Apron Marking and Sign Manual

November 2023

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Forward

In accordance with provision 14.5.12 of the Bhutan Air Navigation Regulations (BANRs) – 2021, the aerodrome operator is responsible for establishing visual aids for aircraft navigation at the aerodrome. This must be done in compliance with the standards and recommended practices outlined in the Bhutan Aerodrome Standards and other relevant guidance materials.

This manual has been developed to guide the Department of Air Transport (DoAT) in setting up signs and markings in the apron at Paro International Airport (PIA). It includes drawings, specifications, and guidance materials for the implementation of these markings and signs at PIA. The manual aims to provide essential guidance for the DoAT to ensure the safety of air operations on the apron.

The referenced markings, signs, and detailed dimensions in this manual are drawn from the Bhutan Aerodrome Standards 2021, the ACI marking handbook, and various best practices. DoAT is encouraged to regularly update the manual to reflect the latest amendments in apron markings and signs and to apply the necessary changes on site.

Kinley Wangchuk

Director

BHUTAN CIVIL AVIATION AUTHORITY
PARO
BHUTAN

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Introduction

The apron is a defined area on the airside of the airport intended for the accommodation of aircraft, serving purposes such as loading or unloading passengers, mail or cargo, fueling, parking, or maintenance.

The establishment of apron markings and signs ensures regulatory uniformity and compliance. Regulating the activities and movement of aircraft and vehicles on the apron is crucial for ensuring the safety of the aircraft, passengers, and ground workers

To guarantee safe and efficient operations on the apron, various markings and signs are employed to guide pilots, ground crews, and other personnel

Apron markings help facilitate quick and unobstructed emergency access routes to the aircraft during emergencies

These markings also include safety lines and zones that establish clear boundaries between different operational areas on the apron, crucial for preventing accidents and ensuring that ground equipment and personnel stay clear of active aircraft movements

Well-defined apron markings contribute to the overall efficiency of airport operations. Pilots can quickly and easily identify their assigned taxi routes and parking positions, reducing the time it takes for aircraft to move on the ground

Paro International Airport has an apron size of 22,320 sqm, which can accommodate eight A319/A320 aircraft

In summary, apron markings play a crucial role in enhancing safety, preventing accidents, and promoting the efficient movement of aircraft on the ground within airport facilities. They are a key component of the overall airport layout and contribute to the smooth functioning of airport operations

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1. Taxiways, Taxiway/Runway Intersections, Taxiway/Taxiway Intersections

Taxiways are defined as the paths that are used for the taxiing of aircraft from one part of an airport to another.

All taxiway markings are yellow. The different types of taxiway markings are as follows:

- Taxiway Centerline Marking
- Taxiway Edge Marking
- Holding Position Markings
- Markings for a Taxiway in Front of a Runway

➢ Taxiway Centerline Marking

Taxiway centerlines are marked to provide a visual identification of the designated taxiing path. Taxiway centerlines are yellow and consist of a continuous stripe along the centerline of the designated taxiway. On a taxiway curve, the markings continue from the straight portion of the taxiway at a constant distance from the outside edge of the taxiway.

The centerline will be continuous in length except where it intersects a holding position marking or runway marking element. For taxiway intersections designed for the straight thorough method of taxiing, the centerline markings continue straight through the intersection.

At taxiway intersections with a runway end, the taxiway centerline marking is terminated at the runway edge, (with the exception of the situation where there is a displaced threshold, in which case the taxiway centerline may be extended onto the runway displaced area). On taxiways used as an entrance or exit to a runway, the taxiway centerline marking curves onto the runway and extends parallel to the runway centerline marking for 60 meters past the point where the two markings become parallel.

Colour	**Centreline**	**Borderline**
Dimension	Yellow	Black
	A	**B**
	15 cm	10cm

Figure 1-taxiway centerline marking and dimension

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- **Taxiway Edge Marking**

Taxiway edge markings are used to delineate the edge of the taxiway. They are used when the taxiway edge does not correspond with the edge of the pavement and where the full strength pavement of the taxiway is not readily visible. Taxiway edge markings are yellow and can either be continuous or dashed. Continuous taxiway edge markings are used to identify the taxiway from the shoulder or some other surface not intended to be used by aircraft. ***Dashed taxiway*** edge markings are used when the aircraft would need to cross the lines, for example when a taxiway enters or crosses aprons. Continuous taxiway edge markings consist of a continuous double yellow line, each being at least 15 cm in width and spaced 15 cm apart. Dashed taxiway edge markings consist of a broken double yellow line, each being at least 15 centimeters wide spaced at 15 cm apart from edge to edge.

Colour	**Yellow**
Dimension	**A**
	15 cm

Figure – 2 taxiway edge marking *and dimension*

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- **Taxiway shoulder marking**

Taxiway shoulder markings indicate that the paved shoulders along the taxiway are unusable. Taxiway shoulder markings are yellow and are perpendicular to the taxiway edge markings. The width of the lines should be 15 to 20 centimeters.

Although shoulders may have the appearance of full strength pavement, they are not intended for use by aircraft and may be unable to support an aircraft. The taxiway edge marking will define this area.

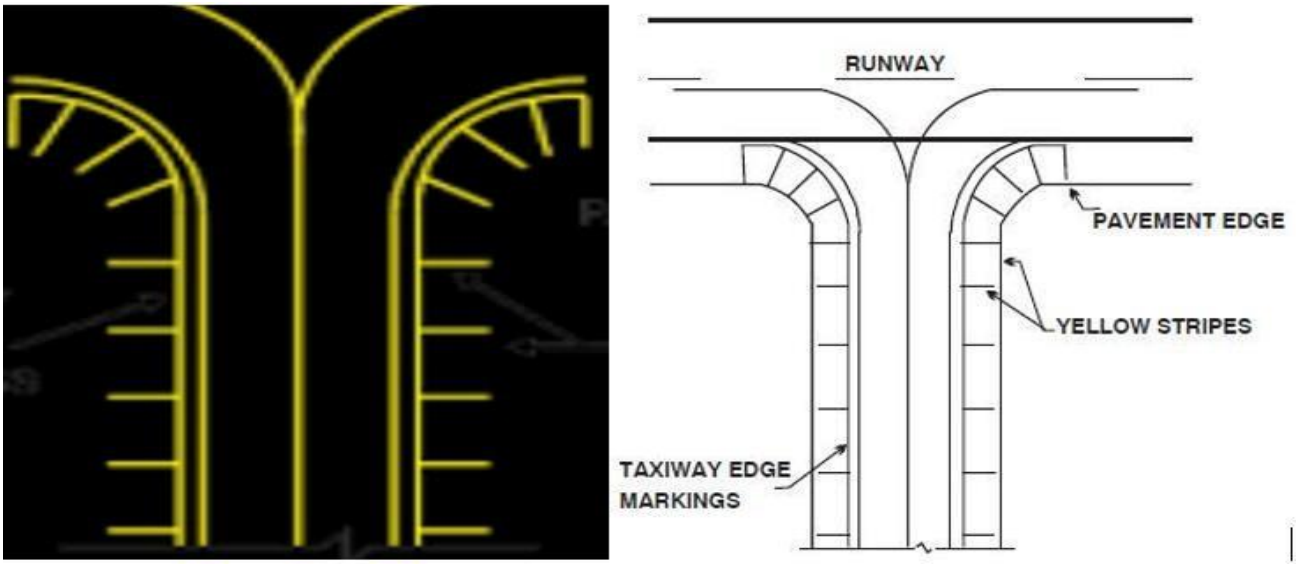

Figure – 3 taxiways shoulder markings

- **Runway holding position markings on taxiways**

Holding position markings identify the location on a taxiway where an aircraft is supposed to stop while awaiting clearance to proceed onto the runway. Holding position markings should be located on all taxiways that intersect runways based upon the most critical aircraft using the runway. There are two types of holding position markings. These markings are outlined with black lines and black interim spaces if needed for improved visibility on light colored (such as Portland cement) pavement areas.

