Bridge Diagnostics, Inc. Live Load Monitoring System

November 30, 2005

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Introduction

The live load monitoring system consists primarily of a Campbell Scientific, Inc (CSI) CR5000 datalogger and 16 BDI strain transducers. The CR5000 is completely programmable so that measurements, data storage, and data processing can be customized to perform specific applications. All of the programming and user interaction with the CR5000 is done with CSI's LoggerNet software. The following sections contain information regarding the operation of the monitoring system and indicate areas that need consideration with regards to operational parameters, user interaction, data storage, and data retrieval. As data is collected and examined, it is likely that program settings will change over time. Basic program information is provided within this document so that minor changes can be made without having extensive knowledge of the data logger programming. Equipment specifications, programming and operation details can be found in the CR5000 Operator's Manual.

Data Acquisition Goals and Concepts

The purpose of the live load monitoring system is to collect stress cycle data, periodic stress extremes and capture stress history records when events of interest occur such as the crossing of a heavy vehicle.

Stress cycle counting is done on a continuous basis using the "rainflow" histogram approach. The term rainflow refers to a graphical representation of a stress history plot being filled with water. Stress ranges are represented as the imaginary pool depths that would occur as the time history plot is filled or drained. The stress ranges result from the various relative minima and maxima that occur in the stress history plot. Results from the rainflow analysis contain the number of cycles that occur within predefined stress range bins. The number and size of stress bins are defined by the data acquisition program. Each bin contains a single counter that increases with time as the bridge experiences load cycles. This type of data is best visualized as a bar graph where each series represents a single transducer and each bar represents the number of cycles at the specific stress range. Typically, rainflow histograms are only generated for data channels with strain gage type sensors. The strains are converted to stress and the stress cycle data can be used for fatigue studies. The resulting stress cycle counters are recorded hourly and the reset after each entry into the output table. This makes it easy to see time trends for both stress magnitude and frequency. It also eliminates the need to keep track of when the program was modified or restarted. The total number of cycle counts is obtained from summing the values for each bin and is easily performed by a spreadsheet or database type program.

Data that is more relevant to short term assessment is the periodic storage of extreme stress values. Currently, the monitoring system is setup to store the maximum and minimum stress values from each sensor over a period of one hour. Trends in the extreme values will be influenced by changes in load magnitudes and any change in the structures response behavior. It will be important to look for changes in peak stress over time and also variations in peak stress as a function of gage position. Stress changes due to variations in load magnitude will generally have a uniform influence on all gages where as more localized effects can be expected if the changes are due to differences in structural behavior (i.e. deterioration or changes in boundary conditions).

Stress history records are blocks of stress data that are recorded as a function of time at a specified sample rate. The sample rate and duration of each data block are defined by the data acquisition program. In order to keep the amount of stored data reasonable, stress history blocks are only recorded when a certain trigger condition is met. This trigger can be a manual switch, a signal from an outside source, or a function of the measured stress values. Since strain/stress will be measured continuously (50 Hz), it is possible for the CR5000 to capture and store data before and after the trigger event. Since no external triggering devices are available at this initial stage, a trigger based on a stress magnitude will be implemented. Some controlled load tests and data monitoring will be required to determine the best parameters for the trigger. It will be necessary to determine which sensor or group of sensors would provide the best trigger, what magnitude or magnitude function should be implemented, and define appropriate pre and post trigger times so as to capture full load cycle events.

Communication with the CR5000 is controlled via a link to a PC running PC9000 or CSI's LoggerNet software. The link can be a direct connection from the CR5000 to a computer's serial port or via a phone line/modem connection between the computer and CR5000. Once a program is downloaded to the CR5000 and running, the link between the computer and CR5000 can be terminated and the datalogger program will run unattended. A link must be re-established to modify the program, change user flag settings to alter the program operation, and download data from the logger. An alternate method for retrieving data is through a PCMCIA flash memory card. The Iberia Bridge System contains a 1GB flash memory card that can be pulled from the CR5000 and inserted into a computer with Type II PCMCIA slots. Data files can then be copied to the computer hard drive. It is important to note that this option requires that the memory cards be powered down before removing them from the logger. Details of this procedure are discussed later.

