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The Civil Aviation Authority of Thailand

Guidance Material for Global Reporting Format

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0. Introduction

0.1 Background

A statistical analysis of high-risk accidents from 2008 to 2016 has shown that runway safety-related accidents, notably runway excursions, remain aviation's number one safety risk category. The top contributing factors included poor braking action due to contaminated runways or taxiways combined with shortfalls in the accuracy and timeliness of runway surface conditions. In 2017, ICAO's Global Runway Safety Action Plan called for the widespread deployment of the ICAO format for assessing and reporting runway surface conditions as an effective mitigation.

This new methodology, commonly known as the Global Reporting Format (GRF), has its origins in the FAA's Take-off and Landing Performance Assessment (TALPA), will become applicable in 4 November 2021. The GRF targets the standardized reporting of runway surface conditions on wet and contaminated runways, the impact of which is then directly correlated with an aircraft's performance, enabling a better flight crew prediction of their take-off and landing performance as well as an improved situation awareness.

Although the ability to link the output of a measuring device (such as the Mu-meter) to actual aircraft performance has long been an aspiration, there is currently no universally accepted relationship. Therefore, to avoid any misunderstanding, the GRF is based upon human observation and standardized reporting.

The methodology, intended to cover conditions found in all climates, provides a means for aerodrome operators to rapidly and correctly assess runway surface conditions, whether they are exposed to wet runway conditions, snow, slush, ice or frost. It comprises the evaluation of a runway and the assignment of a Runway Condition Code (RWYCC) ranging from 0 for a very slippery surface to 6 for a dry surface. This code is complemented by a description of the surface contaminant, based upon its type, depth and coverage, for each third of the runway.

This information is then used to complete a standard report called the Runway Condition Report (RCR) which is forwarded to air traffic services for dissemination to the flight crew. If needed, the RCR will also be disseminated to users through a SNOWTAM.

The RCR is used by flight crew to make a correlation between the reported surface conditions and their aircraft's performance, based upon data provided by manufacturers. This correlation is made using another important element of the GRF methodology, the Runway Condition Assessment Matrix (RCAM).

The RCR encompasses important information that may be required by flight crew throughout their flight, in particular when there are rapidly changing weather conditions (i.e. winter or tropical) when timely decisions may be required. As a consequence, the aerodrome is expected to closely monitor runway conditions and be ready to issue a new RCR whenever a significant change occurs.

Another important element of the GRF is a process that enables a pilot to provide ATC, aerodrome personnel and other pilots with their own observation confirming the assessment or providing an alert of deteriorating (or improving) conditions based upon their experience of actual braking action or lateral control. A corresponding mechanism for the airport operator to downgrade (or upgrade) the RWYCC on the basis of such reports has been incorporated in the GRF.

0.2 Purpose

This Guidance Material (GM) provides guidance for the operation of Thailand registered aircraft operating worldwide using the Global Reporting Format (GRF) to enable pilot providing important information to ATC, aerodrome personnel and other pilots regarding the issuance of Runway Condition Code (RWYCC) and the Runway Condition Report (RCR).

0.3 Applicability

The provision of this guidance material applies to all Thailand operators when operating in designated airspace or aerodrome promulgated in the particular State's AIP. It should be noted that beyond the Thailand FIR, operators shall comply with the Thailand Civil Aviation Regulations and other foreign State's regulations, whichever is more restrictive.

0.4 Effective Date

23-Jul-2021

0.5 Reference

There are some associated documents in the provision of this guidance material, as listed below:

Document Reference No.	Name of Document
Doc 10064	Aeroplane Performance Manual
Cir 355	Assessment, Measurement and Reporting of Runway Surface Conditions

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1. Definitions, Acronyms and Abbreviations

1.1 Definitions

Term	*Definition*
Accelerate-stop distance available (ASDA)	The length of the take-off run available plus the length of the stopway, if provided. Note: Where the minimum recommended length of runway end safety areas is achieved by application of Annex 14 - Aerodromes, Volume I - Aerodrome Design and Operations, Attachment A, Section 9.2, the ASDA may be shorter than the take-off run available.
Aeroplane	An airplane is a specific type of aircraft that has fixed wings and is heavier than air that is capable of sustained, powered, and controlled flight.
Air-report	A report from an aircraft in flight prepared in conformity with requirements for position, and operational and/or meteorological reporting.
Aircraft	An aircraft is any machine that can fly. Airplanes, hot air balloons, helicopters, or even flying platforms are considered aircraft.
Airworthiness Standards	Detailed and comprehensive design and safety criteria applicable to the category of the aeronautical product (aircraft, engine and propeller) that satisfy, at a minimum, the applicable Standards of Annex 8 - Airworthiness of Aircraft.
Braking action	A term used by pilots to characterize the deceleration associated with the wheel braking effort and directional controllability of the aircraft.

Term	*Definition*
Coefficient of friction	A dimensionless ratio of the friction force between two bodies to the normal force pressing these two bodies together.
Contaminant	A deposit (such as snow, slush, ice, standing water, mud, dust, sand, oil and rubber) on an aerodrome pavement, the effect of which is detrimental to the friction characteristics of the pavement surface.
Contaminated runway	A runway is contaminated when a significant portion of the runway surface area (whether in isolated areas or not) within the length and width being used is covered by one or more of the substances listed in the runway surface condition descriptors. Note: Further information on runway surface condition descriptors can be found in the Annex 14, Volume I Definitions.
Critical tire-to-ground contact area	An area (approximately 4 square meters for the largest aircraft currently in service) which is subject to forces that drive the rolling and braking characteristics of the aircraft, as well as directional control.
Friction	A resistive force along the line of relative motion between two surfaces in contact.
Friction characteristics	The physical, functional and operational features or attributes of friction arising from a dynamic system.
Grooved or porous friction course runway	A paved runway that has been constructed and maintained with lateral grooving or a porous friction course (PFC) surface to improve braking characteristics when wet in compliance with the Aerodrome Design Manual (Doc 9157) or equivalent.
Landing distance available (LDA)	The length of runway which is declared available and suitable for the ground run of an aeroplane landing.

Term	*Definition*
Runway condition assessment matrix (RCAM)	A matrix allowing the assessment of the runway condition code, using associated procedures, from a set of observed runway surface condition(s) and pilot report of braking action.
Runway condition code (RWYCC)	A number describing the runway surface condition to be used in the runway condition report. Note: The purpose of the runway condition code is to permit an operational aeroplane performance calculation by the flight crew. Procedures for the determination of the runway condition code are described in the PANS-Aerodromes (Doc 9981).
Runway condition report (RCR)	A comprehensive standardized report relating to runway surface conditions and its effect on the aeroplane landing and take-off performance.
Runway surface condition(s)	A description of the condition(s) of the runway surface used in the runway condition report which establishes the basis for the determination of the runway condition code for aeroplane performance purposes. Note 1: The runway surface conditions used in the runway condition report establish the performance requirements between the aerodrome operator, aeroplane manufacturer and aeroplane operator. Note 2: Aircraft de-icing chemicals and other contaminants are also reported but are not included in the list of runway surface condition descriptors because their effect on runway surface friction characteristics and the runway condition code cannot be evaluated in a standardized manner. Note 3: Procedures on determining runway surface conditions are available in the PANS-Aerodromes (Doc 9981).

Term	*Definition*
Skid resistant	A runway surface that is designed, constructed and maintained to have good water drainage, which minimizes the risk of hydroplaning when the runway is wet and provides aircraft braking performance shown to be better than that used in the airworthiness standards for a wet, smooth runway.
SNOWTAM	A special series NOTAM given in a standard format providing a surface condition report notifying the presence or cessation of hazardous conditions due to snow, ice, slush, frost, standing water or water associated with snow, slush, ice or frost on the movement area.
Take-off distance available (TODA)	The length of the take-off run available plus the length of the clearway, if provided.
Take-off run available (TORA)	The length of runway declared available and suitable for the ground run of an aeroplane taking off.
Take-off surface	That part of the surface of an aerodrome which the aerodrome authority has declared available for the normal ground or water run of aircraft taking off in a particular direction.

1.2 Acronyms and Abbreviations

Acronyms / Abbreviations	*Meaning*
AFM	Aeroplane flight manual
AIC	Aeronautical information circular
AIM	Aeronautical information management
AIP	Aeronautical information publication
AIREP	Air-report
AIS	Aeronautical information services
AMC	Acceptable means of compliance
ARC	Aviation Rulemaking Committee (FAA)
ASDA	Accelerate-stop distance available
ASR	Air safety report
ATC	Air traffic control
ATIS	Automatic terminal information service
ATS	Air traffic service
CDL	Configuration deviation list
CS	Certification specifications (EASA)
EASA	European Aviation Safety Agency
EFB	Electronic flight bag
FAA	Federal Aviation Administration (United States)
FTF	Friction Task Force
HF	High frequency
ICAO	International Civil Aviation Organization
ISA	International standard atmosphere

Acronyms / Abbreviations	*Meaning*
LDA	Landing distance available
LDF	Landing distance Factor
LDTA	Landing distance at time of arrival
MEL	Minimum equipment list
MET	Meteorological services
NOTAM	Notice to airmen
OAT	Outside air temperature
PANS	Procedures for Air Navigation Services
PFC	Porous friction course
RCAM	Runway condition assessment matrix
RCR	Runway condition report
RESA	Runway end safety area
RWYCC	Runway condition code
SARPS	Standards and Recommended Practices
SLA	Service level agreement
SMS	Safety management system
SOP	Standard operating procedure
TALPA	Take-off and Landing Performance Assessment
TC	Type certificate
TODA	Take-off distance available
TORA	Take-off run available
TWY	Taxiway
VHF	Very high frequency

Acronyms / Abbreviations	*Meaning*
WMO	World Meteorological Organization
μ	Mu (coefficient of friction)
μ_{max}	Maximum friction coefficient as experienced by an aircraft

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2. Assessment and Reporting of Runway Surface Condition

2.1 Background Information and Conceptual Understanding for Implementation

Aeroplane performance can be considered to be impacted whenever the coverage of any water-based contaminant on any runway third exceeds 25 percent. The intent of the assessment and reporting procedures is to communicate the runway surface conditions impacted by any remaining contamination to the aeroplane operators in a way consistent with the effect on aeroplane performance.

The intent of the RCR is to put into place a common language between all system actors that is based on the impact of runway surface conditions on aeroplane performance. It is therefore necessary that all members of the information chain, from data origin to end users, have been given proper training.

It is important for aerodrome personnel to make the best attempt to accurately report runway surface conditions, rather than seek a systematically conservative assessment. Conservatism is recommended in the judgement of observations versus criteria such as 3 mm depth or 25 percent coverage, but not for the RWYCC. “Conservatism” is different from “downgrade” motivated by other observations or local knowledge. Flight crews are asked to evaluate the worst runway surface conditions that are acceptable for the intended operation. This is an additional safeguard against lack of conservatism.

Aircraft manufacturers have determined that variances in contaminant type, depth and air temperature cause specific changes in aircraft braking performance. As a result, it has been possible to take the aircraft manufacturers’ data for specific contaminants and produce the RCAM for use by aerodrome operators.

2.2 Operational Needs for Reporting

The flight crew needs information relevant for the safe operation of the aircraft, as far as it is relevant to the conditions of the runway surface, obtained through the use of NOTAMs (slippery wet runway) and the RCR.

The introduction of the RCR based on the RCAM and RWYCC, in conjunction with new or existing performance data, establishes a clear link between the observation, reporting and accounting of runway surface conditions in performance. It also creates new paths to errors, of which it is important to be aware.

It is the task of the aerodrome personnel assessing and reporting runway surface conditions to determine the RWYCCs that appropriately reflect the conditions on the runway and that are to be used for the performance check at the time of arrival. It is important that the aerodrome personnel understand the operational use of the RWYCC by the flight crew in order to assess and report it properly.

Proper assessment and reporting is ensured by an RWYCC that is reported in line with the classification shown in the RCAM in PANS-Aerodromes (Doc 9981), Part II, Chapter 1, and its downgrading or upgrading in accordance with the procedures in the said chapter. These procedures require that aerodrome personnel use all other observations available to them to downgrade or upgrade the RWYCC to an RWYCC that is different from that which is usually associated with a contaminant and depth.

Through the upgrading procedures, RWYCC 1 or 0 can be upgraded to no higher than RWYCC 3.

For RWYCC 0 assessed by aerodrome personnel or a pilot report of runway braking action reported as LESS THAN POOR by a flight crew, the suspension of operations on that runway shall be considered until corrective action has been taken to improve the runway surface conditions and an RWYCC between 1 and 3 can be reported appropriately. In case of complete removal of a contaminant, the remedial action may result in higher RWYCCs being reported.

