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Grade-Evaluation Guide for Engineer Positions Concerned With Production

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NOTE

This standard has been converted from the original paper format to electronic format without substantive change in series coverage or grading criteria. The standard was reviewed to correct errors that may have been introduced during the conversion process. In some standards minor corrections were made such as updating references to other documents that may have become obsolete, or correcting minor typographical errors in the original standard. Any errors that remain due to conversion to electronic format should be minor and are not intended to change the meaning of the original standard.

If you find page references near the right hand margin of this standard they indicate the pagination of the official, printed version of this standard. For example, a notation "PAGE 2, 4/88, TS-87" would mean that (1) page two of the printed version begins here, (2) the date of issuance was 4/88, and (3) the Transmittal Sheet number was TS-87.

Grade-Evaluation Guide for Engineer Positions Concerned with Production

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INTRODUCTION[1]

This guide is for use in determining grades of professional engineering positions that are concerned with means for the continuous and systematic fabrication and manufacture of uniform products and the industrial-type repair, overhaul, and assembly of such products, in-house or through contractors. The coverage of this guide also includes quality assurance positions that apply professional engineering knowledges in identifying quality requirements and assuring the adequacy of production test procedures that measure product quality and reliability. The guide is intended to be used to evaluate positions in various professional engineering series.

Specifically, the work covered by this guide involves such activities as the following:

-- Determining the optimum processes and methods to be followed in manufacturing, overhauling, repairing, and assembling products in-house; or monitoring and evaluating contractors' processes and methods.

-- Advising on modifications to product designs in order to (1) facilitate manufacturing, repairing, assembling, or modifying the products, (2) reduce raw material costs or production equipment costs, and (3) insure that feasible and adequate factory test and inspection procedures can be devised and administered.

-- Conducting pre-production design reviews to judge producibility of items; insuring availability of resources for their production.

-- Providing engineering support for acquisition of products and services by evaluating contractor capability and adequacy of plant facilities, on the newer, more complex, and high value procurements; evaluating design change proposals and waivers for their effects on production efficiency, production costs, production methods, function, quality, and delivery schedule.

-- Investigating contractors' plants and production operations to uncover production methods, processes, or quality verification methods that contribute to product failure or unsatisfactory performance.
-- Evaluating contractors' estimates of production costs.

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[1] This document is identified as a "guide" rather than a "standard" because it provides grade-level criteria for positions in several occupations rather than describing different classes of positions in one occupation. However, it has the same force and effect as a standard and is issued under the authority of 5 U.S. Code 5105.

-- Devising, applying, and monitoring procedures to measure and assure that end products comply with standards and requirements of interchangeability, reliability, maintainability, function, and safety.

-- Determining design requirements for and approving final designs for tools, dies, jigs, fixtures, gages, special machines, test equipment, and other specialized equipment required for production of a given item.

-- Planning the layout of machines, painting booths, welding stations, materials handling equipment, etc., within the plant.

-- Evaluating requests for acquisition, modernization, rehabilitation, utilization, and maintenance of Government-owned industrial plant equipment, special test equipment, and special tooling.

RELATIONSHIP TO OTHER PUBLISHED STANDARDS AND GUIDES

This guide supplements published classification standards for specific engineering series (e.g., Mechanical Engineering Series, GS-830; Electronics Engineering Series, GS-855; Industrial Engineering Series, GS-896), and the General Grade-Evaluation Guide for Nonsupervisory Professional Engineering Positions, GS-800. This guide supersedes the grade-level criteria in the individual standards for positions concerned with production. Those positions which are entirely or primarily oriented to production should be evaluated by this guide. Positions which are primarily engaged in other engineering functions should be evaluated by criteria in the individual standards or other published guides (e.g., Test and Evaluation Engineering Grade-Level Guide). However, if only portions of individual positions are devoted to production, those portions should be evaluated by reference to this guide.

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Supervisory positions should be evaluated by reference to the Supervisory Grade-Evaluation Guide, Part II.

SERIES DETERMINATION AND TITLING

This guide does not affect series or title determinations. Positions classified to grade by this guide are to be placed in the most appropriate classification series in accordance with definitions published in the "Handbook of Occupational Groups and Series of Classes," and amplifying material in published classification standards. The titles authorized in the published position-classification standards are to be used as appropriate.

OCCUPATIONAL INFORMATION

Most materials, goods, and equipment required by Federal agencies in order to carry out their missions are purchased from the private sector of the economy. There is some actual manufacture of new products by the Government, such as ammunition, pyrotechnics, combat vehicles, coins, and chemicals.

Feasibility studies may indicate the need for pre-production units and pilot production of these items prior to firm documentation and awarding a contract for volume production. However, in some instances, the agency has the resources and can more economically produce the items in its own facilities, following the pilot production. During pilot production the engineers seek to (1) devise or improve methods and processes, and (2) prove the feasibility of consistently producing end items of the desired quality.

Not all production pertains to fabrication of new products; it may involve overhauling, repairing, reconditioning, or assembling items on a large scale. In that case many of the same facilities, tools, and technical skills are necessary. In the Federal establishment, industrial-scale overhaul and repair facilities are more common than those for new item production. They are primarily in the military departments.

The engineers play an especially significant part in preparation for production. Their role is vital in (1) planning arrangements of machines and personnel for production; (2) determining test requirements for sophisticated products; (3) determining where substitutions and changes can be made in raw materials, parts, production methods, etc., in order to effect greater savings without sacrificing performance, reliability, maintainability, interchangeability of parts, etc.; and (4) determining adequacy of documentation for producing an item.

