ESD-TR-66-149

# A STUDY IN INFORMATION PROCESSING: ELECTROLUMINESCENT VS TELETYPE READABILITY OF WEATHER MESSAGES



Alan M. Kershner
Donald L. Avery

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DECISION SCIENCES LABORATORY
ELECTRONIC SYSTEMS DIVISION
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United States Air Force
L.G. Hanscom Field, Bedford, Massachusetts

Project 7682
Task 768201

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## FOREWORD

The experimental work reported here is part of the in-house research effort in support of Project 7682 and was performed under Task 768201.

The authors wish to express their gratitude to the following:

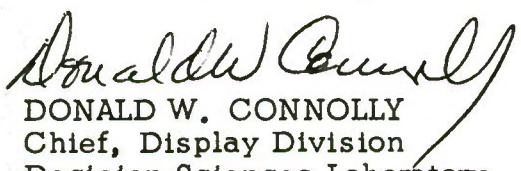
Major Bernard H. De Witt, former Commander, Detachment 6, 4th Weather Group for critical suggestions and the cooperation of the personnel of the Base Weather Station.

Staff Sergeant Joseph J. Jozik for the preparation of the 50 weather messages used in this experiment and T/Sgt Richard C. Swanson for a review and critique of the erroring scoring.

Francis R. Valovcin, Satellite Metereology Branch, Cambridge Research Laboratories for critical suggestions and the preparation of the questions used with each weather message.

Captain Thomas J. Smith and Technical Sergeant Owen H. Sullivan of the Aerospace Instrumentation Laboratory of CRL, Teletype Repair personnel of the 2014th Communication Squadron and John R. Schjelderup of this Laboratory for organizing, adapting, and maintaining the equipment and attendant electrical circuits for the presentation and timing of each display.

This technical report has been reviewed and is approved.



DONALD W. CONNOLLY
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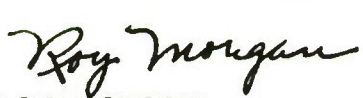

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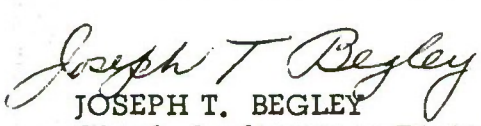

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A Study in Information Processing: Electroluminescent vs Teletype Readability of Weather Messages


## ABSTRACT

An investigation was undertaken to provide a human factors evaluation of an electroluminescent display designed for the presentation of around-the-base weather messages.

Time and error data were obtained for 42 Air Force weather, GCA, and pilot personnel in responding to six questions for each of 50 weather messages, 25 of which were presented on an electroluminescent display and 25 by conventional teletype format.

The few significant differences found do not warrant a conclusion that the electroluminescent format employed is inferior to the conventional teletype format.

It is concluded that weather message information processing may be improved by the development of time and error normative data for a standard set of weather messages, thereby permitting the identification of high-error (perhaps error-prone) personnel, by training to improve the interpretation of visibility coding and more specifically, by an improved formating of fractions concerned with visibility. The suggestion for the development of normative data may have applicability for other military information systems.

This study may be of assistance to the display designer and for the training of military and civilian personnel in weather message interpretation. It has value for the improvement of weather message formating as well as highlighting the importance of appropriate personnel selection and training for tasks involving the processing of information in complex displays.

The study further demonstrates the importance of not relying upon premature curbstone judgments of a display feasibility in lieu of an actual experimental test.

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## I. PURPOSE

Although this investigation was undertaken to provide a human factors evaluation of an electroluminescent display which was designed to present around-the-base weather messages, the results have added implications for the formating of weather messages for training of personnel in weather message interpretation, and for military information processing.

## II. METHOD

Forty-two military personnel each read and responded to 50 weather messages. The subjects consisted of 16 weather forecasters and observers from Detachment 6 of the Hanscom Base Weather Station; 8 Hanscom GCA personnel; and 18 Air Force pilots. It was believed that this choice of subject groups would provide differential levels of familiarity or experience with weather message interpretation. Twenty-five weather messages were presented on the electroluminescent display while the other twenty-five were presented in conventional weather teletype. The messages varied in length from fourteen to sixty-four characters. The messages were composed in the Base weather station and were designed to be equated for length and difficulty on a one to one basis for each display format. There was a time lag of six months between the time the messages were composed and their administration to the subjects; the data were collected in the fall of 1963. The task of each subject was to read each weather message and to record answers to six questions for each message. (See Instructions to Subjects, Appendix A). The elapsed time in hundreths of a minute

from the presentation of the first character of a message until the subject completed his responses was controlled by each subject and recorded by the experimenter. (See Appendix A). Half of each group of subjects were presented the electroluminescent messages first, whereas the other half viewed the teletype messages first. Prior to the electroluminescent presentation, each subject received a ten-minute standardized orientation with considerable repetition which presented the electroluminescent format for each letter, numeral, and weather symbol; the test was not begun until each subject signified he was confident of being aware of all the code and format differences. Subjects viewing the electroluminescent display were seated at a distance of three feet from the display, whereas they viewed the teletype presentation from about a foot and a half away. The illumination as measured by a McBeth Illuminometer was 24 foot candles.

Appendix A presents the weather messages employed. The reader, however, should bear in mind that the actual Alpha, Numeric, Symbolic characters viewed by the subjects on the electroluminescent display are as depicted in the photos on pages 39 and 40 of the same appendix. Wind arrows were displayed in fixed positions nos. 31 and 32 on the top line of the electroluminescent display. This appendix further contains the questions to which subjects responded and the instructions to the subjects. Both displays were activated through the same paper tape reader, hence messages were exposed at identical rates.

## III. RESULTS AND DISCUSSION

The results and discussion will consider (A) the electroluminescent vs the teletype data, (B) implications for the Air Force, the Air Weather Service, and for weather message presentation and interpretation, and (C) general implications for military information processing.

Two different types of analyses were made of the data: (1) response time and error scores by individual subject for each subject group by display type and (2) error categorization by specific weather information in an Alpha, Numeric, and Symbolic framework. Tables I and II present by display type the mean response times and the percentage of not-correct responses respectively for the different subject groups. Table III shows the not-correct response frequencies for the teletype and electroluminescent displays classified according to the Alpha, Numeric, and Symbolic form of the data within each weather message and partitioned by subject group; this classification happens to show an almost identical number of questions asked pertaining to these specific categories for the two different displays. Response times and error frequencies by individual subjects are presented in Appendix B which also contains a note on the scoring and questions, and a summarization of subjects' comments. Appendix C contains a detailed presentation of erroneous responses which should be of assistance in training personnel in the pitfalls of weather message interpretation.

A. Electroluminescent vs Teletype Presentation.

From an analysis of the time and error scores for each group of subjects only one firm significant difference is found, namely the time scores for weather personnel ($.03 > p > .02$). The larger difference in mean time scores for pilots fails to meet the 5% level of significance because of their greater variability.

TABLE I

Mean Response Time in Minutes for Weather, GCA, and Pilot Personnel for 25 Weather Messages by Display Type

| | Weather | GCA | Pilot |
|---|---|---|---|
| Teletype | 10.4 | 19.3 | 17.1 |
| Electro-luminescent (EL) | 11.7 | 19.4 | 19.5 |

TABLE II

Percent Not-Correct Responses for Weather, GCA, and Pilot Personnel by Display Type

| | Weather | GCA | Pilot |
|---|---|---|---|
| Teletype | 1.9 | 7.4 | 9.8 |
| Electro-luminescent (EL) | 2.6 | 11.2 | 10.1 |

Weather personnel have suggested that questions on barometric pressure tendency and cloud types were unfair for both GCA and pilot groups - questions which generated error rates from 87% to 100% for these groups as contrasted with error rates largely below 10% and in no case exceeding 28% for either of these groups for any other specific response category (see Table VII). Five questions on the electroluminescent displays dealt with these matters, whereas only two were so concerned for the teletype displays.* With the elimination of responses for these questions, the error difference for the GCA group is not significant. Furthermore, when the not-correct responses for these questions are subtracted from the error total for each display group, the remainders in Table III would become 344 for the teletype and 339 for the electroluminescent.

In view of the brief ten minutes' orientation to the altered symbology and formating on the electroluminescent display, it cannot be concluded that the operational use of such a display would result in a performance decrement. The results of this investigation should serve as a warning to those prone to advance curbstone judgments concerning proposed display formats. It had been freely opined with supporting "logical" reasons that use of this particular electroluminescent display would give rise to marked degradation in performance. That an actual test failed to support such opinion strengthens a growing belief of some display investigators that there is probably a point beyond

*For the EL #12.5, 12.6, 22.3, 22.5 and 23.6; For the TT 22.3 and 22.5 (see Appendix A)

TABLE III

Alpha, Numeric, Symbolic Error Summary
by Subject Group & Display Type

| | | Teletype | | | | Electroluminescent | | | Totals | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Wx n=16 | GCA n=8 | Pilots n=18 | | Wx n=16 | GCA n=8 | Pilots n=18 | TT | | EL |
| ALPHA | | | | | | | | | | | |
| Station identification | (25) | 7 | 0 | 0 | (25) | 6 | 16 | 3 | 7 | * | 25 |
| Visby & Remarks | (11) | 5 | 21 | 47 | ( 9) | 2 | 19 | 48 | 73 | | 69 |
| SYMBOLIC | | | | | | | | | | | |
| Sky:a | ( 5) | 0 | 0 | 4 | ( 6) | 2 | 4 | 4 | 4 | | 10 |
| :b | (22) | 2 | 4 | 17 | (24) | 6 | 3 | 6 | 23 | | 15 |
| :c | (18) | 7 | 8 | 39 | (16) | 14 | 25 | 25 | 54 | | 64 |
| Wind Direction | ( 8) | 0 | 0 | 15 | ( 7) | 3 | 0 | 4 | 15 | | 7 |
| Alpha/Symbolic | ( 5) | 4 | 6 | 24 | ( 5) | 2 | 4 | 12 | 34 | * | 18 |
| NUMERIC | | | | | | | | | | | |
| Height of ceiling or cloud cover | ( 5) | 3 | 3 | 4 | ( 5) | 1 | 1 | 3 | 10 | | 5 |
| Temperature | ( 7) | 0 | 1 | 2 | ( 7) | 0 | 0 | 0 | 3 | | 0 |
| Dewpoint | ( 7) | 2 | 1 | 4 | ( 7) | 1 | 0 | 1 | 7 | | 2 |
| Wind Speed | ( 9) | 4 | 2 | 3 | ( 7) | 2 | 0 | 3 | 9 | | 5 |
| Baro-Altimeter | ( 9) | 0 | 2 | 1 | ( 8) | 2 | 0 | 2 | 3 | | 4 |
| Baro pressure tendency & amt | ( 1) | 3 | 8 | 18 | ( 3) | 7 | 21 | 54 | 29 | | 82 |
| Visibility | ( 8) | 2 | 13 | 21 | ( 7) | 7 | 9 | 14 | 36 | | 30 |
| Cloud types | ( 1) | 2 | 7 | 18 | ( 2) | 0 | 14 | 36 | 27 | | 50 |
| Alpha/Numeric | ( 9) | 5 | 13 | 48 | (12) | 8 | 18 | 59 | 66 | | 85 |
| | (150) | 46 | 89 | 265 | (150) | 63 | 134 | 274 | 400 | | 471 |
| Fractions | *( 6)* | *4* | *17* | *23* | *( 8)* | *7* | *10* | *16* | *44* | * | *33* |

Figures in parentheses indicate the number of questions asking for basic weather message data falling within said categories. For explanation of Sky a, b, and c see note on scoring and questions in Appendix B.

which the improvement of physical display characteristics may not be worth the cost. Clearly, in this investigation the most important parameters were a knowledge of weather symbols, codes and formating. There is, of course, the possibility that with increased practice with the electroluminescent symbology and formating, a reduction in error rates as compared with the teletype might result; however, this investigation did not address itself to this question.

