The NRC and industry representatives interfaced for several years via meetings and workshops in development of NEI. (April, 2013). *"Guidelines for Effective Prevention and Management of System Gas Accumulation," NEI 09-10 [Rev 1a-A], ML13136A129.* Vortexing was outside of the NEI 09-10 scope but needed to be covered as an aspect of addressing gas accumulation and management. The NRC assigned Warren Lyon to prepare a NUREG to provide background and guidance for addressing vortexing. A meeting was held on April 18, 2013 that continued the process of working together to address gas issues [Lyon, W. C. (May 9, 2013). *"Meeting Minutes Covering the April 18, 2013 Closed Meeting to Discuss Gas Intrusion Due to Vortexing," NRC Memorandum, ML13129A089].* A meeting of the Pressurized Water Reactor Owners Group is planned for August 13, 2013 and the material in the following paragraphs has been made available to keep industry up-to-date regarding progress in drafting the NUREG. It is important to realise that this material has not been reviewed by the NRC staff and does not represent an NRC staff position. It is being made available only as an example of the current thinking of one member of the NRC staff.

"Figure 19 provides bounding checks to determine if there is a vortex concern that needs to be addressed with test data and, if so, then provides an assessment of the test. Figure 20 covers acceptance of the test data. Table 4 provides clarifications and supplemental information.

