

DOD-HDBK-345,  
20 June 1988  
SUPERSEDING  
AFSCP 84-1  
20 APRIL 1987

# MILITARY HANDBOOK

MIL-STD 1567, WORK MEASUREMENT  
VERIFICATION AND COMPLIANCE PLAN



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Department of Defense  
Washington DC 20301

Work Measurement Verification and Audit Plan

1. This military handbook is approved for use by all Departments and Agencies of the Department of Defense. It was developed by the Department of Defense with the assistance of the military departments and industry.
2. All references to MIL-STD-1567 contained in this handbook pertain to the most current issue cited in the Department of Defense Index of Specifications and Standards (DODISS).
3. This document provides suggested guidance for the review of defense contractors' work measurement systems. It contains guidelines, checklists, and statistical techniques for determining standards' accuracy for fully compliant MIL-STD-1567 work measurement systems. Contractual tailoring of the requirements of MIL-STD-1567 necessitates tailoring of the corresponding sections of this handbook prior to conducting a work measurement review for that contract.
4. Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Air Force Systems Command, ATTN: PLEQ, Command Standardization Office, Andrews AFB DC 20334-5000 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

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## 1. SCOPE

1.1 Purpose. This handbook prescribes guidelines for performing verification of offerer/contractor policies and procedures with MIL-STD-1567 contractual requirements and review of contractor compliance. It applies to DOD buying activities and contract administration services. The provisions of this handbook should not be used or cited as contractual requirements. The source of contract requirements for work measurement is MIL-STD-1567. This handbook can be used by DOD and industry program management to develop and structure effective work measurement systems. Offerers/contractors may use this handbook as a guide when demonstrating compliance with MIL-STD-1567.

1.2 Objectives. The objective of this handbook is to provide consistent guidelines for evaluating offerer/contractor work measurement policies, procedures, and practices according to contract requirements.

1.3 Guidelines. The format of this handbook closely matches that of MIL-STD-1567. This was purposely done to facilitate reference between the two documents.

a. The Contract Administration Office (CAO) is normally responsible for initiating and conducting verification and compliance reviews. The CAO may request support from procuring activities with in-house programs that meet MIL-STD-1567 application criteria. The procuring activity initiating contractual action should take the lead for conducting work measurement reviews only when CAO support is not available or delegation of authority is impractical, i.e., classified programs. The government should avoid unnecessary multiple reviews, conflicting direction to the offerer/contractor, and duplication of effort.

b. A verification review should normally be initiated before contract award, and also at scheduled implementation milestones when appropriate. Verification review is defined in Section 3.1.

c. A compliance review should be performed for areas of the work measurement system that have undergone verification review and have been found in compliance. It should be initiated during or shortly after the start of the contractor's audit. Both the contractor audits and CAO compliance reviews should be performed on an annual cycle; These actions should be preferably scheduled to support a concurrent review that complements contractor efforts. Compliance reviews may be performed as part of the normal CAO function. Compliance review is defined in Section 3.2.

d. Verification and compliance reviews should be conducted by government personnel having skills in the following disciplines:

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- (1) Methods analysis.
- (2) Standard development.
- (3) Performance measurement.
- (4) Variance reduction.
- (5) Budgeting, planning, and scheduling.
- (6) Cost estimating.
- (7) Subcontractor management.

e. When implementing MIL-STD-1567 provisions on individual contracts, procuring activities should use contractual language written in a manner that promotes consistent interpretation and implementation. They should also coordinate with the cognizant CAO in order to apply contractual requirements consistent with those already applied. The objective should be to evolve the work measurement system into a factory-wide system, i.e., one that can be applied consistently throughout a manufacturing facility.

f. The government should be permitted access to all areas of the work measurement system for purposes of reviewing compliance with verified offerer/contractor policies and procedures. However, the government should provide the offerer/contractor enough advance notice of the verification or compliance review to allow the offerer/contractor an opportunity to collect materials and schedule personnel.

g. Unless otherwise specified in the Request for Proposal (RFP) or contract, a offerer/contractor is not required to make data available to the government which a MIL-STD-1567 compliant system does not otherwise collect or maintain. If data does exist, there is no requirement to make available such data in a form or manner different from that in which the offerer/contractor maintains such data. Data reporting is only required for those specific instances where there is a Contract Data Requirements List (CDRL) and where specific items of data are requested in the form of a Data Item Description (DID).

h. In order for contractors to use this handbook to review subcontractor work measurement systems, substitute the words "prime contractor" for "government" and "subcontractor" for "contractor" unless otherwise specified. In cases where the government has agreed to review subcontractor work measurement systems for the prime contractor, the word "government" will remain and the word "subcontractor" will replace the word "contractor."

## 2. REFERENCED DOCUMENTS

2.1 Government documents. Unless otherwise specified, the following specifications, standards, and handbooks of the issue listed in that issue of the Department of Defense Index of Specifications and Standards (DoDISS) specified in the solicitation form a part of this handbook to the extent specified herein.

MIL-STD-1567	Work Measurement
DI-MISC-80295	Work Measurement Labor Performance Report
DoD 5010.15.1-M	Standardization of Work Measurement, Basic Volume

2.2 Order of precedence. In the event of a conflict between the text of this handbook and the references cited herein, the text of MIL-STD-1567 and DI-MISC-80295, when cited contractually, shall take precedence. For work measurement definitions not covered in these documents, refer to DoD 5010.15.1-M, Glossary of Terms, Appendix IV. Supplemental definitions may also be given in a Memorandum of Agreement (MOA) with the contractor.

2.3 Source of documents. Copies of listed military standards, specifications, and associated documents listed in the Department of Defense Index of Specifications and Standards are available from the Department of Defense Single Stock Point, Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia PA 19120.

### 3. DEFINITIONS

3.1 Verification review. The verification review is an indepth examination of the offerer's/contractor's documented work measurement system to primarily determine if policies and procedures conform to MIL-STD-1567 contractual requirements. When conducting a verification review, the reference to contractor in this handbook should be interpreted as offerer or contractor, as appropriate.

a. When an offerer/contractor has either been found to have changed its system so that it no longer conforms to MIL-STD-1567 contractual requirements, or is not complying with its verified policies and procedures, the deficient portions of the system will be rated noncompliant and after completion of corrective action, those areas will be subject to review.

b. If MIL-STD-1567 requirements have been contractually modified (e.g., tailoring) or the offerer/contractor has modified the system, then the verification review and subsequent compliance reviews should be based on the latest contractual requirements. The government should reverify only the affected portions of the offerer's/contractor's system.

c. Once policies and procedures have been verified, they should be considered verified for all existing and future contracts having the same MIL-STD-1567 contractual requirements.

3.2 Compliance review. The compliance review is an annual work measurement study by the government, normally performed by the cognizant Contract Administration Office (CAO), to confirm that a contractor is following the policies and procedures determined satisfactory through verification review.

a. The lead activity should apply a structured and consistent approach toward verifying and reviewing compliance with work measurement contractual provisions.

b. The lead activity should annually reevaluate the work measurement system through a compliance review to verify effective application.

c. Government compliance reviews should not be performed to determine adequacy of established contractor policies or procedures if they already have been determined as compliant during the verification review.



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#### 4. GENERAL REQUIREMENTS

4.1 Verification and compliance review of general requirements. This section provides general direction on how the government should perform verification and compliance reviews using the general requirements of MIL-STD-1567.

a. The contractor should have a documented definition of "standard time" conforming to sec 3.14 of MIL-STD-1567, or as contractually amended.

b. The plan for implementing and maintaining a work measurement system in accordance with MIL-STD-1567 contractual requirements should be documented and acceptable to the government.

c. The organizational structure and specific individuals responsible for the implementation, operation, and maintenance of the work measurement system should be clearly defined and documented. Work measurement system focal points within the contractor's organization should be identified along with their specific areas of responsibility.

d. The plan to establish and maintain the accuracy of Type I labor standards in accordance with the MIL-STD-1567 contractual requirements should be documented and acceptable to the government.

e. The plan to conduct methods engineering studies, improve operations, and upgrade Type II labor standards to achieve the 80 percent coverage requirement of MIL-STD-1567, or as contractually amended, should be documented and acceptable to the government. The plan should specify the organizations responsible for methods engineering. It should also specify the establishment of the contractor's time-phased goals for reducing standard hour content and procedures for cost-effectively identifying candidate operations and processes for methods improvement. The government should have access to all methods improvement studies along with the rationale for any changes made to touch labor standards (including machine process time).

f. The contractor should have a documented plan that clearly states how labor standards are to be used in budgeting, estimating, production planning, and touch labor performance evaluation.

g. The contractor's procedures should document how system data will be revised to reflect changes in the labor standards, and their application reviewed to ensure compliance with the plan as specified in sec 5.11 of MIL-STD-1567, or as contractually amended.

