APPENDIX I

BC MOTI POLICIES, PROCEDURES AND METHODOLOGY FOR EVALUATION OF STRUCTURES FOR EXTRAORDINARY OVERWEIGHT PERMITS

Ministry of Transportation and Infrastructure

BC MOTI Policies, Procedures and Methodology for Evaluation of Structures for Extraordinary Overweight Permits

Background and Definitions

Extraordinary Overweight: any overweight vehicle that cannot be pre-approved for weight based on current policies

Overload: any vehicle exceeding legal gross vehicle weights or legal axle weights that requires a permit

Structure: any structure supporting vehicles with a span > 3 m

Screening Evaluation (SE) refers to a simplified and rapid method of doing a 2D model key load effects comparison evaluation where the overload vehicle load effects (Demand) are compared to reference vehicles load effects (Capacity), of which the latter are considered to represent the safe capacity of the structure.

Standard SE refers to the method where the effects of vehicle track width, transverse wheel layouts and lateral distribution to structural components are NOT considered - which means they are assumed to be the same for both the demand and capacity vehicles and therefore cancel each other out in the Demand/Capacity (D/C) ratios.

Enhanced SE refers to the method where differences resulting from track widths, transverse wheel layouts and lateral distribution are also included in the D/C ratios. This is typically done only on a case by case basis when the Standard SE is failing and when these benefits can be calculated by simplified methods (e.g. for 2 girder bridges or through-truss bridges, or also for very wide vehicle track widths like dual lane trailers where the distribution benefits are substantial).

Detailed Evaluation: a structure live load evaluation undertaken in accordance with Section 14 of CSA S6, or the equivalent sections of older codes, where Live Load Capacity Factors (LLCFs) are calculated for all critical components and locations.

Reference Capacity Vehicles: The structure design vehicle if known, the legal vehicle(s) if the bridge is not load restricted (or load posted), an evaluation vehicle x LLCFs (if the structure has been "detail evaluated" in accordance with the bridge code), or a previous known overload permit vehicle that has crossed the structure without resulting in known damage. Overload vehicle LLCFs from a report paid for by a hauler for a specific overload study are not used or made public as they are considered proprietary to the hauler.

Robust Substructures: mass concrete abutments or piers, wall piers or similar with no cantilever beam or corbel supporting live load; columns in pier bents with 3 or more columns, pier beams supporting live load (not directly over columns), with span/depth ratios ≤ 2; stocky columns ($KL/r \leq 20$)

Screening Evaluation Methodology and Procedures

- 2D single spine models of all bridges are developed and maintained which accurately represent span lengths (as defined by CSA S6), span articulations, restraints and hinges, and span variable "EI" (if not statically determinate for longitudinal effects distribution) – basically all conditions that will significantly affect the longitudinal distribution of live load effects.
- the model must capture all main spans and floor systems such as stringers and floor-beams and truss hangers, and main support reactions, however duplicate similar spans and symmetry should be taken advantage of to reduce the number of load effects evaluated and tracked
- a min. of 2 spans are modeled for simple span floor system stringers (or decks) and a min. of 4 spans are modelled for continuous span stringers and decks
- span lengths should be modeled to an accuracy of 0.5%
- an Excel spreadsheet (Structure Model Record Sheet) is prepared that includes a brief description of the superstructure and substructure types, photos, dwg section clips of key reference details, schematic of the model, one column for each key load effect being tracked and compared, the reference vehicle load effects, LLCFs if applicable, live load factor adjustments if applicable to adjust reference vehicles to the baseline of "PS" Single Trip permits.
- the reference vehicles should be run on the model and the key load effects permanently recorded and checked
- the Model Record Sheet and the corresponding analysis model should be independently checked, and both signed off by a P.Eng. as well as any future significant modifications to them
- Abutments in compression under live load are typically considered very robust and low risk and are not evaluated, however abutment reactions with live load uplift should be evaluated
- Key load effects to be tracked and D/C ratios calculated typically are at locations of maximum moment and shear in each span, reactions at piers, shear at in span hinges, pins or dapped (or half) joints, however engineering judgment must be used as on certain bridges other locations may be critical. For floor systems max. shear and moment in the stringer (or deck) spans and the reaction on the floor-beam (and hanger if applicable).
- Decks that span transversely between longitudinal girders as one-way slabs are not required to be evaluated, however if they span longitudinally between floor-beams they should be evaluated in a similar manner as floor stringers
- For concrete components not designed or evaluated for shear based on Modified Compression Field Theory or Strut and Tie methods, the design or evaluation vehicle shear load effects are not used as reference capacities as they are likely unconservative, rather the 63.5T legal or 63.5T permit vehicles must be used (provided the bridges are not load posted or restricted for less than legal loading)
- Robust substructures are assigned an 83.5T Standard PS Permit Vehicle LLCF of 1.5 without any evaluation
- LLCFs used in screening evaluation on the capacity side are based on the MOTI standard 83.5T PS Permit Vehicle taken from bridge load rating reports if completed for a bridge (see attached 85T Load Rating Terms of Reference for the procedures).
- D/C ratios may be adjusted by live load factors to account for the different live load factors of the overload permit vehicles from Section 14 vs. the reference capacity vehicles provided the

latter is clear as to what live load factors were used. NT live load factors should be assumed for non-permit legal traffic.

- When comparing single trip overloads to the legal reference vehicle and the structure is in good condition and not load posted, a max. 5% exceedance tolerance or benefit is acceptable, and a max. 2% exceedance tolerance is acceptable for term permit overloads.
- DLA (dynamic load allowance) benefits of the overload travelling at reduced speeds as per Section 14 of CSA S6 may be applied to the D/C ratios, however the amount of DLA 'embedded' in the reference capacity vehicles must be verified. If the reference vehicle DLA cannot be verified based on clear records (such as reference to a code or from an evaluation report) then a maximum benefit of 6% is allowed for the overload crossing at a speed of ≤ 10 kph. If speed reduction benefits are required to pass an overload, then max. speeds of 25 and 10 kph are considered.
- Example calculations: for a DLA of 0.25, the 10 kph benefit is (1.25)/(1+0.3x0.25)-1 = 16%, or for a DLA of 0.3, 19%
- If design or evaluation vehicle lane loads are used as the reference capacity vehicles (beneficial only for long spans) then the reduced DLA for the lane loads based on the applicable era code must be used, and further the crossing condition of "no other vehicles in the same lane" must be assigned to the overload to avoid cancelling the benefit of the UDL portion of the reference lane load. Note for older codes like S6-88 the DLA was different for the UDL and truck portion of the lane load.
- For permits that will not have bridge crossing conditions and the vehicle could likely to be crossing in a traffic jam scenario representing the lane load condition, 100% of the truck load combined with the code UDL starting 3 m before and after the overload vehicle (but not overlapping it) is used.
- For structures at least 2 lanes wide, the benefit of travelling down the centerline of the bridge or straddling 2 lanes and with no other vehicles on the bridge at the same time shall be 10% for all components and load effects. The one exception is for moment in main girders of multi-girder (≥ 4 girders) or slab superstructures where the benefit shall be 30%, which is taken from a paper by Bakht/Jaeger "A Rational Procedure for Overweight Permits" - Transportation Research Record 950).
- Term permits cannot have bridge crossing conditions or crossing restrictions and the permit vehicles are assumed to travel mixed with normal traffic which is the CL1-625 design vehicle (see attached Terms of Reference for Divisible Load permits).
- If a PC permit (Controlled Permit) is required to get a pass on any bridges, then the overload vehicle weights and axle dimensions must be independently verified before the permit is issued and the bridge crossings must be supervised by an independent BC licensed engineer. Independent verification of the weights and dimensions must be done either by official government weigh scale operators or by a BC licensed engineer and verification documents provided. See attached Weighing and Supervision Requirements for more details.
- If the screening evaluation methodology is exhausted without achieving a pass then the overload permit request is denied, and the applicant has the options of reducing weights, changing their vehicle configuration, changing their route, or hiring a consultant to undertake detailed evaluations of the failing bridges (see attached Single Trip Permit Detailed Evaluation

Terms of Reference). If the detailed evaluation is successful, then the permit is issued based on the bridge crossing requirements of the accepted detailed evaluation reports.

- The structural engineering approval portion of the permit is delivered as a sealed secure pdf file and contains the vehicle configuration and details, the approved route as clear step by step directions in order of the direction of travel, and the list of bridges that have crossing conditions/restrictions and the km station (to the nearest 0.1 km) from a clear upstream reference point, typically a junction.
- The most common bridge crossing conditions/restrictions used are: travel down the centerline of the bridge, straddle 2 lanes in the direction of travel, no other vehicles on the bridge at the same time as the overload, no other vehicles in the direction of travel at the same time as the overload, at a speed less than 10 km/h
- Reduced speed restrictions are always the last restrictions to be considered as the rate of compliance is lower as observed by MOTI, further most heavy overloads require multiple pilot cars, travel during off-peak traffic times, and many are over-width, so straddling 2 lanes and no other vehicles on the bridge has less impact on the hauler and compliance is greater
- Structural Culverts with a cover of > 1 m are screen evaluated based on a vertical stress comparison approach at the obvert elevation (rather than beam model load effects), with the stress based on wheel and axle loads and Boussinesq theory stress distribution. Culverts are only evaluated for vehicles with axle weights exceeding overload permit policy limits as defined by the MOTI CTPM, (typically single axle: 11,000 kg, tandem axle group: 24,000 kg, tridem axle group: 29,000 kg), and these vehicles are most typically municipal fire trucks. The overload is compared to the PS permit tandem and tridem group and if necessary the era design vehicle axles shown below, however no live load factor adjustments are used for this stress comparison method.

