

**MARSHALL SPACE FLIGHT CENTER**

**SKILLS CODES/DEFINITIONS  
HANDBOOK**

**Revision 1**

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## Table of Contents

### MANAGEMENT

<b>101-00 MANAGEMENT .....</b>	<b>1</b>
<b>101-01 CENTER MANAGEMENT:.....</b>	<b>1</b>
<b>101-02 PROJECT MANAGEMENT: .....</b>	<b>1</b>
<b>101-03 SCIENCE AND ENGINEERING MANAGEMENT: .....</b>	<b>1</b>
<b>101-04 TECHNICAL/PROFESSIONAL MANAGEMENT:.....</b>	<b>1</b>
<b>101-05 DIVISION/OFFICE MANAGEMENT:.....</b>	<b>1</b>

### ENGINEERING/SCIENTIFIC/TECHNICAL SUPPORT

<b>201-00 SYSTEMS ENGINEERING: .....</b>	<b>2</b>
<b>201-01 General Systems Engineering: .....</b>	<b>2</b>
<b>201-02 System Functional Requirements Engineering:.....</b>	<b>2</b>
<b>201-03 Interface Definition and Control: .....</b>	<b>2</b>
<b>201-04 Mass Properties Analyses: .....</b>	<b>2</b>
<b>201-05 Payload Analytical Integration:.....</b>	<b>2</b>
<b>201-06 Systems Verification: .....</b>	<b>3</b>
<b>201-07 Ground Integration Engineering:.....</b>	<b>3</b>
<b>202-00 STRUCTURAL SYSTEMS DESIGN:.....</b>	<b>3</b>
<b>202-01 Structural Design: .....</b>	<b>3</b>
<b>202-02 Pyrotechnic Systems: .....</b>	<b>3</b>
<b>202-03 Micro-meteoroid/Orbital Debris Protection: .....</b>	<b>4</b>

<b>203-00 STRUCTURAL ANALYSIS:</b> .....	<b>4</b>
<b>203-01 Stress and Fracture Analysis:</b> .....	<b>4</b>
<b>203-02 Structural Dynamics and Loads:</b> .....	<b>4</b>
<b>203-03 Dynamic Data Analysis:</b> .....	<b>4</b>
<b>203-04 Vibroacoustics:</b> .....	<b>5</b>
<b>203-05 Rotordynamics and POGO Stabilization:</b> .....	<b>5</b>
<b>203-06 Experimental Mechanics:</b> .....	<b>5</b>
<b>204-00 DESIGN INTEGRATION:</b> .....	<b>5</b>
<b>204-01 Configuration Layout:</b> .....	<b>5</b>
<b>204-02 Assembly and Integration:</b> .....	<b>5</b>
<b>205-00 TEST ENGINEERING:</b> .....	<b>6</b>
<b>205-01 Systems Acceptance and Qualification Test:</b> .....	<b>6</b>
<b>205-02 Systems Development Test:</b> .....	<b>6</b>
<b>205-03 Propulsion Mechanical Test Engineer:</b> .....	<b>6</b>
<b>205-04 Propulsion Electrical Test Engineer:</b> .....	<b>7</b>
<b>205-05 Structural Strength Test:</b> .....	<b>7</b>
<b>205-06 Vibration, Acoustics, and Shock Test:</b> .....	<b>.7</b>
<b>205-07 Modal and Control Dynamics Test:</b> .....	<b>8</b>
<b>205-08 Quasi-Static Load Test Measurement Processing:</b> .....	<b>8</b>
<b>205-09 Fluid Dynamic Facilities and Equipment Engineering:</b> .....	<b>8</b>
<b>206-00 TECHNICIANS:</b> .....	<b>8</b>
<b>206-01 Mechanical:</b> .....	<b>8-9</b>
<b>206-02 Electrical/Electronic:</b> .....	<b>9-11</b>
<b>206-03 Design and Drafting:</b> .....	<b>11</b>

206-04 Optics: .....	11-12
<b>207-00 GUIDANCE, NAVIGATION, AND CONTROL: .....</b>	<b>12</b>
207-01 Flight Dynamics, Simulation, and Control Design: .....	12
207-02 Guidance, Navigation, and Trajectory Design: .....	13
207-03 Components: .....	13
207-04 Control & Instrumentation Electronics: .....	14
207-05 Embedded System Design:.....	14
<b>208-00 MISSION ANALYSIS: .....</b>	<b>14</b>
208-01 Mission Analysis:.....	15
<b>209-00 PERFORMANCE ANALYSIS: .....</b>	<b>15</b>
209-01 Performance Analysis:.....	15
<b>210-00 ENVIRONMENTAL CONTROL AND LIFE SUPPORT:.....</b>	<b>15</b>
210-01 Environmental Control:.....	15
210-02 Life Support:.....	16
<b>211-00 THERMAL ENGINEERING:.....</b>	<b>16</b>
211-01 Thermal Design and Analysis (Propulsion Systems):.....	16
211-02 Thermal Design and Analysis (Spacecraft/Payloads/Experiments):.....	17
<b>212-00 FLUID MECHANICS AND AERODYNAMICS:.....</b>	<b>17</b>
212-01 Fluid Mechanics: .....	17
212-02 Aerodynamics:.....	18
<b>213-00 PROPULSION SYSTEMS: .....</b>	<b>18</b>
213-01 Solid Motor Performance Analysis:.....	18
213-02 Combustion Physics Analysis: .....	18

213-03	Liquid Engine Performance Analysis:.....	19
213-04	Liquid Engine System Design:.....	19
213-05	Fluid Systems Design and Analysis: .....	19
213-06	Propellant Feed System Analysis:.....	19
213-07	Cost/Operability/Reliability Analysis:.....	20
213-08	Propellant Management Systems Design: .....	20
213-09	Combustion Devices Design:.....	20
213-10	Turbomachinery Design: .....	20
213-11	Control Systems Design: .....	21
213-12	Energy Conversion Design:.....	21
213-13	Advanced Propulsion Research, Design and Analysis:.....	21
213-14	Operability and Performance Integration and Analysis:.....	21
213-15	Engineering Photographic Analysis:.....	21
214-00	MECHANISM DESIGN: .....	22
214-01	Mechanism Design:.....	22
215-00	GROUND SUPPORT, SERVICING, AND TEST EQUIPMENT DESIGN:	22
215-01	Test Equipment/Fixture Designer: .....	22
215-02	Mechanical Support and Servicing Equipment Design:.....	22
216-00	ELECTRICAL SYSTEMS:.....	22
216-01	Network Integration Engineering: .....	23
216-02	Electronic Hardware Design Engineering:.....	23
217-00	POWER SYSTEMS:.....	23
217-01	Electrical/Electronic Power Conditioning Circuit Design: .....	23

217-02 Power Systems Engineering:.....	24
217-03 Energy Conversion/Storage Engineering: .....	24
<b>218-00 DATA SYSTEMS: .....</b>	<b>24</b>
218-01 Flight Design and Evaluation: .....	24
218-02 Ground Design and Evaluation: .....	24
218-03 Flight Computer Design:.....	25
218-04 Ground Computer Design and Development:.....	25
218-05 Flight Computer Development:.....	25
218-06 Flight Data Systems Design:.....	25
218-07 Flight Data Systems Development:.....	25
<b>219-00 DATA SYSTEMS ENGINEERING/ANALYSIS:.....</b>	<b>26</b>
219-01 Data Systems Engineering/Analysis:.....	26
<b>220-00 DATA EQUIPMENT:.....</b>	<b>26</b>
220-01 Data Equipment:.....	26
<b>221-00 AUTOMATIC DATA PROCESSING: .....</b>	<b>27</b>
221-01 Automatic Data Processing:.....	27
<b>222-00 THEORETICAL SIMULATION TECHNIQUES: .....</b>	<b>27</b>
222-01 Theoretical Simulation Techniques:.....	28
<b>223-00 EEE PARTS ENGINEERING: .....</b>	<b>28</b>
223-01 EEE Parts Engineering:.....	28
<b>224-00 AEROSPACE INSTRUMENTATION SYSTEMS: .....</b>	<b>28</b>
224-01 Aerospace Instrumentation Systems:.....	29

<b>225-00 RESERVED:</b>	<b>29</b>
<b>226-00 SOFTWARE ENGINEERING:</b>	<b>29</b>
<b>226-01 Software Systems Engineering:</b>	<b>30</b>
<b>226-02 Software Implementation:</b>	<b>30</b>
<b>226-03 Software Requirements and Test:</b>	<b>30</b>
<b>227-00 FLIGHT RF COMMUNICATIONS &amp; TELEMETRY SYSTEMS:</b>	<b>30</b>
<b>227-01 Flight RF Systems:</b>	<b>31</b>
<b>227-02 RF Antennas:</b>	<b>31</b>
<b>228-00 OPTICAL SYSTEMS:</b>	<b>31</b>
<b>228-01 Optical Design/Analysis:</b>	<b>31</b>
<b>228-02 Optical Coating:</b>	<b>31</b>
<b>228-03 Optical Fabrication:</b>	<b>31</b>
<b>228-04 Optical Testing:</b>	<b>32</b>
<b>228-05 Precision Optomechanical Design/Analysis:</b>	<b>32</b>
<b>228-06 Video Systems:</b>	<b>32</b>
<b>228-07 Electro-Optical Systems:</b>	<b>32</b>
<b>229-00 MATERIALS ENGINEERING:</b>	<b>32</b>
<b>229-01 Materials Selection and Control:</b>	<b>32</b>
<b>229-02 Corrosion/Stress Corrosion:</b>	<b>33</b>
<b>229-03 Metallurgical:</b>	<b>33</b>
<b>229-04 Failure Analysis:</b>	<b>33</b>
<b>229-05 Contamination Analysis:</b>	<b>33</b>
<b>229-06 Material Coatings and Films:</b>	<b>33</b>

229-07	Nondestructive Evaluation Engineering: .....	33
229-08	Space Environmental Effects:.....	34
229-09	Lubrication/Tribology: .....	34
229-10	Polymer Chemistry: .....	34
229-11	Ceramic Material Engineer: .....	35
229-12	Analytical Chemistry: .....	35
229-13	Combustion Research: .....	35
229-14	Data Base Management: .....	35
230-00	PROCESS ENGINEERING:.....	35
230-01	Metallic Materials Process Development: .....	36
230-02	Nonmetallic Materials Process Development: .....	36
230-03	Process Control: .....	36
231-00	RESERVED: .....	36
232-00	MANUFACTURING:.....	36
232-01	Manufacturing Engineering: .....	37
232-02	Manufacturing Planner: .....	37
232-03	Fabricator:.....	37
233-00	PRODUCTION ENGINEERING: .....	37
233-01	Production Engineering:.....	37
234-00	PRODUCTION CONTROL: .....	37
234-01	Production Control:.....	38
235-00	LOGISTICS ENGINEERING: .....	38
235-01	Logistics Engineering:.....	38

<b>236-00 SAFETY AND MISSION ASSURANCE:</b>	<b>38</b>
<b>236-01 Safety and Mission Assurance:</b>	<b>38</b>
<b>237-00 SYSTEMS SAFETY ENGINEERING:</b>	<b>39</b>
<b>237-01 Systems Safety Engineering:</b>	<b>39</b>
<b>238-00 RELIABILITY ENGINEERING:</b>	<b>39</b>
<b>238-01 Reliability Engineering:</b>	<b>39</b>
<b>239-00 QUALITY ENGINEERING:</b>	<b>39</b>
<b>239-01 Quality Engineering:</b>	<b>39</b>
<b>240-00 RESERVED:</b>	<b>39</b>
<b>241-00 SPACE SCIENCES:</b>	<b>40</b>
<b>241-01 Space Physics and Astronomy:</b>	<b>40</b>
<b>241-02 Earth System Sciences:</b>	<b>40</b>
<b>241-03 Microgravity and Materials Sciences:</b>	<b>40</b>
<b>241-04 Solar Physics:</b>	<b>40</b>
<b>241-05 Space Plasma Physics:</b>	<b>40</b>
<b>241-06 Cosmic Ray Astrophysics:</b>	<b>40</b>
<b>241-07 Gamma Ray Astronomy:</b>	<b>40</b>
<b>241-08 X-Ray Astronomy:</b>	<b>40</b>
<b>241-09 Microgravity and Biotechnology Sciences:</b>	<b>41</b>
<b>242-00 RESERVED:</b>	<b>41</b>
<b>243-00 TECHNOLOGY UTILIZATION:</b>	<b>41</b>
<b>243-01 Technology Utilization :</b>	<b>41</b>

<b>244-00 CONFIGURATION MANAGEMENT:</b> .....	<b>41</b>
<b>244-01 Configuration Management:</b> .....	<b>42</b>
<b>245-00 NATURAL AND INDUCED ENVIRONMENTS:</b> .....	<b>42</b>
<b>245-01 Natural Space Environments:</b> .....	<b>42</b>
<b>245-02 Natural Terrestrial Environments:</b> .....	<b>42</b>
<b>245-03 Aerothermodynamics:</b> .....	<b>43</b>
<b>245-04 Acoustics:</b> .....	<b>43</b>
<b>245-05 Electromagnetic Environment and Effects:</b> .....	<b>43</b>
<b>246-00 MISSION OPERATIONS ENGINEERING:</b> .....	<b>43</b>
<b>246-01 Human Engineering:</b> .....	<b>43</b>
<b>246-02 Orbital Mechanics: :</b> .....	<b>43</b>
<b>246-03 Training Engineering:</b> .....	<b>44</b>
<b>246-04 Operation Engineering and Integration:</b> .....	<b>44</b>
<b>246-05 Payload Operations Director:</b> .....	<b>44</b>
<b><u>247-00 MISSION OPERATIONS GROUND SYSTEMS:</u></b> .....	<b>44</b>
<b>247-01 Facility Development Management:</b> .....	<b>44</b>
<b>247-02 Ground System Engineering:</b> .....	<b>44</b>
<b>247-03 Voice/Video System Engineering:</b> .....	<b>45</b>
<b>247-04 Reserved:</b> .....	<b>45</b>
<b>247-05 Computer/Network Engineering:</b> .....	<b>45</b>
<b>247-06 Project Engineering:</b> .....	<b>45</b>
<b>248-00 RESERVED:</b> .....	<b>45</b>

<b>249-00 ENGINEERING COST ANALYSIS:</b> .....	<b>45</b>
<b>249-01 Engineering Cost Analysis:</b> .....	<b>45</b>
<b>250-00 ADVANCED SYSTEMS PLANNING:</b> .....	<b>46</b>
<b>250-01 Advanced Systems Planning:</b> .....	<b>46</b>

**ADMINISTRATIVE**

<b>301-00 GENERAL ADMINISTRATIVE:</b> .....	<b>47</b>
<b>301-01 Administrative Support:</b> .....	<b>47</b>
<b>301-02 Clerical Steno/Typing/Office Automation:</b> .....	<b>47</b>
<b>301-03 Clerical - Subject Matter:</b> .....	<b>47</b>
<b>301-04 Office and Laboratory Service Support:</b> .....	<b>47</b>
<b>302-00 RESOURCES MANAGEMENT:</b> .....	<b>47</b>
<b>302-01 Central Budget Operations and Funds Control:</b> .....	<b>47</b>
<b>302-02 Project Control:</b> .....	<b>47</b>
<b>302-03 Institutional Budget Management:</b> .....	<b>48</b>
<b>302-04 Program Analysis:</b> .....	<b>48</b>
<b>302-05 Independent Cost Analysis:</b> .....	<b>48</b>
<b>302-06 Schedule Analysis:</b> .....	<b>48</b>
<b>302-07 Performance Measurement Analysis:</b> .....	<b>48</b>
<b>303-00 FINANCIAL MANAGEMENT:</b> .....	<b>48</b>
<b>304-00 PROCUREMENT:</b> .....	<b>48</b>
<b>304-01 Contract Negotiation and Administration:</b> .....	<b>48</b>
<b>304-02 Pricing:</b> .....	<b>49</b>
<b>304-03 Small Purchases:</b> .....	<b>49</b>

