

## CHAPTER 15 - AVIATION PSYCHOLOGY

### 1 INTRODUCTION

The performance of aviators requires certain cognitive, psychomotor and interpersonal capabilities in order to perform operational tasks in a reliable way especially during high workload and stress. These capabilities may decrease to such a critical level that safe flight operation is no longer [possible]. However, a reduction in pilot capability is never easily detected or demonstrated. The majority of accidents in aviation is caused by human error not by physical incapacitation or technical failures. People may become unsafe for various reasons [. Problems may be] low mental [capacity], [ ]psychomotor [problems, inadequate decision making] or accelerated ageing, to name a few. Such personal conditions are not usually classified by psychiatric and neurological standards as disqualifying criteria. They have to be assessed by a psychological evaluation.

### 2 INDICATION

A psychological evaluation should be considered when the AMS receives information which evokes doubts concerning the mental fitness or [the] personality of a particular individual. Sources for this information can be accidents or incidents, problems in training or proficiency checks, delinquency or knowledge relevant to the safe exercise of the privileges of the applicable licences. [Dependent upon the individual case] the evaluation [may be separate], part of, or complementary to, a specialist psychiatric or neurological examination.

### 3 TESTING FACILITIES

Only psychologists acceptable to the AMS or organisations which employ psychologists acceptable to the AMS are allowed to perform the psychological evaluation [in the aeromedical context mentioned].

### 4 PSYCHOLOGICAL CRITERIA

The [ ]psychological evaluation includes a collection of biographical data, the [assessment of aptitudes] as well as personality tests and a psychological interview. The following aspects will be investigated:

- a *Biography*
  - i General life history
  - ii Family
  - iii Education
  - iv Socio-economic status
  - v Training progress and occupational situation
  - vi Critical behavioural incidents
  - vii Diseases and accidents
  - viii Delinquency

- b *Operational aptitudes*
  - i [Reasoning]
  - ii Mental arithmetic
  - iii Memory function
  - iv Attention
  - v Perception
  - vi Spatial comprehension
  - vii Psychomotor function
  - viii Multiple task abilities
  
- c *Personality factors*
  - i [Working behaviour and performance style] [ ]
  - ii Social [capabilities]
  - iii [Emotional stability] [ ]

Definitions of aptitudes and personality factors as well as recommendations for the use of adequate test methods are further elaborated below.

## 5 OPERATIONAL APTITUDES

### 5.1 General considerations

The general demands on pilots (applicants for, or holders of a Class 1 medical certificate) require operational aptitudes like cognitive and psychomotor capabilities. The complexity of the tasks and the time stress inherent to flight deck operations necessitate an accurate and fast task performance. Therefore it is recommended, when feasible, to apply tests with tight time constraints.

An adequate performance in the aptitude categories listed below is regarded as essential.

### 5.2 [Reasoning]

#### a *Definition*

The ability to find rules [(Inductive Reasoning) or] to apply [logical rules] in various task situations, using verbal, mathematical and other abstract material [(Deductive reasoning)]. In aviation Deductive Reasoning is more important than Inductive Reasoning].

#### b *Description*

[Deductive] Reasoning is a cognitive process which refers to [application of] general rules or analogies [in order to find problem solutions or to make proper] judgements. [This also includes mathematical tasks].

### 5.3 **Mental arithmetic**

a *Definition*

The ability to mentally operate with numbers and to solve simple and more complex computational problems.

b *Description*

Mental arithmetic requires the practical and effective use of algorithms and working memory. Typical test items include mentally performing basic calculations[ ].

### 5.4 **Memory function**

a *Definition*

The ability to memorise and retrieve from memory visually and/or verbally coded information [and to process information in the working memory].

b *Description*

The use of memory refers to holding a detailed record of sensory information for a relatively brief period of time, after which forgetting will occur unless special efforts are made to retain the information, as by rehearsal, long enough to permit identification and classification of sensory information and response with corresponding behavioural actions.

