LONG TERM PAVEMENT PERFORMANCE
PROGRAM DIRECTIVE

For the Technical Direction of the LTPP Program

Program Area:	**IMS**	**Directive Number:**	**I-77**
Date:	**May 24, 2000**	**Supersedes:**	**I-74**
Subject:	**Upgrade of the IMS to Version 2.7**		

This directive implements the upgrade of the IMS from version 2.6 to version 2.7, incorporating changes issued in the interim to facilitate processing for the May upload.

IMS version 2.7, its installation instructions and associated change notice will be distributed by the Technical Support Service Contractor (TSSC). Instructions on the processing sequence for revising the **MON_DEFL_*** module are included in this directive. Other processing details are included on the instruction sheet distributed with the software. The upgrade of the database software to version 2.7 and completion of the processing steps presented in this directive shall be completed by close of business June 2, 2000.

The following steps outlined below shall be followed for implementation of the revised **MON_DEFL_*** tables contained in IMS version 2.7. In this directive, the tables in the **MON_DEFL_*** module are referenced under two generic names, the **MON_DEFL** "data" tables are those which contain the FWD measurement data and the **MON_DEFL** "backcalculation" tables are those which contain the results of the backcalculated layer moduli and other computed parameters generated by the LTPP Data Analysis Technical Support Contractor. The table names can be used to distinguish between the **MON_DEFL_*** data and backcalculation tables. All of the backcalculation tables included in IMS version 2.7 have table names which begin with **MON_DEFL_FLX_***.

1. RCOCs receive IMS version 2.7 from TSSC.

2. RCOCs run the build script which creates the new the **MON_DEFL_*** tables. The script will populate the data tables by converting the data contained in the current tables to the new format. The backcalculation tables will not initially be populated. Due to the relatively long processing time required to make this conversion, the RCOCs should consider the impact on their operations when scheduling a time to run this script.

3. After the script has been successfully executed, the RCOCs shall review the new **MON_DEFL_*** data tables to confirm that the conversions were performed correctly. The current version of the new IMS specifications for the **MON_DEFL** tables are included with this directive for use in this review. Some of the checks that should be performed include record counts between old and new tables, conversions to POINT_LOC from feet to meters, conversion of **MON_DEFL_TEMP_VALUES**.LAYER_TEMPERATURE_* from degrees F to C, conversion of **MON_DEFL_TEMP_DEPTHS**.LAYER_TEMP_DEPTH_* from inches to mm, conversion of **MON_DEFL_POINT_LOC**.CRACK_JOINT_OPEN_WIDTH from units of .01 inch to mm, and correct transfer of fields between the old and new tables.

4. After confirmation that the data tables were converted correctly, the RCOC shall run the QC programs for the **MON_DEFL** data tables and work through the QC process. As shown in the revised **MON_DEFL** IMS specifications, extensive revisions and additions have been made to the QC on the **MON_DEFL** data tables. Attachment A to this directive contains guidance on QC processing and data editing issues. The RCOCs shall complete the QC processing on the **MON_DEFL** data tables before proceeding to the next step.

5. After QC processing of the **MON_DEFL** data tables has been completed, the RCOCs shall notify FHWA to confirm completion of the conversion and processing of the data tables and to provide records counts by RECORD_STATUS for each table on the results of the QC checks.

6. After FHWA has been notified in step 5 that QC processing to the **MON_DEFL** data tables has been completed, the RCOCs shall then import data into the **MON_DEFL_FLX_*** backcalculation tables. After the import procedure is complete, RCOCs shall review the backcalculation tables to check for errors occurring during the import process. A copy of the IMS specifications for the flexible pavement backcalculation tables will be distributed to the RCOCs at a later date for use in this review.

7. After the RCOCs confirm correct import of backcalculation data, they shall then execute the QC programs for the backcalculation tables. Questions regarding the content of the backcalculation tables, guidance on manual QC upgrades and technical details associated with the backcalculation should be directed to the Amy Simpson, 512-346-0870. Questions regarding IMS software operational issues should be directed to Rick Cale, 865-481-2198.

8. After QC processing of the **MON_DEFL** backcalculation tables has been completed, the RCOCs shall notify FHWA to confirm completion of the loading and processing of the backcalculation tables and to provide record counts by RECORD_STATUS for each table on the results of the QC checks.

9. **RCOCs shall not attempt to load FWD Edition 25 data or remaining FWD Version 20 data which have not previously been uploaded, until after completion of the previous 8 steps. RCOCs shall obtain approval from FHWA before attempting to use the new filter programs to load new data into the MON_DEFL_* data tables.**

Technical questions associated with operational software issues for this upgrade should be directed to Rick Cale, 865-481-2198.

Prepared by: TSSC

Approved:

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Attachment A
Guidance on **MON_DEFL_*** Data Table QC Processing and Editing Issues

Attachment A
Guidance on **MON_DEFL_*** Data Table QC Processing and Editing Issues

Editing and QC Checks - MON_DEFL_*

The following guidelines pertain to editing and procedures to follow when records fail the QC checks.

