Inquiry: What alternative rules to those of paras. ISTB 4.3, 4.4, 4.5, 5.2, and 6.1 may be used when it is impractical to adjust a centrifugal or vertical line shaft pump to a specific reference value as required by subpara. ISTB 5.2(b)?

Reply: It is the opinion of the Committee that the following rules may be used for testing of centrifugal or vertical line shaft pumps where adjustment to a specific reference value is impractical, in lieu of the requirements of paras. ISTB 4.3, 4.4, 4.5, 5.2, and 6.1.

Applicability: See Applicability Index.

1 ADDITIONAL DEFINITIONS

maximum pump curve range: the maximum potential flow or differential pressure range for the pump curve, from shutoff conditions to maximum required flow rate.

reference curve: a range of values of a test parameter versus flow or differential pressure, for a centrifugal or vertical line shaft pump, measured or determined when the pump is known to be operating acceptably.

2 REFERENCE VALUES

Reference values shall be determined from the results of preservice testing or from the results of the first inservice test. Reference values shall be at points of operation readily duplicated during subsequent tests. All subsequent test results shall be compared to these initial reference values or to new reference values established in accordance with sections 4 and 5 below. Reference values shall only be established when the pump is known to be operating acceptably. If the particular parameter being measured or determined can be significantly influenced by other related conditions, then these conditions shall be analyzed.1

3 REFERENCE CURVES

If the establishment of specific reference values is impractical for a centrifugal or vertical line shaft pump, the Owner may establish reference curves. Reference curves shall be determined from data measured during preservice testing or from the first inservice test. A reference curve shall be established from a minimum of three data points and shall have at least one data point for each 20% of the maximum pump curve range. The range of the reference curve shall be sufficient to bound the points of operation expected during subsequent tests. All subsequent test results shall be compared to the initial reference curves or to new reference curves established in accordance with sections 4 or 5 below. Reference curves shall only be established when the pump is known to be operating acceptably. If vibration is relatively unaffected by changing differential pressure or flow over the reference curve range, a single reference value may be used for that test quantity, provided it is at the minimum of the measured data. If reference curves are used, the reasons for doing so and the suitability of the methods used to develop the reference curves and acceptance criteria shall be justified and documented in the record of tests (see section ISTB 7).

4 EFFECT OF PUMP REPLACEMENT, REPAIR, AND MAINTENANCE ON REFERENCE VALUES OR REFERENCE CURVES

When a reference value, set of reference values, or reference curve may have been affected by repair, replacement, or routine servicing of a pump, a new reference value, set of reference values, or reference curve shall be determined or the previous value, or curve, reconfirmed by an inservice test run before declaring the pump operable. Deviations between the previous and new set of reference values or reference curves shall be identified, and verification that the new values or curves represent acceptable pump operations shall be placed in the record of tests (see section ISTB 7).

5 ESTABLISHMENT OF ADDITIONAL SET OF REFERENCE VALUES OR REFERENCE CURVES

If it is necessary or desirable, for some reason other than stated in section 4 above, to establish an additional set of reference values or reference curves, an inservice test shall be run at the conditions of an existing set of reference values, or within the range of existing reference curves, and the results analyzed. If operation is acceptable per section 7 below, a second test run at the new reference conditions shall follow as soon as practicable.

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1 Vibration of pumps may be foundation, driver, and piping dependent. Therefore, if initial vibration readings are high and have no obvious relationship to the pump, the vibration measurements should be taken at the driver, at the foundation, and on the piping, and analyzed to ensure that the reference vibration measurements are representative of the pump and that the measured vibration levels will not prevent the pump from fulfilling its function.
The results of this test shall establish the additional set of reference values or reference curves. Whenever an additional set of reference values or reference curves is established, the reasons for so doing shall be justified and documented in the record of tests (see section ISTB-7). The requirements of section 2 or 3 above apply.

6 TEST PROCEDURE

An inservice test shall be conducted with the pump operating at the specified test conditions. The test parameters shown in Table ISTB 5.2-1 shall be determined and recorded as directed in this paragraph. The test shall be conducted as follows:

(a) The pump shall be operated at nominal motor speed for constant speed drives and at a speed adjusted to the reference speed for variable speed drives.

(b) The resistance of the system shall be varied until the flow rate equals the reference value. The pressure shall then be determined and compared to its reference value. Alternatively, the flow rate can be varied until the pressure equals the reference value, and the flow rate shall be determined and compared to the reference flow rate value.

(c) Where system resistance cannot be varied or if reference curves are used, flow rate and pressure shall be determined and compared to their respective reference values or the associated reference values from the reference curves.

(d) Pressure, flow rate, and vibration (displacement or velocity) shall be determined and compared with corresponding reference values or associated reference values from the reference curves. All deviations from the reference values shall be compared with the limits given in Table ISTB 5.2-2 and Fig. ISTB 5.2-1, and corrective action taken as specified in section 7 below. If the reference curve test method is used, the comparison may be done graphically as shown in Examples 1 and 2 of Fig. 1.

Vibration measurements are to be broadband (unfiltered). If velocity measurements are used, they shall be peak. If displacement amplitudes are used, they shall be peak-to-peak.

7 ACCEPTANCE CRITERIA

If deviations fall within the alert range of Fig. ISTB 5.2-1 and Table ISTB 5.2-2, the frequency of testing specified in para. ISTB 5.1 shall be doubled until the cause of the deviation is determined and the condition corrected. If deviations fall within the required action range of Table ISTB 5.2-2, the pump shall be declared inoperable until the cause of the deviation has been determined and the condition corrected. If using reference curves, evaluations for deviations in the alert or required action range may be done graphically as demonstrated in Examples 1 and 2 of Fig. 1. When a test shows deviations outside of the acceptable range of Table ISTB 5.2-2, the instruments involved may be recalibrated and the test rerun.

8 RECORDS AND REPORTS

Use of this Code Case shall be documented in the inservice test plans per para. ISTB 7.2.
Fig. 1 Examples of Graphical Evaluation of Tests Using Reference Curves

Example 1A

- Alert low (95%)
- Action high (110%)
- Action low

Example 1B

- Alert low (95%)
- Action high (110%)
- Action low

Example 2

- Alert high (2.5 \( V_r \))
- Action high (6 \( V_r \))

Vibration

0.7 in./sec or 22 mils

0.325 in./sec or 10.5 mils

Flow or DP, %

A = acceptable operation
B = required action
X = data points used to establish reference curve