304-04 Analysis: .....	49
304-05 Acquisition Analyst:.....	49
<b>305-00 PERSONNEL MANAGEMENT:.....</b>	<b>49</b>
305-01 General: .....	50
305-02 Labor Relations:.....	50
305-03 Training and Career Development:.....	50
305-04 Recruitment:.....	50
<b>306-00 LEGAL:.....</b>	<b>50</b>
<b>307-00 PUBLIC INFORMATION: .....</b>	<b>50</b>
307-01 Media Relations Specialist:.....	50
307-02 Writer/Editor: .....	51
307-03 Public Information Specialist: .....	51
307-04 Education Specialist:.....	51
<b>308-01 EEO: .....</b>	<b>51</b>
<b>309-01 INTERNAL CONTROL: .....</b>	<b>51</b>
<b>310-01 PROCESS IMPROVEMENT: .....</b>	<b>51</b>
 <b><u>INSTITUTIONAL</u></b>	
<b>401-00 FACILITIES AND EQUIPMENT ENGINEERING: .....</b>	<b>53</b>
401-01 Architect:.....	53
401-02 Civil Engineer: .....	53
401-03 Electrical Engineer:.....	53
401-04 Mechanical Engineer: .....	53
401-05 Facilities Support Specialist:.....	53

<b>402-00</b>	<b>COMPUTER SERVICES:</b>	<b>53</b>
<b>402-01</b>	<b>Data Systems Engineering:</b>	<b>54</b>
<b>402-02</b>	<b>Data Systems Analysis:</b>	<b>54</b>
<b>402-03</b>	<b>Software Engineering and Implementation:</b>	<b>54</b>
<b>403-01</b>	<b>TELECOMMUNICATIONS:</b>	<b>55</b>
<b>404-01</b>	<b>INDUSTRIAL SAFETY:</b>	<b>55</b>
<b>405-01</b>	<b>SUPPLY:</b>	<b>55</b>
<b>406-01</b>	<b>SECURITY:</b>	<b>55</b>
<b>407-01</b>	<b>AUTOMOTIVE SERVICE:</b>	<b>55</b>
<b>408-01</b>	<b>FOOD PREPARATION AND SERVICE:</b>	<b>55</b>
<b>409-01</b>	<b>GENERAL MAINTENANCE AND SUPPORT SERVICES:</b>	<b>56</b>
<b>410-01</b>	<b>HEALTH SERVICES:</b>	<b>56</b>
<b>411-01</b>	<b>GRAPHICS/INFORMATION AND ARTS:</b>	<b>56</b>
<b>412-01</b>	<b>MATERIALS HANDLING AND PACKING:</b>	<b>56</b>
<b>413-01</b>	<b>MECHANICS AND MAINTENANCE AND REPAIR:</b>	<b>56</b>
<b>414-01</b>	<b>TRANSPORTATION:</b>	<b>57</b>
<b>415-01</b>	<b>MACHINE TOOL OPERATION AND REPAIR:</b>	<b>57</b>
<b>416-01</b>	<b>ENVIRONMENTAL ENGINEERING:</b>	<b>57</b>
<b>416-01</b>	<b>General Environmental Engineering:</b>	<b>57</b>
<b>416-02</b>	<b>Environmental Chemistry:</b>	<b>57</b>
<b>416-03</b>	<b>Environmental Information Systems &amp; Modeling:</b>	<b>58</b>

## **MANAGEMENT**

**101-00 Management:** to include:

### **101-01 Center Management:**

General management of the Center including its internal operations and external relationships to ensure effective accomplishment of mission objectives and adherence to agencywide programs, policies, and procedures. This skill code covers supervisory positions that report to the Center Director, except for Program/Project Management.

### **101-02 Project Management:**

Management of MSFC and industry performance in planning, design and engineering, integration, development, production, testing, delivery and operation of programs and projects assigned to MSFC. This skill code covers project managers, and other non-supervisory technical project management positions.

### **101-03 Science and Engineering Management:**

Management of technical laboratories and offices in the execution of their assigned engineering support to the programs and projects assigned to the Center. This skill code includes supervisory personnel who report to the S&E Director.

### **101-04 Technical/Professional Management:**

Management of technical or business professional organizational entities in the execution of their assigned engineering, computer support, facilities or development programs and projects assigned to the Center. This skill code includes supervisory personnel who report to heads of major organizations such as directorates.

### **101-05 Division/Office Management:**

Management of technical or business professional organizational entities in the execution of their assigned engineering, computer support, facilities or development programs and projects assigned to the Center. This skill code includes supervisory and other engineering positions which require skills in the areas of technical management, technical engineering operations management, technical engineering resources management, or technical management systems.

## **ENGINEERING/SCIENTIFIC/TECHNICAL SUPPORT**

### **201-00 Systems Engineering:**

This category represents the multi-disciplines involved in performing the engineering functions associated with analysis, system requirements and design definition, configuration definition, integration, and verification as applied to overall new and existing systems. The category is subdivided into the following subcategories:

#### **201-01 General Systems Engineering:**

This subcategory involves planning the engineering activities and performing/coordinating the system engineering functions required for a project. Technical activities include: performing analyses and trade studies; developing system requirements, specifications, and requirements flowdown and traceability; task costing and scheduling; and ensuring system design adequacy.

#### **201-02 System Functional Requirements Engineering:**

This subcategory includes the identification of the top-level requirements for the system, their systematic decomposition down to the testable functions, and documentation in specifications and system designs. This process involves requirements research, analysis, and trade studies to define flight and ground system functional and performance requirements and their allocation to hardware, software, or manual functions.

#### **201-03 Interface Definition and Control:**

This subcategory involves the identification of necessary analyses to define and document interface requirements and design solutions to ensure compatibility of all system interface elements. Individuals coordinate with the project management and discipline engineers to support interface analyses, trade studies, and change control to increase confidence that the hardware end items will function as an integrated system.

#### **201-04 Mass Properties Analyses:**

This subcategory involves the performance of mass properties analyses, data base development, and reporting for a broad range of launch vehicles, spacecraft shuttle payloads, and individual experiments. Individuals define the method of controlling mass properties and how contingencies are allocated and accounted.

#### **201-05 Payload Analytical Integration:**

This subcategory involves the engineering activities required in establishing payload integration approaches, processes, and in performing analyses and documenting physical and functional relationships between elements of payloads, payload carriers, and payload installations. This function includes the evaluation of

payloads and integrated payload systems for compliance with carrier requirements and compatibility with mission resources and constraints.

**201-06 Systems Verification:**

This subcategory involves the definition of requirements and planning for the system level verification of flight and associated ground support equipment. Develops detailed test requirements for system testing and defines the overall verification approach to ensure system compliance with design and performance requirements. Coordinates all aspects of the verification program to ensure an efficient and effective approach.

**201-07 Ground Integration Engineering:**

This sub-category involves the definition, coordination, and integration of pre-launch and post-landing ground operations requirements and planning necessary to support physical integration/deintegration of a flight system. This includes the areas of test and checkout, servicing, maintenance, calibration, and related activities necessary to ensure operational readiness of the system for launch. Coordinates overall ground integration requirements with launch site personnel.

**202-00 Structural Systems Design:**

This category involves design of vehicle propellant tankage; thrust structures; heat shields; thermal protection systems; payload supports; aerodynamic fairings; special-purpose structures, such as space-deployable and space-fabricated antennae, solar arrays, and recovery systems; thermal distortion free supports for space telescopes; meteoroid protection shields; fiber composite structures; and low-conductivity structures.

**202-01 Structural Design:**

This category involves the detail design, using either metallic or composite material or a combination, of advanced vehicles, spacecraft, including propellant tanks, primary and secondary structures, aerodynamic fairings, payloads, microgravity experiments, and support equipment hardware. Design special test structures where an intimate knowledge of the flight hardware being tested is required. Support proposals by performing conceptual and trade studies. Provide and utilize efficient design computer codes for accurate and fast structural trade studies including different materials to optimize the strength to weight ratio. Perform in-house research on the development of advanced structural concepts and develop technology for efficient and lightweight launch and space vehicles structures. Support the manufacturing and testing of the designed hardware.

**202-02 Pyrotechnic Systems:**

This category involves establishing requirements for pyrotechnic components and systems such as devices for ignition, separation, and range safety, and establishing the qualification and acceptance testing requirements for this hardware. Provides design guidance during the development and qualification of pyrotechnic components and systems for in-house and contractor programs. Serves as a

consultant in the program critical field of pyrotechnics for space vehicles and payloads.

**202-03 Micro-meteoroid/Orbital Debris Protection:**

This category involves the design and analysis of advanced hypervelocity impact shields for manned and unmanned spacecrafts and payloads. The design activity includes development of metallic, composite, and in some cases ceramic structural systems capable of survivability in the lower earth orbit debris environment. The analysis includes the prediction of damage and survivability/reliability of the orbiting structure. Integral to the design/analysis is the hands-on support to hypervelocity impact testing and data reduction, a key function in the generation of prediction damage equations and methodologies.

**203-00 Structural Analysis:**

This category involves the development of math models for flight and ground support equipment hardware, the analysis of the models to determine structural response to multiple external and internal environmental conditions, and dynamic analysis of flight and test data for structural and propulsion systems. These analyses support the development of requirements and the verification of structural performance in the areas of loads, dynamic response, structural stiffness, damping, stress, test, and fracture mechanics.

**203-01 Stress and Fracture Analysis:**

This subcategory involves the performing of stress, stability, deflection, fatigue, creep, and fracture mechanics analysis in support of structural design, analytical verification, and qualification testing of advanced aerospace vehicles, propulsion systems, payloads, and associated ground support equipment and facilities. This category also involves the determination of static structural test/instrumentation and fracture control requirements, structural strength design criteria, and investigation of structural failures.

**203-02 Structural Dynamics and Loads:**

This subcategory involves the performing of structural dynamic analyses and load analyses which support the development and verification of advanced aerospace vehicles, payloads, and propulsion systems. This requires the development of math models, the performance of modal analyses to calculate the flexible body data used in stability analyses, the performance of transient response analyses to calculate the structural loads used in stress analyses. This category also involves the definition of dynamic and modal test requirements for math model verification, the establishment of test instrumentation requirements, and the analysis and correlation of test data.

**203-03 Dynamic Data Analysis:**

This subcategory involves the performance of dynamic data analysis and diagnostics for propulsion system engines and engine components and establishes engine system dynamic characteristics and responses. This category requires the

selection of the appropriate analysis techniques which may vary from linear analysis for a nominal test to in-depth nonlinear diagnostic analysis for anomalous conditions. This category also defines measuring system requirements, data processing requirements, and measuring programs for engine system analysis.

**203-04 Vibroacoustics:**

This subcategory involves the formulation of component vibration, acoustic and shock design and test criteria, defines dynamic response loads for component design and establishes component dynamic test policies, requirements, and procedures and supports dynamic testing in the laboratory. This category also requires the maintenance of large volumes of measured vibration and acoustic data, defines the measuring system, the data processing requirements, and the programs for measuring the dynamic and structural load environments.

**203-05 Rotordynamics and POGO Stabilization:**

Constructs math models, simulation strategies and stability analyses of high speed rotordynamics and propulsion system coupling with vehicle fluid and flexible body dynamics. Generates requirements governing the dynamic response in these areas. Devises damping strategy and devices necessary to meet dynamic requirements.

**203-06 Experimental Mechanics:**

This sub-category involves performing or specifying stress, fatigue, fracture, residual stress, and other measurements using experimental methods (strain gage, photoelastic, moire, etc.) on the structure or an appropriate laboratory analog. Specify the proper experimental technique for a given situation and evaluate the results.

**204-00 Design Integration:**

This category involves performing configuration analysis and assembly engineering for the layout and installation of subsystem hardware and structural components into the basic system design.

**204-01 Configuration Layout:**

This subcategory involves providing CAD/CAE configuration layouts, models, and analyses in developing concepts for launch vehicles, shuttle payloads, spacecraft, experiment hardware, and neutral buoyancy/mockup hardware. Includes development of the system configuration with appropriate consideration of launch vehicle constraints, interaction of subsystems, required field-of-view constraints, and accessibility for maintenance.

**204-02 Assembly and Integration:**

This subcategory involves development of engineering documentation (drawings, EO's, etc.) for assembly and installation of flight hardware. Includes performance of detail design for the installation of experiment hardware, instrumentation, electrical cabling, thermal protection systems, electrical "black boxes", etc.

### **205-00 Test Engineering:**

This category involves planning, conducting, and evaluating experimental, developmental, qualification, and acceptance testing of aerospace systems, subsystems, components, piece parts, ground support equipment and other assigned systems.

#### **205-01 Systems Acceptance and Qualification Test:**

This subcategory consists of the skills required for the planning and conduct of acceptance and qualification testing of flight systems, subsystems, components, and parts. It involves the application of electrical, electronic, mechanical, and electromechanical skills and knowledge in the devising and implementation of complex test concepts to accomplish comprehensive acceptance testing of flight hardware. It includes the detail evaluation of system performance requirements, redundant features of the systems, safety aspects, mission peculiar requirements, and off nominal performance requirements to establish a comprehensive test program to verify, exercise all operational modes, and assure the delivery of flight qualified hardware for the respective mission. The knowledge and application of ground support equipment, power supply systems, data acquisition systems, control systems, and facilities is required to plan and implement the appropriate test program. The knowledge and conscientious application of flight hardware handling and processing requirements is required.

#### **205-02 Systems Development Test:**

This subcategory consists of the skills required for the planning, operation of complex test facilities, and conduct of development testing of systems, subsystems, and components to characterize, determine and evaluate design approaches, evaluate systems interactions, and limits of systems performance capabilities. This involves the application of electronic, electrical, mechanical, and electromechanical skills to devise test concepts, plan, determine test equipment requirements, and integrate the test system to perform the required development testing. The knowledge of and determination of simulation techniques is required to devise the most appropriate test concepts. Knowledge of data acquisition systems, power supply systems, mechanical systems, facility systems, and control systems is required in the implementation of and operation of the test support equipment and facilities.

#### **205-03 Propulsion Mechanical Test Engineer:**

Plans, establishes requirements for, coordinates, schedules, conducts, and evaluates design, development, build-up, and operation of mechanical systems for hazardous testing of aerospace vehicles, subsystems, components, and subcomponents. Has professional knowledge of mechanical engineering principles, practices, and analytical methods for hazardous test operations including: cryogenic fluids and associated systems; high pressure gases and associated systems, thermal vacuum conditions; liquid propulsion systems; and liquid, solid, or hybrid rocket engines/motors.

**205-04 Propulsion Electrical Test Engineer:**

Plans, establishes requirements for, coordinates, schedules, conducts, and evaluates design, development, fabrication, installation, checkout, calibration, and operation of comprehensive measurements and control systems, equipment, and facilities for hazardous testing of aerospace vehicles, subsystems, components, and subcomponents. Has working knowledge of electronic and electrical engineering principles and practices for the qualitative assessment of measurement, control, and data acquisition systems and their application to hazardous test operations. Assures the proper function and performance of measurement and control systems in hazardous test environments including: cryogenic fluids and associated systems; high pressure gases and associated systems, thermal vacuum conditions; liquid propulsion systems; and liquid, solid, or hybrid rocket engines/motors.