Consideration of production factors typically occurs concurrently with design and fabrication of development models. The production-concerned engineer reviews and advises on preliminary designs or prototypes, principally from the standpoint of feasibility of systematically producing the new items, availability of production expertise and facilities, cost, and likelihood of being able to maintain a reasonable quality level during production.

The engineer's assessment of the adequacy of the developer's technical data and drawings and prototype test results is essential to the successful and economical production, deployment, and maintenance of the item. The engineer's role is especially important when highly advanced items are involved.

Design analysis is basic to the work of most production-related work covered by this guide, whether the work consists of specifying methods and processes for an overhaul operation or evaluating engineering change proposals for their impact on inspection and test methods.

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After an item goes into production, the engineer's involvement does not end. However, diverse technical specialists, such as industrial specialists and quality assurance and inspection personnel, assume responsibility for carrying out specialized aspects of the overall production program. The engineer's education and experience enable him to take a comprehensive approach to production planning and resolution of associated technical problems. This is particularly true in the case of advanced or state-of-the art items, or problems which require especially competent engineering judgment based on knowledge of engineering principles.

EVALUATION CRITERIA

Two broad factors determine grade levels for engineering positions covered by the criteria in this guide. They are: *Nature of assignments* and Level of responsibility.

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Qualification requirements are not described separately; rather the Nature of assignments and Level of responsibility factors reflect them.

Nature of assignments

This factor deals with:

- -- scope, difficulty, complexity, and purpose of work;
- -- originality required;
- -- knowledge and judgment required.

At the lower levels, assignments are characterized by:

- -- narrow scope and limited factors to be considered;
- -- availability of adequate data, drawings, test methods, engineered standards, etc., that require limited judgment in their use;
- -- related precedent;
- -- use of widely known and proven simple production processes, shop techniques, production test methods, machine tools, test equipment, etc., common to the specialized area or commodities

At the higher levels, the assignments typically require:

- -- experienced judgment and originality;
- -- considerable breadth of knowledge of the appropriate engineering discipline because assignments involve products or processes that embody novel engineering concepts or require use of novel or highly advanced production processes, methods, and equipment and testing techniques;
- -- supplemental knowledge of at least one other branch of engineering since the item designs and production often involve more than one discipline;

-- comprehension of the functional relationships between a particular end item and related items of a system;
-- understanding of the functional relationship of each production method, process, or piece of production equipment to every other method, process, or equipment in a production system. This understanding is prerequisite to proper assessment of the impact that changes in the methods, processes, equipment may have on each other, the plant layout, or other engineering programs, e.g., safety or value engineering.

Level of responsibility

This factor deals with:

-- supervision received;
-- availability and pertinency of guidelines;
-- nature, scope, and significance of recommendations, determinations, advice rendered, and commitment authority;
-- nature and purpose of personal contacts.

At the lower levels, supervision is relatively close. The supervisors or more experienced engineers are readily available to give guidance or advice.

At the lower levels, guidelines on production engineering, quality assurance, and other pertinent topics are adequate. Assignments can typically be completed by direct application or slight adaptation of precedent approaches or prescribed format.

Advice at the lower levels is limited in scope; there is precedent for it or it receives review. Personal contacts are diverse, but tend to be with engineers in the local activity. If there is in-house production, the engineers have frequent contact with production shop personnel, quality inspectors, etc., for exchange of information and views.

At the higher levels, the engineers are under little or no technical supervision. They must draw on their extensive experience in the specialized area and knowledge of the latest engineering concepts and developments since precedents or guidelines require considerable modification; or they may be inadequate or even absent.

Higher-level engineers make recommendations and give advice on matters which determine the success of production programs in--meeting delivery schedules, complying with requirements of specifications and drawings, and producing items efficiently and economically. They make many of their recommendations at contractors' plants; therefore review of the engineers' actions is sometimes after-the-fact. The contacts that higher-level engineers have are with engineers and other technical people in the immediate activity and in industry. These contacts tend to be with knowledgeable specialists who often have opposing views or are withholding information in order to further their own ends; therefore disagreement may result.

EVALUATION NOTES

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This guide provides grade-level criteria for nonsupervisory positions in grades GS-5 through GS-13. The few nonsupervisory positions in the type of engineering covered by this guide at grades GS-14 and above are highly individualized. It is not practicable to provide grade-level criteria for such positions. Positions at GS-14 and above should be evaluated by extension of criteria in this standard in accordance with sound position-classification judgment. Also, the General Grade-Evaluation Guide for Non-supervisory Professional Engineering Positions, GS-800, may be used for evaluation of positions above GS-13.

The guide provides several different work situations under *Nature of assignments* that illustrate the grade-level worth of production-oriented positions. The illustrations are typical but do not reflect the full range of duties covered by this guide. Positions should not be evaluated on the basis of superficial resemblances to the illustrations. The overall grade-level concepts embodied in the discussions under the two broad factors at each grade level are more important for grade-determining purposes.

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Nature of assignments

GS-5 trainees apply the basic framework of concepts and principles of professional engineering to their assignments. GS-5 assignments have the following purposes:

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-- To acquaint the trainees with the commodities, i.e., items or materials assigned to the particular unit.

-- To familiarize trainees with the various other functional areas whose work relates closely to, or ties in with production (e.g., safety, development, research, production control, methods and time standards, item design) of the unit's assigned commodities.

-- To acquaint the trainees with the raw materials, practical shop techniques, machinery, and tools commonly used in the manufacture or overhaul, assembly, and inspection and test of the assigned commodities. Also, if the activity has in-house manufacturing, the trainees typically work closely with production shop personnel and quality control inspectors for a period in order to learn the practical aspects of production.