They are as follows:

- Holding Position Markings for Taxiway/Runway Intersections
- Holding Position Markings for Taxiway/Taxiway Intersections

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➢ **Holding positions markings for taxiway/runway intersections**

Runway holding position markings indicate where an aircraft is supposed to stop. They consist of four yellow lines two solid, and two dashed spaced as indicated in the figure and extending across the width of the taxiway. The solid lines are always on the side where the aircraft is to hold. There are three locations where runway holding position markings are encountered.

When approaching the holding position marking, a pilot should not cross the marking without ATC clearance at a controlled airport or without making sure of adequate separation from other aircraft at uncontrolled airports. An aircraft exiting a runway is not clear of the runway until all parts of the aircraft have crossed the applicable holding position marking.

The markings are installed perpendicular to the taxiway centerline as seen in Figure 4

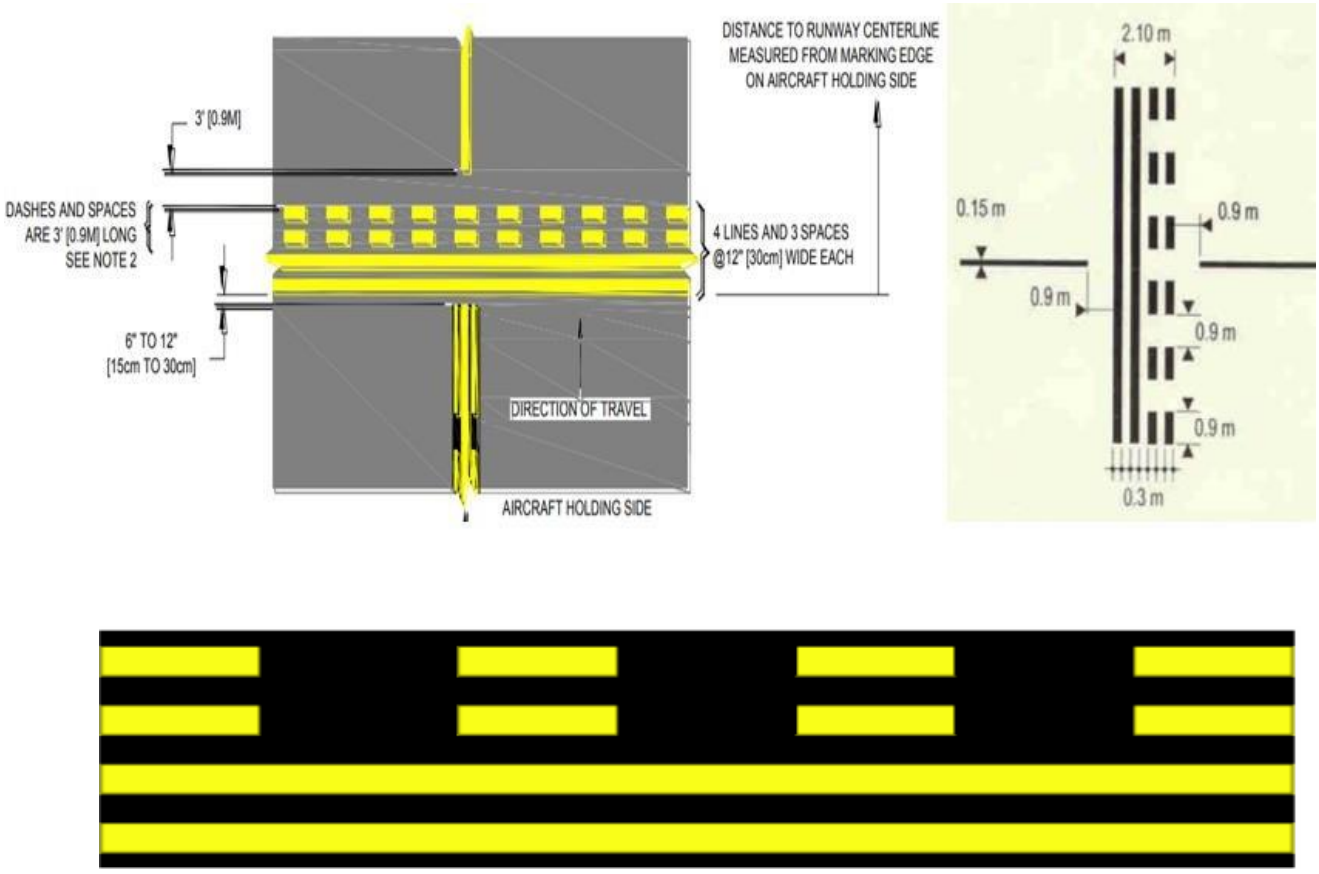

Figure – 4 Runway Holding Positions Markings

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➢ **Holding positions markings for taxiway/taxiway intersections**

Intermediate holding positions are designated positions intended for traffic control at which taxiing aircraft and vehicles shall stop and hold until further cleared to proceed, when so instructed by the aerodrome control tower.

Where an intermediate holding position marking is displayed at an intersection of two paved taxiways, it shall be located across the taxiway at sufficient distance from the near edge of the intersecting taxiway to ensure safe clearance between taxiing aircraft.

Intermediate holding positions are designated positions intended for traffic control at which taxiing aircraft and vehicles shall stop and hold until further cleared to proceed, when so instructed by the aerodrome control tower.

