# LONG TERM PAVEMENT PERFORMANCE
# PROGRAM DIRECTIVE

*For the Technical Direction of the LTPP Program*

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| **Program Area**: | IMS | **Directive Number**: | I-56 |
| **Date**: | July 1, 1998 | **Supersedes**: | NA |
| **Subject**: | **LTPP IMS Standards and Conventions** | | |

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This directive implements the guidelines for the modification of the LTPP Oracle Database commonly referred to as the IMS. The guidelines are found in "Long-Term Pavement Performance Information Management System Standards and Conventions". The guidelines apply to changes to existing tables, replacement of existing tables for reasons other than metrication and the creation of computed parameters tables.

The document is available as hard copy or as a *.pdf file. The electronic file format has been selected so that questions and requests for clarification may be made using a fixed page numbering system which will not be affected by printer selection.

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# *LTPP Information Management System Standards and Conventions*

**July 1998**

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**Federal Highway Administration**

**Long-Term Pavement Performance**
*Serving Your Need for Durable Pavements*

**Long-Term Pavement Performance Information Management System**
**Standards and Conventions**

This document contains the guidelines for the creation and modification of elements within the Long-Term Pavement Performance (LTPP) ORACLE database commonly referred to as the LTPP IMS or IMS. While this document does not address storage and retrieval of all types of data accumulated by LTPP, it does reference those electronic files, paper forms and software elements which are integral to the creation and maintenance of the IMS. Discussion of the data philosophy for LTPP and the concept and organization of the auxiliary information management system is contained in other documents.

This document describes the expected design specifications for adding information to the IMS. While the basic structure is in place, analysis of LTPP data is expected to produce derived quantities which should be included in the IMS for other analysts. These quantities, computed parameters, represent a subset of LTPP data which may have special requirements for specifications and documentation. These requirements are grouped within each section and are in addition to any other considerations.

While review of IMS specifications is done by multiple parties, the P.I. on the TSSC prime contract with oversight responsibilities for IMS activities is the individual who must approve the final version prior to initiation of coding activities.

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I. Guidelines for Adding Elements to the IMS database

This guideline defines the approaches that will be used in adding new elements to the IMS database. This constitutes only a portion of the process in data collection and information management. The decisions on what studies to conduct and what information will be collected from them is separate from the mechanics of how data will be assembled in the IMS. What elements do eventually appear in the IMS and how they will be processed into it must, however, be considered as a part of the data identification and acquisition process.

The inclusion of information in the IMS is an iterative and multi-stage process. The initial phase is the identification of the elements which should be readily available via the IMS. Not all elements collected are necessary or suitable for inclusion in electronic form. Furthermore, not all elements which should be present in the database can be collected directly. In many cases raw data must be manipulated to create appropriate elements for the database.

Once the elements have been identified, their organization for effective storage and retrieval must be determined. When tables for storage are identified, the elements are specified in detail. They are formally named, given definitions, and units and precision are identified. The elements are organized within a schema and any limitations on the values identified. The process of transforming collected information into elements for IMS data entry is specified and executed. Following the inclusion of the information in the IMS, it is reviewed and various aspects of the entire process evaluated. This document presents the expectations in the creation of documentation for the various stages of the process and the details in writing the specifications for the IMS.

Elements may belong to any of the following categories: additional data for studies in progress, computed parameters, explanatory variables, data resulting from special studies and information on accuracy, precision and bias. An example of a computed parameter is back calculated modulus from FWD information. An example of an explanatory variable is buffer shape for FWD. Special studies data would include items from dynamic load response testing where only a small number of sections is collected. Information on accuracy would be calibration test results from a piece of weigh-in-motion (WIM) equipment. Precision and bias would be confidence intervals on a specific data element at the record level. Where precision and bias is known for a process or a group, such as within rater and between rater surveys for manual distress surveys, that information is not routinely stored within the IMS.

In addition to the categories listed above there are other ways to classify IMS information for LTPP. One is the relationship of the element to physical things. Data is either associated with a point or area on the ground, or with the means of data collection. Items in the first group are the most common in the IMS whether they are section specific or site specific. Even point specific data is stored in relation to a section. Subdivision of sections does not currently occur and is unlikely to unless significant structure differences can be demonstrated. The group of items associated with a means of collection is currently represented only by the information on equipment calibration for FWD.

Another method of categorization is by dependence on pavement materials. Items of climatic information such as precipitation are independent of whether the pavement is asphalt concrete or portland cement concrete. However, materials testing depends on the type of material so asphalt layers should not have information in tables dealing with subgrades.

## II. IMS Update Criteria

The term update has different connotations depending on the context of the discussion for LTPP data. Updating is different from maintenance. Updating is the addition of information to the database. Maintenance is revisions to database structures or data in response to changes in software, data collection procedures or receipt of data with values not anticipated in the initial design.

The IMS is a distributed database system with portions of the database in each of LTPP's four regional offices. Regional offices are responsible for the majority of the data entry and data review in the LTPP program. Data is continuously and routinely added by the regional offices in accordance with LTPP directives on field data collection and processing. This is one type of updating being done in LTPP.

The IMS also contains a centrally located release database which has data from all four regions. It is relatively static, being periodically updated a portion at a time. These updates are referred to as uploads. Since there are changes in the release database on a month to month basis, it is never an exact match with the regional segments. This copy is maintained to simplify support of outside users. Knowing exactly what the database structure and content were when data is provided allows replication and investigation of problems using duplicate data sets. It is the release database that is generally being referred to when discussing updates of the database with individuals not directly involved in IMS processing.

### A. Structure, Monitoring and Materials Data

A majority of the items in the IMS are collected in the field by either the regional offices or state and provincial agencies. They are reviewed, manipulated and input to the database with a minimum of human intervention by the regional offices. Data manipulation is a completely automated process. Review requires a judgement on whether or not the number to be entered in the IMS is valid where validity is a quality control function.

For the release database a cycle has been established which recognizes data is collected and/or summarized on an annual, monthly or infrequent basis. The release database is updated twice a year for most data items. The timing of the upload depends on whether or not a complete year's worth of data is required for summary statistics and the demands of field operations. Data which is summarized annually requires a calendar year to complete an estimate. If the data is collected on an infrequent basis, such as materials testing or inventory, an annual upload is scheduled. The regions are responsible for transferring the collected data for inclusion in the release database.

B. Computed Parameters

Throughout the discussion of updates in this section, the terms parameter and table are used interchangeably. The suite of data associated with a computed parameter or set of parameters is considered an indivisible unit when discussing computed parameter updates.

Computed parameters are the result of manipulation of collected data elements. They can be as simple as average layer thicknesses from multiple cores at a site or more complicated such as back calculated moduli requiring materials and monitoring data prepared for input into an algorithm implemented in a software package. Simple computed parameters like averages, IRI, resilient modulus of unbound materials and rut depth can be incorporated in the processing of inputs. They require no data besides that in the input data stream. Their updating is incorporated in the normal regional database processing. Other parameters like back calculated moduli, virtual weather station data and ESALs require considerable effort in review and preparation of input data prior to computation. They may be referred to as externally computed or external parameters. They require use of data elements collected at different times or as part of several distinct protocols. These parameters will be created by processes and software other than the IMS database software. They will be tasked separately from ongoing regional database updating. The updates will be no more often than once a year. The regions are expected to load this data into the database and review it after entry. However, the computations may be assigned to any contractor. The computations referred to here include manipulating extracted data to create an input data set, making all requisite calculations, reviewing the outputs and formatting the data for an IMS update.

