Annex B

(informative)

The systems engineering management plan

B.1 Engineering plan template

The purpose of this engineering plan template is to provide an enterprise with a format for preparing a systems engineering management plan. Typically, a project has a project-specific engineering plan for each stage of development and uses it to guide and track systems engineering activities. The project-specific engineering plan should be compliant with project management plans; enterprise plans, capabilities, and constraints; and customer expectations.

Since each project may have unique life cycle dimensions, tolerance for risk, and need for data, the engineering plan should be tailored for each application.

B.2 Engineering plan structure

The engineering plan is a living document and needs to be structured to allow for ease of updating to reflect changes and progress throughout a stage of the life cycle. Frequently changed data may be collected in a table. Data that require high-level approval to change should be separate from that which the enterprise may change. A configuration management plan for the engineering plan should be included in the engineering plan. Information should not be duplicated in multiple sections. A simple cross reference would be helpful in appropriate sections. As a guide to a preparer, typical sections are provided in the recommended template structure. A description of what each section and subsection should contain is given below.

Title Page. Includes the words "systems engineering management plan," the document control number for the project, organization involved, and the document title and/or applicable system. Figure B.1 provides an example of a title page with the necessary information identified.

Table of Contents. Lists the section title and page number of each titled paragraph and subparagraph. The table of contents should also list the title and page number of each figure, table, and appendix, in that order. (Page numbers in Figure B.2 represent template references only. No document length is inferred or implied.)

Section 1.0—Scope. Includes a brief description of the purpose of the system to which the engineering plan applies and a summarization of the purpose and content of the engineering plan and how its configuration will be managed.

Section 2.0—Applicable Documents. Lists all government, ISO, industry, enterprise, project, and other directive documents applicable to the conduct of the tasks within the engineering plan.

Section 3.0—Systems Engineering Process (SEP) Application. Describes the tasking/enterprise's SEP activities as they are to be applied to the total engineering effort of the project and the organizational responsibilities and authority for systems engineering activities, including control of supplier engineering. Descriptions include the tasks needed to satisfy each accomplishment criteria identified in the master schedule and the milestones and schedules of the systems engineering detailed schedule (detail schedule) for the project. Descriptions include narratives, supplemented as necessary by graphical presentations, detailing the plans, processes, and procedures for the application of the SEP.

