OAK RIDGE
NATIONAL LABORATORY
MANAGED BY UT-BATTELLE
FOR THE DEPARTMENT OF ENERGY

ORNL/TM-2011/463

Preliminary Assessment of Overweight Mainline Vehicles

October 2011

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Energy and Transportation Science Division

OVERWEIGHT VEHICLE ASSESSMENT

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CONTENTS

Page

LIST OF FIGURES

Page

LIST OF TABLES

Page

ACRONYMS AND ABBREVIATIONS

Term	Definition
CMV	Commercial Motor Vehicle
CMVRTC	Commercial Motor Vehicle Roadside Technology Corridor
FMCSA	Federal Motor Carrier Safety Administration
IS	Inspection Station
lb	Pounds
NAS	North American Standard
OOS	Out-of-Service
ORNL	Oak Ridge National Laboratory

EXECUTIVE SUMMARY

The Federal Motor Carrier Safety Administration requested information regarding overweight and oversized vehicle traffic entering inspection stations (ISs) in order to develop strategies for future research efforts and possibly help guide regulatory issues involving overweight commercial motor vehicles (CMVs). For a period of one month, inspection stations in Knox County and Greene County, Tennessee, recorded overweight and oversized vehicles that entered these ISs. During this period, 435 CMVs were recorded using an electronic form filled out by enforcement personnel at the IS. Of the 435 CMVs recorded, 381 had weight information documented with them.

The majority (52.2%) of the vehicles recorded were five-axle combination vehicles, and 50.6% of all the vehicles were permitted to operate above the legal weight limit in Tennessee, which is 80,000 lb for vehicles with five or more axles. Only 16.8% of the CMVs recorded were overweight gross (11.5% of permitted vehicles) and 54.1% were overweight on an axle group. The low percentage of overweight gross CMVs was because only 45 of the vehicles over 80,000 lb. were not permitted. On average, axles that were overweight were 2,000 lb. over the legal limit for an axle or group of axles.

Of the vehicles recorded, 172 vehicles were given a North American Standard (NAS) inspection during the assessment. Of those, 69% of the inspections were driver-only inspections (Level III) and only 25% of the inspections had a vehicle component (such as a Level I or Level II). The remaining 6% of inspections did not have valid Aspen numbers; the type of was inspection unknown. Data collected on the types of trailers of each vehicle showed that about half of the recorded CMVs could realistically be given a Level I (full vehicle and driver) inspection; this estimate was solely based on trailer type. Enforcement personnel at ISs without an inspection pit have difficulty fully inspecting certain vehicles due to low clearance below the trailer. Because of this, overweight and oversized vehicles were normally only given a Level III (driver) inspection; thus, little is known about the safety of these vehicles. The out-of-service (OOS) rate of all the inspected vehicles (driver and vehicle inspections) was 18.6%, while the OOS rate for vehicle inspections (Level I and II) was 52.4%.

Future work will focus on performing Level I inspections on five-axle combination tractor-trailers and the types of violations that overweight vehicles may have. This research will be conducted in Tennessee and possibly in other states as well.

ACKNOWLEDGMENTS

The Commercial Motor Vehicle Roadside Technology Corridor team would like to thank the Tennessee Highway Patrol and the staff of the Greene County and Knox County Commercial Motor Vehicle Inspection Stations for their support of this research. Without their effort in collecting the required data, this research would not have been possible.

1. INTRODUCTION

In order to preserve infrastructure and keep commercial motor vehicles (CMVs) moving efficiently, states must comply with federal size and weight standards which are certified by the Federal Highway Administration. In the state of Tennessee, interstate vehicles are allowed to weigh up to 80,000 lb. gross, with single axles supporting a maximum of 20,000 lb., tandem axles supporting 34,000 lb., and tri-axles supporting up to 54,000 lb. without a permit. Permitted loads are allowed for well over 100,000 lb. gross vehicle weight based on the number of axles and permit type, with up to 40,000 lb. and 60,000 lb. on tandem and tri-axle configurations respectively.