-- To acquaint the trainees with the appropriate agency and activity handbooks and manuals on production engineering, quality assurance, etc.

Usually trainees work closely with more experienced engineers. They learn by carrying out very limited and well-defined portions of the higher-level engineers' assignments and observing the engineers.

Level of responsibility

Supervisors give detailed instructions and information to GS-5 trainees when making assignments. Supervisors or higher-level engineers check the work frequently while it is in progress and review it thoroughly when it is completed. There are adequate guidelines and precedents for GS-5 assignments, which the supervisors point out when they make the assignments.

Contacts within the unit and activity are primarily for gathering factual information. The trainees accompany more experienced engineers in contacts outside the immediate activity as observers. For example, trainees might accompany higher-level engineers on a pre-award survey of a new contractor's facilities to evaluate adequacy of the process control methods for production of an important chemical substance; or to advise a contractor on the solution of production equipment problems.

GS-0800-7

Nature of assignments

Assignments of GS-7 engineers are developmental. The assignments require familiarity with the simpler and most commonly-used and widely-known production processes, shop techniques, quality control techniques, machinery, machine tools, test equipment and methods, and process control methods associated with manufacturing or reworking the commodities assigned to their activities and particular units. By comparison, GS-5 assignment require no prior competence in applying the basic concepts and principles to actual operating situations and the solution of problems. GS-7 assignments are straightforward and relationships between the various factors to be considered are typically clear. Assignments require the exercise of limited judgment in applying the widely accepted and well-established approaches and techniques of the assigned area. Assignments typically pertain to production of items comprised of few parts that perform simple functions.

GS-7 engineers assist higher-level engineers by gathering in formation and making tentative determinations of approaches and solutions pertinent to narrow aspects of broader assignments.

Level of responsibility

GS-7 engineers receive complete instructions on what procedures to follow or precedents to apply and the goals. The supervisors give particularly thorough explanations of any aspects of the new assignments which the GS-7 engineers have not encountered in previous ones. Supervisors or higher-level engineers are readily available should the GS-7 engineers need guidance.
By comparison, GS-5 engineers receive close supervision and frequent review of work in progress. Supervisors or higher-level engineers review their completed work for accuracy and proper adherence to accepted procedures and standard practice. GS-7 engineers make recommendations which higher-level engineers or their supervisors review before taking any final action. The GS-7 engineers justify their findings and recommendations.

Contacts are usually for the purposes of obtaining information from engineering and production shop personnel within the immediate activity or for giving information to them on routine matters. Outside contacts are primarily in the company of more experienced engineers.

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Nature of assignments

GS-9 engineers independently plan and carry out a variety of assignments. By comparison, assignments of GS-7 engineers are limited and the supervisors either prepare the work plan or review it before work begins. The assignments of GS-9 engineers pertain to the overhaul or manufacture of an assigned group of commodities. GS-9 engineers are required to understand the established design concepts and materials of construction associated with their specialized area. In addition to their professional engineering knowledge of the subject matter, GS-9 engineers apply a sound knowledge of the production facilities, production equipment, materials, processes and test methods.

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Individual assignments pertain to either new or established commodities; however, at this level, the engineers complete the assignments by drawing upon the well-established approaches, criteria, and practices that apply to their particular commodities and functions. Usually they can pattern their approaches after a closely-related precedent without great difficulty. Assignments of GS-9 engineers typically cover a limited portion of much broader and more complicated assignments which higher-level engineers coordinate. Typically, there are sufficient background information, refined technical data, specifications, and adequate engineering drawings available. In conducting some assignments, they consult the designer for additional insight concerning his intentions in selecting a particular approach.

GS-9 assignments differ from GS-7 assignments in the amount of analysis and number of independent factors and problems that must be accurately assessed or solved and coordinated before the GS-9 engineers can complete the overall assignments.

Illustrative assignments

1. Reviews process drawings and technical data for production of subassemblies or components of straightforward design to assure that the programs are adequately documented with specifications, drawings and standards as well as quality control documentation. The items usually conform closely to precedent designs, e.g., a modified version of an in-service rocket motor or projectile casing. This assignment requires knowledge of professional engineering practice, design analysis, quality control principles, production methods, and industrial processes necessary to control quality during an overhaul or manufacturing process.

    -- Determines where the items should be inspected during the production process. Uses approved and standardized statistical sampling plans with little modification. Prescribes

criteria for acceptance including average quality level, test requirements, and standards of workmanship.

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-- Determines need for new mechanical and electrical gages.

-- Determines needed characteristics and properties of any parts or raw materials needed in the production processes which must be purchased.

-- During production, reviews inspection data to monitor product or process quality, issue changes in the inspection plan or test requirements as necessary, if physical and performance characteristics are not being adequately measured. Also, prescribes substitute test equipment when that which is listed fails or is not available.

-- Verifies adequacy of the inspection plan and solves most problems by adaptation of standard approaches or precedent.

2. Independently prepares plant layout plans for relocation of production or assembly lines for small caliber firearms, low energy chemicals, fire control devices, or artillery. Evaluates feasibility and desirability of replacing individual items of machinery in the lines with updated models. Recommends their replacement after determining (1) replacement would not affect the overall process, method, quality of the end product, or have other significant adverse ramifications; (2) increase in production capacity would justify the additional cost.

-- Provides construction or structural modification requirements for the civil engineer.

-- Prepares cost estimates for facilities, equipment, tooling procurement and installation, and estimates lead time.

