GEORGIA INSTITUTE OF TECHNOLOGY — OFFICE OF CONTRACT ADMINISTRATION

PROJECT ADMINISTRATION DATA SHEET

[x] ORIGINAL [ ] REVISION NO. ______

Project No. A-3338 GTRI/~~GIT~~ DATE 9/23/82

Project Director: Thomas B. Wells ~~School~~/Lab ECSL/EED

Sponsor: VSE Corporation

Type Agreement: Purchase Order No. 53501 (under Gov't Prime #DAAK 70-81-D-0109)

Award Period: From 8/18/82 To ~~10/17/82~~ 12/31/82 (Performance) ~~10/17/82~~ 12/31/82 (Reports)

Sponsor Amount: Total Estimated: $ 10,000 Funded: $

Cost Sharing Amount: $ Cost Sharing No:

Title: Radar Transmission Characteristics of Radar Scattering Camouflage Screens

ADMINISTRATIVE DATA OCA Contact Faith G. Costello

1) Sponsor Technical Contact:

J. Ward Buyer's Technical Representative
VSE Corporation
2550 Huntington Avenue
Alexandria, VA 22303

PH: (703) 960-4600

2) Sponsor Admin/Contractual Matters:

Robert Coyle, Buyer's Admin. Rep.
VSE Corporation
2550 Huntington Avenue
Alexandria, VA 22303

PH: (703) 960-4600

Defense Priority Rating: DO-C9

Military Security Classification: NA
(or) Company/Industrial Proprietary:

RESTRICTIONS

See Attached Gov't Supplemental Information Sheet for Additional Requirements.

Travel: Foreign travel must have prior approval – Contact OCA in each case. Domestic travel requires sponsor approval where total will exceed greater of $500 or 125% of approved proposal budget category.

Equipment: Title vests with Sponsor

COMMENTS:

COPIES TO:

Research Administrative Network	Research Security Services	Research Communications (2)
Research Property Management	Reports Coordinator (OCA) ✓ OHR	Project File
Accounting	GTRI	Other
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GEORGIA INSTITUTE OF TECHNOLOGY OFFICE OF CONTRACT ADMINISTRATION

SPONSORED PROJECT TERMINATION SHEET

Date 3/3/83

Project Title: Radar Transmission Characteristics of Radar Scattering Camouflage Screens

Project No: A-3338

Project Director: Thomas B. Wells

Sponsor: VSE Corporation

Effective Termination Date: 1/31/83

Clearance of Accounting Charges: 1/31/83

Grant/Contract Closeout Actions Remaining:

- [x] Final Invoice and Closing Documents
- [ ] Final Fiscal Report
- [ ] Final Report of Inventions
- [ ] Govt. Property Inventory & Related Certificate
- [ ] Classified Material Certificate
- [ ] Other ____________

Assigned to: ECSL/EED (School/Laboratory)

COPIES TO:

Administrative Coordinator
Research Property Management
Accounting
Procurement/EES Supply Services
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Project File
Other Project Director

FORM OCA 10:781

A-3338

ENGINEERING EXPERIMENT STATION
Georgia Institute of Technology
A Unit of the University System of Georgia
Atlanta, Georgia 30332

1 November 1982

VSE Corporation
2550 Huntington Avenue
Alexandria, Virginia 23307

Attention: Mr. Jim Ward

Reference: P. O. 53501 under Government Contract No. DAAK70-81-D-0109
(Georgia Tech Project No. A-3338)

Title: "Radar Transmission Characteristics of Radar Scattering Camouflagle Screens"

Subject: Monthly Status Report No. 1
1 August 1982 through 31 August 1982

Gentlemen:

This Monthly Status Report covers a reporting period of 1 August 1982 to 31 August 1982. During this period final contract negotiations were completed. The research program has been designated by Georgia Tech as Engineering Experiment Station Project A-3338. The project is under the general superviison of Dr. C. E. Ryan, Jr., Chief, Electromagnetic Effectiveness Division and is under the direct supervision of Dr. T. B. Wells, Project Director. As of 31 August, authorization for contract expenditures has not been created.