Typically, CMVs that enter the inspection station (IS) and are overweight on one or more axles, are above their allowed gross vehicle weight, or are permitted do not receive a North American Standard (NAS) Level I (full vehicle and driver) or Level II (driver and vehicle walk-around) safety inspection. This is due, in part, to the fact that in many cases overweight vehicles are also oversized and/or on specialized trailers that are not practically accessible for inspection, and many states combine the overweight assessment with an NAS Level III (driver only inspection). Because of this very little is known about the safety of the CMV operating at a weight above the legal limit.

2. DATA COLLECTION

The main focus of this effort was to provide the Federal Motor Carrier Safety Administration (FMCSA) with current information about the number and type of oversized and overweight vehicles to develop strategies for future research efforts. Data was collected at the Knox County, Tennessee and Greene County, Tennessee ISs within the Commercial Motor Vehicle Roadside Technology Corridor (CMVRTC) for a period of one month. The Greene County IS collected data for the entire month on regular, short-term shifts, while the Knox County IS collected data during two 24 to 48 hour long intervals.

During this time, enforcement personnel were asked to collect data on vehicles with loads that fell into the following categories: oversized (large loads), overweight gross, overweight on an axle, and permitted. NAS inspections (driver or vehicle) were not required during this effort, but some inspections were performed as part of the IS's normal operation.

The Oak Ridge National Laboratory (ORNL) developed a web-based form for enforcement personnel to enter vehicle and weight information in order to reduce the amount of paperwork handled and to reduce the amount of time analyzing the data. A screenshot of this form is shown in Figure 1. Electronic inspection data from the submitted Aspen reports were received from Tennessee Highway Patrol without personal driver information (name, date of birth, license number etc.).