The criteria and potential frequency of updating will be established as a part of the initial acceptance process to include any parameter in the database. In selecting a criteria and frequency the following should be considered: the frequency with which the inputs are likely to change, the amount of preprocessing required for inputs, the likelihood of developing alternative calculation methodologies, and the expected utility of the parameter. The starting point for evaluation of any update recommendation for externally computed parameters is the following.

Intervals for Externally Computed Parameters

- An interval in which less than a ten percent increase in the number of records occurs for a given parameter will generally be considered too short. If that increase occurs in less than a year's time, the minimum interval will be a year.

- The final update of a parameter for which no new data is being collected should occur within one year of the last upload of the relevant inputs.

- Parameters which require collection of information not included in standard LTPP protocols will not be updated.

- Parameters requiring up to twelve man-days for the computations will be suitable for regularly scheduled updating.

- Parameters requiring fifteen to twenty-five man-days for computation will not be updated more frequently than every three years.

- Parameters requiring more than thirty-five man-days for computation should be not be updated.

III. IMS Tables and Their Properties

Adding tables is the simplest way into include new or additional information in the IMS. The minimum number of tables practicable will be used in adding new information. It is recognized that a balance must be struck between efficiency in storage and the utility of an extracted data set. In some cases modification of existing tables will be allowed. The information about tables is contained in the schema portion of IMS specifications.

A. Determining the Number of Tables

If the data is a function of location, the minimum number of tables consistent with good practice for a relational database will be used. Generally, a single table will be used where each set of inputs and outputs occurs without substantial duplication.

> **MON_PROFILE_MASTER** *is an example of a single table where the results of one run produce nearly a dozen parameters. All of the parameters exist in a single record because they all relate to the same input data and all of them are calculated for all runs for all sections.* **TST_L05B** *is another example of a single table where all of the layer information is contained in a single table. Here there are multiple records for a section, one for each layer, since not all sections have the same number or types of layers. Thus the minimum amount of space is taken up by using multiple records with information which is common across all layers.* **MON_DEFL_MASTER** *is an example of one of a series of tables. This table contains all of the information which is taken once at each site visit in a single record. It does not have a record for every drop taken because that would result in several hundred duplicate records for each site visit.*

Link tables will only be used where the data collected consistently applies to multiple sections. This is data which applies to all sections on an SPS project, such as AWS or the GPS control section inventory data; virtual weather station data where multiple physical sites comprise a virtual station; LTPP sections are in such close proximity that they experience the same virtual weather conditions; and vehicle data which is independent of section properties and can represent the same traffic stream over multiple sections.

Where the decision is made to store a substantial portion of the inputs and intermediate results in an off-line database, a link table will be created to match IMS records to off-line sources.

> *The IMS will only contain virtual weather station data. The values for the contributing first order and responsive weather stations will be contained in an off-line database. A user who wants to see the range of high and low temperature values from the various real weather stations needs to know what files to request from off-line sources.*

If the application of a protocol produces the same outputs for all cases, a single table will be created for each logical collection of data.

> *Profile information is the same for all LTPP sections. While multiple tables exist, all profile data of a given type for all sections may be found in one table.*

If similar protocols produce similar outputs, each protocol should have a different table. Generally, each protocol, procedure or methodology should have a different table. The intent is to have the user recognize that the values being used are not the same and do not necessarily have the same accuracy, precision or bias.

> *The* **MON_RUT_X_Y** *table is an exception to this guideline as both dipstick and PASCO wireline transverse profile measurements are included in the same table. The calculations of apparent length and dielectric constant from manual TDR traces and the electronic traces will be separated because although the same approach is used in terms of defining trace types and assigning a method of interpretation, the processes to produce the values are different.*

If the outputs of a protocol or guideline are determined by a site property, a different table will be created for each basic property which influences the creation of a specified set of outputs.

> *Distress information is collected on all sections. What distresses are possible are a function of the surface layer, therefore, each surface layer type has its outputs in a different table.*

If the frequency or location of a measurement is affected by a site property, the property will be reflected in the table, not in the creation of multiple tables.

> *FWD outputs are the same for all sections. What varies by section is the location and frequency of measurement. Location is a function of material and structure and is reflected in several key fields by appropriate codes and location data. Frequency is a function of*

*experiment and is reflected in date and time information required in the records. There is not a separate* **SMP_FWD** *table nor are there separate tables for AC and PCC pavements.*

If operator or analyst comments are considered an integral part of the data set, consideration should be given to creating a table exclusively for comments. The comments table should have the same key field considerations as any other table.

**MON_DEFL_FWDCHECK_CMTS** *is an example of such a comments table although it does not contain key fields which make it easy to associate comments with field visits.*

An administrative table(s) will exist to track the externally computed parameters in the IMS database. The table would be updated by screen entry and include such items as table name, inputs, last update, next possible update, frequency of update, and a code for sections affected.

B. Naming IMS Tables

Within the IMS table names must be unique.

Table names will begin with the three-character module code and an underscore followed by any applicable monitoring type or test protocol identifiers.  Only letters, numbers and the underscore may be used in a table name.

A descriptive name to identify the table's contents is expected.

*A table with the dielectric constant and apparent length from manual traces could be named* **SMP_TDR_MAN_DIELECTRIC** *since the knowledgeable user should know that apparent length is required to calculate the dielectric constant. However,* **SMP_TDR_MAN_CALC** *is unacceptable because CALC gives no clue as to what the table contains beyond some type of manual calculation.*

Table names will be restricted to 25 characters in length.

A table definition will be provided in clear English describing precisely the contents of the table. The definition will not  exceed 210 characters including spaces. Definitions will not contain single quotes (apostrophes) or ampersands.

*The* **SMP_TDR_MAN_DIELECTRIC** *table above should be defined as -- Apparent length of TDR probes and dielectric constant values calculated from manual TDR traces using method of peaks, not -- Dielectric constant and apparent lengths.*

A minimum number of acronyms will be used. Accepted common acronyms as of 1 July 1998 are in the table below.

| | | | |
|---|---|---|---|
| AC | Asphalt Concrete | ***INV*** | Inventory |
| ACO | Asphalt Concrete Overlay | JPCC | Jointed Portland Cement Concrete |
| ***AWS*** | Automatic Weather Station | ***MNT*** | Maintenance |
| ***CLM*** | Climatic | ***MON*** | Monitoring |
| CMRAP | Cold-mix Recycled Asphalt Pavement | PCC | Portland Cement Concrete |
| | | PCCO | Portland Cement Concrete Overlay |
| CRCP | Continuous Reinforced Concrete Pavement | PMA | Plant-mix Asphalt |
| | | RCYPCC | Recycled Portland Cement Concrete |
| DEFL | Deflection | | |
| DIS | Distress | ***RHB*** | Rehabilitation |
| ***DLR*** | Dynamic Load Response | ***SMP*** | Seasonal Monitoring Program |
| ERESIST | Electrical Resistivity | ***SPS*** | Specific Pavement Studies |
| GPS | General Pavement Studies | TDR | Time Domain Reflectometry |
| HMRAP | Hot-mix Recycled Asphalt Pavement | ***TRF*** | Traffic |
| | | ***TST*** | Materials Testing |

Table names will reflect different versions of a protocol when the outputs are similar but are not identical.

