorological observatories (or places) at high elevations in Pakistan are good places for observing of new Moon. The southern parts of Pakistan are in the range of advantage of new Moon visibility as described above and Western parts of Pakistan are also in favor of visibility of new Moon (as Sun set late in western parts of Pakistan). According to Jang newspaper dated (13 October ,2007; 20 September,2009;10 September,2010) the Eidul Fitr falling in these years was celebrated one day before in Khyber Pakhtunkhwa and Northern areas of Pakistan than rest of country. To reduce such cases, the Astronomical Telescopes are suggested to be installed at meteorological observatories, so that observer can find the location of thin new Moon and then he can see with naked eye.

Conclusions

In this study, it is found that the percentage accuracy in observing new Moon data by using theodolite at some selected Meteorological observatories is not satisfactory. The zero percent consistency in new Moon azimuths is found at Jacobabad while maximum consistency in azimuths 69 % is found at Chhor. The minimum consistency11 % in altitudes of new Moon with computed altitudes is found at Hyderabad and maximum consistency in altitudes 42 % found at Karachi. The maximum new Moon observations (39 out

of 48 observations) by using theodolite have been recorded at Karachi and minimum new Moon (13 out of 48) observations have been recorded at Chhor. The observing station Hyderabad recorded 8 observations while other stations recoded 10 observations on first date.

The zero percent consistency of recorded azimuth at meteorological observatory Jacobabad with computed azimuth show, there is need to check datum point of theodolite at observing stations. The accuracy in observation of pilot balloon and recording new Moon data at Meteorological observatories can be improved by correct leveling and azimuth setting of theodolite with true north. The negative errors can be avoided by providing accurate clock at the observatories that are regularly synchronized with the local zone time. This will improve the accuracy in recording new Moon data and observation of upper wind data, which will increases the accuracy in flight operation, weather forecast and in upper wind research. During the comparisons of observational new Moon data with the computed results of both models, it is found that the outputs are the same with difference in fraction of a degree (Table-1 (d) S. No. 28 & 31) .Both models can be used for earliest visibility of new Moon in Pakistan.

As main use of theodolite is to observe the pilot balloon at meteorological observatories for obtaining upper wind direction and speed at different heights and it is also used for surveying purposes because these instruments measure horizontal angles more accurately than vertical angles as this is the main function in surveying. Due to refraction, theodolite cannot measure accurately vertical angle. Therefore by using theodolite it is difficult to observe (identify) thin crescent in the sky. In this study it is found that observer at meteorological observatories always claimed sighting of new Moon by using theodolite and also by naked eye. No observation is found in which observer claimed sighting of new Moon by using theodolite only. It means theodolite at meteorological observatories is being used to record altitude and azimuth of new Moon but not to identify the thin new Moon. The observations recorded at the meteorological observatories across Pakistan can be useful for any scientific study or research. Therefore, the instrument (theodolite) used for observation of new Moon should be replaced with Astronomical Telescope. Because, when Meteorological observatories are producing inaccurate, the same data cannot be used for any research or any critical analysis of existing models of earliest visibility of new Moon. As in these days there is a lot of conflict on Moon sighting in Pakistan. Pakistan Meteorological Department has the responsibility to observe the new Moon and forecast when it will be seen. By observing new Moon with Astronomical Telescope, it is easy for observer to find the location of thin crescent in sky and then he can see with naked eye. Therefore, it is necessary to observe new Moon at Pakistan meteorological observatories by using Astronomical Telescope. For observation of new Moon, four inch Celestron, Orion or Meades Telescopes are suggested to be installed at Pakistan meteorological observatories. The staff posted at observatories should be well trained. This will help to celebrate religious events (begins month of Ramzan, celebrate Eidul Fitre & Eidul Azha) on the same date in Pakistan.

Meteorological and Aero-Met offices in Pakistan Meteorological Department discharging duties for providing the Aviation Meteorological Services to national and international air navigation (to meet the requirement of WMO and international Civil Organization ICAO to establish and implement the ISO 9001:2008) have been certified as per the ISO 9001:2008 complaint Quality Management system (QMS) standards from 2013. By installing astronomical Telescopes at meteorological observatories and by establishing and implementing the ISO 9001:2008 compliant Quality Management System in Meteorological observatories. If the accuracy in observational new Moon data is improved this would help extension of such certifications.