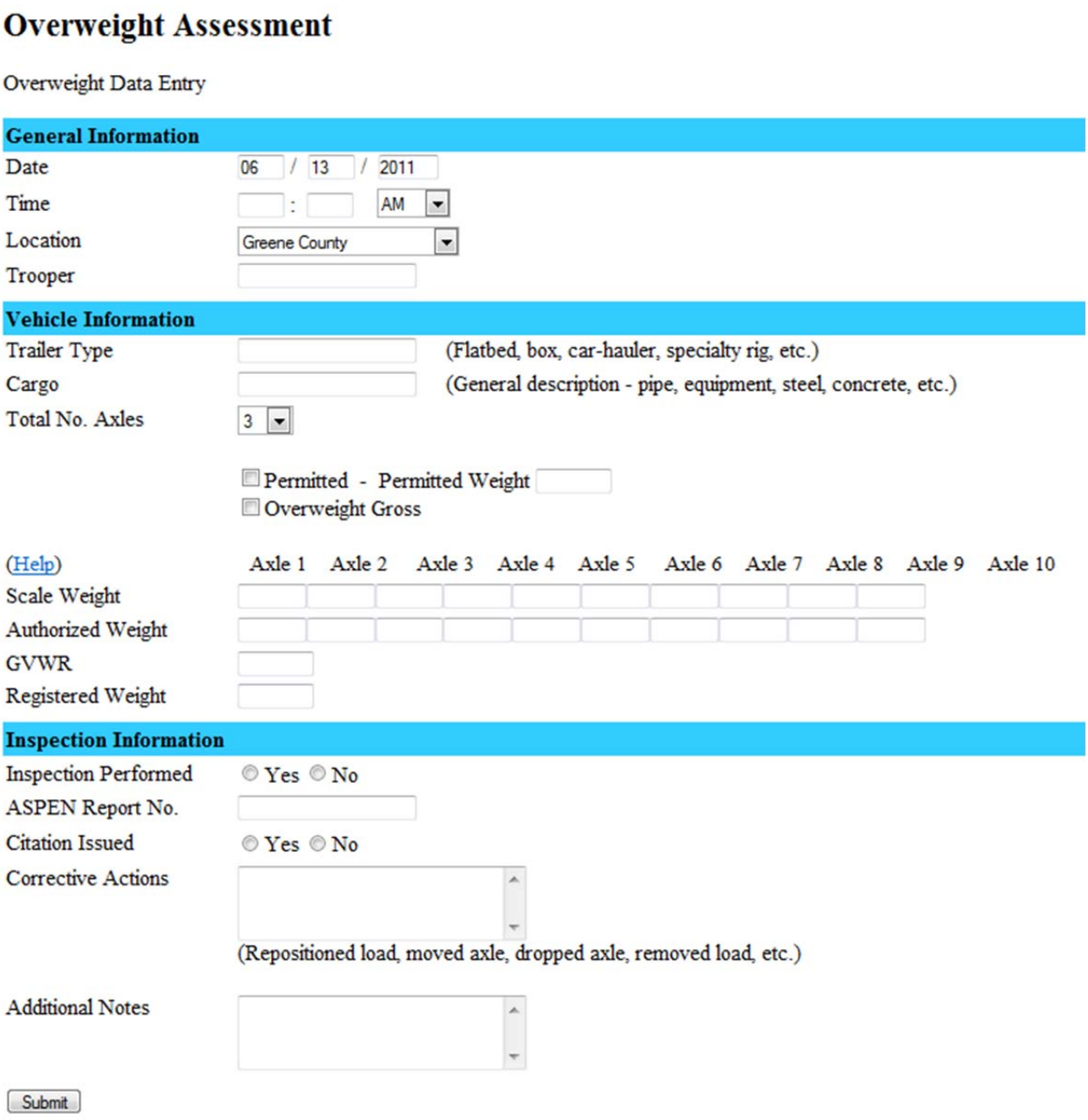

Figure 1. Web-based data collection form.

The weight data collected from the Knox County IS did not have weight measurements for all the CMVs due to roadside hardware prohibiting oversized and most permitted vehicles from being weighed. In cases where no weight data was available, all other information was still received by ORNL.

3. DATA ANALYSIS

The data collected at the two ISs was inherently different due to the layouts of the individual stations. The Knox County IS does not have sufficient clearance on the pit scale to weigh oversized loads that come into the station; thus, weight information was not available for oversized vehicles.

Table 1 shows the total number of CMVs that were recorded at both Greene and Knox County ISs during the assessment. As shown in the table, the majority of the vehicles recorded had five axles, and over half of the recorded vehicles had permits to operate over the legal weight limit in Tennessee.

Table 1. Summary of All Recorded CMVs

Number of Axles on CMV	Number of Recorded CMVs	CMVs Permitted
2	6	0 0.0%
3	7	2 28.6%
4	4	0 0.0%
5	227	33 14.5%
6	85	81 95.3%
7	77	75 97.4%
8	16	16 100.0%
9	3	3 100.0%
10	2	2 100.0%
11	8	8 100.0%
Totals	**435**	**220** **50.6%**

To accurately present the overweight vehicle data, the 54 CMVs could not be weighed at the Knox County IS were removed, and only weighed vehicles were used in the weight analysis calculations. Table 1 shows general information about the CMVs weighed at both the Knox and Greene County ISs during the assessment; this data is separated into groups based on the number of axles the CMV had. It is clear that the majority of the overweight and oversized vehicles that came into the IS were five-axle CMVs.

Also, vehicles with more than five axles typically had a permit that would allow them to carry more than 80,000 lbs. of gross weight and the full 20,000 lbs. per axle. Also, it can be seen that not many vehicles were overweight gross (16.8%), but rather were overweight on an axle group (54.1%) instead, which is usually the result of poor load placement. Vehicles which are overweight gross are considered overweight because the gross vehicle weight is above the legal limit specified by the state, or above the permitted weight if the CMV is permitted.