Respectfully submitted,

Thomas B. Wells
Project Director

Approved:

Charles E. Ryan, Jr.
Chief,
EM Effectiveness Division

A-3338

ENGINEERING EXPERIMENT STATION
Georgia Institute of Technology
A Unit of the University System of Georgia
Atlanta, Georgia 30332

1 November 1982

VSE Corporation
2550 Huntington Avenue
Alexandria, Virginia 23307

Attention: Mr. Jim Ward

Reference: P. O. 53501 under Government Contract No. DAAK70-81-D-0109 (Georgia Tech Project No. A-3338)

Title: "Radar Transmission Characteristics of Radar Scattering Camouflagle Screens"

Subject: Monthly Status Report No. 2
1 September 1982 through 30 September 1982

Gentlemen:

This Monthly Status Report covers the reporting period 1 September 1982 to 30 September 1982. The VSE purchase order funding this project was accepted by the Georgia Tech Research Institute on 17 September 1982 and spending authorization in the form of an internal charge number was in place as of 23 September 1982. The Sullivan camouflage screens were received prior to this.

Despite the late start, significant progress has been made. Specifically, the near-field range was returned to the configuration appropriate to camouflage screen measurements and its basic operation was checked in anticipation of project funding. This operational check revealed an instability in the phase locking tuner of the near-field range dedicated receiver and malfunctions in the Micronova data acquisition computer. Both these problems were corrected using general overhead funds. Since any reconfiguration of the range will result in a slightly different clear-site field, new measurements of the same sense and cross polarized clear-site fields have been made. The averages of the current and previous clear-site fields are within 0.15 dB of one another.

To achieve this level of reproducibility in this and future measurements, a tripod was obtained and used to mount the transmitting horn. This replaces a styrofoam stand previously used and facilitates precise alignment of the transmitting horn. Measurements of the net have begun.

Respectfully submitted,

Thomas B. Wells
Project Director

Approved:

Charles E. Ryan, Jr.
Chief,
EM Effectiveness Division

A-3338

ENGINEERING EXPERIMENT STATION
Georgia Institute of Technology
A Unit of the University System of Georgia
Atlanta, Georgia 30332

10 November 1982

VSE Corporation
2550 Huntington Avenue
Alexandria, Virginia 23307

Attention: Mr. Jim Ward

Reference: P. O. 53501 under Government Contract No. DAAK70-81-D-0109 (Georgia Tech Project No. A-3338)

Title: "Radar Transmission Characteristics of Radar Scattering Camouflagle Screens"

Subject: Monthly Status Report No. 3
1 October 1982 through 31 October 1982

Gentlemen:

This Monthly Status Report covers a reporting period of 1 October 1982 to 31 October 1982. During this period, the main body of work comprising the referenced Purchase Order has been completed. Specifically, measurements of the seven foot by seven foot section of Sullivan camouflage screen and measurements of five sections of a full hexagonal Sullivan screen have been completed. Preliminary processing of this data has been performed and the results are summarized in Table I.

The measurement protocols are the same as those described in the Final Letter Report of 17 June 1982 for Contract No. DAAK70-81-D-0109 (Georgia Tech No. A-3230) used in the measurement of two hexagonal Brunswick camouflage screens. For the sake of comparison, the Brunswick data is reproduced in Table II. Table I and II list the average and standard deviation of the field magnitude for the same and cross polarized measurements of the different net sectors. The averages are calculated relative to the average for the clear-site field which is 2.1 and 2.2 dB below the maximum power of the clear-site field for Tables I and II, respectively. The lines marked "Total" are the averages, and standard deviations, of the averages for the different net sectors. They therefore provide an estimate of the average field that would be obtained if another net sector were measured. The standard deviation σ (Total) is a measure of the large scale variations.

The Brunswick screens are denoted as net 1 and net 2 in Table II. The hexagonal Sullivan screen is listed as net 3 in Table I and the seven foot by seven foot Sullivan net is described as the wind tunnel net in Table I since it was to be and has been subjected to wind tunnel tests. Although not formally subject to the above referenced Purchase Order, measurements of the wind tunnel net after the wind tunnel test have been completed and the preliminary results are included in Table I as the final row of data. The wind tunel net (final) data is not included in the averages.

The data of Table I must be considered preliminary and some variance between this and the final data should be expected. The occasion of this variance would be data transmission errors in transferring data from the data acquisition computer to the main frame computer and the indicated variation between this and final data should be no more than 0.1 dB. The presence of such errors is inferred from normalization checks and auxiliary calculations. The magnitude of these errors is evidenced by cross checks.

