Next Generation Weather Radar (NEXRAD) Principal User Processor (PUP) Operational Test and Evaluation (OT&E) Operational Report

Baxter Stretcher

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16. Abstract

This report details the results of the Operational Test and Evaluation (OT&E) Operational Test of the Next Generation Weather Radar (NEXRAD), Principle User Processor (PUP). The PUP was evaluated at the Leesburg, Virginia, and Houston, Texas, Air Route Traffic Control Centers (ARTCC) during the period March 22 through April 1, 1993.

The objective of the OT&E Operational Test was to obtain the Central Weather Service Unit (CWSU) meteorologists' evaluation of the NEXRAD PUP. A questionnaire was used to obtain responses from the meteorologists.

This report includes the meteorologists' evaluation of the quality and quantity of the products provided by the PUP, the workload, operational procedures, radar connections, and training.

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EXECUTIVE SUMMARY

The Next Generation Weather Radar (NEXRAD), Principal User Processor (PUP), was evaluated at the Leesburg, Virginia, and Houston, Texas, Air Route Traffic Control Centers (ARTCC) during the period March 22 through April 1, 1993. This was the first Operational Test and Evaluation (OT&E) of the NEXRAD PUP in the Center Weather Service Unit (CWSU) environment.

The objective of the OT&E Operational Test was to obtain CWSU meteorologist evaluation of the NEXRAD PUP aviation weather products, equipment, operations, and workload. A questionnaire was used to obtain responses from the meteorologists relative to the operational effectiveness and suitability of the PUP.

Highlights of the operational evaluation, and subsequent debriefings, are the following: (1) The participants were satisfied with the quality of products provided via the PUP; (2) There was general agreement that the PUP provided them with too many products, many which are not useful in CWSU operations; (3) The PUP increased their workload; (4) Some of the operational procedures and functions were too time consuming for one operator to perform; (5) The lack of more than one directly connected radar was seen as operationally unsuitable; and (6) The training should have focused more on the PUP procedures as related to CWSU activities, and less on nonaviation oriented meteorological subjects.

It is recommended that a review of the PUP's procedures, functions, and personnel requirements in the context of a CWSU environment be considered. It is also recommended that the training for the CWSU meteorologists be focused on the CWSU operations and procedures. The results of this evaluation should be shared with the Real-Time Weather Processor (RWP) Program Office for incorporation into the RWP Specification.

INTRODUCTION

PURPOSE.

The purpose of this evaluation was to determine the operational suitability and effectiveness of the Next Generation Weather Radar (NEXRAD) Principal User Processor (PUP) in providing aviation weather radar products to the Air Route Traffic Control Center (ARTCC) Weather Service Unit (CWSU). The primary focus was to assess the usefulness of the PUP, and the associated NEXRAD products in aiding the CWSU personnel in detecting and forecasting aviation hazardous weather. The evaluation was conducted by the Weather and Primary Radar Division, ACW-200D, of the Federal Aviation Administration (FAA) Technical Center. The plan for this evaluation is detailed in the FAA Technical Center's "Next Generation Weather Radar (NEXRAD) Principal User Processor (PUP) Operational Test and Evaluation (OT&E) Operational Test Plan."

The NEXRAD system is an "S"-band doppler weather radar system developed by the Paramax Corporation. This system is designed to provide information on environmental wind profiles, and to detect wind shear and other hazardous weather phenomena for the Department of Transportation (DOT), and also to perform other functions for the Department of Defense (DOD) and the Department of Commerce (DOC).

BACKGROUND.

In October of 1983, the NEXRAD Program Council (NPC) requested that the Air Force Operational Test and Evaluation Center (AFOTEC) conduct the NEXRAD Initial Operational Test and Evaluation (IOT&E). To facilitate this, an integrated tridepartmental test team under the management of AFOTEC signed a Memorandum of Agreement (MOA) in April of 1984. The test team consisted of the DOC, the DOD, and the DOT. The NEXRAD Test and Evaluation Master Plan (TEMP) was coordinated and approved by all participating agencies in March of 1985. The TEMP detailed the responsibilities of the participants and the general IOT&E scenario. A second MOA was signed by the NPC members and the AFOTEC commander on November 1988, and focused on IOT&E(2).

Two independent test teams, under the overall management of the AFOTEC, conducted IOT&E of the competing contractors' (Raytheon and Unisys, formerly Sperry) NEXRAD units. Unisys was selected as the production contractor, and preparations were initiated for the IOT&E(2). A 160-member integrated tridepartmental test team under the management of AFOTEC conducted an IOT&E(2) on the Unisys (Paramax) preproduction NEXRAD system. The IOT&E(2) was divided into two parts (A and B). Part A combined activities from March to May 1989. Part B was a dedicated OT&E from May to August 1989. The DOC conducted their part of the test at the Weather Service Forecast Office (WSFO) in Norman, Oklahoma. The DOD conducted their testing at Tinker Air Force Base, Oklahoma, at the Base Weather Station. The DOT (FAA) completed their OT&E Operational Testing at the FAA Academy in Oklahoma City, Oklahoma.

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An agreement between Unisys and the government was reached, and Unisys (Paramax) was awarded the full production contract. Follow-on OT&E Operational Testing on the full-production system was recommended by the Deployment Readiness Review (DRR) Committee to establish operational suitability of the system. This OT&E Operational Testing at the Washington and Houston ARTCC CWSUs fulfills this recommendation.

METHOD

PARTICIPANTS.

Eight CWSU meteorologists participated in this OT&E Operational Test. Four at the Houston ARTCC and four at the Washington ARTCC. Their current operational duties at their facilities are in the capacity of two Meteorologists in Charge (MIC) and six CWSU meteorologists.

The eight meteorologists had a combined total of 85 years of CWSU experience and 6.7 years of NEXRAD PUP operational experience.

TRAINING.

Seven of the eight meteorologists attended the 4-week Weather Surveillance Radar, 1988 Doppler (WSR-88D) Operations Course given by the Operations Training Branch, at the Operational Support Facility (OSF) in Norman, OK. They received training on PUP and NEXRAD System operations, and interpretation of NEXRAD products and algorithms, including principles of Doppler radar.

EQUIPMENT.

