Summer 2004
Issue 13

Emphasis on WSR-88D Data Quality

Recently, there has been a great deal of discussion concerning the Radar Operations Center's (ROC's) proactive efforts toward data quality. There have been questions as to why this seems to be happening all of the sudden. Hopefully, I can help alleviate concerns and address these questions from managers, meteorologists, and technicians.

The increased emphasis isn't really sudden, but has been gaining momentum for the last few years. The ROC recognizes that data quality is becoming more and more important for several reasons.

Reason 1: WSR-88D data is being widely distributed to many untrained users. Years ago, distribution of WSR-88D data consisted of a limited set of products to specific private companies, who paid for the information. These companies were collectively called NEXRAD Information Dissemination Service (NIDS) vendors. There were approximately 550 end users, directly connected to the radars; every one of the users was a government entity, with direct 1-800 access to the WSR-88D Hotline and had some formal training. NIDS vendors took care of their customer base training issues by removing non-meteorological data.

Contrast that time period with today, where wideband connections and a selected set of products is free to anyone via the Internet. As a result, the number of users has increased by orders of magnitude and only a small percentage of them has a meteorology background and/or WSR-88D training. Such users are unaware of the technical issues and limitations of the data, but routinely use government-provided data to make operational, financial, and personal decisions. This is one of the reasons the NEXRAD Program Management Committee (NPMC) mandated the ROC develop and implement a radar data quality program.

Reason 2: Often, WSR-88D data is used without knowledge of how the radar was operating when the data was collected. For example, a meteorologist using radar data for a study on a significant precipitation or tornado event would not always know the state of the radar when the radar data was collected. Factors such as the type of clutter suppression used, whether the radar was properly calibrated, and whether the antenna pointing angle was accurate could affect the outcome of the study. There are hundreds of private, educational, and government organizations using WSR-88D data for research and business. That is why it is vital WSR-88D data be the highest quality possible.

Reason 3: Open RDA deployment is just around the corner! Work is quickly progressing toward the deployment of a hardware upgrade to the

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Radar Data Acquisition (RDA) system, also known as Open RDA (ORDA). Radars not optimized before ORDA deployment may introduce data quality issues for ORDA.

Reason 4: Sites exist, which are running alarm-free, within specifications, but which are producing questionable data. The ROC is working hand-in-hand with agencies, regional headquarters, and site offices to determine how this situation can occur. While monitoring network data quality, the ROC identified a few radar sites experiencing data quality problems that were running within maintenance specifications. Working with regional headquarters, as well as, site technicians and meteorologists, the ROC is investigating how this is occurring by visiting these sites. Thus far, all radar sites visited were running alarm-free, had been updated with the applicable modifications, and had completed the required preventative maintenance inspections (PMIs). Yet, the data being generated was of questionable quality.

All of the sites had problems suppressing terrain. With zero suppression, the terrain returned over 75 dBZ of power. With the clutter filters on maximum, more than 50 dBZ of "residual clutter" remained. At the RDA, it was confirmed that the radar should be suppressing at least 50 dBZ of clutter with maximum filtering. But, the radars were only suppressing between 25-30 dBZ of clutter. Obviously, this amount of total suppression is not good enough.

After several days at each site, technical personnel were able to determine and correct the causes of the problems. Basically, each radar part was checked and tuned individually. At most sites, major improvements to clutter filtering were observed after replacing and aligning the pulse charge regulator (PCR) and/or the automatic gain control (AGC). At the end of the process, in all cases, each radar was able to effectively suppress over 75 dBZ of clutter. In fact, once all the problems were corrected, each radar was able to adequately suppress the terrain with only medium suppression using the bypass map. Site meteorologists were amazed that their ever-present land forms could be suppressed so effectively. These results have been repeated at five radar sites which have had persistent terrain issues for years.

Although an overused cliché, in this case, the phrase, "A picture is worth a thousand words" applies. Below are before and after images from two sites. In each image, all bin suppression, high is being used. Figure 1 and 2 show base reflectivity images from the first site, with the radar suppressing all bins on high. Figure 1 is before any data quality work was completed, and Figure 2 depicts how the site appeared after ROC and site technicians completed their work

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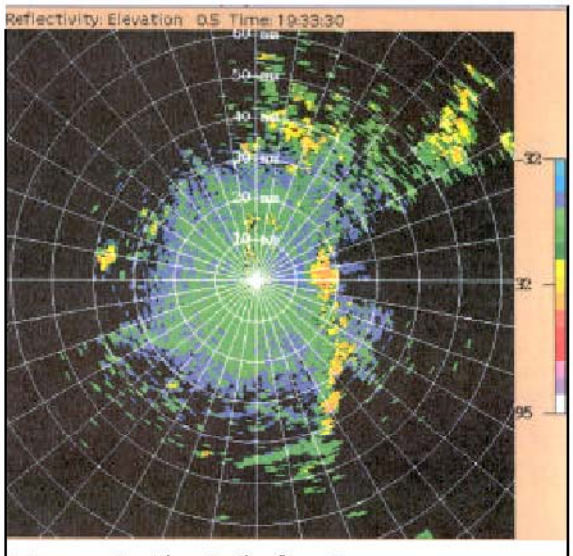

Figure 1: Site 1 "before."

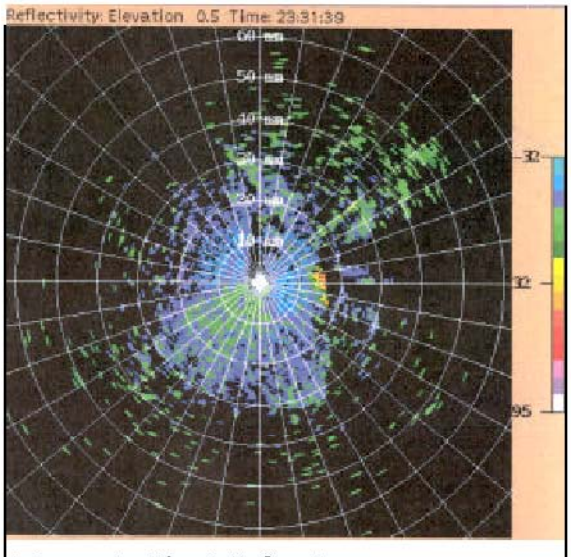

Figure 2: Site 1 "after."

Data Quality *(Cont.)*

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on the system.

Figures 3 and 4 are before and after imagery for the second site. However, these are 8 bit reflectivity products obtained from AWIPS.

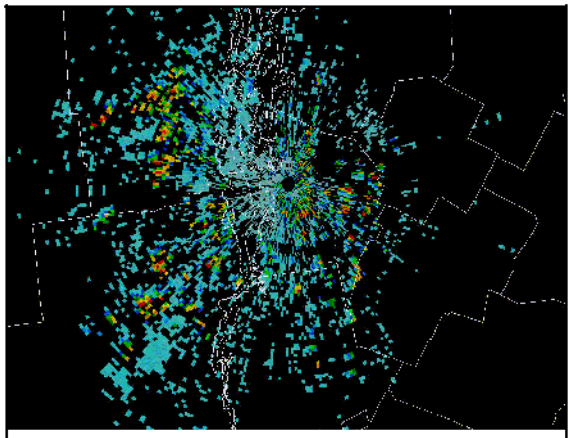

Figure 3: Site 2 "before."