Comparison of the Sullivan and Brunswick nets can be summarized as follows. The average transmission for all sections of Brunswick and Sullivan nets respectively are -2.5 dB and -1.9 dB normalized to average clearsite fields. Examination of the "Grand Total" field magnitudes and standard deviations indicate that this is $\gtrsim \sigma$, one standard deviation. Note that the high transmission through the wind tunnel net (-0.9 dB) changes the Sullivan average from -2.1 dB to -1.9 dB. (The Brunswick nets individualy transmit -2.4 dB and -3.1 dB.) Detailed comparison shows greater variations between sections of the Sullivan nets than between sections of the Brunswick net as indicated by the "Total" σ's and more uniformity within sections for the Sullivan nets indicated by smaller σ's for individual sections. The cross polarized returns from the Brunswick and Sullivan nets are similar in magnitude and distribution.

The differences between the Brunswick and Sullivan nets in the transmission of parallel polarization must be considered statistically significant. The distributions of average transmission through individual net sections of Sullivan and Brunswick nets do overlap in part. However, three of the six sections of Sullivan net transmit more than any sections of the Brunswick net and four of the ten sections of the Brunswick nets transmit less than any sections of the Sullivan nets. These observations are consistent with the one standard deviation difference in transmission noted above.

Respectfully submitted,

Thomas B. Wells
Project Director

Approved:

Charles E. Ryan, Jr.
Chief,
EM Effectiveness Division

TABLE I

PRELIMINARY AVERAGES AND STANDARD DEVIATIONS OF THE TRANSMITTED FIELD MAGNITUDES RELATIVE TO THE AVERAGE OF THE CLEAR-SITE FIELD MAGNITUDE. TOTALS ARE COMPUTED FROM THE AVERAGES FOR THE SEPARATE SECTIONS

		Parallel Polarization					Cross Polarization		
Net	Section	$\lvert E \rvert$	E (dB)	σ	$\lvert E \rvert^2 + \sigma$ (dB)	$\lvert E \rvert^2 - \sigma$ (dB)	$\lvert E \rvert$	$\lvert E \rvert^2$ (dB)	σ
Clear-Site		1.0	0.0	0.13	1.1	-1.2	†		
3	A	0.75	-2.5	0.12	-1.9	-4.1	0.086	-21.4	0.056
3	B	0.74	-2.7	0.13	-1.2	-4.4	†		
3	C	0.77	-2.2	0.13	-0.9	-3.9	0.069	-23.2	0.042
3	D	0.82	-1.7	0.17	0.0	-3.6	0.092	-20.7	0.052
3	E	0.85	-1.4	0.14	-0.3	-3.2	0.045	-27.0	0.026
Total (Net 3)		0.79	-2.1	0.05	-1.6	-2.6	0.073	-22.7	0.021
Wind Tunnel Net	Initial	0.88	-0.9	†			0.095	-20.5	0.053
Grand Total		0.80	-1.9	0.06	-1.3	-2.6	0.077	-22.2	0.021
Wind Tunnel Net	Final	0.87	-1.2	0.14	0.1	-2.8	0.082	-21.7	0.049

† Data Not Validated Currently

TABLE II

AVERAGES AND STANDARD DEVIATIONS OF THE TRANSMITTED FIELD MAGNITUDES RELATIVE TO THE AVERAGE OF THE CLEAR-SITE FIELD MAGNITUDE. TOTALS ARE COMPUTED FROM THE AVERAGES FOR THE SEPARATE SECTIONS

		Parallel Polarization					Cross Polarization		
Net	Section	$\|E\|$	$\|E\|^2$ (dB)	σ	$\|E\|^2 + \sigma$ (dB)	$\|E\|^2 - \sigma$ (dB)	$\|E\|$	$\|E\|^2$ (dB)	σ
Clear-Site		1.0	0.0	0.14	1.1	-1.3	0.029	-30.6	0.013
1	A	0.78	-2.1	0.16	-0.5	-4.2	0.066	-23.7	0.036
1	B	0.74	-2.6	0.17	-0.8	-4.8	0.063	-24.1	0.035
1	C	0.81	-1.8	0.19	0.0	-4.2	0.076	-22.4	0.042
1	D	0.74	-2.6	0.18	-0.7	-5.0	0.053	-25.6	0.029
1	E	0.74	-2.6	0.16	-0.9	-4.7	0.058	-24.7	0.032
Total (Net 1)		0.76	-2.4	0.03	-2.0	-2.7	0.069	-23.2	0.010
2	A	0.73	-2.7	0.14	-1.2	-4.6	0.066	-23.5	0.037
2	B	0.69	-3.3	0.15	-1.5	-5.4	0.051	-25.8	0.030
2	C	0.78	-2.2	0.19	-0.3	-4.6	†		
2	D	††					0.090	-21.0	0.050
2	E	0.70	-3.1	0.20	-0.9	-6.0	0.078	-22.2	0.044
Total (Net 2)		0.72	-2.8	0.04	-2.4	-3.2	0.071	-22.9	0.014
Grand Total		0.74	-2.6	0.04	-2.1	-3.0	0.070	-23.1	0.012