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Table 1 (a): MOS Karachi

C1	C2	C3	C4	C5	C6	C7	C8	C9
Sr. No.	**Dated**	**Dated**	**Time**	**A1**	**A2**	**A3**	**A2-A1**	**A3-A1**
1	20/1/2007	20/1/2007	1320	12.5	12.8	12.7	0.3	0.2
2	18/2/2007	19/02/2007	1335	22.0	22.8	22.7	0.8	0.7
3	19/3/2007	20/03/2007	1355	20.0	16.3	16.2	-3.7	-3.8
4	18/4/2007	18/04/2007	1416	9.0	9.8	9.7	0.8	0.7
5	17/52007	18/05/2007	1412	23.0	22.98	22.9	-0.02	-0.1
6	15/6/2007	16/06/2007	1435	6.0	15.1	15.0	9.1	9.0
7	15/7/2007	17/07/2007	1450	18.0	22.0	-	4.0	-
8	14/8/2007	15/08/2007	1425	19.0	14.4	14.2	-4.6	-4.8
9	12/9/2007	13/09/2007	1354	7.0	7.6	7.4	0.6	0.4
10	12/10/2007	13/10/2007	1307	10.0	11.8	11.6	1.8	1.6
11	11/11/2007	11/11/2007	1325	10.2	0.7	0.2	-9.5	-10.0
12	10/12/2007	11/12/2007	1255	10.0	11.0	11.0	1.0	1.0
13	9/1/2008	10/1/2008	1315	18.5	18.0	17.6	-0.5	-0.9
14	8/2/2008	8/2/2008	1331	14.0	13.6	13.4	-0.4	-0.6
15	8/3/2008	9/3/2008	1348	20.0	20.7	20.6	0.7	0.6
16	7/4/2008	7/4/2008	1410	14.5	14.0	13.9	-0.5	-0.6
17	6/5/2008	8/5/2008	1410	43.0	40.9	-	-2.1	-
18	4/6/2008	5/6/2008	1520	23.5	10.7	10.6	-12.8	-12.9
19	4/7/2008			MNS				
20	2/8/2008	4/8/2008	1405	29.0	26.8	-	-2.2	-
21	1/9/2008	2/9/2008	1435	12.0	7.3	7.1	-4.7	-4.9
22	30/9/2008	1/10/2008	1430	10.0	-2.8	-3.3	-12.8	-13.3
23	29/10/2008	31/10/2008	1310	10.0	11.9	11.8	1.9	1.8
24	28/11/2008	29/11/2008	1300	9.5	9.0	8.9	-0.5	-0.6
25	28/12/2008	29/12/2008	1300	10.0	16.50	16.52	6.5	6.52
26	27/1/2009	27/1/2009	1340	6.0	6.2	6.2	0.2	0.2
27	25/2/2009	26/2/2009	1340	14.0	14.4	14.3	0.4	0.3
28	27/3/2009	28/3/2009	1400	10.0	19.5	19.4	9.5	9.4
29	26/4/2009	26/4/2009	1410	15.0	15.7	15.6	0.7	0.6
30	25/5/2009	26/5/2009	1500	15.0	17.3	17.2	2.3	2.2
31	23/6/2009			MNS				
32	23/7/2009			MNS				
33	21/8/2009			MNS				
34	20/9/2009	21/9/2009	1445	15.0	2.6	-	-12.4	-
35	19/10/2009	20/10/2009	1404	13.0	2.6	2.3	-10.4	-10.7
36	18/11/2009	18/11/2009	1257	7.0	9.4	9.2	2.4	2.2
37	17/12/2009	18/12/2009	1252	12.5	16.9	16.8	4.4	4.3
38	16/1/2010	16/01/2010	1333	1.0	6.1	5.9	5.1	4.9
39	14/2/2010	15/2/2010	1344	4.0	10.4	10.3	6.4	6.3
40	16/3/2010	17/3/2010	1358	9.5	13.9	13.8	4.4	4.3

41	15/4/2010	16/4/2010	1410	19.0	19.8	19.7	0.8	0.7
42	14/5/2010	15/5/2010	1435	9.0	12.5	12.3	3.5	3.3
43	13/6/2010	14/6/2010	1442	18.0	19.0	19.0	1.0	1.0
44	12/7/2010	14/7/2010	1430	19.0	24.4	24.3	5.4	5.3
45	11/8/2010	11/8/2010	1435	4.0	4.2	4.1	0.2	0.1
46	9/9/2010			MNS				
47	8/10/2010	9/10/2010	1319	9.0	9.8	9.6	0.8	0.6
48	7/11/2010	8/11/2010	1242	18.0	20.0	19.8	2.0	1.8

In each table column1 contains serial number, column 2 contains first date issue by Pakistan meteorological department (C.D.P.C Karachi) of 29th of Islamic month and column 3 contains date at which new Moon sighted at observing station, fourth column represents time (UTC) of observation of Crescent at Meteorological observatories, fifth column contains altitude (A1) in table1 and azimuth (Z1) in table2 respectively of new Moon recorded by using theodolite. The altitude (A2) and (A3) of recorded new Moon computed with software Moon calculator version 6 and Accurate Times are presented in column 6 and 7, while in table2 these columns contains computed azimuth. In tables1 (a to e) column 8 and column 9 gives altitude difference (A2-A1) and (A3-A1) respectively, in table 2(a to e) these columns contains azimuth difference (Z2 - Z1) and (Z3-Z1) respectively.