**205-05 Structural Strength Test:**

This subcategory consists of skills required for planning and conduct of quasi-static load tests of flight hardware including the application of test technologies, development and utilization of facilities and equipment, and transmission of data to interacting engineering disciplines. It involves laboratory simulation of flight vehicle loads and environments, measurement and analysis of test article response parameters, and experimental functions in support of structural research and development. It requires specialized knowledge of servo control load application, elastic and inelastic structural strain, deflection measurements including strain gauge and photoelastic concepts, cryogenics, and pressurant dynamics. It requires thorough knowledge of the principles of structural mechanics, mechanical and hydraulic engineering, aerospace test technologies, and experimental research. Test hardware and software includes systems for multi-channel load control, hydraulic force generation, load reaction structures including inertial and anchored systems, and test article interface structure.

**205-06 Vibration, Acoustics, and Shock Test:**

This subcategory consists of skills for vibration, acoustics, and shock tests of flight hardware including development and application of test and analysis technologies, execution of test programs for evaluation and certification of flight articles, and utilization of test facilities and equipment. It involves laboratory simulation of flight vehicle dynamic loads, measurement and analysis of structural dynamic response parameters, and experimental test functions to support structural dynamics research. It requires specialized knowledge of dynamic spectra control and data processing concepts and strategies, sensors and transducers, signal conditioning, parameter estimation, system calibration and test support structure design. Control and test article response data processing includes time, frequency and spatial domain analysis, signal analysis, and a broad range of mathematical functions. Measurement parameters include impedance, force, acceleration, velocity, displacement and transfer functions. It requires thorough knowledge of principles of aerospace test technologies, structural mechanics, electronics

instrumentation, electrical power distribution, mechanical and hydraulics engineering, and computational systems.

**205-07 Modal and Control Dynamics Test:**

This subcategory consists of the skill required to plan and conduct modal and control dynamic tests. This includes the development and maintenance of the test facilities and utilization of new technologies to provide experimental dynamics data that are used for the following: verification of analytical models, analysis of coupled loads, definition of on-orbit dynamics loads, characterization of structural response parameters, and experimental evaluation of the structural interaction of mechanical, thermal, and electro-mechanical systems. Engineering skills in the disciplines of structural dynamics, modal test and analysis technology, dynamics control technology and design, dynamics instrumentation, data acquisition and processing, signal analysis, application of laser and optical techniques, and computer technology are required.

**205-08 Quasi-Static Load Test Measurement Processing:**

This subcategory encompasses skills required to acquire, process, format, and transmit structural test measurement including simultaneous acquisition of multi-channel on-line measurements in engineering units at high speed sample rates. It requires specialized knowledge in signal processing, system calibration, transducer applications, remote sensing, measurement parameter evaluation for coherence and validity, computational systems, and data transmission networks. It requires thorough knowledge of the principles of aerospace engineering, structural mechanics, electronics instrumentation, software programs and sub-routines, and laboratory operating procedures.

**205-09 Fluid Dynamic Facilities and Equipment Engineering:**

This subcategory includes providing plans, mechanical and electrical design/analysis of fluid dynamic test facilities and test models. Provides oversight in the construction, checkout and acceptance verification of facilities/models, control and instrumentation systems. This category also includes mechanical and electrical technician support for the assembly, operation and maintenance of Fluid Dynamic Facilities.

**206-00 Technicians:**

This category primarily involves the application of practical knowledge and techniques in the following areas:

**206-01 Mechanical: (includes the following:)**

Mechanical Technician - Operates and maintains mechanical systems, vacuum systems and related equipment and instruments in support of fabrication, assembly, test, and installation. Participates in design and operational analysis. Organizes, controls and performs complex mechanical operations in support of aerospace

experimental development, acceptance and/or testing of launch vehicle systems, ground support equipment, space systems, subsystems, components and parts.

Structural Test Technician (Mechanical) - Includes skills for development and operation of structural test systems, components, and support structures. It involves conceptual design, assembly, integration and checkout of quasi-static load and dynamics test systems consisting of force generation and control systems, load reaction structures including hydraulic devices, inertial components and anchored structures, and test article interface fixtures. It requires working knowledge in the principles of hydraulics, structural design, cryogenics, pressurant utilization, pyrotechnics, and test modeling. It requires specialized knowledge of aerospace test concepts, test system performance parameter measurements, and evaluation criteria, quasi-static load and dynamic test procedures, safety regulations, and flight hardware handling procedures.

Materials Mechanical Test Technician - Technician having mechanical knowledge and training necessary to perform and report on chemical/environmental test, mechanical test, thermal test, physical test, nonmetallic processes, and metallic processes; prepare nonmetallic and metallic components for various: (1) processes including welding, bonding, brazing, molding, and curing, (2) testing to include metallography, corrosion, thermal treatment, tensile, fatigue, bend, fracture toughness, crack growth and shear; maintain and operate equipment necessary to perform processes and testing to generate such data as specified above, and to evaluate the reactivity, compatibility, flammability, combustion, and toxicity of materials under varying conditions and environments. The technician typically has extensive experience with various types of materials, test equipment and environments including reactive fluids, fuels, oxidizers, hypergols; machining; material specimen preparation; mechanical measurement systems; mechanical trouble shooting and assembly; cryogenic and high pressure fluids; and operation of computerized control systems.

Propulsion Mechanical Test Technician - Participates with the mechanical test engineer in the planning and conduct of build-up and operation of mechanical systems for hazardous testing of aerospace vehicles, subsystems, components, and subcomponents. Assesses performance characteristics, installation specifications, criteria and design requirements for mechanical components and subsystems. Troubleshoots, maintains, repairs, and operates a wide variety of mechanical systems and associated equipment including those for transfer and storage of cryogenics fluids.

**206-02 Electrical/Electronic: (includes the following:)**

Electrical Technician - Operates and maintains electrical/electronic systems, components, and related equipment/instrumentation in support of fabrication, assembly, test, and installation. Works with systems, plants, equipment and

materials for the generation, transmission, conversion, distribution, control measurement or use of electrical energy. Participates in design and operational analysis. May work in electronic activities where extensive knowledge of electronics is not required. Works with electronic circuitry, devices, equipment and systems used in instrumenting, measuring and recording test performance, and controlling launch vehicle systems, ground support equipment, space systems, subsystems, components and parts.

Electronics Technician - Involves a variety of technical tasks in the design, development, fabrication, assembly, testing, and evaluation of complex analog, digital, power, and other electronic systems, subsystems, and components; the design and construction of special test fixtures and breadboards used in design and testing; performing tests and evaluation on electronic and instrumentation systems and components; conducting analyses of items failing under testing; preparing purchase requests for electronic system components and associated test support equipment and/or measuring instrumentation; and coordinating calibration and maintenance of test and development equipment.

Structural Test Technician (Electrical) - Includes skills for structural test instrumentation, signal conditioning, system calibration and measurement acquisition. It involves installation of sensors and transducers to test article, set-up of instrumentation circuits including cabling for remote test sites, system verification tests, and end-to-end calibration of measurement channels. It requires specialized knowledge and skills in strain gauge, photoelastic and accelerometer measurement concepts, electronic signal generation and transmission, analog circuits, and digital recording. Measurement systems acquire data in the range of 4,000 channels recorded on magnetic disc and tape and provide access to all measurements for display during test conduct. Dynamic measurements range from low frequency approaching DC to 20K Htz.

Materials Electrical Test Technician - A technician having electrical knowledge and training necessary to prepare, perform, maintain and report on chemical and physical tests and equipment necessary to evaluate the reactivity, compatibility, flammability, combustion, and toxicity of materials under adverse conditions. The technician typically has extensive experience with various types of materials, test equipment, electrical subsystems of welding systems, manipulators, machining equipment and environments; electrical assembly, electronic control, measurement and data recording systems; as well as, computerized and digital control systems. This technician can maintain equipment, modify as needed, trouble shoot, or integrate manufacturing systems as required.

Propulsion Electrical Test Technician - Participates in the planning, design, integration, and operation of electronic and electrical systems for sensing, measuring, controlling, recording, monitoring, and evaluating parameters associated with hazardous testing of aerospace vehicles, subsystems, components,

and subcomponents. Fabricates, assembles, installs, calibrates, checks out, interconnects, monitors, evaluates, and modifies a variety of measurement, data, and control equipment and systems. Assesses performance characteristics, installation specifications, criteria and design requirements for electronic and electrical equipment. Troubleshoots, diagnoses/corrects problems in, maintains, repairs, and operates a wide variety of electronic and electrical systems and equipment, including data acquisition, archival, and processing systems and supporting equipment.

Video Technician - Works with video systems. Requires skill in electronics, video systems, subsystems and components.

Propulsion Photo/Video Technician - Installs, configures, operates, and maintains video recording equipment, still cameras, infrared cameras and high speed film recording in support of propulsion testing. Fabricates control and distribution cables. Requires skills in electronics, video systems, infrared recording, still photography, and knowledge of hazardous areas vacuum systems, cryogenics and high pressure systems.

Propulsion Test Software Technician - Designs, develops, documents, verifies and maintains computer software for measurement and control systems to support hazardous propulsion testing.. Has professional knowledge of software design, coding standards, real-time/deterministic operating systems, industry standard architecture and programming languages, database applications development and software verification/validation techniques.

RF Technician - Operates and maintains special purpose RF system test facilities: Requires knowledge of antenna systems, special purpose RF test equipment and operation and maintenance of antenna test range and anechoic chamber.

### **206-03 Design and Drafting:**

This subcategory involves the development of conceptual design models and drawings for components, assemblies, subassemblies, and systems via CAD/CAE tools, photo plotters, etc. Prepares design layouts, models and manufacturing drawings for structural/mechanical, electrical, thermal, and propulsion disciplines in accordance with established engineering principles, drafting procedures, drawing release procedures, and manufacturing processes.

### **206-04 Optics: (includes the following:)**

Optician - Performs fabrication of optical components including lenses, mirrors, prisms and other devices. Requires skill in the use of both manual and computer controlled machines for the grinding and polishing of components.

Metrology Technician - Performs measurement of optical systems, subsystems and components. Requires skill in the use of instrumentation, techniques and facilities for measuring component parameters and system and subsystem performance.

Diamond Turning Operator - Performs diamond turning for the fabrication of optical components. Requires skill in the area of precision computer controlled diamond turning machines.

Precision Mechanical Technician - Performs precision machining and works with precision mechanical systems for the fabrication and testing of optomechanical systems. Requires skill in the operation and maintenance of precision mechanical systems.

Coating Technician - Works with coating systems. Requires skill in the operation and maintenance of coating systems including vacuum system operation and maintenance.

Optomechanical CAD Operator - Performs detailed computer controlled design of optomechanical systems. Requires skill in the area of optomechanical design and the use of CAD systems.

### **207-00 Guidance, Navigation, and Control:**

This category involves the assessment of requirements and the definition of specifications for guidance, navigation, control and instrumentation systems; and the establishment of component and systems test and verification requirements. Technical activities included are: Defining concepts and designing, developing, and assuring adequate functional performance and reliability of guidance, navigation, control, stabilization, and instrumentation components; defining requirements for control actuator systems such as thrust vector control system, reaction control system, control momentum exchange devices, magnetic control devices and establishing momentum management schemes, attitude control policies and control sensor and flight computer requirements; performing design and verification analysis of control systems and servomechanisms, establishing stability margins, performing POGO analysis and verifying dynamic interaction of all systems, subsystems and components; planning and performing the design, development, modification and testing of measuring instrumentation for ground system testing performed by MSFC; performing engineering analysis and determining configuration design and operational requirements, interfaces, and characteristics of guidance, navigation, control, and instrumentation systems for vehicles, experiments and mission integration; integration of guidance system components and associated computer programs and verification of the guidance scheme by analysis and/or simulation with flight hardware.

### **207-01 Flight Dynamics, Simulation, and Control Design:**

This subcategory involves: transient response and stabilization analyses; synthesis of control systems; design and implementation of higher order computer languages

specifically configured for control design and flight dynamics analysis; verification of control systems via analysis and real time simulation; specification of control system requirements and requirements on control components; control algorithm specification; control laws and filtering; health monitoring and control algorithms; specification of data storage requirements; review of flight and ground data for flight failures; simulation of failure conditions; determination of pointing requirements; construction of error budget and specification of control component requirements necessary to meet the budget; analyse and devise means to suppress low level vibrations including specification of advanced control laws, stabilization strategies and filtering; devise closed loop control systems to obtain optimum performance from segmented and flexible optics; design filtering algorithms to obtain optimum attitude determination systems; devise measurement and computational systems which estimate the performance of large optical systems in real time.

**207-02 Guidance, Navigation, and Trajectory Design:**

Trajectory design involves development of computer tools and use of existing tools to optimize space vehicle trajectories with constraints. These trajectories are for ascent to orbit, orbital operations, and reentry and landing during return from orbit. Trajectory design also includes analysis of the effects of winds, vehicle and environmental perturbations, and vehicle changes on the trajectories. Measures of merit include mass performance and various indicators of the stress placed on the vehicle during its travel. Optimum vehicle parameters, reserves, margins, and sensitivities are determined using these analyses. Guidance design involves development of software algorithms that command the correct orientation and throttle level (when applicable) for a space vehicle when it is undergoing forces other than gravity alone. The objective is to enable the vehicle to successfully fly to its destination, with whatever constraints are placed on the trajectory and with whatever dispersions exist in the actual flight. Navigation design includes development of algorithms to perform the navigation function of determining the vehicle position and velocity from sensor measurements. Navigation design also includes prediction of the navigation dispersions to be expected, given a certain space vehicle, a planned trajectory, and an assumed set of navigation sensors.

**207-03 Components:**

This subcategory involves the assessment of requirements and the definition of specifications for guidance, navigation and control systems. Technical activities included are: Defining concepts and design, developing, and assuring adequate functional performance and reliability of guidance, navigation, control and pointing components. Included in this category are the research, design, development, testing and evaluation, and analyses of laser gyros, sun sensors, star trackers, fine guidance systems, earth sensors, inertial measuring units, control moment gyros, reaction wheels, gimballed systems, etc.: Performing engineering analysis and determining design and requirements, interfaces, and characteristics of components

for guidance, navigation, and control systems for vehicle experiments and mission integration of flight hardware.

**207-04 Control & Instrumentation Electronics:**

This subcategory involves the assessment of requirements and definition of specifications for control and instrumentation systems. Technical activities included are: conception, definition, research, design, development, fabrication and test of analog and/or digital electronic systems for control of actuator systems such as thrust vector control systems, reaction control systems, magnetic control devices, for instrumentation signal conditioning, control of science experiments, thermal system control, CCD focal plane conditioning and control, etc. Perform verification test and engineering analysis of electronic systems to assure adequate performance, stability margins and reliability.

**207-05 Embedded System Design :**

This sub-category involves the design and development of embedded control and data acquisition systems. Embedded design includes the use of hardware such as Reduced Instruction Set Computers (RISC) and Complex Instruction Set Computer (CISC) processors, Micro-controllers, Digital Signal Processors (DSP), Programmable Logic Devices (PLD), Field Programmable Gate Arrays (FPGA), and discretes for analog and digital design. The embedded design also requires the knowledge in the design and development of the embedded control software (firm-ware) and/or hardware development tools. This includes the use of the native processor's assembly language tools, compilers, and the Very-Highspeed-Development-Language (VHDL)/Verilog languages for FPGA development.

**208-00 Mission Analysis:**

Mission analysis includes activities in orbital analysis and mission design. Mission requirements are initial inputs to this activity which can include selecting orbits and/or launch times to maximize/minimize orbital evens and payoff functions and to determine decay rates and orbital lifetimes, launch windows, relative motions, rendezvous profiles, sensor viewing opportunities, and orbital event timing. It also includes determining spacecraft attitudes for power generation, scientific pointing or engineering purposes. Spacecraft sizing analyses are also performed to determine propellant quantities required to satisfy mission destination and payload objectives. These sizing analyses include lunar and planetary stages and landers. Performance evaluations of low-thrust transportation options with regard to payload/altitude capabilities are also included in mission analyses tasks. Accurate ephemeris generation is one of the essential requirements of these tasks and efforts to improve this capability is an on-going activity. Maintaining up-to-date standard environmental models such as the atmospheric density, trapped radiation and the Earth's magnetic field is also a required activity.