Holding position markings for taxiway/taxiway intersections are indicated with a single line of dashes and spaces. These markings should only be installed at taxiway/taxiway intersections where there is an operational need to hold aircraft at this point, and are often not necessary. These markings are installed perpendicular to the taxiway centerline as seen in Figure 5

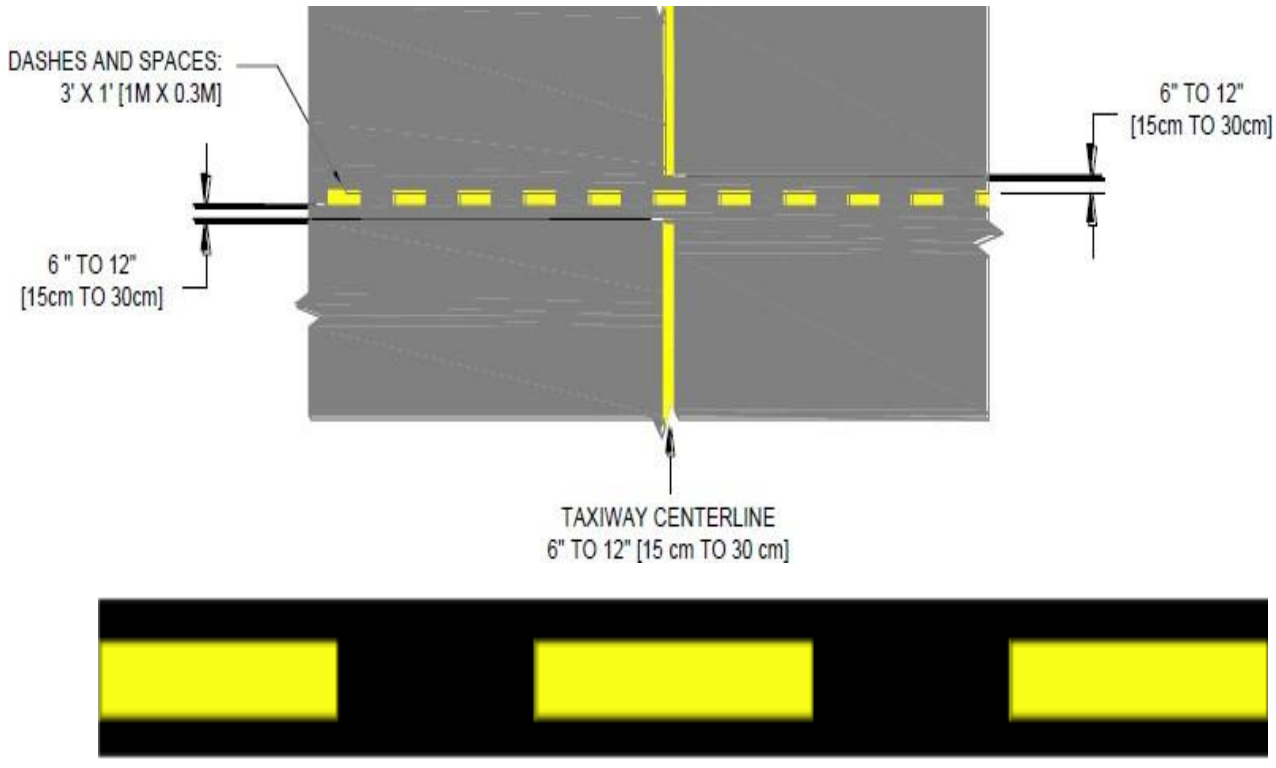

Figure – 5 Runway Holding Positions Markings

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2. Road holding position markings

A road-holding position marking are provided at the entrances to a runway.

The road-holding position marking are located across the road at the holding position. The Vehicle roadway markings are white.

The road-holding position marking and specifications will be in accordance with the Bhutan Construction and Transport Authority (BCTA)

Examples of road holding markings and signs are as below:

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Color	Charakters	Background	Border
	White	*Red*	*White*

Dimensions	A	B	C	D
	2,0 m	*3,0 m*	*Acc. to character width*	*0,1 m*
	4,0 m	*5,0 m*	*Acc. to character width*	*0,1m*

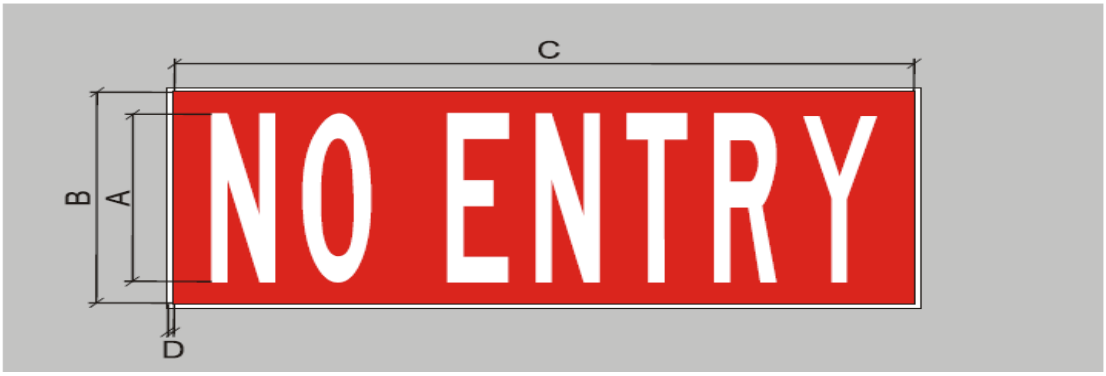


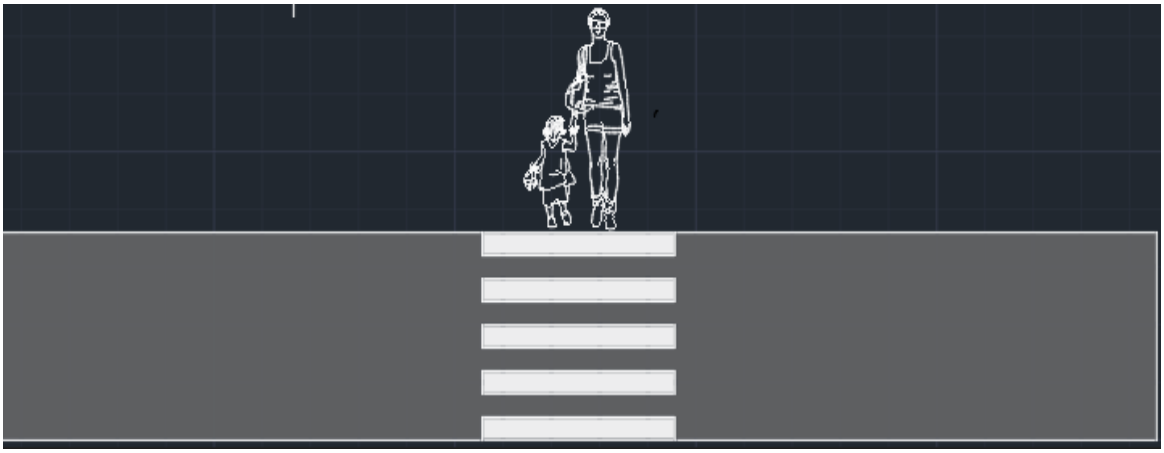
Figure – 6 Road Holding Positions Markings and Signs

3. Apron safety lines

Apron safety lines should be provided on a paved apron as required by the parking configurations and ground facilities

Apron safety lines shall be located so as to define the areas intended for use by ground vehicles and other aircraft servicing equipment, etc., to provide safe separation from aircraft

Apron safety lines should include such elements as wing tip clearance lines and service road boundary lines as required by the parking configurations and ground facilities. An apron safety line should be continuous in length and at least 10 cm in width.



