



ICAO

The Second Meeting of the Asia/Pacific Aerodrome Design and Operations Task Force (AP-ADO/TF/2)

Video Teleconference, 26 to 29 January 2021

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**Agenda Item 2: Planning, Design and Construction of Aerodromes**

**CHALLENGES AND SAFETY MANAGEMENT DURING EXTENSION OF RUNWAY AND CONSTRUCTION OF RESA IN THE VICINITY OF OPERATIONAL RUNWAY: A CASE OF TRIBHUVAN INTERNATIONAL AIRPORT, KATHMANDU, NEPAL**

(Presented by Nepal)

**SUMMARY**

This paper presents efforts made to safely execute the construction works for the Extension of Runway and construction of RESA in the vicinity of operational runway including replacement of the existing Precision Approach Lighting System (PALS) at Tribhuvan International Airport (TIA), Kathmandu.

**1. INTRODUCTION**

1.1. ICAO Annex 14 stipulates the requirements for the runway strip and runway end safety areas. ICAO describes a RESA as an area symmetrical about the extended runway center line and adjacent to the end of the strip primarily intended to reduce the risk of damage to an aircraft undershooting or overrunning the runway. The dimensions of a RESA for the various categories of runways can be found in the appropriate section of ICAO Annex 14. The provision of a Runway End Safety Area is a critical safety factor in reducing the severity of runway excursions and improving post-accident survivability.

1.2. Often airports do not have sufficient land to accommodate RESAs as recommended in ICAO Annex 14, Volume I – Aerodrome Design and Operations. Many aerodromes were constructed before requirements for RESAs were introduced by ICAO, and consequently many airports do not operate with recommended RESA dimensions.

1.3. Tribhuvan International Airport, Kathmandu (TIA) also had the same problems in the past and now RESA has been provided at both ends of the Runway 02-20 with 300-meter runway extension to the south.

1.4. As the runway extension work was executed for the operational runway, ensuring safety in such an operational airport was very critical along with timely completion of the project.

**2. DISCUSSIONS**

The Master Plan

2.1. Review and upgrading of Tribhuvan International Airport Master Plan was undertaken in 2008-2009 which resulted in the development of a revised *Master Plan 2010-2028* that recommended extension of the 3050 m long runway by 300 m to the south. The extension was necessary as there was insufficient safety buffer beyond the north end of the runway 02/20 and the terrain was steeply falling that could lead to severe consequences if an aircraft overruns Runway 02.

2.2. In light of the above, the Civil Aviation Authority of Nepal (CAAN) decided to implement the above master plan to extend the runway to the south by 300 m.

The scope of works as per the contract

2.3. The contract was signed on 19 December 2018 to carry out the following major works under the same package:

- a) 300-meter extension of Runway at runway 02 including new turn pad (Flexible Pavement)
- b) Construction of Runway Strip for extended part of the runway and RESA
- c) Installation of new RCLL, REL and other AFLs
- d) Upgrading of PALS (CAT-I) with LED lights and frangible masts (of latest technology)
- e) Construction of Airport Drainages
- f) Construction of Airside Perimeter Service Roads

Challenges: The existing situation before construction

2.4. TIA has precision approach lights category-I, 870 m long on the southern approach. The existing approach lights needed to be decommissioned from the runway extension work site for the work and recommissioned after completion of pavement works. The approach light in the runway extension part (300 m) was to be installed on pavement as inset approach lights and remaining lights was to be installed on poles/masts as elevated approach lights.

2.5. Some International Airlines/Aircraft were using the RNP AR approach. The runway threshold was to be displaced temporarily. The procedure was to be redesigned as the displacement would affect the decision height.

Challenges: The soil condition and the design of pavement

2.6. The subsoil was composed of heavy clay that needs very careful handling because it cannot be compacted by normal methods. So, the design demands for replacement of this clayey soil with better quality material. For constructing the runway extension pavement, the clayey soil was to be removed up to a depth of 2 to 2.5 m from the existing ground level, covered with a layer of geo-composite materials, and then a 150 cm thick CBR 35 (minimum) material is laid before the 1.5 m thick good soil is placed and compacted in layers. Each layer is required to be compacted, tested and followed by another layer of soil before the actual pavement can be constructed. This takes considerable amount of time and initial 300 m of the existing approach lights are in this construction area and are obstructions to carrying out the works.



