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# DEPOT MAINTENANCE PRODUCTION SHOP CAPACITY MEASUREMENT HANDBOOK



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**OFFICE OF THE ASSISTANT SECRETARY OF DEFENSE  
INSTALLATIONS AND LOGISTICS**

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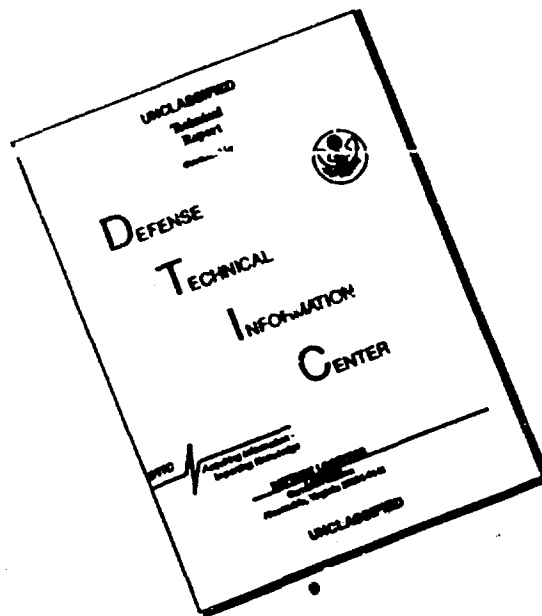


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ASSISTANT SECRETARY OF DEFENSE  
WASHINGTON, D.C. 20301

INSTALLATIONS AND LOGISTICS

July 28, 1976

PREFACE

This Handbook, authorized by DoD Instruction 4151.15, Depot Maintenance Support Programming Policies, provides guidance and procedures for use in determining the capacity of depot level activities to perform maintenance of material. Although published under the auspices of this office, it represents the joint efforts of members of each Military Department. The contribution of each is appreciated.

Frank A. Shrontz  
Assistant Secretary of Defense  
(Installations & Logistics)

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DEPOT MAINTENANCE PRODUCTION  
SHOP CAPACITY MEASUREMENT

Reference: (a) DoD Handbook 7220.29-H, "DoD Depot Maintenance and Support Cost Accounting and Production Reporting Handbook," October 21, 1975, authorized by DoD Instruction 7220.29, October 20, 1975

I. PURPOSE AND SCOPE

This Handbook provides guidance for a common methodology to determine capacity of depot level activities to perform maintenance of military material. It is to be used by all DoD activities and organizations responsible for the determination and reporting of shop or plant capacity for depot maintenance functions.

II. DEFINITIONS

- A. Physical Capacity. The amount of workload, expressed in actual direct labor hours, that a facility can accommodate with all work positions manned on a single-shift, 5-day, 40-hour week basis while producing the product mix that the facility is designed to accommodate.
- B. Peacetime Workloading Capacity. The amount of workload, expressed in actual direct labor hours, that a facility can effectively produce considering the management limitations upon applying sufficient workers to continuously fill every work position on a single-shift, 5-day, 40-hour week basis while producing the product mix that the shop is designed to accommodate.
- C. Work Position. The designated space of equipment/process usage that can be occupied consistently by one direct production worker to accomplish the assigned task on a full time basis. A work position may include more than one location if the worker moves to other locations as he accomplishes his assigned task.
- D. Work Station. The lowest order of equipment/process location which requires separate analysis of work flow and function during the capacity calculation. It will consist of one or more work positions as determined by the criteria in Step 3 of the physical capacity calculation in this Handbook.

- E. Shop. The term "shop" refers to a shop, work center, functional work group or resource group.
- F. Availability Factor. The availability factor is the percentage of an 8-hour shift that work stations can be utilized to accomplish direct productive work.
- G. Bottleneck. A bottleneck is a process in the production flow within which capacity to do work is limited to the degree that it restricts the ability to achieve full, single-shift utilization of the other processes either preceding or following the bottleneck.
- H. Depot Maintenance. That maintenance which is the responsibility of and performed by designated maintenance activities, to augment stocks of serviceable materiel, and to support Organizational Maintenance and Intermediate Maintenance activities by the use of more extensive shop facilities, equipment, and personnel of higher technical skill than are available at the lower levels of maintenance. Its phases normally consist of inspection, test, repair, modification, alteration, modernization, conversion, overhaul, reclamation, or rebuild of parts, assemblies, subassemblies, components, equipment end items, and weapon systems; the manufacture of critical non-available parts; and providing technical assistance to intermediate maintenance organizations, using and other activities. Depot Maintenance is normally accomplished in fixed shops, shipyards and other shore-based facilities, or by depot field teams.
- I. Dedicated Facilities. Dedicated facilities support essential workloads for specific weapon systems. A dedicated facility usually includes a complete process that cannot be used for other applications without significant modifications.
- J. Direct Labor Factor. That percentage of the 2000 hours of annual duty time per production employee which remains for direct application to the job after subtraction of leave, training and other recognized indirect hours.
- K. Product Mix. A combination of heterogeneous workloads usually identified by portions related to major systems, subsystems, components, stock classes, or items.