Further examination by Alpha, Numeric, Symbolic categories, however, does disclose (see Table III) three significant differences in errors between the two displays:

1. The probability of the error difference being chance in favor of the teletype display in the recording of station letters is less than 5 in 1,000. The specific errors with a frequency breakout are shown in Appendix B with the single most significant error being the recording of D for B with the electroluminescent display. It may be noted there is only one small segment of difference between the electroluminescent presentation of these two letters. It may also be noted that for the teletype display the largest frequency for any specific error was one. One other confusion was identified, namely, the recording of 5 for S, an error which occurred once for EL question 3.4 and six times for EL question 19.6.

2. The probability of the error difference favoring the electroluminescent display for the Alpha/Symbolic information being chance is between 1 and 2 in 100. This classification embraces the codes for such information as "heavy thundershowers" and for visibility remarks such as "scattered variable to overcast." (See EL

messages #8 and #4 respectively). This difference may be explained in terms of information density, i.e., the ratio of occupied spaces to overall linear spaces occupied by the message. It has already been stated that the wind arrows for the electroluminescent display were displayed in fixed positions #31 and #32; since they were preceded by temperature and dew point, this resulted in a varying number of unused matrix positions preceding the temperature/dewpoint information. Accordingly, four of five of the electroluminescent Alpha/Symbolic codes occupied what amounted to terminal positions, whereas only one of the teletype Alpha/Symbolic codes could be considered as terminal - "terminal" here meaning "followed by more than one unused space".

3. The third significant difference between the two displays pertains to the processing of fractions, and the results favor the electroluminescent display. The probability of the difference being chance is less than 1 in 100. It should be noted, however, that this difference is concerned with error frequency alone. A more detailed analysis of errors involving fractions suggests that because of the face-plate junction between electroluminescent matrix positions #18 and #19, the magnitude of specific errors may be greater than the errors most frequently found with the teletype. (See Section B.2).

Another disadvantage of this face plate is that from extreme wide-angle viewing the matrix elements adjacent to the face plate

for positions 1, 18, 19, 36, 37, 54, 55, and 72 are masked, or at least partially so. Thus an N in position #19 could be taken for a V if one were viewing the display from a position sufficiently far enough to the left.

B. Air Force - Air Weather Service Implications.

Although studies such as this are of little value in indicating that "to err is human...,"[1] they can be of value in indicating possible ways in which human error may be reduced. Furthermore, it is possible that the term "error prone" may become as useful a term in information processing as has "accident prone" in traffic and industry research.

Whereas in the preceding section the concern was merely comparative between the electroluminescent and teletype presentations, two facets of concern to the Air Force are the performance of the individuals and the effects of specific display coding and formating. The results from this experiment indicate that improvement in weather information processing should be possible from two standpoints: (1) improved personnel processing and (2) altered weather message formating.

1. It is apparent that, regardless of which group of subjects are examined, the major proportion of the errors are made by a minor proportion of the subjects and there are rather sizeable individual

1. Alexander Pope, Essay on Criticism, 1711

TABLE IV

Error Frequencies, Percent and Rate (in percent) for Successive 25 Percents of Weather, GCA, and Pilot Subjects for Both Displays

| | Weather N = 16 | | | GCA N = 8 | | | Pilot N = 18 | | |
|---|---|---|---|---|---|---|---|---|---|
| | Error Frequencies | Percent of Errors | Error Rate (percent) | Error Frequencies | Percent of Errors | Error Rate (percent) | Error Frequencies | Percent of Errors | Error Rate (percent) |
| Highest Error 25% of Subjects | 51 | 56.8 | 4.3 | 99 | 44.4 | 16.5 | 212 | 39.3 | 15.7 |
| Second Highest Error 25% of Subjects | 30 | 27.5 | 2.5 | 56 | 25.1 | 9.3 | 149 | 27.6 | 11.0 |
| Third Highest Error 25% of Subjects | 20 | 18.4 | 1.7 | 39 | 17.5 | 6.5 | 96 | 17.8 | 7.1 |
| Lowest Error 25% of Subjects | 8 | 7.3 | .7 | 29 | 13.0 | 4.8 | 82 | 15.2 | 6.0 |

differences. Among the weather personnel, total errors for both displays ranged from zero to 18 with a median of 6.5. For GCA subjects, the range was from 14 to 52 with a median of 22, while for pilots the range was from 17 to 55 with a median of 25. Table IV shows that the four weather subjects having the greatest number of errors made more than six times the number of errors made by the four subjects having the fewest errors. For the GCA group the two highest error subjects had almost four times the errors made by the two lowest error subjects, whereas among the pilots (by apportionment) the highest error 25% had about 2 2/3 times the errors of the lowest 25%. Improved selection, training or more frequent retraining would appear to be needed.

2. If the results from this experiment are not atypical, the formating of fractions in weather messages is in urgent need of improvement. Both error frequency and error magnitude are large enough to give cause for genuine alarm. For weather personnel the error rate for fractions was more than double that of their overall error rate; for GCA personnel it was more than 2 1/2 times and for pilots 1 1/2 times the overall error rate. In point of fact, the true ratios of fraction errors to average error for GCA and pilot subjects are even larger than set forth above because the errors on barometric tendency and cloud types should probably be excluded from their average error rates.

Since all questions requiring responses involving fractions were

concerned with visibility, this problem merits a more detailed analysis in terms of error direction, error magnitude, and error distribution among the different groups of subjects because of the criticality of such figures for the safe landing of aircraft.

Table V shows that for the teletype display 32 of 44 errors involving fractions for visibility were reported as greater than the visibility mileage displayed whereas but 11 of 33 errors were so reported for the electroluminescent display. However, the actual mileage reported as greater than that displayed is larger for the electroluminescent than for the teletype.

TABLE V

Visibility Errors Involving Fractions Reported Greater Than, Less Than or Other Than That Displayed

| | Greater | Less | Other | Totals |
|---|---|---|---|---|
| Electro-luminescent | 11 | 15 | 7 | 33 |
| Teletype | 32 | 3 | 9 | $\frac{44}{77}$ |

Although the numerals and symbol constituting the fractions were sequentially shown in both displays (i.e., they occurred in the form of 13/4 for one and three quarters as contrasted with $1\ \frac{3}{4}$), the error pattern for the teletype is highly different from that occurring with the electroluminescent. Of the 44 fraction errors with the teletype, 26 were committed by the selection of the denominator as the correct answer, whereas with the electroluminescent display, this happened only once. With this display the greatest error frequency of 14

involved the selection of the complete fractional part (e. g. 3/4 rather than 1 3/4); the second largest error frequency of 7 involved the selection of the whole number in combination with the numerator of the fraction, a type of error which explains how eleven "greater than" errors for the electroluminescent display can produce greater total mileage error than 32 for the teletype.

TABLE VI

Types of Errors in Reporting Visibility Mileage Involving Fractions

| | Teletype | Electroluminescent |
|---|---|---|
| Denominator Only | 26 | 1 |
| Numerator Only | 2 | 2 |
| Whole Number and Numerator | 1 | 7 |
| Fractional Part of a Whole Number & Fraction | 0 | 14 |
| Other - inc Dk (Don't know) | 15 | 9 |

To say that subtle figure/ground relationships have been operative to produce these differential response patterns in the reporting of fractions is to say nothing more than the obvious. The apparent explanation of this differential error pattern lies in the fact that a number of the fractions straddled the EL face plate across the 18th and 19th matrix positions.. Thus where the slash (/) in the fraction fell in the eighteenth matrix position there would probably be a greater tendency to reply with the whole number and numerator as the visibility mileage. If photographs had been taken of each electroluminescent display a more definitive explanation might be

warranted. It seems safe to say, however, that the multiple functions of the slash (/) in weather messages may be detrimental to accuracy of interpretation.

When the distribution of errors in responding to fractions is examined, it is found that 21% of the subjects making errors commit 71% of the errors, or alternately that 38% of the subjects making errors on fractions make 90% of the errors. Except for the Weather personnel, the concentration of errors among a minor percentage of subjects is greater for fractions than for errors in general as shown in Table IV. This provides additional evidence of the importance of identifying and taking some kind of corrective action where high error personnel are involved; a suggested procedure for accomplishing this purpose is set forth in section III C this report.

3. There remain for discussion those response classifications which exhibit substantially above average error rates as shown in Table VII. Mention has already been made of questions concerning barometric pressure tendency and amount and the ones on cloud types. Those to be discussed are (a) the Alpha classification of Visibility and Remarks, (b) the Alpha/Symbolic combinations, (c) the Numeric Visibility items, and (d) the Alpha/Numeric ones, all of which, with one exception, show above average rates for each of the subject groups.

a. Visibility and Remarks

With the exception of station identification letters, all response items which contained no symbolic or numeric characters, were classified here. There were a total of 20 questions for both displays

and, except for weather personnel, the error rates were high; 25% for GCA and 26.7% for pilots, rates which are almost 3 and 2 times respectively the average error rates for GCA and pilot personnel.

In searching for common elements among the questions one can say that over half the questions specifically asked about "visibility restriction" and most of the remaining involved elements such as precipitation, haze, smoke, and fog which are germane to visibility.

Only three of the twenty questions involved single letters within the weather message, i.e., two for haze (H) and one for rain (R). About two thirds of the items here classified came after the visibility mileage where about one third were found in the "Remarks." There is some evidence that a few questions were not properly understood, a matter which is discussed in more detail in "A Note on Scoring and the Questions" in Appendix B.

b. Alpha/Symbolic Classifications

Comment has already been made on the significant difference between the errors on the two displays for these responses. The pilot error rate for this class of items was double their overall average error rate; for GCA it was 1 1/3 times the average and for weather personnel 1 1/2 times the average. The items of concern here dealt, in the main, with visibility restrictions and variance in sky cover; they were composed of differential letter and symbol components, such as TRW+K and ⊕V⊖, and apparently were not integrated with ease by the subjects. Since "relaxed criteria"

were used in scoring most of the items in this category (see Note in Appendix B) the whole subject is worthy of some attention.

c. Numeric Visibility Items

The errors reflected in this classification are mainly those involved in the reading of fractions and when the errors concerned with reading of fractions are subtracted, the remainder of 11 errors for six questions involving "whole number" visibility mileage is comparatively inconsequential.

d. Alpha/Numeric Combinations

Here again we find quite substantial error rates ranging from almost double the average error rate for weather personnel to almost three times the average error rate for pilots. The remainder of the errors involving fractions are contained in these totals but comprise less than 14% of the total number of errors.

Most of the questions here again are ones dealing with visibility variation and a few on ceiling variation; typical correct responses were F1, D2, 2V2 1/2, 2400 V 2600, and 2 1/4 V.

In summary, it may be said that there exists a general weakness in replying to questions on visibility that is exhibited regardless of whether the information is Alpha only, Alpha/Symbolic, Numeric, or Alpha/Numeric. It is to be noted that this information may appear in various parts of the weather message rather than in a fixed position. With few exceptions multiple characters were involved with high error rates.