4.2 Goals.

a. A clear distinction should be made between goals designated for government reporting purposes and goals established for contractor internal management purposes.

b. Goals established for government reporting (for example, via DI-MISC-80295) shall be at the contract end-item level.

c. Contractor management goals can provide for effective control of touch labor hours. These goals can be subcategorized into methods improvement goals (reduction of standard hour content) and variance reduction goals (reduction of actual hours above standard). Reference sections 5.8.3, 5.9, 5.10 and 5.13. However, goals mutually agreed to by contractor, procuring activity, and CAO are recommended.

d. Goals should be reviewed regularly by both contractor and government, and reset by the contractor as needed to promote continuing downward trends in variance and standard hour content.

## 5. SPECIFIC REQUIREMENTS

### 5.1 Type I engineered labor standards.

#### a. Operations analysis documentation.

(1) Contractor supporting documentation should contain a detailed breakdown of the operations that make up each Type I labor standard. Historical labor standard records should reflect a general trend towards development of cost-effective alternatives. The contractor may retain a history of the operational breakdown of each Type I labor standard. These historical records can be compared to current standard breakdowns to determine if a trend of decreasing standard hour content exists.

(2) Contractor documentation should provide historical background information that demonstrates a trend, by process or product line, towards reducing labor standard time. It should not be necessary for the contractor to document all the possible methods and associated operations for each job. The selection of the most cost-effective method should be confirmed through government interview of contractor process planners and methods analysts using a select sample of operations for an audit trail. The manufacturing method(s) used should be questioned when it is clearly evident that they are not based upon sound technical and management rationale.

#### b. Standard practice and method record.

(1) The government should confirm that contractor policies and procedures ensure that the current standard practices or methods prescribed are documented.

(2) Contractor policies and procedures should address how labor time standards will be adjusted to reflect measurable changes in methods or processes. When a revised manufacturing method or process is released to the shop floor, the original standard should, within a reasonable time, be reclassified as an estimate and it, along with its supporting documentation, be updated to reflect any changes. For relatively insignificant changes, contractor documentation should indicate the overall percentage change (+ or -) allowed before it must be updated and how cumulative delta values outside these thresholds will be tracked and evaluated. Records of standard revisions should be documented and maintained by the contractor, and made available to the government upon request.

(3) When a revised method or process is identified, contractor policies and procedures should describe how all active Type I labor time standards affected by the change will be revised to maintain consistency of application throughout the system. Likewise, when a new method or process is identified, contractor policies and procedures should prescribe that an investigation be performed to identify all the manufacturing operations that could benefit from that change.

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c. Rating and leveling record. The government should confirm that contractor policies and procedures require personnel, who are rating or leveling either time studies or work sampling, be properly certified through accepted industry practices. Rating or leveling recertification should be accomplished at least once every three years, in accordance with the original certification requirements, or other reasonable time period as agreed between government and contractor. Rating films should be reviewed every month or other reasonable time period as agreed between government and contractor. Time study analysts' certifications should be reviewed for currency each month or other reasonable time period as agreed between government and contractor.

d. Standard time computation record. Contractor policies and procedures should clearly identify how standard times, including allowances, are calculated. The government should verify that the system used to compute labor time standards has the appropriate review checks necessary to confirm system integrity.

e. Time value record. Contractor policies and procedures should clearly identify the system used for documenting and maintaining observed or predetermined time values. The government should confirm through a random check that the elemental time values derived from time studies, standard data, recognized predetermined time systems, or work sampling are correctly referenced.

f. The contractor is responsible for establishing procedures, policies, and techniques that result in accurate standards. The government's task is to verify that the contractor is applying its procedures consistently. Independent government checks on standard accuracy may be made using any of a number of techniques. For example, time study or work sampling technique checks can be made using appendixes B or C, respectively, or any other statistically valid technique. However, commercially available predetermined time systems advertised as meeting MIL-STD-1567 criteria should be considered acceptable if applied according to the manufacturer's prescribed specifications for generating accurate time standards. The government review should include an investigation of machine cycle times and set up times to ensure that the appropriate machine or process time is applied and correct set up time is applied for the appropriate lot size. Any standard that does not have at least  $\pm 10$  percent accuracy with a 90 percent confidence level (or as contractually amended) will be considered to be a Type II time standard.

g. If supporting documentation does not exist, the contractor should revise its policies and procedures to require sufficient supporting documentation to demonstrate compliance with contractual MIL-STD-1567 requirements. However, it may not be cost-effective to generate supporting documentation for existing standard data that was developed before issuance of the revised policies and procedures except as required through routine maintenance. The contractor's "reconstruction" effort should identify the inherent level of accuracy and confidence of the existing standard data system. A contractor's

existing standard data system should not be accepted if it does not meet contractual coverage or accuracy requirements, or if it is not applied and used consistently within the contractor's plant. Accurate standards will not provide meaningful results if not applied consistently. Reference section 5.1.A of appendix, MIL-STD-1567.

h. Type I labor standards developed using contractor derived techniques, including predetermined time systems, time study, standard data, and work sampling, should be verified and annually reviewed by evaluating a representative sample of the contractor's operation and standard data audits. government check studies could be performed based on the length, variability, and cost of the tasks to be reviewed and the size and complexity of the tasks being represented. They should demonstrate that the contractor derived techniques yield accurate results. Refer to appendixes B and C for possible approaches to determine representative sample sizes. The government should avoid actually developing its own labor standards for comparison against contractor standards. The contractor's internal audit should provide enough detail for the government to verify compliance.

5.1.1 Predetermined time systems. The contractor's policies and procedures should either reference or describe the methods, techniques, and practices specified by developers of predetermined time systems. The government should confirm that the predetermined time systems used by the contractor are applied according to the developer's prescribed methods and procedures.

## 5.2 Operations analysis.

a. Contractor policies and procedures should emphasize the importance of the operations analysis as a major technique for identifying the most cost-effective method for accomplishing an operation. Refer to section 3.5.B of appendix, MIL-STD-1567, for information that should be kept by the contractor.

b. If operations analysis documentation is incomplete, a more indepth investigation may be required to determine if a weakness exists in the contractor's system. Interviews with process planners and methods analysts should be performed along with inspection of product line performance improvement trends to accomplish government verification and compliance reviews. However, the government should not require the contractor to broaden its operations analysis data base merely to strengthen the audit trail. Full consideration should be made of the costs associated with increased documentation requirements versus the benefits of increased contractor discipline and improved management visibility.

### 5.3 Standard data.

a. The government should verify that the contractor's policies and procedures confirm that standard data is applied consistently across the labor standard base without compromising accuracy and traceability requirements.

b. Standard data is an important link between elemental data and the calculation of the Type I standard. The government should confirm the existence of a clear audit trail through all phases of labor standard development. This could be satisfied by selecting a random sample of Type I labor time standards and tracing them back through their standard data components and formulas to their elemental data.

### 5.4 Labor standard coverage.

a. The government should verify that contractor policies and procedures address how labor standard coverage will be calculated, and how and when 80 percent Type I coverage (or other as contractually amended) will be achieved and maintained. The contractor should be able to calculate current coverage on a routine basis for both program and factory levels as contractually required. Coverage calculations should be based upon the actual touch labor operations performed or scheduled to be performed. The basis for determining coverage should include Type I plus Type II labor time standards scheduled/earned as well as any estimated/actual unmeasured work for all deliverable production hardware covered by MIL-STD-1567 contractual requirements.

b. To maintain the 80 percent coverage requirement (or other as contractually amended), the contractor should have a plan for converting Type II standards to Type I as drawings and specifications are produced and manufacturing processes stabilize. The government should monitor contractor coverage to confirm that coverage milestones are being achieved.

c. Labor standards that do not meet the Type I criteria should be reclassified as Type II. The contractor's work measurement system should identify part numbers or operations for which the reclassified standards apply. When the number of standards requiring reclassification suggests that the 80 percent coverage requirement (or other as contractually amended) is no longer being met, the government should request the contractor to recalculate its percent Type I standards coverage of touch labor hours. In addition, the contractor should recalculate its percent of Type I standards coverage of touch labor hours at least once every twelve months or whenever a government review or contractor audit indicates that the eighty percent coverage criteria (or other as contractually amended) is not being achieved.



