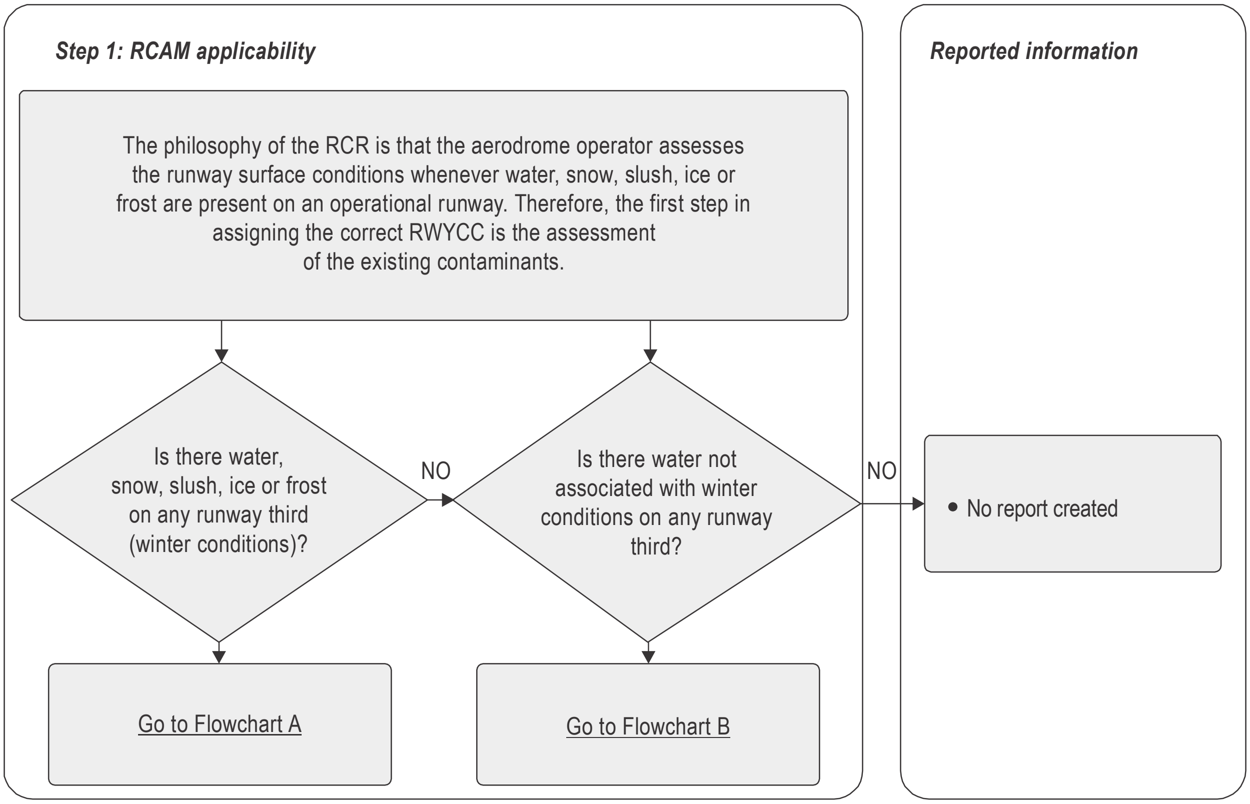

Figure 4-3. The basic RCAM flowchart process

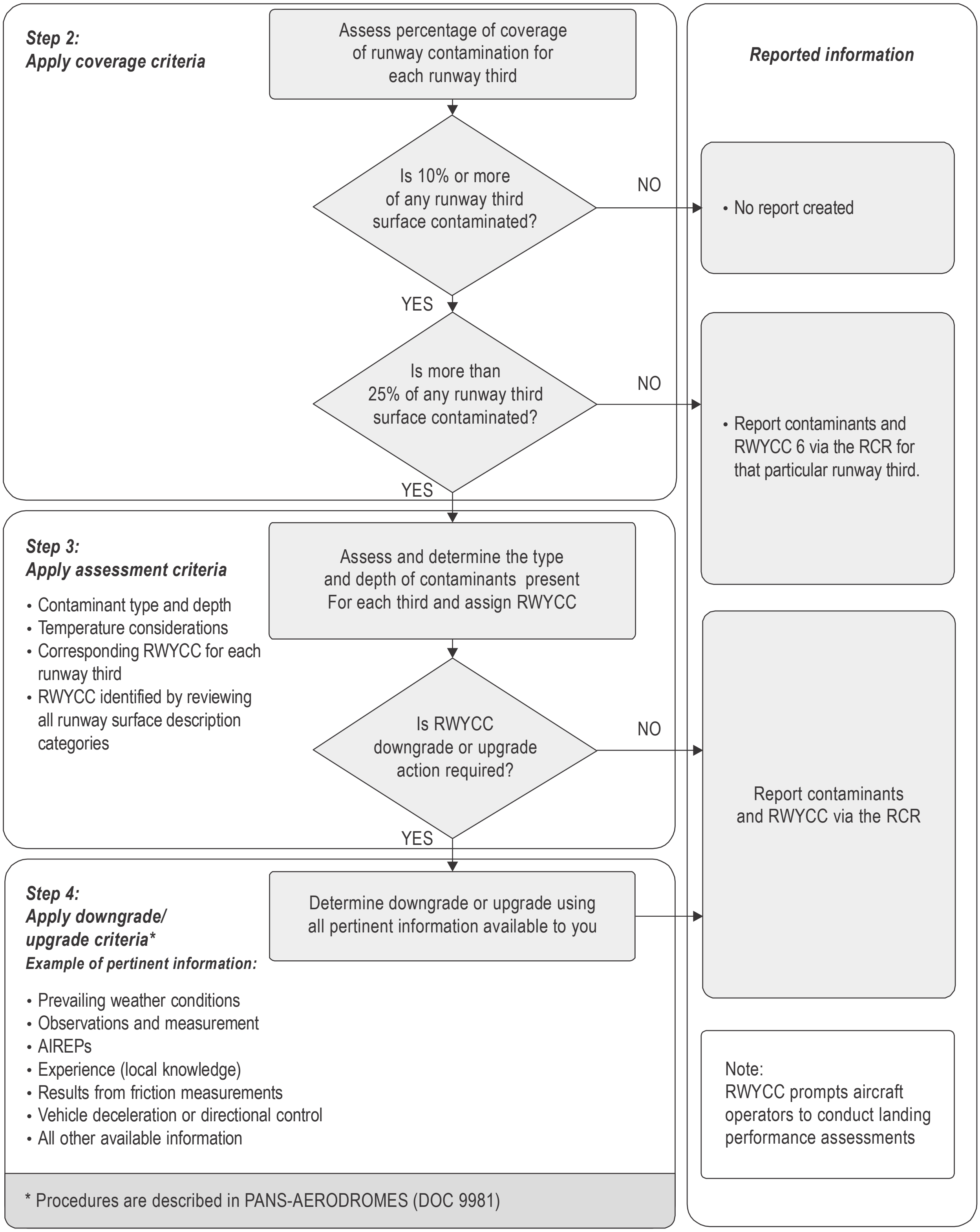

Figure 4-4. Flowchart A

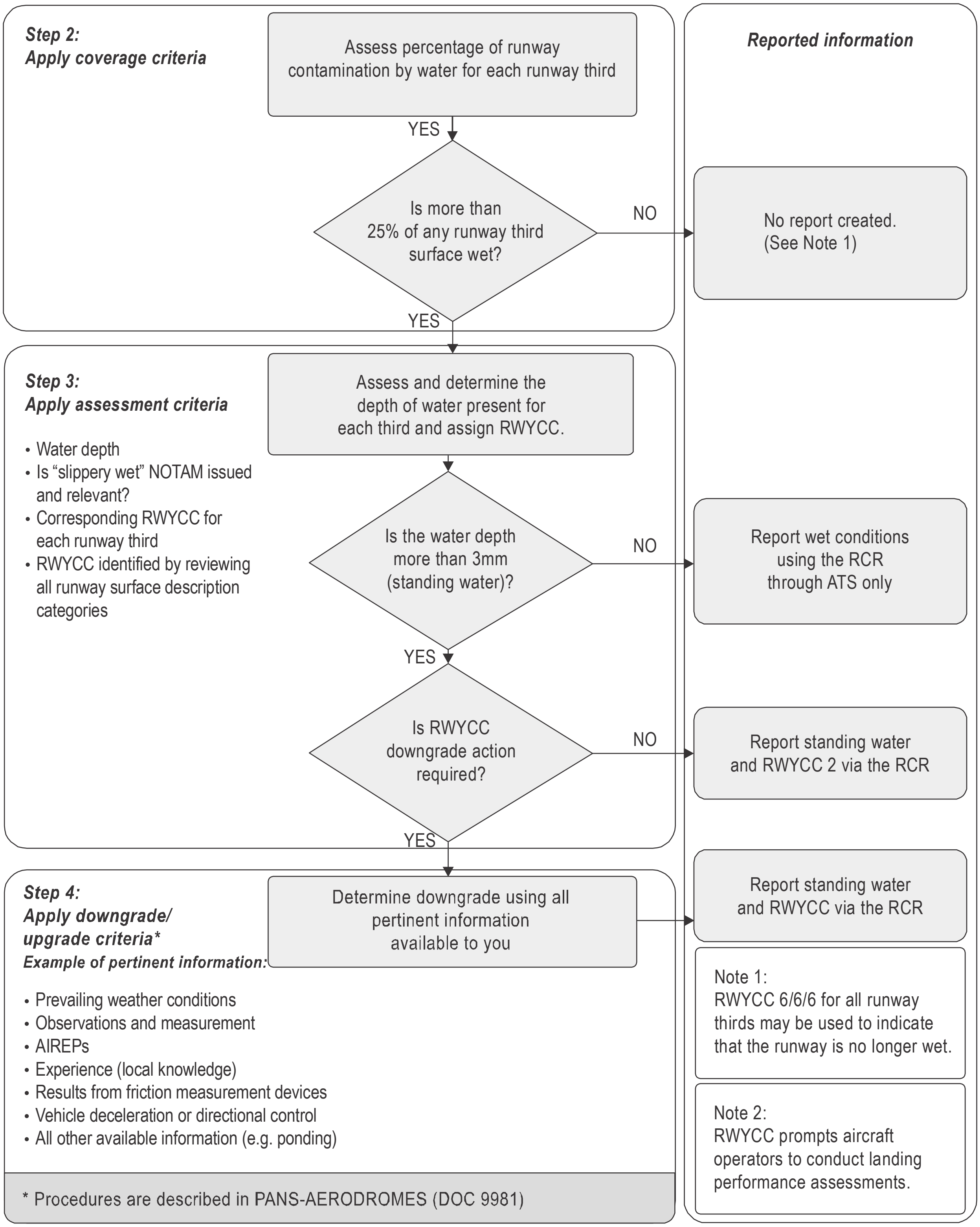

Figure 4-5. Flowchart B

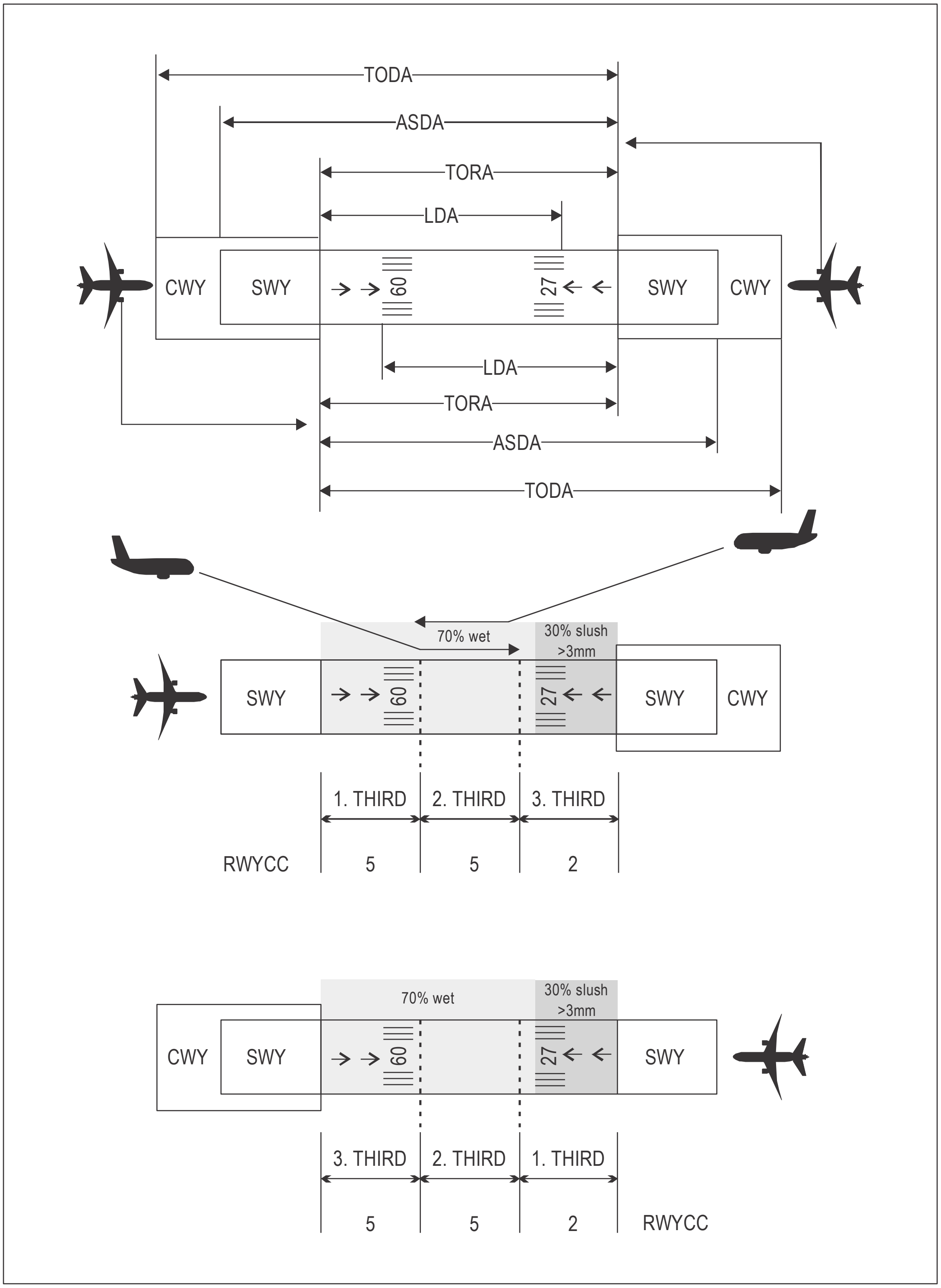

Figure 4-6. Reporting of RWYCC for runway thirds from ATS to flight crew on a runway with displaced threshold

DISPLACED THRESHOLD AND REPORTING OF RWYCC

4.51 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.

4.52 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.

4.53 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.

ICAO REPORTING FORMATS

4.54 The need to report and promulgate runway surface conditions is specified in Annex 14, Volume I, 2.9.1, which stipulates that information on the condition of the movement area and the operational status of related facilities shall be provided to the appropriate aeronautical information services (AIS) units, and similar information of operational significance to the ATS units, to enable those units to provide the necessary information to arriving and departing aircraft. The information shall be kept up-to-date and changes in conditions reported without delay.

