U.S. DEPARTMENT OF COMMERCE
National Technical Information Service

AD-A029 072

Support to MASSTER Phase II Camouflage Test

Army Natick Research & Development Command

April 1976

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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER TR 76-38-CEMEL	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) SUPPORT TO MASSTER PHASE II CAMOUFLAGE TEST		5. TYPE OF REPORT & PERIOD COVERED Summary of Research and Development- July 74-July 75 6. PERFORMING ORG. REPORT NUMBER CEMEL 159
7. AUTHOR(s) F.J. Rizzo, A.O. Ramsley, A.M. Campbell, W.B. Bushnell, B.A. Natsios, A. Merola, G. Kidder		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS US Army Natick Research and Development Command ATTN: DRXNM-VTC Natick, MA 01760		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 62723A 1Y762723AH98-AB-002
11. CONTROLLING OFFICE NAME AND ADDRESS		12. REPORT DATE April 1976 13. NUMBER OF PAGES 65
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report).

Approved for public release; distribution unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Camouflage
Clothing
Personal Equipment
Shelters
Packaging

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)
The report lists and describes all of the items furnished to the Modern Army Selected Systems Test, Evaluation and Review (MASSTER) for the Phase II Camouflage Test begun in June 1975. Also included is a concept of testing personal camouflage items by emphasizing that they are components of an integrated system of clothing and personal equipment. All experimentally developed items are described with photographs, reflectance data, pertinent associated computational data, and colorant composition formulations. Standard items furnished for reference in the test are included in the listing.

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PREFACE

This report covers the work performed by US Army Natick Research and Development Command during FY 75 in support of the camouflage testing program of MASSTER. This work was performed by NARADCOM under a transfer of funds from US Army Mobility Equipment Research and Engineering Command. These funds were used for the purchase of materials and outside processing and services for fabrication of items.

The report also covers work performed by contract under technical guidance by NARADCOM. The contract on camouflage of tents with Franklin Institute Research Laboratory was equally funded by MERADCOM and NARADCOM with Dr. C. J. Monego of NARADCOM as Project Officer. The contract on camouflage of packaging materials with Battelle Columbus Laboratories was funded by MERADCOM with technical guidance provided by Mr. Raymond Mansur of NARADCOM.

All technical guidance by the above and by the authors of this report was supported by NARADCOM mission funds.

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SUPPORT TO MASSTER PHASE II CAMOUFLAGE TEST

1. Introduction

The US Army Natick Research and Development Command (NARADCOM) US Army Mobility Equipment Research and Development Command (MERADCOM), and Modern Army Selected Systems Test, Evaluation, and Review (MASSTER) have been engaged in a cooperative assessment of developments in personal camouflage for the past several years. The results of the earlier, somewhat limited efforts, clulminated in the Phase I Camouflage Test which was performed during FY 1973. The following statement from the Phase I report[1] summarizes the basis for MASSTER's participation in the Army-wide camouflage program.

"An evaluation, conducted during MASSTER combined test ACCB II and TRICAP I,[2] indicated the camouflage posture of participating Army units required considerable improvement. The VCofSA indicated a desire that MASSTER take a leading role in developing innovative camouflage techniques. As a result, MASSTER developed a camouflage evaluation program, and this report documents Phase I of that program."

Before Phase I was completed it became apparent that a second exercise would be necessary, mainly to compensate for the rather low level of emphasis on camouflage of the individual soldier. This is stressed in plans for Phase II Camouflage Test, that began in the summer of 1975.

To allow for proper emphasis on personal camouflage in the Phase II Test, it was necessary that extnesive support in material be given by NARADCOM and MERADCOM. The Lead Laboratory for Camouflage Technology at MERADCOM transferred $52,000 to NARADCOM to supply the many items listed in Section 3. These funds were used exclusively for purchases of materials and services from outside sources, both governmental and commercial. In addition NARADCOM supplied approximately $100,000 of mission funds, largely for technical and managerial support by NARADCOM.

Some of the items furnished were suggested by MERADCOM and MASSTER, and others by NARADCOM. The list of items was subsequently agreed upon at meetings of personnel of all three agencies. The basic intent was to furnish those items needed to permit a camouflage evaluation of the complete system of clothing and person equipment as used by a soldier in combat rather than on the item-by-item basis.

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1. Marrero-Camacho, G. and R.B. McDermott, Camouflage Evaluation Report (Phase I), MASSTER Test Report No. FM 153, Hq MASSTER, Ft. Hood, Texas 76544 (21 January 1974).

2. Humphreys, Adolph H., Camouflage Team Report of MASSTER ACCB II/TRICAP I, Report 2028, US Army Mobility Equipment Research and Development Center, Fort Belvoir, VA 22060 (April 1972).

2. Concepts of Testing Clothing for Camouflage Effectiveness

In 1962 a joint exercise[3] on effectiveness of personal camouflage was conducted under the auspices of the Infantry Board, the Engineer Research and Development Laboratories and the Quartermaster Research and Development Command. This exercise was conducted at Fort Benning and utilized troops wearing different uniforms, both patterned and monotone. The subjects were viewed by a group of trained observers from elevated booths that provided each with a clear line of sight to the targets in the test area. Six uniforms were considered in a detailed, quantitative field test:

a. British monotone similar to Olive Green 107

b. U.S. Army Olive Green 107 without load-carrying equipment

c. U.S. Army Olive Green 107 with load-carrying equipment

d. U.S. Army 1948 four-color camouflage pattern

e. U.S. Marine Corps Mitchell pattern

f. U.S. Army Khaki 1 uniform similar in design to b and d.

Observation ranges varied from 500 to 1800 meters. It was reported[3] that at none of t he ranges could any of the patterns be visually resolved into their individual components. Also, the average, integrated colors were nearly the same for the first five colors listed. If it is assumed that a subject was uniformly illuminated and the brown, dark green and black areas of the 4-color pattern are visually equivalent at the observation ranges, a dark-light pattern should be discernible at some range. Under the conditions of the test the contrast between the dark and light areas was about 1.0. For an average area of about 60 cm^2 for parts of the light green portion of this 4-color pattern, Tiffany data[4,5] suggest the dark-light pattern could not have been resolved beyond about 200 meters. Thus, both by expectation and observation, the contrast of each of the first five uniforms (listed above) with the background against which it was viewed was approximately the same. Unfortunately, extremely hot and dry weather seared the grass that comprised most of the viewing background and, therefore, the contrast with the terrain for these five uniforms was high, probably equivalent to about 0.8. The Tiffany data also suggest that all five of these target uniforms with a perceived area of about 0.75 m^2 should be visible at all ranges, under the good viewing conditions that generally prevailed during the test.

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3. Gee, D. L., and A. H. Humphreys, User Review of Camouflage for the Individual Combat Soldier in the Field, ERDL Report No. 1834, Mobility Equipment R&D Command, Ft. Belvoir, VA. 22060, Oct 1965.

4. Blackwell, H. R., Contrast Thresholds of the Human Eye, J. Opt. Soc. Amer., 36, 624-643 (1946).

5. Middleton, W.E.K., Vision Through the Atmosphere, U. Toronto Press, 1952.

The same data suggest that the detection range for the Khaki 1 uniform, with a lower contrast with the background (probably about 0.2), should be about half that of the other uniforms. The results of the test, indeed, supported the conclusion that the Khaki 1 uniform was substantially less conspicuous than the other five, which were indistinguishable from one another.

The color of the terrain, its near absence of perceptual clutter, and the extreme observation ranges combined to preclude any quantitative comparison of patterned uniforms and their monotone equivalents. Moreover, as the test progressed, the observers became familiar with the test area. This may have biased the results. Some of these unfortunate factors were avoided in the design of MASSTER test FM 204b: the grass was greener, observation ranges were shorter; observers were frequently rotated. Yet the contrast with the immediately surrounding terrain against which targets were viewed was still rather high, probably near 0.5.

The qualitative visual portions of the 1962 test yielded some interesting observations. An ambush and an infiltration test were conducted at shorter ranges and in more cluttered terrains, where patterns could be resolved. It was generally agreed that patterned uniforms were more effective than monotone uniforms under these conditions. It was also observed, however, that additional measures need to be taken beyond a camouflaged uniform and helmet cover to achieve camouflage effectiveness. In none of the 1962 testing was a specific attempt made to disrupt the soldier's silhouette beyond modest use of indigenous materials such as foliage or long grass. One of the most conspicuous clues was the black, shiny boots that were worn. At long ranges they were generally obscured, but at the short ranges used in the informal, qualitative observations, the boots were often visible. Another conspicuous clue to recognition of a man at all ranges was the characteristic head-neck-shoulder outline. These subjective observations were generally borne out in the later Vietnam experience.

MASSTER FM 204b was partly intended as a prelude to a more definitive test of camouflage effectiveness. Improving on the design of the 1962 test, it was also hoped that quantitative data on probability of detection as a function of range would be generated that could be useful in various computer models. From FM 204b it was hoped that one of the patterned uniforms could be identified as being less conspicuous than the others. This uniform could then be augmented with other patterned or otherwise camouflaged items to provide the soldier with a full complement of camouflage within the state of the art. It was planned that this augmented, patterned, camouflage clothing and equipment system would be compared later with a similar system consisting only of standard items in the monotone olive green color in competitive unit exercises. The rational for this type of test was that a quantitative measure of camouflage effectiveness should be in realistic operational terms that relate to a tactical environment.

Such an exercise involves pitting one fully camouflaged force against an equivalent force equipped only with standard, authorized olive green monotone equipment in a field setting. At the time FM 204b was being formulated, it was planned that the follow-up exercise would be squad-on-squad scale using an appropriate, available scenario. The basis of effectiveness would have included scoring probable casualties by available techniques.

It was not necessarily expected that the squad-on-squad exercise would, by itself, provide a total basis for a cost/effectiveness analysis, but that it would at least have pointed the direction that future, definitive testing should take. It is anticipated that implementing personal camouflage to the full extent now possible within the current state of the artmight add about 15 per cent to the cost of a complete clothing and personal equipment system for the combat soldier. Proper analysis requires that the effectiveness data also be quantitative and realistic. It is within this context that the many items listed and described in the following sections were produced and made available for the MASSTER test.

3. Summary of Items to be Tested

The list below tabulates the items furnished to MASSTER for test beginning the summer of 1975. The items were not intended to be evaluated separately, but to be used as components of experimental ensembles that represent total clothing and personal equipment systems, typical of those that might be seen by soldiers in combat stations. Although some items will be subjected to individual evaluation, and some screening of similar items is under way, the more rigorously conducted tests will deal with comparisons among systems of personal equipment.

a. Standard Combat Tropical Uniforms, Olive Green 107

b. Standard Combat Tropical Uniforms, US Army 1948 4-color pattern

c. Experimental Desert Uniform, 6-color pattern

d. Experimental Uniforms for Verdant Terrains with four levels of expansion of the US Army 1948 4-color pattern

e. Experimental Uniforms with Experimental Disruptive Camouflage for Verdant Terrains

f. Experimental Uniforms with "Tiger" pattern oriented horizontally

g. Standard Helmet Covers, Reversible

h. Standard Helmet Covers, 1948 4-color pattern

i. Experimental Helmet Covers, Coarse Net

j. Experimental Body Net, Coarse Net

k. Standard Ballistic Vests, Olive Green 106

l. Ballistic Vests, Standard 4-color pattern

m. Ballistic Vest, Experimental 4-color pattern expanded by 60 per cent

n. Experimental Poncho, Experimental 4-color pattern

o. Experimental Watch Covers

p. Experimental Weapon Covers

q. Standard Load Carrying Equipment

r. Load Carrying Equipment with Experimental 4-color Camouflage Pattern

s. Experimental Pack Covers, 4-color

t. Experimental Pack Covers, 6-color

u. Experimental Overcoloring Compound, Removable

v. Experimental Overcoloring Compound, Durable

w. Experimental Combat Boots, Green

x. Experimental Combat Boots, Tan

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bb. Experimental Dye Packets for Field Dyeing of Personal Items (Handkerchiefs, Underwear, etc.)

cc. Standard Leather Gloves, Tan

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ee. Experimentally Patterned General Purpose Small Tent, Nature Pattern

ff. Experimentally Patterned General Purpose Small Tent, MERDC Pattern

gg. Experimentally Patterned General Purpose Medium Tent, Nature Pattern

hh. Experimentally Patterned General Purpose Medium Tent, MERDC Pattern

ii. Experimental Recoloring Compound for Tentage

jj. Experimentally Camouflaged Packaging Materials

kk. Experimentally Camouflaged Mobile Field Kitchen

Descriptions of each item furnished by Natick Research and Development Command for testing by MASSTER in the Phase II Camouflage Test are given in Section 4 of this report.

4. Development of Items for Test

As indicated in the tabulation in Section 3, many of the items furnished to MASSTER are standard and available from stock. For that reason no developmental data are furnished for these items.

a. Standard Combat Tropical Uniforms, Olive Green 107

Thirty-five coats and trousers, combat tropical, have been furnished in a variety of sizes. The fabric used in these garments is cotton poplin with a 6.35 mm nylon rip-stop, vat dyed to an Olive Green 107 shade.

The Olive Green 107 shade is vat dyed and was developed in 1950 by the Quartermaster Research and Development Command directed to sniperscope detection. It was type classified in 1952. Figure B.1 is the reflectance curve from 400 to 1000 nm for this uniform. Included are C.I.E. tristimulus coordinates, visual reflectance and the ratio of infrared to red reflectances integrated with respect to the sensitivity functions of CD film. Figure A.1 includes a photograph of this uniform.

b. Standard Combat Tropical Uniforms, 1948 4-color Pattern

Fifty coats and trousers in the same fabric as 4.a. have been furnished in a variety of sizes. The four colors were vat printed over a vat-dyed ground shade in a regular procurement.

The pattern was originally designed in 1948 at the Engineer Research and Development Center. Subsequently, it was translated to fabric under guidance by the QM Research and Development Command and type classified in 1966 as the US Army 1948 camouflage pattern, also directed toward minimizing sniperscope detection.

Figure B.2 gives reflectance curves and computational data for each of the four colors of the camouflage pattern of this uniform. Figure A.1 is a photograph of the 1948 4-color pattern with the standard Olive Green 107 uniform described in 4.a.

c. Experimental Desert Uniforms, 6-color Pattern

Fifty experimentally developed desert uniforms were furnished for the Phase II test in the same tariff of sizes as in 4.a. This camouflage pattern was designed at MERADCOM. Subsequently, the pattern was printed under NARADCOM technical guidance on a fabric that was designed for use in combat clothing for desert terrains. This is the pattern design evaluated by MASSTER in Phase I, of which it was said, "the desert uniform was the most effective in breaking up the silhouette at the longer ranges".[1]

This comment was based on subjective visual observation alone. Simultaneous laboratory investigation at NARADCOM demonstrated that some alteration in visual color and substantial changes in infrared reflectance should be made. To make the indicated corrections a total reformulation of the vat dyed printing was required. Guidance for the reformulation was provided by application of the Kubelka-Munk analysis of colorant layers.[6] Figures A.2. and A.3 are photographs with conventional and infrared color film, respectively, of the original and corrected 6-color desert uniforms, those sent for Phase I and Phase II, respectively. Figures B.3 and B.4 are reflectance curves for each of the five major colors of each of the two uniforms. The dye formulations used for the base color and the colorant components of the print paste for each of the six colors are given in Appendix C.1. The fifty uniforms provided to MASSTER were produced using these corrected formulations.

In fabricating the experimental uniforms a nylon/cotton sateen, approximately 290 g/m^2, was used. The design of the jacket and trousers is similar to the combat tropical uniforms, a design agreed upon jointly for all uniforms in the test in the interest of consistency to eliminate the factor of garment design and outline.

d. Four-Color Pattern Expansion

The MASSTER report of Phase I[1] indicated a definite subjective preference for camouflage patterned uniforms. It also suggested that a larger pattern might be more effective at longer observation ranges. Accordingly, a series of four uniforms was made in which four sizes of camouflage pattern were used. The colorant formulations, shown in Appendix C.2., were identical in each of the levels of expansion and all printing was done by the same mill at the same time on the same base fabric.

