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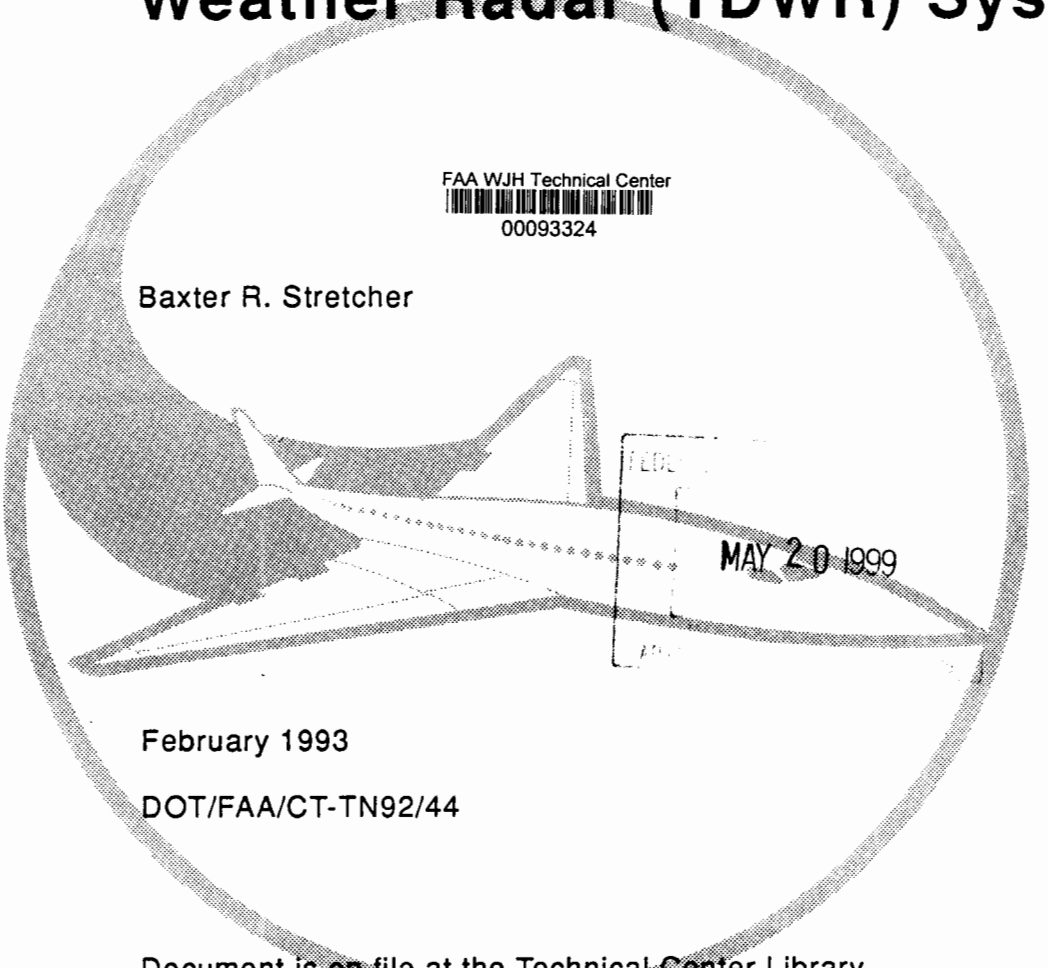
Plan for the Evaluation of the Prototype Terminal Doppler Weather Radar (TDWR) System

Baxter R. Stretcher



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Federal Aviation Administration

Technical Center
Atlantic City International Airport, N.J. 08405

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16. Abstract

The purpose of this plan is to detail the procedural approach and methods to be employed in evaluating the air traffic control (ATC) interface of the prototype Terminal Doppler Weather Radar (TDWR) system.

The plan describes the evaluation that will be performed at the Orlando International Airport (MCO) during the summer of 1992. The Federal Aviation Administration (FAA) Technical Center will be interested in the controller's and supervisor's evaluation of the Geographical Situation Display (GSD) and the Ribbon Display Terminal (RDT), installed at the ATC tower. The evaluation of these displays may determine the operational suitability of the TDWR in the National Airspace System (NAS).