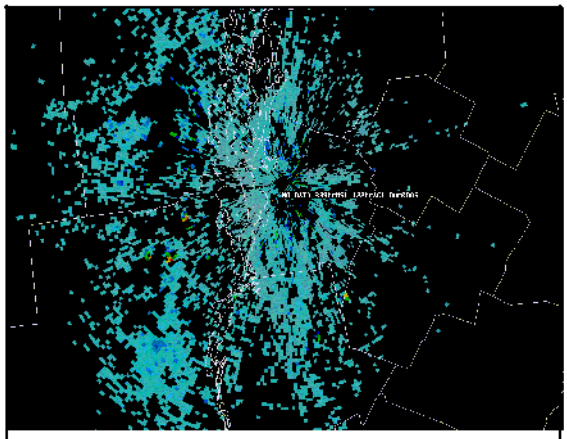

Figure 4: Site 2 "after."

Lessons Learned from Data Quality Site Visits

1. A radar running with no alarms is not necessarily producing good data. All radars in the above discussion were running with no alarms.

2. Although the ROC is still researching these issues, it is believed that to optimize a system, all major components of the system should be aligned together. This process differs from typical maintenance where one or a few parts are fixed, tuned, or replaced, and no other parts are tuned until the next maintenance period weeks later. Components "drift" with time, so in order to optimize the system, all components must be returned to original specifications at the same time.

3. Some hardware specifications/alignments have wide tolerances. And, due to variables in frequency and system components, the most optimum system performance will likely be found within the baselines, but unique from other systems. It takes a critical meteorologist, a patient electronics technician, and plenty of time to optimize the system.

4. "Filtered" and "Unfiltered" suppression numbers, obtained from the RDA, can be misleading. An operator must determine how much clutter the terrain produces with no filtering, then download various suppression levels. Only then can site personnel know exactly how much suppression is occurring. From the site visits conducted, an optimized radar should be able to suppress at least 75dbz of clutter.

5. High levels of residual return may not be terrain. Residual clutter may be due to highly reflective, moving ground targets, such as wind farms or vehicular traffic. Wind farms can still be detected by the radar well outside the half-power beam width. Each site should assess their residual clutter return pattern to determine if their radar routinely detects such non-terrain targets.

6. Spinning the antenna faster as with volume coverage patterns (VCPs) 121 and 12, will likely cause a reduction in clutter filtering capability of the system.

7. Assessing and maintaining data quality begins with site meteorologists. They are trained to routinely make subjective assessments of the atmosphere, using various tools, including the radar. When the radar needs work, it's up to the operators to advise their technicians, especially if the radar is alarm-free, but putting out poor quality data. If there is an alarm, obviously the technician will know there is a problem.

Tony Ray
RSIS/ROC Operations Branch

On the Comms Front...

With changes in technology and tri-agency needs, the area of WSR-88D telecommunications is very dynamic. As of June 1, 2004, twelve Department of Defense (DoD) to NWS Advanced Weather Interactive Processing System (AWIPS) and Distant Master System Control Function (MSCF) connections have been converted from analog telecommunications to frame relay. By the end of June 2004, the transition of the Federal Aviation Administration (FAA) to NWS AWIPS and Distant MSCF connections to frame relay will also be underway. It is anticipated that all DoD/FAA to NWS AWIPS and Distant MSCFs telecommunications will have been transitioned to frame relay by the end of August 2004 (Figure 1).

For more background on the implementation of frame relay and to view the frame relay activation schedule, visit https://www.roc.noaa.gov/FrameRelay/modnoteforrocinstall.asp.

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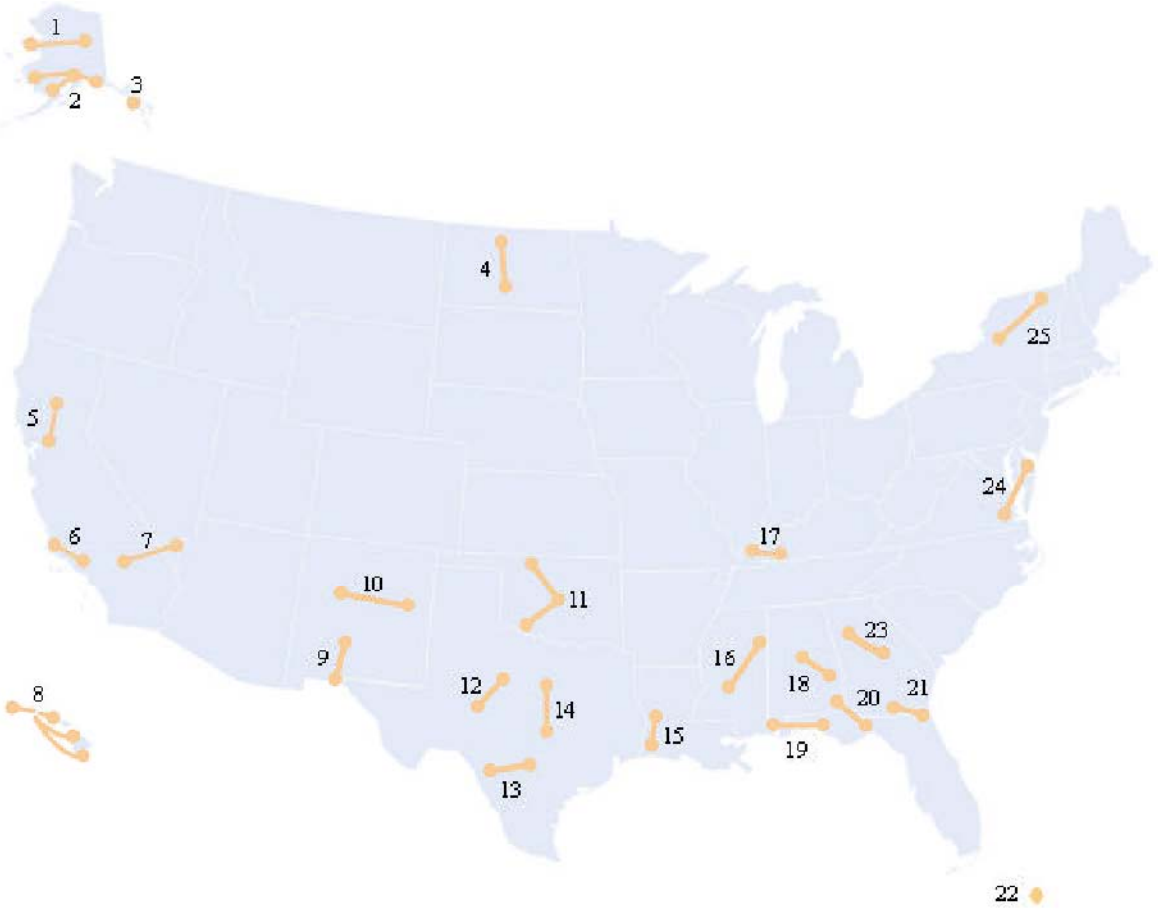
Figure 1: DOD/FAA to NWS AWIPS and MSCF frame relay connections.