Memory function testing may include visual and/or auditory tests for working memory, tolerance against interference by required responses, memory for instructions.

### 5.5 **Attention**

Important aspects of attention are concentration, vigilance, divided attention and selective attention. [In aviation most information is processed via the visual and the auditory system.]

a *Concentration*

i *Definition*

The ability to direct attention for a long time to a task in order to attain a stable performance.

ii *Description*

Concentration refers to a high degree of continuous and focused attention which requires a high degree of effort. Fluctuations in concentration are reflected in the selective aspects of task performance (tunnelling, distraction). Tasks of concentration may include both monotonous tasks and tasks of varying difficulty, as well as of long duration.

b *Vigilance*

i *Definition*

The ability to maintain a state of readiness [and attention] for a long time in order to detect and respond to certain specified, infrequently occurring events in a stream of [potentially distracting] events which have to be neglected.

ii *Description*

In vigilance tests the subject has to pay attention to all the events, most of which do not need a response. Good vigilance is reflected by a high probability of detecting a signal, a low errors rate and a high speed of response.

c *Divided attention*

i *Definition*

The ability to direct attention to different tasks simultaneously in an efficient and effective way.

ii *Description*

The subject has to perform several tasks at the same time by setting priority and switching attention quickly and effectively between tasks (time sharing, see also multiple task abilities).

d *Selective attention*

i *Definition*

The ability to direct attention selectively to one of several sources of information by switching the focus of attention.

ii *Description*

Tests of selective attention may include measuring the ability to discriminate among various sources of sensory information and attend to one without being distracted by irrelevant information.

5.6 **Perception**

[Perception is the interpretation of the information taken in by our senses. It is the] ability to perceive information, auditory and visual, in an effective and efficient way. Relevant aspects of perception are: perceptual speed and [ ]closure.

a *Perceptual speed*

i *Definition*

The ability to perceive information quickly and accurately, simple as well as complex material.

ii *Description*

Perceptual speed can be assessed by e.g. tachistoscopic instrument reading tests.

b *[Flexibility and speed of] closure*

i *Definition*

[The ability to recognise incomplete forms, i.e. that incomplete objects or patterns are perceived as complete ones or a whole (the literature uses the German term 'Gestalt') or] to form 'Gestalts' from [ ]incomplete [or masked] material[ ].

ii *Description*

Tests presenting incomplete figures or tests where "hidden" figures are to be detected are appropriate.

5.7 **Spatial comprehension**

Two aspects of spatial comprehension should be assessed which can be designated by the classical psychological terms '*Visualisation*' and '*Spatial Orientation*'.

a *Visualisation*

i *Definition*

The ability to construct an appropriate mental image of two or three-dimensional spatial patterns and to manipulate or to transform these images into other visual arrangements.

ii *Description*

One indicator of good visualisation is the capability of rotating mental images, e.g. the capability of identifying given spatial patterns, even if these patterns are presented at various orientations in the picture plane.

[b] *Spatial Orientation*

i *Definition*

Spatial Orientation is the ability to perceive correctly the spatial relations between objects or parts of a spatial pattern in a two- or three-dimensional space and to maintain orientation even if these objects or patterns are seen from different perspectives.

ii *Description*

Spatial Orientation is closely related to visualization. However, whereas visualization is characterized by the capability of transforming mental images, Spatial Orientation involves the perception and mental representation of spatial relations between fixed (immovable) objects or parts of abstract patterns with the observer himself as a reference frame. Typical tests of Spatial Orientation involve the differentiation between left, right, above, and below dependent on the position of the subject.]