TABLE VII

FREQUENCY TOTALS & PER CENT NOT CORRECT FOR BOTH DISPLAYS

| | FREQUENCIES | | | ERROR RATE IN PER CENT | | |
|---|---|---|---|---|---|---|
| | Wx N= 16 | GCA N= 8 | Pilots N= 18 | Wx | GCA | Pilots |
| ALPHA | | | | | | |
| Station Identification (50) | 13 | 16 | 3 | 1.6 | 4.0 | 0.3 |
| Visby & Remarks (20) | 7 | 40 | 95 | 2.2 | 25.0 | 26.7 |
| SYMBOLIC | | | | | | |
| *Sky: a (11) | 2 | 4 | 8 | 1.1 | 4.5 | 4.0 |
| : b (46) | 8 | 7 | 23 | 1.1 | 1.9 | 2.8 |
| : c (34) | 21 | 33 | 64 | 3.9 | 7.7 | 10.5 |
| Wind Directions (15) | 3 | 0 | 19 | 1.3 | 0.0 | 7.0 |
| Alpha/ Symbolic (10) | 6 | 10 | 36 | 3.8 | 12.5 | 20.0 |
| NUMERIC | | | | | | |
| Height of ceiling or cloud cover (10) | 4 | 4 | 7 | 2.5 | 5.0 | 3.9 |
| Temperature (14) | 0 | 1 | 2 | 0.0 | .9 | .8 |
| Dewpoint (14) | 3 | 1 | 5 | 1.3 | .9 | 2.0 |
| Wind Speed (16) | 6 | 2 | 6 | 2.3 | 1.6 | 2.1 |
| Baro-Altimeter (17) | 2 | 2 | 3 | .7 | 1.5 | 1.0 |
| Baro or Pressure tendency and amt. (4) | 10 | 29 | 72 | 15.6 | 90.6 | 100.0 |
| Visby (15) | 9 | 22 | 35 | 3.8 | 18.3 | 13.0 |
| Cloud types (3) | 2 | 21 | 54 | 4.2 | 87.5 | 100.0 |
| Alpha/ Numeric (21) | 13 | 31 | 107 | 3.9 | 18.5 | 28.3 |
| (300) | 109 | 223 | 539 | 2.3 | 9.3 | 10.0 |
| *Fractions (14)* | *11* | *27* | *39* | *4.9* | *24.1* | *15.5* |

*For an explanation of Sky a, b, and c refer to note in Appendix B.

C. Implications for Military Information Processing

The institution of such programs as "Zero Defects" would augur for the importance of facing up to the difficult question of what constitutes acceptable, or perhaps more appropriately, tolerable error in the processing of military information. Because of the small number of significant differences between the two displays, the liberty of summing the error frequencies and of showing the overall error rates has been taken in Table VII.

It should be borne in mind that subjects could look at the weather messages displayed while they were responding to the questions. It also should be borne in mind that weather airmen constitute a highly select group of airmen in general.*

The data represented in Table VII are based upon 300 possible responses per individual subject. From the point of view of weather information processing the specific error rate data should be considered only as indicative rather than definitive for two reasons: (a) there were purposely a preponderant number of questions on sky cover in order to test the altered electro-luminescent symbology and hence there was not a balanced query of subjects concerning the various elements which constitute weather messages and (b) it is not known how representative the relatively small number of individual subjects in each group are of the populations from which they came.

It should be pointed out, though, that the weather message with its variety of manipulable Alpha, Symbolic, and Numeric

*See AFM 50-5, Change C, Oct 65, Section V, Page 5-20-3, Para ABR 25231 (AFM means Air Force Manual)

data might well be used in a factorially designed experiment to produce some definitive conclusions on the subject of military information processing. Such an experiment should contain provisions to insure high motivation.

From this experiment, however, several things are quite clear:

1. The data definitely are indicative that certain individuals may be error prone. The preponderance of errors by a minority of the subjects as shown in Table IV as well as a correlation of .75 within subjects on errors made between the two displays are strong testimony. However, before the error prone concept can be considered as valid, it should be demonstrated that after a certain point in the training and/or experience of such subjects that no significant improvement can be effected in their performance through added training or experience.

2. For the processing of weather information, the employment of personnel of <u>known</u> proficiency or ability could be a relatively simple matter. It is suggested that a standard set of weather messages of increasing difficulty and complexity be developed. These weather messages could be administered in standardized fashion to weather personnel (and to GCA, navigator and pilot personnel if desired) in both sufficient and representative numbers to secure normative data on time and errors for the various groups. With such information at hand the relative proficiency of a given individual or individuals could easily be determined whenever desired.

3. A logical extension of the proposal above leads to the question - among the spectrum of military information systems, how many lend themselves to such relatively simple procedures for insuring that they can be manned with personnel of known proficiency?

APPENDIX A

Weather Messages Displayed by Teletype

Weather Messages Displayed by Electroluminescence

Response Sheets with Questions

Photographs of Alpha, Numeric, and Symbolic Characters Used on the Electroluminescent Display (Courtesy Sylvania Electric Products, Inc.)

Instructions to Subjects

* The typewriter used to prepare both groups of weather messages for this report had no slash on the zero; however both the teletype and electroluminescent messages as actually displayed to the subject did have a slash across the zero.

TELETYPE DISPLAYED WEATHER MESSAGES

1. BED O7 73/68C/986
2. FOK O5HK 71/69→↘6/986
3. CAR 80O6HK 68/66→↘8/984
4. POU 45OM75O9 68/59→ 14/983/OVO
5. MGW -XM30O70O2BD 69/65→ 15+30/978/D3 VSBY E7
6. AKR M25O85O120O10 75/69→↘10/978/VIRGA NW-N
7. RAN M30O90O150O200O10 69/65↘ 6/986/CB OVHD FQT LTGIC N
8. HAR M25O90O150O250O2TRW 73/68→ 10+20/985/T OVHD MOVG E AB35E55
9. PSM M25O80O200O11/4TRW+ 73/71↘ 10+30/985/T NE OCNL LTGICCCCG N-E
10. PLN -X20O50OM150O13/4VRF 40/28→ 3/998/F1 VSBY 11/2V2 OCNL SW --
11. YIP M45O/O10TORNADOW RW -70/69→↘30/982/UNCONFIRMED TORNADO 5W BED 1600 E
12. MRB M35O/O9WATERSPOUT S 69/M→ 10+25/985/WATERSPOUT S B25 RW-OVR RDGE
13. COF O10 73/70→ 4/985
14. BUF 90O10 70/69→ 5/986
15. MPV M80O5BD 67/65↑ 11/987
16. BHL M40O70O6BD 69/67↘ 15+20/982
17. SAW -XM40O70O2FK 66/65→ 14/995/F1 VSBY NE 7
18. BLX 30OM75O120O6HK 75/74↗ 4/988/CB NW MOVG NE
19. HVN 30OM85O150O250O7RW 69/68→ 10+20/985/CB OVHD FQT LTGIC NW-NE
20. GRL M25O90O150O13/4TRW+K 73/70→ 10+20/998/T W MOVG E FQT LTGCC N
21. AYE M29VO90-O200O11/4BD 75/45↗ 30/986/CIG 28V30 DUST DEVILS NW
22. LEX -XM25VO150O/O1/2RF 125/33/31↘ 4/986/F1 CIG 23V27/11500 1727 22
23. TYS -XM25VO150O/O11/4SFH 35/34→ 9/988/FIGIG 23V27 S OCNLY S- WET SNW
24. BGM 30O50-OM150O5H 28/27→ 5/986/CONTRAILS SNW SHWRS S PATCH GF W
25. SWF 35-O70-O150-O/-O5H 60/59→ 10+15/998/K DRFTG OVR RNWY 11 K LYR S-N

ELECTROLUMINESCENT DISPLAYED WEATHER MESSAGES

1. QB O8 74/69 C/985
2. ACK O6HD 70/45↓ 6/986
3. HUL 85O5BD 67/66↗ 10/984
4. INR 40OM60O8 70/65→↘ 15/984/OVO
5. NEL -XM35O75O1BD 65/60→ 12+40/984/D2 VSBY W8
6. MSS 25OM85O100O12 69/54→ 9/986/ VIRGA N-NE
7. ZZV 25OM80O100O250O12 71/70↘ 6/983/CB OVHD FQT LTGCC W
8. AOO M35O90O200O11/4TRW+ 74/69↗ 10+25/986/T N-NE MOVG E AB10E50
9. PWM M30O90O200O13/4TRW- 74/70↗ 15+25/987/T N-E OCNL LTGICCC NE-E
10. APN -X30OM50O150O21/4VFK 38/26↘ 2/989/F1 VSBY 2V21/2 INTMT R-
11. HAT M45O8FUNNEL CLOUD NNW71/68↘ 20+35/981/FUNNEL CLOUD NNW MOVG NEWD B34
12. LEB 5O25O50O70-OA90O2FH 70/MC /983/HIR CLDS VSBL SFC VSBY 9/115 1487
13. CEF O6H 72/69→ 5/986
14. PHL 85O10 69/651 6/985
15. HAT M75O6HK 67/66↗ 12/983
16. ART M35O70O5HK 68/65↓ 12+15/985
17. DET -XM30O80O5BD 54/51→ 20/987/D1 VIRGA NW
18. BDR 20OM80O120O5KH 70/68↗ 5/985/CB SW MOVG NE
19. CLE 25OM60O100O250O6SW 40/35↘ 10+15/992/CB N MOVG E FQT LTGCC N
20. SGV M30O90O150O11/2TRW-K 75/70↘ 10+23/986/T N MOVG E FQT LTGIC E
21. JXN M25VO80-O250-O21/2H 76/65→ 10/999/CIG 24V26 VSBY NE13/4SE1
22. QR -X2OM30O90O/O1/2VF 225/34/30↗ 10/987/F1 VSBY OV1/12001 1577 22
23. BKL -XM25O150O11/2VR 233/33/30↘ 9/996/F1 CONTRAILS VSBY 1V2/113 1780
24. BAL -XM30O50-O/O4F 32/29→ 2/985/F3 INTMT ZR- OCNL S- PATCH GF NW
25. BAF 40-O80-OM150O250O7 59/40→ 4/995/VIRGA NW GF BANK N WND DRCTN VRBL

TT Display

DISPLAY #1

1. What are the station identification letters? 1. _____
2. What is the sky cover? 2. _____
3. What is the temperature? 3. _____
4. What is the dewpoint? 4. _____
5. What is the altimeter setting? 5. _____
6. What is the visibility? 6. _____

DISPLAY #2

1. What are the station identification letters? 1. _____
2. What is the sky cover? 2. _____
3. What is the temperature? 3. _____
4. What is the dewpoint? 4. _____
5. What is the wind direction? 5. _____
6. What is the wind speed? 6. _____

DISPLAY #3

1. What are the station identification letters? 1. _____
2. What sky cover is reported at 8000'? 2. _____
3. What is the visibility restriction? 3. _____
4. What is the wind direction? 4. _____
5. What is the wind speed? 5. _____
6. What is the altimeter setting? 6. _____

DISPLAY #4

1. What are the station identification letters? 1. _____
2. Give the sky cover for the 1st layer of clouds? 2. _____
3. Give the height of the ceiling? 3. _____
4. Give the sky cover for the 2nd layer of clouds? 4. _____
5. What is the altimeter setting? 5. _____
6. How is the sky cover varying? 6. _____

DISPLAY #5

1. What are the station identification letters? 1. _____
2. What sky cover is reported at 3000'? 2. _____
3. What sky cover is reported at 7000'? 3. _____
4. What is the dewpoint? 4. _____
5. What is causing the partial obscuration? 5. _____
6. What are the remarks concerning visibility? 6. _____

DISPLAY #6

1. What are the station identification letters? 1. _____
2. What is the sky cover of the 1st layer of clouds? 2. _____
3. What is the sky cover of the 2nd layer of clouds? 3. _____
4. What is the sky cover of the 3rd layer of clouds? 4. _____
5. What is the wind direction? 5. _____
6. What is the wind speed? 6. _____