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EXECUTIVE SUMMARY

The air traffic control (ATC) element of the prototype Terminal Doppler Weather Radar (TDWR) will be evaluated at the Orlando International Airport (MCO), Orlando, Florida, during the period May 4, 1992, through July 7, 1992. The purpose of this plan is to describe the procedural approach and methods to be employed in the evaluation of the system by the air traffic controllers and supervisors at the MCO tower. The radar used in this evaluation is a functional prototype radar utilized by the Massachusetts Institute of Technology/Lincoln Laboratory (MIT/LL) to test algorithms and products for possible use in the production TDWR.

The TDWR data is directly disseminated to controllers and supervisors in the MCO tower and the Terminal Radar Approach Control (TRACON). This is accomplished by using two types of displays; one is the Ribbon Display Terminal (RDT) for displaying wind shear hazard messages to controllers, the other is the Geographical Situation Display (GSD), which presents weather in a graphic format to air traffic supervisors for planning purposes. These displays will be installed in the MCO tower cab for the purpose of this evaluation.

Once the displays are installed, MIT/LL will train the controllers and supervisors in the interpretation and use of the TDWR products and the operational use of the GSD and the RDT. This operational training will take approximately 9 weeks, then the evaluation will take place. The Plans and Procedure Specialist (PPS) at MCO will brief the controllers and supervisors on the purpose, scope, and procedures of the evaluation and distribute the questionnaires.

Controllers and supervisors are requested to complete two questionnaires. One questionnaire concerns the GSD, the other concerns the RDT. The completed questionnaires will be analyzed by the ACW-200D personnel. The data collected will form the basis for a final report.

PURPOSE

The purpose of this plan is to describe the procedural approach and methods to be employed in evaluating the air traffic control (ATC) interface elements of the functional prototype Terminal Doppler Weather Radar (TDWR). This evaluation will be performed at the Orlando International Airport (MCO) during the summer of 1992. The plan outlines the method for evaluating the operational suitability and effectiveness of the new products involved in the TDWR hazardous weather messages given to the controllers and supervisors.

From May 4, 1992, to June 21, 1992, the prototype TDWR will be using the same algorithms that were used in the 1991 demonstration. From June 22, 1992, to July 8, 1992 (end of the demonstration), the system will be using the algorithms for the prototype TDWR and the Low Level Wind Shear Alert System with eight additional Sensors (TDWR/LLWAS-3 integrated system).

The 1992 demonstration of the prototype TDWR is a continuation of the operational demonstration conducted during the summer of 1991 (May 27 through July 7, 1991). The 1992 demonstration is testing new products and algorithms in addition to the existing products. Some of the new products will be the integration of the TDWR and the 14-Sensor LLWAS-3, storm tracking, and the Reflectivity Attenuation Flagging function.

The radar used in this demonstration is a functional prototype radar utilized by the Massachusetts Institute of Technology/Lincoln Laboratory (MIT/LL) to test algorithms and products to be provided for possible use in the production TDWR. The radar, called the C-band prototype TDWR, is a system developed to detect wind shear and other kinds of hazardous weather in the airport terminal area. The prototype radar is a "C" band radar like the production TDWR, but utilizes different hardware. The prototype TDWR data is directly disseminated to controllers and supervisors in the MCO tower and the Terminal Radar Approach Control (TRACON). This is accomplished by using two types of displays: (1) a ribbon (alphanumeric) display terminal (RDT) for displaying wind shear hazard messages to controllers, and (2) a geographical situation display (GSD) which presents weather data in a graphic format to air traffic supervisors for planning purposes. These displays provide data which is intended to be similar to that provided by the production TDWR. Maintenance, reliability, and interface functions of the prototype TDWR may be different from the production TDWR.

REFERENCE DOCUMENTS

This section lists the applicable documents and reference materials which relate to the contents of this plan.

FAA-STD-024a	Preparation of Test and Evaluation Documentation.
FAA-E-2806B November 14, 1989	Terminal Doppler Weather Radar (TDWR) Specification.