#### 5.4.1 Cost trade-off analysis.

a. Verification of an offerer's/contractor's work measurement system should be based on MIL-STD-1567 (or as contractually amended). Before negotiating MIL-STD-1567 contractual provisions, the offerer/contractor should be requested, as part of its proposal, to identify any areas where it would not be cost-effective to apply specific MIL-STD-1567 requirements. When exact requirements are determined, offerers/contractors should be given an opportunity to price the effort prior to contract award.

b. During verification of an offerer's/contractor's work measurement system, the government should consider the cost-effectiveness of requiring the offerer/contractor to modify its existing system. Changes to the offerer's/contractor's system should result in not only improved visibility and traceability, but also a cost-effective vehicle for encouraging productivity improvement. These changes may require an equitable price adjustment to the contract(s). The procuring contracting officer must authorize any changes directed by the government.

5.4.2 Initial coverage. Contractor policies and procedures should identify how Type II labor time standards will be established and implemented. The government should confirm that the organizations responsible for establishing Type I standards approve Type II standards before they are implemented.

5.4.3 Upgrading. The government should verify that the contractor has a plan for achieving and maintaining 80 percent of Type I standards or as mutually agreed by government and contractor. The plan should specify development milestones. The government should check at least quarterly to see if the milestones are being achieved.

5.5 Leveling and performance rating. The government should verify that contractor policies and procedures address how consistency will be maintained between certified time study analysts. The contractor should have an effective program for recertifying analysts at least once every three years, in accordance with the original certification requirements and accepted industry practice, or other reasonable time period as agreed between government and contractor. Leveling or performance rating is only applicable to Type I standards developed with time study.

5.6 Allowances. Contractor policies and procedures should provide the detailed rationale used for applying personal, fatigue, and delay allowances (PF&D). Each allowance should be identified and quantified. On a cumulative total basis, allowance factors typically average 15 percent. If the contractor's allowances appear to be unsubstantiated, the government should perform an indepth analysis into the reasonableness of the contractor's allowances using DOD 5010.15.1-M, PF&D, as guidance. Note that in some predetermined time systems, PF&D has already received partial or complete consideration and an additional PF&D factor may not be warranted.

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5.7 Estimating. Contractor policies and procedures should detail how labor standard information will be used to estimate and price direct manufacturing labor costs. The government should verify that contractor procedures address how realization factors are determined and tracked along with touch labor standards.

5.8 Use of labor standards.

5.8.1 Budgets, plans, and schedules. The government should verify that contractor policies and procedures address how labor standard information is used as an effective tool by management. The contractor should audit, at least annually, the labor standard information applied in budgets, plans, and schedules to confirm that they are applying both the current, or as appropriate, projected labor standard base and realization factors. The government should also verify that the contractor has a procedure for effectively enforcing proper use of labor standards by management area.

5.8.2 Touch labor hours.

a. Contractor policies and procedures should describe how pricing personnel use available labor standard information when estimating touch labor hours. If the information is not available, the contractor's management information system should so indicate, and when applicable, a Type I or II labor standard should be generated.

b. Contractor pricing personnel should be able to tell if a touch labor cost estimate is based upon Type I or Type II labor standards. Type II labor standards should be approved by the organizations responsible for establishing and implementing Type I labor standards. The government should be able to check the rationale used to prepare the labor hour and cost estimates using the same systems used by contractor personnel.

c. For development or other unstable periods, contractor policies and procedures should indicate who is responsible for developing labor time standards, when they will be developed, how they will be released for use, and how management will separate unmeasured work performed from work performed on standard.

d. Although realization factors can be applied to labor standards, the contractor is required by MIL-STD-1567 to keep adequate auditable documentation segregating the labor standard from the realization factor and to give the government visibility into the breakdown of both. Major elements of the realization factor should be identified and documented in the contractor's policies and procedures. If the contractor uses an algorithm for calculating realization, its rationale should also be available for government review (reference sec 5.9).



### 5.8.3 Measuring performance.

a. The government should verify that contractor policies and procedures adequately address how touch labor performance will be measured including the collection and reporting of any work measurement information contractually required and specified in a Data Item Description. Performance reports should provide enough detailed information to allow visibility into the major elements of realization. Performance reports should also provide a starting point for management to identify and analyze the major causes of unacceptable performance.

b. Performance reports are not stand alone documents. They should identify problem areas as far down as work center, department level, or lowest appropriate organizational level, and by major element of realization. They should not be expected to give management all the information it needs to analyze the causes of poor performance. Variance analysis should be performed when labor performance exceeds appropriate upper or lower control limits from standard. Whenever possible, control limits should be established on an area-by-area basis to reflect current shop conditions and to avoid alarms for obvious or temporary circumstances.

c. The procedure for setting contractor improvement goals should be documented. Those who are involved in establishing goals should also monitor and evaluate performance to them on a routine basis. This could be accomplished by comparing historical improvement trends to projected ones. A reduction in the realization factor should be evident. Both short term (less than annual) and long term (equal to or greater than annual) goals should be established for each work center, cost center, or other appropriate organizational level, and at each higher level of management.

d. Improvement goals should be both aggressive and achievable. They should not be based on a budget or financial target, but should consider the overall conditions and limitations of the actual manufacturing environment. Generally, improvement goals should be more ambitious than budget or financial targets. Therefore, improvement goals should encourage productivity beyond historical learning or performance curve trends. Performance goals set to standard on a program undergoing many design, process, or method changes, should not be expected.

e. The government should verify that the contractor's policies and procedures adequately address performance tracking for the equivalent unit, end items, or other selected production count work unit.

f. Contractor policies and procedures should address how performance is measured. For example, the management information system could roll up performance to standard by functional areas such as fabrication, assembly, and functional test.

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5.9 Realization factor. Contractor policies and procedures should address how each element of realization will be quantified. A detailed description of the realization factor should list each labor category contained in the realization factor, how actuals are collected, and how the elements are evaluated. Also included should be all uses of this data such as the establishment of improvement goals; use of this data in estimating, planning, scheduling, budgeting; and, in performance measurement. There should be evidence that effort is being made by the contractor to reduce and eliminate inefficiencies.

5.10 Labor efficiency.

a. Contractor policies and procedures should indicate how work force planning uses labor standards to forecast labor requirements. The contractor should be able to demonstrate how scheduled labor standards, modified by realization factors, are being used to determine current and future work force loading for each shop area.

b. The government should verify that contractor work force planning procedures reflect consideration of improvements resulting from achievement of aggressive labor performance goals.

5.11 Revisions.

a. Contractor policies and procedures should indicate how labor standards will be maintained to reflect current work content, method, process, material configuration, workplace, work layout, and use of tools, including jigs and fixtures. The government should review a select sample of recently revised labor standards and determine the causes of these changes, their reasonableness, and timeliness.

b. The government should confirm that shop floor concerns regarding a specified method, process, or labor standard time are investigated by management. Results from these investigations should be documented and available for government review.

5.12 Production count.

a. Contractor policies and procedures should clearly indicate what work unit will be used for measuring work completed. The same unit of measure does not have to be used throughout the factory. However, contractor production, finance and quality control systems should all focus on correct production count information. In addition, it should be used consistently within manufacturing areas such as fabrication, assembly, and functional test. The contractor should have a procedure for insuring data accuracy. This could include guidelines for accomplishing periodic random floor audits to confirm data accuracy.

b. Government representatives should at least annually check the accuracy of the contractor's production count tracking system. This may be

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accomplished by comparing the total or equivalent number of end items reported to government records modified by work-in-process. When possible, this effort should be coordinated with the cognizant representative for the Defense Contract Audit Agency.

5.12.1 Partial credit. The government should confirm that the contractor's system for calculating partial credit is consistently applied across manufacturing functional areas and within the manufacturing information system. The budgeting and scheduling systems should have the capability to determine partial credit.

