

## Interpretation of Static Position Testing in VNG/ENG

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### Biography

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### Abstract:

The purpose of static position testing, also known as the positional test, in the video- and electro-nystagmography (VNG/ENG) test battery is to determine the presence and characteristic of nystagmus when the patient's head is placed in different orientations with respect to gravity. Although the test procedure is relatively simple (see Barin, 2006, for details), the interpretation of the results may not be straightforward to inexperienced VNG/ENG examiners. This article provides a basic step-by-step algorithm for the interpretation of static position testing.

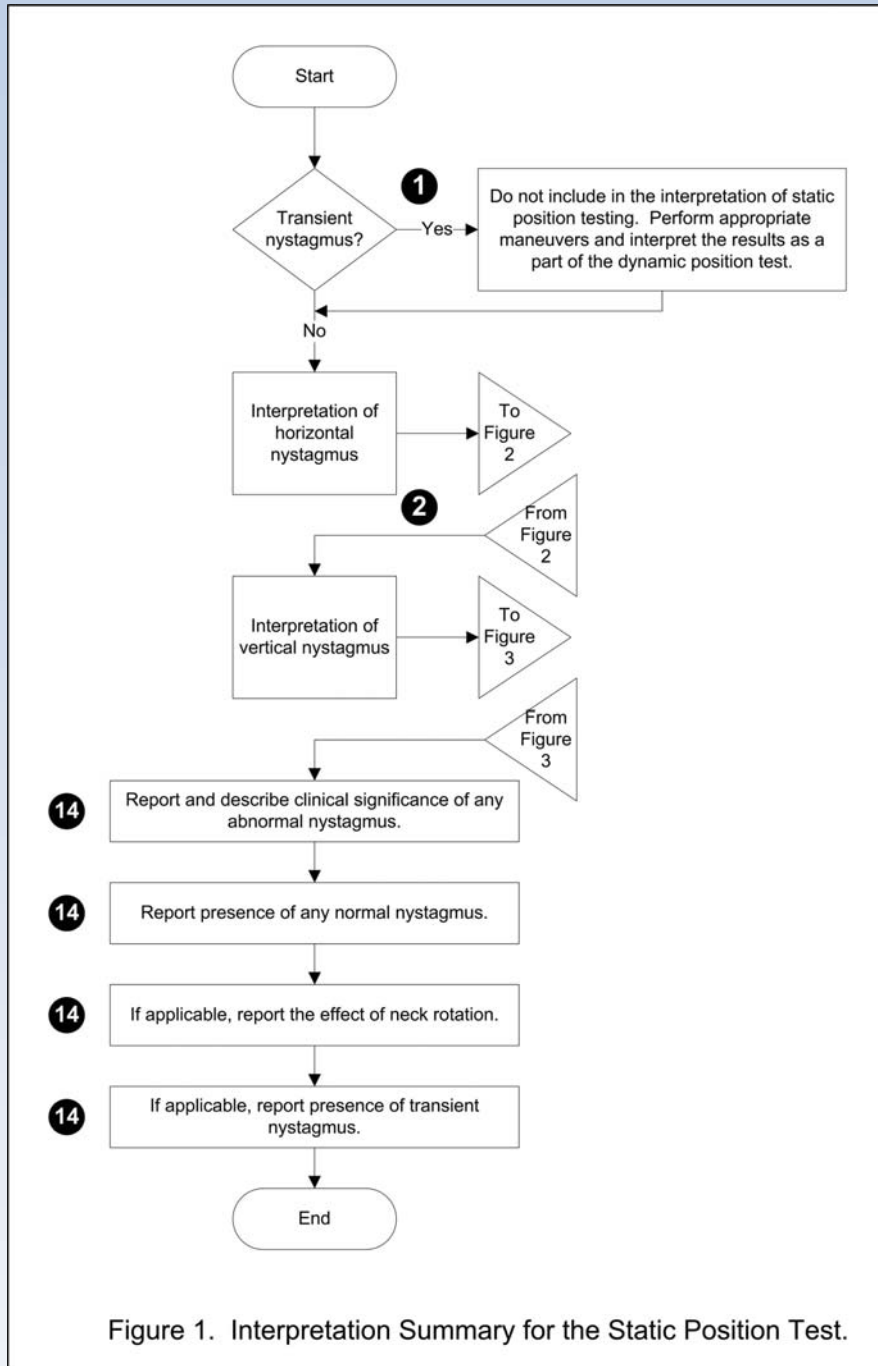
The flow chart in Figure 1 is a summary of the interpretation process. Additional information is provided below for the numbered items on the flow chart.