2.7. Pavement Layers (As-built):

a) Asphalt Concrete Surface Course	t=60 mm
b) Asphalt Concrete Binder Course	t=80 mm
c) Asphalt Treated Base Course	t=150 mm (CBR>=5%)
d) Well Graded Crushed Aggregate Base Course	t=237 mm (CBR>=80%)
e) Geogrid 4.75m wide across the runway width	Only at new and old connection
f) Crushed Aggregate Subbase Course	t=150 mm (CBR>=35%)
g) Geogrid 4.75m wide across the runway width	Only at new and old connection
h) Replacement of unsuitable clay (Subgrade)	t=1500 mm (CBR>=5%)
i) Crushed Aggregate Subbase Course	t=150 mm (CBR>=35%)
j) <u>Geo-Composite</u>	At whole area
<b>Total top to bottom thickness</b>	<b>t=2327 mm</b>

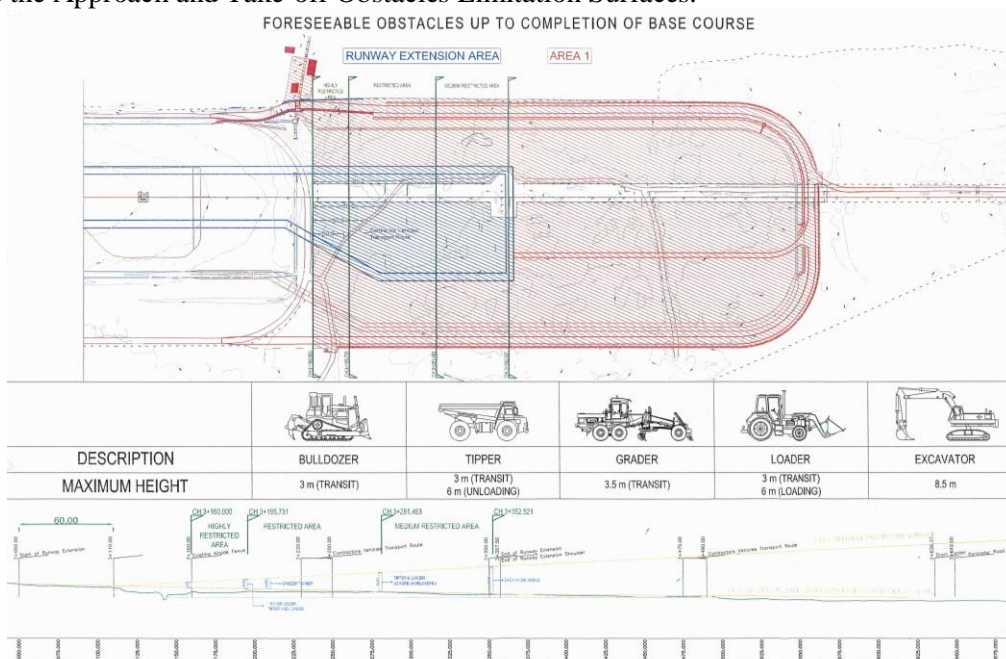
2.8. Geo-Composite below River Bed Material below Geo-Textiles were provided at Ch. 3+265 to Ch. 3+355 at width of 20 to 60 meters where the Black Cotton Soil with water seepage was encountered.

Challenges: Other Construction Difficulties

2.9. Working in between the lights is not a practicable and would lead to delays, as even those areas under the existing lights should be subjected to the above construction procedures. It would create additional construction joints, more than the minimum essential.

2.10. While earthwork will not be impacted much by the ambient temperatures at Kathmandu during winter, asphalt concrete laying would be a challenging one if the temperature controls - of the mix at the time of laying and at the time of compaction – are inadequate. Success or failure of the asphalt concrete work would depend directly on this.

2.11. Heavy construction equipment like bulldozers, loaders, excavators, graders, tippers, roller, pavers were to be used for the construction in the vicinity of the operating runway which would infringe the Approach and Take-off Obstacles Limitation Surfaces.



The ICAO Safety Requirements

2.12. ICAO Annex 14, Volume I – Aerodrome Design and Operations (8<sup>th</sup> edition) specifies that a runway must have a runway strip that commences 60 m before the threshold and ends 60 m after the end of the runway. Additionally, the Annex also mandates the provision of Runway End Safety Area (RESA) at least to a distance of 90 m from the end of the runway strip, or 150 m (60+90) from the runway end. It applies to both ends of the runway. This is a safety requirement based on aircraft accident/incident statistical data over a long period of time. Therefore, in order to undertake the runway extension work, there is a need to displace the threshold of Runway 02 by 150 m.