Pedestrian crossing – stripes white, background – black

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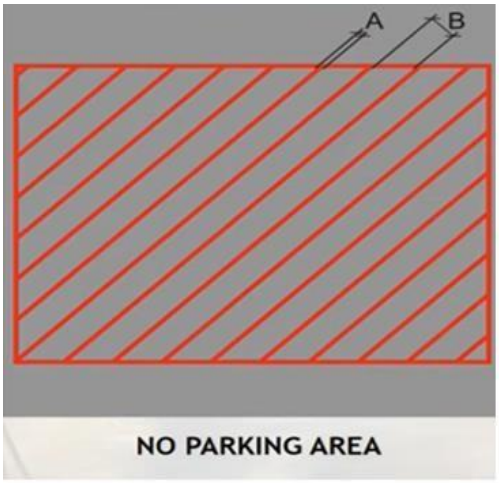
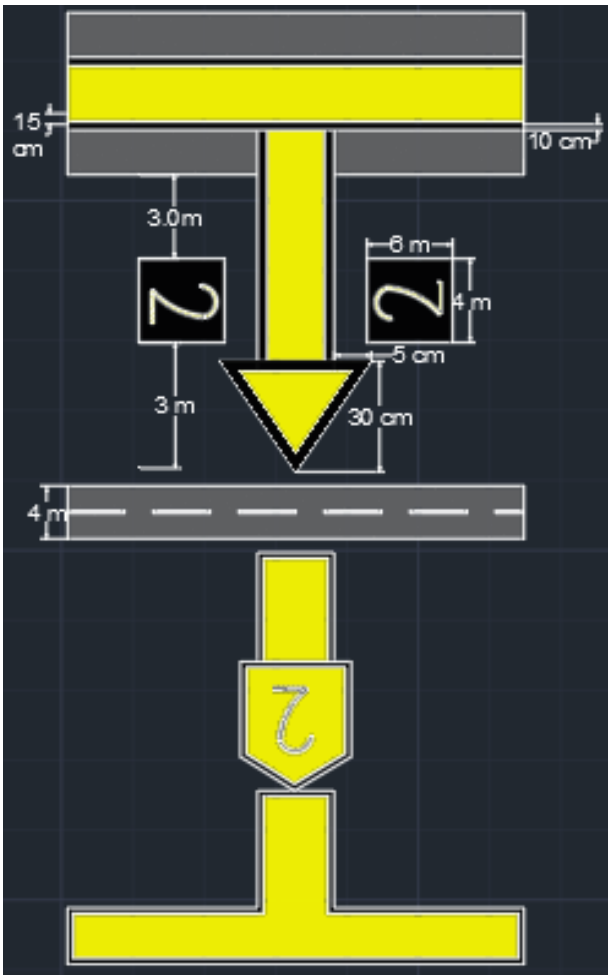
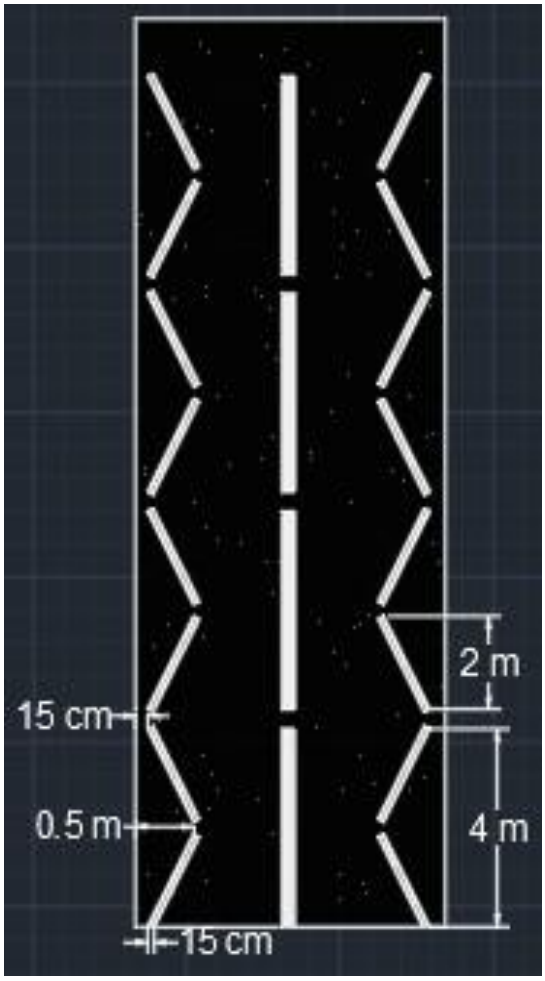


A - 15cm, B -50cm

Equipment staging area/clearance area



Apron aircraft stand taxi lane



adjacent service road between two aircraft stands –zig-zag marking indicates restricted parking

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Apron service road/airside road

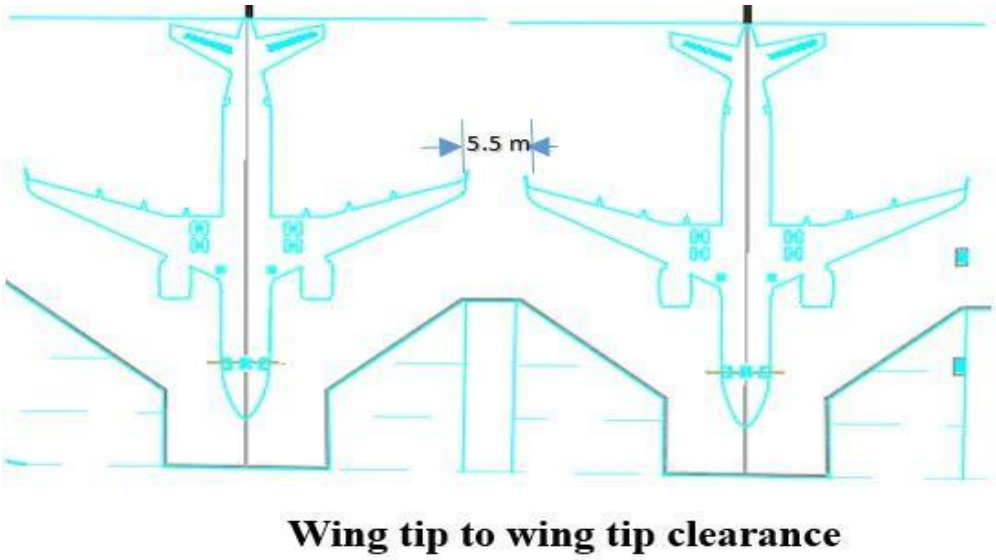

Figure – 7 **Apron safety lines, *Markings and Signs***

4. Information markings and signs

Where operationally required an information sign should be supplemented by an information marking.

An information (location/direction) marking should be displayed prior to and following complex taxiway intersections and where operational experience has indicated the addition of a taxiway location marking could assist flight crew ground navigation.

An information (location) marking should be displayed on the pavement surface at regular intervals along taxiway length.

The information marking should be displayed across the surface of the taxiway or apron where necessary and positioned so as to be legible from the cockpit of an approaching aircraft

An information marking shall consist of:

- an inscription in yellow upon a black background, when it replaces or supplements a location sign
- an inscription in black upon a yellow background, when it replaces or supplements a direction or destination sign.