- 1 Sometimes moving the head from one position to another provokes a transient nystagmus, either immediately or after a short delay. As the purpose of the static position test is to detect the steady-state nystagmus that is present as long as the head remains in the critical head position, transient nystagmus should not be included in the interpretation of this test. Instead, the examiner should perform the appropriate maneuver and interpret the results as a part of the dynamic position testing.
- 2 Traditionally, static position testing has been limited to the interpretation of horizontal eye movements. The main reason for this is that the vertical channel in ENG is often noisy and contaminated by eye blinks. In VNG, the differences in the noise level and resolution between horizontal and vertical channels are relatively insignificant. Therefore, VNG users should consider vertical nystagmus in the interpretation of the static position test. ENG users may wish to skip this step because of the high level of artifacts in the vertical channel. The flow charts in Figures 2 and 3 show the interpretation for horizontal and vertical nystagmus, respectively.

When nystagmus has both horizontal and vertical components, the examiner must make sure that it represents true eye movements and is not due to crosstalk. Crosstalk occurs when eye movements in one channel generate activities in the other channel. Those activities do not represent true eye movements and are usually caused by the misalignment of the electrodes in ENG or

*continues*





the misalignment of cameras or goggles in VNG. Crosstalk can be recognized when the patient is asked to make purely horizontal or vertical eye movements. Any activities in the other channel represent crosstalk. The examiner should either repeat the test or subtract the effect of the crosstalk from the tracings.

- 3 Static position testing should include examining the eye movements in at least four different positions: sitting, supine, head right, and head left. If fewer head positions are tested, a partial interpretation is still possible according to the guidelines of the flow chart. The examiner should be aware that the position testing for some head positions may be embedded in other parts of VNG/ENG. For example, the results from the spontaneous nystagmus test or the gaze test may be used in place of the position test in the sitting position as long as the fixation conditions are taken into account.

Sometimes it is necessary to include other head positions such as body right, body left, or head hanging. Some laboratories routinely include those and other head positions. The interpretation algorithm is also applicable to those cases.

- 4 The static position test is typically performed in the absence of fixation. However, the effect of fixation is the single most useful factor in differentiating nystagmus that is generated by central lesions from other types of nystagmus. Therefore, some laboratories routinely test the patient with and without fixation. The algorithm allows for this possibility. However, even when position testing with fixation is not available, the effect of fixation for the sitting position can be determined from the gaze test or the spontaneous nystagmus test.
- 5 Horizontal nystagmus with fixation is always abnormal. No other criterion, such as nystagmus intensity, is needed and the simple presence of nystagmus with fixation is enough. To localize the lesion, the nystagmus with fixation should be compared to the nystagmus without fixation. If the nystagmus intensity does not increase significantly (at least double) when the fixation is eliminated, the results are

consistent with a central lesion. If the nystagmus intensity increases significantly without fixation, the nystagmus with fixation should be considered “leak through” of the strong nystagmus without fixation. Therefore, the interpretation should follow the same path as that of nystagmus without fixation.

- 6 Horizontal nystagmus that changes direction in a single head position is always abnormal. This type of nystagmus, called *periodic alternating nystagmus*, is usually present both with and without fixation and changes direction about every 2-4 minutes. This finding is consistent with a central lesion.

Detection of periodic alternating nystagmus is hampered by the fact that typical recording of eye movements in each head position is much shorter than 2-4 minutes. Instead, the examiner must look for inconsistencies in the direction of nystagmus for parts of the VNG/ENG test battery that provide equivalent test conditions. For example, the nystagmus direction in the gaze or spontaneous nystagmus test without fixation is expected to be the same as the nystagmus direction in the sitting position. When such inconsistencies are observed, the duration of the recording for the suspected head position should be extended to determine if the nystagmus changes direction.

- 7 Horizontal nystagmus without fixation does not always indicate an abnormality. A number of studies have shown that some form of nystagmus without fixation is present in many individuals without a history of dizziness or other balance disorders (Barber and Wright, 1973). The most important characteristic that differentiates normal from abnormal nystagmus without fixation is the nystagmus intensity. Other criteria, such as the number of head positions in which the nystagmus is persistent or intermittent, are outdated and should not be used. The presence and intermittency of nystagmus are related to technical issues such as the patient’s level of alertness or gaze direction. Therefore, it does not seem logical to include those factors in identifying abnormal nystagmus without fixation. To avoid such technical issues and to obtain a valid static position test, it is important for the