Table 1 (b): MOS Hyderabad

C1	**C2**	**C3**	**C4**	**C5**	**C6**	**C7**	**C8**	**C9**
Sr.No.	**Dated**	**Dated**	**Time**	**A1**	**A2**	**A3**	**A2-A1**	**A3-A1**
1	20/1/2007			MNS				
2	18/2/2007			MNS				
3	19/3/2007			MNS				
4	18/4/2007	18/4/2007	1408	7.0	10.5	10.4	3.5	3.4
5	17/52007	18/5/2007	1305	15.0	35.8	35.8	20.8	20.8
6	15/6/2007	16/6/2007	1448	11.5	11.6	11.5	0.1	0.0
7	15/7/2007	17/7/2007	1430	21.0	25.2	-	4.2	-
8	14/8/2007	16/8/2007	1410	30.2	22.3	-	-7.9	-
9	12/9/2007	14/9/2007	1355	16.0	12.1	-	3.9	-
10	12/10/2007	13/10/2007	1335	14.0	5.1	4.9	-8.9	-9.1
11	11/11/2007	12/11/2007	1258	20.5	12.3	12.2	-8.2	-8.3
12	10/12/2007	11/12/2007	1259	16.0	9.3	9.2	-6.7	-6.8
13	9/1/2008	10/1/2008	1255	24.0	20.3	20.3	-3.7	-3.7
14	8/2/2008	8/2/2008	1350	13.5	8.3	8.2	-5.2	-5.3
15	8/3/2008	9/3/2008	1345	25.0	20.2	20.1	-4.8	-4.9
16	7/4/2008	7/4/2008	1427	13.0	9.4	9.3	-3.6	-3.7
17	6/5/2008	7/5/2008	1418	25.0	24.5	24.5	-0.5	-0.6
18	4/6/2008	5/6/2008	1430	18.5	19.8	19.8	1.3	1.3
19	4/7/2008			MNS				
20	2/8/2008	4/8/2008	1415	28.0	36.12	-	8.12	-
21	1/9/2008	2/9/2008	1330	26.0	19.6	19.2	-6.4	-6.8
22	30/9/2008	1/10/2008	1330	9.0	8.0	8.0	-1.0	-1.0
23	29/10/2008	31/10/2008	TNM	13.0				
24	28/11/2008	29/112008	1255	16.0	8.6	8.5	-7.4	-7.5
25	28/12/2008	30/12/2008	1257	31.5	26.5	-	-5.0	-
26	27/1/2009	28/1/2009	1345	15.0	15.4	15.4	0.4	0.4

27	25/2/2009	26/2/2009	1346	15.5	11.9	11.8	-3.6	-3.7
28	27/3/2009	28/3/2009	1430	22.0	12.0	11.9	-10.0	-10.1
29	26/4/2009	26/4/2009	1435	14.0	9.7	9.6	-4.3	-4.4
30	25/5/2009	26/5/2009	1430	29.0	22.4	22.4	-6.6	-6.6
31	23/6/2009	25/6/2009	TNM	24.0				
32	23/7/2009	24/7/2009	TNM	40.5				
33	21/8/2009	22/8/2009	TNM	20.5				
34	20/9/2009	21/9/2009	TNM	12.0				
35	19/10/2009	20/10/2009	1320	19.0	9.5	9.4	-9.5	-9.6
36	18/11/2009	18/11/2009	1300	12.6	7.5	7.4	-5.1	-5.2
37	17/12/2009	18/12/2009	1258	11.0	14.5	14.5	3.5	3.5
38	16/1/2010	16/1/2010	1326	14.5	6.2	6.1	-8.3	-8.4
39	14/2/2010	-		MNS				
40	16/3/2010	17/3/2010	1350	16.0	14.5	14.4	-1.5	-1.6
41	15/4/2010	16/4/2010	1355	20.0	21.9	21.9	1.9	1.9
42	14/5/2010	15/5/2010	1420	18.0	14.5	14.4	-3.5	-3.6
43	13/6/2010	13/6/2010	1420	20.0	11.5	11.4	-8.5	-8.6
44	12/7/2010	14/7/2010	T.N.M	32.0				
45	11/8/2010	11/8/2010	1427	8.5	4.9	4.7	-3.6	-3.8
46	9/9/2010	12/9/2010	1340	16.0	4.6	-	-11.4	
47	8/10/2010	9/10/2010	1318	11.0	8.6	8.5	-2.4	-2.5
48	7/11/2010	8/11/2010	1247	23.5	17.8	17.8	-5.7	-5.7

Table 1 (c): MOS Jacobabad

C1	**C2**	**C3**	**C4**	**C5**	**C6**	**C7**	**C8**	**C9**
Sr.No.	**Dated**	**Dated**	**Time**	**A1**	**A2**	**A3**	**A2-A1**	**A3-A1**
1	20/1/2007	20/01/2007	1310	4.5	12.0	12.0	7.5	7.5
2	18/2/2007	19/02/2007	1325	18.0	22.9	22.8	4.9	4.8
3	19/3/2007	20/03/2007	1355	10.5	15.2	15.2	4.7	4.7
4	18/4/2007	18/04/2007	1420	2.0	8.9	8.7	6.9	6.7
5	17/52007	18/05/2007	1420	8.5	21.4	21.4	12.9	12.9
6	15/6/2007	16/06/2007	1500	7.5	10.4	10.3	2.9	2.8
7	15/7/2007	16/07/2007	1431	6.5	17.5	17.5	11.0	11.0
8	14/8/2007	15/08/2007	1413	7.0	15.4	15.3	8.4	8.3
9	12/9/2007	13/09/2007	1350	6.5	6.5	6.4	0.0	-0.1
10	12/10/2007	13/10/2007	1304	8.5	9.5	9.4	1.0	0.9
11	11/11/2007	12/11/2007	1247	0.5	12.1	12.1	11.6	11.6
12	10/12/2007	11/12/2007	1251	14.5	8.8	8.7	-5.7	-5.8
13	9/1/2008	10/1/2008	1300	2.6	17.8	17.7	15.2	15.1
14	8/2/2008	8/2/2008	1330	4.5	11.6	11.5	7.1	7.0
15	8/3/2008	9/3/2008	1335	1.4	22.2	22.2	20.8	20.8
16	7/4/2008	7/4/2008	1402	13.5	15.6	15.2	2.07	1.7
17	6/5/2008	6/5/2008	1425	9.5	10.2	10.1	0.7	0.6

