INTER PLANT STANDARD IN STEEL INDUSTRY		
IPSS	**CODE OF PRACTICE FOR VIBRATION MONITORING**	**IPSS:3-02-011-18**
	Corresponding IS does not exist	Formally : IPSS:3-02-011-00

0. FOREWORD

0.1 Interplant standardization in steel industry was initiated under the aegis of the Indian Standards Institution (ISI) and the Steel Authority of India Limited (SAIL). This IPSS was prepared by the standard committee on Operation and Maintenance, IPSS 3:2 and firstly published in 2000. Lastly, this has been revised by the standard committee in July 2018 with the active participation of the representatives from major Indian steel plants and leading consultants.

0.2 In today's competitive world the success of a manufacturing industry depends on the continuous, safe & economical operations of its plant and equipment. This calls for a very systematic and proactive approach to maintenance whereby the health of the equipment of a plant is periodically monitored. Planned preventive action is taken in time to avoid the equipment failures based on its condition.

0.3 Condition Based Maintenance (CBM) helps in reduction of Maintenance cost along with improvement in equipment availability & reliability. Various Condition Monitoring techniques are applied for machine health assessment.

0.4 Vibration is one of the important parameters used for condition monitoring of rotating machines. It can be defined as the motion of a machine or machine part back and forth from its position of rest.

0.5 All rotating/reciprocating machines vibrate. Vibration increases as equipment condition deteriorates. Different defect produces vibrations of different characteristics.

1. SCOPE

1.1 Vibration monitoring can be applied to almost all rotating machines. But the measurement & analysis are slightly different for shaft speed less than 600 RPM. Vibration monitoring on high speed machines with speed more than 600 RPM has been considered in this standard.

1.2 This standard covers the general practices and recommended methods for vibration monitoring, alarm levels and frequency of measurement for rotating machines. Based on these recommendations schedules of measurement and alarm levels for target equipment will have to be made as per place of installation and criticality of operation of that equipment.

2. CRITERIA FOR SELECTION OF EQUIPMENT

2.1 All equipment which directly or indirectly affects the production should be included under vibration monitoring. All H.T. motors & driven equipment should be included. Equipment where repair cost is very high due to primary or secondary damages should also be included.

3. EQUIPMENT IDENTIFICATION

3.1 Vibration should be measured on bearing housing or at the point nearest to it. Bearings should be numbered starting from Non-drive end bearing of motor or exciter in motor driven mechanism. Numbering of bearings should start from Mechanical Oil Pump (M.O.P.) or Non-drive end bearing of the Turbine in case of Turbine mechanism. In case of mechanism having both motor and turbine, number of bearings should be from non-drive end bearing of turbine.

3.2 Kinematic diagrams of five configurations are given at **Figures at 1 to 5 at Annexure-I.**

4. MODE OF MEASUREMENT

4.1 There are three modes in which vibration amplitudes can be measured. They are :

- Displacement
- Velocity
- Acceleration

4.2 Usually velocity is used as the measure of severity for equipment operating in the range of speed from 600 rpm to 60000 rpm. Displacement should be used below 600 rpm. Acceleration should be used for frequency component at more than 60000 CPM usually found as gear or vane pass frequencies of high speed gear boxes or centrifugal compressors.

4.3 Displacement is also used for measuring shaft vibration of high speed turbines/compressors.

4.4 Requirement for instruments for measuring vibration severity of rotating machines are as per ISO 2954-11975 (IS 11726:1985).

5. UNITS OF MEASUREMENT

5.1 Displacement is displayed as microns peak to peak.

5.2 Velocity is displayed as mm/sec R.M.S.

5.3 Some instruments display velocity in mm/sec zero to peak.

5.4 Acceleration is displayed in M/sec^2 or `g' rms.

6. FREQUENCY OF MEASUREMENT

6.1 Most of the equipment are monitored periodically by portable instruments. Maximum time period between two measurements should be 1 month. Depending upon the criticality and MTBF (Mean Time Between Failure), the frequency can be increased to fortnightly or weekly. When vibration level has already crossed the alarm level, measuring frequency may be increased to daily or even hourly.

6.2 Very high speed critical machines like turbo-generators & centrifugal compressors where failure can be catastrophic, on-line vibration monitoring should be done. For fans of Gas Cleaning Plant or exhausters of Sinter Plant where there is a possibility of the fan becoming unbalanced in a very short time, on line vibration monitoring is recommended.

7. VIBRATION CHARACTERISTICS & DIRECTION OF MEASUREMENT

7.1 Periodic vibrations have three characteristics :

- Amplitude
- Frequency
- Phase

7.2 Amplitude indicates the severity of problem.

7.3 Frequency indicates the cause of vibration.

7.4 Phase indicates the location & confirms the fault.

7.5 Vibrations are normally measured on bearing housings in three orthogonal directions.

- Axial (parallel to shaft axis)
- Horizontal
- Vertical

7.6 Readings should be repeated at the same measurement point. The point should be identified either by paint or punch mark.