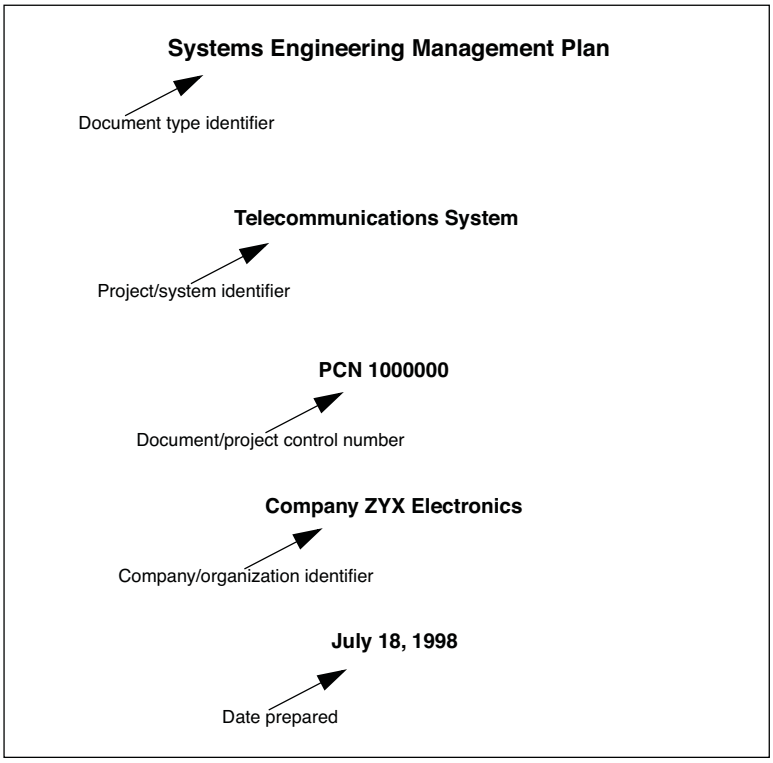

Figure B.1—Example title page

Section 3.1 Systems Engineering Process Planning. Briefly describes an overview of the key project technical objectives, deliverables and results from the process, needed process inputs, and product work breakdown structure development.

Section 3.1.1 Major Deliverables and Results. Describes in detail the major technical deliverables and results, both to the customer and internal within Company X, as a result of the SEP activities.

Section 3.1.1.1 Integrated Database. Describes the implementation of the decision database. Includes a description of how information will be captured, traced, and maintained. Provides a description of the provisioning for design-capture data/schema to include domain models (processes, technologies, etc.); product models (design prototypes—location, availability, characterization, etc.); archival data (lessons learned, past designs, empirical data); requirements, goals, and constraints; project management models (cost, schedule, and risk); integrated views, multiple views, and multidisciplinary designs and their rationale; trade-off analyses and system/cost-effectiveness analysis rationale and results; verification data; and product and process metrics.

Section 3.1.1.2 Specifications and Baselines. Describes how the generation of specifications and baselines will be documented and controlled.

Section 3.1.2 Process Inputs. Identifies the depth of detailed information needed to be able to accomplish the activities (appropriate to the level of development) of the SEP, how needed information will be acquired, and how conflicts will be resolved.

Section 3.1.3 Technical Objectives. Describes the technical objectives related to success of the project, system, and system effectiveness [e.g., customer measures of effectiveness (MOEs)]. Technical objectives may include those related to the system products and their life cycle processes.

Table of Contents

Figure B.2—Example table of contents

Section 3.1.4 System Breakdown Structure (SBS). Describes how the elements of the SBS will be developed. The relationship of the specification tree and the drawing tree with the elements of the SBS and how the system products and their life cycle processes will be related should be explained. This section should describe for each element of the SBS the methods for development and control of work packages; development of planning packages and their conversion to work packages; sizing of work packages; resource use, including integrated product teams (IPTs); traceability of changes; cost reporting and its integration to scheduling and critical path identification; and configuration management.

Section 3.1.5 Training. Identifies both internal and external (suppliers/customers) training needed. Includes analysis of performance or behavior deficiencies or shortfalls, required training to remedy, and schedules to achieve required proficiencies.

Section 3.1.6 Standards and Procedures. Describes major standards and procedures that the project will follow. Incorporates implementation of standardization tasking into pertinent sections of the SEP.

Section 3.1.7 Resource Allocation. Describes the method of resource allocation to technical tasks. Includes resource-requirements identification, procedures for resource control, and reallocation procedures.

Section 3.1.8 Constraints. Describes major constraints on the project. Includes those things the project cannot or will not do. Also includes funding, personnel, facilities, manufacturing capability/capacity, critical resources, or other constraints.

Section 3.1.9 Work Authorization. Describes the method by which work to be performed is authorized within the project. Also describes the method by which changes to work efforts will be authorized.

Section 3.2 Requirements Analysis. Documents the approach and methods for analysis of system product uses; utilization environments; inherent human limitations and capabilities; performance expectations; and design constraints and identification of needs, requirements, and constraints related to life cycle processes. Documents the approach and methods for analysis of hardware, software, and human systems engineering (manpower, personnel, training, human engineering, and system safety). Also documents the approach and methods to be used to define the functional and performance requirements for the following quality factors: producibility, testability, and integrated diagnostics, distributability (including packaging and handling, transportability, and installability), usability, supportability, trainability, and disposability; and for the following engineering specialty areas: reliability, maintainability, electromagnetic compatibility and electrostatic discharge, health hazards and environmental impact, system security, infrastructure support, and any other engineering specialty bearing on the determination of functional and performance requirements for the system for the appropriate level of development. Additionally, the approach and methods for evolving system products are described.

