

# INT114 LAB 2.1: MILLING II

Student Name: \_\_\_\_\_

Student ID: \_\_\_\_\_

## LAB OUTCOMES:

Upon completion of this lab procedure, the student should be able to:

1. Interpret a plan for a mill-machined part
2. Use a milling machine to drill, ream, and tap accurately located holes in a workpiece.

## LAB PROCESS:

Before entering the machine shop, ensure that you have observed all required safety procedures:

- Safety glasses on
- Closed-toed shoes
- No rings or other jewelry
- No loose-fitting clothing
- Long hair pulled back
- Not under the influence of any substance that dulls reaction time or judgement

### Part 1:

1. Review the print on the last page of this lab. You will be continuing the work from Lab 114-1.2.
2. Check the alignment of the vise. Does it need to be adjusted? Ensure that the vise is clean of any chips or burrs.

### Part 2:

1. You will be drilling and reaming two 1/8" holes. Locate the appropriate cutting tools.

What are they?

How will these tools be mounted to the spindle?

2. Calculate the RPM and feed rate using the standard formulas. The table in the text gives the recommended cutting speed for steel as 100-235 fpm and the feed rate as 0.005 – 0.010 ftr.
3. Consult with the instructor on the appropriate spindle speed.

What speed is set?

How does this compare to your calculated values?

4. Mount the workpiece in a vise on parallels, with the top surface facing upward. Ensure that the work is setting flat against the vise and there is enough clearance for the through holes.
5. Locate, center drill and drill the first of the 1/8" holes to the appropriate depth.
6. Use a reamer to expand and finish the hole.
7. Locate, center drill, and drill the second 1/8" hole to the appropriate depth.
8. Use a reamer to expand and finish the hole.

**Part 3:**

1. You will be drilling and tapping a ¼-20 hole. Locate the appropriate cutting tools.

What are they?

How will these tools be mounted to the spindle?

2. Calculate the RPM and feed rate using the standard formulas. The table in the text gives the recommended cutting speed for steel as 100-235 fpm and the feed rate as 0.005 – 0.010 ftr.
3. Consult with the instructor on the appropriate spindle speed.

What speed is set?

How does this compare to your calculated values?

4. If needed, re-mount the workpiece in a vise on parallels, with the top surface facing upward. Ensure that the work is setting flat against the vise and there is enough clearance for the through holes.
5. Locate, center drill, drill, and tap the hole. Use cutting oil for tapping.

#### **Part 4:**

1. You will be drilling and reaming  $\frac{3}{4}$ " hole. Locate the appropriate cutting tools.

What are they?

How will these tools be mounted to the spindle?

2. Calculate the RPM and feed rate using the standard formula. The table in the text gives the recommended cutting speed for steel as 100-235 fpm and the feed rate as 0.005 – 0.010 ftr.

3. Consult with the instructor on the appropriate spindle speed and feed rate.

What speed is set?

How does this compare to your calculated values?

4. If needed, re-mount the workpiece in a vise on parallels, with the top surface facing upward. Ensure that the work is setting flat against the vise and there is enough clearance for the through holes.
5. Locate, center drill, drill, and ream the hole.
6. Measure the depth and diameter of all holes. Are these all within tolerance?

*The outcomes of this exercise (listed on page 1) specifies the skills that the Student must demonstrate to the Instructor. Once the Instructor is satisfied with the demonstration of Knowledge & Skills by the individual student, they will sign this document (for the student), then enter a 100% into the Hands-On Lab grade in Sakai.*

I verify that this student has completed all of the requirements of this Hands-On Assessment:

Student Name: \_\_\_\_\_

Faculty Signature: \_\_\_\_\_ Date: \_\_\_\_\_

**DOL DISCLAIMER:**

This product was funded by a grant awarded by the U.S. Department of Labor's Employment and Training Administration. The product was created by the grantee and does not necessarily reflect the official position of the U.S. Department of Labor. The Department of Labor makes no guarantees, warranties, or assurances of any kind, express or implied, with respect to such information, including any information on linked sites and including, but not limited to, accuracy of the information or its completeness, timeliness, usefulness, adequacy, continued availability, or ownership.



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# Performance Standards

## Vertical Milling Level I

### Material

Mild steel or low carbon steel 1.5" x 2" x 2.6"

### Duty

Setup and operate vertical milling machines. Perform routine milling, and location of hole centers within  $\pm .005$ ".

