

WSR-88D Tropical Cyclone Operations Plan

05/01/2018 Build 18.0 Systems

NOTE

For assistance with this Operations Plan at any time, contact the WSR-88D Field Support Hotline.

OPERATIONS PLAN GUIDANCE

- The plan is designed to be used as an *operational reference*. Consult with the local Unit Radar Committee (URC) **in advance** concerning any changes that might result in system wide modifications. Reminder, in accordance with the [Memorandum of Agreement for the Interagency Operation of the WSR-88D](#), all WFOs are tasked to conduct URC meetings twice per year. In addition to any local contacts, WFOs are encouraged to include the email address roc.urb.invite@noaa.gov to invite the tri-agency NEXRAD program managers and the Hotline to the URC meetings. Pre-hurricane URC agreements will allow changes to be made operationally as the need arises.
- A few colors are used in this document. **Blue** indicates a hyperlink or a link to a different location in this document (i.e. an email address or an internet address). **Red** is for a menu or a menu selection. **Green** font is used in the **NOTE** section and serves as an informational section. **Yellow** background is a note that provides operational guidance.
- Changes will likely be made to adaptable parameters settings prior to and during a tropical cyclone. It is recommended that a backup of adaptable parameters be made prior to the event. The “**Adaptation Data Backup**” procedure is in Table 4-34 (Page 4-110-111) of the Build 18.0 version of EHB 6-520 (Revision No. 8, dated 12 February 2018). It can be accessed with a secure login through the ROC website <https://www.roc.noaa.gov/WSR88D/Program/MaintenanceManuals.aspx>.
- Keep in mind that the recommended adaptable parameter changes in this Plan are performed by the WFO using the URC level change of authority. There are **NO commands** requiring Agency or ROC level passwords in this document.

NOTE: The following RDA and RPG features are important to be aware of during a tropical weather event. They each serve to remind and explain their importance and how they impact the operational use of the radar.

RDA Processing Algorithms

- **CMD** should be used as opposed to Clutter Suppression Regions or a static Bypass Map.
- **AVSET** is a feature that produces faster volume scan updates even when a tropical cyclone is still fairly distant from the radar site.

RPG Processing Algorithms

- In Build 18.0, VCP 215 (with *one* SAILS cut available only) serves as the new general surveillance precipitation VCP.
- In Build 18.0, the Shift Checklist (SCL) product will be available via AWIPS. This added feature places select adaptable parameter values in one location to view.
- In Build 18.0, an FTM can now be sent via AWIPS (as long as AWIPS Build 17.3.1 has been installed) and that same message will be sent to the RPG. The RPG will then resend it as a normal FTM to all dedicated users except from the sending AWIPS.
- In Build 18.0, the setting of legacy PPS Max Precip Rate [MXPRA] and the DP QPE Max Precip Rate have been combined. Therefore, the parameter is no longer listed or shown in the Hydromet Rate menu.
- With Max Precipitation Rate being under one URC parameter setting, the selected value remains site dependent. It can be set as low as **50 mm/hr**, but the value should **never** exceed **200 mm/hr**.
- PRFs can be edited in the 200 series (i.e. SZ2) VCPs but the same PRF must be used in all 3 sectors.
- Ensure the appropriate velocity increment (0.97 kt or 1.94 kt) for the anticipated maximum velocities is being used. Monitor the 2DVDA algorithm performance during the tropical storm/cyclone.
- It is encouraged to **issue a Free Text Message (FTM)** to All Users from AWIPS notifying neighboring WFOs, the national centers, River Forecast Centers, the NEXRAD tri-agencies, and the weather enterprise when major operational changes are made (e.g. resetting precip accumulations, changing adaptable

parameters, etc.).

