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C-A OPERATIONS PROCEDURES MANUAL

13.25 Operation of NARDA NBM-550 Broadband Field Meter

Text Pages 2 through 13

Attachments

Hand Processed Changes

<u>HPC No.</u>	<u>Date</u>	<u>Page Nos.</u>	<u>Initials</u>
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Approved: \_\_\_\_\_ ***Signature on File*** \_\_\_\_\_  
Collider-Accelerator Department Chairman Date

P. Cirnigliaro

## 13.25 Operation of NARDA NBM-550 Broadband Field Meter

### 1. Purpose/Scope

This procedure provides a method of operation of the NARDA Model NBM 550 Broadband Field meter. This meter covers the frequency wavelengths 300 kHz – 1GHz magnetic field (H) and 100kHz – 50GHz electric field (E).

This instrument is used to measure non-ionizing radiation to:

- Determine the need for area warning posting.
- Determine the need for personnel exposure monitoring.
- Determine if inclusion in a medical surveillance program is required.
- Measure the effectiveness of engineering controls.

### 2. Responsibilities

- 2.1 Use of the NARDA NBM- 550 shall be limited to persons who act under the direction of a competent hazard assessment person and have demonstrated the competency to satisfactorily use the meter, as evidenced by experience and training, to the satisfaction of their supervision or existing qualification criteria set by their organization.
- 2.2 Personnel that perform exposure monitoring with this instrument are responsible to follow all steps in this procedure.
- 2.3 The data collected using this meter must have an appropriate evaluation of the hazard and risk by a knowledgeable Industrial Hygiene professional.

### 3. Prerequisites

#### 3.1 Area Access:

- 3.1.1 Contact the appropriate Facility Support Representative or Technician to obtain approval to enter radiological areas, if applicable. Verify with the appropriate Facility Support Representative or Technician if a Work Permit or Radiological Permit is needed or is in effect. If so, review and sign the permit. Use appropriate PPE for area, including hear protection, safety glasses, etc.

## 4. Precautions

### 4.1 Hazard Determination:

- 4.1.1 The operation of this device does not cause exposure to any chemical, physical, or radiological hazards. The meter design does not cause significant ergonomic concerns in routine use.
- 4.1.2 The meters do not generate Hazardous Waste.
- 4.1.3 The primary hazard from rf/microwave is heating of the body. The eyes and genitals/reproductive organs are the most sensitive body parts. Prolonged exposure to very high sources of radiation can result in death to the individual.

### 4.2 Personal Protective Equipment:

- 4.2.1 If high fields are expected, alarming personnel dosimetry should be worn.
- 4.2.2 Additional PPE: Other appropriate PPE for the area being entered. Check with your FS representative.

#### NOTE:

The meter is sensitive and can be damaged by entry into high field locations. Approach sources from low background areas.

## 5. Procedure

### 5.1 Equipment:

- 5.1.1 Meter Body
- 5.1.2 Probes
- 5.1.3 RF source for functionality test



1	Probe connector socket
2	Microphone
3	Display
4	Operating panel
	Function keys Used to select the menu functions shown on the display.
	ESC key Used to exit from a menu / reset functions and measured values.
	OK key Used to open a menu or function / confirm a setting.
	UP / DOWN arrow keys Used to select menus and functions / change values / lock the keypad / change the contrast.
	ON/OFF key Used to switch the instrument on or off.
Charge	Charge state Indicates the charge state (red = rapid charging, green = trickle charging).
Status	Operating status Indicates the instrument operating status: Green = normal operation, red = remote operation, flashing red = firmware unavailable or faulty.
5	Tripod bush
6	Electrical and optical connectors
6a	Multi-function socket for USB / GPS (optional) / external trigger
6b	Earphone
6c	Optical connector
6d	AC Adapter / Charger
7	Tripod bush (on back of instrument)
8	Battery compartment (on back of instrument)
	Probe (various models available)
9	Probe head
10	Probe plug

- 5.2 Connecting the probe
- 5.3 There are many different probes available for different applications for the NBM-550.

**CAUTION:**  
Always hold the probe at the metal plug end (10) to avoid damaging the probe head

**Connecting the probe**

The red dot on the probe plug is pointing towards the front and on the top of the instrument. Push the probe plug straight down into the probe socket (1) until it clicks into place.

