Version 1.2

**Machinery Information Management Open Systems Alliance**
**CONVENTIONS FOR IDENTIFYING VIBRATION MEASUREMENT LOCATIONS ON MACHINE SYSTEMS**

## Introduction

The following proposed convention for identifying vibration measurement locations on machine systems combines requirements from current specifications (e.g., API 670), common practice (determined from a comprehensive user survey conducted by E. Peter Morgan of Sunoco, Sarnia), and a logical combination of the two that extends the convention to equipment where inconsistency appears to be the norm (e.g., vertical machines).

During the process of developing the convention, a decision was made to include provisions for designating internal and auxiliary components such as shafts and accessory gears. A means is also provided to identify transducers, primarily axial vibration, mounted on opposite ends of a machine such that machine motion in a given direction results in a positive signal from one and a negative signal from the other. These additions, explained in detail in later paragraphs, are not typically found in current schemes of measurement identification. However, their necessity can be anticipated as automated expert diagnosis advances. Where the additions are not considered necessary or not included in current data, software translation routines should be constructed to accommodate the additions without placing any burden on the user. It is recognized that adding component identification and direction of motion increases the complexity of the measurement location convention. Flexibility to meet anticipated requirements without translation or a change in format was judged ample justification for the expanded convention.

## MIMOSA Machinery Vibration Measurement Location Code

The MIMOSA machinery vibration measurement location code defines component part, bearing housing location, transducer type, angular orientation, transducer sensitive axis direction, and direction of motion separately. These six definitions are then combined into an unambiguous, fourteen alpha-numeric character measurement location code as follows:

| | |
|---|---|
| Component [Device (3 char.) / Shaft (1 char.)] | four alphanumeric characters (XXXX if unknown) |
| Bearing Housing Location on Machine System: | three digits (001 to 999) |
| Transducer Type Code: | two alphabetic characters (XX if unknown) |
| Angular Orientation: | three digits (000 to 360 degrees, XXX if unknown) |
| Transducer Sensitive Axis Direction: | one alphabetic character (X if unknown) |
| Direction of Motion: | one alphabetic character (X if unknown) |

e.g.: MTRA001AC090RN (motor, shaft A, bearing housing number 1, single axis accelerometer positioned 90 degrees counterclockwise from zero, mounted radially, normal motion)

This 14-character measurement location name is a standard nomenclature which should be constructed by software with minimum user concern for leading zeroes, exact placement of the 6 fields, etc. Most users will use an abbreviated code to physically mark the measurement locations, i.e. (1A), but at a minimum, must input the transducer type and tranducer sensitive axis direction into the software. If known, the user should also be able to specify the 4-character component device and shaft designation. If unknown, the software will default to ‘XXXX’. The user should also be able to specify the angular orientation in degrees. If unknown, the software to default to ‘XXX’. The user should also be able to specify the direction of motion. If unknown, the MIMOSA software should fill in the appropriate ‘X’ characters when storing to the field to the database. The user interface software should not show the ‘X’ characters when displaying the code to the user, but should translate the ‘X’ characters to spaces to make the user aware that this data was not available.

The illustrative examples described in the following paragraphs cannot cover all possible machine system configurations. However, following the principles will assure full identification of any measurement on any machine system.

**Component Device and Shaft**

A total of four user-defined alpha-numeric characters are provided to designate both a component device (normally 3 characters) and a shaft (normally 1 character). The first 3 characters of this field are normally utilized to identify a specific component device, i.e., PMP (pump) or MTR (motor), as well as a specific letter designation for a shaft (normally beginning with "A" and continuting through "Z"). Anexample is "GBXC", indicating shaft C on an auxiliary gearbox with multiple shafts which may differ from the shaft speeds of the main machine.

**Bearing Housing Location on Machine System**

A numeric sequence identifying the specific bearing housing on which a vibration measurement is recorded is employed by 73% of the users responding to the survey noted in the introduction. Three numerals are sufficient for the vast majority of machine systems.