The RCR continues to include information on contaminant types and depth for determining performance limitations at time of take-off. Take-off performance data are provided for each type of winter contaminant and the operable range of depths of loose contaminants. The RWYCC alone does not permit a conservative description of the effect of the runway surface condition on aeroplane take-off performance.

The RCR contains all the necessary information for the determination of the relevant runway condition for the performance assessment by the flight crew. This information is required at several stages of the flight, in particular in dynamic winter event conditions. The flight crew may need updates throughout the flight.

The operational need for the information can be categorized as:

a) relevant for aeroplane performance;

b) relevant for situational awareness; and

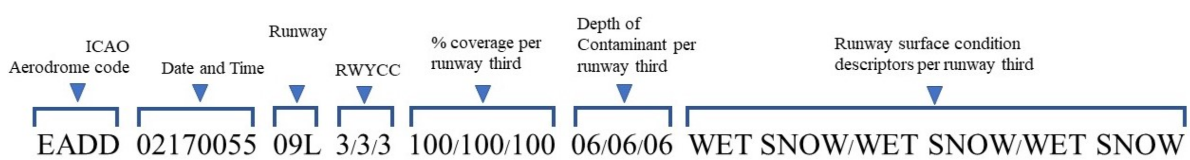
c) relevant if there has been any significant change.

Note: The need for information on any significant changes coincides with the trigger for generating new information in the RCR.

2.2.1 Aircraft Performance Calculation

The "performance calculation" section contains information that is directly relevant in performance computation. This section is a string of grouped information with clear identifiers to distinguish it from the situation awareness section or from the aircraft performance calculation section of anther runway.

Example of Runway Condition Report (RCR) "Aircraft Performance Calculation" section



2.2.2 Situation Awareness

The situation awareness section contains information that the flight crew should be aware of for a safe operation, with on direct impact on the performance assessment. This section provides guidance on how flight crews should take situation awareness information into consideration in briefing and actual flight operations in cold weather conditions.

Example of runway condition report (RCR) "situation awareness" section

'RWY 09L LDA REDUCED TO 1450. SNOWBANK R20 FM CL. RWY 09R ADJ SNOWBANKS.

TWY B POOR. APRON NORTH POOR'

2.3 The Define Concept

The definitions of the terms listed in this section define the fundamental, conceptual part of the report and assessment of the runway surface conditions methodology.

There are five fundamental elements:

2.3.1 Runway Condition Report (RCR).

The Runway Condition Report (RCR) is a comprehensive, standardized report relating to runway surface conditions and its effect on the aircraft landing and takeoff performance. The Runway Condition Report (RCR) contains the elements that are published in SNOWTAM, in a standard format providing a surface condition report notifying the presence or cessation of hazardous conditions due to snow, ice, slush frost, standing water or water associated with snow, slush, ice, or frost on the movement area.

2.3.2 Runway Condition Code (RWYCC)

A Runway Condition Code (RWYCC) is a number that describes the runway surface conditions to be used in the Runway Condition Report (RCR).

a) The purpose of Runway Condition Code (RWYCC) is to permit an operational aircraft performance calculation by the flight crew. Procedures for the determination of the Runway Condition Code (RWYCC) are described in the PANS-Aerodrome, Doc 9981.

b) As per the International Civil Aviation Organization (ICAO) SNOWTAM format, the Runway Condition Code (RWYCC) should be understood as the total assessment of slipperiness of the surface as judged by trained and competent aerodrome personnel based upon given procedures and available information.

c) The introduction of the Runway Condition Code (RWYCC) is the fundamental change introduced through the new reporting system. It has been developed in alliance with major aircraft manufacturers involved in aircraft performance.

2.3.3 Runway Condition Assessment Matrix (RCAM)

The Runway Condition Assessment Matrix (RCAM) is a matrix that allows the assessment of the Runway Condition Code (RWYCC). It uses associated procedures from a set of observed runway surface conditions and the pilot report, when appropriate on braking action.

2.3.4 Runway Surface Conditions

It describes the runway surface condition(s) used in the Runway Condition Report (RCR), which establishes the basis for the determination of the Runway Condition Code (RWYCC) for aircraft performance purposes. The four runway surface conditions are: Dry runway, Wet runway, Slippery runway and Contaminated runway.

a) ***Dry runway:*** A runway is considered dry if its surface is free of visible moisture and not contaminated within the area intended to be used.

b) ***Wet runway:*** The runway surface is covered by any visible dampness or water up to and including 3 mm deep within the intended area of use.

c) ***Slippery wet runway:*** A wet runway where the surface friction characteristics of a significant portion of the runway have been determined to be degraded.

d) ***Contaminated runway:*** A runway is contaminated when a significant portion of the runway surface area (whether in isolated areas or not) within the length and width being used is covered by one or more of the substances listed in the runway surface condition descriptors.

Note: Procedures on determination of contaminant coverage on runway is available in the PANS-Aerodromes (Doc 9981).

Note: Due to the challenges of reporting fluctuations between damp and wet runway conditions in a timely manner, any water film up to 3 mm in depth is reported as wet for the purposes of performance calculation.

2.3.5 Contaminated Runway Surface Condition Descriptors

There are eight contaminated runway surface condition descriptors:

a) ***Compacted snow:*** Snow that has been compacted into a solid mass such that aeroplane tires, at operating pressures and loadings, will run on the surface without significant further compaction or rutting of the surface;

b) ***Dry snow:*** Snow from which a snowball cannot readily be made;

c) ***Frost:*** Frost consists of ice crystals formed from airborne moisture on a surface whose temperature is below freezing. Frost differs from ice in that the frost crystals grow independently and therefore have a more granular texture;

Note 1: Below freezing refers to air temperature equal to or less than the freezing point of water (0 degree Celsius).

Note 2: Under certain conditions frost can cause the surface to become very slippery and it is then reported appropriately as reduced braking action.

d) ***Ice:*** Water that has frozen or compacted snow that has transitioned into ice, in cold and dry conditions;

e) ***Slush:*** Snow that is so water-saturated that water will drain from it when a handful is picked up or will splatter if stepped on forcefully;

f) ***Standing water:*** Water of depth greater than 3 mm;

Note: Running water of depth greater than 3 mm is reported as standing water by convention

g) ***Wet ice:*** Ice with water on top of it or ice that is melting;

Note: Freezing precipitation can lead to runway conditions associated with wet ice from an aeroplane performance point of view. Wet ice can cause the surface to become very slippery. It is then reported appropriately as reduced braking action in line with procedures in the PANS-Aerodromes (Doc 9981);

h) ***Wet snow:*** Snow that contains enough water content to be able to make a well-compacted, solid snowball, but water will not squeeze out.

Note: The descriptions above are used solely in the context of the runway condition report and are not intended to supersede or replace any existing WMO definitions.

2.4 Runway Condition Assessment Matrix (RCAM) Table

2.4.1 Central to this concept is the RCAM, shown in Table 2.1

Table 2.1. Runway Condition Assessment Matrix (RCAM)

(Source: PANS-Aerodromes (Doc 9981)

RUNWAY CONDITION ASSESSMENT MATRIX (RCAM)			
Assessment criteria		**Downgrade assessment criteria**	
Runway condition code	**Runway surface description**	**Aeroplane deceleration or directional control observation**	**Pilot report of runway braking action**
6	• DRY	---	---
5	• FROST •WET (The runway surface is covered by any visible dampness or water up to and including 3 mm depth) ***Up to and including 3 mm depth:*** • SLUSH • DRY SNOW • WET SNOW	Braking deceleration is normal for the wheel braking effort applied AND directional control is normal.	GOOD
4	***-15ºC and lower outside air temperature*:** • COMPACTED SNOW	Braking deceleration OR directional control is between Good and Medium.	GOOD TO MEDIUM
3	• WET ("slippery wet" runway) • DRY SNOW or WET SNOW (any depth) ON TOP OF COMPACTED SNOW ***More than 3 mm depth:*** • DRY SNOW • WET SNOW ***Higher than -15ºC outside air temperature***[1]: • COMPACTED SNOW	Braking deceleration is noticeably reduced for the wheel braking effort applied OR directional control is noticeably reduced.	MEDIUM
2	***More than 3 mm depth of water or slush:*** • STANDING WATER • SLUSH	Braking deceleration OR directional control is between Medium and Poor.	MEDIUM TO POOR
1	• ICE [2]	Braking deceleration is significantly reduced for the wheel braking effort applied OR directional control is significantly reduced.	POOR
0	• WET ICE [2] • WATER ON TOP OF COMPACTED SNOW [2] • DRY SNOW or WET SNOW ON TOP OF ICE [2]	Braking deceleration is minimal to non-existent for the wheel braking effort applied OR directional control is uncertain.	LESS THAN POOR

[1] Runway surface temperature should preferably be used where available.

[2] The aerodrome operator may assign a higher RWYCC (but no higher than code 3) for each third of the runway, provided the procedure in PANS-Aerodromes, Doc 9981, 1.1.3.15 is followed.

The RCAM is not a standalone document and cannot be dissociated from the procedures outlined in PANS-Aerodromes (Doc 9981).

Visually inspecting the movement area to assess the surface condition is the core method for determining an RWYCC. An overall assessment, however, implies more than that. Continuously monitoring the development of the situation and prevailing weather condition is essential to ensuring safe flight operations. Other information that might influence the assessment result includes the outside air temperature (OAT), surface temperature, dew point, wind speed and direction, control and deceleration of the inspection vehicle, pilot reports of runway braking action, friction readings (continuous friction measuring device or decelerometer), weather forecast, etc. Due to the interaction between such factors, it is not possible to define a precise deterministic method for determining how they affect the RWYCC to be reported.

The RCAM supports the classification of runway surface conditions according to their effect on aeroplane braking performance using a set of criteria identified and quantified based on the best industry knowledge, built on dedicated flight testing and in-service experience. The agreed thresholds at which a criterion changes the classification of a surface condition are intended to be reasonably conservative, without being excessively pessimistic.

It is important for aerodrome personnel to monitor and accurately report when the following conditions close to the thresholds value.

a) ***Percentage of coverage of contamination in each runway third:*** A runway is considered to be contaminated when the extent of the coverage is more than a quarter of the surface of at least one third of the runway. It is important to note that, whenever coverage is assessed to be below the 25 percent threshold in each third, the calculation assumption made by flight crew will be a dry runway (uniformly bare of moisture, water and contamination). It has been demonstrated that in conditions of contamination just below the reporting threshold but concentrated in the most unfavorable location, this assumption of dry runway still provides positive stop margins.

b) ***Type of contaminant:*** Different contaminants affect the contact area between the tire and runway surface, where the stopping force is generated, in different ways. A water film of any depth leads to the partial separation (viscous aquaplaning) or total separation (dynamic aquaplaning) of the tire from the surface. The smaller the surface, the smaller the force of adhesion, and the less braking is available. This is why the maximum braking force decreases at higher speed and depends on contaminant depth. Other fluid contaminants have a similar effect. Hard contaminants such as ice or compacted snow prevent contact between the tire and runway surface completely and at any speed, effectively providing a new surface that the tire rolls on. A deterministic classification of the stopping performance can be made only for the contaminants listed in the RCAM. For other reportable contaminants (oil, mud, ash, etc.), there is a large variance in the aeroplane performance effect, or insufficient data are available to permit a deterministic classification. An exception is rubber contamination, for which in-service data indicate that an assumption of RWYCC 3 restores usual performance margins. Runway surface treatments with sand, grit or chemicals may be very effective or detrimental depending on the conditions of the application, and no credit can be attributed to such treatment without verification and validation.

c) ***Depth of the contamination:*** The industry accepts that the threshold for the effect of depth of fluid contaminants on aeroplane performance is 3 mm. Below this threshold, any type of fluid contaminant can be removed from the tire/runway contact zone either by forced drainage or by compressing the contaminant into the macrotexture of the surface, thus allowing adhesion between tire and surface, albeit on less than the full footprint surface area. This is why contamination depths of up to 3 mm are expected to provide similar stopping performance as a wet runway. The physical effects causing reduced friction forces begin to take effect from very small film thickness, which is why damp conditions are considered to provide no better braking action than a wet runway. It is important for aerodrome personnel to be aware of the fact that the capability to generate friction in wet conditions (or with thin layers of fluid contaminants) highly depends on the inherent qualities of the runway surface (friction characteristics) and may be less than normally expected on poorly drained, polished or rubber-contaminated surfaces. Above the 3 mm threshold, the impact on friction forces is more significant, leading to classification in lower RWYCCs. Above this depth, and depending on the density of the fluid, additional drag effects start to apply due to displacement or compression of the fluid and impingement on the airframe of the aeroplane. These latter effects depend on the depth of the fluid and affect the aeroplane's ability to accelerate for take-off. It is thus important to report depths with the precision required.

d) Surface or air temperature: Significant changes in surface conditions can occur very quickly close to the freezing point. Surface temperature is more significant for the relevant physical effects, and surface and air temperature may be significantly different due to latency and radiation. However, surface temperature may not be readily available, and it is acceptable to use air temperature as a criterion for the contaminant classification. The threshold for the classification of compacted snow in RWYCC 4 (below OAT -15°C) or RWYCC 3 (above this temperature) may be very conservative. It is recommended that the classification be supported by other assessment means. Such assessment means must be based on a specific rationale, specific procedures and substantiating aeroplane data, and reviewed and approved by the appropriate authority in order for the RCAM to be changed.