18	4/6/2008	5/6/2008	1435	17.5	19.8	19.7	2.3	2.2
19	4/7/2008	4/7/2008	1445	9.0	12.0	12.0	3.0	3.0
20	2/8/2008	4/8/2008	1530	22.5	6.7	-	-15.8	-
21	1/9/2008	2/9/2008	1445	13.0	3.2	3.0	-9.8	-10.0
22	30/9/2008	1/10/2008	1416	1.5	-2.1	-2.7	-3.6	-4.2
23	29/10/2008	31/10/2008	1250	11.5	12.2	12.1	0.7	0.6
24	28/11/2008	29/11/2008	1242	6.5	9.1	9.0	2.6	2.5
25	28/12/2008	30/12/2008	1250	22.0	25.8	-	3.8	-
26	27/1/2009	27/01/2009	1335	3.0	5.2	5.0	2.2	2.0
27	25/2/2009	26/02/2009	1340	4.0	12.9	12.8	8.9	8.8
28	27/3/2009	-		MNS				
29	26/4/2009	26/04/2009	1402	6.0	17.2	17.2	11.2	11.2
30	25/5/2009	26/05/2009	1418	25.4	25.7	25.7	0.3	0.3
31	23/6/2009	-		MNS				
32	23/7/2009	-		MNS				
33	21/8/2009	22/08/2009	1410	9.0	10.9	10.9	1.9	1.9
34	20/9/2009	20/09/2009	1435	3.0	-6.0	-6.0	-9.0	-9.0
35	19/10/2009	20/10/2009	TNM	5.0				
36	18/11/2009	19/11/2009	TNM	15.4				
37	17/12/2009	17/12/2009	1240	13.5	15.9	15.9	2.4	2.4
38	16/1/2010	17/01/2010	1305	11.5	19.9	19.8	8.4	8.3
39	14/2/2010	15/02/2010	1335	6.5	10.5	10.4	4.0	3.9
40	16/3/2010	17/03/2010	1350	11.5	14.7	14.6	3.2	3.1
41	15/4/2010	16/04/2010	1415	12.0	18.5	18.4	6.5	6.4
42	14/5/2010	15/05/2010	1430	11.0	13.5	13.4	2.5	2.4
43	13/6/2010		-	MNS				
44	12/7/2010	14/7/2010	1429	20.5	23.1	23.1	2.6	2.6
45	11/8/2010	-	-	MNS				
46	9/9/2010	-		MNS				
47	8/10/2010	9/10/2010	1312	5.0	8.4	8.0	3.4	3.0
48	7/11/2010	8/11/2010	1245	34.0	16.2	16.2	-17.8	-17.8

Table 1 (d): MOS Jiwani

C1	**C2**	**C3**	**C4**	**C5**	**C6**	**C7**	**C8**	**C9**
Sr. No.	**Dated**	**Dated**	**Time**	**A1**	**A2**	**A3**	**A2-A1**	**A3-A1**
1	20/1/2007	21/01/2007	1354	10.0	24.4	24.4	14.4	14.4
2	18/4/2007	19/04/2007	TNM	8.0				
3	17/52007	18/05/2007	1500	17.0	18.0	18.0	1.0	1.0
4	12/10/2007	13/10/2007	1335	8.5	10.4	10.3	1.9	1.8
5	11/11/2007	11/11/2007	1328	5.0	4.4	4.3	-0.6	-0.7
6	9/1/2008	10/1/2008	TNM	19.0				
7	8/2/2008	8/2/2008	1355	11.0	13.7	13.8	1.7	1.8
8	8/3/2008	9/3/2008	1405	21.5	22.5	22.4	1.0	0.9

9	7/4/2008	7/4/2008	1445	10.0	11.3	11.3	1.3	1.3
10	4/7/2008	5/7/2008	1545	25.5	14.3	14.2	-11.2	-11.3
11	1/9/2008	2/9/2008	1525	6.0	1.9	1.6	-4.1	-4.4
12	30/9/2008	1/10/2008	1348	10.0	10.4	10.3	0.4	0.3
13	29/10/2008	31/10/2008	1340	10.0	10.8	10.8	0.8	0.8
14	28/11/2008	29/11/2008	1318	8.5	9.5	9.5	1.0	1.0
15	28/12/2008	29/12/2008	1338	14.0	14.1	14.0	0.1	0.0
16	27/1/2009	27/01/2009	1345	4.0	10.3	10.2	6.3	6.2
17	25/2/2009	26/02/2009	1410	11.0	12.6	12.6	1.6	1.6
18	27/3/2009	28/03/2009	1425	18.5	18.8	18.8	0.3	0.3
19	26/4/2009	26/04/2009	1425	14.5	17.8	17.1	3.3	2.6
20	25/5/2009	25/05/2009	1615	4.5	-4..8	-4.8	-9.3	-9.3
21	23/6/2009	24/06/2009	1510	13.5	15.9	15.9	2.4	2.4
22	23/7/2009	24/07/2009	1509	15.0	16.9	17.2	1.9	2.2
23	21/8/2009	22/08/2009	1430	11.5	13.7	13.3	2.2	1.8
24	20/9/2009	20/09/2009	1358	7.0	9.1	9.0	2.1	2.0
25	19/10/2009	21/10/2009	1423	13.0	12.3	-	-0.7	-
26	18/11/2009	18/11/2009	1320	8.0	9.0	8.4	1.0	0.6
27	16/1/2010	16/1/2010	1352	4.0	6.6	6.5	2.6	2.5
28	16/3/2010	17/3/2010	1428	11.0	12.8	12.0	1.8	1.0
29	15/4/2010	15/4/2010	1430	21.0	8.3	8.1	-12.7	-12.9
30	14/5/2010	15/5/2010	1454	9.5	13.1	13.0	3.6	3.5
31	9/9/2010	10/9/2010	1442	5.0	6.5	5.8	1.5	0.8