Number	DOD/FAA Location	NWS Weather Forecast Office Location
1	PAEC - Nome, AK	PAPD - Fairbanks, AK
2	PABC - Bethel, AK PAKC - King Salmon, AK PAIH - Middleton Island, AK	PAHG - Anchorage, AK
3	PACG - Sitka, AK	PACG - Juneau, AK
4	KBMX - Minot AFB, ND	KBIS - Bismarck, ND
5	KBBX - Beale AFB, CA	KDAX - Sacramento, CA

Comms…*(Cont.)*

Number	DOD/FAA Location	NWS Weather Forecast Office Location
6	KVBX - Vandenberg AFB, CA	KVTX - Los Angeles, CA
7	KEYX - Edwards AFB, CA	KESX - Las Vegas, NV
8	PHKI - South Kauai, HI PHMO - Molokai, HI PHKM - Kohala, HI PHWA - South Shore, HI	PHFO - Honolulu, HI
9	KHDX - Holloman AFB, NM	KEPZ - El Paso, TX
10	KFDX - Cannon AFB, NM	KABX - Albuquerque, NM
11	KVNX - Vance AFB, OK KFDR - Altus AFB, OK	KOUN - Norman, OK
12	KDYX - Dyess AFB, TX	KSJT - San Angelo, TX
13	KDFX - Laughlin AFB, TX	KEWX - Austin/San Antonio, TX
14	KGRK - Central Texas	KFWD - Dallas/Ft. Worth, TX
15	KPOE - Ft. Polk, LA	KLCH - Lake Charles, LA
16	KGWX - Columbus AFB, MS	KJAN - Jackson/Brandon, MS
17	KHPX - Ft. Campbell, KY	KPAH - Paducah, KY
18	KMXX - East Alabama	KBMX - Birmingham, AL
19	KEVX - Northwest Florida	KMOB - Mobile, AL
20	KEOX - Ft. Rucker, AL	KTLH - Tallahassee, FL
21	KVAX - Moody AFB, GA	KJAX - Jacksonville, FL
22	TJUA - San Juan, PR	TJUA - San Juan, PR
23	KJGX - Robins AFB, GA	KFFC - Atlanta, GA
24	KDOX - Dover AFB, DE	KAKQ - Norfolk, VA
25	KTYX - Ft. Drum, NY	KCXX - Burlington, VT

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With DoD/FAA to NWS frame relay connections in place, AWIPS is immediately able to send larger RPS Lists to DoD/FAA WSR-88Ds and routinely receive the larger, high resolution 8-bit/256 data level products. With the receipt of more products from the DoD/FAA radars, AWIPS is able to disseminate a larger set of products to the radar central server.

Frame relay will provide new support tools and telecommunication providers that are largely new to the WSR-88D network. All CONUS frame relay service was awarded to MCI, while AT&T was awarded all OCONUS frame relay service. Both companies offer web-based support tools that are made accessible to the WSR-88D Hotline for near real-time support.

NWS and Air Force Telecommunications (Telco) Managers have been provided with schedules for disconnecting the analog Distant MSCF (Air Force funded) and analog AWIPS (NWS funded) circuits following the frame relay activation dates. The analog circuits will be scheduled for disconnection 60 days after the Distant MSCF and AWIPS are successfully transitioned to the frame relay circuits.

WSR-88D Radar Products Generator (RPG) Build 5.0 and AWIPS Operational Build 3 (OB3) combine to offer AWIPS operators a new means of processing One Time Requests (OTRs) to non-associated RPGs via the AWIPS terrestrial Wide Area Network (WAN OTR). With frame relay implemented between the DoD/FAA radars and LAN-to-LAN connectivity to the NWS

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Comms…*(Cont.)*

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AWIPS, WAN OTR is possible to DoD/FAA radars. The advent of WAN OTR, will allow additional NWS dial lines on RPGs and AWIPS to be deactivated and substantial cost savings realized as a result.

Only those same products that are currently made available via dial OTRs to an RPG are accessible with the initial Build 5.0 WAN OTR implementation. The larger 8-bit/256 data level high resolution products will not be available, however, the product set available for WAN OTR is being expanded in software Build 6.0 to include the following products:

24 - V -Mean Radial Velocity 8 data level, .54nmi, 0 - 124

37 - CR - Composite Reflectivity 16 data level, .54nmi, 0 - 124

32 - DHR - Digital Hybrid Reflectivity, 256 data level, .54nmi, 0 - 124 (compressed)

94 - DR - Reflectivity Data Array, 256 data level, .54nmi, 0 - 248 (compressed)

99 - DV - Base Velocity Data Array, 256 data level, .13nmi, 0 - 124 (compressed)

(Products 32, 94, and 99 are the high resolution '8-bit' products.)

All Air Force Open Principal User Processors (OPUPs), with the possible exception of the Elmendorf, Alaska, 11th Operational Weather Squadron (OWS), have been deployed using the TCP/PPP protocol. 23 of 35 Navy/Marine Small OPUPs will also have been deployed with the remaining systems to be delivered by the end of July.

Navy/Marine weather units previously provided with a legacy Principal User Processor (PUP) obtained a one for one transition to a small OPUP. In contrast, several Air Force Combat Weather Teams (formerly Base Weather Stations) will not receive a Small OPUP. No time line has been established for the deactivation of the remaining Air Force legacy PUPs. WSR-88D Modification Notes 65,71, 72, and 73 incrementally dealt with the conversion of RPG DoD ports to the TCP/PPP protocol.

The FAA is proceeding with Integrated Terminal Weather System (ITWS) deployments and associations to WSR-88Ds in accordance with Modification Note 59. This calendar year, four new ITWS systems will be installed. The new ITWS systems will be located at Boston, associated to KBOX; Denver, associated KFTG by 06/04; Minneapolis, associated to KMPX by 06/04; and Charlotte, associated to KGSP by 09/04. The Boston ITWS, and subsequent installations, will occur with a WSR-88D port upgrade to 33.6 Kbps. The 12 pre-existing ITWS to WSR-88D connections will be upgraded to 33.6 Kbps ports via Modification Note 69.

Successful connections were established between the WSR-88D and the FAA's Microprocessor En Route Automated Radar Tracking System (Micro-EARTS). Staff members established connectivity between the William J Hughes Tech Center in Atlantic City, NJ and the Brookhaven, NY WSR-88D, KOKX, and between the Air Traffic Control Towers in the Hawaiian Islands and the four Hawaiian Island WSR-88Ds. A micro-EARTS association is expected in the near term linking the FAA Program Support Facility at the Mike Monroney Aeronautical Center in Oklahoma City, OK and the Twin Lakes WSR-88D, KTLX, in Norman, OK. Additional Micro-EARTS associations are also anticipated prior to calendar year 2005 for San Juan, PR and Guam. For Micro-EARTS information visit http://www.faa.gov/aua/oceanicatc/index.cfm?content=microearts.

Work with NWSH has been undertaken in hopes of consolidating several RDA-to-RPG wideband T1 circuits under a common Telco provider. The advantages of having most of the wideband circuits provided by a common provider will be many and will likely include web-based support tools similar to those being used with the new frame relay telecommunications.