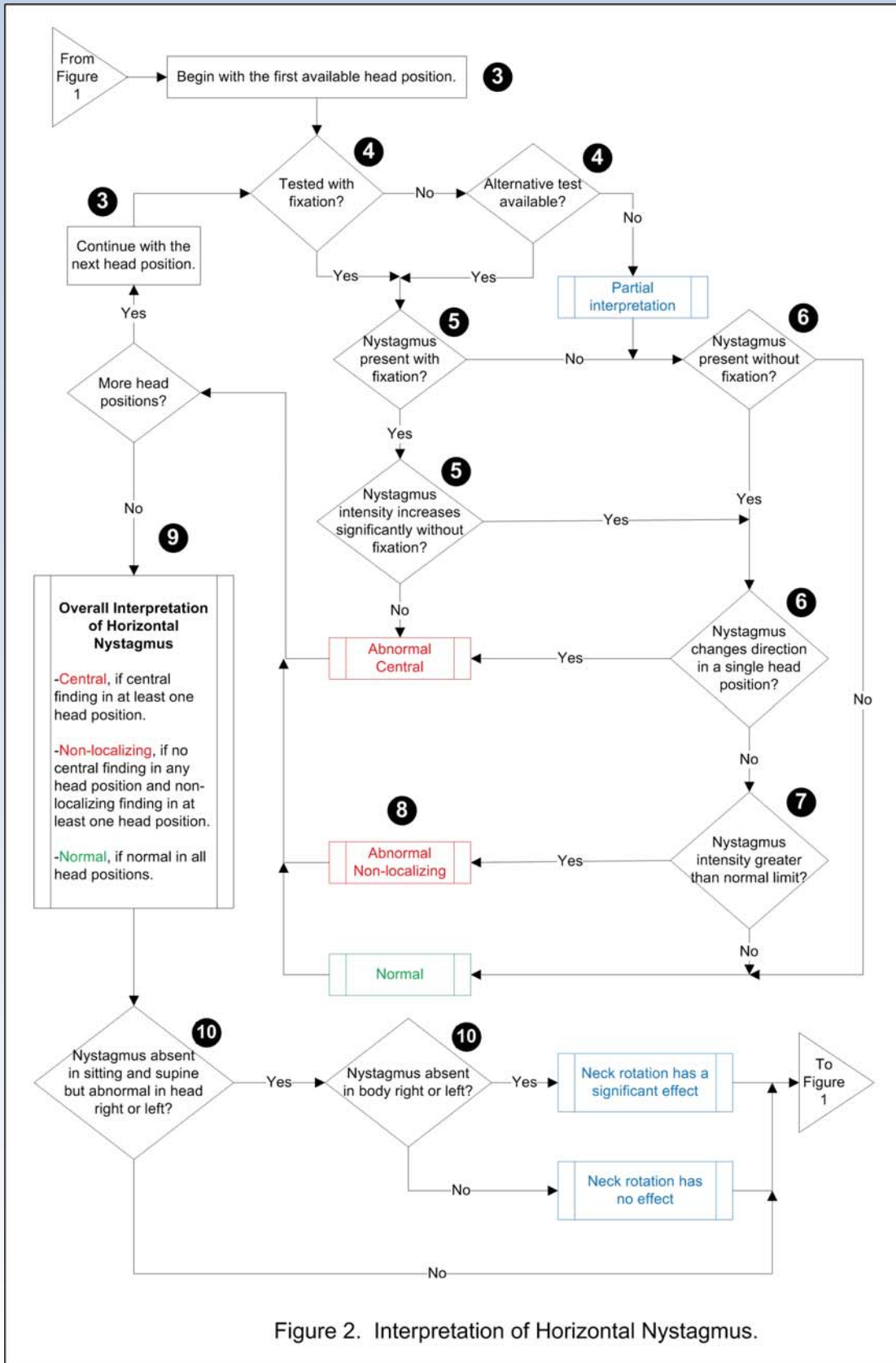


Figure 2. Interpretation of Horizontal Nystagmus.

examiner to maintain a steady level of patient alertness throughout the test.

Nystagmus intensity is defined as the velocity of the nystagmus slow-phase. Traditionally, a threshold of  $6^\circ/\text{sec}$  has been used for pathologic nystagmus without fixation (Barber and Stockwell, 1980). This limit has been derived based on ENG testing and there is a question whether the same limit should apply to VNG (Hain, 2008). In a yet unpublished study of 40 normal individuals in our laboratory, we found the normal limit using VNG to be about  $4^\circ/\text{sec}$ . However, until this finding is confirmed by more large-scale studies of VNG findings in the normal population, we continue to use the normal limit of  $6^\circ/\text{sec}$  for both ENG and VNG.