Time Period	Culvert Design Live Loading	Heaviest Axle
1950 - 1962	HS20	32 kip / 142.3 kN
1962 - 1978	HS25	40 kip / 177.9 kN
1978 - 1988	MS250	200 kN
1988 - 2000	CS-600	180 kN
2000 - 2007	CS-600	180 kN
2007 - 2017	BCL-625	175 kN

Reference Capacity Vehicles

TRTR3 8 Axle Legal B-Train - Normal Traffic (Pre-approved for all bridges open to full legal loading)

Axle No.	1	2	3	4	5	6	7	8	GVW
Description	Steer	Tandem Drive		Tridem Trailer			Tandem Trailer		kg
Weight of axle (kg)	5,500	17,000		24,000			17,000		63,500
Mass (kg)	5,500	8,500	8,500	8,000	8,000	8,000	8,500	8,500	63,500
Force (kN)	53.94	83.360	83.360	78.456	78.456	78.456	83.360	83.360	63,500
Axle spacing (m)		4.00	1.20	5.50	1.20	1.20	5.50	1.40	
No. of Tires	2	8		12			8		

63.5T 7 Axle Permit Vehicle - PS Traffic (Pre-approved for all bridges open to full legal loading)

Axle No.	1	2	3	4	5	6	7	GVW
Description	Steer	Tridem Drive			Tridem Jeep			kg
Weight of axle (kg)	5,500	29,000			29,000			63,500
Mass (kg)	5,500	9,667	9,667	9,667	9,667	9,667	9,667	63,500
Force (kN)	53.939	94.801	94.801	94.801	94.801	94.801	94.801	63,500
Axle spacing (m)		4.40	1.40	2.25	7.3-18	1.50	1.50	
No. of Tires	2	12			12			

80T 9 Axle Permit Vehicle - PS Traffic (Pre-approved for all 80T Route bridges (if not load restricted))

Axle No.	1	2	3	4	5	6	7	8	9	GVW
Description	Steer	Tandem Drive		Tandem Jeep		Tandem Trailer		Tandem Booster		kg
Weight of axle (kg)	5,000	18,750		18,750		18,750		18,750		80,000
Mass (kg)	5,000	9,375	9,375	9,375	9,375	9,375	9,375	9,375	9,375	80,000
Force (kN)	49.04	91.94	91.94	91.94	91.94	91.94	91.94	91.94	91.94	80,000
Axle spacing (m)		4.4	1.37	3.76	1.37	9.00	1.37	3.76	1.37	
No. of Tires	2	8		8		8		8		

83.5T 9 Axle Permit Vehicle - PS Traffic (Pre-approved for all 85T Route and BCL-625 bridges (if not load restricted))

Axle No.	1	2	3	4	5	6	7	8	9	GVW
Description	Steer	Tandem Drive		Tandem Jeep		Tridem Trailer			Booster	kg
Weight of axle (kg)	5,500	20,000		20,000		29,000			9,000	83,500
Mass (kg)	5,500	10,000	10,000	10,000	10,000	9,667	9,667	9,667	9,000	83,500
Force (kN)	53.939	98.070	98.070	98.070	98.070	94.801	94.801	94.801	88.263	83,500
Axle spacing (m)		4.4	1.37	4.60	1.37	7-18	1.50	1.50	3.70	
No. of Tires	2	8		8		12			4	

Ministry of Transportation and Infrastructure

TERMS OF REFERENCE
LOAD CAPACITY EVALUATION OF BRIDGES FOR 85 TONNE CLASS PERMIT LOADS

1.0 Background and Scope of Work

The Ministry has an ongoing program to evaluate the load capacity of bridges on specific routes throughout the Province in order to enable routine issuance of permits for 85 tonne GVW permit loads. Consultants are advised that the Ministry has modified its methodology from using the most cost effective method and minimizing the amount of work to get a positive but reliable answer, to using sophisticated analysis methods to obtain the best possible answer to aid in later evaluation of the structure for higher loadings. The Consultant shall use sophisticated methods, as defined by CSA S6 Clause 14.11.3 in the undertaking of this assignment.

Strengthening designs are not part of this assignment. For structures that are confirmed as under capacity, rehabilitation design and work will be procured under separate contracts by Ministry Region or District personnel.

The Ministry regularly evaluates bridges for passage of loads greater than 85 tonne GVW with special crossing restrictions such as travelling down the bridge centerline and with no other vehicles on the structure. Therefore load cases are included which facilitates these ongoing evaluations.

The Ministry also considers the capacity of bridges on some routes to carry 6 axle mobile cranes. Evaluation of the bridges for this load case may also be required.

The scope of work for this assignment involves the load rating of the specified elements identified in **Table 2**, which shall be based on the available drawings for the structures and inspection reports supplied by the Ministry.

2.0 Evaluation Criteria

2.1 Evaluate structures in accordance with CHBDC CAN/CSA S6-14 (including all current revisions), Section 14 using Ultimate Limit States methods unless noted otherwise. Live loading reductions shall be applied in accordance with Tables 14.3 and 14.4.

2.2 Incorporate the relevant provisions of the MoT Supplement to the CHBDC S6 (Volume 1 of the Bridge Standards and Procedures Manual dated October 2016).

http://www2.gov.bc.ca/gov/content/transportation/transportation-infrastructure/engineering-standards-guidelines/structural/standards-procedures/volume-1

2.3 The Inspection Category shall be INSP2.

2.4 For the mobile crane load case, the following live load factors provided in **Table 1** shall be used instead of those given in Clause 14.13.3.

Table 1 – Live Load Factors for Mobile Cranes

Analysis Type	Span Type	Beta Factor						
		2.50	**2.75**	**3.00**	**3.25**	**3.50**	**3.75**	**4.00**
Static	Short	1.15	1.19	1.23	1.27	1.32	1.36	1.41
	Other	1.10	1.10	1.15	1.19	1.24	1.28	1.33
Sophisticated	Short	1.17	1.22	1.27	1.32	1.37	1.42	1.48
	Other	1.10	1.11	1.16	1.21	1.26	1.31	1.36
Simplified	Short	1.19	1.25	1.31	1.37	1.43	1.50	1.57
	Other	1.10	1.11	1.17	1.22	1.27	1.33	1.39

2.5 Rating of concrete decks, superstructure bracing elements (except for curved in plan bridges), bearings, vertical substructure elements not susceptible to buckling, and foundations are generally not required (unless noted otherwise in Table 2). Single and two column pier bents shall be evaluated.

2.6 Fatigue analysis is not required.

2.7 System Behaviour Category S1 shall be used for the girders in 3 girder simple span bridges.

2.8 If available, shop drawings will be provided for bridge girders, which typically represent the as-built condition. In the event of a discrepancy with the design drawings the shop drawings generally shall govern. The Consultant shall notify the Ministry if any significant difference (e.g. # of strands, concrete strength, plate sizes, number of bolts, etc.) is encountered.

2.9 For concrete girders, shear and moment capacity calculations shall be undertaken in accordance with the Ministry's Supplement to S6, Section 14.14.1.6.1. Note the iteration procedure required for shear resistance calculations. Concrete girders shall be evaluated for shear at dv from the support, at changes in stirrup spacing and at prestressing hold-down points typically.

2.10 When interaction of forces may govern a member capacity, the LLCF shall be calculated by iteration (or comparable method) that results in the applicable interaction equation being equal to 1.0, or the data point falling on the factored resistance interaction curve. Some examples of this are Section 10.9.4.1 (axial compression and bending in a steel column), Section 10.10.5.2c (combined shear and moment in steel girders with slender webs that rely on tension field action) and reinforced concrete columns. The LLCF shall be inserted into the interaction equation by replacing for example Mf by (MfD+LLCFxMfL). The interaction curve for reinforced concrete columns should be developed using factored material strengths and it shall also include the resistance adjustment factor U of S6 14.14.2.

2.11 For the purposes on Section 14.12.5, structures shall not be considered as “important”.

2.12 The evaluation of arch bridge curved compression members shall be in accordance with the most current version of the AASHTO LRFD Bridge Design Specifications following

the first order analysis moment magnification methodology, or an alternative methodology may be proposed to the Ministry for approval prior to proceeding.

2.13 For continuous modular truss panel bridges such as Acrow, Bailey, Mabey etc. the negative moment resistance at piers, if based on the supplier's information for simple spans or based on the full panel section properties, shall be reduced by a factor of 0.75 to account for shear interaction at the panel pin connections.

2.14 For Acrow panels in good condition and not considering fatigue, the ULS Mr = 0.95 x Fy x S and the ULS Vr = 1.6 x Shear Capacity Values (based on allowable stress), based on values from the Acrow manual. Similarly for Bailey panels; ULS Mr = 0.90 x Fy x S and ULS Vr = 0.90 x "Failing Load" (based on testing), based on values from the "The Bailey and Uniflote Handbook".

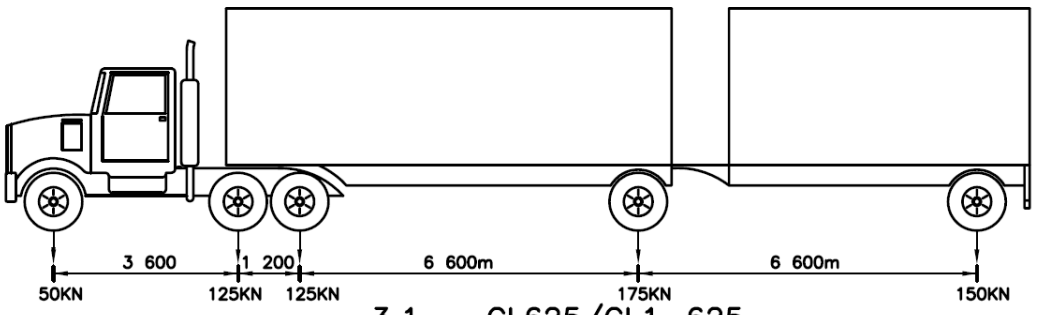
2.15 Companion vehicles are the Normal Traffic loading in the other lanes at the same time as a permit vehicle for the multi lane loading cases. If companion vehicle force effects are significant for a particular force effect and component, then they may be considered as Category A force effects in the LLCF equation (i.e. subtracted from the numerator). The exception is if they are of the opposite sign to the overload vehicle force effects (i.e. causing force reversal) in which case they shall be neglected.

3.0 Dead Load

Unless otherwise indicated in the Terms of Reference, assume that all structures with concrete decks have been designed for an additional 50 mm of concrete overlay and that the overlay has been or will be installed in the future. The dead load category shall be D2.