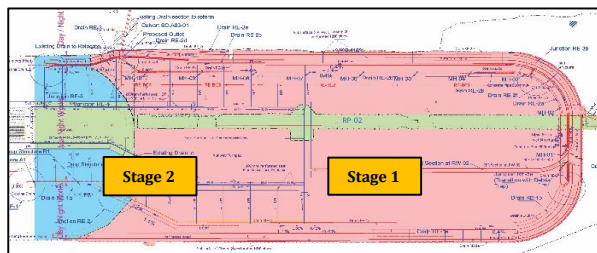
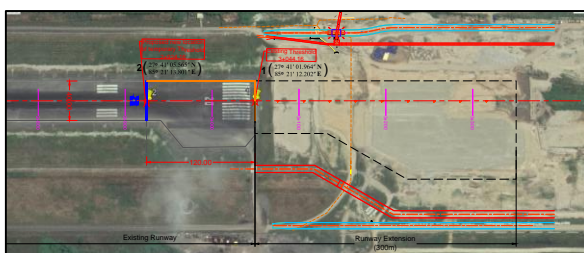
Safety Management: Safety Risk Assessment

2.13. Air Transport Capacity Enhancement Project (ATCEP), CAAN conducted a study through an international expert to make a safety risk assessment and identify suitable risk mitigation measures so that the project work can progress for timely completion while minimizing disruptions to aircraft operations and operational safety. The assessment is attached in Annex-1.

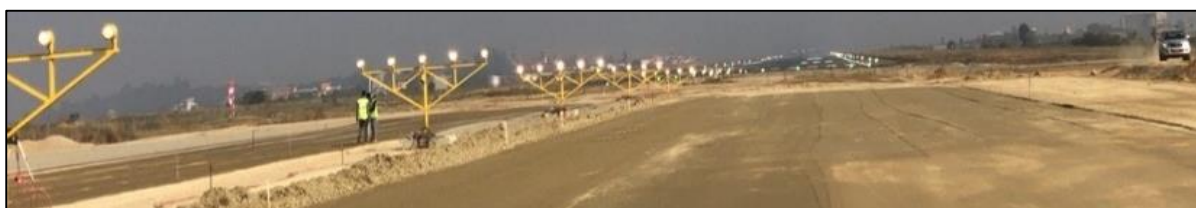
Safety Management: Staging of Works and Construction Progress

2.14. The runway extension works commenced in January 2019 through a local contractor. In the first Stage, a following NOTAM was issued about the work in the runway extension area in the south and the contractor had commenced the work from a point approximately 120 m from the existing threshold towards south (away from the operational runway). The work was being progressed in various stages keeping in mind the rather tight workspace and short window of time.

A) VNKT B) 1902230015 C) 1905220015  
E) RWY, RWY STRIP AND RESA CONSTRUCTION WIP FM 110M SOUTH OF RWY 02 THR UPTO 608M SOUTH. HEAVY EQUIPMENTS WILL BE MOVING THROUGHOUT THE CONSTRUCTION AREA WI OBSTACLE LIMITATION SURFACE. SAFETY FLAG WILL BE USED DURING DAY TIME AND FLASHER LIGHTS DURING NIGHT TIME. PILOTS TO ECT/ECL)



2.15. By the end of September 2019, the work of replacing the poor-quality natural soil with better quality soil had been taken up from 120 m from the existing threshold up to the end of extension (Stage-1 Area). Granular subbase course had been laid in some areas of the extension portion. The existing approach lights were still functioning, as they had not been removed yet.



A) VNKT B) 1908030015 C) 1910312359  
E) APPROACH LIGHT AT RWY 02 END ARE UNDER MAINT. ONE SET OF LIGHT ON ONE MAST MAY NOT BE AVBL. PILOTS TO ECT AND ECL.)

2.16. Between October 2019 and March 2020, this 180 m of the extension portion (Stage-1 Area) has progressed to have the crushed stone base course also. Work had also been undertaken closer to the operational runway leaving a gap of about 60 m only. This is equal to the specified length of runway strip before the threshold of Runway 02 and there was no runway end safety area at all for Runway 20. This is not a sound practice and introduces a significant risk to aircraft operations. Such practices should be avoided in future.

2.17. Meanwhile, during the period from October 2019 to March 2020, the construction work at the available site had been progressed and a *local arrangement* was made to continue provision of existing full-length approach lights. The arrangement was to mount the frame containing the approach lights on concrete blocks (alternative to fixing them on poles on normal foundations). During the construction period, these lights would be lifted away and removed beyond the runway shoulder area and relocated at the end of the work shift in the morning.