FAA Technical Center ACN-240 November 27, 1991	Orlando OT&E Quick Look Report
MIT/LL 43C-2188 April 20, 1992	Test Plan Demonstration of Terminal Doppler Weather Radar in Orlando,
NAS-SS-1000 Volume III October 1989	DOT/FAA Specification NAS System System Specification Volume III Functional and Performance Requirements for the National Airspace System Ground-to-Air Element
NAS ORDER 1810.4B	NAS Test and Evaluation Policy

EVALUATION PHILOSOPHY

Since 1988, the ANR-500 Weather Radar Program has sponsored MIT/LL to develop and evaluate algorithms for a functional prototype TDWR. A major goal of the TDWR program is to provide automatic detection and warning of microburst, wind shear, and other weather hazards in the vicinity of airport terminals.

The operational evaluation of the TDWR by Air Traffic Controller Specialists (ATCS) and supervisors, is designed to give the ATCSs an opportunity to have input to the design of the TDWR system.

The ATC evaluation will pay particular attention to the following areas:

1. timeliness of the weather warning,
2. readability of the RDTs,
3. adequacy of the RDT size,
4. rate of false alarms, and
5. storm movement and track prediction products on the GSD.

The results from this evaluation will be utilized, by the TDWR Program Office to make changes to the TDWR, if necessary.

EVALUATION APPROACH

The ATC operational evaluation will be conducted at Orlando International Airport (MCO), Orlando, Florida. The MIT/LL will install four RDTs and one GSD in the MCO Tower, and one each of the displays will be installed in the TRACON.

Once the displays are installed at the designated places, MIT/LL will train the Air Traffic Control Tower (ATCT) and TRACON personnel in the interpretation and use of the TDWR products, and in the use of the GSD. The ATCSs and the supervisors will use the system for approximately 9 weeks (duration of the demonstration), then the ATC evaluation will take place. The Plans and Procedure Specialist (PPS) at MCO will brief the air traffic controllers on the purpose, scope, and procedures of the evaluation and distribute the questionnaires.

Controllers and supervisors will be requested to complete two questionnaires. The questionnaires are organized to highlight the two TDWR displays, system areas, and interfaces that the controllers/supervisors will utilize. Following the evaluation, the completed questionnaires will be analyzed by ACW-200D personnel. The data collected will form the basis for a draft final report (30 days after the evaluation), which will be forwarded to the principle organizations supporting the prototype TDWR evaluation. A final report will follow the draft within 30 days.

EQUIPMENT

The components of the prototype TDWR system that will be installed in the tower and the TRACON consists of four RDTs and one GSD in the tower, and one each RDT and GSD in the TRACON.

RIBBON DISPLAY TERMINAL (RDT).

The alphanumeric products from the TDWR will be displayed on RDTs located at the controller's positions (circular) in the tower and supervisor's position in the TRACON. There are two different RDTs sizes: (one each) 12" x 11 1/4" x 6" (small size) and (four each) 15" x 15" x 6" (large size). The small RDT will be located near the tower cab. During the evaluation, in lieu of the hazardous alert data from the operational LLWAS, alphanumeric wind shear and microburst alert messages from the prototype TDWR system will be displayed on the RDTs.

These messages are displayed along with the LLWAS center field and active runway threshold winds. (NCP# 14767)

The alert warning messages are displayed on the RDTs in the following form:

Runway ID (dir/kts)	Wind Shear Type	Expected loss/gain	Location 1st Encounter (kts)	Threshold
A typical example might be:				
19D	MBA	80K	2MD	320 14

which is read as: runway 19 departure, microburst alert (MBA), expect 80 knot loss, encounter at 2 miles on departure, runway threshold winds at 320° at 14 knots.

GEOGRAPHICAL SITUATION DISPLAY (GSD). The tower and TRACON supervisors have a color GSD which uses a Sun workstation to display weather information to ATC supervisors and controllers. It functions as a situation display monitor and as an air traffic planning tool for runway management. This color workstation provides graphical representation of the location and intensity of precipitation, microbursts (MBs) and gust fronts (GFs), as well as estimates of the speed and direction of motion for precipitation cells and gust fronts.

