

## **Executive Summary (U)**

### **Laser Eye Protection**

(U) The Naval Research Advisory Committee (NRAC) Panel was requested to undertake a rapid review of the laser threat to Navy and Marine Corps aviation to reassess the threat, the adequacy of Operational Requirements (OR) to develop means to protect against it, to review present Navy protection programs and the Research and Development (R & D) organization, and to make recommendations for broader R & D leading to the development of protection against the emerging frequency agile threat. The Terms of Reference (TOR) are included as Appendix A.

(U) The panel membership, included as Appendix B, contained members with engineering, research, and medical backgrounds and was assisted by the Navy in-house R&D community. The panel drew the conclusions and made the recommendations described below. The (Acting) Assistant Secretary for Research, Engineering and Systems (ASN (RE&S)) signed three tasking letters in response to this panel's recommendations. These are also included in the Appendices.

(U) There are a variety of friendly and hostile lasers currently developed by military forces in the form of laser range finders and designators. Some of the Soviet lasers may have power levels unwarranted by range finder or designator applications, but it is not known whether these are intended as anti-personnel weapons. Laser radiation has been experienced by U.S. flight crews flying reconnaissance missions. While there are several different damage mechanisms (discussed in this report), present lasers can cause eye damage at ranges up to a few miles. However, they can cause a "dazzle" effect at greater ranges (particularly at night) when illumination of a cockpit and the scattering of light results in the inability of the crew perform its mission and can result in the loss of the aircraft. The panel concluded that the laser threat is growing and whether intentionally used as anti-personnel weapons or causing damage only accidentally, lasers must be considered a growing anti-personnel threat against which protection should be provided. The naval aviators most exposed to this threat are the air-to-surface attack aircraft and the Marine aircraft and helicopter crews supporting ground combat.

(U) While early deployed lasers operated predominantly at only two wavelengths, the number of wavelengths used is now proliferating. It is expected that a tunable (frequency agile) laser threat will also develop soon. The present program to protect naval aviators from the laser threat is based on developing helmet visors or goggles which have narrow band spectral line rejection filters at the threat laser wavelengths, attenuating incident laser energy at these wavelengths, thus preventing laser radiation from damaging eyes. The panel reviewed the OR of the Navy and of the other services and found them to be similar and the R&D effort well coordinated. The OR called for protection at two wavelengths. The OR did not address the frequency agile threat, nor protection from the "dazzle" effect, and did not address the possibility of providing protection by evoking aircraft sensors to warn of laser illumination and the reflexive application of eye

protection for the crew . The panel recommended changes in the OR to correct these deficiencies, and these changes were made.

(U) The technical approach used to protect against fixed frequency lasers cannot be applied to protection from the agile threat or even to the protection from a larger number of fixed frequency threats. As more band rejection filters are built into a sandwich, transmissivity of the visor at other wavelengths decreases also, making it unusable at night and limiting its utility in the daytime. In addition, the level of attenuation provided by visors at present laser wavelengths is only adequate against laser powers used at present and may not be adequate against higher power Soviet lasers, should these be intended as anti-personnel weapons. There are other mechanisms that may be effective against the agile threat. Among these are the optical limiters that restrict the intensity of light they transmit and the intensity activated optical shutters that make the visor momentarily nontransparent when illuminated by strong laser light. The investigation of these mechanisms is still in an early stage (6.1 and 6.2). The panel identified a list of possible physical mechanisms from which the more promising need to be pursued to develop protection against the agile threat. The panel also recommended the initiation of sensors on the aircraft as part of the laser protection approaches which involve the use of sensors on the aircraft as part of the laser protection program. This can provide illumination sensing and analysis capability on the aircraft prior to the illumination of the crew itself. The time so gained can be used to initiate reflexive protection measures and pilot illumination evasion. Recommendations to increase the 6.2 funding to provide for this research were made and the funds were provided in the FY 88 budget.

(U) The panel reviewed the Navy organization for R&D for laser eye protection for aviators and found the organization and the Navy laboratory support and leadership excellent. It must be pointed out, however, that as laser protection moves from the protection of eyes of aviators by visors to systems solutions involving the aircraft and its sensor system, the R&D management of the laser protection program may have to be broadened.

(U) The panel identified priority intelligence collection requirement against the laser threat. The ASN (RE&S) signed a letter to initiate such increased intelligence collection and efforts are underway to carry out these tasks.

(U) In conclusion, the panel found the threat to be growing rapidly and the need for R&D for protection from the agile threat to be of great importance. The panel is pleased that its recommendations were acted upon rapidly and commends the Navy laboratory personnel for its strong technical leadership in this important area for the Navy.