Datalogger Programming

Currently the data acquisition program samples all strain transducers at 50Hz. This data is processed for the rainflow cycle counting and the stress bin counters are incremented appropriately. Periodically (hourly) the rainflow data table will be written to a file on the PCMCIA card for storage until a computer retrieves it. Extreme stress values from each gage are also written out on an hourly basis; note that this time interval is completely adjustable. Depending on how the data is to be used, a different time interval, such as one day, may be more appropriate.

In general, the raw stress data is not stored on a continuous basis. However, when a predefined trigger condition is met, a portion of buffered data is captured and stored to the PCMCIA card as a stress history data block. All of the different types of data are stored in different data tables having different file names.

Experimentation with the system will be required to define reasonable parameters for the stress history blocks. After examining the data it may be desirable to modify the sample rate to reduce the amount of stored data or modify the duration of the stress block data. The time duration of the data block is dependent on the span length, the typical vehicle speed, and the relative location of the trigger sensor. For example, a vehicle speed of 45mph translates into 66 fps. If the span is 100 feet and a typical truck length is 80 feet, the minimum block duration would be about 2.7 seconds (180 ft / 66 ft/sec). Currently the time block is set at 8.0 seconds – 4 seconds before the trigger event and 4 seconds after.

The amount of data to store before the trigger event is dependent on the trigger. If the trigger is based on measurements from a midspan strain gage, the amount of data before and after the trigger should be approximately equal. Where as, if the trigger occurs at the beginning of the bridge, then very little pre-trigger data will be required. The trigger condition can be based on any numeric value within the data acquisition program. This can be a measured value or a calculated value based on several measurements. Currently, the trigger is based on the maximum of two measurements. With the 50Hz sample rate on 16 transducers, the program will utilize a relatively small portion of the logger's processing capabilities. Along with trigger timing issues, the stress/strain magnitudes to initiate a trigger must also be determined. Experimentation will be required to determine what stress levels are generated by a heavy truck so as not to obtain too much data and to insure that all data is not filtered out completely. For programming considerations it will be important to determine which data channel is best to be used as the "trigger" sensor. For data processing considerations it is probably a good idea for the trigger conditions to occur at relatively consistent truck positions so that captured load response history will include the entire load cycle and a reasonable estimate of truck position can be determined. Since all traffic is traveling in the same direction, all trigger sensors should be at approximately the same location on the span.

The datalogger program also has a feature to re-zero the transducer readings periodically to eliminate sensor drift or temperature effects. Gage readings are taken when the bridge does not have traffic on it and those values are used as the new offset. The no-load condition is determined by a minimal change in stress over a period of time. Some experimentation may be required for determining no traffic conditions. Currently the program examines the change in the measured stress values. On 5-minute intervals, the program will search for a "zero stress change". When the stress remains constant for a period of 5 seconds, the current stress level will be used as the new offset. When the sum of the absolute values of all gages is less than a predefined limit a no-load condition is assumed. For concrete bridges an initial value of 0.25 ksi is suggested, however this may need to be adjusted depending on noise levels and actual live-load stress levels. Note that this program logic can be fooled if truck is parked on the bridge.

Various program control flags are used to provide user interaction with the program while it is running. The flags are used to control what type of output is generated and to activate the re-zeroing process. When the program is initially activated, strains are measured from all 14 data channels. Stress and other computed values can be monitored in real time; however no data will be stored until the user sets specific Flags. Flag 1 is used to control whether or not the hourly stress cycle, extreme value, and logger status data tables are written. Activation and storage of stress block data is controlled by Flag 2. Re-zeroing of the strain gages is done anytime Flag 8 is turned on. This is automatically done at 5 minute intervals by the program but can be done manually as well. Flag 8 is set high at program initialization so data is automatically zeroed after the first program scan. If vehicles are on the bridge when the program is initiated a manual re-zero may be necessary prior to setting the output flags (1 and 2) high. Table 1 provides a brief description of the program control flags.

Table 1 Program control flags.

Flag Number	Flag Off	Flag On
1	Hourly data tables inactive.	Hourly data tables activated. Rainflow stress cycles and extreme value data tables are computed on an hourly basis and written in the data tables.
2	Stress data blocks inactive.	Stress data blocks active. Stress values for specified interval of time are stored when the predefined trigger condition is met.
3	Not used.	Not used.
4	Not used.	Not used.
5	Not used.	Not used.
6	Not used.	Not used.
7	Not used.	Not used.
8	No effect	Re-zeros strain gages. Flag 8 immediately returns to off after gages re-zeroed. Program sets Flag 8 high at approximately 5 minute intervals.