3. Reviews the product drawings, specifications, etc., in order to plan and prepare for the repeat production of spare parts for an in-service artillery fire control device. The assignment requires knowledge of the commonly-utilized machines and their capabilities, shop techniques, etc., utilized in production of this class of commodity.

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-- Determines whether benefits to be derived from use or improved production equipment, such as numerical control equipment, justify the cost. (The numerical control equipment automatically controls machine operations that would otherwise be performed manually.)

-- Modifies the method sheets or process drawings which were utilized for the earlier production in order to incorporate specification and drawing modifications. (The method sheets or process drawings outline the sequence of machining operations, machinery required, time and tools needed for each operation, and time required for machine conversion, in order to produce the item.)

-- Prepares bill of materials and prescribes the reliability (mean-time-between-failure) and performance specifications for those raw materials and parts to be procured.

-- Develops estimates of per unit manufacturing and assembly costs, based on analysis of the design and consideration of the manufacturing technology involved.
-- Investigates and determines proper substitute materials and parts to reduce costs or avoid production delays.

-- Evaluates the adequacy of production line setup, performance of equipment, adequacy of production methods, and of the final products.

-- Advises production shop personnel on interpretation of specifications and drawings and resolves problems during the production process.

Level of responsibility

GS-9 engineers receive their assignments in either oral or written form. Their supervisors brief them fully on the scope of the assignments, what problems to expect, whom to contact. Though supervisors may offer suggestions, the GS-9 engineers characteristically evaluate the various alternatives and appropriate precedents, and select the one they feel is most applicable or best suited to the task.

Supervisors screen assignments in advance, for matters that are controversial, that have policy implications, or are unusually complex. The supervisors infrequently spot check the more routine work of GS-9 engineers while it is in progress or at predetermined milestones. The GS-9 engineers refer serious safety or hazard matters to their supervisors for guidance or solution as the occasion arises. They also discuss deviations from standard practices and techniques with their supervisors before applying them. These checks are to insure that the engineers are on the right track and have considered all necessary aspects.

Supervisors review the completed assignments thoroughly for appropriateness of approach, technical accuracy, soundness of conclusions, and conformance to policy. GS-9 engineers have some authority to give advice, recommendations, and interpretations without prior consultation with their supervisors. For example, GS-9 engineers might advise activity workload planners on the capability of the activity to produce spare parts or standard items in-house. These items are no longer commercially available, but will be needed in order to maintain in-service equipment. By comparison, supervisors or higher-level engineers review such actions of GS-7 engineers before any action can be based on them.

The contacts of GS-9 engineers are with other engineering personnel in their immediate offices and in other programs, with which there is a close relationship, e.g., safety, value engineering, and maintenance. Also, GS-9 engineers deal constantly with contracting officers and personnel in

procurement, job procedures and timed standards, production shops, quality control inspection, etc.

Typically, the contacts are of an interpretive, explanatory, or coordinative nature. For instance, GS-9 engineers explain changes in the overhaul or fabrication process to shop personnel; or they instruct key quality inspectors on the reasons for changes to inspection procedures for a commodity. GS-9 engineers make their contacts with persons outside the activity independently, whereas GS-7 engineers make such substantive contacts in the company of a higher-level engineer who acts as the spokesman.

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Nature of assignments

GS-11 engineers apply extensive theoretical and practical knowledge of the means for overhauling or manufacturing the diverse products which comprise their areas of expertise, e.g. small arms, avionics, or propellants. This knowledge covers the manufacturing or overhaul procedures and processes, necessary machinery and facilities, materials, assembly, and production testing of the items.

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GS-11 engineers make competent analyses of item designs and evaluate the various means of producing end items and the feasibility of testing for required characteristics during production. GS-ll engineers are typically concerned with products that: (1) are complicated because they include several complex subassemblies; (2) require performance of many difficult and critical machining, assembling, or difficult-to-control processes in their production; (3) require use of complicated testing and inspection methods and specially designed test equipment. G-ll engineers often find it necessary to introduce or evaluate use of new technique or to modify a precedent technique.

GS-ll engineers must apply good judgment and originality, to modify established production and quality verification concepts or criteria to fit the particular situation, to introduce a new type of machine tool, to automate some formerly manual process, or to conceive a new inspection technique. This is typically attributable to the newness of a product or significant and extensive changes in processes or specifications, subsequent to the previous production or procurement of it. By comparison, GS-9 engineers apply less originality to their assignments; they largely follow standard approaches and data, with little modification.

Illustrative assignments

1. Evaluates adequacy of proposed techniques and documentation for controlling processes for production of a group of related chemicals. The chemicals could be produced by a wide variety of processes that are well known in the industry. Also, the products are usually adaptations and upgraded versions of established products. They are typically important

compounds which require use of difficult and hard-to-control processes to produce them and several delicate and critical steps in preparation of the raw materials.

-- Analyzes physical properties of materials and the processes; then verifies inspection and testing requirements, i.e., what should be inspected and tested, where in the process, how, for what characteristics, and type or level of inspection. Utilizes statistical techniques to determine sampling level.

-- Insures that the characteristics can be economically tested for and that inspection aids would be available.

-- Insures that there is an adequate program for detecting, correcting, and preventing defects.

-- Suggests modifications to specifications that would facilitate inspection and testing, to the extent that performance of the end product would not suffer.

-- Sets up requirements for testing and inspecting the chemicals when stockpiled, also standards for reconditioning, as appropriate.

-- Evaluates failure data to determine trends; establishes need for corrective action and conducts investigations to resolve unsatisfactory conditions.