5.8 **Psychomotor function**

Two aspects of psychomotor function [, as defined below,] should be assessed, namely, psychomotor co-ordination and [ ]reaction time.

a *Psychomotor co-ordination*

i *Definition*

Psychomotor co-ordination can be defined as the capability to co-ordinate the [movements] of arms, hands and feet in response to visual [or auditory] stimuli.

ii *Description*

Usually tests of psychomotor co-ordination involve some kind of display-control tasks, where the subject has to control a dynamic system by means of appropriate (joystick) and/or pedal inputs.

b *[Reaction] time*

i *Definition*

[Reaction] time can be defined as the interval between the onset of a stimulus [ ]and the subjects correct response.

ii *Description*

[Simple] reaction time [is the ability to give a fast response to one signal. More important in aviation is the choice reaction time. Choice] reaction time is measured in tasks, where the presented stimulus is randomly chosen from a set of different stimuli each of which is associated with a certain response. In order to vary the degree of

cognitive control associated with response choice, the assessment of choice reaction time should include a comparison of those for (spatial) compatible and incompatible stimulus-response mappings. Stimulus response compatibility in this sense is given when the spatial arrangement of stimuli required (e.g. light on the left requires response with the left hand). Furthermore the possibility of speed-accuracy trade-offs should be taken into account by a recording of error rates.

## 5.9 Multiple task abilities

### a *Definition*

Multiple task abilities (time sharing abilities) can be defined as abilities which are needed in situations where at least two independent tasks have to be performed simultaneously.

### b *Description*

Multiple task abilities include:

- i effective timing of responses,
- ii rapid [inter-task] switching,
- iii parallel information processing,
- iv adequate allocation of processing resources according to task priorities.

Usually a high level of multiple task abilities is reflected in relatively low performance decrements (compared with single task performance) in the tasks to be performed simultaneously, and relatively small performance trade-offs between these tasks under multiple task conditions. In order to assess multiple task abilities, multiple tasks should be used which consist of at least dual tasks that are similar with respect to their demands on response related resources (e.g. psychomotor tasks which are similar in their demands on response-related resources, or memory demanding tasks, which are similar in their demands on perceptive-cognitive resources).

## 6 PERSONALITY FACTORS

### 6.1 General considerations

[Personality factors which are important in aviation can be divided into three categories. These categories include personality factors which are related to working behaviour and performance, to social capabilities and to the emotional stability of a person. Facets of all three aspects are a necessary completion of the operational aptitudes as listed above. These personality factors are not only important in the psychological evaluation of pilot applicants, but have a direct impact on behaviour of licence holders in daily flight environments. Personality factors related to work orientation and performance are important for aspects like flight preparation, situational awareness, decision making, risk taking behaviour, physical fitness and other aspects in aviation. Factors of social capabilities have to be considered particularly in respect to leadership behaviour, crew co-ordination and crew resource management. Emotional instability can directly affect performance as well as social behaviour and is the cause for many performance or health problems in a flying career.

A world wide accepted model of personality structure is the OCEAN – model, also known as the Big-Five -Model. Five personality factors (Openness, Conscientiousness, Extraversion, Agreeableness, Neuroticism) have to be found as very stable personality traits mostly independent from cultural differences.] The concept behind this trait-oriented assessment is that relatively stable dispositions are influencing behaviour under various conditions in a typical way. Although there is no doubt that such dispositions do exist, there is even no doubt that actual behaviour is not only a function of these traits but also a complex dynamic process where the traits interact with a manifold of other aspects, e.g. actual individual needs or situational demands.

The trait structure itself can also be the reason for specific dependencies. Certain combinations of trait intensities can interact in the way of typical syndromes. Therefore, in applying the personality traits as evaluation criteria it has to be carefully considered that such complex psychological processes exist and might display critical information in addition to pure trait assessment. Often such information is revealed by behavioural observation and psychological interview which should follow psychometric testing.

[Three categories of personality factors are important for aviation (working behaviour and performance style; social capabilities; emotional stability). They are described with their facets in the following.]

## 6.2 [Working behaviour and performance style]

### a *Definition*

The disposition to develop, direct, regulate and maintain energy in order to reach an objective (despite obstacles or difficulties) while keeping up a positive attitude towards work, tasks and, in general, towards occupational demands.

### b *Description*

[The main personality factors related to this category are “Conscientiousness” and partly “Openness” with their different aspects. Important indicators are need of achievement, rigidity, readiness to acquire new knowledge and skills, acceptance of responsibility, vitality, mobility and decision making.]