The fabric used was also a nylon/cotton sateen approximately 290 g/m^2 and fabricated into the combat tropical design. Figure A.4. is a photograph that illustrates the appearance of the four sizes of patterns used. The smallest pattern size is the same as the standard US Army 1948 4-color verdant pattern; the others are of the same geometry and color but linearly expanded by 30, 60 and 100 per cent. Area expansions are therefore, approximately 70, 250 and 400 per cent, respectively. Figure B.5. presents reflectance and associated computed data for each of the four colors used in all the patterns.

e. Disruptive Patterned Camouflage

Based on observations in Phase I of certain foreign uniforms, it was agreed by participants in the test that a variation in pattern design from the 4-color pattern should also be considered. The pattern selected was one made by printing the black portion of the "Tiger" pattern (see 4.f.) oriented in a vertical direction over the standard 4-color 1948 pattern. This resulted in a darker total effect than other uniforms, as is shown in Figure A.5. The 4-color patterned fabric, all cotton sateen approximately 290 g/m^2, was withdrawn from general stock and over printed with the same black formulation used in the expansion series described in 4.d. (see Appendix C.2).

6. Judd, Deane B., Color in Business, Science and Industry, Wiley, New York, 1952.

f. Tiger Patterned Uniforms

This pattern, with one variation is that which was widely used by the ARVN in Vietnam. This uniform is also illustrated in Figure A.5. with the reflectance data given in Figure B.6. The dye formulations used for the various colors are given in Appendix C.3.

g. Standard Reversible Helmet Covers

Two hundred (200) standard reversible helmet covers, FSN 8415-00-261-6830, were sent to MASSTER to be used with a variety of uniforms. One side of the helmet cover is predominantly greenish, the other tan. The green side of the helmet cover is illustrated with the Standard Olive Green 107 and the Standard 1948 4-color patterned uniform in Figure A.1. The tan colored side is illustrated with the 6-color Desert uniform in Figures A.2 and A.3.

h. Standard 4-color Patterned Helmet Cover

One hundred (100) standard helmet covers made of the US Army 1948 4-color pattern, FSN 8415-105-0605 were sent to MASSTER. These are illustrated in Figure A.4. with the expansion series of uniforms.

i. Experimental Helmet Covers, Coarse Netting

A coarsely woven net was vat printed with formulations described in Appendix C.4. in the 4-color verdant pattern. When fully stretched, the net has a mesh of about 15 mm with strands about 3 mm thick. Helmet covers made of this are illustrated in Figure A.4. To prevent hang-up in view of the tendency to snag, the fabric was tenderized by soaking for 2 minutes in a one-per cent solution of hydrochloric acid, dried at 105° C, and neutralized with soda ash.

To form the helmet cover the fabric was cut into 50 cm squares, draped over the helmet and held in place with an elastic tape. It is intended that the excess fabric be raised above the tape to enhance the gross texture and be formed into an uneven surface with paper covered wire.

j. Experimental Body Net, Coarse Netting

The experimental body nets were made of the same fabric as the helmet cover in 4.i. Each net measures about three meters long when stretched longitudinally, and about two meters wide when stretched laterally. The large size was chosen to permit troops to use the net experimentally for camouflage purposes in addition to a close fitting body net as was illustrated in the Phase I report[1]. Figure A.6 illustrates one use of the experimental netting as a personal camouflage net. The individual body nets weigh about 900 grams and folds easily into a package 40 cm by 18 cm by 5 cm.

k. Standard Ballistic Vest

Fifty (50) standard ballistic vests were withdrawn from stock and sent to MASSTER for Phase II. The outer layer is nylon and was commercially dyed Olive Green 106 in a regular procurement. The vest is shown in Figure A.1. by the subject wearing the standard Olive Green 107 coat and trousers.

l. Ballistic Vests, Standard Size 4-color Pattern

Nylon duck was dyed and printed with formulations also given in Appendix C.4 to produce the standard size 4-color pattern. The fabric was then used to produce (50) otherwise standard ballistic vests that were sent to MASSTER for Phase II. This item is illustrated in Figure A.1 by the subject wearing the standard 1948 4-color patterned uniform. Reflectance and related data are given in Figure B.7.

m. Ballistic Vest, Experimental Pattern

The same formulations (C.4.) and fabric were used to print a 4-color pattern linearly expanded 60 per cent compared with the standard 1948 4-color pattern. This was used to make fifty (50) armored vests that also were sent to MASSTER for Phase II. This vest is illustrated in Figure A.4. by the subject wearing the uniform with the camouflage pattern also expanded 60 per cent. Reflectance curves and associated computed data for each of the four areas of the camouflage pattern are the same as those that appear in Figure B.7.

n. Experimental Poncho

Figure A.6 also illustrates an experimental 4-color patterned poncho, fifty (50) of which have been sent to MASSTER for Phase II. Nylon rip-stop (approx. 55 g/m^2) was printed with a 4-color pattern using formulations also listed in Appendix C.4. This camouflage pattern was then coated with clear polyurethane film to render the item water repellent. Reflectance curves and related computed data are given in Figure B.8.

o. Experimental Watch Covers

It was pointed out by MERADCOM personnel that the highly directional reflection from a watch crystal may provide an early clue to detection of an infantry soldier. They requested that a few experimental fabric watch covers be furnished to MASSTER for evaluation. These were fabricated from the same fabric as the uniform in 4.b., with a 4-color pattern. The watch cover is illustrated in Figure A.4., by the subject wearing the uniform with the standard size 4-color camouflage pattern.

p. Experimental Weapon Covers

MERADCOM also recommended that MASSTER evaluate the usefulness of devices to disrupt the distinctive outline of individual weapons. NARADCOM fabricated such items from fabric for fifty (50) M-16 rifles and forwarded them to MASSTER. These items are illustrated in Figure A.4., by one of the subjects. The fabric used was a standard sized 4-color patterned poplin, as in 4.d., incised by hand, and provided with Velcro fasteners to hold the cover in place. The items were designed so as to minimize interference with the weapon's function.

q. Standard Load Carrying Equipment

Fifty (50) sets of the new nylon sets of the latest standard load-carrying equipment were sent to MASSTER to be worn with the standard Olive Green 107 in the Phase II test. This is illustrated in Figure A.1.

r. Patterned Load Carrying Equipment

Fifty sets of load carrying equipment were patterned in a manner similar to the US Army 4-color pattern by brushing, using the durable experimental overcoloring compound (see 4.v). These are intended to be worn with the 4-color patterned uniforms as illustrated in Figure A.4. The items of the load carrying equipment are the same as in 4.q.

s. Experimental Pack Covers, US Army 4-Color Pattern

As an alternative to field patterning of load carrying equipment, pack covers of cotton sateen, approximately 290 g/m^2, with a 4-color pattern the same as 4.b., were fabricated. The design was the same as the standard white pack cover for snow camouflage. This is illustrated in Figure A.4.

t. Experimental Pack Covers, 6-Color Desert Pattern

Pack covers, similar to those in 4.s., were fabricated of a nylon/cotton, approximately 290 g/m^2, with the 6-color desert pattern described in 4.c. The pack covers are illustrated in Figures A.2 and A.3 with the comparable uniform.

u. Experimental Overcoloring Compound, Removable

Five gallons in each of four colors of a removable overcoloring compound for textiles were sent to MASSTER. The compound is water based and is intended to be applied to textiles that are not water repellent. Compositions of the four colors are given in Appendix C.5. Although the colorant system resists water (e.g. rain), it is readily removed in an alkaline laundry. Reflectance curves for each of the four colors and computed associated data are given in Figure 9. Reflectance curves of specimens after removal of the compound are shown in Figure B.10.

v. Experimental Overcoloring Compound, Durable

For those applications that demand a more permanent overcoloring, a durable formulation has been developed. Five (5) gallons of each of four colors have been furnished MASSTER for their consideration. This formulation also is intended for application to textile items, including those that are water repellent. To illustrate one use for this overcolorant compound, load carrying equipment was colored with the four colors in a pattern resembling the US Army 1948 4-color pattern (4.b.) The formulation is given in Appendix C.6.

Reflectance and colorimetric data are shown in Figure B.11., while the patterned load carrying equipment is illustrated in Figure A.4.

w. Experimental Combat Boots, Green

One clue to detection that often has been cited is the shined, black combat boot. Only recently NARADCOM has found ways to overcome problems of water resistance of a flesh-out boot. Accordingly, fifty (50) pairs of combat boots were made with the flesh side outward. These were tanned and dyed green, as outlined in Appendix C.7., and were sent to MASSTER for testing in verdant terrains.

Figure A.4 shows one of the subjects wearing a pair of the green flesh-out boots; reflectance and colorimetric data are shown in Figure B.12.

x. Experimental Combat Boots, Tan

Fifty pairs of tan flesh-out boots were also made and sent to MASSTER for testing in an arid terrain. The color of these boots is due entirely to the tanning process as described in Appendix C.7. The tan boots are illustrated in Figures A.2 and A.3; reflectance and colorimetric data are also given in Figure B.12.

y. Experimental Face Paint, Desert Colors

Camouflage face paints have long been used to tone down the highlights and color of the face and hand, particularly of Caucasians. In recent years an insect repellent was incorporated to provide a dual function for the face paint stick. One hundred (100) sticks of the loam and sand colored face paints were sent to MASSTER for testing in an arid terrain. The composition varied from standard only in respect to the colorants for the sand color and was done to improve the infrared reflectance properties. The formulation is described in Appendix C.8., and illustrated in Figures A.2 and A.3. Reflectance curves and computed data are given in Figure B.13 for the compound as a mass tone.

z. Experimental Face Paints, Verdant Terrains

In a manner similar to the face paint for arid terrains, the green color was reformulated as a camouflage face paint color for verdant terrains. The second color in the stick is the same loam color as in the stick for arid terrains. The reason for change in the colorant of the green stick was its poor reflectivity in the infrared spectrum. The difference between the old and new formulation is shown in the reflectance curves of Figure B.14. The appearance of the new face paint is illustrated in several figures of Appendix A. Appendix C.9., contains information on the composition of formulations used.

aa. Experimental Face Veil

A camouflage problem that often has been cited is that of glare from spectacles. Since approximately one-third of the Army wear corrective lenses and many more use sun glasses, the problem is wide spread. One approach to mitigate the problem is by the use of a netting to cover the face. To minimize impairment of vision, a face veil must have a large mesh size and be dark in color to minimize light scattering by the grid. Fifty (50) items were fabricated from the same netting as used in the body net (see 4.j.). To minimize scattering of light, the inner surface was colored with the black durable over-coloring compound (see 4.v.). The face veil is mounted on an elastic band and attached to the helmet as illustrated in Figure A.4.

bb. Field Dyeing Packets

Another camouflage problem arises from the fact that many personal items, e.g., towels, underwear, and handkerchiefs, are issued in a white state. When troops wash such items in the field, they may spread them on bushes or the ground to dry, in obvious conflict with good camouflage practice. A field dyeing packet has been developed to permit troops in the field to dye such personal items to appropriate camouflage colors to minimize their adverse contribution to battlefield litter.

Standard field dyeing packets, Olive Green 109, FSN 6820-782-2682 were withdrawn from stock and sent to MASSTER for evaluation. Preliminary trials showed that the color produced was far from an Olive Green 107 shade and that adjustments in the dye formulation were indicated. A packet was developed such that when it was added to the stock item, the proper shade was obtained. Sufficient dye has been sent to MASSTER, and personnel at the base laundry at Fort Hood were instructed by NARADCOM personnel in the appropriate dyeing procedure. The formulation for the supplementary package are given in Appendix C.10. Figure A.8 is a photograph of several items that have been dyed with the revised formula and displayed as they might be in a field situation.

cc. Leather Gloves, Standard Black Color

Leather gloves have been furnished to MASSTER for the Phase II test as an alternative means of camouflaging the hands. The black color is that of the standard item and is illustrated in Figure A.1.

dd. Leather Gloves, Tan

Gloves, similar to those in 4.bb., have been sent to MASSTER in a tan color. These are furnished as an alternative to the face paint for camouflaging the hands and are to be worn with the 6-color desert uniform. Figures A.3 and A.4., show the gloves being worn by one of the subjects. The reflectance and associated data are included in Figure B.15. The color was attained by use of a vegetable tanning process alone.

ee. Tents, General Purpose, Small and Medium, Nature Pattern

One each of subject tents were camouflage patterned in a configuration referred to as the Nature Pattern. This is a pattern designed by Franklin Institute Research Laboratories under contract to NARADCOM[7] and was intended to resemble foliated terrains that likely would serve as a background to a properly sited tent in a foliated region. Four colors were used to produce the pattern using a formulation described in 4.gg. Figure A.9 is a photograph of the GP Medium tent sited in a manner to illustrate the pattern, not its camouflage effectiveness. The patterns for these two tents were applied by spraying techniques suggested by the contractor.

7. De Benedictis, John A., Camouflage Study of the GP Small and GP Medium Tents, US Army Natick Research and Development Command, Natick, Mass. 01760, (in preparation).

ff. Tents, GP Small and Medium, MERDC Pattern

One of each of subject tents was camouflage patterned in a design referred to as the MERADCOM Pattern. This pattern is included in a compendium of patterns designed by MERADCOm for the camouflage of a wide variety of vehicles and other field equipment. The same colorant formulations were used for these tents as for those discussed in 4.ee., and are illustrated in Figure A.10. Application was by brush which resulted in somewhat better coverage than in 4.ee.

gg. Recoloring Compound for Tentage

Part of a contract with the Franklin Institute Research Laboratories produced four colors of a compound to be used in recoloring field tents.[6] The composition of the formulations was intended to preserve the resistance of existing tents to mildew, rain, wind and fire. Use of the compounds is illustrated in Figures A.9., and A.10.; reflectance and related data are given in Figure B.16. The composition of each of the four colorant formulations is given in Appendix C.11.

hh. Camouflaged Packaging Materials

Under a MERADCOM-funded contract[8] colorant finishes were developed for camouflage of fiberboard cartons, wooden crates, polyethylene film for food packaging and tin cans. As currently procured none of these items is properly camouflaged; all can easily contribute to battlefield litter in a manner that violates good camouflage practice. Figure A.11. displays the above items with the developed colorants. Reflectance and related data are given in Figure B.17., and the composition of the formulations is reported in the Battelle report.[8]

ii. Camouflaged Mobile Field Kitchen

The mobile field kitchen that has been designed by NARADCOM was patterned using two formulations, one for the metal parts, and one for the fabric components. For the surfaces of ranges and ovens that face outward a commercial stove blacking was used. All other metal parts, the storage containers, floor, trailer chassis and roof were painted with the alkyd enamel (Mil-E-52798). The fabric components were patterned with the tentage recoloring compound discussed in paragraph 4.gg.

Two patterns were used, the MERADCOM Pattern (4.ff) for those areas exposed when the unit is configured as a trailer. This includes the roof and the nylon tarpaulins. The Nature Pattern was applied to those areas that are exposed when the unit is deployed as a kitchen. The garbage cans and lids were painted with the alkyd enamel with a free-hand version of the Nature Pattern. Figure A.12 illustrates the unit deployed as a kitchen with the side curtains down. In this configuration the Nature Pattern predominates.

8. Nowacki, Louis J., Camouflaged Packaging Materials, Battelle Columbus Laboratories, US Army Mobility Equipment Research and Development Center, Fort Belvoir, VA 22060 (27 December 1974).

APPENDIX A

Appendix A contains photographs of the items that were produced during the FY 75 program and sent to MASSTER for the Phase II test. The items are portrayed by troops in a somewhat realistic manner and in an appropriate terrain. No special effort was made to display the subjects in a tactical situation; emphasis was placed on illustrating the items. Infrared color film (CD) was used for Figure 3; all other photographs were made using Ektachrome (ASA64) film.

