Position Classification Flysheet for Materials Engineering Series, GS-0806

Table of Contents

SERIES DEFINITION

This series includes professional positions in engineering, or in engineering and physical science, which are concerned primarily with the properties, processing, uses, and in-service behavior of engineering materials, where the work performed and the qualifications required are such that the position is not more characteristic of a series appropriate to some other academic discipline. The work is characterized by the following three requirements: (1) a highly developed knowledge of materials and their properties, processing, uses, and behavior under environmental influences; (2) an understanding of and the ability to utilize advances of the fundamental materials sciences, e.g., as they pertain to the interrelationships of composition, structure, and properties; and (3) knowledge of and ability to apply pertinent engineering principles and practices including considerations such as cost, availability, fabrication, performance, and use.

This is a new series coverage standard, i.e., it provides sufficient occupational background information to clarify the intent of the series definition, although it does not include grade-level criteria. It revises the concept and coverage of the former Materials Engineering Series so as to exclude positions concerned with the materials activity of construction projects.

BASIC CONCEPTS

The Materials Engineering Series rests on the following foundation:

1. The availability of materials with properties and characteristics which satisfy unprecedented requirements under extreme environmental conditions and loads is a critical item in development of modern weapons, electronics, space, aircraft, nuclear, and other types of engineering systems.

2. There has been tremendous and accelerating development in the materials sciences, in the availability of new materials, and in new uses for old materials.

3. The evaluation, selection, and application of engineering materials increasingly require specialized knowledge of materials and materials sciences more intensive than that possessed by the typical design engineer.

4. The selection of the best materials and combinations thereof for a specific use needs to be made from a wide spectrum of metals, ceramics, organic polymers, composites, and other materials.

Materials engineering represents a distinct approach to a general problem common to many engineering fields. As such, it has developed as an outgrowth of a variety of scientific and engineering disciplines, and as development continues, the field becomes more and more distinguishable as a separate engineering discipline.

The Materials Engineering Series as treated here has a dual character:

1. It is a specialized field of engineering definable in terms of specified duties, subject matter, and qualification requirements. It is the field of engineering concerned with the test, evaluation, standardization, and selection of materials for use in engineering design.

2. It is a "general" series for general or specialized professional positions in engineering, or in engineering and physical science, where (a) the work is characterized by the three requirements specified in the series definition, namely, knowledge of materials, materials sciences, and engineering principles and practices; and (b) the' position is not more appropriately classifiable in the Metallurgy Series GS-1321, Ceramic Engineering Series GS-0892, or other series.

Professional positions in materials engineering, like those in other branches of engineering, are characterized by the application of basic principles, concepts, and techniques of higher mathematics, various physical and engineering sciences, and engineering practice. Materials engineers are characterized additionally by their concern for the development of new and improved materials through the utilization of new concepts resulting from basic research in materials sciences and for the full exploitation of the properties of developed, and available materials. Normally, these concerns involve investigations into the properties of materials, defining and measuring properties, comparing materials as to one or more properties, identifying those properties of particular significance to a potential application, selecting one or more materials with a combination of properties which appear to match the needs of the application, testing to validate and narrow the selection, enhancing some and diminishing other properties, standardizing, and providing for inspection and quality control. The critical properties of materials as viewed in relation to loading conditions and the environment in which the materials must be used often dictate not only the selection of materials for a specific purpose but the very physical limitations on the achievement of a given engineering goal.

Materials engineers are frequently specialists in materials with certain properties, uses, and applications, e.g., optical materials (plastics, glass); protective coatings (paints, plastics, enamels, metals); lubricants (greases, powders, liquids); dielectric materials (insulators, varnish, tapes, molding compounds); papers (cellulose, glass, mineral); or structural materials (metals, plastics, composites, wood, concrete, ceramics). The materials engineer may be responsible for one or more functions (research, development, test, evaluation, design support, standardization, application, and production) for one or more categories of materials, or for all materials of interest to an engineering organization.

In connection with their application responsibilities, materials engineers may, for a major proportion of their time, perform, monitor, or administer applied research and development of the type performed by materials scientists. This is especially true for composite materials.

The materials sciences of interest to the materials engineer will vary to some extent with the assignment. These include: chemistry; physics of solids and liquids; physical metallurgy; ceramics; crystallography; and polymer science.