NOTE—Some areas may impact requirements analysis only after synthesis efforts identify implementation solution alternatives. Some of the descriptive information may be more appropriately covered under other SEP activities.

Section 3.3 Requirements Baseline Validation. Includes the approach and methods to validate that the requirements baseline established from requirements analysis is both upward and downward traceable to customer expectations, project and enterprise constraints, and external constraints.

Section 3.4 Functional Analysis. Includes a description of the approach and methods planned to determine lower-level functions, to allocate performance and other limiting requirements to lower-level functions, to define functional interfaces, and to define the functional architecture. Approaches and methods for the quality factors and engineering specialty areas in Section 3.2 are also defined.

Section 3.5 Functional Verification. Includes a description of the approach and methods planned to verify that the functional architecture established from functional analysis is both upward and downward traceable to the validated requirements baseline.

Section 3.6 Synthesis. Includes the approach and methods to transform the functional architecture into a design architecture (hardware, software, and humans to support the system life cycle), to define alternative system concepts, to define physical interfaces, and to select preferred product and process solutions. Describes how requirements are converted into detailed design specifications for hardware, software, human engineering, manpower, personnel, safety, training, and interfaces. Approaches and methods for the engineering areas, quality factors, and engineering specialty areas in Section 3.2 are also defined. In addition, nondevelopmental items and parts control are included.

Section 3.7 Design Verification. Includes a description of the approach and methods planned to verify that the design architecture, established from synthesis, is both upward and downward traceable to the functional architecture and satisfies the requirements of the validated requirements baseline; and supports baseline of configurations and specifications (including the human engineering, manpower, personnel, safety, and training specification).

Section 3.8 Systems Analysis. Includes an overview of the approach and methods planned to be utilized to arrive at a balanced set of requirements, and a balanced functional and design architecture to satisfy those requirements and control the level of development dependent outputs of the SEP. Provides an overview of the specific systems analysis efforts needed (including hardware, software, and human allocation analysis). Includes methods and tools for trade-off analyses, systems and cost effectiveness analyses, and risk management.

Section 3.8.1 Trade-off Analyses. Describes the studies planned to make trade-offs among stated requirements; design; project schedule; functional and performance requirements; function; task; and decision allocation between human, software, and hardware and life cycle/design to cost. Describes the use of criteria for decision-making and trade-off of alternative design solutions. Includes a description of technical objectives, criteria and weighting factors, and utility curves as applicable. Also describes the methods and tools planned to be used and interfaces with the integrated database.

Section 3.8.2 System/Cost Effectiveness Analyses. Describes the implementation of system and cost effectiveness analyses to support the development of life cycle balanced products and processes and to support risk management. Describes the MOEs, how they interrelate, and criteria for the selection of measures of performance (MOPs) to support the evolving definition and verification of the system. Includes description of the overall approach for system/cost-effectiveness analysis as well as manufacturing analysis; verification analysis; distribution analysis; operational analysis; human engineering, manpower, personnel, and training analysis; usability analysis; supportability analysis; safety, health hazards, and environmental analysis; and life cycle cost analysis. Describes how analytical results will be integrated.

Section 3.8.3 Risk Management. Describes the technical risk program, including the approach, methods, procedures, and criteria for risk assessment (identification and quantification), selection of the risk-handling options, and integration into the decision process. Also describes the risks associated with the development and verification requirements. Identifies critical risk areas. Describes plans to minimize technical risks (additional prototyping, technology and integration verification, and evolutionary system development). Identifies risk control and monitoring measures including special verifications, technical performance measure parameters, and critical milestones/events. Describes the method of relating technical performance measurement (TPM), the master schedule, and the detail schedule to cost and schedule performance measurement, and the relationship to the SBS.