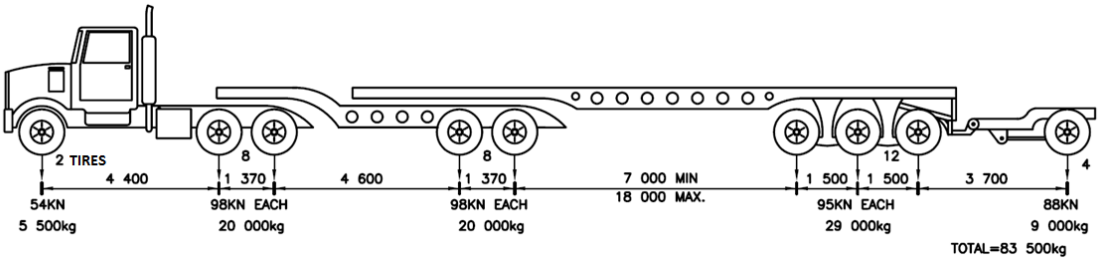
4.0 Live Load

4.1 All structures shall be evaluated for the following live load vehicles unless noted otherwise:

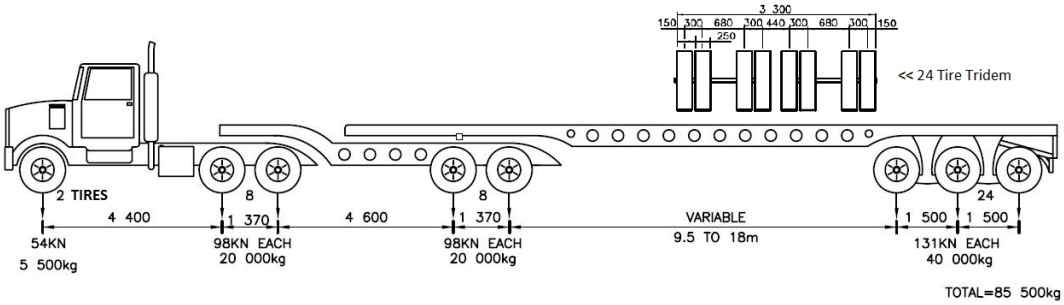


3.1 – CL625/CL1–625

i. CL1-625 Truck or Lane Load, Normal Traffic, Evaluation Level 1



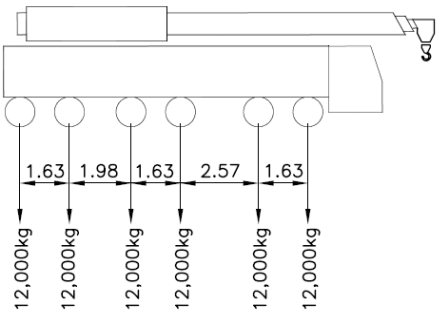
ii. 83.5t 9 Axle PS Permit Vehicle, Truck or Lane Load



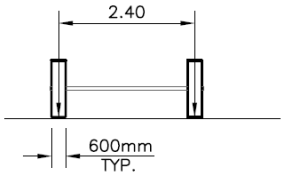
iii. 85.5t 8 Axle PS Permit Vehicle, Truck or Lane Load (Wheeler axle version)

Each of the above vehicles shall be assumed to have a track width of 1.8 m c/c of the wheel lines except for the wheeler axles as shown. Lateral placement of the Permit Vehicles within the Section 14 evaluation lanes shall be in accordance with S6 3.8.4.1 (0.6 m from center of outer wheel (dual tires) to the edge of lane - therefore wheeler tridem will control the lateral position for the 85.5T vehicle).

iv. 6 Axle Mobile Crane PA Permit Vehicle, Truck or Lane Load



Crane–6ax



Transverse Dimension Between ℄'s of Wheels (Typical All Cranes) = 2.4m

4.2 Multiple lane loading shall be in accordance with S6 Section 14.9.4. Loading in "other lanes" than the single permit vehicle shall be CL1-625 (reference S6 Section 14.9.4.3). The number and widths of the evaluation lanes shall be the number of current operating lanes as given in **Table 2** with the widths as defined in S6 Section 14.9.4.1. All load combinations shall include the factors in accordance with S6 Tables 14.3 and 14.4 as applicable.

4.3 The following live load cases shall be considered to produce the governing load effects on the elements being evaluated:

i. CL1-625 Normal Traffic (Truck or Lane Load) in all combinations of evaluation lanes (except this load case is not required for bridges designed to BCL-625)
ii. Permit vehicles (Truck or Lane Load) in any single evaluation lane with normal traffic (CL1-625) (Truck or Lane Load) in the other lanes, with all lane combinations considered
iii. For the PS permit vehicles, additional load cases shall be analyzed with the permit vehicles (**Truck Load only**) positioned for various lane configurations as follows, with a lateral tolerance of ±600 mm:
    - 1 or 2 lane bridges - straddle the bridge centerline with no other traffic on the bridge
    - 3 lane bridges - straddle two lanes with no other traffic in those lanes with potential CL1-625 traffic (Truck or Lane Load) in the 3rd lane
    - 4 Lane bridges / 2 lanes in each direction - straddle two lanes of one direction with no other traffic in those lanes, with potential CL1-625 (Truck or Lane Load) in the opposing direction lanes.

4.4 If applicable, for evaluation of single and two column pier bents, braking load and wind load shall be considered in combination with vehicle loads to determine moment and shear forces that may interact with axial forces.

5.0 Bridges and Bridge Components to be Evaluated

Specified bridges and bridge components for evaluation are noted in **Table 2**.

Table 2 – Specific Bridges and Components

Structure No.	Structure Name	Superstructure and Substructure Components to be Evaluated	Hwy Class	Number of Operating Lanes

6.0 Report Format

Provide 1 electronic copy each of the draft report and sealed final report for each bridge, in pdf format. One hard copy of the final report shall also be provided upon request. The report layout and **minimum** content shall be as follows unless approved otherwise by the Ministry. A separate report shall be prepared for each bridge.

6.1 Introduction

- Brief project background and description,
- Reference to Terms of Reference (to be attached as an Appendix).

6.2 Bridge Description

- Reference to General Arrangement Drawing (include drawing in this section or in Appendix),
- Description/discussion of significant features of the structure affecting the load capacity evaluation,
- Description of modifications or rehabilitation of the structure over time which may be significant relative to the load capacity evaluation.

6.3 Analysis

- Evaluation Criteria,
  - Design Codes and code modifications
  - Live Loading including Lane Loading (Hwy Class)
  - Inspection information or assumptions
- Analysis Assumptions and Methodologies,
  - Material properties
  - Dead loads
- Discussion of structural models and issues.

6.4 Results

- General discussion of results,
- Summary table of the lowest LLCF per load case and related member and force effect.
- Evaluation results for each rated member in a standardized tabulation containing at least the following information (**see attached sample table**):
  - Member identification (Element)
  - Failure mode, (shear, bending etc.)
  - Critical section, location for where capacity is being checked (reference to diagram for complicated geometry structures, as required)
  - Reason for selection of specific location for checking
  - Target Reliability Index: System (S) and Element (E) Behavior categories, Inspection Level (typically INSP2)
  - Beta Factor type(s), Beta values shall not be modified for important structures as per Clause 14.12.5;
  - Dead load, dead load category, dead load factor, factored dead load;
  - Live load, live load factor, dynamic load allowance, factored live load;
  - Member resistance and U factor;
  - LLCF; indicate whether vehicle or vehicle/uniformly distributed load combination governs, and;
  - identification of evaluator and checker for each load case, plus hand written signatures.

6.5 Calculations Brief

The Ministry may request a copy of the detailed calculations for review. The Consultant shall record calculations in an organized and complete format and retain them on file for this purpose.

7.0 Ministry Information

The following information will be provided:

Digital pdf copies of all drawings noted on the drawing list for each structure.

Annual inspection reports and inspection pictures from BMIS. If available, two routine inspection reports along with one detailed inspection report will be provided.

The Consultant shall review the inspection reports and advise if any condition issues are noted which could impact the capacities of the elements being evaluated.

Ministry Contact

8.0 Schedule

Submit draft evaluation report(s)	Not later than xxxxxx
Submit final evaluation report(s)	Not later than xxxxxx

Provide the Ministry with a schedule which indicates the proposed delivery dates for the draft and final evaluation reports for each structure within the general guidelines noted above.

Sample Evaluation Table

Bridge Name and Number

Element	Failure Mode (Units)	Critical Section	Target Reliability Index				Dead Loads (per element)							Live Load (per element)					Resistance		
							Unfactored Loads			Load Factors											
			Sys. Behav.	Elem. Behav.	Insp. Level[1]	Beta	D1	D2	D3	α_{D1}	α_{D2}	α_{D3}	Fact'd Load	Load Case[2]	Unfact. Load	DLA	Load Factor	Fact'd Load	Fact'd Resist.	Adjust. Factor U	LLCF
20m span Prestress I Girder	Shear (kN)	Change of Stirrups @5.2 m	S2	E2	INSP2	3.25								CL-625 NT							
														83.5T PS							
														85.5T PS							
														83.5T PS*							
														85.5T PS*							
														Crane PA							
20m span Prestress I girder	Positive Moment (kNm)	@ 0.5L	S2	E3	INSP2	3.00								CL1-625 NT							
														83.5T PS							
														85.5T PS							
														83.5T PS*							
														85.5T PS*							
														Crane PA							

Notes:

Hwy Class

Inspection Category (if not shown in table)

* Truck Load only, straddling 2 Lanes (example for 2 lane bridge)

DLA = 0 indicates Lane Loading Governs

	Name	Signature
Evaluator		
Checker		

1. Not necessary if INSP category is the same for all
2. Report all load cases together by element

Ministry of Transportation and Infrastructure

TERMS OF REFERENCE
DETAILED LOAD CAPACITY EVALUATION OF BRIDGES FOR DIVISIBLE LOAD OVERWEIGHT VEHICLES

1.0 Background and Scope of Work

A Proponent has approached the BC Ministry of Transportation and Infrastructure (**MOTI**) with a request to allow a vehicle with a gross vehicle weight (GVW) that exceeds legal limits to travel on a specific corridor under a special permit. The Ministry requires the Proponent to evaluate the bridge structure(s) on the route to determine whether the proposed vehicle can safely cross them without crossing restrictions or disruption of existing traffic. The Proponent shall retain and pay for the services of a qualified BC licensed Bridge Engineering Consultant to undertake the work. The Consultant shall have experience in undertaking detailed bridge overload evaluations in accordance with the Ministry's requirements. The Consultant shall carry Professional Liability and General Liability Insurance in the amounts of $1M and $2M respectively and shall provide such evidence to the Ministry upon request.