### III. GENERAL

- A. Although the techniques in this Handbook are oriented toward capacity measurement of covered shop space, the techniques can be applied to uncovered areas utilized in depot operations. For example, the techniques are appropriate for measurement of the capacity of uncovered test and calibration areas. Unless otherwise directed, however, other uncovered work areas and those areas included in the production shop categories titled "other" and "general shop support" are not to be included in the capacity measurement calculations.
- B. Two factors govern the capacity to accomplish depot maintenance of material. The facility, its included shop equipment, and the product mix establish the physical capacity. The ability to place the necessary work force skills on the job when needed establishes the peacetime workloading capacity. Both need to be determined before programming workloads or calculating utilization. This Handbook establishes techniques for determining each.

### IV. PHYSICAL CAPACITY

- A. Physical capacity may be limited by the availability factor and/or by bottlenecks. The calculation of the availability factor is described in Step 5 of this section of the Handbook. Bottlenecks may be found among the work stations within a shop and among shops in the work flow process.
- B. The following steps outline procedures for calculating the physical capacity. The steps are repeated in flow chart form on enclosure 1. Steps 1 through 11 apply to calculation of current capacity. The Step 12 through 14 procedures apply programmed changes which will impact capacity during the following 2 years and project the capacity for the second out-year:
  - 1. Determine the product mix that the shops will be required to accommodate.
  - 2. Obtain detailed shop layouts which identify the function of each shop, its boundaries, its area and its equipment/work bench locations. Verify and update the layouts to reflect the current situation.

3. Determine and identify on the layouts the number of work stations and the work positions in each. Work station identification will be covered by the following rationale.
  - a. If only one person would operate the equipment/process, the work station will include the equipment/process and be recorded as having a capacity of one work position.
  - b. If the work station is designed to be operated by more than one person, the capacity is the number of work positions that these personnel represent.
  - c. If, under design conditions, an equipment/process would only be infrequently utilized or support more than one work station, it will be included in a designated work station and labeled as support equipment.
  - d. If an equipment/process is designed to be frequently but not continuously utilized, it should be included as part of a related work position.
  - e. If a position is designed to be manned continuously but is currently vacant because of reduced workload quantity, it shall be counted as a work position.
  - f. Some examples of work stations are:
    - (1) Stall/Work Bay/Aircraft Dock. For the stall/work bay/aircraft dock situation, the number of people who can effectively work during each phase of the process cycle will be determined. The weighted average over the cycle will be used as the work position quantity of the work station. An analysis of product mix and process variations may be necessary to determine this value.
    - (2) Major Special Facilities (Engine Test Cell, Radar Range, etc.).
    - (3) Bulk Processing (Plating, Chemical Cleaning, Heat Treating, etc.). Bulk processing work stations, where design is largely determined by required capability, can be regarded as one work station with capacity determined by the number of persons necessary to effectively man the entire work station.

- (4) Bench (Hydraulics, Electronics, etc.). A work station in a bench type situation may consist of one or more work benches and support equipment items.
- (5) Equipment (Machine Tools, Component Test Stands, etc.). Equipment work stations may include a single work position on one or more equipment items, or multi-work positions on one or more equipment items.
4. Multiply the number of work positions in each work station by 2000 hours to obtain the gross capacity.
  5. Calculate the availability factor by deducting equipment and facility downtime that is not included in the man-hour standards and that is expected to have to occur during the prime shift. These factors may include reductions for nonproductive times such as calibration/maintenance/repairs of real property and shop equipment, utility failure, unscheduled facility closures, and equipment installation/rearrangement. Multiply the gross capacity by the availability factor to determine available physical capacity.
  6. Identify the significant bottleneck (if any) which limits work flow between work stations.
  7. Where feasible and practical, bottlenecks should be eliminated through methods improvement, shop redesign or other techniques. If a bottleneck is not eliminated, it should be treated as follows. Assume that the bottleneck function can be operated at 1.5 shifts and analyze the result as shown in the sample on enclosure 2.
  8. Identify the significant bottleneck (if any) which limits work flow between shops.
  9. Apply the techniques described in Step 7 to the correction or analysis of this bottleneck.
  10. Summarize capacities to derive the capacity by production shop category. The total is the current single-shift physical capacity, unadjusted for manpower availability.
  11. Record the current capacity.