5.13 Labor performance reporting.

a. Contractor policies and procedures should document how labor performance reports will be prepared and to whom they will be submitted for review. Reports will be published at least weekly (or as contractually amended) for each work center and summarized at each appropriate management level. Weekly reports, as a minimum, should present current standard hours earned, unmeasured or off-standard time, labor efficiency, and the pre-established goal or target (reference section 5.8.3.a).

b. The government should verify that the contractor routinely audits performance reports to ensure that the work force reports their time properly and that management investigates major deviations from pre-established goals. Defense Contract Audit Agency periodic accounting system audits may adequately address this area for verification and compliance review purposes.

c. The government should review a select sample of work center and manufacturing area performance reports to determine if the contractor is aggressively pursuing its pre-established improvement goals. Normally this should involve interviews with shop foremen and area superintendents to assess their general knowledge and involvement with managing to their performance improvement goals.

d. Performance goals should be both short term and long term. Long term goals, where applicable, should contain annual milestones for achieving overall performance improvement and cost reduction.

e. When a series of aggressive performance involvement goals are established, the government should verify that they are being properly used by the contractor to measure performance. The contractor should routinely reset goals that no longer provide a challenge for improvement.

5.13.1 Variance analysis.

a. The government should verify that contractor policies and procedures adequately address when, how, and who will perform variance analysis, corrective action, and follow-up. Both supervisory and staff

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personnel responsible for establishing performance improvement goals should be made aware of variance analysis findings.

b. The contractor should be working under an appropriate set of upper and lower control limits to quantify when a "...significant departure from projected performance goals..." occurs. The control limits should be acceptable to both the government and the contractor. Control limits which trigger a variance analysis should be related to pre-established goals at appropriate organizational levels. When these limits are exceeded, the contractor is required to perform a written variance analysis.

c. The government should review a select set of variance analyses, identified directly from contractor performance reports for content, corrective action planned and taken, and results. The government should confirm that contractor management establishes reasonable milestones for completing the planned corrective action, and then implements and follows up on the corrective actions taken.

d. Control limits should be of a manageable magnitude so as to permit the best concentration of management resources. As work performed in a work center reaches a mature production level, control limits for that center should be tightened to permit the identification of more inefficiencies.

5.13.2 Report retention. The government should verify that contractor policies and procedures require documented performance reports and variance analyses to be kept for at least a 6 month period (or as contractually amended). The government should be permitted complete access to this information.

#### 5.14 System audit.

a. Contractor policies and procedures should provide a detailed explanation of how the work measurement system will be audited. The audit function must ensure compliance with contractor internal operating procedures.

b. The government should confirm that the contractor's audit function is being performed by individuals other than those who have established and are maintaining the labor standards and management systems under audit. This does not mean that a separate audit organization must be maintained. The auditors should be fully qualified in work measurement and manufacturing management procedures. Furthermore, the audit function should advise the appropriate management function to devise and take corrective action, and, if necessary, elevate unresolved issues to upper level management for final disposition.

c. Contractor policies and procedures should require contractor management to routinely advise cognizant government representatives of

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upcoming or ongoing system audits. Government representatives should be permitted to monitor contractor audits.

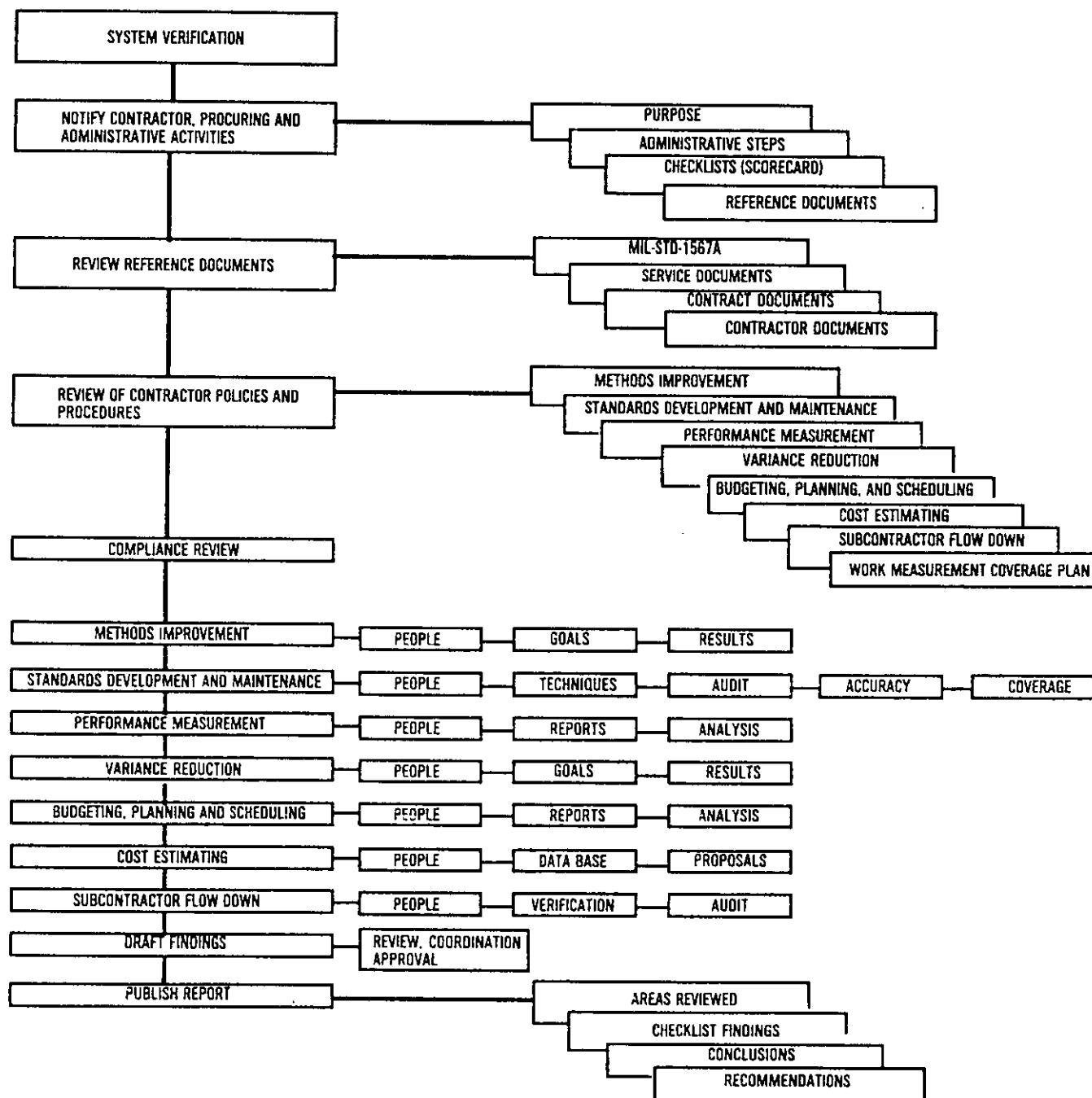
5.14.1 Scope of system audit. The government should verify that contractor policies and procedures address all of the minimum annual audit requirements as specified in sec 5.14.1 of MIL-STD-1567. If the government can determine that the contractor's audit effectively enforces the requirements of MIL-STD-1567, or as contractually amended, and the contractor is successful in achieving performance improvement goals, the work measurement system for those portions audited complies with MIL-STD-1567 contractual requirements, or other as contractually amended.

5.14.2 Audit reports.

a. The government should confirm that contractor organizations responsible for auditing the development of standard data have, as a *minimum*, a record of results from the last audit of that data. If this documentation does not exist, the persons responsible for performing the last audit should explain how it was accomplished, what was found, and what recommendations and changes were made.

b. Contractor policies and procedures will require all written audit report findings to be kept for at least a two year period from the date of their publication, or as contractually amended.

PLX1 (83p03p 84p03p)

FIGURE 1. Verification and compliance review flowchart.

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Appendix A.1

VERIFICATION REVIEW  
(Administrative Steps)

1. Notification:

a. The lead activity should notify offerer/contractor and government procuring and administrative activities before initiation of review.

b. Provide copies of verification review checklists to offerer/contractor.

c. Request offerer/contractor identify focal points.

d. Invite procuring and administrative activity participation.

2. Lead activity responsibilities:

a. Before review, assign functional areas and responsibilities to team members:

- (1) Methods.
- (2) Standard development.
- (3) Use of standards.
- (4) Performance.
- (5) System audit.

b. Make available copies of all applicable documents (reference appendix A.3).