- After the tropical cyclone threat has passed, ensure all parameters are returned to their original values. The “**Restore Adaptation Data**” procedure is in Table 4-35 (Page 4-140) of the Build 18.0 version of EHB 6-520 (Revision No. 8, dated 12 February 2018). **Keep this information near the MSCF in case the data need to be restored.** If data is entered manually, refer to the current *WSR-88D Guidance on Adaptable Parameters Handbook*, Volume 1 (Revision No. 8, dated 25 September 2017) for system-wide defaults and your own notes for your site-specific ones. It can be accessed at <https://www.roc.noaa.gov/WSR88D/Program/OperationsManuals.aspx> (which requires a security log-in).
- This Tropical Cyclone Operations Plan has been designed for sites that are using Build **18.0** software. If there is a question about the RPG software build being used, check with maintenance technicians or radar focal point. Contact the **WSR-88D Hotline** for immediate issues or concerns.

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NOTE: Procedures 1, 3 through 9 are performed at the RPG HCI and 2, 10 through 12 are performed at your AWIPS Workstation. Some procedures may require the URC-Level Password.

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At the WSR-88D RPG Human Computer Interface (HCI):

1. Generator Fuel

Approximately three days prior to a tropical cyclone, ensure that the RDA emergency power **generator fuel level** is adequate. The levels can be checked by selecting the **Tower/Utilities** tab under the **RDA Performance Data** window.

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NOTE: With the removal of the RDA UPS, it is important that Procedure 1 has been performed and all components are working properly.

2. Shift Change Checklist

The Shift Change Checklist (SCL) Product, which is generated every volume scan, can be viewed through AWIPS. AWIPS requests it once an hour and it can be viewed using the Text Window (typing **SCLxxx** in **AWIPS ID** box (where xxx is the 3-letter radar identifier)). Current volume scan values of the SCL Product can be retrieved by doing an OTR.

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3. Reinitializing Memory and Precipitation Accumulations

3a. It is recommended that a **Restart** of the RPG Software be performed from the RPG Control window prior to a tropical cyclone. An “**RPG Clean Startup**” can be done as an alternative. If changes were made to the *Adaptation Data*, then an *Adaptation Data Backup* should be performed or else changes will be lost when the Clean Startup is executed.

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3b. Reset the Dual Pol QPE, Legacy PPS, and Differences products from the RPG Control window prior to the tropical event. This should be done in conjunction with your Service Hydrologist and River Forecast Center.

NOTE: Do not shutdown the RPG Software while resetting rainfall accumulations. If a Clean Startup was performed in step 3a, then this step can be skipped.

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3c. Values used for starting and ending precip accumulations should be set to reasonable numbers. The Reflectivity rain rate values used to initiate accumulation should remain the *default* values. For Legacy PPS, the **RAINZ** default is **20.0 dBZ**. For Dual Pol Precip, **PAIF Rate Threshold** is **0.5 mm/hr**.

The *Area Thresholds* (**RAINA** for Legacy PPS and **PAIF Area Threshold** for Dual-Pol

Precip – Both set to **80 km²** by *default*) should be determined locally during fair weather by viewing the **Significant Rain Area Detected** in the **Precipitation Status** Window. Alternatively, the *TOTAL RAIN AREA* is listed on the *Supplemental Precipitation Product (SPD)* on AWIPS (via **SPDxxx** in **AWIPS ID** box (where xxx is the 3-letter radar identifier)). These parameters are viewed/modified on the **Algorithms** Window (via the **Hydromet Preprocessing** and **Dual-Pol Precip** screens).

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4. Clutter Suppression

Use “CMD” whenever possible. This helps improve rainfall estimates and overall algorithm performance. **CMD enabled** is generally better than using either operator-defined Clutter Suppression Regions or a static Bypass Map because ground clutter locations change with beam propagation. Additionally, switching to a SZ-2 VCP automatically enables CMD and downloads the default clutter map. CMD Status is displayed at the lower right of the HCI.

For additional information on Clutter Suppression and its usage refer to Section 3.8.9 in the EHB 6-521 (Operations Instructions RPG Refresh (Linux) Manual, Revision No. 8, dated 12 February 2018). It can be accessed through the Radar Operations Center website <https://www.roc.noaa.gov/WSR88D/Program/OperationsManuals.aspx>.)