LIST OF ILLUSTRATIONS

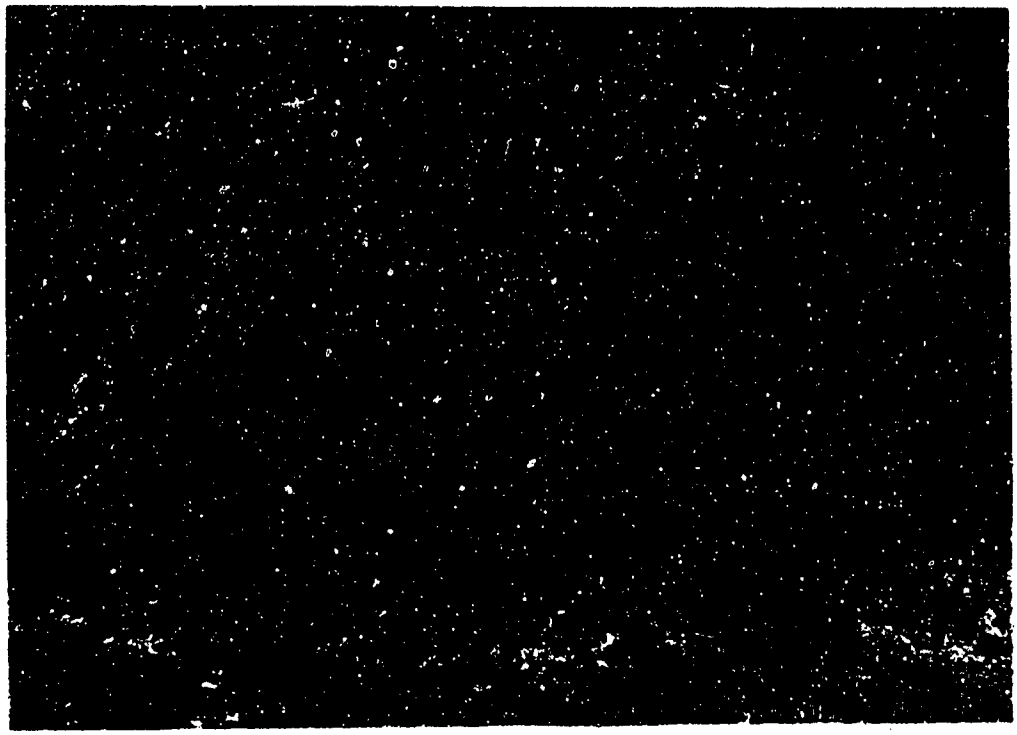


Figure A.1. Left: Standard Olive Green 107 uniform, black gloves, standard reversible helmet cover, standard face paint, standard load-carrying equipment.

Center: Standard US Army 1948 camouflage patterned uniform, standard reversible helmet cover, experimental 4-color patterned armored vest, experimental green and loam face paint.

Right: Standard Olive Green 107 uniform, standard reversible helmet cover, standard Olive Green 106 armored vest, standard face paint.

Figure A.2. Desert Camouflage, 6-Color Pattern

Left: New colorant formulation, 6-color patterned desert uniform and pack cover; experimental tan flesh-out boots; standard reversible helmet cover; experimental face paint.

Right: Old colorant formulation, 6-color patterned desert uniform; standard reversible helmet cover.

Figure A.3. Desert Camouflage. Sames as Figure A.2. except that Infrared Color film was used.

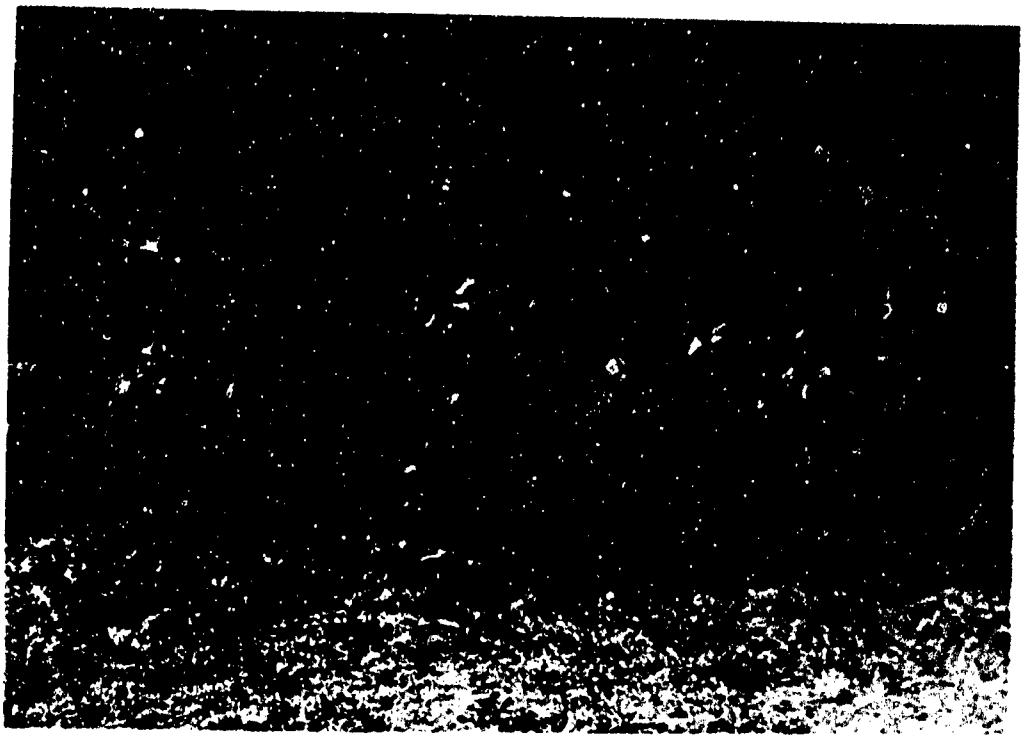


Figure A.4. Pattern Expansion Series, Experimental.

Left: Standard size patterned uniform, standard size patterned armored vest, standard 4-color helmet cover, experimental watch cover.

Left - center: 1.3 times expansion patterned uniform, standard 4-color helmet cover, weapon cover, camouflage patterned standard load carrying equipment.

Right - center: 1.6 times expansion patterned uniforms, 1.6 times expansion patterned armored vest, experimental helmet cover, weapon cover, experimental green shoes.

Right: 2.0 times expansion patterned uniforms, 4-color pack cover, face veil, 4-color helmet cover, black gloves.

Figure A.5. Disruptive and Tiger Patterns

Left: Disruptive patterned uniform, standard reversible helmet cover, experimental face paint.

Right: Tiger patterned uniform, standard reversible helmet cover, standard face paint.

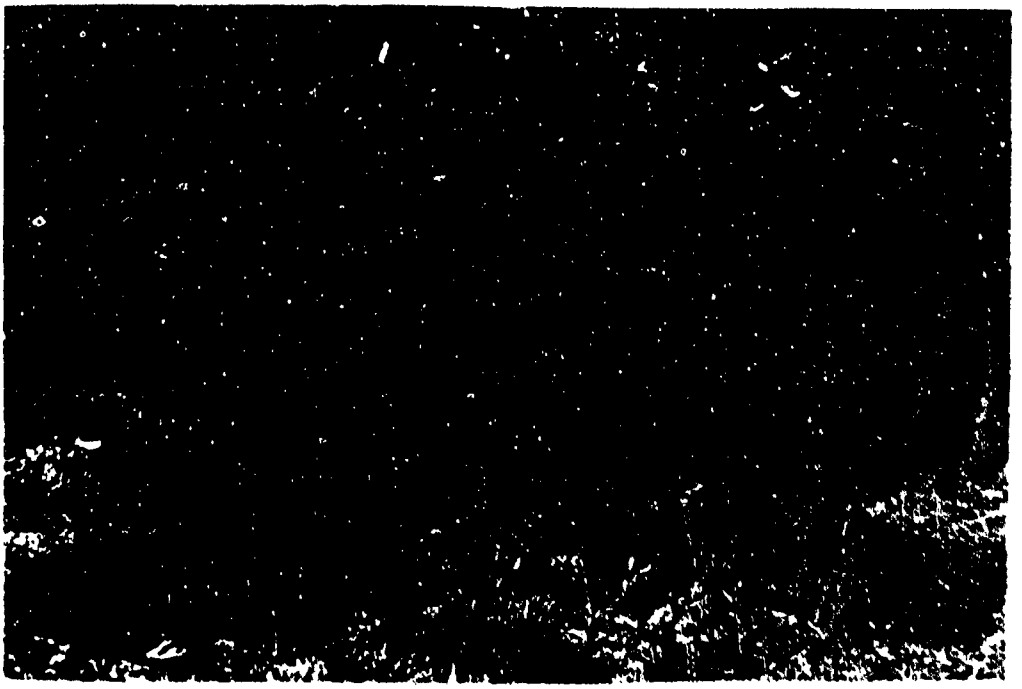


Figure A.6. Body net deployed as a personal camouflage screen.

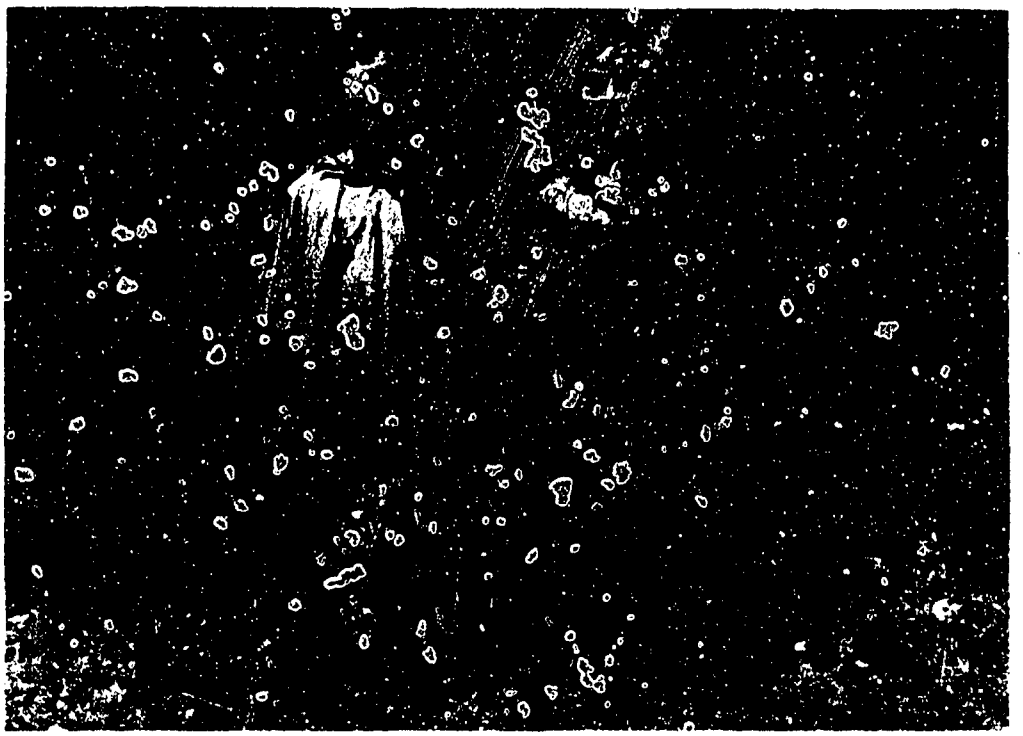


Figure A.7. Standard and Experimental 4-color Ponchos.

Figure A.8. Field-dyed underwear.

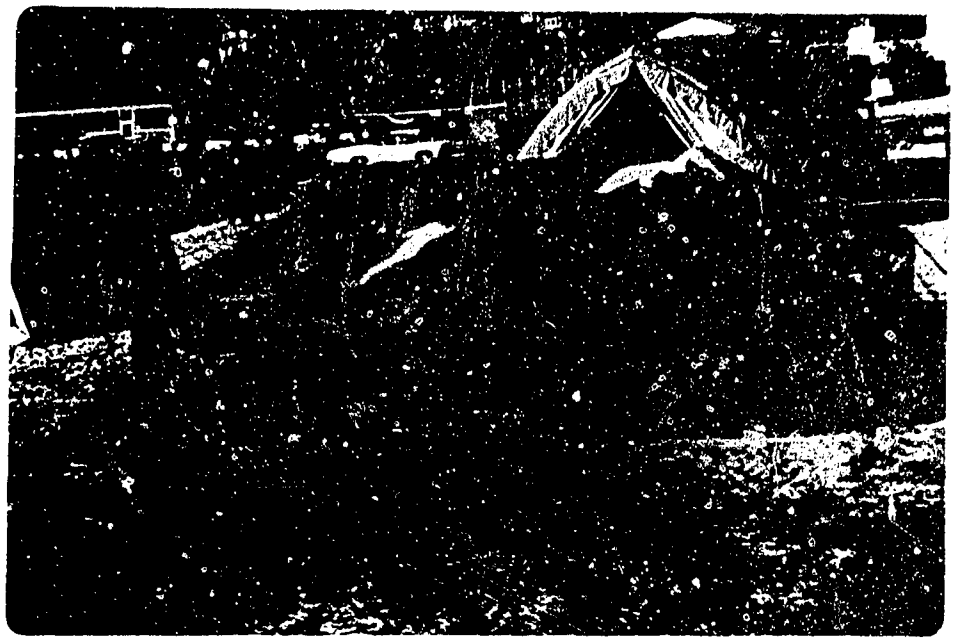


Figure A.9. General Purpose Medium Tent with Nature Pattern.

Figure A.10. General Purpose Medium Tent with MERADCOM Pattern.

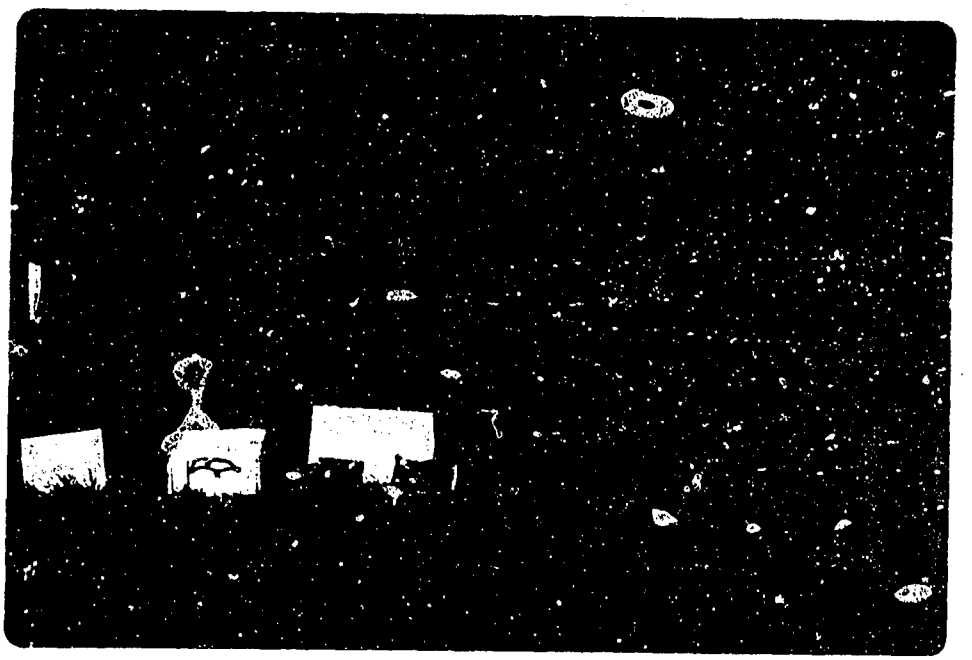


Figure A.11. Packaging Materials
Left: Standard items; wood ammunition box, fiberboard carton, tin cans, plastic/aluminum laminates.
Right: Same items coated with camouflage color formulation.

Figure A.12. Mobile field kitchen camouflaged with Nature Pattern.

APPENDIX B

This appendix contains spectral reflectance curves from 380 to 1000 nanometers for all items sent to MASSTER for Phase II. Curves were obtained using the General Electric Recording Spectrophotometer. Tristimulus coordinates (x, y) were calculated from tristimulus values automatically computed with respect to the Standard Observer and Source "C" with a Davidson-Hemmendinger Tristimulus Integrator. Red and Infrared reflectances were computed as defined in Mil-E-52798 (ME) using a Hewlett-Packard programmable calculator and curve tracer.

