"PILOT ACCELERATION TRAINING IN THE EGYPTIAN AIR FORCE"

Tamara L. Chelette

KRUG INTERNATIONAL
Technology Systems Division
Dayton, Ohio

Abstract

The Egyptian Air Force is currently constructing an Aeromedical Research and Training Center in Cairo for the purpose of training personnel to meet the demands of high performance flight. The Human Training Centrifuge is a key ingredient of the facility, providing rapid onset and sustained Gz exposure to pilots and air crew members for the purpose of teaching methods to increase an individual's tolerance to extreme acceleration. The centrifuge, as well as six other physiological training devices, has been designed and built by KRUG International and is currently in operation at KRUG's Dayton, Ohio facility. Equipment installation is planned concurrent with the Cairo facility construction and is scheduled to be complete in June of 1990.

Introduction

Keeping pace with the rapid modernization of the Arab Republic of Egypt, the Egyptian Air Force is currently implementing a comprehensive plan to provide aeromedical education and training to its pilots and flight crews. Central to the plan is the construction of an Aeromedical Research and Training Center in Cairo that will provide for operational and tolerance training, academic instruction, flight physiology research, medical treatment, and crew housing. After careful planning and design, the four story facility is under construction at a site near Air Force headquarters. It will consist of academic, medical, and training wings and is located adjacent to a large conference center. The training wing will be equipped with a host of physiological trainers designed to simulate or induce various flight conditions and human stresses. This equipment includes a Human Training Centrifuge, two Spatial Disorientation Trainers, a temperature and humidity Stress Test Enclosure, an Ejection Seat Trainer, two Altitude Simulation Chambers, and a Night Vision Training Classroom. There will also be a medical treatment Hyperbaric Chamber provided for both routine therapy and emergency compression treatment. The intent of this paper is to describe the requirements of the training equipment with special focus on the acceleration protection training of the Human Centrifuge.

Training Concept

The Aeromedical Research and Training Center will facilitate the total training of the pilots and flight crews of the Egyptian Air Force. Each trainee will be housed at the facility while receiving classroom instruction, physiological evaluation, and training.

The first phase of instruction will center on a general understanding of physiology and physical limits of human performance. After careful medical examination, each trainee will be put through a series of training episodes to demonstrate expected flight sensations. They will be evaluated and trained for performance enhancement in the various areas of flight experience. Exposures will include work load performance while under temperature, humidity, g-load, hypoxia, low light levels, and spatial disorientation conditions. Procedural training will be provided in oxygen equipment use, emergency procedures, physiological pressure equalization, instrument flight, g-tolerance improvement techniques, ejection procedures, and night vision accommodation.

Flight Personnel Selection

The wide variety of aircraft in the Egyptian Air Force perform different functions and induce different types of physiological and mental stress on the pilots and flight crew members. Each trainee's performance record will be scientifically matched to capabilities needed to function within a certain aircraft, optimizing the performance of that aircraft's mission.