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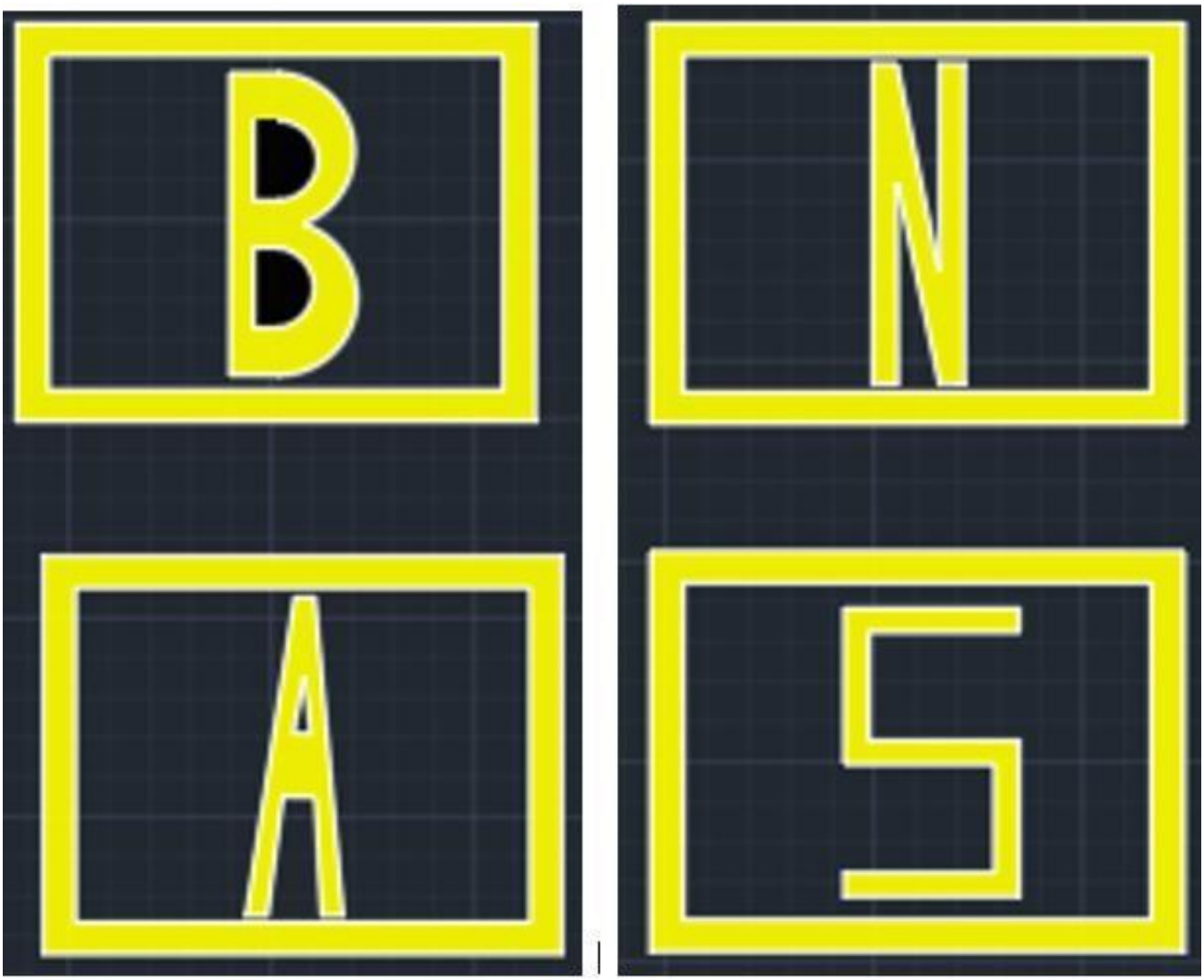
Where there is insufficient contrast between the marking background and the pavement surface, the marking shall include:

- a black border where the inscriptions are in black; and
- a yellow border where the inscriptions are in yellow.



Location signs

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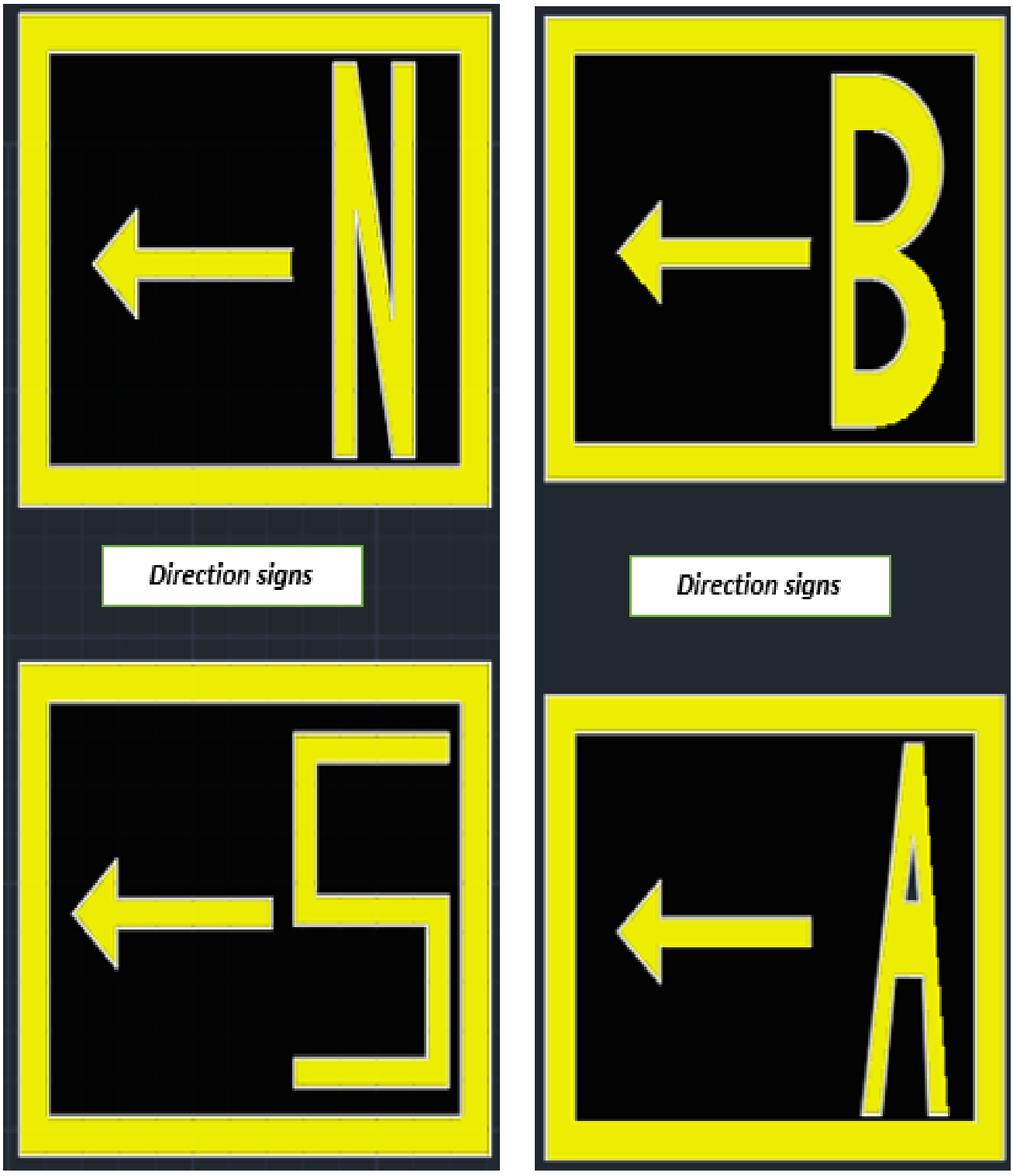