ORGANIZATION ROLES AND RESPONSIBILITIES

The principal organizations participating in the evaluation of the prototype TDWR include the following:

1. TDWR Program Office (ANR-500),
2. FAA Technical Center (ACW-200D),
3. Orlando ATC,
4. MIT/LL,
5. University of North Dakota (UND).

RESPONSIBILITIES.

ANR-500. ANR-500 has the overall responsibility for the TDWR program.

FAA TECHNICAL CENTER/ACW-200D. The FAA Technical Center/Weather and Primary Radar Division, ACW-200, has been designated as the Associate Program Manager for Testing (APMT). ACW-200D will provide a Test Director who is responsible for the overall management and direction for the TDWR operational evaluation. The ACW-200D personnel will develop an operational evaluation plan and associated questionnaires. ACW-200D evaluation conductors will participate in the initial site visits to coordinate the evaluation. A data analysis will be performed on all questionnaire data collected. This data will be used in the preparation of a draft final report and a final report.

ORLANDO ATC. The PPS at MCO will provide the necessary meeting/briefing facilities and space to accommodate the evaluation. The PPS will administer the questionnaires to the supervisors/controllers. (See appendix A.)

MIT/LL. The MIT/LL provides the functional prototype TDWR radar display, workstations, and technical personnel in the MIT/LL Display Trailer at the Massachusetts Institute of Technology/Lincoln Laboratory prototype C band TDWR site located at Orlando, Florida (FL-2C) to:

1. monitor the quality of the radar's base data products.

2. monitor the quality of the graphical output products generated by the system.

3. monitor the status of the TDWR testbed hardware and software computation.

4. provide real-time logging of wind shear event locations for subsequent scoring.

The MIT/LL also provided and installed GSDs and alphanumeric RDTs in the MCO Tower and TRACON to:

1. be used by air traffic controllers to provide warnings to pilots of dangerous wind shear events near the airport.

2. be used by tower cab and TRACON supervisors for the purpose of planning changes to current operations.

3. provide direct communication equipment in the MCO tower cab for immediate access between the FL-2C testbed radar and the MIT tower monitor personnel.

4. provide a radar meteorologist/analyst at the FL-2C radar site during the active shifts of the demonstration to monitor GSD and message operations and interface with AT personnel.

5. train the Federal Aviation Administration (FAA)/ATCT and TRACON personnel in the interpretation and use of the TDWR products and in the use of the GSD in preparation for the demonstration.

UND. The University of North Dakota responsibilities are to:

1. provide a second Doppler radar coverage to the TDWR operational coverage sector.

2. provide logs of significant weather events to assist in the analysis of the FL-2C radar data.

3. provide logs and recorded Doppler data resolving missed event anomalies.

4. participate in the Radar Truth Scoring Team.

5. provide radar data conversion to MIT/LL common format (CFT) and Universal formats as required.

ROLES.

The roles for conducting the TDWR evaluation are as follows:

TEST DIRECTOR
The Test Director is a member of the FAA Technical Center/ACW-200D and oversees all aspects of the evaluation including the preparation of the final report.

EVALUATION CONDUCTOR
The Evaluation Conductor is the FAA Technical Center/ACW-200D representative who will coordinate the on-site evaluation with the support from MCO PPS. The Evaluation Conductor will participate in all site visits, reviews, and briefings. The Evaluation Conductors will support data analysis and the preparation of reports.

EVALUATION PARTICIPANTS
The ATCSs and supervisors at MCO will evaluate the prototype TDWR displays that are installed in the tower and TRACON facilities.

DOCUMENT REQUIREMENTS AND CONTROL

The documents required to conduct, describe, and report the results of the prototype TDWR evaluation are listed below.

EVALUATION PLAN.

This plan describes the requirements, methods, and responsibilities for conducting the operational evaluation of the prototype TDWR displays located in the tower of MCO. It provides a plan that will allow for an evaluation by the ATCSs and supervisors in a live operational environment.

EVALUATION QUESTIONNAIRE.