Materials engineers are normally distinguished by their concern with materials and their applications as opposed to a concern for equipment components and their fabrication, design, or use. However, the processing and fabrication characteristics of materials are frequently of major concern to materials engineers.

When the successful fabrication, design, or use of a component of equipment is dependent on the physical and mechanical characteristics of a material, the materials engineer advises on or participates in the selection of materials with optimum processing and fabrication characteristics as well as in-service behavior. In such instances, he is still characterized by a primary interest in the materials and their properties rather than the broader, overall considerations of equipment fabrication, design, and use. When the design or fabrication of an equipment component is the primary means of inducing desired properties or eliminating detrimental properties and when design or fabrication work is undertaken for that purpose, such work characterizes the materials engineer.

The performance of materials engineering duties requires knowledge of various materials and their properties, various experimental and theoretical approaches and techniques to characterize such properties, the appropriateness of these properties for specific loads and environments, the means of testing and evaluating these properties, and the means by which properties may be induced, modified, eliminated, and most effectively used. It further requires some knowledge and understanding of other engineering disciplines as they relate to the end use of the materials worked on. It requires an ability to comprehend the advances of the basic materials sciences and to utilize these advances in the solution of materials engineering problems. Finally, it requires the skills and knowledge appropriate to the specific function or materials involved in the work performed.

FUNCTIONS

Positions classifiable in this series typically include, for a major portion of the time, one, several, or a combination of the following illustrative functions:

Research and development: Materials engineers plan, administer, monitor, or perform applied research and development on materials. Research and development functions in materials engineering are typically directed toward the solution of specific, general, or forecasted materials problems through the search for and development of new or improved materials or composites with unique properties, new or improved methods for the inducement of desirable properties, into materials, new and improved fabrication techniques, or new and as yet unexplored uses of existing, on-the-shelf materials. Such work may involve extension of solid-state advances to problems of application. An important byproduct of materials engineering research may include new concepts and theories on the behavior, structure, and properties of materials.

Testing and evaluation: Materials engineers may supervise or participate in the testing of the properties of materials to ascertain their appropriateness for use. Work processes typically

involve development of test methods and specifications, environmental stimulation, administration of tests, and evaluation of test results in relation to the materials problems under study.

Standardization: Materials engineers promote materials standardization programs and participate in the development of standard specifications and standard references for the evaluation of materials and their properties.

In-service evaluation: Materials engineers supervise, coordinate, or participate in in-service inspection, testing, and evaluation of operating systems and components for the purpose of identifying unanticipated materials problems, correlating the laboratory or applied materials engineering functions with specific operating conditions and requirements, and evaluating or verifying the accomplishments of a materials program.

Product engineering: Product engineering typically involves the selection or recommendation for selection of available materials for specific applications. Such work represents the ultimate exploitation of materials to meet operating requirements. Product engineering in materials may include testing and evaluating materials to determine or verify their properties in relation to a specific engineering requirement, sponsoring materials research when appropriate materials are not available, preparing specifications and insuring manufacturer compliance, inspecting manufacturing facilities and processes, insuring compliance with any existing regulatory requirements (usually pertaining to safety factors), and collaborating on improvements in fabrication and design to best exploit available materials.

In this functional area, applied engineering considerations of economic desirability and functional feasibility in terms of operation, maintenance, modification, support, and rehabilitation of in-service equipment are normally paramount. In addition to the general requirements for materials engineers, product engineering normally requires a familiarity with the commercial availability of a broad range of materials.

Qualification requirements

A few schools have established ECPD-accredited curricula in materials engineering. More common academic preparation in chemical or metallurgical engineering is also particularly appropriate for materials engineering work.

Many positions in the Materials Engineering Series also involve work in chemistry, metallurgy or other materials sciences. Other positions have evolved through experience from a position in chemistry or other science to a materials engineer position. Because of the emphasis on materials sciences in the required knowledge, materials engineering is a field of engineering in which candidates with a degree in a physical science plus professional engineering experience can be expected to qualify. The qualification standard for all professional engineer positions includes provisions appropriate to this situation.

RELATED OCCUPATIONS

Because almost all engineers have a general concern for the properties of materials as they affect their particular functions and because many branches of the physical sciences (e.g., solid-state physics, chemistry, physical metallurgy, etc.) are concerned largely with the properties and behavior of materials, the problems of individual position coverage under the series and of inter-series relationships are necessarily complex.