The PUP receives NEXRAD products from the Radar Product Generator (RPG) upon request from the operational personnel. The PUP is located in the ARTCC, while the RPG is located elsewhere, usually at the WSFO. The PUP contains the display unit for product control, status monitoring, local annotation, and product archiving. The PUP has three major components: (1) the data processor, (2) the system console, and (3) the workstation.

The data processor is a two-bay cabinet containing the necessary hardware/software for all data processing activities. The cabinet also contains the narrow-band links used between the PUP and its associated RPG for internal product request and distribution, along with the dial-out port for external requests and distribution from nonassociated RPGs.

The system console holds an alphanumeric terminal consisting of a keyboard and a 14-inch Cathode Ray Tube (CRT) screen. The console is an interactive peripheral device connected to the display processor port on the data processor cabinet. The functions provided by the console include system initialization and startup, control of the disk/tape operations, loading and execution of processor diagnostic programs, and start/stop of the system's application software.

The workstation is the primary operational position for the PUP. It provides the meteorologist with the capability to request, display, and manipulate weather products generated by the RPG. The workstation consists of a table structure with operator work space and support provisions for an application terminal, two color monitors, a graphic tablet, and an audio alarm. A hard copy device is also provided on a separate table that may be positioned up to 50 feet from the workstation.

EVALUATION QUESTIONNAIRE.

In order to obtain feedback from the meteorologists, a questionnaire was developed and administered by the FAA Technical Center, ACW-200D (appendix A). The questionnaire was structured to obtain an evaluation of the operational suitability and effectiveness of the NEXRAD PUP and the associated NEXRAD products in an aviation environment. The questionnaire consists of the following five sections:

Section   I: PUP Weather Products
Section   II: FAA PUP Operations
Section III: Workload
Section   IV: Training
Section   V: Overall Operational Effectiveness and Suitability

The questionnaire was structured to obtain an evaluation by rating a statement Disagree, Neutral, or Agree, or by Yes or No. Comments were encouraged. Open-ended questions were also asked on several issues in order to obtain comprehensive feedback.

PROCEDURE.

On November 19, 1992, an initial site visit was made to the Washington ARTCC CWSU to obtain specific information necessary to conduct the evaluation. Information that was obtained included the number of meteorologists that would participate, layout of the CWSU area, display equipment being used, duty schedule of participants, and other pertinent information. Since the Washington ARTCC CWSU is similar to the Houston ARTCC CWSU, the information from this visit was sufficient for both sites.

The OT&E of the NEXRAD PUP took place at the Washington ARTCC CWSU, the week of March 22, 1993, and at the Houston ARTCC CWSU, the week of March 29, 1993. The FAA Technical Center representative provided adequate copies of the questionnaire to the MIC, and insured that each participant was briefed concerning the intent of the evaluation, and that all questions and concerns were addressed. The briefings were held on an as needed basis to cover all duty shifts. After the questionnaires were completed, debriefings in which the respondents could express any additional comments or concerns were informally conducted. During these debriefings, discussions resulted which related to suggested changes and improvements. This report includes any additional information relayed during these debriefings.

ANALYSIS.

The responses to the questionnaires have been tabulated to give the number of Yes or No, or Agree, Disagree, or Neutral responses as compared with the total number of responses. Five or more positive responses were rated as Operationally Acceptable; four or less positive responses were rated as

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Operationally Unacceptable. Neutral responses are treated as negative responses.
In addition to the numerical responses, comments were analyzed using content
analysis to give additional input and are referred to as appropriate in the Results
and Discussion section.

Only seven of the eight meteorologists' responses were considered in the analysis
as one did not attend the NEXRAD PUP training. (This was a requirement in
accordance with the NEXRAD PUP OT&E Operational Test Plan.)

RESULTS AND DISCUSSION

All of the meteorologists, at Leesburg, VA and Houston, TX, completed the
questionnaires. Both sites had similar equipment and staffing. The Results and
Discussion section follows the format of the questionnaire. Response totals and
specific comments to each question are shown in appendix B.

PUP WEATHER PRODUCTS.

Six of seven participants indicated by their positive responses that the NEXRAD
PUP provided the products needed for their operational duties in the CWSU
(question #1). The respondent that said No, commented:

> "There are 3 altitudes on the layer reflectivity and turbulence products. The
> mid altitude should be changed from 24,000-33,000 ft to 24,000-40,000 ft
> so we can view the reflectivity and turbulence at the altitudes flown by
> commercial airliners in ARTCC Operations."

It may be beneficial for the FAA to investigate whether the layer reflectivity and
turbulence products could be adjusted for aviation purposes.

The respondents indicated that some of the products provided were in excess of
their needs for normal CWSU operations. This is reflected in the response to the
question, "Are all of the products provided by the NEXRAD PUP necessary for your
operational duties in the CWSU?" (question #2). Their response was a unanimous No.
At the debriefings, the meteorologists indicated that some established lists may
call up certain products that were not needed for the CWSU operations. Requesting
these extra products slowed down other operations. Some of the products the
respondents had no need for included spectrum width, combined shear, 3 hours echo
tops, 3 hours precipitation, and storm totals. It was suggested that the problem
may be solved by using the Routine Product Set (RPS) list. This list allows the
operators to select the products that are useful and needed for their operation.
The RPS list would be used as a part of their Standard Operating Procedure (SOP).
It would take time to make a RPS list, but in the long run, it would save time in
many of their callup operations. Both MICs indicated that they are in the process
of making their RPS list for their facilities. The sentiment that there were too
many products was reiterated in question #9, "Were the procedures for acquisition
and display of the FAA Air Traffic oriented products (such as layer products)
adequate for your operational requirements?" This received an unacceptable rating,
with three Yes responses, three No responses, and one Yes/No response. From these
responses and comments, it appears that the procedure for the acquisition of

the products was adequate but the products received were not adequate for the meteorologists. The respondents' comments on this question and question #2 seem to indicate that the procedure for the callup of aviation products resulted in display of unnecessary products. This is a situation that may be resolved with the RPS lists becoming SOP.

The respondents were asked about the timeliness of the alphanumeric and graphic products and the time between a weather event and the display of the event (questions #3, #4, and #5). Five of the meteorologists felt that the alphanumeric products were provided in a timely manner and were an aid to their operations. Six of the respondents agreed with this statement, "The time required for the system to display graphic products was reasonable." Six of the seven meteorologists also agreed that the time between the weather event and display of products was satisfactory, which showed a high level of acceptance in all situations.