Table 2. Summary of Weighed CMVs

Number of Axles on CMV	Number of Weighed CMVs	CMVs Permitted	Permitted CMVs Overweight Gross*	Not Permitted CMVs Overweight Gross	CMVs Overweight on Axle	CMVs Inspected
2	6	0 0.0%	0 0.0%	0 0.0%	6 100.0%	6 100.0%
3	5	0 0.0%	0 0.0%	0 0.0%	2 40.0%	3 60.0%
4	4	0 0.0%	0 0.0%	0 0.0%	3 75.0%	3 75.0%
5	225	31 13.8%	2 0.9% (6.5%)	40 17.8%	185 82.2%	156 69.3%
6	62	58 93.6%	8 12.9% (13.8%)	5 8.1%	4 6.5%	1 1.6%
7	56	54 96.4%	8 14.3% (14.8%)	0 0.0%	1 1.8%	1 1.8%
8	14	14 100.0%	0 0.0%	0 0.0%	1 7.1%	0 0.0%
9	2	2 100.0%	1 50.0% (50.0%)	0 0.0%	1 50.0%	0 0.0%
10	2	2 100.0%	0 0.0%	0 0.0%	0 0.0%	0 0.0%
11	5	5 100.0%	0 0.0%	0 0.0%	3 60.0%	2 40.0%
Totals	**381**	**166 50.6%**	**19 5.0% (11.5%)**	**45 11.8%**	**206 54.1%**	**172 45.1%**

*Value in parentheses is percentage of overweight gross for permitted CMVs (as opposed to percentage of whole population of CMVs).

The specific axle group that is overweight is important in determining whether a given violation (such as over-worn brakes or low tire) is in some way related to that overweight violation. As shown in Table 3, overweight axle groups tend to occur mostly on the trailer tandems, which are typically the last set of axles on five-axle CMVs. This is most likely due to load placement or improper adjustment of the trailer tandems location. Because of the likelihood of the weight being the highest on this axle group, it is also likely that one would find possible brake violations or worn tires on this axle group.

Table 3. Detailed Summary of Overweight Locations on Weighed CMVs

Number of Axles on CMV	Number of Weighed CMVs	Overweight on Single Trailer Axle*	Overweight on Drive Axle(s)*	Overweight on Trailer Tandem	Overweight on both the Drive and Trailer Tandems	Overweight on Trailer Tri-axle	Total
2	6	0 0.0%	6 100.0%	0 0.0%	0 0.0%	0 0.0%	6 100.0%
3	5	0 0.0%	2 40.0%	0 0.0%	0 0.0%	0 0.0%	2 40.0%
4	4	1 25.0%	1 25.0%	0 0.0%	0 0.0%	1 25.0%	3 75.0%
5	225	10 4.4%	63 28.0%	96 42.7%	16 7.1%	0 0.0%	185 82.2%
6	62	0 0.0%	2 3.2%	1 1.6%	0 0.0%	1 1.6%	4 6.5%
7	56	0 0.0%	0 0.0%	0 0.0%	0 0.0%	1 1.8%	1 1.8%
8	14	0 0.0%	0 0.0%	0 0.0%	0 0.0%	1 7.1%	1 7.14%
9	2	0 0.0%	0 0.0%	0 0.0%	0 0.0%	1 50.0%	1 50.0%
10	2	0 0.0%	0 0.0%	0 0.0%	0 0.0%	0 0.0%	0 0.0%
11	5	0 0.0%	0 0.0%	1 20.0%	1 20.0%	1 20.0%	3 60.0%
Totals	**381**	**11** **2.9%**	**74** **19.4%**	**98** **25.7%**	**17** **4.5%**	**6** **1.6%**	**206** **54.1%**

*Vehicles that were overweight on the drive axle had either a single or a tandem axle. Single axles that were considered to be the drive axle (usually second axle) were listed in the drive axle category and not the single axle category. Axles in the single axle category were all trailer axles.