A) VNKT B) 1909110615 C) 1912102359  
E) EXISTING APPROACH LIGHT CROSS BAR LIGHTS AT 300 M FROM THR 02 IS RELOCATED AT 310 M FROM THR 02 PILOTS TO ECT/ECL

The main challenge: Construction adjacent to the existing operational runway end, temporary displacement of threshold and arrangement for availability of PALS

2.18. The gap of 60 m of the runway extension remained untouched pending the temporary displacement of Runway 02 threshold to the north by 120 m in order to maintain minimum runway strip dimensions (60 m) and provide RESA of 60 m (less than the minimum mandatory requirement of the RESA of 90 m).

2.19. In order to carry out the work at the 60 m gap in the extension area, i.e. from the existing Runway 02 threshold, and due to the need to displace the existing threshold, the existing approach lights would need to be decommissioned and removed from the work site for the work to progress unhindered. The remaining approach lights beyond the extension area obviously could not be used. Effectively, the entire approach light system would not be available.

2.20. To tackle this problem, the availability of full-length approach lights was considered more appropriate from the safety point of view and hence, it was accepted that the *local temporary arrangement* (as in Paragraph 2.17) of mounting the approach lights in the runway extension area on concrete blocks that can be lifted and moved easily, was used during the temporary threshold displacement period.



### Meeting with Stakeholders

2.21. A meeting was held at the ATCEP office on 5 March 2020 in which the operating airlines (Royal Nepal Airlines, Himalaya Airlines, Qatar Airways, Etihad Airways, China Southern, Shree Airlines), TIA officials, TIA Air Traffic Control officials, CAAN/Aerodromes Standards and Safety Directorate officials participated. ATCEP made a presentation to inform the stakeholders about the detailed plan of action related to the displacement of the threshold of Runway 02. The meeting was informed that in the interest of aircraft operational safety, the following actions are necessary to be implemented for the duration of the displacement:

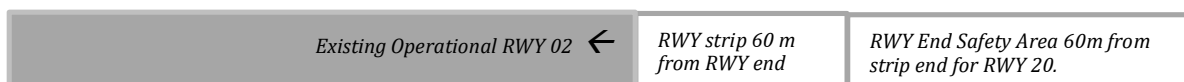
- New displaced threshold markings including the pre-threshold markings that would indicate the new beginning of Runway 02;
- Consequent repositioning of the Aiming Point marking only;
- Obliteration and non-availability of touchdown zone markings for Runway 02;
- A new set of PAPIs had been installed and it was already flight-calibrated;
- Consequent changes in the characteristics of the center line lights and runway edge lights for operating on Runway 20;
- Installation of red Runway end lights just before the new Runway 02 threshold;
- The approach light system would be moved to commence from the new threshold of Runway 02, including four barrettes in the 120 m displaced portion;
- Consequently, the southern turn pad cannot be accessed and thus, would not be available for use. The Codes A, B and C aircraft need to turn around within the 45 m wide runway or use the northern turn pad.

2.22. There was in general agreement about the Runway 02 threshold displacement and the safety measures being put in place. Shree Airlines representative asked what would be the situation if in the mornings there were IFR conditions. It was assured that the contractor would be required to vacate the site within a reasonable time, considering that moving heavy construction machinery to the designated parking positions was not easy.

2.23. The airlines also agreed that as long as the full approach light system for Runway 02 would be available together with the new set of PAPIs, it was adequate for safe operations. The concern was about the availability of approach lights for Runway 02. Royal Nepal Airlines (RNA) requested that advance information be given of the Runway 02 threshold displacement so that they can carry out a flight check of the relocated approach light system and the PAPIs before the closure on 26 March 2020.

### Displacement of Threshold and Recalculation of Declared Distances

2.24. However, a decision was taken to displace the threshold only by 120 m (as shown below) instead of 150 m in order to provide as long a runway as possible and minimize payload penalties.



2.25. Any such displacement of a runway threshold would mean recalculation of the four declared distances – Take-off run available (TORA), Take-off distance available (TODA), Accelerate-stop distance available (ASDA) and Landing distance available (LDA) – to account for the inevitable reduction imposed by the displacement. Consequently, this may require the operating airlines to review their flight plans for possible payload penalties in order to operate safely within the available runway length. The reduced declared distances with 120 m displacement (existing distances in parenthesis) are given in the paragraph below.