Table 1 (e): MOS Chhor

C1	**C2**	**C3**	**C4**	**C5**	**C6**	**C7**	**C8**	**C9**
Sr. No.	**Dated**	**Dated**	**Time**	**A1**	**A2**	**A3**	**A2-A1**	**A3-A1**
1	8/2/2008	8/2/2008	1324	15.0	12.5	12.4	-2.5	-2.6
2	8/3/2008	9/3/2008	1345	6.0	18.9	18.9	12.9	12.9
3	7/4/2008	7/4/2008	1402	14.5	13.5	13.5	-1.0	-1.0
4	1/9/2008	1/9/2008	1356	7.8	6.4	6.2	-1.4	-1.6
5	27/1/2009	27/01/2009	1330	7.5	5.9	5.8	-1.6	-1.7
6	26/4/2009	26/04/2009	1414	13.5	12.8	12.7	-0.7	-0.8
7	25/5/2009	25/05/2009	1535	10.2	-3.8	-4.0	-14.0	-14.2
8	20/9/2009	20/09/2009	1533	6.8	-19.0	-19.0	-25.8	-25.8
9	18/11/2009	18/11/2009	1245	10.0	9.1	9.1	-0.9	-0.9
10	13/6/2010	13/6/2010	1442	9.0	6.0	6.0	-3.0	-3.0
11	11/8/2010	11/8/2010	1409	8.5	7.6	7.5	-0.9	-1.0
12	9/9/2010	10/9/2010	1352	11.8	9.3	9.3	-2.5	-2.5
13	8/10/2010	9/10/2010	1316	8.6	7.8	7.7	-0.8	-0.9

Table 2 (a): MOS Karachi

C1	C2	C3	C4	C5	C6	C7	C8	C9
Sr. No.	**Dated**	**Dated**	**Time**	**Z1**	**Z2**	**Z3**	**Z2-Z1**	**Z3-Z1**
1	20/1/2007	20/1/2007	1320	243.5	242.8	242.8	-0.7	-0.7
2	18/2/2007	19/02/2007	1335	258.0	257.7	257.7	-0.3	-0.3
3	19/3/2007	20/03/2007	1355	277.0	274.0	274.0	-3.0	-3.0
4	18/4/2007	18/04/2007	1416	288.5	287.5	287.5	-1.0	-1.0
5	17/52007	18/05/2007	1412	292.0	291.3	291.3	-0.7	-0.7
6	15/6/2007	16/06/2007	1435	302.0	292.5	292.5	-9.5	-9.5
7	15/7/2007	17/07/2007	1450	291.0	271.0	-	-20.0	-
8	14/8/2007	15/08/2007	1425	292.0	264.4	264.4	-27.6	-27.6
9	12/9/2007	13/09/2007	1354	259.0	256.9	257.0	-2.1	-2.0
10	12/10/2007	13/10/2007	1307	241.0	239.5	239.5	-1.5	-1.5
11	11/11/2007	11/11/2007	1325	234.4	240.2	240.2	5.8	5.8
12	10/12/2007	11/12/2007	1255	233.0	232.4	232.4	0.6	-0.6
13	9/1/2008	10/1/2008	1315	240.0	239.0	239.0	-1.0	-1.0
14	8/2/2008	8/2/2008	1331	254.0	253.5	253.0	-0.5	-1.0
15	8/3/2008	9/3/2008	1348	270.0	270.1	270.	0.1	0.0
16	7/4/2008	7/4/2008	1410	285.0	284.1	284.1	-0.9	-0.9
17	6/5/2008	8/5/2008	1410	286.0	285.4	-	-0.6	-
18	4/6/2008	5/6/2008	1520	290.0	293.6	293.7	3.6	3.7
19	4/7/2008			MNS				
20	2/8/2008	4/8/2008	1405	246.0	255.9	-	9.9	-
21	1/9/2008	2/9/2008	1435	255.0	255.3	255.3	0.3	-0.3
22	30/9/2008	1/10/2008	1430	245.5	251.3	251.3	5.8	5.8
23	29/10/2008	31/10/2008	1310	240.5	233.0	233.1	-7.5	-7.4
24	28/11/2008	29/11/2008	1300	234.5	234.1	234.1	-0.4	-0.4
25	28/12/2008	29/12/2008	1300	240.0	236.0	236.1	-4.0	-3.9
26	27/1/2009	27/1/2009	1340	252.5	251.7	251.8	-0.8	-0.7
27	25/2/2009	26/2/2009	1340	266.0	265.0	265.0	-1.0	-1.0
28	27/3/2009	28/3/2009	1400	284.5	279.9	279.9	-4.6	-4.6
29	26/4/2009	26/4/2009	1410	289.5	289.0	289.0	-0.5	-0.5
30	25/5/2009	26/5/2009	1500	290.0	290.5	290.5	0.5	0.5
31	23/6/2009			MNS				
32	23/7/2009			MNS				
33	21/8/2009			MNS				
34	20/9/2009	21/9/2009	1445	240.0	248.3	-	8.3	-
35	19/10/2009	20/10/2009	1404	237.0	242.1	242.2	5.1	5.2
36	18/11/2009	18/11/2009	1257	231.0	235.3	235.3	4.3	4.3
37	17/12/2009	18/12/2009	1252	230.0	234.1	234.1	4.1	4.1
38	16/1/2010	16/01/2010	1333	244.0	248.7	248.7	4.7	4.7
39	14/2/2010	15/2/2010	1344	257.0	261.3	261.3	4.3	4.3
40	16/3/2010	17/3/2010	1358	270.5	275.5	275.5	5.0	5.0