- 8 Abnormal horizontal nystagmus without fixation does not provide localizing information. It can be caused by lesions in the peripheral as well as central vestibular pathways.

Horizontal nystagmus without fixation can be classified based on its direction and intensity in different head positions. For example, nystagmus that has the same direction and intensity in different head positions is usually classified as *spontaneous nystagmus* whereas nystagmus that has the same direction but different intensity in different head positions is classified as *positional nystagmus*. At times, nystagmus can beat in different directions in the head right and head left positions. When the nystagmus beats toward the ground (right-beating in head right and left-beating in head left), it is classified as *geotropic nystagmus*. When the nystagmus beats away from the ground (left-beating in head right and right-beating in head left), it is classified as *ageotropic* or *apogeotropic nystagmus*.

Over the years, different classes of nystagmus without fixation have been associated with lesions in the peripheral or central vestibular pathways. For example, ageotropic nystagmus has been considered a central finding by some laboratories. However, there are many counter-examples to such assumptions. For example, *positional alcohol nystagmus*, which is caused by the change of the cupula density with respect to the endolymph density within the peripheral vestibular system, can result in either geotropic

or ageotropic nystagmus depending on the elapsed time since the ingestion of alcohol.

As a result, abnormal horizontal nystagmus without fixation, including all of its variations of spontaneous, positional, geotropic, and ageotropic, is a non-localizing finding that can originate from the peripheral vestibular system in either ear or central vestibular pathways.

- 9 The overall interpretation of static position testing for horizontal nystagmus is based on the combination of findings for each head position. For example, the overall interpretation indicates a central lesion if a central finding is identified for any head position. In the absence of a central finding, all other abnormalities indicate a non-localizing finding.
- 10 When horizontal nystagmus is not present in the sitting or supine positions but appears in the head right or head left position, the effect of neck rotation should be examined by testing the patient in the body right or body left positions. If the nystagmus disappears in the body right or body left position, it should be attributed to the neck rotation. Otherwise, neck rotation has no effect.
- 11 Vertical nystagmus with fixation is always abnormal (Baloh and Honrubia, 1990). No other criterion is needed and the simple presence of nystagmus with fixation is enough. This type of nystagmus, either down-beating or up-beating, is consistent with a central lesion.
- 12 Vertical nystagmus without fixation has been reported in both healthy individuals with no prior history of dizziness or balance disorders as well as in patients with various abnormalities (Barber and Wright, 1973; Kim et al, 2000). Currently, there are no established normal limits for vertical nystagmus without fixation. In the previously mentioned study, we found vertical nystagmus without fixation to be common in our sample of 40 normal individuals. The 95% confidence limit of this sample was about  $7^\circ/\text{sec}$ . This limit was established using VNG but we currently use the normal limit of  $7^\circ/\text{sec}$  for vertical

