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MAINTENANCE BEST PRACTICES FOR ROTATING EQUIPMENT

(PROJECT STANDARDS AND SPECIFICATIONS)

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SCOPE

This Project Standards and Specification covers the maintenance best practices for rotating equipment.

ALIGNMENT SYSTEMS AND PROCEDURES

1. SCOPE

This section covers the standard alignment systems and procedures for rotating machinery, precautions to be taken before carrying out the alignment and general alignment guidelines.

2. SYSTEM SURVEY

Many steps vital to good machinery alignment should be taken well ahead of the actual ‘cold alignment’. Some of the items, which warrant specific attention, are as follows:

A. PIPING

A Visual inspection of piping is vital. The following checks should be carried out:

a) Whether the piping is installed in apparent agreement with the design criteria and is complete in all respects as per the drawing.

b) Whether proper placement and adjustment of guides, anchors and supports have been done, whether proper adjustment of tie bolts on expansion joints, correct positioning of hangers have been carried out, whether make up of flanges with gaskets in place have been completed and the bolts tightened.

c) Whether the system is in order so that post alignment piping modifications will not nullify the alignment effort.

d) Nomenclature with flow direction on pipes shall be given.

B. Grouting

Grouting should be checked to be sure it is complete and satisfactory.

C. Foundation bolts

Foundation bolts should be checked for tightness.

D. Shim packs

Shims are vital link between the machine and foundation. All shim packs should be removed at every machine support just prior to alignment. If the shims have burrs, rust etc. these should be removed and shims without rust, wrinkles, burs, hammer marks and dirt should be used. Use as few shims as possible and replace many thin shims with fewer shims of greater thickness. Stainless steel shims minimize alignment problems associated with shim deterioration.

E. Checking for Misalignment

Misalignment should be checked in the following manner. A dial indicator should be mounted on the machine support with the indicator stem resting on the sole plate. Watch the indicator as the hold-down bolts are loosened. If movement of the indicator is more than 0.025 to 0.05 mm, it is an indication of a problem that must be defined and eliminated. Remove the shim pack and check with feeler gauges to be certain the machine support is parallel with the sole plate. If not, re-grout, re-machine the support or prepare tapered shims.

F. Checking the Causing for distortion

Test for gross distortion of casing can be made when shim packs are checked in the following manner:

a) With three supports tightened down, remove the shim pack from the fourth support.

b) Determine the total thickness of the shim pack and record the dimension.

c) Using feeler gauges, determine the distance from the sole plate to the machine support. Measure the dimension.

d) Subtract the feeler gauge dimension from the shim pack thickness. This is the total deflection of the machine casing with no support at the corner being checked.

e) Repeat the procedure at each of the four supports and compare the deflection of each. Gross differences in deflections at any of the four supports is an indication of probable casing distortion.

G. Checking for piping strain

Piping strain is seldom detectable by visual observation. However, gross problems can be detected by the following tests. Following the check of casing distortion, place dial indicators on the machine to monitor both vertical and horizontal movement of the casing or shaft. Loosen all the hold down bolts. If the machine moves more than the average observed when checking individual supports, it is obviously the result of an external force, i.e. the piping.

H. Bearings

Ensure that the bearings are properly installed in the machines and they are lubricated. Also check the bearing covers for proper tightening.

3. PLANNING

Alignment program should be properly planned in order to achieve good results within minimum time. Plans should include:

a) Determination of the desired placement of the shafts (cold settings) considering anticipated thermal growth of the various components. Definition of movement of shafts within bearing clearances, hydraulic loading and any other factors expected to produce relative movement of shaft center when the machines are operated.

b) Determining the sequence of alignment for multi unit trains. For two component trains determine which of the two machines is to be moved.

c) Selecting a specific method for determining relative shaft positions.

d) Deciding on tolerances for theoretical cold alignment settings.

e) Ensuring the quality of alignment bracket, dial indicators and shims required for alignment.

f) Making provisions for permanent recording of alignment data.

g) Ensuring that jack bolts are provided and they are free for moving the machine for alignment.

4. COLD ALIGNMENT

The term ‘cold alignment’ refers to the position of a machine’s shaft center line relative to the shaft center line of a connected machine, with both machines in a non operating or ‘cold condition. Cold alignment is normally the only check made to directly determine the relative position of the two shafts. Results of the check form the basis for determining shaft alignment during operation.

The face and rim method and the reverse indicator method are commonly used for accurately measuring the shaft alignment between machinery. In the face and rim method, a face (axial) measurement and a rim (radial) measurement determine the angle and position respectively of one shaft relative to another. The reverse indicator method uses two rim measurements, one from each coupling to locate both shaft center line relative to the other. Both the face and rim measurements are to be taken with dial indicators.

The face and rim method of alignment can be carried out by using a single dial indicator for taking the face reading or using two dial indicators for taking the face readings. The use of two dial indicators for taking face readings eliminates the effect of axial movement of the shafts during alignment. Procedure for carrying out the alignment using three dial indicators is as follows:

A. Alignment measuring procedure - Three dial method

The normal method of alignment measurement for turbomachinery is by using an apparatus with three dial indicators as shown in fig 1. The dial indicator with its axis in a radial direction B measures the radial misalignment of the shafts. The two dial indicators with their axis in an axial direction measures the axial misalignment of the shafts. Normally the heaviest or the most centrally placed machine is made the reference for alignment.

B. Reading of the radial misalignment

Zero the radial indicator in correspondence to the vertical plane as indicated in the figure. Rotate the shaft in the operational direction of rotation and note the gauge readings at 90 degree intervals. Interpret the readings as positive if the dial indicator rod re-enters its appropriate place and negative if it does not. The readings are to be taken at least twice and ensure that the indicator operates with the rod at half stroke. It is advisable, especially for couplings with spacers, to recheck by moving the apparatus with the indicators from one shaft to the other.