### Performance Standard

Given raw material, print, hand, precision, and cutting tools, as well as access to an appropriate vertical milling machine and its accessories, produce a part matching the blueprint specifications using appropriate trade techniques and speeds and feeds. The part specified should require squaring up from the raw state, have at least one milled slot, require the location of at least two drilled and reamed holes within positional tolerance of .014" and have three steps controlled by tolerances of  $\pm .005$ ".

### Other Evaluation Criteria

1. Finishes are at least 125 Ra microinches.
2. No sharp edges.

*Accuracy Level:*  $\pm .015$  on all fractions,  $\pm .005$  on all decimals unless otherwise specified on the blueprint. Finishes Surfaces to be square within .005 over 4". Finished surfaces are to be 125 Ra microinches unless otherwise specified.

### Assessment Equipment and Material

*Workstation:* A common workbench, a vertical mill. Table capacity of approximately 12"X36".

*Material:* A part matching the material requirements of the vertical milling print, material: Mild steel.

*Tooling:* A 6" milling vise or greater, screws, studs, nuts, washers, and clamps sufficient to secure the vise, or the part to the table. Assorted parallels, ball peen, and soft-faced hammers, assorted cutters and cutter adapters fitted to the machine spindle, files, magnetic base for indicators, soft jaws for the vise, drill chuck, drills, reamers, combination drill and countersink or spotting drill, countersink, and edge finder. Coolants and cutting oil.

*Measuring*

*Instruments:* 0-3 Micrometers, combination set, dial indicator, 6" rule, a 6" vernier, dial, or electronic caliper, adjustable parallels, and depth micrometer, and surface finish comparison plates.

Pin gages. .123", .124", .125", .126", .127"

Solid square

¼ - 20 UNC 2B plug gage

Telescopic gage .750

Small hole gage

*Reference:* Machinery's Handbook.

# Performance Assessment Worksheet

## Vertical Milling Level I

**INSTRUCTIONS:** Rate the candidate's performance for the Milling project according to the sixteen (16) criteria below. The checklist below represents a listing of the only criteria to be evaluated. It is not a sequence of process steps or a process plan for making the part. For each item, check the box under Pass or Fail accordingly.

Remember, NIMS requires that all specifications must be met within the allowable tolerance limits. If the part does not meet all specifications, the candidate/trainee must correct or redo the project.