2. Exercises technical direction over operation of a chemical manufacturing plant which produces and loads commercial quantities of a highly sensitive material such as a toxic gas, or high energy material, such as casting powder for a missile. The material is one which requires especially close control of the processes in order to avoid catastrophe as well as to assure the quality of the end item. The material is produced by combining many ingredients, each of which has a different character, in diverse smaller sublots into a whole. The sublots must be combined in certain sequence and under very tightly controlled conditions.

-- Traces problems in process which affect performance of end products through process variable studies. Such studies reveal how differences in mixing times, particle size, temperature, sublot blending, etc., affect performance characteristics of the end product.

-- Performs statistical analyses of inspection and test results to discern trends, recurring deficiencies, degree and stability of control.

-- Plans for and produces special mixes, using raw mate rials of nonapproved producers that will be tested and evaluated for significant variance in the end product.

-- Determines requirements for new facilities and equipment to increase productivity, economy of operation, and improve processes; rules on the acceptability of equipment designs for achieving production goals.

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-- Traces variables which cause sublots to fail to meet specifications; determines how to blend them in order to meet specifications.

3. Plans the production of the pilot or the short-run of a new product, e.g., small arm, artillery, or artillery fire control item. Assignment requires extensive theoretical and practical knowledge of diverse means of manufacturing such items, including shop techniques and appropriate machinery. Typically, the item incorporates several design changes some of which occur after production begins and require inventive ness to meet the changing requirements. Defective end items may raise questions of shortcomings in the production methods, processes, or techniques which the engineer re solves. Though design of the item basically conforms to established design criteria, the item may consist of at least several subassemblies or components which must be produced independently and assembled to form a functioning unit. On the other hand, it may be a rather straightforward design but requires extra strict control of the production process for the end product to meet exacting requirements. Typically, knowledge of two or more technologies is required, e.g., mechanical engineering, adhesives, and optics; materials and mechanical engineering; electrical and mechanical engineering.

   -- Prepares the complete set of process drawings, detailing methods, processes, and sequence of operations to be followed in producing the item.

   -- Prepares design requirements for any necessary molds, tools, patterns or other special equipment for tool designers.

4. Using process drawings for reference, determines arrangement of equipment and machinery to be used in pilot production of an end item comprised of several components and subassemblies, such as a heavy artillery with a mechanical timing device. Considers such factors as: Utility requirements (water, power, drainage, ventilation); machinery weight; disposal of waste, e.g., chips; space for assembly health or safety hazards; soil conditions, if machinery is heavy.

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   -- Determines necessary (a) special machine tools, (b) materials handling equipment, such as monorails, conveyors, forklifts, explosives handling equipment, and (c) foundry equipment, etc. Specifies their performance requirements for procurement and design.

   -- Evaluates frequent engineering change proposals that involve design. The work entails ascertaining: (1) The need for special tooling, handling equipment, and additional facilities; (2) the need for unusual materials and special processing for these materials; (3) impact of proposed changes on production rate, economy of production, test equipment, and delivery schedule.

5. Devises or evaluates the adequacy of methods for measuring and assuring that the pilot lot production of new products in a specialized area (e.g., combat vehicle engines, automatic test equipment, ship guidance and control systems) fall within the acceptable tolerances required

by the specifications and drawings. Production of the items involves many processing and fabrication steps, using diverse semi-automatic and automatic machine tools.

-- Conducts statistical analyses to determine best of several possible means of assuring quality; constructs a statistical model for each method.

-- Evaluates initial or pre-production model test results to determine whether the production methods, processes, and test methods result in an acceptable product.

-- Resolves problems of quality variation during production by designing procedures for introducing or locking out variables, in order to identify the source of variability through statistical means. Revises test requirements during production, in response to design changes and changed performance specifications. On certain items, runs correlation analyses to determine how closely a particular non-destructive test relates to a destructive test.

-- Evaluates proposed contractor's engineering capability to produce items of the desired standards of uniformity and reliability called for in the specifications and drawings; i.e., determines compatibility of contractor's production methods with required end item reliability.

-- Evaluates engineering change proposals to determine whether the change would affect (1) function, (2) interchangeability, (3) life of the item, (4) safety, and (5) compatibility of testing with end item delivery schedule.

6. Utilizes recognized approaches of an engineering discipline to adapt manufacturers' repair and overhaul procedures to a local activity's particular facilities, equipment, and operations. Also, investigates problem areas in the repair and overhaul that relate to basic design as well as the overhaul and test methods and processes. The assignments may pertain to new configurations or modified versions of various in-service aircraft components, e.g., bomb releases, data recording equipment, gasoline turbine engines.

-- Analyzes the manufacturer's technical manuals and overhaul procedures and writes a locally applicable repair standard which details the work processes involved in disassembly, overhaul, repair, and reassembly of the items. The standard also lists all parts and specifies test procedures and tolerances that the repaired items must meet.

-- Monitors the overhaul work and issues locally applicable changes to the repair standard as necessary, such as prescribing new test specifications and methods for repair and inspection when failure reports show that reliability of the product is not satisfactory.

-- Advises production shop personnel on solution of problems encountered in the repair standard and technical manuals; recommends substitute equipment when the equipment

specified in the repair standard is not available; identifies and authorizes substitute material for use, when the original is not available.