Figure 2 shows the distribution of gross vehicle weights of both permitted and non-permitted CMVs weighed during the assessment. Most of the vehicles were in the 75,000 lb. to 82,500 lb. gross weight range. A fair number of vehicles were also in the 105,000 lb. to 112,000 lb. range as well, and accounted for the majority of the six- and seven-axle vehicles recorded. It is clear that the majority of the vehicles that were over 80,000 lb. (160 of 205 CMVs) were permitted as required by law.

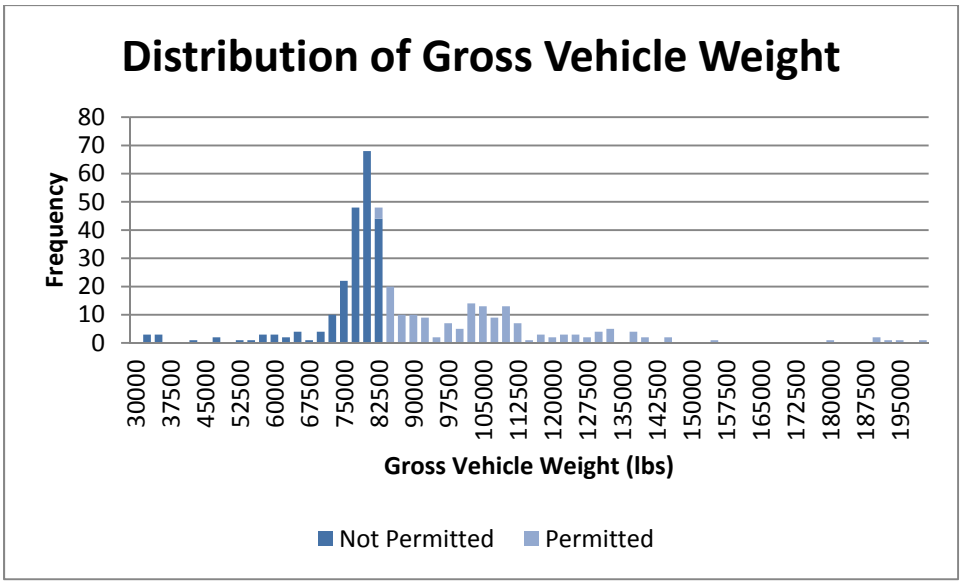

Figure 2. Distribution of gross vehicle weight.

The amount of weight over the allowable axle rating is also important. A CMV which is a few hundred pounds overweight does not pose as significant a safety risk as one which is a few thousand pounds overweight. Figure 3 shows the range and frequency of weights by which axles exceeded the allowed weights. The majority of these weights were below 3,000 lbs., with the average overweight amount being nearly 2,000 lbs. In most cases 2,000 lbs. represents 6% above the allowable weight of 34,000 lbs. on a tandem set of axles.