#### i **Need of achievement**

##### a *Definition*

The aspiration to succeed in competition with some standards of excellence.

##### b *Description*

Achievement oriented individuals prefer challenging situations with moderate risks, like to get performance feedback, like to perform well and better (mastery) and attribute successful performance to internal factors like personal effort and/or abilities.

#### ii **[Rigidity]**

The tendency how structured and systematic people are as well as how flexible they are in new situations.

#### iii **Readiness to acquire new knowledge and skills**

Readiness and open-mindedness to acquire new knowledge and skills which are necessary for the successful conduct of new tasks and responsibilities.

#### iv **Acceptance of responsibility**

The readiness to accept formal roles, tasks and duties and to behave accordingly.

#### vi **Vitality**

The positive attitude towards physical activities like sports, hiking, mountaineering.

#### vi **Mobility**

The readiness to be open for new activities, to move, to travel, to take risks.

vii **Decision making**

a *Definition*

Decision making is the capability to choose actions properly in complex situations where several alternatives are possible. The capability is very important in aviation and is influenced by situational or personal factors like situational awareness, mental fitness, workload or different personality factors.]

b *Description*

Decision making is concerned with problem solving behaviour which only partially is based on knowledge and skills. Three different categories of decisions performed by humans can be distinguished.

- i Choice of alternatives,
- ii Decisions under uncertainty,
- iii Decisions after diagnosing available information (e.g. from displays or from crew members).

The efficiency of decision making varies as a function of many different factors including appropriateness of the mental representation of the problem structure, adequate problem solving heuristics, correct estimation of probabilities of events, workload and practice. Personality factors such as flexibility, creativity and dominance are also important.

6.3 **Social [capabilities]**

a *Definition*

The capability to develop, maintain and enjoy contacts and relations with other persons.

b *Description*

In interpersonal and group activities social capability is manifested by team orientation, verbal and non-verbal expressivity, sensitivity and tolerance with respect to individual needs and cultural differences. Team orientation includes effective management of human resources, situational/group oriented leadership style, acceptance of group objectives, tasks and roles and striving towards consensus.

The main personality factors related to this category are "Extraversion" and different facets of "Agreeableness" like dominance, empathy and aggressiveness.

i **[Extraversion]**

The need for affiliation and change paired with the disposition to communicate one's ideas, opinions and feelings in a manner that conforms to social forms.

Extreme [extraverts] possess a high requirement for the company with other people and social life. They quickly make and adapt to new friends which they keep in a loose fashion. They are extremely talkative, temperamental, quick-witted and skilled in social situations.

Extreme introverts do not mind being alone. They prefer small groups and have few but very close friends. They are taciturn, serious, reserved and inhibited in social situations.

ii **[Dominance]**

Dominance refers to the need for appreciation and leadership.

High dominant people have an extreme need for appreciation and have a tendency to take on responsibility and leadership in any case paired with the disposition to impose their own goals, ideas and wishes on others.

Low dominant people have the tendency to submit themselves under the goals and leadership of others. Usually they stay passive and avoid taking on responsibility in social situations.

iii Empathy

The ability to understand and feel with the experiences and emotions of other persons.

iv [Aggressiveness]

[Aggressiveness] is characterised by a lack of self-control regarding hostile reactions which manifests itself in spontaneous as well as reactive aggressivity.

Reactive aggressivity refers to a disposition to defend oneself against unfairness and attacks.