Section 3.9 Control. Provides an overview of plans for design capture, interface management, data management, event-based scheduling, calendar-based scheduling, TPM, technical reviews, supplier control, and requirements traceability.

Section 3.9.1 Design Capture. Describes the approach and methods planned to manage the system definition (configuration) of identified system products and the related life cycle processes for manufacturing, verification, distribution, support, training, and disposal. Includes a description of change management, configuration

control procedures, and baseline management. Describes the design record for alternatives, trade-off analyses, decisions/conclusions, and lessons learned.

Section 3.9.2 Interface Management. Describes the approach and methods planned to manage the internal interfaces appropriate to the level of development to ensure that external interfaces (external to the project or at a higher level of the functional or design architecture) are managed and controlled. Includes description of change management and the interrelationship with configuration control procedures.

Section 3.9.3 Data Management. Describes the approach and methods planned to establish and maintain a data management system and the interrelationship with the design-capture system and decision database. Includes descriptions of how and which technical documentation will be controlled and the method of documentation of project engineering and technical information. Plans for security and preparation of deliverable data will also be described.

Section 3.9.4 Systems Engineering Master Schedule (SEMS). Describes the critical path methodology and criteria for event transition used to derive the master schedule and supporting systems engineering detailed schedule (detail schedule) and their structure. Includes a description of the approach and methods planned to update and maintain both the master schedule and the detail schedule.

Section 3.9.5 Technical Performance Measurement. Describes the approach and methods to identify, establish, and control key technical parameters (limited to those that are critical and/or identified by the customer). Descriptions include the thresholds, methods of measuring and tracking, update frequencies, level of tracking depth, and response time to generate recovery plans and planned profile revisions. Described parameters include identification of related risks. Describes the relationship between the selected parameter and lower-level parameters that must be measured to determine the critical parameter achievement value, which is depicted in the form of tiered dependency trees and reflects the tie in to the related system performance requirement (critical parameter). Includes definition of the correlation of each parameter in the dependency tree to a specific SBS element.

Section 3.9.6 Technical Reviews. Describes the technical reviews and/or audits (system, subsystem, component, and life cycle process) applicable to the level(s) of development covered by the engineering plan. Describes the approach and procedures planned to complete identified reviews and/or audits. The tasks associated with the conduct of each review, including responsibilities of personnel involved and necessary procedures (e.g., action item closeout procedures) are described. Includes a description of how conformance with the tasking activity engineering plan/master schedule and/or this engineering plan and enterprise master schedule will be determined, how the discrepancies identified as not meeting engineering plan/master schedule requirements will be handled, and how system products and related life cycle processes assessed to have a moderate to high risk of conformance will be addressed prior to conducting the review.

Section 3.9.7 Supplier Control. Describes the technical control of suppliers and vendors. Includes the approach and methods to flow-down requirements, manage interfaces, control quality, build long-term relationships, and assure participation on IPTs.

Section 3.9.8 Requirements Traceability. Describes how requirements traceability will be implemented. Includes the traceability between SEP activities, SBSs, and correlation, as pertinent, with the master schedule and the detail schedule. Describes the interrelationship of requirements traceability with data management and the integrated database.

Section 4.0—Transitioning Critical Technologies. Describes the approach and methods for identifying key technologies and their associated risks, and the activities and criteria for assessing and transitioning critical technologies from technology development and demonstration projects internal to the enterprise or from suppliers or other sources. Describes how alternatives will be identified and selection criteria established to determine when and which alternative technology will be incorporated into the product when moderate- to high-risk technologies are assessed, as required, to meet functional and performance requirements. Describes the planned method for engineering and technical process improvement, including procedures for establish-

ing an evolutionary system development to enable an incremental improvement approach for system products as technologies mature, or for evolution of the system.