† No data

†† Incomplete data

A-3338

ENGINEERING EXPERIMENT STATION
Georgia Institute of Technology
A Unit of the University System of Georgia
Atlanta, Georgia 30332

5 January 1983

VSE Corporation
2550 Huntington Avenue
Alexandria, Virginia 23307

Attention: Mr. Jim Ward

Reference: P.O. 53501 under Government Contract No. DAAK70-81-D-0109 (Georgia Tech Project No. A-3338)

Title: "Radar Transmission Characteristics of Radar Scattering Camouflage Screens"

Subject: Monthly Status Report No. 4
1 November 1982 through 30 November 1982

Gentlemen:

This Monthly Status Report covers a reporting period of 1 November 1982 through 30 November 1982. During this period, the large Sullivan screen was returned to Georgia Tech after life cycle testing by VSE. Near-field transmission measurements were performed for five sections of the camouflage screen prior to the life cycle testing. Identical transmission measurements have begun on the life cycle tested screen. Since these measurements are intended to characterize the screen as a whole, no effort was made to make the measured areas in the initial and final measurements physically identical. Therefore, only the overall measures of camouflage screen effectiveness, i.e., the average and the standard deviation of the transmission, are to be compared between the initial and final camouflage screen measurements. (The measurements of individual sections of the camouflage screen before and after life cycle testing are not to be compared directly.)

To further validate the measurement systematics and stability of the range configuration, the clearsite measurement has been repeated.

Respectfully submitted,

Thomas B. Wells
Project Director

Approved:

Charles E. Ryan, Jr.
Chief,
EM Effectiveness Division

A-3338

ENGINEERING EXPERIMENT STATION
Georgia Institute of Technology
A Unit of the University System of Georgia
Atlanta, Georgia 30332

1 February 1983

VSE Corporation
2550 Huntington Avenue
Alexandria, Virginia 23303

Attention: Mr. James Ward

Reference: VSE Purchase Order No. 49160
under Government Prime No. DAAK70-81-D-0109
Georgia Tech Project A-3338

Title: "Radar Transmission Characteristics of two Sullivan Radar Scattering Camouflage Screens"
Government Contract No. DAAK70-81-D-0109
Job No. 0300.002N
Purchase Order No. 49160

Subject: Final Letter Report

Gentlemen:

This letter report describes the measurement and data analysis of radar transmission characteristics of two Sullivan radar scattering camouflage screens. These measurements are made for screens which are in a new condition and after life cycle or wind tunnel degradation of the screen. The measurements are planar near-field measurements of the field transmitted through sections of the camouflage screen. These measurements are analyzed to obtain cumulative probability distributions of the transmitted field strengths relative to the clear-site (i.e., incident) field. The average and standard deviation of the transmitted power for each sector of the camouflage screen are then obtained from the cumulative probability distributions. Large sectors of the camouflage screen were illuminated in order to ensure statistically significant results. The average transmission characteristics of the screens were thus obtained and these characteristics provide one measure of camouflage screen effectiveness.

Range Configuration and Measurement Parameters

The planar near-field range was utilized by Georgia Tech in this determination of radar transmission characteristics. The configuration and instrumentation of this range are indicated schematically in Figure 1. The