DISPLAY #7

1. What are t he station identification letters? 1. _____
2. What is the sky cover at 9000'? 2. _____
3. What is the height of the 1st broken layer of clouds? 3. _____
4. What is the sky cover at 15,000'? 4. _____
5. What is the sky cover at 20,000'? 5. _____
6. What is the altimeter setting? 6. _____

DISPLAY #8

1. What are the station identification letters? 1. _____
2. What is the sky cover at 2500'? 2. _____
3. What is the sky cover at 9000'? 3. _____
4. What is the sky cover at 15,000'? 4. _____
5. What is the visibility? 5. _____
6. What is the restriction to visibility? 6. _____

DISPLAY #9

1. What are the station identification letters? 1. _____
2. What is the sky cover of the 1st layer of clouds? 2. _____
3. What is the sky cover reported at 8000'? 3. _____
4. What is the sky cover at 20,000'? 4. _____
5. What is the visibility? 5. _____
6. What is the restriction to visibility? 6. _____

DISPLAY #10

1. What are the station identification letters? 1. _____
2. What is the visibility? 2. _____
3. What is the restriction to visibility? 3. _____
4. What is the dewpoint? 4. _____
5. What is causing the partial obscuration? 5. _____
6. How variable is the visibility? 6. _____

DISPLAY #11

1. What are the station identification letters? 1. _____
2. What is the sky cover at the 1st layer of clouds? 2. _____
3. What is the wind direction? 3. _____
4. What is the wind speed? 4. _____
5. What is the temperature? 5. _____
6. What is the dewpoint? 6. _____

DISPLAY #12

1. What are the station identification letters? 1. _____
2. What is the sky cover at 3500'? 2. _____
3. What is the sky cover of the top layer? 3. _____
4. What is the wind speed? 4. _____
5. What is the altimeter setting? 5. _____
6. Are there rainshowers near the station? 6. _____

DISPLAY #13

1. What are the station identification letters? 1. _____
2. What is the sky cover? 2. _____
3. What is the wind direction? 3. _____
4. What is the wind speed? 4. _____
5. What is the altimeter setting? 5. _____
6. What is the temperature? 6. _____

DISPLAY #14

1. What are the station identification letters? 1. _____
2. What is the height of the 1st layer of clouds? 2. _____
3. What is the sky cover? 3. _____
4. What is the temperature? 4. _____
5. What is the dewpoint? 5. _____
6. What is the altimeter setting? 6. _____

DISPLAY #15

1. What are the station identification letters? 1. _____
2. What is the height of the 1st sky cover? 2. _____
3. What is the sky cover? 3. _____
4. What is the temperature? 4. _____
5. What is the dewpoint? 5. _____
6. What is the altimeter setting? 6. _____

DISPLAY #16

1. What are the station identification letters? 1. _____
2. What is the sky cover at 4000'? 2. _____
3. What is the sky cover at 7000'? 3. _____
4. What is the wind direction? 4. _____
5. What is the wind speed? 5. _____
6. What is the restriction to visibility? 6. _____

DISPLAY #17

1. What are the station identification letters? 1. _____
2. What is the sky cover at 4000'? 2. _____
3. What is the sky cover at 7000'? 3. _____
4. What is the visibility? 4. _____
5. What is the present weather? 5. _____
6. What is causing the partial obscuration? 6. _____

DISPLAY #18

1. What are the station identification letters? 1. _____
2. At what height is the 1st layer of clouds reported? 2. _____
3. What is the sky cover of the 1st layer of clouds? 3. _____
4. What sky cover is reported at 7500'? 4. _____
5. What sky cover is reported at 12,000'? 5. _____
6. What is the temperature? 6. _____

DISPLAY #19

1. What are the station identification letters? 1. _____
2. What is the sky cover of the first layer of clouds? 2. _____
3. What is the sky cover of the 2nd layer of clouds? 3. _____
4. What is the sky cover of the 3rd layer of clouds? 4. _____
5. What is the sky cover for the 4th layer of clouds? 5. _____
6. What is the visibility? 6. _____

DISPLAY #20

1. What are the station identification letters? 1. _____
2. What is the sky cover for the first layer of clouds? 2. _____
3. What is the sky cover for the 2nd layer of clouds? 3. _____
4. What is the sky cover for the 3rd layer of clouds? 4. _____
5. What are the restrictions to visibility? 5. _____
6. What is the visibility? 6. _____

DISPLAY #21

1. What are the station identification letters? 1. _____
2. What is the sky cover at 2900'? 2. _____
3. What is the sky cover at 9000'? 3. _____
4. What is the sky cover at 20,000'? 4. _____
5. Does the ceiling vary and if so, between what altitudes? 5. _____
6. What is the obstruction to visibility in the N.W. quadrant? 6. _____

DISPLAY #22

1. What are the station identification letters? 1. _____
2. What is the sky cover of the top layer of clouds? 2. _____
3. What is the barometric tendency and amount? 3. _____
4. How is the ceiling varying? 4. _____
5. What are the cloud types? 5. _____
6. What is the visibility? 6. _____

DISPLAY #23

1. What are the station identification letters? 1. _____
2. What is the sky cover at 15,000'? 2. _____
3. What is the visibility? 3. _____
4. What is the restriction to visibility? 4. _____
5. How does the ceiling vary? 5. _____
6. What are the remarks concerning precipitation? 6. _____

DISPLAY #24

1. What are the station identification letters? 1. _____
2. What is the sky cover of the top layer of clouds? 2. _____
3. What is the wind direction? 3. _____
4. What is the wind speed? 4. _____
5. What are the remarks concerning precipitation? 5. _____
6. What is the altimeter setting? 6. _____

DISPLAY #25

1. What are the station identification letters? 1. _____
2. What is the sky cover at 15,000'? 2. _____
3. What is the wind speed? 3. _____
4. What is the local obstruction to vision? 4. _____
5. What is the wind direction? 5. _____
6. What are the quadrants of the smoke layer? 6. _____

EL DISPLAY

DISPLAY #1

1. What are the station identification letters? 1. _____
2. What is the sky cover? 2. _____
3. What is the temperature? 3. _____
4. What is the dewpoint? 4. _____
5. What is the altimeter setting? 5. _____
6. What is the visibility? 6. _____

DISPLAY #2

1. What are the station identification letters? 1. _____
2. What is the sky cover? 2. _____
3. What is the temperature? 3. _____
4. What is the dewpoint? 4. _____
5. What is the wind direction? 5. _____
6. What is the wind speed? 6. _____

DISPLAY #3

1. What are the station identification letters? 1. _____
2. What sky cover is reported at 8500'? 2. _____
3. What is the visibility restriction? 3. _____
4. What is the wind direction? 4. _____
5. What is the wind speed? 5. _____
6. What is the altimeter setting? 6. _____

DISPLAY #4

1. What are the station identification letters? 1. _____
2. Give the sky cover of the 1st layer of clouds? 2. _____
3. Give the height of the ceiling? 3. _____
4. Give the sky cover for the 2nd layer of clouds? 4. _____
5. What is the altimeter setting? 5. _____
6. How is the sky cover varying? 6. _____

DISPLAY #5

1. What are the station identification letters? 1. _____
2. What sky cover is reported at 3500'? 2. _____
3. What sky cover is reported at 7500'? 3. _____
4. What is the dewpoint temperature? 4. _____
5. What is causing the partial obscuration? 5. _____
6. What are the remarks concerning visibility? 6. _____

DISPLAY #6

1. What are the station identification letters? 1. _____
2. What is the sky cover of the 1st layer of clouds? 2. _____
3. What is the sky cover of the 2nd layer of clouds? 3. _____
4. What is the sky cover of the 3rd layer of clouds? 4. _____
5. What is the wind direction? 5. _____
6. What is the wind speed? 6. _____

DISPLAY #7

1. What are the station identification letters? 1. _____
2. What is the sky cover at 2500'? 2. _____
3. What is the height of the 1st broken layer of clouds? 3. _____
4. What is the sky cover at 10,000'? 4. _____
5. What is the sky cover at 25,000'? 5. _____
6. What is the altimeter setting? 6. _____

DISPLAY #8

1. What are the station identification letters? 1. _____
2. What is the sky cover at 3500'? 2. _____
3. What is the sky cover at 9000'? 3. _____
4. What is the sky cover at 20,000'? 4. _____
5. What is the visibility? 5. _____
6. What is the restriction to visibility? 6. _____

DISPLAY #9

1. What are the station identification letters? 1. _____
2. What is the sky cover of the 1st layer of clouds? 2. _____
3. What is the sky cover reported at 9000'? 3. _____
4. What is the sky cover at 20,000'? 4. _____
5. What is the visibility? 5. _____
6. What is the restriction to visibility? 6. _____

DISPLAY #10

1. What are the station identification letters? 1. _____
2. What is the visibility? 2. _____
3. What is the restriction to visibility? 3. _____
4. What is the dewpoint? 4. _____
5. What is causing the partial obscuration? 5. _____
6. How variable is the visibility? 6. _____

DISPLAY #11

1. What are the station identification letters? 1. _____
2. What is the sky cover? 2. _____
3. What is the wind direction? 3. _____
4. What is the wind speed? 4. _____
5. What is the temperature? 5. _____
6. What is the dewpoint? 6. _____

DISPLAY #12

1. What are the station identification letters? 1. _____
2. What is the sky cover at 500'? 2. _____
3. What is the sky cover at 2500'? 3. _____
4. What is the sky cover at 5000'? 4. _____
5. What is the barometric tendency and pressure change? 5. _____
6. What are the cloud types reported? 6. _____

DISPLAY #13

1. What are the station identification letters? 1. _____
2. What is the sky cover? 2. _____
3. What is the wind direction? 3. _____
4. What is the wind speed? 4. _____
5. What is the restriction to visibility? 5. _____
6. What is the temperature? 6. _____

DISPLAY #14

1. What are the station identification letters? 1. _____
2. What is the height of the 1st layer of clouds? 2. _____
3. What is the sky cover? 3. _____
4. What is the temperature? 4. _____
5. What is the dewpoint? 5. _____
6. What is the altimeter setting? 6. _____

DISPLAY #15

1. What are the station identification letters? 1. _____
2. At what altitude is the first sky cover found at? 2. _____
3. What is the sky cover? 3. _____
4. What is the temperature? 4. _____
5. What is the dewpoint? 5. _____
6. What is the altimeter setting? 6. _____

DISPLAY #16

1. What are the station identification letters? 1. _____
2. What is the sky cover at 3500'? 2. _____
3. What is the sky cover at 7000'? 3. _____
4. What is the wind direction? 4. _____
5. What is the wind speed? 5. _____
6. What is the restriction to visibility? 6. _____

DISPLAY #17

1. What are the station identification letters? 1. _____
2. What is the sky cover at 3000'? 2. _____
3. What is the sky cover at 8000'? 3. _____
4. What is the visibility? 4. _____
5. What is the present weather? 5. _____
6. What is causing the partial obscuration? 6. _____

DISPLAY #18

1. What are the station identification letters? 1. _____
2. At what height is the 1st layer of clouds reported? 2. _____
3. What is the sky cover of the 1st layer of clouds? 3. _____
4. What sky cover is reported at 8000'? 4. _____
5. What sky cover is reported at 12,000'? 5. _____
6. What is the temperature? 6. _____

DISPLAY #19

1. What are the station identification letters? 1. _____
2. What is the sky cover of the 1st layer of clouds? 2. _____
3. What is the sky cover of the 2nd layer of clouds? 3. _____
4. What is the sky cover of the 3rd layer of clouds? 4. _____
5. What is the sky cover of the 4th layer of clouds? 5. _____
6. What is the visibility? 6. _____