**Horizontal process and turbo machine systems (turbines, motors, pumps, fans, compressors, associated speed changing gears, etc.):** The sequence begins with the bearing housing at the non drive, uncoupled (outboard), end of the driver designated number 001 and continues in numerical order toward the driven equipment to the last bearing housing on the first shaft axis. In some cases, multiple bearings may be located within a single housing, e.g., radial and thrust bearings, see location 001 figure 1. When this occurs both bearings will have the same three digit location code. On multiple axis (geared) machine systems,`the bearing housing sequence continues in numerical order from drive to driven along the second shaft axis followed by the third until the end of the machine system is reached (figure 1).

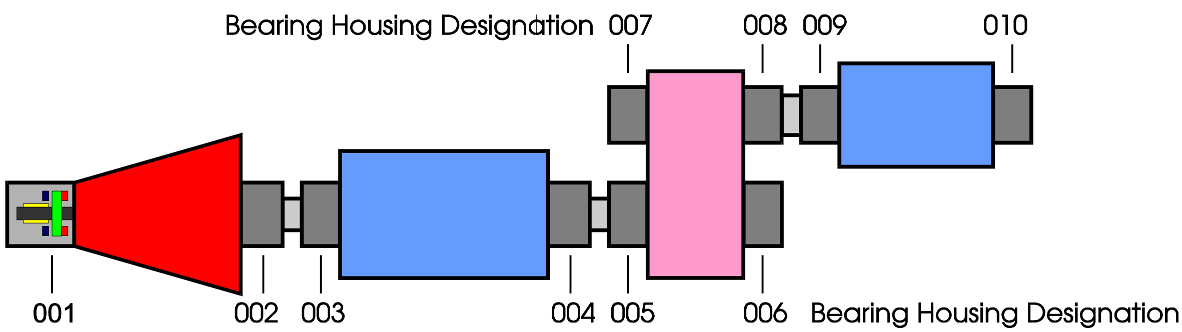


*figure 1 Bearing Housing Designation on a Conventional Process Turbomachine System*

Bearing housings on gearbox idler or lay shafts follow the same numerical sequence across each shaft from drive to driven (figure 2).

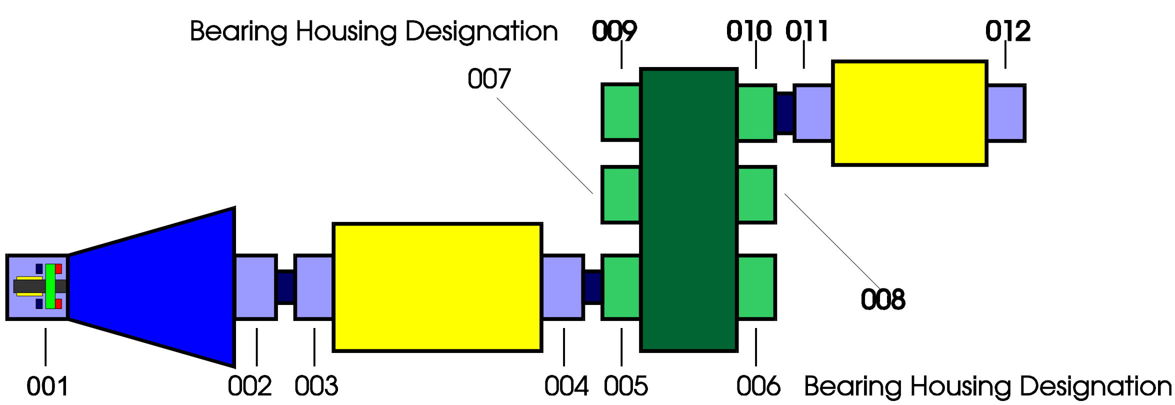


*figure 2 Bearing Housing Designation Convention -- Gear with Idler Shaft*

If two or more machines are driven from a single gear, bearing housings are numbered in sequence proceeding down the drive shaft to its end, then the sequence moves to the next shaft and proceeds to its end. This process repeats until all bearing housings are numbered (figure 3).