6.4 [Emotional stability]

a *Definition*

Emotional stability (or inversely "Neuroticism" as a main factor in personality) refers to the tendency to react in an appropriate and emotionally controlled way to situations which seem to be difficult or threatening.

b *Description*

People who score high on "Neuroticism" (or low on Emotional Stability) may experience primarily one specific negative feeling such as anxiety, anger, or depression or several of these emotions at the same time. They are emotionally reactive and respond emotionally to events that would not affect most people, and their reactions tend to be more intense than normal. They interpret ordinary situations often as threatening or frustrating and hopeless. Their problems in emotional regulation can make them unable to make decisions or to cope effectively with stress. They tend to avoid demanding situations. Beside the main personality factor "Neuroticism", aspects of stress management and, for professional pilots, the readiness to bear privations or deprivations are important.

i Neuroticism

A tendency to easily experience unpleasant emotions such as anger, anxiety, depression, or vulnerability.

ii Stress management

Stress coping is the capability to cope with external and/or internal stressors in order to maintain control and reach the objective. Contributing factors are emotional stability, readiness to bear privations, flexibility and stress management abilities.

Stress management is the capability to actively develop and implement cognitive and behavioural strategies in order to master stressful situations. It includes identification and evaluation of stresses and an active approach towards altering the sources of stress.

iii Readiness to bear privations

The disposition to accept, tolerate and adjust oneself to physical discomforts and/or psychological hardships like lack of privacy, sleep deprivation and separation from family.]

## 7 METHODOLOGICAL RECOMMENDATIONS

Because of the diversity of psychological methods (e.g. tests, questionnaires, observer ratings, interview data, biographical data) available for the assessment of the different criteria mentioned on the criteria list above, no tests, questionnaires or other methods have been recommended for the assessment of these criteria. However, general guidelines are described below for guidance and finding adequate assessment methods.

### 7.1 Tests and questionnaires

Whenever possible, standardised psychological tests and questionnaires which fulfil at least the following general requirements should be used for criteria assessment.

#### a *Reliability*

The stability (test-retest-reliability) or at least the internal consistency of tests/questionnaires has been proved (whenever possible with regard to an application in personnel selection).

#### b *Construct validity*

The extent to which a test-questionnaire measures the construct (aptitude, personality trait) it is intended to measure has been proved (whenever possible with regard to an application in personnel selection).

The test or questionnaire should clearly differentiate between the applications (ideally normal distribution of test scores) even in a highly pre-selected group like, e.g. holders of a pilot licence.

#### c *Norms*

In order to evaluate the test / questionnaire results of individual subjects, standard norms have to be available for the test / questionnaire. These norms should be derived from the distribution of test results in samples which are more similar in important characteristics (e.g. age, education, level etc.) to the group of applicants under discussion. For reasons of standardisation it is recommended to use STANINE scores as norms for all tests or questionnaire.

### 7.2 Rating scales and classification systems

In case that observer ratings are used for criteria assessment, it should be ensured that the observers are very well trained and that the inter-rater-reliability is high, i.e. that different observers agree about their evaluation of a certain behaviour shown by an applicant. As a rule, a high inter-rater-reliability can be achieved by using clearly defined rating scales and/or classification systems.

### 7.3 Sources of information

The whole test system used for the criteria assessment should be characterised by redundancy with regard to the sources of information used to assess the aptitudes/personality traits mentioned in the criteria list [(see 4 (b) and (c))]. Whenever possible each of these aptitudes/personality traits should be assessed/tested on the basis of at least two independent sources of information (tests, questionnaires, observer ratings, interview-data, biographical data). This kind of cross [evaluation] is recommended in order to improve the overall reliability of the whole test system.

### 7.4 Decision rules

The decision about the classification of an applicant or holder of a Class 1 or Class 2 medical certificate should be based on the following general rules. However, in the case of clear deficiencies in operational aptitudes of already experienced pilots, it has to be considered whether or not [personal] characteristics can compensate for the resulting risks.

a *Operational aptitudes*

In order to be assessed as non-critical an examinee should not have a clear deficiency in any operational aptitude as compared with the norm group (see paragraph 7.1.c, above).

b *Personality factors*

An examinee must be evaluated (by a psychologist) as non-critical with regard to the main personality factors:

- motivation and work orientation
- social capabilities
- stress coping

This usually implies that the examinee is not assessed as an extreme case with regard to the normal range of variation in the contributing factors.

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