In order to obtained a feedback from the users, two questionnaires were developed by the FAA Technical Center. One of the questionnaires concerns itself with the RDT and the other questionnaires concerns itself with the GSD. The questionnaires are structured to obtain the evaluation of the prototype TDWR by rating a statement about each feature/function on a five-point scale ranging from Good to Poor, plus a "Don't Know" category for participants who did not see a specific feature working. Comments are encouraged. (See appendix B.)

DRAFT FINAL REPORT.

Within 30 days following the end of the FAA Technical Center evaluation, a draft final report will be submitted to ANR-500 for review.

FINAL REPORT.

After review and editing of the draft final report, the final report will be prepared and will include the conclusions, problems/issues, and recommendations resulting from the evaluation. This report will be sent to ANR-500 and the participants within 45 days after receiving comments on the draft final report.

TRAINING

Detailed training of the air traffic controllers and supervisors participants was conducted by MIT/LL in coordination with the Orlando tower management. Training at MCO was performed prior to the 1992 operational demonstration.

During the week prior to the start of the operational demonstration, the supervisors and controllers were given the opportunity for hands-on experience with the GSD and RDT training system. The ATC supervisors and controllers were encouraged to become familiar with the functionality of the GSD and to practice reading wind shear and MB messages aloud to simulate the delivery of the messages to pilots. The training system was made available to ATC personnel throughout the demonstration period to allow them the opportunity to use the GSD off-line or to demonstrate new products before their introduction into the operational ATC environment.

EVALUATION SUPPORT REQUIREMENTS

This section describes the instrumentation required for the evaluation, the types of data analysis to be performed, and the evaluation configuration.

INSTRUMENTATION.

No special instrumentation is required for the evaluation. The MIT/LL will install the prototype TDWR displays that are needed in the MCO tower and TRACON (four RDTs and one GSD in the tower; one RDT and one GSD in the TRACON).

DATA ANALYSIS.

Numerical values will be assigned to the questionnaire responses, and then analyzed using statistical methods. The intent of the analysis is to find the degree of satisfaction or dissatisfaction the supervisors and controllers have with the prototype TDWR displays and their products. The suggestions and free-form comments will be analyzed using content analysis. The responses will be grouped so as to provide maximum ATC feedback. The evaluation of the responses to the questionnaires will help to answer questions regarding AT operational usage and evaluation of the prototype TDWR display equipment in the MCO tower.

EVALUATION CONFIGURATION.

The evaluation is taking place at MCO ATCT. The prototype TDWR display installation includes four RDTs and one GSD in the tower cab, and one each RDT and GSD in the TRACON. The GSD is located at the supervisor's position in the tower cab and the RDTs are located at the controller's position in the tower cab. The RDT and the GSD will be located at the supervisor's position in the TRACON.

REVIEWS AND MEETINGS

The visits, briefings, and reviews described below are necessary to successfully conduct the operational evaluation of the prototype TDWR.

INITIAL SITE VISIT.

An initial visit to the Orlando International Airport and the FL-2 MIT/LL radar test bed is needed to obtain specific information necessary to conduct the evaluation. Information to be gathered includes the number of controllers/ supervisors participants, layout of the tower cab, display equipment being used, duty schedule of participants, etc. These visits will be coordinated with the ATCT personnel and the MIT/LL personnel.

EVALUATION BRIEFING.

Once the ATC training has been completed, briefings will be held at MCO tower to insure that the intent of the evaluation is conveyed, the logistics are understood, and the questionnaires are thoroughly explained. The PPS, who will be holding the briefing, will insure that each participant has been briefed and that all questions and concerns are addressed. The briefing will be held on an as needed basis so that all duty shifts are covered.

SCHEDULE

Installation of TDWR Displays	April 20 through May 1, 1992
Develop Evaluation Plan	May 5 through July 1992
Prepare Evaluation Questionnaires	May 5 through July 1992
LLWAS Integration Complete	June 1992
Operational Evaluation Complete	July 1992
Draft Final Report	30 days after the evaluation
Final Report	45 days following return of comments on draft final

TDWR EVALUATION REQUIREMENTS MATRIX

THE TDWR evaluation requirements matrix contains the National Airspace System, (NAS)-SS-1000 TDWR operational requirements that pertain to the Air Traffic (AT) interface. This matrix will be utilized to insure traceability from the TDWR evaluation questionnaires to the NAS-SS-1000. The matrix contains the specification reference, requirement, and the evaluation questionnaire category under which it will be evaluated. (See appendix C.)