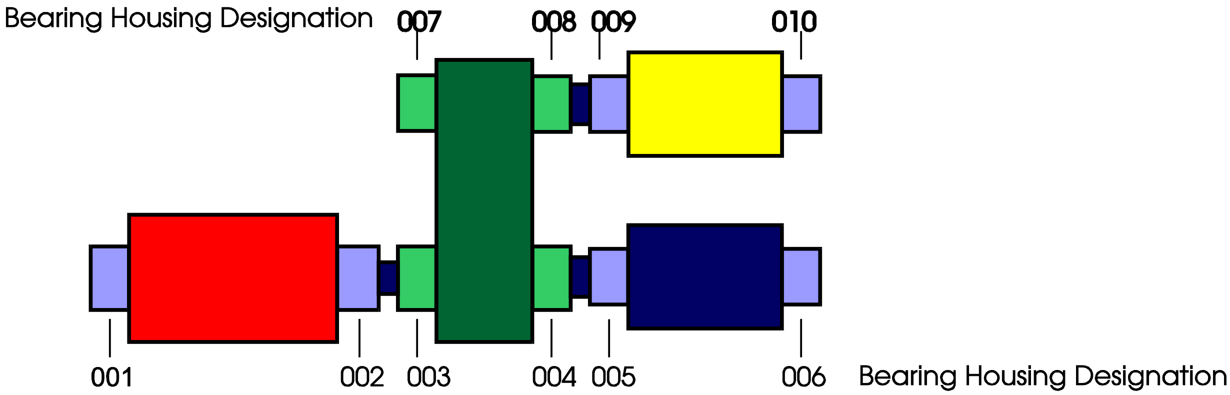


***figure 3 Bearing Housing Designation Convention -- Gear with Two or More Driven Shafts***

When the driving machine is coupled at both ends, the bearing housing at the non drive (uncoupled), end of the driven machine coupled to the thrust end (usually governor end on steam and gas turbines) of the driver is normally designated location number 001. The sequence continues as before (figure 4).

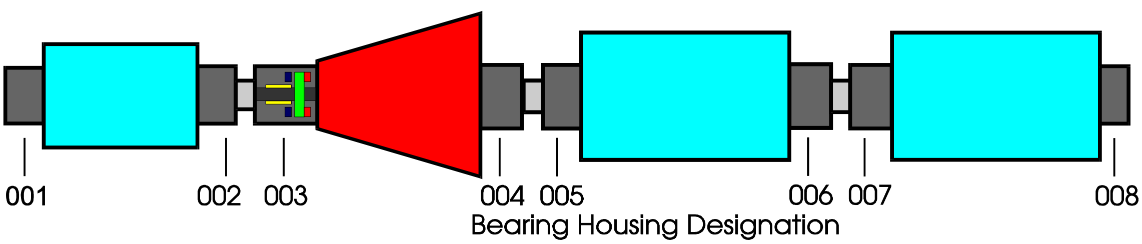


***figure 4 Bearing Housing Designation Convention When Both Ends of the Driver are Coupled***

**Vertical machine systems** follow the same convention. The topmost bearing housing is designated 001, the numerical sequence proceeds down the shaft axis (figure 6).