The objective is to evaluate each structure using the most cost effect method taking advantage of simplified analysis methods and symmetry wherever possible. i.e. minimize work to get a positive but reliable answer, rather than expending a lot of effort to maximize the known capacity of the structure. Should the initial evaluations using simplified methods result in unfavorable results (LLCF's less than 1.0), then sophisticated or refined analysis methods shall be undertaken.

If required, strengthening designs for structures that are confirmed as under capacity are not part of this scope but rather will be addressed by a separate project phase and Terms of Reference provided by the Ministry.

The scope of work for this assignment involves the load rating of specified elements for each of the structures identified in **Table 1** for the proposed overload configuration occupying one lane and CL1-625 loading in other lanes, based on the drawings for the structure and inspection reports supplied by the Ministry.

If requested, the Consultant shall attend a start-up meeting with the Ministry to review the order structures should be evaluated (structures with a lower likelihood of having sufficient capacity should be checked first), structural elements that need evaluation, evaluation methodology, report format and schedule.

2.0 Design Criteria

2.1 Evaluate structures in accordance with CHBDC CAN/CSA S6-14, Section 14 using Ultimate Limit States methods unless noted otherwise.

2.2 Incorporate the relevant provisions of the **MOTI** Supplement to the CHBDC S6 (Volume 1 of the Bridge Standards and Procedures Manual dated October 2016).
http://www2.gov.bc.ca/gov/content/transportation/transportation-infrastructure/engineering-standards-guidelines/structural/standards-procedures

2.3 The Inspection Category shall be INSP2. This applies even if the Terms of Reference require detailed inspection of the structure by the Consultant.

2.4 Rating of concrete decks, girder bracing elements (except for curved in plan bridges), bearings, vertical substructure elements NOT susceptible to buckling, and foundations are generally not required (unless noted otherwise in **Table 1**). Single and two column pier bents shall be evaluated.

2.5 Fatigue analysis is not required.

2.6 System Behaviour Category S1 shall be used for 3 girder simple span bridges.

2.7 When interaction of forces may govern a member capacity, the LLCF shall be calculated by iteration (or comparable method) that results in the applicable interaction equation being equal to 1.0, or the data point falling on the resistance interaction curve. Some examples of this are Section 10.9.4.1 (axial compression and bending in a steel column), Section 10.10.5.2c (combined shear and moment in steel girders with slender webs that rely on tension field action) and reinforced concrete columns. The LLCF shall be inserted into the interaction equation by replacing for example Mf by (MfD+LLCFxMfL). The interaction curve for reinforced concrete columns should be developed using factored material strengths and it shall also include the resistance adjustment factor U of S6 14.14.2.

2.8 The live load factors to be used shall be as follows:

a) For CL1-625 loading – Normal Traffic
b) For the divisible overload vehicle – Normal Traffic Alternative Loading, unless the industry proponent implements a monitoring program for actual truck weights, satisfactory to the Ministry, that confirms the statistical variation in actual truck weight is within the variation permitted by the CSA S6-14 for Permit Single (PS). Agreement with the Ministry on a satisfactory monitoring program would have to be in place before PS load factors can be used for the divisible overload vehicle.

2.9 Shop Drawings

If available, shop drawings will be provided for bridge girders, which typically represent the as-built condition. In the event of a discrepancy with the design drawings the shop drawings generally shall govern. The Consultant shall notify the Ministry if any significant difference (e.g. # of strands, concrete strength, plate sizes, number of bolts, etc.) is encountered.

2.10 Concrete Girders

For concrete girders, shear and moment capacity calculations shall be undertaken in accordance with the Ministry's Supplement to S6, Section 14.14.1.6.1. Note the iteration procedure required for shear resistance calculations. Concrete girders shall be evaluated for shear at dv from the support, at changes in stirrup spacing and at prestressing hold-down points typically.

2.11 Dapped Structures

The Consultant shall thoroughly review the as-built dapped concrete connection details for any concrete structures that have dapped girder ends and complete rigorous analysis and evaluation of each detail as it relates to current code provisions for concrete shear. Depending upon the results of this analysis and the resulting LLCF for shear, detailed inspection may be warranted. Ministry approval will be required prior to proceeding with any on-site inspection and will only be considered after submission of the draft evaluation report and subsequent review and discussion with the Ministry.

The Consultant shall include within the evaluation report, additional information as necessary to summarize the analysis methodology, results and conclusions.

2.12 Arch Bridges

The evaluation of arch bridge curved compression members shall be calculated in accordance with the most current version of the AASHTO LRFD Bridge Design Specifications following the first order analysis moment magnification methodology, or an alternative methodology may be proposed to the Ministry for approval prior to proceeding.

2.13 Modular Steel Truss Panel Bridges

For continuous modular truss panel bridges such as Acrow, Bailey, Mabey etc. the negative moment resistance at piers, if based on the supplier's information for simple spans or based on the full panel section properties, shall be reduced by a factor of 0.75 to account for shear interaction at the panel pin connections.

2.14 Companion Vehicle(s) Force Effects

Companion vehicles are the normal traffic loading in other lanes than the overload vehicle for multi lane load cases. If they are significant for a particular load effect and component, then they may be considered as category A force effects in the LLCF equation (subtracted from the numerator). The exception is if they are of the opposite sign as the overload vehicle force effects (i.e. causing force reversal) in which case they shall be neglected.

3.0 Dead Load

Unless otherwise indicated for specific bridges in the Terms of Reference, assume that all structures have been designed for an additional 50 mm of concrete overlay and that the overlay has been or will be installed in the future. The dead load class for concrete overlays shall be D2.

4.0 Live Load and Live Load Cases

All structures shall be evaluated for the following live load cases:

The live load model of the Proponents approved overload vehicle in one lane and Evaluation Level 1, CL1–625 in other lanes as required to cause the largest load effect. Both truck and lane loading shall be considered for both the overload and CL1-625 loading. Multiple lane loading shall be in accordance with S6 14.9.4.3 and Table 14.4 The number of evaluation (design) lanes used for the analysis shall be the number of

current operating lanes as given in **Table 1** and the widths shall be as defined in S6 14.9.4.1.

If applicable, for evaluation of single and two column pier bents, braking load and wind load shall be considered in combination with vehicle loads to determine moment and shear forces that may interact with axial forces and resulting in the governing LLCF's.

5.0 Bridges and Bridge Components to Be Evaluated

Specified bridges and bridge components for evaluation are noted in Table 1.

Table 1 – Specific Bridges and Components

Structure No.	Structure Name	Superstructure and Substructure Components to be Evaluated	Hwy Class	Number of Operating Lanes

6.0 Report Format

Provide 1 electronic copy each of the draft report and sealed final report for each bridge, in pdf format. One hard copy of the final report shall also be provided upon request. The report layout and minimum content shall be as follows unless approved otherwise by the Ministry. A separate report shall be prepared for each bridge.

6.1 Executive Summary

- Simple Project Description
- Scope Description
- Lowest LLCF and related load case

6.2 Table of Contents

6.3 Introduction

- Brief project description
- Scope including major parts of structure to be evaluated, inclusion of inspection (or not) etc.
- Reference to load cases
- Reference to Terms of Reference (to be appended)

6.4 Bridge Description

- Reference to General Arrangement Drawing included in this section or in appendix

- Span arrangement and articulation
- Span materials, strengths and grades
- Description / discussion of significant features of the structure affecting the load capacity evaluation
- Description of modifications and rehabilitation of the structure over time which are significant relative to the load capacity evaluation.

6.5 Analysis

- Evaluation Criteria
  - Design codes and code modifications
  - Live Loading including Lane Loading (Hwy Class)
  - Inspection information or assumptions

- Analysis Assumptions
  - Material properties
  - Dead loads
- Discussion of structural models and issues
- Resistance calculation methods
- Discussion of which components and sections were chosen for analysis and why others were not. In cases where the superstructure is fairly complex a simple sketch or diagram shall be included showing the locations of the critical sections chosen for analysis.

6.6 Results

- General discussion of results
- Summary table of lowest LLCF per load case and related member and force effect. Discussion of what additional analysis refinements or other steps could be taken to improve results should this be desired. This is particularly important when LLCF's are less than 1.0.

- Evaluation results for each rated member in a standardized tabulation containing at least the following information:

  - Member identification, clearly defined location for which capacity is being checked references in diagram for complicated geometry structures)
  - Mode type, e.g. shear, bending etc., reason for selection of specific location for checking
  - System (S) and Element (E) Behaviour categories, Inspection Level (INSP2)
  - Beta Factor type(s), Beta values shall not be modified for important structures as referenced in S6-14 Clause 14.12.5
  - Dead load, dead load category, dead load factor, factored dead load
  - Lateral Distribution Analysis Type and Span Type (Short, Other)
  - Live load, live load factor, dynamic load allowance, factored live load
  - Member resistance and U factor
  - LLCF
  - Indicate whether vehicle or vehicle/uniformly distributed load combination governs, and
  - Identification of evaluator and checker for each load case, plus hand written signatures for each table.

6.7 Calculations Brief

The Ministry may require copies of detailed calculations for review. The Consultant is to record calculations in an organized and complete format and retain them on file for this purpose.

6.8 Disclaimers

The Ministry shall be entitled to use and rely on the information contained in the report for the purpose of completing load evaluations and ratings for bridges in relation to permit issuance and any such disclaimer attached to the report must allow for same.

For the Confidentiality, Copyright and Disclaimers, the following clauses shall be included in the report:

This report is for the sole use and reliance of the Ministry of Transportation and Infrastructure ("**MOTI**"), ***Name of Applicant*** and ***Name of Consultant***. This report contains proprietary and confidential information that shall not be reproduced in any manner or disclosed to or discussed with any other parties without the express written permission of ***Name of Consultant***. Information in this report is to be considered the intellectual property of ***Name of Consultant***, in accordance with Canadian copyright law.