**Disconnecting the probe**

Slide the sleeve on the probe plug upwards and pull the probe upwards to remove it.

**5.3.1 Switching on**

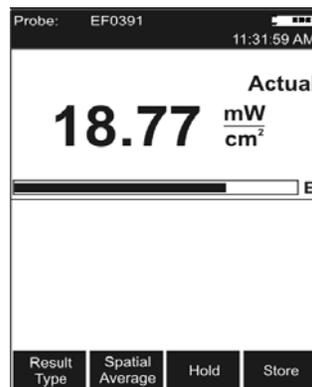
The instrument performs a self test. The progress of the self test is displayed on the screen. Press the **ON/OFF** key to switch the instrument on. The instrument is not ready for use until all tests have been completed successfully and **OK** is displayed.

**5.3.2 Calibration**

The NBM-550 and probes must be calibrated at certain intervals to guarantee the quality of the measurement results. If you have missed the date for a calibration, this will be displayed by default after the self test is complete. Record the calibration due dates for the NBM- 550 and the selected probe on the survey form

**5.3.3 The measurement screen**

You can directly activate a function or make a selection by pressing one of the four function keys in the measurement screen. All other settings have to be made using the menus described below.



**5.3.4 The main menu**

The MAIN menu opens when you press the **OK** key. All other settings are made from this menu. The most important settings are once again assigned to the function keys in the MAIN menu.

MENU - MAIN			
Measurement Settings			
Data Logger			
Memory Manager			
Interface			
Information			
Setup			
Clock			
Displays device related information			
Unit: mW/cm <sup>2</sup>	Display: History	Zero	Data Viewer

### 5.3.5 The sub-menus

Select a sub-menu from the MAIN menu and press the **OK** key to open the selected sub-menu. The example shows: DATA LOGGER

MENU - DATA LOGGER	
History Time Scale	20 min
Timer Start	00:00:00
Timer Duration	00:00:00
Timer Interval	1 s
Store Condition	Upper THRHL D
Storing Range	Store All
Upper Threshold	61.4 V/m
Lower Treshold	19.4 V/m
Voice Recorder	Off
Start of time controlled logging	
Unit: V/m	Condition Logging
Timer Logging	

### 5.3.6 The function levels

Select a function from the sub-menu and press the **OK** key to open the selected function. You can then make the settings you require or read out the desired information. The example shows: Timer start.

MENU - DATA LOGGER	
History Time Scale	20 min
Timer Start	00:00:00
Timer Duration	00:00:00
Timer Interval	1 s
Store Condition	Upper THRHL D
Storing Range	Store All
Upper Threshold	1.0 mW/cm <sup>2</sup>
Lower Treshold	0.1 mW/cm <sup>2</sup>
Voice Recorder	Off
Start of time controlled logging	

### 5.3.7 Navigating in the menus

Use the following keys to navigate through the menus and select the functions. To simplify the description of the selection of a menu level or function, the menu and function names will be listed one after the other and separated by a slash.

#### Function keys

Select the function shown in the display, which depends on the menu selected.

#### ESC key

Exits from the menu (with or without making changes).

#### OK key

Opens a menu or a function and confirms a setting.

#### ▲/▼ key

Select a menu or a function and change values.

### 5.3.8 Setting the auto zero adjustment

If the **Auto-Zero Interval** function is activated, an automatic zero adjustment will be performed at the specified intervals. The following settings are possible:

- **minutes**: Auto zero every 6 minutes
- **15 minutes**: Auto zero every 15 minutes
- **1 hour**: Auto zero every hour
- **off**: Auto zero function disabled

The default setting is **15 minutes**.

#### Changing the setting

1. Open the **Auto-Zero Interval** function (MAIN/MEASUREMENT SETTINGS/Next/...).
2. Use the ▲/▼ arrow keys to select the desired setting and then press the **OK** key to confirm the setting.

### Starting a zero adjustment manually

1. Open the MAIN menu.
2. Press the **Zero** function key.  
A zero adjustment is performed.

### 5.3.9 Setting the auto off function

You can set the instrument to switch off automatically after a specified time without any activity to protect the batteries from being discharged.