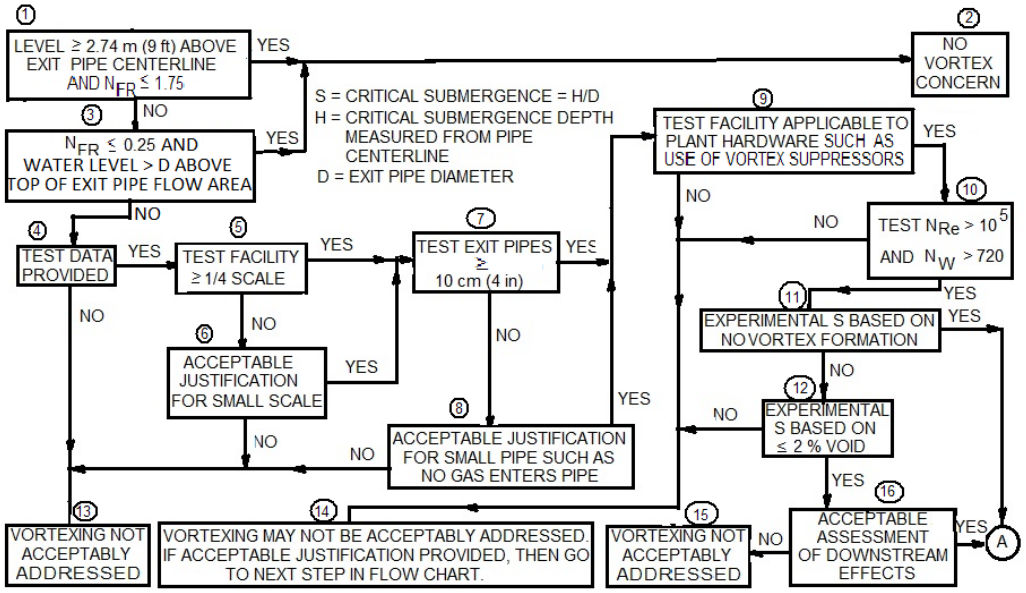


Figure 1. Assessment of vortex characterization – Part 1

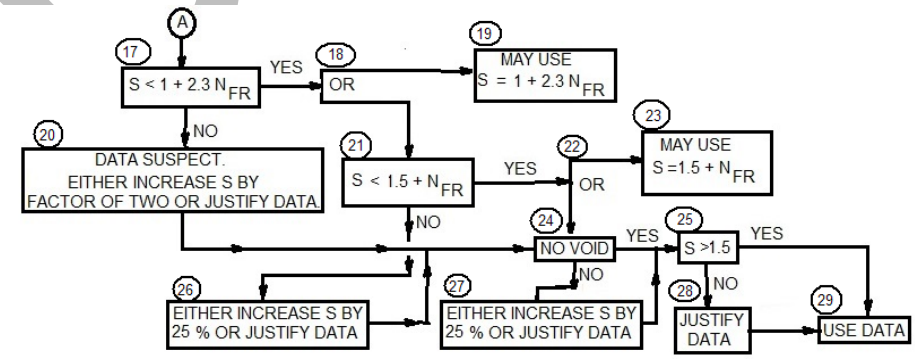


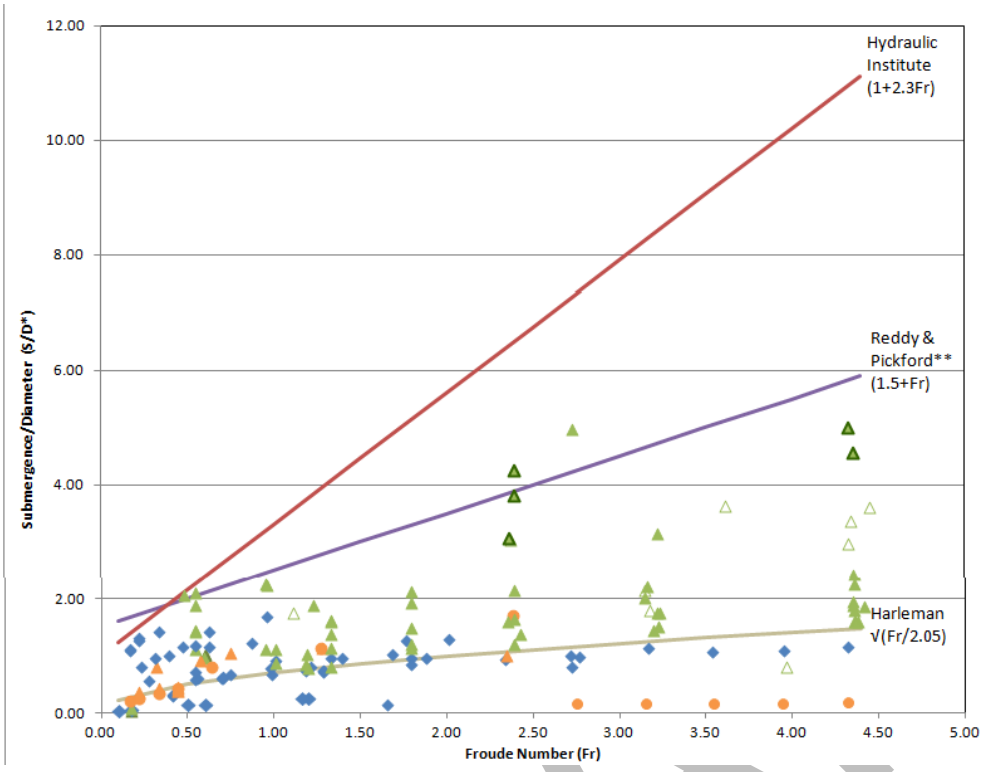
Figure 2. Assessment of vortex characterization – Part 2