3. Conduct of review:

a. Emphasis to be placed on policies and procedures:

(1) If policies and procedures are already implemented, a cursory review of the system may be appropriate.

(2) Ensure mutual understanding of intent of offerer's/contractor's policies and procedures.

b. Begin with an introductory meeting between team members and offerer/contractor representatives:

- (1) Discuss review process.

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(2) Receive an overview of the offerer's/contractor's work measurement system.

c. Team members should meet each day to discuss the following:

- (1) Problems.
- (2) Progress.
- (3) Report any preliminary observations or findings.

d. At completion of the review, give the offerer/contractor an outbriefing summarizing preliminary findings.

e. A verification review must be performed when the contractor's organizational structure or administrative practices have changed such that they no longer conform to MIL-STD-1567.

4. Preparation of detailed findings:

a. Each team member's preliminary findings should be written and compiled into a single document shortly after the review is completed.

b. The preliminary findings should clearly identify areas of compliance as well as noncompliance with rationale included:

(1) Assign a rating to each specific requirement:

- (a) Compliant.
- (b) Partially compliant.
- (c) Noncompliant.

(2) Provide rationale for each specific requirement's rating and the overall work measurement system's rating.

(3) Before the preliminary findings are published, review and coordinate the preliminary findings according to the lead activity service policy.

c. Any verification review issues remaining unresolved after completion of the actual review should be elevated according to the appropriate defense acquisition service policy when applicable.

d. Upon successful completion of the coordination process and prior to contract award, the lead activity should permit the offerer/contractor to review and comment on the preliminary findings. Final publication should normally take place after contract award.



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e. Copies of the detailed findings should be made available to all procuring activities requiring MIL-STD-1567 on their contracts, and other activities on an as requested basis.

5. Contractor corrective action is needed as follows:

a. If the verification review findings indicate that the contractor's policies and procedures are noncompliant with MIL-STD-1567 (or as contractually amended), the contractor should prepare and submit a corrective action plan that includes a milestone schedule for achieving compliance with MIL-STD-1567 contractual requirements. The government should confirm that the contractor's corrective action plan and milestone schedule are reasonable and achievable. The CAO is responsible for advising the contractor in writing that the work measurement system, in whole or in part, is noncompliant.

b. After the contractor completes their corrective action plan, the lead activity should reverify those areas previously classified as noncompliant.

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Appendix A.2

COMPLIANCE REVIEW  
(Administrative Steps)

1. Notification:

a. On an annual basis, the lead activity should notify the contractor and government procuring and administrative activities of their intent to initiate a compliance review.

b. Provide copies of compliance review checklists to contractor.

c. Before initiating the compliance review, coordinate a schedule with the contractor that will be compatible with its annual audit cycle.

d. The review should address all portions of the work measurement system that have been determined compliant through the verification review process.

2. Lead activity responsibilities:

a. The group or individual responsible for performing the compliance review should have the following background:

(1) A thorough knowledge of contractor verified policies and procedures.

(2) Training in the labor standard setting techniques used by the contractor.

b. Make available to all team members and the contractor copies of all applicable documents (reference appendix A.3).

3. Conduct of review:

a. Initiate the compliance review with a system overview of the contractor's verified policies and procedures, followed by a thorough system review.

b. Changes to the contractor's policies and procedures made after verification review require reverification.

4. Preparation of detailed findings:

a. Detailed findings should be published at the end of each annual cycle summarizing review results.

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(1) Assign a rating to each specific requirement.

- a. Compliant.
- b. Partially compliant.
- c. Noncompliant.

(2) Provide rationale for each specific requirement's rating and the overall work measurement system's rating.

b. Copies should be forwarded to contractor and appropriate procuring and administrative activities for comment and appropriate action.

c. Compliance issues remaining unresolved three months after initiating the coordination process should be elevated to the appropriate defense acquisition service focal point for work measurement policy, if applicable.

5. Contractor corrective action is needed as follows:

a. If the compliance review findings indicate that the contractor is not adhering to its verified policies and procedures, then the contractor should develop a corrective action plan and milestone schedule that are acceptable to the government.

b. If the deficiency remains uncorrected, that portion of the system will be rated noncompliant. The CAO is responsible for advising the contractor in writing that the work measurement system, in whole or in part, is noncompliant. A corrective action plan and milestone schedule that are acceptable to the government should also be requested at that time.

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## Appendix A.3

VERIFICATION AND COMPLIANCE CHECKLIST  
(Specific Requirements)

This section of appendix A outlines the specific requirements to which the contractor should comply. Before beginning the review, this checklist must be modified to match the work measurement contractual requirements (e.g., allow for tailoring, Memorandum of Agreement (MOA), Data Item Description (DID), etc).

1. Verify contractual requirements directly imposed on the prime contractor or as flowed down to the subcontractor from the prime contractor:

- a. MIL-STD-1567 (USAF).
- b. MIL-STD-1567A.
- c. MIL-STD-1528.

2. Check contract language for work measurement requirements:

- a. Statement of Work (SOW).
- b. Contract Data Requirements List (CDRL).
- c. Data Item Description (DID).
- d. Special provisions clause (Sec H).

3. Check other documents for work measurement requirements:

- a. Memorandum of Agreement (MOA).
- b. Manufacturing plan.
- c. Production plan.
- d. Compliance plan.
- e. Implementation plan.
- f. Maintenance plan.
- g. Milestone charts.

4. Check contractor's procedures:

a. If the procedures are in compliance, proceed to evaluate work measurement system for compliance with the procedures.

b. If the procedures are noncompliant, they must be corrected.

c. Proceed to evaluate the system for compliance with the contractual requirements.

d. If a predetermined time system is used by the contractor, check the application criteria for that system.

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5. Plan and conduct the government review according to specific contractual requirements, and those imposed by the contractor's procedures.

6. Check subcontractor flow down requirements imposed on the prime contractor, and actions taken by the prime contractor to comply with these requirements:

a. Verify that the prime contractor is following its contractual direction.

(1) Check documentation and tasking from procuring activity.

(2) Check documentation and tasking from contracting officer.

b. Review contractual requirements from prime contractor to subcontractor.

c. Examine documentation showing that the prime contractor is reviewing applicable subcontractors. Although it is desirable for prime contractor to review applicable subcontractors' work measurement systems, there may be instances when the government will be asked to perform these subcontractor reviews.

7. The following checklist contains items to consider when verifying and reviewing contractor work measurement systems. For ease of reference, the numbering sequence used from this point on follows the numbering sequence specified in MIL-STD-1567, and as used previously in this handbook.

#### 4.1 General requirements:

a. Check that the contractor's definition of standard time is used consistently throughout the work measurement system.

b. Check that a work measurement plan exists and will result in contractual compliance with MIL-STD-1567, or as contractually amended.

(1) Description of system implementation.

(2) Implementation milestones.

c. Check the contractor's work measurement procedures for assignment of the organization and personnel responsible for the work measurement system.

d. Check that a plan exists to establish and maintain Type I standards.

e. Review the contractor's methods engineering studies plan.

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(1) Check that candidate operations and processes for methods improvement are identified.

(2) Verify that goals to reduce standard hour content exist, and that they are reset when necessary.

(3) Review methods analyses, which may include the following:

- (a) Process charts.
- (b) Operations analyses.
- (c) Value engineering.
- (d) Simulation techniques
- (e) Operation charts.
- (f) Motion studies.
- (g) Tool and equipment design.
- (h) Multiple activity process charts.
- (i) Work sampling.
- (j) Operation resequencing.
- (k) Economic lot sizing.

(4) Verify methods improvement implementation and follow up, i.e., check to see if work instructions have been revised.

(5) Review record of hours and dollars saved, where applicable.

f. Review the contractor's plan to use labor standards as an input to budgeting, estimating, production planning, and "touch labor" performance evaluation.

g. Review the contractor's plan to correct work measurement system data when labor standards are revised.

#### 5.1 Type I labor standards:

a. Accuracy =  $\pm 10\%$  with a 90% confidence level:

(1) Verify time study and work sampling standards' accuracy using appendixes B or C, respectively in this handbook or an alternate approach.

(2) Verify predetermined time system by checking with the developer of that system.

(3) Thirty minute super operation is allowable.

b. Check for detailed breakdown of operations (standard development worksheets).