2.5 Downgrading and Upgrading the RWYCC

The RCAM enables aerodrome personnel to make an initial assessment based on visual observation of contaminants on the runway surface, specifically the contaminant type, depth and coverage, as well as the OAT. Downgrading and upgrading is an integral part of the assessment process and is essential to making relevant reports of the prevailing runway surface conditions. When all other observations, experience and local knowledge indicate to trained aerodrome personnel that the primary assignment of the RWYCC does not accurately reflect the prevailing conditions, a downgrade or upgrade can be made.

Aspects to be considered when assessing the runway's slipperiness for a downgrade include:

a) prevailing weather conditions:

   i. stable below freezing temperature;

   i. dynamic conditions;

   ii. active precipitation.

b) observations (information and source);

c) measurements:

   i. friction measurements;

   ii. vehicle behaviour;

   iii. shoe scraping;

d) experience (local knowledge); and

e) AIREPs.

If the contaminants cannot be completely removed and the initially assigned RWYCC does not reflect the real runway surface conditions (such as a treated ice-covered or compacted snow-covered runway), the aerodrome personnel may apply upgrade procedures. Upgrading is applicable only when the initial RWYCC is 0 or 1 and is not permitted to go beyond RWYCC 3. Upgrading is conditioned on meeting the standard set or agreed by the State and is supported by all other aspects, as described in paragraph above.

When friction measurements are used as part of the overall runway surface assessment of a compacted snow- or ice-covered surface, the friction measuring device meets the standard set or agreed by the State. Table 2.2 gives information on each reportable runway surface description and whether the friction measuring device can be used for downgrading and upgrading.

<table>
<tr><th>Runway surface description (reportable)</th><th>Criterion</th><th>RWYCC</th><th>Downgrading using a friction measuring device</th><th>Upgrading using a friction measuring device</th></tr>
<tr><td>DRY</td><td></td><td>6</td><td rowspan="6">N/A</td><td rowspan="15">N/A</td></tr>
<tr><td>FROST</td><td></td><td rowspan="5">5</td></tr>
<tr><td>WET</td><td>The runway surface is covered by any visible dampness or water up to and including 3 mm depth</td></tr>
<tr><td>SLUSH</td><td rowspan="3">Up to and including 3 mm depth</td></tr>
<tr><td>DRY SNOW</td></tr>
<tr><td>WET SNOW</td></tr>
<tr><td>COMPACTED SNOW</td><td>-15°C and lower OAT</td><td>4</td><td>Standard set or agreed by the State</td></tr>
<tr><td>WET</td><td>“Slippery wet” runway</td><td rowspan="6">3</td><td rowspan="5">N/A</td></tr>
<tr><td>WET SNOW ON TOP OF COMPACTED SNOW</td><td></td></tr>
<tr><td>DRY SNOW ON TOP OF COMPACTED SNOW</td><td></td></tr>
<tr><td>DRY SNOW</td><td rowspan="2">More than 3 mm depth</td></tr>
<tr><td>WET SNOW</td></tr>
<tr><td>COMPACTED SNOW</td><td>Higher than -15°C OAT</td><td>Standard set or agreed by the State</td></tr>
<tr><td>SYANDING WATER</td><td></td><td rowspan="2">2</td><td rowspan="2">N/A</td></tr>
<tr><td>SLUSH</td><td></td></tr>
<tr><td>ICE</td><td></td><td>1</td><td>Standard set or agreed by the State</td><td>Standard set or agreed by the State</td></tr>
<tr><td>WET ICE</td><td></td><td rowspan="4">0</td><td rowspan="4">N/A</td><td rowspan="4">N/A</td></tr>
<tr><td>WATER ON TOP OF COMPACTED SNOW</td><td></td></tr>
<tr><td>DRY SNOW ON TOP OF ICE</td><td></td></tr>
<tr><td>WET SNOW ON TOP OF ICE</td><td></td></tr>
</table>

Table 2.2 Downgrading or upgrading using a friction measuring device

When a friction measuring device is used for upgrading purposes, a preponderance of evidence needs to exist. To upgrade an RWYCC 0 or 1 to RWYCC 3 or less, the friction measuring device has to demonstrate an equivalent friction to that of a wet runway (RWYCC 5) or higher.

Pilot reports of runway braking action via AIREPs may be a trigger for a new assessment or be directly taken into account in the downgrade process (in accordance with the last two columns of the RCAM).

2.6 Pilot Report of Runway Braking Action

Pilot reports of runway braking action via AIREPs will typically provide aerodrome personnel and other pilots with an observation that can confirm the ground-based assessment or alert of degraded conditions experienced in terms of braking capability and/or lateral control during the landing roll. The braking action observed depends on the type of aircraft, aircraft weight, runway portion used for braking and other factors. Pilots will use the terms GOOD, GOOD TO MEDIUM, MEDIUM, MEDIUM TO POOR, POOR and LESS THAN POOR. When receiving an AIREP, the recipient should consider that these terms rarely apply to the full length of the runway and are limited to the specific sections of the runway surface in which sufficient wheel braking is applied. Since AIREPs are subjective and contaminated runways may affect the performance of different aeroplane types in different ways, the reported braking action may not be directly transferrable to another aeroplane.

If air traffic service (ATS) units receive an AIREP by voice communications concerning braking action that is found not to be as good as that reported, they will forward the AIREP without delay to the appropriate aerodrome operator. This is a prerequisite for using the AIREP for downgrading purposes when assessing the RWYCC. The distribution of AIREPs to aerodrome operators may be regulated by service level agreements (SLAs).

Increasingly, AIREPs may be generated by automated systems processing aeroplane data recorded during the deceleration phase. Such reports are deemed to be less subjective than those generated based on the flight crew’s perception alone and may provide additional information. It is therefore encouraged to discriminate between the two types of report origins.

2.7 Source of Information

In the data-gathering process, almost all runway information can typically be gathered from visual observations. If information is gathered from measuring devices or instruments, they have to be calibrated and operated within their limitations and in compliance with standards set or agreed by the State. The collected data are converted into information by personnel trained to perform their duties. Table 2.3 lists the sources of the provided information in the order in which it appears in the RCR.

Runway condition Report (RCR)	
Aeroplane Performance calculation section	
Information	Source
Aerodrome location indicator	Doc 7910, Location Indicators
Date and time of assessment	UTC time
Lower runway designation number	Actual runway
RWYCC for each runway third	Assessment based on the RCAM and associated procedures
Percent coverage contaminant for each runway third	Visual observation for each runway third
Depth of loose contaminant for each runway third	Visual observation assessed for each runway third, confirmed by measurements when appropriate
Condition description (contaminant type) for each runway third	Visual observation for each runway third
Width of runway to which the RWYCCs apply if less than published width	Visual observations while at the runway and information from local procedures/snow plan
Situational awareness section	
Information	Source
Reduced runway length	NOTAM
Drifting snow on the runway	Visual observation while at the runway
Loose sand on the runway	Visual observation while at the runway
Chemical treatment on the runway	Known application of the treatment. Visual observation of residual chemicals on the runway.
Snowbanks on the runway	Visual observations while at the runway
Snowbanks on taxiway	Visual observations while at the taxiway
Snowbanks adjacent to the runway penetrating level/profile set in the aerodrome snow plan	Visual observations while at the runway, confirmed by measurements when appropriate
Taxiway conditions	Visual observations, AIREPs, reports by other aerodrome personnel, etc.
Apron conditions	Visual observations, AIREPs, reports by other aerodrome personnel, etc.
State-approved and published use of measured friction coefficient	Dependent upon the standard set or agreed by the State
Plain language remarks using only allowable characters in capital letters	Any additional significant operational information to be reported

Table 2.3 source of information of Runway Condition Report (RCR)

2.8 Single and Multiple Contaminant

When single or multiple contaminants are present, the RWYCC for any third of the runway is determined using the following rules:

a) when the runway third contains a single contaminant, the RWYCC for that third is directly based on that contaminant in the RCAM as follows:

i. if the contaminant coverage for that third is less than 10 percent, a RWYCC of 6 is to be generated for that third and no contaminant is to be reported. If all thirds have less than 10 percent contaminant coverage, no report is generated; or

ii. if the percent contaminant coverage for that third is greater than or equal to 10 percent and less than or equal to 25 percent, a RWYCC of 6 is to be generated for that third and the contaminant reported at 25 percent coverage; or

iii. if the percent contaminant coverage for that third is greater than 25 percent, the RWYCC for that third shall be based on the contaminant present.

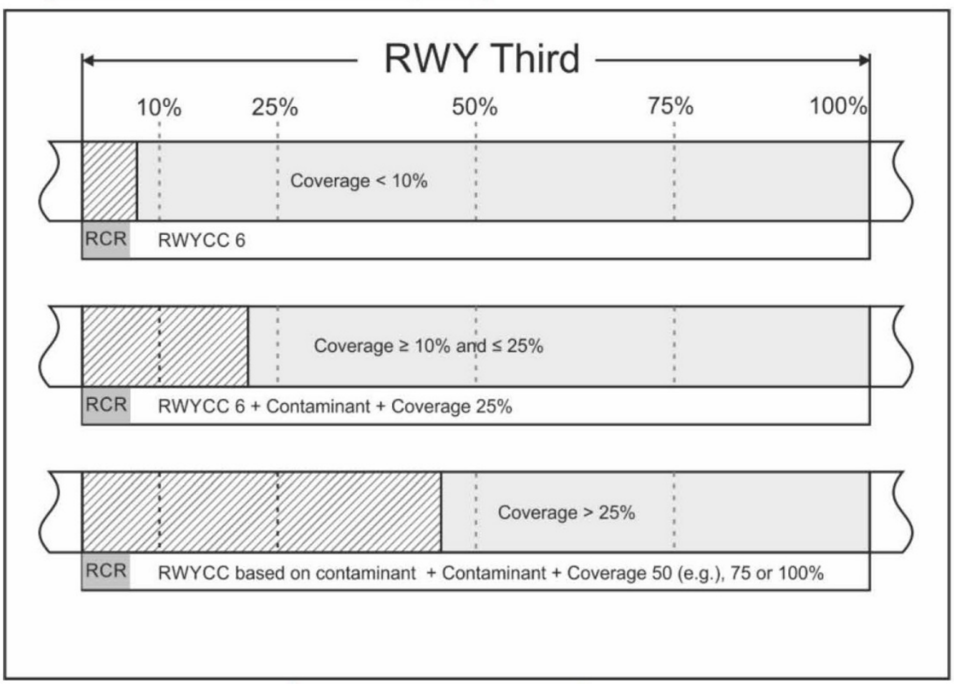


Figure 2-1 Single Contaminant

if multiple contaminants are present where the total coverage is more than 25 percent but no single contaminant covers more than 25 percent of any runway third, the RWYCC is based upon the judgment by trained personnel, considering what contaminant will most likely be encountered by the aeroplane and its likely effect on the aeroplane's performance. Typically, this would be the most widespread contaminant, but this is not an absolute; and

b) the RCAM lists contaminants in the runway surface description column from top to bottom with the most slippery contaminants at the bottom. However, this order is not an absolute since the RCAM is landing-oriented by design and, if judged in a take-off scenario, the order could be different due to the drag effects of loose contaminants.

2.9 Runway Condition Assessment Process

The runway condition assessment process is described by the following flowcharts

a) the generic runway condition assessment process; and

b) the basic RCAM flowchart process associated with Flowchart A and B.

Changes that are considered significant are detailed in PANS-Aerodromes (Doc 9981).

The generic runway condition assessment process. Figure 2-2 illustrates the generic assessment process for creating an RCR and Figures 2-3 to 2-4 illustrate the assessment and reporting of runway surface conditions using the RCAM.