Table 1. Discussion of flow chart construction

Chart Item No.	Discussion
1	An initial check of level and Froude number is provided to determine if there is any need to pursue a vortex concern.
2	There is no vortex concern and the further steps in the flow chart are unnecessary. This is an exit from the chart.
3	A check to determine if Froude number is ≤ 0.25. If so, vortex formation is unlikely, there is no need for further assessment, and the chart may be exited.
4	At this point, test data are necessary and availability is assessed. It is not necessary that a separate test be conducted for each facility. It is necessary, however, that the test design be applicable. When this is the case, it is acceptable to provide a reference to a document that is available in ADAMS.
5	If the facility scale is ≥ 1:4, then it is large enough to potentially meet scaling criteria and transfer is to Block 7. If not, transfer is to Block 6 where there is an opportunity to justify a smaller scale.
6	As discussed above, many investigators have concluded that a test facility can be no smaller than ¼ the size of the plant hardware. If an in-depth justification for a smaller facility is not provided, then vortexing has not been acceptably addressed as indicated by the transfer to Block 13. If a vortex suppressor is used, some designs cannot be scaled. This is addressed in Block 9.
7	Flow characteristics generally require an exit pipe diameter ≥ 10 cm (4 in) when addressing two phase flow. Consequently, the test facility should normally meet this requirement.
8	There are exceptions to the ≥ 10 cm (4 in) requirement such as no gas enters the exit pipe or flow is into the tank or sump, not from it. Other justifications may be acceptable.
9	A careful comparison of the test and plant hardware should be accomplished. Any differences should be addressed in the test facility description. Potential areas of concern in tanks are the exit pipe configuration, presence of pipes or baffles that may need to be modeled and presence of recirculation. The entrance configuration into a sump may be challenging and CFD may be helpful in assessing behavior subject to being backed up with applicable test data. Many vortex suppressors have small openings or other intricate paths which prevent scaling. Others can be scaled and scaling of such designs should be addressed in the test facility description. Further, as discussed in Section 2.1.10.1, some vortex suppressors, such as built from grates, have been shown to be effective in sumps if provided with a sufficient layer of water and further testing is unnecessary. If the plant hardware check identifies issues, transfer is to Block 14 where additional justification can be assessed. If the assessment is successful, then chart flow continues to Block 10.
10	This check provides coverage for additional typical requirements for Froude number simulation via testing; namely whether the Reynolds and Weber number requirements are met consistent with the Section 2.1.3.2 and other sections discussion.

Chart Item No.	Discussion
11	One of the concerns is introduction of gas via vortexing and many test results are predicated on an estimate of void fraction introduced by vortexing. This box provides a check on whether downstream gas needs to be considered.
12	If vortexing is allowed when determining critical submergence, then the experimental void fraction that is used is assessed. If > 2%, transfer is to Block 14 where additional justification is indicated regarding acceptability of the void. Note further that some tests do not provide an accurate void fraction determination and this needs to be considered.
14	This block covers possibilities where additional justification is needed. If justification is obtained, transfer should be to the next step in the sequence that follows the originating block.
16	This block is reached if vortexing tests may allow a void to be introduced due to vortexing. The block requires that the effects of the void be acceptably addressed. This includes such potential concerns as a small void fraction may result in gas accumulation at a downstream location where a pertubation may move the gas as a slug or operators may be mislead by control board indications.
17	As shown in Figure 17, the Hydraulic Institute (HI) $S = H/D = 1 + 2.3\ N_{FR}$ bounds all of the ARL data obtained by extensive testing of scaled nuclear power plant components. Consequently, if this is the case for the evaluation, there is an option at 18 to either use the HI equation in 19 or to continue to 21 for a less conservative approach. Conversely, if the S datum is greater than provided by the HI equation, there may be a problem as addressed in 20.
20	This unanticipated result is addressed by either doubling the S datum and continuing or justifying the datum before continuing.
21	Again, as shown in Figure 17, the data are generally bounded by the Reddy & Pickford (RP) $S = H/D = 1.5\ N_{FR}$. Consequently, if the S datum is less than predicted by RP, there is an option at 22 to use RP at 23 or to continue to 24 for a potentially less conservative approach. Conversely, if the S datum is greater than predicted by the RP equation, the datum is to be increased by 25% before progressing to 24.
24	This block addresses the concerns associated with tests that allow some vortexing with accompanying air ingestion. If the test S was determined with a no-vortexing or zero void criterion, then chart flow is to 25. If vortexing or air ingestion was allowed when determining S, then S is to be increased by 25% to compensate for the test conditions or use of the datum is to be justified. This justification should include evaluation of plant components downstream of the air ingestion location as identified in 16. If entrance to 24 was from 25 and the S was increased by 25%, the S to be used in 24 is the S that was increased in 25 (i.e. 1.25 X 1.25).
25	This check is to satisfy the minimum S requirement that the level be one pipe diameter above the entrance to an exit pipe. If S > 1.5, then the datum may be used without further qualification as indicated in 29. If S ≤ 1.5, then the conditions should be evaluated and justified in 28 before continuing to 29.
27	This block may result in an increase in S by 25% from 26 with an additional increase of 25% in 27.

The Figure 17 referenced in the table is:



This was provided by Lin, A. (May 28, 2013). '*Industry Meeting with the NRC on Draft Vortexing NUREG,' email with attachments to Warren Lyon, NRC. ML13150A153.*"