This report was prepared by ***Name of Consultant*** for the account of ***Name of Applicant*** for the purpose, in whole or in part, of completing a load evaluation and rating for ***Name of Bridge No. XXXXX***. The material in it reflects ***Name of Consultant's*** best judgment, in light of the information available to it at the time of preparation. No other parties except ***Name of Applicant*** and the **MOTI** can use or rely on this report and the information and data therein. Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. ***Name of Consultant*** accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

7.0 Inspection (If Required)

7.1 Bridge Inspection Accreditation

The Ministry requires that the bridge inspector(s) proposed for this assignment have credentials which meet or exceed one of the following criteria:

- BCIT Bridge Inspection Diploma with 5 years bridge inspection experience
- FHWA Bridge Inspection Certificate with 5 years bridge inspection experience
- Registered Professional Engineer with APEGBC with 2 years bridge inspection experience

7.2 Bridge Access

All access to Ministry structures shall be coordinated with the Area Bridge Manager and the Regional Bridge Engineer. The Consultant shall arrange their own access. Below are companies which may be able to provide bridge inspection snooper truck services.

Company	Contact	Contact Number
Copcan Ltd.	Brian Gregson	250 754-7260 250 755-6523 (Cell)
H.M.C Ltd.	Mark Warren	250 442-2025 Ext 105 250 442-4406 (Cell)

The Consultant shall arrange for traffic control as required. The current lane closure restrictions are referenced in the Ministry's Maintenance contract at: http://www2.gov.bc.ca/gov/content/transportation/transportation-infrastructure/contracting-to-transportation/highway-bridge-maintenance/highway-maintenance/agreement/local-area-specifications-las

7.3 Detailed Inspection

Review drawings and previous inspection reports for each bridge and prepare an inspection plan for review by the Ministry prior to accessing the site. Modify the inspection plan as required, to incorporate review comments from the Ministry. The Consultant is to provide recommendations regarding any NDT or specialized testing that is considered necessary.

The dapped connection components of the bridge shall be inspected from a position which allows the inspector to physically touch each component. Condition ratings are to be in accordance with the Ministry's Bridge Inspection Manual and the rating guide for that specific element. Any defects found shall be recorded in the Inspection Report with reference to member type and number, location of defect and size of defect, along with any specialized test procedures.

Detailed inspection reports shall be provided separately for each structure. In addition to the detailed inspection data, the reports shall contain a summary of the inspection data in Ministry BMIS format. The Ministry will provide forms in electronic format.

7.4 Recommendations

The Consultant shall provide recommendations regarding any rehabilitation work required to allow unrestricted use of the overload vehicle, coincident with other traffic.

8.0 Ministry Information

The following information will be provided to the successful Consultant:

8.1 Digital pdf copies of all drawings noted on the drawing list for each structure.

8.2 Annual inspection reports and inspection pictures from BMIS. If available, two routine inspection reports along with one detailed inspection report will be provided.

The Consultant shall review the inspection reports and advise if any condition issues are noted which could impact the capacities of the elements being evaluated.

8.3 Ministry Contact

9.0 Schedule

Draft and final reports shall be submitted to the Ministry for each bridge as they are completed rather than the reports for all bridges submitted at one time.

VEHICLE WEIGHING AND BRIDGE CROSSING SUPERVISION REQUIREMENTS

1) Supervisor Requirements

The vehicle weighing, axle spacing measurements and the bridge crossings must be supervised by a B.C. registered Professional Engineer or a qualified technical person working under their direct supervision. Both must be hired by the carrier and must be acceptable to the Ministry. The supervisors must not be direct employees of the carrier or its related companies. The carrier shall submit to motengov@gov.bc.ca, extraordloads.dc@gov.bc.ca, mark.frew@gov.bc.ca and jacob.pietrzyk@gov.bc.ca the resumes of their proposed supervisors. The resumes must indicate that the supervisors have appropriately related highway bridge experience and the resumes must be accepted by the Ministry prior to them undertaking any work.

2) Vehicle Weighing and Axle Spacing Verification Requirements

The carrier shall provide acceptable evidence to MOTI that the axle group weights for each overload vehicle do not exceed the approved weights and the axle spacings conform to the approved spacings. Vehicles which include a platform trailer are exempt from axle spacings verification. Push-trucks are exempt from both weighing and axle spacings verification provided that the axle weights do not exceed the corresponding pull-truck values and the axle spacings are not less than the corresponding pull-truck values.

The carrier has the following **two** options:

Option A): Provide to: dawcreek@gov.bc.ca & extraordloads.dc@gov.bc.ca a vehicle weigh slip AND axle spacings report from a BC (AB or USA where applicable) government scale or:

Option B): The weighing and measuring of the overload vehicle is supervised by an engineer hired by the carrier.

The engineer's responsibilities shall include:

- Ensuring each and all actual axle weights don't exceed the approved weights indicated below and all axle spacings conform to the approved spacings indicated below.
- Prior to weighing they shall review the scale calibration documents (once) to ensure the scales or load cells are calibrated properly within the last 12 months (government owned vehicle weigh scales are exempt).
- If load cells are used to weigh the commodity or the loaded vehicle, it is the responsibility of the engineer (or the technical person under their direction) to physically witness the weighing, the placing of the commodity on the trailer, to confirm the distribution of weight to the axles, and to confirm that the lateral centre of gravity of the commodity coincides with the centre of gravity of the trailer.
- If a SELF-WEIGH vehicle scale is used it is the responsibility of the engineer to witness the weighing and the axle spacing measuring. If a non-government owned scale is used the scale calibration documents shall be reviewed. Where available, technology such as

video calling may be used to allow the engineer to remotely witness the vehicle weighing and axle spacing measurements and clear sample video and photographic evidence must be included with the engineer's report. This option to remotely witness is only applicable for permanent drive over type vehicle weigh scales.

- Confirming in a letter report submitted to motengov@gov.bc.ca, extraordloads.dc@gov.bc.ca, mark.frew@gov.bc.ca and jacob.pietrzyk@gov.bc.ca that the proposed axle weights are a true representation of the actual axle weights. They shall also confirm the axle spacings conform to the approved spacings and where applicable that the centre of gravity of the commodity coincides with the centre of gravity of the trailer. In short, they shall take full responsibility for the vehicle configuration proposed by the carrier for this move. As applicable, scales and load cells calibration documents, and axle weight and spacing measurement results shall be included in the report.

3) Bridge Crossing Supervision Requirements

The following **X** bridge(s) require supervision:

- **Bridge Name, No. XXXX (Highway XXX)**
- **Bridge Name, No. XXXX (Highway XXX)**

The engineer's responsibilities for supervising the bridge crossing shall include:

- Identifying the bridge on the route before the overload vehicle crosses
- Ensuring the overload vehicle follows the bridge crossing restrictions specified herein
- Noting any obvious visual evidence of distress in any bridge component(s) caused by the overload vehicle and supplying MOTI with a copy of the field notes along with any photos taken before, during or after the overload vehicle crosses the bridge
- The engineer shall have the authority to stop the move if restrictions are not being observed or if there is some obvious distress in the bridge prior to or after the overload vehicle crosses

The Professional Engineer shall submit the letter report(s) covering the above points to motengov@gov.bc.ca, extraordloads.dc@gov.bc.ca, mark.frew@gov.bc.ca and jacob.pietrzyk@gov.bc.ca within 2 business days of the overload vehicle crossing the last bridge requiring supervision on the route.

Prior to a permit being issued the Permit Centre must receive:

- **Acceptance by MOTI Bridge Engineering of the proposed overload vehicle weighing supervision engineer (if applicable), the bridge crossing supervision engineer, and respective technical persons (as applicable)**
- **Either A) a weigh slip AND axle spacings report from a BC (AB or USA where applicable) government scale**
  OR
  B) Acceptance by MOTI Bridge Engineering of the report addressing the weighing and axle spacing measurements of the overload vehicle, supervised by an engineer

All emails submitted shall include the OL number in the subject line.

Ministry of Transportation and Infrastructure

CONSULTANT'S TERMS OF REFERENCE
Single Trip Overload - Detailed Bridge Evaluation

1.0 Administration

At project conception, the Consultant shall provide to the Ministry of Transportation and Infrastructure (Ministry):

- A list of engineering personnel to be used on the project with a list of their project function and relevant experience,
- A description and discussion of the methodology to be used,
- A list of information requested from the Ministry,
- Evidence of Professional Liability (Errors and Omissions) Insurance for a minimum of $1,000,000 and General Liability Insurance for a minimum of $2,000,000,
- All documents submitted to the Ministry shall become the property of the Province and as such will be subject to the provisions of the Freedom of Information and Protection of Privacy Act,
- The Ministry Representative is Mr. Mark Frew, P.Eng, (236-468-1991, mark.frew@gov.bc.ca), and an alternate Ministry Representative is Mr. Jacob Pietrzyk, P.Eng., (250-565-6068, jacob.pietrzyk@gov.bc.ca).

2.0 Background

The Ministry requires a single trip overload detailed bridge evaluation to be undertaken on behalf of an Applicant for a single overload trip on a specific route, to assist the Applicant in attaining an overload permit. The list of bridges (provided separately) shall be evaluated by a qualified Consultant whom shall be retained by and paid for by the Applicant.

3.0 Bridge Inspection

It is not necessary for the Consultant to inspect the bridges unless it becomes necessary to achieve a Live Load Capacity Factor (LLCF) > 1.0. If inspection is necessary, it is the Consultant's responsibility to inspect the structures to a degree necessary to ascertain changes from the drawings, and deterioration which impacts structural capacity, etc. The Ministry will provide available inspection data for reference purposes.