FIGURE B.1 - STANDARD COMBAT TROPICAL UNIFORM, OG 107

x	y	Y	RED	IR	RATIO
.3398	.3693	8.39	6.50	10.53	1.62

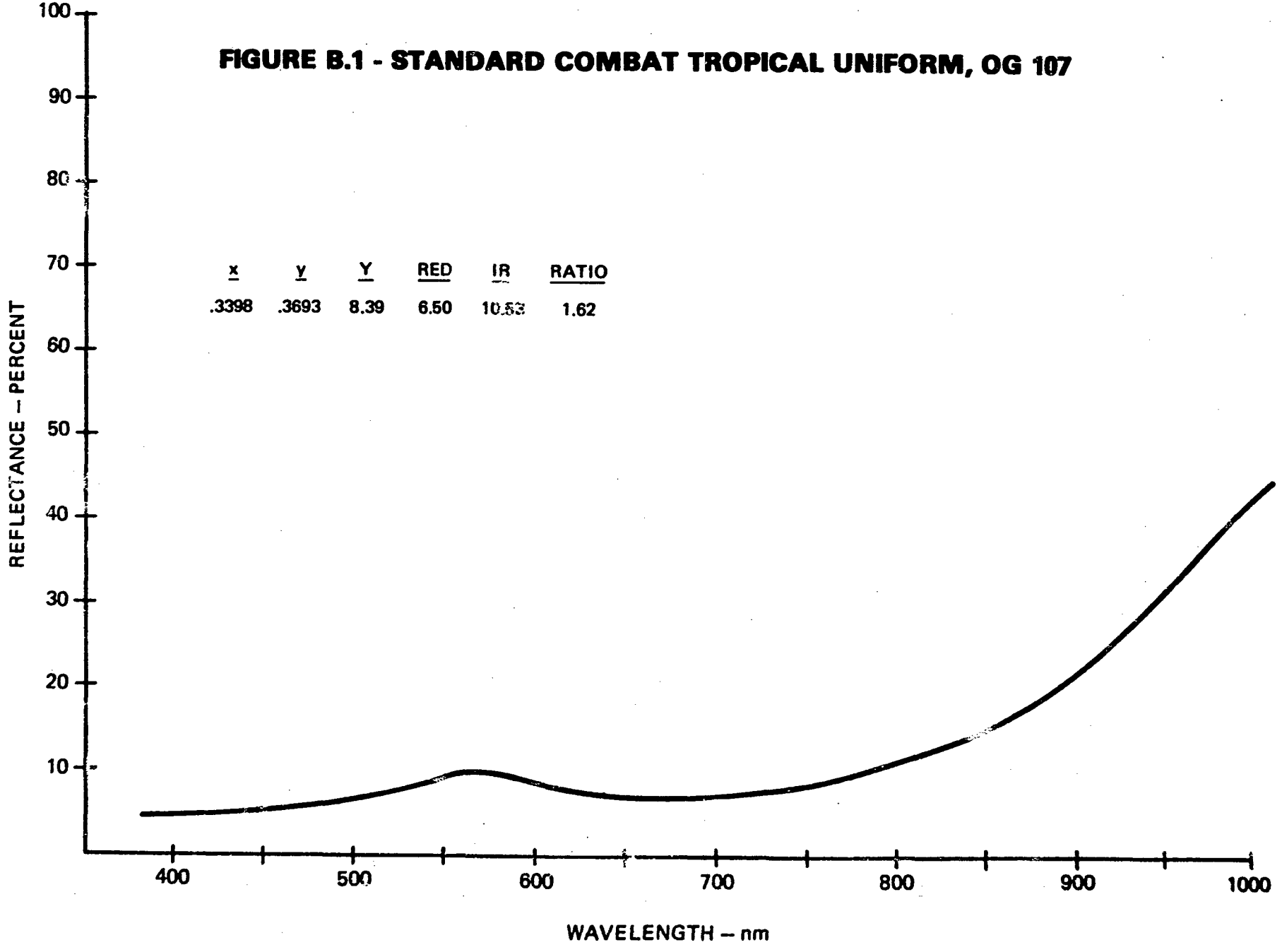


FIGURE B.2 - STANDARD COMBAT UNIFORM
1948 FOUR COLOR PATTERN

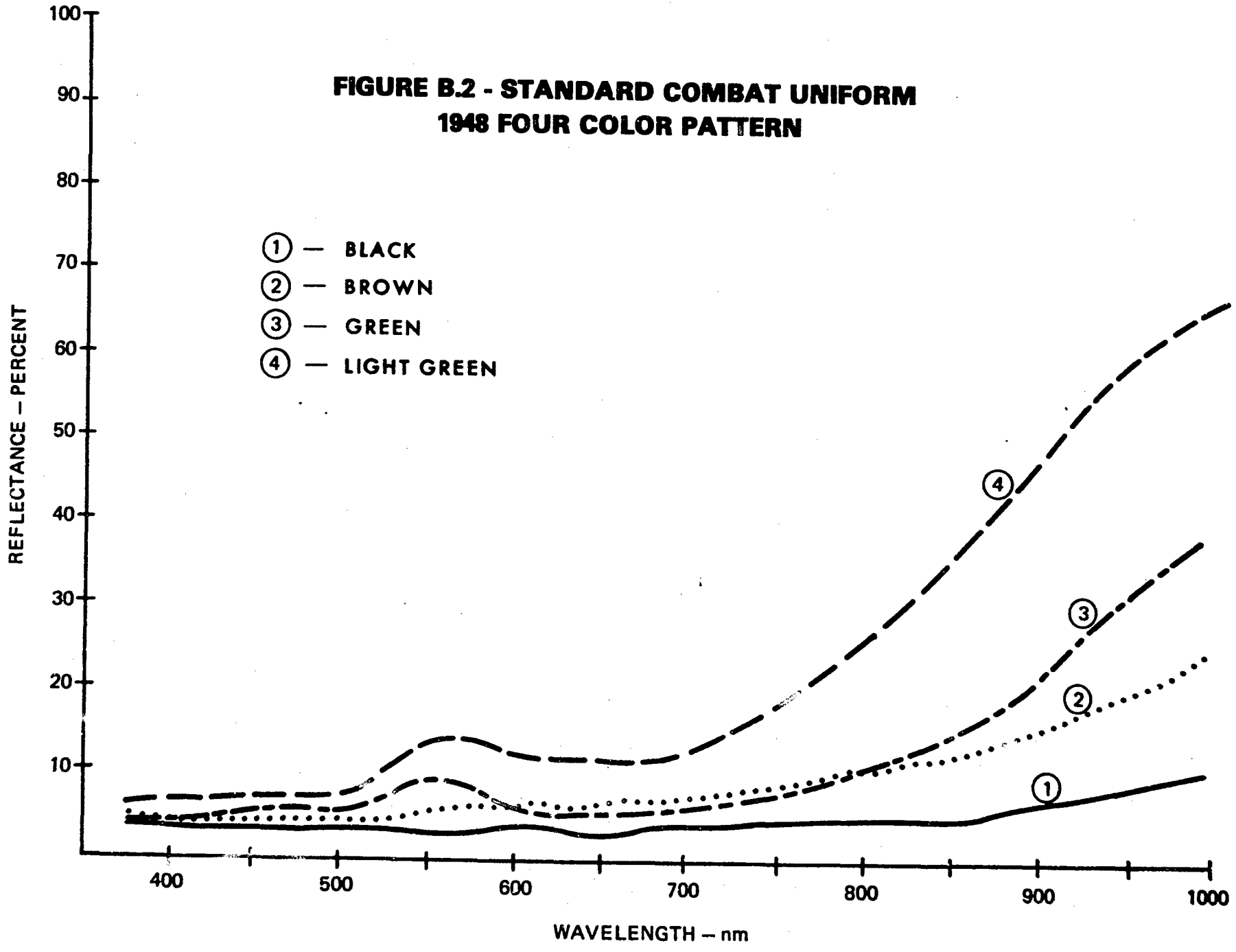


TABLE B.2.1. STANDARD COMBAT UNIFORM, 1948 4-COLOR PATTERN

	x	y	Y	RED	IR	RATIO
Black	0.3169	0.3219	3.86	4.12	4.67	1.13
Brown	0.3543	0.3554	6.32	7.52	11.30	1.50
Green	0.3211	0.3701	7.78	5.55	11.37	2.05
Yellow	0.3537	0.3768	12.88	12.26	26.41	2.15

FIGURE B.3 - EXPERIMENTAL DESERT UNIFORM, SIX COLOR PATTERN - OLD FORMULATION

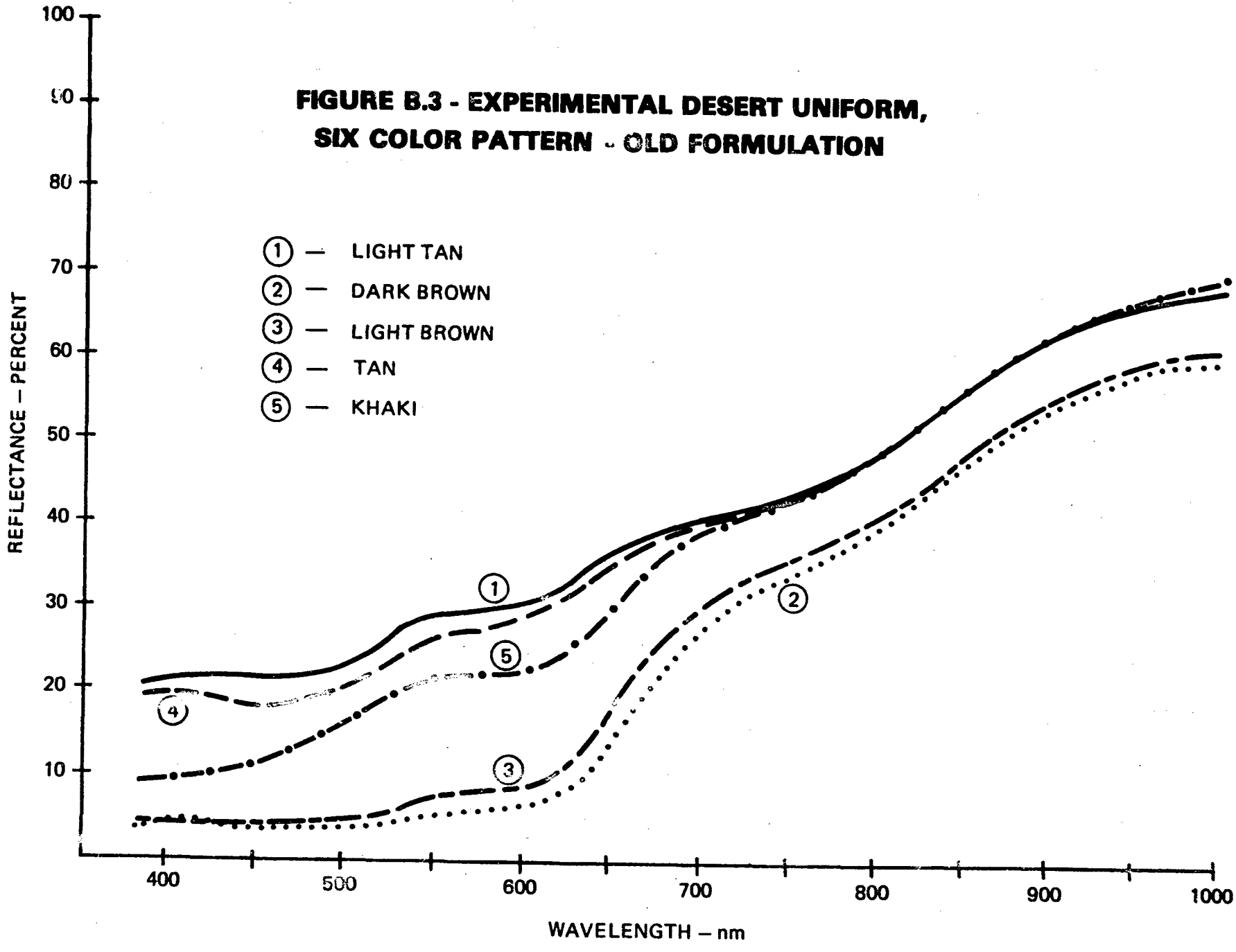


TABLE B.3.1 EXPERIMENTAL DESERT UNIFORM, 6-COLOR PATTERN - OLD FORMULATION

	x	y	Y	RED	IR	RATIO
Light Tan	0.3455	0.3455	29.86	35.21	47.83	1.36
Dark Brown	0.3833	0.3439	6.28	13.80	39.82	2.89
Light Brown	0.3945	0.3567	8.10	17.25	40.63	2.36
Tan	0.3536	0.3487	26.40	34.81	42.28	1.21
Khaki	0.3681	0.3744	21.39	29.63	47.95	1.62

FIGURE B.4 - EXPERIMENTAL DESERT UNIFORM, SIX COLOR PATTERN - NEW FORMULATION

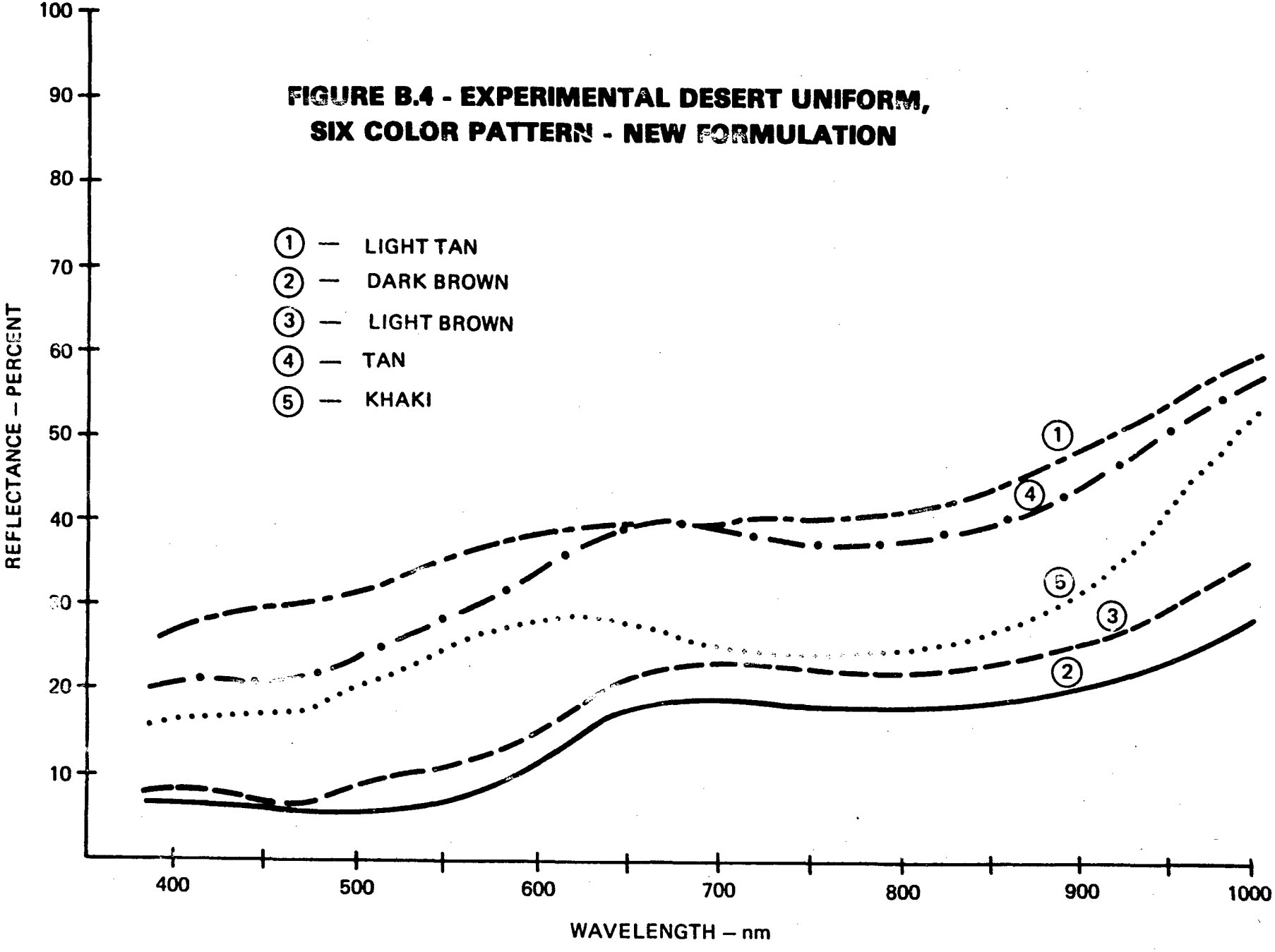


TABLE B.4.1. EXPERIMENTAL DESERT UNIFORM, 6-COLOR PATTERN - NEW FORMULATION

	x	y	Y	RED	IR	RATIO
Dark Brown	0.2741	0.3369	8.74	12.10	18.76	1.55
Khaki	0.3528	0.3557	25.49	28.71	25.98	0.90
Light Tan	0.3345	0.3359	35.96	40.26	42.15	1.05
Light Brown	0.3966	0.3598	11.94	21.30	22.92	1.08
Tan	0.3549	0.3474	30.37	39.32	39.03	0.99