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#### **209-00 Performance Analysis:**

This category includes performing launch vehicle systems performance analysis to include trajectory optimization, trajectory accuracies based on guidance and navigation system inaccuracies sizing, FPR, staging velocity and delta V split considering constraints and mission objectives.

#### **209-01 Performance Analysis :**

This sub-category includes performing launch vehicle systems performance analysis to include trajectory optimization, trajectory accuracies based on guidance and navigation system inaccuracies sizing, FPR, staging velocity and delta V split considering constraints and mission objectives.

#### **210-00 Environmental Control and Life Support:**

This category involves engineering design, analysis, and test related to heat and mass transfer, thermodynamics, fluid mechanics, and chemical, biological, and metabolic processes. Systems applications include and human rated launch vehicles, spacecraft, and flight experiments. Areas of specialty include development of life support systems and subsystems, environmental control systems and subsystems, and evaluation of microgravity and reduced gravity effects. Performance includes definition of design, instrumentation, and testing requirements, and definition of design margins. Project engineering support includes design/development, qualification, verification, and flight assessments.

#### **210-01 Environmental Control:**

This sub-category involves design, analysis, and testing of spacecraft and launch vehicle environmental control subsystems and components. The expertise required includes design knowledge of environmental control systems and heat transfer analyses which include thermodynamic phenomena. Subsystems typically include temperature and humidity control, refrigeration and freezer systems and subsystems, fire detection and suppression systems, ventilation, and avionics cooling. These analyses require integration of active cooling and heat transport

systems, and evaluation of condensing heat exchangers. Understanding of microgravity and reduced gravity effects is required. Definition and sizing of insulation systems, and temperature control systems are required. These efforts support design/development, qualification, verification, test, and flight programs for spacecraft and launch vehicle environmental control subsystems. Definition of design requirements, instrumentation requirements, testing requirements, and design margins is also required.

**210-02 Life Support:**

This sub-category involves design, analysis, and testing of manned spacecraft and launch vehicle life support systems, and systems engineering and integration analyses of life support systems. The expertise required includes design knowledge of life support systems including atmospheric control, supply, and revitalization, trace contaminant detection and control, microorganism control, water recovery and management, and waste management. Technical expertise includes diverse understanding of microbiology, chemical processes including carbon dioxide reduction and oxygen generation, metabolic functions and loads, and human physiological requirements. Analytical modeling may include transient tracking of constituents and determination of thermodynamic states simulating heat transfer, chemical reactions, combinations, and decompositions, and mass and energy balances. Understanding of microgravity and reduced gravity effects is required. Definition of appropriate technologies for loop closure for water, oxygen, food, and solid waste subsystems may be required. These efforts support design/development, qualification, verification, test, and flight programs for manned spacecraft and launch vehicle life support systems. Definition of design requirements, instrumentation requirements, testing requirements, and design margins is also required.

**211-00 Thermal Engineering:**

This category involves engineering design, analysis, and test related to heat and mass transfer, thermodynamics, and fluid mechanics. Systems applications include propulsion systems, liquid, solid, and hybrid rocket motor systems, spacecraft, payloads, experiments. Areas of specialty include analysis for and development of launch vehicle thermal design, and design of thermal control systems for spacecraft, payloads and microgravity science experiments. Performance includes definition of design, instrumentation, and testing requirements, and definition of design margins. Project engineering support includes design/development, qualification, verification, and flight assessments.

**211-01 Thermal Design and Analysis (Propulsion Systems) :**

This sub-category involves thermal design, analysis, and testing of liquid rocket engines, solid rocket motors, hybrid rocket motors, upper stage engines, and other propulsion system components. The expertise required includes solid modeling of components and the accomplishment of heat transfer analyses, which include thermodynamic phenomena. These analyses require integration with fluid dynamic assessments and the results are integrated with structural analyses. Modeling tasks

range from cryogenic systems to combustion chambers and turbomachinery components. Definition and sizing of insulation systems, thermal protection systems, motor insulation systems, and nozzle liners is required. These efforts support design/development, qualification, verification, test, and flight programs for aerospace flight vehicles. Definition of thermal design requirements, instrumentation requirements, and design margins is also required.

**211-02 Thermal Design and Analysis (Spacecraft/Payloads/Experiments) :**

This sub-category involves thermal design, analysis, and testing of spacecraft systems and subsystems, payloads, and experiments. This includes design and definition of active and passive thermal control systems, prediction of transient orbital and interplanetary thermal environments, and heat transfer analysis to predict hardware thermal response. The expertise required includes surface geometry and solid modeling of spacecraft structures and components, prediction of thermal radiation interchange for complex geometries, prediction of absorbed orbital heating rates, and detailed predictions of orbital system performance including heater power consumption and pointing system thermal control. These analyses may require design, analysis, and integration of heat transport fluid systems. Modeling and design of high temperature furnace systems, microgravity experiments, and facilities are also required. Definition and sizing of insulation systems, thermal control surfaces, and heater control systems are required. These efforts support design/development, qualification, verification, test, and flight programs for spacecraft systems. Definition of thermal design requirements, instrumentation requirements, thermal vacuum testing requirements, and design margins is also required.

**212-00 Fluid Mechanics and Aerodynamics:**

This category includes providing aerodynamic stability and control, damping, drag and lift coefficients, aerodynamic load distribution, jet plume impingement loads, venting criteria, and performing configuration geometry shaping for aerodynamic performance. Also includes the planning, initiating and coordinating of wind tunnel programs to support Center and NASA missions including specification of mode requirement and instrumentation requirements.

**212-01 Fluid Mechanics:**

This subcategory includes the development, validation and application of Computational Fluid Dynamic (CFD) techniques and codes for reacting and combustion driven flows, assessment of aerothermal and aerodynamic environments for space propulsion systems and launch vehicles. This involves the numerical simulation of high temperature reacting flow fields of internal and external flow environments with the complex physics of non equilibrium, finite-rate chemistry and multiphase effects.

### **212-02 Aerodynamics:**

This subcategory includes providing aerodynamic stability and control, drag and lift coefficients, aerodynamic load distributions, jet plume impingement loads, venting criteria, and performing configuration geometry shaping for aerodynamic performance. Also, includes the planning, initiating and coordinating of Wind Tunnel Test Programs to support Center and NASA Missions including specification of model requirements and instrumentation. In addition, this category includes the planning, design, conduct and interpretation of experimental tests to determine the fluid flow environments internal to space vehicle propulsion systems.

### **213-00 Propulsion Systems:**

This category involves design and development activities, assessment of requirements and the establishment of specifications, and evaluation to insure proper functioning and compatibility for launch vehicle stage propulsion systems. Technical activities included are: Defining concepts and designing, developing and assuring adequate functional performance, reliability and cost estimation of propulsion and power equipment related to fluid-mechanical coupling, fluid pumping, transport, energy conversion and control; ignition, combustion, and expansion, cooling, combustion stability, hot gas containment and control and propellant and working fluid performance; design and evaluation of solid motor and hybrid launch vehicle stages or auxiliary separation and retro-motor propulsion systems, including motor case, nozzle, propellant, liner, insulation, ignition, and thrust termination components; and mathematical simulations of propulsion system elements including propellant conditioning, pressurization systems, feedline configurations, propellant orientation, engine and component performance, combustion physics, operability/reliability, costs and video/photographic analysis.

#### **213-01 Solid Motor Performance Analysis:**

The execution of complex analyses in the fields of internal ballistics, viscoelastic behavior, thermochemistry, combustion instability, erosive burning, propellant degradation, three dimensional-two-phase high velocity gas flows, systems analyses and interface engineering of solid rocket motors and systems; includes conceiving and defining design and development techniques, equipment and simulation requirements associated with developing, integrating, and using solid propulsion systems and motors.

#### **213-02 Combustion Physics Analysis:**

The development, preparation, and utilization of advanced analytical techniques, methods, and computer models for the evaluation, verification, and investigation of thermodynamic, heat transfer, fluid flow, combustion processes, and thermochemical performance analysis of liquid and solid propulsion systems, subsystems, and components. Includes the development of new advanced analytical and computational methods for the most accurate and complete simulation of component combustion processes. Also includes the pursuit of experimental research and technology projects related to heat transfer, combustion, and fluid flow processes associated with liquid and solid propulsion systems.

### **213-03 Liquid Engine Performance Analysis:**

The development and maintenance of analytical and computational models required for thermodynamics, heat transfer, fluid flow, combustion, and thermochemical performance analysis in support of current and advanced rocket propulsion components and systems. Involves the development and verification of analytical models of the phenomena, processes, and characteristics of rocket propulsion systems, particularly in the areas of heat transfer and combustion processes and diagnostics and includes the development of new advanced analytical and computational methods for the most accurate and complete simulation of components, subsystems and systems.

### **213-04 Liquid Engine System Design:**

The execution of complex analyses in the fields of mechanical design, thermodynamics, fluid mechanics, system analysis and interface engineering of launch vehicle propulsion systems and engines, including conceiving and defining design and development techniques, equipment and simulation requirements associated with developing, integrating, and using propulsion systems and engines.

### **213-05 Fluid Systems Design and Analysis:**

This category involves design and development for launch vehicle, stage, and reaction control propulsion systems. Technical activities included are as follows: Conceptual definition and design, requirement development, developing and assuring adequate function performance of propulsion systems and components related to fluid-mechanical coupling, fluid pumping, transport, and control; propellant and working fluid performance; and mathematical simulations of propulsion system elements including propellant conditioning, pressurization systems, feedline configurations, and propellant orientation and acquisition. Knowledge of fluid systems analysis, component stress analysis, as well as computer aided design are required. Performs fluid mechanics and heat transfer analyses, kinematic analyses, component design, and integrated system layouts/designs and evaluates their capability to satisfy functional and performance requirements. Systems to which this expertise is applied are gas pressurization/supply and propellant fill/drain/vent/dump/recirculation. The use of cryogenic and hypergolic fluids as well as the materials of construction for these systems add complexity to this functional area.

### **213-06 Propellant Feed System Analysis:**

Originates, conducts, and coordinates analytical studies to establish propellant feed system requirements and performance capability for launch and space vehicles. Establishes analytical procedures for predicting multi-phase pressure drop and heat transfer to propellant feed system for thermal preconditioning of cryogenic engine subsystems. Directs and evaluates analytical studies of fluid dynamic phenomena in the propellant subsystem of launch and space vehicles. Performs fluid mechanics and heat transfer analyses, component designs, and integrated system

layouts and evaluates their capability to satisfy functional and performance requirements.

**213-07 Cost/Operability/Reliability Analysis:**

Directs and coordinates the development of propulsion system performance, cost, reliability, and operability models and analyses. Performs studies and analyses of propulsion systems to verify powered flight performance, reliability, and efficient operations requirements can be met. Ensures all requirements imposed upon a project are compatible with design goals and the engineering design. Maintains cognizance of propulsion system and vehicle interfaces and impacts of propulsion system performance, reliability, and operability on vehicle systems. Provides overall technical direction, planning, and scheduling of laboratory activities in support of performance and operability design assessment activities.

**213-08 Propellant Management Systems Design:**

This subcategory addresses the issues associated with controlling the location, motion and thermodynamic state of propellants in a low-gravity environment. Propellant Management involves the combined operation of several subsystems, including high performance foam/multilayer insulation, low-gravity venting and pressure control systems, low-gravity fluid acquisition devices and fluid quantity gages. Design of Propellant Management Systems also involves the definition of procedures and methods for on-orbit resupply of cryogenic propellants, transfer of two-phase fluid in low-gravity and supply tank pressurization.

**213-09 Combustion Devices Design:**

This subcategory involves the design, development, and testing of liquid engine combustion devices for advanced propulsion systems. This includes all preliminary design with respect to approach, dimensions, structural analysis, performance predictions and meeting engine balance requirements. Development responsibilities include coordination of all activities necessary for finalization of design, fabrication, and testing of all combustion devices components which includes, injectors, thrust chambers, nozzles, preburners, heat exchangers, and ignition systems.

**213-10 Turbomachinery Design:**

This subcategory involves the use of engine level performance to derive turbomachinery design requirements, perform design analyses necessary to size turbomachinery, define hydrodynamic and aerodynamic performance, establish geometry of flow path components, and perform trade studies required to evaluate the mechanical layout of the machine. Technical responsibilities include engine and turbomachinery interfaces; internal flow dynamics, heat transfer, rotordynamics, structural design, and material selection for all turbomachinery components especially high speed seals and bearings, component design verification testing, and systems evaluation.

**213-11 Control Systems Design:**

This subcategory involves the development, design, technical review and monitoring of aerospace closed loop control systems, propellant flow control systems, auxiliary power devices, positioning control mechanisms, and experiment support mechanisms required for advanced space launch vehicles and flight payload applications.

**213-12 Energy Conversion Design:**

This subcategory involves the development, detail design, monitoring and review of turbomachinery, combustion devices, auxiliary power units and propulsion, pointing and thrust vector control systems required for advanced launch and space vehicles.

**213-13 Advanced Propulsion Research, Design and Analysis:**

This sub-category covers a broad set of functions. These include conducting experimental and theoretical research on exotic propulsion systems (E.g., nuclear fission, nuclear fusion, beamed energy, magnetoplasmadynamic thrusters) and supporting preliminary design studies via design and analysis of advanced propulsion concepts.

**213-14 Operability and Performance Integration and Analysis:**

This sub-category involves directing, coordinating, and integrating the development of propulsion system performance, cost, reliability, and operability models and analyses. Integrates the multidisciplinary studies in performance, operability, reliability, and cost to ensure trades within and between areas are supported. Performs studies and analyses of propulsion systems to verify powered flight performance, reliability, and operability requirements are met. Ensures all requirements imposed upon a project are compatible with design goals and the engineering design. Maintains cognizance of propulsion system and vehicle interfaces and impacts of propulsion system performance, reliability, and operability on vehicle systems. Provides overall technical direction, planning, and scheduling of laboratory activities in support of performance and operability design assessment activities.

**213-15 Engineering Photographic Analysis:**

This sub-category involves originating, conducting, and coordinating photographic and video analytical studies to detect, analyze, and identify anomalous conditions or events of interest that may occur during the flight of a launch vehicle or the test of a propulsion system or component. Directs and conducts the development of models and tools to ensure and maintain photographic analysis capabilities. Activities include enhancement, CAD overlay, development of timeliness, development of identification and acquisition systems, algorithm development, and report generation.

### **214-00 Mechanism Design:**

This category involves evaluating and designing mechanisms such as deployers, latches, translation devices and deployable booms. This requires the basic knowledge and skills to perform kinematics, stress and torque analysis. Also, a knowledge of the MSFC design standards, computer graphics, and material and lubrication mechanical properties and compatible is necessary.

#### **214-01 Mechanism Design:**

This sub-category involves evaluating and designing mechanisms such as deployers, latches, translation devices and deployable booms. This requires the basic knowledge and skills to perform kinematics, stress and torque analysis. Also, a knowledge of the MSFC design standards, computer graphics, and material and lubrication mechanical properties and compatible is necessary.

### **215-00 Ground Support, Servicing, and Test Equipment Design:**

This category involves the design and developmental activities associated with access, calibration, checkout, conditioning, emulation, handling, installation, packaging, protection, shipping, sampling, servicing, supporting, testing, and verification hardware used in the development and processing of flight hardware.