DISPLAY #20

1. What are the station identification letters? 1. _____
2. What is the sky cover for the 1st layer of clouds? 2. _____
3. What is the sky cover for the 2nd layer of clouds? 3. _____
4. What is the sky cover for the 3rd layer of clouds? 4. _____
5. What are the restrictions to visibility? 5. _____
6. What is the visibility? 6. _____

DISPLAY #21

1. What are the station identification letters? 1. _____
2. What is the sky cover at 2500'? 2. _____
3. What is the sky cover at 8000'? 3. _____
4. What is the sky cover at 25,000'? 4. _____
5. Does the ceiling vary and if so, between what altitudes? 5. _____
6. What is the prevailing visibility in the NE quadrant? 6. _____

DISPLAY #22

1. What are the station identification letters? 1. _____
2. What is the sky cover of the top layer of clouds? 2. _____
3. What is the barometric tendency and amount? 3. _____
4. How is the visibility varying? 4. _____
5. What are the cloud types? 5. _____
6. What is the visibility? 6. _____

DISPLAY #23

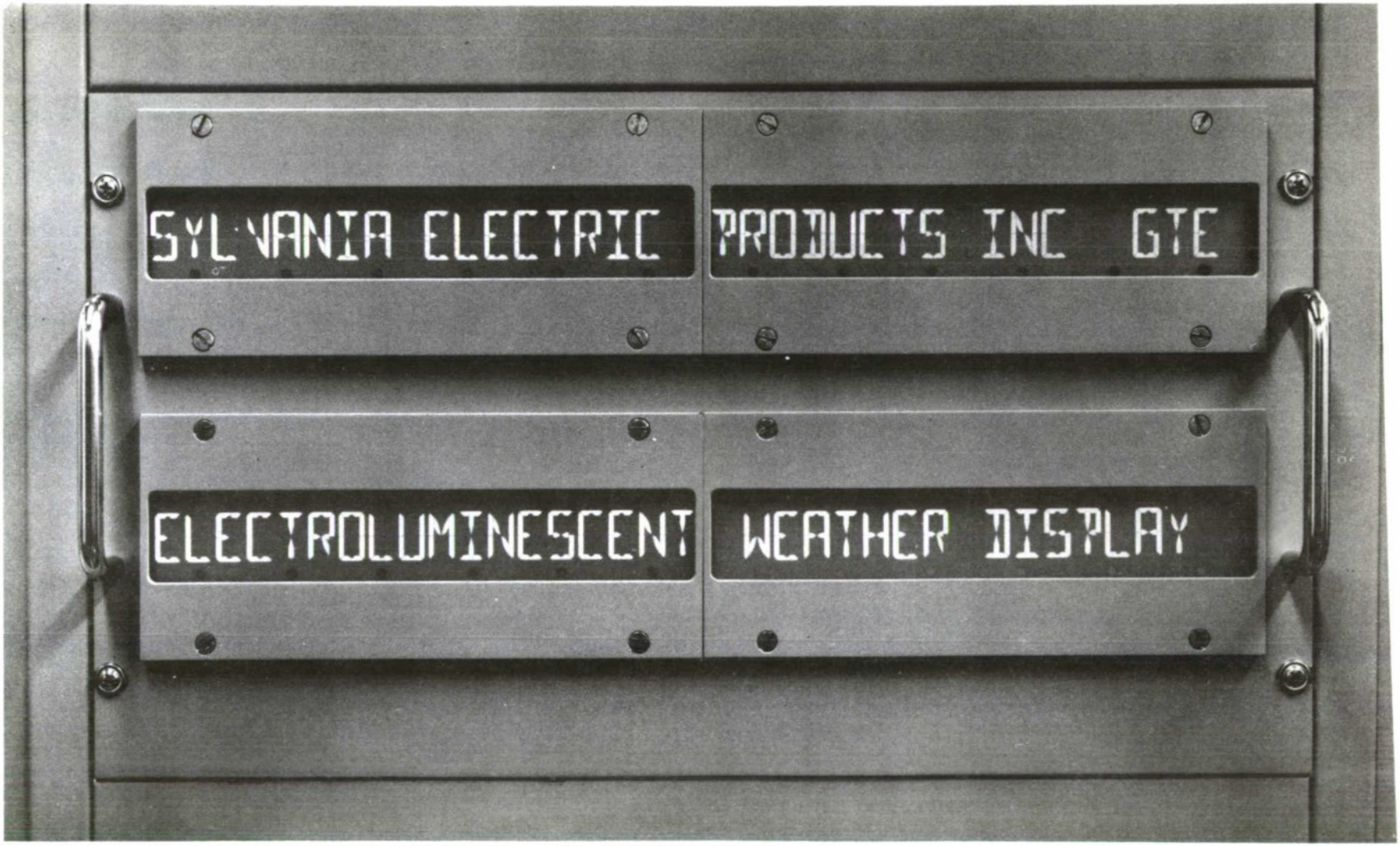
1. What are the station identification letters? 1. _____
2. What is the sky cover at 15,000'? 2. _____
3. What is the visibility? 3. _____
4. What is the restriction to visibility? 4. _____
5. What are the remarks concerning visibility? 5. _____
6. What is the pressure tendency and amount change? 6. _____

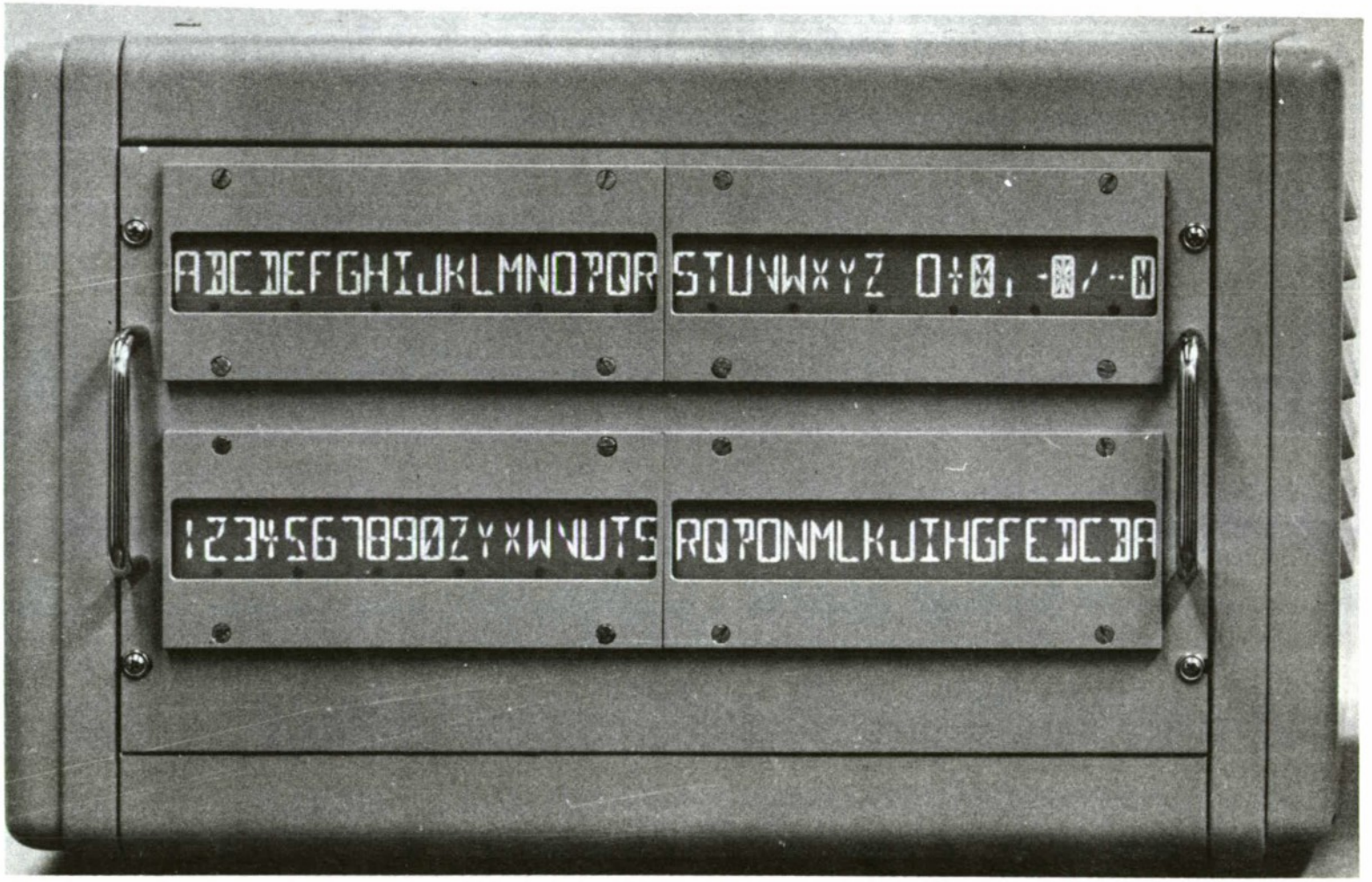
DISPLAY #24

1. What are the station identification letters? 1. _____
2. What is the sky cover of the top layer of clouds? 2. _____
3. What is the wind direction? 3. _____
4. What is the wind speed? 4. _____
5. What is causing the partial obscuration? 5. _____
6. What is the altimeter setting? 6. _____

DISPLAY #25

1. What are the station identification letters? 1. _____
2. What is the sky cover at 25,000'? 2. _____
3. What is the remarks concerning precipitation? 3. _____
4. What are the remarks concerning fog? 4. _____
5. What are the remarks concerning the wind direction? 5. _____
6. What is the altimeter setting? 6. _____


SYLVANIA ELECTRIC
PRODUCTS INC GTE
ELECTROLUMINESCENT
WEATHER DISPLAY


ABCDEFGHIJKLMNOPQR
STUVWXYZ 0123456789
1234567890ZYXWVUTS
RQPONMLKJIHGFEDCBA

Instructions to Subjects

We appreciate your coming up to help us very much. This exercise involves reading 25 weather messages on teletype and 25 on this electroluminescent display and recording your answers to questions for each message.

We would like you to read these as you would any normal weather message in a situation where the information is needed by you. There are six questions for each message.

You are to start each message by throwing the switch toward the ON position. As soon as you have read the message and recorded your answers, you are to throw the switch back to its original position. The red light is a signal to you that you can start when you're ready. Only throw the switch when the red light is on.

You should read the questions pertaining to each display first. Also, (for the electroluminescent) you should consider that the message is a single straight line.

Do you have any questions?