Level of responsibility

Supervisors typically do not give GS-11 engineers detailed instructions on how to carry out their assignments. Supervisors give the goals of the assignments and general background information when it is available. By comparison, supervisors of GS-9 engineers outline the scope and may suggest a possible approach. However, if the supervisors think there might be serious policy implications involved in the assignments or the assignments go beyond established concepts, they either give more detailed instructions or work more closely with the GS-11 engineers. For general operating rules and procedural information, the engineers consult their agency engineering manual, manuals on program requirements for quality assurance, production engineering hand book, procurement regulations, etc. Generally, the methodology, analyses, and findings of the GS-11 engineers stand up under the supervisor's general technical review, when the assignments are completed. GS-1 1 engineers often are away from supervision; therefore they are not as subject to spot checks as GS-9 engineers.

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The GS-11 engineers have many contacts with engineers inside and outside the organization. On those occasions they make judgments and recommendations on engineering matters and advise contractors' engineers. Commonly, they make on-the-spot determinations regarding the acceptability of finished products, test results for pre-production models, test procedures, etc. They suggest changes in production processes, and equipment to contractors. They recommend changes in materials, designs, etc., to design agents for the purposes of reducing material costs, reducing manpower requirements, promoting standardization, and facilitating and reducing cost of test and inspection. By comparison, unreviewed opinions and recommendations of GS-9 engineers are largely confined to routine and precedented matters within the employing activity.

The contacts of GS-11 engineers with contractors' engineers may be either alone or in the company of engineers who represent other but related program areas of the same installation. Each team member concerns himself with a particular aspect of the overall assignment or problem. In either case, GS-11 engineers represent their activity on assigned aspects. During the pre-production planning stages, GS-11 engineers coordinate their assignments with engineers who are concerned with such specialized aspects of the item as safety, development or design, and value engineering.

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Nature of assignments

GS-12 engineers carry out assignments which typically have characteristics such as the following:

-- The many different or special applications of the same product by various customers require consideration, perhaps in packaging or testing;
-- the products are advanced and are especially complex because of the numerous subassemblies or component parts, circuits, and critical tolerances;
-- the technical documentation or background information is unproven or inadequate;
-- the assignments are without precedent, perhaps involving initial production units of complex and high risk products from new contractors;
-- the concurrent contracts with more than one producer complicate obtaining identical equipment from different production lines and assuring interchangeability of components and performance;
-- the production involves diverse machining, mixing, and other operations that must be done to very precise tolerances, and numerous significant design changes occur during production.

The assignments require a thorough knowledge of production technology and quality verification in the appropriate specialized area to define and resolve issues and problems of conflicting requirements. By comparison, assignments of GS 11 engineers tend to be more conventional, rather than unique or atypical. Assignments of GS-12 engineers require that the engineers apply extensive knowledge of the latest design concepts of the assigned commodity area, and how they affect production and control of product quality. Also, GS-12 engineers apply a thorough under standing of the relation of production to other functional areas, such as development, research or safety.

The broad scope and complexity of assignments require GS-12 engineers to apply substantial knowledge of additional engineering disciplines. For example, an engineer who is educated in electrical engineering, in dealing with a primarily electrical commodity, may have to apply supporting knowledge of mechanical design principles. They may have acquired the needed knowledge through his experience in establishing production testing requirements for electro-mechanical machinery.

GS-12 engineers apply judgment and their knowledge of advanced concepts in advising on the possibility of economically producing an item or material while it is still in the developmental stage. In such work they apply knowledge of established and advanced concepts of production methodology, cost determination, material strength and physical capabilities; parts supply sources, and the functional and operational purposes of the product. They recommend whether to produce it in-house or contract it out. GS-12 engineers also develop technical data and specifications, and estimate the probability of maintaining an acceptable quality level for the commodity if it goes into volume production.

GS 12 engineers investigate and apply new product evaluation methods and techniques, new production processes, new types of tools and equipment in their assignments, on their own initiative.

The soundness of the approaches they utilize typically has not been previously borne out or thoroughly investigated.

Typically, the well-known and often-used approaches are not adequate to the task, in that they require major modification before they can be applied to the particular assignment. GS-12 engineers analyze item designs in order to formulate techniques and methodology for estimating material and labor requirements and to determine plant facility and tooling requirements. GS-12 engineers use considerable judgment in determining how and if existing policy relates to such assignments.

GS-12 engineers apply breadth and depth of knowledge in providing technical guidance to those engineers who encounter difficulty in adapting and modifying established methods and precedents. The GS-12 engineers typically suggest possible means of resolving those engineers' perplexing or unusual problems.

Conflict is common in GS-12 assignments. For example, a commodity may be destined for use by two different customers who have conflicting requirements. The GS-12 engineers satisfy both customers by perhaps convincing one or both customers to modify requirements or proposing changes in the functional design which meet the requirements of both customers.

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Illustrative assignments

1. Plans the transition of newly developed chemical products from pilot production to large quantity production. The assignments characteristically require establishment of complicated new processes or major changes to established ones. There are unique requirements for materials handling equipment, mixers, vats, conveyors, though insofar as possible existing equipment and facilities are used. Plans the complex of equipment, facilities and special tools, necessary personnel, the process flow, production schedule, and quantities.

    -- Advises development personnel on the scaling up from pilot to production scale, particularly on such matters as availability of facilities, production capacities, availability and cost of materials, and requirements for drawings and specifications, etc.

    -- Determines requirements for conversion of existing plants or construction requirements for new plants.

2. Provides technical advice, monitors production programs and resolves requests for design changes and waivers, for the more unusually complicated pyrotechnic devices. An illustrative device consists of perhaps 200 parts and the explosive train has numerous transfer points. Also, the device is carried and deployed in many configurations.

    -- Evaluates the specifications, drawings, etc., to insure their adequacy for use in the production of the device and evaluates reasonableness of cost estimates; this may result in the engineer recommending alternatives in both design and manufacture for further study or development.