#### **215-01 Test Equipment/Fixture Designer:**

This subcategory includes selecting and/or designing necessary test and interface equipment and tooling for test activities, including environmental structures, propulsion and related hazardous items.

#### **215-02 Mechanical Support and Servicing Equipment Design:**

This subcategory includes a broad area of applications oriented mechanical engineering skills as well as specific skills such as hydraulics, pneumatics, and vacuum technology are required to produce hardware items such as flight hardware simulators, access floors, interfacing adapters, thermal cooling units, leak test sets, fluid servicers, rotating fixtures, tilt pallets, gas servicers, and support stands.

### **216-00 Electrical Systems:**

This category involves the performance of research design, development, and testing of LSI, microelectronics, monolithic and hybrid circuits, storage elements, electronic components and subsystems; electrical, electronic and electromechanical parts, flight packaging interconvection, distribution and techniques. Also, includes development and evaluation of sequencing controls and displays, and ordnance ignition subsystems and assemblies and the electrical support equipment associated with these systems; and the performing of the integration of the GSE electrical, mechanical, and data systems equipment.

### **216-01 Network Integration Engineering:**

This subcategory involves the performance of research, design, and development of components and techniques necessary to produce distribution systems and associated electrical ground support equipment (EGSE). Includes knowledge of performing electrical system analyses such as voltage drop and wire/fusing compatibility in support of design verification. Also includes the development and evaluation of sequencing, ordnance ignition, and control and display subsystems; and performing the electrical integration of flight and EGSE electrical subsystems. Nontechnical abilities include knowledge of specifications and standards, CAD/CAM techniques, and drawing release procedures.

### **216-02 Electronic Hardware Design Engineering:**

This subcategory involves the research, design, development, documentation, and testing of printed wiring boards and assemblies, interconnections, wire harnesses, housings, and chassis assemblies for power electronics and power distribution systems, flight computers, command and data management systems, signal conditioning systems, flight experiments, and electrical support equipment associated with these systems. Also includes thermal analysis of printed wiring assemblies, evaluation of new interconnection technology, generation and maintenance of electronic packaging specifications, and electronic hardware problem investigation and resolution.

### **217-00 Power Systems:**

This category involves the design, development, test, and evaluation of hardware for electrical power generation, storage, conditioning and distribution for all launch vehicles, spacecraft, and experiments assigned to the Center. Specifically involved are design and analysis of electrical network systems, design and development of power sources including solar arrays, fuel cells, and batteries; design and development of power switches and distribution systems; and design and development of control and display systems.

### **217-01 Electrical/Electronic Power Conditioning Circuit Design:**

This subcategory involves identifying requirements for power processing, electronic hardware design, and power electronics equipment testing for space electrical power systems; developing requirements for design and test of power electronic circuits to provide processing and control of electrical power for critical space applications; performing analysis and interface definition of space power electronic circuits, boxes, and subsystems; and working with other disciplines involved in the overall electrical power system to accomplish required tests at the system level to characterize properly the electrical dynamics of the overall system.

### **217-02 Power Systems Engineering:**

This subcategory involves functional definition and allocation of functions to hardware and software for space power systems; performing analyses and trade studies to develop requirements specifications and designs; system error budgets; system power and energy margins allocation and tracking; operational and

parametric performance analyses; developing power system architectures involving power sources, energy storage devices, and power processing electronics and verifying performance by fabrication and operation of breadboards and testbeds; identifying sensing needs, response times, algorithm requirements, and approaches necessary to automate the diagnostic and control functions involved in space power system; and coordinating inputs from other hardware and software disciplines to assure sensing and controlling requirements are met.

**217-03 Energy Conversion/Storage Engineering:**

This subcategory includes identifying requirements for the design and test of space photovoltaic electrical power energy storage components and generators; selecting the proper technology for energy storage applications through studies and trade-offs; performing analyses and trade studies for selecting technologies in specific applications; defining and modeling electrical interface characteristics of energy storage components and electrical power generators for compatibility with other spacecraft subsystems; and working with all other spacecraft subsystems in defining system level tests and verification requirements for validating the end to end electrical performance and the overall fit and functionality of the integrated energy sources component.

**218-00 Data Systems:**

This category involves planning and performing the research, design, development and evaluation of flight and ground data computational, acquisition, storage and distribution systems and subsystems such as computers, storage subsystems, data busses, and multiplexers. Includes research, design, and development of special-purpose analog/digital data handling and data systems interfaces and development of unique interface applications software.

**218-01 Flight Design and Evaluation:**

This subcategory involves planning and performing the research, design, development, and evaluation of flight data computational, acquisition, storage and distribution systems and subsystems such as computers, storage subsystems, data busses, and multiplexers.

**218-02 Ground Design and Evaluation:**

This subcategory involves planning and performing the research, design, development, and evaluation of ground data computational, acquisition, storage and distribution systems and subsystems such as computers, storage subsystems, data busses, and multiplexers.

**218-03 Flight Computer Design:**

This sub-category involves estimating, planning, performing, research, design, development, board and component level testing, and evaluation of flight computers. It also includes the coordination with other disciplines for the fabrication and qualification of the hardware for its intended flight application.

knowledge and experience in the application of modern design technique tools such as VHDL is utilized in the design phase of projects.

**218-04 Ground Computer Design and Development:**

This sub-category involves the estimating, planning, performing research, design, development, and testing of ground computers which are to be used as component unit testers or as a part of an overall EGSE system used for checkout and control of launch vehicles, spacecraft, ground test complexes, and other systems. It also includes gathering requirements and developing software to be used in unit tester applications.

**218-05 Flight Computer Development:**

This sub-category involves technical monitoring of hardware requirements definition, design, and development activities performed by companies under contract to the center. It includes interfacing with the chief engineer's office as well as main-line management to keep them aware of progress and problems. Past experience and knowledge of space flight computer application and operation are utilized to provide recommendations and direct the design to achieve the highest level of performance and reliability within cost and schedule constraints.

**218-06 Flight Data Systems Design:**

This sub-category involves estimating, planning, performing research, design, development, board and component level testing, and evaluation of flight data systems. Requires design expertise in digital data processing, flight data storage technology, command and telemetry standards, such as CCSDS and IRIG, data compression, data error correction coding, and ground support equipment design. Past knowledge and program experience are utilized to design with state-of-the-art techniques and applications to flight data systems development. It also includes the coordination with other disciplines for the fabrication and qualification of the hardware for its intended flight application. Knowledge and experience in the application of modern design technique tools such as VHDL is utilized in the design phase of projects.

**218-07 Flight Data Systems Development:**

This sub-category involves planning and performing the research, development, and evaluation of flight and ground data acquisition, storage, and distribution systems, including research and development of unique data systems interfaces. Requires expertise in digital data processing, flight data storage technology, command and telemetry standards, such as CCSDS and IRIG, data compression, data error correction coding, and telemetry ground station development. Past knowledge and program experience are utilized to provide evaluation of state-of-the-art technology and applications to data systems development. Perform trade studies to determine cost-effective data acquisition solutions to program-specific data systems development. Team with data systems contractors to provide

program office/chief engineer's office highest level of performance and reliability within cost and schedule constraints.

**219-00 Data Systems Engineering/Analysis:**

This category involves: The functional definition of data systems, allocation of functions to hardware and software, and/or analyses to develop requirements specifications and design definition including data acquisition, handling, processing and dissemination. Development of requirements accommodation approaches for both hardware and software involving software/hardware trade studies to establish lowest cost/most efficient mix in computer systems; end-to-end data system analysis; development of efficient software for embedded computer control; system error budgets; development of systems for data reduction and data analysis; advanced ground and flight equipment and technique development.

**219-01 Data Systems Engineering/Analysis:**

This sub-category involves the functional definition of data systems, allocation of functions to hardware and software, and/or analyses to develop requirements specifications and design definition including data acquisition, handling, processing and dissemination. Development of requirements accommodation approaches for both hardware and software involving software/hardware trade studies to establish lowest cost/most efficient mix in computer systems; end-to-end data system analysis; development of efficient software for embedded computer control; system error budgets; development of systems for data reduction and data analysis; advanced ground and flight equipment and technique development.

**220-00 Data Equipment:**

This category includes design, development, test or evaluation of data handling and computing and peripheral equipment for use in solving problems associated with aerospace programs. Expertise in installation, modification, and maintenance of computational systems, hybrid analog /digital equipment is essential to the category. Equipment may be intended for general use or specialized use and the engineer must be aware of the equipment's purpose, the problems to be solved or data to be handled, and the operational requirements to be met. Includes research and planning for life-cycle engineering process integration, and development of enterprise-wide engineering standards. Expertise in the development, integration, and test of application specific software is required.

**220-01 Data Equipment:**

This sub-category includes design, development, test or evaluation of data handling and computing and peripheral equipment for use in solving problems associated with aerospace programs. Expertise in installation, modification, and maintenance of computational systems, hybrid analog /digital equipment is essential to the category. Equipment may be intended for general use or

specialized use and the engineer must be aware of the equipment's purpose, the problems to be solved or data to be handled, and the operational requirements to be met. Includes research and planning for life-cycle engineering process integration, and development of enterprise-wide engineering standards. Expertise in the development, integration, and test of application specific software is required.

**221-00 Automatic Data Processing:**

This category includes skills concerned with the utilization of the computer in the analysis and solution of business, scientific, engineering and other technical problems; operating electronic, optical, and electromechanical machines that record, store, process, and transcribe data from multiple sources to solve mathematical, engineering, accounting, or technical problems, to keep records or to supply information; writing programs in computer languages to perform mathematical, engineering, and scientific computations or auditing, payroll, mailing list and text handling functions; and storing and retrieving computer data via various media (tapes, disks, cassettes, etc.). Includes skills pertinent to computer programmers, computer systems analysts, computer operators, computer data librarians, and peripheral equipment operators.

**221-01 Automatic Data Processing:**

This sub-category includes skills concerned with the utilization of the computer in the analysis and solution of business, scientific, engineering and other technical problems; operating electronic, optical, and electromechanical machines that record, store, process, and transcribe data from multiple sources to solve mathematical, engineering, accounting, or technical problems, to keep records or to supply information; writing programs in computer languages to perform mathematical, engineering, and scientific computations or auditing, payroll, mailing list and text handling functions; and storing and retrieving computer data via various media (tapes, disks, cassettes, etc.). Includes skills pertinent to computer programmers, computer systems analysts, computer operators, computer data librarians, and peripheral equipment operators.

**222-00 Theoretical Simulation Techniques:**

This category involves the application of computer theory to the formulation and study of theoretical models of aerospace research and development problems. This includes the formulation or reformulation of theoretical models as dictated by computer capabilities and limitations and involves a knowledge of analytical techniques in fluid and flight mechanics and other aerospace fields as required. Also included is the determination of specifications for modification of analog, hybrid, or digital computers to adapt them for aerospace, dynamic systems applications.

**222-01 Theoretical Simulation Techniques:**

This sub-category involves the application of computer theory to the formulation and study of theoretical models of aerospace research and development problems. This includes the formulation or reformulation of theoretical models as dictated by computer capabilities and limitations and involves a knowledge of analytical techniques in fluid and flight mechanics and other aerospace fields as required. Also included is the determination of specifications for modification of analog, hybrid, or digital computers to adapt them for aerospace, dynamic systems applications.

### **223-00 EEE Parts Engineering:**

This category involves engineering, analysis, testing, data assimilation, and evaluation of electrical, electronic, and electromechanical (EEE) parts for the proper application to space flight systems. The work includes the basic and applied research into the electrical and physical properties of electronic materials, the effects of radiation upon materials, parts, and subsystems, the evaluation of EEE parts with respect to their reliability, the analysis of EEE parts failures, the development and coordination of NASA, Military, MSFC, and Manufacturer specifications for reliable EEE parts and the design of EEE parts programs for MSFC projects, taking into account mission objectives, schedules, and program costs.

### **223-01 EEE Parts Engineering:**

This sub-category involves engineering, analysis, testing, data assimilation, and evaluation of electrical, electronic, and electromechanical (EEE) parts for the proper application to space flight systems. The work includes the basic and applied research into the electrical and physical properties of electronic materials, the effects of radiation upon materials, parts, and subsystems, the evaluation of EEE parts with respect to their reliability, the analysis of EEE parts failures, the development and coordination of NASA, Military, MSFC, and Manufacturer specifications for reliable EEE parts and the design of EEE parts programs for MSFC projects, taking into account mission objectives, schedules, and program costs.

### **224-00 Aerospace Instrumentation Systems:**

This category involves the assessment of requirements and the definition of specifications for flight instrumentation systems and the evaluation of the design, development, application, and performance of measuring transducers and associated signal conditioning to ensure proper functional, operational, and compatibility requirements are met. Technical activities included are: Defining concepts and designing, developing, and assuring adequate functional performance and reliability of measuring instrumentation components for aerospace application; Planning and performing the design, development, modification, and evaluation testing of measuring instrumentation components for flight application; Performing engineering analysis and determining configuration design and

operational requirements, interfaces, and characteristics of flight instrumentation systems for aerospace experiments and mission integration.

**224-01 Aerospace Instrumentation Systems:**

This sub-category involves the assessment of requirements and the definition of specifications for flight instrumentation systems and the evaluation of the design, development, application, and performance of measuring transducers and associated signal conditioning to ensure proper functional, operational, and compatibility requirements are met. Technical activities included are: Defining concepts and designing, developing, and assuring adequate functional performance and reliability of measuring instrumentation components for aerospace application; Planning and performing the design, development, modification, and evaluation testing of measuring instrumentation components for flight application; Performing engineering analysis and determining configuration design and operational requirements, interfaces, and characteristics of flight instrumentation systems for aerospace experiments and mission integration.

**225-00 Reserved:**

**226-00 Software Engineering:**

This category involves software systems assessment and establishment of software trade studies, software architectures, specifications, design, code, testing and sustaining engineering for embedded computer systems, operational ground systems, distributed computer systems and electrical ground support systems. Technical activities included are analysis and development of software architectures, specifications, design, code, and testing of embedded computer systems executing in flight real time environments; analysis and development of operational ground software that meets flight control standards for performance, architectures, and quality for command and control, mission planning, operations engineering, training systems, and distributed software systems; analysis and development of electrical ground support system software supporting software development and test activities; performing software computer systems administration and software quality assurance assessments; installation of security protection schemes, establishment and implementation of software configuration management plans and procedures; performing software resources requirements; performing software research activities; performing sustaining engineering of software systems; and performing software technical management of contractor developed software systems.

**226-01 Software Systems Engineering:**

This sub-category involves software systems engineering technical management; performing trade studies to establish lowest cost; establishment of resource requirements; establishment of computer hardware/software system configuration and sizing and timing requirements; evaluation and/or development and implementation of software management, development and configuration management plans; development, implementation and/or analysis of software

security protection schemes; development, implementation and/or analysis for software integration; development, implementation and/or analysis of software sustaining engineering plans; performing mission support; and performing associated software research.

**226-02 Software Implementation:**

This sub-category involves the technical management and/or analysis and synthesizing of software requirements into a software design; analysis and/or development of software architectures; performing software trade studies to identify software tools for implementation; software coding and module testing and integration; performing sizing and timing of software modules developed or under development; performing sustaining engineering of the software design and code; and performing associated software research.

**226-03 Software Requirements and Test:**

This sub-category involves the technical management and/or analysis and synthesizing of system requirements into detailed software requirements; the technical management and/or development and implementation of software test plans and procedures; review and/or generation of software test reports; analysis of software requirements; performing trade studies to determine appropriate software test and requirements tools; performing software computer systems administration and software quality assurance assessments; performing sustaining engineering of the software requirements; and performing associated software research.