Figure – 8 Information markings and signs

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Recommended dimensions as per standards

Width of a Number	
Letter height (400 mm)	
Number	Width
1	98 mm
2	274 mm
3	274 mm
4	274 mm
5	274 mm
6	274 mm
7	274 mm
8	274 mm
9	274 mm
0	286 mm

Width of the letter	
Letter height (400 mm)	
Letter	Width
A	340 mm
B	274 mm
N	274 mm
S	274 mm

space of a number and letter		
Letter height		
150 mm	300 mm	400 mm
space		
10 mm	19 mm	26 mm

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5. Aircraft stand marking

Aircraft stand markings should be provided for designated parking positions on a paved apron.

Aircraft stand markings on a paved apron should be located so as to provide the clearances when the nose wheel follows the stand marking.

Aircraft stand markings should include such elements as stand identification, lead-in line, turn bar, turning line, alignment bar, stop line and lead-out line, as are required by the parking configuration and to complement other parking aids.

An aircraft stand identification (letter and/or number) should be included in the lead-in line a short distance after the beginning of the lead-in line. The height of the identification should be adequate to be readable from the cockpit of aircraft using the stand.

Lead-in, turning and lead-out lines should normally be continuous in length and have a width of not less than 15 cm. Where one or more sets of stand markings are superimposed on a stand marking, the lines should be continuous for the most demanding aircraft and broken for other aircraft.

The curved portions of lead-in, turning and lead-out lines should have radii appropriate to the most demanding aircraft type for which the markings are intended.

Where it is intended that an aircraft proceed in one direction only, arrows pointing in the direction to be followed should be added as part of the lead-in and lead-out lines.

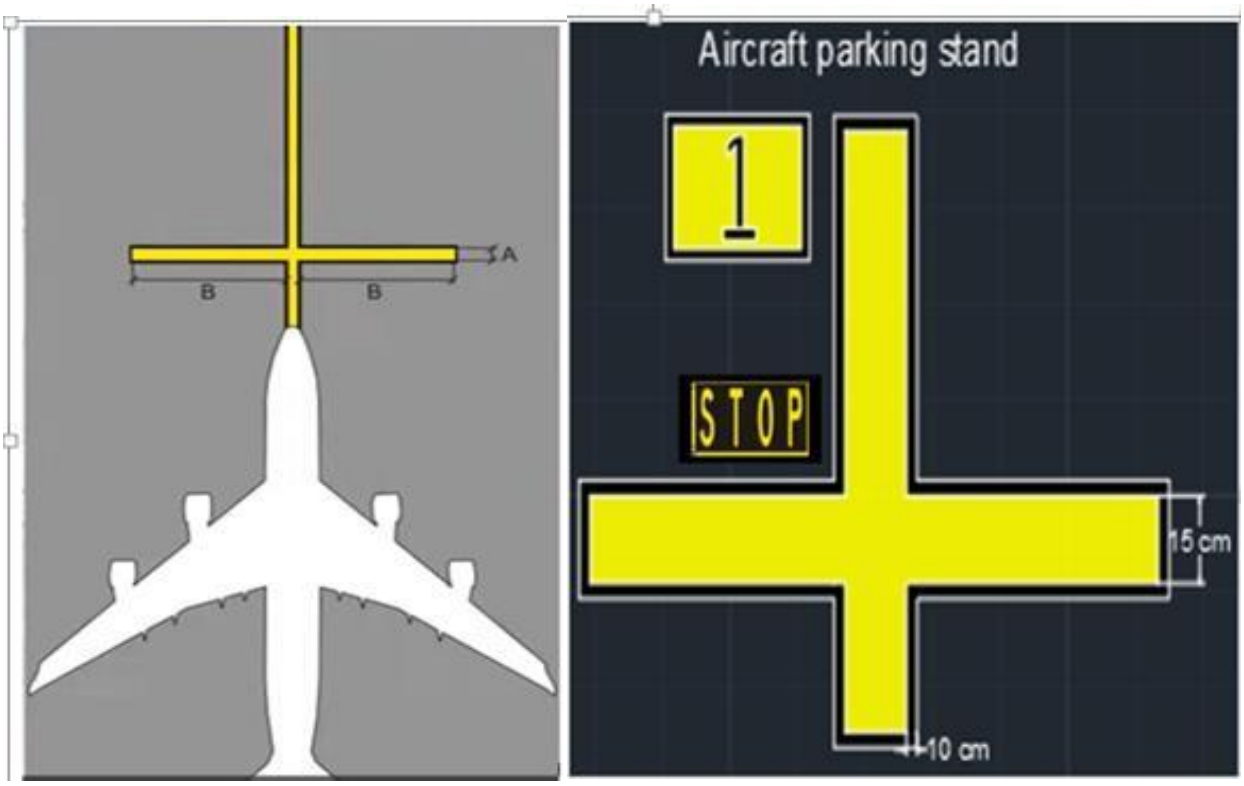

Figure – 9 aircraft stand markings and dimensions

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6. Vehicle and equipment parking/clearance/staging area

Vehicle and equipment parking/clearance/staging area is a confined area where vehicles and equipment can be staged for serving the departing or arriving aircraft. Equipment or vehicle shall remain within the equipment clearance/staging area until all engine has been shut down and the anti-collision lights have been switched off, vehicles/equipment then cross the line to service the aircraft.

This line is marked with the aircraft parking position that it is protecting. Drivers must remain behind this line when aircraft are taxing to parking stand and departing from the stand. This line is strictly prohibited for pre-staging of equipment/vehicle if left unattended meaning the equipment/vehicle must not left unattended at any time.

This marking is used to delineate the area within which vehicles and equipment can park freely without infringing any stand areas or taxiways.

Vehicle and equipment parking area/staging area/clearance area/vehicle stop line

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Color	Line	Borderline
	Red	White
Dimension	A	B
	15cm	10cm

Figure – 10 **Vehicle and equipment staging area marking**

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7. Airside road/service road

Airside road/service roads are provided to for movement of ground vehicles and equipment for serving the aircraft on the apron. The road or lane may be provided at the front, rear or side of the apron with markings and signs restricting the speed.