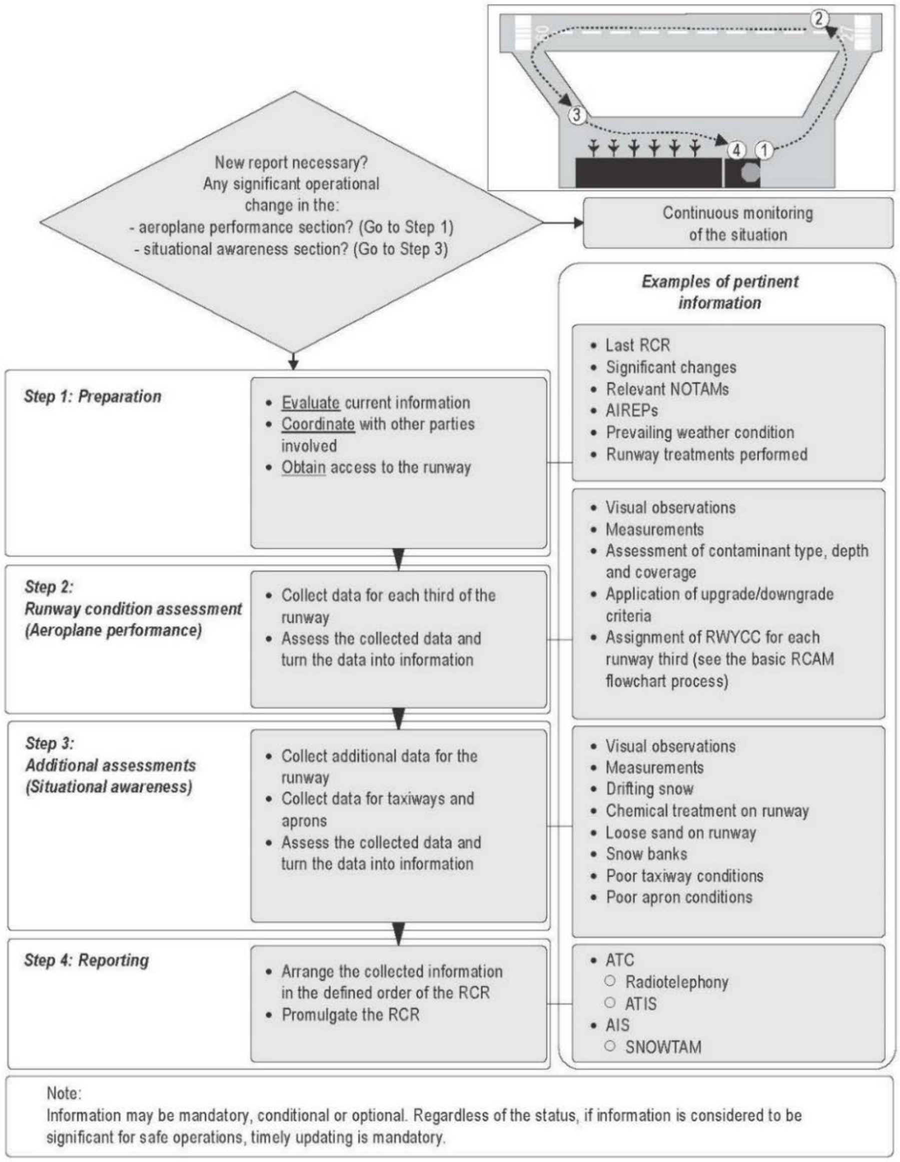


Figure 2-2 The generic runway condition assessment process

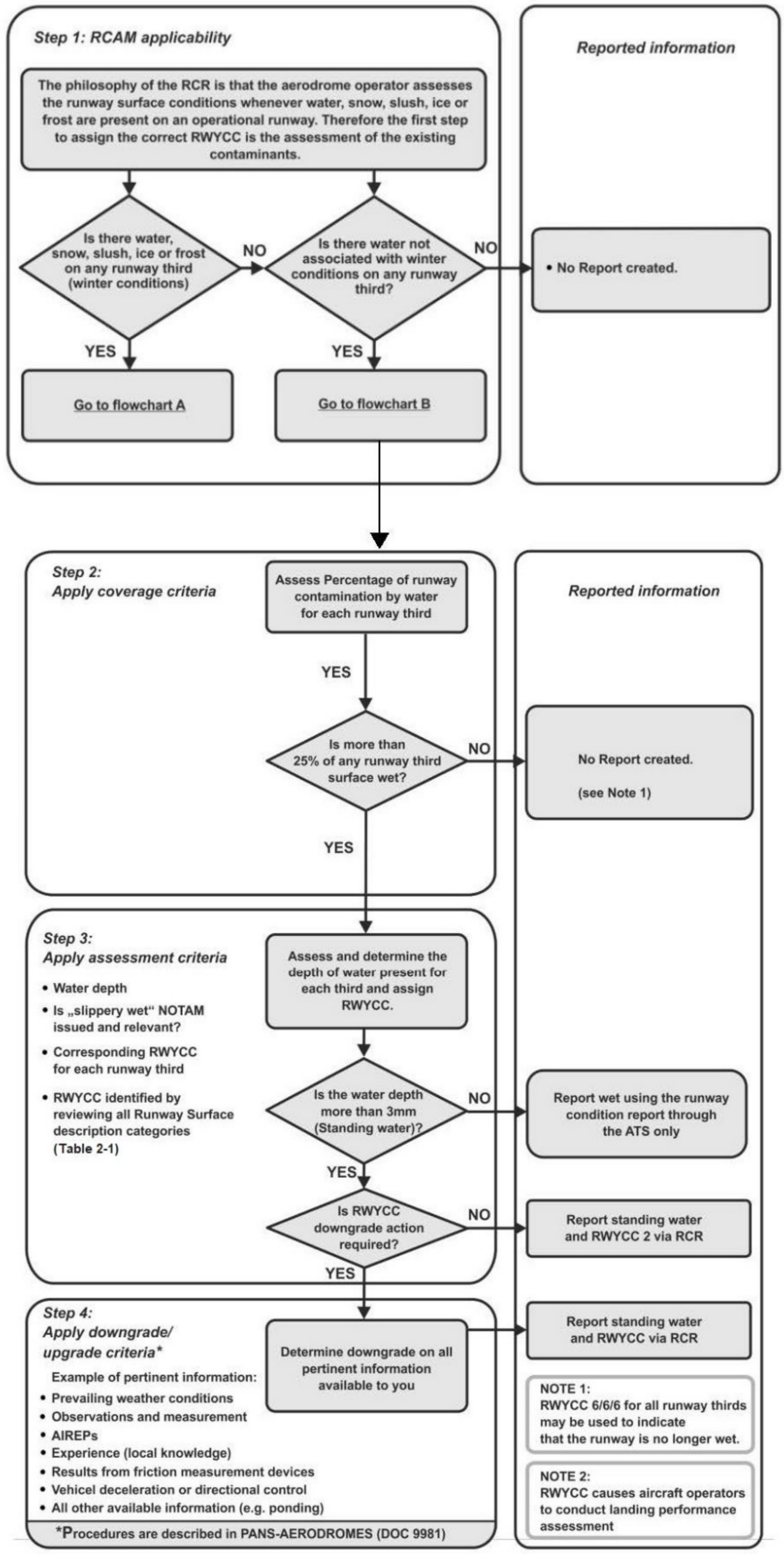


Figure 2-3 Flowchart A

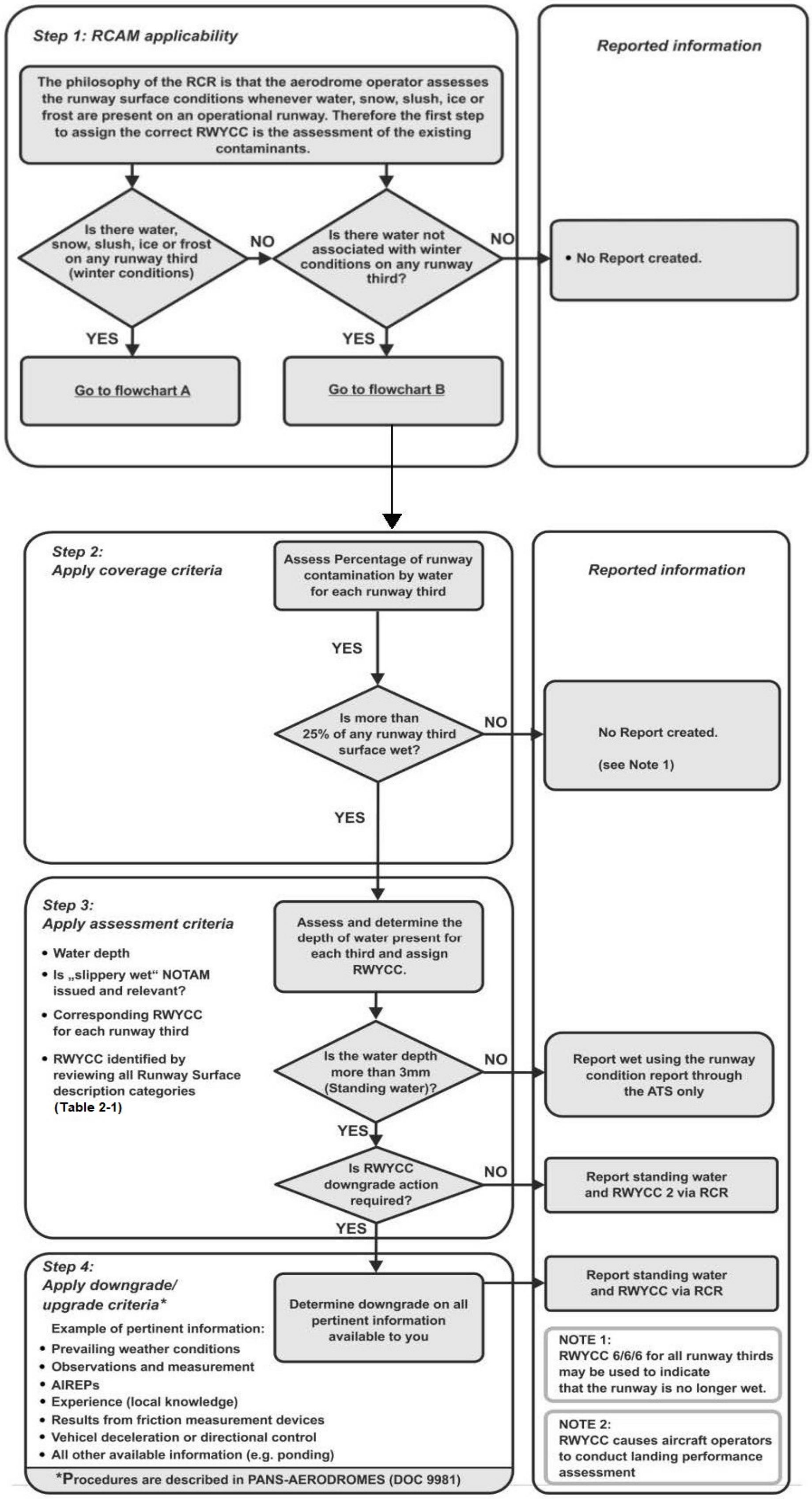


Figure 2-4 Flowchart B

2.10 Displacement Threshold and Reporting of RWYCC

The information reported in the RCR refers to the physical extent of the runways, notwithstanding the length and position of declared distances within this extent. The flight crew understands this when interpreting the RCR, in particular when:

a) landing on a runway with a significantly displaced threshold;

b) performing an intersection take-off; or

c) when a part of a runway is declared as a runway end safety area (RESA) but is available for take-off in the opposite direction.

In the RWYCC layout, the three runway thirds are reported in a sequence starting with the lowest runway designator – for example, in the 09 direction, even if the runway is being used in the 27 direction

The surface friction characteristics of a stopway before and after the runway threshold not maintained to the surface friction characteristics at or above the level of those of the associated runway is reported in the free text comment section of the RCR.