In order to modify any of the parameters, the datalogger program must be modified and reloaded. The datalogger programming language is similar to Basic and can be modified relatively easy. Use the CSI editor to open and edit the program (LaTechOL.CR5). From the LoggerNet main menu, select the CSI Editor menu option. Following are sections of program code that will likely need to be modified after the system is installed and live-load data has been examined. After making any modifications to the program, save the file and download to the datalogger. During the downloading process, the user can select where the program should be stored – select CPU. Also check the “Run Now” option. The program file will then be compiled and checked for errors. If no errors occur the program will start running immediately.

Modifying the Trigger

The code sections that are specific to the trigger logic that initiates the stress block data table are listed below. Note that Flag 2 must be turned on in order for the trigger to be effective.

- The Constant NTrigger specifies the number of trigger channels.
- To channel numbers of each trigger channel are stored in **TrigChan(#)..**
- The stress limit for which to initiate data recording is stored in variable **TrigLim**.

```
'____________________________ Variables used for stress block triggering
Const NTrigger = 2
Public TrigChan(NTrigger)             'Data channels to use for trigger
Public TrigChVals(NTrigger)           'Current stress values from each trigger channel
Public TrigLim                        'Stress limit to trigger stress block data table
Public TrigStress(2)                  'Maximum stress on a trigger channel and trigger number generating the
stress
Units TrigLim = ksi
...
…
  TrigChan(1) = 1          ' channel number of 1st sensor being used to trigger stress block recording
  TrigChan(2) = 2          ' channel numbers of 2nd sensor being used to triggers stress block recording
  TrigLim = 0.50           ' ksi  ~ approximately 100 microstrain
```

Modifying Transducer Calibration Factors

Calibration factors for each sensor are applied individually. Before recording data it will be necessary to modify the applied calibration factors to match the transducers attachment to each channel of the CR5000. If any transducers are replaced after the system is up and running, the applied calibration factors will need to be modified. The following lines can be modified to contain the correct calibration factors. Units for the calibration factor are in terms of $\mu\varepsilon/mV_{output}/V_{excitation}$. The CR5000 automatically adjusts for the input voltage so the calibration factor to use is the BDI General Cal Factor. Presumably it is desirable to store all data in units of stress. Therefore all of the strain calibration factors are multiplied by the material modulus divided by 1x10-06 to convert units of micro-strain to ksi. The modulus value will likely need to be modified to reflect the actual concrete modulus.

```
'''''''''''''' BDI General Cal Factors (microstrain/mV/Vin)'''''''''''''
MBBlk1(1) = 527.5         'B1015 GCF for BBlk1(1) alias "Stress01"
MBBlk1(2) = 549.7         'B1016 GCF for BBlk1(2) alias "Stress02"
MBBlk1(3) = 514.8         'B1017 GCF for BBlk1(3) alias "Stress03"
MBBlk1(4) = 508.1         'B1018 GCF for BBlk1(4) alias "Stress04"
MBBlk1(5) = 510.0         'B1019 GCF for BBlk1(5) alias "Stress05"
MBBlk1(6) = 517.5         'B1020 GCF for BBlk1(1) alias "Stress06"
MBBlk1(7) = 513.0         'B1021 GCF for BBlk1(2) alias "Stress07"
MBBlk1(8) = 511.9         'B1022 GCF for BBlk1(3) alias "Stress08"
MBBlk1(9) = 514.3         'B1023 GCF for BBlk1(4) alias "Stress09"
MBBlk1(10) = 520.3        'B1024 GCF for BBlk1(5) alias "Stress10"
MBBlk1(11) = 520.3        'B102# GCF for BBlk1(5) alias "Stress11"
MBBlk1(12) = 520.3        'B102# GCF for BBlk1(5) alias "Stress12"
MBBlk1(13) = 520.3        'B102# GCF for BBlk1(5) alias "Stress13"
MBBlk1(14) = 520.3        'B102# GCF for BBlk1(5) alias "Stress14"

' Convert micro-strain to stress (ksi)
Modulus = 0.005           ' ksi (E ksi/1,000,000 microstrain/strain)
```