> *Round 1 and 2 distress interpretations from film used the original version of the Distress Identification Manual. The AC distresses are recorded in* **MON_DIS_PADIAS_AC**. *The round 4, 5 and so forth distress interpretations use both a different version of the Distress Identification Manual and new interpretation software, version 4.2. Therefore the AC distresses for the more recent rounds are saved in* **MON_DIS_PADIAS42_AC.**

Computed parameters tables will be incorporated into the module which have the majority of their input data or the protocol which led to their existence. There will be no distinguishing characteristics required of the table name to associate it generally with other computed parameters.

> *The table for rut indices could potentially be named* **MON_RUT_INDICES** *or* **MON_RUT_X_Y_DEPTHS**, *while the table for back calculated modulus could be* **MON_DEFL_BACK_CALC_LIN83**. *These table names are associating the values with their input sources and not simply being labeled as computed parameters.*

C. IMS Table Structure

IMS tables have key fields which uniquely identify the records within a table. The key fields within any table are dependent on the record elements and their relation to the temporal and structural properties of the LTPP experiment. Key fields include a relationship to a site, project or piece of equipment.

Key fields are the first elements in a table. All key fields appear together. Key fields are ordered from the general to the specific. STATE_CODE should precede SHRP_ID. The most commonly encountered key fields are STATE_CODE, SHRP_ID, CONSTRUCTION_NO, LAYER_NO, SURVEY_DATE (or other date or time designator), LOC_NO (or other location identifier) and TEST_NO.

If the key fields include a SURVEY_DATE or TEST_DATE field or similar time stamp, CONSTRUCTION_NO will not be a key field.

> *Key fields make records unique. The field* CONSTRUCTION_NO *is not required to make a record unique and will not be made part of the unique index. It should be shown as the last key field because it is useful information for the data user and should be a required element.* CONSTRUCTION_NO *is used to relate changes in pavement structure with other time dependent data elements. This field is set to 1 when a test section is initially accepted into LTPP and is incremented with each construction related change to the pavement layer structure.*

Key fields in link tables, tables relating a group of sections to a single data collection source, should also be ordered with STATE_CODE and SHRP_ID appearing first.

RECORD_STATUS immediately follows the key fields.

IMS records are structured with key fields, RECORD_STATUS and then data fields followed by any comment fields. Comment fields should immediately follow the data field(s) to which they apply.

D. Creating Computed Parameters Tables

In addition to the basic properties of IMS tables, the following principles should be observed in determining the number of tables and their required elements.

- A computed parameters table must have key fields which link it to the tables which provided the inputs.

> *If the inputs have key fields* STATE_CODE, SHRP_ID, SURVEY_DATE *then the parameters table at a minimum should have the key* fields STATE_CODE, SHRP_ID, SURVEY_DATE *to be able to match inputs to outputs.*

- If multiple tables provided the inputs and they have different sets of key fields creation of a inputs table for that parameter is recommended.

> *Consider the case of ESALs where the inputs are in* **TRF_MONITOR_AXLE_DISTRIB***, with key fields* SHRP_ID, STATE_CODE, DATE_YEAR, MODIFICATION_NO, AXLE_GROUP and

WEIGHT_RANGE_LOW *and* **TST_L05B** *with key fields* SHRP_ID, STATE_CODE, CONSTRUCTION_NO *and* LAYER_NO. DATE_YEAR *may affect more than one value of* CONSTRUCTION_NO *and* CONSTRUCTION_NO *= 1 may be used for several values of* DATE_YEAR. *Independent of the manipulation of the* **TST_L05B** *table needed to get SN and D values, an inputs table should be created in this situation.*

- If the inputs for a computed parameter reflect a modification of IMS values, a table with the modified values must be created.

*Back calculation models are limited to three or five layers of pavement in their calculations.* **TST_L05B** *for a section generally has four to six and sometimes as many as ten layers. The layer structure actually used in the back calculation represents the section differently, and since it cannot be automatically reproduced by any other user, must be explicitly stated in the IMS. (There is no rule for example that says all asphalt layers will be aggregated into a single layer independent of material type or the existence of an overlay.)*

- If the original inputs are reasonably expected to be modified over time, an inputs table should be created to preserve the original values. Note that the inputs table may not warrant inclusion or duplication in the IMS. Off-line storage as a part of the auxiliary information management system (AIMS) will be an acceptable alternative.

*The weather stations which comprise a virtual weather station were selected based on proximity, elevation and length of time in service. If at the next update a closer weather station is accepted that was initially rejected due to insufficient time history the values for the virtual weather station may change. An analyst who has both sets of values has no way of determining whether the change is due to corrupted files or a revision of inputs. In the case of a table like* **MON_DEFL_DROP_DATA** *off-line storage of the input table due to size is reasonable. Additionally, if records tend to be reprocessed or deleted or affected by QC so that they are no longer at Level E,* **MON_PROFILE_*** *tables being a recurring case, the inputs table provides a record of available data at the time the computation was done.*

- Input data will be stored in S.I.

*A conversion of the* **TST_L05B** *table from U.S. customary to S.I. units is considered a modification of input values.*

- If the inputs are not a part of the IMS they must be incorporated in an IMS table either directly or by a link table.

*If a distress specific model is using the actual distress survey maps to qualify what is and is not a corner break, then the details about the map used must be included in the database. It could be as simple as a yes/no variable to indicate that the map was actually reviewed or it could detail map location and analyst comments and changes to the number and severity of corner breaks accepted for the analysis.*

- Computed parameters tables will have as one element of the data suite a date element, i.e., IMS release number for input data, input data extracted date, input data upload date or load date for the computed parameter.

*Data for an externally computed parameter such as ESALs should have a date on the input data such as release date to indicate the cut off for availability of inputs. Data for computed parameters which are part of a filter process such as dielectric constant from manual traces should have a load date.*

## IV. IMS Fields and Their Properties

Fields are used to store the individual elements of information within the IMS. Their properties and definitions are part of the schema portion of IMS specifications.

The principles suggested for field names do not currently apply for all elements. Modifications of current tables should be made during metrication. There are some which clearly cannot be changed. Uniqueness is also desirable to deal with the convention that codes list tables are named for the variable they apply to. This may not be possible in all cases.

### A. IMS Field Names and Definitions

To avoid user confusion, field names should be unique. Uniqueness is defined to be only one element existing with that specific definition. Conversely all tables with an element with a specific definition will use the same name for that element.

Field names will be restricted to 31 characters in length. Only letters, numbers and the underscore may be used in field names.

Fields with the following types of information will normally be exceptions to the uniqueness criteria: comments and dates. Comment fields may be COMMENT_X, COMMENT_CODE, COMMENT_TYPE without violating the uniqueness requirement. Date fields are those named and entered as dates such as TEST_DATE or SURVEY_DATE and fields like YEAR or MONTH. Time fields should include a qualifier such as PROFILE_TIME or FRICTION_TIME.

The table developer is responsible for reviewing the most recent copy of the data dictionary to insure uniqueness. The table developer is also responsible for verifying that no element with an identical definition exists with a different name.

Field definitions will be in plain English with a minimum number of acronyms. Adjustments to existing definitions to clarify their meaning will be handled through the existing SPR procedure. Definitions will not exceed 120 characters including spaces. Definitions will not contain single quotes (apostrophes) or ampersands.