41	15/4/2010	16/4/2010	1410	286.0	285.4	285.4	-0.6	-0.6
42	14/5/2010	15/5/2010	1435	292.0	291.6	291.6	-0.4	-0.4
43	13/6/2010	14/6/2010	1442	289.0	284.2	284.2	-4.8	-4.8
44	12/7/2010	14/7/2010	1430	270.0	266.5	266.5	-3.5	-3.5
45	11/8/2010	11/8/2010	1435	270.0	271.8	271.8	1.8	1.8
46	9/9/2010			MNS				
47	8/10/2010	9/10/2010	1319	244.0	243.2	243.2	-0.8	-0.8
48	7/11/2010	8/11/2010	1242	230.0	229.	229.0	-1.0	-1..0

Table 2 (b): MOS Hyderabad

C1	**C2**	**C3**	**C4**	**C5**	**C6**	**C7**	**C8**	**C9**
Sr. No.	**Dated**	**Dated**	**Time**	**Z1**	**Z2**	**Z3**	**Z2-Z1**	**Z3Z1**
1	20/1/2007			MNS				
2	18/2/2007			MNS				
3	19/3/2007			MNS				
4	18/4/2007	18/4/2007	1408	289.0	287.1	287.1	-1.9	-1.9
5	17/52007	18/5/2007	1305	293.5	287.3	287.3	-6.2	-6.2
6	15/6/2007	16/6/2007	1448	293.5	294.0	294.0	0.5	0.5
7	15/7/2007	17/7/2007	1430	274.0	270.2	-	-3.8	-
8	14/8/2007	16/8/2007	1410	253.5	253.0	-	-0.5	-
9	12/9/2007	14/9/2007	1355	260.0	248.1	-	-11.9	-
10	12/10/2007	13/10/2007	1335	242.0	243.4	243.4	1.4	1.4
11	11/11/2007	12/11/2007	1258	232.0	230.3	230.3	-1.7	-1.7
12	10/12/2007	11/12/2007	1259	233.5	233.5	233.5	0.0	0.0
13	9/1/2008	10/1/2008	1255	240.0	236.7	236.7	-3.3	-3.3
14	8/2/2008	8/2/2008	1350	256.5	256.3	256.3	-0.2	-0.2
15	8/3/2008	9/3/2008	1345	270.5	270.2	270.2	-0.3	-0.3
16	7/4/2008	7/4/2008	1427	286.0	286.0	286.0	0.0	0.0
17	6/5/2008	7/5/2008	1418	291.5	289.8	289.8	-1.7	-1.7
18	4/6/2008	5/6/2008	1430	292.0	290.1	290.1	-1.9	-1.9
19	4/7/2008			MNS				
20	2/8/2008	4/8/2008	1415	279.0	257.6	-	-21.4	-
21	1/9/2008	2/9/2008	1330	249.5	248.2	248.5	-1.3	1.0
22	30/9/2008	1/10/2008	1330	260.0	245.5	245.5	-14.5	-14.5
23	29/10/2008	31/10/2008	TNM	240.0				
24	28/11/2008	29/112008	1255	234.5	234.1	234.1	-0.4	-0.4
25	28/12/2008	30/12/2008	1257	235.5	232.6	-	-2.9	-
26	27/1/2009	28/1/2009	1345	253.0	252.6	252.6	-0.4	-0.4
27	25/2/2009	26/2/2009	1346	266.5	265.9	265.9	-0.6	-0.6
28	27/3/2009	28/3/2009	1430	280.5	283.0	283.0	2.5	2.5
29	26/4/2009	26/4/2009	1435	291.0	291.5	291.5	0.5	0.5
30	25/5/2009	26/5/2009	1430	262.0	288.5	288.5	26.5	26.5
31	23/6/2009	25/6/2009	TNM	274.0				

32	23/7/2009	24/7/2009	TNM	244.5				
33	21/8/2009	22/8/2009	TNM	261.5				
34	20/9/2009	21/9/2009	TNM	251.0				
35	19/10/2009	20/10/2009	1320	237.0	237.7	237.7	0.7	0.7
36	18/11/2009	18/11/2009	1300	237.0	236.2	236.3	-0.8	-0.7
37	17/12/2009	18/12/2009	1258	241.0	235.6	235.6	-5.4	-5.4
38	16/1/2010	16/1/2010	1326	249.5	248.5	248.5	-1.0	-1.0
39	14/2/2010			MNS				
40	16/3/2010	17/3/2010	1350	276.0	275.1	275.1	-0.9	-0.9
41	15/4/2010	16/4/2010	1355	284.5	284.4	284.4	-0.1	-0.1
42	14/5/2010	15/5/2010	1420	291.0	290.7	290.7	-0.3	-0.3
43	13/6/2010	13/6/2010	1420	278.0	290.5	290.5	12.5	12.5
44	12/7/2010	14/7/2010	T.N.M	267.5				
45	11/8/2010	11/8/2010	1427	271.0	271.5	271.5	0.5	0.5
46	9/9/2010	12/9/2010	1340	275.0	261.0	-	-14.0	
47	8/10/2010	9/10/2010	1318	248.0	243.7	243.7	-4.3	-4.3
48	7/11/2010	8/11/2010	1247	230.5	230.1	230.1	-0.4	-0.4