Modifying the Stress Block Data Table

The duration of stress block when a trigger event occurs can be modified by changing the number of data samples recorded before and after the trigger. It may also be desirable to change the number of data points if the sample (scan) rate is modified. For example if the scan rate is reduced to 40 Hz (Period = 25 mSecs) but 3 seconds of data are desired before and after the trigger, the number of pre and post scans can be changed to 75.

```
'---------------------------- Table 1----------------------------
DataTable(STRSBLK,True,-1)                'Trigger, auto size
   DataInterval(0,INTERVAL1,UNITS1,0)     '20 mSec interval, 0 lapses, 1.67 Hours
   DataEvent(200,TrigStress > Triglim, True,200)  'Pre-scans, start, stop, post-scans
   CardOut(0,600000)                      'PC card , size 800000)
   '_______________________ Bridge Blocks _______________________
   Sample (1,NEvent,FP2)
   Sample (BREP1,BBlk1(),FP2)             '16 Reps,Source,Res
EndTable                                  'End of table STRSBLK
```

Memory and Data Storage Concepts

The CR5000 has two types of memory – 2 MB of CPU memory and a flash memory card (1 GB). The CPU memory contains the logger operating system, BIOS information and the data logging program, which contains the measurement and data storage instructions. Storage of measurements and processed results are generally stored on the PC flash memory card because of the available capacity. As previously mentioned, there are three different types of bridge response data; stress cycle counting, hourly extreme stress values, and stress data blocks due to specific triggered events. Measurements and processed data are stored in data files called data tables. The storage scheme of the data tables are based on ring memory that is continuously overwritten. A fourth data table is also generated that contains logger status information such as the supply voltage and the number of missed scans.

The data tables were made sufficiently large so that data can be stored for one month between downloads without resulting in data loss. Since memory is allocated to buffer data within the files, the files utilize the same amount of space regardless of whether they are full or empty. The best analogy of a data table is a spreadsheet with a fixed number of cells – all cells initially containing zeros. As data is recorded the cells are populated with new data, when the end of the worksheet is reached data storage starts over at the beginning of the worksheet. Each column of the data table (worksheet) corresponds to a specific output value or data field. Each line or row of data corresponds to the output of all the output values for a specific time. In the case of the stress cycle and extreme value data tables, one line or row is generated each hour of operation. Stress block data is generated during each trigger condition and then 400 lines of data are stored (4 seconds of data before the trigger and 4 seconds of data after the trigger with a sample rate of 50Hz).

There are two methods of retrieving data from the data tables. The first is to collect data records from the data tables using the Collect Data option in LoggerNet/Connect. This method requires a communication connection between the computer and the data logger. The Data Retrieval feature has various collection methods and data formats. The methods include collecting all available records, all records since last collection, or a specific number of records. Normally all records since last collection is selected and then the memory address of the last collection point is stored on the computer. Various ASCII and Binary formats are available, but the most common is the comma delimited ASCII format since it can be easily imported into a spreadsheet or database application.

The second collection procedure is to copy the entire data table files from the memory card to the PC. This can be done from the file by pulling the memory card from the logger and placing it in a PCMCIA slot on a notebook computer. When the entire data table is retrieved the data file is in binary format (TOB2) and cannot be used directly. It will be necessary to use the file conversion utility in LoggerNet. Included in the file conversion utility is the ability to process file marks and separate data into individual files. While this is probably not desirable with the stress cycle or extreme value data tables, it may be the preferred option for processing the stress block data which has a large amount of data associated with a single load event.

Some experience with the system and with the data processing will likely be required to determine the preferred method of downloading data. In general the Data Downloading method is much slower since the data is transferred over the RS232 link and converted to the appropriate format at the same time. On the other hand it is a simpler process. The stress cycle and extreme value data tables are low volume and the time required to download data using the Data Retrieval method is relatively insignificant. Furthermore the option to collect only new data can reduce the download time so it may only take a few minutes to collect data from the small tables. Another possible advantage is that the data can be written and appended to existing data files, which can simplify subsequent data processing.

Depending on the trigger settings and the number of truck crossing events captured, the Data Retrieval method may prove impractical when downloading the stress block data. Each stress block will contain approximately 400 records with 18 data values in each record. This translates to approximately 29KB per captured truck crossing. If the number of load events approaches 1000 between download intervals, the time required to download the data will be well over an hour. When performing a direct download of data, all of the data is written to a single file. An event number is written along with the stress values so data processing can be used to separate data associated each load event, but the file will grow exceptionally large over time.