FIGURE B.5 - FOUR-COLOR PATTERN EXPANSION

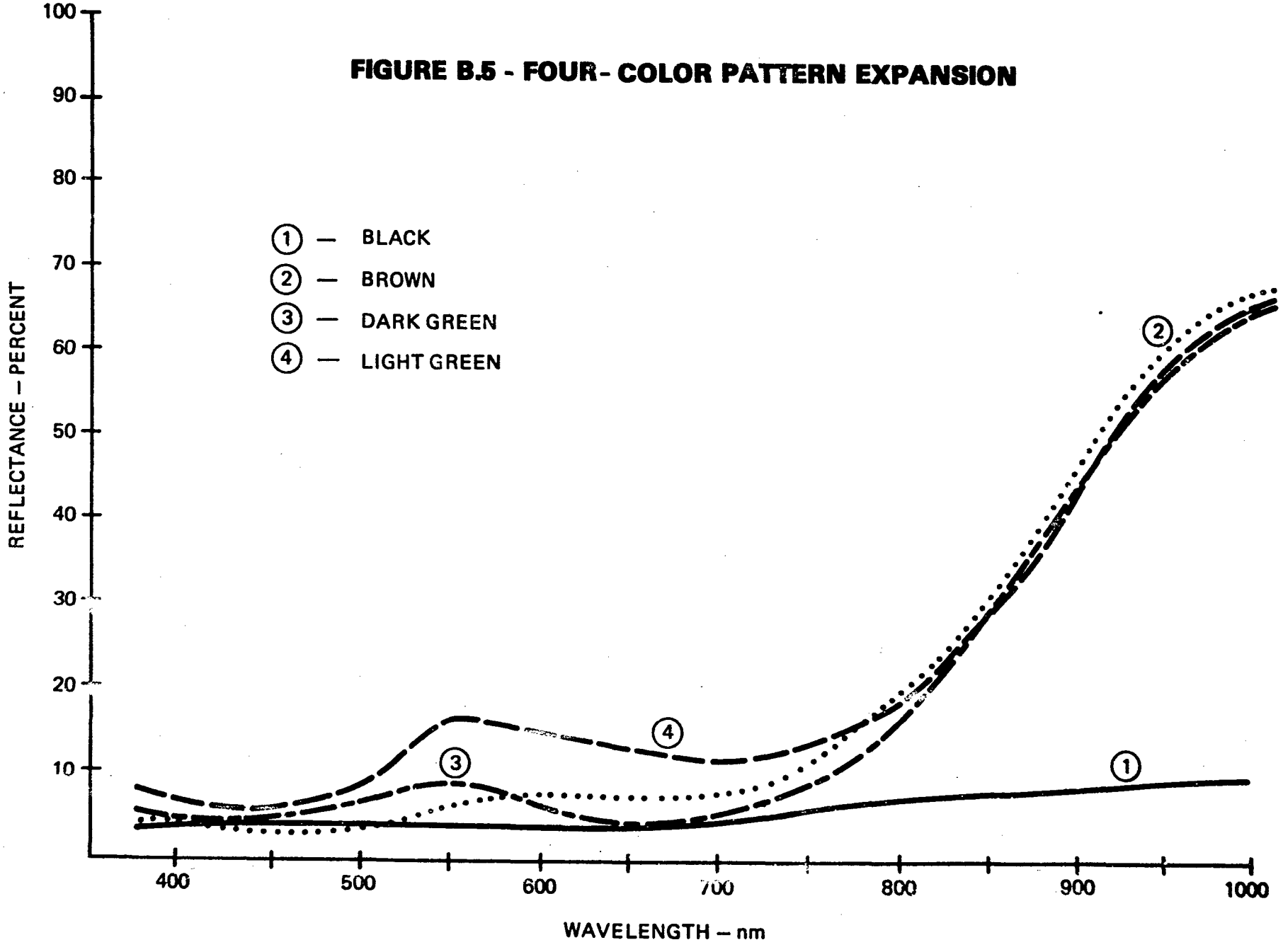


TABLE B.5.1, FOUR-COLOR PATTERN EXPANSION

	x	y	Y	RED	IR	RATIO
Black	0.3071	0.3197	4.06	3.98	6.99	1.76
Brown	0.3691	0.3644	6.96	8.00	20.08	2.51
Dark Green	0.3170	0.3831	7.42	5.23	17.90	3.42
Light Green	0.3636	0.3984	15.12	13.70	20.61	1.50

FIGURE B.6 - TIGER PATTERNED UNIFORMS

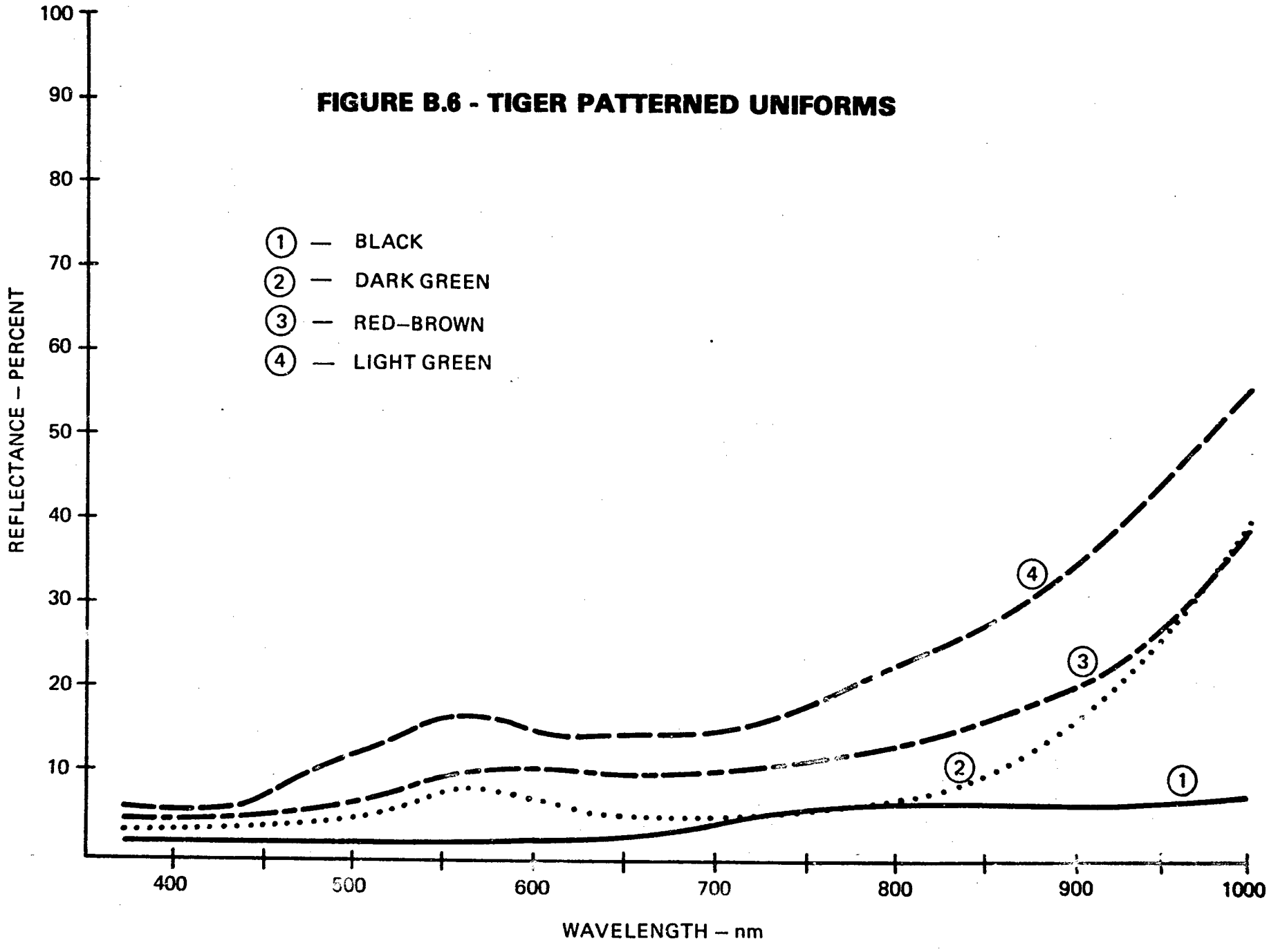


TABLE B.6.1, TIGER PATTERNED UNIFORMS

	x	y	Y	RED	R	RATIO
Black	0.3086	0.3062	2.48	3.26	6.35	1.95
Dark Green	0.3417	0.3812	7.25	5.87	8.00	1.36
Red-Brown	0.3609	0.3756	9.22	10.85	13.67	1.26
Light Green	0.3893	0.2565	15.54	15.19	22.75	1.50

FIGURE B.7 - BALLISTIC VESTS, STANDARD AND EXPANDED 4 COLOR PATTERN

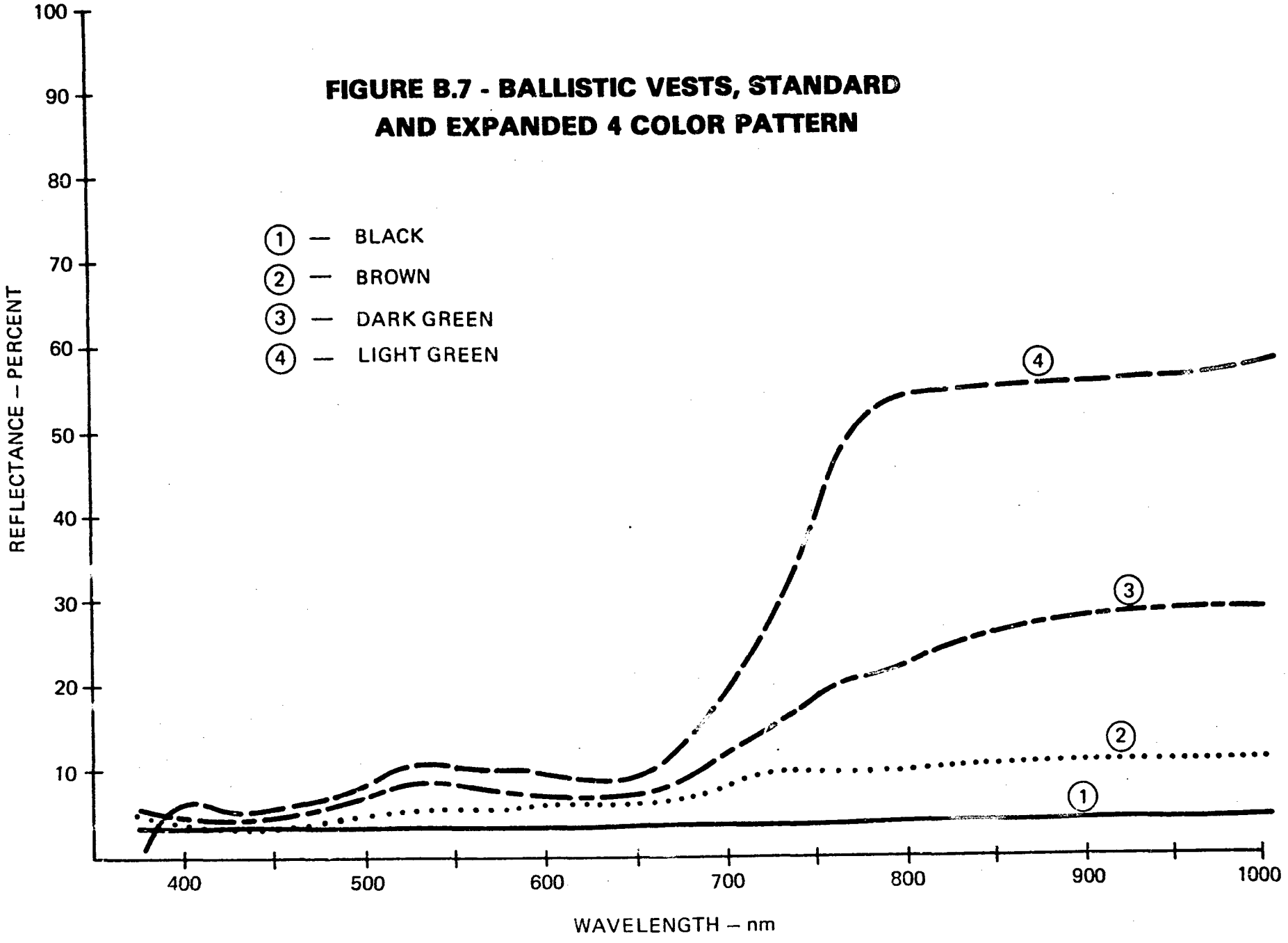


TABLE B.7.1. BALLISTIC VESTS, STANDARD AND EXPANDED, 4 COLOR PATTERN

	x	y	Y	RED	IR	RATIO
Black	0.3167	0.3227	3.24	3.21	4.12	1.28
Brown	0.3422	0.3548	5.06	5.39	9.87	1.83
Dark Green	0.3323	0.3861	7.39	6.64	20.82	3.14
Light Green	0.3540	0.3945	9.65	9.47	47.42	5.01

FIGURE B.8 - EXPERIMENTAL PONCHO

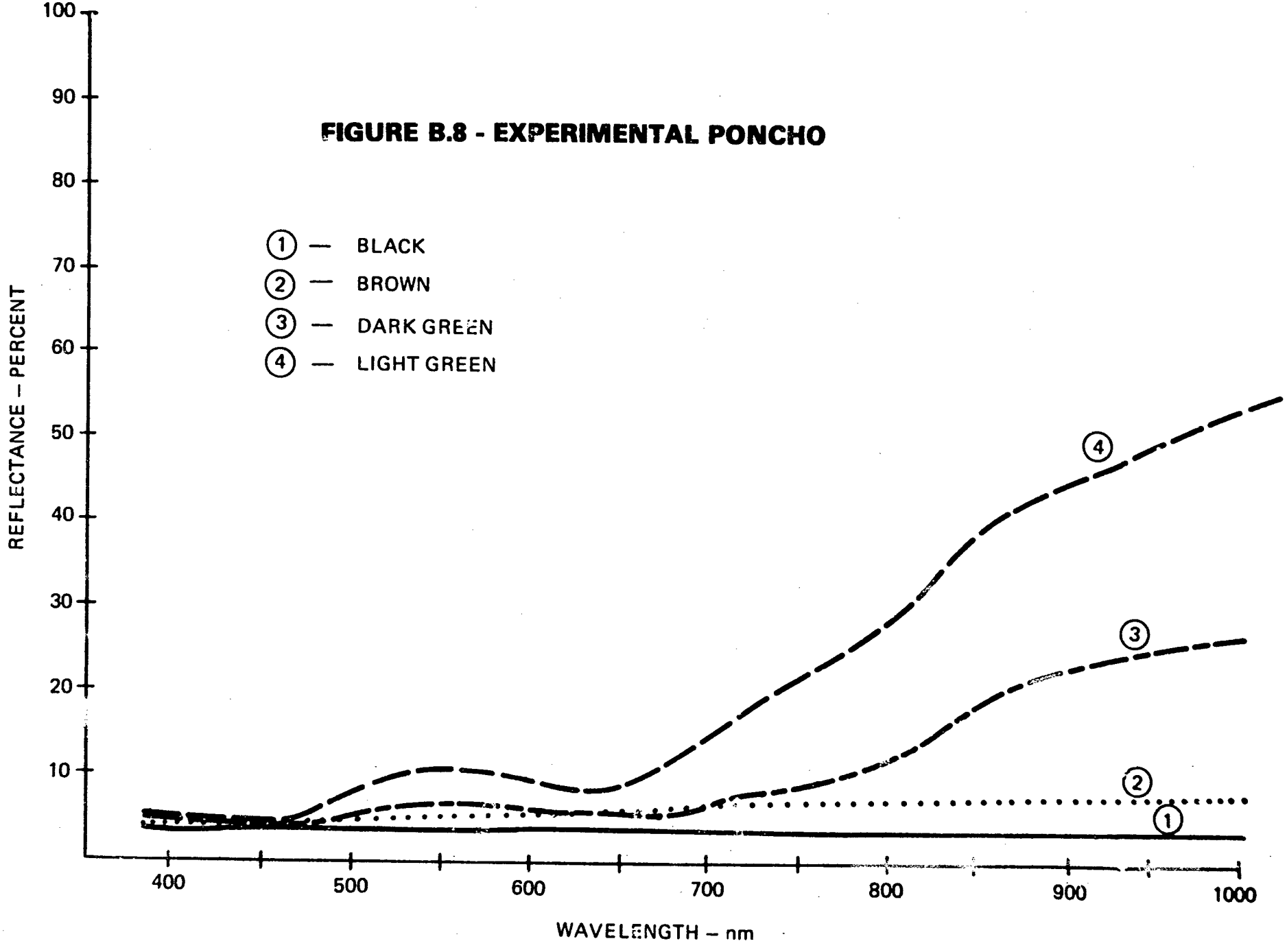


TABLE B.8.1. EXPERIMENTAL PONCHO

	x	y	Y	RED	IR	RATIO
Black	0.3159	0.3274	4.26	4.28	4.59	1.07
Brown	0.3318	0.3324	5.01	5.72	7.26	1.27
Dark Green	0.3241	0.3701	6.28	5.23	12.68	2.42
Light Green	0.3493	0.4011	10.06	9.55	29.01	3.04

