

Installation of DF antennas

Information and guidance on the installation of Narda SignalShark Direction Finding Antennas

Automatic direction finding antennas such as the Narda ADFA 1 and ADFA 2 models when used with the measuring receivers in the Narda SignalShark range are characterized by their high direction finding speed and accuracy. The ADFA 2 additionally covers an extremely wide frequency range. The specifications of such antennas are always determined under ideal conditions, without any reflections or other disruptive influences.

In reality, though, the environmental conditions at the point of use will be more or less hostile. These non-ideal but real conditions can lead to distortions in the field that are reflected in the measurement result. If a field that is already distorted is received by the measuring antenna, then it will exactly measure this distorted field. It is therefore important to pay special attention to the avoidance of field distortions.

Many interfering factors can be avoided with mobile direction finding, e.g. from the roof of a vehicle.

Lightning protection is often unnecessary, and by using a heatmap for localization, the statistical process means that many reflections can be eliminated by the constant changes in location.

This does not apply to fixed installations on a mast. The mast itself, building or parts of the building, other antennas, lightning conductors, and so on, all have an effect on the field and hence on the measurement result that cannot be ignored. These effects are, however, of a systematic nature and can largely be compensated for by calibrating the system first.

As every installation location will be different, any general installation instructions can only be recommendations and guidelines. The actual installation at the point of use must therefore be meticulously planned and executed in order to obtain optimal direction finding results.



Figure 1: The Narda SignalShark family (from left to right):
Handheld measuring receiver, Outdoor Unit measuring receiver, Automatic Direction Finding Antenna ADFA,
Remote measuring receiver

Installation of direction finding antennas

The best method always avoids influencing the field, as there is then no need to compensate for such effects later. Unfortunately, however, the surroundings of the measuring antenna are usually already fixed. Nevertheless, much can be achieved with a little effort.

1. The mast

A non-conductive mast made e.g. of plastic is ideal. Often, though, metal masts are already specified or are absolutely necessary. The effects are relatively small for frequencies above a few hundred MHz. However, when the ADFA 2, which is specified for frequencies from 10 MHz upwards, is mounted on a metallic mast, the following should be considered:

The ADFA 2 uses the Watson-Watt principle for direction finding at frequencies below 200 MHz. The advantages are high direction finding sensitivity from a small size installation. In turn, a small size means lower wind resistance.

Far field conditions are a prerequisite for accurate direction finding using the Watson-Watt principle, that is, orthogonality between the electric and magnetic fields. When a metallic mast reaches its natural resonance, strongly elevated fields occur at the mast ends. These distort the field at the direction finding antenna location. To reduce such effects, Narda offers a nonmetallic antenna adapter. This adapter is fitted between the end of the metal mast and the ADFA, which enables this effect to be minimized.

2. The RF and control cable

The RF cable is another component that can have a considerable influence on the direction finding result. Even if the mast can be constructed of nonmetallic material, the cable cannot. However, the influence of the cable can be considerably reduced by the use of ferrites. Consequently, Narda RF and control cables are sheathed in ferrites as standard. If the ADFA 2 is to be operated right down to its lower frequency limit, additional ferrites (e.g. split ferrites) should be added around the cable in the area of the nonmetallic part of the mast. The antenna factor and cable attenuation are automatically factored in and compensated for when Narda antennas and Narda RF cables are used.

3. Lightning protection

Lightning protection is absolutely essential for installations in exposed locations. Such as on the roof of a building. However, a lightning conductor rod in RF terms represents a monopole, and reflects the incident signal. Since measurement accuracy must give way to safety in the event of a lightning strike, the lightning conductor rod must be as "invisible" as possible from the RF point of view. In collaboration with the company DEHN SE + Co KG, Narda has been able to develop a lightning conductor rod that is practically transparent to RF thanks to the use of ferrites. As a result, it only marginally affects the direction finding results, while still fulfilling its purpose of providing effective lightning protection.



Figure 2: ADFA installation with optimized lightning conductor

Corrective measures

The information given above can help to improve conditions so that perfect direction finding can be achieved. However, if the metal mast resonates because of its length, or it proves impossible to alter the structure of, say an elevator machine room to avoid reflections, some way of applying subsequent correction is the only remaining option.