12. Determine programmed or expected changes in product mix, facilities or equipment which would change the capacity for the second out-year.
13. Analyze the changes and repeat all steps impacted by the changes to obtain the forecast physical capacities in the same summary formats. This calculation should be accomplished for the second year (for example, during FY 1977, calculate the capacity for FY 1979). The result is the forecast single-shift physical capacity.
14. Record the forecast capacity.

V. UNUTILIZED SPACE

Unutilized space in (or forecast to be in) the custody of depot maintenance can represent potential production capacity. If placement of the proper equipment in the unutilized space would enable it to be made into productive maintenance space, then it should be counted as potential capacity. This capacity should be reported separately and identified by the production shop category that it would be most adaptable to. The capacity of unutilized space may be estimated by dividing the area by the square feet normally required per worker in the production shop category.

VI. PEACETIME WORKLOADING CAPACITY

- A. Full single-shift utilization of each work position requires the proper skill to be working the position for 2000 hours of direct labor per year. Leave, training, and miscellaneous indirect factors as described in DoD Handbook 7220.29-H preclude obtaining 2000 hours of direct labor from an individual worker.
- B. The alternatives are to either have one worker per work position and expect to have positions unmanned when workers are absent or to obtain more workers than there are work positions and fill all vacant positions from a pool of extra workers. Peacetime needs for the most cost effective operation favor the first alternative. Surge or wartime situations, where volume of production could be more important than cost considerations, tend to favor the second to the

extent that trained workers can be generated.

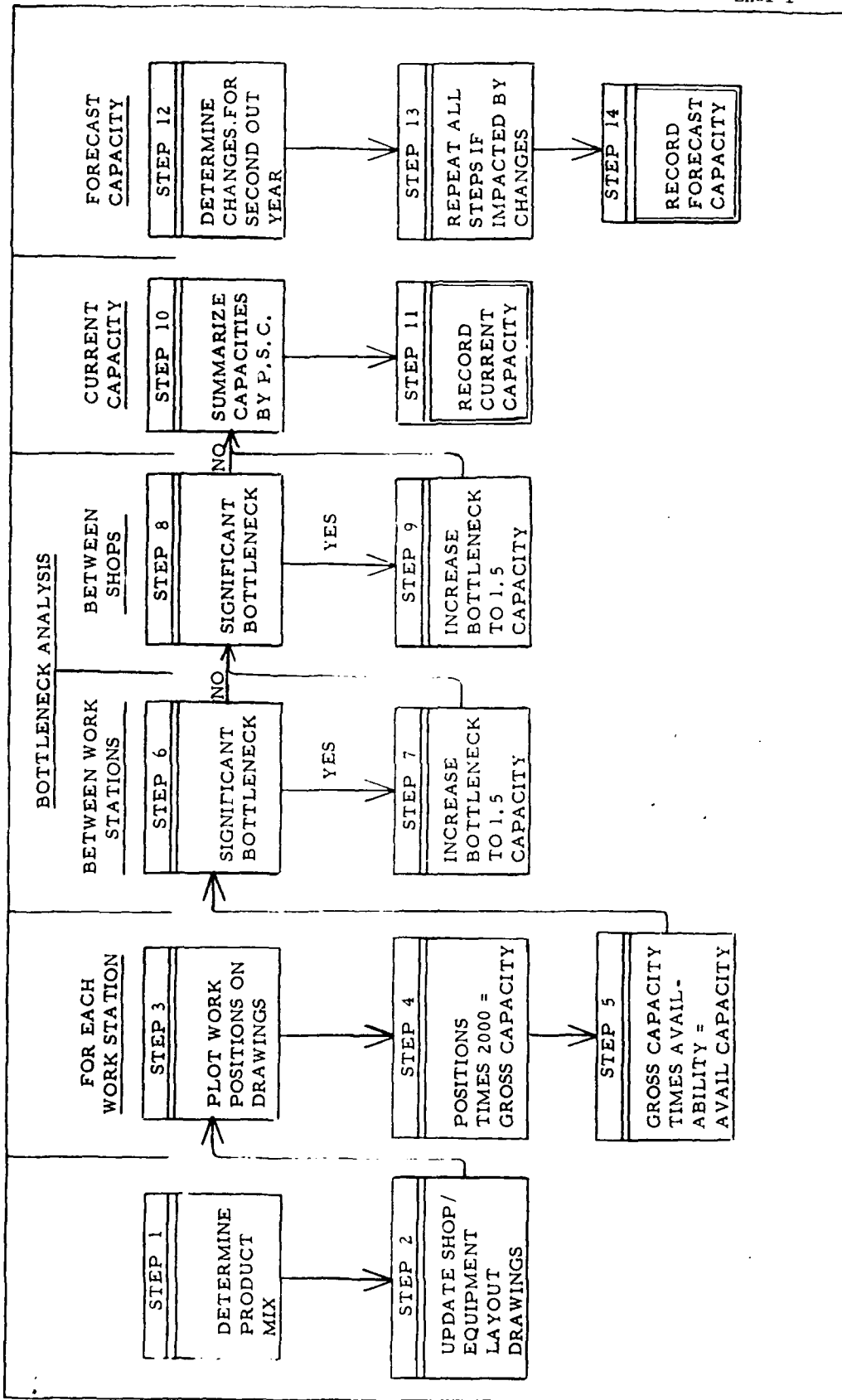
- C. When warranted by the required volume of production, work stations and shops may be operated under the second alternative during peacetime. For example, workers can be dispatched as needed from a skill pool to an aircraft dock, ship drydock, vehicle bay or similar function. Sufficient skilled workers are maintained on the payroll to ensure that workers are available to man all work positions each day. This practice is common when the flow time on the equipment being repaired must be kept within the shortest possible time.
  