Question #6 asked if the system adequately provided products under various scan strategies. All seven of the meteorologists replied Yes.

Questions #7 and #8 were similar questions asking about the use of the mouse with the graphic tablet. Question #7, however, asked if the mouse/tablet was convenient to use for PUP procedures, whereas question #8 asked if the mouse/tablet was a suitable device in general. Only three of the seven meteorologists felt that it was easy and convenient to use the mouse/tablet to select various products and perform different functions such as map overlays and graphic editing. On the other hand, all seven of the meteorologists felt that the mouse/tablet was, in general, suitable in the CWSU operations. The debriefings and comments from the respondents seem to indicate that while the mouse/tablet use is operationally acceptable, it is not the preferred method of doing certain CWSU operations. The respondents felt that they needed to become more familiar with the graphic tablet puck system (the procedure of selecting products via way of the graphic tablet) so that it becomes less time consuming and easier to utilize, and that there were too many choices on the tablet. Question #3, of section II of the questionnaire, reiterates this response.

Six of the respondents agreed that the hard copy device and the graphic displays (questions #10 and #11) were suitable and adequate for their CWSU operations. This was an acceptable rating for this equipment.

The statement: "The procedure to maintain a local data base containing the products that are used regularly within the CWSU, is reasonable (#12)," was rated unacceptable with four agrees and three neutrals. It should be noted, however, that only the method of maintaining a data base was questioned. The respondents that rated the comment "neutral" seem to take their view because of the method to be used in maintaining the data base, and not the concept of a data base.

Question #13 asked the respondents about the ease of the PUP startup procedure. Five of the respondents agreed that it was easy, while two expressed the feelings that having to go downstairs in the CWSU area to perform this procedure made it difficult.

Six of the respondents agreed with the statement, "The system should provide you with adequate notification of upcoming system shut-downs in the case of system failure, or maintenance action." The only No answer was in regard to the frequency of the notification and not to the need of the notification as the question asked.

The final question in section I of the Questionnaire asked, "Were the products provided from the NEXRAD PUP helpful to you in preparation for weather briefing?" All seven of the respondents answered Yes.

PUP OPERATIONS.

The participants explai...d at the debriefings that some of the CWSU PUP procedures and functions that were explained in the training have not been experienced by all of the meteorologists in the CWSU; however, they knew the procedures as explained in the Federal Meteorological Handbook (FMH). The meteorologists indicated that they will be able to perform the operations when they become necessary.

The PUP's display procedure was efficient and adequate for all of the meteorologists (question #1). One operator responded to the question by saying "Although confusing at first, the product display procedure has become easy to use with time." All of the respondents were satisfied with the map background/deselection process (question #3).

In question #4, the respondents rated as unacceptable the procedure to request a group of products with the use of the graphic tablet/mouse (Y - 3, N - 3, Y/N - 1). The comments noted that the procedure was cumbersome and time-consuming. The debriefing discussion on this question indicated that the respondents felt that with more time and experience with the graphic tablet that they would grow to appreciate its use and functions in their operations.

In response to the statement, "Requesting, displaying and manipulating weather products via the keyboard (data entry device) was a routine operation free of problems." (Question #5), four said Yes, two said No, one said Yes/No. This question has a response rating that is operationally unacceptable. The meteorologists' comments were as follows:

"Seldom used and also more time consuming."

"Rather complex...much simpler to use the Graphic Tablet."

"Have not done enough of this."

"Although it takes much longer to request or display products, using the keyboard... it is not hard to do."

The debriefings, indicated that requesting, displaying, and manipulating products by using the keyboard took longer to do but was not difficult.

Both the selection and manipulation of the archive, and alert area functions, were rated as adequate (questions #8 and #9).

The respondents were asked for additional comments on the selection and manipulation of any graphic tablet function and/or alphanumeric terminal function not covered in previous questions that was unsatisfactory. Six of the respondents made comments on this question. The comments had a range of dissatisfactions and suggestions, such as: (1) graphic tablet manipulations and alphanumeric terminal are too complex, (2) the time lapse function stops, (3) not enough time in severe weather to look up selections, and (4) adapt the system more for CWSU operations.

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WORKLOAD.

The majority of the participants (six of seven) felt that the PUP system added to their workload. The increase in the workload was expressed by the following responses from the participants:

> "Having the NEXRAD with its literal plethora of information available to you means that just looking at the reflectivity of a storm... you have to look at its velocities, echo tops VIL [Vertically Integrated Liquid], etc!!"

> "Yes very much, we don't have time to monitor. To use the PUP properly you should have someone in front of it at all times when weather (WX) is present."

> "The amount of new data coming from the PUP just takes more time to view."

In the debriefings, the meteorologists generally felt that the PUP is a sophisticated piece of equipment that comes with defined procedures and functions that require a high degree of proficiency and experience to operate properly. Despite its complexity, five of the seven respondents felt that the NEXRAD PUP was a help in the performance of their duties. The products received from the PUP were rated as operational useful, however, the workload increased because of the attention that must be given to the PUP in order to get the fullest value from the system.

TRAINING.

The general opinion of the participants concerning the training that they received was that it was adequate but too comprehensive (five said it was adequate, two said not adequate). It was clear from their comments, and the debriefings, that they felt that the training should stress more CWSU operational duties and less general meteorological topics. They wanted to learn more about the standard procedures and functions used in the PUP.

OVERALL EFFECTIVENESS AND SUITABILITY.

Question #1 of section V asked, "How do you feel about the overall effectiveness and suitability of the NEXRAD PUP?" All of the respondents answered favorably about the NEXRAD PUP. This is reflected in the following comment:

> "Overall PUP is a good product. However, it must be stressed that the needs of CWSU meteorologists are for instantaneous products which will enable you to make real time operational decisions. Having fast access to needed products with proper time-lapse features/map background is much more critical than something with a lot of "bells and whistles" which requires extensive operator manipulation. Being staffed by only 1 person, anything at a CWSU which requires time-consuming or extensive operator manipulation will be counter-productive."

It is further reiterated with this comment:

> "The NEXRAD PUP is great but it first comes down to bodies to work it. You need someone to be in front of it at all times when we have severe weather especially if you have to switch radars, and of course bodies cost money and that's something the FAA doesn't have."

