Statement of Hammett & Edison, Inc., Consulting Engineers

The firm of Hammett & Edison, Inc., Consulting Engineers, has been retained by Channel 5 Public Broadcasting, Inc., licensee of Station KNPB, Channel 15, Reno, Nevada, to prepare the technical portions of an application for a new 14 GHz Ku-band satellite uplink station.

Justification for Requested EIRP Levels

Because of heavy snow conditions that can sometimes exist in the Reno, Nevada, area, a 400-watt high-power amplifier has been installed, which can provide up to 270 watts of Ku band RF at the input flange to the 4.5-meter uplink antenna. This results in the requested main beam EIRP of up to 77.9 dBW. Only the power necessary to establish reliable communications with the satellite transponder will be used; during good-weather conditions, it is anticipated that this power level will be between 10 and 20 dB less power than the maximum power.

Prevailing Exposure Standards

The U.S. Congress requires that the Federal Communications Commission ("FCC") evaluate its actions for possible significant impact on the environment. In Docket 93-62, effective October 15, 1997, the FCC adopted the human exposure limits for field strength and power density recommended in Report No. 86, "Biological Effects and Exposure Criteria for Radiofrequency Electromagnetic Fields," published in 1986 by the Congressionally chartered National Council on Radiation Protection and Measurements ("NCRP"). Separate limits apply for occupational and public exposure conditions, with the latter limits generally five times more restrictive. The more recent standard, developed by the Institute of Electrical and Electronics Engineers and approved as American National Standard ANSI/IEEE C95.1-2006, "Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz," includes similar exposure limits. These limits apply for continuous exposures and are intended to provide a prudent margin of safety for all persons, regardless of age, gender, size, or health.

For 14.0–14.5 GHz Ku-Band satellite transmitting antennas, the prevailing standard for occupational exposures of unlimited duration is 5 mW/cm^2, and 1 mW/cm^2 for public exposures of unlimited duration.

Proposed Uplink Facilities

It is proposed to use a General Dynamics/VertexRSI Model 4.5KPK 4.57-meter diameter satellite earth station Ku-Band transmitting antenna. The maximum antenna input power for any combination

of signals would be 270 watts (24.3 dBW). The antenna would be mounted on the ground, in a fenced area to the south of the KNPB studios at 1670 North Virginia Street, Reno, Nevada.

The eastern-most geostationary communication satellite that the proposed antenna would communicate with would be at 72°W longitude, and the western-most satellite would be at 129°W longitude. The antenna orientation to the eastern-most satellite would be 120.0°T with an elevation angle of 23.2°, the antenna orientation to the satellite at the approximate middle of the domestic satellite arc at 101°W longitude would be 151.8°T with an elevation angle of 40.3°, and the antenna orientation to the western-most satellite would be 194.2°T with an elevation angle of 43.3°. The greatest elevation angle would occur when communicating with a satellite at 119.5°W, where an elevation angle of 44.2° would be achieved. Thus, communication with the eastern-most satellite represents the antenna orientation with the lowest elevation angle.

NIST Nomograph

The worst-case power density was determined using a method developed by the staff of the National Bureau of Standards (NBS, now the National Institute for Standards and Technology, "NIST"), "An Efficient and Accurate Method for Calculating and Representing Power Density in the Near-Field Zone of Microwave Antennas."* Figure 2 from Page 6 of that report is applicable to the proposed installation, and it is reproduced here in Figure 1. According to the NIST paper, this nomograph is applicable to all aperture antennas with diameter-to-wavelength ratios of 30 or greater. Since a 4.5-meter diameter antenna at 14.2 GHz (the mean of the Ku uplink band) has a diameter-to-wavelength ratio of approximately 214 to 1, the nomograph is clearly applicable.

Figure 1 characterizes the power density variation in the near-field. The extent of the near-field covered by this nomograph extends to a D^2/λ ratio of unity, where D is the antenna diameter and λ is the wavelength, expressed in compatible units (*i.e.*, either both in meters or both in centimeters). For Ku-Band uplinks the mid-band wavelength is 0.021 m (2.1 cm), so for the proposed 4.57-m antenna, D^2/λ equals approximately 995 meters (3,264 feet). Thus, the distance over which this nomograph is applicable includes the entire KNPB studio/transmitter site.

