

040

**HUMAN
PERFORMANCE
& LIMITATIONS**

**INSTRUMENT RATING (A)
(HUMAN PERFORMANCE AND LIMITATIONS)**

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
040 00 00 00	HUMAN PERFORMANCE AND LIMITATIONS	
040 01 00 00	HUMAN FACTORS BASIC CONCEPTS	
040 01 01 00	Human Factors in aviation - State that Human Factors training is an ICAO and JAA requirement. - Justify the relevance of Human Factors in aviation	
040 01 01 01	Competence and limitations - State that all participants in aviation activities have a role to play with respect to Flight Safety. - Give examples of possible individual and organisational limitations.	
040 01 01 02	Becoming a competent pilot - Describe the general factors to be considered in assessing the competency of a pilot. - List the qualities that a competent pilot will possess. - Stress the relationship between self-confidence and expertise. - Emphasise that a pilot should not to rely on formal training to increase expertise and importance self-training to achieve professionalism.	
040 01 02 00	Accident statistics - Give an estimate of the accident rate in commercial aviation. - Compare aviation accident rates with other means of transport. - State in general terms the percentage of aircraft accidents which are caused by human factors. - Name the major single cause for a pilot-induced accident. - Summarise the accident trend in modern aviation. - State that the role of accident statistics is primarily to develop strategies for future improvements to flight safety. - Name the most significant item of technical equipment introduced in the 1980's and 1990's which has contributed to the reduction of accidents.	
040 01 03 00	Flight safety concepts	

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	<ul style="list-style-type: none"> - Explain the importance for flight safety in understanding the causes and categories of accidents and incidents. - Describe and compare the elements of the SHEL model. - Describe the interaction between the different components of the SHEL model. - Summarise the relevance of the SHEL model to work in the cockpit. - Explain how the interaction between individual crew members can affect flight safety. - Identify and explain the interaction between flight crew and management as a factor in flight safety. 	
040 02 00 00	BASIC AVIATION PHYSIOLOGY AND HEALTH MAINTENANCE	
040 02 01 00	Basics of flight physiology	
	- List those factors which may effect the normal working of the human body when in flight.	
040 02 01 01	The atmosphere	
	- State the units used in measuring total and partial pressures of the gases in the atmosphere.	
	- State the composition in terms of % of Oxygen, Nitrogen of the gases in the atmosphere and the approximate altitude that these volume percentages will remain constant.	
	- State the Gas Laws, including:	
	Boyle's Law	
	Dalton's Law	
	Henry's Law	
	The General Gas Law	
	- State the relevance of each of the above Laws to Human Factors and their physiological significance.	
	- State at what altitudes in the standard atmosphere the atmospheric pressure will be ¼, ½ and ¾ of MSL pressure.	
	- Explain the oxygen requirement of tissues.	
040 02 01 02	Respiratory and circulatory systems	

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	<ul style="list-style-type: none"> - List the main components of the respiratory system and their function. - State the normal breathing rate and the volume of air exchanged with each normal breath (“tidal volume”). - State how oxygen and carbon dioxide are transported throughout the body. - Explain the process by which oxygen is transferred to the tissues and carbon dioxide is eliminated from the body. - Explain the role of carbon dioxide in the control and regulation of respiration. - Describe the process of inhalation and exhalation (“external respiration”) and the metabolism of carbohydrates in the body (“internal respiration”). - Name the major components of the circulatory system and describe their function. - Differentiate between veins, arteries and capillaries in their structure and function. - State the functions of the coronary arteries and veins. - Define “systolic” and “diastolic” blood pressures and give the normal values for an adult at rest. - List the composition of the blood and the purpose of the constituent parts. - Explain the function of haemoglobin. <p>Hypoxia</p> <ul style="list-style-type: none"> - Define ‘hypoxia’ - State that a healthy individual is able to compensate for altitudes up to approximately 10,000 to 12,000 feet. - List the signs and symptoms of hypoxia and define their characteristics. Explain their effects on flight safety. - Name the three physiological thresholds and their altitudes. - State the altitude at which “short-term memory” begins to be affected by hypoxia. - Describe the counter-measures against hypoxia. - Define the term “Time of Useful Consciousness” (TUC). - State the TUC for 20,000 ft, 30,000 ft, 35,000 ft and 43,000 ft. for a person at rest and when a person is moderately active. - List the factors determining the severity of hypoxia. - State the precautions to be taken when donating blood. 	