The types of service road at the apron are provided below:

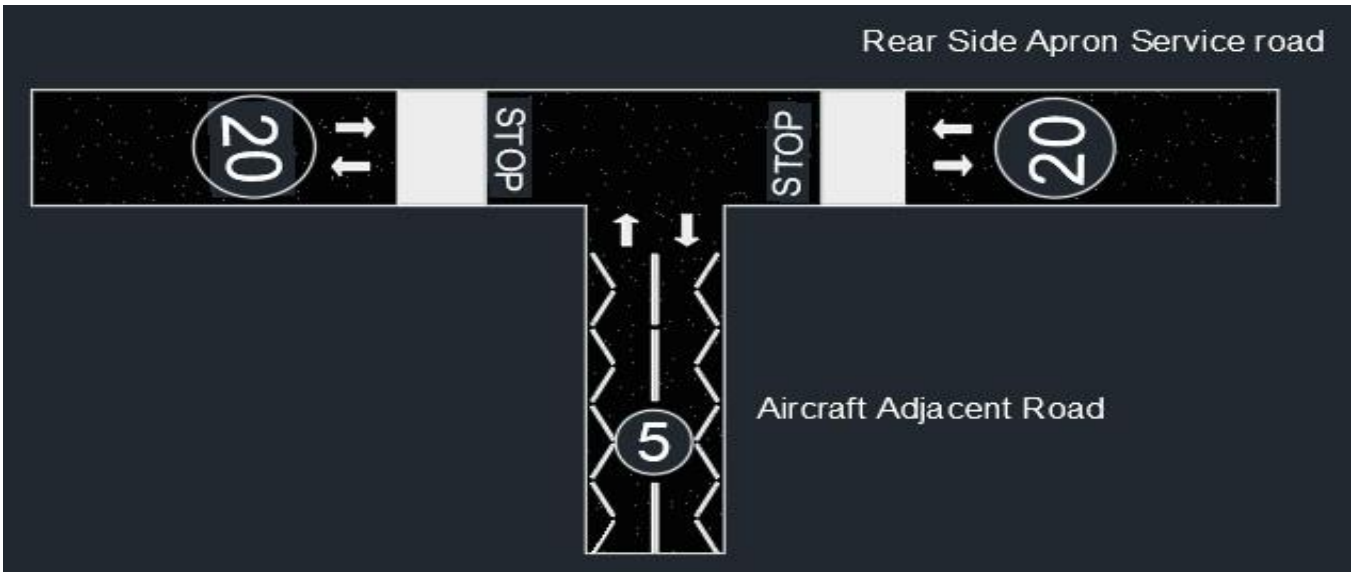

Figure – 11 Airside road/service road

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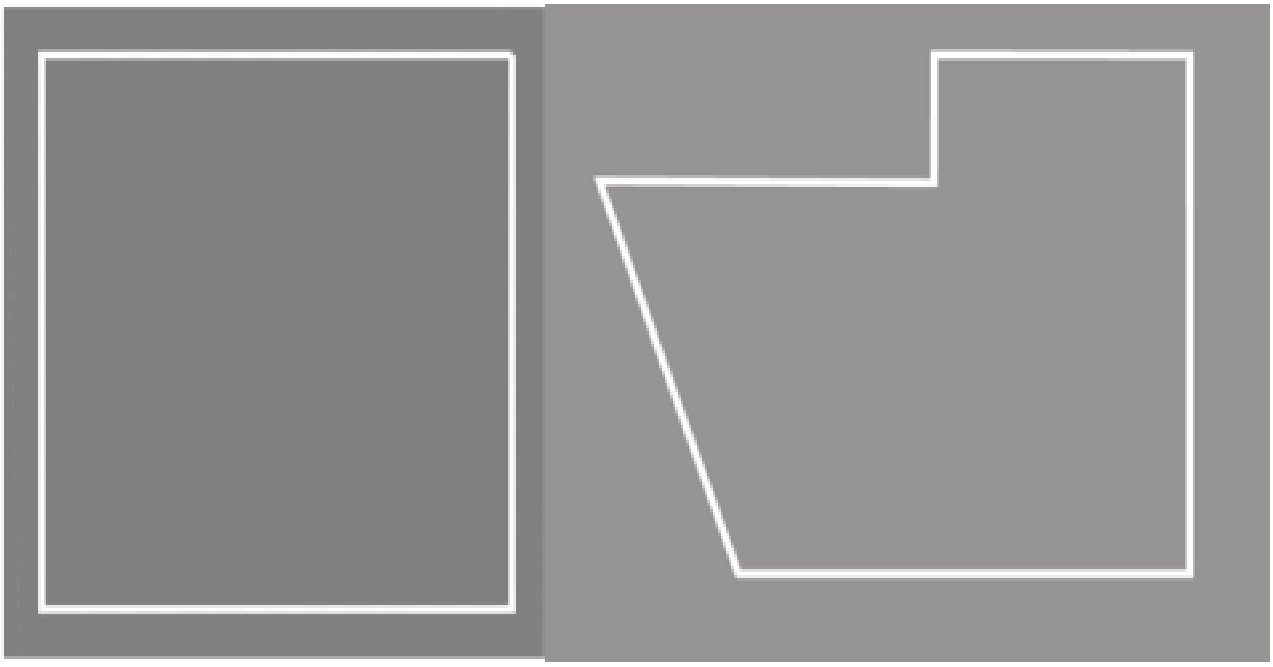
8. Vehicle and equipment parking area

The vehicle/equipment parking line is used to delineate limits of areas which are intended for parking of vehicles and aircraft servicing equipment where they are not in used.

The vehicle/equipment shall not block entrance to the terminal building and apron service roads nor restrict access to fire hydrants.

The shape and size of vehicle and equipment parking area marking may not be restricted to square or rectangle only. It has to suit the available space for the vehicle and parking area.



Dimension A – 10 cm, line colour – white

Figure - 12 - Example of equipment parking area marking line

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9. Tow tug area

The clear area in front of the aircraft parking is for aircraft tractor/tow truck only and vehicles must not block this area.

This line marking is for the use of a tractor (tug) driver when pushing back an aircraft from a stand.