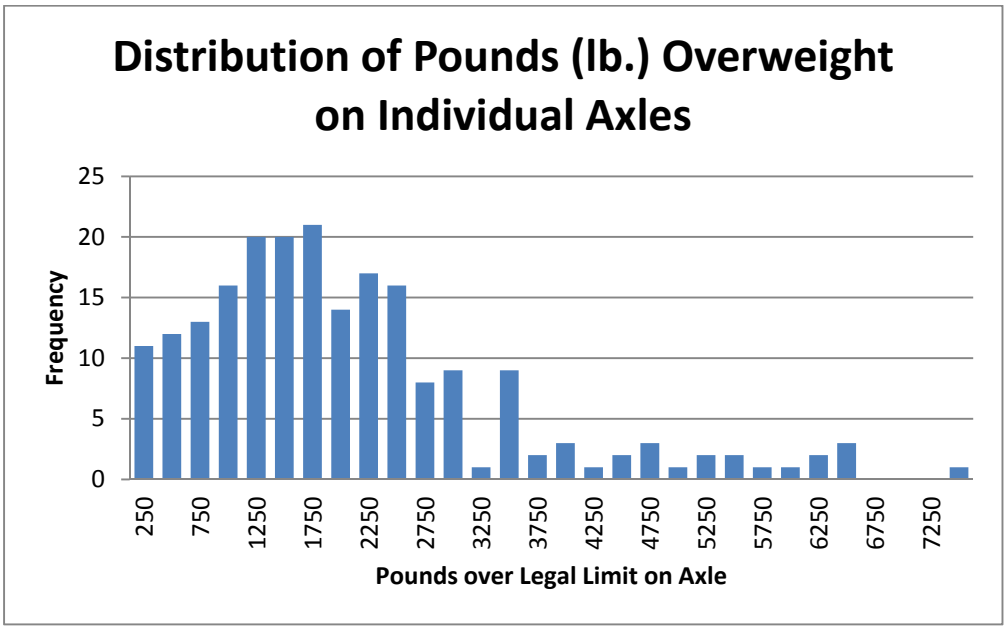

Figure 3. Distribution of pounds (lb.) overweight on individual axles.

The type of trailer is the main reason that overweight and oversized vehicles cannot be inspected. Many oversized loads are on trailers which do not allow enforcement personnel to safely get under them to conduct an inspection. The Greene County IS has an inspection pit which allows some of these low-clearance trailers to be inspected. Table 4 shows the types of trailers that were seen throughout the assessment. The *Other* category includes trailer types that were observed infrequently, including cattle haulers. *Specialty* trailers are trailers that are designed for special equipment to be hauled (such as very large equipment or machines).

Table 4. Summary of Trailer Types

Type of Trailer	Number of Trailers
Tank	7
Car Hauler	13
Specialty	28
Other	32
Lowboy	53
Flatbed	80
Drop Deck	94
Box	128
Total	**435**

Figure 4 shows the distribution of the trailer types observed in this study. Only about half of the trailers encountered in this study could be easily inspected (box, flatbed, tank).

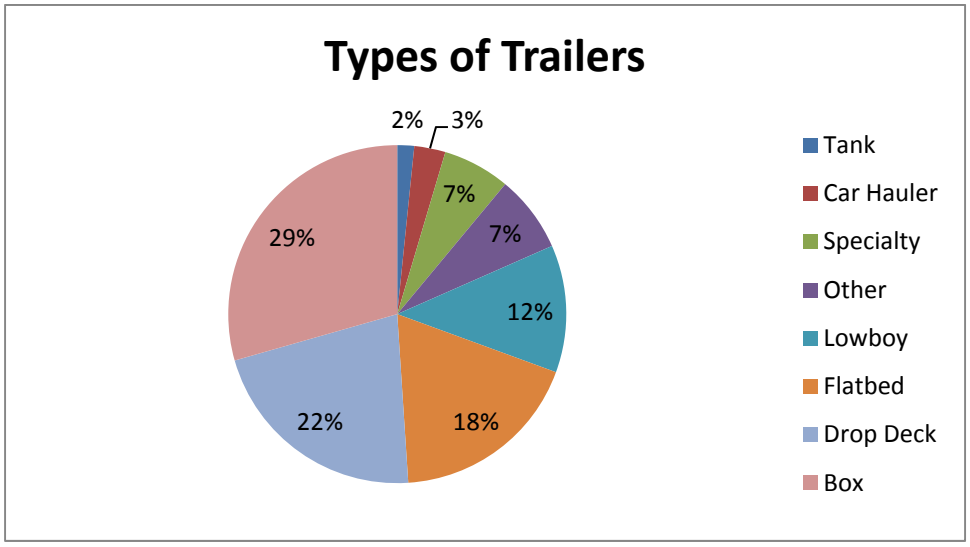

Figure 4. Distribution of trailer types.

Overall there were 435 vehicles recorded within the CMVRTC. While not required for the purposes of this research, 172 of these vehicles were given an NAS inspection of some type. Table 5 shows the number of CMVs recorded and inspected at each IS.