The following settings are possible:

- **minutes**: Switches off after 6 minutes
- **15 minutes**: Switches off after 15 minutes
- **1 hour**: Switches off after 1 hour
- **off**: Auto off function disabled

The default setting is **15 minutes**.

**Note:** The auto off function is disabled during long-term measurements using the **Timer Logging** function.

#### Changing the setting

1. Open the **Auto Power-Off** function (MAIN/MEASUREMENT SETTINGS/Next/...).
2. Use the **▲/▼** arrow keys to select the desired setting and then press the **OK** key to confirm the setting.

### 5.3.10 Setting the backlight

The display backlight is activated every time you press a key and switches off after a specified time to preserve battery power. The following settings are possible:

- **off**: Backlight disabled
- **5 s**: Backlight switches off after 5 seconds
- **10 s**: Backlight switches off after 10 seconds
- **30 s**: Backlight switches off after 30 seconds
- **60 s**: Backlight switches off after 60 seconds
- **permanent**: Backlight is switched on permanently The default setting is **10 seconds**.

#### Changing the switch off delay time

1. Open the **LCD Backlight** function (MAIN/MEASUREMENT SETTINGS/Next/...).
2. Use the **▲/▼** arrow keys to select the desired setting and then press the **OK** key to confirm the setting.

#### Setting the contrast

The display shows the measurement screen. Press the **▲** or **▼** arrow keys to increase or decrease the contrast.

### 5.3.11 Changing the display units

1. Open the MAIN menu.
2. Press the **Unit** function key repeatedly until the desired units are displayed. Units are set in the following order: mW/cm<sup>2</sup> – W/cm<sup>2</sup> – V/m – A/m – mW/cm<sup>2</sup> –...
3. Press the ESC key. The display reverts to the measurement screen and the selected units are displayed.

#### Changing the units format

The units for the measurement values can be displayed in two different formats:

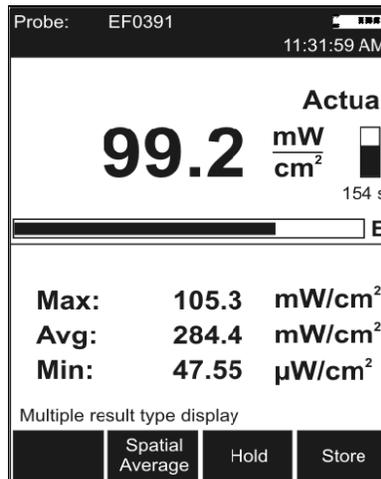
##### Fixed Triad

Units are displayed with a fixed format (mW/cm<sup>2</sup>, W/m<sup>2</sup>, V/m, A/m).

##### Variable Triads (recommended)

Units are adjusted to match the size of the measured value (47.55 μW/cm<sup>2</sup> in the example shown on the left).

**Tip:** We recommend that you use the **Variable Triads** format for signals that have a high dynamic range, otherwise the display of very small or very large values will be meaningless.



#### Changing the units format

1. Open the **Results Format** function (MAIN/MEASUREMENT SETTINGS/Next/...).
2. Use the ▲/▼ arrow keys to select the desired format and then press the **OK** key to confirm the setting.

**Note:** Be careful not to make read-off errors due to the different formats when you use the **Variable Triads** setting.

## 5.4 Measuring with the NBM-550

### 5.4.1 Measuring in Normal display mode

The latest measurement results are displayed in Normal mode. You can also display maximum and average values.

#### Selecting the result type

You can select the following result displays on the NBM-550:

#### Selecting a result type

Press the **Result Type** key repeatedly until the desired result type is shown.

#### Result type Description

- **Actual** – The latest measured value of field strength is shown numerically and as a bar graph.
- **Max Hold** – The maximum field strength measured during the course of the measurement is frozen and displayed numerically and as a separate line on the bar graph. The bar graph continues to display the latest value. Press the **ESC (Clear)** key to reset the display value to 0.
- **Average** – The average of the current measurement values is determined and displayed. The progress in forming the average value is shown as a bar graph until the first valid average value has been determined. The remaining measurement time in seconds is shown in the window on the right.