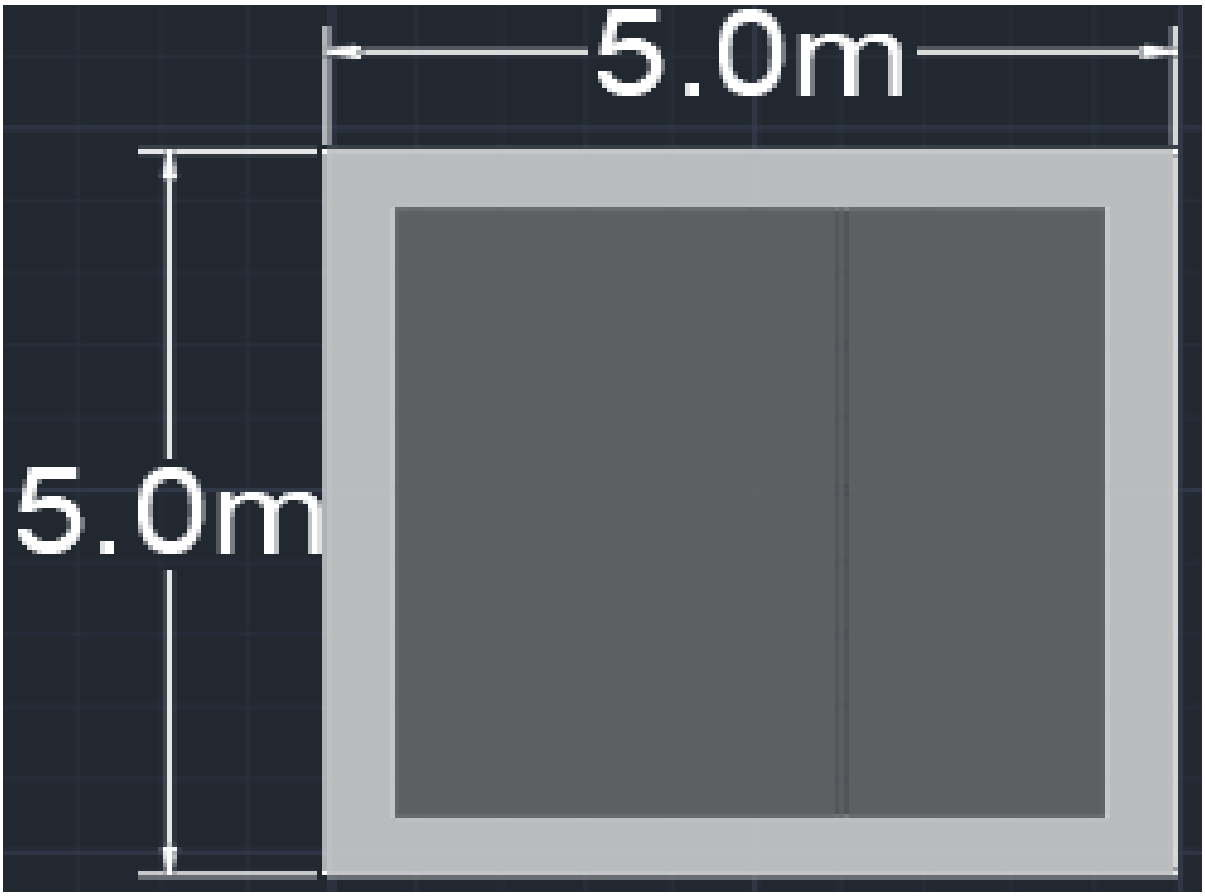

Figure - 12 - tow tug area marking and dimension

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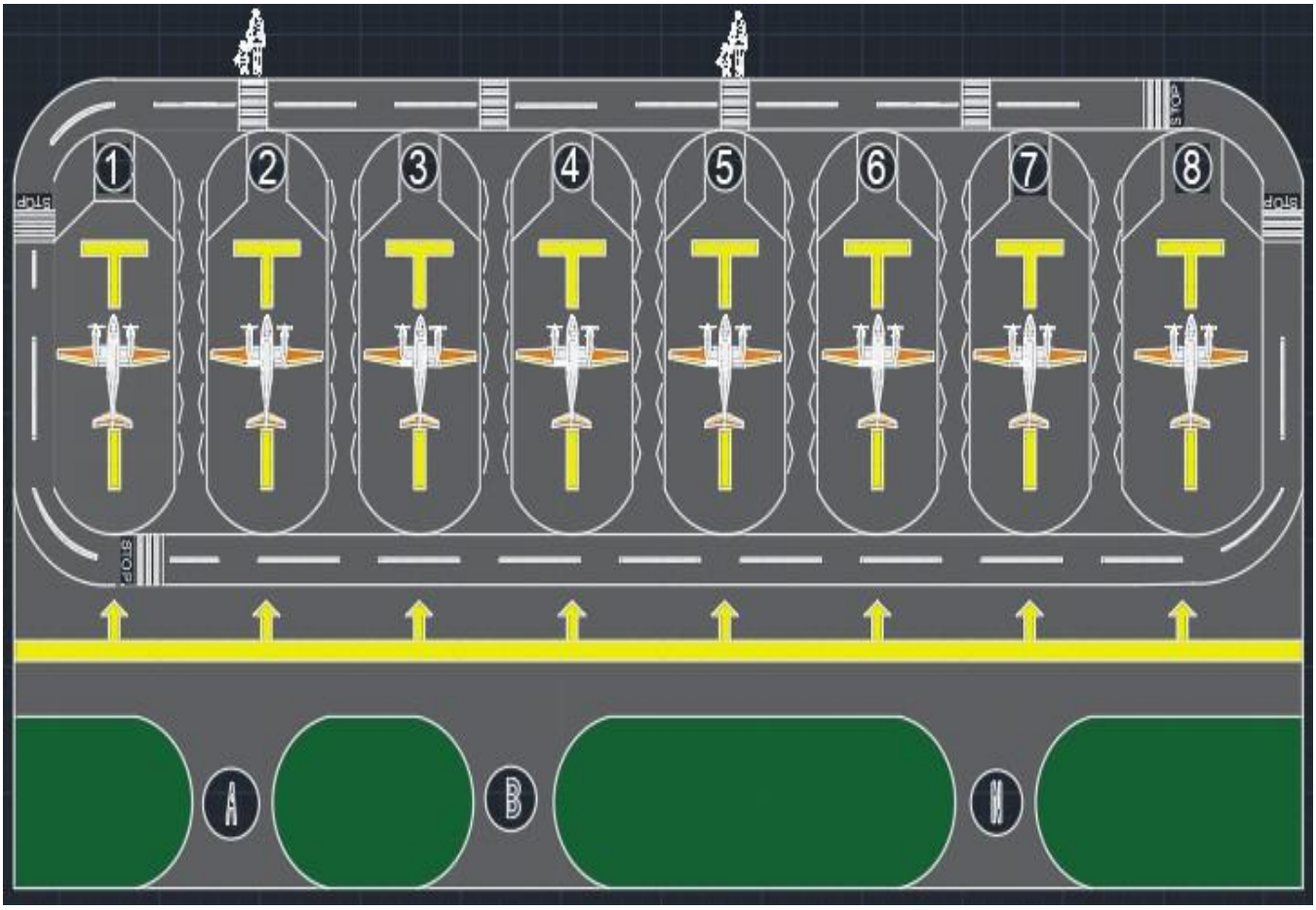
10. Apron layout plan



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11. Marking paint solution proportion and pavement surface preparation

- **Preparation and application**

- Water quantity - 5% of the quantity/volume of the container and stir thoroughly before use.
- Surfaces must be clean, dry, free from oil, grease, lichen, etc and any loose, flaky material Can be applied directly to bare, unprimed or unsealed surfaces.
- Recommended application method is by spraying – either airless or conventional.
- The paint layer should be thick

12. Line marking machine

RS-5E series cold paint line striper (pavement marking machine) is special designed for efficient marking. Stable internal reversing hydraulic pump, adjustable spray gun and paint filter ensure the marking performance. RS-5E road line marking machine has a long service life due to simple structure, reliable pump and engine.

RS-5E line striper is widely used in parking lots, road striping, air ports, city streets, bike paths and intersections.

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W-TPD Driving Thermoplastic Road Marking Equipment

W-TPD is a small driving type thermoplastic road marking equipment. It has compact structure, simple operation and high construction efficiency, so it is widely used in medium or large highway line marking and continuous urban thermoplastic paint marking projects. Just need to replace different road marking shoes, you can stripe ordinary thermoplastic paint flat line markings, or vibration line markings. Just do some simple settings on computer controller, you can set different length of road marking lines & spacing, then can mark long solid lines and skip lines.