4.0 Evaluation Criteria

Structures shall be evaluated in accordance with Canadian Highway Bridge Design Code (CHBDC) CSA S6–14 and supplements, Section 14 using Ultimate Limit States methods unless noted otherwise below. The evaluation shall incorporate the relevant provisions of the Ministry's Bridge Standards and Procedures Manual, which is available at the following web site:
http://www2.gov.bc.ca/gov/content/transportation/transportation-infrastructure/engineering-standards-guidelines/structural/standards-procedures/volume-1

- With respect to Section 14.9.4.1 of CHBDC, the traffic lanes shall be as actually delineated in the field.
- Unless indicated otherwise by the Ministry, the Inspection Category of Section 14.12.4 shall be INSP2. The most recent inspection reports from the Bridge Information Management System for the list of bridges will be provided by the Ministry.

- For the purposes on Section 14.12.5, structures shall not be considered as “important”.
- Concrete decks do not require evaluation unless the deck spans longitudinally, or the wheel loads of the load rating vehicle, except for the steering axle, exceed 2,900 kg (but not to exceed 100 kg/cm of tire width per the Commercial Transport Regulations).
- Evaluation of superstructure bracing elements (except for curved in plan bridges), bearings, vertical substructure elements not susceptible to buckling, deep horizontal substructure elements (excluding cantilever portions of pier caps), mass concrete abutments and piers, and foundations are generally not required, however the Consultant shall make their own determinations on a site by site basis based on engineering judgment.
- For concrete girders, shear and moment capacity calculations shall be undertaken in accordance with the Ministry's Supplement to S6, Section 14.14.1.6.1. Note the iteration procedure required for shear resistance calculations. Concrete girders shall be evaluated for shear at dv from the support, at changes in stirrup spacing and at prestressing hold-down points typically.
- Slip resistance of steel girder bolted connections shall be evaluated at service loads if this is judged to be critical, as splice plate slippage must be prevented.
- Steel girder bolted field splices, if located at high force locations, may be checked at ULS by assuming the capacity of the connection is at least equal to 75% of the capacity of the girder on the weaker side of the splice.
- System Behaviour Category S1 shall be used for 3 girder simple span bridges.
- Fatigue analysis is not required.
- When interaction of forces may govern a member capacity, the LLCF shall be calculated by iteration (or comparable method) that results in the applicable interaction equation being equal to 1.0. Some examples of this are Section 10.9.4.1 (axial compression and bending in a steel column), Section 10.10.5.2c (combined shear and moment in steel girders with slender webs that rely on tension field action) and reinforced concrete columns. The LLCF shall be inserted into the interaction equation by replacing for example Mf by (Mf_D+LLCFxMf_L). The interaction curve for reinforced concrete columns should be developed using factored material strengths and it shall also include the resistance adjustment factor U of S6 14.14.2.
- The evaluation of arch bridge curved compression members shall be in accordance with the most current version of the AASHTO LRFD Bridge Design Specifications following the first order analysis moment magnification methodology, or an alternative methodology may be proposed to the Ministry for approval prior to proceeding.
- Shop drawings will normally be provided for the prestressed concrete and steel girders. Shop drawings typically represent the as-built condition and in the event of a discrepancy with the design drawings, the former generally shall govern. The Consultant shall notify the Ministry Representative if any significant differences (e.g. strand pattern, material strengths, plate sizes, etc) are encountered.
- For continuous modular truss panel bridges such as Acrow, Bailey, Mabey etc. the negative moment resistance at piers, if based on the supplier’s information for simple spans or the full panel section properties, shall be reduced by a factor of 0.75 to account for shear interaction at the panel pin connections.
- To potentially limit the scope of detailed evaluation work, the Consultant may contact the Ministry Representative for a list of load effects by bridge that passed the Ministry’s screening evaluation with a D/C (demand to capacity) ratio of ≤ 0.95 and the associated bridge crossing restrictions. It may take from 1 to 3 business days to receive this information. At the sole option of the Consultant, the bridge components represented by these load effects may not require detailed evaluation unless the Applicant desires to improve on the associated bridge crossing restrictions. If the Consultant elects not to

evaluate the affected components then the Ministry will take responsibility for them, along with the other complete bridges that passed the initial screening evaluation.

- For substructure elements an enhanced live load comparison evaluation method may be tried before a detailed evaluation, which considers lateral distribution, track width and crossing restriction benefits of the overload vehicle(s) as compared to the MOTI "capacity vehicles". The Consultant may request from MOTI the capacity vehicles for the bridge (such as the pre-approved 85T permit vehicles) and the applicable multi-vehicle presence, live load and DLA factors as applicable. The LLCF reported should be the Capacity to Demand ratio based on factored and adjusted live loads.

5.0 Dead Load

Unless a re-surfacing report is available from the Ministry, the Consultant shall assume that all concrete deck structures have been designed for an additional 50 mm of concrete overlay and that the overlay has been installed.

6.0 Live Load

The overload configurations used in the load rating shall be based on a conservative estimate of the payload weight, so that re-evaluation of bridges is not necessary if there is a small change in the manufactured weight. The vehicle configuration should be identical to the one that the MOTI screening evaluation and denial letter was based on, or it could be a bit more conservative with axle weights. If the Applicant has changed the vehicle then the current screening evaluation is invalid and a new overload application to the Extraordinary Loads department will need to be done before undertaking any detailed evaluation.

The overload vehicle shall be assumed to cross each bridge under the following conditions:

Bridge with one or two lanes:

- Travel down the centerline of the bridge roadway (lateral tolerance of 600 mm),
- Crossing speed less than 10 km/h (25 km/h if possible), and
- No other vehicles on the bridge (if bridge is longer than 200 m, no other vehicle within 200 m).

Bridges with more than two lanes, or bridges with more than two lanes and where the two directions of traffic are separated by a raised median or a median barrier, shall be evaluated for the following conditions:

- Straddle two lanes of traffic,
- Crossing speed less than 10 km/h (25 km/h if possible),
- No other vehicles on the bridge travelling in the same direction as the overload (if bridge is longer than 200 m and no other vehicle within 200 m), and
- Closing down traffic in the lanes on the opposite side of a median barrier (or in the opposing direction of travel if there is no median structure) increases the complexity of traffic control considerably and will only be considered in exceptional circumstances.

If a PC Permit classification is required, then additional requirements such as weighing of the overload vehicle and engineer supervision of the bridge crossings will be required.

7.0 Live Load Factors

- Permit – Single Trip (PS) traffic load factors shall be applied to the load effects from the overload vehicles.
- Normal Traffic load factors shall be applied to the load effects caused by non-permit traffic (CL1-625 Evaluation Level 1) that is allowed to use the bridge simultaneously with the overload vehicle, and reduction factors of S6 14.9.4.3 shall be applied.
- Permit – Controlled (PC) load factors shall be used only if the load rating using PS load factors yields LLCF's that are less than 1.0.

8.0 Optional Pre-Work Consultation with Ministry

Prior to proceeding with detailed evaluations, the Consultant is encouraged to provide the Ministry (in writing) with a summary of the components of each bridge and the load effects for each of those members that they plan to evaluate. The System and Element Behavior that they plan to use in the evaluation of each load effect shall be included in the summary, as well as justification as to why any members are not being evaluated. This will generally reduce re-work effort and time between the draft(s) and final report.

9.0 Report Format

A separate report shall be prepared for each bridge evaluated and if multiple vehicle configurations are considered they can be addressed in the single report. Draft reports in PDF format shall be submitted to the Ministry for review. Final reports, that address review comments, shall be sealed and submitted to the Ministry as follows:

- One digital copy in PDF format.
- One Cerlox bound paper copy IF requested by the Ministry

Reports shall incorporate the following information as a minimum:

- A cover page including name of the Applicant, Consultant and a photo of the bridge (if available),
- A brief introduction section,
- A general description of the bridge and history of modifications and rehabilitations if known,
- A brief description of the condition of the bridge,
- A description of the components of the bridge that have been evaluated, and a discussion and justification as to why any components of the bridge and effects do not require evaluation (including those that passed the Ministry's screening evaluation),
- A brief description of the live load path from the deck down to the foundations,
- A description of the evaluation methodology including analysis methods, and methods and assumptions used to distribute dead load and live load to the components being evaluated,
- Any Code variances employed,
- Material properties, assumptions and methods used for resistance calculations,
- A Results section which has the LLCF summary tables embedded in this section (rather than in an appendix – an exception will be allowed if the tables are too numerous and in this case they should be in the first appendix following the report),
- Recommended vehicle crossing restrictions and a clear conclusion statement that the bridge has sufficient structural capacity to support the overload with the recommended restrictions,

- Include a cross section sketch of the transverse location of the vehicle on the bridge IF a unique location is specified beyond which simple words can clearly describe (this sketch may be included in the permit for clarity),
- Disclaimer wording as per below,
- Appended overload configuration drawing(s) of the overload vehicles evaluated, showing axle spacings, axle weights and wheel and tire layout on every axle,
- Appended General Arrangement drawing of the bridge,
- Appended inspection reports (and inventory report) if provided by the Ministry, and
- Appended Ministry Terms of Reference.

Evaluation results for each rated member in a table containing at least the following information all shown together on the same table:

- The table of Live load Capacity Factors shall have no shading (with the exception of heading rows),
- member identification, clearly defined location for which capacity is being checked, mode type, e.g. shear, bending etc., reason for selection of the location for checking (if not obvious),
- Permit Classification (PS or PC), System (S) and Element (E) Behavior categories, Inspection Level (INSP2),
- Target Reliability Index (β),
- dead load categories (D1, D2, D3), dead load factors (αD), total factored dead load (separate dead load category values need not be shown if they are factored inside a model and difficult to split apart)
- live load (L), live load factor (αL), dynamic load allowance (DLA), live load distribution factor (DF), live load lateral distribution category (per § 14.11), span type (short or other per § 14.13.3), factored live load for each lane of traffic, listed separately,
- member resistance (R) and Resistance Adjustment Factor (U),
- Live Load Capacity Factor (LLCF),
- Indicate whether vehicle (Truck Load) or vehicle/uniformly distributed load combination (Lane Load) governs, and
- Identification of evaluator and checker for each load case including signatures.

The Ministry may require copies of detailed calculations for review. The Consultant shall record calculations in an organized and complete format for this purpose.

The Ministry shall be entitled to use and rely on the information contained in the report for the purpose of completing load evaluations and ratings for bridges in relation to permit issuance and any such disclaimer attached to the report must allow for same.