- D. This Handbook provides guidance for calculating peacetime workloading capacity under both alternatives. The steps are repeated in flow chart form on enclosure 3.
  - 1. Obtain the physical capacity.
  
  - 2. Determine whether sufficient workers are hired to regularly man the available work positions.
    - a. If the answer is yes, the second alternative situation exists and the physical capacity is also the peacetime workloading capacity. Proceed to Step 6.
  
    - b. If the answer is no, proceed to Step 3.
  
    - c. If the answer is between yes and no, a judgment must be made to determine what percentage of the capacity should be treated in accordance with Step 2. a. and what percentage should be treated in accordance with Step 2. b.
  
  - 3. From data gathered in accordance with the provisions of DoD Handbook 7220.29-H determine the direct labor hours that have been received from the workers assigned to the function under review.
  
  - 4. Divide the direct labor hours by 2000 hours per year to obtain the direct labor factor.
  
  - 5. Multiply the direct labor factor by the physical capacity to determine the peacetime workloading capacity.
  
  - 6. Record the peacetime workloading capacity.

VII. RECORDS

The following information utilized in the latest measurement of current and forecast capacity should be maintained in the record file for review and validation:

- A. Shop product mixes.
- B. Shop drawings designating work station locations, support equipment, work station capacity, and dedicated facilities where applicable.
- C. Downtime elements and the amount of each utilized in calculating the availability factors.
- D. Bottlenecks for which adjustments of shop capacities were accomplished.
- E. Programmed changes in work mix, facilities/equipment and the reasons for each change resulting from Steps 13 and 14, forecast capacity.
- F. Capacity calculations.
- G. Identification of unutilized space.