AIP Supplement (Effective from 26 March 2020) and NOTAMs

2.26. For the construction at most critical 60 m section the following AIP supplement was published to displace the threshold and to make the necessary changes to the visual aids:

- a) *Existing Threshold RWY 02 is displaced by 120 m towards North. Subsequently post displacement Declared Distances has been changed as follows:*

Runway Desig	TORA (m)	TODA (m)	ASDA (m)	LDA (m)	Remarks
Runway 02	2930 m <i>(3050m)</i>	3080 m <i>(3200 m)</i>	2930 m <i>(3050 m)</i>	2930 m <i>(3050 m)</i>	
Runway 20	2930 m <i>(3050 m)</i>	3175 m <i>(3295 m)</i>	2930 m <i>(3050 m)</i>	2807m <i>(2927 m)</i>	

- b) *PAPI, RTIL and Wing Bar Threshold Light are installed and existing PALS will be relocated with respect to Displaced Threshold with following details:*

RWY DES IG	APCH LGT, Type, LEN, INTST	RTIL	TH R LG T, Col or	VAS IS/ PAP I	TD Z LG T, LE N	RWY Center Line LGT, LEN, Spacing, Color, INTST	RWY edge LGT, LEN, Spacing, Color, INTST	RW Y End LG T, Col or	SW Y LG T, LE N, Col or	Rema rks
1	2	3	4	5	6	7	8	9	10	11
02	PALS, 870 m, (29x30 m) (High Intensity consistin g of extended center line)	White Flashin g Light Symmet rical about RWY center line, in line with THR	Gre en	PAP I 3.00 °	NI L	2930 m, 30 m C/C, Bi- directional inset white amber lights, High intensity	2930 m, 60 m C/C, Bi- directional raised white amber edge lights, High intensity	Red	NIL	
20	NIL	White Flashin g Light Symmet rical about RWY center line, in line with THR	Gre en WB AR	PAP I 3.00 °	NI L	2930 m, 30 m C/C, Bi- directional inset white amber lights, High intensity	2930 m, 60 m C/C, Bi- directional raised white amber edge lights, High intensity	Red	NIL	

- c) *Existing Turn Pad at RWY 02 will not be available.*  
 d) *New RWY Markings will be provided as per displaced Threshold, Existing Threshold Marking will be obliterated. All TDZ markings for RWY 02 will be obliterated and not available during runway extension period.*

2.27. To trigger the above AIP Supplement and to impose the restrictions in the RNP AR approach the following NOTAMs were published:

A) VNKT B) 2003260001 C) 2004090001 E) TRIGGER NOTAM-AIRAC AIP SUP 07/20 WEF 26MARCH2020 RUNWAY EXTENSION WORKS IS BEING SCHEDULED ON THE FIELDS SOUTH OF RWY02 AT TROPICANA INTERNATIONAL AIRPORT
A) VNKT B) 2003261915 C) 2004300215 D) 1915-0215 NXT DAY DLY E) 1) FOR INTL CARRIERS, RWY CLSD DUE CIV CONST WORKS FOR RWY EXTENSION, RWY STRIP AND RWY END SAFETY AREA (RESA). CONST AREA FM THR RWY02 TO 610M SOUTH OF RWY02.
A) VNKT B) 2003260000 C) 2004302359 E) ALL ACFT CONDUCTING RNP AR APCH FOR RWY02 IS IMPOSED BY FLW RESTRICTION DUE TEMPORARY DISPLACED THR RWY02 BY 120M TOWARDS NORTH -DA (DH) RAISED TO 5120FT (800FT) WITH VIS MINIMA 3000M FOR ALL ACFT -AUTOPILOT OR FLT DIRECTOR MUST NOT BE USED BELOW DA (DH))

#### Impacts of Lockdown due to COVID-19

2.28. Lockdown due to COVID-19 began on March 24, 2020. The international and domestic flights to and from the airport were suspended excluding the rescue flights and the emergency flights. The suspension of the regular flights contributed to the longer working time and safer construction activities. The transportation of construction materials and supply of construction labor was difficult due to the lockdown. Due to worldwide lockdown situations importation of airfield lighting fixtures took very long time than in the normal situations.

#### Completion of the Works

2.29. The runway pavement works was completed by the end of May 2020. After the completion of pavement works, threshold 02 and the associated visual aids were reinstated to its original position on first week of June, 2020 and the NOTAMs and AIP Supplements were issued accordingly. The airfield lighting works were delayed due to importation of the goods and its installations were completed by mid-December 2020.



2.30. The whole of the runway extension and RESA construction works was completed successfully by the end of December 2020 without any accident or incident during the construction period.

### **3. ACTION BY THE MEETING**

3.1. The meeting is invited to:

- a) note the information contained in this paper; and
- b) share the experience of TIA runway extension for similar ongoing and future projects in the operational airports in the region.