ACRONYMS AND ABBREVIATIONS

APMT	Associate Program Manager for Testing
AT	Air Traffic
ATC	Air Traffic Control
ATCS	Air Traffic Control Specialist
ATCT	Air Traffic Control Tower
CFT	MIT/LL common format
FAA	Federal Aviation Administration
FL-2	MIT/LL prototype C band TDWR site located at Orlando, Florida
GF	Gust Fronts
GSD	Geographic Situation Display (terminal)
LL	Lincoln Laboratory
LLWAS-3	LLWAS with 8 additional sensors (14)
MB	Microburst
MBA	Microburst Alert
MCO	Orlando International Airport
MIT	Massachusetts Institute of Technology
NAS	National Airspace System
PPS	Plans and Procedure Specialist
RDT	Ribbon Display Terminal
TDWR	Terminal Doppler Weather Radar
TRACON	Terminal Radar Approach Control
UND	University of North Dakota

APPENDIX A

MEMORANDUM TO THE PLANS AND PROCEDURE SPECIALIST, MCO ATCT, AND THE EVALUATION BRIEFING

INFORMATION: TDWR/LLWAS EVALUATION

Test Director, ACW-200D

Plans and Procedure Specialist, MCO ATCT

Per your discussion with myself and R. Martinez on June 15, 1992, inclosed you will find copies of the questionnaires to be used during the TDWR/LLWAS evaluation. Also, inclosed is a copy of the Briefing we would like to be given to the Air Traffic Supervisors/Controllers prior to the administration of the questionnaires. We would like for the evaluation to be completed on or before the 10th of July (the last day of the TDWR test period).

The questionnaires have been shortened to one page each. One questionnaire concerns the Ribbon Display Terminal (RDT) and the other concerns the Geographical Situation Display (GSD).

Your cooperation in this endeavor is greatly appreciated. If you have any questions, please contact me at (609) 484-6784, Radame' Martinez at (609) 484-5618, or Baxter Stretcher at (609) 484-6898.

Elizabeth A. Turcich

attachments:
briefing
questionnaires

cc:
R. Weimer, ANR-150
A. Levy, ANR-150
T. Watton, ATR-120
W. Mowdy, MCO ATCT

BRIEFING FOR AIR TRAFFIC CONTROLLERS AND THEIR SUPERVISORS ON THE HUMAN FACTORS EVALUATION OF THE PROTOTYPE INTEGRATED, TERMINAL DOPPLER WEATHER RADAR AND THE LOW-LEVEL WIND SHEAR ALERT SYSTEM (TDWR/LLWAS) AT ORLANDO INTERNATIONAL AIRPORT TO BE GIVEN BY MCO MANAGEMENT.

The FAA Technical Center is supporting the TDWR/LLWAS Integration test at Orlando. One of their support roles is the collection and analysis of user evaluation from you, the Orlando controllers/supervisors; users of the system. We are collecting user data by means of questionnaires which will be sent back to the FAA Technical Center. The Technical Center wants to get your evaluation of the prototype TDWR.

You are being asked to complete the Questionnaires just prior to the end of the TDWR demonstration, which is July 10 1992.

The Technical Center realizes that you are busy. Therefore they have designed the questionnaires to minimize the time and effort needed to complete them. Please remember to:

(a) complete the GSD or the RDT questionnaire only if you observed the GSD or RDT.

(b) provide written comments where asked. They provide valuable data to improve the system.

(c) if you did not observe a particular function you need not answer that question. "Do not know" is an acceptable answer.

(d) ask for clarification on all unclear items.

Your considered inputs as users of the TDWR/LLWAS are very important in the effort to improve airport weather hazard detection and the display interface.

Please read over the questions carefully. If any of them are unclear, ask me for clarification.