AUTOMATED PLANAR SCANNER FACILITY CONFIGURATION

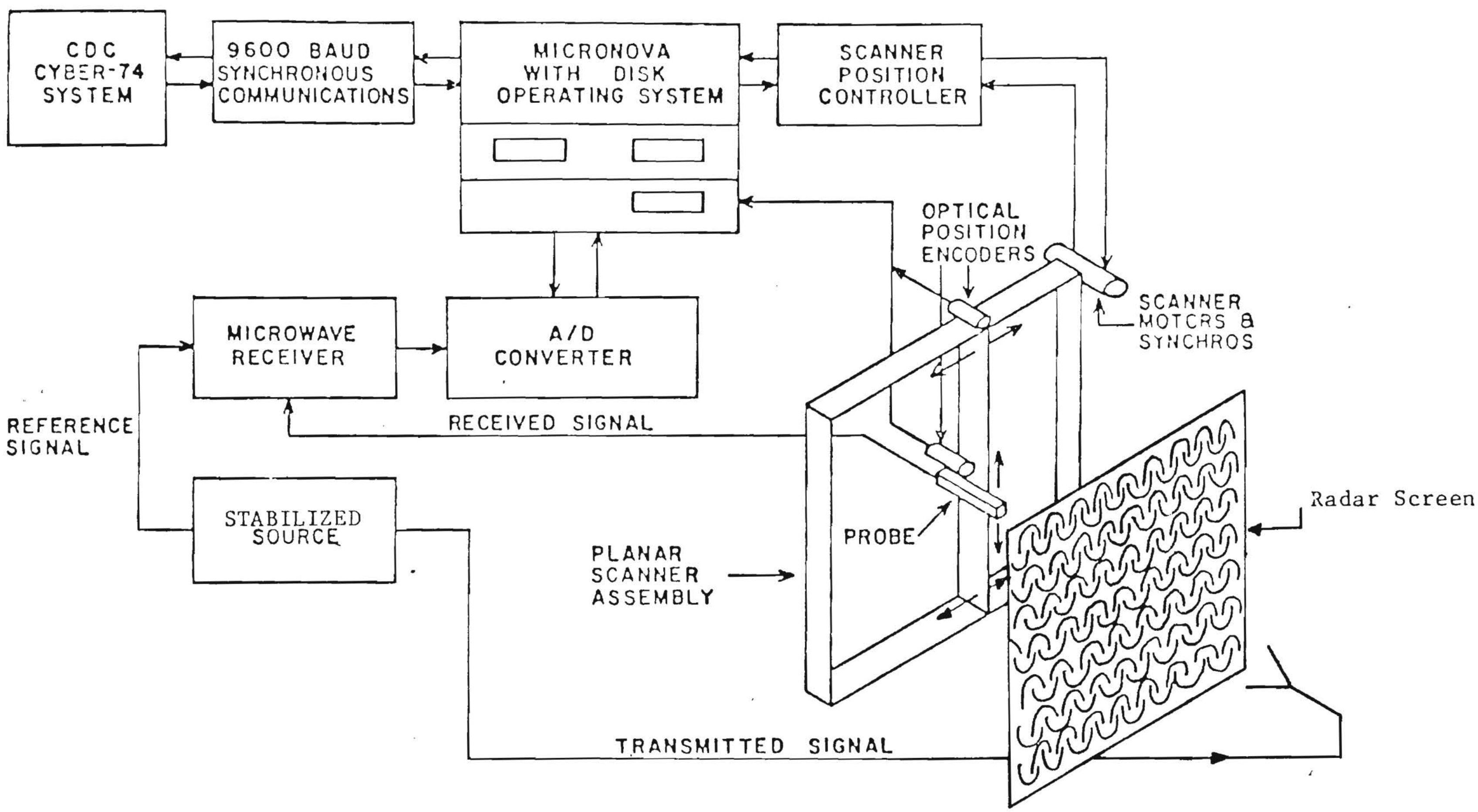

Figure 1. Planar near-field range configuration for transmission measurements of camouflage screens. Phase and amplitude of the field are acquired under automatic control at a planar rectangular grid of points.

net is roughly 18 feet from the transmitting horn and approximately 4 inches from the plane of the probe used to sample the field. The net is wound around a wooden mandrel supported 12 feet above the floor by wooden towers 14 feet apart. (The sides of the towers facing the transmitting horn are covered by absorber). The range geometry is similar to that of a pyramidal anechoic chamber.

The Sullivan camouflage screens tested are as follows. The first is hexagonal in shape with sides of length sixteen feet for a diagonal dimension of thirty-two feet. The second screen is a seven foot by seven foot section cut from a larger screen. Both screens consist of a rectangular grid net to which sections of incised camouflage cloth are attached by metal fasteners. The sections of cloth may have large incision or small incision patterns. The different sections of cloth (garnishment) as applied to the net may overlap or fail to meet. Life cycle testing of the large screen consisted of 120 deployment cycles. A deployment cycle consisted of erecting the screen on spreaders, taking it down and packing it, and carrying it a short distance. The wind tunnel test consisted of exposing the screen to winds of roughly 55 miles per hour. Both life cycle and wind tunnel testing were performed independently by V.S.E.

The measurement configuration and measurement plane were selected for compatibility with a number of related objectives. Thus the nominal 4-inch separation of the plane of the camouflage screen and that of the probe was sufficient to preclude significant coupling between the net and the probe. The probe was still close enough to the camouflage screen that each sample of the field corresponds to transmission through a small area of the screen. The proximity of the probe to the net also assures that the clear-site field is very similar to the field actually incident on the net. In all respects, the measurement technique is that employed earlier in the characterization of two Brunswick camouflage screens under Purchase Order No. 49160 and Job No. 0300.002N of Government Contract No. DAAK70-81-D-0109.

