

# PennDOT e-Notification

Bureau of Solutions Management  
Highway Applications Division



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## TRLRFD

No. 002  
April 29, 2024

## Release of Version 1.1.0.0

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This notification announces the initial release of Department's **LRFD Truss Analysis and Rating (TRLRFD)** program. TRLRFD is not approved for final design, but can be used for preliminary member sizing.

The Version 1.1.0.0 has been placed on PennDOT servers for use by the Districts. Consultants and others can obtain **TRLRFD v1.1.0.0** by submitting an [Order Form](#) along with the **initial license fee of \$1000 for private organizations and \$100 for governmental agencies**. The license fee is waived for federal and state transportation agencies. If you already have license, it will be a free upgrade.

Once payment is received, an e-mail will be sent with download instructions. A valid e-mail address must be provided on the Order Form to receive the download instructions.

Please direct any questions concerning the above to:

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Attachment

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Archived copies of all previously distributed e-Notifications can be obtained from the PennDOT LRFD and Engineering Programs website at <http://penndot.engrprograms.com/home> and clicking on "e-Notification" and then "Mailing List Archives."

**Program Title:** LRFD Truss Analysis and Rating  
**Program Name:** TRLRFD  
**Version:** 1.1.0.0  
**Subsystem:** Superstructure  
**Authors:** Pennsylvania Department of Transportation  
and Michael Baker International

## **ABSTRACT:**

Since the release of TRLRFD Version 1.0.0.0 several revision requests and user requested enhancements have been received. This release of TRLRFD Version 1.1.0.0 contains the following revisions and enhancements.

### **Specification Related Revisions**

1. For gusset plate locations with chord members and a vertical member, but no diagonals (a "post and hanger" condition), the program was previously not checking the gusset plates at the chord locations because it was assuming that a chord splice would carry all of the load from the chords. The program has been revised to check the gusset plates at the chord locations when a chord splice has not been defined at that location, or if a chord splice has been defined and is not adequate for the forces in the chords (Request 118).
2. Three vehicles specified as part of the FAST Act (EV2, EV3, and SU6TV) have been added as live load options to the program (Live Load Code H on the CTL command or Live Load Codes J, K, and L on the LLP command) (Request 169).
3. A new permit design vehicle, P2016-13, has been added to several live load options for the program (Live Load Code J on the CTL command or Live Load Codes J, K, and L on the LLP command) (Request 170).
4. A check for the slip resistance of the bolts in the gusset plates has been added. New input parameters for the minimum required bolt tension and the surface condition at the gusset plate have been added to calculate the slip resistance (Request 185).
5. The chord splice checks of LRFD Specifications Section 6.14.2.8.6 have been added to the gusset plate specification checks and the results now appear in the output (Requests 186 and 226).
6. The Fatigue-I and Fatigue-II limit state load factors have been revised to 1.75 and 0.80, respectively, due to revisions in the LRFD Specifications, 8th Edition. Because of this update, the program input for Pennsylvania Traffic Factor has been removed as per the 2019 Edition of DM-4. Finally, the ADTT limits for the application of Fatigue-I versus Fatigue-II have been updated because of the load factor changes (Request 197).
7. The coefficient for LRFD Specifications Equation 6.13.2.7-2 for the nominal shear resistance of bolts has been revised to 0.45, as per the LRFD Specifications 8th Edition (Request 202).

8. Previously, the HL-93 reactions at interior supports did not have the 90% factor applied to the lane load portion of the truck pair + lane load combination. This factor has been added, and now the PHL-93 and HL-93 interior support reactions are identical, as expected (Request 209).
9. The program now uses the permit dynamic load allowance value in the calculations of the deflections of the P-82 vehicle as well as using the minimum (most negative) value for the controlling negative deflection. Also, the program now stops with an error if the user defines distribution factors for force and deflection on the CTL command and enters a CDF (Computed Distribution Factor) command, since entering values in both locations can be contradictory (Request 213).
10. The calculated deflections of the PHL-93 combination will now be multiplied by 1.25, in accordance with DM-4 Section 3.6.1.3.2. Previously, the program did not multiply the values by 1.25. Also, the program will now report the governing deflection vehicle combination (125% Truck Alone or 125% [25% Truck + Lane]) at each location for the deflection calculations (Request 214).
11. When applying the two tandem + live load combination for the HL-93 vehicle, the program will now make sure that the tandems are not in the same span. Previously, both tandems could be placed in the same span and a 0.9 factor was applied to both the tandems and lane load (Request 215).