CH2759-9/89/0000-0783 $1.00 © 1989 IEEE

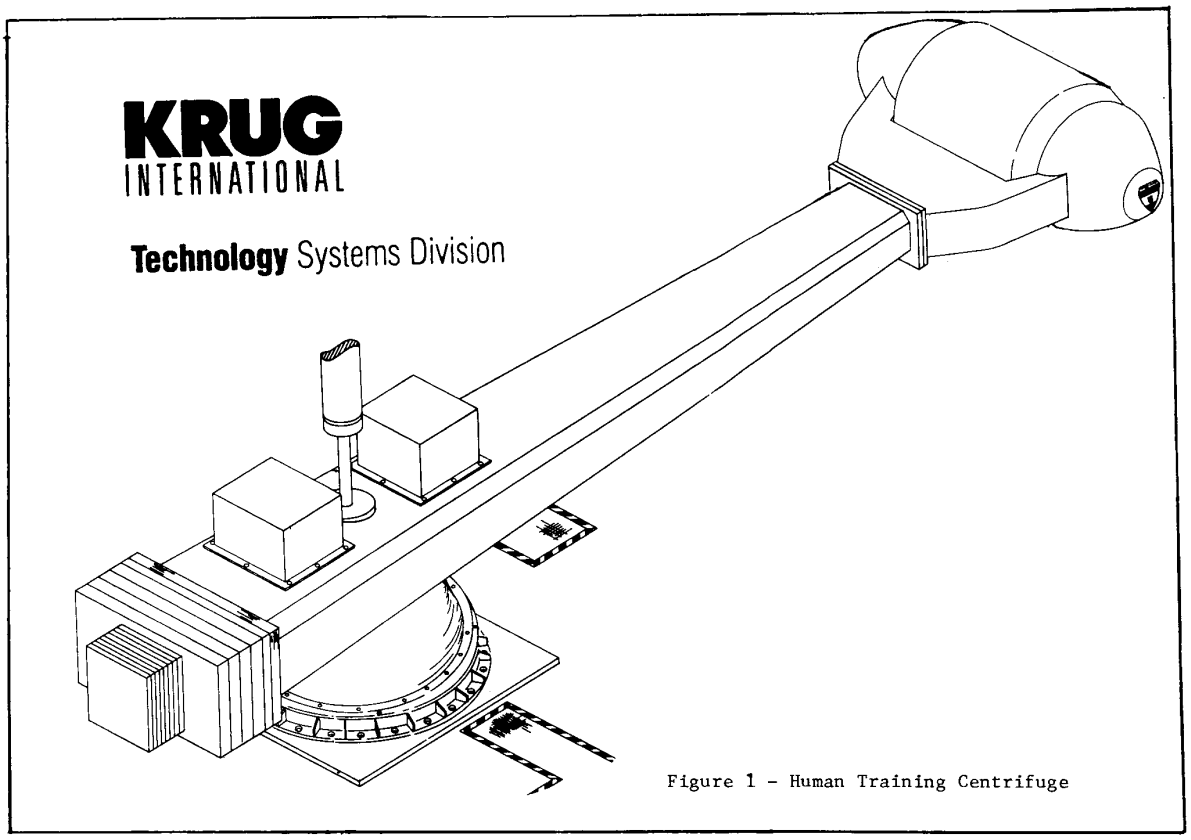

Figure 1 - Human Training Centrifuge

Centrifuge Mission

The high performance human centrifuge, as designed and built by KRUG International, provides exposure, tolerance improvement, and work load assessment for each trainee. The device provides for simulated air combat maneuvers, target tracking performance, and rapid onset.

In addition, the device will be used for aeromedical research related to flight physiology and flight equipment performance (Figure 1).

Centrifuge Requirements

The centrifuge functions as an acceleration training device to orient aircrews to the high Gz acceleration environment experienced in high performance aircraft. Preprogrammed profiles are used to direct centrifuge operation. The centrifuge is capable of eight hours of continuous operation with a 700 pound payload in the gondola. Acceleration levels may vary from 1 Gz (stopped) to 15 Gz, with average onset and offset rates varying from 0.05 Gz per second to 6 Gz per second.

An anti-G suit allows for human tolerance training to 9 Gz. Operation above the human occupant limit of 9 Gz requires manual intervention in the electrical drive system. To prevent inadvertent activation, this intervention is not possible from the console. The controls require two operating personnel. One crew member observes the trainee through the closed circuit television monitor, medical monitoring instrumentation, open channel audio communication, and viewing of the target tracking performance scores while the other crew member operates the trainer. The control console includes safety features such as status indicators, key locks, and step oriented operation. Additional safety features are included in the centrifuge area/room in safety interlocks and emergency shut down switches.

Gondola

The centrifuge gondola houses the seat, footrest, and adjustable body restraints. Attachment mechanisms allow the seat and footrest to be positioned at either a Mirage 2000 or an F-16 tilt back angle of

approximately 13 and 30 degrees, respectively. A peripheral vision loss indicator, remote control color CCTV camera, and a color graphics target tracking monitor are mounted in front of the trainee. Center and side mounts allow for positioning of a force stick as needed to simulate a Mirage 2000 or F-16, respectively. The trainee may initiate Gz onset by aft movement of the stick. A hand held switch slows the centrifuge to a stop upon release. The gondola rolls out as much as 90 degrees due to centrifugal force. Gondola roll oscillation is controlled by a hydraulic cylinder roll damping system to eliminate adverse roll sensations.

The door of the gondola opens upward (internal and external control) using pneumatic power to provide easy floor level access to the trainee. Pressurized air also provides inflation of the trainee's G-suit through an F-16 type control valve. The valve provides a pressurization check to the restrained student through a pressure indicator on the console.