The ITU "Spectrum Monitoring" handbook describes the need for and how to perform such calibrations and corrections for entire measuring stations in Section 4.7: "Radio direction-finding and location".

Narda has provided a free facility for ITU compliant correction of bearing values with the aid of a correction file in the SignalShark with firmware version 1.7.5 or above.

4. Omni phase correction

Particularly at very low frequencies and with long masts, ambiguities in the display can occur despite taking the above-mentioned actions. In other words, the bearing result suddenly changes by 180° below a certain frequency. This shift is systematic, can be determined, and for the most part compensated for across a wide range with the exception of the point at which it occurs.

5. Azimuth correction

Static effects caused by objects in close proximity, e.g. reflections from other antennas, parts of buildings, lightning conductors, etc., are mostly of a systematic nature and can therefore be compensated for.

6. Generating a correction file

The correction file can be compiled using an XML editor. The general layout is shown in Figure 3.

```

<?xml version="1.0" encoding="UTF-8"?>
<Narda_3300_DF_CORR_DATA>
  <Info>
    <ShortName size="1" type="string">DF-CORR-01</ShortName>
    <LongName size="1" type="string">DF-CORR-01_3361_01_B-0005</LongName>
    <Fmin size="1" type="string">27 MHz</Fmin>
    <Fmax size="1" type="string">300 MHz</Fmax>
    <AntennaPN size="1" type="string">3361/01</AntennaPN>
    <AntennaSN size="1" type="string">B-0005</AntennaSN>
    <CorrDataDate size="1" type="date" Format="%d.%m.%Y">21.10.2021</CorrDataDate>
    <Comment size="1" type="string">DF error correction data for site XY</Comment>
  </Info>
  <OmniPhaseCorrection>
    <OPCorrItems size="4" type="OPCorrItems">
      <OPCorrItem size="1" type="OPCorrItem">
        <Freq size="1" type="double">2.700000e+07</Freq>
        <AzimuthCorrOffset size="1" type="float">0.0</AzimuthCorrOffset>
      </OPCorrItem>
      <OPCorrItem size="1" type="OPCorrItem">
        <Freq size="1" type="double">2.800000e+07</Freq>
        <AzimuthCorrOffset size="1" type="float">180.0</AzimuthCorrOffset>
      </OPCorrItem>
      <OPCorrItem size="1" type="OPCorrItem">
        <Freq size="1" type="double">3.000000e+07</Freq>
        <AzimuthCorrOffset size="1" type="float">180.0</AzimuthCorrOffset>
      </OPCorrItem>
      <OPCorrItem size="1" type="OPCorrItem">
        <Freq size="1" type="double">3.400000e+07</Freq>
        <AzimuthCorrOffset size="1" type="float">0.0</AzimuthCorrOffset>
      </OPCorrItem>
    </OPCorrItems>
  </OmniPhaseCorrection>
  <AzimuthCorrection>
    <AzimuthCorrItems size="4" type="AzimuthCorrItems">
      <AzimuthCorrItem size="1" type="AzimuthCorrItem">
        <Freq size="1" type="double">1.490000e+08</Freq>
      <AzimuthCorrOffsets size="4" type="AzimuthCorrOffsets">
        <AzimuthCorrOffset size="1" type="float" azimuth="0°">0</AzimuthCorrOffset>
        <AzimuthCorrOffset size="1" type="float" azimuth="90°">0</AzimuthCorrOffset>
        <AzimuthCorrOffset size="1" type="float" azimuth="180°">0</AzimuthCorrOffset>
        <AzimuthCorrOffset size="1" type="float" azimuth="270°">0</AzimuthCorrOffset>
      </AzimuthCorrItem>
      <AzimuthCorrItem size="1" type="AzimuthCorrItem">
        <Freq size="1" type="double">1.500000e+08</Freq>
      <AzimuthCorrOffsets size="8" type="AzimuthCorrOffsets">
        <AzimuthCorrOffset size="1" type="float" azimuth="0°">0</AzimuthCorrOffset>
        <AzimuthCorrOffset size="1" type="float" azimuth="45°">10</AzimuthCorrOffset>
        <AzimuthCorrOffset size="1" type="float" azimuth="90°">0</AzimuthCorrOffset>
        <AzimuthCorrOffset size="1" type="float" azimuth="135°">0</AzimuthCorrOffset>
        <AzimuthCorrOffset size="1" type="float" azimuth="180°">0</AzimuthCorrOffset>
        <AzimuthCorrOffset size="1" type="float" azimuth="225°">0</AzimuthCorrOffset>
        <AzimuthCorrOffset size="1" type="float" azimuth="270°">0</AzimuthCorrOffset>
        <AzimuthCorrOffset size="1" type="float" azimuth="315°">0</AzimuthCorrOffset>
      </AzimuthCorrItem>
      <AzimuthCorrItem size="1" type="AzimuthCorrItem">
        <Freq size="1" type="double">2.000000e+08</Freq>
      <AzimuthCorrOffsets size="4" type="AzimuthCorrOffsets">
        <AzimuthCorrOffset size="1" type="float" azimuth="0°">10</AzimuthCorrOffset>
        <AzimuthCorrOffset size="1" type="float" azimuth="90°">170</AzimuthCorrOffset>
        <AzimuthCorrOffset size="1" type="float" azimuth="180°">0</AzimuthCorrOffset>
        <AzimuthCorrOffset size="1" type="float" azimuth="270°">0</AzimuthCorrOffset>
      </AzimuthCorrItem>
      <AzimuthCorrItem size="1" type="AzimuthCorrItem">
        <Freq size="1" type="double">3.000000e+08</Freq>
      <AzimuthCorrOffsets size="4" type="AzimuthCorrOffsets">
        <AzimuthCorrOffset size="1" type="float" azimuth="0°">0</AzimuthCorrOffset>
        <AzimuthCorrOffset size="1" type="float" azimuth="90°">0</AzimuthCorrOffset>
        <AzimuthCorrOffset size="1" type="float" azimuth="180°">0</AzimuthCorrOffset>
        <AzimuthCorrOffset size="1" type="float" azimuth="270°">0</AzimuthCorrOffset>
      </AzimuthCorrItem>
    </AzimuthCorrItems>
  </AzimuthCorrection>
</Narda_3300_DF_CORR_DATA>

