The Statement of Equivalency

The Part 15.255 (b) (1) "For products other than fixed field disturbance sensors, the average power density of any emission, measured during the transmit interval, shall not exceed 9 μW/cm^2, as measured 3 meters from the radiating structure, and the peak power density of any emission shall not exceed 18 μW/cm^2, as measured 3 meters from the radiating structure." explicitly states to measure the power density at 3 meters away. Therefore, the method used in the test report produced by InterTek Testing Service faithfully follows the rule.

The equation you have provided is the basis of the test report. The fundamental relationship known as the free-space or Friis equation may be written as

$$\frac{P_R}{P_T} = G_T G_R \left[\frac{\lambda}{4\pi d}\right]^2 \qquad \text{(Eq.1)}$$

where L_p is the path loss at distance d = 300 cm. P_T is the power supplied to the transmitting antenna with a gain of G_T in the direction of the receiving antenna. P_R is the power at the receiving antenna of gain G_R. λ =0.5 cm is the wavelength of propagation. Assumption is reflection-matched, polarization-matched, aligned for maximum reception.

Thus far, we are in agreement.

The power density is defined as a total power at an unit area of the spherical surface of the isotropic radiation front, and *EIRP* is defined as $P_T\, G_T$, thus,

$$P_{SD} = EIRP / (4\pi d^2) = P_T\, G_T / (4\pi d^2) \qquad \text{(Eq.2)}$$

$$P_T = P_{SD}\,(4\pi d^2) / G_T \qquad \text{(Eq.3)}$$

The total output power in logarithmic(dB) format;

$$P_{T(\text{dB})} = P_{SD\,(\text{dB})} + 10 \log (4\pi d^2) - G_{T\,(\text{dB})} \qquad \text{(Eq.4)}$$

The total output power evaluation can be done in absolutely the worst case. Let us assume that the radio with a 13 inch Parabola has a power density as much as the rules permits, which is P_{SD} = 18 μW/cm^2 at 3 meters away. This can be converted into EIRP of 20.35 W or 43.08 dBm. The only unknown in this figure is the transmitter antenna gain G_T. According to Eq.4 above, larger and more efficient antenna minimizes the total output power of the radio. Within the given worst-case antennae gain 37 dBi yields the total output power is equal to 6.08 dBm or 4 mW. The 43 dBi antennae gain suggested by the calculation based on the Bulletin 65, yields 0.08dBm or 1.02 mW. The limit of the total output is 500mW or 27 dBm.

Therefore, the total peak power out does not exceed the required by Part 15.255(e).

While Eq.1 and 2 together and λ =0.5 cm yields

$$P_{SD} = P_T\, G_T / (4\pi d^{\,2}) = 4\pi\, P_R \;/ \;(G_R\, \lambda^2) = 16\pi\, P_R \;/\; G_R \quad \text{(Eq.5)}$$

In logarithmic(dB) format;

$$P_{SD\,(\mathrm{dB})} = 10\ \log 16\pi + P_{R\,(\mathrm{dB})} - G_{R\,(\mathrm{dB})} \quad \text{(Eq.6)}$$

Power density is measured as received power at 3 meters with calibrated instruments such as the standard gain antenna and power meters. The test report further elaborates this equation by introducing corrections such as a correction factor for their receiver mixer, line loss caused by the cable, etc. Eq. 6 becomes;

$$P_{SD\,(\mathrm{dB})} = P_{R\,(\mathrm{dB})} + (10\ \log 16\pi - G_{R\,(\mathrm{dB})})$$

$$= (P_{Reading\,(\mathrm{dB})} + L_{\mathrm{Cable\,(dB)}} + L_{\mathrm{Mixer\,(dB)}}) + F_{\mathrm{Antenna\,(dB)}} \quad \text{(Eq.7)}$$

where $P_{Reading}$ is the actual power reading at the receiver instruments in dB, L_{Cable} is the actual power reading at the receiver instruments in dB, L_{Mixer} is the Mixer loss of the receiver instruments in dB, F_{Antenna} is the antenna factor of the receiver instruments in dB, which is defined as $4\pi / (G_R\, \lambda^2)$.

This is equivalent to your suggestion since it is derived from the same formula.

For example, power density of the High Channel Unit with a Parabola Antenna is the worst case, see fourth row from the end of the Table 2. $P_{Reading\,(\mathrm{dB})}$, the CW reading of the field strength was 64.5 dB μV/m @63.597860 GHz, the Antenna Factor: $F_{\mathrm{Antenna\,(dB)}}$ is 41.3 dB, the Cable loss: L_{Cable} is 0.8 dB, the Mixer loss: L_{Mixer} is 24.0 dB. Thus, $P_{SD\,(\mathrm{dB})}$ is 138.0 dB μV/m.

Conversion from μV/m to mW/cm^2 is given by the Equation (1) of OET Bulletin 65.

$$P_{SD}\,(\mathrm{mW/cm^2}) = \mathrm{E^2(V/m)} / 3770 \quad \text{(Eq.8)}$$

Since dB V/m converts to power in dB = 20 log E,

$$P_{SD}\,(\mathrm{mW/cm^2}) = (10^{(138\,/\,20)} \times 10^{-6})^2 / 3770 = 16.736\ \mu\mathrm{W/cm^2}$$