TOTAL SYSTEM DEVELOPMENT

DETAIL DESIGN PHASE GUIDELINES

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1. GENERAL

1.01 The primary objectives to be satisfied during the Detail Design Phase are:

(a) Complete and finalize the design of the system.

(b) Produce the detailed specifications that are required to construct the system.

1.02 Whenever this section is reissued, the reason(s) for reissue will be included in this paragraph.

1.03 This section is a guideline. It provides expanded information in support of the concepts of Total System Development specified in Section 007-220-300*, Total System Development — Milestones.

1.04 Many of the activities within this phase are interactive. Because major activities may be assigned to several groups of people, each designer or design group must be sure to identify all critical design interfaces and monitor the progress of individuals responsible for related system modules. The design of a module may also be affected by decisions made in performing activities later in the phase. For these reasons, the designer may find the design or at least the specification of a module may not be finalized until near the end of the phase.

1.05 Although they are not highlighted as a separate activity because they are embedded in the system design, such things as error control, system controls and examination, reliability, and recovery must be considered throughout the Detail Design Phase.

1.06 It is recognized that some detail design activities may actually be performed by support organizations; for example, physical data base design, data communications specification, facility planning, etc. Each project must determine its specific responsibility for each of these design functions and provide a means for overall coordination of the design effort.

1.07 Control of change during this phase is critical. The design change requests that are received

* Check Divisional Index 007 for availability.

during this phase and the next will usually impact either the system design, the system development schedule, or both. In order to properly control such changes, procedures to document, evaluate, put in order of priority, and determine the disposition of each design change request must be strictly followed.

2. PERSONNEL PROCEDURES

2.01 Procedures must be developed for all of the work modules and functions of the system. This includes:

(a) Application work modules

(b) Support work modules/functions

(c) Supervisor work modules/functions

(d) User functions.

2.02 Tasks within each work module or function must be analyzed to determine the complete, detailed processing requirements. This may involve breaking each task down into further levels of detail until all required activities for accomplishing the tasks have been identified.

2.03 The designer must also analyze each task and step to determine the conditions under which malfunctions or errors are likely to occur. The objective of this analysis is to identify each possible error condition; determine how frequently it is likely to occur; and decide how to prevent, minimize, or correct such occurrences. If there is no way to prevent certain types of contingencies, it may be necessary to design corrective procedures to handle these problems.

2.04 The resulting procedure should optimize both processing flow and human performance. The processing sequence should be logical and efficient. All decision points should be clearly identified and all subsequent processing steps specified. Control steps should be provided as necessary to avoid unnecessary or incorrect processing. Whenever possible, feedback mechanisms should be provided to inform the operator of how well the function is being performed.

2.05 Once each manual procedure has been developed, the designer should determine the need for exhibits, decision or statement tables, performance aids, forms, reference materials, or other tools that will aid the operator in performing the manual activities.

2.06 When forms are to be used in the work module, each form should be designed and a specification prepared, stating:

(a) Format and physical description

(b) Retention, stocking, and ordering information

(c) Usage requirements.

When forms are to be stored in manual files, the content, organization, and physical attributes of the file must be determined.

2.07 Some work modules require unique equipment, furniture, or facilities. Such special work station requirements must be identified and reflected in the development of the manual procedures. This is particularly important for Visual Display Terminal (VDT) or equipment positions as these mechanisms may have special capabilities or restrictions on usage.

2.08 Once the procedures, forms, files, and facilities have been designed, the means by which each procedure will be documented must be decided. All procedures should be documented, both to properly communicate required operating methods and to provide for system integrity, auditability, and control. However, the means selected for this documentation may vary depending upon system requirements. Procedures may be captured in:

(a) Updates of existing documentation

(b) Performance aids

(c) Forms

(d) Instruction packages (eg, practices and guides)

(e) Program code (text or messages) for on-line systems

(f) Training materials

(g) Supervisor information

(h) Maintenance documents.

The designer must select the best means of documentation in light of user requirements, the nature of the

procedure itself, on-the-job usage of the product, and document maintenance considerations.

2.09 Section 007-230-210, System Deliverable Documentation, provides content and packaging specifications for documentation delivered with a centrally developed system.

3. PROGRAM LOGIC

3.01 At this point in the Detail Design Phase, the detailed logic procedures for each program or module must be developed. Potential techniques to be utilized include detailed functional analysis, stepwise refinement, use of a program definition language, flowcharts, and structure charts.

