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Diurnal variation of visibility and RVR during the winter months over I.G.I. airport (Palam)

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सार — इस शोधपत्र में (*i*) दृश्यता के माध्य घंटावार मानों और (*ii*) दृश्यता की माध्य और विभिन्न परास के आर.वी.आर. निकालकर दिल्ली हवाई अड्डे के ऊपर नवम्बर से फरवरी तक के महीनों के दौरान दृश्यता की दैनिक परिवर्तनशीलता का अध्ययन किया गया है।

अध्ययन से यह पता चलता है कि दृश्यता के निम्नत्तम मान (दृश्यता की अधिकत्तम आवृतियों और विभिन्न परासों) के धावन-पथ दृश्य परास (आर.वी.आर.) 0200 बजे ग्री.मा.स. के आसपास होता है। यह घटना 0400 बजे ग्री.मा.स. के बाद, तेजी से कम होती जाती है। यह भी प्रेक्षित किया गया है कि सामान्यत: 1600 बजे ग्री.मा.स. के आसपास एक और न्यूनत्तम (आवृतियों के लिए अधिकत्तम) मान दिखाई पड़ता है किन्तु यह अच्छी प्रकार से स्पष्ट नहीं है।

ABSTRACT. In this paper diurnal variation of visibility during the months of November to February over Delhi airport has been studied by working out (*i*) Mean hourly values of visibility, (*ii*) Mean hourly frequencies of visibility and RVR of different ranges.

The study suggests that lowest values of visibility (maximum frequencies of visibility and RVR of different ranges) occur around 0200 GMT. The incidence rapidly decreases after 0400 GMT. It is also observed that generally there is another minimum (maximum for frequencies) around 1600 GMT which is, however, not well defined.

1. Introduction

Occurrence of thick fog or smog over an airport continues to be a major aviation hazard, even to modern jet airlinear, during their landing and take-off phases. Occurrence of fog over Delhi airport has been studied by Puri (1972). He has developed an objective method of forecasting occurrence of fog, its commencement, duration and lifting. However, with the provision for better navigational and landing aids over the airports, the visibility minima have been considerably reduced/ lowered, particularly at the international airports. In fact, with the installation of category II instrument landing system and its operationalisation at Palam airport, the visibility minima at Palam airport are being reduced to a RVR of the order of 400 m (approx 200 m visibility). It can, therefore, be appreciated that with technological advancement in landing facilities forecasting of fog alone (visibility 1000 m) is not sufficient but needs to be supplemented with the forecasts and/or climatology of incidence of occurrence of poor visibility and RVR *of various ranges, atleast up to 400* m. Similarly, there is need to know the climatology of the visibility/RVR of various ranges even up to 2000 m for flight planning and operational use of our national domestic carriers. The mean hourly frequencies of visibility and RVR of various ranges, which are based upon 13 years data will, therefore, find their great usefulness in indicating the probability of poor visibility in the terminal forecasts issued by Meteorological Office, Palam.

2. Data used

The data utilised in this study have been collected from the current weather registers of Meteorological Office, Palam airport for the period 1973-1985. A skopograph system for providing instrumental values of visibility and RVR was installed at runway-28 in the year 1972. Another skopograph was installed on runway-10 in the year 1980. The values of visibility and RVR from 1973 to 1980, in this study, pertain to the values obtained from skopograph at runway-28. The values of visibility and RVR, thereafter, pertain to the values lower of the two, obtained from two skopographs.

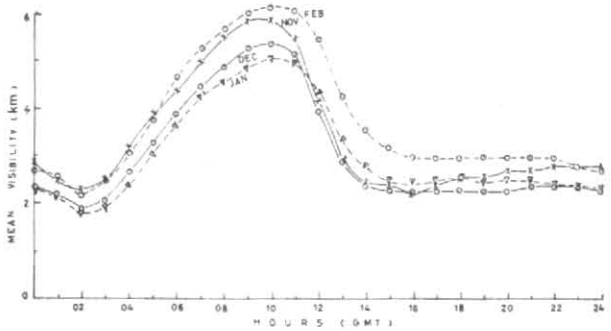

Fig. 1. Mean hourly values of visibility (km) at Palam airport for November, December, January and February