-- Evaluates various aspects of cost proposals for e.g., raw material quantity, product fabrication hours, tooling fabrication hours, quantity of material handling equipment. This task requires considerable analysis of the bases for the cost estimates.

-- Has technical responsibility for review of design change. The changes are typically aimed at reducing the cost of the item through substitution of materials, changes in processes used, or change in design or specifications. Considers the effect of the change on the functioning, handling, storage, quality, and cost of the item.

-- Works with the producing activity to solve production problems through reviewing and proposing changes to production processes, tooling, and materials; as necessary approves deviations from established procedures.

-- Evaluates run-in of plant when production commences.

3. Reviews designs and evaluates performance specifications for a new state-of-the-art product, e.g., electronic counter-measure or helicopter transmission, preparatory to determining the acceptance standards for it. The item requires strict mandatory inspection at numerous critical stages in the fabrication and assembly of its various components to insure that the average quality level is high. Preparing the quality assurance requirements for such an item is especially difficult because: (1) there are novel performance characteristics that must be tested for; (2) problems and deficiencies which affect reliability are still inherent in the development model; (3) the developer did not adequately document his own quality program during development; or (4) the ultimate quality of the hardware can only be ascertained through in-service test, as in the case of a missile or rocket.

   -- Determines acceptability for use of items which during inspections do not meet the specifications, e.g., the rejection rate may be too high or there is a serious question of the interchangeability, performance, or reliability of the item or its spare parts due to the defect.

   -- Makes final engineering recommendations to material review board on nonconforming supplies.

4. Plans the small lot and subsequent quantity production of a state-of-the-art product, e.g., artillery fire control equipment, which consists of various newly-developed subassemblies and components, requiring numerous critical machining and grinding, and assembly operations. Analyzes design to determine optimum means for performing those operations, i.e., automatically or manually.

   -- Makes especially difficult engineering determinations involving more than one branch of engineering. Because he is working with the developer's designs or prototype he must innovate in effecting the item's transition to one that can be produced on a pilot lot and

ultimately quantity basis. Recognizes where compromises can be made in order to facilitate production but not impair reliability, maintainability, and function of the item.

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-- Prepares design requirements for novel tools and fixtures.

5. Performs or directs a team in planning layout and design of a large and complete new overhaul and repair facility. The facility will process a system of very advanced design, such as a rocket launcher, aircraft engine, or combat vehicle. Since the items are of unusually complex design, they will require origination of many new or little used approaches to layout as well as introduction of many "first-of-its-kind" types of processes, production machinery, and materials handling equipment in order to meet exacting repair standards.

   -- Plans layouts and flow charts for the complete over haul facility, including individual work station layouts for: disassembly, cleaning, initial inspection, routing, reconditioning, painting, final inspection, stacking, final assembly.

   -- Judges adequacy of designs of necessary mechanical equipment, instrumentation, and machinery.

6. Evaluates manufacturers' proposed repair and overhaul procedures for prototype or advanced products within his specialized area, e.g., airframes, electronic countermeasures, search and tracking radar, for feasibility and economy. His recommendations characteristically result in design or material changes, or a general revision of the overhaul procedures for the item which is then incorporated in the manufacturer issued manuals.

   -- Evaluates capability of existing equipment to perform new operations and determines specifications for need ed modifications to the equipment.

Level of responsibility

GS 12 engineers define the scope and isolate problem areas of their assignments independently. They plan and execute any necessary analysis and problem solving, normally without assistance from their supervisors. However, when the engineers feel that policy questions or a radical departure with far-reaching implications will be involved, they discuss them with their supervisors for clearance, but seldom for direction. They bring such matters as funding and scheduling to the supervisors' attention and for their information. Supervisors review the completed assignments of GS-12 engineers to determine technical adequacy, how well goals were met, and extent of compliance with policy. The supervisors are confident that the methodology which GS-12 engineers employ is technically sound and that their findings and recommendations are on firm technical footing.

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GS-12 engineers characteristically plan and advise on the pilot production and volume manufacture of products which do not lend themselves to use of established product evaluation and production methods. The items and materials may be at the state-of-the-art, radically changed versions of existing ones which require use of untried methods and machines in the production process; therefore

guidelines and approaches used in previous manufactures are partly applicable at best. By comparison, GS-11 engineers typically carry out their assignments by modifying available guidelines or precedent approaches. GS-12 engineers may exercise technical direction and coordinate the work of other engineers on very broad assignments or when time is critical, as GS-11 engineers do.

Often the commodities assigned to GS-12 engineers require coordination with one or several other commands, agencies, etc., who are potential users with their own individual performance, packaging, or environmental requirements. For example, the commodity may be a portable unit designed to detect a certain type of gas. The gas detection unit will be deployed in various environments. Some customers will use it as a unit to be transported by one person on foot, while another customer will mount the unit on a combat vehicle.

GS-12 engineers have continuing contacts with project engineers assigned to related commodities and program areas, contractors' engineers, production plant workers, key inspectors, methods personnel, etc. GS-12 engineers make technical decisions and recommendations on a variety of matters which require especially thorough knowledge. For instance, typical decisions pertain to the acceptability of terms, production waivers, production methods, acceptability of new designs of replacement production machinery that the contractor wishes to introduce into the production lines. The engineers arrive at their decisions and recommendations without prior consultation with their supervisors. The recommendations of GS-12 engineers are usually accepted by higher authority except when policy, program, or budgetary considerations are overriding.