3.02 Although largely independent of the programming language that will be used for implementation, the design should take the capabilities and limitations of the language used into consideration. The limitations in particular may require restructuring the functions of a program or module so they coincide with a physical structure that can be implemented in the language.

3.03 At this point, the designer must specify any messages or codes that may be produced by the program and describe their intent.

3.04 It is also critical that the designer determine how each module is to be implemented. The designer must specify any interfaces explicitly and design the internal data structures that will be used by the module.

4. DATA BASE, RECORDS, AND FILES

4.01 Detailed specifications must be developed at this time for all the data and physical structures used by the mechanized portion of the system. These specifications will serve as documentation of the system and should provide a vehicle to ensure system integrity, auditability, control, and maintenance.

4.02 Each data group and element should be assigned a unique identifier or alias that will be used in programs that refers to data. The designer must analyze each use of a group or element to determine the best formats (including length and data type) for storage and display, taking into account space requirements, the need for conversion, efficiency, versatility, and readability. Specific codes, including record type designators, should be assigned to all applicable elements.

4.03 The physical layout of each record or segment must be designed now so the precise record length can be determined.

4.04 The organization and use of each file that will not reside under a data base management system must also be specified.

4.05 The design of the physical data bases must be completed. The designer must select the specific data base physical structures and internal access methods that will be used to store and retrieve the data. The designer must also provide for data security and recoverability of the data base as required by the Preliminary Design specifications.

5. COMMUNICATIONS NETWORK SPECIFICATION

5.01 In performing this activity, designers must consider how their data requirements fit into the overall company network. Much money and resources can be wasted if the characteristics of the corporate environment are overlooked. Therefore, the proposed network design should be reviewed with Planning, Technical Support, Computer Operations, and Marketing to assure proper compatibility and completeness.

5.02 If an existing corporate communications network specification does not meet the needs for this system, a new data network specification must be prepared. A data network specification must include all the elements of the data system. In addition to the communication lines, the designer also must consider who is communicating, what is being transmitted and where, the type of transmission, teleprocessing software packages and access methods, network speed, control, security, backup and recovery.

5.03 The capabilities and services to be provided by the application system will definitely influence the decisions made by the network designer. For example, line selection, terminals, and response times will vary depending on whether the application is batch, inquiry/response, message switching, data entry, or data collection. A further consideration is whether or not the network will use on-line, off-line, or interactive processing.

5.04 In planning a data communications system the following seven basic factors should be considered:

(a) ***Function:*** The designer should carefully review and/or further define the overall objectives of the teleprocessing system in terms of the functions it must perform.

(b) ***Distribution:*** The designer must identify all locations to be served by the network. The locations may be within the same building or in separate buildings, at short or long distances. Once the locations and the required functions are known, lines and terminals can be considered. The line selected could be dial up or private, switched half duplex or full duplex. Also to be considered is the pattern of flow, in terms of who receives and who transmits.

(c) ***Volume:*** Next, the amount of information to be communicated should be determined. Analyze both the number and length of messages, as well as peak volumes and potential growth. When estimating the probable volumes, retransmission requirements resulting from line or operational errors must also be considered.

(d) ***Urgency:*** Closely associated with volumes is the need to know when the information is available for transmission, when it is required, and what response times are allowable. Speed of transmission will be dependent upon the types of media, terminals, and lines used. Backup, recovery, and equipment or hardware availability (up time) will also require consideration in the network design.

(e) ***Language:*** The language required by the user (the data and programs) is another important consideration. In this respect, particular software or hardware and conversion or interface requirements may have to be met. In addition, human performance characteristics should be considered in the design of the human/machine interface, input coding, output interpretation, etc.

(f) ***Accuracy:*** The designer must consider the performance aspect of the teleprocessing network. The requirements set for transmission accuracy are critical to the selection of the proper physical components of the communication system. In addition, the teleprocessing software facilities for editing, checking, balancing, and data correction must be compared to the actual functional requirements of the application system.

(g) ***Cost:*** After weighing all of the factors above, the designer must evaluate the cost of the network that has been designed. Trade-offs may be necessary, based on what is required and provided versus how much it costs and how much is available, with particular attention paid to the true value of the total system.

5.05 The communication network specification should define the configuration and components of the network, the data to be shared via the network with other systems, network utilization and performance requirements, and any special procedures for network operation.