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- c. Check for documentation of operation analyses.
- d. Check for record of standard practice or method.
- e. Check for record of rating or leveling on time studies.
- f. Check for record of rating of standard time calculation plus allowance (PF&D).
- g. Check for record of predetermined time system calculations (reference developer's guidance).
  - (1) Check predetermined time system data application.
  - (2) Ensure that system accuracy is not compromised.
  - (3) Ensure that appropriate machine or process time is applied.
- h. Verify industrial engineering training:
  - (1) Check training schedules.
  - (2) Check training completion certificates, where applicable:
    - (a) Predetermined time systems.
    - (b) Time study.
    - (c) Work sampling.
    - (d) Performance rating.
  - (3) Training certificates should be current to ensure that engineers are trained in the latest techniques.
- i. Check how labor standards are applied to set up hours.

5.2 Operations analysis:

- a. Check documentation as applicable:
  - (1) Purpose of operation.
  - (2) Inspection requirements.
  - (3) Workplace layout.
  - (4) Design of part.
  - (5) Material description.
  - (6) Workplace set-up.
  - (7) Working conditions.
  - (8) Manufacturing processes.

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- (9) Material handling.
- (10) Workplace tools.
- (11) Method sheet.

b. Documentation should be traceable and complete.

5.3 Standard data:

a. Check data accuracy for time study and work sampling (reference appendixes B and C, respectively, and for predetermined time systems (reference developer's guidance).

b. Check traceability.

c. Should be applied and used consistently.

5.4 Labor standards coverage:

a. The contractor's definition and categories of touch labor many include:

- (1) Machining.
- (2) Welding.
- (3) Fabrication.
- (4) Set-up.
- (5) Cleaning.
- (6) Painting.
- (7) Assembly.
- (8) Functional test.
- (9) Labor required to complete the manually controlled process portion of the work cycle.

b. Check cost trade-off analysis for the work measurement coverage plan:

- (1) Check time phased plan to achieve 80% coverage.
- (2) Check contractor's achievement of planned milestones.

c. Initial coverage:

- (1) Type II standards are acceptable.
- (2) Plan to upgrade Type II standards to Type I.



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(3) Type II standards should be approved by contractor industrial engineering personnel responsible for establishing and implementing standards.

d. Check coverage calculation and recalculation schedule:

(1) Should calculate coverage at least annually.

(2) Percent coverage =  $\text{Type I} / (\text{Type I} + \text{Type II} + \text{unmeasured})$ .

e. Check that there is at least 80% coverage of all categories of touch labor hours with Type I standards, or that a plan exists to obtain this goal in a timely manner.

5.5 Leveling and performance rating:

a. Check for use of recognized techniques.

b. Check training schedules and certifications.

5.6 Personal, fatigue, and delay allowances:

a. Verify application for reasonableness.

b. Verify traceability and consistency.

c. Check review schedule.

5.7 & 5.8 Use of labor standards:

a. Estimating proposals.

b. Initial and replenishment spares.

c. Engineering change proposals.

d. Follow-on production buys.

e. Other contractual changes.

f. Budgets (used in development of cost schedule controls).

g. Plans:

(1) Machining capability and capacity.

(2) Manpower.

(3) Multi-shift analysis.

(4) Production rate.

(5) Plant layout.

h. Schedules:

(1) Shop.

(2) Material control.

i. As a basis for measuring touch labor performance.

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- (1) Operator (if applicable).
- (2) Work center.
- (3) Provides management visibility of goals.

5.9 Realization factor:

a. Identify and quantify major elements, where applicable, such as:

- (1) Repair.
- (2) Rework.
- (3) Scrap.
- (4) Reinspection.
- (5) Engineering changes.
- (6) Tooling errors.
- (7) Worker training.
- (8) Design errors.
- (9) Temporary operations.
- (10) Schedule interruptions.
- (11) Machine malfunction.
- (12) Operator errors.
- (13) Material delays.
- (14) Personnel shortages.
- (15) Equipment problems.
- (16) Supervisor errors.
- (17) Familiarization.
- (18) Fit problems.
- (19) Operation sheet errors.
- (20) Planning errors.
- (21) Work order errors.
- (22) Sequencing errors.
- (23) Manufacturing and design engineering coordination.
- (24) Incorrect hardware.
- (25) Parts shortages.
- (26) Waiting for inspection.

b. Check the goals for each major element of realization.

c. Verify that progress is being made toward reducing the realization factor.

d. Check calculation of realization factor.

(1) Performance factor = actual manufacturing hours worked on standard/total earned standard hours.

(2) Performance index = total actual manufacturing hours/total earned standard hours.

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- e. Verify that collection of actuals is accurate.

5.10 Labor efficiency:

- a. Labor efficiency = earned hours/actual hours.
- b. Check if used in work force planning forecasts; one source of manpower planning forecasts is the Forward Pricing Rate Agreement.
- c. Check for labor efficiency improvement goals.

5.11 Revision to standards:

- a. Check that standards are reviewed and revised, if necessary, when changes occur to:
  - (1) Methods or procedures.
  - (2) Tools, jigs, and fixtures.
  - (3) Work place and work layout.
  - (4) Specified materials.
  - (5) Work content of job.

- b. Check that revision of a standard's method or process has been applied to all standards affected by that change.

5.12 Production count:

- a. Check for consistent production unit definition, such as:
  - (1) Contractual end items (required for government reporting).
  - (2) Operations.
  - (3) Lots or batches of end items.
- b. Check for partial credit definition and consistency.
- c. Check equivalent work unit calculation.

5.13 Labor performance reporting:

- a. If DID on contract, review this section also according to DID requirements.
- b. Check that report is prepared at least weekly for each work center or other appropriate organizational level.
- c. Check that report is summarized at each appropriate management level.

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d. Report should show labor efficiency or realization factor (performance factor or performance index).

(1) If labor efficiency is used, report must include, as prescribed by the contractor's disclosure statement, the following items:

- (a) Lost or idle time.
- (b) Off standard work.
- (c) Unmeasured work.

(2) If realization factor is used, see section 5.9 of these specific requirements.

e. Report should show equivalent unit and standard hour information.

f. Report should compare current results with pre-established contractor goals (long term and short term).

g. Review goals:

- (1) Aggressive.
- (2) Achievable.
- (3) Based on shop potential not budget.
- (4) Should be reset when necessary.

h. Check that there is visibility to analyze variance from standard at the work center level or other appropriate organizational level.

i. Variance analysis includes:

(1) Upper and lower control limits.

(2) Formal, written analysis of problem, cause, and areas affected at the most appropriate level:

- (a) Part numbers.
- (b) Operations.
- (c) Work center.
- (d) Departments.
- (e) Cost centers.

(3) Corrective actions and milestones schedules.

(4) Corrective actions implemented according to scheduled milestones.

(5) Follow-up performed.

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j. Check for evidence that inefficiencies are reduced and eliminated where cost-effective.

k. Realization and standard hour content trends should show improvement. Items that may impact the improvement trend are:

- (1) Engineering changes.
- (2) Specification changes.
- (3) Contractual changes.

l. Check that contractor audits report and corrects errors found.

m. Check that contractor keeps reports and analyses for a minimum of 6 months.

n. Unmeasured work hours should not be included in earned standard time and should be segregable from other work when included in the following:

- (1) Actual time.
- (2) Coverage calculations.
- (3) Realization calculations.

5.14 System audit:

a. Standards should be reviewed by individuals other than those who establish and maintain standards.

b. Verify that the contractor's audit identifies and corrects system weaknesses and failures.

c. Verify that the contractor's audit is conducted at least annually.

d. Check that the contractor's audit reaffirms:

(1) Validity of prescribed method:

- (a) Methods.
- (b) Tools.
- (c) Workplace.
- (d) Materials.
- (e) Work content.

(2) Accuracy of labor standards.

(3) Percent coverage of Type I and Type II standards.

(4) Effectiveness of labor standards usage for:

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- (a) Planning.
  - (b) Estimating.
  - (c) Budgeting.
  - (d) Scheduling.
- (5) Timeliness, accuracy, and traceability of production count reporting.
- (6) Accuracy of labor performance reports.
  - (7) Reasonableness and attainment of efficiency goals established.
  - (8) Effectiveness of corrective actions from variance analysis.
- e. Confirm that the contractor's audit findings are retained for 2 years.
- f. Data from last contractor's audit should be available for government review.