If a relatively large number of load events are captured, it is best to copy the entire data table and then convert the data table. The option to “process file marks” can be selected so that data from each load event will be written to a separate data file. These data files can be dropped directly into a spreadsheet program such as Excel and plotted. It will likely be impractical to view all of the data files manually so some type of post processing application may be necessary that can sort the files by stress magnitude, stress-time volume, or some other criteria.

Data Collection Instructions

Following are specific instructions for collecting data from the logger.

Retrieving Data

The data logger program should be running when this data collection method is used.

- Connect PC to logger via direct RS232.
- Start LoggerNet program.
- Select the Connect menu option and select the correct station if there are more than one.
- Click on the Connect Button.
- Select Collect Now or Custom Collect.

- Collect Now utilizes the data file and conversion methods specified within Station Setup.
- Custom collect allows the user to specify what data is to be retrieved, the filename and location, and the data format with each download.

Copying Data Tables Directly From PCMCIA Card

It is necessary to power down the PC card prior to removing from the CR5000. If the card is removed while it is being written too, it will likely corrupt the data tables and could damage the card. The cards can be powered down through the CR5000 keypad and LCD menus or the logger can be turned off. If the logger is turned off or if the program is stopped, all counters and variables will be returned to the initial values when the program is restarted. If the card is powered down without terminating the program the counters such as NEVENT will remain at its current value.

- Using the CR5000 keypad press <Enter> twice to display the online menu on the LCD screen.
- Select PC Card <Enter>. Remove Card <Enter>. Remove the memory card from the logger carefully – it has a tendency to shoot out of the slot and travel rather far if not restrained. Insert memory card into notebook PCMCIA slot and wait for computer to acknowledge card.
- Copy data files to PC hard drive. Keep in mind that LoggerNet/ Convert Data Files option is required to retrieve data from the data table.
- Use appropriate procedures to remove memory card from PC.
- Reinsert card in CR5000 and reactivate. User will be prompted if the tables should be reset. Choose “Yes”.
- Restart program if the program was stopped. Press the Enter button <Enter> on the CR5000 keyboard to display the Main Menu. Press File to display main File menu <Enter>. Highlight File Control <Enter>. Select CPU files <Enter>. Highlight LaTechOL.CR5 file <Enter>. Highlight Run Now <Enter> to stop the program. The asterisk next to Run Now should be visible. Then highlight Execute <Enter>. Ignore warning message that data tables will be destroyed – select Yes <Enter>. Return to the main menu.
- Reset appropriate flags to for data storage. Remember to turn Flag 8 on prior to turning on Flags 1 and 2.

Copy File From PC Card (entire data table)

This process has the identical result as the previously mentioned Downloading Data procedure. The entire table is retrieved from which the data can be extracted. When the card is replaced and the program is restarted the tables will begin filling from the beginning of the table. Because of the size of the STRSBLK.DAT data table, removal of the memory card and copying directly to the computer is significantly faster. It is very important to follow the instructions for removing the PC card from the logger or data can be lost and the PC card can be damaged.

- Stop program execution: Press the Enter button <Enter> on the CR5000 keyboard to display the Main Menu. Press File to display main File menu <Enter>. Highlight File Control <Enter>. Select CPU files <Enter>. Highlight Cowane~.CR5 file <Enter>. Highlight *Run Now <Enter> to stop the program. The asterisk next to Run Now should have disappeared. Then highlight Execute <Enter>. Ignore warning message that data tables will be destroyed – select Yes <Enter>. Return to the main menu.

- Procedures to remove card from logger. Select PC Card <Enter>. Remove Card <Enter>. Remove the memory card from the logger carefully – it has a tendency to shoot out of the slot and travel rather far if not restrained. Insert memory card into notebook PCMCIA slot and wait for computer to acknowledge card.
- Copy data files to PC hard drive. Keep in mind that the LoggerNet/ Convert Data Files option is required to retrieve data from the data table. Use appropriate procedures to remove memory card from PC.
- Reinsert card in CR5000 and reactivate. Main menu <Enter>. PC Card <Enter>. <Format>
- Restart program. Press the Enter button <Enter> on the CR5000 keyboard to display the Main Menu. Press File to display main File menu <Enter>. Highlight File Control <Enter>. Select CPU files <Enter>. Highlight Cowane~.CR5 file <Enter>. Highlight Run Now <Enter> to stop the program. The asterisk next to Run Now should be visible. Then highlight Execute <Enter>. Ignore warning message that data tables will be destroyed – select Yes <Enter>. Return to the main menu.
- Reset appropriate flags to for data storage. Remember to turn Flag 8 on prior to turning on Flags 1 and 2.