6. EQUIPMENT AND FACILITIES SPECIFICATIONS

6.01 Once work module and/or work station design has been completed, all equipment requirements should be fully detailed. Specific types and quantities of equipment items will have been determined and vendor negotiations initiated.

6.02 Any requests for equipment modification or redesign to be done by the vendor must be specified so these requirements may be stated in the contract agreement. The same is true for any special work that will be done within the company or by a local contractor.

6.03 An equipment specification should be developed for each equipment item that will be used with the system. The specification should include a general description of the item, any required modifications, delivery and test requirements, maintenance characteristics, installation locations, quantity, and cost. This specification will serve as a useful checklist during system test and conversion. Therefore, all activities that must be performed to obtain the equipment and assure that it is operational should be included in the specification.

6.04 The term "facilities" refers to the total physical space that will be occupied by the personnel and machine components of the system. The facilities requirements should include the amount of space, the physical location, and the environmental characteristics of the facility allotted to each component of the system.

6.05 In most cases, planning or engineering will be involved in the detailed planning of machine facilities. However, the facilities requirements are critical to assuring that the actual physical facilities will properly support the operational system. For

machine facilities, the following factors should be considered in preparing the requirement:

(a) Size of machine

(b) Media flow and volumes

(c) Media storage

(d) Temperature requirements

(e) Noise characteristics

(f) Machine operator

(g) Maintenance

(h) Machine backup

(i) Building restrictions

(j) Machine replacement

(k) Space for growth

(l) Interaction with other components of the system.

6.06 If the facility is to be occupied by personnel, the following factors should be considered:

(a) Number of people

(b) Nature of the work performed

(c) Work station configuration

(d) Media flow within facility

(e) Interaction between personnel

(f) Lighting

(g) Noise

(h) Temperature

(i) Equipment

(j) Occupational Safety Health Administration (OSHA) requirements

(k) Supervisory considerations

(l) Space for growth

(m) Building restrictions.

6.07 The final descisions concerning these types of work facilities will probably be made by the user organization. In fact, the facilities requirements themselves may be developed by the user representatives on the project team. However, if the design decisions and facilities preparation is to be the responsibility of the user department, the system designers must identify all the facilities characteristics that will impact overall system performance and assure that the final design adequately supports system operation.

7. HARDWARE AND SOFTWARE SPECIFICATIONS

7.01 Once the basic design of the system has been completed, the hardware and software specifications can be finalized. This may require revision to the requirements developed in Preliminary Design or it may necessitate further detailing of specific features or items.

7.02 The hardware requirements developed in Preliminary Design have provided Information Systems Organization (ISO) Planning with an early estimate of the resources required for operation of the new system. When program, data base, and file designs are complete, the original estimates should be reviewed using the more detailed specifications developed during this phase. Estimates of individual program sizes can be used to validate earlier estimates of module size, device requirements can be modified as necessary, and the specific content of records within files can be used to recalculate data transfer requirements and validate estimated run times.

7.03 The planning organization will use detail design estimates to adjust the composite projection of processing requirements. If any modeling or simulation of the application was done, those results should also be forwarded to the planning group. Such results may aid the planning group in viewing the total operations environment. This is a critical phase for planning, because if the resources required by this system or others are less than previously anticipated, a slippage in the equipment installation schedule could be indicated. On the other hand, an increase in requirements may dictate an accelerated installation plan, a different machine assignment, or a change in the projected system conversion date.

7.04 When the system is to be installed in more than one location, hardware sizing guidelines

should be developed. The guidelines should define the various parameters, formulas, and/or processing options that can be used to estimate resource requirements for a given processing site.

7.05 Basic software requirements will probably remain constant after Preliminary Design. However, changes in the types of operating control system, release, or level may affect project plans for test, conversion, and/or operation. New software or features announced since the last software evaluation may be of significant benefit to the new system. Therefore, a review of software needs and the preparation of a final specification is recommended.

8. PERSONNEL REQUIREMENTS SPECIFICATION

8.01 The total personnel requirement to convert, operate, and maintain the system must be determined. Personnel estimates should include these categories:

(a) Application work modules

(b) Support work modules/functions

(c) Supervision

(d) Data center/control center

(e) Technical support

(f) System administration

(g) Training

(h) Maintenance Computer Subsystem (CSS) and Personnel Subsystem (PSS)

(i) Special Conversion Activities.