Table 5. Summary of Vehicle Inspections

Station Location	Number of CMVs Recorded	NAS Inspections Performed
Greene County	305	129
Knox County	130	43
Totals	**435**	**172** **39.5%**

Figure 5 shows the types of inspections performed on the vehicles recorded at the ISs. This figure shows that while the inspections were not mandatory, the large majority of the CMVs were only given a Level III (driver) inspection instead of a Level I (vehicle and driver) or Level II (vehicle only) inspection, which is similar to how inspections of overweight vehicles are handled currently at ISs. The *Unknown* category represents inspection numbers that were not able to generate an electronic report because of an invalid number or the inspection was not uploaded. Although the inspection type is not known, it is likely that they were Level III inspections as well.

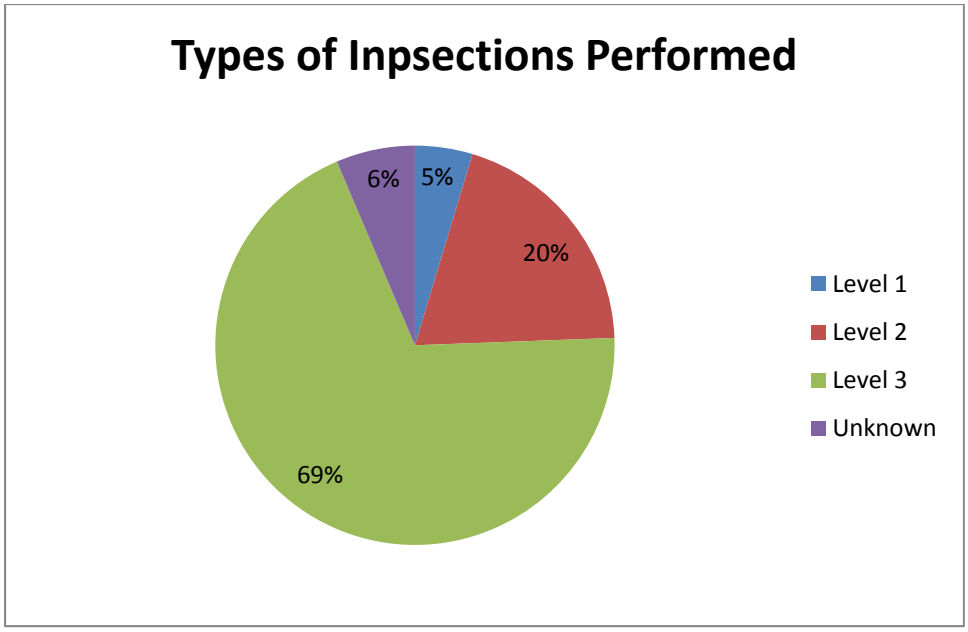

Figure 5. Types of NAS Inspections Performed

Table 6 shows the respective OOS rates for each type of inspection. While the number of CMVs given a Level I inspection was low (not statistically significant), the OOS rate for the percentage of vehicles placed OOS was very high. The Level II inspections given during this research also resulted in a high OOS rate compared to the observed Level III OOS rate of 6.7%. Overall, the OOS rate was only 18.6% which is below the national average of about 22%. If driver-only inspections were removed, the OOS rate would be 52.4% combined for Level I and Level II inspections.

Table 6. Summary of Out-of-Service (OOS) CMVs

Inspection Type	CMVs Inspected	CMVs Placed OOS	OOS Rate
Level I	8	6	75.0%
Level II	34	16	47.1%
Level III	119	8	6.7%
Total	**161**	**30**	**18.6%**

Table 7, Table 8, and Table 9 show the vehicle violations found during the 42 vehicle inspections performed.