Data Table Format

Each data table has a specific format. Typically the beginning of the table will have Header and Units information that are provided by the program. The measured and processed data will follow the header section and will be written in the same format with each entry. The number of data values will be constant throughout the data table.

Stress Cycle Data Table – STRSCYCL.DAT

The data table “STRSCYCL.DAT” contains the number of stress cycles for each stress range bin for each strain gage. The stress cycle histograms are setup to contain 10 bins for each gage. The lowest stress range starting at 0.2 ksi and the highest being 2 ksi. Including a time stamp and a record number, each record contains 142 data values (time stamp, record number, 10 stress bin counters for data channel 1, ……, 10 stress bin counters for data channel 16.

Extreme Value Data Table – MinMax.DAT

Data table “MinMax.Dat” contains the extreme stress values measured at each strain transducer over a period of 1 hour. Each record or row in the data file contains 42 data values including the time stamp, record number, maximum stress values for 14 data channels, and 14 minimum stress values.

Stress Block Data Table – STRSBLK.DAT

The stress block data table, “STRSBLK.DAT” contains stress values for each data channel. It is different from the other tables in that each record represents a single data sample. 17 data values are written on each line; a time stamp, record number, event number, and 14 stress values. Typically 400 lines of data are generated when a trigger occurs, the time interval between each record being 0.02 seconds. Typically 200 data records will be provided before the trigger condition and 200 after the trigger condition. The exception to this is when two or more data blocks are generated simultaneously without a break. If a heavy truck stops on the bridge or is traveling very slowly, or if multiple heavy trucks cross in close proximity of each other such that the trigger condition is still true when the data block is complete, only the post trigger data (200 records) will be recorded for the subsequent event since the pre-trigger data was already recorded from the previous event. The third value (column) contains the event number; this is an integer number that increments by one each time a data block recording is complete. Therefore, the event number will remain constant throughout the event. This number is useful when all of the stress block data is stored in a single file (resulting from a Data Retrieval or if file marks were not processed when files were converted). Note that the data event number is reset to zero any time the program is stopped and restarted so it cannot be used as a counter for the total number of heavy truck crossings.

Data Logger Status Data Table – LogStat.DAT

Battery voltage information and the number of skipped scans is stored hourly in the data table, LogStat. The format is the time stamp, record number, the maximum supply voltage experienced during the hour, the time at which the maximum voltage occurred, the minimum voltage occurrence, and the time of the occurrence, and the number of skipped scans. Any power problems should be apparent from the voltage values. Any non-zero value of skipped scans is an indication of a program problem and the system may not be operating correctly.

Operating the LaTechOL Monitoring System

This section contains the basic steps to get the live-load monitoring system up and running.

- Install CSI LoggerNet Software onto a PC (PC must have an available serial port and a PCMCIA slot for the memory card).
- Connect the CR5000 to one of the computer's serial ports.
- Provide power to the data logger and make sure the logger is grounded. Turn on the datalogger.
- Start the LoggerNet software.
- Define the station setup information using the Setup or the EZSetup options.
- The data logger program (LaTechOL.CR5) is already loaded into the CR5000 flash memory. The file names in memory can be displayed by clicking on Tools/Logger_Files. Highlight the file name "Cowanes~.CR5" by clicking on it and then check the "Run Now" box. Click on Execute and the program will be loaded in the CR5000 SRAM, compiled (checked for errors) and activated.
- Initially measurements will be made from all transducers however no data will be collected until program control flags are set appropriately.
- Use the Real Time/Field monitor to view stress values and set flags.
- Flag 8 must be turned on manually the first time after the program is started. Flag 8 is used to perform the gage zeroing and must be turned on before turning on the Flag 1 or Flag 2.
- Turn Flag 1 on to store hourly rainflow and extreme value data tables.
- Turn Flag 2 on to store triggered stress blocks.