Chapter 1 – INTRODUCTION

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Over thousands of years of evolution humans have developed exceptional photopic or day vision, but have a somewhat less sensitive scotopic or night vision system. While some animals, such as cats, have improved night vision through the evolutionary development of a tapetum (a reflector which directs more light toward the retina), humans have opted for a technical solution by creating image intensification systems, or Night Vision Goggles (NVGs). NVGs have been particularly helpful in improving night flight operations. However, they do not yet provide field of view, resolution, colour and dynamic range equivalent to full normal day vision. As a consequence, engineers and scientists (both human factors specialists and physicists) have focused their efforts on developing NVGs that provide good image quality and a more realistic view of the world at night. The requirement to operate millions of dollars of air assets safely and efficiently at night has driven a significant number of advances in the field.

Research and development has produced the current state-of-the-art NVG systems with extensive capabilities in key visual performance areas:

1) Reduced electro-optically produced noise, or grainy image display at low illumination levels;
2) Halo reduction, and better imagery in urban environments;
3) Visual acuity or resolution approximating the limits of the human eye and delivering nominal resolution values of 20-20;
4) Contrast sensitivity performance, is less affected at low light levels contributing to an expanded dynamic range and enhanced image detail; and
5) Field-of-view (FOV)-traditional aviator systems offer a 40 degree FOV, while newly developed panoramic NVGs have expanded the FOV to nearly 100 degrees.

The development of smaller/lighter tubes has resulted in the development of a system with expanded FOV. Such a system produces less neck strain for the user because the centre of gravity is distributed and less visual scanning is required. As a consequence, pilots have a significantly enhanced visual flight environment. The current level of performance and image quality delivered by state-of-the-art direct view systems is exceptional, and further enhancements will be made within 5 to 10 years. In addition, reduced weight, lower power consumption and enhanced durability are on the very near horizon for these systems. Although this technology is improving it will be necessary to expand research and development efforts to incorporate new technological advances. The key strength of this well developed field of research is that a well developed nomenclature of engineering specifications of device characteristics exists (e.g. see Mil Std 3009). Militaries from NATO countries select their night vision technologies on the basis of these engineering specifications. These specifications are then used to predict visual performance when using NVGs. This was an accepted standard until a more unified approach towards NVGs was initiated in which

the importance of human factors and vision studies of how NVGs affect visual performance were acknowledged. As a consequence, a breadth of NVG studies has developed; demonstrating the need to provide behavioural specifications of NVG system performance. Although the methodologies for investigating the impact of NVGs on visual performance are not standardized, the general thrust of this emerging field should be to use a unitary approach towards the investigation of the perceptual effects of NVGs that includes both laboratory experimental methods and flight test methods.

This AGARDograph presents a general summary of suggested methods and should be used as a framework for developing airborne and laboratory based experiments to evaluate equipment. While there may be basic NVG test methods that can be applied regardless of the eventual use of the NVGs, some organizations will require specific tests of the equipment representative of the operational environment. An evaluation that involves ground and flight tests is desirable to address specific questions and general use issues, respectively. This approach is important because it extends measurements of device characteristics to real vision and flight performance.

The objective of this document is to provide an inventory of rules, standards, procedures, methods and means needed to test and evaluate night vision systems. It identifies best practice methods from each of the participating countries. This is the first step in synthesizing a standardized test methodology.

In order to meet its objective, the scope of this AGARDograph is limited to the testing of night vision devices based on image intensification technology. It does not cover other systems such as thermal imaging, infra-red (IR), millimetre wave radar and low light level television (LLTV). It extensively covers the test methodologies currently used by NATO countries to evaluate night vision systems. It also discusses specific system test methodologies relating to rotary wing aircraft.

This AGARDograph includes sections covering the basic theory of the systems in use today, human vision and its relationship to the technology, general flight test methodology and an inventory of flight test techniques from NATO countries. Some consideration is given to the testing required as a precursor to flight test such as mock-up trials, simulation and aircraft ground trials. However, tests focused on health hazards, ballistic protection, acoustic protection, laser protection and the fitting and wearing of the helmet are not covered. The AGARDograph addresses the influence of NVGs on human visual perception and does not consider other sensor modalities (e.g. auditory or tactile) or aeromedical factors (e.g. neck strain, visual adaptation, eye strain, fatigue).