FIGURE B.9 - REMOVABLE OVERCOLORING COMPOUND OVER NYLON PACK

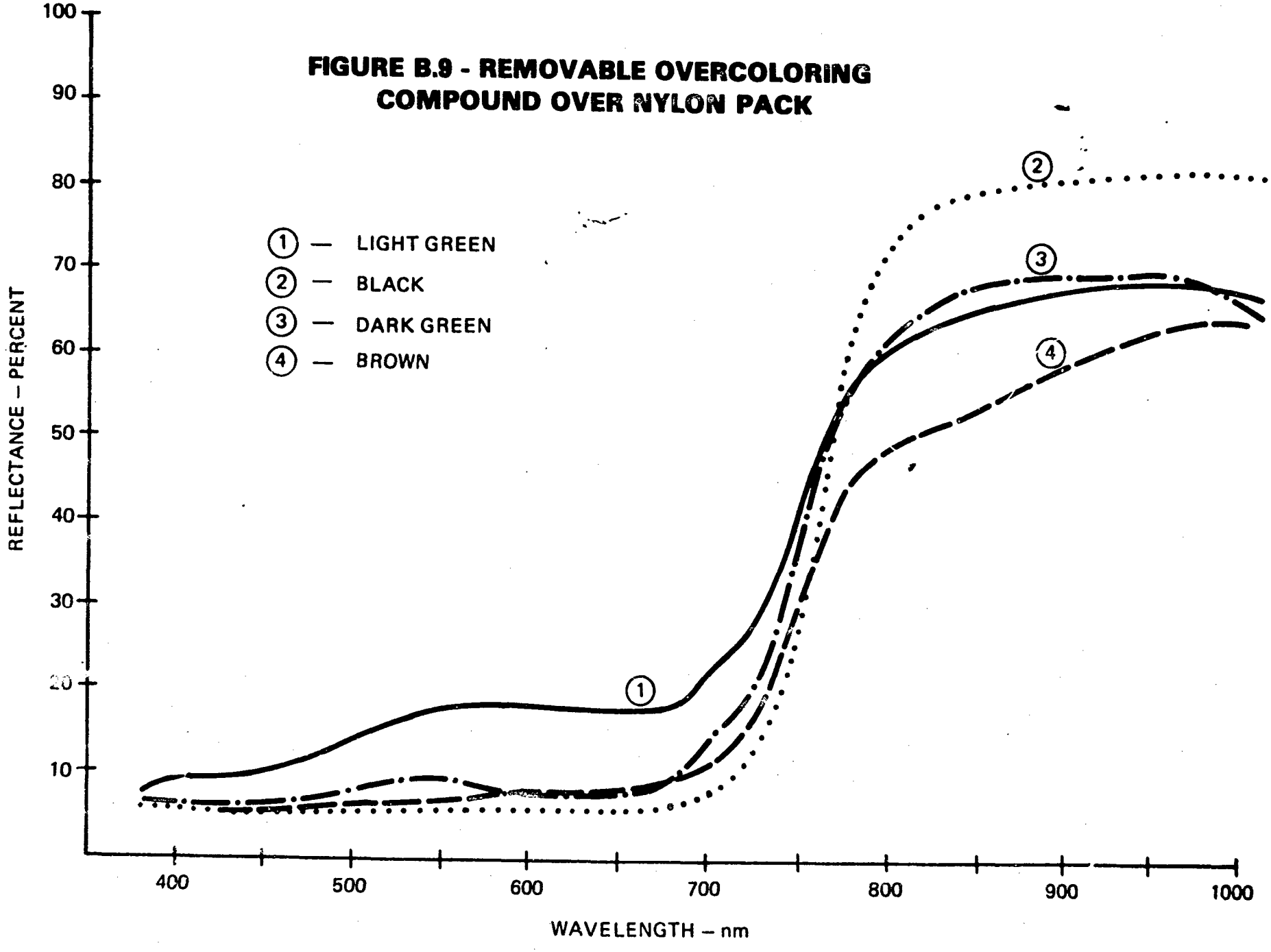


TABLE B.9.1. REMOVABLE OVERCOLORING COMPOUND, OVER NYLON PACK

	x	y	Y	RED	IR	RATIO
Light Green	0.3488	0.3670	16.74	17.52	54.01	3.08
Dark Green	0.3244	0.3597	8.68	8.11	53.07	6.54
Dark Brown	0.3438	0.3461	7.67	9.06	42.36	4.67
Black	0.3055	0.3096	6.14	6.23	57.23	9.20

FIGURE B.10 - NYLON PACK FABRIC AFTER REMOVAL OF OVERCOLORING COMPOUND

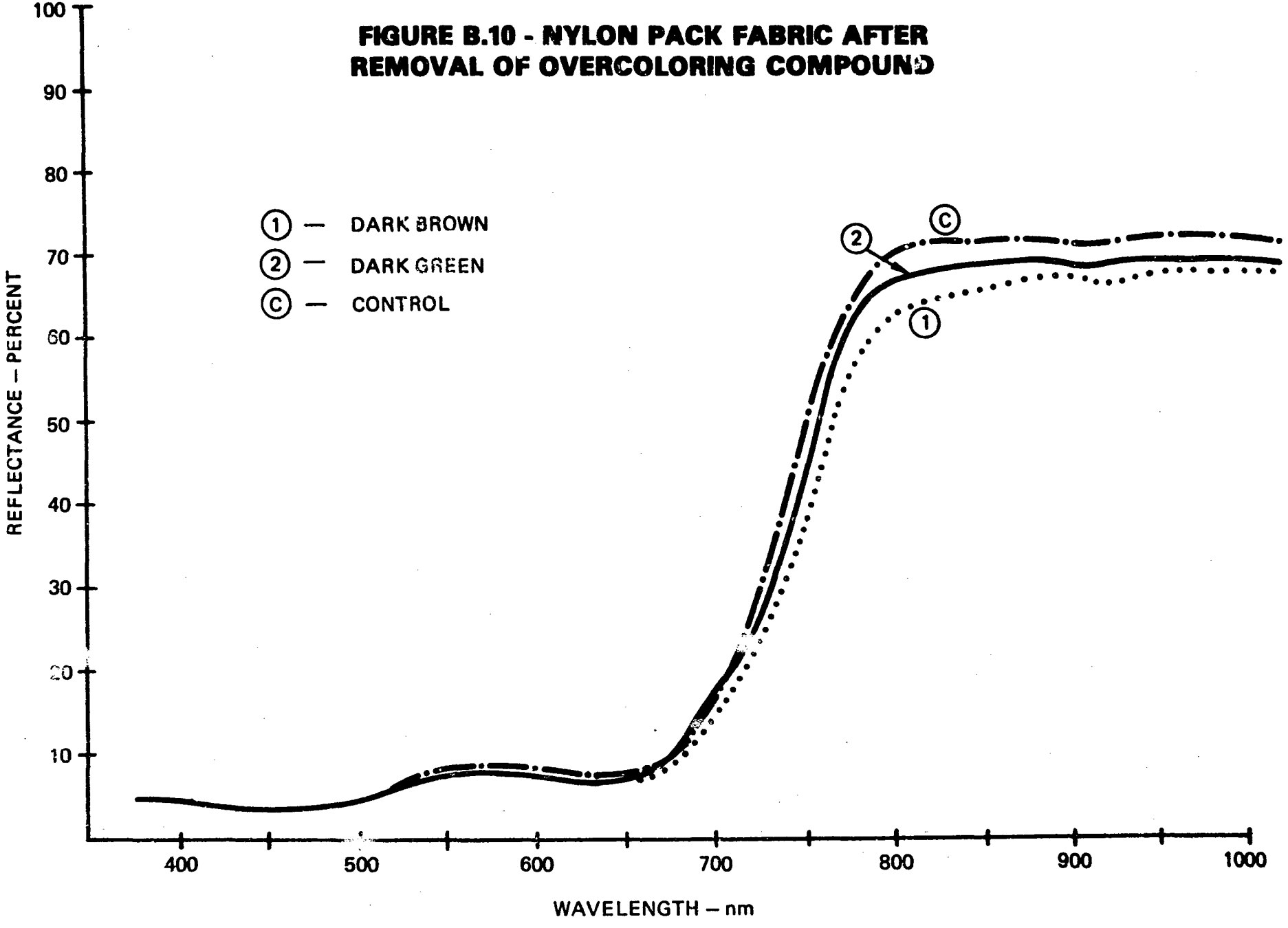


TABLE B.10.1 NYLON PACK FABRIC AFTER REMOVAL OF OVERCOLORING COMPOUND

	x	y	Y	RED	IR	RATIO
Substrate	0.3624	0.3886	8.02	8.53	60.58	7.10
*Light Green	0.3586	0.3789	7.09	7.37	56.10	7.65
Dark Green	0.3551	0.3845	7.14	7.86	56.70	7.21
Dark Brown	0.3564	0.3767	6.85	7.22	54.25	7.51
*Black	0.3507	0.3697	6.40	7.17	58.95	8.22

*Curves for Light Green and Black areas after removal are too close to those illustrated for useful presentation.

FIGURE B.11 - OVERCOLORING COMPOUND DURABLE

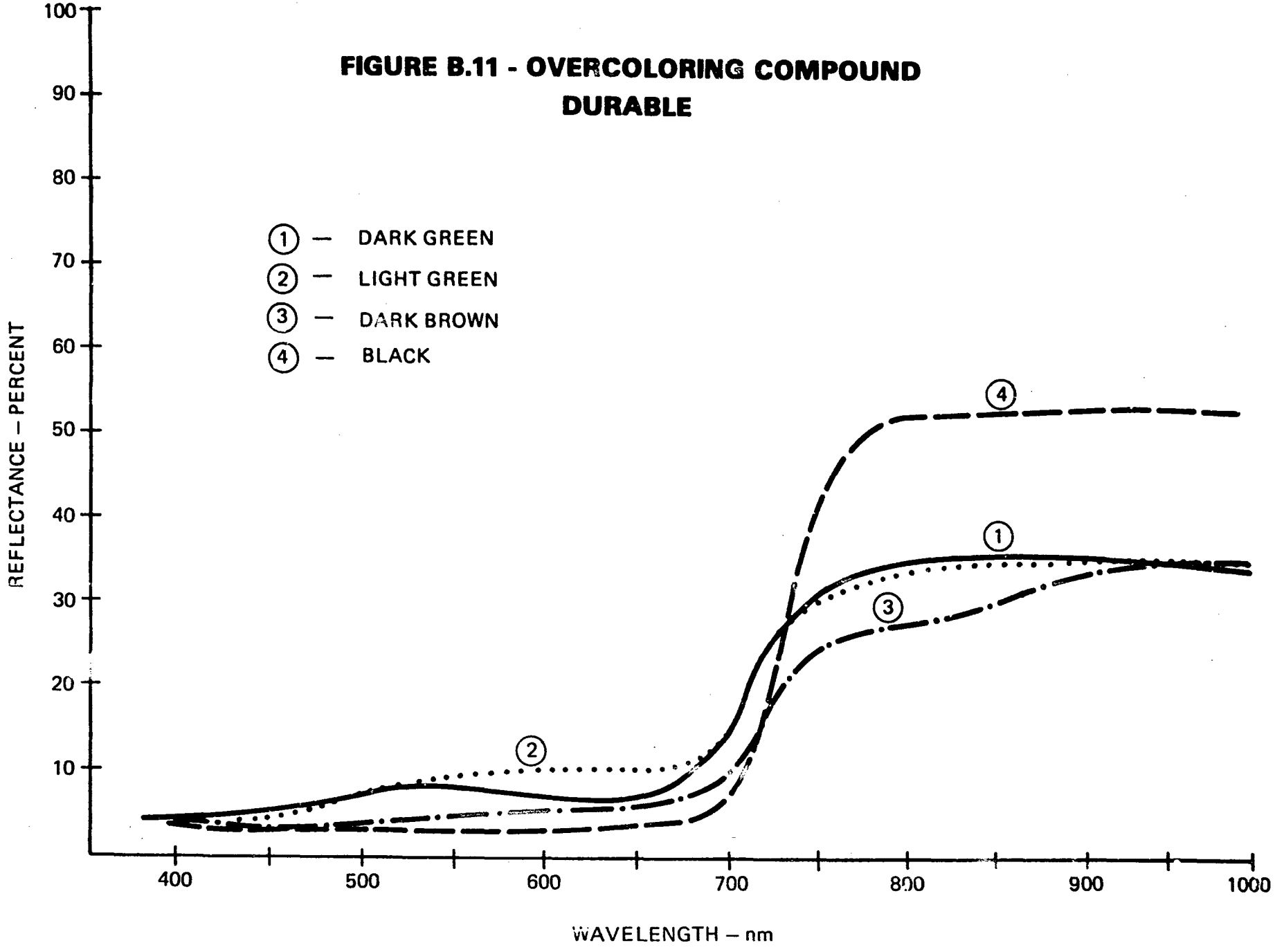
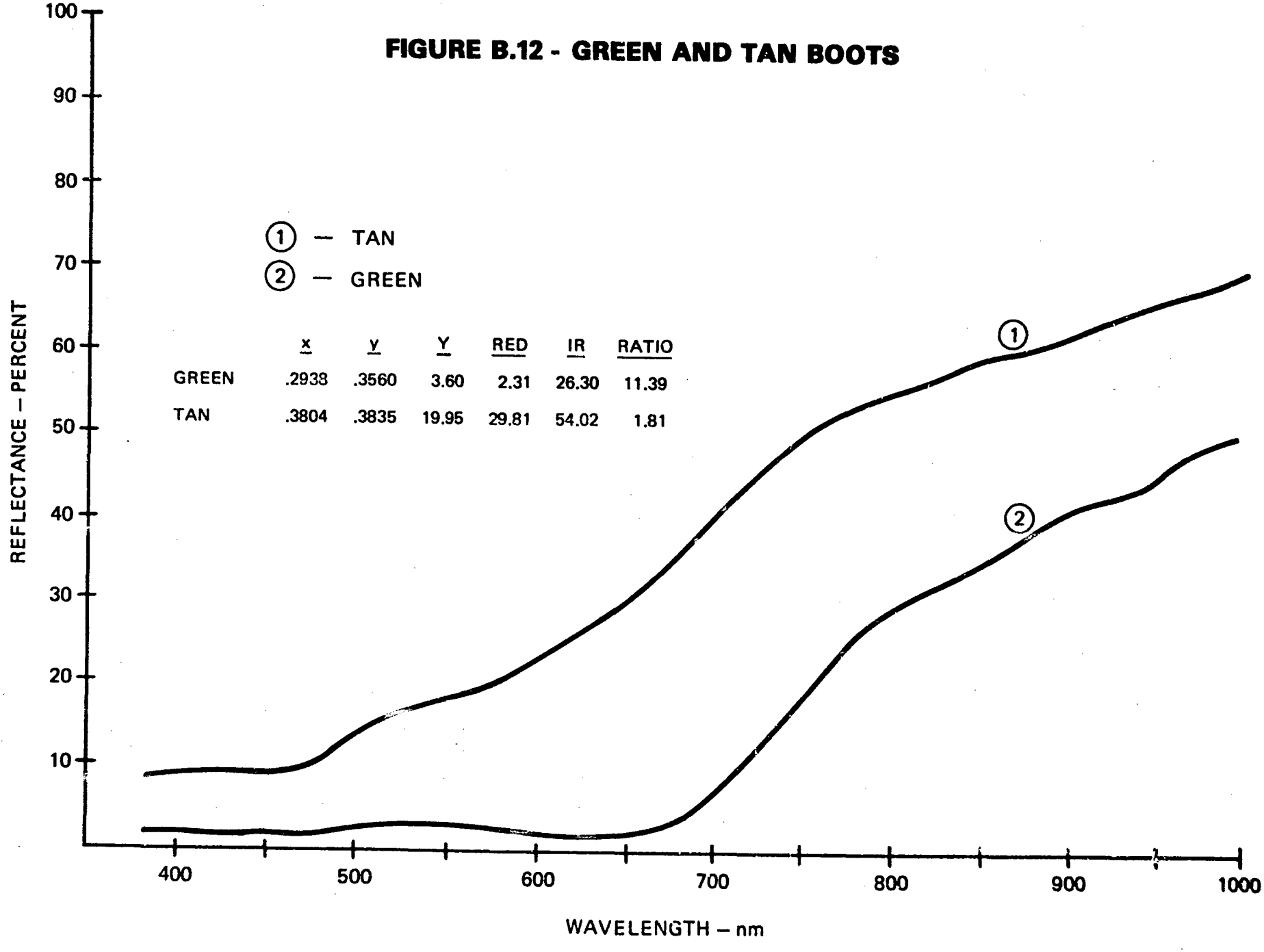