For the Confidentiality, Copyright and Disclaimers, the following clauses shall be included in the report:

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This report was prepared by ***Name of Consultant*** for the account of ***Name of Applicant*** for the purpose, in whole or in part, of completing load evaluation and rating for ***Name of Bridge No.***

XXXXX. The material in it reflects ***Name of Consultant's*** best judgment, in light of the information available to it at the time of preparation. No other parties except ***Name of Applicant*** and the MOTI can use or rely on this report and the information and data therein. Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. ***Name of Consultant*** accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

10.0 Information Provided by the Ministry

The Ministry will provide the following information:

- Lists of available drawings, plus digital versions of drawings scanned from microfilm,
- Bridge deck resurfacing reports if available, and
- The two most recent Bridge Inspection Reports if available.

The Ministry contact for the above information is Mr. Dale Wood (dale.wood@gov.bc.ca).

11.0 Bridge Drawings and Information Not Available

If the Ministry does not have sufficient drawings and/or other information for a particular bridge to complete the evaluation, then the Consultant shall make a site visit to that bridge to make field measurements of member sizes and if necessary perform sampling and material testing to determine material properties.

6.3.2 Weight

6.3.2.A. Legal Weights

The following chart outlines the legal weights allowed for axles and axle groups. Regardless of the weights listed below, a vehicle may not exceed the axle weight rating as specified by the manufacturer, or the tire size as specified in the CTAR on any axle or axle group.

If legal dimensions are exceeded, then an overweight permit is required. If a vehicle and/or load is also oversize, an oversize/overweight permit is required. For more information on permits and fees, please refer to Chapter 3 of this Manual. Please refer to the subsequent sections in this Chapter for more information on overweight calculation and approved routes.

Steering Axle	
Tandem Drive	6,000 kg – truck tractor 9,100 kg – truck tractor with PME or a truck
Tridem Drive	7,300 kg – truck tractor or truck* 9,100 kg – truck tractor or truck with PME*
Other Axles	
Single (other than steering axle and includes jeeps and boosters)	9,100 kg ✓
Tandem	17,000 kg
Tandem Drive with Single Axle Jeep	24,000 kg or the weight allowed under 7.17(2) CTAR—whichever is greater
Tridem	24,000 kg
Axle Group Combinations	
Refer to 7.17(2) of the CTAR Refer to the Heavy Haul Quick Reference Chart on page 12	
Notes: * Minimum of 27% of tridem drive axle group when loaded ✓ Legal allowable is to be determined by S.7.17 (2) CTAR for all jeeps and boosters in a combination 1. A maximum of 100 kg/cm of tire width is applicable to tires on all vehicle configurations. 2. A maximum of 3,850 kg/super single tire and 3,000 kg/tire for all others is applicable to all tires except the steering axle.	

Table 6.3.2.A. Weight: Legal Weights

6.3.2.B. Overload Weights

i) Issuance

a) Overweight permits are issued for non reducible loads (as defined in section 6.1), fixed equipment vehicles (as described in section 5.3.4), and may be issued for the specialized bulk haul loads that are approved through the 'Reducible Load Overweight Policy', as set out in section 6.5.

b) Operators of vehicles with non reducible loads unevenly distributed on axles creating the requirement for an overload permit shall be issued permits provided the axle unit is not overloaded by more than 10% of the legal allowable weight (e.g., 1,700 kg overload would be permitted on a tandem

axle with a 17,000 kg legal allowable weight). If an axle unit is overloaded by more than 10 percent, loads must be redistributed on the axles to achieve legal axle weights, when this can be accomplished safely and without undue economic hardship to the carrier.

ii) Heavy Haul Restrictions

a) When pony trailers and full trailers are used with trucks to haul non-reducible loads, the maximum weight allowed by permit is 21,000 kg for tandem axles. Tridem axles are restricted to legal weights of 21,000 kg (Appendix E CTAR). No jeeps or boosters are allowed with these trailers.

b) Maximum allowable weight on a full trailer is 34,000 kg; otherwise S.7.17(2) CTAR applies for non-TAC full trailers. No jeeps or boosters are allowed with these trailers.

c) As a general rule the axle track width of the trailer must be a minimum of 50% of the width of the load.

iii) Bridge Formula

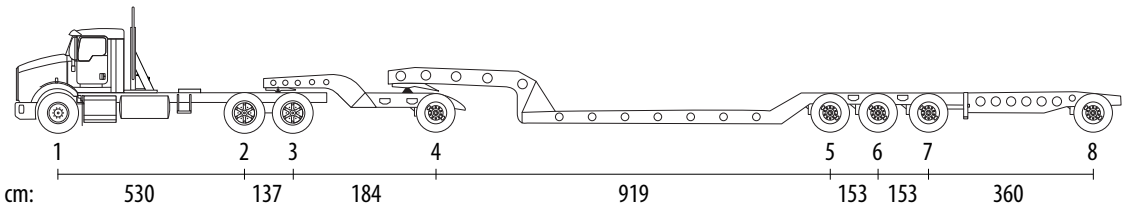
Bridge formula is a mathematical equation that is used to calculate the maximum allowable weight allowed by permit for various axle groups in a combination.

Bridge Formula: 30 x wheelbase (cm) + 18,000 kg = Maximum weight allowed by permit

For the purposes of calculating bridge formula, wheelbase means the distance between the centers of the first axle and last axle of any group of axles of a vehicle or combination of vehicles.

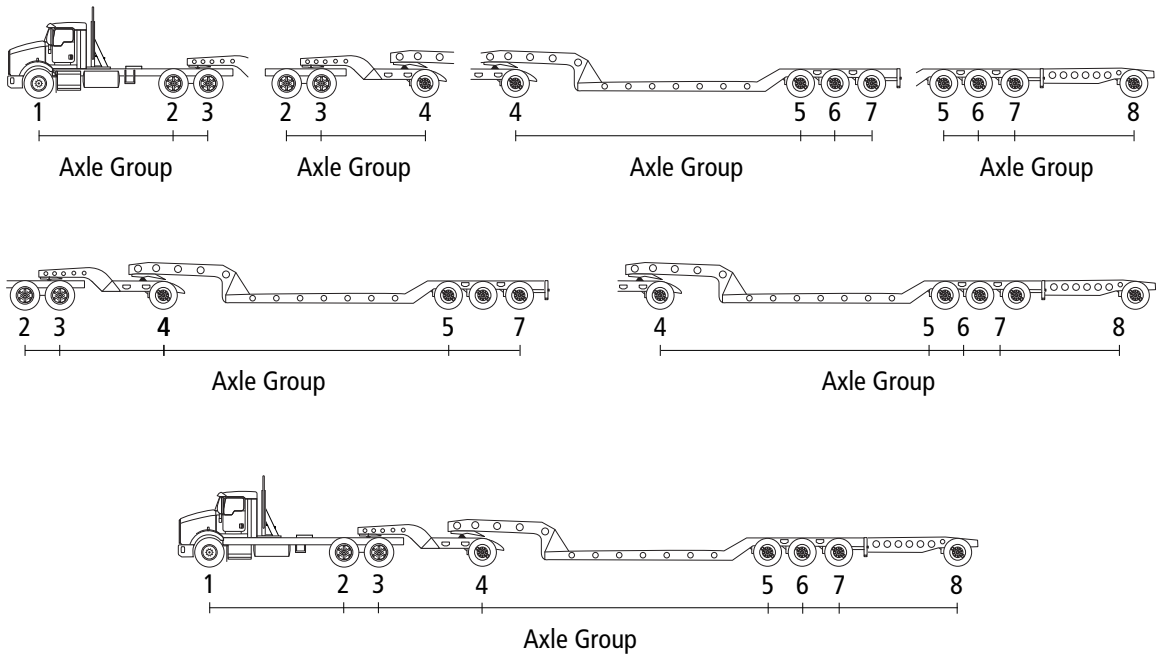
HOW TO CALCULATE BRIDGE FORMULA:

- Determine the wheelbase for each axle group and axle group combinations for the vehicle or combination of vehicles.
- For the purpose of Bridge Formula, **Wheelbase** means the distance between the center of the first axle and last axle of any group of axles.



- The configuration above consists of 8 axles, each axle is numbered 1-8. There are also a number of **axle groups** in this configuration.

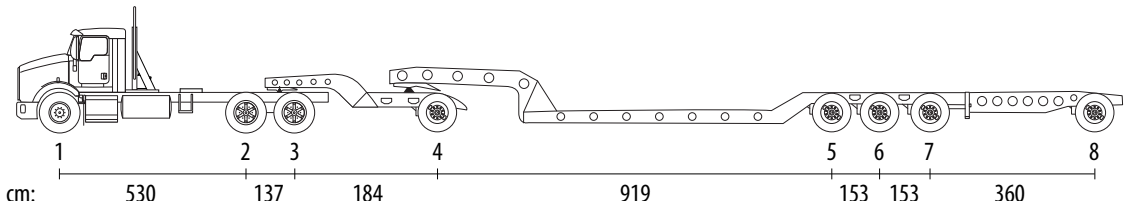
The following are considered **Axle Group Combinations:**



- Once the wheelbase for each axle group has been determined, you can now apply these measurements to the Bridge Formula equation.