## Transducer Type Code

Transducer type is designated by a two letter abbreviation according to the following table:

| | | | |
|---|---|---|---|
| AC | Single Axis Accelerometer | PD | Dynamic Pressure |
| AV | Single axis accelerometer w/internal integration | PS | Static pressure |
| AT | Triaxial Accelerometer | SG | Strain Gage |
| CR | Current | TC | Temperature -- thermocouple |
| DP | Displacement Probe | TR | Temperature -- RTD |
| DR | Displacement Probe used as a Phase Reference | TT | Torque Transducer |
| LT | LVDT (linear voltage differential transformer) | TO | Torsional transducer |
| MP | Magnetic Pickup (shaft speed/phase reference) | VL | Velocity Pickup |
| MI | Microphone | VT | Voltage |
| OP | Optical Pickup (shaft speed/phase reference) | OT | Other |

**Angular Orientation**
The following identification for angular orientation is proposed as the best combination of existing conventions.

**Horizontal Machines:** The angular orientation of a vibration transducer is measured from a zero reference located at 3 O'clock when viewed at position number 001, looking into the machine. The angle increases counterclockwise (regardless of the direction of shaft rotation) in the plane of shaft rotation from 0 to 360 degrees (figure 5).

**Vertical machines:** The zero reference is located in the direction of flow with angular orientation measured counterclockwise in the plane of shaft rotation when viewed from the top (position 001) looking down (figure 6). The zero reference on machines that reverse flow, e.g., pump storage units, is established for operation as a generator.

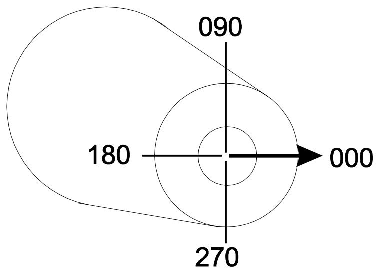


*figure 5 Angular Convention - Horizontal*

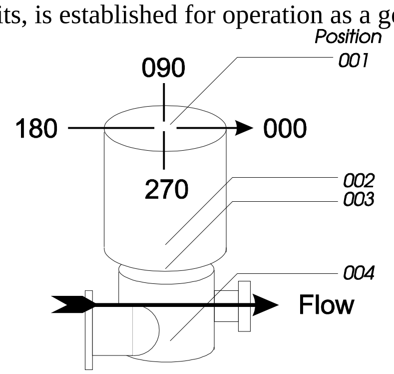


*figure 6 Position and Angular Convention - Vertical*

**Transducer Sensitive Axis Direction**
A single letter defines the direction of the transducer sensitive axis. This portion of the identification provides unique descriptive information when the transducer sensitive axis does not coincide with the radial defined in the previous section (figure 7: XXXAC135H, AC090T, AC315A). It is redundant when the sensitive axis coincides with the defined radial.

| | |
|---|---|
| R - radial: | transducer sensitive axis perpendicular to and passes through the shaft axis |
| A - axial: | transducer sensitive axis parallel to the shaft axis |
| T - tangential: | transducer sensitive axis perpendicular to a radial in the plane of shaft rotation |
| H - horizontal: | transducer sensitive axis located at 000 or 180 degrees only |
| V - vertical: | transducer sensitive axis located at 090 or 270 degrees only |

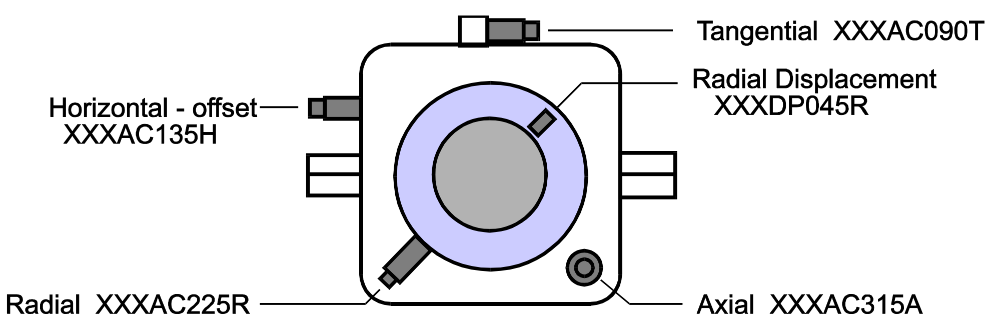


*figure 7 Direction of Transducer Axis*

**Motion for a positive signal output**

This convention requires that:

a. Motion into the transducer is defined as positive (+), motion away from the transducer is designated negative (-) (figure 8). This is normal convention for casing accelerometers, velocity pickups and non contact shaft displacement (proximity) transducers.