### 5.4.2 MEASUREMENT SETTINGS/Averaging Time menu

The bar graph disappears once the first average value has been determined. The average result is then valid. As the measurement continues, the average is formed continuously using the results obtained during the time window (averaging time). Press the **ESC (Clear)** key to reset the display value to 0.

**Max Avg** - The maximum value of the measured average values is displayed. The average values are determined as described for the Average result type. Only the highest average value determined during the course of the measurement is displayed. Press the **ESC (Clear)** key to reset the display value to 0.

#### Freezing a measured value

Press the **Hold** key to freeze the measured value being displayed at the moment. Press the **Release** key to resume the measurement.

### 5.4.3 Setting the averaging time

You can set the time used to form the average for **Average and Max Avg** display types in the range 4 s to 30 min. in 2 second steps.

#### Setting the time and resolution

1. Open the **Averaging Time** function (MAIN/MEASUREMENT SETTINGS/...).

2. Select the digit using the </> function keys.
3. Change the value using the ▲/▼ arrow keys.
4. Press the **OK** key to confirm the settings.

### 1. **Measuring the spatial average**

You can determine the spatial average of the field strength using the Spatial Average function. This function is used to determine the exposure to electromagnetic radiation of the human body, for example. Two measurement methods are available:

- **Discrete**  
Individual results are recorded and averaged. You can measure at specific locations using this method
- **Continuous (recommended)**  
Results are recorded and averaged continuously during the time that the probe is moved around the area of interest. You can measure the field strength affecting a particular space using this method.

### Selecting the measurement method

1. Open the **Spatial AVG Mode** function (MAIN/MEASUREMENT SETTINGS/Next/...).
2. Use the ▲/▼ arrow keys to select the method and press the **OK** key.

#### 5.4.4 **Measuring discrete values**

You selected **Discrete** as the **Spatial AVG Mode**.

1. Press the **Spatial Average** key. **Spatial** measurement mode is displayed. The result counter top left shows #0, indicating that no values have been measured yet.
2. Press the **Measure** key. The measured value is stored#1 indicates that one result has been stored. Pos. 1 shows the measured value.
3. Press the **Measure** key again to make another measurement. The measured values are stored#... indicates the number of measurements. The average of all the measurements is shown after Pos. 1.
4. When you have recorded all the measured values,
  - you can either add positions so you can record more results (e.g. at different locations),
  - or you can store the entire measurement.

### **Adding a position**

1. Press the **Add Position** key. **Pos. 2** is displayed. The result counter shows #0.
2. Record new measured values as described above.
3. You can add more positions and record more results if necessary.

**Avg Pos** shows the average value for all the positions measured, along with the positions used to form the average (e.g. 1-4 for positions 1 through 4)  
You can store the measurement results when you have recorded all the measured values.

**Storing the results** Press the **Store** key. The average of all positions and the averages for each separate position are stored.

#### 5.4.5 Measuring values continuously

##### **Making the measurement**

You have selected **Continuous** as **Spatial AVG Mode**.

1. Press the **Spatial Average** key. **Spatial** measurement mode is displayed.
2. Press the **Start** key. The measurement starts. The elapsed measurement time is shown top left in the display.
3. Move the NBM-550 evenly around the space to be measured. Press the **Stop** key to end the measurement. **Pos.1** displays the measured average value.
4. You can then– add positions to record further average values– or store the entire measurement.

**Note:** The NBM-550 emits an audible signal every second to assist you in moving it evenly.

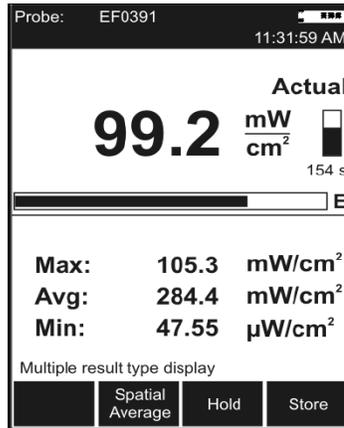
##### **Adding a position**

1. Press the **Add Position** key. **Pos. 2** is displayed  
The elapsed time counter shows **00:00 s**.
2. Record new measured values as described above.
3. You can add more positions and record more results if necessary.