Table 7. Brake Violations Found During Level I and II Inspections

Violation Code	Number Of Vehicles	Number Wheel Ends	Description of Violation
396.3A1BOS	4	4	BRAKES OUT OF SERVICE: 20% Criteria
393.47E	4	9	Clamp or Roto type brake out-of-adjustment
393.45B2	2	2	Brake hose or tubing chafing and/or kinking
393.45D	2	2	Brake connections with leaks or constrictions
393.48A	2	2	Inoperative or Defective Brakes
393.47A	1	2	Inadequate brakes for safe stopping
393.47D	1	2	Insufficient brake linings
396.3A1BL	1	1	Brake-reserve system pressure loss

Table 8. Tire Violations Found During Level I and II Inspections

Violation Code	Number Of Vehicles	Number Wheel Ends	Description of Violation
393.75F	3	3	Tire-load weight rating/under inflated
393.75C	2	3	Tire-other tread depth less than 2/32 of inch
393.75A4	1	1	Tire-cut exposing ply and/or belt material
393.75A3	1	1	Tire-flat and/or audible air leak
393.75B	1	1	Tire-front tread depth less than 4/32 of inch
393.75A2	1	1	Tire-tread and/or sidewall separation

Table 9. Miscellaneous Vehicle Violations Found During Level I and II Inspections

Violation Code	Number Of Vehicles	Total Occurrences	Description of Violation
393.207F	8	14	Air suspension pressure loss
393.53B	4	6	CMV manufactured after 10/19/94 has an automatic airbrake adjustment system that fails to compensate for wear
393.207A	3	3	Axle positioning parts defective/missing
393.9T	2	2	Inoperable tail lamp
393.102A	1	1	Improper securement system
392.9A	1	1	Failing to secure load
396.5B	1	1	Oil and/or grease leak
393.9	1	1	Inoperable required lamp
393.207B	1	1	Adjustable axle locking pins missing or not engaged
392.9A2	1	1	Failing to secure vehicle equipment
393.25F	1	1	Stop lamp violations
393.9TS	1	1	Inoperative turn signal

4. CONCLUSIONS

The overweight vehicle assessment provided useful information regarding the typical stream of overweight vehicles that enter ISs. Only 16.8% of the CMVs (11.5% of permitted CMVs) weighed were overweight gross, which was substantially lower than the 54.1% of vehicles that were overweight on an axle group. Axles that were overweight on an axle group were on average 2,000 lb. above the legal limit. Over half of the vehicles that are overweight or oversized were found to be five-axle combination vehicles; of those, most were found to be overweight on the trailer tandem axles. Of the vehicles over 80,000 lb., only 45 were without a permit (meaning they were operating outside the legal limit).

The data collected suggests why overweight vehicles are not normally given Level I inspections. Of the 172 NAS inspections performed during the assessment, only 25% of them were Level I or II vehicle inspections. Not only is there a general safety concern when getting under overweight vehicles that may or may not be defective , but this study also showed that nearly half of these vehicles had a trailer with an extremely low clearance, making it impossible for enforcement personnel to inspect components under the vehicle, such as brakes, without the use of an inspection pit. Overall, the OOS rate for all inspections (driver and vehicle) was 18.6% which is below the national average of about 22%. Of the vehicles that were given a Level I or II inspection, the OOS rate was high at 52.4% which shows the potential safety benefit to giving either a Level I or Level II inspection to overweight vehicles.

5. FUTURE WORK

This assessment serves as a precursor to additional work involving overweight vehicles for FMCSA. In the next step of this work, overweight combination vehicles will be given an NAS Level I inspection, and data involving brake and weight correlations will be collected. Also, there is a desire to expand this work to other states to get a better representation of overweight vehicles across the country. In all future work, it would be beneficial to disable any preclearance technologies in order to get a better representation of the overweight vehicles on the mainline.

OWA Report Revision Log (to be removed from final report)			
Revision Number	Document ID	Description of Change	Change Effective Date
0	0	Initial Draft	28 June 2011
1	0.1	Implemented comments	17 Aug 2011