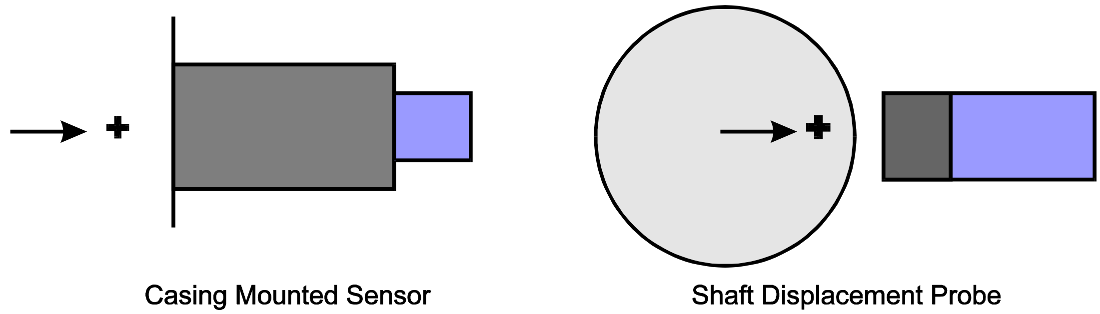


***figure 8 Motion Convention***

b. When radial transducers are installed in an X-Y pair, the X transducer will be 45 degrees to the right (clockwise) from a radial bisecting the angle between the two transducers when viewed from position number 1 (regardless of the direction of shaft rotation. The Y transducer will be 45 degrees to the left (counterclockwise) from the bisecting radial (figure 9). Utilizing this convention will always produce a correct orbital rotation.

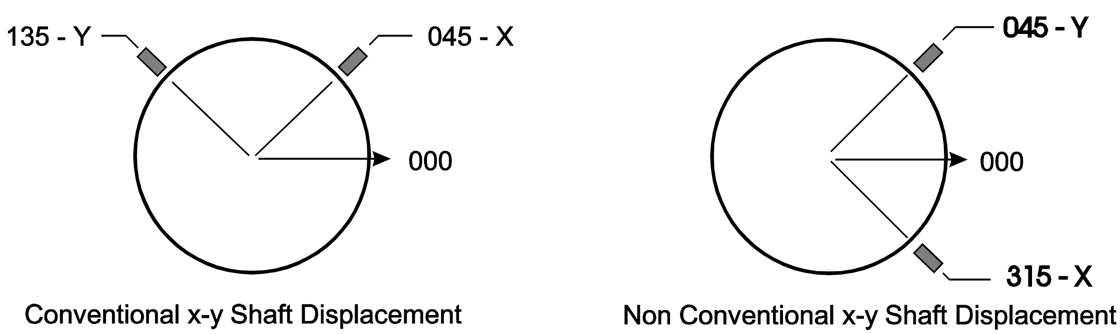


***figure 9 X-Y Shaft Displacement Probe Designation***

**<u>Direction of Motion</u>**

The final character in the vibration measurement location identification code is either an N (normal) or R (reverse) to identify transducers mounted in opposition where machine motion in one direction results in positive motion in one transducer (N -- normal) and negative motion (R -- reverse) in the other. Axial transducers mounted in opposite directions at the two ends of a machine are the primary example, figure 10. Axial machine motion toward the reference end is normally designated positive. The axial transducer closest to the reference end of the machine system, position 001, will be designated normal (N) when mounted such that positive motion toward the transducer produces a positive signal output. Likewise, motion toward the reference end will produce a negative signal from the axial transducer at the opposite end which is then designated R (reverse). The angular orientation defines the direction of motion for radially mounted transducers. Therefore, a default of N (normal) should be utilized for transducers mounted radially.