Site specific WSR-88D communication documentation made available via the ROC Web page continues to evolve in order to meet the requirements of new communications initiatives. The most recent updates to web-based communication documentation have been to accommodate frame relay and to show the addition of the WAN OTR ports.

Mark Albertelly
ROC Operations Branch

WSR-88D Radome and Tower Maintenance Programs

The WSR-88D Radar Operations Center (ROC) has responsibility for the depot-level maintenance of both the WSR-88D radome and tower. Over the past several years, there have simultaneously been both a preventive maintenance program and corrective maintenance program in place to address radome and tower maintenance requirements. The ROC used a team from Hill Air Force Base (AFB) to support a preventive maintenance program, which focused on radome painting, but also addressed some minor radome repairs and tower maintenance issues. The ROC also contracted L3-ESSCO Communications to support the corrective maintenance program for the past five years.

The Radome Preventive Maintenance and Inspection (PMI) program tasked to Hill AFB consisted of a continuous schedule of WSR-88D site visits on an approximate four-year cycle to perform a series of tower and radome component inspections and various depot-level repairs. Although the Hill team performed a number of tasks during these visits, the main purpose for this program was to ensure that each WSR-88D radome was repainted during this four-year cycle of visits. The four-year visit cycle has now been completed and all radomes have been coated with Ameron PSX-700 coating that was selected after extensive testing. With this extremely durable Ameron paint, continuous recoating of the radomes should not be necessary, as multiple layers of paint will negatively impact the performance of the radars. As a result, the ROC made the decision to temporarily halt the Radome PMI program until we begin to witness degradation in the condition of the Ameron paint previously applied.

Does that mean that sites no longer have a radome or tower depot level maintenance capability available to support them? Absolutely not! *All* the radome and tower maintenance tasks previously performed by the Hill PMI team are still available through the ROC's radome maintenance contract with L3-ESSCO Communications, and the tower depot level maintenance is now provided through a recently awarded tower maintenance contract with Southeastern Communications Services (SECS). Each of these contracts provides for every level of service from inspection and minor repair to complete repainting or even replacement.

If a site has a radome or tower issue that requires depot-level maintenance, simply contact the ROC Hotline and request support. The site will be contacted by either ROC personnel from the Retrofit Management Team (RMT) or directly by the contractors providing the maintenance. For both the radome and tower maintenance contracts, the contractors will first coordinate a visit with the site to assess the maintenance required and return at a later date to perform the maintenance. In the event of catastrophic damage or other urgent repairs, the assessment and repair can be performed in a single visit. Common examples of radome and tower problem reports include:

- Leaking radome
- Panel damage from hail, lightning, bullet holes, etc.
- Radome/Tower paint issues (extensive corrosion, peeling, algae, etc.)
- Loose radome panel-to-panel or tower bolts
- Broken down-conductor clips in radome

Each problem reported to the Hotline is evaluated to determine if depot-level maintenance is warranted. The severity of the problem must justify the considerable cost of mobilizing a team for inspection and repair, so site personnel should be prepared to provide digital photographs or detailed descriptions that illustrate the problem scope and severity.

Marty Williams, RMT Team Lead
ROC Program Branch

NEXRAD Now is an informational publication of the WSR-88D Radar Operations Center (ROC).

We encourage our readers to submit articles for publication. Please e-mail all articles and comments to:

ruth.e.jackson@noaa.gov

All previous issues of *NEXRAD Now* can be viewed on the ROC Home Page at:

http://www.roc.noaa.gov/nnow.asp

Director.....Richard Vogt
Editor.....Ruth Jackson

New WSR-88D Mesocyclone Detection Algorithm

With Radar Products Generator (RPG) Build 6.0 and Advanced Weather Interactive Processing System (AWIPS) Operational Build 4.0 (OB4), forecasters will be able to call up a new mesocyclone product from the Mesocyclone Detection Algorithm (MDA). The new product will be available via one time requests or a Routine Product Set (RPS) list and has a mnemonic of MD. The new algorithm is similar to the legacy MESO algorithm in that it finds and displays the location of 3D vortices. The biggest difference between the new and legacy algorithms is that MDA identifies all circulations and assigns a strength rank parameter to each circulation. The strength rank value indicates the strength of each 3D vortex. Forecasters will be able to remove weaker circulations with a strength rank filter. The MD product will also include past and future circulation tracks.

A second new product called the Data-array Mesocyclone Detection (DMD) product, will initially provide rapid update, trend displays, and an interactive circulation attribute table in OB4 SCAN. Additional DMD capabilities will be provided in Display 2 Dimensions (D2D) in a future AWIPS software build. The MDA rapid update function, similar to the Mesocyclone Rapid Update available since RPG Build 4.0, is very different in presentation.

The new MDA algorithm identifies circulations more consistently and outperforms the legacy MESO algorithm. Table 1 compares the performance of MDA and the legacy MESO algorithms and shows the performance advantage of MDA. Information listed in Table 1 and additional MDA details can be found in Stumpf et.al. 1998.

In order to provide for a smooth transition, products from both the new MDA and legacy MESO algorithms will be available for several RPG builds. The legacy MESO algorithm will be removed once users become familiar with the new MDA and its added functionality.

The Warning Decision Training Branch (WDTB) will provide on-line training on MDA in early August 2004, prior to the deployment of AWIPS OB4 currently scheduled for August 16, 2004. For OB4 Beta sites, WDTB will deliver live teletraining on OB4 (including MDA) in June and early July.

As the new MDA algorithm is fielded and forecasters begin to use the new MDA products, the Radar Operations Center (ROC) Applications Branch would like to receive feedback from users. Please send your feedback and comments to Robert Lee, ROC Applications Branch, Robert.R.Lee@noaa.gov. We look forward to hearing your input about the new algorithm and associated products.

Reference: Stumpf, G. J., A. Witt, E. D. Mitchell, P. L. Spencer, J. T. Johnson, M. D. Eilts, K. W. Thomas, and D. W. Burgess, 1998: The National Severe Storms Laboratory Mesocyclone Detection Algorithm for the WSR-88D. *Wea. Forecasting*, **13**, 304-326.

Robert Lee
ROC Applications Branch

Tornadic Circulations				
Algorithm / Performance	POD	FAR	CSI	HSS
Legacy MESO	0.65	0.90	0.09	0.05
MDA (Strength Rank >= 4)	0.58	0.76	0.21	0.31

Table 1: Performance comparison between the legacy MESO and MDA algorithms.

Air Traffic Controllers Using WSR-88D Products

It's been a little more than a year since the FAA began full-fledged use of WSR-88D products as advisory overlays on the air traffic controller displays. So it might be a good opportunity to reintroduce ourselves and to discuss our use of these important visual tools for aviation safety. In fact, we have anecdotal reports that controllers have a significantly improved awareness of precipitation events that could impact air traffic flows and safety. Departures from Dallas-Ft. Worth were able to depart during a series of thunderstorms, because controllers could see where the weather was. Armed with this improved awareness, controllers are able to more efficiently manage their sectors. They can anticipate pilot requests to change their routings to avoid weather and can report what they see more precisely. Can you assign a dollar figure to this? That's the 6 million dollar question, but we can say it's a contributor in FAA efforts to create an infrastructure to promote efficiency and safety.