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5. Mode and Volume Coverage Pattern (VCP) Selection

5a. Mode Selection Function (MSF)

In order to ensure that the automatic MSF doesn't override the VCP you have selected, set the Precipitation and Clear Air Switching selections to **Manual and Manual**.

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5b. VCP Selection and Velocity Dealiasing

The following table summarizes the recommended VCPs with their limitations and optimal usage in tropical cyclone events:

VCP	Tilts	Time*	Usage	Limitations
121	9	6 min.	Compared to other VCPs, this one significantly reduces range-obscured V/SW data within 230 km and is also useful when a tropical cyclone has a distant center or eye with no echoes near the radar. This should be the first choice for mitigating velocity dealiasing problems.	There are gaps in coverage above 5° and low elevation circulations may be missed. All Bins clutter suppression is NOT recommended. Likewise, PRFs are not editable for any tilt.

VCP	Tilts	Time*	Usage	Limitations
**212	14	4.6 min.	Rapidly evolving, severe convective events. Uses SZ-2 to significantly reduce range-obscured V/SW data compared to VCP 12.	All Bins clutter suppression is not recommended. High antenna rotation rate decreases the effectiveness of clutter filtering and decreases the accuracy of the base data estimates. PRF sectors not allowed.
**215	15	6 min.	VCP for general surveillance of precipitation with the best vertical coverage. Lower SNR than VCPs 12/212. Uses SZ-2 to reduce range-obscured V/SW data. Low-level antenna rotation rates increase the accuracy of base data estimates. Shares common lower elevations with VCPs 12/212.	All Bins clutter suppression is not recommended. Slower low-level updates than VCP 12/212. Limited to a <u>single</u> SAILS scan. PRF sectors not allowed.
**12	14	4.3 min.	This VCP is good for detecting severe convective events (e.g., TVSS) particularly for tropical cyclones over land. Extra low elevation angles increase low-level vertical resolution. It has the fastest update rate. PRF sectors allowed.	Velocities need to be monitored closely (for range folding) around the center or the eye. With PRFs possibly needing to be manually changed, the use of Storm-Based Auto PRF may help. Also note that high antenna rotation rates slightly decrease the accuracy of the base data estimates.

* VCP update times are approximate.

** The VCP time changes if SAILS and/or AVSET are enabled.

For a more comprehensive overview of *all* VCPs, see Figure 3-1, the “VCP Comparison Table” in EHB 6-521 (Revision No. 8, dated 12 February 2018).

Simplifying the choices and prioritizing by the primary concerns:

Choice	Velocity Dealiasing	Tornado Detection
#1	121	212
#2	215	12
#3	212	215

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5c. Mitigation of Range Folding

By selecting **Manual PRF** on the **PRF Control** window, operators have the ability to move the maximum unambiguous range (R_{max}) out to **94 nm** and the minimum distance in to **63 nm** by adjusting the PRF when allowed by the VCPs described in the table under Section 4b (VCP Selection and Velocity Dealiasing). **Manually-selected PRFs** can be defined for up to three sectors. Remember, the SZ2 VCPs (212 and 215) cannot be sectorized.

Auto PRF Storm is useful when embedded severe convection is present with a tropical cyclone. Typically, this is the default setting.

For additional information, refer to the Guidance on Adaptable Parameters. (WSR-88D

Handbook, Volume 1, RPG, Revision No. 8, dated 25 of September 2017).

NOTE: The NHC prefers the R_{max} with sufficient range to provide velocity data near the eye or center of a tropical system. However, local needs may dictate otherwise, and will take precedence. Therefore, a VCP with an operator-specified PRF (e.g., VCP 12) may be needed to mitigate range folding in the region of concern. VCP 121 does not use **Auto PRF.**

For further information about the improved Auto PRF function, see <https://www.roc.noaa.gov/WSR88D/NewRadarTechnology/NewTechDefault.aspx>.

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5d. AVSET (Automated Volume Scan Evaluation and Termination)

Using **AVSET** potentially produces faster volume scan updates. That is, the volume scan terminates when no echoes of at least 18 dBZ (covering at least 80 km²) above 5° elevation are detected.