APPENDIX B

Response Times in Minutes and Errors by Subjects and Display Type

Errors on Electroluminescent in Station Identification

Errors on Teletype in Station Identification

Remarks Summary

Note on Scoring and the Questions

Appendix B

Response Times in Minutes and Errors by Subjects and Display Type

| Subject # / Weather | Time | | Errors | |
|---|---|---|---|---|
| | TT | EL | TT | EL |
| 1 | 10.2 | 16.8 | 4 | 14 |
| 2 | 10.6 | 12.1 | 1 | 3 |
| 3 | 8.8 | 10.2 | 2 | 5 |
| 4 | 7.8 | 9.2 | 3 | 5 |
| 5 | 10.2 | 9.8 | 3 | 0 |
| 6 | 10.7 | 10.7 | 3 | 3 |
| 7 | 11.0 | 12.6 | 14 | 2 |
| 8 | 12.4 | 11.4 | 1 | 3 |
| 9 | 7.5 | 10.1 | 0 | 0 |
| 10 | 9.7 | 14.1 | 3 | 5 |
| 11 | 12.2 | 11.3 | 4 | 5 |
| 12 | 12.8 | 15.3 | 0 | 1 |
| 13 | 10.0 | 10.5 | 0 | 5 |
| 14 | 11.6 | 10.9 | 4 | 3 |
| 39 | 8.7 | 11.4 | 2 | 6 |
| 41 | 11.7 | 10.8 | 2 | 3 |
| GCA | | | | |
| 15 | 14.5 | 19.3 | 6 | 17 |
| 16 | 11.4 | 16.3 | 3 | 12 |
| 17 | 23.5 | 15.9 | 7 | 7 |
| 18 | 19.7 | 14.5 | 20 | 27 |
| 19 | 16.0 | 18.2 | 21 | 31 |
| 20 | 21.6 | 15.5 | 13 | 8 |
| 21 | 15.2 | 13.9 | 8 | 10 |
| 22 | 32.9 | 41.3 | 11 | 22 |

| Pilots | Time | | Errors | |
|---|---|---|---|---|
| | TT | EL | TT | EL |
| 23 | 20.8 | 15.4 | 19 | 23 |
| 24 | 16.3 | 27.1 | 20 | 22 |
| 25 | 15.4 | 23.0 | 9 | 11 |
| 26 | 16.9 | 12.6 | 11 | 9 |
| 27 | 15.4 | 15.3 | 10 | 15 |
| 28 | 17.9 | 30.9 | 9 | 16 |
| 29 | 16.1 | 15.1 | 8 | 10 |
| 30 | 15.8 | 22.3 | 9 | 10 |
| 31 | 13.7 | 21.1 | 9 | 16 |
| 32 | 20.3 | 23.7 | 10 | 10 |
| 33 | 13.9 | 14.0 | 11 | 10 |
| 34 | 15.3 | 18.9 | 8 | 9 |
| 35 | 23.8 | 21.3 | 9 | 9 |
| 36 | 15.3 | 27.8 | 11 | 25 |
| 37 | 20.6 | 15.2 | 27 | 19 |
| 38 | 13.7 | 17.4 | 28 | 20 |
| 40 | 16.4 | 14.3 | 34 | 21 |
| 42 | 21.1 | 16.6 | 23 | 19 |

## Appendix B

### Errors on Electroluminescent in Station Identification

| Station Identification Presented | Erroneous Responses | | |
|---|---|---|---|
| | Weathermen | GCA | Pilots |
| AOO | | ADO | ROD |
| ART | | | AKT |
| BAF | | DAF (2) | |
| BAL | | DAL (2) | |
| BDR | | DDR | |
| BKL | | DKL (2) | |
| CLE | | CIE | |
| HAT | HRT (2) | | |
| LEB | LED (2) | | |
| PWM | AWM | | |
| QB | QD | OB (2)<br>QD (2)<br>Dk | Dk |
| SGV | | EGV<br>SGN | |

| | | | |
|---|---|---|---|
| A for P | 1 | K for R | 1 |
| D for B | 12 | N for V | 1 |
| D for O | 2 | O for Q | 2 |
| E for S | 1 | R for A | 2 |
| I for L | 1 | Dk for QB | 2 |

## Appendix B

### Errors on Teletype in Station Identification

| Station Identification Presented | Weathermen | GCA | Pilots |
|---|---|---|---|
| AKR | HKR | | |
| BGM | BGN | | |
| BLX | BLK<br>BIX | | |
| FOK | FOR | | |
| MGW | MCW | | |
| RAN | RAW | | |

| | |
|---|---|
| C for G | 1 |
| H for A | 1 |
| I for L | 1 |
| K for X | 1 |
| N for M | 1 |
| R for K | 1 |
| W for N | 1 |

Appendix B

| Remarks Summary | Frequency |
|---|---|
| Cloud symbols confusing | 2 |
| V confusing | 6 |
| Division of display into two lines distracting | 4 |
| Wind arrows too small | 4 |
| Z and 2 confusing - should add horizontal bar thru center of Z | 3 |
| 8 difficult to recognize | 2 |
| S and 5 confused | 4 |
| B and D confused | 1 |
| 1 difficult to recognize | 1 |
| Clear and zero gave trouble | 3 |
| Spacing too close - especially on cloud symbols | 2 |
| Diagonal marks confusing | 2 |
| No trouble anticipated after practice | 5 |
| Wind arrow positions should be changed so for example, North wind is shown as follows  | 1 |

## Appendix B

### Note on Scoring and the Questions

(1) The error scoring set forth in this report reflects the not-correct responses; thus included, are responses scored as erroneous, responses of "Don't know" and omitted responses, the last named having also been reported as "Dk".

It should be pointed out that this report does not contain maximumly obtainable error rates because subjects were not specifically instructed to make their responses as specific as possible in terms of the information contained in the weather messages presented. For example, Question 3.3 for the electroluminescent asks "What is the visibility restriction" with the most complete answer being "blowing dust;" if the subject responded "dust" it was not scored as an error. Similarly, for Questions 5.5 on both displays, "What is causing the partial obscuration;" depending upon the display the most specific answers were "dust 2/10ths or 3/10ths;" however, if the subject merely responded "dust" it was not scored as erroneous. Again, question 8.6 on the electroluminescent, calls for the response "Thunder, heavy rain showers and smoke (TRW+ K);" if the subject responded with three of the four underscored elements, the response was not scored as erroneous.

It should be apparent that if a response criterion of specificity equivalent to that of the message is required something very close to 100% objectivity in scoring may be achieved. In the present study about 90% of the questions were scored on a strictly objective

basis, whereas in about 10%, specific scoring criteria had to be determined for each question.

(2) Almost 50 years ago Muscio, in the British Journal of Psychology (1916) called attention to the influence of the form of the question upon the response. Since the initial purpose of this experiment was comparative and the same types of questions were being used for both displays, the only pre-testing of questions and procedures conducted was with knowledgeable weather personnel. What Muscio was talking about is particularly evident in the error rates for the questions on sky cover which involved symbolic displays. Three different kinds of questions were addressed to the subjects (a) What is the sky cover? (b) What is the sky cover at _____ft. ? and (c) What is the sky cover of the (1st, 2nd, 3rd or 4th) layer of clouds? Table VII shows that the last form of the question contributed substantially higher error rates than the first two forms of the questions. Question 17.5 for both displays asked "What is the present weather?" The requisite responses for the teletype and electroluminescent were "blowing dust" (BD), and fog and smoke (FK) respectively. When questions requiring identical responses (Teletype 3.3 and 10.3) were asked the error rates were much less, particularly for GCA and pilot personnel. If a factorial experiment is to be designed to conduct some basic research with weather information processing, there should be rigorous pre-testing of the questions employed.

## Appendix C

### Detailed Erroneous Responses by Display Type and Subject Group

Parentheses have been used in two ways in the following pages: (1) to bracket responses which had to be typed on more than one line, and (2) to encase numerals which specify incorrect response frequencies in the last three columns.

## TELETYPE WEATHER MESSAGES

| QUESTION | # OF ERRORS | CORRECT RESPONSES | INCORRECT RESPONSES | | |
|---|---|---|---|---|---|
| | | | Wx | GCA | PILOTS |
| 1.2 | 1 | clear | | | overcast |
| 1.4 | 1 | 68 | | | 76 |
| 1.5 | 1 | 2986 | | 2886 | |
| 1.6 | 2 | 7 mi. | | | unlimited<br>C |
| 2.1 | 1 | FOK | FOR | | |
| 2.2 | 2 | clear | | | 500<br>overcast |
| 2.3 | 1 | 71° | | | Dk |
| 2.4 | 1 | 69° | | | 71 |
| 2.5 | 2 | WNW | | | ESE (2) |
| 3.2 | 2 | scattered | | | broken (2) |
| 3.3 | 2 | haze and smoke | 6 | | hale |
| 3.4 | 2 | WNW | | | ESE (2) |
| 4.2 | 6 | scattered | 45 (2) | | 4500 (3)<br>45 |
| 4.3 | 2 | 7500 | | | 4500<br>no ceiling |
| 4.4 | 2 | broken | | | 7500 (2) |
| 4.6 | 3 | (broken variable to scattered) | | | decreasing (variable scattered)<br>(overcast variable to scattered) |

## TELETYPE WEATHER MESSAGES

| QUESTION | # OF ERRORS | CORRECT RESPONSES | INCORRECT RESPONSES | | |
|---|---|---|---|---|---|
| | | | Wx | GCA | PILOTS |
| 5.1 | 1 | MGW | MCW | | |
| 5.2 | 2 | broken | | Dk | obscured |
| 5.3 | 1 | overcast | | Dk | |
| 5.4 | 3 | 65 | 69 (2) | | 69 |
| 5.5 | 4 | dust 3/10 | | Dk | smoke<br>Dk (2) |
| 5.6 | 5 | (East quad. 7 miles) | | estimated 7 | estimated 7<br>est 7 (2)<br>Vis est 7 |
| 6.1 | 1 | AKR | HKR | | |
| 6.2 | 3 | broken | 25 | | 2500 (2) |
| 6.3 | 3 | broken | 85 | | 12000<br>8500 |
| 6.4 | 4 | overcast | 120 | | 1200; 8500<br>broken |
| 6.5 | 2 | WNW | | | ESE (2) |
| 7.1 | 1 | RAN | RAW | | |
| 7.3 | 3 | 3000 | | broken (2) | 9000 |
| 8.2 | 1 | broken | overcast | | |
| 8.3 | 1 | broken | | | (scattered broken) |
| 8.4 | 1 | broken | | | (scattered broken) |
| 8.5 | 1 | 2 miles | | | 10 |
| 8.6 | 6 | thunder showers | | (Hale mov East) | Dk (4)<br>trace rain |

## TELETYPE WEATHER MESSAGES

| QUESTION | # OF ERRORS | CORRECT RESPONSES | INCORRECT RESPONSES | | |
|---|---|---|---|---|---|
| | | | Wx | GCA | PILOTS |
| 9.2 | 1 | broken | | | 2500 |
| 9.5 | 8 | 1 1/4 miles | | Dk<br>4 (3) | 1 1/2<br>4 (2)<br>10<br>(rain showers) (2)<br>rain<br>Temp Rain SHO<br>light rain |
| 9.6 | 5 | (thunder and heavy showers) | | | |
| 10.2 | 6 | 1 3/4 variable | 1 1/4<br>1/4 | 4<br>Dk | 4<br>3 |
| 10.3 | 8 | rain and fog | | Dk<br>(OCNL very light snow showers) | Dk (4)<br>(partially obscured)<br>snow |
| 10.5 | 15 | fog 1/10 | SW--<br>(occasional snow showers) | (light snow showers)<br>Dk<br>(very light snow showers) | Dk (4)<br>(very light snow showers)<br>(occasional snow showers) (2)<br>snow showers<br>light showers<br>CV |
| 10.6 | 7 | (1 1/2 variable to 2 mi.) | | Dk (2) | 2 1/2 mi.<br>varying 2 miles<br>Dk (2)<br>1 |

## TELETYPE WEATHER MESSAGES

| QUESTION | # OF ERRORS | CORRECT RESPONSES | INCORRECT RESPONSES | | |
|---|---|---|---|---|---|
| | | | Wx | GCA | PILOTS |
| 11.2 | 3 | broken | | | 4500 (2)<br>(4500 broken to overcast) |
| 11.3 | 2 | WNW | | | SE<br>ESE |
| 11.4 | 2 | 30 | 3 | 3 | |
| 11.5 | 2 | 70° | | 40° | 69 |
| 11.6 | 2 | 69° | | 28 | 70 |
| 12.2 | 4 | broken | | | (broken to overcast) (4) |
| 12.3 | 10 | overcast | Dk | 35 | 3500 (3)<br>(broken to overcast) (4)<br>high |
| 12.4 | 4 | 10 + 25 | 25<br>W | 10 gust | Dk |
| 12.5 | 1 | 2985 | | | 2982 |
| 12.6 | 8 | (yes or over ridge) | no | no (2)<br>Dk | no (2)<br>over head<br>out range |
| 13.3 | 2 | West | | | East<br>E4 |
| 13.4 | 1 | 4 | | | light |
| 13.5 | 1 | 2985 | | 2885 | |
| 14.2 | 2 | 9000 | scattered | scattered | |
| 14.3 | 1 | scattered | | | broken |