Air traffic controllers using WSR-88D products are called en route controllers. They are from 22 Air Route Traffic Control Centers (ARTCCs) across the country, along with slightly smaller facilities in Alaska, Hawaii, Puerto Rico and Guam. They control aircraft during their flights between airport terminal areas. (There are a few times when en route controllers provide approach control services to aircraft at smaller airports or during contingencies.) But most of the time the approach to landing services are provided by terminal controllers in radar approach control centers or in towers. The system used by en route controllers to display WSR-88D products is called the Weather and Radar Processor, or WARP. WARP is just one tool in the National Airspace System or NAS. NAS automated systems include controller displays, state of the art communication systems, and support systems like WARP.

Users of the WARP and WSR-88D products have designated focal points for FAA participation on WSR-88D Unit Radar Committees (URCs).

WARP performs a wide array of functions, but they can be listed as three basic ones. One function is to provide meteorologists and briefers with products similar to those provided by the AWIPS used by Weather Forecast Offices and remoted to Central Weather Service Units (CWSUs). That function is used to analyze and compile briefing graphics for ARTCCs. A second function of WARP is to collect and distribute Rapid Update Cycle wind products to FAA computers that predict the future flight paths of aircraft on Instrument Flight Rules (IFR) flight plans. The third function of WARP is to provide a graphic overlay that depicts areas of moderate or greater precipitation. This third function has created a time-sensitive element to use of the overlay products that we have not had in the past.

Controllers are not meteorologists, so they report what they see on their display. Three colors are assigned to their display of precipitation: light cyan (greenish blue), royal blue and checkered cyan. An example of these can be found in Figure 1. The light cyan is termed, "moderate weather." Controllers phraseology for the other two colors is "heavy weather." We have learned that there can be a small, but acceptable, time delay in the portrayal of the data, but this is overshadowed by the much more accurate depiction now available to the controllers. Prior to this improved display, controllers had to rely on their aircraft tracking radar – less than optimally tuned to view precipitation – and a generalized depiction of slash marks (///) for moderate weather and uppercase h's (HHH) for heavy weather. Comparisons of the two reveal much more clarity of detail with the WSR-88D overlay.

But this has been an evolutionary learning process. For example, the Weather Forecast Office (WFO) can control the base altitude for lrml (known to us as Product 65). The corresponding view on the controller scope is 000 – 240 (surface to 24 thousand feet). The FAA discovered that the base altitude settings varied from WFO to WFO. When the base altitude is not set to the default setting, important weather conditions may be hidden from the controller's view. So, until May of 2004, controllers were instructed not to use this view, for obvious safety reasons. (In February and May of 2004, the ROC released maintenance messages to ensure this product is set to the default setting).

Another learning process is being able to know when a single WSR-88D radar is degraded or out of service. The WARP system can alarm when the data flow between WSR-88Ds and FAA users is interrupted. However, we still do not have an automated way to inform air traffic controllers that a radar affecting their sector is not providing data. For the time being, ARTCCs have to use a verbal notification process. We've learned that free text messages contribute greatly to our understanding of the reason for an outage. Estimates of system restoration are

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Air Traffic Controllers *(Cont.)*

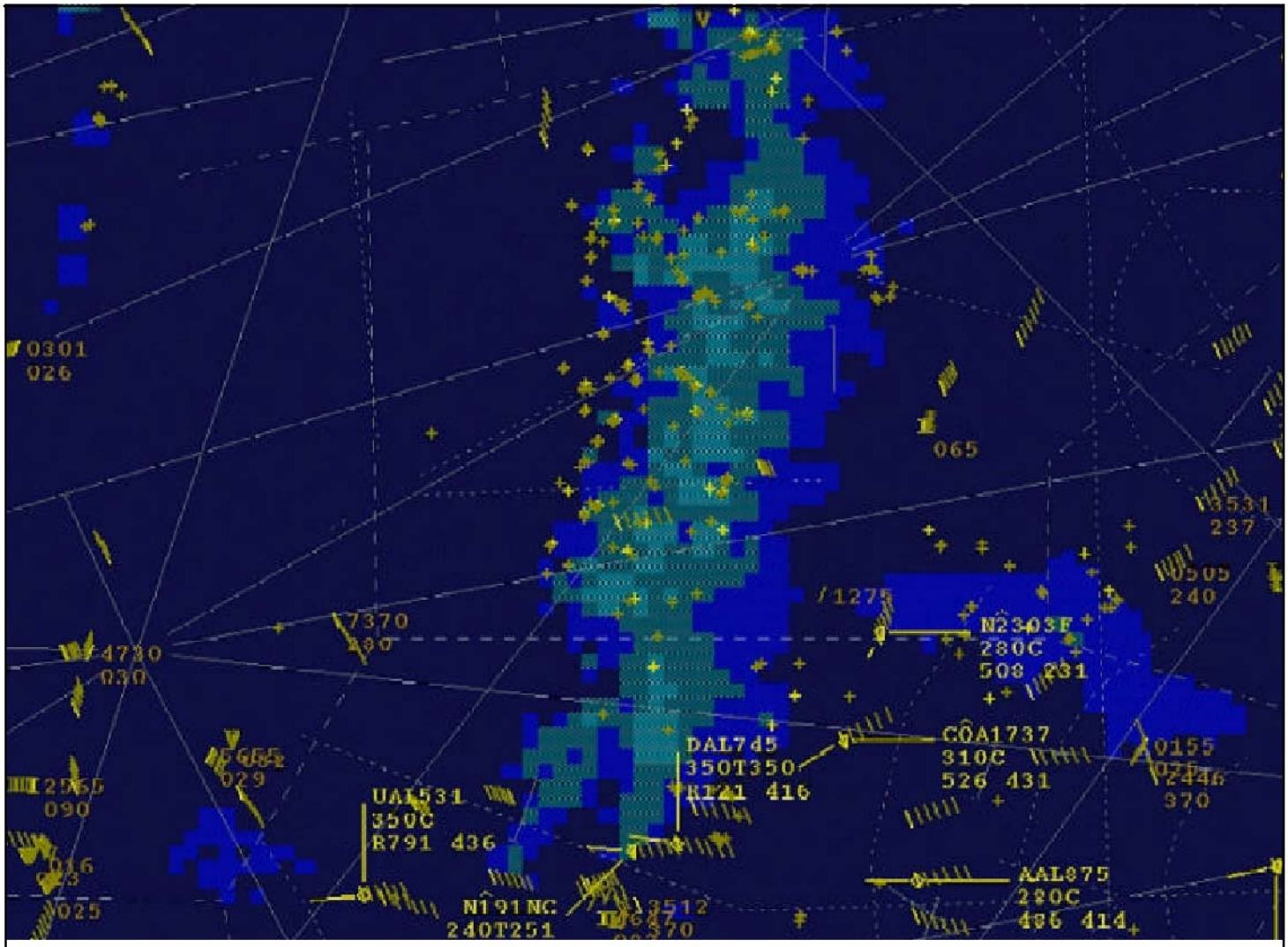

Figure 1: An FAA Air Traffic Controller's Display System Replacement (DSR) with three-color precipitation displayed.

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extremely valuable as a planning tool.

