Author Instructions

Objectives

Create three sets of technical requirements that are:

- Derived correctly from existing Saudi Arabian laws, regulations, and codes to create credibility
- Consistent from project to project, regardless of who is on the design team, to create patterns for design reproduction
- Easy to query for use in design activities
- Easy to verify in a design
- Easy to query for purchasing activities
- Easy to verify in the field as a basis for progress reports and payment of invoices
- Easy to modify for continuous improvement
- Amenable to incorporation in Building Information Models (BIM) and in other databases such as those used for cost estimates and payment of invoices

The three sets are defined in IC-TA-ED-03-01, *Technical Requirements,* Rev 1

1. **Engineering Manual:** Defines the basis of the design in terms of the codes and standards that are to be used for specifications and drawings. Also defines requirements for the content of drawings.
2. **Standard Specifications**: Defines requirements for the quality of products, materials, equipment, and workmanship. Division 00, Procurement and Contracting, is used to prepare and award construction contracts.
3. **Standard Details:** Defines the standard details in drawings. Drawings show the size, form, and extent of construction. Drawings complement, they do not duplicate the requirements in specifications.

References

See the files in the References Channel for more elaboration.

1. PDPG, *Project Delivery Practice Guide*, Construction Specifications Institute (CSI), 2nd Edition
2. GWR, *Guide for Writing Requirements*, International Council on Systems Engineering (INCOSE), Rev 2
3. SFPF, *SectionFormat/PageFormat*, Construction Specifications Institute (CSI), 2008 Edition
4. TR, *Development and Implementation of Technical Requirements*, IC-TA-ED-03-01, Rev 1

Definitions

See the Project Delivery and Design Terms file in the Tables > Files tab for a complete list of definitions

- **Design**: Specifications and drawings that implement the RC's vision and requirements for a project (PDPG 5.3)
- **Design Criteria**: Performance criteria for a particular requirement, stated in qualitative or qualitative
  terms. Criteria must be either measurable or observable. (PDPG 10.5.2.1)
- **Drawing**: A document that indicates relationships between elements, location, identification, dimension, size, connections, shape and form. (PDPG 11.2.1; 11.2.2)

- **IDC: Interdiscipline Coordination**. Some sections involve more than one discipline. Where that's the case, then one discipline is identified as the lead with an "L" in the Technical Requirements Review Matrix (TRRM)
- **Specification**: A document that defines the requirements for a defined work result: products, materials, workmanship, and for administration and performance of the work. (PDPG 11.1)
- **TRRM: Technical Requirements Review Matrix**. Identifies who is responsible as Lead for a section/detail (L) and for Review (R).

Requirements

Characteristics of Requirement Statements (derived from GWR)

C1 - Necessary: Traceable to either 1) a Saudi Arabian law, regulation, or code or 2) a need such as an analysis or a lesson learned.
C2 - Appropriate: Placed in the correct requirement set. Additionally, technical requirements define what is required in the design. They do not define how to create the design as is done with procedures.

C3 - Unambiguous: Stated such that it can be interpreted in only one way. Use standard terms defined in the tables provided in the Files tab of the Tables Channel.

C4 - Complete: The requirement does not require further elaboration.

C5 - Singular: Each paragraph in a Word file is a title or it states a single requirement. Insert a title at the beginning of each paragraph consisting of 2 to 3 words followed by a colon, then the requirement.

C6 - Feasible: Feasible for RC projects considering historical constraints on cost, schedule, availability, and risk.

C7 - Verifiable: Can be proven by measurement or objective observation.

C8 - Correct: An accurate representation of the source from which it was derived as defined in C1 above.

C9 - Conforming: Uses the standard templates and styles provided for each document. The template for Standard Specifications uses the same styles as used in MasterSpec files.

Characteristics of Requirement Sets (derived from GWR)

C10 - Complete: Aside from the sources identified in C1, the requirement set stands alone such that it describes the necessary capabilities, characteristics, constraints, and/or quality factors in the design without the need for supplements or procedures.