CALCULATION OF PHYSICAL CAPACITY



SAMPLE BOTTLENECK CALCULATION

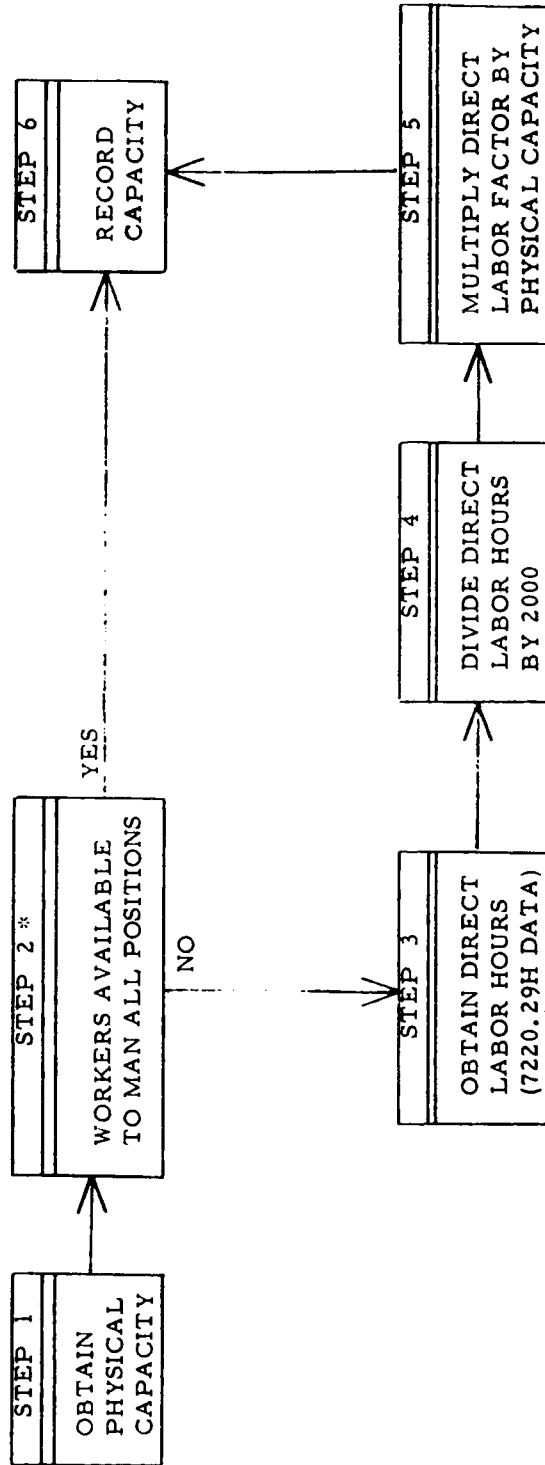
Encl 2

ENGINE DISASSEMBLY SHOP

| Steps | Work Station   | Preliminary Inspection | Disassembly | Cleaning | Parts Inspection |  |
|-------|--|------------------------|-------------|----------|------------------|--|
| A     | Work Positions   | 2                      | 30          | 16       | 24               |  |
| B     | Gross Capacity (Direct Labor Hours)                      | 4,000                  | 60,000      | 32,000   | 48,000           | Work positions x 2,000 hours   |
| C     | Availability Factor                                      | .98                    | .95         | .92      | .90              |  |
| D     | Available Capacity (BXC)                                 | 3,920                  | 57,000      | 29,440   | 43,200           |  |
| E     | Portion of Workload                                      | .04                    | .43         | .22      | .31              | Portion of workload hours to be accomplished in each work station (based on analysis of product mix and work requirements.)  |
| F     | Test Capacities (D ÷ E)                                  | 98,000                 | 132,600     | 133,800  | 139,400          | For each work station, the test capacity reflects the maximum workload that can be supported by the entire shop with that particular work station operating at full single shift capacity. In this example, it identifies the preliminary inspection work station as the bottleneck.   |
| G     | Additional 0.5 Shift for Bottleneck (Direct Labor Hours) | 1,960                  | ---         | ---      | ---              |  |
| H     | New Bottleneck Capacity (D + G)                          | 5,880                  | ---         | ---      | ---              |  |
| I     | New Test Capacity for Bottleneck (H ÷ E)                 | 147,000                | ---         | ---      | ---              | Reflects maximum workload that can be supported by the entire shop with bottleneck work station at 1.5 shifts. This adjustment results in the disassembly work station now becoming a bottleneck. Since the disassembly work station can support a test capacity of within 10% of the highest on line F, increased shifts in the disassembly work station are not necessary for this analysis (see note). The disassembly test capacity (132,600 hours) becomes the baseline capacity of the shop. |
| J     | Work Station Capacities (E x 132,600)                    | 5,304                  | 57,000      | 29,172   | 41,106           | Hours allocated to each work station to achieve the baseline shop capacity of 132,600 hours.   |
| K     | Hours in Excess of Single Shift (J - D)                  | 1,384                  | ---         | ---      | ---              |  |
| L     | Physical Capacity (J - K)                                | 3,920                  | 57,000      | 29,172   | 41,106           | Reflects physical capacity on a single shift while recognizing that it can only be utilized by application of 1,384 hours of extra shift labor in the preliminary inspection work station.   |

NOTE: If the difference in step F exceeds 10%, steps G through L should be repeated with the new bottleneck (disassembly) receiving up to 1.5 shift of utilization.

CALCULATION OF PEACETIME WORKLOADING CAPACITY



\* If The Answer To STEP 2 Is Between Yes And No, A Judgment Must Be Made To Determine What Percentage Of The Capacity Should Be Immediately Treated In Accordance With STEP 6 And What Percentage Should Be Treated In Accordance With STEP 3.