## TELETYPE WEATHER MESSAGES

| QUESTION | # OF ERRORS | CORRECT RESPONSES | INCORRECT RESPONSES | | |
|---|---|---|---|---|---|
| | | | Wx | GCA | PILOTS |
| 15.2 | 1 | 8000 | broken | | |
| 16.4 | 2 | NW | | | SE<br>SW |
| 16.5 | 1 | 15 & 20 | 15 | | |
| 16.6 | 3 | blowing dust | | Dk | 2982 ; none<br>147 to NE |
| 17.4 | 1 | 2 miles | | | Dk (5) |
| 17.5 | 24 | fog and smoke | none | Dk (5)<br>-x<br>1 FR | (thin obscured<br>4000 broken)<br>(partially<br>obscured) (5)<br>all above<br>obscured (2)<br>lousy<br>overcast |
| 17.6 | 3 | fog 1/10 | K | | smoke<br>haze |
| 18.1 | 2 | BLX | BLK<br>BIX | | |
| 18.2 | 2 | 3000 | 40 | | S |
| 18.3 | 1 | scattered | | | B |
| 18.5 | 1 | broken | OVR | | |
| 19.2 | 2 | scattered | | 30 | 3000 |
| 19.3 | 2 | broken | | 85 | 8500 |
| 19.4 | 2 | broken | | 150 | 1500 |
| 19.5 | 2 | overcast | | 250 | 2500 |
| 19.6 | 1 | 7 miles | | | 10-20 |

## TELETYPE WEATHER MESSAGES

| QUESTION | # OF ERRORS | CORRECT RESPONSES | INCORRECT RESPONSES | | |
|---|---|---|---|---|---|
| | | | Wx | GCA | PILOTS |
| 20.2 | 2 | broken | | 25 | 2500 |
| 20.3 | 2 | broken | | 90 | 9000 |
| 20.4 | 2 | overcast | | 150 | 15000 |
| 20.5 | 10 | (heavy thunder-showers and smoke) | K (rain showers and smoke) | smoke (thunder-storms W moving East) | smoke (2)<br>haze<br>rainshowers (2)<br>1 HVR rain show |
| 20.6 | 11 | 1 3/4 miles | | Dk<br>4 (4) | 10-20<br>4 (5) |
| 21.3 | 1 | thin broken | | | scattered |
| 21.5 | 9 | 2800 to 3000' | | 29-200<br>2900-20000 | no<br>2900 to 9000 (2)<br>2900<br>9000<br>29-90<br>Dk |
| 22.2 | 4 | overcast | | | 15000 (3)<br>broken |
| 22.3 | 28 | 115 | -00 (2)<br>1 | Dk (5)<br>125<br>2986<br>1012.5 | Dk (10)<br>2986/Fl<br>2986 falling<br>1012.5<br>falling<br>falling 1(2)<br>125<br>2986 falling |

## TELETYPE WEATHER MESSAGES

| QUESTION | # OF ERRORS | CORRECT RESPONSES | INCORRECT RESPONSES | | |
|---|---|---|---|---|---|
| | | | Wx | GCA | PILOTS |
| 22.4 | 9 | 2300-2700' | | (broken to overcast)(2) | (thin obscured to overcast)<br>Dk<br>variable broken 2500 to 15000<br>(broken to overcast)<br>(obscured to broken)<br>broken cumulus |
| 22.5 | 27 | 727 or SF, AS, CS | (st, none none)<br>Dk | Dk (6)<br>(broken to overcast) | RF<br>Dk (12)<br>low stratos<br>fog<br>stratos<br>rain to fog |
| 22.6 | 6 | 1/2 mi. | 2 | Dk<br>2 | 2 (3) |
| 23.2 | 8 | broken | | (broken to overcast) (2) | (broken to overcast) (5)<br>thin overcst |
| 23.3 | 6 | 1 1/4 mi. | 4 | 11V B14<br>4 | 4 (3) |
| 23.4 | 4 | snow, fog, haze | H | Dk<br>fog | Dk |

## TELETYPE WEATHER MESSAGES

| QUESTION | # OF ERRORS | CORRECT RESPONSES | INCORRECT RESPONSES | | |
|---|---|---|---|---|---|
| | | | Wx | GCA | PILOTS |
| 23.5 | 8 | 2300 to 2700 | | | Dk (3)<br>2500 to 15000 variable broken broken<br>OCNY<br>(thin obscured to broken) |
| 23.6 | 16 | (moderate snow occasional light snow wet snow) | OCNLS-(2) | (occ. lt. snow) (2)<br>wet snow<br>S- | (south to NW quad)<br>Dk<br>variable light wet snow (3)<br>occ lt. snow (2)<br>lgt snow<br>(occasional lt. snow NW) |
| 24.1 | 1 | BGM | BGN | | |
| 24.2 | 3 | broken | overcast | | 1500 (2) |
| 24.3 | 2 | West | | | East (2) |
| 24.4 | 1 | 5 miles | | | light |
| 24.5 | 3 | (snow showers to the south) | Shwrs | Dk Shwrs | |
| 25.2 | 1 | thin broken | | | (broken to overcast) |
| 25.4 | 13 | haze | | smoke (3) | smoke (9)<br>smoke drift |
| 25.5 | 1 | West | | | East |
| 25.6 | 2 | South to North | | | South<br>SE to NE |

## ELECTROLUMINESCENT DISPLAY WEATHER MESSAGES

| QUESTION | # OF ERRORS | CORRECT RESPONSES | INCORRECT RESPONSES | | |
|---|---|---|---|---|---|
| | | | Wx | GCA | PILOTS |
| 1.1 | 7 | QB | QD | OB (2)<br>QD (2)<br>Dk | Dk |
| 1.2 | 2 | clear | | Dk (2) | |
| 1.5 | 3 | 29.85 | 2998 | | 2998 (2) |
| 1.6 | 6 | 8 miles | | Dk | unlimited<br>15 +<br>clear (2)<br>5 |
| 2.2 | 2 | clear | | scattered | haze |
| 2.5 | 1 | north | | | south |
| 3.2 | 2 | scattered | | broken | broken |
| 3.3 | 4 | blowing dust | | Dk (2) | 5 (2) |
| 3.4 | 2 | SW | | | NE<br>5 |
| 3.5 | 2 | 10 miles | | | 9<br>1 |
| 4.2 | 10 | scattered | 4000 | Dk<br>4000<br>40<br>broken | 4000 (5) |
| 4.3 | 2 | 6000 | | 4000 | 4000 |
| 4.4 | 14 | broken | 6<br>6000 (2)<br>60<br>overcast (2) | Dk (2)<br>6000 (2)<br>overcast | 6000 (3) |
| 4.6 | 5 | broken variable to scattered | (scattered v broken) | (overcast v broken) | Dk (2)<br>100 F |

## ELECTROLUMINESCENT DISPLAY WEATHER MESSAGES

| QUESTION | # OF ERRORS | CORRECT RESPONSES | INCORRECT RESPONSES | | |
|---|---|---|---|---|---|
| | | | Wx | GCA | PILOTS |
| 5.2 | 1 | broken | | (partly obscured) | |
| 5.4 | 1 | 60° | 65 | | |
| 5.5 | 5 | dust 2/10 | 65 | Dk blowing | Dk (2) |
| 5.6 | 7 | W quad 8 miles | | Dk | Dk (4)<br>8<br>indefinite |
| 6.2 | 4 | scattered | 2500 | Dk<br>25 | 25 |
| 6.3 | 3 | broken | 8500 | 85 | 8500 |
| 6.4 | 3 | overcast | 10000 | 100 | 10000 |
| 7.2 | 1 | scattered | broken | | |
| 7.3 | 2 | 8000 | 25 | | 2500 |
| 8.1 | 2 | AOO | | ADO | ROD |
| 8.5 | 5 | 1 1/4 mi. | | 1/4<br>11 v Bl 4 | 11<br>4<br>1/4 |
| 8.6 | 8 | (thunder and heavy rain showers) | | rain<br>(sand and dust) | (rain showers) (3)<br>(thunder and light rain)<br>rain showers |

## ELECTROLUMINESCENT DISPLAY WEATHER MESSAGES

| QUESTION | # OF ERRORS | CORRECT RESPONSES | INCORRECT RESPONSES | | |
|---|---|---|---|---|---|
| | | | Wx | GCA | PILOTS |
| 9.1 | 1 | PWM | AWM | | |
| 9.2 | 4 | broken | scattered | 30<br>scattered | 3000 |
| 9.3 | 1 | broken | | scattered | |
| 9.5 | 6 | 1 3/4 miles | 3/4 (2) | Dk<br>3/4 | 13<br>3/4 |
| 9.6 | 1 | (light thunder showers) | | Dk | |
| 10.2 | 3 | (2 1/4 miles variable) | | Dk | 21<br>obscured |
| 10.3 | 5 | fog and smoke | | Dk<br>(partially obscured) | haze<br>fog (2) |
| 10.5 | 12 | fog 1/10 | (intermittent rain) | Dk<br>(very light rain)<br>(intermittent rain showers) | (intermittent light rain) (2)<br>(intermittent rain) (2)<br>rain<br>(intermittent very light rain)<br>(light rain) (2) |
| 10.6 | 4 | 2 v 2 1/2 | | | 2 1/4 to 1/2<br>2 v 21<br>(variable 1/2 mile)<br>2 v 2 1/4 |

## ELECTROLUMINESCENT DISPLAY WEATHER MESSAGES

| QUESTION | # OF ERRORS | CORRECT RESPONSES | INCORRECT RESPONSES | | |
|---|---|---|---|---|---|
| | | | Wx | GCA | PILOTS |
| 11.1 | 1 | HAT | HRT | | |
| 11.2 | 3 | overcast | | 45 | 500<br>4500 |
| 11.4 | 1 | 20 + 35 | | | 20 + 30 |
| 11.6 | 1 | 68° | | | 69 |
| 12.1 | 2 | LEB | LED (2) | | |
| 12.2 | 2 | scattered | broken | | broken |
| 12.3 | 2 | scattered | broken | | broken |
| 12.4 | 3 | scattered | broken | | broken (2) |
| 12.5 | 26 | 115 | 1 | Dk (5)<br>2983<br>1487 | Dk (13)<br>HIR<br>(high rate increase)<br>2983 (2)<br>983 |
| 12.6 | 25 | low 4 SC<br>middle 8 or AC<br>high 7 CS | | Dk (5)<br>(scattered broken overcast)<br>(HIR clouds VSBL at surface) | sirrus<br>FC<br>HIR clouds<br>fog<br>scattered<br>stratus<br>SFS<br>(variable surface)<br>high<br>Dk (9) |
| 13.3 | 2 | West | East (2) | | |