B. Properties  of IMS Fields

ORACLE supports data types character, numeric, date and LONG.

The ORACLE field type LONG is a notes or memo field capable of holding 64k of data. Its use should be avoided due to the difficulties associated with extracting data of this type.

Character Fields:

Character fields may be several thousand characters long. Fields of 240 characters in width are common for comments in the IMS but can cause problems in other software. The maximum length of character fields used for descriptions should be 200 characters. Comment fields should be coded whenever possible. Comment fields to explain other items, those not on a codes list, should be restricted to 60 characters or less.

Codes:

Codes represent an efficient use of space in the database. Codes provide a shorthand for describing properties of materials, data collection or qualitative items. To the maximum extent possible codes should be used instead of character fields for descriptions  or comments in the IMS.

Codes are contained in character fields.

Existing code tables should be used whenever possible. Codes may be added to the tables as needed as long as the additional values are consistent with the development of the original codes list.

Codes will be numbers in a character field except for Yes/No fields.  Yes/No fields will be coded Y/N, uppercase only.

Alpha codes where used will be mnemonic rather than sequential. As an example consider the DATA_AVAIL_CODE field in the **TRF_TOT_ANL_EST_LTPP_LANE** table which is populated using the SRO code; S is site-specific, R is site-related and O is other.

Code fields will be specified no wider than the number of characters of the largest expected code. A code should not exceed 5 characters.

The information which is equivalent to the code will not exceed 75 characters including spaces.

Zero will not be used as a code. (The few existing zero valued codes will not be modified.)

Codes should be sequential without gaps starting with 1.

*OTHER* as a code option should be the highest valued code when the codes list is initially created. A code for other is required if a comment field to describe other is included as a data element.

Codes Tables:

The table of codes for each coded field includes both a header and all of the relevant codes. The header includes the name of the codes table, a description of the code and a reference. The codes are listed in sequence below.

Names of codes tables are unique. The name of the code's table is usually identical to the name of the field to which it applies. If it is not, it will not exceed 31 characters. If the field name and code's table name are not identical, the alternative chosen should be very close to the actual field name.

The code's description is a clear English definition of the code's purpose not to exceed 90 characters including spaces. It may be omitted if the code's name makes its usage obvious.

The reference for the code is the basic source where the code is documented. It may be a form, a protocol or a guideline.

Numbers:

Numeric fields may be integer or real and are shown in the ORACLE format (X,Y). The value to the left of the comma, X, is the total number of digits excluding sign or decimal point. The value to the right of the comma, Y, is the number of places to the right of the decimal point.

> *A field which could hold a value as large as 999.99 or as small as -999.99 would be defined as (5,2).*

Numeric fields for inputs will not be specified more accurately than they may be measured.

Final results should not be specified to an accuracy greater than the accuracy of the least precise input. Generally there should be no more than three significant digits. Use the significant digits of the inputs as a guideline.

Intermediate results of calculations stored in the IMS will not have more than 4 places to the right of the decimal point.

Dates and Times:

Date fields will have four digit years.

Fields that are year only will be numeric with a four digit value. Similarly month and day fields will be numeric with a two digit value.

Time fields will be character with four spaces and use a 24 hour clock.

C. Fields for Computed Parameters Tables

All data inputs, intermediate values and outputs will be in S.I. units unless no S.I. equivalent exists.

In the case of conflicts arising from simultaneous development of computed parameters tables, the party responsible for IMS coding will resolve the issue and notify the developers of any changes which must be made in the specifications submitted.  Possible conflicts are field names, field definitions, different numeric types or specifications of precision.

V. IMS Data Entry

Data may be entered in the IMS by one of two means: screen entry or electronic file transfer. The former is generally the result of data being collected on some type of form. The latter is the output of an automated process.

A. Basic Concepts

For any particular IMS table only one method of data entry, either form or filter, may be used.

If a data suite uses multiple IMS tables, different data entry methods may be used for each table.

All data entered will be entered key fields first. When all key fields are entered, a check will be made to see if a matching record exists. If so, it will be displayed for edit. Otherwise a new record may be entered. The fields need not be entered in the same order as they appear in the table.

Key fields which are also found in **EXPERIMENT_SECTION** will be verified before data entry proceeds. Key fields which need to be validated using other tables will be specified by the developer.

*At a minimum every set of section related data will be checked against* **EXPERIMENT_SECTION** *to verify that the* STATE_CODE *and* SHRP_ID *combination exist for the relevant point in time. If the data requires that a record exist in a table of inputs, such as an overlay record for* CONSTRUCTION_NO *greater than 1 in* **TST_L05B***, the developer must state that in the specification.*

The table developer is responsible for documenting the required sequence for data entry. This includes either the sequence for multiple forms or the order of forms and filters. Where a specific sequence is required, it must be stated in the specifications. If no sequence is explicitly stated, random order will be considered possible, but sequential order will be the default.

*Traditionally, IMS forms have advanced a field at a time for data entry due to the original operating system. The current one permits design of forms with location of data entry controlled by mouse, not just fixed order entry.*

CONSTRUCTION_NO is populated as a function of existing IMS software.

RECORD_STATUS is set to A on entry for all records.

B. Forms

All data lines will be identified with a description and where possible with a number for reference in coding.

All screen forms will match paper forms as closely as possible.

All paper forms will contain all information required for screen without shifting to another piece of paper. However, multiple screens may be filled from a single sheet.

When submitting the specifications for coding, the data descriptions will be annotated with the field name if different from the description.

Specifications will include the existence of any relevant pick lists. Pick lists are identical to the codes list for a field. When preparing specifications a copy of the form will be annotated with the name of the codes list table as well as the field name.

*When submitting Inventory Sheet 3 for coding, the Layer Description column would not only have the field name* DESCRIPTION *annotated on it, but the codes list found in Note 2 would indicate that the list was called LAYER_DESC.*

Any fatal errors which would preclude adding the information from the form to the database should be identified by the developer. These are fields other than key fields which will be specified as non-null in database design.  Problems which can be corrected either by manual upgrades after QC or at another data entry session, may be identified. For fields that allow the use of a default in the absence of critical data, the allowable default value will be specified on the form.

> *If the data are dependent on a value such as* LAYER_TYPE *and* LAYER_TYPE *is not a key field, then this is a value which should appear in the input sequence immediately after the key fields and before any other data. The input sequence should require this entry and preclude any other data entry from occurring until this field is non-null with an appropriate value. If the data need layer thickness and a value for thickness is not currently available but all of the other information is present, then a code value for thickness or something known to be invalid when any future checks are applied could be entered.* **TST_L05B** *has functioned this way with a value of 999.9 used for unknown thicknesses, particularly when creating records for overlaid sections.*

C. Filters

Files to be filtered are the result of some external process. While all data to go into the IMS must be in a file to be filtered, not all data in the file has to go into the IMS.

The file naming convention will be specified by the developer. The convention chosen will produce unique file names which can be used to identify file contents. Use of a directory structure as part of the naming convention is permissible. File names will be designed with eight characters to the left of the decimal and three characters to the right.

Filtered data may be structured in one of two ways, all elements in a data suite for all tables as a single line or multiple lines carrying various parts of the information. Either the single line format or multiple line format may be specified one per file or multiple repetitions per file. The single line format generally should be specified with multiple repetitions allowed within a file.