**227-00 Flight RF Communications & Telemetry Systems:**

This category involves the functional definition and allocation of functions to hardware and software for RF communications and telemetry systems; performing analyses, evaluation, and trade studies to develop requirements specifications and designs; system error budgets; the design, analysis and test of RF communications and telemetry systems to include all types of transmitters, transponders, antennas, beacons, power amplifiers, low noise amplifiers, receivers, diplexers, couplers and passive RF components. The data transmitted includes telemetry, ranging, command and television. This category involves spread spectrum transmission techniques, the TDRSS communications system as relates to space vehicles, the operation, design, analysis, test, and implementation of GPS systems as relates to all types of space vehicles, the planning and conducting of theoretical analyses and trade studies to predict system performance for communications and tracking.

**227-01 Flight RF Systems:**

This sub-category involves the design, analysis and test of RF systems that provide data, command, range, acceleration, angular position and angular rate of change of launch vehicles, payloads or selected targets. This category includes RADAR and GPS systems.

**227-02 RF Antennas:**

This sub-category designs, analyses, test and evaluates all types of antennas. Must have knowledge of antenna theory and practical applications. This category performs performance test of all antenna types using a 1/2 mile antenna measurement range, 400 foot range, and anechoic chamber. This category analyzes test results, generates reports and make recommendations on the overall antenna system design.

### **228-00 Optical Systems:**

This category involves the design, fabrication, test and analysis of optical systems, subsystems and components. The category includes, telescope systems, optical instruments, video systems, laser systems, lidar systems and optical fabrication and testing equipment development.

### **228-01 Optical Design/Analysis:**

This sub-category involves the design of normal incidence, and grazing incidence optics. It specifically requires the use of industry standard optical design software tools such as Code V as well as requiring the development and utilization of special purpose design codes for application to unique systems. The analysis requires the ability to incorporate mechanical and thermal deformations along with metrology results to determine as built optical performance both in ground based testing and space based operation. This category also includes the

### **228-02 Optical Coating:**

This sub-category involves the design, application and characterization of optical coatings for high reflectance optics, filters, and anti-reflectance coatings. It requires knowledge of thin films, coating systems (including e-beam deposition, thermal evaporation, dc magnetron and rf magnetron sputtering) and surface morphology measurement.

### **228-03 Optical Fabrication:**

This sub-category involves the fabrication of reflective, refractive and diffractive optical components in a variety of materials including metal, glass, crystals, glass ceramics composites and silicon carbide. It employs fabrication techniques including diamond turning, grinding, polishing, lithography, replication and ion figuring.

### **228-04 Optical Testing:**

This sub-category involves the testing of optical components and systems. It requires the knowledge and use of surface and figure metrology instrumentation and the ability to set up and employ special test configurations, techniques and facilities for measuring the performance of optical systems, subsystems and components.

### **228-05 Precision Optomechanical Design/Analysis:**

This sub-category involves the design and analysis of precision optomechanical systems, including optical mounts, special tooling for precision fabrication and testing and precision fabrication and testing systems, subsystems and components.

**228-06 Video Systems:**

This sub-category involves the design, development and testing of video systems, subsystems and components. It also includes the development and application of image processing techniques.

**228-07 Electro-Optical Systems:**

This sub-category involves the design development and testing of electro-optical systems, subsystems and components, including lasers, electro-optic modulators, coherent lidar systems and detectors, both single element and arrays. analysis of straylight using industry standard software tools such as APART or GUERAP.

**229-00 Materials Engineering:**

This category includes the following:

**229-01 Materials Selection and Control:**

A materials engineer having sufficient expertise to plan, direct, evaluate, analyze, recommend and execute materials and processes design, development, testing and engineering documentation for space flight hardware systems. The engineer must ensure and certify that all technical requirements are met relative to the selection and practical application of materials and processes for current and future projects and programs. The engineer is specialized in the testing and evaluation of new and experimental materials for application to aerospace hardware, including the generation of the properties and characteristics required for design and analysis of materials in extreme operating environments. This includes evaluating the performance of various materials in test beds simulating operational environments, and in subscale, and full scale tests. In addition, the engineer must typically assure that Laboratory resources are properly utilized, applied and supported to accomplish the project/program requirements and to fabricate and produce reliable space flight hardware systems.

**229-02 Corrosion/Stress Corrosion:**

A materials engineer who can recognize whether combinations of metallic materials and environments are compatible with their intended use. Routinely test various material/environmental combinations, generating information that will be used to prevent future hardware problems.

**229-03 Metallurgical:**

A materials engineer to test and evaluate new and experimental alloys for use in cryogenic, ambient, and elevated temperature applications. Must have sufficient expertise to understand mechanical and thermal processing, including material's

resultant microstructure and properties. Analyze material behavior in operating environments, design and develop new materials for improved performance, and develop and/or modify new material processing methods. Develop advanced metallic, intermetallic, and composite materials, including lightweight materials, alloys to resist hydrogen embrittlement, and materials for oxygen-rich service.

**229-04 Failure Analysis:**

A materials engineer with sufficient expertise to analyze, plan, and execute a failure analysis for a component fabricated of a structural material. Identify failure mode and recommend improvements to resolve original problem (e.g., redesign component, which may include fabricating it from a more resistant material). Operate electro-optical equipment (such as SEM, TEM, ESCA, SIMS, and Auger microprobe) to analyze surface chemistry of the first few atomic layers, as well as bulk microstructural features.

**229-05 Contamination Analysis:**

This subcategory involves the surface analysis and outgassing of materials for contamination effects on bonding surfaces, surfaces to be painted or coated, optical surfaces, windows, heat transfer, and other critical surfaces. Technical activities included are: Analysis of the cleanliness of materials surfaces using Optically Stimulated Electron Emission (OSEE), Scanning Infrared Spectroscopy, Ultraviolet Fluorescence Imagery, Fiber Optic Near-Infrared/Visible /Ultraviolet Spectroscopy and Particulate Image Analysis.

**229-06 Material Coatings and Films:**

This subcategory involves the application of coatings to materials substrates by vapor, sputter or spray application. The end items can be mirrors, heat transfer surface, conductive films or standards for instrument calibrations to film thicknesses.

**229-07 Nondestructive Evaluation Engineering:**

This subcategory involves the development, specification, implementation, and performance of nondestructive evaluation (NDE) techniques to improve the reliability, performance, and cost-effectiveness of NASA programs and facilities. A broad working knowledge of electromagnetics, radiation, and thermal phenomena and a general understanding of the origin of flaws in materials is required, in addition to a more in-depth understanding of at least one of the following methods: radiography, eddy current, magnetic particle, dye penetrant, computed tomography, thermography, ultrasonics, optics, or data analysis and interpretation.

**229-08 Space Environmental Effects:**

This subcategory involves the definition, measurement, simulation, testing, and development of new or improved materials or material systems for spacecraft exposed to the deleterious effects of the space environment. A general knowledge is required of engineering physics including optical, radiation, and plasma physics

for the development and operation of space environmental simulation systems capable of producing degradation of materials and/or material systems. A more in-depth knowledge is required of the combined space environmental effects of vacuum, solar electromagnetic radiation, solar ionizing particulates, atomic oxygen, plasma, contamination, and hypervelocity impacting meteoroids or orbital debris. A general knowledge of complex ground and flight instruments, instrumentation or other hardware for the insitu measurement or monitoring of effects due to physical and chemical changes in the properties of materials or surfaces in the simulated or real space environment.

**229-09 Lubrication/Tribology:**

This subcategory involves the study of friction, lubrication and wear. In particular, it is studied how these relate to propulsion elements for spacecraft obtaining orbital Earth velocities and also for those spacecraft sent on to other areas. A general knowledge is required of engineering and physics skills in evaluating lubricants and bearings in simulated environments where they are used. An in-depth knowledge is required in high speed bearings for use in high performance turbomachinery, much of which involves understanding bearing operation in cryogenic fluids. In-depth knowledge of dry film lubricants for either propulsion applications or satellites is required. An in-depth knowledge is required in lubricants, bearing designs, bearing materials and bearing analysis.

**229-10 Polymer Chemistry:**

An engineer that specializes in the development, selection, and characterization of nonmetallic material systems for application to aerospace vehicles, propulsion systems, and payloads. Technical responsibilities include testing, evaluation and verification of properties of both traditionally used and advanced material systems such as seal materials, composite material systems, thermal insulation systems, and adhesive systems. A broad working knowledge and in-depth understanding of chemistry, surface science, adhesive bonding, polymer science, fuel technologies, and coatings. Also included is planning, scheduling, cost estimating, and material requisitioning activities associated with nonmetallic material systems.

**229-11 Ceramic Material Engineer:**

An engineer that specializes in the selection, characterization, and evaluation of various ceramic and glass materials for aerospace applications which include lenses, mirrors, windows, and thermal insulation. The engineer has broad expertise including failure analysis of glass and ceramic components, processing of glass and ceramic fibers under nominal and microgravity conditions, and development and testing of ceramic matrix composites.

**229-12 Analytical Chemistry:**

A professional specialist having the capability, training and expertise necessary to prepare, conduct, analyze, monitor, identify and report on the composition and quality of metals, non-metals, composites, gases, liquids, solids, as well as air,

water, soil and process byproducts generated by the Center Programs and institutional base facilities. Requires chemistry and environmental engineering skills necessary for sampling, analysis and data reporting in compliance with State (ADEM) and Federal (EPA) laws. Must determine the trace contaminant offgas products from materials, assembled articles and spacecraft, and evaluate the potential toxicity of these components in manned compartments. The specialist develops test methods, prepares samples and standards for analyses, and is skilled in the operation of instrumentation to ascertain results. The specialist must also develop and perform analytical testing of materials at elevated temperatures and in environments that support combustion, and conduct quantitative and qualitative chemical analysis of the products produced from resulting reactions, oxidation, combustion or thermal decomposition. Assists in the investigation and analysis of MSFC on-site accidental spills of hazardous materials.

**229-13 Combustion Research:**

A specialist experienced in performing chemical and physical test methods and procedures necessary to perform analyses on a wide variety of engineering materials. Conducts research in the areas of materials reactivity and compatibility, flammability, toxicity, materials combustion, thermal vacuum stability, LOX/GOX and aerospace fluid compatibility.

**229-14 Data Base Management:**

A specialist experienced in both the technical and operational areas of the design, development and maintenance of database systems. The engineer must evaluate material properties and test data and develop and maintain a computer knowledge base available for a broad base of users to evaluate and select materials and processes.

**230-00 Process Engineering:**

This category includes the following:

**230-01 Metallic Materials Process Development:**

A materials engineer with extensive knowledge of materials processes and techniques associated with fabricating space structures. Must understand tooling requirements, machining, forming, factory layout, critical path planning, networking, automated and non-automated fabrication techniques, assembly operations, and clean room technology. Conduct basic and applied research on various manufacturing processes (such as welding, vacuum plasma spray, casting, etc.). Establish materials systems processing and fabrication requirements to ensure appropriate microstructures and properties for components. Develop improved materials for production of models, molds, and tooling to expedite design and manufacturing processes. Develop advanced nonmetallic and composite materials, including materials for lightweight applications, thermal protection systems, and oxygen-rich service.

**230-02 Nonmetallic Materials Process Development:**

An engineer with extensive knowledge and expertise in the processing of nonmetallic material systems required for the fabrication of aerospace components and structures. Technical responsibilities include applied research and process development of techniques required for bonding, composite material processing, thermal insulation process development, coatings, surface science, fuel technologies, and polymer science. This engineer is also required to possess an ability to transfer knowledge and expertise from the development and testing of subscale and full scale articles to qualification and fabrication of flight structures, where necessary. This engineer must also understand tooling requirements, machining, forming, factory lay-out, critical path planning, networking, procurement, automated and non-automated fabrication techniques, and assembly operations. Proficiency in trouble shooting and problem resolution is also required

**230-03 Process Control:**

A materials engineer in selection, characterization, and fabrication of plastic and elastomeric materials. Must have knowledge of joining processes, control systems, sensors, robotics, automation, and computers. Evaluate seal materials and elastomer compounding. Develop and test thermal insulation and foam. Perform adhesives characterization, formulation, mixing, casting, and evaluation of fuel grains for hybrid motors. Apply state-of-the-art electronic and control technology to material joining processes, in order to improve quality and productivity.

**231-00 Reserved:**

**232-00 Manufacturing:**

This category includes management, planning, coordinating, fabrication, and assembly of development, qualification, flight, and test hardware for programs and projects at MSFC.

**232-01 Manufacturing Engineering:**

Works with design engineering to perform concurrent engineering and producibility review of design documentation, determines resource requirements for manufacturing activities, researches and develops manufacturing processes, plans and manages hardware fabrication and assembly, develops and maintains manufacturing project schedules, and resolves manufacturing related problems.

**232-02 Manufacturing Planner:**

Works with engineering design documentation to determine material and hardware requirements, generate procurement of materials, parts, and manufacturing equipment, plan and develop detailed manufacturing flow and process documentation, maintain detailed manufacturing schedules, and coordinate resolution of manufacturing problems. Maintains and refurbishes existing equipment and facilities.

**232-03 Fabricator:**

Works with materials, parts, hardware, equipment, tooling, and facilities related to fabrication and assembly processes in the fields of machining, sheetmetal, welding, heat treatment, surface treatment, precision cleaning, and electrical/electronics.

**233-00 Production Engineering:**

This category involves MSFC and industry performance in planning, design, engineering, integration, development, production, testing, delivery and operations of elements to be furnished by MSFC, assuring that cost, schedule and performance goals are met; and for management and overall technical direction for manufacturing and programmatic aspects of the production activities, fabrication and delivery of launch and spacecraft systems.

**233-01 Production Engineering:**

This sub-category involves MSFC and industry performance in planning, design, engineering, integration, development, production, testing, delivery and operations of elements to be furnished by MSFC, assuring that cost, schedule and performance goals are met; and for management and overall technical direction for manufacturing and programmatic aspects of the production activities, fabrication and delivery of launch and spacecraft systems.

**234-00 Production Control:**

This category includes the development and maintenance of schedule data for detailed manufacturing work orders, gathering, handling, and staging of materials and hardware for manufacturing activities, coordination of manufacturing work orders through manufacturing processes and inspection operations, and maintaining traceability and configuration control of materials and hardware. Also includes maintenance and operation of controlled storage areas for manufacturing materials, parts, hardware, and supplies.

**234-01 Production Control:**

This sub-category includes the development and maintenance of schedule data for detailed manufacturing work orders, gathering, handling, and staging of materials and hardware for manufacturing activities, coordination of manufacturing work orders through manufacturing processes and inspection operations, and maintaining traceability and configuration control of materials and hardware. Also includes maintenance and operation of controlled storage areas for manufacturing materials, parts, hardware, and supplies.

**235-00 Logistics Engineering:**

This category involves determining logistics requirements for support of assigned programs, availability of program tooling, equipment and facilities. Includes the SRB logistics program.

**235-01 Logistics Engineering:**

This sub-category involves determining logistics requirements for support of assigned programs, availability of program tooling, equipment and facilities. Includes the SRB logistics program.

**236-00 Safety and Mission Assurance:**

This category includes the development, implementation and operation of a safety, reliability and quality assurance management system in concert with design, manufacturing and program activities. Includes the performance of safety, reliability and quality assurance functions in assigned program/project offices through co-location assignments; management of the Lead Center Standard Parts activity; and the monitoring of in-house testing and assuring hardware and systems compliance with safety, reliability and quality assurance requirements.

**236-01 Safety and Mission Assurance:**

This sub-category includes the development, implementation and operation of a safety, reliability and quality assurance management system in concert with design, manufacturing and program activities. Includes the performance of safety, reliability and quality assurance functions in assigned program/project offices through co-location assignments; management of the Lead Center Standard Parts activity; and the monitoring of in-house testing and assuring hardware and systems compliance with safety, reliability and quality assurance requirements.