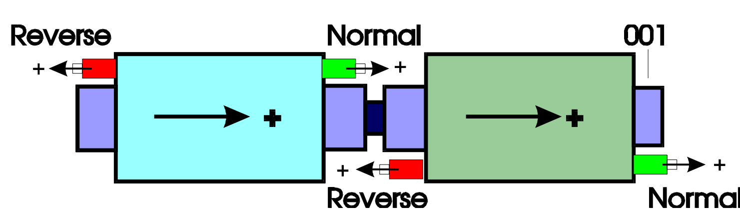


***figure 10 Normal and Reverse Motion Convention***

## MIMOSA Schema Requirements for Machinery Vibration Measurement Locations

The six definitions which compose the 14-character MIMOSA Machine Vibration Measurement Location Code are incorporated into the Meas_Location MIMOSA table (reference #47) directly or as a foreign key reference to create the code as shown below:

**Component Device and Shaft** => mim_user_prefix (4 characters or XXXX if null)
**Bearing Housing Location on Machine System** => mim_loc_seq (3 digits with leading zeroes)
**Transducer Type Code** => TRANS_TYPE.tr_type_abbrev (2 characters referenced by tr_db_site, tr_db_id, tr_type_code or XX if null)
**Angular Orientation** => ta_orient_deg (3 digits with leading zeroes or XXX if null)
**Transducer Sensitive Axis Direction** => 1st character from TR_AXIS_DIR_TYPE.name referenced by ta_db_site, ta_db_id, ta_type_code
**Direction of Motion** => motion_direction (1 character or X if null)

Vendors which desire MIMOSA compliance must allow a user to specify the bearing house location (mim_loc_seq column) and the tranducer sensitive axis direction (referenced by ta_db_site, ta_db_id, ta_type_code). With multiple condition monitoring systems, the user of the system must insure that common MIMOSA measurement location id's are used between various condition monitoring systems if these systems refer to the same measurement location. In addition, the user should use the same MIMOSA segment_id's and asset_id's between different MIMOSA databases to insure that all information is linked to the same machinery.

MIMOSA also requires that the machine system, component machines, shaft, and bearing segments are specified in a consistent order in the SEGMENT table (using the SEGMENT table's ordering_seq column) for a machine system beginning at one end of the system and proceeding in order of shaft connections to the end of the system.

It is advisable to define shaft orientation (horizontal or vertical) for the machine system and/or the machine components in segment and asset numeric data.tables. If the entire machine system has the same orientation it should be specified at system level. In unusual cases such as a horizontal motor driving a vertical pump through a right angle gearbox, the shaft orientation must be defined at the individual machine segment or asset level.

Example of Entries in SEGMENT & SEGMENT_CHILD tables:

NOTE: An indention refers to an entry in the SEGMENT_CHILD table with this segment denoted as a child of the segment listed above. The same name listed more than once (i.e., Shaft A) refers to the same segment, but shows designates another entry in the SEGMENT_CHILD table for this segment.

```
Segment.name                  Segment_Type.name
Boiler Feed Pump A            (Boiler Feed System, Pump)
    Motor                     (Motor, AC)
        Shaft A               (Shaft)
            MTRA001 Bearing Housing (Bearing Housing)
                Msmt. Loc. Names:   MTRA001AC000RN or MTRA001AC000HN
                                    MTRA001AC090RN or MTRA001AC090VN
                                    MTRA001AC000AN
                MTRA001 Bearing   (Bearing, Anti-friction)
            MTRA002 Bearing Housing (Bearing Housing)
                Msmt. Loc. Names:   MTRA002AC000RN or MTRA002AC000HN
                                    MTRA002AC090RN or MTRA002AC090VN
                                    MTRA002AC045AR
                MTRA002 Bearing (Bearing, Anti-friction)
    Coupling                  (Coupling, Flexible, Diaphragm)
        Shaft A               (Shaft)
        Shaft B               (Shaft)
    Pump                      (Pump, Centrifugal)
        Shaft B               (Shaft)
```