In applying the following criteria, it should be noted that there are many interdisciplinary, combination, or borderline positions for which the classification decisions must be based on relative emphasis of the work and factors such as lines of promotion, career staffing patterns, management intent, and the impact of the qualifications of the incumbent on the work. (See the Introduction to Engineering and Architecture Group, GS-0800.)

Metallurgy

The Metallurgy Series, GS-1321, includes engineering and scientific positions in extractive metallurgy (which deals with production of metals from their ores), process metallurgy (which deals with refining and forming metals to usable shapes), and physical metallurgy (which deals with the composition, structure and properties of metals and the processes for their modification).
Positions which involve evaluation and selection of metals for use in engineering design are placed in the Materials Engineering Series if the selection of materials is not restricted to metals hut encompasses the whole range of metals, ceramics, plastics, composites, etc. On the other hand, the career development patterns of such positions and the performance of related metallurgical work may also support classification of the positions in the Metallurgy Series.

Although investigation and evaluation of the in-service behavior of materials are typically performed by materials engineers, such investigations for metals may require such intensive knowledge of metallurgy as to warrant treatment of the position as interdisciplinary.

Ceramics

The Ceramic Engineering Series, GS-0892, similar to the Metallurgy Series but is concerned with inorganic, nonmetallic materials which are unusually rendered serviceable through high temperature processing.

Both the Ceramic Engineering Series and the Metallurgy Series cover work in engineering and in applied physical science. The different occupational grouping (GS-0800 vs. GS-1300) reflects historical practice and preference of practitioners rather than any conceptual differences in the functions performed. Many new materials involve combinations of ceramics and metals. Positions concerned with such composite materials may be primarily in metallurgy or in ceramic engineering, may be inter-disciplinary (classified in series appropriate to qualifications of incumbent), or may be classified in the general series for engineering and applied physical science work on diverse materials, that is, the Materials Engineering Series.

Chemistry

Positions involving formulation and synthesis of protective coatings, plastics, elastomers (rubber-like materials), and similar organic and inorganic materials; investigation of the chemical reactivity, composition, and structure of such materials; or development of processes for modification of these, are typically classifiable in the Chemistry Series, GS-1320.

Positions concerned with test, evaluation, development, improvement, techniques of application, and use of such materials in engineering design are typically classifiable in the Materials Engineering Series.

Some positions involve administration or monitoring of research and development work in chemistry plus evaluation and application work in materials engineering. Such positions may be treated as interdisciplinary. However, consideration should be accorded the primary purpose of the activity to provide materials with properties and characteristics which best satisfy specified requirements for use. Moreover, by definition, materials engineers need to be competent in applicable aspects of chemistry; chemists may not be competent in engineering. Thus, broadly speaking, the Materials Engineering Series would appear to be more appropriate for many non-bench-type positions which involve both chemistry and materials engineering. In bench-type positions the professional competence as a chemist is likely to be controlling.

Chemical engineering

It should be noted that work on materials which involve a combination of chemistry and engineering does not equate to work in chemical engineering. Chemical engineering is characterized by a concern for the conditions which control changes of state or composition of materials. These are commonly defined as unit operations and unit processes and usually involve industrial-type processes and equipment. However, the chemical synthesis and analysis of materials (chemistry) plus environmental test, engineering evaluation, and specification of the material for use in structures (engineering) is not work in chemical engineering as that discipline is defined. (See position-classification standard for the Chemical Engineering Series, GS-0893.)

Textiles

The Textile Technology Series, GS-1384, is appropriate for non-engineering positions concerned with the development, production, and processing of textiles or textile fibers. Some textile technology curricula concerned with processing plant and animal fibers are clearly nonengineering in nature. Positions concerned with the application of fibrous materials such as ceramics, metals, and synthetic polymers as engineering materials in design of structures and equipment such as parachutes, inflatable structures, insulation, belting, etc., should be placed in the Materials Engineering Series, Many positions concerned with textiles are interdisciplinary.

Wood

The Forest Products Technology Series, GS-1380 is appropriate for positions concerned primarily with the application of wood as an engineering material. The well-established curricula in forestry schools for this occupation are appropriate to such work but are not engineering curricula. Positions which involve the application of wood, and a variety of other engineering materials should be placed in the Materials Engineering Series.