At Page 3 of the NIST paper, the formula $S = 38.6 - 20\log_{10}D$ is given for calculating the maximum power density for 1 watt of antenna input power, where S is the power density in dBm/cm^2 and D is the antenna diameter in centimeters. For higher input powers a $10\log_{10}(P)$ factor must be applied, where P is the antenna input power in watts. Thus for the maximum antenna input power of 270 watts the main beam the power density would be $38.6 - 20\log_{10}(457) + 10\log_{10}(270)$, or

* Publication number NBSIR-85/8036, December 1985. This paper was written by Richard L. Lewis and Allen C. Newell, and was sponsored by the U.S. Environmental Protection Agency (EPA).

+9.7 dBm/cm^2. This is 9.7 dB higher than the 1.0 mW/cm^2 (0 dBm/cm^2) NCRP guideline for uncontrolled (public) exposures. Thus, the closest applicable and conservative contour line in Figure 1 defining the NCRP public limit is the -10 dB contour, and the closest and conservation applicable contour line defining the five-times higher occupational limit is the -5 dB contour.

For the NCRP public limit of 0 dBm/cm^2, Figure 1 shows that the maximum distance in the main beam to the -10 dB contour is a Z-axis distance of $0.76D^2/\lambda$, or 756 m. Given the worst case antenna elevation angle of 23.2° when communicating with the western-most satellite, this point would occur at a height of more than 700 meters (2,300 feet) above the antenna site elevation. Since as shown by the attached Figure 2 the KNPB site and surrounding area is relatively flat, and consisting only of one and two-story structures at the periphery of the site, the above-the-public limit main beam would occur hundreds of feet above ground, where of course public access would not exist. As shown by Figure 2A, the closest structure in the direction of the satellite arc look azimuths is approximately 44 meters from the satellite uplink dish. Even conservatively assuming the minimum elevation angle of 23.2°, at the edge of the building roof the main beam of the uplink signal would be at approximately 21 meters AGL, which would be 11.9 meters above an assumed rooftop height of 9.1 meters AGL. Thus, the main beam of the uplink dish would still be well above the roof of even this nearby building.

The nomograph shows that perpendicular to the main beam distance to the -10 dB contour does not exceed about 0.33D, or 1.5 meters, at any distance along the main beam. Thus, a 3.0-meter diameter virtual cylinder extending upwards at 23.2° above the horizontal and from the pedestal height of approximately 2.0 m AGL would define the worst-case distance to the public exposure limit. Since no public exposures would again occur in this space, the uplink antenna is inherently compliant with respect to public exposures, and no public exposure mitigation measures are necessary.

Occupational Exposures

The nomograph shows that on the back side of the uplink antenna, and outside the periphery of the of about 0.24D, or 1.1 meters perpendicular to the main beam, no exposures in excess of the 7 dBm/cm^2 occupational limit could occur. Exposures in excess of the occupational limit could occur within the 2.2-meter virtual cylinder out to approximately $0.28D^2/\lambda$, or 279 meters. However, access to this volume would require either climbing into the face of the uplink antenna, or using a "bucket" truck to place a person in the main beam. At the maximum distance to the main-beam 7 dBm/cm^2 occupational limit, the centerline height would be 110 m AGL, or more than 350 feet AGL. Therefore, the only occupational mitigation measure is that no worker access be allowed to the feedhorn side of the dish unless the uplink transmitter has been turned off.

Summary

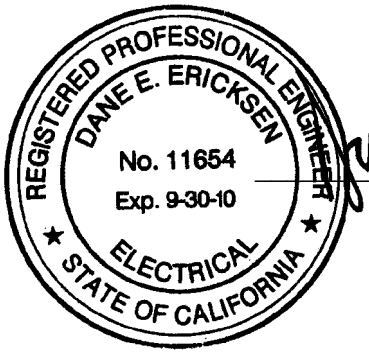
Operation of the proposed uplink will comply with the public exposure guidelines, even at the highest possible HPA power, since the uplink antenna will be inside a fenced area with a locked gate, and no portion of the 3.0-meter virtual cylinder defining the worst-case radial distance to the public exposure limit will illuminate the KNPB studio building nor any other nearby structures. Therefore, the only occupational exposure restriction that is needed is that the uplink transmitter be turned off before allowing workers to access the front (feedhorn) side of the uplink antenna for maintenance purposes.