The following actions can be taken whenever data with known errors has been uploaded or when records fail the various QC checks:

Delete Data	Single data fields, multiple fields and complete records can be removed.
Edit Data	Change data elements.
Manual Upgrades	After inspection of records failing checks, SQL statements can be applied to increase RECORD_STATUS to the next level. In some instances, a record failing a check may be left at a non-level E RECORD_STATUS without removal from the data base.

Delete Data

Erroneous data caused by measurement and equipment errors should be removed from the IMS. In some cases single or groups of data elements within a record can be removed, and in other cases the entire record should be deleted. If records are to be modified, then the modification should occur prior to running the QC check programs. If records are modified after running the QC programs, then all related records for the field measurement set in the other **MON_DEFL_*** tables must have their RECORD_STATUS reset to A and the QC programs re-executed. If changes are made to a data set after they have been previously uploaded to the NIMS, then **MON_DEFL_MASTER**.LOAD_DATE should be set to the current date. Some examples of deletions of FWD data include:

- Bad air or surface temperature measurements from the on-board FWD temperature sensors should be deleted.

- Within a drop data set record in **MON_DEFL_DROP_DATA**, peak deflection measurements can be removed under the following conditions:

    + Measurements contained in the PEAK_DEFL_1 field can be deleted from a record if the value exceeds 2032 microns. Note that this is based on the maximum limit of accuracy for the deflection sensors stated by the manufacturer.

+ If PEAK_DEFL_2 exceeds 2032 microns, and PEAK_DEFL_1 also exceeds 2032 microns, and if the test is a basin measurement, then both PEAK_DEFL_1 and PEAK_DEFL_2 can be deleted from a record.

+ If the test is a load transfer measurement, then the complete record must be deleted if any of the PEAK_DEFL_* values exceed 2032 microns.

+ If the test is a basin test and PEAK_DEFL_*N* where *N* is 3 or greater exceeds 2032 microns, then the complete record must be removed.

+ If any of the PEAK_DEFL_* readings are negative, the complete record should be deleted.

- For records in **MON_DEFL_DROP_DATA** failing the minimum level D range check on PEAK_DEFL_*, the entire drop data set should be examined for reasonableness. It has been found that drop data sets which contain zero peak deflections are most often associated with equipment errors and have irregular deflection basin shapes. Records with anomalous or erroneous deflection basins should be deleted. In some cases it is useful to refer to the COMMENTS_1 and COMMENTS_2 field in the related record in **MON_DEFL_LOC_INFO** to see if the field operator has identified the drop set as being erroneous. In many cases such as this, the entire drop set should be deleted as well as the related record in MON_DEFL_LOC_INFO.

- In general, single fields or values in the **MON_DEFL_DEV_SENSORS** and **MON_DEFL_DEV_CONFIG** tables should never be deleted. Deletions to these tables should be made to complete records if needed. However, since multiple FWD data sets from measurements performed on different days at different sites, can share the same records in these tables; i.e. have the same CONFIGURATION_NO, these deletions should be performed with caution. If records in either one of these tables are deleted, then the record with matching CONFIGURATION_NO in the other table must be deleted as well as complete FWD data sets with matching CONFIGURATION_NO in the **MON_DEFL_LOC_INFO**.

Data Edits

Within this context, data editing means changing the value of a field in the data base. This should only be performed when there is overwhelmingly convincing evidence available which supports the change. If records are to be modified, then the modification should occur prior to running the QC check programs. In general, if data fields in a record are modified after running the QC programs, then all related records for the field measurement set in the other **MON_DEFL_*** tables must have their RECORD_STATUS reset to A and the QC programs re-executed. There

are a few edits that can be made without the need to reset RECORD_STATUS, as noted below. If changes are made to a data set after they have been previously uploaded to the IMS, then **MON_DEFL_MASTER**.LOAD_DATE should be set to the current date.

- The following edits can be made without need to reset RECORD_STATUS:
  - + Changes to the comments fields in **MON_DEFL_LOC_INFO**
  - + Changes to the values in **MON_DEFL_DROP_DATA**.HISTORY_STORED, although an edit to this field should not normally be needed.
  - + Entry or changes of values in **MON_DEFL_DEV_SENSORS**.CENTER_OFFSET_FLAG of 1 or 2.
  - + Changes to **MON_DEFL_TEMP_VALUES**.WEATHER_CONDITION.
  - + Changes to any field in **MON_DEFL_FWDCHECK_CMNTS**.
- The following fields can be edited, provided convincing evidence is available supporting the change. If any of these fields are modified, the RECORD_STATUS of all other related records in the **MON_DEFL_*** tables should be reset to A. (note that for some of these changes, the IMS will automatically reset the record status back to A.)
  - + LANE_NO in **MON_DEFL_LOC_INFO** and **MON_DEFL_DROP_DATA**. Note that if changes are made to this field in either table, then the change must also be made to related records in the other table. Since LANE_NO is a key field, it can not be changed to a value for another existing record.
  - + If a value of 3 is entered in **MON_DEFL_DEV_SENSORS**.CENTER_OFFSET_FLAG field, then the record status in **MON_DEFL_DEV_SENSORS** should be reset to A so that the QC will check for matching record(s) in **MON_DEFL_EST_SENSOR_OFFSET** table.
  - + Correction of entries to .LAYER_TEMP_DEPTH* or LOCATION_NO in **MON_DEFL_TEMP_DEPTHS**. The QC needs to be re-run to check related entries in **MON_DEFL_TEMP_VALUES** and valid range.
  - + Correction of entries to LAYER_TEMPERATURE_* or LOCATION_NO in **MON_DEFL_TEMP_VALUES.** The QC needs to be re-run to check related entries in **MON_DEFL_TEMP_DEPTHS** and valid range.