These comments are similar to the ones discussed in the Workload section. They all address the staffing in the CWSU as being inadequate for their operations.

Only four of seven respondents view the current NEXRAD PUP as suitable for the CWSU operational environment (unacceptable rating). One respondent said "Yes/No. Yes, because of the additional weather support for ZHU [Houston ARTCC] major terminals. No, because of the entire ZHU airspace is not being supported by the PUP." Another respondent said "First I don't think the development of NEXRAD was solely for the operation of a CWSU -- suitable, maybe, but not built with a CWSU in mind. The system I am sure is capable but needs improvements or adjustments." The two respondents that answered No to the question had comments relating their concern with accessing the nonassociated NEXRAD radars in their ARTCC airspace. One respondent commented, "We need an additional dedicated PUP for southern half ZDC [Washington ARTCC] (dedicated). No dial...."

One respondent commented, "FAA Hdqtrs. will have to make the dial-in procedure to non-associated radar sites as easy, fast and efficient as possible to enable CWSU Mets to detect/observe echoes outside their associated radar's coverage area but still within their ARTCC's airspace."

Comments were also made by several of the respondents expressing the "hope" that the FAA will provide a means that will allow ready access to NEXRAD RPGs in and around the ARTCC airspace; one that will provide mosaics of radar products.

SUMMARY.

The most outstanding overall benefits that the meteorologist noted in their comments and debriefings were that the PUP gave them quality weather products and helped them in the preparation of weather briefings given to the FAA. The most significant issues noted were the lack of time and staff to get the full benefits of the PUP, the lack of dedicated radars to cover airspace, and the need for CWSU specific NEXRAD PUP training. The participants were also concerned with the increased workload that was experienced due to the excessive amount of unnecessary products.

CONCLUSIONS

The evaluation of the Next Generation Weather Radar (NEXRAD) Principal User Processor (PUP) by the Washington and Houston Air Route Traffic Control Centers (ARTCC) Center Weather Service Unit (CWSU) meteorologists provided significant input to the operational suitability and effectiveness of the NEXRAD PUP in the ARTCC environment. Some of the significant findings are:

Although the NEXRAD PUP increased their workload, the meteorologists generally liked the system and found the superior radar information useful in their duties.

Due to the complexity of the PUP procedures and the numerous amount of NEXRAD radar products, the meteorologists felt that it was difficult and that there was insufficient time for one person to adequately utilize all the information available.

The dial-up system to access nonassociated radars in the ARTCC area was viewed with concern, and thought to be inadequate for CWSU operations, especially during periods of widespread thunderstorm activity.

The NEXRAD PUP training was generally adequate, but greater emphasis on CWSU activities, with lesser emphasis on nonrelated weather activities, would have been more beneficial.

Maintaining and sharing lists of User Functions (UF) and Routine Product Set (RPS) lists, with other CWSUs, would decrease the workload associated with requesting products. The RPS list would save time and effort by providing only the products necessary for the CWSU operations.

RECOMMENDATIONS

This data should be shared with the Real-Time Weather Processor (RWP) Program Office for input to the RWP specification. This applies particularly to the Center Weather Service Unit (CWSU) requirement which has a system with the means to automatically and readily access all Next Generation Weather Radar (NEXRAD) Radar Product Generators (RPGs) within and around the Air Route Traffic Control Center (ARTCC) airspace, and also has the capability of displaying timely mosaics of specific radar products.

The workload should be reviewed in terms of personnel requirements for efficient and effective operations with the Principal User Processor (PUP).

It is also recommended that specific training be provided to CWSU personnel which focuses on CWSU operations, particularly on the acquisition and manipulation of those products which are most useful for air traffic control (ATC), including optimum use of User Functions (UF).

ACRONYMS AND ABBREVIATIONS

AFOTEC	Air Force Operational Test and Evaluation Center
ARTCC	Air Route Traffic Control Center
CRT	Cathode Ray Tube
CWSU	Center Weather Service Unit
DRR	Deployment Readiness Review
DOC	Department of Commerce
DOD	Department of Defence
DOT	Department of Transportation
FAA	Federal Aviation Administration
FMH	Federal Meteorological Handbook
IOT&E	Initial Operation Test and Evaluation
MIC	Meteorologist in Charge
MOA	Memorandum of Agreement
NEXRAD	Next Generation Weather Radar
NPC	Nexrad Program Council
OSF	Operational Support Facility
OT&E	Operational Test and Evaluation
PUP	Principal User Processor
RPG	Radar Product Generator
RPS	Routine Product Set (list)
RWP	Real-Time Weather Processor
SOP	Standard Operating Procedure
TEMP	Test and Evaluation Master Plan
UF	User Function
VIL	Vertically Integrated Liquid
WSR-88D	Weather Surveillance Radar 1988 Doppler
ZDC	Washington, DC Air Route Traffic Control Center

APPENDIX A

NEXRAD PUP EVALUATION QUESTIONNAIRE

SECTION I: PUP'S WEATHER PRODUCTS.

1. Does the NEXRAD PUP provide you with the products you need for your operational duties in the CWSU?

   ___ Yes ___No

   If your answer is No, please comment.

   _____

   _____

   _____

2. Are all of the products provided by the NEXRAD PUP <u>necessary</u> for your operational duties in the CWSU?

   ___ Yes ___No

   If your answer is No, please comment.

   _____

   _____

   _____

3. Were the alphanumeric products provided to you in a <u>timely manner</u> so as to aid you in your operational functions in the CWSU?

   ___Yes ___No

   If your answer is No, please comment.

   _____

   _____

   _____

4. The time required for the system to display graphic products was reasonable.

   A. Disagree   B. Neutral   C. Agree

Please comment:

   _____

   _____

   _____

5. The time required between the weather event and display of products is satisfactory for your operational requirements.

   A. Disagree   B. Neutral   C. Agree

Please comment:

_____

_____

_____

6. Did the system adequately provide requested products in the various scan strategies?

   ___Yes ___No

   If your answer is No, please comment.

_____

_____

_____

7. Was it easy and convenient to use the Graphic Tablet with the mouse to select various products and perform different functions (such as map overlays, cursor control, graphic editing and etc.)?

   ___Yes ___No

   If your answer is No, please comment.