4.55 Information on the runway surface condition includes the runway surface friction characteristics, which are assessed according to the aerodrome maintenance programme, the presence of water, snow, slush, ice or other contaminants on the runway, as well as the RWYCC in operational conditions.

4.56 ICAO's methods of reporting and promulgating information are as follows:

a) aeronautical information publications (AIPs);

b) aeronautical information circulars (AICs);

c) notice to airmen (NOTAM);

d) SNOWTAM;

e) AIREPs;

f) automatic terminal information services (ATIS); and

g) air traffic control (ATC) communications.

The reporting formats for a) to d) are described in Annex 15 — *Aeronautical Information Services*. The SNOWTAM template is shown in Appendix G of this document. The reporting formats for e), f) and g) are described in the *Procedures for Air Navigation Services — Air Traffic Management* (PANS-ATM, Doc 4444).

4.57 The increasing use of ground/air-ground data link and computerized systems, both on board the aircraft and on the ground, is being progressively supplemented with digitized information.

4.58 Currently, Annex 15 still requires, inter alia, a description to be provided in the AIP of the type of friction measuring device used, although it is accepted that those values cannot be related to aircraft performance. In addition, the runway surface friction characteristics are required to be described in the AIP, AICs and NOTAMs. For winter operations, a brief description of the snow plan is also required to be promulgated in the AIP.

Aeronautical information publication (AIP)

4.59 Friction issues in the AIP are related to:

a) runway physical characteristics; and

b) the snow plan.

4.60 *Procedures for Air Navigation Services — Aeronautical Information Management* (PANS-AIM, Doc 10066), Appendix 2, Part 3 — Aerodromes (AD), AD 2.12, requires that a detailed description of runway physical characteristics be provided. The physical characteristics of a wet, skid-resistant surface can be included in the remarks.

4.61 As per AD 1.2.2, a brief description should be given of general snow plan considerations for aerodromes and heliports available for public use at which snow conditions are normally liable to occur. Related friction issues include:

a) measuring methods and measurements taken;

b) system and means of reporting;

c) cases of runway closure; and

d) distribution of information about snow, slush or ice conditions.

Aeronautical information circular (AIC)

4.62 An AIC should be originated whenever it is necessary to promulgate aeronautical information that does not qualify for inclusion in an AIP or a NOTAM. Related friction issues include the advance seasonal information on the snow plan.

Notice to airmen (NOTAM)

4.63 A NOTAM should be originated and issued promptly whenever information to be distributed is of a temporary nature and of short duration or when operationally significant permanent changes or temporary changes of long duration are made at short notice.

4.64 This applies to the friction issues related to the:

a) physical characteristics published in the AIP; and

b) presence or removal of, or significant changes in, hazardous conditions due to snow, slush, ice or water on the movement area.

DATA GATHERING AND INFORMATION PROCESSING

4.65 Several automated systems are becoming available to provide a remote indication of runway surface conditions, while others are still under development. At present, these systems are not in widespread use, and systems that provide an accurate indication of braking action seem a long way off. This unavailability strongly affects the related communication process.

4.66 Consequently, aerodrome operators need to gather relevant data, process the related information using manual systems and make information available to users using conventional ways that require a considerable amount of time in addition to the need to obtain access to runways, which is often difficult, particularly at busy aerodromes.

4.67 Presently, the primary means of communication are ATIS and ATC, in addition to SNOWTAM.

Automatic terminal information service (ATIS)

4.68 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 about the runway condition should be mentioned whenever the runway is not dry (RWYCC 6):

Aeroplane performance section:

a) operational runway in use at time of issuance;

b) RWYCC for the operational runway, for each runway third in the operational direction;

c) condition description, coverage and depth (for loose contaminants);

d) width of the operational runway to which the RWYCC applies, if less than the published width; and

e) reduced length, if less than the published length.

Situational awareness section:

f) drifting snow;

g) loose sand;

h) operationally significant snowbanks;

i) runway exits, taxiways and apron if POOR; and

j) any other pertinent information in short, plain language.