APPENDIX B

QUESTIONNAIRES FOR SUPERVISORS/CONTROLLERS, MCO ATCT, ORLANDO, FLORIDA

RDT

TOWER_____ TRACON_____

CONTROLLER_____ SUPERVISOR_____

Please rate the TDWR using the following scale: -2=poor; -1=Fairly poor; 0=Fair; +1=fairly good; +2=good; ?=Don't Know.

1. EVALUATION OF THE RIBBON DISPLAY TERMINAL (RDT)	RATING SCALE					
	-2	-1	0	+1	+2	?
a. Adequacy of display size "small"						
b. Adequacy of display size "large"						
c. Daytime readability of "small" RDT						
d. Nighttime readability of "small" RDT						
e. Rate of false alarms (microburst)						
f. Rate of false alarms (gust front)						
g. Timeliness of displayed data						
h. Usefulness of the displayed Microburst information						
i. Usefulness of the displayed Gust Front information						

2. Please state instances (if any) of wind shear that the system did not display:

   a. Microburst _____,
   b. Gust Front _____.

3. Please provide comments on any rating of 0 or lower and/or any other comments on the role of the RDTs (Ribbon Display Terminals).

_____

_____

_____

_____

_____

USE BACK OF PAGE IF NECESSARY

GSD

TOWER_____ TRACON_____

CONTROLLER_____ SUPERVISOR_____

Please rate the TDWR using the following scale: -2=poor; -1=Fairly poor; 0=Fair; +1=fairly good; +2=good; ?=Don't Know.

1. EVALUATION OF THE GEOGRAPHICAL SITUATION DISPLAY (GSD)	RATING SCALE					
	-2	-1	0	+1	+2	?
a. Usefulness of the Wind Shift Prediction						
b. Rate of false alarms (microburst)						
c. Rate of false alarms (gust front)						
d. Usefulness of the displayed Microburst information						
e. Usefulness of the displayed Gust Front information						
f. Usefulness of the displayed storm motion information						

2. Please state instances (if any) of wind shear that the system did not display:

   a. Microburst _____,
   b. Gust Front _____.

3. <u>Supervisors only:</u> Was the GSD useful in making runway configurations changes prior to weather events? Yes or No. Please explain.

_____

_____

_____

4. Please provide comments on any rating of 0 or lower and/or any other comments on the Geographical Situation Displays (GSD).

_____

_____

_____

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APPENDIX C

TDWR EVALUATION REQUIREMENTS MATRIX

TDWR AIR TRAFFIC SUPERVISOR/CONTROLLER EVALUATION

NAS-SS-1000	REQUIREMENT DESCRIPTION	QUESTIONNAIRE SECTION	REMARKS
3.2.1.2.5.1.1.A	The TDWR identify the presence of a microburst	TDWR GSD AND RDT Displays	
3.2.1.2.5.1.1.B	The TDWR identify the presence of a gust front	TDWR GSD Display	
3.2.1.2.5.1.1.C	The TDWR identify the present of a wind shift	TDWR GSD Display	
3.2.1.2.5.1.1.D	The TDWR identify the presence of precipitation	TDWR GSD AND RDT Displays	
3.2.1.2.5.1.4.A	The TDWR shall generate a microburst map	TDWR GSD Display	
3.2.1.2.5.1.4.B	The TDWR shall generate a microburst message/alarm	TDWR GSD AND RDT Displays	
3.2.1.2.5.1.4.C	The TDWR shall generate a gust front map	TDWR GSD Display	
3.2.1.2.5.1.4.D	The TDWR shall generate a message/alarm	TDWR GSD AND RDT Displays	
3.2.1.2.5.1.4.E	The TDWR shall generate a wind shift map	TDWR GSD Display	
3.2.1.2.5.1.4.F	The TDWR shall generate a wind shift message/alarm	TDWR GSD AND RDT Displays	
3.2.1.2.5.1.4.G	The TDWR shall generate a precipitation map	TDWR GSD Display	
3.2.1.2.5.1.5	The TDWR shall generate alarm messages indicating the presence of MB, GF, and wind shift when pre-specified threshold conditions occur	TDWR GSD AND RDT Displays	
3.2.1.2.5.1.8	The TDWR shall be capable of supplying operational status	TDWR GSD AND RDT Displays	