For each category, the numbers of people, skill levels, departmental affiliation, time frame needed, etc, should be specified. If the system is to be installed in multiple locations, personnel staffing guidelines, parameters, or formulas may have to be developed.

8.02 If work modules have been grouped into jobs, either with certainty or as a guideline, each job should be described and personnel estimates provided.

8.03 Organization recommendations, (if any) should be described, giving the structure or the work group, personnel and physical requirements, administrative requirements, etc.

9. TRAINING SPECIFICATIONS

9.01 Several types of training may be required for system conversion and/or operation for:

(a) Application work modules

(b) Support work modules

(c) Data center personnel

(d) System users

(e) Information systems staff

(f) General management orientation.

9.02 The designer should consider the specific training needs of these groups of people as well as any others whose jobs may be affected by the new system. The extent of training can be determined by comparing the existing skills and knowledge of the people to the skills and knowledge they will need in order to operate and manage the new system. The basis for training then becomes those ***new*** capabilities that personnel will have to develop. For each personnel category, and for most jobs within a category, a specific training package will be identified.

9.03 Obviously, not all training packages will have to be developed from scratch. In some cases there may be existing course materials that will serve perfectly well with some modification and/or additions. The designer should review current training packages and determine where development time might be save through minor revision to existing courses.

9.04 The designer should also determine the number of people who will require each type of training. The amount of time spent on the development of a specific training package will depend to a large degree on the number of people who will use it.

9.05 For each training package, whether for formal or informal instruction, the designer should determine what the people should know or be able to do by the time they complete their training. Those things they will need to know or do become the basis for establishing course objectives.

9.06 Course objectives should be stated so they can be measured in terms of the trainee's actual

performance. Objectives that cannot be measured are of doubtful value for inclusion in the course specification. The setting of course objectives is important in assuring that all required topics are included in the course specification.

9.07 The course objectives will help the designer to decide on the best training method to use. Examples of training methods are seminars, lectures, programmed instruction, computer aided instruction, workshops, etc. The selection of the proper instruction method depends greatly on the content of the course, the number of students predicted, the skill of the developer, the time available for development or instruction, and the materials and equipment available.

9.08 With a method selected, the designer can determine how the course should be presented. The course could be taught in one continuous session or broken up into segments or modules that address specific aspects of the course content. The duration of the training sessions are determined by the type of training being given, the method of instruction, and the number and location of the people being trained. Judgment and common sense are perhaps the best guides in making this determination.

9.09 The materials required for the training package must be identified. Examples of training materials are instructor guides, student workbooks, handouts, audio and video tapes, slides, exercises and case problems, quizzes, student and course evaluation forms, etc. In addition to these materials, the deliverable user documentation may be used extensively in the training environment. Such documents as user manuals, administrative guides, work module instructions, performance aids, and forms can all be effectively used in the classroom. Any document that will be used on the job should be introduced and reviewed in the training session.

10. SYSTEM VERIFICATION, VALIDATION, AND CERTIFICATION TEST PLANS

10.01 In preparation for the testing activities in the Implementation and Conversion Phases, detailed test plans for the following three levels of testing must be prepared:

(a) Unit testing examines each discrete component (module, program, work module or procedure) of the system.

(b) Integration testing examines how each component of the system interacts with each other as they are assembled in a stepwise manner. This testing concentrates on chained programs or work modules and human/machine interfaces.

(c) System testing examines the operation of all components of the system as a whole, according to its system requirements and performance criteria.

10.02 As test plans for each level of testing detail are developed, the following testing strategies, based primarily on environment, should be considered:

(a) Verification examines the logical correctness of each component (module, program, work module, developmental component, or procedure), either individually or together, using controlled data in a test environment.

(b) Validation examines the logical correctness of the system using controlled data in the operating environment or one that approximates the operating environment as closely as possible.

(c) Certification examines the performance, quality, and reliability of the system to ensure that the system meets its objectives and its performance requirements. This type of testing is conducted in the actual operating environment using real data. Certification emphasizes the performance aspect (eg, volume, response time, fallback, and recovery, etc) of the system rather than the logical correctness of the system.

10.03 Acceptance testing is conducted as an extension of system testing and completes certification testing. It is performed by or on behalf of those who will use and operate the system to ensure the user's needs are met. It must be performed as a condition of acceptance by organizations installing a Centrally Developed System (CDS). The Project Manager will coordinate acceptance testing requirements with the recipients of the CDS.