_____

_____

_____

8. Was the mouse suitable for use with the Graphic Tablet?

   ___Yes ___No

   If your answer is No, please comment.

_____

_____

_____

9. Were the <u>procedures</u> for acquisition and display of the FAA Air Traffic oriented products (such as layer products) adequate for your operational requirements?

___Yes ___No

If your answer is No, please comment.

_____

_____

_____

10. The hard copy devise (printer) was capable of producing suitable printouts in a timely manner.

A. Disagree   B. Neutral   C. Agree

Please comment:

_____

_____

_____

11. The color graphic displays were free of flicker and distortion and were adequate for the CWSU operational environment.

A. Disagree   B. Neutral   C. Agree

Please comment:

_____

_____

_____

12. The procedure required to maintain a local data base containing the products that are used regularly within the CWSU, is reasonable.

A. Disagree   B. Neutral   C. Agree

Please comment:

_____

_____

_____

13. Was there a PUP startup procedure in place that could be easily used in the event of a shutdown of the NEXRAD PUP?

___Yes ___No

If your answer is No, please comment.

_____

_____

_____

14. The system could provide you with adequate notification of upcoming system shutdowns in the case of system failure, or maintenance action.

A. Disagree   B. Neutral   C. Agree

Please comment:

_____

_____

_____

15. Were the products provided from the NEXRAD PUP helpful to you in preparation for weather briefings?

___Yes ___No

If your answer is No, please comment.

_____

_____

_____

SECTION II: FAA PUP OPERATIONS

1. Did you find the "Product Display" procedure efficient and adequate for the NEXRAD PUP operations?

___Yes ___No

If your answer is No, please comment.

_____

_____

_____

2. Was the Graphic Tablet convenient to use in the CWSU operational environment?

___Yes ___No

If your answer is No, please comment.

_____

_____

_____

3. Were the background maps capable of easy selection or deselection?

___Yes ___No

If No, please explain.

_____

_____

_____

4. Was the <u>procedure</u> required to request a group of products with the use of the Graphic Tablet/Mouse reasonable and convenient?

___Yes ___No

If No, please explain.

_____

_____

_____

5. Requesting, displaying, and manipulating weather products via the keyboard (data entry device) was a routine operation free of problems.

___Yes ___No

If your answer is No, please comment.

_____

_____

_____

6. Are the capabilities, selection, and manipulation of the archive functions adequate for your requirements?

___Yes ___No

If your answer is No, please comment.

_____

_____

_____

7. Are the capabilities, selection, and manipulation of the "Alert Area" functions on the Graphic Tablet adequate for your operations?

___Yes ___No

If your answer is No, please comment.

_____

_____

_____

8. Are the capabilities, selection, and manipulation for setting and editing product alerts on the Alphanumeric Terminal adequate for your operational requirements?

___Yes ___No

If your answer is No, please comment.

_____

_____

_____

9. Are the resolution capabilities associated with the time-lapse function adequate for your operational requirements?

___Yes ___No

If your answer is No, please comment.

_____

_____

_____

10. Please make additional comments on the selection and manipulation of any Graphic Tablet function and/or Alphanumeric Terminal function, not covered above, that was not satisfactory for your operational requirements.

_____

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SECTION III: WORKLOAD.

1. Did the NEXRAD PUP add to your workload?

___Yes   ___No

If yes, please explain.

_____

_____

_____

2. Did the NEXRAD PUP equipment help or hinder you in the performance of your CWSU duties?

___Yes   ___No

Please explain.

_____

_____

_____

3. Provide comments on any workload impacts that you experience in using any of the equipment in the NEXRAD PUP. (Both positive and negative comments are requested.)

_____

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_____

SECTION IV: TRAINING

Was the training you received adequate for your duties in operating the PUP in the CWSU?

___Yes   ___No

Provide any comments (negative or positive) on the training you received for your duties in the NEXRAD PUP.

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SECTION V: OVERALL OPERATIONAL EFFECTIVENESS AND SUITABILITY

1. How do you feel about the overall effectiveness and suitability of the NEXRAD PUP.

    Please comment.

    _____

    _____

    _____

    _____

2. Do you view the current NEXRAD PUP as suitable for a FAA CWSU operational environment?

    ___Yes   ___No

    Please explain.

    _____

    _____

    _____

3. Please list any further comments you have regarding the NEXRAD PUP.

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Your input is valuable to this OT&E test, thank you for your cooperation.

APPENDIX B

PARTICIPANTS' RESPONSES AND COMMENTS

I. PUP'S WEATHER PRODUCTS

Question 1. Does the NEXRAD PUP provide you with the products you need for your operational duties in the CWSU?

Response: YES - 6   NO - 1

Comments: "The WSR-88D system due to its greater sensitivity and power can provide the same standard products provided by older weather radars but of much superior quality. It also provides other products very useful to the CWSU environment such as doppler products, but the utility of many of these PUP products must wait for more field experience."

"There are 3 altitudes on the layer reflectivity and turbulence products. The "mid" altitude should be changed from "24,000-33,000 ft" to "24,000-40,000 ft" so we can view the reflectivity & turbulence at the altitude flown by commercial airliners in ARTCC Operations."

Question 2. Are all of the products provided by the NEXRAD PUP <u>necessary</u> for your operational duties in the CWSU?

Response: YES - 0   NO - 7

Comments: "NEXRAD (WSR-88D) system products were developed to fulfill the needs of several weather disciplines. Some of these products may have little direct application to CWSU support, but the system allows you to select which products will be useful to your operations via Routine Product Set (RPS) lists."

"The following products are not necessary: one and three hour precipitation, comp ref & echo tops contour, combined shear and shear contour products seldom used; sw cross section, combined moment, VAD."

"Nexrad was set up for weather service use. About 10 to 20% of NEXRAD products are used."

"Certain products..like 'storm total pcpn' are not directly necessary for CWSU operations."

"Spectrum width is unnecessary. Combined shear is useless."

"NEXRAD was set up for weather service use. About 10-20% of NEXRAD products are used."

Question 3. Were the alphanumeric products provided to you in a <u>timely manner</u> so as to aid you in your operational functions in the CWSU?

Response: YES - 5   YES/NO = 1   DID NOT KNOW - 1

Comments: "Yes/No. Not certain just how to answer this question. Most alphanumeric products observed/used are automatically annotated to graphic products or on the Application Terminal in response to user commands or user functions. Probably more experience needed to evaluate this function."