Candidate Name \_\_\_\_\_

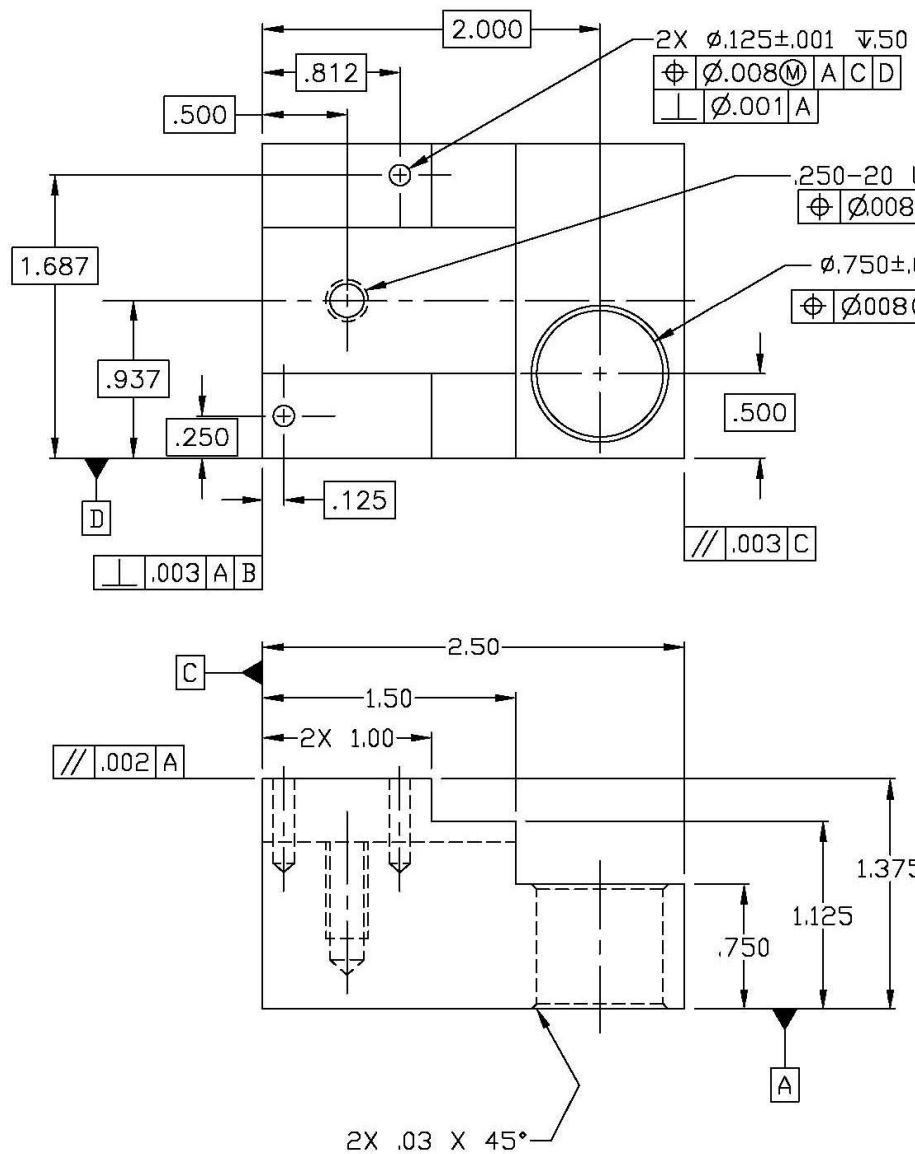
Evaluation Date \_\_\_\_\_

| <b>Performance Project – Milling</b>  |   |                          |                          |
|---|---|--------------------------|--------------------------|
| <b>Evaluation Criteria</b>  |   | <b>Pass</b>              | <b>Fail</b>              |
| 1. Lengths $2.50 \pm .015$ , $1.50 \pm .015$ , $1.00 \pm .015$  | Pass = within tolerance<br>Fail = out of tolerance              | <input type="checkbox"/> | <input type="checkbox"/> |
| 2. Heights $1.375 \pm .005$ , $1.125 \pm .005$ , $.750 \pm .005$ , $1.000 \pm .005$   | Pass = within tolerance<br>Fail = out of tolerance              | <input type="checkbox"/> | <input type="checkbox"/> |
| 3. Width $1.875 \pm .005$   | Pass = within tolerance<br>Fail = out of tolerance              | <input type="checkbox"/> | <input type="checkbox"/> |
| 4. All surfaces are $\square$ or $//$ within specified tolerance zones in the feature control symbols to their respective datums                    | Pass = within tolerance zones<br>Fail = exceeds tolerance zones | <input type="checkbox"/> | <input type="checkbox"/> |
| 5. $\varnothing .750 \pm .005$ bore   | Pass = within tolerance<br>Fail = out of tolerance              | <input type="checkbox"/> | <input type="checkbox"/> |
| 6. True position of $\varnothing .750$ bore $.014$ tolerance zone to datums A, C and D  | Pass = within tolerance<br>Fail = out of tolerance              | <input type="checkbox"/> | <input type="checkbox"/> |
| 7. $\varnothing .25$ - 20 UNC-2B Thread<br>True position tolerance zone of $.014$ to datums A, C and D (base true position from tap drill diameter. | Pass = within tolerance<br>Fail = out of tolerance              | <input type="checkbox"/> | <input type="checkbox"/> |