> *Data for interpretation of automatic TDR traces could include* STATE_CODE, SHRP_ID, SMP_DATE, TDR_TIME, TDR_NO, APPARENT_LENGTH, DIELECTRIC_CONSTANT. *A single line format for data entry would produce a record with* STATE_CODE, SHRP_ID, SMP_DATE, TDR_TIME, TDR_NO1, APPARENT_LENGTH1, DIELECTRIC_CONSTANT1, TDR_NO2, APPARENT_LENGTH2, DIELECTRIC_CONSTANT2, ... TDR_NO10, APPARENT_LENGTH10, DIELECTRIC_CONSTANT10
> *A multiple line format could appear as follows:*
> STATE_CODE, SHRP_ID, SMP_DATE, TDR_TIME
> TDR_NO, APPARENT_LENGTH, DIELECTRIC_CONSTANT
> TDR_NO, APPARENT_LENGTH, DIELECTRIC_CONSTANT
> ....
> STATE_CODE, SHRP_ID, SMP_DATE, TDR_TIME

TDR_NO, APPARENT_LENGTH, DIELECTRIC_CONSTANT
TDR_NO, APPARENT_LENGTH, DIELECTRIC_CONSTANT
....

Within a filter file data elements should be grouped in a logical fashion. Key fields and others required for input acceptance should be first.

Data to be filtered will be in ASCII comma separated value format. Dates should be in the format mm/dd/yyyy. Character fields will be bracketed with double quotes. Character fields will not include commas, single quotes (apostrophes), or ampersands (&). Avoiding inappropriate characters is the data set creator's responsibility. Null valued fields will not use place holders (blank, zero etc.).

> *Traffic data for a site with calibrated weigh-in-motion with* STATE_CODE = *36,* SHRP_ID= *3421,* YEAR=*1998,* MONTH=*5,* WIM_CALIBRATED=*Y,* WIM_CALIBRATION_METHOD=*3 (other),* WIM_CALIBRATION_METHOD_OTHER = *Ten runs each, two trucks, no moving average of runs allowed, should appear as: 36,"3421",1998,5,"Y", 3,"Ten runs each; two trucks; no moving average of runs allowed".*

The developer will specify actions resulting from an attempt to filter a duplicate record into the IMS. Automatically overwriting a duplicate record is not considered desirable. Checking all fields if the key fields are identical is not a desirable option due to run time and programming issues inherent with the existing software.

> *Let the record in the IMS be: 48, 0001, 19-May-97, E, 34, 46, 48, 35 where the first three fields are key fields. Let the record being filtered be: 48, 0001, 19-May-97, A , 34, 46, 48, 53. (Note that the value for* RECORD_STATUS*, the variable after date, has been included with the value A. It could also be left blank with no spaces or omitted and the value of* RECORD_STATUS *filled by the filter with the default value.) Automatically overwriting the record does not let anyone know that a record has been changed. If the record has been manually upgraded because the original value of 35 was in fact correct, the comments on upgrading will be inappropriate. And if the value flunks again, the question will arise as to why it is different if it was accepted the first time.*

Filter software may include error checking. The error messages to be returned when a violation is encountered should also be created by the developer. Only fatal errors which preclude data being entered in the IMS should be identified. All other errors should permit continued data entry and require review only once, during QC.

Filter software may include default values for the IMS such as TODAY as a date for LOAD_DATE.

D. Entry of Computed Parameters Data

An underlying assumption in computed parameters data entry is that only those results for which the necessary inputs exist will be entered in the IMS. The relevant input data to be verified will be specified by the parameter's developer. Instructions will be included on the actions to be taken when the input data is modified or deleted and a separate inputs table for the parameter does not exist either within the IMS or off-line.

A replicate of the inputs database for externally computed parameters will exist off-line as a part of AIMS when duplication of elements within the IMS is not prudent.

All computed parameters entered via forms will have range checks on every screen entry field.

All files for filtering will contain only those values to be loaded into the IMS.

## VI. IMS Reports

IMS reports on table structure and contents include the schema, data dictionary and codes list. This information is sufficient to recreate the database structure except for the data.

### A. Schema

A schema extracted from the IMS and the schema incorporated in the IMS specifications are different in form and function. The IMS schema has the table name, definition, extension and fields. The fields are listed in the order they appear in a record with key fields flush left. Additional information on variable type and format, columns used when extracted in ASCII fixed column format and units is also included. This schema is generated with IMS software. In contrast the schema in IMS specifications contains all of the information necessary to create an ORACLE table and populate portions of the data dictionary.

### B. Data Dictionary

The data dictionary is a field specific reference for all items in the IMS. Every field in every table is included. It contains all of the information necessary to recreate a database table except for the order of the fields. There are eleven items in a data dictionary entry: field name, table name, description, field type, units, existence of a codes list, existence of Level C QC, existence of Level D QC, and testing protocol if applicable. It is compiled from the schema, codes list and QC specifications of an IMS table by the programmers working on the IMS database. The field name, table name, description, field type, units, and protocol come from the schema in the specifications. The codes table used is determined from the codes list specifications and produces the entry called *Validation*. Level C QC when it exists determines the entry in *QC Required*. The Level D QC when it exists produces the entry in *QC Range*.

C. Codes List

The codes list contains all of the codes tables in the IMS. The list includes information on the code table name, the source document that describes the origin of the code and the actual codes themselves. The IMS specifications for a codes table match the format of the codes list.

VII. QC

QC is done on the IMS for selected fields in all tables. Checks are done for mandatory information, reasonable values and conflicts with information in other fields. Not all tables need all types of checks. Many elements are not checked.

Key fields are automatically checked for non-null values by ORACLE. Selection of other mandatory fields is at the discretion of the table developer but should reflect any data which must be present by design of the protocol or to make sense of the data.

Existence checks correspond to Level C. These are checks for mandatory fields which may have a must be present requirement or be conditional on some factor relevant to the table. Existence checks will be included for any element which is the primary reason for the tables's existence, affects release of a record through **EXPERIMENT_SECTION**, is necessary for validating experimental factorials, or is required to interpret other data in the table.

> *Bulk specific gravity test results are the reason for tables* **TST_AC02**, *therefore, BSG, the field which contains the value of bulk specific gravity must have a value.* **EXPERIMENT_SECTION** *QC requires the associated record in* **INV_AGE** *to be at E. In that table* CONSTRUCTION_DATE *is checked against* TRAFFIC_OPEN_DATE. *Therefore both of these field must have values.*

It is possible, but not reasonable to assign a range of expected values to every numeric, date and coded field in the IMS. Range checking (Level D)should be done selectively. Ranges should identify potential outliers, values outside of expected ranges which could possibly be anomalous. Where ever possible ranges should be substantiated by research or experimental design. Ranges used in checks may be discontinuous or dependent on a site or material property. If the range is dependent on a value in a closely related table or **EXPERIMENT_SECTION** it should be considered for inclusion as a check for conflicting information.

Checks for conflicting information (Level E) may be done within a record, within a table, between tables in the same module or between tables in different modules. Such checks should be limited to fields which should contain the same information, fields which have a logical order within or between records or tables and fields for which timing or existence is essential to use of the data.

QC results are reviewed and problems identified may be verified as truth or corrected. Manual upgrades of data are permitted through the Browser software which runs on the IMS. When QC is specified any conditions on manual upgrades are included in the QC documentation.