Table 2 (c): MOS Jacobabad

C1	**C2**	**C3**	**C4**	**C5**	**C6**	**C7**	**C8**	**C9**
Sr. No.	**Dated**	**Dated**	**Time**	**Z1**	**Z2**	**Z3**	**Z2-Z1**	**Z3-Z1**
1	20/1/2007	20/01/2007	1310	230.0	241.5	241.5	11.5	11.5
2	18/2/2007	19/02/2007	1325	242.5	255.6	255.6	13.1	13.1
3	19/3/2007	20/03/2007	1355	262.0	273.6	273.6	11.6	11.6
4	18/4/2007	18/04/2007	1420	279.0	287.8	287.8	8.8	8.8
5	17/52007	18/05/2007	1420	210.5	291.0	291.0	80.5	80.5
6	15/6/2007	16/06/2007	1500	290.5	294.4	294.4	3.9	3.9
7	15/7/2007	16/07/2007	1431	270.0	279.2	279.2	9.2	9.2
8	14/8/2007	15/08/2007	1413	251.5	262.8	262.8	11.3	11.3
9	12/9/2007	13/09/2007	1350	245.5	256.7	256.7	11.2	11.2
10	12/10/2007	13/10/2007	1304	228.5	239.3	239.3	10.8	10.8
11	11/11/2007	12/11/2007	1247	217.5	228.3	228.3	10.8	10.8
12	10/12/2007	11/12/2007	1251	221.5	232.1	232.0	10.6	10.5
13	9/1/2008	10/1/2008	1300	225.0	236.6	236.6	11.6	11.6
14	8/2/2008	8/2/2008	1330	237.5	253.3	253.3	15.8	15.8
15	8/3/2008	9/3/2008	1335	255.6	267.9	267.9	12.3	12.3
16	7/4/2008	7/4/2008	1402	271.5	253.3	282.9	-18.2	11.4
17	6/5/2008	6/5/2008	1425	281.5	293.0	293.0	11.5	11.5
18	4/6/2008	5/6/2008	1435	278.0	289.5	289.5	11.5	11.5
19	4/7/2008	4/7/2008	1445	281.5	286.7	286.7	5.2	5.2
20	2/8/2008	4/8/2008	1530	242.5	265.5	-	23.0	
21	1/9/2008	2/9/2008	1445	183.0	256.7	256.7	73.7	73.7
22	30/9/2008	1/10/2008	1416	82.0	250.6	250.5	168.6	168.5

23	29/10/2008	31/10/2008	1250	217.5	230.5	230.5	13.0	13.0
24	28/11/2008	29/11/2008	1242	220.5	232.0	232.0	11.5	11.5
25	28/12/2008	30/12/2008	1250	217.5	230.2	-	12.7	-
26	27/1/2009	27/01/2009	1335	240.0	251.5	251.5	11.5	11.5
27	25/2/2009	26/02/2009	1340	273.5	264.6	264.6	-8.9	-8.9
28	27/3/2009			MNS				
29	26/4/2009	26/04/2009	1402	278.5	287.8	287.8	9.3	9.3
30	25/5/2009	26/05/2009	1418	272.9	286.3	286.3	13.4	13.4
31	23/6/2009			MNS				
32	23/7/2009			MNS				
33	21/8/2009	22/08/2009	1410	247.5	259.0	259.0	11.5	11.5
34	20/9/2009	20/09/2009	1435	237.5	257.7	257.7	20.2	20.2
35	19/10/2009	20/10/2009	TNM	277.5				
36	18/11/2009	19/11/2009	TNM	212.3				
37	17/12/2009	17/12/2009	1240	220.5	232.3	232.3	11.8	11.8
38	16/1/2010	17/01/2010	1305	231.5	243.2	243.2	11.7	11.7
39	14/2/2010	15/02/2010	1335	246.5	260.2	260.2	13.7	13.7
40	16/3/2010	17/03/2010	1350	262.0	274.3	274.3	12.3	12.3
41	15/4/2010	16/04/2010	1415	275.5	285.2	285.2	9.7	9.7
42	14/5/2010	15/05/2010	1430	276.0	290.9	290.9	14.9	14.9
43	13/6/2010			MNS				
44	12/7/2010	14/7/2010	1429	263.0	265.6	265.5	2.6	2.5
45	11/8/2010			MNS				
46	9/9/2010			MNS				
47	8/10/2010	9/10/2010	1312	240.5	242.5	242.5	2.0	2.0
48	7/11/2010	8/11/2010	1245	218.0	229.2	229.1	11.2	11.1