**237-00 Systems Safety Engineering:**

This category involves the review/assessment of systems safety trade studies, and the developing of procedures for, and performing in-house hazard analyses for MSFC programs and projects, and review of contractor hazard analyses, to insure that they meet the program/agency requirements. Also includes the work performed in support of MSFC Operational Readiness Reviews for all new and modified facilities to determine the readiness of a facility to operate in a safe manner.

**237-01 Systems Safety Engineering:**

This sub-category involves the review/assessment of systems safety trade studies, and the developing of procedures for, and performing in-house hazard analyses for MSFC programs and projects, and review of contractor hazard analyses, to insure that they meet the program/agency requirements. Also includes the work performed in support of MSFC Operational Readiness Reviews for all new and

modified facilities to determine the readiness of a facility to operate in a safe manner.

**238-00 Reliability Engineering:**

This category involves engineering, analytical testing, and data assimilation and evaluation from design inception to operations in which the chief concern is developing and measuring the reliability of the system, through FMEA's and/or statistical analysis.

**238-01 Reliability Engineering:**

This sub-category involves engineering, analytical testing, and data assimilation and evaluation from design inception to operations in which the chief concern is developing and measuring the reliability of the system, through FMEA's and/or statistical analysis.

**239-00 Quality Engineering:**

This category involves establishing, maintaining and evaluating quality assurance systems throughout all program phases.

**239-01 Quality Engineering:**

This sub-category involves establishing, maintaining and evaluating quality assurance systems throughout all program phases.

**240-00 Reserved:**

**241-00 Space Sciences:**

This category includes the planning, coordinating, directing and conducting of original and supporting research in Space Physics and Astronomy, Earth System Sciences, and Microgravity and Materials Sciences.

**241-01 Space Physics and Astronomy:**

This subcategory includes the planning, coordinating, directing and conducting of original and supporting research in solar and space plasma physics, optical and high-energy astronomy, gravitational physics, and other assigned technological and information systems areas associated with space physics and astronomy.

**241-02 Earth System Sciences:**

This subcategory includes the planning, coordinating, directing and conducting of original and supporting research in atmospheric science, climate and environmental processes, remote sensing technology, global hydrologic processes, and other

assigned technological and information systems areas associated with earth system science.

**241-03 Microgravity and Materials Sciences:**

This sub-category includes the planning, coordinating, directing and conducting original and supporting research in crystal growth and solidification processes; advanced materials characterization and space fabrication processes; and other assigned technological and information systems areas associated with microgravity and materials science.

**241-04 Solar Physics:**

This sub-category includes the study of the Sun and its influence on the planets: solar variability, coronal heating, flares, magnetic fields and energy release.

**241-05 Space Plasma Physics:**

This sub-category includes the study of particles and waves interacting with planetary magnetic fields. Investigate the processes which influence the geospace plasma environment.

**241-06 Cosmic Ray Astrophysics:**

This sub-category includes examining the content, structure, origin and evolution of the universe by measuring the highest energy cosmic ray particles.

**241-07 Gamma Ray Astronomy:**

This sub-category includes examining the content, structure, origin and evolution of the universe by measuring the highest energy electromagnetic waves from celestial sources.

**241-08 X-Ray Astronomy:**

This sub-category includes examining the content, structure, origin and evolution of the universe by studying the x-ray emission from celestial sources.

**241-09 Microgravity and Biotechnology Sciences:**

This sub-category includes the planning, coordinating, directing, and conducting original and supporting research in macromolecular crystal growth, diagnostics, and analysis; advanced space systems for biotechnology processes and research; and other assigned technological and information systems areas associated with microgravity and biotechnology science.

**242-00 Reserved:**

### **243-00 Technology Utilization:**

This category involves developing, implementing, and administering a technology utilization program for the Center that includes identifying and evaluating new technology derived from MSFC developed programs, both in-house and contractor-performed, and dissemination to the Nation's industrial and educational communities. Also included is the identification, development and management of Technology Transfer Engineering Application Projects with U.S. industries and other Government agencies. **NOTE: This skill code is appropriate for professional engineering positions as well as non-engineering positions.**

#### **243-01 Technology Utilization :**

This sub-category involves developing, implementing, and administering a technology utilization program for the Center that includes identifying and evaluating new technology derived from MSFC developed programs, both in-house and contractor-performed, and dissemination to the Nation's industrial and educational communities. Also included is the identification, development and management of Technology Transfer Engineering Application Projects with U.S. industries and other Government agencies. **NOTE: This skill code is appropriate for professional engineering positions as well as non-engineering positions.**

### **244-00 Configuration Management:**

This category includes individuals involved in the planning and directing of all functions related to implementation and administration of the MSFC Configuration Management (CM) System, providing Center configuration management policies, requirements and procedures and performing functions associated with baseline definition, change processing, tracking, accounting, drawings and documentation checking, documentation release functions, reviews and audits. This category also includes data requirements management which involves the development of standard data requirements descriptions and data procurement/requirements documents. The category further provides co-located personnel with configuration management experience to the projects.

#### **244-01 Configuration Management:**

This sub-category includes individuals involved in the planning and directing of all functions related to implementation and administration of the MSFC Configuration Management (CM) System, providing Center configuration management policies, requirements and procedures and performing functions associated with baseline definition, change processing, tracking, accounting, drawings and documentation checking, documentation release functions, reviews and audits. This category also includes data requirements management which involves the development of standard data requirements descriptions and data procurement/requirements documents. The category further provides co-located personnel with configuration management experience to the projects

### **245-00 Natural and Induced Environments:**

This category involves the definition and the determination of the effects of the natural space, natural terrestrial, and induced environments.

#### **245-01 Natural Space Environments:**

This subcategory involves the analyses and determination of the effects of spacecraft operating in the neutral thermosphere, ionizing radiation, plasma, meteoroid & orbital debris, solar and thermal environments. This involves performing analyses to determine the actual definition of the environments; quantifying their effect on spacecraft design, development, and operations; performing trade-off studies in order to effectively optimize spacecraft performance, risk, cost and reliability.

#### **245-02 Natural Terrestrial Environments:**

This subcategory involves the analyses and determination of the effects of wind profiles and turbulence on launch vehicle operations; specifications of the natural environmental parameters that must be considered in the development of space vehicles; performing of analyses of boundary layer wind profiles, wind shears and turbulence, ice/frost formation, and warm fog formation dissipation as they affect aircraft operation; definition of thermodynamic properties as they affect ice/frost studies; performing of experimental and theoretical studies of the microphysical processes in clouds and development of systems for measuring the three-dimensional wind fields near severe weather activity; development of statistical models of atmospheric properties, such as cloud cover, thermodynamic properties, wind profiles, for use in space vehicle development programs; and analyzing exhaust growth and diffusion processes in conjunction with the assessment of the environmental impact of launching of space vehicles.

#### **245-03 Aerothermodynamics:**

This subcategory includes providing aerothermodynamic design environments for launch vehicles and components under various flight conditions including liftoff, ascent, stage separation and reentry. Plans, conducts and interprets results of experimental tests to derive aerothermo environments. This category also includes determination of the effects of propulsion system plumes on the vehicle/component environments.

#### **245-04 Acoustics:**

This subcategory includes providing inflight acoustic environmental definition upon which inflight acoustic design and qualification criteria are based. Technical activities include determining the influence of aerodynamic and internal flow conditions for the areas of vibration, shock, and test criteria and the conception, planning, and implementation of test programs which are designed to establish inflight acoustic and propulsion system internal environments.

**245-05 Electromagnetic Environment and Effects:**

This subcategory involves the engineering activities required to assure the successful operation of spacecraft and payloads in the spacecraft's electromagnetic environment. This function includes the organization and management of electromagnetic compatibility (EMC) programs for large systems as well as developing and tailoring EMC requirement specifications. This function develops electrical bonding, grounding, and wire routing requirements. This function develops lightning protection requirements and guidelines and provides electrostatic discharge (ESD) immunity requirements. This function generates spacecraft charging analyses and charging effects mitigation guidelines. This function also provides electromagnetic interference (EMI) test services, EMI test evaluations and integrated EMC analyses, EMC design guidelines, and unique trade studies, analyses, and developmental testing to support NASA programs.

**246-00 Mission Operations Engineering:**

This category involves the engineering analysis required for operational integration and development for ground operations, preflight, flight, and postflight operations for launch and spacecraft systems.

**246-01 Human Engineering:**

This sub-category involves quantitative and qualitative assessment of the role of man in the performance of operations functions; providing the man/machine integration to include skill determination, training requirements, medical requirements, extra-vehicular activity/intra-vehicular activity requirements, and safety procedure requirements; performing human factor engineering activities and conducting and directing research activities aimed at the definition of establishing man/systems integration requirements, criterion, and guidelines.

**246-02 Orbital Mechanics:**

This sub-category involves the performance of orbital analyses (orbit selection, launch windows, orbital ephemeris, communication opportunities), and payload and experiment compatibilities. This includes development and evaluation of integrated mission timelines for pre-flight and real-time operations.

**246-03 Training Engineering:**

This sub-category involves developing and integrating the requirements for crew and ground operations team training, as well as the planning and execution of the training of flight crew and ground controllers. Also included is the overall coordination of the definition of how training will be accomplished and associated responsibilities of involved parties, i.e., NASA organizations, contractors, payload developers, and principal investigators, and development of requirements for simulations used in the above training.

**246-04 Operation Engineering and Integration:**

This sub-category provides for the operations analysis, development, and execution of mission operations performed by flight crews, ground personnel, and automation. Products include the establishment of operational requirements on flight and ground systems, including the human/machine interfaces; definition of operational concepts, plans, procedures, and support; definition of tools to support detailed planning and operations integration; and the real-time conduct of mission operations.

**246-05 Payload Operations Director:**

This sub-category involves the overall integration and management of all activities associated with the preparation and execution of payload operations. Included is the preparation, training, and simulations to assure payload cadre, experiments teams, and remote operations are prepared for the payload mission as well as responsibility for leading the payload operations during the mission period.

**247-00 Mission Operations Ground Systems:**

This category represents the multi-disciplines involved in the engineering of the mission operations ground system required to ensure operational readiness and execution.

**247-01 Facility Development Management:**

This sub-category includes the technical management of the parameters required to provide for sound development of operational facilities to meet program objectives. This includes layout, design, utilities, capabilities, and operational efficiency of all facilities.

**247-02 Ground System Engineering:**

This sub-category provides for design, analysis, development, verification, and sustaining engineering of ground operational support systems including all aspects of ground system data capture, processing, command and control, and training.

**247-03 Voice/Video System Engineering:**

This sub-category involves system planning, design, and implementation of an operational voice and video system that functions as an integral part of the overall ground support system with associated reliability and maintainability.

**247-04 Reserved**

**247-05 Computer/Network Engineering:**

This sub-category provides engineering analyses required to produce the research, design, and component acquisition for a computer/network system to support the ground operational system.

**247-06 Project Engineering:**

This sub-category provides the multi-discipline overall engineering and integration necessary to bring the individual elements together into an operational support

system/facilities. This encompasses the total life cycle of a project in technical, cost and schedule planning, development, and implementation.

**248-00 Reserved:**

**249-00 Engineering Cost Analysis:**

This category involves the development of cost estimates and supporting cost analysis for ongoing and future NASA space flight projects. Both detailed labor and material estimating and parametric estimating approaches are used. Activities include historical data collection, data normalization, statistical data analyses, statistical derivation of cost estimating relationships, computer modeling, cost risk analysis, discounted cash flow analysis, cost benefit analysis, business planning and evaluation activities, etc.

**NOTE: This skill code is appropriate for professional engineering positions as well as non-engineering positions.**

**249-01 Engineering Cost Analysis:**

This category involves the development of cost estimates and supporting cost analysis for ongoing and future NASA space flight projects. Both detailed labor and material estimating and parametric estimating approaches are used. Activities include historical data collection, data normalization, statistical data analyses, statistical derivation of cost estimating relationships, computer modeling, cost risk analysis, discounted cash flow analysis, cost benefit analysis, business planning and evaluation activities, etc.

**NOTE: This skill code is appropriate for professional engineering positions as well as non-engineering positions.**

**250-00 Advanced Systems Planning:**

This category embraces technical and programmatic planning efforts expended in the pursuit of future projects and business opportunities for MSFC. Such efforts involve the accomplishment of program planning, engineering, scientific planning, feasibility studies, and technical analyses and assessments including development of plans, requirements, and schedules to conceptually define, evaluate, and support the initiation of potential development programs in: advanced space flight systems, advanced transportation systems, science and applications payloads, and endeavors pertaining to the commercialization of space technologies. Also included is the identification and implementation of supporting research and technology requirements related to advanced systems and future projects. Advanced systems planning involves extensive interface and liaison with technical and managerial officials within the Government, industrial and scientific communities to maintain an awareness of future space related research and development activities.

**250-01 Advanced Systems Planning:**

This category embraces technical and programmatic planning efforts expended in the pursuit of future projects and business opportunities for MSFC. Such efforts involve the accomplishment of program planning, engineering, scientific planning, feasibility studies, and technical analyses and assessments including development of plans, requirements, and schedules to conceptually define, evaluate, and support the initiation of potential development programs in: advanced space flight systems, advanced transportation systems, science and applications payloads, and endeavors pertaining to the commercialization of space technologies. Also included is the identification and implementation of supporting research and technology requirements related to advanced systems and future projects. Advanced systems planning involves extensive interface and liaison with technical and managerial officials within the Government, industrial and scientific communities to maintain an awareness of future space related research and development activities.

## **ADMINISTRATIVE**

### **301-00 General Administrative:**

This category includes the following:

#### **301-01 Administrative Support:**

This skill code definition may be used for a wide variety of business/professional positions such as management analyst, administrative officer/assistant, management support specialist, etc.

#### **301-02 Clerical Steno/Typing/Office Automation:**

This subcategory includes secretarial work in steno/typing, employing office automation systems, solely or in combination with clerical work except when the clerical requires such specialized experience or training that it constitutes the paramount qualification for the position.

#### **301-03 Clerical - Subject Matter:**

This subcategory includes specialized and non-professional clerical /administrative support functions in administration, supply, procurement, travel, financial, personnel, mail and messenger service, and similar or related activities.

#### **301-04 Office and Laboratory Service Support:**

This subcategory includes general clerks, mail clerks, calibration clerks, computer aids, duplication/copier operators, documentation control and other skills. This category specifically excludes clerk typists, stenographers and subject matter clerks. These skills are necessary to support normal operations within the laboratories and offices.

### **302-00 Resources Management:**

This category includes development of budget and human resources requirements and the execution of approved program support items (e.g., contracts, materials, equipment, supplies, etc.). The category is subdivided into the following subcategories:

#### **302-01 Central Budget Operations and Funds Control:**

Directs the development of total installation budget requirements and controls the distribution of funds within the installation.

#### **302-02 Project Control:**

Resource managers assigned to specific projects or installation organizations that perform the function of budget development, budget implementation and control allocation of funds within the project or organization.

**302-03 Institutional Budget Management:**

Development and implementation of institutional budgets such as R&PM, CofF or other funds sources providing installation-wide as opposed to project support, and control allocation of funds for these activities.

**302-04 Program Analysis:**

Assessments of resource status, estimates of future resource requirements, evaluation of possible alternative budget plans and recommendations of budget requirements for on-going projects or activities. Includes project level performance measurement analysis.

**302-05 Independent Cost Analysis:**

Develops budget projections for proposed new programs, collects and maintains historical cost data, and conducts periodic reviews of on-going program performance. Not part of project staffs.

**302-06 Schedule Analysis:**

Develops, monitors and assesses schedules for new and on-going projects or activities. Includes logic network development and monitoring and critical path analysis (CPM).