C11 - Consistent: The set of requirements contains individual requirements that are unique, do not conflict with or overlap with other requirements in the set, and the units and measurement systems they use are homogeneous. The language used within the set of requirements is consistent (i.e., the same word is used throughout the set to mean the same thing):

C12 - Feasible: The requirement set can be realized within RC constraints of cost, schedule, technical, legal, and regulatory with acceptable risk.

C13 - Comprehensible: The set of requirements must be written such that it is clear as to what is expected in the design by the RC and the role of each requirement set relative to other sets.

C14 - Able to be Validated: It must be able to be proven the requirement set will lead to the achievement of the entity needs within constraints such as cost, schedule, technical, legal and regulatory compliance.

Rules (derived from GWR)

Precision

R1 - Use the Definitive Term "the": For example, state "display the time" rather than "provide a time display"

R2 - Use an Active Voice: When an action is required, start with the verb. For example, "Test the system" rather than "the system shall be tested".

R3 - Assign to the Correct Level of Detail: For example, "Concrete: Reinforced" rather than "Building: Reinforced".

R4 - Use Defined Terms: See the tables provided for entities, work results, products, and materials. However, do not change the words in the titles of references.

R5 - Quantify Precisely: Do not use words such as “some,” “any,” “several,” “many,” “a lot of,” “a few,” “approximately,” “almost always,” “very nearly,” “nearly,” ”about,” “close to,” “almost,” “approximate,” “significant,” “flexible,” “expandable,” “typical,” “sufficient,” ”adequate,” “appropriate,” “efficient,” “effective,” “proficient,” “reasonable.”

R6 - Use Appropriate Units: Use appropriate units, with tolerances or limits, when stating quantities.

R7 - Avoid Adverbs: Adverbs modify verbs and often end with "ly". Words such as "usually" and "typically" indicates that the statement is not a requirement and is, therefore, unnecessary.

R8 - Avoid Vague Adjectives: Adjectives modify nouns such as the subject of a requirement. Avoid vague adjectives such as “ancillary,” “relevant,” “routine,””common,” “generic,” and “customary.”

R9 - Avoid Escape Clauses: Escape clauses such as "if practical" provide excuses not to comply with a requirement.

R10 - Avoid Open-Ended Clauses: Avoid phrases such as”including but not limited to,” “etc.” and “and so on." Open-ended clauses say that there is more required without stating exactly what.

Conciseness

R11 - Do Not Add Unnecessary Words: For example, state "Sink: Stainless Steel" rather than "the sink shall be made of stainless steel". The word "shall" is unnecessary in the context of requirements.

R12 - Do Not Separate Subject and Verb. For example, state "display system temperature while in operating mode" rather than, "display while in operating mode the system temperature".

Non-Ambiguity

R13 - Use Correct Grammar: Use the Word application to improve the grammar in the document. However, remember that the rules in one language differ from others. Therefore, eliminating unnecessary words as stated in R11 is very important in a multi-cultural environment.

R14 - Use Correct Spelling. Use the Word application to spell check. If the word is not in the Word dictionary, check other sources for a consensus on the spelling.

R15 - Use the Correct Punctuation. Use the suggestions provided by the Word application. Use one space between sentences. Place a period at the end of every requirement to indicate the end of text.

R16 - Do Not Use "Both" with "And": The word "and" is understood to combine two items so "both" is unnecessary and becomes confusing in a complicated sentence.

R17 - Do Not Use "And/Or": This isn't logical for a requirement. The word "or" means that the requirement applies if one of two conditions is met. Therefore, "and" is redundant. The word "and" means that the requirement applies only if both conditions are met. Therefore, "or" is not logically consistent.

R18 - Do not use "/": State two requirements 1) "Time to open: less than 1 second." 2) "Time to close: less than one second" rather than "Open/Close in less than 1 second". The latter could be interpreted as "Open and close within one second".

Singularity

R19 - Use a Single Sentence: If a requirement must be stated using a subject and a verb, keep it to one simple sentence consisting of a single topic and, if necessary, qualified by one or more sub-clauses. For example, state two requirements 1) "display temperature while in operating mode" and 2) "shut the system off after reaching X temperature" rather than "display temperature while in operating mode and shut the system off after reaching X temperature".