4.69 One inherent weakness in the ATIS system is the currency of the information. This is due to the fact that flight crews generally listen to ATIS on arrival, some twenty minutes before landing, and in rapidly changing weather, the runway conditions may alter dramatically in such a time span.

Air traffic control (ATC)

4.70 The organization responsible for gathering data and processing information of operational significance relating to runway conditions usually transmits such information to ATC, and ATC, in turn, provides this information to the flight crew if different from the ATIS. At present, this procedure appears to be the only one that is able to provide timely information to the flight crew, especially in rapidly changing conditions.

4.71 In addition to being timely, information disseminated through ATC may contain additional information associated with weather observed and forecasted by meteorological (MET) personnel, even before it is available on ATIS, as well as information gathered by other flight crews, such as braking action reports. This arrangement provides pilots with the best possible information available within the current system for sound decision-making.

4.72 Finally, where visibility conditions and aerodrome configuration permit, ATC can provide the flight crew, at very short notice, with their own immediate observations, such as a rapid change in rainfall intensity or the presence of snow, notwithstanding that this may be considered as unofficial information.

Communication network

4.73 Air-ground communication between the flight deck and ATS has generally been conducted through radiotelephony speech but large areas remain beyond the high frequency (HF) or very high frequency (VHF) coverage. The burden of voice communication and the saturation of present ATC capabilities have created a strong demand for automated ATS transmission of which digital data link has become a key element. Therefore, in the near future, service providers and users will need to adapt their ground communications systems to international data link requirements.

DIGITAL NOTAM

4.74 A transition strategy is being developed to ensure the availability of real-time accredited and quality-assured aeronautical information to any air traffic management (ATM) user in a globally interoperable and fully digital environment. It is recognized that to satisfy new requirements arising from the Global ATM Operational Concept, AIS must transition to the broader concept of aeronautical information management (AIM).

4.75 One of the most innovative data products that will be based on the standard aeronautical data exchange model is a digital NOTAM that will provide dynamic aeronautical information to all stakeholders with an accurate and up-to-date common representation of the aeronautical environment in which flights are operated. The digital NOTAM is defined as a data set that contains the information included in a NOTAM in a structured format which can be fully interpreted by an automated computer system for accurate and reliable updating of the aeronautical environment, both for automated information equipment and humans.

Chapter 5

AIRCRAFT OPERATIONS

FUNCTIONAL FRICTION CHARACTERISTICS

How rolling, slipping and skidding affect the aircraft

5.1 *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.

5.2 *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.

5.3 *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.

Rolling friction forces

5.4 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 per cent of the aircraft apparent weight.

Braking forces — general effects

5.5 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).

5.6 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.

5.7 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, μ_{max}, can exceed 0.6, which means that the braking force can represent more than 60 per cent of the load on the braked wheel. On a dry runway, speed has little influence on μ_{max}. When the runway condition is degraded by contaminants such as water, rubber, slush, snow or ice, μ_{max} can be reduced drastically, affecting the capability of the aircraft to decelerate after landing or during a rejected take-off.

5.8 The general effects of runway surface conditions on the braking friction coefficient are briefly summarized in paragraphs 5.9 to 5.17 below.

5.9 *Wet condition (up to 3 mm of water).* μ_{max} 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 kt, μ_{max} 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.

5.10 On a wet runway, μ_{max} is also dependent on runway texture. A higher microtexture (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.

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

5.12 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.

5.13 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 kt. Once started, the dynamic aquaplaning effect may remain a factor down to speeds significantly lower than those necessary to trigger it.

5.14 *Solid contaminants (compacted snow, ice and rubber).* These contaminants affect the deceleration capability of aircraft by reducing μ_{max}. These contaminants do not affect acceleration.

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

5.16 The stopping capability on ice can vary depending on the temperature and roughness of the surface. In general, wet ice has very low friction (μ_{max} 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.

5.17 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. Runway maintenance should 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.