Plastics and rubber

These specializations are abolished. Positions concerned with these materials should be placed in the Materials Engineering Series, Chemistry Series, or other appropriate series.

Civil Engineering

Positions which include engineering work involving soils, or which are concerned primarily with construction operations requiring the use of concrete, bituminous and other materials, or which involve the investigation, test, selection, application, and control of earth, concrete, and other materials for specific construction projects are classified in the Civil Engineering Series, GS-0810. However, positions involving research, development, test, evaluation, and standardization of concrete, bituminous materials, paints, sealers, and other building materials for general applicability to construction practice an other uses may be classifiable in the Materials Engineering Series. In differentiating between the Civil Engineering Series and the Materials Engineering Series, the relative emphasis of the knowledge requirements (construction methods and techniques or the materials sciences) as well as career and staffing patterns are important.

Aerospace engineering

The Materials and Structures specialization of the Aerospace Engineering Series, GS-0861, includes positions concerned primarily with structures or with structures and materials: (We contemplate revision of that specialization to limit it more specifically to work concerned with structures.)

Equipment and component fabrication and design: Work involved primarily in the fabrication and design of equipment and components is excluded from the Materials Engineering Series, and classifiable in another appropriate engineering series, e.g., the Mechanical Engineering Series GS-0830. However when the design of a component is the primary determinant of the properties of the material and when the engineer is developing a process or producing a design in order to induce desired properties and to eliminate detrimental properties (as opposed to having as his primary concern the overall feasibility and workability of the design or process), such work is properly classifiable in the Materials Engineering Series.

Test methods and equipment development: Materials engineers participate in development of test methods and equipment as a corollary activity to the solution of materials

problems. However, when the primary knowledge requirements center around the body of knowledge associated with test techniques rather than consisting of those identified as required for the performance of materials engineering (e. g., materials and their properties, behavior under varying conditions, etc.), such work is excluded. For example, professional positions concerned with the development and application of equipment and techniques for the nondestructive testing and inspection of materials by X-ray, gamma ray, ultrasonic, dye penetration, neutron radiography, and similar techniques, now classified as Technologist (Industrial Radiography) in the GS-1390 Series, are best classifiable in an engineering or physical science series appropriate to the technique used. Similarly, positions concerned primarily with test methods and equipment for evaluating electrical materials (e.g., dielectrics, are classifiable in the Electrical Engineering Series, GS-0850.

Nonprofessional positions: Positions which involve similar but nonprofessional engineering-type work in materials engineering are classifiable in the Engineering Technician Series, GS-0802. (See the Introduction to Engineering and Architecture Group, GS-0800.)

TITLES

The basic title for all positions in this series is "Materials Engineer." Supervisory positions are further identified by the addition of the prefix "Supervisory" to the basic title. The title "Materials Research Engineer" is authorized for research positions.

Many materials engineers specialize by type of material marked by a set of distinctive knowledge requirements. The following broad areas of specialization are recognized for use as parenthetical additions to the basic title at grades GS-9 and above.

Coatings -- This specialization includes positions concerned with organic and inorganic coatings for control of radiant energy or protection from environmental conditions.

Fibrous Materials -- This specialization includes positions concerned with natural or synthetic fibers, fibrous materials, and textiles.

Lubricants -- This specialization includes positions concerned with liquid, solid, and gaseous lubricants and their properties and characteristics under various loads and environmental conditions.

Plastics -- This specialization includes positions concerned with plastics, plastic composites, and similar high-polymer materials.

Rubber -- This specialization includes positions concerned with rubber, elastomers, and other high-polymer rubber-like materials.

Structural Materials. -- This specialization includes positions concerned with metals, ceramics, and metal-ceramic combinations, for use where structural and environmental protection considerations are paramount.

The basic title should be used where these specialized titles are not appropriate.

GRADE-LEVEL CRITERIA

Positions in this series are classifiable to grade level by reference to the:

General Grade-Evaluation Guide for Nonsupervisory Professional Engineering Positions GS-0800;

Research Grade-Evaluation Guide; Chemical Engineering Series GS-0893;
Job Family Position Classification Standard for Professional Work in the Physical Science Group, GS-1300, or other appropriate standards.