Within the gondola is a bank of relevant medical monitoring instruments and amplifiers. Parameters measured include two channels of ECG, heart rate, two channels of biopotentials (i.e, EEG, EMG, EOG), arterial oxygen saturation, pulse rate, oral flow respiration rate, and temporal artery blood velocity. Each amplifier or instrument is wired to a patch panel for simple connection into the slip rings. These signals are transmitted to the control console.

The Egyptian Air Force will be using a pressurized oxygen cylinder with a manual diluter demand regulator in the gondola to provide thoracic positive pressure breathing (PPB) as a possible means of improving G tolerance. Research in the operational feasibility, benefits, side effects, hazards, and fatigue aspects of this technique is planned. (Note: In PPB training, the potential for incorrect execution leading to pneumothorax or air embolism is mitigated by the presence of hyperbaric compression therapy within the same building.)

Drive System

The mechanical drive system transmits the output power of the electrical drive motor to the arm of the centrifuge through a reducing gear box. The variable speed, DC motor is located in a pit below the centrifuge. It delivers 10,000 ft-lbs of starting torque to turn the right angle

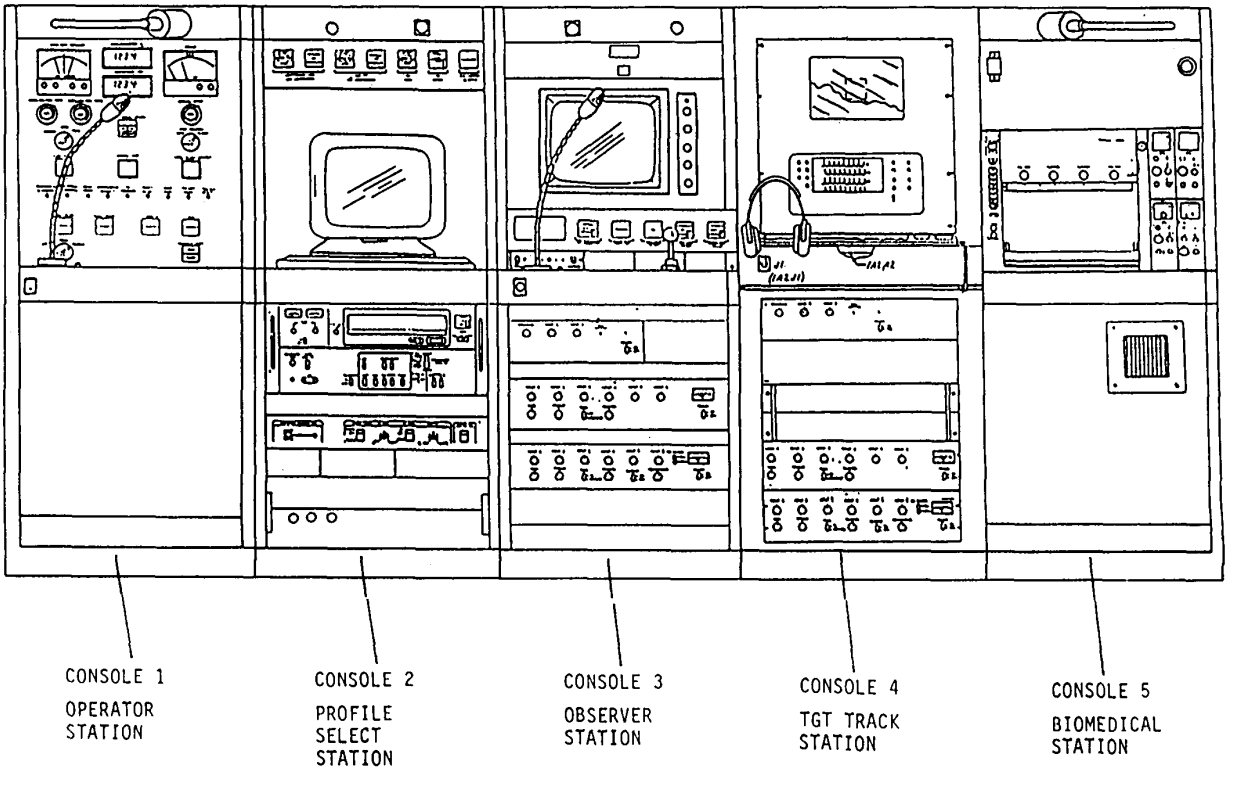

Figure 2 - Control Console

gear box and thus turn the arm. The DC motor's speed is driven by the control computer according to the various training profiles. With an approximate 20-foot moment arm, the system rotational rates range between 6.7 RPM and 47.3 RPM, corresponding to the acceleration limits of 1.05 Gz and 15 Gz. Slowing and stopping the centrifuge is accomplished by reversing the field of the electric motor and diverting the energy into large resistors in the electrical drive cabinet. Should power fail, a mechanical band brake will close down on the shaft to slow the arm to a safe stop.