8. DATA COMPILATION

8.1 Data can be compiled either on paper or P.C. Many a good software are available for P.C. database management.

8.2 Initially data can be compiled in notebooks. The compilation should be such as it is easily retrievable. One of the suggested format is given at **Table-I, Annexure-II.**

9. ALARM LEVEL

9.1 Alarm level can be set based on manufacturer's recommendations, International standard ISO 3945-1985(E) or maintenance experience.

9.2 ISO 3945 defines Mechanical vibration of large rotating machines with speed range from 10 to 200 r/s - Measurement and evaluation of vibration severity in situ. Quality judgement of vibration severity is given at **Table-2, Annexure-II.**

9.3 For a flexible support, the fundamental natural frequency of the machine/support system is lower than its main excitation frequency for a rigid support, the fundamental natural frequency of the machine/support system is higher than its main excitation frequency.

9.4 In some cases, a machine/support system will be rigid at one measurement point in one direction and flexible in the other. In such cases, the vibration severity shall be judged in accordance with the relevant classification and measurement.

9.5 For certain electrical machines (shaft height 80-400 mm) vibration severity should be assessed based on ISO 2373 (IS 11725).

10. ANALYSIS

10.1 Potential failure can be declared if either the vibration amplitude has crossed alarm level or there is an increasing trend in vibration level.

10.2 For fault diagnosis, analysis should be done of the trends on all the bearings in three directions & relative strength of the amplitudes in three orthogonal directions.

10.3 Frequency spectra & phase analysis will supplement the above analysis.

11. FEEDBACK SYSTEM

11.1 On the basis of alarm & further analysis, list of possible faults are indicated. Details of actual faults found & maintenance actions done must be feedback to the system. This will improve upon fault prediction in future and root cause analysis for frequent failures. Design or maintenance practice changes can be adopted based on tribological studies to eliminate the root cause.

12. TRAINING OF PERSONNEL

12.1 Engineers & Technicians should be trained in the class and on the job about vibration measurement & analysis, quality & repeatability of data, safety while monitoring on the running machines, etc.

12.2 Latest technology for vibration monitoring shall be adopted. Training to be imparted to the personnel.

13. ON-LINE VIBRATION MONITORING SYSTEM FOR SENSITIVE/CRITICAL EQUIPMENT

13.1 Vibration Transducers, preferably accelerometer should be mounted rigidly on bearing housing to measure vibration amplitude. Display should be in mm/sec

RMS velocity. It may have option to switch over to displacement in microns - Peak to Peak. The on-line monitoring system should display vibration amplitude minimum up to 100 mm/sec RMS to help in field balancing of fan rotors especially in Gas cleaning Plant and LD Fans. Separate scales should be three for on-line monitoring with alarm and trip level and for field balancing requirements. This will help in field balancing of fan using on-line instrument.

13.2 For shaft vibration proxy meters are used and display is in microns - peak to peak. For high speed turbo-generators & centrifugal compressors two transducers orthogonal to each other as per drg. given at **Fig-1, Annexure-III**. There should be provision to perform frequency analysis & orbit analysis.

14. TESTING DURING COMMISSIONING

Steps involved in testing during commissioning are as follows :

14.1 Take vibration measurements at both bearing housings in three directions & all feet of motor in vertical direction in decoupled state after motor alignment.

(Note: There should be no movement of motor after the measurement.)

14.2 Take vibration measurement after motor is coupled at all the bearings of the motor and driven equipment in three directions.

14.3 The vibration measurements can be repeated at various RPM, Load condition, Vane opening, etc.

REFERENCES

1. ISO: 3945-1985 (E) adapted as IS:11727-1985 (reaffirmed in 1990)

2. ISO:2372-1991, IS:11724-1985 (reaffirmed 1990), IS:12075-1987 (reaffirmed in 1991).

3. IS:11726-1985 Requirements for instrument for measuring vibration severity machines (ISO 2954-1975)

4. IS:11725-1985 Measurement (ISO 2373-1974) and evaluation of vibration severity of certain rotating electrical machinery with shaft heights between 80 and 400 mm.

5. IPSS:2-07-027-97.

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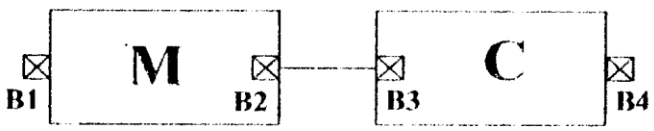
ANNEXURE-I