A. QC Requirements for Computed Parameters

Records with input data values which are not in a computed parameters table will not have their record status changed.

Level C checks will be done for all computed parameters inputs. For a computed parameter to exist, all of its inputs must exist. Level C checks can only be created for input data where those data are in a computed parameters table. If the data are not in a table contained in the specifications, then an inter-table or inter-module check exists. This is by definition a Level E check. If a separate inputs tables is not created, all of the input data existence checks will be done as Level E checks.

> *The TDR apparent length table in the example (pg.25) requires probe length as an input, yet this value is not in the table. It is possible for the record containing this value to have been manually upgraded in a separate QC sequence. Resetting the record to C is not appropriate as a part of the apparent length QC. However, an apparent length record could be prevented from going to E if the probe length value is null.*

Level C checks may be conditional. Conditional checks should be dependent on a single condition in either **EXPERIMENT_SECTION** or an input data table. Multiple conditions will be included in Level E.

> *Existence of a set of transverse profile measurement data for rut indices is a single condition. Existence of both single and tandem axle distributions with positive values in the first three weight bins to do an ESAL calculation is a multiple condition.*

Range checks on input data should reflect the requirements of an algorithm, not the values which could be expected in LTPP data collection. The ranges need not match those of the same element in or for any other table. Computed parameter range checks are not looking for possible anomalies, they are excluding data for which the calculations are invalid. If the inputs are contained in a separate inputs table, the check will be specified as a part of Level D. For externally computed parameters only sets of input data which meet all Level D checks should exist when separate input tables are created. If the values are in other IMS tables, the check will be specified as a part of Level E.

Range checks on outputs data must be supported by research results either from LTPP or in publicly available documents.

If the same inputs have different ranges for different algorithms and their outputs, the range check should be a Level E check related to the output. (If the inputs are not in this range, the output value should be null.)

Conflict checks for computed parameters may include: comparative values (i.e. min < mean < max); date sensitive (i.e. before rehab); conditional (under some set of input ranges); and counting (number of observations required for a valid result).

Where multiple tables exist for an externally computed parameter, data entry in all relevant tables will be verified as a part of Level E. The condition of RECORD_STATUS at E in all tables for all associated records for any to be at E will be included.

Upgrade conditions for computed parameters tables will be specified as a part of the QC. If there are no upgrade conditions listed for a record, there will be no manual upgrade.

Externally computed parameters will have QC embedded in the computational software. IMS QC will duplicate the Level C and D checks. The number of Level E checks may equal or exceed those of the computational software.

For any externally computed parameters not computed by the contractor loading the data, only those records identified by the party computing the parameter as approved for manual upgrade will be. If the party computing the parameter does not provide a list of records to be upgraded, no manual upgrade will be performed.

## VIII. Computing Parameters

A fundamental assumption of computed parameters is that the process must be replicable by any individual provided the same inputs and computational instructions. The inputs must be generally available without special access criteria. The computational instructions must be written out so that the algorithms can be programmed or a graphical solution derived without expertise which is exclusive to LTPP.

### A. Inputs

Field data may be used for computations without entry into the IMS database and all subsequent processing.

> *IRI is a computed parameter which is calculated prior to IMS processing. Rut indices would be a similar example since they could be calculated from transverse profile data as that data was filtered into the IMS.*

Extraction of inputs for externally computed parameters will be done from the release database.

All records for externally computed parameters will be extracted at Level E.

B. Metrication

All computed parameters will have conversion of inputs to S.I. units as needed at the start of the computational process. This is to eliminate the need to change computational algorithms or recompute parameters when IMS inputs are converted. Conversion will be done according to the LTPP directive on metrication.

IX. Documentation for IMS Database Additions

Additions to the IMS database are documented by their specifications. IMS specifications can be generated by the LTPP IMS Technical Support Services Contractor or other organizations that are providing specifications for IMS database elements. These specifications form the basis for the IMS development and the standard documentation necessary for using the data. Therefore, all specifications must follow standards for content and format. The draft template provided in section A below is to be used when providing IMS specifications for coding.

A. Format for IMS Specifications

The content of IMS specifications are dealt with elsewhere in the sections on the schema, data dictionary, codes list, field and table naming, QC, forms and filters. IMS specifications will submitted in both electronic and hard copy. The electronic copy is to facilitate creation of the as coded documentation and incorporation of the QC checks into the QC manual. The electronic file format will be WP 6.1. Every page of the specification will be numbered and dated. A sample of the most commonly provided items in a specification is included below.

Specifications Outline

- Background
- Database Schema, QC, and Filter Specifications
- Appendices: Applicable appendices can be presented in any order.
    - Database Schema and QC Specifications (required)
    - Off-Line Storage Schema Specifications (if applicable)
    - File Format and LTPP Filter Program Specifications (required for data to be loaded electronically via filter programs)
    - Data Entry Form or Screen Format (required for data to be manually keyed)
    - Algorithms (required for Computed Parameters; provided for information only)
    - Sample Data (required)

Formatting Standards

- Module abbreviations (i.e., ***TST***): uppercase, bold, and italics
- Table names (i.e., **TST_L05B**): uppercase, bold
- Field names (i.e., LAYER_NO): uppercase, regular type

Items displayed in italics in the template are descriptions of general information that are to be replaced in a specifications document with specific information. Instructional comments are provided in italics and enclosed in "[]."

Cover Memorandum Example:

**MEMORANDUM**

| | |
|---|---|
| TO: | |
| FROM: | |
| DATE: | |
| SUBJECT: | LTPP *Module*[1] Database Schema and QC Specifications |
| PAPER FILE: | *[if applicable]* |
| CC: | |

## Background

*[1-2 paragraphs of background information.*
*What data does this represent?*

*Why is this being included in the IMS?]*

## ***Module*** Database Schema, QC and Filter Specifications

*[Overview of the IMS table definitions.*
*Number of IMS tables*
*Organization of IMS tables (any specific groupings, types of data in each group)*
*IMS Module where tables will reside*
*Source of Data*

[1] Module refers to an IMS module [i.e., Materials Testing (***TST***)] or a set of computed parameters [i.e., SMP Manual TDR].

*Method of Entry (data entry or filtering)*

*Reference Appendices that are included.*

- *Appendix: Database Schema and QC Specifications*
- *Appendix: Off-Line Storage Schema Specifications (if applicable)*
- *Appendix: File Format and LTPP Filter Program Specifications (if applicable)*
- *Appendix: Data Entry Form or Screen Format (if applicable)*
- *Appendix: Algorithms (if applicable; provided for information only)]*

## Appendix
## ***Module* Database Schema and QC Specifications**

*[Overview of contents of appendix.*

*Example: This appendix contains schema and QC specifications for tables proposed for storage of essential information on ... QC specifications have been developed only for data that are to be stored in LTPP IMS database.]*

Schema Example:

**TABLENAME*:*** *[1-2 sentence table description. As appropriate include information on the type of data, method of collection (i.e., manual), collection frequency or applicable time period, unit system, and any special considerations.*

*The table name, 25 characters or less. The table definition not exceeding 210 characters including spaces. If there is a single source or protocol which should be referenced in the data dictionary for all data items, it should also precede the table. The maximum length for describing a materials testing protocol is 10 characters including spaces.]*

*[Table should contain the following information.*

*Fields that must have non-null values and that are required to uniquely identify a specific record should be left justified; all others should be indented. Field names are entered in the order in which they appear in the record.*