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	<ul style="list-style-type: none"> - Define 'anaemia'. - Differentiate between hypoxic hypoxia and anaemic hypoxia. Decompression - List the physiological and psychological effects of rapid decompression. - Detail how the effects of decompression sickness can be treated. - State the normal range of cabin pressure altitude in pressurised commercial aircraft and describe their protective function for aircrew and passengers. - List the vital actions that the crew must perform when cabin pressurisation is lost. - Define the hazards of diving and flying and state the regulations associated with these activities. Decompression Sickness - Identify the causes of decompression sickness in flight. - List the signs and symptoms of decompression sickness. - State how decompression sickness can be prevented. Barotrauma - Define 'barotrauma'. - Indicate the major types of barotrauma to include otic, gastrointestinal, sinus and aerodontalgia (teeth) and list their signs and symptoms. - List the precautions that should be observed to reduce the occurrence of the different types of barotrauma. Hyperventilation - Define the term 'hyperventilation'. - Describe the role of carbon dioxide in hyperventilation. - Describe the effects of hyperventilation on the acid balance of the blood. - List the factors causing hyperventilation. - List the signs and symptoms of hyperventilation. - State the measures which may be taken to avoid and counteract hyperventilation. 	

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040 02 02 03	<p>and explain their function or relevance in the acquisition of visual information.</p> <ul style="list-style-type: none"> - State the limitations of night vision and state the effect of hypoxia and smoking on this. - Explain visual adaption both when moving from high levels of light to low illumination and visa versa together with the approximate times involved. - Distinguish between monocular and binocular vision. - Define the term 'scanning technique'. - Explain the nature of colour deficient vision ('colour blindness'). 	
040 02 02 04	<p>Hearing</p> <ul style="list-style-type: none"> - Name the main parts of the ear and state their basic functions. - Differentiate between the auditory and vestibular aspects of the ear. - Define the main causes of: conductive deafness, noise induced hearing loss (NIHL) and presbycusis. - State the role of the Eustachian tubes and how they may be affected by colds or influenza. <p>Equilibrium</p> <ul style="list-style-type: none"> - List the main elements of the vestibular system. - State the function of the vestibular system on the ground and in flight. - Distinguish between the components parts of the vestibular system in the detection of linear and angular acceleration. - Explain how the otoliths and the semi-circular canals are stimulated. 	
040 02 02 05	<p>Motion Sickness</p> <ul style="list-style-type: none"> - Describe motion sickness and its accompanying symptoms. - List the causes of motion sickness. - Describe the actions to be taken to counteract the symptoms of motion sickness. <p>Integration of sensory inputs</p> <ul style="list-style-type: none"> - State the interaction between the visual system and the vestibular system to obtain spatial orientation in flight. - Define the term 'illusion'. - Give examples of visual illusions based on shape, size constancy, aerial perspective, atmospheric 	

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	<p>perspective, the absence of focal or peripheral cues, autokinesis and vectional false horizons.</p> <ul style="list-style-type: none"> - Relate these visual illusions to problems that may be experienced in flight and stress the dangers attached to them. - State the conditions which cause the 'black hole effect' and 'empty field myopia'. - Give examples of approach and landing illusions. State the dangers involved and give recommendations to avoid or counteract these problems. - Give examples of vestibular illusions, including the somatogravic, somatogyral, coriolis and g effect illusions as well as 'the leans'. - Relate the above vestibular illusions to problems encountered in flight and state the dangers involved. - Describe the illusions associated with the proprioceptors and the problems they may cause in flight. - State that the proprioceptive information (seat-of-the-pants sense) is completely unreliable when visual contact with the ground is lost. - Explain how spatial disorientation can result from a mis-match in sensory input and information processing. - State the problem of the flicker effect (e.g. due to strobe lights, propeller movement, etc.) and appropriate counter-measures. - Define 'Vertigo' and list both its physiological and psychological effects. - List the measures to prevent and/or overcome spatial disorientation or vertigo during flight. 	
040 02 03 00	Health and hygiene	
040 02 03 01	Personal hygiene	
	<ul style="list-style-type: none"> - Explain how health and hygiene are interrelated. 	
040 02 03 02	Common minor ailments	
	<ul style="list-style-type: none"> - Describe how common minor ailments may be made worse by flying. - Discuss the precautions that need to be taken when taking over-the-counter medicines to treat the symptoms of common minor ailments. - List the negative effects of suffering from cold or influenza on flight operations especially with regard to the middle ear, the sinuses and the teeth. - Describe the measures to prevent and/or clear problems due to pressure changes during flight. 	

