3. Significance

3.1 Blue-light reflectance measurements were originally designed to provide an indication of the amount of bleaching that has taken place in the manufacture of pulp. The higher the blue-light reflectance, generally the whiter the products will appear. The method provides a simple, single-number index useful for comparing similar white materials; however, colored materials are better identified by using a standardized three-dimensional color space [see TAPPI T 524 "Color of Paper and Paperboard (45/0 Geometry)" and T 527 "Color of Paper and Paperboard (d/0 Geometry)"].

3.2 Because the instrument geometry of this method is different from that of TAPPI T 452 "Brightness of Pulp, Paper and Paperboard (Directional Reflectance at 457 nm)," there is no simple relationship between the two brightness scales (*3*).

3.3 Specularly reflected light (gloss) is excluded from the measurement of diffuse brightness by the use of a gloss trap (specular reflectance absorber) as required in 5.1.1.3.

NOTE 2: Material containing fluorescent brightening agents will exhibit higher reflectance values to a degree which is dependent upon the ultraviolet (UV) content of the radiation incident on the specimen. Control of such UV content is essential to maintain continuity of measurement among optically brightened pulps.

NOTE 3: No known material is both perfectly reflecting and perfectly diffusing, but standards can be calibrated in terms of absolute reflectance factors (*2,4*). Standards with calibrations based on this reference can be obtained from Calibration Laboratories[1], as defined in Section 5.3 of TAPPI T 1211 "Acceptance Procedures for Calibration Laboratories."

4. Definitions

4.1 *Diffuse reflectance factor*, the ratio of the radiance factor of a specimen to that of a perfectly reflecting diffuser, each being irradiated and viewed identically (*4*).

4.2 *Absolute brightness*, the diffuse reflectance factor for blue light in terms of a perfectly reflecting, perfectly diffusing specimen as determined on an instrument as described in section 5.

4.3 *Perfect reflecting diffuser,* the ideal reflecting surface that neither absorbs nor transmits light, but reflects diffusely, with the radiance of the reflecting surface being the same for all reflecting angles, regardless of the angular distribution of the incident light.

5. Apparatus

5.1 *Reflectometer*[1], an instrument designed for the measurement of diffuse reflectance which employs the following geometric, photometric, and spectral characteristics:

5.1.1 *Geometric characteristics*

5.1.1.1 One or more light sources direct light into an integrating sphere which provides diffuse illumination of the specimen. The integrating sphere has an inside diameter of 150 mm and is coated with a matte white paint with absolute reflectance of 96 or greater from the light source. The sphere shall be equipped with screens to eliminate direct illumination of the specimen.

5.1.1.2 The sum total of the areas of the apertures and other non-reflecting areas in the sphere does not exceed 13% of the area of the inner surface of the sphere.

5.1.1.3 The receptor aperture is surrounded by a gloss trap (black circular area) of external diameter subtending a half-angle of 15.5 ± 0.5° at the center of the specimen aperture.

5.1.1.4 No light reflected from the rim of the specimen aperture shall reach the receptor.

5.1.1.5 The measured test area on the specimen is circular with a diameter of 28 mm ± 2 mm.

5.1.1.6 The specimen aperture diameter shall be 34 mm ± 1 mm and the edge thickness shall not exceed 1.5 mm.

5.1.1.7 The specimen is viewed perpendicularly (0°). Only reflected rays within a solid cone, whose vertex is in the center of the specimen aperture and of half-angle not greater than 4°, shall fall on the receptor.

5.1.1.8 Stray light from all sources shall not exceed 0.5%.

5.1.2 *Photometric characteristics.* The accuracy of the photometer, whether mechanical or electronic, is such that the departure from photometric linearity after calibration does not exceed 0.3% reflectance factor.