Section 5.0—Integration of the Systems Engineering Effort. Describes how the various inputs into the systems engineering effort will be integrated and how integrated product teaming will be implemented to integrate appropriate disciplines into a coordinated systems engineering effort that meets cost, schedule, and performance objectives. Provides a brief description of the approach and methods planned to assure integration of the engineering specialties to meet project objectives.

Section 5.1 Organizational Structure. Describes how the organizational structure will support teaming. Describes the composition of teams organized to support a specific element of the SBS. Also describes major responsibilities and authority of team members by name, and includes present and planned project technical staffing. Includes planned personnel needs by discipline and performance level, human resource loading, and identification of key personnel.

Section 5.2 Required Systems Engineering Integration Tasks. Describes the approach and methods for systems engineering integration tasks such as technology verification, process proofing, fabrication of engineering test articles, development test and evaluation, implementation of software designs for system products, and customer and supplier engineering and problem solving support. This description includes an articulation of the required support team.

Section 6.0—Additional Systems Engineering Activities. Contains a brief description of other areas not specifically covered in Sections 1.0 through 5.0, but essential for planning a total systems engineering effort. Includes a brief description of additional systems engineering activities essential to successfully engineering a total system solution.

Section 6.1 Long-lead Items. Describes the long-lead items that affect the critical path of the project.

Section 6.2 Engineering Tools. Describes the systems engineering methods and tools that are planned to be implemented on the program to support systems engineering. Identifies those tools to be acquired and training requirements.

Section 6.3 Design to Cost. Describes the design-to-cost planning and how cost will be implemented and controlled as a design parameter.

Section 6.4 Value Engineering. Describes the approach and methods planned to address value engineering throughout the development cycle.

Section 6.5 Systems Integration Plan. Describes the approach and methods by which the system is assembled and integrated.

Section 6.6 Interface with other life cycle support functions. Describes the approach and methods to assure compatibility with other life cycle support functions consistent with project and enterprise plans.

Section 6.7 Safety Plan. Describes the approach and methods for conducting safety analysis and assessing the risk to operators, the system, the environment, or the public.

Section 6.8 Other Plans and Controls. Describes the approach and methods for any other plans and controls designated the tasking activity or which the enterprise system architect, systems engineer, or system integrator will use.

Section 7.0—Notes. Contains any general information that aids in understanding the engineering plan (e.g., background information; alphabetical listing of all acronyms, abbreviations, and their meanings, as used in the engineering plan; and glossary of terms used). Explains which of the items in this section are mandatory or are provided for general information.

Section 7.1 General Background Information. Provides background information that will help the implementers and managers of the activities and tasks of this engineering plan better understand and accomplish their responsibilities.

Section 7.2 Acronyms and Abbreviations. Provides an alphabetical list of acronyms and abbreviations, and their meanings.

Section 7.3 Glossary. Provides an alphabetical listing of key terms and their applied meaning within the context of this engineering plan.

Appendices. Appendices are included, as necessary, to provide information published separately for convenience in document maintenance. Included would be charts and proprietary data applicable to the systems engineering efforts required in the engineering plan. Also included as an appendix would be a summary of technical plans associated with the project. Each appendix should be referenced in one of the sections of the engineering plan where data would normally have been provided.

Annex C

(informative)

Bibliography

[B1] IEEE/EIA 12207.0–1996, IEEE/EIA Standard—Industry Implementation of ISO/IEC 12207: 1995, Standard for Information Technology—Software life cycle processes.[4]

[B2] ISO 9001: 1994, Quality systems – Model for quality assurance in design, development, production, installation, and servicing.[5]

[4]This publication is available from the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331, USA (http://www.standards.ieee.org/).

[5]ISO publications are available from the ISO Central Secretariat, Case Postale 56, 1 rue de Varembé, CH-1211, Genève 20, Switzerland/Suisse (http://www.iso.ch/). ISO publications are also available in the United States from the Sales Department, American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036, USA (http://www.ansi.org/).