For additional information about AVSET, see Section 2.4.16.5.2 in EHB 6-521 (Revision No. 8, dated 12 February 2018).

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5e. SAILS (Supplemental Adaptive Intra-volume Low-level Scan)

With **SAILS** inserting extra 0.5° elevation scan(s), it applies to VCPs 12, 212, and 215. Additionally, while MESO-SAILS scan are available for VCP 12 and 212, the new VCP (215) only has 1 additional cut available only. These additional cuts are inserted into the VCP depending upon whether AVSET is being used or not.

For additional information about SAILS, see Section 2.4.16.5.3 in EHB 6-521 (Revision No. 8, dated 12 February 2018).

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6. Velocity Increment for Extreme Wind Speeds

Velocity measurements are limited to approximately +/- 122 kts when velocity increment is set to 0.97 kt (default). When hurricane speeds exceed 122 kt, NHC recommends operators change the velocity increments to 1.94 kt (from 0.97) **prior** to the hurricane becoming a Category 3 storm.

The velocity color scale displayed with all 8-bit (256-data level) Velocity products on AWIPS is the same. This could create confusion on which velocity increment is being used. Fortunately, the AWIPS CAVE cursor sampling of the velocity products indicates speeds **in tenths of a knot** for velocity increments of **0.97 kt** and **in whole knots** for velocity increments of **1.94 kt**. The velocity increment setting is located on the **VCP and**

Mode Control button. It is found by clicking the **VCP** button on the RPG HCI window. In addition, the new SCL product displays the current velocity increment being used.

NOTE: Changing the VMI (Velocity Measurement Increment) to 1.94 knots automatically switches the RPG to the legacy velocity dealiasing algorithm. Additionally, confirmation of the current VMI setting can be found on the SCL.

NOTE

Ensure the velocity increment is the last change you make when modifying a VCP. Otherwise, changes will be lost when a VCP change is made or the system is rebooted.

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7. Algorithm Adaptable Parameter Changes

NOTE: Procedures 7a and 7b will independently increase the radar's detection efficiency for small, shallow circulations typically found in tropical cyclones. Precipitation algorithm changes (procedures 7ci and 7ciii) will result in more realistic rainfall estimates during tropical weather situations.

7a. Mesocyclone Detection Algorithm Optimization

The Minimum Display Filter Rank should be lowered to enable detection of weaker circulations within the tropical cyclone. However, doing this particular procedure may result in a greater number of false alarms being generated. To help reduce the false alarm rates, detections must be within 20 km of a SCIT-identified cell.

Select **MDA** (under **Algorithms** → **Adaptation Item**) and change **Minimum Display Filter Rank** from **5** to **4** (or even **3**).

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7b. Tornado Detection Algorithm Optimization

Similar to MDA, TDA values should be changed to better detect weak or distant tornadoes. Select **Tornado Detection** (under **Algorithms** → **Adaptation Item**) and change **(i) Min 3D Feature Depth** from **1.5** to **1.6**; **(ii) Min 3D Feat Low-Lvl Delta Vel** from **25** to **27**; and **(iii) Min TVS Delta Velocity** from **36** to **27**.

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7c. Precipitation Estimate Optimization

NOTE: Subsections i and ii refer to PPS (legacy) radar parameters, subsection iii the QPE (DP) parameter, and subsection iv R(Z,ZDR) setting. In addition,

exclusion zones should be in PPS but not in QPE with MetSignal now available (since Build 17.X). *Other changes (i.e. Z-R relationship, maximum precipitation rate) should be coordinated with the servicing River Forecast Center(s) (RFCs).*

i. PPS Z-R Relationship

In Build 18.0, the Z-R relationship settings (select **Hydromet Rate** under **Algorithms** → **Adaptation Items**) went from using assigned values to naming convention. You will change from **CONVECTIVE** (the old value of **300R^{1.4}**) to **TROPICAL** (previously entering **250R^{1.2}**) during tropical events.