Control System

The control system is located in an elevated control room and consists of five control consoles; the Operator, Profile Select, Observer, Biomedical, and Target Tracking consoles (Figure 2). The Operator console provides the primary operational controls and status indicators of the centrifuge trainer. The Profile Select console supports the CRT and keyboard used for entry of preprogrammed performance profiles and preview of the selected profile. Profile selection is made in response to a displayed menu. The Observer console houses the color CCTV monitor and controls for camera pan, tilt, and zoom lens. It also provides an event timer, a closed loop enable, the main circuit breaker, a trainee brake bypass, an operator's brake bypass and an observer's brake lever that must be held closed for centrifuge operation. The Target Tracking console contains the personal computer which controls the tracking system. A forward scene display that matches the student's display, and a four channel CRT oscilloscope indicates trainee performance. The Biomedical console provides 4 channels of strip chart recording and a patch panel for signal reconfiguration.

Pilot Acceleration Training

The high performance aircraft of the Egyptian Air Force fleet are capable of flying at high G levels and high G onset and offset levels which may be beyond pilot tolerance. The simulated G levels of the human training centrifuge will enhance each student's awareness of the hazards of such an environment. Instruction and practice in methods to enhance G tolerance will permit aircraft to be operational at higher G performance levels with less probability of accident caused by G-LOC.

Following a period of classroom instruction on flight physiology and G tolerance methods, each trainee will be exposed to a single gradual G increase profile until a visual end point (peripheral vision loss). After recovery, the student will be exposed to a rapid G increase profile where each rapid onset is initiated by the trainee (Figure 3.)

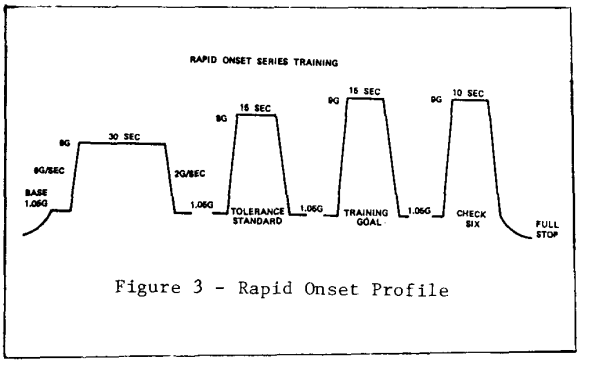

Figure 3 - Rapid Onset Profile

Subsequently, the trainee will be exposed to a preprogrammed Air Combat Maneuver while performing a variety of cockpit tasks including target tracking (Figure 4). Medical monitoring will be available during all training exercises. As each trainee progresses through the centrifuge training, as well as the other

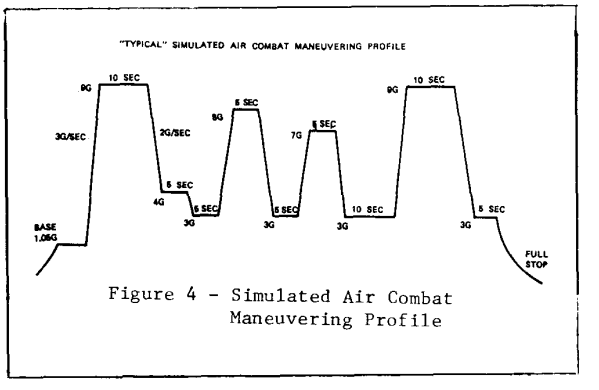

Figure 4 - Simulated Air Combat Maneuvering Profile

physiological trainers and simulators, his performance record may be computerized in a master library for use in comparative studies and crew selection.

Summary

The Egyptian Air Force Aeromedical Research and Training Center will provide the facilities needed to train and develop aircraft pilots and crew members, enabling them to meet the unique demands of high performance flight. The Arab Republic of Egypt will provide regional leadership in the development of operational training techniques unique to the demands of a diverse high performance aircraft fleet.