NASA TECH BRIEF

Occulting-Filter Method for Obtaining Flashing-Light Visibility Data

During planetary missions, it is expected that many rendezvous and docking maneuvers will be performed. The visibility of a flashing beacon has important implications in the design of rendezvous guidance systems to aid in these precise maneuvers. An objective in the design of flashing beacons is to maximize target visibility while minimizing average electrical power consumption. Previous experiments have established that greater target visibility can be obtained by storing electrical energy and periodically releasing it in a high-intensity flash than can be achieved by a continuous source using the same average power. In an effort to achieve an improvement in beacon power consumption, an experimental study was made concerning the perception of flashes at the visual threshold.

One of the most significant results of the study was the development of a simple and accurate technique for obtaining several types of flashing-light visibility data. The indications of the experiments are that, at the visual threshold, an observer requires almost five times as much average luminous power from a steady point source as he does from a point source of the same spectral quality flashing briefly at a rate of one flash per second. Or, inversely, a source that flashes briefly once every second requires only approximately 20 percent of the average power that is required to maintain a steady source of the same spectral quality, both sources being at or near the visual threshold. The precision of the occulting-filter method used in the threshold determinations was significantly high. The indications are that the method can be used to compare sources of radically different spectral composition. Presumably, the results would depend on the "luminosity function" of the observer. This method might be of scientific interest in examining subjects with abnormal luminosity functions. Additionally, the procedure devised for the occulting-filter experiments should greatly simplify the determination of the number of candle-seconds of luminous energy emitted by a discharge tube that flashes periodically.

The source of light used in the experiment was an incandescent lamp with a horizontal tungsten filament approximately 2 mm wide. The effective length of the filament was reduced to 2 mm by an aperture adjacent to the envelope. These 4 square millimeters of hot tungsten were reduced to a "point source" by a 10X microscope objective turned end for end. As a matter of convenience, the observer sat beside the source, which was in a ventilated, light-tight box, and he observed the point target by reflection from a first-surface mirror on the opposite wall of the room, the total distance from the target to the observer being some 25 feet.

In the plane of the target was an opaque disk rotating at 30 rps. A radial slot in this disk produced 30 flashes of light per second, each with a duration of approximately 0.001 second. Another disk rotated about the same axis at only 1 rps. This latter disk occulted 29 of the 30 flashes per second; so that, in the flashing mode, the observer saw one brief flash every second.

When making observations, the observer looked with one eye into a tube which allowed him a 10° field of view. This tube contained a sheet of glass which served as a beam-splitter; and the luminance level of his field of view was provided by an auxiliary diffuse source attenuated by appropriate neutral gelatin filters.

In the space between the lamp and the microscope objective was a trough with slots to support neutral gelatin filters for coarse adjustment of the intensity of the point source. The fine adjustment was provided

(continued overleaf)

by a neutral-density wedge and compensator, the wedge being moved longitudinally by a micrometer screw. In the days when it was believed that a visual threshold represented a discontinuity between "seeing" and "not seeing," the procedure would have been to set the wedge near its midpoint, to find a neutral filter that reduced the intensity of the target to a value close to the visual threshold, and then to determine the "end point" by adjusting the neutral wedge. This procedure was again used with the addition of a special feature, an occulting filter, whose optical density was ordinarily 0.3 (transmittance = 50%). The observer could introduce this occulting filter into the target beam at will by depressing a foot switch. His end point was the setting of the wedge that enabled him to see the flashes without difficulty before introducing the occulting filter, but to miss seeing the first flash after the occulting filter had been introduced.

Note:

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