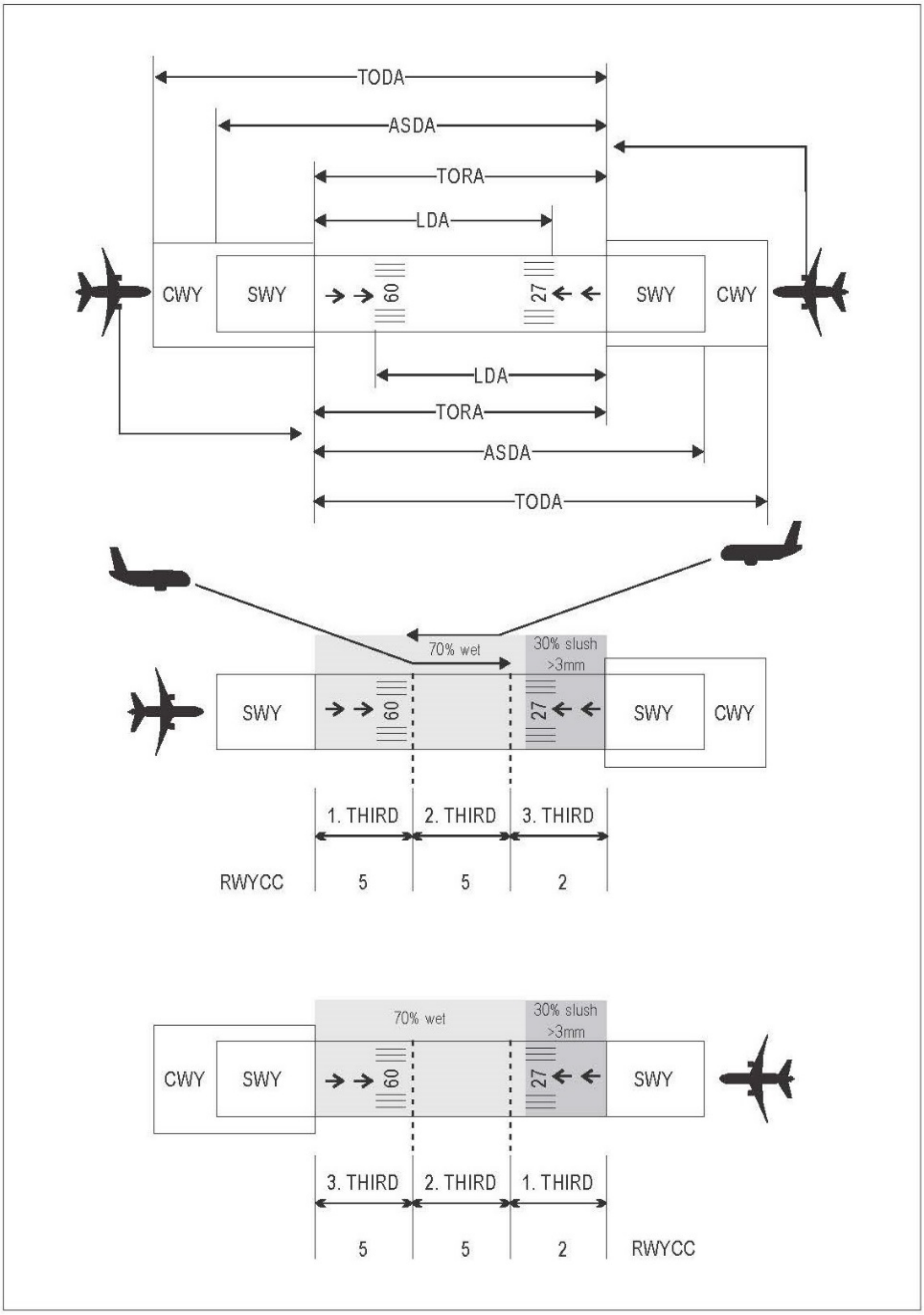


Figure 2-5 Reporting of RWYCC for runway thirds from ATS
to flight crew on a runway with displaced threshold

2.11 Dissemination of Information

It is the responsibility of the ATS/AIS provider to ensure the readiness of the RCR to flight crew. Depending on the situation, the RCR may be disseminated by means of:

a) SNOWTAM by Aeronautical information service (AIS);

b) ATIS, or radiotelephony by Air traffic service (ATS).

2.11.1 The distribution methods to provide the information for flight crew are as follows:

a) Through the AIS and ATS (SNOWTAM and ATIS): when the runway is wholly or partially contaminated by standing water, snow, slush, ice or frost, or it wet associated with clearing or treatment of snow, slush, ice or frost.

b) Through the ATIS only: when the runway is wet, not associated with the presence of now, slush, ice or frost.

2.11.2 Automatic Terminal Information Service (ATIS)

An ATIS presents a very important means of transmitting information, relieving operational personnel from the routine duty of transmitting runway conditions and other relevant information to the flight crew. In addition to normal operational and weather information, the following information regarding the runway condition should be mentioned whenever the runway is not dry (RWYCC 6):

a) Aeroplane performance section:

i. operational runway in use at time of issuance;
ii. RWYCC for the operational runway, for each runway third in the operational direction;
iii. condition description, coverage and depth (for loose contaminants);
iv. width of the operational runway to which the RWYCC applies, if less than the published width; and
v. reduced length, if less than the published length.

b) Situational awareness section:

i. drifting snow;
ii. loose sand;
iii. operationally significant snowbanks;

iv. runway exits, taxiways and apron if POOR; and

v. any other pertinent information in short, plain language.

3. Aircraft Operations, Impact of Contaminant & Their Depth on Aircraft Performance

3.1 Functional Friction Characteristic

3.1.1 How Rolling, Slipping and Skidding Affect the Aircraft

Aircraft/runway interaction. Mechanical interactions between aircraft and runways are complex and depend on the critical tire-to-ground contact area. This small area (approximately 4 square metres for the largest aircraft currently in service) is subject to forces that drive the rolling and braking characteristics of the aircraft, as well as directional control.

Lateral (cornering) forces. These forces allow directional control on the ground at speeds where flight controls have reduced effectiveness. If contaminants on the runway or taxiway surface significantly reduce the friction characteristics, special precautions should be taken (e.g. reduced maximum allowable crosswind for take-off and landing, reduced taxi speeds) as provided in operations manuals.

Longitudinal forces. These forces, considered along the aircraft speed axis (affecting acceleration and deceleration), can be split between rolling and braking friction forces. When the runway surface is covered by a loose contaminant (e.g. slush, snow or standing water), the aircraft is subjected to additional drag forces from the contaminant.

3.1.2 Rolling Friction Forces

Rolling friction forces (unbraked wheel) on a dry runway are due to the tire deformation (dominant) and wheel/axle friction (minor). Their order of magnitude represents only around 1 to 2 percent of the aircraft apparent weight.

3.1.3 Braking Forces - General Effects

Braking forces are generated by the friction between the tire and the runway surface when brake torque is applied to the wheel. Friction exists when there is a relative speed between the wheel speed and the tire speed upon contact with the runway surface. The slip ratio is defined as the ratio between the braked and unbraked (zero slip) wheel rotation speeds in revolutions per minute (rpm).

The maximum possible friction force depends mainly on the runway surface condition, the wheel load, the speed and the tire pressure. The maximum friction force occurs at the optimum slip ratio, beyond which the friction decreases. The maximum braking force depends on the friction available as well as the braking system characteristics, i.e. anti-skid capability and/or torque capability.

The coefficient of friction, μ, is the ratio between the friction force and the vertical load. On a good, dry surface, the maximum friction coefficient, μmax, can exceed 0.6, which means that the braking force can represent more than 60 percent of the load on the braked wheel. On a dry runway, speed has little influence on μmax. When the runway condition is degraded by contaminants such as water, rubber, slush, snow or ice, μmax can be reduced drastically, affecting the capability of the aircraft to decelerate after landing or during a rejected take-off.

The general effects of runway surface conditions on the braking friction coefficient are briefly summarized in paragraphs below.

a) Wet condition (up to 3 mm of water). μmax in wet conditions is much more affected by speed (decreasing when speed increases) than it is in dry conditions. At a ground speed of 100 kts, μmax on a wet runway with standard texture will be typically between 0.2 and 0.3; this is roughly half of what one would expect to obtain at a low speed such as 20 kt.

   On a wet runway, μmax is also dependent on runway texture. A higher micro texture (roughness) will improve the friction. A high macrotexture, PFC or surface grooving will add drainage benefits; however, it should be noted that the aircraft stopping performance will not be the same as on a dry runway. Conversely, runways polished by aircraft operations or contaminated by rubber deposits or where texture is affected by rubber deposits after repeated operations can become very slippery. Therefore, maintenance must be performed periodically.

b) Loose contaminants (standing water, slush, wet or dry snow above 3 mm). These contaminants degrade μmax to levels which could be expected to be less than half of those experienced on a wet runway. Micro texture has little effect in these conditions. Snow results in a fairly constant μmax with velocity, while slush and standing water exhibit a significant effect of velocity on μmax.

Because they have a fluid behaviour, water and slush create dynamic aquaplaning at high speeds, a phenomenon where the fluid's dynamic pressure exceeds the tire pressure and forces the fluid between the tire and ground, effectively preventing physical contact between them. In these conditions, the braking capability drops drastically, approaching or reaching nil.

The phenomenon is complex, but the driving parameter of the aquaplaning speed is tire pressure. High macrotexture (e.g. a PFC or grooved surface) has a positive effect by facilitating dynamic drainage of the tire-runway contact area. On typical airliners, dynamic aquaplaning can be expected to occur in these conditions above ground speeds of 110 to 130 kts. Once started, the dynamic aquaplaning effect may remain a factor down to speeds significantly lower than those necessary to trigger it.

c) Solid contaminants (compacted snow, ice and rubber). These contaminants affect the deceleration capability of aircraft by reducing μmax. These contaminants do not affect acceleration.

Compacted snow may show friction characteristics that are quite good, perhaps comparable to a wet runway. However, when the surface temperature approaches or exceeds 0°C, compacted snow will become more slippery, potentially reaching a very low μmax.

The stopping capability on ice can vary depending on the temperature and roughness of the surface. In general, wet ice has very low friction (μmax as low as 0.05) and will typically prevent aircraft operations until the friction level has improved. However, ice that is not melting may still allow operations, albeit with a performance penalty.

d) Runway surface contaminants resulting from the operation of aircraft, but which are not usually considered as contaminants for aeroplane performance purposes, are rubber deposits or de-icing fluid residues. These items are usually localized and limited to portions of the runway. There is a responsibility of Runway Maintenance to monitor these contaminants and remove them as needed. Affected portions will be notified via NOTAM when the friction drops below the minimum required friction level.

3.1.4 Contaminant Drag Forces

When the runway is covered by a loose contaminant (e.g. standing water, slush, non-compacted snow), there are additional drag forces resulting from the displacement or compression of the contaminant by the wheel. The driving factors of these displacement drag forces are aircraft speed and weight, tire size and deflection characteristics, and contaminant depth and density. Their magnitude can significantly impair the acceleration capability of the aircraft during take-off. For example, 13 mm of slush would generate a retardation force representing about 3 percent of the aircraft weight at 100 kts for a typical mid-size passenger aircraft.

A second effect of these displaceable contaminants (slush, wet snow and standing water) is the impingement drag, whereby the plume of sprayed contaminant creates a retardation force when impacting the aircraft structure. The combination of the displacement retardation force and impingement retardation force can be as high as 8 to 12 percent of the aircraft weight for a typical small/mid-size passenger aircraft. This force can be large enough that in the event of an engine failure, the aircraft may not be able to continue accelerating.

3.1.5 Aircraft Runway Performance Implications

It is obvious from the information provided above that as soon as the runway condition deviates from the ideal dry and clean state, the acceleration and deceleration capabilities of the aircraft may be affected negatively with a direct impact on the required take-off, accelerate-stop and landing distances. Reduced friction also impairs directional control of the aircraft, and therefore the acceptable crosswind during take-off and landing will be reduced.

3.2 A Brief Summary of Aircraft Performance

3.2.1 Takeoff Performance

a) As the runway condition deviates from the ideal dry and clean state, the acceleration and deceleration capabilities of the aircraft may become affected.

When runway is not dry and clean:

i. Coefficient of friction (μ) decreases.
ii. Maximum Coefficient of friction (μmax) as experienced by aircraft decreases.

b) Loose contaminant inhibit acceleration due to drag cause by displacement or compression of the contaminant and impingement on the airframe.

As a result

i. Acceleration and deceleration capabilities are affected negatively.
ii. Required takeoff, accelerate-stop and accelerate-go distances are impacted.

c) The impacts on the aircraft's runway performance vary based on the presence of WET, SOLID and LOOSE contaminant.

Impact of wet and solid contaminants:

i. Acceleration and takeoff distance are not affected.
ii. Braking capability is reduced.
iii. Accelerate-stop distances are longer.

Impact of Loose contaminant:

i. Reduction of the acceleration capability by displacement and impingement drag that occur in the presence of SLUT, WET SNOW, DRY SNOW or STANDING WATER, the deeper the contaminant, the higher the drag force will be.
ii. Deceleration capability is reduced by lower friction and aquaplaning at high speed.
iii. Takeoff distance is longer, worse when the contaminant is deeper.
iv. Runway limit weight adjustment must be applied as per the aeroplane manufacturer's recommendations.

d) Contaminant Drag forces

When the runway is covered by a loose contaminant (for example STANDING WATER, SLUSH, NON-COMPACTED SNOW), there are additional drag forces resulting from the displacement or compression of the contaminant by the wheel.