The plane of the near-field measurement was chosen to be $64\lambda \times 64\lambda$ where the wavelength $\lambda = f/c$ with f the frequency and c the speed of light. At the 10.0 GHz measurement frequency this corresponds to a 75.52 x 75.52 inch measurement plane. This area is large enough to cover multiple sections of the incised cloth so that statistics for a measurement sector should approximate those of the whole net or of other measurement sectors. The field is sampled at a spacing of $\frac{1}{2}\lambda$ for Nyquist sampling of the transmitted field. The data array is 128 x 128 points.

The illuminating horn was chosen to be one of moderate directivity such that the amplitude roll-off across the measurement plane would not be great. The roll-off obtained was 3 dB along the principal plane cuts of the measurement plane and 4 to 5 dB in the corners of the measurement plane. The phase taper across the measurement plane corresponds to the difference in path length between the transmitting horn and the center and edge of the measurement plane.

Measurement Procedure and Results

Some discussion of the physical aspects of the measurement procedure is in order to indicate the handling to which the camouflage screens are subject. The net is spread on the ground and one side is folded over until the width of the net can be accommodated on the sixteen foot 2x4 which serves as a mandrel. The net is then wound around the mandrel and the mandrel suspended on two support towers in front of the measurement plane. If a clear-site measurement is needed, it is made at this point. The net is then manually unwrapped from the mandrel until the net falls below the edge of the measurement plane. The net is then stretched moderately by attaching it to vertical members of the towers so that the measured section of net will nominally lie in a plane. At this point, there is a single layer of the screen across the measurement plane with a multi-layer bundle of material by one tower. The parallel polarized and cross polarized components of the transmitted field are then measured and points of the camouflage screen adjacent to the corners of the measurement plane are marked by light plastic flaps. The center of the measured sector is marked by a flag with the sequence number of the measurement. A new section of the net is brought down and the measurement repeated. After two or a maximum of three sections have been measured, it is necessary to take the net down and refold and rewrap to obtain new sections of the net. The net sectors so obtained are not square or parallel to one another.

Five sections of the large (hexagonal) screen were measured before life cycle testing and five sections of the screen were measured after the life cycle testing. The measured sections before and after life cycle testing are not the same physical areas. The smaller (square) screen corresponded closely to a single measurement sector and a single measurement is made before and after the wind tunnel testing of this screen.

Statistical Data Analysis

There are a number of statistical factors represented in these measurements. These range from small scale variations as in the distribution of metal fibers on the camouflage cloth to the large scale distribution of garnishment sections on the net. Included are variations in the incision size, random variations in the draping of the incised cloth and systematic variations in the stretching (deployment) of the net for measurements. Therefore only statistical valuations of the measured data are valid. The measurement plane is large enough to encompass the large scale variations but does not include a statistically significant number of such variations. Differences in the statistical quantities for different net sectors reflect these large-scale variations as well as the net deployment. For design purposes it would be beneficial to isolate statistical factors and evaluate their effects individually. However, the present measurements are specifically designed to compare the performance of various finished products.

Tables I and II list the average and standard deviation of the transmitted field magnitude for the same and cross polarized measurements of the different net sectors before and after life cycle or wind tunnel testing.

The hexagonal Sullivan screen is listed as net 3 in Tables I and II and the seven foot by seven foot Sullivan net is described as the wind tunnel net. Results of earlier measurements of two Brunswick hexagonal screens are included in Table III with these being denoted as nets 1 and 2.

The meaningful comparisons are between the initial and final measurements of the Sullivan screens and between the Brunswick screen measurements and the initial Sullivan screen measurements.

The most immediate observation respecting the initial and final Sullivan screen measurements is that the wind tunnel test has little if any effect on screen transmission. Indeed, the transmission through the screen after the wind tunnel test is slightly less than before the wind tunnel test. The initial average transmitted field is 0.88 and the final average transmitted field is 0.87 for the wind tunnel net both relative to the average clearsite field. While this difference is smaller than standard deviation between individual measurement points, approximately 0.14, it is larger than standard deviation between initial net section transmission, Initial Grand Total σ = 0.06. Since one cannot expect that the wind tunnel exposure reduced the average net transmission, this difference is more indicative of the systematic error in, or repeatability of the current set of measurements.