5.1.3 *Spectral characteristics.* The spectral distribution of the brightness function is shown in Table 1. This function has an effective wavelength of 457.0 nanometers ± 0.5 nanometers with a bandpass at half peak height of 44

[1] Names of suppliers of testing equipment and materials for this method may be found on the Test Equipment Suppliers list in the bound set of TAPPI Test Methods, or may be available from the TAPPI Quality and Standards Department.

NOTE 4: A reference standard is used to transfer calibration from a Calibration Laboratory to a given instrument. Reference standards should never be cleaned as cleaning may change their value. Instrument standards should be used frequently to check the stability of a given instrument's calibration. An instrument standard evaluated on one instrument should never be used to calibrate another instrument. Instrument standards may be cleanable (consult the manufacturer's instruction manual).

7.2 *Calibration of instrument standard(s)*

7.2.1 Procedure for instruments which are not equipped with an internal instrument standard.

7.2.1.1 Turn instrument on and allow it to come to operating equilibrium. Consult instruction manual for manufacturer's recommended warm-up time.

7.2.1.2 Clean one or more opal glass or ceramic instrument standards (per manufacturer's instructions) if they have not been cleaned recently.

7.2.1.3 Select the brightness measurement (457 nm) position.

7.2.1.4 Adjust the instrument to read the black cavity value with the black cavity in the specimen position.

7.2.1.5 Place the reference standard in the specimen position. Adjust the instrument to read the assigned value.

7.2.1.6 Place an instrument standard in the specimen position and read and record the calibration value for this standard. Repeat this procedure to obtain values for additional standards if desired.

7.2.1.7 If the instrument is to be calibrated for the measurement of fluorescent materials, the fluorescent and non-fluorescent reference standards must be used interactively per the manufacturers recommend procedure to achieve calibration for both standards.

7.2.2 *Procedure for instruments equipped with an internal instrument standard.*

7.2.2.1 Turn instrument on and allow it to come to operating equilibrium. Consult the instruction manual for manufacturer's recommended warm-up time.

7.2.2.2 Use the manufacturer's recommended instruction to calibrate the instrument to the black cavity.

7.2.2.3 Place the reference standard in the specimen position. Use the manufacturer's recommended procedure to establish calibration based on this standard and to transfer calibration to the instrument's internal instrument standard.

7.2.2.4 If the instrument is to be calibrated for the measurement of fluorescent materials, the fluorescent and non-fluorescent reference standards must be used interactively per the manufacturer's recommended procedure to achieve calibration for both standards.

NOTE 5: The reflectance of opal-glass or ceramic standards is relatively stable; however, they must be calibrated at regular intervals on the specific instrument with which they will be used by making use of reference standards and the procedures described in Section 7.

8. Use of instrument standards

If instrument standards have been evaluated in accordance with the instructions in Section 7.2, one of the instrument standards may be used on a regular basis to check and, if necessary, reestablish calibration. If a second instrument standard was evaluated, it may be stored away to periodically check the stability of the first instrument standard. For instruments which are equipped with an integral standard, an external instrument standard may be maintained, if desired, but doing so is not a requirement of this method.

NOTE 6: Reference standards should be acquired on a regular basis (not less than 4 times per year) to assure the stability of calibration..

9. Test specimens

Use handsheets prepared according to T 218 or T 272, or machine dried pulp sheets. Remove the filter paper cover from the dried handsheets. Cut the handsheets into tabs large enough to cover the measurement aperture of the instrument. Use a pad of tabs of sufficient number that doubling it will not change the brightness reading. Six tabs may be sufficient.

10. Procedure

10.1 Select the brightness (457 nm) measurement position and calibrate the instrument.

NOTE 7: A single 150 mm diameter handsheet can be conveniently cut into six pie-shaped tabs using a paper cutter with a special template. The six tabs can be stored in the folded filter paper cover until ready to read the brightness.

10.2 Remove the top cover tab and place it on the bottom of the stack of tabs. Place the tabs, with the smooth side up, on a clean specimen holder.