DIAGRAM 1

8 Axles



Wheelbase from axle 1 to axle 8 = 2,436 cm

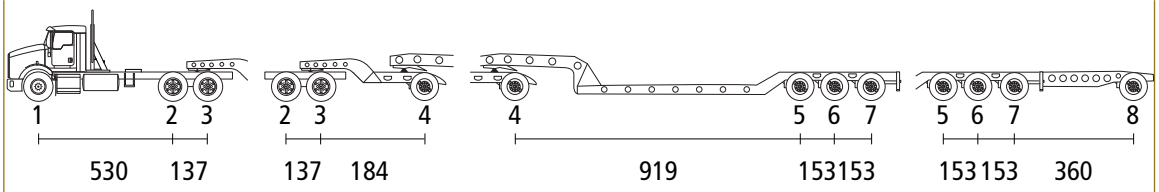
Bridge Formula: 30 x 2,436 (cm) + 18,000 = 91,080 kg

The maximum allowable weight for this configuration based on Bridge Formula cannot exceed 91,080 kg (*APPROVED ROUTE ONLY)

DIAGRAM 2

NOTE: THE FOLLOWING DIAGRAM SHOWS THE MOST COMMON BRIDGE FORMULA CALCULATIONS FOR THIS CONFIGURATION BUT IT IS NOT A COMPLETE REPRESENTATION OF ALL AXLE GROUP POSSIBILITIES

8 Axles, divided into separate AXLE GROUPS (each axle group must not exceed Bridge Formula)



Axles 1, 2, and 3:	30 x 667 (cm) + 18,000 = 38,010 kg (*according to Bridge Formula, the maximum allowable weight for this group is 38,010 kg. However, if this was the actual weight for this group of axles, it would be exceeding the maximum allowable AXLE weights. Therefore, this group would only be allowed a maximum of 32,100 kg)
Axles 2, 3, and 4:	30 x 321 (cm) + 18,000 = 27,630 kg (*axle spacing does not exceed 3.7 m, therefore, this axle group would be allowed 29,000 kg)
Axle 4, 5, 6, and 7:	30 x 1225 (cm) + 18,000 = 54,750 kg (*according to Bridge Formula the maximum allowable weight for this group is 54,750 kg. However, if this was the actual weight for this group of axles, it would be exceeding the maximum allowable AXLE weights. Therefore, this group would only be allowed a maximum of 40,000 kg)
Axle 5, 6, 7, and 8:	30 x 666 (cm) + 18,000 = 37,980 kg (*according to maximum allowable AXLE weights this group would be allowed 40,000 kg. However, Bridge Formula only allows 37,980 kg)

For vehicles and loads exceeding Bridge Formula, please refer to 6-4 Extraordinary Loads for more information.

iv) Permittable Overload Weights

The following chart outlines the maximum permittable weights for heavy haul configurations. In addition to this chart, heavy haul configurations must be compliant with the Heavy Haul Quick Reference Chart which is provided immediately following this chart. If a vehicle and/or load do not comply with weights listed below or in the Heavy Haul Quick Reference Chart, except if utilizing wheeler groups in the Peace River Area only, please refer to 6-4 Extraordinary Loads.

Steering Axle	
Tandem Drive/Tridem Drive	9,100 kg – truck tractor or a truck provided the manufacturer's axle weight rating and tire size (100 kg/cm of tire width – See Note 1) is not exceeded – **WEIGHT MUST BE LEGAL WHEN EMPTY**
Other Axles – Semi-Trailers	
Single (other than steering axle and includes jeeps and boosters)	11,000 kg
Spread Axle Tandem (S.7.24 CTAR)	18,200 kg for non-reducible loads and fixed equipment only provided either one of the axles does not exceed 11,000 kg
Tandem*	23,000 kg
Tandem Drive with Single Axle Jeep ✓	28,000 kg – 2.4 m to 3.0 m axle spread
	29,000 kg – over 3.0 m to 3.7 m axle spread
Tridem Drive	28,000 kg – 2.4 m to 2.8 m axle spread
Tridem Jeep	28,000 kg – 2.4 m to 3.1 m axle spread
Tridem Trailer	28,000 kg – 2.4 m to 3.7 m axle spread with tandem or tridem booster
	29,000 kg – 2.4 m to 3.7 m with no booster or single booster
Tridem Booster	28,000 kg – 2.4 m to 3.1 m (only allowed with tridem lowbed)
Other Axles – Pony and Full Trailers	
Tandem	21,000 kg
Tridem	21,000 kg (legal)
Axle Group Combinations	
Bridge formula applies	
Gross Vehicle Weight	
64,000 kg – unless travelling on approved overload routes	

Notes:

* Bridge formula does not apply

✓ If the axle spacing of the 3 axles, tandem drive and single axle jeep, exceed 3.7 m then the Bridge Formula applies

1. A maximum of 100 kg/cm of tire width is applicable to all tires on all vehicle configurations, except that 445 tires may be used on an appropriate steering axle to achieve 9,100 kg.
2. A maximum of 3,850 kg/super single tire and 3,000 kg/tire for all others is applicable to all tires except the steering axle.
3. The drive axle group must have a minimum of 20% of the gross vehicle weight.
4. The "bridge formula" is applicable to all axle groups and does not terminate at 800 cm.
5. Regardless of the weights outlined above, weight restrictions as specified on the CVSE1011, exceptions listed in approved overload routes, or posted weight restrictions at bridges must not be exceeded.
6. Pony and full trailers must be legal dimensions, and no jeeps or boosters are allowed with these trailers.

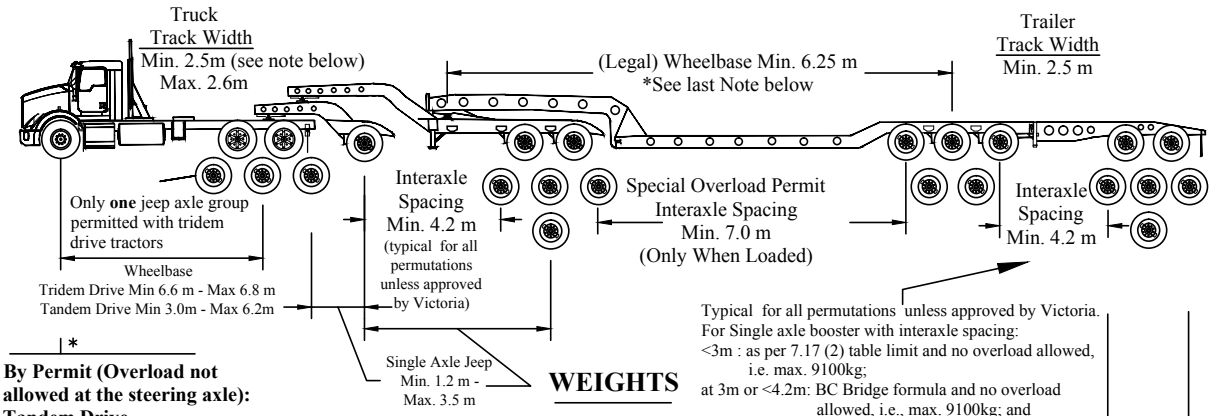
Table 6.3.2.B.iv) Weight: Permittable Overload Weights

Heavy Haul Quick Reference Chart

Diagram of Tandem/Tridem Drive Axle Truck-Tractors – Heavy Haul Configurations

Permit Conditions (Overload)

TRUCK TRACTOR WITH JEEP AND HEAVY HAUL LOWBED SEMI-TRAILER WITH BOOSTER



*

By Permit (Overload not allowed at the steering axle):
Tandem Drive
Max 9 100kg

Tridem Drive**
Max. 9 100 kg
Min. 27% of Tridem Drive Axle Group Weight.

By Permit (Overload):
Tandem Drive:
Max 23 000 kg
Tridem Drive:
Max. 28 000 kg

By Permit (Overload):
Single axle (Jeep)
Max. 11 000 kg
Tandem axle (Jeep)***
Max. 23 000 kg
Tridem axle (Jeep)***
Max. 28 000 kg

Tandem Drive Axle Group Must Be Greater Than 20% of GCVW or 23 000 kg, whichever is less;

Tridem Drive Axle Group Must Be Greater Than 20% of GCVW or 28 000 kg, whichever is less; and

For combinations with having a GCVW in excess of 115 000kg, the use of a tridem drive truck tractor is highly recommended for routes with steep grades and/or in slippery road surface conditions

If Drive axle group and Jeep axle group have an equal number of axles, the two axle groups must be load equalized to within 1 000 kg.

By Permit (Overload):
Tandem axle (Lowbed)
Max. 23 000 kg
Tridem axle (Lowbed)
Max. 28 000 kg with Tandem axle booster or Tridem axle booster.
Max. 29 000 kg with or without Single axle booster

By Permit (Overload):
Single axle (Booster)
Max. 11 000 kg
Tandem axle (Booster)
Max. 23 000 kg
Tridem axle (Booster)
Max. 28 000 kg
Tridem Booster only allowed with Tridem Lowbed.

*** Tandem drive axle weight must be maximized first, before adding weight to Tandem or Tridem Jeep

Typical Maximum Gross Combination Vehicle Weight (GCVW)

(Based on typical axle spacing, and taking bridge formula into account)
116 300 kg without PME 118 100 kg with PME

* Single steering axle weight is exempted from seasonal axle weight restrictions.
** Minimum steering axle weight is not applicable when a tridem tractor is towing an unladen lowbed and booster.

Table A: Interaxle Spacing (Min. Distances)
Applicable when loaded within Legal weight.

	Single	Tandem	Tridem
Single	3 m	3 m	3 m
Tandem	3 m	5 m	5.5 m
Tridem	3 m	5.5 m	6 m

Table B: Axle Spread

Single	Up to Max. 1.0 m
Tandem	Min. 1.0 m - Max. 1.85 m
Tridem Jeep and Tridem Booster:	Min. 2.4 m - Max. 3.1 m
Tridem Lowbed:	Min. 2.4 m -Max. 3.7 m
Tridem: Drive	Min. 2.4 m - Max. 2.8 m

Notes:
- For all tridem drive configurations and all configurations after Dec 31, 2004 maximum of 100 kg/cm of tire width applies to all tires, and a maximum of 3000 kg/tire is applicable to all axles except steering axle.
- All weights shown are subject to bridge formula limit, whichever is less, unless by special request and approved by Victoria.
- For Heavy Haul applications only, automated steering dolly or manned dolly allowed to replace axle group in the tridem lowbed and/or lowbed–booster.
- Configuration permutations, by removing jeep or boosters, are allowed.
- Tridem drive tractors manufactured before July 1, 2012 are permitted a minimum track width of 2.4m
- Semi–Trailer lowbed wheelbase up to a maximum 15.25 meters and lowbed overall length up to a maxumum 18.3 meters will be permitted empty or loaded (see Commercial Transport Procedures Manual, Section 6.3.1B for Peace River exemptions). To accommodate overlength loads, lowbed Semi–Trailers may be expanded up to a distance of 18.3 meters from the kingpin to the last axle of the semitrailer