### **Program Input Revisions**

12. The program will now stop with an error if the end of a span does not correspond with the edge of a defined panel (Request 068).
13. The maximum number of spans has been increased to 15 (Request 069).
14. Members framing into a gusset plate that end at a middle node (rather than upper or lower node) are now included in the gusset plate analysis (Request 075).
15. A new input command, UNBRACED LENGTH (UBL), has been added to allow the user to specify different unbraced lengths for each axis (x-, y-, and z-) for calculations of elastic flexural buckling, flexural-torsional buckling, and moment magnification. The UBL command can only be used with members defined via the T## commands, not members defined with the PRP command (Request 102).
16. The upper limits for the number of trucks on the FGV command have all been increased to 300,000 to allow values that match actual PennDOT loadometer survey data ranges (Request 108).
17. The LIVE LOAD DIRECTION input parameter (CTL) command can now only be entered as B (both directions) to ensure that all vehicles will be applied to always produce the maximum live load effect (Request 151).
18. If the user does not define a DC load at an upper or lower joint supported by a vertical or diagonal member, a warning will appear in the program output. The program does not calculate self-weight due of the truss members, so the user must take this into consideration when calculating the DC loads. Also, if the user defines

a DC or DW load at an upper or lower joint that is NOT supported by a vertical or diagonal member, the program will stop with an error.

The warning message for omitted DC dead loads indicates the truss analysis is not valid if loads have been omitted. The lower limit for both DC and DW dead loads is now a small positive value (0.001 kips). Previously, the DC lower limit was -500 kips and the DW lower limit was -200 kips. (Requests 152 and 234).

19. Input parameters for chord splice size have been added to the program and incorporated into the gusset plate specification check calculations (Request 153).
20. A new input command, GUSSET PLATE FILLER (GFL), has been added to allow the user to enter filler plate and connected plate areas to calculate the fastener shear resistance reduction factor from the LRFD Specifications Section 6.13.6.1.4 (Request 184).
21. An additional input parameter, VEHICLE TYPE, has been added to the SPECIAL LIVE LOAD (SLL) command to allow the user to specify whether to apply the Design dynamic load allowance or the Permit dynamic load allowance to the specified special live load (Request 191).
22. A new input value has been added to the Gusset Plate (GUS) command to allow the user to input the hole diameter to use for gusset plate checks. Previously, this value was internally calculated to be equal to the fastener diameter + 1/16". The 8th Edition LRFD Specifications Table 6.13.2.4.2-1 changed the maximum standard hole size to be dependent on bolt diameter. Allowing the user to directly enter the hole diameter allows the most flexibility for design of new gusset plates, or analysis of existing gusset plates that may have nonstandard holes. The value will default to the maximum standard hole size if left blank, but the user may enter any value between the bolt diameter and the maximum standard hole size (Request 203).
23. The input parameter "Hinge At" on the CTL command has been renamed to "Pinned Support" to clarify its purpose and to distinguish it from the hinges defined on the HNG command. Also, this value will now default to joint U0 if the first panel is type 3 and remain defaulted to L0 for all other panel types (Request 210).
24. The program now requires a hinge to be located between panels when Panel Type 2 is followed by Panel Type 1. Likewise, a hinge is required between panels when Panel Type 4 is followed by Panel Type 3. Also, the Truss Dead Loads output now lists all possible joints of the truss and indicates which joints cannot be loaded (Request 199).
25. The program now allows distribution factors entered on the CTL command to be greater than 2.0 with a Warning Message. Previously, the program would stop with an error if the distribution factor entered on the CTL command was greater than 2.0 (Request 216).
26. The bolt diameter, D, on the GUS command now has an upper limit of 1.5 inches. If the user attempts to enter a value greater than 1.5 inches, the program will now stop with an error. In addition, if the user enters a bolt

diameter not present on LRFD Specifications Table 6.13.2.8-1, the program will warn the user to verify their bolt diameter and minimum required bolt tension (Request 221).