IDENTIFICATION OF MEASUREMENT POINT

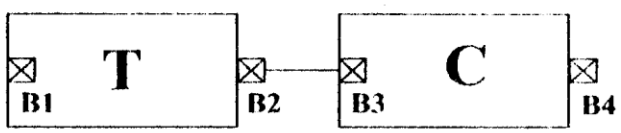
NUMBERING IS FROM THE DRIVE END TO THE DRIVEN END

1

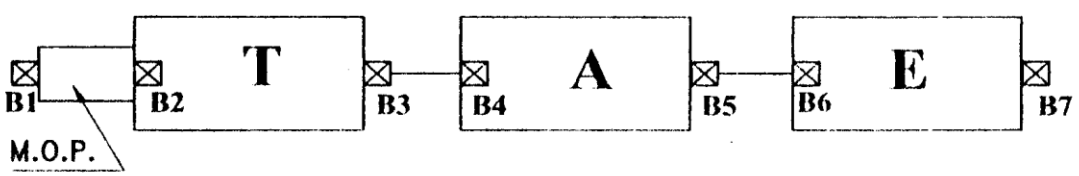


2

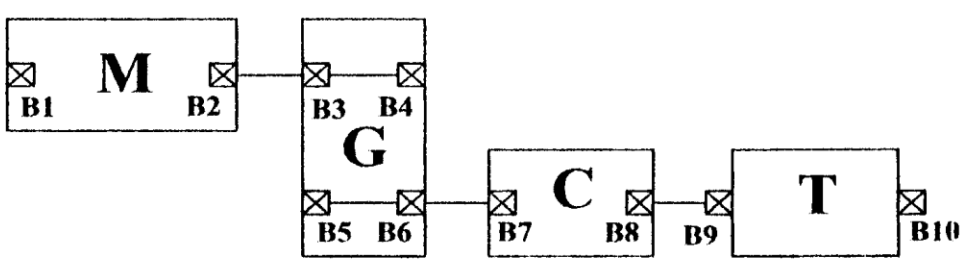
3



4 **Turbo Alternator**



5



Abbreviations

M = Motor

E = Excitor

G = Gearbox

A = Alternator

T = Turbine

C = Mech. Drives : Fan, Pump, Compressor

ANNEXURE-II

TABLE - I

DATA COMPILATION OF VIBRATION MEASUREMENT

Shop :

Equipment :

Date of Measurement	B1			B2			B3			B4		
	A	H	V	A	H	V	A	H	V	A	H	V

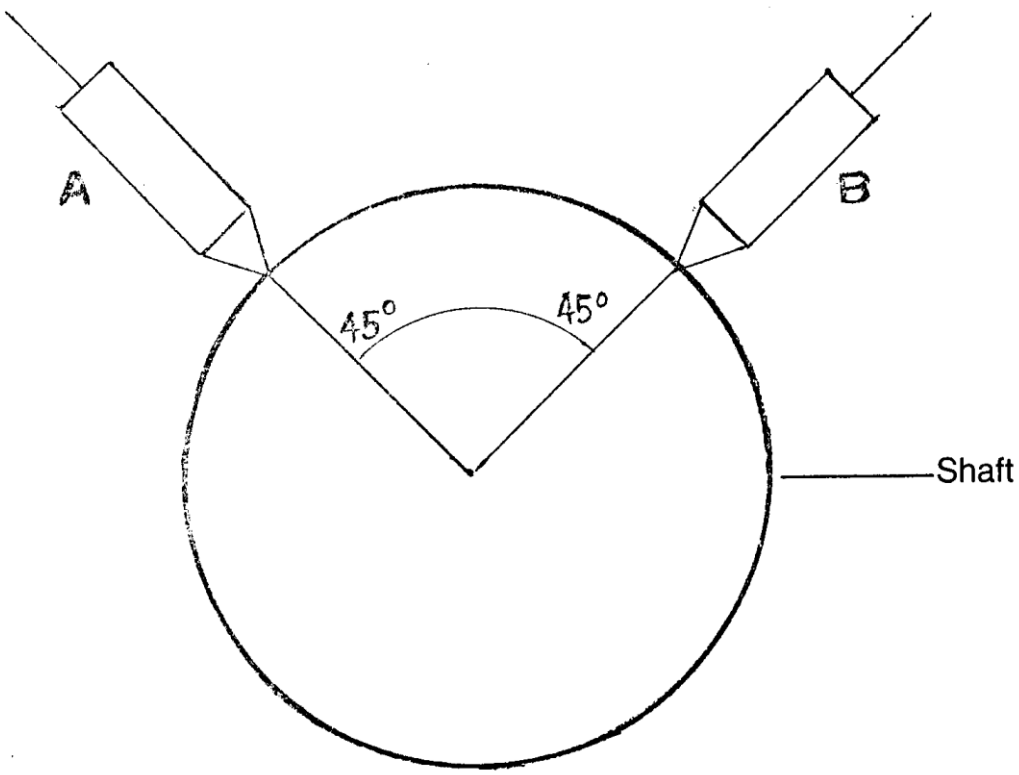
TABLE - 2

QUALITY JUDGEMENT OF VIBRATION SEVERITY

Vibration Severity	Support Classification	
Vmms mm/s	Rigid Supports	Flexible Supports
0.46 0.71 1.12 1.8	Good	Good
2.8	Satisfactory	
4.6		Satisfactory
7.1	Unsatisfactory	
11.2		Unsatisfactory
18.0 28.0 71.0	Unacceptable	Unacceptable

ANNEXURE-III

"LOCATION OF PROBES FOR ON-LINE MEASUREMENT OF SHAFT VIBRATION"



A & B - Eddy Current Probes

Figure-4