R20 - Avoid Words that Combine: Avoid words that join clauses, such as “and,” “or,” “then,” “unless,” “but,” “/,” “as well as,” “but also,” “however,” “whether,” “meanwhile,” “whereas,” “on the other hand,” and “otherwise.” Their presence in a requirement usually indicates that the statement has multiple requirements.

R21 - Use Bracket to Combine Conditions: Use brackets to clarify logic. For example, state "Open if X and [Y or Z]" rather than "Open if X and Y or Z".

R22 - Do Not State the Purpose. Do not use phrases such as “in order to,” “so that,” “thus allowing.” The subsequent text is not a requirement that can be used in a model or database.

R23 - Avoid Parentheses: Text that is included in parentheses indicates unnecessary text.

R24 - Do Not Use Generalizations: For example, state 1) "Read temperature every second" 2) "Activate cooling when the temperature is between X and Y degrees" rather than "Manage the temperature",

R25 - Use Diagrams for Complex Behavior: For example, "The sequence and timing of each mode is specified in Diagram X."

Completeness

R26 - Avoid Pronouns: Repeat nouns in full instead of using pronouns to refer to nouns in other requirement statements. Pronouns are words such as “it,” “this,” “that,” “he,” “she,” “they,” and “them.”

R27 - Do Not Rely on Headings: Do not use headings to identify pronouns. Example heading: "Alarm"; Unacceptable requirement: "Sound it upon detection of X." The requirement should read: "Sound alarm upon detection of X.

Realism

R28 - Avoid Absolutes: Avoid the use of "all", "100%", "minimized", "maximized", "highest" and other absolutes that are unrealistic.

Conditions

R29 - State Conditions Explicitly: Make sure that the condition identified for a set of requirements is logically correct and unambiguous. Example: "Upon detection of fire, 1) Turn off power to X 2) Unlock Y". Both requirements are applicable to the condition of "detection of fire".

R30 - State Combinations Explicitly: Make sure that the combination of conditions is logical an unambiguous. Example: "Shut off power <u>when any one</u> of following conditions are met: 1) Upon detection of fire; 2) The emergency stop is activated."

Uniqueness

R31 - Classify the Requirement: Group requirements to identify duplication and conflict. Example classifications: functional, performance, operational, reliability, availability, safety, security, standards, physical characteristics.

R32 - Express Once Only: Express each requirement once and only once.

Abstraction

R33 - Don't State a Solution: Identify "what" is required rather than impose constraints on "how" to create the "what".

Quantifiers

R34 - Use "Each": The use of “all,” “both,” or “any” is confusing because it is hard to distinguish applicability to the whole set or to each element of the set. The word "each" is more explicit.

Tolerance

R35 - Use Ranges for Values: Single-point values for requirements are difficult to meet without a tolerance on the measurement. Use words such as "nominal" as a qualifier if the exact quantity or dimension is not important.

Quantification

R36 - State Measurable Performance: Do not use words such as “prompt,” “fast,” “routine,” “maximum,” “minimum,” “optimum,” “nominal,” “easy to use,” “close quickly,” “high speed,” “medium-sized,” “best practices,” and “user-friendly.” These are ambiguous and need to be replaced by specific quantities that can be measured.

R37 - State Timing Explicitly: Do not use words for timing such as “eventually” and “at last,”. These are ambiguous and must be replaced by specific timing constraints.

Uniformity of Language

R38 - Use Defined Terms: Use the terms defined in these instructions and in the tables provided separately.

R39 - Define Acronyms: Make sure all acronyms are defined in an acronym list.

R40 - Avoid Abbreviations: The same abbreviation may have two meanings such as "op" for operation and "op" for operator. Use words such as "degrees" instead of symbols.

R41 - Use the Style Guide: Each paragraph in a file must use one of the styles provided for requirement.

Modularity

R42 - Group Dependent Requirements: For example, group performance requirements with their related functional requirement.

R43 - Group Related Requirements: Group requirements according to classification as stated in R31.

R44 - Use the Defined Template: Templates are provided for each of the three sets of requirements.