*The codes column has the name of the codes list. Codes tables may appear in the description if they are short. Longer ones should be provided following the schema.*

*Field definitions are written in plain English with a minimum of acronyms. Definitions are not to exceed 220 characters including spaces. Source information may be as much as an additional to 40 characters. Materials testing protocol names may add 10 characters. ]*

| Field Name | Units | Field Type | Codes | Data Dictionary Description |
|---|---|---|---|---|
| KEY_FIELD_ 1 | *[units; see std abbreviations*] | *[Oracle format*] | *[Name of existing codes table or provide attachment showing code value and associated description]* | *[1-2 sentence description of the data element.*] |
| KEY_FIELD_ 2 | | | | |
| FIELD_3 | | | | |

***Example:***

**SMP_TDR_MAN_COMPUTED**. Contains interpreted apparent length and dielectric constant from manually recorded Time Domain Reflectometry (TDR) traces.

| Field Name | Units | Field Type | Codes | Data Dictionary Description |
|---|---|---|---|---|
| SHRP_ID | | CHAR(4) | | SHRP_ID for a test site |
| STATE_CODE | | NUMBER(2) | | State/Province code |
| CONSTRUCTION_NO | | NUMBER(1) | | Construction event number |
| SMP_DATE | | DATE | | Measurement date |
| TDR_TIME | | CHAR(4) | | TDR measurement time |
| TDR_NO | | NUMBER(2) | | ID number of TDR probe |
| PROBE_LENGTH | m | NUMBER(4,3) | | TDR probe length |
| TRACE_TYPE | | NUMBER(1) | see desc | Trace type: 1-classic; 2-shorted; 3-open; 4-rounded |
| VELOCITY_PROP | | NUMBER(3,2) | | Cable tester propagation velocity setting |
| INTERPRET_METHOD | | NUMBER(1) | | Interpretation method: 1-tangents; 2-peaks |
| APPARENT_LENGTH | m | NUMBER(3,2) | | Interpreted apparent length (La) |
| DIELEC_CONSTANT | | NUMBER(3,1) | | Computed dielectric constant |
| RECORD_STATUS | | CHAR(1) | | Status code related to level of QC |

QC Example:

***Module* Data Quality Control Specifications**

*[Tables should be listed in alphabetical order for each level of checks. Fields should be listed in alphabetical order within each table. All tables should be listed under each level of checks with the comment, "No Checks Performed," for those tables that have no QC checks defined. If there are any conditions on manual upgrades they follow the relevant table. Multiple conditions within a table are numbered.]*

**Minimum Data Elements ("C" Level Checks)**

*[An "X" under Condition indicates a data element is always required. An "*" under Condition indicates that a data element is required under certain conditions. Do not list key fields as they are automatically required to have non-null values. ]*

| Table | Field | Condition | |
|---|---|---|---|
| **TABLENAME_1** | FIELDNAME_1 | *X or ** | *If "*", condition requiring entry* |

**Example:**

| Table | Field | Condition |
|---|---|---|
| **SMP_TDR_MAN_COMPUTED** | TDR_NO | X |
| | PROBE_LENGTH | X |
| | TRACE_TYPE | X |
| | VELOCITY_PROP | X |
| | INTERPRET_METHOD | X |
| | APPARENT_LENGTH | X |
| | DIELEC_CONSTANT | X |

**Expanded Range Checks ("D" Level Checks)**

*[All Level D checks performed on fields defined as real numbers, should specify values to same number of significant digits as the maximum defined for the field.]*

***TABLENAME_1***

| | | |
|---|---|---|
| *FIELDNAME_1* | *units* | *range* |

**Example:**

**SMP_TDR_MAN_COMPUTED**

| | | |
|---|---|---|
| SMP_DATE | | >= 01-AUG-92 |
| TDR_TIME | | First two digits 0 - 24, last two digits 0 - 59 |
| TDR_NO | | 1 - 12 |
| PROBE_LENGTH | m | 0.200 - 0.207 |
| TRACE_TYPE | | 1- 4 |
| VELOCITY_PROP | | 0.60 - 0.99 |
| INTERPRET_METHOD | | 1 - 2 |
| APPARENT_LENGTH | | 0.20 - 1.70 |
| DIELEC_CONSTANT | | 1.0 - 70.0 |

**Intra modular Checks ("E" Level Checks)**

*[Each E-type check is separated by a single line. In general, each bullet represents a procedure, action, etc. All cross table validation checks should clearly indicate key fields to query and indicate whether the comparison is a one to one comparison or a one to many comparison. If the all or nothing check goes across modules, the modules affected by the record status check must be identified.]*

---

Table: **TABLENAME_1**

- *check 1*
- *check 2*

---

Table: **TABLENAME_1, TABLENAME_2**

- *check 1*

---

**Example:**

---

**Table: SMP_TDR_MAN_COMPUTED**

- For matching SHRP_ID, STATE_CODE, and CONSTRUCTION_NO
  SMP_DATE $ **SMP_LAYOUT_INFO**.INSTALL_DATE
  Error message: Data collection date not $ installation date

---

Off-Line Data Sample:

## Appendix
## Schema for *Module* Off-Line Storage

*[If applicable, this appendix contains the schema for tables proposed for storage of data to be stored off-line. The format is identical to that for data stored in the IMS; however no QC checks are provided.]*

File Format and Filter Example:

## Appendix
## File Format and LTPP Filter Program Specifications

*[This appendix contains the file formats for any data that are to be loaded into the IMS electronically through filter programs. As documented in the IMS Standards, comma separated values (CSV) is the preferred format; however, other formats can be accommodated as long as a detailed file format is provided. The general file format, file naming conventions, and IMS tables that will be updated from the file must be identified. The file format must identify a value from the file, the format of the value, the corresponding IMS table and field, and any manipulation that is necessary. Instructions should be provided on how to populate any IMS field that does not have a specific value provided in the input file; how to handle records with duplicate key fields, and a list of any checks that must be performed during data loading.*

*Unless specified otherwise, the file will be assumed to have a one to one correspondence between lines and records to be read.*

*The comments should have any entry conditions including error checking and validation conditions to be incorporated with the filter. For each error check specified, including the* *verification against* **EXPERIMENT_SECTION***, the appropriate error message will be stated. Error messages will be 50 characters or less.*

*Entry conditions will not include transformation of variables from character to numeric or vice versa nor interpretation of codes.*

*[An example format is provided below.]*

File Name:
IMS Tables:
File Format:
Duplicate Instructions:

| Item | Format | Units | IMS Table Name | IMS Fieldname | Comments |
|---|---|---|---|---|---|
| *position of item in file (i.e., field n for csv files, columns n-m for fixed column format)* | *character, numeric, or date. For dates, provide format (i.e., mm/dd/yyyy, dd-mon-yyyy). Indicate, where possible, a maximum size.* | *Units for value in the file* | *This column is optional. It is required if the input file populates multiple tables.* | *IMS Fieldname as specified in the schema* | *Any extra validations or manipulations of data needed.* |

**Example:**

File Name: 01xxxxxx.PST, where x's represent in order STATE_CODE and SHRP_ID
IMS Tables: **TRF_BASIC_INFO**
File Format: CSV, all fields separated by commas with character field enclosed by double quotes
Duplicate Instructions: If record already exists in table, do not load, but report as duplicate.