10.04 For each specific test, a test design is prepared outlining objectives, techniques, media, expected results, resources, and schedules.

10.05 The design and creation of a test data base is also a major testing activity in this phase. This data base should contain the media required to

test the system and assure its performance is to specification. For each test plan, a complete description of the contents of the test data base and documentation on how it may be used for testing purposes is required.

10.06 A test status report system should also be established to provide the Project Manager with an effective means to observe and control the test activity.

11. SYSTEM PERFORMANCE SPECIFICATION

11.01 Although primary system performance specifications are established early in development, the specific means by which these objectives will be met are reflected in the detailed specifications of each of the system components. Because of the volume of such specifications, it is desirable to provide a summary of the overall performance attributes of the system as seen at the end of design.

11.02 The following information should be provided in the performance specification:

(a) System schedules

(b) Processing performance criteria (accuracy, throughput, resource utilization, etc)

(c) System reliability characteristics

(d) Recovery procedures

(e) System controls, security, and audit features

(f) Performance measurement capabilities.

11.03 The purpose of this specification is to describe how the system will perform, what measures have been taken to assure that performance level, and the means by which system performance can be measured in the operational environment.

12. DETAILED CONVERSION PLAN

12.01 The conversion plan should include all preconversion activities, a description of each step in the conversion process, and a conversion schedule. The schedule should indicate the start and completion date for all activities, personnel assignments by name, both project and user personnel, and dependencies on nonproject events. It is of critical importance that the project personnel and the users agree on the conversion plan, including the commitment to provide personnel as identified on the conversion schedule.

12.02 Since, in some cases, conversion may follow the completion of the Detail Design Phase by only a few weeks, the preparation of the converison plan has been included as a Detail Design activity. It is recognized, however, that for larger projects the Implementation Phase may last up to a year or longer. Under those circumstances, some of the detailed decisions, actual personnel assignments, and the determination of schedule dates will be postponed until sometime during the Implementation Phase when they can be established with a greater degree of certainty.

12.03 The conversion plan and schedule encompass a number of activities that affect both the developer and the user. While those activities are very dependent upon the project, the characteristics of the system, and the conversion approach, there are a number of items which should be considered by any project. They are:

(a) Personnel staffing (schedules, method of handling displacements or acquisitions, etc)

(b) Position conversion activities

(c) Conversion training

(d) Facility preparation

(e) Hardware/software installation

(f) Equipment installation

(g) Data base creation or conversion

(h) System certification testing

(i) Phase out of old system.

For each conversion activity, the schedule and person or organization responsible should be identified.

12.04 For central developers, the conversion plan must include all those activities required for system installation and development of any interface functions. This information will be contained in the Installation Planning Guide that is delivered to the

companies. (See Section 007-230-210, System Deliverable Documentation.)

12.05 Once the detailed plan for conversion is completed, conversion costs and resources should be reviewed. Any significant deviations from the original estimates should be reviewed with affected organizations.

13. END-OF-PHASE ACTIVITIES

13.01 For most projects, a Detail Design review is desirable or required. However, most of the documentation produced during this phase is fairly detailed and technical. For these reasons, modularized design reviews of the system may be required.

13.02 Within the project, it may be desirable to conduct ***walk-throughs*** to determine the adequacy of individual design specifications. One or more development groups may be involved in this process.

13.03 Technical design reviews may also be conducted to evaluate certain subsystems within the total system. Technical support, planning, operations, or the user may participate in these subsystem reviews.

13.04 A nontechnical system design review with special emphasis on operational procedures, schedules, controls, reports, forms, etc, may be held with user representatives.

13.05 Whatever design review procedures are selected, the amount of information, technical content, and level of detail should be appropriate for the reviewer's area of interest and technical expertise.

14. REFERENCES

14.01 The following sections will provide additional information relevant to the Detail Design Phase:

SECTION	TITLE
007-200-310	Functional Roles in a Systems Environment
007-208-310	Project Management
007-210-320*	Reviews for Conversion and Operations Impact of Centrally Developed Systems
007-220-300*	Total System Development — Milestones
007-227-310	Developmental Documentation Specifications
007-230-210	System Deliverable Documentation
007-233-300*	Testing Recommendations for Information Systems

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