- To prevent air traffic controllers from missing possible precipitation events, verify and maintain the base level altitudes on products used for air traffic controller displays. (Among these are Products 65, 67, 98.)
- Invite FAA WSR-88D users to the Unit Radar Committee meetings. URC points of contact may come from different offices at different ARTCCs. We are working to provide the ROC with an up-to-date listing of FAA URC points of contact.
- Help the FAA by use of clear free text messages containing reasons for outage and estimates for return to service.
- If possible, provide advance notice of planned system outages, even in advance of the use of free text messages.
- Visit the nearest ARTCC for a first-hand view of WSR-88D use on controller displays.
- Invite ARTCC WSR-88D users to visit your WFO and, if possible, your assigned WSR-88D facility.
- Keep the CWSU in the loop.

Steve Pelissier, FAA
Seattle, WA ARTCC

Randy Wickers,
Lockheed Martin

Build 5.0 Precipitation Processing Subsystem Changes

Among the most important changes introduced with Radar Products Generator (RPG) Build 5.0 software was the implementation of new Volume Coverage Patterns (VCPs), namely VCP 12 and VCP 121. VCP 121 has the same elevation angles as the legacy (original) VCP 21. However, VCP 12 contains some elevation angles never used in WSR-88D legacy VCPs. Therefore, some changes were made in the Precipitation Processing Subsystem (PPS): 1) the construction of the hybrid scan using blockage files that enabled both new and prior elevation angles, 2) moving thresholds for initiation and end of accumulations from the Precipitation Detection Function (PDF) to a new version of the Hydromet Preprocessing algorithm, 3) the reduction of clutter contamination by the use of the Radar Echo Classifier (REC) instead of the legacy tilt test, and 4) the use of exclusion zones to ensure that ground returns, especially those close to the radar, are not used in accumulations.

The hybrid scan is a combination of reflectivity from elevation angles and ranges that determine the reflectivity most representative of precipitation reaching the ground. Prior to Build 5.0 the PPS used static terrain-based occultation (or blockage) data and hybrid scan sector definition files to build a hybrid scan reflectivity (HSR), which is the basis for precipitation computations in the PPS. The static files could be used, because the elevation angles at or below 3.5° were approximately the same for all legacy VCPs. Rather than create an additional hybrid scan definition for each new VCP, the Radar Operation Center (ROC) and the National Weather Service (NWS) Office of Hydrologic Development (OHD) created a replacement for the original (legacy) Hydromet Preprocessing algorithm, called Enhanced Preprocessing (EPRE), that allows precipitation estimates to be computed from a VCP with *any* elevation angles. The new PPS uses high resolution Beam Blockage Algorithm data files to aid in the construction of the HSR.

An additional change starting with Build 5.0 is the incorporation of initiation and end of precipitation accumulations in the EPRE algorithm. This was previously performed by the PDF, which included a parameter for the detected area above a specified reflectivity level that must be exceeded before starting accumulation: the Nominal Clutter Area (i.e., an area that is *called* clutter). This clutter area was a residual after clutter filtering (application of clutter suppression regions). Note that *clutter suppression affects base data*, such as Base Reflectivity, and *all* products derived from them. The Nominal Clutter Area *only affected precipitation accumulations*. The equivalent parameter in the EPRE algorithm is *RAINA*. The threshold of reflectivity for the precipitation area computation is the parameter, *RAINZ*, in decibels of reflectivity, dBZ. This was previously in decibels of rainfall rate, dBR, and identified as "Precip Rate Thrsh" in the PDF. The PDF remains in RPG software as the function that automatically causes the system to change from Clear Air Mode to Precipitation Mode (VCP 21).

The legacy PPS used the following tilt test to determine whether the lowest angle had clutter contamination - if the reduction of coverage of significant echoes from the 0.5° elevation to the 1.5° elevation was greater than 75%, the lowest elevation angle was assumed to be contaminated and was discarded from the Hybrid Scan; the 1.5° angle was used instead. EPRE can eliminate clutter contamination from precipitation accumulation by using the REC. REC products, Clutter Likelihood Reflectivity (CLR) and Clutter Likelihood Doppler (CLD), are viewable as backgrounds on the RPG Human Computer Interface (HCI) Clutter Regions graphical user interface. EPRE uses a percentage probability from the REC above which the radar returns are considered to be from clutter and are, therefore, excluded from accumulations. Because the new method uses the lowest elevation angle whenever possible, the resulting accumulations may be higher than computed by the legacy PPS.

Because Build 5.0 testing revealed there was still some residual ground clutter close to each radar site, it was decided that the *500-foot rule* would be applied in the form of hard-coded exclusion zones. This excludes data from being used in precipitation estimation for all elevations at or below 1.6° from a range of 0 to 5 nautical miles (nm), for all elevations at or below 1.0° from a range of 5 to 9 nm, and for all elevations at or below 0.6° from a range of 9 to 25 nm from the radar. (See Figure 1 below for an illustration of these generic exclusion zones.) The result will sometimes be discernible "rings" in precipitation accumulations when there is predominantly low stratiform precipitation, but will be

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Build 5.0 PPS Changes *(Cont.)*

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nearly imperceptible when there are convective storms. Additional exclusion zones can be created at each site for local contamination phenomena, such as wind farms, that would be hard to eliminate from the PPS using only clutter suppression regions and the REC.

Dan Berkowitz
ROC Applications Branch

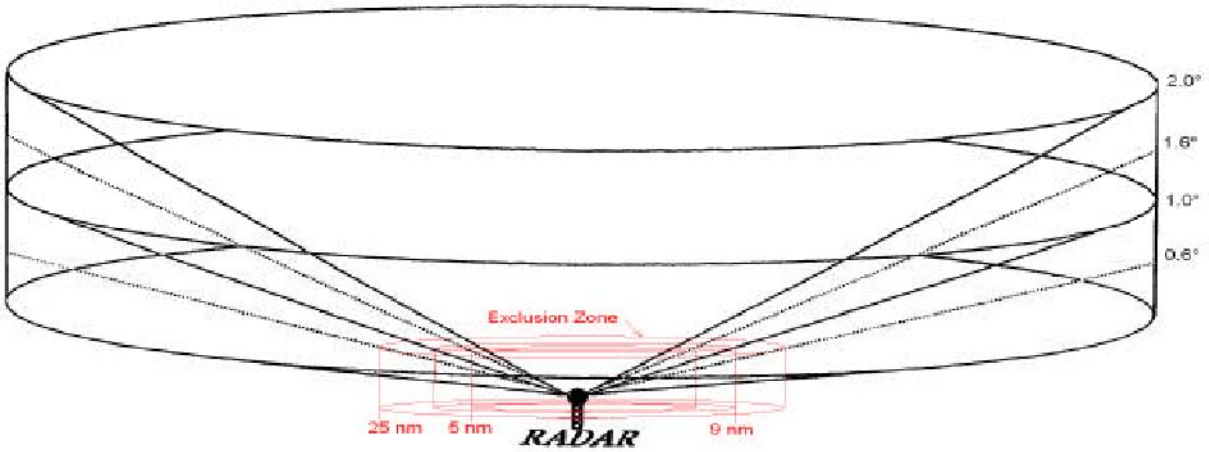

Figure 1: Generic clutter exclusion zones.