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040 02 03 03	<ul style="list-style-type: none"> - Indicate the major sources of gastro-intestinal upsets, state the effects that may result during flight. - List the precautions that should be observed to reduce the occurrence of gastro-intestinal upsets. <p>Problem areas for pilots</p> <p>Hearing loss</p> <ul style="list-style-type: none"> - List the main sources of hearing loss in the flying environment and discuss the precautions that may be taken to reduce the probability of hearing loss. <p>Defective vision</p> <ul style="list-style-type: none"> - List the major causes of defective vision in : <ul style="list-style-type: none"> Long sightedness (Hypermetropia) Short sightedness (Myopia) Presbyopia Cataracts Glaucoma Astigmatism - Differentiate between the corrective lenses for short sightedness and long sightedness. - Describe the requirements of good sunglasses and highlight the types of sunglasses which could caused perceptual problems in flight. - State the possible effects that low humidity may have on the efficient functioning of the eye. - State the rules which are presently applicable for the wearing of corrective spectacles and contact lenses. <p>Hypotension and hypertension</p> <ul style="list-style-type: none"> - Define 'hypertension'. - List the effects that high blood pressure will have on some normal functions of the body. - List the factors which can lead to hypertension in an individual. - State the corrective actions that may be taken to reduce high blood pressure. - Stress that hypertension is the major factor in the occurrence of 'strokes'. - Define 'hypotension'. 	

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	<ul style="list-style-type: none"> - List the effects that low blood pressure may have on some normal functions of the human body. - State that both hypertension and hypotension may disqualify a pilot from obtaining a medical clearance to fly. Coronary disease - Differentiate between a 'heart attack' and 'angina'. - List the major factors that may make an individual vulnerable to a heart attack. - State the role played by exercise in reducing the chances of developing coronary disease. Obesity - Define 'obesity'. - State the causes of obesity. - State the harmful physiological and psychological effects of obesity. - State the relationship between obesity and Body Mass Index (BMI) - Calculate the BMI of an individual (given weight in Kg and height in metres) and state whether this BMI indicates that an individual is underweight, overweight, obese or within the normal range of body weight. Nutrition and diet - State the major constituents of a healthy diet, including the role of vitamins and trace elements. - State the actions to be taken to avoid food contamination. Tropical climates - List the problems associated with operating in tropical climates. - List the possible causes/sources of illness and incapacitation in tropical or emerging countries with reference to: <ul style="list-style-type: none"> - Standards of hygiene. - Quality of the water supply. - Insect-borne diseases. - Parasitic worms. - Rabies or other diseases spread by contact with animals. 	

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040 02 03 04	<ul style="list-style-type: none"> - State the precautions to be taken to reduce the risk of developing problems in tropical areas. Epidemic diseases - State the major epidemic diseases that may kill or severely incapacitate individuals. - State the preventative hygienic measures, vaccinations, drugs and other measures which reduce the chances of suffering from these diseases. Intoxication Tobacco - State the harmful effects of using tobacco on : <ul style="list-style-type: none"> The respiratory system The cardio-vascular system The ability to resist hypoxia Night vision Caffeine - State the effects of caffeine. - Besides coffee, indicate other beverages containing caffeine. Alcohol - State those aspects of ICAO and JAA rules governing flying and the consumption of alcohol. - State the effects of consuming alcohol on: <ul style="list-style-type: none"> Ability to reason Inhibitions and self-control Vision Sense of balance and sensory illusions Sleep patterns Hypoxia - State the effects alcohol may have if consumed with other drugs. - Identify the WHO definition of 'alcoholism'. 	

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040 02 03 05	<ul style="list-style-type: none"> - List the signs and symptoms of alcoholism. - Define the 'unit' of alcohol. - State the normal rate of metabolism and those factors which may affect this rate. - State the maximum daily and weekly intakes of units of alcohol which may be consumed without causing damage to the organs and systems the body. - State the actions to be taken if a crew member is suspected of being an alcoholic. <p>Drugs and self-medication</p> <ul style="list-style-type: none"> - State the dangers associated with the use of non-prescription (over-the counter) drugs. - State the side-effects of common prescription drugs used to treat colds, influenza, hay fever and other allergies especially those containing anti-histamine preparations. - Interpret the rule that 'if a pilot is so unwell that he/she requires any medication then he/she should consider himself/herself unfit to fly'. <p>Toxic materials</p> <ul style="list-style-type: none"> - List those materials commonly used in aviation which, when uncontained, may cause health problems. - List those aircraft components which, if burnt, may give rise to toxic fumes. <p>Incapacitation in flight</p> <ul style="list-style-type: none"> - List the major causes of in-flight incapacitation. - Discuss the various aspects of sudden and insidious incapacitation. - Describe possible warning signs of insidious incapacitation. 	
040 03 00 00	BASIC AVIATION PSYCHOLOGY	
040 03 01 00	Human information processing	
040 03 01 01	<p>Attention and vigilance</p> <ul style="list-style-type: none"> - Differentiate between 'attention' and 'vigilance'. - Define 'hypovigilance'. 	