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Nature of assignments

GS-13 engineers are widely recognized as technical specialists in their fields and typically serve as advisor and coordinating engineer for a specialized part of an extensive production engineering program. By comparison, GS-12 engineers are typically not so recognized. The following are illustrations of program scope and responsibility for engineers at this level:

-- Unit operations and processes for manufacture of cast and extruded propellants for various types of advanced missiles.

-- Facilities, equipment, processes, methods, materials, and techniques for producing electronic components, mechanical devices, or aerospace vehicles.

-- Methods, procedures, and techniques for production of pyrotechnic items; toxic-filled munitions; or chemical agent detection and warning devices.

The GS-13 engineers typically monitor and maintain surveillance over the specialized phase of manufacturing or overhaul activities at the supporting installations (e.g., arsenals or depots) and contractor facilities.

With respect to assigned areas, an engineer:

1. Develops standards, criteria, policies, and overall long-range plans for the specialized area, that apply throughout the organization;

2. Coordinates, reviews, and evaluates the work performed by engineers assigned to his program at field installations;

3. Provides advice and problem-solving expertise on especially difficult and novel problems to engineers at supporting or field installations;

4. Reviews and evaluates the status of current approaches, processes, methods, and systems in the specialized area.

Assignments at this level require comprehensive knowledge and unusually good judgment in dealing with state-of-the-art designs, engineering and scientific concepts, and manufacturing technology. GS-13 engineers apply knowledge of the latest technology in their program guidance and planning. By comparison, GS-12 engineers primarily apply such knowledge to the solution of unusual problems involved in particular assignments.

GS-13 engineers must be able to conceptualize and visualize the impact of various courses of action, designs, new processes, and advances in technology on their areas of responsibility with reasonable accuracy. Their technical judgments may determine the success or failure of the production programs. Their determinations of the contractor's readiness to enter into the transition from the development to production phase of a major item require unusually sharp perception and good judgment.

Illustrative assignments

1. Provides technical direction to industrial production programs for highly advanced equipment in a specialized area, e.g., ground reconnaissance vehicles, airborne infra-red surveillance or photographic equipment, rocket nuclear war heads. These items utilize complicated circuitry and state-of the-art components. The concepts, materials, functions, and techniques are newly developed and not completely proven. Furnishes technical advice and guidance concerning facilities, machinery, manpower methods, materials and standards for industrial production of the assigned equipment.

    -- Oversees the activities of and lends technical assistance to supporting production installations and contractor facilities on the unusual problems and policy matters relating to the program, or in resolving major performance deficiencies of equipment.

    -- Keeps abreast of research and development on assigned items by reviewing pertinent reports and other related data, to insure proper emphasis on design for producibility.

-- Anticipates problems and areas of major difficulty in the transition of the item from design or development to actual production and guides supporting production installations in their resolution; prepares policy instructions and guidance material for use of supporting production installations and contractors.

-- Establishes milestones for the production cycle and delivery cycle.

-- Recommends design changes that would be required for quantity production.

2. Serves as technical specialist on one of the critical and more technically difficult equipment programs of agency-wide significance--the crew ejection capsule for a state-of-the-art jet fighter or the telemetry system for a new spacecraft. The item must operate in diverse, adverse, or novel environments. The assignment requires knowledge of some of the more advanced findings in the particular field of engineering or physical science, since some of the concepts and materials are likely to be newly-developed and not thoroughly proven. Purpose of the assignment is to insure that during production, all tests, modifications, substitutions, variations, engineering changes, assemblies, materials, and workmanship comply with requirements of the drawings and specifications for: interchangeability, reliability, maintainability, function, and safety.

   -- Represents the agency as the engineering expert on first article configuration inspection, design review, and acceptance teams to evaluate and approve design, production, and test criteria.

   -- Evaluates reliability test criteria, test manner and results to determine adequacy of environmental testing; orders correction of unsatisfactory methods, conditions, and results.

Level of responsibility

Supervisors of GS-13 engineers furnish advice and consultation upon request regarding critical issues and policy. GS-13 engineers initiate many of their own assignments. Since they are advisors in their fields and typically have technical cognizance over the assigned area, they usually are in the position to determine where their efforts and those of others assigned to their programs should be expended. By comparison, GS-12 engineers are primarily regarded as very competent and capable problem solvers, but not as organization-wide advisors. The GS-13 engineers periodically apprise their supervisors of the status of their projects and programs. Supervisors review the projects and reports of GS-13 engineers in terms of attainment of goals and integration of results with other programs and projects.

Both technical and nontechnical personnel regard the advice and recommendations of GS-13 engineers as authoritative. Their advice and recommendations lead to (1) major change in the design of critical items; (2) expenditure of large amounts of money on production equipment, tools, and facilities for expansion of production capability; (3) major research or development efforts in order to

improve the reliability and maintainability of products; (4) suspension of major production programs because of unsatisfactory in-service performance, that is traceable to production processes or the in-plant quality program. Advice and recommendations of GS-13 engineers on such matters are normally accepted as final, without technical review. By comparison, advice and recommendations of GS-12 engineers on similar matters strongly influence action, but receive somewhat greater technical review.

Personal contacts of GS-13 engineers are with high-level managers and engineers within their employing activities, other agencies or commands, and industry. They act as spokesmen for their activity on assigned programs and present the activity position. The purposes of these contacts are diverse; however, characteristically they involve issues and points of difference that pertain to such matters as: acceptability of production schedules; reasonableness of production costs; manpower requirements; prime contractor's compliance with testing requirements; producibility of complex items which are still in the conceptual stage; long-range programing of production facilities and resources.