PMPB003 Bearing Housing (Bearing Housing)
**Msmt. Loc. Names:** PMPB003AC000RN or PMPB003AC000HN
PMPB003AC090RN or PMPB003AC090VN
PMPB003AC045AN
PMPB003 Bearing (Bearing, Anti-friction)
PMPB004 Bearing Housing (Bearing Housing)
**Msmt. Loc. Names:** PMPB004AC000RN or PMPB004AC000HN
PMPB004AC090RN or PMPB004AC090VN
PMPB004AC000AR
PMPB004 Bearing (Bearing, Anti-friction)

Main Turbine Generator (Turbine Generator Set)
HP/IP Turbine (Turbine, Steam)
Shaft A (Shaft)
HTBA001 Bearing Housing (Bearing Housing)
**Msmt. Location Names:** HTBA001DP000AN
HTBA001DP045RN
HTBA001DP135RN
HTBA001AC000RN or HTBA001AC000HN
HTBA001AC090RN or HTBA001AC090VN
HTBA001AC000AN
HTBA001 Thrust Bearing (Bearing, Fixed Thrust)
HTBA001 Bearing (Bearing, Journal, Plain)
HTBA002 Bearing Housing (Bearing Housing)
**Msmt. Location Names:** HTBA002DP045RN
HTBA002DP135RN
HTBA002AC000RN or HTBA002AC000HN
HTBA002AC090RN or HTBA002AC090VN
HTBA002AC045AR
TRBA002 Bearing (Bearing, Journal, Plain)
Coupling (Coupling, Rigid)
Shaft A Bearing (Shaft)
Shaft B Bearing (Shaft)
LP Turbine (Turbine, Steam)
Shaft B (Shaft)
LTBB003 Bearing Housing (Bearing Housing)
**Msmt. Location Names:** LTBB003DP045RN
LTBB003DP135RN
LTBB003AC000RN or LTBB003AC000HN
LTBB003AC090RN or LTBB003AC090VN
LTBB003AC045AN
LTBB003 Bearing (Bearing, Journal, Plain)
LTBB004 Bearing Housing (Bearing Housing)
**Msmt. Location Names:** LTBB004DP045RN
LTBB004DP135RN
LTBB004AC000RN or LTBB004AC000HN
LTBB004AC090RN or LTBB004AC090VN
LTBB004AC045AR
LTBB004 Bearing (Bearing, Journal, Plain)
Coupling (Coupling, Rigid)
Shaft B (Shaft)
Shaft C (Shaft)
Generator (Generator, AC)
Shaft C (Shaft)
GENC005 Bearing Housing (Bearing Housing)
**Msmt. Location Names:** GENC005DP045RN
GENC005DP135RN
GENC005AC000RN or GENC005AC000HN

GENC005AC090RN or GENC005AC090VN
GENC005AC045AN

GENC005 Bearing (Bearing, Journal, Plain)

GENC006 Bearing Housing (Bearing Housing)

**Msmt. Location Names:** GENC006DP045RN
GENC006DP135RN
GENC006AC000RN or GENC006AC000HN
GENC006AC090RN or GENC006AC090VN
GENC006AC045AR

GENC006 Bearing (Bearing, Journal, Plain)

Exciter (Exciter)

Shaft C (Shaft)

EXCC007 Bearing Housing (Bearing Housing)

**Msmt. Location Names:** EXCC007DP045RN
EXCC007DP135RN
EXCC007AC000RN or EXCC007AC000HN
EXCC007AC090RN or EXCC007AC090VN
EXCC007AC000AR

EXCC007 Bearing (Bearing, Journal, Plain)