                "I use only graphics products, usually reflectivity or velocity products."

                "Seldom used."

Question 4.   The time required for the system to display graphic products was reasonable.

Response: AGREE - 6   NEUTRAL - 1

Comments: "The response time for displaying a reflectivity or velocity loop sometimes seems a little slow (sometimes 5 seconds or more). One-time request sometimes take several minutes."

                "Products can be displayed within a few secs. of requested time."

                "All the products with the Associated NEXRAD are appropriate."

Question 5.   The time required between the weather event and display of products is satisfactory for your operational requirements.

Response: AGREE - 6   DISAGREE - 1

Comments: "For a rapidly changing weather situation (e.g., gust front or fast moving thunderstorm) or a short term situation downburst) the display is too "old". Also when in B mode the vert wind profile updates winds every 10 minutes which is too course time resolution for a fast moving front. Most of the time (90%) the products are timely enough."

                "Screen should be monitored a lot more than is possible by us."

                "Although there can be up to six mins difference between a weather event & product..this does not cause a problem in CWSU."

Question 6.   Did the system adequately provide requested products in the various scan strategies?

Response: YES - 7   NO - 0

Comments: "The system provides routinely those products you have specified on your RPS lists. One-time request products are always available depending on radar mode (pcpn or clear air) which the PUP operator should be aware of."

                "Aside from the normal range folding problems."

Question 7. Was it easy and convenient to use the Graphic Tablet with the mouse to select various products and perform different functions (such as map overlays, cursor control, graphic editing and etc.)?

Response: YES - 3   NO - 3   DID NOT KNOW - 1

Comments: "It is a complex and flexible system with which the operator must become familiar with to operate properly. The Graphic Tablet Puck system works quite well."

"Using the graphics tablet to overlay products and use functions rarely performed sometimes results in products lost or not received at all (probably due to lack of familiarity in using certain functions)."

"Too many choices on tablet to call up different products."

"Cross-sections are still too time consuming to create."

Question 8. Was the <u>mouse</u> suitable for use with the Graphic Tablet?

Response: YES - 7   NO - 0

Comments: None.

Question 9. Were the <u>procedures</u> for acquisition and display of the FAA Air Traffic oriented products (such as layer products) adequate for your operational requirements?

Response: YES - 3   NO - 3   YES/NO - 1

Comments: "Yes/No. Again these products are acquired via one-time requests from the radar or routinely via RPS lists which are prepared by the local PUP focal point. It appears that layer products may have only limited advantages over base products. We have not had sufficient time to evaluate other products such as turbulence and spectrum width."

"Procedures are similar for all products."

"See question #1's comments. Change mid altitude to "24,000-40,000 ft" which is the altitude most commercial airliners fly to improve the use of layer products in CWSU operations."

"A lot of the different products are not necessary like spectrum width."

"The spectrum does not seem very useful."

Question 10. The hard copy devise (printer) was capable of producing suitable print-outs in a timely manner.

Response: AGREE - 6   NEUTRAL - 1

Comments: "Sometimes in a busy period printing several products is a slow process since printing each product takes a few minutes."

Question 11. The color graphic displays were free of flicker and distortion and were adequate for the CWSU operational environment.

Response: AGREE - 6   DISAGREE - 1

Comments: "The dual CRT display system employed by the system is quite good."

Question 12. The procedure required to maintain a local data base containing the products that are used regularly within the CWSU, is reasonable.

Response: AGREE - 4   NEUTRAL - 3

Comments: "The data base is controlled by RPS lists which we have control of here at the CWSU. The procedure for generating and maintaining these lists is not difficult. It will take a year or so to become sufficiently familiar with all the PUP products and be able to prepare and use RPS lists which best fit particular CWSU situations."

"Building and changing RPS lists is very easy."

"Going through the NEXRAD radar committee and the WSFO to add products to our data base can be time consuming."

"The "local data base" revolves around map backgrounds, RPS lists and UFs. Each CWSU should share its lists of UFs and RPS with the other CWSUs to obtain new ideas as well as assisting newly installed PUPs as other CWSU come on line."

Question 13. Was there a PUP startup procedure in place that could be easily used in the event of a shutdown of the NEXRAD PUP?

Response: YES - 5   NO - 2

Comments: "The procedures for bringing the PUP up from a simple graphics hang-up to a more serious locking of the processor was discussed in Norman training, in the manuals from the Norman training, and in the PUP Operations Manual provided by the OSF. In addition, the PUP Operations Guide prepared and maintained at the CWSU, explains these methods in detail. Last but not least, this is a proficiency requirement for PUP operators."

"That information is located in our station duty manual."

Question 14.   The system could provide you with adequate notification of upcoming system shutdowns in the case of system failure, or maintenance action.

Response: AGREE - 6   DISAGREE - 1

Comments: "Preventive maintenance should be accomplished on days of no significant weather. Notification of such interruptions should be coordinated between the CWSU and the person in charge at the office where the radar is located. This could be a URC committee agreement."

"We are dependent upon how frequently the RPG operator disseminates a free text message for information on prev maint and system crashes and estimated time the Sterling WSR-88D will return to operation."

"The system sometimes "lock-up" or "freezes" with no update, and messages in. User function 13 can be helpful understanding why an outage occurs."

Question 15.   Were the products provided from the NEXRAD PUP helpful to you in preparation for weather briefing?

Response: YES - 7   NO - 0

Comments: "Most useful for oral briefings where you can display and explain for the user NEXRAD products."

"The vertical wind profile and selected user functions are very helpful in preparing weather briefings when there are enough "scatters" to get a vertical wind profile, etc."

II. FAA PUP OPERATIONS

Question 1.   Did you find the "Product Display" procedure efficient and adequate for the NEXRAD PUP operations?

Response: YES - 7   NO - 0

Comments: "Although confusing at first, the "product display" procedure has become easy to use with time."

Question 2.   Was the Graphic Tablet convenient to use in the CWSU operational environment?

Response: YES - 5   NO - 2

Comments: "Too many things to pick from when trying to call up products."

"Too time consuming."

Question 3. Were the background maps capable of easy selection or deselection?

Response: YES - 7   NO - 0

Comments: None.