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040 03 01 02	<ul style="list-style-type: none"> - Identify the factors which may affect the state of vigilance. - List the factors which may forestall hypovigilance during flight. - Indicate the signs of reduced vigilance. - Name factors which may affect a person's level of attention. - Distinguish between selective and divided attention. <p>Perception</p> <ul style="list-style-type: none"> - Explain the basis of the perception process. - Describe the subjectivity of perception and the factors which influence the interpretation of perceived information. - Describe the mechanism of perception ('bottom up / top down') process. - Describe some basic perceptual illusions. 	
040 03 01 03	<p>Memory</p> <ul style="list-style-type: none"> - State the differences and describe the links between sensory memory, short-term (working) memory and long-term memory. - State the capacity and retention time of the above types of memory. - Describe how one may increase the capacity and duration of short-term (working) memory. - State and describe the sub-divisions of long-term memory (semantic, episodic and procedural memories) and the factors which may affect them. - List the errors associated with motor programmes (skills) and the measures to counter these errors. - Emphasise the importance of monitoring motor programmes. 	
040 03 01 04	<p>Response selection</p> <ul style="list-style-type: none"> - State factors which are necessary to promote the quality of learning. - Discuss ways to facilitate the memorisation of information by the use of mnemonics, association and mental training. - Define the term 'learning'. - Differentiate between the following basic types of learning : Classical and operant conditioning 	

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	<p>Learning by insight Learning by imitation</p> <ul style="list-style-type: none"> - Describe the advantages of planning and anticipation of future actions. - Define the term 'skills'. - State the phases of learning a skill (ANDERSON). - Define 'motivation'. - Describe and list examples of physiological and psychological motivators. - Explain the influences of different levels of motivation on performance and the affects of arousal and task difficulty. 	
040 03 02 00	Human error and reliability	
040 03 02 01	Reliability of human behaviour <ul style="list-style-type: none"> - Name and explain factors which influence human reliability. - Explain the importance of training, planning and briefing and their influence on human reliability. 	
040 03 02 02	Hypotheses on reality <ul style="list-style-type: none"> - Cite examples of the relationship between perception and reality in given circumstances. - List factors which influence one's sense of reality. - Define the term 'mental model' in relation to aviation and describe their advantages and disadvantages. - List the factors which may influence selection of a mental model (including similarity, frequency and expectation). 	
040 03 02 03	Theory and model of human error <ul style="list-style-type: none"> - Define the term 'human error'. - Explain the concept of the 'error chain'. - Distinguish between different forms/types of errors (e.g. slips, lapses, mistakes, etc.). - Distinguish between active and latent errors. - Distinguish between 'errors' and 'violations'. 	
040 03 02 04	Error generation	

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040 03 03 00	<ul style="list-style-type: none"> - Distinguish between internal and external error generation. - Give examples to illustrate the following factors in external error generation in the cockpit : <ul style="list-style-type: none"> Ergonomics Economics / Commercial pressures Social environment (group / organisational). - List and describe strategies which can be used to reduce human error (frequency and impact). - Define the term 'error tolerance'. - Identify the need for pilots to be aware of the limitations of others as possible error sources. <p>Decision making</p>	
040 03 03 01	<ul style="list-style-type: none"> - Define the term 'decision making'. - Describe the structure (phases) of the decision making process in aviation. <p>Decision making concepts</p>	
040 03 04 00	<ul style="list-style-type: none"> - Describe the human's positive capabilities in decision making. - Describe the main error sources and limits in an individual's decision making mechanism. - State the factors upon which an individual's risk assessment is based. - Describe the influences (both negative and positive) exerted by other crew members on an individual's decision making process. - Illustrate a practical approach for decision making between crew members. - Emphasise the need for pilots to actively strive to increase their skill of risk assessment. <p>Avoiding and managing error: cockpit management</p>	
040 03 04 01	<p>Safety awareness</p> <ul style="list-style-type: none"> - Justify the need for being aware of one's own performance and limitations before and during a flight. - Define 'situation(al) awareness. - Identify the factors which can interfere with being situationally aware. - List the cues which indicate a loss of situational awareness. - Name the steps towards regaining lost situational awareness. 	