Table 2 (d): MOS Jiwani

C1	**C2**	**C3**	**C4**	**C5**	**C6**	**C7**	**C8**	**C9**
Sr. No.	**Dated**	**Dated**	**Time**	**Z1**	**Z2**	**Z3**	**Z2-Z1**	**Z3-Z1**
1	20/1/2007	21/01/2007	1354	66.0	242.2	242.2	176.2	176.2
2	18/4/2007	19/04/2007	TNM	290.0				
3	17/52007	18/05/2007	1500	114.0	293.1	293.1	179.1	179.1
4	12/10/2007	13/10/2007	1335	244.0	240.2	240.2	-3.8	-3.8
5	11/11/2007	11/11/2007	1328	238.0	237.5	238.2	-0.5	0.2
6	9/1/2008	10/1/2008	TNM	237.0				
7	8/2/2008	8/2/2008	1355	247.0	253.5	254.2	6.5	7.2
8	8/3/2008	9/3/2008	1405	271.5	269.6	269.6	-1.9	-1.9
9	7/4/2008	7/4/2008	1445	128.0	285.3	285.3	157.3	157.3
10	4/7/2008	5/7/2008	1545	276.0	280.2	280.2	4.2	4.2
11	1/9/2008	2/9/2008	1525	263.0	258.1	258.1	-4.9	-4.9
12	30/9/2008	1/10/2008	1348	67.0	244.4	244.4	177.4	177.4
13	29/10/2008	31/10/2008	1340	55.0	234.1	234.0	179.1	179.0

14	28/11/2008	29/11/2008	1318	235.0	233.6	233.6	-1.4	-1.4
15	28/12/2008	29/12/2008	1338	238.0	238.3	238.3	0.3	0.3
16	27/1/2009	27/01/2009	1345	253.0	249.8	249.9	-3.2	-3.1
17	25/2/2009	26/02/2009	1410	266.0	265.8	265.8	-0.2	-0.2
18	27/3/2009	28/03/2009	1425	280.0	280.2	280.2	0.2	0.2
19	26/4/2009	26/04/2009	1425	316.8	288.4	288.4	-28.4	-28.4
20	25/5/2009	25/05/2009	1615	296.0	302.0	302.6	6.0	6.6
21	23/6/2009	24/06/2009	1510	286.0	285.5	285.4	-0.5	-0.6
22	23/7/2009	24/07/2009	1509	268.0	268.5	268.5	0.5	0.5
23	21/8/2009	22/08/2009	1430	259.5	258.7	258.5	-0.8	-0.8
24	20/9/2009	20/09/2009	1358	252.0	250.8	250.4	-1.2	-1.6
25	19/10/2009	21/10/2009	1423	236.0	233.8	-	-2.2	-
26	18/11/2009	18/11/2009	1320	246.0	235.4	235.4	-10.6	-10.6
27	16/1/2010	16/1/2010	1352	250.0	248.4	248.4	-1.6	-1.6
28	16/3/2010	17/3/2010	1428	268.0	276.0	276.3	8.0	8.3
29	15/4/2010	15/4/2010	1430	285.5	286.4	286.4	0.9	0.9
30	14/5/2010	15/5/2010	1454	290.0	291.0	291.3	1.0	1.3
31	8/9/2010	10/9/2010	1442	255.0	253.4	253.5	-1.6	-1.5

Table2 (e): MOS Chhor

C1	**C2**	**C3**	**C4**	**C5**	**C6**	**C7**	**C8**	**C9**
Sr. No.	**Dated**	**Dated**	**Time**	**Z1**	**Z2**	**Z3**	**Z2-Z1**	**Z3-Z1**
1	8/2/2008	8/2/2008	1324	253.5	253.8	253.4	0.3	-0.1
2	8/3/2008	9/3/2008	1345	42.0	270.7	270.7	228.7	228.7
3	7/4/2008	7/4/2008	1402	284.0	284.2	284.2	0.2	0.2
4	1/9/2008	1/9/2008	1356	262.2	262.4	262.4	0.2	0.2
5	27/1/2009	27/01/2009	1330	251.4	251.9	251.8	0.4	0.4
6	26/4/2009	26/04/2009	1414	290.0	290.1	290.1	0.1	0.1
7	25/5/2009	25/05/2009	1535	295.0	301.3	301.3	6.3	6.3
8	20/9/2009	20/09/2009	1533	252.7	263.5	263.5	10.8	10.8
9	18/11/2009	18/11/2009	1245	234.0	235.0	235.0	1.0	1.0
10	13/6/2010	13/6/2010	1442	292.5	293.0	293.0	O.5	0.5
11	11/8/2010	11/8/2010	1409	270.5	270.3	270.3	-0.2	-0.2
12	9/9/2010	10/9/2010	1352	264.0	251.7	251.7	-12.3	-12.3
13	8/10/2010	9/10/2010	1316	245.0	244.1	244.1	-0.9	-0.9

Table 3: Negative observations

C1	**C2**	**C3**	**C4**	**C5**	**C6**	**C7**
Karachi	Shawwal 1429 A. H	01/10/2008	1430	1419	10.0°	-03.3°
Shaheed Benazirabad	Shawwal1429 A. H	01/10/2008	1442	1411	10.5°	-07.3°
Shaheed Benazirabad	Shawwal1430 A. H	20/9/2009	1440	1413	9.5°	-06.5°
Jacobabad	Shawwal1429 A. H	01/10/2008	1416	1408	01.5°	-02.6°

Jacobabad	Shawwal 1430 A. H	20/9/2009	1435	1412	03.0°	-05.95°
Jiwani	Jamadiussani1430 A. H	25/05/2009	1615	1555	04.5°	-04.85°
Chhor	Jamadiussani1430 A. H	25/5/2009	1535	1519	10.2°	-03.98°
Chhor	Shawwal1430 A. H	20/09/2009	1533	1409	6.8°	-19.03°

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