List of Figures

In carrying out these engineering studies, the following attached figures were prepared under my direct supervision:

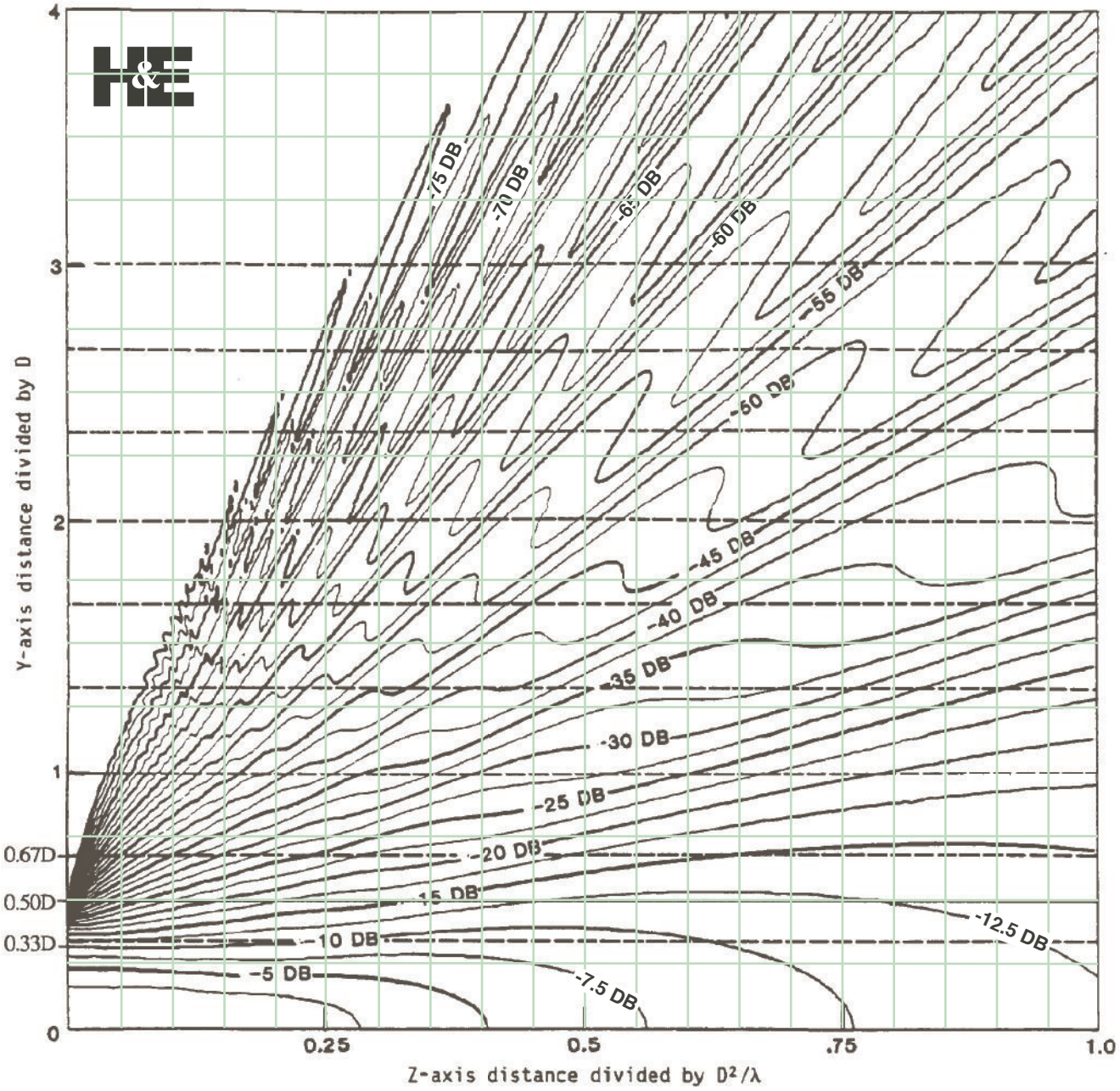
1. NIST nomograph
2. Satellite photograph views of the KNPB site.

March 18, 2010



Dane E. Ericksen, P.E.

Relative Power Density Contours in the Y-Z Plane for D >30λ



Nomograph from NTIS #NBSIR85-3036, page 6.
Additional notations by Hammett & Edison, Inc., Consulting Engineers, San Francisco.

New Ku-Band Satellite Uplink Station • Reno, Nevada

Site Satellite Photographs

Satellite photograph of the KNPB studios. Source: ACME Mapper.

New Ku-Band Satellite Uplink Station • Reno, Nevada

Site Satellite Photographs

The uplink antenna is the western-most satellite antenna, at marker "A." There is an 8-foot high fence with a locked gate around the satellite antennas. Source: ACME Mapper.