The drag force magnitude significantly impairs the acceleration capability of the aircraft during takeoff. For example, 13 mm of SLUSH generates a retardation force representing about 3 percent of the aircraft weight at 100 kt for a typical mid-size passenger aircraft.

SLUSH, WET SNOW, and STANDING WATER create a retardation force when impacting the aircraft structure. The combination of the displacement and impingement retardation forces can be as high as 8 to 12 percent of the aircraft weight for a typical small/mid-size passenger aircraft.

e) Runway Contaminants and Aircraft Performance – Takeoff Summary

Dry Runways	Wet Runways	Contaminated Runways
Under the Global Reporting Format (GRF), there are no changes to the rules and procedures associated with takeoffs on dry runways.	• Acceleration and takeoff distance not affected. • Reduced braking capability. • Longer accelerate-stop. Note: 3 mm and below of LOOSE contaminants or any type of fluid contaminant with the associated a Runway Condition Code (RWYCC) of 5/5/5 can be treated as WET for takeoff.	• Takeoff distance is longer (worse when the contaminant is deeper). • Reduced braking capability. • Accelerate-stop distance is longer (less so when the contaminant is deeper because of higher displacement and impingement drag).
Wet	**Loose Contaminant**	**Solid Contaminant**
• Longer accelerate-stop distance because of reduced braking capability • Takeoff distance is increased by 10 to 20 percent Note: In case of rejected takeoff, use of reverse thrust (one-engine inoperative) will reduce this effect by 20 to 50 percent depending on the effectiveness of the reversers and runway conditions.	• Reduced acceleration capability by displacement and impingement drag • Reduced deceleration capability by lower friction	• Acceleration and continued takeoff are not affected • However, reduced braking/deceleration capability.

3.2.2 Landing Performance.

a) DRY Conditions

On a dry runway, the maximum friction coefficient as experienced by an aircraft is also dependent on the runway texture.

i. _Dry Runway – Runway Condition Code (RWYCC):_ Following a period of contamination, when the runway condition is assessed to be DRY it will be assigned a Runway Condition Code (RWYCC) of 6/6/6.

ii. _Dry Runway – Takeoff & Landing:_ When in a dry and clean state, individual runways provide operationally insignificant differences in friction levels, regardless of the type of pavement and configuration of the surface. Moreover, the friction level available is relatively unaffected by the speed of the aircraft. Hence, operations on dry runway surfaces do not require any special additional friction-related precautions.

b) WET Conditions

The maximum friction coefficient as experienced by an aircraft (μmax) in wet conditions (up to and including 3 mm water) decreases much more when the speed increases than it does in dry conditions.

At a ground speed of 100 kt, μmax on a wet runway with standard texture will be typically between 0.2 and 0.3.

Due to their fluid behavior, WATER and SLUSH create dynamic aquaplaning at high speeds, a phenomenon where the fluid's dynamic pressure exceeds the tire pressure and forces the fluid between the tire and ground, effectively preventing physical contact between them.

Aircraft Performance – Landing – WET Conditions considerations:

i. Consider delaying the landing for 15- to 20-minutes after a downpour, as this waiting period is usually enough to drain the water from the runway surface.

ii. Pilots should always be aware that approach and landing to a wet runway increases the possibility of a go-around.

iii. It is important not to exceed VTH (Runway Threshold Speed) plus wind corrections at the runway threshold.
iv. Maintain a stabilized approach.
v. It is recommended to use maximum flaps to provide minimum approach speed.
vi. Do not allow the aircraft to float in the flare. Touch down firmly in the touch down zone without a bounce.
vii. Maintain aircraft alignment with the runway centerline.
viii. Anti-skid braking should be applied steadily.
ix. Apply reverse thrust as per airline/company policy.

c) CONTAMINATED Conditions

For landing, the Runway Condition Code (RWYCC) and Pilot Braking Action Reports are what drive the performance calculation.

The airport is responsible for the Runway Condition Report (RCR) with the appropriate Runway Condition Code (RWYCC).

The Runway Condition Assessment Matrix (RCAM) provides the relationship between contaminant type and depth and its associated Runway Condition Code (RWYCC).

Aircraft Performance – Landing – CONTAMINATED Conditions considerations:

i. Landing on a contaminated runway requires a stabilized final approach and a firm landing within the prescribed touch down zone. If either is not achieved, a go around is appropriate.
ii. Autobrakes target a specified deceleration rate for a given setting and typically include a longer delay after touchdown. Consider selecting maximum allowable auto brake setting for landing.
iii. It is recommended to use maximum flaps to provide minimum approach speed.
iv. It is important not to exceed the Runway Threshold Speed (VTH) plus wind corrections at the runway threshold.

v. The presence of contaminants can increase any negative impact of longitudinal and transverse slopes of a runway on aircraft performance.

3.3 Runway Contaminants Affecting Lateral Controls

For the purpose of the performance assessment at the intended time of takeoff and landing, the latest available Runway Condition Report (RCR) should be considered.

a) Performing a safe takeoff/landing on a contaminated runway involves several dimensions, including lateral controls.

b) Landing on contaminated runways involves increased levels of risk related to both deceleration and lateral controls.

c) Crosswind limits become more restrictive as the Runway Condition Code (RWYCC) decreases.

d) The effects of differential manual braking are likely to be greater. The use of autobrakes, if available, would be encouraged.

e) The use of asymmetric thrust reversers/reverse pitch is likely to exacerbate lateral control issues.

f) The yaw effects arising from differential braking effectiveness are increased.

g) A crosswind in conjunction with a wet or contaminated runway can have the most significant impact upon deceleration and lateral control.

4. Aeroplane Performance

This chapter provides guidance for air operator, which can use when developing performance data for the operations of turbine-powered subsonic transport type aeroplanes over 5,700 kg maximum certificated takeoff mass having two or more engines on contaminated runways.

4.1 Contaminated Runway Takeoff Performance Data

Takeoff performance data should be provided in terms of a runway surface condition description for the approved operational takeoff envelope.

Information regarding runway surface condition descriptions contained in table 4-1 below should be included in takeoff performance data.

Runway Surface Condition	Contaminant Category
Dry	-
Wet	-
Ice	Solid contaminant
Compacted snow	Solid contaminant
Dry Snow	Loose contaminant
Wet Snow	Loose contaminant
Slush	Loose contaminant
Water	Loose contaminant

Table 4-1. Runway Surface Condition-Descriptions and Contaminant Categories

4.1.1 Guidance for Existing Type Designs

Contaminated runway takeoff performance data approved by the FAA AC 25-31 or EASA CS-25 in compliance with either their contaminated runway type certification or operating requirements are acceptable.

4.1.2 Documentation

Takeoff performance data may be provided in either document such as Airplane Flight Manual (AFM), Flight crew operation manual, Quick reference handbook, Electronic flight bag, and/or other appropriate concerns flight manual.

However, there may be a case that takeoff performance data is unable to be certified or approved by a certification agency, as such, the disclaimer "Advisory Data Only" or any suitable statement should be clearly labelled with that takeoff performance information.

At least, the following information should be provided in takeoff performance data;

a) Instructions for use of the data.

b) Definitions of the different runway surface conditions.

c) Restriction for takeoff or takeoff prohibition on runways with contaminants and depths are not specified in the published takeoff performance data.

d) Any other recommendations associated with use of the contaminated runway takeoff performance data.

e) Statements which mentioned that the performance data are based on a uniform depth (for loose contaminants) and uniform coverage of a layer of contaminant with uniform properties throughout.

4.2 Landing Performance

4.2.1 Landing Performance Data

The landing performance data for the aeroplane type should be derived and published by the aeroplane manufacturer which include the uses of different deceleration devices available or the use of devices as recommended by the manufacturer.

For example, the uses of maximum manual braking and/or autobrake for the Landing distances calculation at Time of Arrival and the thrust reverser system settings (where applicable for contaminated runway only, to calculate the Landing Distances at Time of Takeoff).

The formatting of Performance data should be presented to the intended user where can be easily understood and applied. This principle should be followed when the information is presented as tables, charts, figures, and when it is determined interactively by computational tools, such as electronic flight bags (EFB).

Landing performance data may be published as tabulated information in either the flight manual or the operations manual. Tabulated data should be supplemented with electronic computation tools and such tools should comply with applicable industry norms. These computation tools should be designed in such way that actively supports the flight crew in establishing the worst acceptable condition rather than only calculating for the user-defined conditions.

If the Landing distances data at Time of Arrival is not approved by the State of Design, it should be labelled as “Advisory Data Only”. In any case, the assumptions on which the data was built should be made available, in particular regarding whether any margin is basically included in the data. Instructions for its use should be provided. Any limitations of the data and the operations it covers should be clearly stated, for example maximum contaminant depths. Operators should provide guidance on maximum crosswind as a function of the runway surface condition.

Landing distance data should cover all normal operations with all engines operating, such data shall be calculated within the normal landing operating envelope. The effect of each parameter affecting landing distance should be provided. Moreover, the following conditions should be taken into account.

a) approved landing configurations, including Category III landing guidance where approved;

b) approved deceleration devices (wheel brakes, speed brakes and spoilers);

c) reverse thrust, including pilot and system delays for its selection and activation, as well as recommendations for stowing at low speed;

d) pressure altitudes within the approved landing operating envelope;

e) mass, up to the maximum take-off mass (to cover overweight landing);

f) winds within the approved landing operating envelope:

   i. not more than 50 percent of the nominal wind components along the landing path opposite to the direction of landing; and
   ii. not less than 150 percent of the nominal wind components along the landing path in the direction of landing;

g) crosswinds, including limits for reverse thrust use, if necessary. Flight crew may reduce the thrust reversers or store the reversers to restore directional control,

h) icing conditions, as applicable.

In addition, these following factors should be taken into consideration when calculate the Landing Distances at Time of Arrival:

i) expected airspeeds at the runway threshold, including speeds up to the maximum recommended final approach speed considering possible speed additives for winds and icing conditions

j) temperatures within the approved landing operating envelope; and

k) runway slopes within the approved landing operating envelope.

An appropriate information should be provided in a minimum equipment list and configuration deviation list items that affect landing distance, the non-normal configurations landing distances should also be included. A landing distance assessment should be based on data consistent with the recommended aeroplane operating methods.

4.2.2 Landing Performance Check at Time of Takeoff

Landing – Dry Runway (Destination)

a) An aeroplane should not commence a take-off at a mass in excess of that which permits the aeroplane to be brought to a full stop landing at the aerodrome of intended destination from the threshold, the following factor should be taken into consideration in regards of performance calculation:

   i. Turbo jet powered aeroplanes, the landing performance check at time of takeoff should be within 60 percent of the landing distance available (LDA); and

   ii. Turbo-propeller aeroplanes, the landing performance check at time of takeoff should be within 70 percent of LDA.

b) The mass of the aeroplane is assumed to be reduced by the mass of the fuel and oil expected to be consumed in flight to the intended destination aerodrome. The assumption above should consider the following conditions:

   i. the aeroplane is landed on the most favorable runway, in the most favorable direction, in still air condition, and

   ii. the aeroplane is landed on the runway which is the most suitable with wind conditions anticipated at the aerodrome at the time of arrival, taking due account of the probable wind speed and direction, of the ground handling characteristics of the aeroplane, and other conditions (i.e. landing aids, terrain). If compliance cannot be shown with this provision, the aeroplane may be taken off if a destination alternate aerodrome is designated which permits compliance with requirements for destination and alternate aerodromes.

c) If the forecast meteorological conditions at the destination aerodrome do not allow complying with all of the above, the aeroplane should only be dispatched if an alternate aerodrome is designated that allows full compliance.

d) For this compliance demonstration, the following factors should be considered, at minimum:

i. the altitude of the aerodrome;
ii. the runway slope in the direction of the landing if greater than ± 2.0 percent; and
iii. not more than 50 percent of the headwind component or not less than 150 percent of the tailwind component.