```

Figure 3: Layout of a correction file in XML format

7. Correction file format in detail

Root node:

```
<Narda_3300_DF_CORR_DATA>...</Narda_3300_DF_CORR_DATA>
```

<Info> child node:

The <Info> child node contains general information about the correction file and the data in it:

```
<Info>
  <ShortName size="1" type="string">DF-CORR-01</ShortName>
  <LongName size="1" type="string">DF-CORR-01_3361_01_B-0005</LongName>
  <Fmin size="1" type="string">27 MHz</Fmin>
  <Fmax size="1" type="string">300 MHz</Fmax>
  <AntennaPN size="1" type="string">3361/01</AntennaPN>
  <AntennaSN size="1" type="string">B-0005</AntennaSN>
  <CorrDataDate size="1" type="date" Format="%d.%m.%Y">21.10.2021</CorrDataDate>
  <Comment size="1" type="string">DF error correction data for site XY</Comment>
</Info>
```

Figure 4: Info child node

<OmniPhaseCorrection> child node:

The <OmniPhaseCorrection> child node contains data that enables correction of phase shifts.

```
<OmniPhaseCorrection>
  <OPCorrItems size="4" type="OPCorrItems">
    <OPCorrItem size="1" type="OPCorrItem">
      <Freq size="1" type="double">2.70000e+07</Freq>
      <AzimuthCorrOffset size="1" type="float">0.0</AzimuthCorrOffset>
    </OPCorrItem>
    <OPCorrItem size="1" type="OPCorrItem">
      <Freq size="1" type="double">2.80000e+07</Freq>
      <AzimuthCorrOffset size="1" type="float">180.0</AzimuthCorrOffset>
    </OPCorrItem>
    <OPCorrItem size="1" type="OPCorrItem">
      <Freq size="1" type="double">3.30000e+07</Freq>
      <AzimuthCorrOffset size="1" type="float">180.0</AzimuthCorrOffset>
    </OPCorrItem>
    <OPCorrItem size="1" type="OPCorrItem">
      <Freq size="1" type="double">3.40000e+07</Freq>
      <AzimuthCorrOffset size="1" type="float">0.0</AzimuthCorrOffset>
    </OPCorrItem>
  </OPCorrItems>
</OmniPhaseCorrection>
```

Figure 5: Omni Phase Correction child node

The <OPCorrItems> sub node contains a list of pairs of values <OPCorrItem>.