**Avg Pos** shows the average value for all the positions measured, along with the positions used to form the average (e.g. 1-4 for positions 1 through 4). You can store the measurement results when you have recorded all the measured values.

**Storing the results** Press the **Store** key. The average of all positions and the averages for each separate position are stored.

## 5.4.6 Display overview



### Measuring in Monitor display mode

**Monitor** display mode simultaneously shows the maximum, average, and minimum measured values as well as the latest measured value.

**Changing to Monitor display mode** The display is in measurement mode.

1. Press the **OK** key to open the MAIN menu.
2. Press the **Display** function key until **Display: Monitor** appears.
3. Press the **ESC** key to return to measurement mode. Measurement and determination of the maximum, average, and minimum values starts immediately.

### Display overview

#### Resetting the values shown in the lower display area

Press the **ESC (Clear)** key.

## 5.5 Implementation and Training

Prior to using this meter, the operator shall :

- 5.5.1 Demonstration of proper operation of this instrument to the satisfaction of the employee's supervision.
- 5.5.2 Other appropriate training for the area to be entered (check with ESH coordinator or FS Representative for the facility).

**6. Documentation**

None

**7. References**

7.1 NARDA NBM-550 Manual

7.2 BNL SHSD SOP IH99150, Radio-frequency and Microwave Field Measurement Principles

7.3 ACGIH American Conference of Governmental Industrial Hygienists Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices.

**8. Attachments**

8.1 Short Operating Instructions

8.2 GMRS/FRS Radio Frequency Chart

8.3 CAD RF Direct Reading Instrument Survey Form

8.4 RF Measurements with NARDA NBM-550 Job Performance Measure (JPM) Completion Certificate

## Attachment 8.1

### Short Operating Instructions

	<b>Step</b>	<b>User Action</b>
	<b>Install Probe</b>	Red arrow faces up
1.	<b>Power On</b>	Press <i>Green</i> $\text{\textcircled{D}}$ key
2.	<b>Self Test</b>	Observe screen for OK to be displayed
3.	<b>Zero</b>	Zero takes place after self test automatically
4.	<b>Check calibration due dates</b>	Press <b>OK</b> Select Information Settings press <b>OK</b> Select device press <b>OK</b> record cal due date, press <b>ESC</b> Select probe information press <b>OK</b> record cal due date, press <b>ESC</b>
	<b>Check Measurement settings</b>	Press <b>OK</b> Select Measurement Settings press <b>OK</b> Ensure parameters are appropriate for measurement Press <b>ESC</b> to exit
5.	<b>Functionality check</b>	Using an appropriate source of RF, such as a FRS/GMRS radio, transmit on a known frequency and observe meter reading to indicate an increase over background
6.	<b>Check Background</b>	<ul style="list-style-type: none"> <li>▪ Measurement screen recommended is Variable Triad</li> <li>▪ Press <b>OK</b> to change display mode choose Display Monitor for NORMAL display Press <b>ESC</b>.</li> <li>▪ In a low background area press <b>ESC</b> to zero last measurement, and after an appropriate interval note maximum reading for background.</li> <li>▪ Take measurements in appropriate fashion, spatial averaging, min-max, etc. Record data.</li> </ul>
	<b>Measuring</b>	Take measurements in appropriate fashion, spatial averaging, min-max, etc. Record data.
	<b>CAUTION</b>	NOTE: To change probes turn off instrument prior to removal or installation.
7.	<b>Power Off</b>	Press <i>Green</i> $\text{\textcircled{D}}$ key

## Attachment 8.2

### GMRS/FRS Radio Frequency Chart

Channels 15 GMRS / 7 FRS  
Operating Frequency UHF 462.5500-  
467.7125 MHz

#### Frequency Chart

<b>Ch.</b>	<b>Freq.</b>	<b>Ch.</b>	<b>Freq.</b>
1	462.5625	12	467.6625
2	462.5875	13	467.6875
3	462.6125	14	467.7125
4	462.6375	15	462.5500
5	462.6625	16	462.5750
6	462.6875	17	462.6000
7	462.7125	18	462.6250
8	467.5625	19	462.6500
9	467.5875	20	462.6750
10	467.6125	21	462.7000
11	467.6375	22	462.7250