Manual Upgrades

One concept in development of the QC checks is to flag data extremes, illogical relationships, and data relationships which violate LTPP test protocols. The MON_DEFL QC specifications were significantly revised based on problems that have been identified with the FWD data. Some of the checks were set to catch the "symptoms" of errant or abnormal data, but because of the structure and nature of the data, data failing a check does not always mean the data is bad. Therefore, the RCOCs must exercise judgement in the upgrade decision. In most cases an investigation of the data will be required to differentiate good from bad data and to make the decision on whether or not to apply a manual upgrade, remove the errant data, or leave the data in the IMS at a sub-level E status. The following examples are not exhaustive, other conditions may exist which may dictate another action. When in doubt, FHWA guidance and approval should be sought.

The following are some examples of when data failing a QC check should **not** be upgraded.

- In general, data failing a level C check should not be upgraded. The level C checks are considered mandatory data elements. Records failing these checks, and those in other related tables should be considered for removal from the IMS.

- When a peak deflection value exceeds 2032 microns. See previous discussion on deletion of fields with excessive deflection.

- Crack and joint opening measurements which exceed 25-mm. This is the maximum value that can be entered by protocol. Values greater than 25-mm generally indicate that the measurements were not performed using a metric measurement device.

- Data sets for which the deflection sensors relative gain values exceed the level D specifications. In this situation, consideration should be given to either removing the peak deflection values of the offending sensor, or leaving the entire FWD data set at level C.

- Data sets for which the POINT_LOC values exceed the level D specification. The level D ranges have been set so that measurements occurring more than 31-m (100 feet) in front of or after a 304-m (1,000 foot) test section are flagged. More precise level E checks are also performed, in which the actual length of SPS test sections are determined from the **SPS_PROJECT_STATIONS** table. Thus, records for SPS test sections failing the POINT_LOC level E criteria maybe due to an error in the **SPS_PROJECT_STATIONS** table, which should be corrected. In those cases where measurements outside the monitoring portion of the test section were performed for LANE_NO like J0 and F0, it is recommended that the matching records in MON_DEFL_POINT_LOC and MON_DEFL_DROP_DATA be left in the data base at a non-level E level, since some of

these tests were performed as part of pre-SMP installation testing. Since these measurements were performed outside the monitoring portion of the test section, the objective of this action is to make them harder to obtain so that they are not automatically included in general data releases.

- Data sets with LANE_NO values which fail the level D check should not be upgraded. Instead the LANE_NO should be corrected in accordance with LTPP protocol. SPR's should be issued for valid LANE_NO that are not defined in the level D QC check.

- Records which fail logical (i.e. less than, greater than, equal to) level E date relationship checks should never be upgraded. The cause for these errors should be found and corrected.

- Records which fail the **MON_DEFL_LOC_INFO** level E check on CRACK_JOINT_OPEN_WIDTH. Crack and joint openning measuremens should not be included for data sets in which the LANE_NO is not C4, C5, J4, or J5.

- Records which fail the **MON_DEFL_TEMP_DEPTHS** level E checks on relationship between LAYER_TEMP_DEPTH_(N) and LAYER_TEMP_DEPTH_(N+1). These depths should be corrected so that LAYER_TEMP_DEPTH_(N) is shallower than LAYER_TEMP_DEPTH_(N+1).

- Records which fail the level D check on **MON_DEFL_DEV_CONFIG**.PLATE_RADIUS. The LTPP FWDs are equipped with only the two defined size load plates. Records should not normally fail this check.

The following are examples of when records failing the QC should be manually upgraded:

- **MON_DEFL_DROP_DATA** records in which the peak deflection for the outer most sensors fail the minimum range check. In this case the deflection basin must pass an engineering reasonableness test in which the entire deflection basin must either all contain very small defections, or the deflection basin suggests a very weak deflection signature with a very steep deflection-distance curvature. This check was added since it was found that the majority of data sets with zero or very low deflection response were errant.

- Data set which fail the level E check between LANE_NO and CENTER_OFFSET. This should only be done in the case where the RCOC has compelling evidence to suggest or prove that the data was collected with non-standard sensor spacings.

- Data sets, which exhibit strange or abnormal behavior, which can not be accounted to equipment or measurement errors, provided they pass the test of engineering reasonableness.