27. A warning message is now given when filler plates are specified for a member that is not present for the specified gusset plate location. Also, filler plate properties are reported in the Input Summary only for gusset plate locations with filler plates entered on the GFL command (Request 222).
28. When the distance between the first and last row of fasteners is greater than 38 inches and the member force is tensile, the shear resistance is taken as 0.83 times the original value (Request 223).
29. The program now allows distribution factors entered on the CTL command to be greater than 2.0 with a Warning Message. Previously, the program would stop with an error if the distribution factor entered on the CTL command was greater than 2.0 (Requests 216 and 230).
30. The unbraced length is limited to the member length calculated from the panel geometry. An unbraced length that exceeds the member length will result in a specification check warning (Requests 236 and 242).
31. The sum of all defined panel widths must be within 0.5" of the sum of all span lengths and the sum of all defined panel widths for a given span must be within 0.5" of the span length of that span (Request 229).

#### **Program Output Revisions**

32. For the PHL-93 and HL-93 vehicles the calculated tonnage will now be left blank on the RATING SUMMARY output report because the PHL-93 and HL-93 results are defined from multiple vehicles (Request 071).
33. Several issues regarding the calculation of Extreme Event III loads have been identified and resolved (Request 072).
34. The MEMBER FORCES AND RATINGS output reports have been revised to indicate a rating failure (RF < 1.0) with an asterisk (\*) in the right-most column of the report (Request 188).
35. The Critical Rating and Rating Summary output tables now include a Rating Failure column to identify rating factors that are less than 1. (Request 228)
36. The gusset plate Input Summary now includes data past the mid-point of the truss for non-symmetrical trusses. Previously, only gusset plate input data up to the mid-point of the truss was included in the Input Summary. Also, for symmetrical trusses, if users enter data past the symmetry point, the program stops with input error messages. (Request 235)

#### **Program Documentation Revisions**

37. The detailed description of the FGV (Fatigue Gross Vehicle) command in Chapter 6 of the TRLRFD User's Manual has been revised to give more detailed information on how to input the parameters of the command (Request 111).

38. The contact information and revision request forms in Chapter 9 of the User's Manual have been revised. And, directions on the revision request form have been updated to request that input files be provided in an e-mail or as an e-mail attachment (Requests 193 and 195).
39. The User Manual now refers to Highway Application Division rather than Engineering Software Section (Request 220).
40. Clarifications regarding the modeling of the chord splice were added to chapter 2 and 5 of the User's Manual as well as the configuration file GCS.RTF (Request 225).
41. Chord members are assumed to be continuous at gusset plates unless Gusset Chord Splice plates are defined using the GCS command. Chord splices can only be defined at gusset plate locations (Request 227).
42. The Revision Request Forms (User Manual and Word Template) do not refer to a PennDOT fax number (Request 237).
43. Verified that the live load live results from TRLRFD differ slightly from the BAR7 live load results due to a different impact factor / dynamic load allowance. Also, emphasized in section 5.9 of the User's Manual that a series of simple span trusses must be entered in separate input files and cannot be analyzed in a single run of TRLRFD (Request 231).
44. References to the FHWA Publication FHWA-IF-09-014 and the LRFD Specifications 7th Edition in the User's Manual Section 3.12 have been removed. All gusset plate calculations in TRLRFD use the LRFD Specifications 8th Edition (Request 243).

### **Programming Revisions**

45. TRLRFD has been revised to use Visual Studio 2019 and Intel Parallel Studio XE 2019 Fortran Update 5 for compilation and linking (Request 196).
46. Errors with the post processing of the LLP command which resulted in live loads being placed in incorrect lanes have been resolved (Request 212).

### **APRAS Requests**

47. The program is now compatible with APRAS NextGen (Request 042).