Future Meteorologists?

A total of 16 children learned more about the NOAA Weather Partners during Take Our Daughters and Sons to Work Day April 22. The participants toured the Storm Prediction Center, Norman Forecast Office and Radar Operations Center, as well as the phased array radar at the National Severe Storms Laboratory. They viewed the new ROC tour video, produced by ROC student James Murnan, and watched a presentation by Phillip Spencer from NSSL about different types of weather and weather safety. The children especially enjoyed a presentation by Daphne Zaras from NSSL about storm chasing that included a lot of video footage. The NSSL/SPC Employees Association treated the participants to a cookout for lunch.

Keli Tarp
NOAA Weather Partners

Participants from Left to Right: (Back Row) ROC Employees Scott Enders, Joe Chrisman, Cindy Chrisman, Mark Betsch, and student intern, Jessica Schultz. (Front Row) Sarah Enders, Ashley Chrisman, Rachel Chrisman, and Brianna Betsch.

Don't Restrict the Klystron

The present WSR-88D Transmitter Technical Manual (NWS EHB 6-511 paragraph 7.8.6.5.4.2 step 54) limits the maximum Pulse Forming Network (PFN) voltage to 5000 volts. Recent research in the area of transmitter tuning has revealed that this is an unnecessarily restrictive requirement. Here's why:

- The most restrictive requirement in the Modulator and Klystron is the maximum Beam Voltage (epy) spec of the Klystron, Drawing Number 1213614, which states that a peak power output of 750 KW shall be obtained with an epy of 62KV max. The Pulse Transformer drawing, 156C742A01, specifies a turns ratio step up of 28:1. The epy spec of 62KV max then results in a primary voltage of 2214 volts peak. The primary voltage divided by 100 is available at 3A12TP2 (modulator). Incidentally, the Pulse Transformer permits an epy of 65KV max.

How does this relate to PFN voltage? Transmission line theory states that if a delay line (i.e., the PFN) is charged and a switch (i.e., the RBDT stack) is closed, if the load impedance (looking into the pulse transformer primary) is exactly equal to the source impedance (i.e., the PFN characteristic impedance) exactly ½ of the charged voltage will appear across the load (Primary of pulse transformer) until the line is discharged with no over or undershoots. In practice, the perfectly matched condition is NOT realized so that the primary voltage is 43% of the PFN voltage just prior to closing the Reverse Blocking Diode Thyristor (RBDT) switch and there are undershoots and/or overshoots. This can be seen in Figure 1. Channel 1 is the PFN voltage at 3A12TP1. It indicates a PFN voltage of 4930 volts. Channel 2 is the Pulse Transformer primary voltage. This indicates a voltage of 21.20 X 100 = 2120 volts peak. This is equivalent to an epy of 2120 X 28 = 59.4 KV.

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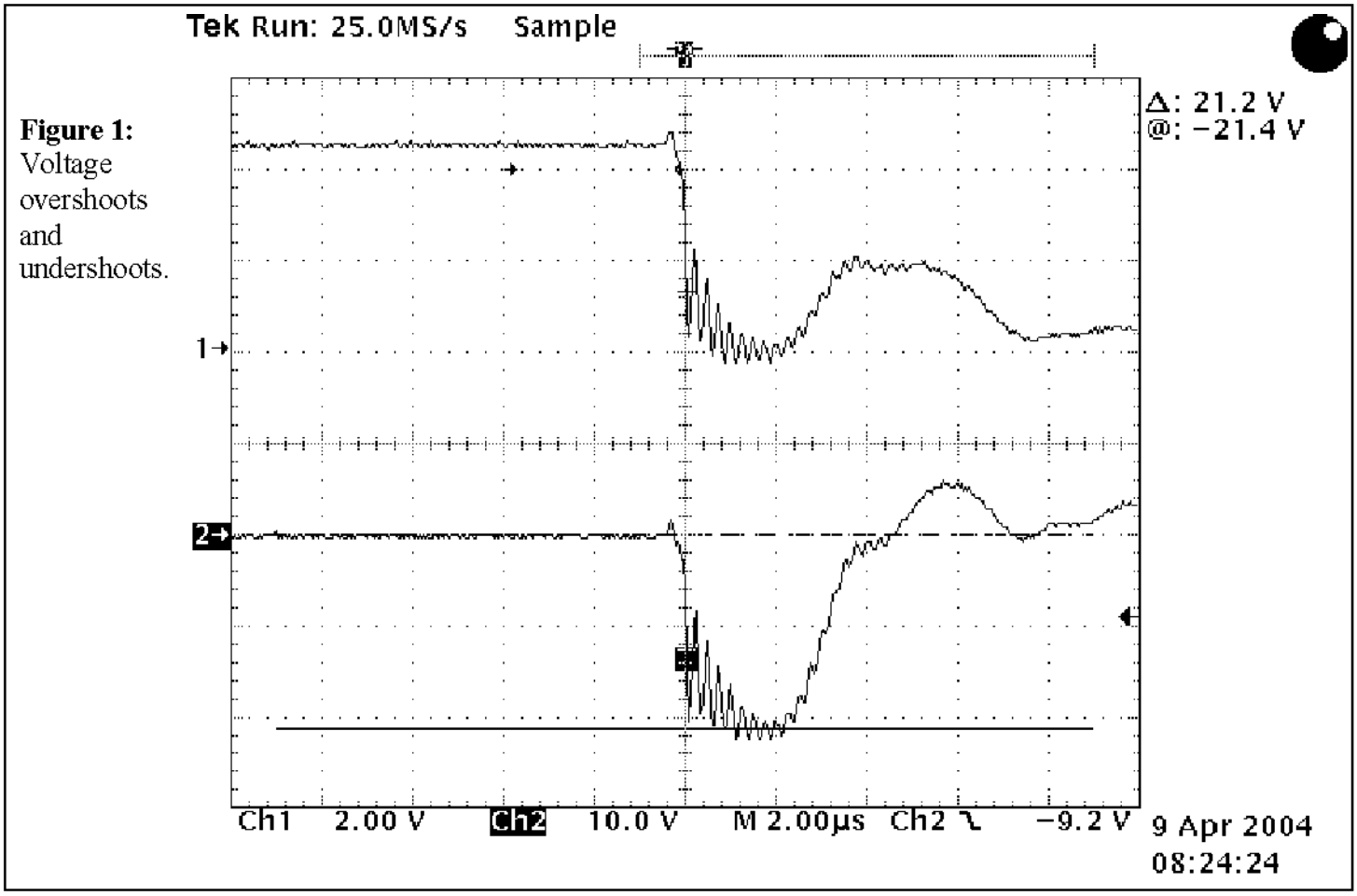

Figure 1: Voltage overshoots and undershoots.