Landing – Wet or Contaminated Runway

a) When the appropriate weather reports or forecasts or a combination thereof indicate that the runway at the estimated time of arrival may be wet, the LDA should be at least 115 percent of the required landing distance determined for dry runways.

b) In case of a landing distance on a wet runway shorter than that prescribed above but not less than that required for dry runways, this landing distance may be used if the flight manual includes specific additional information about landing distance on wet runways.

c) When the appropriate weather reports or forecasts or a combination thereof indicate that the runway at the estimated time of arrival may be contaminated, the landing distance available should be the greater of:

i. the required landing distance for wet runways; or
ii. the landing distance determined in accordance with contaminated landing distance data with 15% safety margin acceptable by the authority, unless a destination alternate aerodrome is designated for which full compliance is shown with landing performance at time of take-off requirements for destination and alternate aerodromes.

d) When complying with required landing performance on wet and contaminated runways, the above criteria for dry runways should be applied accordingly, except when specific safety margin are contained in AFM.

e) The destination aerodrome where a landing depends on a specified wind component, the aeroplane may be dispatched if two alternate aerodromes are designated that permit full compliance with all of the above.

4.2.3 Landing Performance Check at Time of Arrival

During the approach at the intended aerodrome, the landing conditions are fairly well known and any expected changes from the conditions anticipated when the performance check at take-off was conducted can be reasonably assessed. The intent is to produce a best assessment of the distance needed for landing under the prevailing conditions, considering the operational parameters such as approach speed and braking devices intended to be used. It begins with acquiring the latest available weather information and the RCR via the automatic terminal information service (ATIS), ATC or other means and determining the landing mass.

As of 4 November 2021, in-flight landing performance assessment based on a factored distance at time of arrival, furnished for the prevailing conditions is mandated. The flight crew should initiate a performance check at time of arrival on every flight. Operators must have a systematic method for determining that the distance at the time of arrival is adequate based on the conditions that exist at the time of arrival. This check may require a computation of landing distances based on the latest available information on weather and runway surface condition. In many cases it can be sufficient to confirm the validity of a previous assessment, or verify the current conditions against pre-determined worst acceptable conditions for the airport.

The performance check at time of arrival or confirmation of the validity of dispatch calculations should be done before top of descent. While the in-flight procedures in Annex 6, Part I, 4.4.1.2 specify an elevation of 300 m (1000 ft) above the aerodrome, the intent is not for an actual computation to take place at this point, where it would distract attention from essential flying tasks. Rather, the intent is for the flight crew to monitor the actual conditions throughout the approach, to ensure that they do not degrade below a minimum acceptable condition, as determined previously with the anticipated landing distance based on actual outside conditions. The recommended time for this determination is during approach preparation before the start of the final descent.

In the majority of cases, the landing distance check can be satisfied by confirming that the assumptions used at the time of dispatch are still adequate, and no further calculations are required during approach preparation. Depending on applicable regulation and the certification basis of the aeroplane, the dispatch landing field length could be the same as that specified in the aeroplane’s flight manual, based on the appropriate operating regulations., Or an operational performance check that reflects the actual conditions expected at the time of arrival and includes appropriate margins may be required

However, there will be cases where the assumptions used at dispatch will be inadequate and the flight crew will need to evaluate the performance at the destination or alternate airport. Examples of conditions requiring a calculation at time of arrival of landing distance required include but are not limited to:

a) runway surface condition as reported by RCR, consistent with the procedures described in PANS-Aerodromes (Doc 9981), are worse than assumed at dispatch;

b) winds are worse than assumed at dispatch;

c) runway changed from the runway(s) used in the dispatch calculations;

d) excessive operational approach speed additives; and

e) wet runway with “slippery wet” NOTAM or braking action reported as less than “good”.

Note: Judgment may be required based on the location and extent of the section of runway declared “slippery wet”.

For the purpose of the performance assessment at time of arrival, weather conditions and runway surface conditions should be accounted for as reported for the intended time of arrival. This implies that performance data is presented against the terminology defined in Annex 14, Volume I, Definitions and used in the RCAM in PANS-Aerodromes (Doc 9981). In addition, the planned aeroplane configuration, approach guidance, automation and deceleration mean intended to be used, should be considered. The computation should reflect any minimum equipment list (MEL)/configuration deviation list (CDL) items or in-flight failures affecting landing performance and operational choices such as autoland, autothrust and autobrakes.

4.2.4 Minimum Compliance

The following Performance data for Landing distance at time of arrival is acceptable to the Authority (CAAT)

a) **Performance Information for The Assessment of Landing Distance at Time of Arrival (LDTA) – Approved Data:**

Approved data for the assessment of LDTA contained in the AFM should be developed in accordance with FAA AC 25-32, EASA AMC 25.1592, or equivalent.

b) **Performance Information for The Assessment of Landing Distance at Time of Arrival (LDTA) – Supplementary Data:**

When approved data for the assessment of LDTA contained in the AFM is insufficient, the content of the AFM may be supplemented with one of the following set of data, provided by the aircraft manufacturer or the type certificate holder (TCH) or an organization approved under Part-21 and having the relevant privileges in the scope of its organization approval:

i. Data for the assessment of LDTA produced for aeroplanes not having CS-25.1592 or equivalent in their certification basis. Such data may be presented in terms of runway surface conditions, pilot-reported braking actions, or both, and should include at least:
   - ➢ an operational airborne distance;
   - ➢ the range of braking actions as related to the RWYCC;
   - ➢ the effect of speed increments over threshold;
   - ➢ the effect of temperature; and
   - ➢ the effect of runway slope;

ii. Data developed in compliance with FAA AC 25-32;

iii. AFM data for wet runways at time of dispatch;

iv. Data for contaminated runways developed in compliance with CS 25.1591 at Amendment 2 or later;

Before commencing an approach, it should be confirmed that, in accordance with the performance provided for that purpose, the aeroplane can be stopped with appropriate margins within the LDA. A minimum margin of 15 per cent versus the operational landing distance is considered to be appropriate.

c) **Performance Information for The Assessment of Landing Distance at Time of Arrival (LDTA) – Landing Distance Factors**

When there are data available for the assessment of LDTA form the manufacturer, performance information for the assessment of LDTA may be determined by applying the following method:

i. Correction factors may be applied to the certified landing distances on dry runway published in the AFM for turbojet-powered aeroplanes and turboprops-powered aeroplanes.

ii. For this purpose, the landing distance factors (LDFs) from Table 4-2 below may be used:

Table 4-2 Landing Distance Factors (LDFs)

RWYCC	6	5	4	3	2	1
Braking Action	(Dry)	Good	Good to Medium	Medium	Medium to Poor	Poor
Turbo jet, no reverse	1.67	2.6	2.8	3.2	4.0	5.1
Turbojet, With Reverse	1.67	2.2	2.3	2.5	2.9	3.4
Turbo prop Note1	1.67	2.0	2.2	2.4	2.7	2.9

Note 1: These LDFs apply only to modern turboprops with efficient disking drag. For older turboprops without adequate disking drag use the turbojet, no reverse LDFs.

iii. To find the required landing distance (RLD) multiply the AFM (dry, unfactored) landing distance by the applicable LDFs from Table 4-2 above for the runway conditions existing at time of arrival. If the AFM landing distances are presented as factored landing distances, then that data needs to be adjusted to remove the applicable dispatch factors applied to that data.

iv. The LDFs given in Table 4-2 above include a 15 % safety margin and an air distance representative of normal operational practices. They account for variations of temperature up to international standard atmosphere (ISA) + 20 °C, runway slopes between –2 % and +2 %, and an average approach speed increment of 5 up to 20 kt. They may not be conservative for all configurations in case of unfavourable combinations of these parameters.

4.2.5 Reporting in Runway Braking Action

The role of the flight crew in the runway surface condition reporting process does not end once a safe landing has been achieved. While the aerodrome operator is responsible for generating the RCR, flight crew are responsible for providing accurate braking action reports.

The flight crew braking action reports provide feedback to the aerodrome operator regarding the accuracy of the RCR resulting from the observed runway surface conditions.

ATC passes these braking action reports both to the subsequent aeroplane landing at the same runway and to the aerodrome operator, which in turn uses them in conjunction with the RCAM to determine if it is necessary to downgrade or upgrade the Runway Condition Code (RWYCC).

During busy times, runway inspections and maintenance may be less frequent and need to be sequenced with arrivals. Therefore, aerodrome operators may depend on braking action reports to confirm that the runway surface condition is not deteriorating below the assigned RCR.

Since both the ATC and the aerodrome operator rely on accurate braking action reports, flight crew should use standardised terminology in accordance with ICAO Doc 4444 - 'PANS ATM'.

The following Table 4-3 shows the correlation between the terminology to be used in the AIREP to report the braking action and the RWYCC.

AIREP (Braking action)	Description	RWYCC
N/A		6
Good	Braking deceleration is normal for the wheel braking effort applied AND directional control is normal.	5
Good to Medium	Braking deceleration OR directional control is between good and medium.	4
Medium	Braking deceleration is noticeably reduced for the wheel braking effort applied OR directional control is noticeably reduced.	3
Medium to Poor	Braking deceleration OR directional control is between medium and poor.	2
Poor	Braking deceleration is significantly reduced for the wheel braking effort applied OR directional control is significantly reduced.	1
Less than Poor	Braking deceleration is minimal to non-existent for the wheel braking effort applied OR directional control is uncertain.	0

Table 4-3 Association between AIREP and RWYCC

Note: the aerodrome personnel may downgrade or upgrade the reported RWYCC based on the friction coefficient (μ) measured by a friction measuring device meeting standards set or agreed by the state of aerodrome. Such a decision should not be taken by a flight crew on the approach as it must be supported by other observations. Measured friction values poorly correlate with actual aircraft braking capability and landing performance.

An AIREP should be transmitted to the ATC, in accordance with one of the following specifications, as applicable:

a) Good braking action is reported as "BRAKING ACTION GOOD"

b) Good to medium braking action is reported as "BRAKING ACTION GOOD TO MEDIUM"

c) Medium braking action is reported as "BRAKING ACTION MEDIUM"

d) Medium to poor braking action is reported as "BRAKING ACTION MEDIUM TO POOR"

e) Poor braking action is reported as "BRAKING ACTION POOR"

f) Less than poor braking action is reported as "BRAKING ACTION LESS THAN POOR"

In some cases, the differences between two consecutive levels of the six braking action categories between "Good" and "Less than Poor" may be too subtle for the flight crew to detect. It is therefore acceptable for the flight crew to report on a more coarse scale of "Good", "Medium" and "Poor".

Whenever requested by ATC, or if the braking action encountered during the landing roll is not as previously reported by the aerodrome operator in the RCR, pilots should provide a braking action report. This is especially important and safety relevant where the experienced braking action is worse than the braking action associated with any RWYCC code currently in effect for the portion of the runway concerned.

When the experienced braking action is better than that reported by the aerodrome operator, it is also relevant to report this information, which may trigger further actions for the aerodrome operator in order to upgrade the RCR.

If an aircraft-generated braking action report is available, it should be transmitted, identifying its origin accordingly. If the flight crew have reason to modify the aircraft-generated braking action report based on their judgement, the commander should be able to amend such report.

A braking action AIREP of "Less Than Poor" leads to a runway closure until the aerodrome operator can improve the runway condition. An air safety report (ASR) should be submitted whenever flight safety has been endangered due to low braking action.

5. Flight Crew Training Requirement

Flight crew should be trained on the use of the RCR, on the use of performance data for the assessment of the Landing distance at time of arrival and on reporting braking action using the AIREP format. The training should not be less than 1.5 hours.

