Manual Milling Machine Training SOP

Tool Location

Innovation Workshop, Elings 2448

Safety

- Untrained or unsupervised operators risk serious injury.
- Risk of metal splinters and burns from flying chips. Wear safety goggles, closed-toe shoes, long pants.
- Keep body parts clear of spindle and workpiece while machine is moving
- Take care when handling heavy objects
- Make sure the part and tool are secured before starting a machining operation
- Remove chuck keys and other tools before starting the machine

Training

1. Requirements
    1. Machine shop safety test
    2. in-person training
2. Training outline
    1. Technical description
        1. PM-25MV Mill
            1. A 3-axis mill with R8 spindle. Spindle speeds varies continuously from 50-2500 rpm.
            2. Weight: 275 lbs
            3. Spindle motor: Brushless DC 750 W (1 HP)
            4. Travel
                1. X-axis: 20.5"
                2. Y-axis: 7"
                3. Z-axis: 13"
            5. Axis locks
            6. Quill lock
        2. 4" Vice
            1. Hold downs for vice
            2. Indicating vice
        3. DRO
            1. One for table and headstock. A separate DRO for quill.
            2. Functions
                1. zeroing
                2. inputting coordinate
                3. metric/inch interchange
                4. Absolute/incremental coordinates
                5. automatic half
                6. calculator
                7. entering tool offset
    2. Safty

1. Precautions
    1. This machine is designed for milling and drilling operations by experienced users familiar with metal-working hazards.
    2. Wear ANSI-approved full-face or eye protection at all times when using the machine (everyday eyeglasses are not reliable protection against flying particles).
    3. Wear proper apparel and non-slip footwear – be sure toprevent hair, clothing or jewelry from becoming entangledin moving parts. Gloves – including tight-fitting disposables can be hazardous!
    4. Be sure the work area is properly lit.
    5. Never leave chuck keys, wrenches or other loose tools on the machine.
    6. Be sure the workpiece and machine ways are secure before commencing milling or drilling hold-downs and/or vise fully tightened, X-Y-Z axes locked, cutting tool secured
    7. Use moderation: light cuts, low spindle speeds and slow table motion give better, safer results than "hogging".
    8. Don't try to stop a moving spindle by hand – allow it to stop on its own.
    9. Disconnect 110V power from the mill before maintenance operations such as oiling or adjustments
    10. Maintain the machine with care – check lubrication and adjustments daily before use.
    11. Clean the machine routinely – remove chips by brush or vacuum, not compressed air (which can force debris into the ways).
3. Setup
    1. Turn on the mill
        1. Turn on DRO by flipping switch on back
        2. Turn on Quill DRO by pressing power button
        3. Once part and tool are secure, spindle may be turned on by pressing the green power button on the speed controller panel
    2. setting up a vice
        1. Install the T-bolts and align the vise by eye. With one of the clamp nuts snug, but not tight, tighten the other one just short of fully-tight (but tight enough so the vise won't budge without a definite tap from a dead-blow mallet).
        2. Adjust the Y-axis to pre-load the indicator to mid range at the tightly-clamped side of the vise, then lock the Y-axis. Do not allow the spindle to rotate during this procedure.
        3. Note the indicator reading, then watch the indicator as you traverse the table slowly toward the loosely clamped side. (Also watch for any sign of spindle rotation.) Ideally, there should be no discrepancy between the indicator readings at the two ends — unlikely at the first attempt. Return the table to the starting point, then repeat the process, tapping the vise in as you go. Repeat the process as often as necessary for the desired accuracy, progressively tightening the "looser" nut. Now fully tighten both nuts, and re-check again (tightening a nut can itself introduce significant error).
4. Change Tooling
    1. Remove Tooling
        1. Lock the spindle with the C-wrench, loosen the drawbar one half turn or less, just enough to unseat the taper, then tap the top of the drawbar with a soft hammer to release the R-8 device. Unscrew the drawbar with one hand while supporting the R-8 device with the other hand.
    2. install Tooling

1. Install the R-8 device, then hand-thread the drawbar into it until the shoulder on the drawbar bottoms on the splined spindle, diagram above (on the machine this is concealed by the drawbar cap, Figure 3-2). Lock the spindle with the special C-wrench, page 5, while at the same fully tightening the drawbar with an 8 mm wrench.