Question 4. Was the underlined procedure required to request a group of products with the use of the Graphic Tablet/Mouse reasonable and convenient?

Response: YES - 3   NO - 3   YES/NO - 1

Comments: "Yes/No. The only way to accomplish this through the graphics puck is through user functions which have been previously defined through the Application Terminal."

"The graphic table from which one-time request or products of a different elevation angle are chosen is cumbersome - - I would rather select products from a 'simple listing' of products."

"Not applicable when you have a lot of TSTMS."

"Too time consuming."

Question 5. Requesting, displaying, and manipulating weather products via the keyboard (data entry device) was a routine operation free of problems.

Response: YES - 4   NO - 2   UNKNOWN - 1

Comments: "Rather complex...much simpler to use the Graphics Tablet."

"Although it takes much longer to request or display products using the keyboard, it is not hard to do."

"Seldom used and also more time consuming."

Question 6. Are the capabilities, selection, and manipulation of the archive functions adequate for your requirements?

Response: YES - 6   NO - 1

Comments: "No guidance provided from FAA HDQTRS on how, on what frequency and what use of archive products. Also, how can you 'play back' archive products? Currently, it can't be done locally. How useful is it?"

Question 7. Are the capabilities, selection, and manipulation of the "Alert Area" functions on the Graphic Tablet adequate for your operations?

Response: YES - 6   UNKNOWN - 1

Comments: "I do not use the alert area (or haven't so far)."

"Seldom used since plotting desk is next to PUP and also alert feature can't be used when a meteorologist is not on duty."

Question 8. Are the capabilities, selection, and manipulation for setting and editing product alerts on the Alphanumeric Terminal adequate for your operational requirements?

Response: YES — 6   UNKNOWN — 1

Comments: "Only PUP focal point can change alert area one. Individual operators can change area two."

"Again I haven't used the alert functions yet (but I may for the upcoming thunderstorm season). I do use the hail and storm track functions."

"As long as we do not rave a lot of severe weather like TSTMS, etc."

Question 9. Are the resolution capabilities associated with the time-lapse function adequate for your operational requirements?

Response: YES — 6   NEUTRAL — 1

Comments: "It would be better, however, if loss of resolution did not occur at 1 min."

"We use time lapse function very often because it provides a way of updating reflectivity, velocity products without manual manipulation as well as giving information on motion and development of echoes."

Question 10. Please make additional comments on the selection and manipulation of any Graphic Tablet function and/or Alphanumeric Terminal function, not covered above, that was not satisfactory for your operational requirements.

Response/Comments:

"Graphic Tablet manipulation and the Alphanumeric Terminal are both rather complex in that there are so many different products and methods for product manipulation. For the CWSU environment customizing must be accomplished which will allow the user very quick access to frequently used products and sequence of products."

"Continuous loop on time lapse function sometimes stops for no reason."

"This system needs to be adapted more for CWSU use in the future. Specifically, the ability to filter out dBZ of less than 15 or 25 dBZ should be able to be done more quickly than at present. As it is now every reflectivity display which is called up requires you to take the extra step of filtering out the dBZ less than 15 or 25 dBZ. Without this, the display is too "busy" and large. More significant cells are more easily missed or obscured by the large area of extremely weak returns."

"In the event of severe weather we don't have time to look up a lot of the selections on the graphic tablet or use the alphanumeric terminal."

"(1) Time lapse function may run for 5-6 minutes but then gets hung up. (2) Have to reset time lapse to continue update whenever you do pup-down. reinit, etc. Change the default for continuous update from N to Y !"

"Time consuming, especially when TSTMS and not knowing where all the selections are on the tablet."

III. WORKLOAD

Question 1. Did the NEXRAD PUP add to your workload?

Response: YES - 6   NO - 1

Comments: "YES. Explanation: (1) It is and added sophisticated piece of equipment for which local operating guides must be prepared and maintained. (2) It is obviously better and very visible to our user. Therefore we must be proficient in the operation of the system and be able to explain the meaning of NEXRAD data."

"To use the PUP properly you need to monitor the PUP constantly but we cannot do that here because of other workload."

"It gives more information but requires manual manipulation except for the time lapse mode which hangs up and often has to be reset. UFs save time, though."

"Having the NEXRAD with its literal "plethora" of information available to you means that instead of just looking at the reflectivity of a storm and seeing its intensity, you are now likely to look at velocities, echo tops, VIL, etc !!"

Question 2. Did the NEXRAD PUP equipment help or hinder you in the performance of your CWSU duties?

Response: 5 - Help   2 - Help and Hinder.

Comments: "Even the basic reflectivity products from the WSR-88D system are much superior to similar products from the old WSR-57 radars."

"Increase workload takes a little bit from briefing duties and updates to FAA personnel."

"It hinders you in the fact that you want to stay with the PUP and you know that you don't have the time to do it. So you sort of get frustrated because you have too much other stuff to do."

"The PUP has been very helpful in performing CWSU duties. With the radar near our major terminals info from the PUP has improved local CWSU forecast."

"It helps but to get all the information from it you almost need a second meteorologist on duty. Occasional gust fronts will appear on a VIL or SRM time lapse if it is oriented just right with respect to radar site sometimes spectrum width is also helpful."

Question 3. Provide comments on any workload impacts that you experience in using any of the equipment in the NEXRAD PUP. (Both positive and negative comments are requested).

Comments: "For the user, he/she must be proficient in the operation of another complex system and occasionally must go downstairs to restore the system after it has locked up. For the manager, he/she must see that operators are proficient, that the system is properly utilized, and that local operating guides are adequate and properly maintained."

"I sometimes get a little perturbed concerning the frequent (several times per hour) "freezing" of the reflectivity, velocity loops requiring manually "restarting" the loops."

"Time lapse is a good function for us because it helps us save some time so we won't have to look at a series of products because time is short."

"Data from the PUP is fantastic. However, in an active weather situation over a large portion of our 21,000 square miles airspace, the PUP's radar display covers about 1/10 of this area. It is often tempting to get bogged down manipulating/analyzing PUP data, but once more there are still 18,000 other square miles of airspace to worry about, and keep a weather watch over. Bottom line: where the staffing consists of one person, it is very difficult in an active center-wide weather situation to use anything more than the base reflectivity product on the PUP, due to time constraints."