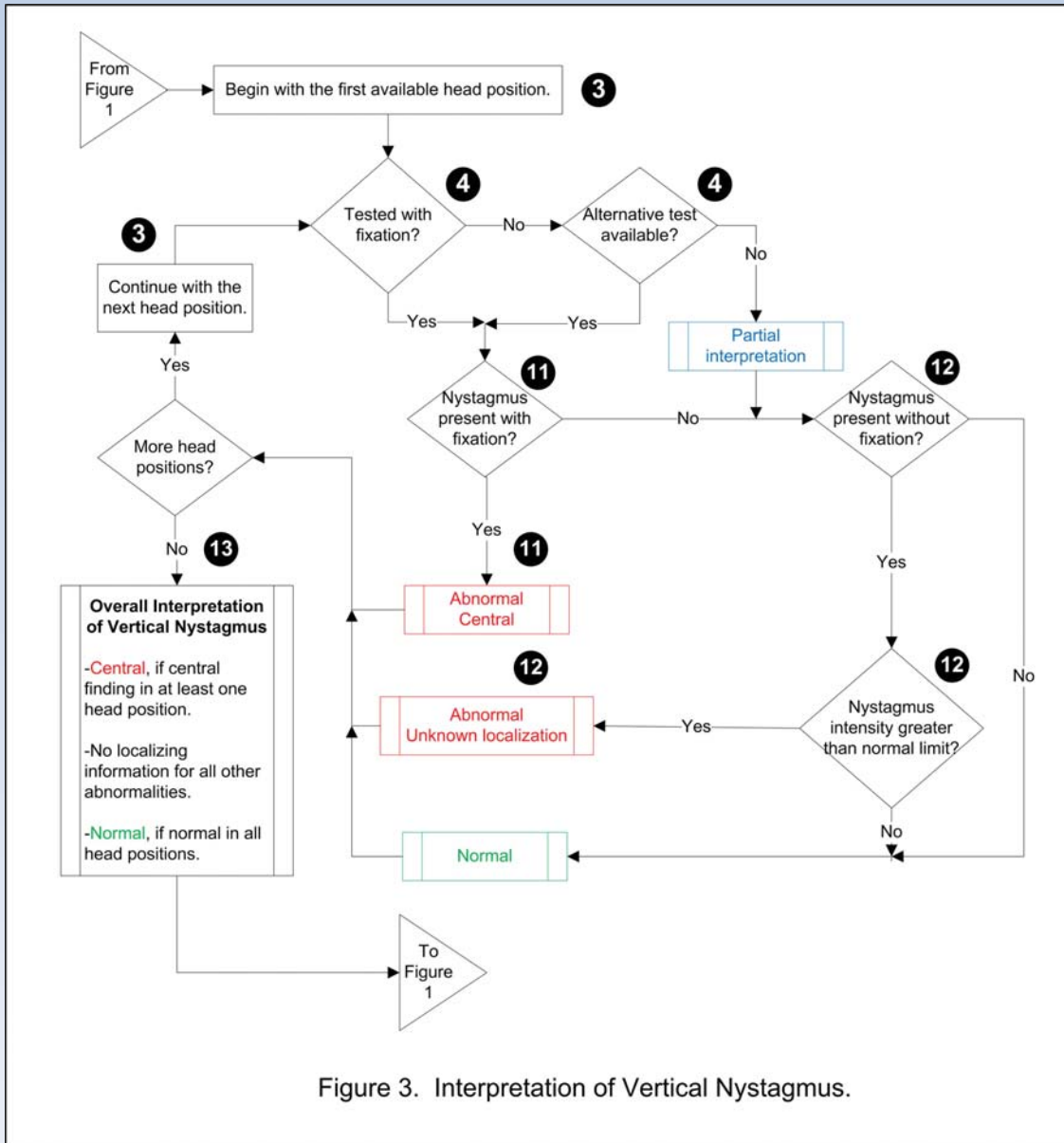


Figure 3. Interpretation of Vertical Nystagmus.

nystagmus without fixation for both ENG and VNG.

Even when vertical nystagmus without fixation is abnormal, currently there is not enough information to determine its localization and clinical significance. In our laboratory, we report presence of abnormal vertical nystagmus without fixation and state that its clinical significance is unknown at this time.

**13** The overall interpretation of static position testing for vertical nystagmus is based on the combination of findings for each head position. For example, the overall interpretation indicates a central lesion if a central finding is identified for any head position. In the absence of a central finding, the localization and clinical significance of all other abnormal findings for vertical nystagmus are unknown.

**14** The report for static position testing should include descriptions of all types of abnormal horizontal and vertical nystagmus and their clinical significance. The report should also include a description of any nystagmus that is present even when it is within normal limits. When applicable, the report should describe the effect of neck rotation on the nystagmus that is absent in the sitting and supine positions but appears in the head right or head left position. Finally, the report should include a description of any transient nystagmus that is provoked as a result of moving from one position to another.

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## Technical note

ICS Chartr 200 software 6.2 and higher implement a version of the above algorithm in the Interpretation Assistant. To use the algorithm, the user must record the eye movements during tests that are specifically identified as "w/ vision" and "w/o vision".

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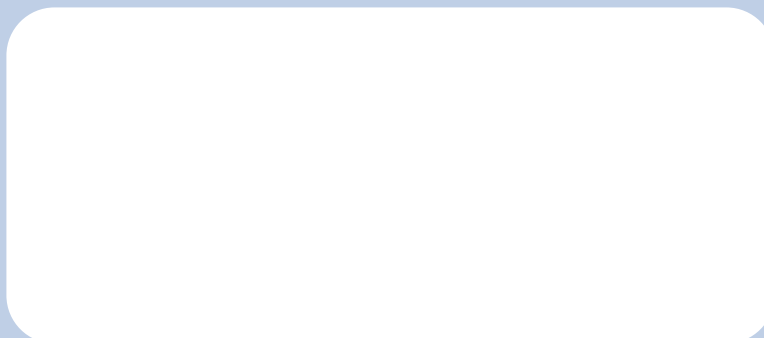
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