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## APPENDIX B

TIME STUDY STANDARD ACCURACY DETERMINATION  
(Step-by-Step)

1. Time study is a work measurement technique consisting of a careful time measurement of a task with a time measuring instrument, adjusted for any observed variance from normal effort or pace and to allow adequate time for unavoidable delays, rest to overcome fatigue, and personal needs. Time study is useful as a means of measuring repetitive, short-cycle work performed at essentially one location, and irregular, medium to long-cycle work frequently performed by moving about several work stations (USA/AMETA, Defense Work Methods and Standards, Vol II, Work Measurement, June 1984, p. 6-1).

2. Obtain the contractor's Type I labor standard accuracy audit data for standards created using time study. This data should be in the form of a statistically valid sample of measurements that have been compared to the proposed labor standard. The contractor's sample should represent those labor standards that are active and in use.

3. Determine your sample size of the contractor's audit data by solving for  $N'$  as follows:

$$N' = \left(\frac{z}{s}\right)^2 \frac{\left(n \sum_{i=1}^n x_i^2 - \left(\sum_{i=1}^n x_i\right)^2\right)}{\left(\sum_{i=1}^n x_i\right)^2}$$

where:  $N'$  = required number of operations for government review.  
 $n$  = number of operations audited in contractor's sample.  
 $s$  = percent accuracy expressed as a decimal = .10.  
 $z$  = 1.645 (normal distribution).  
 $x_i$  = each operation's time value, from the first or  $i=1$  operation to the last or  $i=n$  operation.

4. Randomly select  $N'$  operations from the contractor's audit for your review. Using the example given in Figure 2 to represent one of your  $N'$  selections, perform the following statistical and mathematical calculations to construct the Time Study Standard Accuracy Chart (Figure 3) and determine the accuracy of the operation.

5. For each operation, construct the chart in Figure 3 from which operation accuracy can be determined.

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6. Instructions for calculating each column in Figure 3, as necessary, as are given as follows:

a. Column 1, Element Number, is taken from the time study form. In our example, this information can be found in block 17, Operation, Readings and Computations, subsection (a), N.R.

b. Column 2, No. Observations, is taken from the time study form. The appropriate reference in our example is block 17, Operation, Readings and Computations, either subsection (c), Readings, or subsection (e), Cycle.

(1) If subsection (c) is used, the number of readings in row T can simply be counted. Be aware of any missed readings, usually noted by an M, or any mistakes or inaccurate readings that are circled.

(2) If subsection (e) is used, the value listed can just be transcribed onto your chart. This value has been derived by the same procedure as described in section 6.b(1) above.

c. Column 3, Occurrence Ratio, is taken from the time study form. In the example provided, this information can be found in block 17, Operation, Readings and Computations, subsection (i), Occ.

d. Column 4, Mean (x), is taken from the time study form. In our example, the mean values can be found in block 17, Operation, Readings and Computations, subsection (f), Avg or Sel. Here, it must be noted that although the observation times and subsequent values in subsections (d), (f), (g), (h), and (j) are written as whole numbers, they actually are fractions of minutes in decimal form. For example, subsection (c), row T, reading number 1, shows a value of 7. This is actually .07 minutes. The mean, subsection (d), Avg or Sel, for element number 1 is listed as 064. That is really .064. In time study, decimal points and zeroes are usually left out in order to expedite the handwritten part of the study. For our calculations, it would be more accurate to put these values in their proper form.

(1) If necessary, a mean value can also be calculated as follows:

$$\bar{x} = \left( \sum_{i=1}^n x_i \right) / n$$

(2) Where:  $\bar{x}$  = mean of element.

$x_i$  = each observation's time value for that element, from the first or  $i=1$  reading to the last or  $i=n$  reading.

$n$  = number of good readings or observations for that element.

e. Column 5, Standard Deviation(s), is calculated as follows:



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(1)

$$s = \sqrt{\frac{\sum_{i=1}^n x_i^2 - (\sum_{i=1}^n x_i)^2/n}{n-1}}$$

Where  $s$  = standard deviation of the element.  
 $x_i$  = each observation's time value for that element, from the first or  $i=1$  reading to the last or  $i=n$  reading.  
 $n$  = number of good readings or observations for that element.

(2) For example, the standard deviation for element number 1 is calculated as follows:

$$s = \sqrt{\frac{.0376 - (.58)^2/9}{9-1}}$$

$$s = .00527$$

(3) Notice that the standard deviation for element number 5 has not been calculated. This is because, with only one reading, the denominator of the equation would be zero:

$$s = \sqrt{\frac{.9604 - (.98)^2/1}{1-1}}$$

Since this element only occurs once in 100 cycles, the time value is small enough to omit without significantly changing the accuracy of the operation. If the time value were large enough so that its elimination would impact the accuracy of the operation, a substitute or estimated standard deviation value could be used for element number 5; either a

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standard deviation value for a similar element in this operation or an industrial engineering (IE) estimate could be used.

(4) Note also that most hand-held calculators with statistical functions will easily calculate the mean and standard deviation values.

f. Column 6, % of standard (decimal form), is calculated for each element as follows:

$$(1) \% \text{ of Std.} = \frac{(\text{Col.3})(\text{Col.4})}{\sum_{i=1}^n ((\text{Col.3})(\text{Col.4}))_i} = \frac{(\text{Occ.Ratio})(\bar{x})}{\sum_{i=1}^n ((\text{Occ.Ratio})(x))_i}$$

Where:  $\bar{x}$  = mean of the element.

(2) For example, the % of standard for element number 2 is calculated as follows:

$$\begin{aligned} \% \text{ of Std.} &= \frac{(1/1)(.090)}{(.064+.090+.066+.053+.0098)} \\ \% \text{ of Std.} &= .3182 \end{aligned}$$

(3) Note that the denominator will be the same in each % of standard calculation for the operation. The numerator, however, will change to reflect the values of each specific element.

(4) Also note that the values in column 6, when added, should equal 1 or 100%; allowance can be made for rounding.

g. Column 7, Element Accuracy (decimal form), is calculated as follows:

$$(1) \text{ Element Accuracy} = \frac{(z)(s)}{(\bar{x})(\sqrt{n})}$$

Where:  $z$  = the number of standard deviations from the mean, or 1.645 with a 90% confidence level (assume a normal distribution).  
 $s$  = standard deviation of the element.  
 $\bar{x}$  = mean of element.  
 $n$  = number of good readings or observations for that element.

(2) For example, the element accuracy for element number 3 is calculated as follows:

$$\begin{aligned} \text{Element Accuracy} &= \frac{(1.645)(.00527)}{(.066)(\sqrt{9})} \\ &= .04378 \end{aligned}$$

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(3) Note that since the values of  $n$  are small, the IE may elect to assume a  $t$ -distribution instead of a normal distribution. Either is appropriate. The central limit theorem (typically found in any statistical text), however, allows us to use the normal distribution when measuring variance about the mean. Other values of  $z$ , depending on the confidence level, can usually be found in a normal table in any statistical text.

h. Column 8, Factored Accuracy (decimal form), is calculated as follows:

$$(1) \quad \text{Factored Accuracy} = (\text{Col.6})(\text{Col.7}) = (\% \text{ of Std.})(\text{Element Acc.})$$

(2) For example, the factored accuracy for element number 4 is calculated as follows:

$$\text{Factored Accuracy} = (.1874)(.04741)$$

$$\text{Factored Accuracy} = .0089$$

7. Now that Figure 3 is complete, the accuracy of the operation may be calculated:

$$\text{Accuracy of the Operation} = A_o = \sqrt{\sum_{i=1}^n (\text{Col.8})_i^2} = \sqrt{\sum_{i=1}^n (\text{Factored Acc.})_i^2}$$

a. The  $A_o$  value for the operation used as an example throughout this appendix is calculated as follows:

$$A_o = \sqrt{(.0102)^2 + (.0137)^2 + (.0102)^2 + (.0089)^2}$$

$$A_o = .0218$$

b. To convert this decimal value to percent form, multiply  $A_o$  by 100 as follows:

$$A_o = (.0218)(100) = 2.18\%$$

(%)

This can be done for any of the values in columns 6, 7, or 8 of Figure 3.

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c. Since 2.18 percent is less than (or more accurate than) 10 percent, we have a valid Type I standard assuming all other criteria are met.

d. Note that there may be some rounding error in these calculations. It is recommended that all decimals be expressed to at least the third or thousandths place.

e. This appendix may be used to calculate the accuracy of a 30 minute super operation by substituting the terms "short operation" for "element" and "super operation" for "operation."