"Since the PUP covers only part of the ZHU airspace..sometimes I find I'm neglecting other sections of the ZHU by spending time analyzing PUP data."

IV. TRAINING

Question: Was the training you received adequate for your duties in operating the PUP in the CWSU?

Response: YES = 5 NO = 2

Comments: "The general training was quite good considering the complexity of
              this new system. For it to have been more slanted to CWSU
              operations, the FAA should have been more directly involved."

              "Some of the training received at Norman was not necessary for CWSU
              operation."

              "Training should have involved much _less_ meteorological theory and
              much _more_ operational use of the PUP and alphanumerical terminal!"

              "I could use an abbreviated list of procedures for the various
              functions (without explanations), just a list of steps."

              "OSF training for CWSU too long, covered flood information we don't
              need at CWSU and also UPC was not needed."

              "As more NEXRAD sites become operational the OSF training course at
              Norman, OK should stress retrieving data and map backgrounds for
              nonassociated PUPs since CWSU mets will have to dial in to 3-5
              WSP-88D radars other than their associated radar site."

              "Class too long for CWSU needs. Covered operations which we don't
              need. Also a lot of hydrology, tornado alert and things of this
              nature. We need information for aviation, not for public use."

V. OVERALL EFFECTIVENESS AND SUITABILITY

Question 1. How do you feel about the overall effectiveness and suitability of
              the NEXRAD PUP?

Response: All of the respondents that received training on the PUP responded
              favorably to the system. Their comments are as follows:

              "Primarily the PUP is most useful for the limited area of the
              particular surveillance area of the radar with which it is associated
              (dedicated to) and of lesser value for those areas covered by other
              radar for which must be accessed via dialing. Therefore, it is very
              important that for a single PUP, the dedicated radar be the one that
              covers your center's most critical airspace. Hopefully, the FAA will
              continue the development of the RWP system which will allow timely
              and proper access to all NEXRAD systems in and around the airspace."

              "I'm very pleased with the NEXRAD PUP and find it very effective in
              CWSU operations especially since our radar covers ZHU major terminals
              at IAH and Houston. Once you become familiar with the PUP... it is
              very simple to use."

              The information is invaluable but we can't use it to its fullest
              because of other duties, primarily constant briefing especially
              during TSTMS season."

"The PUP is great it has so many features that we can't use them all. The only way it can be used to its fullest is if we had more people to monitor it. You need someone on it full time."

"Stability is good. However, at the present time, it is impossible for one meteorologist (current CWSU staffing) to adequately monitor weather over a 21,000 square mile area which includes monitoring 10 WSR-57 radars, and at the same time have the freedom of time to put the PUP through its various nuances (that is parking cross sections, looking at velocity products at low altitudes and comparing them with high altitudes)."

"I'm glad we have the NEXRAD display. I find it very valuable and useful, but I realize the amount of info coming from the radar sometimes go beyond my capabilities to interpret and understand (on a few of the products provided by the radar)."

"I think it's a good system overall that provides a lot of useful information as long as you are aware of its basic limitations and have to sit in front of it."

Question 2. Do you view the current NEXRAD PUP as suitable for a FAA CWSU operational environment?

Response: YES - 4   NO - 2   YES/NO - 1

Comments: "The WSR-88D radar to which our PUP is dedicated to cover what I feel is the most critical part of our airspace, and with its superior capability of detecting and displaying weather, it is a valuable tool. Also, the NEXRAD display and archiving of products are clearly superior to the MWP and therefore more useful for operations. I believe the user (Air Traffic) will verify this now and even more emphatically after we've had more operational time."

"We need more than one to cover all our area. Some CWSU will need up to 4 of them to cover theirs. Our airspace is just too big."

"It's great for weather within 124 nm of your associated radar site. FAA HDQTRS will have to make the dial in procedure to non-associated radar sites as easy fast and efficient as possible to enable CWSU MET's to detect/observe echoes outside their associated radar's coverage area but still within their ARTCC's airspace. They will have to be able to obtain the radar data (a sufficient number of products) from non-associated radar sites and the necessary map background quickly and efficiently in order to issue time and accurate CWAs (especially thunderstorm CWAs). The other obtained mosaic of WSR-88D radar sites within/nearby the ARTCC's airspace."

"Yes... because of all the additional Wx support for ZHU major terminals! No... because the entire ZHU airspace is not being supported by the PUP."

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"We need an additional dedicated PUP for Southern half ZDC.
(dedicated). No dialup we need time lapses."

Question 3. Please list any further comments you have regarding the NEXRAD PUP.

Comments: "WSR-88D products displayable on the PUP represent a significant
technological advancement over products from older weather radars.
There is no way within the current CWSU operating structure of only
one meteorologist available on most operational shifts to adequately
utilize the NEXRAD PUP and MWP systems. The FAA consider adding an
additional operational person to the CWSU staff. I suggest a met
intern program similar to that of the NWS. New meteorologists offer
just out of the universities are assigned to field stations as GS-5s
or GS-7s. They can advance to the GS-9 position after which they
must bid and be accepted to a GS-12 journeyman position. This
program would not only provide added help to CWSU staffs but it would
provide the FAA with a pool of trained personnel to fill CWSU slots.
This program should prove to be even more important if there is still
the possibility of CWSU support being extended to 24-hour coverage
and therefore the need for a significant increase in CWSU personnel."

"The NEXRAD PUP is great but it just comes down to bodies to work it.
You need someone to be in front of it at all times when we have
severe Wx especially if you have to switch radars, and of course
bodies cost money and that's something the FAA doesn't have."

"For the fifth time change mid altitude to 24,000-40,000 ft. Fix
time lapse function so it doesn't hang up and it defaults to
continuous update."

"Using the dial-up capabilities of the PUP for viewing other radars
in the ZHU area will not be adequate for CWSU operations."

"Overall, PUP is a good product. However, it must be stressed that
the needs of CWSU meteorologists are for instantaneous products
which enable you to make real time operational decisions. Having
fast access to needed products with proper time-lapse features/map
backgrounds is much more critical than something with a lot of
"bells and whistles" which requires extensive operator manipulation.
Being staffed by only 1 person, anything at a CWSU which requires
time-consuming or extensive operator manipulation will be
counter-productive."

"My main concern is streamlining procedures for requesting products."