

# Transmissive Diffractive Optical Element Solar Concentrators

These would weigh and cost less than do mirror-type solar concentrators.

NASA's Jet Propulsion Laboratory, Pasadena, California

Solar-thermal-radiation concentrators in the form of transmissive diffractive optical elements (DOEs) have been proposed as alternatives to mirror-type solar concentrators now in use. In comparison with functionally equivalent mirror-type solar concentrators, the transmissive, diffractive solar concentrators would weigh and cost less, and would be subject to relaxed mechanical tolerances.

A DOE concentrator would be made from a thin, flat disk or membrane of a transmissive material having a suitable index of refraction. By virtue of its thinness, the DOE concentrator would have an areal mass density significantly less than that of a functionally equivalent conventional mirror.

The DOE concentrator would have a relatively wide aperture — characterized by a focal-length/aperture-diameter ratio ("f number") on the order of 1. A

kinofrom (a surface-relief phase hologram) of high diffractive order would be microfabricated onto one face of the disk. The kinofrom (see figure) would be designed to both diffract and refract incident solar radiation onto a desired focal region, without concern for forming an image of the Sun. The high diffractive order of this kinofrom (in contradistinction to the low diffractive orders of some other kinofroms) would be necessary to obtain the desired  $f$  number of 1, which, in turn, would be necessary for obtaining a desired concentration ratio of 2,500 or greater.

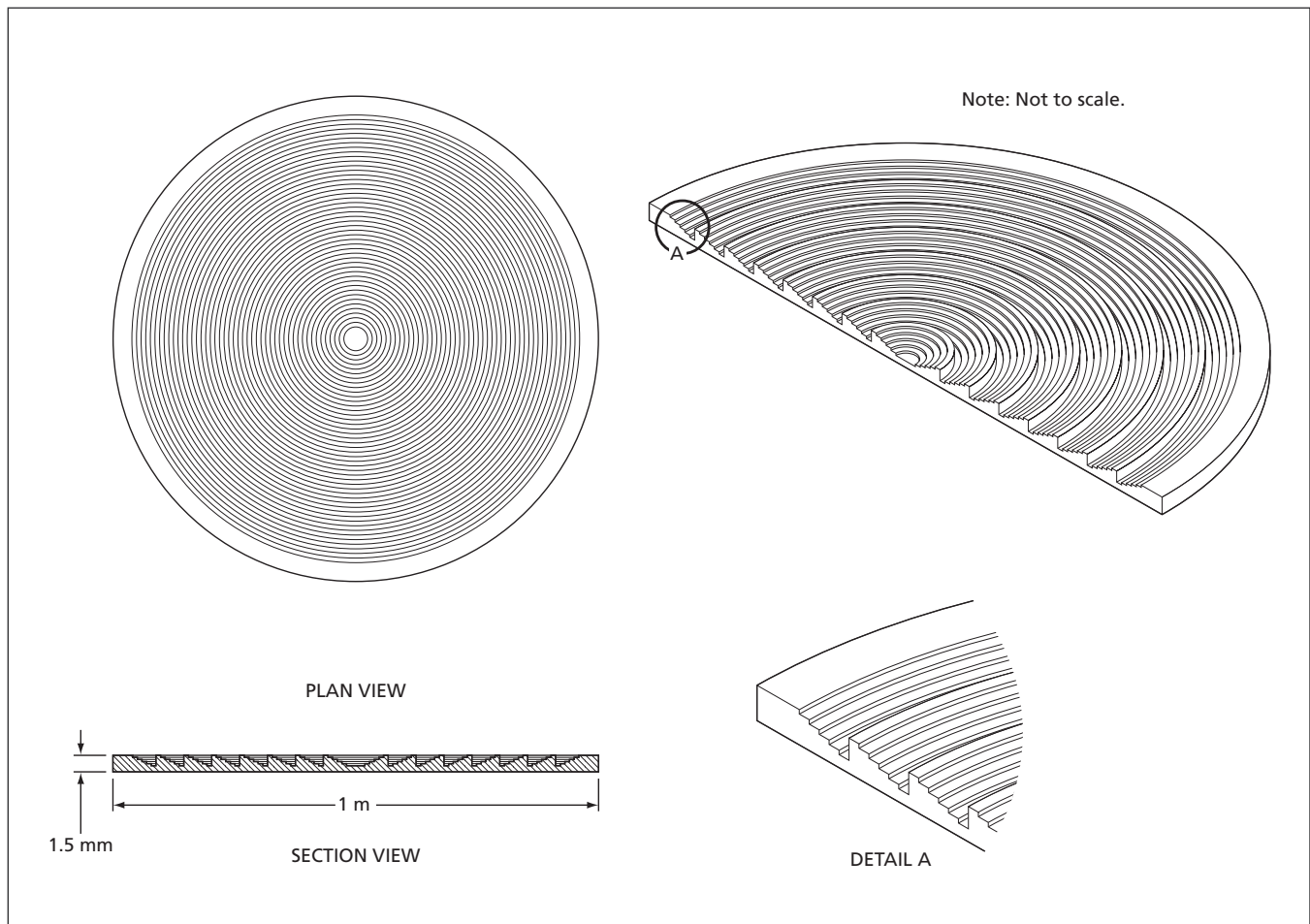
The design process of optimizing the concentration ratio of a proposed DOE solar concentrator includes computing convolutions of the optical bandwidth of the Sun with the optical transmission of the diffractive medium. Because, as in the cases of other non-imaging, light-

concentrating optics, image quality is not a design requirement, the process also includes trading image quality against concentration ratio.

A baseline design for one example calls for an aperture diameter of 1 m. This baseline design would be scalable to a diameter as large as 10 m, or to a smaller diameter for a laboratory test article. Initial calculations have indicated that the characteristics of the test article would be readily scalable to a full-size unit.

*This work was done by Richard Baron, Philip Moynihan, and Douglas Price of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).*

*This invention is owned by NASA, and a patent application has been filed. Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to the Patent Counsel, NASA Management Office-JPL. Refer to NPO-43801.*



A DOE Solar Concentrator should not be confused with a Fresnel lens, which it partly resembles. The DOE is a non-imaging optic designed to exploit both diffraction and refraction to obtain a high concentration ratio.