- <Freq>: Frequency point from which the correction is to be applied
- <AzimuthCorrOffset>: Offset angle to the bearing angle that is determined

The list must contain at least two entries. The first entry specifies the frequency above which corrections are to be applied. The AzimuthCorrOffset is interpolated linearly between the two list entries.

<AzimuthCorrection> child node:

The <AzimuthCorrection> child node contains data for correction of systematic, non-directional bearing deviations.

```
<AzimuthCorrection>
  <AzimuthCorrItems size="4" type="AzimuthCorrItems">
    <AzimuthCorrItem size="1" type="AzimuthCorrItem">
      <Freq size="1" type="double">1.49000e+08</Freq>
      <AzimuthCorrOffsets size="4" type="AzimuthCorrOffsets">
        <AzimuthCorrOffset size="1" type="float" azimuth="0">0</AzimuthCorrOffset>
        <AzimuthCorrOffset size="1" type="float" azimuth="90">0</AzimuthCorrOffset>
        <AzimuthCorrOffset size="1" type="float" azimuth="180">0</AzimuthCorrOffset>
        <AzimuthCorrOffset size="1" type="float" azimuth="270">0</AzimuthCorrOffset>
      </AzimuthCorrOffsets>
    </AzimuthCorrItem>
    <AzimuthCorrItem size="1" type="AzimuthCorrItem">
      <Freq size="1" type="double">1.50000e+08</Freq>
      <AzimuthCorrOffsets size="8" type="AzimuthCorrOffsets">
        <AzimuthCorrOffset size="1" type="float" azimuth="0">0</AzimuthCorrOffset>
        <AzimuthCorrOffset size="1" type="float" azimuth="45">0</AzimuthCorrOffset>
        <AzimuthCorrOffset size="1" type="float" azimuth="90">0</AzimuthCorrOffset>
        <AzimuthCorrOffset size="1" type="float" azimuth="135">0</AzimuthCorrOffset>
        <AzimuthCorrOffset size="1" type="float" azimuth="180">0</AzimuthCorrOffset>
        <AzimuthCorrOffset size="1" type="float" azimuth="225">0</AzimuthCorrOffset>
        <AzimuthCorrOffset size="1" type="float" azimuth="270">0</AzimuthCorrOffset>
        <AzimuthCorrOffset size="1" type="float" azimuth="315">0</AzimuthCorrOffset>
      </AzimuthCorrOffsets>
    </AzimuthCorrItem>
    <AzimuthCorrItem size="1" type="AzimuthCorrItem">
      <Freq size="1" type="double">2.00000e+08</Freq>
      <AzimuthCorrOffsets size="4" type="AzimuthCorrOffsets">
        <AzimuthCorrOffset size="1" type="float" azimuth="0">10</AzimuthCorrOffset>
        <AzimuthCorrOffset size="1" type="float" azimuth="90">170</AzimuthCorrOffset>
        <AzimuthCorrOffset size="1" type="float" azimuth="180">0</AzimuthCorrOffset>
        <AzimuthCorrOffset size="1" type="float" azimuth="270">0</AzimuthCorrOffset>
      </AzimuthCorrOffsets>
    </AzimuthCorrItem>
    <AzimuthCorrItem size="1" type="AzimuthCorrItem">
      <Freq size="1" type="double">2.00000e+08</Freq>
      <AzimuthCorrOffsets size="4" type="AzimuthCorrOffsets">
        <AzimuthCorrOffset size="1" type="float" azimuth="0">0</AzimuthCorrOffset>
        <AzimuthCorrOffset size="1" type="float" azimuth="90">0</AzimuthCorrOffset>
        <AzimuthCorrOffset size="1" type="float" azimuth="180">0</AzimuthCorrOffset>
        <AzimuthCorrOffset size="1" type="float" azimuth="270">0</AzimuthCorrOffset>
      </AzimuthCorrOffsets>
    </AzimuthCorrItem>
  </AzimuthCorrItems>
</AzimuthCorrection>
```

Figure 6: Azimuth Correction child node

The list must contain at least two entries. The first entry specifies the frequency above which corrections are to be applied.

Intermediate values are interpolated linearly.

The <AzimuthCorrItems> sub node contains a list of azimuth offset values <AzimuthCorrItem> that are independent of frequency and direction.