TABLE B.11.1. OVERCOLORING COMPOUND, DURABLE

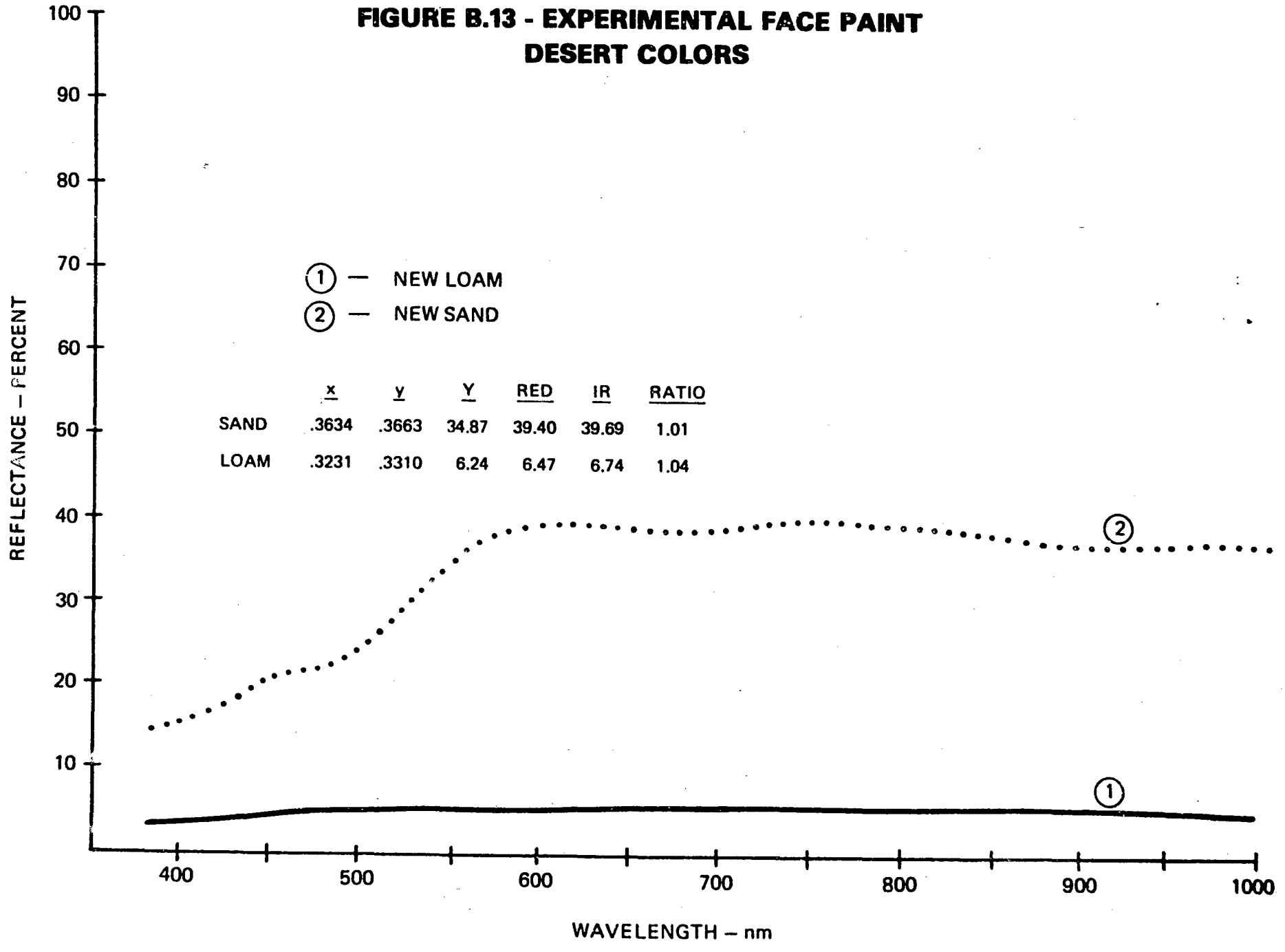
	x	y	Y	RED	IR	RATIO
Light Green	0.3623	0.3806	9.39	10.97	31.18	2.84
Dark Green	0.3270	0.3673	7.84	7.27	32.12	4.42
Dark Brown	0.3493	0.3499	5.98	7.30	26.71	3.66
Black	0.3052	0.3117	4.29	4.47	45.48	10.17

FIGURE B.12 - GREEN AND TAN BOOTS



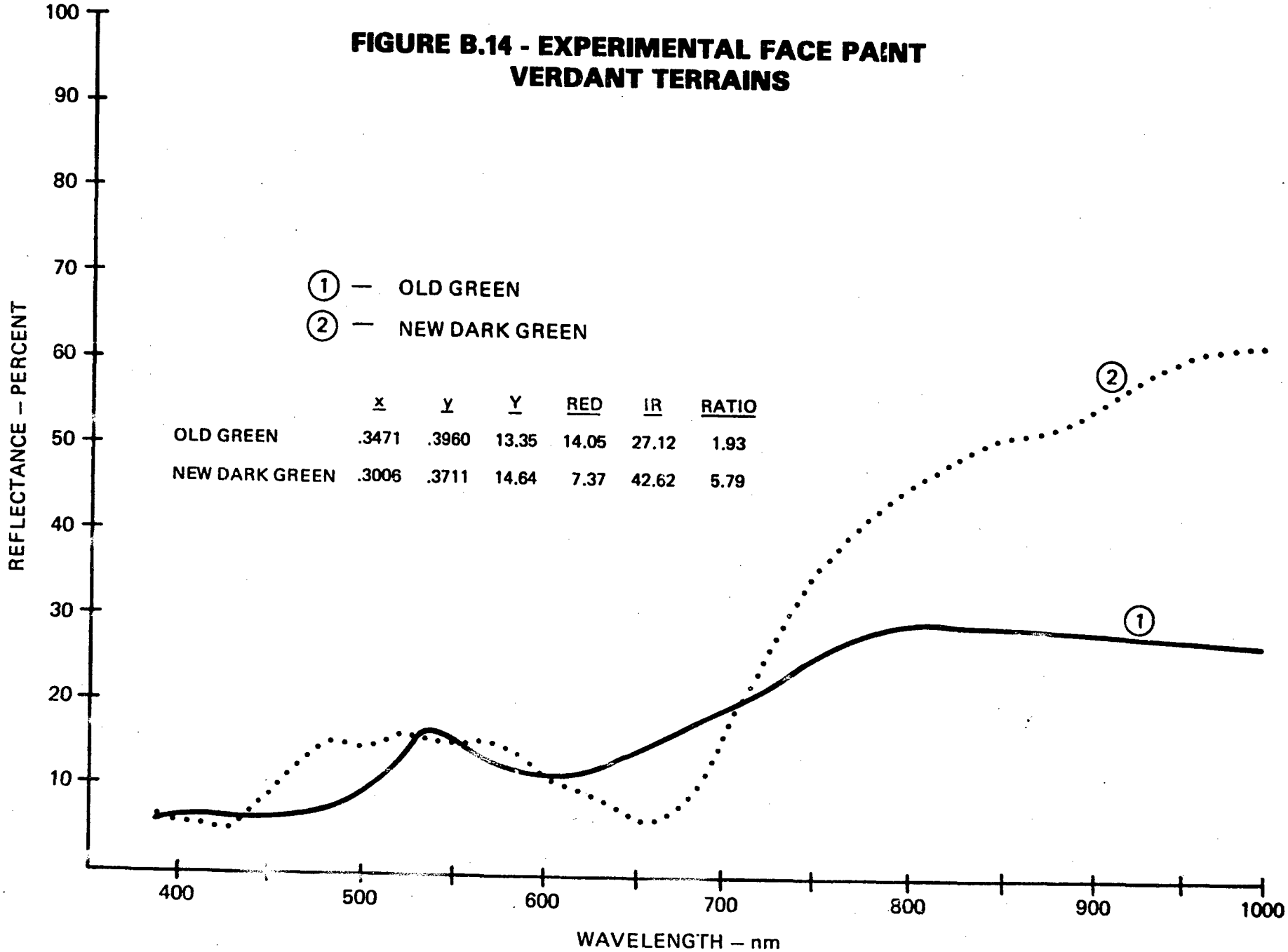
	x	y	Y	RED	IR	RATIO
GREEN	.2938	.3560	3.60	2.31	26.30	11.39
TAN	.3804	.3835	19.95	29.81	54.02	1.81

FIGURE B.13 - EXPERIMENTAL FACE PAINT DESERT COLORS



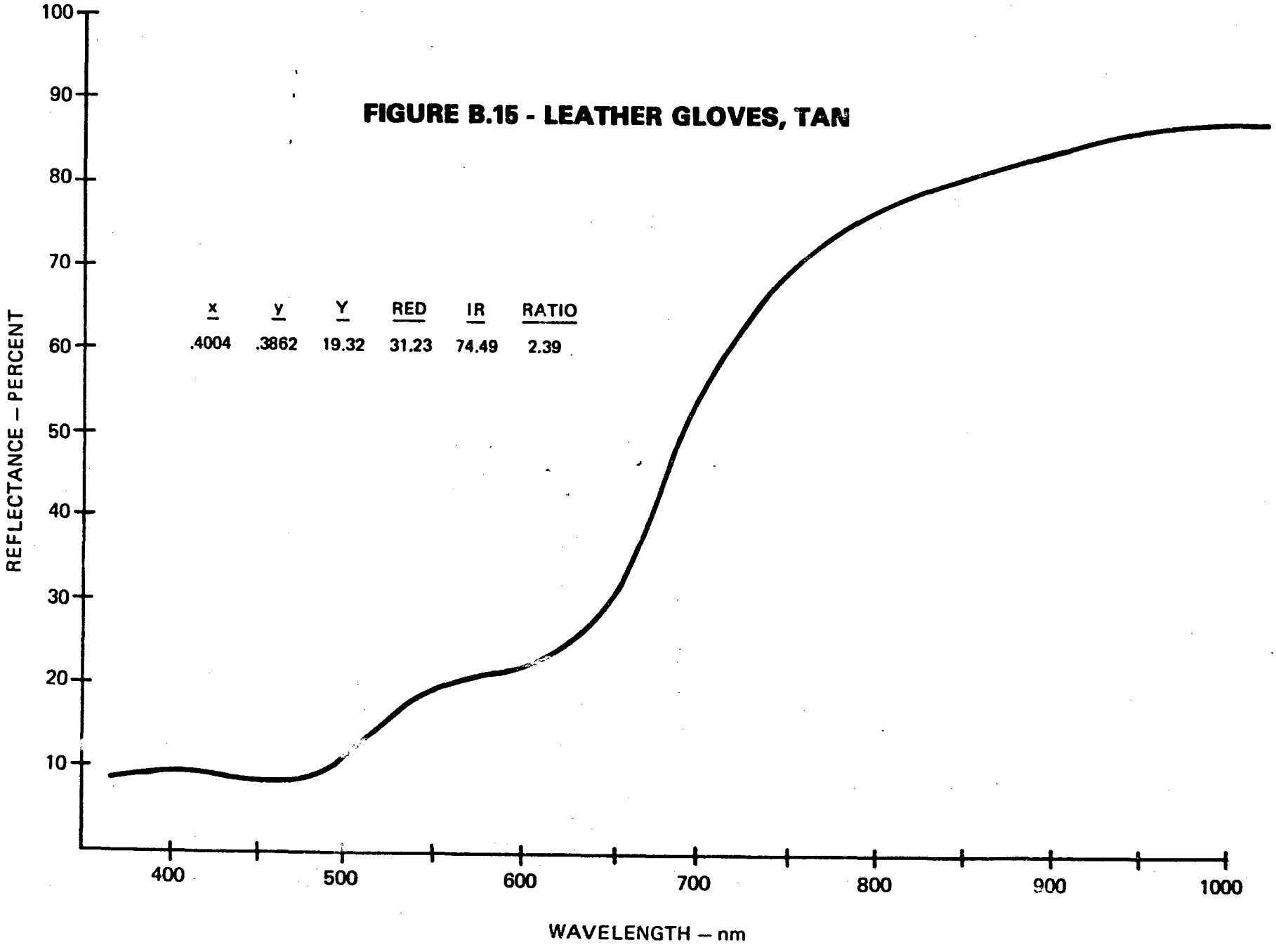
	x	y	Y	RED	IR	RATIO
SAND	.3634	.3663	34.87	39.40	39.69	1.01
LOAM	.3231	.3310	6.24	6.47	6.74	1.04