The life cycle testing of the Sullivan screen has a much greater impact on transmission. The average transmission for all sections of the large Sullivan screen, net 3, is -2.1 dB initially and -0.5 dB after life cycle testing. This corresponds to average transmitted fields of 0.79 and 0.94 relative to clearsite for the initial and final screen. Physical examination of the screen before and after life cycle testing indicates that portions of the cloth used as garnishment are lost in the life cycle exercise and that the remaining garnishment has a tendency to curl up. Thus, there are areas of the screen devoid of garnishment and small areas with more than one layer of garnishment. This is evident both in the larger average transmission after life cycle testing and the larger

TABLE I

AVERAGES AND STANDARD DEVIATIONS OF THE TRANSMITTED FIELD MAGNITUDES RELATIVE TO THE AVERAGE OF THE CLEAR-SITE FIELD MAGNITUDE FOR INITIAL SULLIVAN CAMOUFLAGE SCREENS. TOTALS ARE COMPUTED FROM THE AVERAGES FOR THE SEPARATE SECTIONS

		Parallel Polarization					Cross Polarization		
Net	Section	$\|\bar{E}\|$	$\|\bar{E}\|$ (dB)	σ	$\|\bar{E}\| + \sigma$ (dB)	$\|\bar{E}\| - \sigma$ (dB)	$\|\bar{E}\|$	$\|\bar{E}\|$ (dB)	σ
Clear-Site		1.0	0.0	0.13	1.1	-1.2	0.017	-35.6	0.011
3 (Initial)	A	0.75	-2.5	0.12	-1.9	-4.1	0.086	-21.4	0.056
3 (Initial)	B	0.74	-2.7	0.13	-1.2	-4.4	0.062	-24.2	0.036
3 (Initial)	C	0.77	-2.2	0.13	-0.9	-3.9	0.069	-23.2	0.042
3 (Initial)	D	0.82	-1.7	0.17	0.0	-3.6	0.092	-20.7	0.052
3 (Initial)	E	0.85	-1.4	0.14	-0.3	-3.2	0.045	-27.0	0.026
Initial Total (Net 3)		0.79	-2.1	0.05	-1.6	-2.6	0.071	-23.0	0.019
Wind Tunnel Net	Initial	0.88	-1.0	0.15	+0.3	-2.6	0.095	-20.5	0.053
Initial Grand Total		0.80	-1.9	0.06	-1.3	-2.6	0.075	-22.5	0.020

TABLE II

AVERAGES AND STANDARD DEVIATIONS OF THE TRANSMITTED FIELD MAGNITUDES RELATIVE TO THE AVERAGE OF THE CLEAR-SITE FIELD MAGNITUDE FOR FINAL SULLIVAN CAMOUFLAGE SCREENS. TOTALS ARE COMPUTED FROM THE AVERAGES FOR THE SEPARATE SECTIONS

		Parallel Polarization					Cross Polarization		
Net	Section	$\|\bar{E}\|$	$\|\bar{E}\|$ (dB)	σ	$\|\bar{E}\| + \sigma$ (dB)	$\|\bar{E}\| - \sigma$ (dB)	$\|\bar{E}\|$	$\|\bar{E}\|$ (dB)	σ
Clear-Site		1.0	0.0	0.13	1.1	-1.2	0.017	-35.6	0.011
3 (Final)	A	0.97	-0.2	0.14	+1.0	-1.6	0.039	-28.3	0.024
3 (Final)	B	0.94	-0.5	0.16	+0.9	-2.1	0.086	-21.4	0.054
3 (Final)	C	0.96	-0.4	0.16	+0.9	-1.9	0.074	-22.6	0.049
3 (Final)	D	0.93	-0.6	0.16	+0.8	-2.3	0.093	-20.6	0.066
3 (Final)	E	0.92	-0.7	0.16	+0.7	-2.4	0.063	-24.0	0.036
Final Total (Net 3)		0.94	-0.5	0.02	-0.3	-0.7	0.071	-23.0	0.021
Wind Tunnel Net	Final	0.87	-1.2	0.14	0.1	-2.8	0.082	-21.7	0.049
Final Grand Total		0.93	-0.6	0.04	-0.3	-1.0	0.073	-22.8	0.020

† Data Not Validated Currently

TABLE III

AVERAGES AND STANDARD DEVIATIONS OF THE TRANSMITTED FIELD MAGNITUDES RELATIVE TO THE AVERAGE OF THE CLEAR-SITE FIELD MAGNITUDE FOR TWO BRUNSWICK CAMOUFLAGE SCREENS. TOTALS ARE COMPUTED FROM THE AVERAGES FOR THE SEPARATE SECTIONS