<Freq>:

Frequency point from which the correction is to be applied

<AzimuthCorrOffsets>:

List of azimuth offset angles <AzimuthCorrOffset> at the given frequency.

Intermediate values are interpolated linearly.

The change in angle between the entries is given by the number of entries.

Example:

Four <AzimuthCorrOffset> entries:

- <AzimuthCorrOffsets size="4" type="AzimuthCorrOffsets">
- $360/4 = 90^\circ$
- First measurement at angle of antenna to transmitter of 0° .
- Second measurement at angle of antenna to transmitter of 90° , and so on

To improve legibility, the antenna direction angle should be specified in the "azimuth" attribute of the <AzimuthCorrOffset> node.

```
<AzimuthCorrOffset size="1" type="float" azimuth="0">0</AzimuthCorrOffset>
```

8. Application of a correction file

In an AutoDF task, a correction file can be selected and applied from the Config menu in the Bearing View.

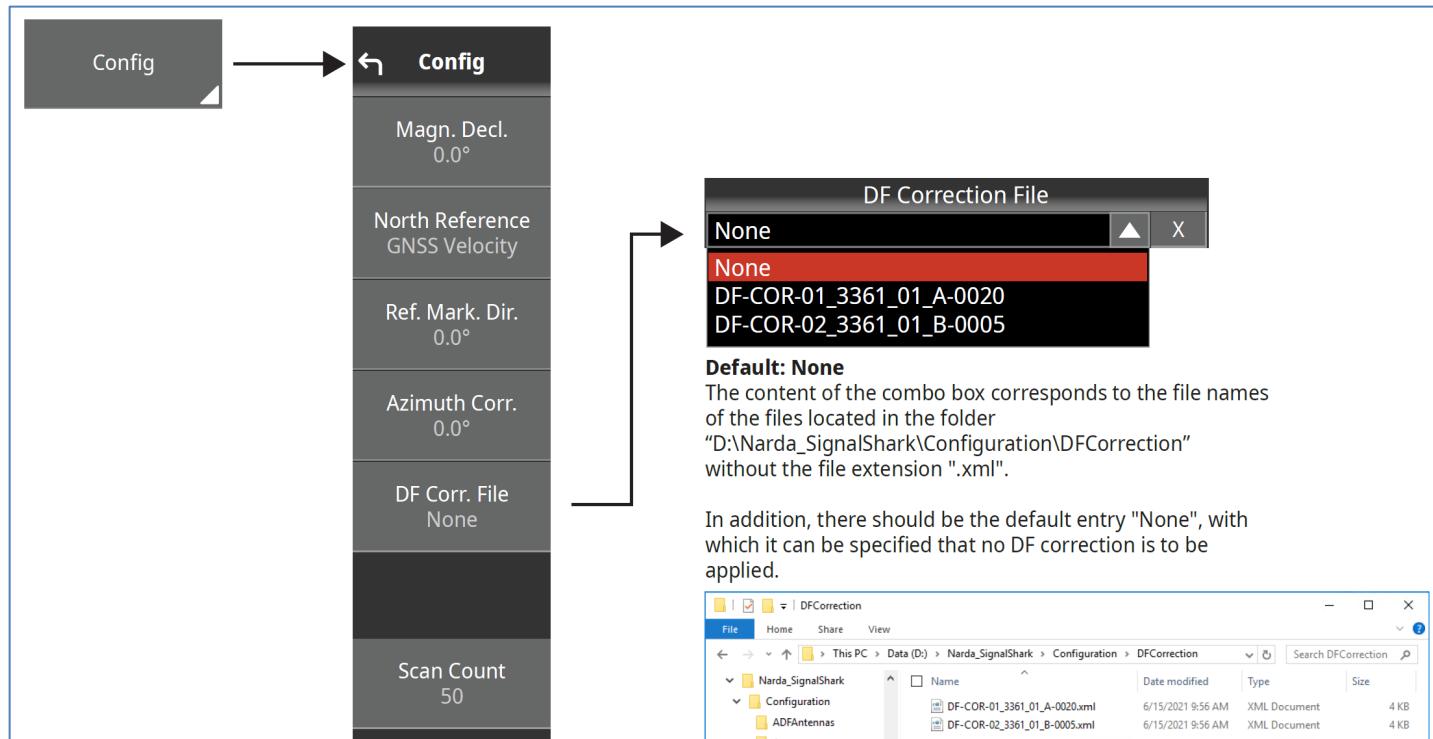


Figure 7: Selection and activation of a correction file.