The MRMS (developmental) website (https://mrms-dev.nssl.noaa.gov/qvs/simple_product_maps.php) has a tool that shows where tropical rainfall will likely occur (**click above link** → **Model (Blended)** → **Tropical Rain Prob**).

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ii. Precipitation Rate Thresholds

In Build 18.0, the **Max Precipitation Rate** setting applies to both Legacy PPS and DP QPE. The **Max Precip Rate** (select **Dual-Pol Precip** (under **Algorithms** → **Adaptation Item**)) will be changed from the *current setting* to between **150.0** and **200.0 mm/hr**. The ROC, however, recommends that the Max Precip Rate *never* be set higher than **200.0 mm/hr (7.9 in/hr)**.

NOTE: While monitoring precipitation accumulations compared to rain gauges, it is important to not change Z-R relationship too soon. This will result in radar overestimation. Contact your River Forecast Center for guidance.

For additional information, review Section 7.11.1 of the Guidance on Adaptable Parameters. (WSR-88D Handbook, Volume 1, RPG, Revision No. 8, dated 25 September 2017).

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iii. Dual-Pol (QPE) Maximum Reflectivity

While the Dual-Pol **Maximum Reflectivity** range is **45-60 dBZ**, the default setting is **53 dBZ** which helps mitigate hail contamination. The value can be changed by selecting **Dual-Pol Precip** (under **Algorithms** → **Adaptation Item**).

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iv. R(Z, ZDR) Tropical vs Continental

Sites can use either the *Continental* (default setting) or the *Tropical equation* for QPE. The selection can be made by selecting **Dual-Pol Precip** (under **Algorithm Adaptation Item**). This allows for the switch from the Continental to Tropical.

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7d. Using Model Data

i. Settings for Sites With Model Data

WFOs across the contiguous US and Puerto Rico have access to the **RAP Model data** via AWIPS. The operator can verify that **Melting Layer Source** is set to **Model_Enhanced** (under **MLDA** via **Algorithms**) and **Model Update** is **On** (from the main HCI).

In order to verify that new model data are actually being received from a host AWIPS, look for the **MODEL DATA** entry shortly after the top of each hour in the RPG Status window.

The Model Data Viewer Tool can be utilized to examine the model data by the RPG to ensure it is correct and representative of the environmental conditions. See Section 2.4.17.9.5 of the EHB 6-521 (Revision No. 8, dated 12 February 2018) for more information about the Model Data Viewer.

If a WFO is unable to use RAP data, then the Operator will need to update environmental data by manually entering data from a sounding closest to the radar site.

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ii. Settings for Sites *Without* Model Data

Sites outside of the contiguous US do not receive model data and should set the **Melting Layer Source** to **Radar_Based** (under **MLDA** via **Algorithms**). Also, use the **Environmental Data Entry** window (under **Environmental Data**) to update the **Height 0 C (0-70 kft MSL)** and **Environmental Wind** data using a local or interpolated sounding as a guide. For additional information on the manual setting of environmental data, see Section 3.10.3.2 in the EHB 6-521 (Revision No. 8, dated 12 February 2018).

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8. Precipitation Product Display Levels

Adjustment to the precipitation data display levels will be needed if the potential for heavy rainfall is expected as the tropical cyclone approaches the radar site. The maximum displayable value for One Hour Precipitation (**OHP**), Three Hour Precipitation (**THP**) and DP One Hour Accumulation (**OHA**) is **12.7 inches**. Likewise, the maximum displayable value for Storm Total Precipitation (**STP**) and 4-bit DP Storm Total Accumulation (**STA**) is **25.4 inches**. User Selectable Precipitation (**USP**) uses the **OHP/THP and OHA Data Levels** unless the maximum value exceeds the value set for code 16. Otherwise, **USP** uses the **STP, STA Data Levels** values.

Select **OHP/THP, OHA Data Levels** and **STP, STA Data Levels** (under **Selectable Parameters**) to set the desired Precip data levels.

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9. Archive Level II

Sites can check the status of Level II data by going to <http://radar2pub.ncep.noaa.gov/>. As a reminder, NWS sites are responsible for monitoring their assigned DoD and FAA site(s).