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040 03 04 04	<p>Communication</p> <ul style="list-style-type: none"> - Define the term 'communication'. - Describe the functions of communication in aviation. - State the attributes of a 'professional language' such as that used in aviation. - Name and explain major obstacles to effective communication. - Describe methods to enhance communication in aviation (e.g. active listening, feedback, etc.). 	
040 03 05 00	<p>Personality</p>	
040 03 05 01	<p>Personality and attitudes</p> <ul style="list-style-type: none"> - Define and distinguish between 'personality', 'attitude' and 'behaviour'. - State the origin of personality and attitudes. - Summarise the influence of a pilot's personality traits on his/her performance (both negative and positive traits). - Discuss the genetic and the environmental influences on personality development (nature versus nurture). - Name those hazardous attitudes which, if prevalent in a crew member, might represent a hazard to flight safety. - Describe the attitude and behaviour of an ideal crew member. 	
040 03 05 02	<p>Individual differences in personality</p> <ul style="list-style-type: none"> - Describe the individual differences in personality by means of a common trait model (HANS EYSENK's personality factors) and use it to describe today's ideal pilot. - State the most important personality trait for effective decision making. - Define 'self concept' and its influence on personality. - Discuss the likely influence of promotion (e.g. from FO to Commander) on an individual's self concept. - Define 'self discipline' and justify its importance to flight safety. - Give examples of mental states and behaviour that may endanger flight safety. 	
040 03 06 00	<p>Human overload and underload</p>	
040 03 06 01	<p>Arousal</p>	

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040 03 06 02	<ul style="list-style-type: none"> - Define 'arousal'. - Describe the relationship between arousal and performance. - Understand the graphical representation of the above relationship. <p>Stress</p> <ul style="list-style-type: none"> - Explain the term 'stress'. - Explain why stress is a natural human reaction. - Differentiate between physiological and psychological stress. - State the relationship between stress and performance. - State the basic categories of stress factors (stressors). - Name the major stress factors (stressors). - List the major environmental sources of stress in the cockpit. - Name the principal causes of domestic stress. - State that stress factors are subjective and are cumulative. - Create and explain a simple model of stress. - Explain the relationship between stress and anxiety. - Describe the effects of anxiety on human performance. - List the physiological and psychological effects of short-term and chronic stress on an individual. - Explain how the completion of a stressful task will reduce the amount of stress when a similar situation arises in the future. - List the sources and symptoms of human underload. - Describe the effect of human overload and underload on an individual's performance in the cockpit. 	
040 03 06 03	<p>Fatigue</p> <ul style="list-style-type: none"> - Define the term 'fatigue' and differentiate between short-term and chronic fatigue. - Identify the signs and symptoms of fatigue. - Identify the common causes of fatigue. 	
040 03 06 04	<p>Body rhythms and sleep</p>	

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040 03 06 05	<ul style="list-style-type: none"> - Name some internal body rhythms. - Explain the term 'circadian rhythm'. - State the approximate duration of a 'free-running' circadian rhythm. - Explain the significance of 'Zeitgebers' in regulating the normal circadian rhythm. - State the effect of the circadian rhythms of body temperature on an individual's performance and on his/her sleep patterns. - List and describe the stages of sleep and differentiate between REM and non-REM sleep. - Explain the functions of REM and non-REM sleep. - Explain the effects of sleep deficit on an individual's performance. - State that sleep deficit can be cumulative. - Explain the simple calculations for sleep/wake credit/debit situation. - Stress that a pilot's attitude towards sleep must be proactive (consider forthcoming duty periods and plan sleep accordingly). <p>Fatigue and stress management</p> <ul style="list-style-type: none"> - List strategies which prevent or delay the onset of fatigue and hypovigilance. - List and describe coping strategies for dealing with stress factors (stressors) and stress reactions (including action coping, cognitive coping and symptom directed coping). - Give example of stress management (including health and fitness programmes, relaxation techniques, religious practices and counselling techniques). 	
040 03 07 00	<p>Advanced cockpit automation</p> <ul style="list-style-type: none"> - Define and explain the basic concepts of automation in aircraft. - Describe the changes to the aircraft / pilot interface in the cockpit brought about by automation. 	
040 03 07 01	<p>Advantages and disadvantages ('criticalities')</p> <ul style="list-style-type: none"> - List the advantages and disadvantages of automation in the cockpit in respect of level of vigilance, attention, workload, situational awareness and crew co-ordination. - Give examples of methods to overcome the disadvantages of automation. 	
040 03 07 02	<p>Automation complacency</p>	

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	<ul style="list-style-type: none">- Define 'automation complacency'.- State the main weaknesses of human monitoring of automatic systems.- Give examples of actions which may be taken to counteract ineffective monitoring of automatic systems.- State the dangers of passive monitoring, blinkered concentration and confusion with regard to automation.- Explain mode error.	