5.1 Training Requirements

A training syllabus, documentation and record should include, at least the following elements:

5.1.1 General

a) *Contamination*

i. Definition
ii. Contaminants which cause increased drag thus affecting acceleration, and contaminants causing reduced braking action affecting deceleration
iii. Slippery when wet condition.

b) *Contaminated Runway*

i. Runway surface condition descriptors
ii. Operational Observations with Friction Devices
iii. Operator´s policy on the usage of:
   - Reduced takeoff thrust
   - Runway thirds in take-off and landing performance calculations;
   - low visibility operations and autoland.
iv. Stopway
v. Grooved runway

c) *Runway Condition Codes (RWYCC)*

i. RCAM

- Differences between those published for aerodromes and flight crew
- Format in use
- The use of runway friction measurements
- The use of temperature
- The concept of performance categories and ICAO runway surface condition codes
- Interpretation of "slippery wet"
- Downgrade/Upgrade Criteria
- Difference between a calculation and an assessment

ii. Braking action

- Reporting of LESS THAN POOR ⇨ no operations

iii. Use of aircraft wind limit diagram with contamination

d) *Runway Condition Report (reference: Doc 10064)*

i. Availability

ii. Validity

iii. Performance and situational awareness

iv. Decoding

v. Situational awareness (reference: Doc 10064)

e) *Aeroplane control in takeoff and landing (reference: Doc 10064)*

i. Lateral control

- Windcock effect
- Effect of reversers
- Cornering forces
- Crosswind limitations, (including operations when cleared runway width is less than published

ii. Longitudinal control

- V1 correction in correlation with minimum control speed on ground
- Aquaplaning

- Anti-skid
- Autobrake

f) *Takeoff distance*

i. Acceleration and deceleration
ii. Takeoff performance limitations
iii. Takeoff distance models
iv. Factors affecting Takeoff distance
v. Why to use the type and depth of contaminant instead of Runway Condition Code
vi. Safety margins

g) *Landing distance*

i. Distance at time of arrival model
ii. Factors affecting landing distance
iii. Safety margins
   - A. Non-Normal Configuration (NNC) does not include any additional margins (e.g. 15%)

h) *Exceptions*

i. States that do not comply with ICAO standards for RCR and assessment of the Landing distance at time of arrival

5.1.2 Flight Planning

a) Dispatch/in-flight conditions

b) MEL/CDL items affecting takeoff and landing performance

c) Operator´s policy on variable wind and gusts

d) Landing performance at destination and alternates

i. Selection of alternates if an aerodrome is not available due to runway conditions
   - En-route
   - Destination alternates

ii. Number

iii. Runway condition

5.1.3 Takeoff

a) Runway selection

b) Takeoff from a wet or contaminated runway

5.1.4 In-flight

a) a) Landing distance

i. Distance at time of arrival calculations

- Considerations for flight crew
- Operator´s policy

ii. Factors affecting landing distance

iii. Runway selection for landing

iv. Safety margins

b) Use of aircraft systems

i. Brakes/autobrakes

ii. Difference between friction limited braking and different modes of autobrakes

iii. Reversers

iv. Aeroplane as a friction-measuring and/or reporting system

5.1.5 Landing Techniques

Flight crew procedures and flying techniques when landing on length limited runway (reference: Doc 10064)

5.1.6 Safety Considerations

a) Types of errors possible

b) Mindfulness principles necessary for high reliability

5.1.7 IREPs (reference: Doc 10064)

a) Assessment of braking action

b) Terminology

c) Automated/aircraft–generated braking action reports, if applicable

d) Air safety reports, if flight safety has been endangered due to insufficient braking action

5.1.8 Specific Areas Concern Runway Surface Conditions and Reporting Format

The introduction of the runway surface condition assessment and reporting format has highlighted some specific areas that should be addressed as part of a training plan, including:

5.1.9 Specific Areas Concern Runway Surface Conditions and Reporting Format

The introduction of the runway surface condition assessment and reporting format has highlighted some specific areas that should be addressed as part of a training plan, including:

a) **Techniques used as a best practice for one organization may not be applicable for others:** Example: Airports that operate frequently in winter conditions may develop observational techniques that rely on extensive experience and apprenticeship. Other airports may find it hard to match that same level of expertise. Using vehicle braking observations, for example, may not be a best practice if the airport is not exposed to winter conditions long enough to maintain this type of corporate knowledge.

b) **Misunderstanding terminology:** Technical discussions on runway observations and aircraft vehicle performance can have similar sounding terms and even numbers: "MU" being a primary example. Anyone using an RCAM should understand what the terms are, and how they are related.

c) **Timeliness of communication:** Beyond 180 NM, flight crews may obtain information from airports in order to make runway surface condition assessments. Between 180 and 40 NM, any change in condition reporting must be communicated to the flight crew. Within 40 NM, any change in runway surface condition must be pro-actively communicated to the aircraft. Any change in condition that occurs too quickly for the flight crew to take notice of can invalidate their assessment and lead to unexpected risk.

d) **Conflicting reports between pilots and aerodromes**: There may be a range of aeroplane performance indicators for a given runway. In some cases, the pilot report of braking action (AIREP) may be more accurate than the condition report. These reports can be more or less conservative than the original report by the aerodrome. If an operator wishes to base their risk management process on an AIREP that is less conservative than a runway condition report, the process must be carefully designed to demonstrate and maintain an equivalent level of quality assurance regarding risk exposure.

e) **Operational bias:** Much of the observational criteria for an RCAM depends on judgment that can be subject to social, political and economic pressures. The differences between 3 mm and 5 mm of contaminant or between wet snow and slush can have a large effect on operations. It is a human factors norm that people tend to bias perceptions in favour of what they expect to hear and see and disregard information that does not fit into a pre-planned expectation. This lack of mindfulness can contribute greatly to errors in the perception, assessment, and reporting of runway surface conditions from flight crews and airports.

5.1.10 Documentation and Records

An operator is required to maintain the training records of GRF topic to ensure the content and compliance of the regulation.

6. Appendix

6.1 Appendix A: Example for Operating Procedure related to Landing Performance at Time of Arrival

6.1.1 During the Approach Preparation and Briefing

Consider the following elements during the approach preparation phase of the landing:

a) acquire the latest available meteorological and RCR, preferably not more than 30 minutes before the expected landing time. In dynamic weather conditions, the latest available information on the runway condition must be used;

b) evaluate the likelihood of significant changes to runway surface conditions, based on the age of the report and evolution of outside conditions. Be aware that winter runway conditions may change not just due to meteorological and environmental effects such as active precipitation or changes in temperature, humidity or solar radiation, but also due to mechanical factors such as traffic and removal. Depending on the operational context, the flight crew should reasonably assess the worst case in which the currently reported runway condition may degrade to;

c) set limits for deteriorating conditions. By preparing for the worst case scenario, check performance and crosswind capability. Establish to which value a parameter (wind/RWYCC) can deteriorate before a safe landing is no longer assured. Include this value in the approach briefing for enhanced collision risk model (CRM) during the approach;

d) evaluate if another runway can provide significantly better safety margins (due to different LDAs, greater margins may be achieved in tail wind conditions). Request this runway as desired to reduce risk exposure;

e) in performance calculations:

   i. use the correct RWY. Calculate for other RWYs if there is a chance for a late RWY change;

ii. use the correct elevation and slope if not automatically set. A higher aerodrome elevation increases the ground speed at which the aeroplane approaches. A higher approach speed has a large impact in terms of the length of the ground roll. A downward slope has a significant impact on the deceleration on slippery runways;

iii. use conservative wind assumptions in variable and gusty conditions, i.e. use an increased tail- or reduced headwind. Wind is measured and reported as an average value over a certain time at a height of 10 m; the real wind may vary from this value. A conservative wind assumption ensures that late changes can be evaluated simply and without doubt as to their performance effect;

iv. use conservative temperature assumptions, i.e. use a higher temperature if it is expected to increase, for example, due to sun rise. Higher temperatures increase the ground speed at which the aeroplane approaches;

v. do not use a higher QNH1/QFE2 than reported. What matters to performance is the pressure altitude. Assuming a higher air pressure leads to a reduced pressure altitude at given elevation;

vi. interpret the RWYCC correctly:

- in case of RWYCC is given on each runway third, flight crew should apply company procedures when available. By default,
  - use the worst RWYCC value of the whole runway (excessively conservative) or;
  - establish policy for disregarding a part of runway such as;
    - use only the last two thirds RWYCC for landing distance calculations or;
    - consider only first two third of runway that will be used for landing if the calculated landing distance, including 15% safety factor, is not more than the 2/3 of runway length.
- if receiving RWYCC, AIREP and/or friction measurement, consider using the worst reported condition; and

- consider RWYCC reporting time and rapidly changing weather, as described above. Assess the worst likely degradation if necessary.

f) insert the intended approach speed. The energy to be dissipated during the landing roll increases with the square of the speed;

g) select the intended braking method. Dispatch considers maximum effort manual braking immediately after main gear touchdown. Autobrakes target a specified deceleration rate for a given setting and typically include a longer delay after touchdown. Many operators include the use of autobrakes in their standard operating procedures. The achievable landing distance without overriding with manual braking may thus be significantly increased;

h) select the intended flap and reverse settings. Higher flap settings allow lower approach speeds. Lower flap settings improve go-around climb capability. Most manufacturers recommend the use of maximum reverse on contaminated runways. Calculated distances typically consider reverser stowage around 70 to 60 kt to avoid re-ingestion of the reversed airflow. Reverse thrust may need to be deselected during the ground roll to regain lateral control on slippery surfaces;

i) select the correct use of automation (autopilot/autothrust). Avoid autoland if possible. The use of autothrust typically requires an increment on the minimum certified approach speed. Autoland is designed to ensure touchdown on the runway centreline, but typically results in increased flare distance as the system is not aiming at a specific touchdown point the way a pilot would;

j) remember to include any defects and their influence. The loss of system failures can lead to an increase of approach speed and/or the loss of braking means (spoilers, brakes or reversers). It may not be advisable to attempt landing on contaminated runways with or without partial reverse thrust available, or with an inoperative anti-skid system;

k) compare calculations to cross-check;

l) check that the cross-wind is within limits;

m) set autobrake as required;

n) brief the intended flying methods thoroughly; and

o) note the runway safety areas and arresting systems. Pilots must be aware of an arresting system installed in lieu of a runway end safety area (RESA), when installed.

6.1.2 Approach

Consider the following elements during the approach phase of the landing:

a) ensure that all landing distance calculation parameters are still valid (current) and that the runway surface condition has not degraded to a level below the worst acceptable condition determined in the approach preparation. This assessment should be biased on the wind reported by METAR whenever it is more conservative than that provided by air traffic control. It may be more representative of prevailing conditions as it is averaged over a longer period;

b) arm spoilers;

c) fly the correct approach speed. Excess approach speed increases the stopping distance by around 8 percent per 5 kt and can additionally lead to extended flare;

d) fly a stabilized approach. Be stable latest at 1000 ft above airport elevation;

e) avoid autoland, follow manufacturer restriction on the use of auto-rollout on contaminated runways;

f) use the correct aiming point;

g) just before touchdown, ensure the airplane trajectory is parallel to the runway centreline. Lateral control may be reduced on contaminated runways; and

h) if all of the above are not fulfilled, go around.

6.1.3 Touchdown

Consider the following elements for the touchdown phase of the landing:

a) touch down on the centreline at the intended touchdown point;

b) with a brief flare, make a firm touchdown to ensure the weight is on the wheels. A firm touchdown ensures spin-up of the tires, even on slippery runway, and a correct initialization of the anti-skid system, ensuring its efficiency. Aerodynamic braking is less efficient than wheel braking. A slow de-rotation can delay the autobrake onset;

c) apply wheel braking as soon as possible in accordance with the operations manual;

d) lower the nose gear without delay. Nose gear ground contact ensures better lateral control and maximum lift dumping, which increases the landing gear load and thus braking force;

e) apply appropriate reverse thrust as soon as possible, in accordance with the operations manual; and

f) do not initiate go-around after selecting the reverse thrust as reversers may not stow correctly.

6.1.4 Deceleration

Consider the following elements for the deceleration phase of the landing:

a) maintain all deceleration methods, including reverse, until the pilot can ensure that the airplane will stop on the remaining runway. While normal procedures usually prompt reverser reduction to idle around 70 to 60 kts, a reverse thrust can be maintained to full stop when required;

b) maintain aerodynamic control during the whole deceleration;

c) in case of loss of directional control (airplane weathercocking), reduce the reverse thrust to idle. Apply appropriate reverse again after gaining directional control;

d) to achieve asymmetric braking when required on slippery runways, completely release the pedal on the opposite side of the desired turn, as a partial release may not result in commanding less than the friction limited braking;

e) remember that "popular" runway exit points usually provide less braking action than surrounding surfaces; and

f) slow down to a very slow taxi speed before attempting to turn the tiller.

6.2 Appendix B: Example for GRF Self-Assessment Matrix

Descriptions	Yes	No	Comments/References
Has the Company establish operational limitations that related runway surface condition and prevailing weather conditions? (e.g. crosswind limitations in accordance with "limitation" section in AFM)	☐	☐	
Has the Company establish standard operating procedure to determine landing distance at time of arrival for pre-flight and in-flight phase by utilizing runway condition report (RCR)?	☐	☐	
Has the Company establish criteria to consider that how much deterioration in runway surface friction characteristics could be accepted when meteorological conditions may lead to a degradation of the runway surface condition?	☐	☐	
Has the company provide approved aeroplane performance and/or supplementary data from the manufacturer or performance data provider to flight crew for determining landing distance at time of arrival. If not, has company establish method to determine landing distance at time of arrival?	☐	☐	
Has the Company establish standard operating procedure for pilot air-report (AIREP) on braking action where experienced braking action is worse than the reported braking action?	☐	☐	
Has the company establish ICAO-GRF Training programme for flight crew and flight operational control/dispatcher in accordance with guideline in this document, Cir 355 appendix H or other guideline that acceptable to the Authority?	☐	☐	