FIGURE B.14 - EXPERIMENTAL FACE PAINT VERDANT TERRAINS



	x	y	Y	RED	IR	RATIO
OLD GREEN	.3471	.3960	13.35	14.05	27.12	1.93
NEW DARK GREEN	.3006	.3711	14.64	7.37	42.62	5.79

FIGURE B.15 - LEATHER GLOVES, TAN



x	y	Y	RED	IR	RATIO
.4004	.3862	19.32	31.23	74.49	2.39

FIGURE B.16 - RECOLORING COMPOUND FOR TENTAGE

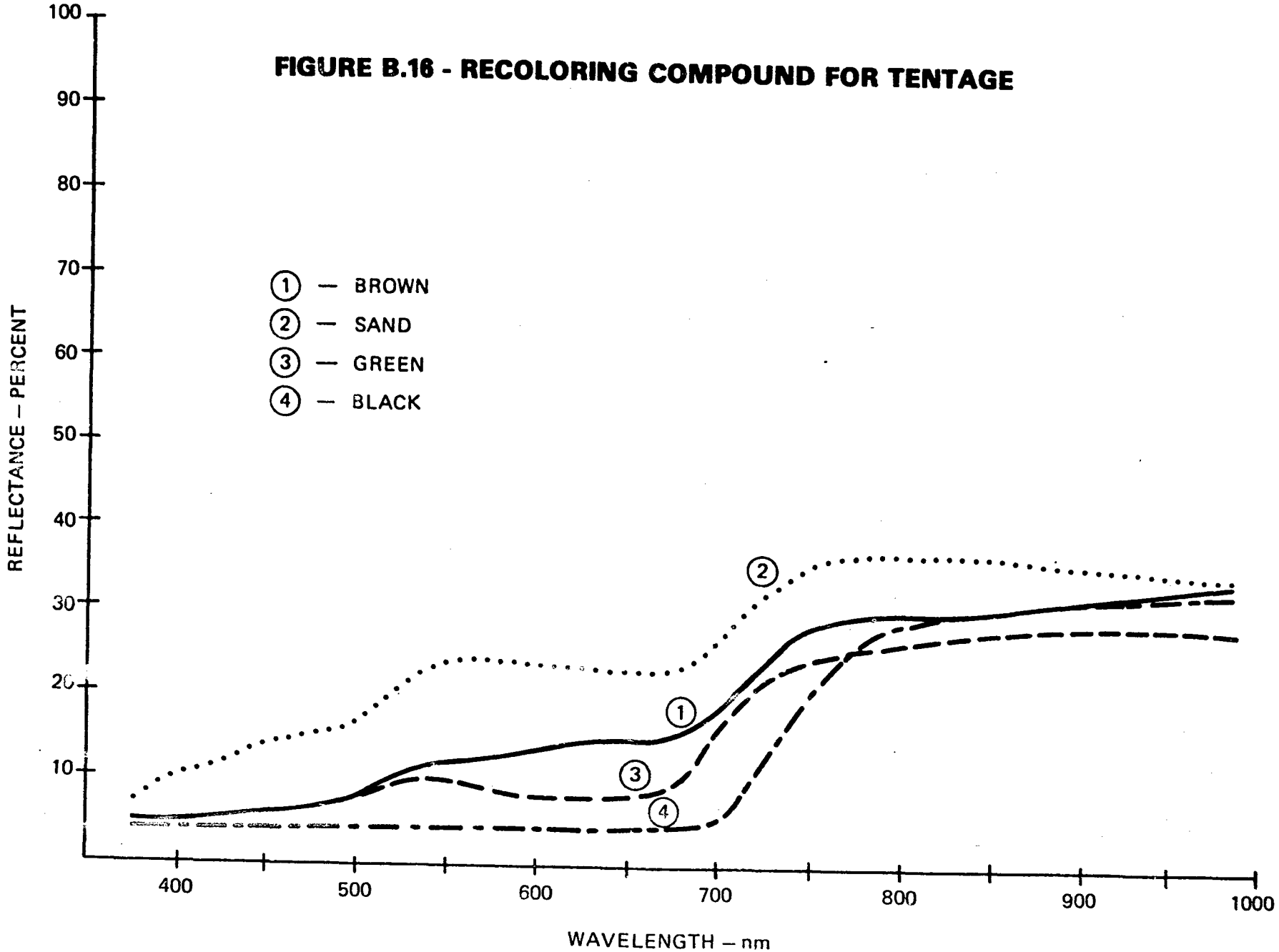


TABLE B.16.1 RECOLORING COMPOUND, FOR TENTAGE

	x	y	Y	RED	IR	IR
Black	0.3087	0.3163	4.96	4.66	24.9[illegible]	5.35
Brown	0.3759	0.3701	12.08	14.91	28.74	1.93
Green	0.3295	0.3716	9.71	8.41	25.03	2.98
Sand	0.3545	0.3702	0.2335	23.91	38.86	1.63

FIGURE B.17 - PACKAGING MATERIALS
FOREST GREEN

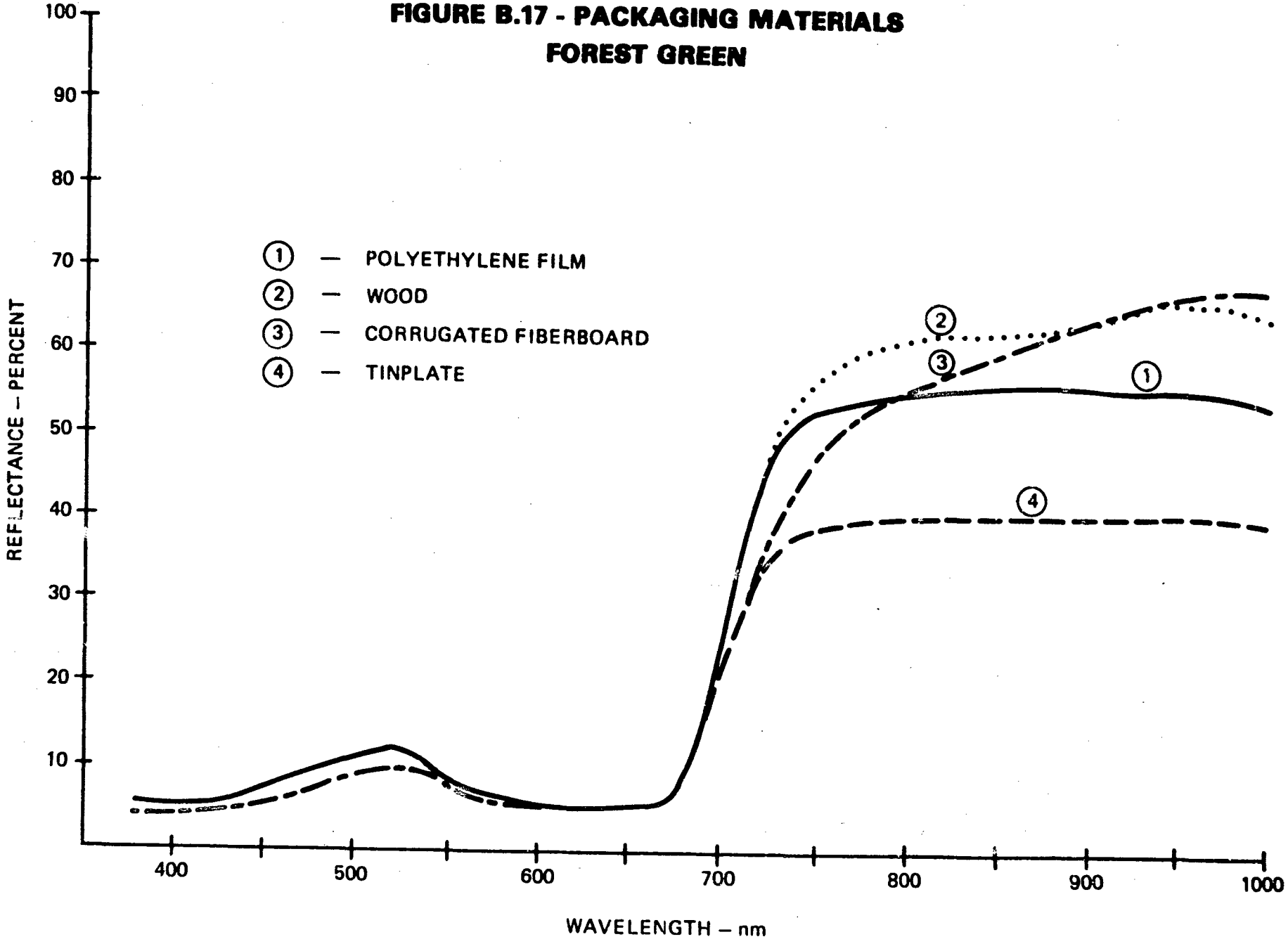


TABLE B.17.1. PACKAGING MATERIALS, FOREST GREEN

	x	y	Y	RED	IR	RATIO
Wood/Spray	0.2954	0.3647	9.68	6.1	58.4	9.6
Corrugated Fiberboard	0.2901	0.3589	8.67	5.6	51.1	9.1
Polyethylene	0.2837	0.3576	9.72	6.1	53.0	8.7
Tinplate	0.2918	0.3625	8.82	5.2	39.3	7.6

APPENDIX C

EXPERIMENTAL COLORANT FORMULATIONS

All experimental colorant formulations used on material furnished to MASSTER are shown. Colorant formulations for items withdrawn from stock are not known, because the relevant specifications under which they were purchased do not require use of specific colorants.

LIST OF TABLES

TABLE C.1. SIX-COLOR PATTERN (NEW)

GROUND SHADE - TAN 379

0.20 Oz/g Intravat Brown 2 BR MD Vat Brown 33
0.26 Oz/g Calcoloid Olive Green 2 GI DP
0.18 Oz/g Intravat Gray 2 GR Paste

TAN 380

0.13% Intravat Brown 2 BR MD Vat Brown 33
0.21% Intravat Brown GR DP Vat Brown 3

BROWN 381
1.6% Intravat Brown 2 BR MD Vat Brown 33
1.9% Intravat Brown GR DP Vat Brown 3

BROWN 382

2.8% Intravat Brown 2 BR MD Vat Brown 33
3.75% Intravat Brown GR DP Vat Brown 3

BLACK 383
Indocarbon CLGS Paste Fine Vat Black 6

KHAKI 384
1.35% Calcoloid Olive Green 2G1 DP
0.25% Intravat Brown GR DP Vat Brown 3

TABLE C.2. FOUR-COLOR PATTERN, EXPANSION SERIES

GROUND SHADE

2.91% Intravat Brown GR DP Vat Brown 3
0.82% Cibanone Green BFD Vat Green 1
1.8 % Algol Yellow GC Vat Yellow 2

LIGHT GREEN 354

0.60% Intravat Brown GR DP Vat Brown 3
0.08% Ponsol Jade Green DP Vat Green 1
0.12% Amanthrene Yellow 10G Paste Vat Yellow 2
99.2 % Vat Reducing Gum

DARK GREEN 355

1.9% Intravat Brown GR DP Vat Brown 3
2.0% Ponsol Jade Green DP Vat Green 1
0.3% Amanthrene Yellow 10 G Paste Vat Yellow 2
95.8% Vat Reducing Gum

BROWN 356

2.43% Hostovat Brown HRR paste Vat Brown 57
0.50% Intravat Brown GR DP Vat Brown 3
0.64% Ponsol Jade Green DP Vat Green 1
0.23% Amanthrene Yellow 10G Paste Vat Yellow 2
96.2 % Vat Reducing Gum

BLACK

7.6% Sodyeco Fast Black FCLG Paste Vat Black 6
1.16% Cibanone Brown F2BR Powder
0.64% Cibanone Blue BO Paste Vat Blue 20
90.6% Vat Reducing Gum

C.3. TIGER PATTERN

DYED GROUND - LIGHT OLIVE GREEN 454

Vat Orange 15	CI #69025
Vat Brown 1	CI #70800
Vat Green 1	CI #59825
Vat Green 3	CI #69500

GREEN 455

Vat Green 3	CI #69500
Vat Green 32	(Veranthrene Khaki E3G)

LIGHT BROWN 456

Vat Green 32	(Veranthrene Khaki E3G)

BLACK 457

Vat Blue 20	CI 59800
Vat Brown 33	
Vat Sulfur Black 6	CI 53295

TABLE C.4

HELMET COVER, BODY NET, BALLISTIC FABRIC, FOUR-COLOR PONCHO

GROUND SHADES

Helmet Cover and Body Net	Ballistic and Poncho Fabrics
Vat Green 1	Irgalan Yellow FGL Acid Yellow 128
Vat Yellow 2	Irgalan Dark Green 2BL Acid Green 58
Vat Brown 3	Irgalan Brill Green 3 GL

PRINT PATTERN FOR ALL FOUR FABRICS

GREEN 354

0.8%	Kemprint Yellow 4234
0.6%	Kemprint Red 4000 RB60
0.4%	Kemprint Blue 4400 RB21
1.8%	Binder
96.4%	Cut Clear

GREEN 355

5.5%	Kemprint Green 4330 RB40
0.4%	Kemprint Black 4600 RB10
4.1%	Kemprint Yellow 4234
2.8%	Kemprint Red 4000 RB60
12.8%	Binder
74.4%	Cut Clear

BROWN 356

5.0%	Sherdye Yellow 4234
2.5%	Sherdye Red 4000 RB60
0.9%	Sherdye Black 4600 RB10
0.4%	Binder
83.2%	Cut Clear

BLACK 357

5.0%	Sherdye Black 4600 RB10
5.0%	Sherdye Brown 4800
10.0%	Binder
8.0%	Cut Clear

TABLE C.5. TEXTILE OVERCOLORING COMPOUND - REMOVABLE

Vehicle and Binder (total parts)

Polyvinyl Acetate Copolymer (Gelva C-5V-10) (Binder)	7.8
Dispersant (Tamol 850)	0.5
Tricresyl Phosphate (Plasticizer)	3.6
Nonyl Phenyl Ethylene Oxide (Igepal CO-630)	0.1
Hydroxyethyl Cellulose (Cellusize QP-4400)	0.1
Defoamer (Foamkill 639)	0.1
Ammonium Hydroxide (26° Be')	0.5
Water	28.5

Pigments (total parts)

	Dark Green	Light Green	Brown	Black
Green K-639*	7.7	3.3	-	-
Yellow V-9112	1.6	4.2	5.6	-
Brown F-6111	-	trace	2.4	-
Black RM 137	0.8	trace	2.2	10.7
Turquoise K-1607	0.7	-	-	-
Rutile TiO_2	-	1.9	-	-

TABLE C.6. TEXTILE OVERCOLORING COMPOUND - DURABLE

Vehicle and Binder (total parts)

Chlorinated Rubber (Parlon S-10) 10 CPS)(Binder)	6.7
Chlorinated Paraffin (Chlorowax 40) Plasticizer)	9.9
Thixotrope (Thixatrol ST) Thickener	0.7
Epoxy Resin (Epon 828) (Heat Stabilizer)	0.3
n-Butyl Acetate (Solvent)	20.0
Epichlorhydrin (Gelation Stabilizer)	0.1

Pigments (total parts)

	Dark Green	Light Green	Brown	Black
Green K-639*	6.4	6.5	-	-
Yellow V-9112	trace	6.5	4.9	-
Brown F-6111	-	trace	4.8	-
Black RM 137	5.9	-	3.7	13.4
Rutile TiO_2	trace	-	-	-

*Except for the rutile titanium dioxide obtained from DuPont, all pigments were obtained from Ferro Corporation, Cleveland, Ohio whose designations are shown.

TABLE C.7. COLORATION OF GREEN SHOES

This combination of dyes was used to achieve the shade for the green boots by the manufacturer.

Acid Green 2G	Acid Green 3
Derma Green B	
Brill Yellow Conc.	
Xylene Dark Green B	Acid Green 20
Duralan Fast Black WA	Acid Black 52

Both the green and tan shoes were tanned in the same way, first with a conventional chrome tan followed by a vegetable retan. The tan color produced is the result of the tanning process alone. Water repellent was applied after coloration was achieved.

TABLE C.8. COMPOSITION - PAINT, FACE, CAMOUFLAGE, ARID TERRAIN

	#23-6667-Loam (Parts by weight)	#21-6667-Sand (Parts by weight)
Castor Wax	17.5	17.5
Carnauba Wax	2.5	2.5
Mineral Oil, U.S.P. Heavy	22.5	22.5
Lanolin, U.S.P., Anhydrous	8.5	8.5
N,N Diethyl m-toluamide	10.0	10,0
Talc	7.0	7.0
Ochre C1624	16.0	7.8
Titanium Dioxide, Atlas White	-	24.0
Carbon Black A 3278		0.2
Black Iron Oxide	16.0	
Total	100.0	100.0

TABLE C.9. COMPOSITION - PAINT, FACE, CAMOUFLAGE, VERDANT TERRAIN

	#46-6667 - Green (Chlorophyll Type) (Parts by Weight)
Castor Wax	21.6
Carnauba Wax	3.1
Mineral Oil, U.S.P.Heavy	22.5
Lanolin, U.S.P. anhydrous	10.5
N,N Diethyl m-toluamide	12.2
Talc	8.6
Titanium Dioxide	10.0
Chlorophyll, Oil-Soluble	11.5
Total	100.0

TABLE C.10. FIELD DYEING PACKETS Mil-D-2273

TYPE IV

Direct Blue 71	CI-34140
Direct Orange 37	CI-40265
Direct Orange 34	CI-40215

TABLE C.11 TENTAGE RECOLORING FORMULATIONS

Batch Compositions
(Parts by Weight)

1.	Polyvinyl Chloride (Geon 222)		100
2.	Cyclohexanone		300
3.	FMC-Tricresyl Phosphate		15
4.	Synpron 966		10
5.	Chlorinated Parafin (Chlorowax 70)		25
6.	Inorganic TiO_2 (Oncor 75 RA)		5
7.	Diatomaceous Earth (Celite)		30
8.	Pigments		40
		Total	525

Pigments
(Parts by Weight)

	Dark Green	Black	Sand	Field Drab
Ferro Green K639	40	-	4.0	10.1
Ferro Black V6782	-	40	2.3	3.4
Ferro Yellow V6951	-	-	6.2	10.7
Ferro Brown V6111	-	-	0.5	11.8
White TiO_2	-	-	27.0	4.0