**Attachment 8.3**

**RF Direct Reading Instrument Survey Form**

**(see next two pages,  
form is a two sided copy)**

## Attachment 8.3

<b>BROOKHAVEN NATIONAL LABORATORY</b>	<b>C-AD RF</b>	<b>DIRECT READING</b>
<b>INSTRUMENT</b>		
DATE:	SURVEYOR(S):	

<b>I. AREA INFORMATION</b>		
DEPT.	BLDG.	ROOM
SOURCE:		
FREQUENCY OF SOURCE:	SOURCE OUTPUT:	
ENGINEERING CONTROLS:		

<b>II. EMPLOYEE INFORMATION</b>		
FIRST NAME:	LAST NAME:	BNL #:
DEPT:	BLDG:	JOB TITLE:
EXPOSURE DURATION(HRS):	EXPOSURE (TIMES PER DAY):	EXPOSURE (DAYS PER YEAR):
JOB/TASK PERFORMED:		

<b>III. SURVEY INSTRUMENT INFORMATION</b>		
INSTRUMENT:	MODEL:	SERIAL#:
FACTORY CAL. DUE DATE:	SELF TEST Y/N	AVERAGING TIME
PROBE TYPE E/H MODEL #	SERIAL NUMBER:	CAL DUE DATE:
FREQUENCY	ZERO Y/N BKG:	FUNCTION TEST Y/N
PROBE TYPE E/H MODEL #	SERIAL NUMBER:	CAL DUE DATE:
FREQUENCY	ZERO Y/N BKG:	FUNCTION TEST Y/N
PROBE TYPE E/H MODEL #	SERIAL NUMBER:ZERO Y/N BKG:	CAL DUE DATE:
FREQUENCY		FUNCTION TEST Y/N
PROBE TYPE E/H MODEL #	SERIAL NUMBER:	CAL DUE DATE:
FREQUENCY	ZERO Y/N BKG:	FUNCTION TEST Y/N

<b>IV: SAMPLING INFORMATION RESULTS (SEE ATTACHMENTS)</b>
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<b>V: ADDITIONAL COMMENTS</b>

**VI. CONCLUSIONS & RECOMMENDATIONS**

## Attachment 8.4



### RF Measurements with NARDA NBM-550 Job Performance Measure (JPM) Completion Certificate

Candidate's Name	Life Number:
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#### Knowledge of the Principles of RF Measurements

Criteria	Qualifying Standard	Unsatis- factory	Recov- ered	Satisf- actory
<b>Hazard Analysis</b>	Understands the need to perform a hazard analysis of the sampling area and potential exposure to the sampler.			
<b>Personal Protective Equipment</b>	Understands the need to be aware of the potential RF exposure to the sampler.			
<b>Sampling Protocol</b>	Understands the exposure monitoring logic necessary to appropriately select sampling locations to accurately measure worker, public, and environmental exposure potential.			
<b>Analysis of data</b>	Understands the need to perform analysis on the sampling data to assess potential exposure to the sampler, worker, public and environment, and to recommend corrective actions as necessary, and employee notification.			

#### Practical Skill Evaluation: Demonstration of Meter Operation

Criteria	Qualifying Performance Standard	Unsatis- factory	Recov- ered	Satisf- actory
<b>Sampling Equipment</b>	Knows where equipment needed for the procedure is located and how to properly sign it out.			
<b>Handling of Microphone</b>	Understands the calibration, zeroing, and measurement operation of the meter.			
<b>Placement of Probes</b>	Demonstrates the proper location of the probes and meter in the work site to prevent meter damage.			
<b>Record forms</b>	Shows how to correctly and completely fill all forms associated with this OPM.			
<b>Data Analysis</b>	Shows how to correctly have the data analyzed and compared to occupational exposure limits. Knows the correct OELs.			
<b>Employee Notification</b>	Knows how to timely and properly notify workers and management of over exposure. Knows how to inform workers and management of exposure that is within OEL.			

**Employee:** I accept the responsibility for performing this task as demonstrated within this JPM and the corresponding SOP.

Candidate Signature:	Date:
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**Evaluator:** I certify the candidate has satisfactorily performed each of the above listed steps and is capable of performing the task unsupervised.

Evaluator Signature:	Date:
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