**302-07 Performance Measurement Analysis:**

Established installation-wide policy on performance measurement, develops implementation plans with project management and conducts audits to ensure compliance.

**303-00 Financial Management:**

This category involves the development, implementation, and administration of a financial management plan and operating program for MSFC and providing an integrated financial reporting and control system for accountability of Center funds.

**304-00 Procurement:**

This category encompasses the skills associated with the performance of all procurement functions at MSFC. The following subcategories are included:

**304-01 Contract Negotiation and Administration:**

This subcategory includes contract specialists involved in administering contracts, grants, cooperative agreements to support research, design, development, fabrication, test and check-out of hardware and software in support of project goals. The contract specialists is also involved in actions from solicitation, evaluation, negotiation, and selection, as required, to award for contracts, research grants/cooperative agreements, for profit cooperative agreements, and military and civilian government orders necessary to provide or support research, design, development, fabrication, and other services relative to crewed and non-

crewed launch and space transportation vehicles, engines, payloads, experiments, spacecraft, and center requirements.

**304-02 Pricing:**

This subcategory includes contract price/cost analysts involved in providing contract cost analysis on all aspects of procurement pertaining to pricing and cost accounting concepts; overhead negotiations; contract cost negotiations; acceptability and effectiveness of contractors' accounting systems and procurement procedures; interpretation of cost management data and impact on assigned projects; and monitorship and evaluation of contractors' cost reduction programs.

**304-03 Small Purchases:**

This subcategory includes purchasing agents involved in awarding purchase orders for commercially available goods and services up to the simplified acquisition threshold required to support research, design, development, fabrication, and other activities relative to crewed and non-crewed launch and space transportation vehicles, engines, payloads, experiments, spacecraft, and other center requirements.

**304-04 Analysis:**

This subcategory includes procurement analysts involved in establishing policies, guidelines, standards, and procedures for the documented engineering evaluation and/or technical analysis of contractor proposals and reviews such evaluations and/or analysis for conformance thereto. The procurement analysts also provides support source selection processes, as required, and to the performance evaluation board for cost-plus-award-fee contracts. Other activities of the analysts involves developing and maintaining NASA procurement electronic commerce (EC) systems; coordinating the development and implementing all future procurement EC activities; and maintaining the MSFC procurement world wide web home page.

**304-05 Acquisition Analyst:**

This sub-category includes analyst involved in the procurement planning and preparation of official procurement packages from the requesting organizations involving Statements of Work, Technical specifications, and documentation required by Federal Acquisition Regulations.

**305-00 Personnel Management:**

This category involves providing advice and technical assistance to management, supervisory personnel, and Center employees in one or more of the personnel functions such as staffing (i.e. recruitment, placement and examining) position classification, wage

administration, and employee relations. The following specialties are included in this group: Personnel Management and Operations; Personnel Staffing; Occupational and Salary Systems.

**305-01 General:**

This category involves management advisory services in the areas of position management, position classification, adverse actions, in-service placement, pay setting, locality wage surveys, hazard pay determinations, appeals, special employee programs, employee-management relations, grievances, conduct, performance management and evaluation, etc.

**305-02 Labor Relations:**

This subcategory involves developing, promoting, and administering Federal Labor Relations Policies and administering the Federal Labor Relations program for the Center. In administering this program, Labor Relations Specialists are concerned with establishing and maintaining effective relationships with labor organizations that represent Federal employees and may be involved in such functions as policy development, agency guidance, and investigation and resolution of certain complaints and appeals.

**305-03 Training and Career Development:**

This subcategory involves the planning, administration, and evaluation of an employee development program which considers human resources and Center requirements to improve overall competency and quality of the workforce.

**305-04 Recruitment:**

This category includes staffing and recruiting specialists concerned with recruiting and the examining process for a wide variety of positions, including the rating, ranking, and certification of highly qualified candidates; maintaining registers, travel, and an expert knowledge of available appointing authorities.

**306-00 Legal:**

This category involves advising, administering, supervising, or performing professional legal work in the administration of laws entrusted to this Center.

**307-00 Public Information:**

This category includes public information officers and specialists in performing work involved in disseminating information about Government programs to the general public and to especially affected or interested individuals by means of public information channels, including educational programs or services.

**307-01 Media Relations Specialist:**

Conceives, plans and executes a comprehensive program for preparing and disseminating information on NASA and MSFC programs and activities to diverse

national publics through the news media. Requires detailed knowledge of the information needs, formats and styles of the media and an ability to take information that NASA needs disseminated and package it in a way that the media finds attractive and acceptable.

**307-02 Writer/Editor:**

Writes and edits NASA news and feature articles and photo captions on a wide variety of subjects. Writes headlines and select type and style; uses computer desktop publishing equipment to design effective page layouts; knowledge of printing operations.

**307-03 Public Information Specialist:**

Works directly with individual members of the general public and/or with specific publics (such as civic clubs, chambers of commerce or national associations) to satisfy requests or provide information on NASA/MSFC programs. Researches and analyzes information, and presents it by developing tools such as exhibits, visitor programs, speakers, freedom of information responses, and visual products.

**307-04 Education Specialist:**

Using the NASA mission, develops K-12 grade curriculum and supporting materials designed to 1) capture elementary student's interest in science and math; 2) channel high school students into college-level science/math programs; and 3) enhance the capabilities of elementary/secondary teachers. Requires professional knowledge of education theories, principles, processes and practices at primary and secondary, or post-secondary levels.

**308-01 EEO:**

This category involves Equal Opportunity Specialists and Officers assisting with Civil Rights and equality of opportunity for minorities, women, and the handicapped. It further provides for a continuing program of Equal Employment Opportunity for all MSFC employees and applicants for employment, to include the full range of employment practices and procedures.

**309-01 Internal Control:**

Involves the evaluation of Center-wide control systems for financial, administrative, program, and operational activities to provide reasonable assurances that obligations and costs are in compliance with applicable law; that funds property, and assets are safeguarded; and that revenues and expenditures applicable to Center operations are properly recorded and accounted for.

**310-01 Process Improvement:**

The area of process improvement provides the skills necessary to increase efficiency and effectiveness for the Center to carry out its missions and functions. The skills required

encompass the philosophies and techniques endemic to the process improvement paradigm and include change management, employee empowerment, customer focus, communication, teamwork, measurement of results, strategic planning, and enlightened leadership as well as the basic tools and methodologies necessary to systematically and improve all processes across the Center.

## **INSTITUTIONAL**

### **401-00 Facilities and Equipment Engineering:**

This category involves the development, implementation, and management of a facilities program encompassing the planning, budgeting, engineering, design, construction, maintenance, operations, and management of facilities in support of aerodynamic and aerophysics facilities and related systems.

#### **401-01 Architect:**

Experience in facilities planning, design, construction, and maintenance with knowledge of governing codes and standards.

#### **401-02 Civil Engineer:**

Experience in facilities planning, design, construction, and maintenance with in-depth knowledge of governing codes and standards.

#### **401-03 Electrical Engineer:**

Experience in facilities planning, design, construction, and maintenance including transmission and distribution, instrumentation, as well as instrument repair and calibration, with in-depth knowledge of governing codes and standards. Knowledge base should also include familiarity with standards traceability to the National Institute of Standards and Technology (NIST) as well as familiarity with calibration laboratory functions, standards, and facility needs.

#### **401-04 Mechanical Engineer:**

Experience in facilities planning, design, construction, and maintenance including instrument repair and calibration, HVAC, cryogenic storage and distribution, high-pressure gas systems, ultrahigh vacuum systems, and instrumentation systems with knowledge of governing codes and standards. Knowledge base should also include familiarity with standards traceability to the National Institute of Standards and Technology (NIST) as well as familiarity with calibration laboratory functions, standards, and facility needs.

#### **401-05 Facilities Support Specialist:**

Facilities technician and specialist with experience in all aspects of facilities support including such areas as real property management, city planning techniques, work order system management, A/E procurement activities, design/construction specification systems, construction practices, budget/funding control processes, and maintenance processes.

### **402-00 Computer Services:**

This category involves overview and administrative management of the Center's information technology resources in support of MSFC programs, other NASA Centers,

and other Government agencies and provides technical and operational management of the Center's general purpose digital, data reduction, supercomputing, distributed systems and Agency lead center computational activities, including monitoring these activities for major contracts.

**402-01 Data Systems Engineering:**

This subcategory involves planning and performing the research, design, evaluation, installation and maintenance of science, engineering, administrative and business information technology computational, acquisition, storage and distribution systems and subsystems such as computers, storage subsystems, networks and associated peripherals.

**402-02 Data Systems Analysis:**

This subcategory involves: The functional definition of data systems, allocation of functions to hardware and software, and/or analyses to develop requirements specifications and design definition including data handling, processing and dissemination. Development of requirements accommodation approaches for both hardware and software involving software/hardware trade studies to establish lowest cost/most efficient mix in computer systems; end-to-end data system analysis; development of efficient software systems concepts; system error budgets; development of systems for data reduction; data analysis; supercomputing; network management; and data management.

**402-03 Software Engineering and Implementation:**

This subcategory involves software systems assessment and establishment of software trade studies, software architectures, specifications, design, code, and testing for distributed computer systems and supporting software systems. Technical activities included are: software systems engineering technical management, trade studies to establish lowest cost, requirements for the number and skill of personnel, computer hardware/software system configuration; evaluation and/or development of software management and development plans; development and/or analysis of schedules and plans for software integration with the hardware; software technical specification analysis and/or development; analysis and development of software concepts; performing systems analysis of functional and performance requirements to support software architectures and establishment of software margins; and performing software research; analysis and synthesizing of software requirements into a software design; analysis and/or development of software architectures; performing software trade studies to identify software tools for implementation; software coding and module testing and integration; performing sizing and timing of software modules developed or under development, and performing sustaining engineering of the software design and code; analysis, development, installation, and sustaining engineering of system software; installation of security protection schemes; and establishment and implementation of software configuration plans and procedures.

#### **403-01 Telecommunications:**

This category involves network architecture planning, design, implementation, operations, maintenance and management of aerospace communications systems and facilities.

Technical activities include: development of communications networks and facilities to support aerospace programs; establish, arrange, maintain, and direct operating procedures and schedules to provide communications support of aerospace operations.

#### **404-01 Industrial Safety:**

This category involves the development and operation of an industrial safety program to include personnel, facilities, fire protection, handling and storage of materials, transportation, and hazardous waste disposal, hazardous testing, construction, and flight hardware projects. **NOTE: This skill code may apply to professional engineering positions as well as non-engineering positions.**

#### **405-01 Supply:**

This category involves work concerned with furnishing all types of supplies, equipment, material, property (except real estate), and certain services to components of the Federal Government, industrial or other concerns under contract to the Government, or receiving supplies from the Federal Government. Included are positions concerned with one or more aspects of supply activities from initial planning, including requirements analysis and determination, through acquisition, catalogue, storage, distribution, utilization to ultimate issue for consumption or disposal.

#### **406-01 Security:**

This category involves security specialists and other security personnel or officers concerned with protecting, directing, planning, developing, coordinating, controlling, inspecting or executing programs designed primarily to protect the national security against espionage, sabotage, threats, theft, damage, hazards, etc., in cases of persons employed or to be employed by the Federal Government.

#### **407-01 Automotive Service:**

This category includes skills concerned with servicing automobiles, trucks, and other motor vehicles. It includes such activities as automobile painting and washing; body and fender repairing, engine repairing, radiator repairing, and tire retreading and repairing; operating parking lots and garages; and selling gasoline and oil at service stations.

#### **408-01 Food Preparation and Service:**

This category includes skills concerned with preparing and serving food in such establishments as hotels, clubs, restaurants, cafeterias, and mess halls on military installations. Includes food service workers, cooks, bakers, meat cutters, dishwashers, and waiters/waitresses.

#### **409-01 General Maintenance and Support Services:**

This category includes skills concerned with moving and handling materials (e.g., loading, unloading, digging, hauling, hoisting, carrying, wrapping, mixing, pouring, spreading); washing and cleaning laboratory apparatus, cars and trucks; cleaning and maintaining living quarters, hospital rooms and wards, office buildings, grounds, and other areas; and doing other general maintenance work, by hand or using common handtools and power equipment. Includes janitors, grounds maintenance laborers, pest controllers, refuse collectors, and window cleaners.

#### **410-01 Health Services:**

This category includes skills concerned with providing health and allied services to assist physicians and other medical practitioners by caring for patients, preparing treatment rooms, transporting patients, mixing pharmaceutical preparations, performing clerical duties and providing medical laboratory services in a variety of medical service establishments such as hospitals, clinics, medical laboratories, blood banks, nursing homes, and community health organizations.

#### **411-01 Graphics/Information and Arts:**

This category includes skills concerned with the communication of information and ideas through verbal, visual, or pictorial means; the collection, custody, presentation, display, and interpretation of art works, cultural objects, and other artifacts; or a branch of fine or applied arts such as industrial design, interior design, or musical composition. Includes audiovisual librarians, exhibits specialists, illustrators, library technicians, and photographers.

#### **412-01 Materials Handling and Packing:**

This category involves skills concerned with preparing and arranging materials and products in bulk and nonbulk forms for distribution or storage; moving and loading or unloading equipment, materials, and products; operating or tending pipeline pumps and valves to transfer liquids; driving forklifts, and related material-handling machinery and equipment; and using scoops, handtrucks, and wheelbarrows to load and move materials.

#### **413-01 Mechanics and Maintenance and Repair:**

This category includes skills concerned with maintaining and repairing buildings, grounds, and related facilities; and with installing, repairing, rebuilding, and maintaining in efficient operating condition a wide variety of engines and mechanical equipment designed for use in domestic, commercial, industrial, and agricultural activities. Includes aircraft mechanics; appliance mechanics; carpenters; electricians; heating, refrigeration, and air conditioning mechanics; heavy equipment mechanics; locksmiths; painters; pipefitters; plumbers; welders; and woodworkers.

#### **414-01 Transportation:**

This category includes skills concerned with the operation and operational maintenance of self-propelled transportation and other mobile equipment used to move materials or passengers, including airplanes, motor vehicles, inland waterway vessels, harbor craft, and floating plants; and trains, locomotives, and train cars. Includes airline pilots, bus drivers, taxi drivers, and truckdrivers.

#### **415-01 Machine Tool Operation and Repair:**

This category includes skills concerned with setting up and operating machine tools and using handtools to make or repair (shape, fit, finish, assemble) metal parts, tools, gauges, models, patterns, mechanisms, and machines.

#### **416-00 Environmental Engineering:**

This category represents the multi-disciplines involved in performing the environmental engineering functions associated with environmental compliance in the management of air, water (surface and groundwater), land, biotic resources, hazardous waste/chemicals, pollution investigation and cleanup, petroleum, asbestos, toxic releases, and pollution prevention.

##### **416-01 General Environmental Engineering:**

This subcategory involves planning the engineering activities and performing/coordinating the environmental engineering functions required for a project. Technical activities include: performing evaluations and determining corrective actions; developing and implementing permits, planning projects to fulfill permit and regulatory requirements, and participating in general facility design reviews through construction to assure environmental compliance are planned for and met.

##### **416-02 Environmental Chemistry:**

A professional specialist having training and experience sampling, analyzing, and identifying regulated chemicals (toxic and/or hazardous) in all media - air, water, soil, and solid materials. The chemist understands the required U.S. Environmental Protection Agency, Standard Methods, or other mandatory procedures for sampling and analyses and is capable of developing and defending through the proper approval authorities alternative methods as necessary.

**416-03 Environmental Information Systems & Modeling:**

A professional specialist having training in geographical and data management systems customized for the management of large amounts of environmental data. The specialist has training and experience in modeling environmental data to provide projected health and environmental impact analyses in a format accepted by the U.S. Environmental Protection Agency and other regulatory agencies.