| Item | Format | Units | IMS Fieldname | Comments |
|---|---|---|---|---|
| 1 | Character(4) | | SHRP_ID | Validate that the combination of STATE_CODE and SHRP_ID are in **EXPERIMENT_SECTION**. |
| 2 | Numeric | | STATE_CODE | See item 2 |
| 3 | Character (2) | | DIR_TRAV_LTPP | Store only first character |
| 4 | Date: | | DATE_OPEN | |

Manual Data Entry Example:

## Appendix
## Data Entry Form/Screen Format

*[This appendix should provide a data entry form having numbered items that will be used for manually keying in data. Screens formats will be developed based on the hard copy form. Information similar to that provided for file formats is needed. By default, if a record already exists, it will be displayed once the key fields are entered.*

IMS Tables:

| Item | Format | Units | IMS Fieldname | Comments |
|---|---|---|---|---|
| *item number on the form.* | *character, numeric, or date. For dates, must provide format (i.e., mm/dd/yyyy, dd-mon-yyyy)* | *Units for value on the form* | *IMS Fieldname as specified in the schema* | *Any extra validations or manipulations of data needed. By default, warnings will be displayed for values outside the range specified in the Level D checks; however, input will not be prevented.* |

Computations Appendix:

## Appendix
## Computation Algorithms

*[This appendix contains computation algorithms provided for informational purposes. If any specific processing is required to transform IMS data for use as inputs it should be specified here. Similarly, any post processing calculations needed to create a file for filtering should be identified. This appendix should also include a catalogue of public domain or commercial off-the-shelf software needed for the process. For the software, the name, and version number and source is needed.]*

*Example:*

*Apparent length, $L_a$, for manual TDR traces is done graphically following LTPP Directive SM-28 dated June 1998. The value of the Dielectric Constant , = $[L_a / (.99 * PL)]^2$ where PL is probe length taken from* **SMP_TDR_DEPTHS_LENGTH**.TDR_PROBE_LENGTH.

# Appendix
# Sample Data

*[This appendix provides details on sample data provided. Sample data actually collected from the prescribed data collection process is preferred. When this data is not yet available, the data sets created should be designed to check all constraints on the data from entry through Level E QC. Data extracted from the IMS as inputs for computed parameters will meet the RECORD_STATUS at E requirement.]*

B. FHWA Concurrence on Computed Parameters:

Due to the infrequent updating expected for many computed parameters, a paper trail must exist on the decisions made. There are two memos associated with adding computed parameters to the IMS database. The first is the initial acceptance of a value and the second is approval to update an externally computed value. At a minimum copies will be retained by FHWA, the TSSC, the central database administrator and the developer of the data set or researcher who provided the foundation for the work.

The initial acceptance memo from FHWA will include the tasking of responsibilities, time lines, any external software to be used, and the update criteria for the parameter. It will be from the Program Manager.

The tasking will identify at a minimum the parties responsible for the following tasks: writing the specifications, reviewing the specifications, coding the IMS software, coding any required external software, testing of external software, testing of IMS software, creation of data sets both extracted and for input into the IMS, data entry, QC of IMS tables, review of results in the IMS, update responsibility for coding, data sets, maintenance responsibility via SPRs of IMS and external software, writing of the algorithm documentation and review of the algorithm publication. Coding IMS software is considered to be a comprehensive set of activities including table creation, creating necessary filters and forms, updating the data dictionary and codes list and modifying both the QC and the QC documentation.

The time line will begin with writing the specifications and end at the first update decision point. If the decision is that no updates will be done, the last item will be review of results in the IMS following the scheduled upload date. The targeted upload date will be included in the time line.

The update criteria will be clearly stated including the decision date if an update is to be allowed for externally computed parameters. The decision to update will generate the next version of the memo to repeat the process.

The memo from FHWA confirming the decision to update is similar to the memo originally approving the addition of the parameter. It will include the tasking of responsibilities, time lines, any external software to be used, and the update criteria. It will be from the Program Manager. Not all updates will require all elements of the original tasking and time line. When the decision to update is made, the update criteria will be reviewed and confirmation or revision included as a part of this memo.

C. External Software Documentation

External software generally falls into three categories: calculation software, pre-processors and post-processors. If a non-IMS piece of software is required to produce the results, it must be generally available as either public domain or a commercial off the shelf product. It must be specified by name and version. An indication of the source and level of support for the package should also be included. Public domain software is preferred. Software which is generic in function such as spreadsheets, databases or word processors will be accepted. Any processing required in these packages must be transferrable between similar packages under the same operating system. Proprietary software will be considered on a case by case basis. Revision of non-IMS software packages is not automatic grounds for an update of a computed parameter. Pre- and post-processing software are considered separate from calculation software.

Calculation software is the software actually used to produce the computed parameters. It may consist of one or more programs and fall in the public domain, commercially available or written as a by-product of an LTPP analysis effort. An uncorrupted, full featured copy of the software will be obtained for the use of LTPP. LTPP will not distribute non-LTPP software without the express written consent of the developer. Software written as part of an LTPP effort will be made available to the public on request without support.

Software not written as a part of an LTPP task must have a documentation of the algorithm used to compute the parameters. This includes copies of any equations, tables, defaults, the closing conditions for iterative methodologies and the correspondence between LTPP data elements and the inputs required by the program. All but the last item should be a part of the documentation available from the developer. If it is not the package will not be considered. All of these elements will be included in the documentation made available to users of LTPP information.

Software written as part of an LTPP task must include the same documentation as above. If conversion to S.I. units is required it will be done as the first module of the program after reading in data. Program design will be modular. All modules will be named and identified with their purpose within the program. Internal documentation will include a list of variable names and their definitions including any counters or functions. At a minimum source code for the algorithms and a compiled version of the program will be provided to LTPP. The source code will not be available for distribution.

Pre-processors are any software used to create input data sets for the calculation software. They may be SQL statements to be applied to the IMS for specific fields and/or standalone programs which manipulate LTPP data into a more appropriate input format. If manual intervention is allowed/required, the manual process must be documented for all possible conditions. Pre-processors may be used to convert data to S.I. units.

Post-processors are any software used to create a data set for filtering into the IMS. Such software may eliminate records that would fail to load into the IMS or would not pass QC.

D. User Documentation on Computed Parameters

Documentation on parameters computed within IMS software is contained in database documentation, generally in the specifications for IMS tables and their filters. Other parameters are generally accepted engineering values which can be found in standard engineering references. IRI is an example of such a value.

For every externally computed parameter and selected internally computed parameters resulting from LTPP data analysis, 3-6 page document will be prepared which will contain sufficient information for a user to generate that parameter independent of LTPP software. The document will be an FHWA publication reviewed and approved via the standard publication process. The document will include:

- A flow chart or description of the calculation process.
- A listing of the inputs at the table or field level as appropriate. This listing should identify the IMS release, schema, data dictionary and codes list in effect when initially computed for externally computed parameters.
- A description of any off-line LTPP data required.
- A discussion of any non-LTPP data required including how to acquire it.
- Identification of the correspondence between LTPP elements and equation variables.
- A listing of all equations used in the calculations and the conditions for their application.
- A listing of all tables of constants used by the computations and when interpolation is allowed.
- Any defaults used in the calculations and the conditions under which they apply.
- A listing of any LTPP software which implements the algorithms.
- A reference list with the relevant data collection protocols or research which apply to the inputs, outputs or computational methodology.