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AWIPS Preparation (at an AWIPS Workstation):

10. Data Archiving

Prior to a tropical cyclone, WFO should confirm that their Data Archiver is running. On AWIPS-II, archiving of the data is a permission-based application and it can only be activated by the System Manager or User Administrator.

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11. Data Requests from Adjacent Radars

As a tropical cyclone approaches your Radar Site, an RMR can be initiated to surrounding sites for products not available via SBN (Satellite Broadcast Network). To view the products available via the SBN, see

http://www.weather.gov/media/tg/noaaport_radar_products.pdf.

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12. Communications Backup

Ensure you have printed out a copy of your latest AWIPS radar file help sheet and the WSR-88D Communications Documentation.

The AWIPS radar file help sheets provide site-specific radar access information that could prove pivotal in the event default telecommunication systems become inoperative during a tropical event. Similarly, each office's WSR-88D Comms Documentation provides site-specific telecoms information for the NWS and NEXRAD tri-agency partners. Both sets of documents are maintained on a secure server at the ROC. ESAs at each office have been provided with the necessary information to access those servers. Contact the WSR-88D Hotline for assistance if your ESA or technicians are not

available to provide you with these documents or if they have trouble accessing either server.

AWIPS to WSR-88D "WAN Dedicated" operations could prove pivotal in the event one WFO needs to perform WSR-88D backup transmission for another WFO. WFO WAN Dedicated permissions were rolled over from AWIPS-1 (A1) to AWIPS-2 (A2) during the A2 transitions. We cannot recommend strongly enough that this functionality be tested during benign weather and well in advance of any land-falling tropical system. This test is needed as the functionality requires pre-constructed and saved RPS Lists for each VCP for each WSR-88D to which your WFO may have access. This recommendation is especially true of locations that might not have re-tested the functionality in the wake of their AWIPS system being transitioned to AWIPS-2.

All WSR-88Ds in CONUS, Puerto Rico, and the Hawaiian Islands that rely on commercial telecoms for either the wideband circuit or the primary DoD or FAA to NWS private-IP connection, now have either 4G wireless or permanent (built-in) VSAT auto-failover backup installed. The WSR-88D Comms Documentation for those locations includes the 4G or VSAT backup comms data.

If your office relies on Backup comms for either the wideband or private-IP to a DoD or FAA WSR-88D, in advance of any land-falling tropical system check with the applicable WSR-88D maintenance staff and determine when NWS EHB 6-503-2 Preventive Maintenance Inspection Work Cards 2-009A (28 Day Status Check) and 2-019A (84 Day Backup Comms Fail-over Test) were last accomplished. Ideally, Backup comms fail-over will be confirmed in advance of any land-falling tropical systems.

In advance of major land-falling tropical systems NEXRAD enterprise telecom Providers Are asked to place a heightened watch on the telecoms they provide to the NWS and WSR-88D systems in the forecast path of any major land-falling tropical system.

The ROC, Regional Focal Points, Office of Dissemination, and AWIPS NCF will partner to evaluate and initiate restorative telecommunication (telecom) solutions, backup scenarios, tertiary, and emergency restorations as required.

For additional information on contingency and operations plans, refer to System Security Manual EHB 6-504 (Change 2 1 August 2016). Likewise, radar service backup is addressed in NATIONAL WEATHER SERVICE INSTRUCTION 10-2201, Appendix I Communications Backup.

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A copy of the National Hurricane Operations Plan can be found on the Office of the Federal Coordinator for Meteorology's website (www.ofcm.gov).

After the tropical cyclone threat has passed, all parameters will be returned to their

original values. The “**Restore Adaptation Data**” procedure is in Table 4-34 of the Build 18.0 version of EHB 6-520 (Revision No. 8, dated 12 February 2018). If the data needs to be manually entered, then refer to the current WSR-88D Guidance on Adaptable Parameters Handbook, Volume 1 (Revision No. 8, dated 25 September 2017) for system-wide defaults.

For all other inquiries or concerns about the information contained in this document, contact the NEXRAD Hotline.

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