Activation of the "DF Corr. File" button opens a selection menu that lists all the DF correction files in the directory "D:\Narda_SignalShark\Configuration\DFCorrection" without their ".xml" file name extensions. "None" is also included in the list. This can be used to specify that no corrections are to be applied by means of a correction file. "None" is the default selection. When a correction file is selected, all direction finding results will be corrected by the correction factors automatically and displayed on the screen.

SignalShark Outdoor Unit, PoE and ADFA Installation Recommendations

The solutions described here are models for stationary mast installation and must be adapted to the specific requirements of the actual installation situation. Please also take into account the specifications of the individual components, e.g. in terms of wind load, temperature, mechanical load capacity and so on.

General Installation Recommendations:

- There should be no obstacles on the roof within a distance of 50 meters from the antenna, except for the special lightning rod.
- Only low obstacles should be located at a distance of 50 meters to 100 meters from the antenna.
- No large structures such as high-tension masts or high-rise buildings up to a distance of 400 m from the antenna.
- No obstacles outside a cone with an angle of 60° below the Non-Conductive Antenna Mast.

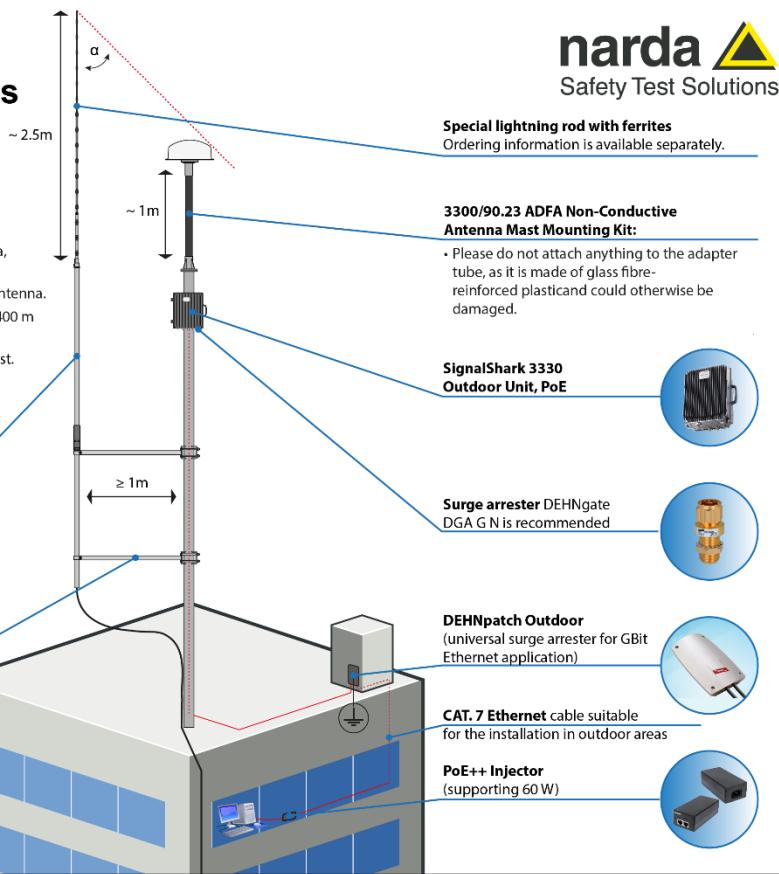


Lightning Rod Position (regarding DF):

- The lightning rod should be positioned within or opposite the main direction of bearing.
- Take into account the protection angle α according to the local conditions and the desired lightning protection class.

Lightning Rod Spacer:

- The distance between the lightning rod and the antenna should be at least 1 meter.
- The spacer of the lightning rod must not be attached to the non-conductive mast adapter of the ADFA, as the mast adapter is made of glass fibre-reinforced plastic!



All information on lightning protection and its components are only of an exemplary nature. The installation must be carried out in accordance with the respective national safety guidelines for lightning and personal protection and may only be carried out by qualified personnel.

Installation instructions considering cabling and corresponding lightning protection.

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