## ELECTROLUMINESCENT DISPLAY WEATHER MESSAGES

| QUESTION | # OF ERRORS | CORRECT RESPONSES | INCORRECT RESPONSES | | |
|---|---|---|---|---|---|
| | | | Wx | GCA | PILOTS |
| 14.2 | 1 | 8500 | | | 500 |
| 14.3 | 2 | scattered | broken | | broken |
| 15.1 | 1 | HAT | HRT | | |
| 15.3 | 1 | broken | overcast | | |
| 16.1 | 1 | ART | | | AKT |
| 16.4 | 1 | north | | | south |
| 16.5 | 1 | 12 + 15 | 12 + 13 | | |
| 16.6 | 1 | haze and smoke | | | haze |
| 17.2 | 2 | broken | scattered | | scattered |
| 17.5 | 25 | blowing dust | none<br>part. obs. | Dk (6) | Dk (9)<br>virga NW<br>obscured<br>(partially obscured) (3)<br>temp. obscured<br>variable NW<br>thin obscured |
| 17.6 | 5 | dust 1/10 | | Dk | Dk (2)<br>smoke<br>virga NW |
| 18.1 | 1 | BDR | | DDR | |
| 18.3 | 1 | scattered | clear | | |

## ELECTROLUMINESCENT DISPLAY WEATHER MESSAGES

| QUESTION | # OF ERRORS | CORRECT RESPONSES | INCORRECT RESPONSES | | |
|---|---|---|---|---|---|
| | | | Wx | GCA | PILOTS |
| 19.1 | 1 | CLE | | CIE | |
| 19.2 | 3 | scattered | | 2500<br>25 | 2500 |
| 19.3 | 2 | broken | | 60 | 6000 |
| 19.4 | 2 | broken | | 100 | 1000 |
| 19.5 | 2 | overcast | | 250 | 2500 |
| 19.6 | 6 | 6 miles SW | 65 | 65 | 65 (4) |
| 20.1 | 2 | SGV | | EGV<br>SGN | |
| 20.2 | 3 | broken | scattered | 30 | 3000 |
| 20.3 | 3 | broken | scattered | 90 | 9000 |
| 20.4 | 2 | overcast | | 150 | 15000 |
| 20.5 | 4 | (light thunder showers and smoke) | smoke | | smoke<br>(rain showers)<br>(light rain showers) |
| 20.6 | 1 | 1 1/2 mile | | Dk | |
| 21.4 | 1 | thin broken | Dk | | |
| 21.5 | 5 | 2400-2600 | 24 v 25 | | no<br>yes-2500<br>2500-8000<br>2500 and up |
| 21.6 | 11 | 1 3/4 miles | 3/4 (3)<br>13<br>3 | 3/4<br>3 | 3/4<br>13<br>Dk<br>2500-8000 |

## ELECTROLUMINESCENT DISPLAY WEATHER MESSAGES

| QUESTION | # OF ERRORS | CORRECT RESPONSES | INCORRECT RESPONSES | | |
|---|---|---|---|---|---|
| | | | Wx | GCA | PILOTS |
| 22.2 | 4 | overcast | | 90 | 9000 (3) |
| 22.3 | 31 | 120 | 200 (2) | Dk (5) | Dk (9) |
| | | | [00 | 1577-22 | Fl |
| | | | 1 | 1577 | (falling |
| | | | 001 | 2987 | 2987) (2) |
| | | | | | Falling (2) |
| | | | | | 2987 (4) |
| 22.4 | 24 | OVl | Dk (2) | OV 1/2 (2) | Dk (5); 200 |
| | | | OV 1/2 | lVl | 1/2 V to F |
| | | | | Dk (2) | OV 1/2 (2) |
| | | | | OV 1/2 | OVl 1/2 (6) |
| 22.5 | 25 | low 5 SC | | Dk (5) | Dk (12) |
| | | middle 7 AC or AS | | (scattered | BY |
| | | high 7 CS | | broken | fog (2) |
| | | | | overcast) | (scattered |
| | | | | 22 | to overcast) |
| | | | | | stratus |
| | | | | | broken |
| 22.6 | 2 | 1/2 mile v | | Dk | 1 1/2 |
| 23.1 | 2 | BKL | | DKL (2) | |
| 23.3 | 1 | 1 1/2 miles | | 1/2 | |
| 23.4 | 5 | rain | | Dk | Dk (2) |
| | | | | fog | fog |
| 23.5 | 8 | 1 v 2 | | contrails (2) | Dk (3) |
| | | | | | contrails (2) |
| | | | | | 1 1/2 |

## ELECTROLUMINESCENT DISPLAY WEATHER MESSAGES

| QUESTION | # OF ERRORS | CORRECT RESPONSES | INCORRECT RESPONSES | | |
|---|---|---|---|---|---|
| | | | Wx | GCA | PILOTS |
| 23.6 | 25 | 113 | 1 | Dk (6) | Dk (10)<br>Fl<br>Falling (2)<br>Falling 1 (2)<br>raising<br>2996<br>2996 falling |
| 24.1 | 2 | BAL | | DAL (2) | |
| 24.2 | 4 | overcast | | 50 | 5000 (3) |
| 24.3 | 1 | West | East | | |
| 24.4 | 1 | 2 miles | 5 | | |
| 24.5 | 4 | fog 3/10 | ZRNOCNL | | rain<br>Dk<br>(intermittent rain) |
| 25.1 | 2 | BAF | | DAF (2) | |
| 25.3 | 17 | Virga NW quad. | | Dk (4)<br>NIRGA | Dk (12) |
| 25.4 | 9 | (ground fog bank N quad.) | | Dk (2) | fog bank NW (2)<br>grd. fog NW (2)<br>(NW grd. fog bank)<br>GF Ban NW HD<br>Var grd. fog NW |
| 25.5 | 3 | variable | | | West<br>Dk<br>(Nort wind dir. var.) |
| 25.6 | 1 | 29.95 | 985 | | |

Unclassified
Security Classification

**DOCUMENT CONTROL DATA · R&D**

*(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)*

1. ORIGINATING ACTIVITY *(Corporate author)*
Decision Sciences Laboratory
Electronic Systems Division
L.G. Hanscom Field, Bedford, Mass.

2a. REPORT SECURITY CLASSIFICATION
Unclassified

2b. GROUP

3. REPORT TITLE
A Study in Information Processing: Electroluminescent Vs Teletype Readability of Weather Messages

4. DESCRIPTIVE NOTES *(Type of report and inclusive dates)*
None

5. AUTHOR(S) *(Last name, first name, initial)*
Kershner, Alan M.
Avery, Donald L.

| 6. REPORT DATE | 7a. TOTAL NO. OF PAGES | 7b. NO. OF REFS |
|---|---|---|
| December 1965 | 71 | 0 |

| 8a. CONTRACT OR GRANT NO. | 9a. ORIGINATOR'S REPORT NUMBER(S) |
|---|---|
| In-House | ESD-TR-66-149 |
| b. PROJECT NO. 7682 | |
| c. Task 768201 | 9b. OTHER REPORT NO(S) *(Any other numbers that may be assigned this report)* |
| d. | None |

10. AVAILABILITY/LIMITATION NOTICES
Distribution of this document is unlimited.

| 11. SUPPLEMENTARY NOTES | 12. SPONSORING MILITARY ACTIVITY |
|---|---|
| None | Electronic Systems Division<br>L.G. Hanscom Field<br>Bedford, Massachusetts 01730 |

13. ABSTRACT

An investigation was undertaken to provide a human factors evaluation of an electroluminescent display designed for the presentation of around-the-base weather messages.

Time and error data were obtained for 42 Air Force weather, GCA, and pilot personnel in responding to six questions for each of 50 weather messages, 25 of which were presented on an electroluminescent display and 25 by conventional teletype format.

The few significant differences found do not warrant a conclusion that the electroluminescent format employed is inferior to the conventional teletype format.

It is concluded that weather message information processing may be improved by the development of time and error normative data for a standard set of weather messages, thereby permitting the identification of high-error (perhaps error-prone) personnel, by training to improve the interpretation of visibility coding and more specifically, by an improved formating of fractions concerned with visibility. The suggestion for the development of normative data may have applicability for other military information systems.

This study may be of assistance to the display designer and for the training of military and civilian personnel in weather message interpretation. It has value for the improvement of weather message formating as well as highlighting the importance of appropriate personnel selection and training for tasks involving the processing of information in complex displays.

The study further demonstrates the importance of not relying upon premature curbstone judgments of a display feasibility in lieu of an actual experimental test.

DD FORM 1 JAN 64 1473

Security Classification

| 14. KEY WORDS | LINK A | | LINK B | | LINK C | |
|---|---|---|---|---|---|---|
| | ROLE | WT | ROLE | WT | ROLE | WT |
| DISPLAY<br>ELECTROLUMINESCENT<br>TELETYPE<br>READABILITY<br>EVALUATION<br>HUMAN FACTORS<br>INFORMATION PROCESSING<br>WEATHER MESSAGES | | | | | | |

INSTRUCTIONS

I. ORIGINATING ACTIVITY: Enter the name and address of the contractor, subcontractor, grantee, Department of Defense activity or other organization *(corporate author)* issuing the report.

2a. REPORT SECURITY CLASSIFICATION: Enter the overall security classification of the report. Indicate whether "Restricted Data" is included. Marking is to be in accordance with appropriate security regulations.

2*b*. GROUP: Automatic downgrading is specified in DoD Directive 5200. 10 and Armed Forces Industrial Manual. Enter the group number. Also, when applicable, show that optional markings have been used for Group 3 and Group 4 as authorized.

3. REPORT TITLE: Enter the complete report title in all capital letters. Titles in all cases should be unclassified. If a meaningful title cannot be selected without classification, show title classification in all capitals in parenthesis immediately following the title.

4. DESCRIPTIVE NOTES: If appropriate, enter the type of report, e.g., interim, progress, summary, annual, or final. Give the inclusive dates when a specific reporting period is covered.

5. AUTHOR(S): Enter the name(s) of author(s) as shown on or in the report. Enter last name, first name, middle initial. If military, show rank and branch of service. The name of the principal author is an absolute minimum requirement.

6. REPORT DATE: Enter the date of the report as day, month, year; or month, year. If more than one date appears on the report, use date of publication.

7a. TOTAL NUMBER OF PAGES: The total page count should follow normal pagination procedures, i.e., enter the number of pages containing information.

7*b*. NUMBER OF REFERENCES: Enter the total number of references cited in the report.

8a. CONTRACT OR GRANT NUMBER: If appropriate, enter the applicable number of the contract or grant under which the report was written.

8*b*, 8*c*, & 8*d*. PROJECT NUMBER: Enter the appropriate military department identification, such as project number, subproject number, system numbers, task number, etc.

9a. ORIGINATOR'S REPORT NUMBER(S): Enter the official report number by which the document will be identified and controlled by the originating activity. This number must be unique to this report.

9*b*. OTHER REPORT NUMBER(S): If the report has been assigned any other report numbers *(either by the originator or by the sponsor)*, also enter this number(s).

10. AVAILABILITY/LIMITATION NOTICES: Enter any limitations on further dissemination of the report, other than those imposed by security classification, using standard statements such as:

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11. SUPPLEMENTARY NOTES: Use for additional explanatory notes.

12. SPONSORING MILITARY ACTIVITY: Enter the name of the departmental project office or laboratory sponsoring *(paying for)* the research and development. Include address.

13. ABSTRACT: Enter an abstract giving a brief and factual summary of the document indicative of the report, even though it may also appear elsewhere in the body of the technical report. If additional space is required, a continuation sheet shall be attached.

It is highly desirable that the abstract of classified reports be unclassified. Each paragraph of the abstract shall end with an indication of the military security classification of the information in the paragraph, represented as *(TS), (S), (C), or (U)*.

There is no limitation on the length of the abstract. However, the suggested length is from 150 to 225 words.

14. KEY WORDS: Key words are technically meaningful terms or short phrases that characterize a report and may be used as index entries for cataloging the report. Key words must be selected so that no security classification is required. Identifiers, such as equipment model designation, trade name, military project code name, geographic location, may be used as key words but will be followed by an indication of technical context. The assignment of links, rules, and weights is optional