

TABLE I ILLUSTRATED VIBRATION DIAGNOSTIC CHART

PROBLEM SOURCE	TYPICAL SPECTRUM	PHASE RELATIONSHIP	REMARKS
MASS UNBALANCE A. FORCE UNBALANCE			Force unbalance will be in-phase and steady. Amplitude tends to increase with the square of speed below first critical up to speed increase of 50% higher vibration. 1X RPM phase constant and usually dominates spectrum. Can be corrected by placement of one or two correction weights in one plane at Force center of gravity (FCG). Approx. 0° phase difference should exist between CIG & FC location (as well as between CIG & FC vertical). Also, approx. 90° phase difference between horizontal & vertical readings usually exists at each bearing of unbalanced rotor (180°).
B. COUPLE UNBALANCE			Couple UNB also exists at 180° out-of-phase motion on same shaft. 1X RPM always present and normally dominates spectrum. Amplitude varies with square of increasing speed below first critical speed. 180° phase difference exists in at least 2 planes. Note that approx. 180° phase difference should exist between CIG & FC horizontal, as exists between CIG & FC vertical. Also, approx. 180° difference between 180° horizontal & 90° vertical readings at each bearing (with 180° in 180°).
C. DYNAMIC UNBALANCE			Dynamic Unbalance is the dominant type of unbalance found and is a combination of both force and couple unbalance. 1X RPM dominates the spectrum, and may require 2 plane correction. Note: two radial phase difference between 2 different radial readings can vary anywhere from 0° to 180° (vertical). The horizontal phase difference should usually match the vertical phase difference (vertical readings should read identical bearing measurements, i.e. 30°). Separately, if unbalance predominates, roughly a 90° phase difference should exist between the horizontal and vertical readings at each bearing (180°).
D. OVERHUNG ROTOR UNBALANCE			Overhung Rotor Unbalance causes high 1X RPM in both axial and radial directions. Axial readings tend to be in-phase with radial phase readings except for unbalance. However, the horizontal phase difference will usually exist. One axial phase difference on the horizontal (near 180°). Overhung rotors have both force and couple unbalance, each of which will likely require correction. Thus, correction weights will most always have to be placed in 2 planes to counteract both force & couple unbalance.
ECCENTRIC ROTOR			Eccentricity occurs when center of rotation is offset from geometric centerline of a shaft, gear, bearing, motor assembly, etc. Largest vibration occurs at 1X RPM or appears in a direction of rotation or that two planes. Complete horizontal and vertical phase readings usually differ either by 0° or by 180° (near 0° indicates centrifugal motion, 180° indicates eccentricity). Eccentricity often results in reducing vibration in one radial direction, but increasing it in the other radial direction, depending on amount of eccentricity.
BENT SHAFT			Bent shaft problems cause high axial vibration with phase differences varying between 180° on the same machine components. Dominant vibration normally occurs at 1X of bent over shaft member, but at 2X if bent over 180°. Coupling the shafts to correct for transducer error before for such axial measurements if you reverse probe direction; use and evaluate for center bent shaft.
MISALIGNMENT A. ANGULAR MISALIGNMENT			Angular Misalignment is characterized by high axial vibration, 180° axial phase across the coupling. Usually will have high axial vibration over 2000 1X and 2X RPM. However, not unusual for either 1X, 2X, or 3X to dominate. These conditions may also indicate coupling problems as well. Some angular misalignment may, with heavy 1X, 2X, 3X, 4X, 5X, 6X, 7X, 8X, 9X, 10X, 11X, 12X, 13X, 14X, 15X, 16X, 17X, 18X, 19X, 20X, 21X, 22X, 23X, 24X, 25X, 26X, 27X, 28X, 29X, 30X, 31X, 32X, 33X, 34X, 35X, 36X, 37X, 38X, 39X, 40X, 41X, 42X, 43X, 44X, 45X, 46X, 47X, 48X, 49X, 50X, 51X, 52X, 53X, 54X, 55X, 56X, 57X, 58X, 59X, 60X, 61X, 62X, 63X, 64X, 65X, 66X, 67X, 68X, 69X, 70X, 71X, 72X, 73X, 74X, 75X, 76X, 77X, 78X, 79X, 80X, 81X, 82X, 83X, 84X, 85X, 86X, 87X, 88X, 89X, 90X, 91X, 92X, 93X, 94X, 95X, 96X, 97X, 98X, 99X, 100X, 101X, 102X, 103X, 104X, 105X, 106X, 107X, 108X, 109X, 110X, 111X, 112X, 113X, 114X, 115X, 116X, 117X, 118X, 119X, 120X, 121X, 122X, 123X, 124X, 125X, 126X, 127X, 128X, 129X, 130X, 131X, 132X, 133X, 134X, 135X, 136X, 137X, 138X, 139X, 140X, 141X, 142X, 143X, 144X, 145X, 146X, 147X, 148X, 149X, 150X, 151X, 152X, 153X, 154X, 155X, 156X, 157X, 158X, 159X, 160X, 161X, 162X, 163X, 164X, 165X, 166X, 167X, 168X, 169X, 170X, 171X, 172X, 173X, 174X, 175X, 176X, 177X, 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Scientific and Technical Aerospace Reports ,1991 *Paper* ,1972 *Centrifugal Compressors in Hydrocarbon Processing Industries* Neetin Ghaisas, 2025-11-07 This book offers a unique perspective on the aerodynamic and mechanical design features of centrifugal compressors It provides detailed explanations of auxiliary systems to support engineering professionals involved in the specification application and selection of compression strings and packages The book covers the fundamentals of centrifugal compressor casing and internal design complemented by in depth analysis of impellers and rotors Chapters on surge detection and control couplings dry gas seals and their support systems and lubrication oil systems provide a comprehensive understanding of the underlying theory operational principles and design processes Topics such as lateral rotordynamics advanced torsional analysis shop testing specialized engineering analyses and condition monitoring address key knowledge based engineering parameters These are essential for achieving industry standard compliant designs optimal performance safety and long term reliability in service In addition to discussing conventional concrete foundations the chapter on machinery modularization introduces innovative installation strategies These include shifting significant portions of site work to module yards reducing material movement at job sites and lowering costs associated with construction and pre commissioning activities Machinery and process modules contribute to optimized plot layouts ultimately reducing the total installed cost of process plant facilities Comprehensive and detailed technical specifications for inquiries

and purchases aim to eliminate guesswork misinterpretation and scope gaps Errors or omissions in purchase orders can be costly and difficult to rectify during project execution The chapter on compressor specifications proposal evaluation and design coordination addresses these challenges using real world examples In light of global initiatives to reduce greenhouse gas emissions a dedicated chapter explores the process of capturing and storing carbon dioxide CO₂ It discusses the two primary compressor types used for CO₂ compression provides an overview of sequestration processes and current challenges and highlights new technologies that extend the life of compressor materials Configuration options for improved overall efficiency are also examined

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