Klystron *(Cont.)*

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- Empirical evidence indicates that the power vs. epy slope is 30+/- 5 KW/KV. In the case above, the PFN voltage can be increased up to 62KV which results in an increase in power output of 2.6 KV X 30 KW/KV = 78 KW. This would result in a PFN of 5150 volts. A Publications Change Request is being processed changing the maximum PFN spec of 5000 volts to an equivalent spec permitting a maximum voltage at 3A12TP2 of 21.14 which is equivalent to an epy of 62KV peak.
- Modulator considerations:

  Backswing diode stack - Prior to the introduction of ECP 0109, which added equalization resistors across the four diodes in the Backswing diode stack, handling the increase in PFN voltage would be problematic. However, by this time, all of the stacks in the field should be modified. Now each diode in the stack is rated at 2400 volts holdoff voltage or a total of 4X2400 = 9600 volts minimum. An increase of PFN voltage up to 5150 volts is obviously no problem for an equalized stack. However, if an increase in PFN voltage is indicated, the Backswing stack should be checked to make sure it is equalized (P/N 2500007-301) If this is not the case, the stack should be replaced with an equalized stack.

  RBDT Stack - Each RBDT in the stack of 10 series connected, equalized RBDT's is rated to holdoff at least 1100 volts each or a total of 11000 volts for the stack of 10. Again, the slight increase in PFN voltage is no problem.

  Transmitter Overvoltage Threshold level - The level is set for a PFN voltage of 5600 volts. Increasing the PFN voltage to 5150 is no problem – the threshold should perform as designed.

Many Klystrons are being returned from field sites with a complaint of low power output. Based upon an analysis of the repair data on returned tubes and the information in this article, almost all of these tubes would still be in service if the new beam voltage requirement had been applied. Therefore, technical manual changes have been submitted in an effort to avoid future voltage problems.

William Urell
ROC Engineering Branch

Award Winning Staff

The WSR-88D program is staffed by dedicated professionals around the world. Here at the ROC we are proud of our employees, many of whom have been recognized for their outstanding work and commitment to excellence.

The **NOAA Administrator's Award** - A combination honorary and monetary award given annually in recognition of employees or groups who have made significant contributions to NOAA programs. The following were recognized at a formal ceremony held in May in the Silver Spring Auditorium:

- For innovation and advances in engineering development that enable faster implementation of new science into the nation's weather radars - Sallie M. Ahlert, Terrell Ballard, Mark Betsch, Joe Chrisman, Scott Enders, Christopher Gilbert, Franklin Hewins, Chris Hunt, Larry Kitchell, and Paul Krenek.
- For enhancing the weather warning service to the public by formulating and successfully managing a project to rescue valuable weather radar training data - John Ferree, Edward Mahoney, and Edward Berkowitz.
- For outstanding support in restoring NWS radar and upper air systems during the San Diego, CA fire (October-December 2003) - Ronald J. Pattison

The **NOAA Technology Transfer Award**

- For the development of a national real-time radar data archival and Internet2 delivery system for university, government and private sectors - Tim Crum (as part of a group nomination submitted by NOAA's Office of Oceanic and Atmospheric Research.)

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Awards *(Cont.)*

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The **NOAA Team Member of the Month Award** for April 2004 was presented to Rich Ice, RC Information Systems (RSIS). This award pays tribute to a non-NOAA employee and gives credit to the outstanding people who make NOAA programs a success but are not actually Federal employees.

The **Oklahoma Federal Executive Board Federal Employee of the Year Award** was established in an effort to recognize outstanding federal employees for their efforts, leadership and/or initiative. This program encourages innovation and excellence in government, reinforces pride in federal service, and helps call public attention to the broad range of services provided by federal employees. The 2004 Oklahoma Federal Executive Board Federal Employee of the Year Program recognized nominees Terrell Ballard, 1st Lt. Ron Fehlen, Erin Foster, MSgt Greg Matthews, Maj. Michael Miller, Janalee Pacheco, Rex Reed and Dave Zittel. Nominees and winners received a plaque at a banquet held at the Tinker AFB Officer's Club on May 3, 2004. At which time, Rex Reed was awarded Supervisory Federal Executive Board Employee of the Year.

The **ROC Employee of the Quarter (EOQ)** and **Team Member of the Quarter (TMOQ) Awards** were established for the ROC Awards Program to recognize people who;

- Demonstrate exceptional performance
- Exceed normal customer service
- Perform a worthy non-duty related act
- Accomplish a unique short-term project or special assignment
- Accomplish an office productivity and efficiency enhancement of procedures
- Produce an office morale enhancement through teamwork.

This quarterly awards program began in October 2001 with representatives from each organization within the ROC. The ROC award team representatives are a group of proactive volunteers dedicated to providing hard working individuals with the appreciation they deserve. This team consists of people who selflessly stepped up to create and implement an internal award program as desired by the ROC employees. The team's birthplace was the Y2K/US vs. Them - Contractor/Tri-agency Relations presentation to the senior ROC staff on July 7, 1999.

Winners of the EOQ and TMOQ are presented with a framed certificate signed by the ROC Director and the winner's name is engraved on a plaque in the large conference room in the ROC South building and on a plaque in the lobby of the ROC North facility. Winners are also considered for NOAA Employee and Team Member of the Quarter and other awards.

The winner of the Employee of the Quarter for the second quarter fiscal year 2004 is 1st Lt. Ron Fehlen, a member of the U.S. Air Force, and the winner for the Team Member of the Quarter is Matt King, an employee of Management and Engineering Technologies International (METI). Both members are assigned to the ROC Engineering Branch.

Nancy Olson
ROC Administrative Officer

TSgt David Riffle
USAF/ROC Program Branch

Portable Davit Crane Manufacturer's Lift Capacity Certification

Both Occupational Safety and Health Administration (OSHA) and EHB-15, WSR-88D Occupational Safety and Health Manual, require that each facility maintain a certification of the capacity of all lifting devices. The manufacturer of the WSR-88D Portable Davit Crane has provided a letter that certifies that all cranes purchased by the National Weather Service have been appropriately load tested. This letter is provided for your records. Click on this link to display the letter. Then please print the certification letter and retain it on file.

Marty Williams, RMT Team Lead
ROC Program Branch

Elevation/Azimuth Drive Motor Replacement

Mike Hazel, ET at KPAH (Paducah, KY) submitted the following helpful "tip" for replacing the elevation/ azimuth drive motor:

Materials required:
4 - 5/16 x 12" Allthread
4 – 5/16 coupling nuts

At EHB 6-510, RDA Maintenance Manual, paragraph 6-5.52.1.3 step 7 - elevation (EHB 6-510, paragraph 6-5.52.7.3 step 3 - azimuth), remove 4 of the 6 hex-head bolts from the adapter housing holding the motor in place. Insert the allthread into the empty holes and tighten the coupling nuts to hold the motor in place (Figures 2 and 3). Remove the 2 remaining hex-head bolts, loosen the flexible coupling, and then lower the motor by loosening the coupling nuts until the motor is free.

Install the motor by sliding the motor onto the allthread and then putting on the coupling nuts. This will hold the motor in place. The motor can now be lifted and the coupling nuts turned until the motor is properly seated. This will eliminate any strain on the flexible coupling (not to mention your arms and back) and the motor will slide correctly into place with little effort.

Technical manual changes have been submitted for this procedure, which will be removed from EHB 6-510 and included in the new combined pedestal manual.

David Hazel
KPAH, Paducah, KY

Tim Stanley
KJKL, Jackson, KY

Figure 1: Required Materials.

Figure 2: Close-up of installed allthreads.

Figure 3: Allthreads installed.