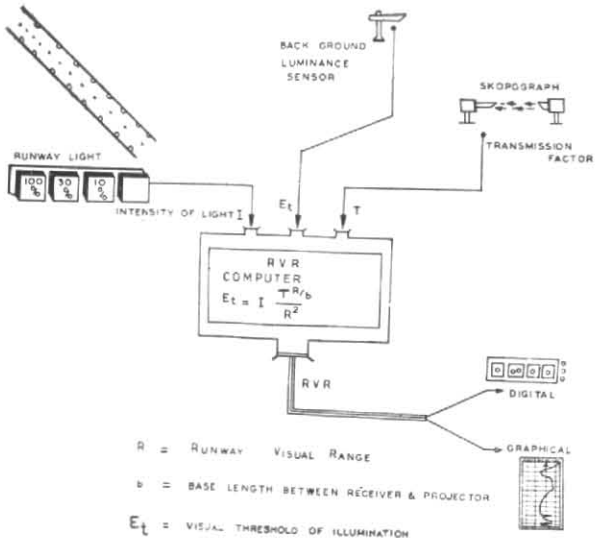

Fig. 2. Schematic representation of RVR system

3. Analysis of data and discussion

3.1. *Mean hourly values of visibility*

Pradhan *et al.* (1976) studied diurnal variation of visibility at Bombay airport by taking mean hourly values of visibility. In the present study also mean hourly values of visibility have been worked out for the four months of November, December, January and February, and presented in Fig. 1. The curves indicate that the lowest visibility occurs around 0200 GMT, being 1.8 km in January, 1.9 km in December, 2.2 km in February and 2.3 km in November. Rapid improvement takes place after 0400 GMT. The visibility falls rapidly after 1200 GMT and there is no appreciable variation between 1600 GMT and 2200 GMT. However, another feeble minimum is seen around 1600 GMT, which is not well defined except in the month of November. It is only after 2200 GMT that the further and rapid fall in visibility starts with a sharp dip around 0200 GMT as stated earlier. Monthwise, the lowest visibility occurs in the month of January, followed by December, November and February.

3.2. *Mean hourly frequencies (number of days in a month) of visibility of different ranges*

The mean hourly values indicated in curves in Fig. 1 do not reflect the instances of occurrence of poor visibility, particularly less than 1000 m, at Palam airport. With this in view, mean hourly frequencies of different ranges, have been worked out. The hourly frequencies of different ranges also suggest that maximum incidence of poor visibility occurs in the early morning around 0200 GMT with rapid improvement after 0400 GMT. However, there is no well defined second maximum except for the month of November where the maximum is even more pronounced than around 0200 GMT. The incidence, *i.e.*, frequencies are generally high from 1500 GMT. Monthwise, the maximum frequencies of different ranges occur in the month of January, followed by December, February and November. These frequencies will find their usefulness in indicating the probabilities of incidence of occurrence of poor visibility of different ranges when coupled with synoptic situations for occurrence of fog and/or mist.

3.3. *Mean hourly frequencies (number of days in a month) of RVR of different ranges*

3.3.1. *Runway Visual Range (RVR)* — RVR is a well defined meteorological value which is now-a-days used operationally for aviation purposes in almost all countries of the world. It is defined as the range over which the pilot of an aircraft on the centre line of a runway can see the runway surface markings or the lights delineating the runway. It is derived, based upon calculations, which take into account the following three parameters:

(*a*) Atmospheric transparency which is measured by transmission factor T (which gives visibility),

(*b*) background luminance and

(*c*) runway light intensity.

Actually the visual range for detection of an object having light of its own, such as runway lights, depends upon the illumination made by the object (runway lights) at the eye of the observer. The minimum illumination at the observer's eye required for detection of the light at a distance 'R' from the observer is called visual threshold of illumination, *i.e.*, E_t and the distance 'R' measures the runway visual range, *i.e.*, RVR. However, threshold value E_t is not constant but is a function of background luminance and, therefore, RVR too varies with background luminance, *i.e.*, state of horizon lighting whether it is night twilight, bright day etc. The schematic representation of RVR system and its mathematical relationship with other factors given above is shown in Fig. 2. It can, thus, be appreciated that RVR values are, in general, more than visibility values and even become two/three times the values of visibility during twilight/night with 100 per cent intensity of runway lights. RVR values, therefore, find their great usefulness under thick fog conditions, when visibility becomes very poor, particularly during night or early morning hours. In fact, most international airlines have changed their landing/taking-off minima in terms of RVR instead of visibility.

3.3.2. Mean hourly frequencies (number of days in a month) of RVR of different ranges for the months have been worked out. The values suggest that diurnal and monthly variation follows the same pattern as for frequencies of visibility, *i.e.*, maximum incidence of poor RVR occurs around 0200/0300 GMT and monthwise it is January, followed by December, February and November. However, RVR frequencies are much less than those of visibility. This is expected as per theoretical considerations made earlier. While at present, RVR values are not used for issue of terminal forecasts, the frequencies of RVR of different ranges can be of great use while tendering advice to airlines for deciding holdings, diversions or delays in departures whenever conditions of poor visibility due to thick fog are expected or exist over Palam airport.

4. Conclusions

(*i*) The frequencies of visibility of different ranges will be useful in indicating the probabilities of incidence of occurrence of such ranges of poor visibility in terminal forecasts, particularly of 800 m and less (last speci of visibility) in view of reduced visibility minima of most airlines because of better landing aids available at the airport.

(*ii*) The frequencies of RVR of different ranges will be useful for tendering advice to airlines for deciding holdings diversions or delayed departures particularly in view of operationalisation of CAT II I. L. S. at the airport which requires RVR of 400 m as minima.

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