5. Securing the part
    1. vice
        1. Position part in vice. Vice maximum length is 4". Use parallels if needed. Press firmly down on part to ensure it is properly seated.
        2. Tighten vice
    2. Hold-downs
        1. Hold downs can be accessed in the "Milling Supplies Drawer" (See Supplies).

6. Moving the Table
    1. Conventionally, left-right movement of the table is said to be along the X-axis (also called "longitudinal travel" or "traversing"). Front-back movement is on the Y-axis, sometimes called "cross travel".
    2. Each axis has a leadscrew with handwheel and graduated dial with 0.001" divisions, 0.1" per revolution.
    3. The position of the table is indicated by the digital readout (DRO)
    4. Leadscrew backlash

7. Z-axis
    1. Moving headstock
        1. for milling
        2. Z-axis crank. When the headstock is in the desired place, lock it in place.
    2. Changing the speed
        1. Adjust the speed knob one the headstock while the machine is on
    3. Quill downfeed
        1. coarse downfeed
            1. For drilling operations, loosen knob (4), allowing the lever hub to rotate independently of sleeve (3).
            2. In the drilling mode, coarse feed, the mill operates like a standard drill press with a 3-lever hub; lever action lowers or raises the quill in the usual way by rack and pinion. Return action is assisted by a compression spring within the quill and spindle assembly.
        2. fine downfeed
            1. For milling operations calling for precise, repeatable control of tool depth, tighten knob (4) to engage hub (1) with the internal taper on sleeve (3). Tighten the Z-axis locks, Figure 3-6.
        3. Quill DRO indicates quill position

8. Using DRO
    1. zeroing
        1. Move the table to the desired position. Zero an axis by pressing X0, y0, or Z0.
    2. inputting coordinate
        1. Press X, Y, or Z
        2. Enter the position using the keypad
        3. Press ENT
    3. metric/inch interchange
        1. Press MM/INCH
    4. Absolute/incremental coordinates
        1. There are two sets of basic coordinates display, ABS (absolute) and INC (incremental) displays.

2. Toggle by pressing ABS/INC
5. automatic half
    1. Touch one side of the workpiece with the tool. Zero the axis.
    2. Touch the tool to the other side of the workpiece.
    3. Press X or Y, then press 1/2
6. calculator
    1. Calculations can be done once the calculator button is pressed.
7. entering tool offset
9. Machining operations
    1. Edgefinding
        1. Load edge finder in the spindle.
        2. Turn RPM to 1300.
        3. Lower the quill so that the edge finder probe can collide with the edge whose position you want to measure.
        4. Move the table so that the probe touches the edge of the part, causing the probe to become offset with the shank. At this point, the edge has been found.
        5. Raise the quill. Offset the table position by half the edge finder diameter. Zero the axis.
    2. Zeroing Z
        1. Find a dowel pin (See Supplies). Lower the tool so it is slightly above the dowel pin
        2. Slide the dowel pin under the tool, gradually lower the Z-axis until the dowel pin rubs the bottom of the tool but can still pass through underneath.
        3. Remove the dowel pin. Raise the table by the diameter of the dowel pin.
    3. drilling
        1. Look up proper RPM for tool and material
        2. locate XY position, use quill to downfeed
        3. center drill, then drill the hole
        4. peck drilling
            1. periodically remove drill from hole to clear chips
    4. milling
        1. consult resources for tool RPM and feed speed.
        2. fully retract the quill and lock it with the lever on the left of the headstock
        3. facing
        4. Side cutting
    5. tapping
        1. Do not turn the spindle motor on during tapping
        2. Place the tap guide in the spindle
        3. Position hole under the tap
        4. Apply tapping fluid
        5. Turn the tap clockwise to cut threads. Periodically reverse tap direction to clear out chip build up.