| <b>Performance Project – Milling</b>  |   |                          |                          |
|---|---|--------------------------|--------------------------|
| <b>Evaluation Criteria</b>  |   | <b>Pass</b>              | <b>Fail</b>              |
| 8. $.875 \pm .005$ position to datum B with a $.005$ tolerance zone.                    | Pass = within tolerance<br>Fail = out of tolerance                    | <input type="checkbox"/> | <input type="checkbox"/> |
| 9. 2 x $.125$ ” holes positioned within $.812 \pm .005$ datums A, C, & D                | Pass = within tolerance<br>Fail = out of tolerance                    | <input type="checkbox"/> | <input type="checkbox"/> |
| 10. $.125$ hole diameter $\pm .001$ (both holes)  | Pass = within tolerance<br>Fail = out of tolerance                    | <input type="checkbox"/> | <input type="checkbox"/> |
| 11. Tap for $.25 - 20 \times .50$ deep min.<br>(No break out at the bottom of the hole) | Pass = within tolerance zones<br>Fail = exceeds tolerance zones       | <input type="checkbox"/> | <input type="checkbox"/> |
| 12. $.031$ deep $\times 45^\circ$ chamfers  | Pass = within tolerance<br>Fail = out of tolerance                    | <input type="checkbox"/> | <input type="checkbox"/> |
| 13. Surface finish, no ground surfaces  | Pass = 125 Ra microinches or better<br>Fail = over 125 Ra microinches | <input type="checkbox"/> | <input type="checkbox"/> |
| 14. Sharp edges $.015$ max. and holes countersunk $.031$ max.                           | Pass = no sharp edges, within maximum allowance<br>Fail = sharp edges | <input type="checkbox"/> | <input type="checkbox"/> |
| <b>END OF MILLING EVALUATION</b>  |   |                          |                          |

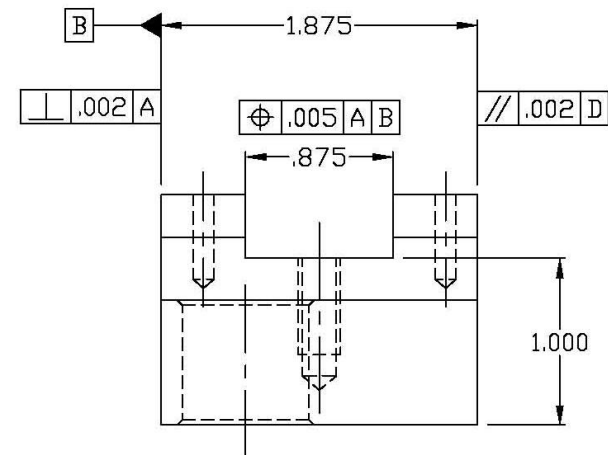
*It is important to note that the part must be 100% within the tolerances listed on the print. The criteria listed here are a guide for instructors and supervisors. Not every dimension is included in this guide. Nonetheless, the completed part must be 100% within the specifications of the print. The print takes precedence over this guide when the parts are inspected by the MET-TEC committee. The part print and the Performance Affidavit should be sent along with the part to the MET-TEC for evaluation. Send to NIMS only the completed Performance Affidavit, signed by the MET-TEC members. A copy of the Performance Affidavit should be retained in the candidate's file documenting completed performance for this credential.*






| REVISIONS |                                 |        |          |
|-----------|---------------------------------|--------|----------|
| REV       | DESCRIPTION                     | DATE   | APPROVED |
| A         | UPDATED DRAWING AND TITLE BLOCK | 3/7/05 | LW       |

- Notes:**
1. FINISH ALL OVER 125 MICROINCHES MAX
  2. BREAK ALL SHARP EDGES .015" MAX
  3. COUNTERSINK ALL HOLES .03" MAX UNLESS SHOWN



|   |          |              |        |  |  |  |  |
|---|----------|--------------|--------|--|--|--|--|
|                                  |          |              |        | MACHINING SKILLS LEVEL I                         |  |  |  |
|   |          |              |        | Job Duty 2.5 & 2.6<br>Vertical Milling Operation |  |  |  |
| UNLESS OTHERWISE SPECIFIED<br>DIMENSIONS ARE IN INCHES<br>INTERPRET DIMENSIONS AND<br>TOLERANCES PER ASME Y14.5M-1994 | DESIGNER | DK           | 8/1/01 | MATERIAL<br>COLD ROLL STEEL<br>OR MILD STEEL     |  |  |  |
| TOLERANCES<br>.X $\pm .032$ .XXX $\pm .005$<br>.XX $\pm .015$ ANGLES $\pm 1$ DEG.<br>FRACTIONS $\pm 1/64$             | DWG CHK  |              |        |  |  |  |  |
|   | DWG APPD |              |        |  |  |  |  |
| SCALE FULL  |          | DWG.#98301 I |        | SHEET 1 OF 1                                     |  |  |  |

DO NOT SCALE DRAWING

### NIMS PROCEDURAL REQUIREMENTS

1. SUBMIT THIS PRINT AND WORKPIECE ALONG WITH THE PERFORMANCE AFFIDAVIT FOR EVALUATION