		Parallel Polarization					Cross Polarization		
Net	Section	$\lvert\bar{E}\rvert$	$\lvert\bar{E}\rvert$ (dB)	σ	$\lvert\bar{E}\rvert + \sigma$(dB)	$\lvert\bar{E}\rvert - \sigma$(dB)	$\lvert\bar{E}\rvert$	$\lvert\bar{E}\rvert$ (dB)	σ
Clear-Site		1.0	0.0	0.14	1.1	-1.3	0.029	-30.6	0.013
1	A	0.78	-2.1	0.16	-0.5	-4.2	0.066	-23.7	0.036
1	B	0.74	-2.6	0.17	-0.8	-4.8	0.063	-24.1	0.035
1	C	0.81	-1.8	0.19	0.0	-4.2	0.076	-22.4	0.042
1	D	0.74	-2.6	0.18	-0.7	-5.0	0.053	-25.6	0.029
1	E	0.74	-2.6	0.16	-0.9	-4.7	0.058	-24.7	0.032
Total (Net 1)		0.76	-2.4	0.03	-2.0	-2.7	0.069	-23.2	0.010
2	A	0.73	-2.7	0.14	-1.2	-4.6	0.066	-23.5	0.037
2	B	0.69	-3.3	0.15	-1.5	-5.4	0.051	-25.8	0.030
2	C	0.78	-2.2	0.19	-0.3	-4.6	†		
2	D	††					0.090	-21.0	0.050
2	E	0.70	-3.1	0.20	-0.9	-6.0	0.078	-22.2	0.044
Total (Net 2)		0.72	-2.8	0.04	-2.4	-3.2	0.071	-22.9	0.014
Grand Total		0.74	-2.6	0.04	-2.1	-3.0	0.070	-23.1	0.012

† No data

†† Incomplete data

standard deviations of individual sections. Indeed, the standard deviation between sections of the final net of 0.02 relative to the 0.06 relative attenuation of the net (1.0 - $|\overline{E}|$ Final Total for net 3) is greater than the ratio of 0.05 Initial Total standard deviation to the 0.21 relative attenuation of the net initially. This indicates that, as expected, the life cycle testing has not degraded the net uniformly. The level of the transmitted cross polarized field is not affected significantly by the life cycle or wind tunnel tests. The Grand Totals in Tables I and II should not be compared since they combine the results of the dissimilar wind tunnel and life cycle tests.

Comparison of the initial Sullivan net measurements and the Brunswick net measurements is as follows. The average transmission for all sections of Brunswick and Sullivan nets respectively are -2.5 dB and -1.9 dB normalized to average clearsite fields. Examination of the "Grand Total" field magnitudes and standard deviations indicate that this is $\gtrsim \sigma$, one standard deviation. Note that the high transmission through the wind tunnel net (-0.9 dB) changes the Sullivan average from -2.1 dB to -1.9 dB. (The Brunswick nets individualy transmit -2.4 dB and -3.1 dB.) Detailed comparison shows greater variations between sections of the Sullivan nets than between sections of the Brunswick net as indicated by the "Total" σ's and more uniformity within sections for the Sullivan nets indicated by smaller σ's for individual sections. The cross polarized transmitted field components from the Brunswick and Sullivan nets are similar in magnitude and distribution.

The initial differences between the Brunswick and Sullivan nets in the transmission of parallel polarization must be considered statistically significant. The distributions of average transmission through individual net sections of Sullivan and Brunswick nets do overlap in part. However, three of the six sections of Sullivan net transmit more than any sections of the Brunswick net and four of the ten sections of the Brunswick net transmit less than any sections of the Sullivan nets. These observations are consistent with the one standard deviation difference in transmission noted above.

Observations and Conclusions

The degradation of the Sullivan screens in life cycle testing is too large to be explained entirely by the loss of or curling up of garnishment observed in physical inspection. Mechanically, it seems unlikely that the metal fibers embedded in the cloth would be broken in the life cycle testing. It seems probable, however, that conducting contact points of overlapping metal fibers could be lost in the life cycle testing and that this could account for the significant degradation of the camouflage screen performance.

The initial transmission of the Sullivan screen is greater than that of the Brunswick screen by a statistically significant amount. Life cycle testing degrades the performance of the Sullivan screen to the point that it is difficult to see any measurable camouflage effect against 10 GHz threats. The wind tunnel test has negligible effect.

Respectfully submitted,

Thomas B. Wells
Project Director

Approved:

Charles E. Ryan, Jr.
Chief,
EM Effectiveness Division