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WORK MEASUREMENT TIME STUDY WORKSHEET (SNAPBACK)			1. DRAWING NUMBER		2. DATE 14 AUG 19xx		3. REFERENCE/FILE/STUDY NR. S-91-Z											
4. OPERATION ASSEMBLE RIFLE CHEEK PADS, OP No. 10			5. ORGANIZATION/WORK CENTER CLOTH & LEATHER CC 4781				6. WORK UNIT ASSEMBLED RIFLE CHEEK PAD											
7. OBSERVER J. DOE			8. NAME OF OPERATOR/OPERATOR NR. H. SMITH				9. MACHINE NR./STOCK NR.											
10. MATERIAL			11. WEIGHT				12. QUANTITY											
13. STOP TIME 10:16.35		14. START TIME 10:12.30		15. ELAPSED TIME (Stop Time Minus Start Time) 4.05 MIN			16. TYPE OF TIMING DEVICE MEYLAN STOP WATCH											
17. OPERATION, READINGS AND COMPUTATIONS																		
NR. (a)	ELEMENT DESCRIPTION (b)		READINGS (c)										TOTAL CYCLE (d) (e)	AVE OR SEL (f) (g)	LEVEL FACTOR (h) (i)	HOR TIME (j) (k)	OCC (l) (m)	BASE TIME (n) (o)
			1	2	3	4	5	6	7	8	9	10						
1	RELEASE	T	7	6	7	6	7	6	6	6	7	16	58	064	115	074	1/1	074
	RING	P		115		115			115		115		9					
2	PICK UP	T	9	10	8	M	9	9	8	9	10	9	81	090	100	090	1/1	090
	ASSEMBLY	P	100				100			100		100	9					
3	LET GO OF	T	6	7	7	M	6	6	7	7	6	7	59	066	105	069	1/1	069
	WEIGHT	P		100		105		110			105		9					
4	LET GO OF	T	5	5	5	6	6	5	5	6	5	5	53	053	106	056	1/1	056
	LEVEL	P	105			105		110		105			10					
5	RETURN FROM	T			98								98	980	90	882	1/100	009
	STOCKROOM	P			90								1					
		T																
		P																
		T																
		P																
		T																
		P																
18. REMARKS ALLOWANCE RATE = 13.2 % ALLOWANCE FACTOR = $\frac{100}{100-13.2} = 1.152$ ELEMENT #5, 1 IN 100												19. TOTAL BASE TIME .298		20. PF & Q ALLOWANCE 13.2 % 1.152				
22. APPROVED (Signature)												23. DATE		21. STANDARD TIME FOR 1 UNIT(S)		MINUTES .343 HOURS .0057		
LEGEND: T - TIME P - PACE RATING																		

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From: USA/AMETA, Defense Work Methods and Standards, Vol II, Work Measurement  
June 1984, p.6-13.

FIGURE 2. Short cycle time study (snapback).

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<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>	<u>7</u>	<u>8</u>
Element Number	No. of Observations (n)	Occurance Ratio	Mean ( $\bar{x}$ )	Std. Deviation (s)	% of Std. (Decimal Form)	Element Acc. (Decimal Form)	Factored Acc. (Decimal Form)
1	9	1/1	.064	.00527	.2263	.04515	.0102
2	9	1/1	.090	.00707	.3182	.04307	.0137
3	9	1/1	.066	.00527	.2334	.04378	.0102
4	10	1/1	.053	.00483	.1874	.04741	.0089
5	1	1/100	.980	-	.0347	-	-
					<u>1.0000</u>		

$$A_o = 2.18\%$$

FIGURE 3. Time study standard accuracy chart.

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## Appendix C

### WORK SAMPLING ACCURACY DETERMINATION (Step-By-Step)

1. Work sampling is a technique for studying an activity by making randomly spaced observations of the activity. The observations are used to estimate the percentage of time devoted to a given task. Work sampling is particularly useful for studying areas involving nonrepetitive work and where it is not economical to measure by time study or pre-determined time systems. These areas include, but are not limited to, clerical work, maintenance, warehousing, rebuild, repair and many indirect labor operations (USA/AMETA, Defense Work Methods and Standards, Vol II, Work Measurement, June 1984, pps.7-1 and 7-2.)

2. Obtain the contractor's Type I labor standard accuracy audit data for standards created using work sampling. This data should be in the form of a statistically valid sample of measurements that have been compared to the proposed labor standard. The contractor's sample should represent those labor standards that are active and in use.

3. Randomly select 20 percent of the operations contained in the contractor's sample for your review.

4. For each operation, do the following:

a. List the contractor's element categories and the number of observations taken during its audit. Total the number of observations.

<u>Categories</u>	<u>Number of Operations</u>
a. Pack Materials	99
b. Service Loads	38
c. Load Trucks	11
d. Get Materials	4
e. Planning and Paperwork	4
f. Unavailable	4
	<u>160</u>

b. Determine P, the percent occurrence expressed as a decimal, for each category.

$$P = \frac{\text{number of observations in category}}{\text{total number of observations}}$$

$$P_a = 99/160 = .62$$

$$P_b = 38/160 = .24$$

$$P_c = 11/160 = .07$$

$$P_{d,e,f} = 4/160 = .02$$

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c. Determine N, the sample size that the contractor should have taken, or the total number of observations required:

$$N = \frac{z^2 P(1 - P)}{S_A^2}$$

Where:  $S_A$  = absolute accuracy expressed as a decimal ( $S_A = .10$  as required by MIL-STD-1567A).

$z$  = number of standard errors = 1.645 (assume normal distribution).

$P$  = percent occurrence expressed as a decimal.

$N$  = total number of observations required.

For example, for category a:

$$\begin{aligned} N_a &= \frac{(1.645)^2 (.62) (1 - .62)}{(.10)^2} \\ &= 63.75 \\ &= 64 \end{aligned}$$

d. If the contractor's number of observations is less than N, the contractor will need to take (the number of observations required) - (the number of observations taken) additional observations to demonstrate  $\pm 10\%$  accuracy with a 90% confidence interval.

For example, for category a:

$$\begin{aligned} \text{Number of Additional Observations} &= (\text{number of observations required}) - (\text{number of observations taken}) \\ &= 64 - 99 \\ &= -35 \end{aligned}$$



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Therefore, since a minimum of 64 observations were required to demonstrate an accuracy of  $\pm 10\%$  with a 90% confidence interval, and 99 observations were actually taken, we do not need additional observations to demonstrate accuracy for this category.

We find the converse to be true, however, for category b:

$$\begin{array}{rcl} \text{Number of} & & \\ \text{Additional} & = & 50 - 38 \\ \text{Observations} & & \\ & = & 12 \end{array}$$

For this category, a minimum of 12 additional observations are needed to demonstrate  $\pm 10\%$  accuracy with a 90% confidence interval.

Once a sufficient number of observations have been taken for each category, Type I standards accuracy will have been proven, assuming all other criteria are met.

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Custodians:

Army - AL

Navy - AS

Air Force - 10

Defense Logistics Agency - SE

Preparing Activity:

Air Force - 10

(Project MISC-0075)

Review Activities:

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Navy - EC, SH, YD

Air Force - 01, 11, 13, 14, 17, 18, 19, 26

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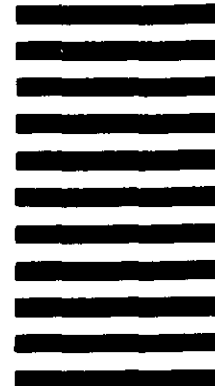
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1. DOCUMENT NUMBER <b>DOD-HDBK-345</b>		2. DOCUMENT TITLE <b>MIL-STD-1567 WORK MEASUREMENT VERIFICATION AND COMPLIANCE PLAN</b>	
3a. NAME OF SUBMITTING ORGANIZATION		4. TYPE OF ORGANIZATION (Mark one)	
		<input type="checkbox"/> VENDOR <input type="checkbox"/> USER <input type="checkbox"/> MANUFACTURER <input type="checkbox"/> OTHER (Specify): _____	
b. ADDRESS (Street, City, State, ZIP Code)			
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7a. NAME OF SUBMITTER (Last, First, MI) - Optional		b. WORK TELEPHONE NUMBER (Include Area Code) - Optional	
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