Comprehensive Truck Size and Weight (TS&W) Study

Phase 1-Synthesis

Enforcement

and

Truck Size and Weight Regulations

Working Paper 10

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1.0 Technical Relationships of Policy Consequence Concerning Enforcement (Type, Intensity, and Consequence)

This paper gives particular attention to the importance of enforcement actions as an integral part of Truck Size and Weight Regulations, and to the potential impacts of changes in TS&W regulations, on the costs and effectiveness of enforcement activities. A great deal of recent research has been conducted on the problems of overweight travel and enforcement strategies to reduce overweight travel. Because of the relative importance of the economic consequences of overweight travel, such as pavement damage and industry costs and revenues, less attention has been given to vehicle dimension or vehicle specification enforcement issues. Little attention has been given to the specifics of whether and how potential changes in TS&W regulations will impact enforcement.

Vehicle weight and safety enforcement activities have often been combined by states. Enforcement activities related to combined weight and safety enforcement are discussed in this paper; safety considerations related to all other TS&W issues are addressed in another working paper.

The importance of enforcement as an integral part of TS&W regulations is recognized in almost all major studies. The TRB Study "Truck Weight Limits: Issues and Options"[1] identified enforcement as a critical element of any plan for controlling vehicle weights. It suggested that enforcement concerns required uniform truck weight laws and regulations be relatively simple to comprehend, apply, and enforce, and be reasonable from the standpoint of the trucking industry and the enforcement community. It identified the need for effective enforcement to act as a deterrent by assuring that those traveling in disregard of laws and regulations would be apprehended and would face effective fines and sanctions.

The need for effective enforcement is fairly independent of TS&W regulations. Given the investment by society in pavements, bridges, and other design features which can accommodate current configurations but not extremes in sizes and weights, total deregulation is neither desirable nor likely. Consideration should be given to whether TS&W regulation revisions promote uniformity, simplicity, and reasonableness for industry and the enforcement community.

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[1]Transportation Research Board, Committee for the Truck Weight Study, Special Report 225 Truck Weight Limits: Issues and Options, Washington D.C., 1990.

1.1 Vehicle Weight Limits

Vehicle weight and safety have received by far the most attention as enforcement concerns. The overweight vehicle problem has been identified and quantified in numerous studies, and the effectiveness of alternative enforcement strategies has been addressed in recent research.

In this issue paper, the discussions of the technical relationships of the policy consequences concerning enforcement are combined for all identified aspects of vehicle loads, including tire-related, axle-related, groups-of-axles-related, and gross-vehicle-weight (GVW) related loads. In reality, almost all concern is with axle loads, due to the pavement effects of overweight trucks. Those vehicles operating in violation of any aspect of weight will be of concern because of the added equivalent single axle loads (ESALs) which that overweight travel inflicts. ESALs are the loads put on pavements by a single axle of 18,000 pounds. All enforcement efforts will address these various weight limit parameters since individual axle load violations, bridge formula violations, and GVW violations are monitored at the same time by the same equipment and personnel.

The only technological changes which may complicate enforcement will occur if the relationships between axle weights and pavement damage change due to technological changes to tires, suspension systems, or other vehicle parameters. Retractable (lift) axles, currently utilized on heavy single unit trucks, are a vehicle parameter worthy of some special attention. A truck driver could put a retractable axle down when encountering (or about to encounter) a weigh station, and be within limits. The retractable axle could be put up afterwards, increasing pavement damage but reducing operating costs.

Enforcement of standards with regard to items such as tire pressures or suspension characteristics will complicate the duties of field personnel. Such technological changes should be considered to be very likely unless regulated. Changes in tires or suspension might require fundamental changes in truck size and weight laws and their enforcement because tire pressures or suspension systems might have to be checked to determine pavement damage attributes. A different approach might be to prohibit equipment with such characteristics as would require very difficult or challenging measurements.

The concern with weight and dimension enforcement relates to both excess pavement costs and to achieving a level playing field within the trucking industry. FHWA has estimated that about 10 to 20 percent of combination vehicles are

operating overweight without a permit.[2] The TRB study provided a rough estimate of national pavement costs due to overweight travel of from $160 million to $670 million per year. The reasons for overweight travel relate to the potential for increased profit if enforcement is not encountered. As an example, the study estimated that a truck operating 20,000 pounds overweight might generate $3,700 more in profit if it could travel overweight for 12,500 miles (an estimated average distance which trucks in Texas travel between encounters with enforcement).[3] These are the incremental costs of damages or of increased profit.

1.2 Magnitude and Issue of Overweight Travel as a Function of Enforcement

Vehicle weight is of great concern because of the consequences of excessive axle loads on pavements and bridges. Quantification of the magnitude of the overweight problem and its relationship to enforcement activities has been provided in a variety of studies, including but not limited to:

Florida: A study by the Florida DOT[4] quantified the proportion of overweight trucks using the I-95 general corridor near the Georgia/Florida border, under conditions of different enforcement strategies. Overweight trucks declined significantly with high and effective levels of enforcement covering I-95 and local bypass routes. The study provides quantitative estimates of the axle weight, bridge formula, and gross weight violations for all sites and strategies. It also provides an estimate of ESALs under each strategy. The study utilized weigh-in-motion (WIM) data to record travel volumes and loads. The WIM readings were calibrated to fixed scale readings. Proportions of overweight travel by amount overweight were also recorded.

Under Strategy A, no enforcement, FDOT found that 12.9 percent of five-axle tractor semi trailer combinations passing through the corridor were in excess of legal limits, compared to 1.4 percent under the highest enforcement level (Strategy D). ESALs per truck for all sites combined dropped from 1.79 with Strategy A to 1.19 with Strategy D which included a very high level of enforcement on parallel routes. The number of trucks also

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[2]FHWA, Overweight Vehicles - Penalties and Permits: An Inventory of State Practice for Fiscal Year 1987, U.S. Department of Transportation, 1989.

[3]TRB, op. cit.

[4]Florida Department of Transportation, "Weigh Station Evasion by Trucks", June 1994, unpublished.

declined, leading to speculation that some trucks may have diverted as far as the I-75 corridor about 60 miles west of the study corridor.

Virginia: A study by B.H. Cottrell of VDOT[5] examined bypass of weigh stations by overweight trucks. At two sites, 11 percent and 14 percent of trucks were found to be overweight on routes used to bypass weigh stations on I-81. Loadings from WIM data collected without enforcement were found to be 30 percent to 60 percent higher than loadings using static scales and enforcement.

Wisconsin: A Wisconsin DOT scale avoidance study[6] found that 20.3 percent of trucks on bypass routes were in violation of size and weight laws, and 69.7 percent of trucks/drivers on bypass routes were in violation of motor carrier safety and driver regulations.

Manitoba and Saskatchewan: A study by Fekpe and Clayton[7] provided an innovative quantification of not only the violation rates but also of how they change under different levels and approaches to enforcement.

Both permanent scales and patrol teams were included as enforcement approaches, and variations of enforcement rates were measured along with the variations in violation rates. Violation rates reported by patrol teams were higher than those at permanent scales, indicating that the permanent scales effectively deterred overweight travel, or caused it to utilize other facilities. Violation rates declined with enforcement intensity.

The authors developed a very innovative and useful "upper bound limit model" to describe the likelihood of traveling overweight based on

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[5]Cottrell, B.H., Virginia Transportation Research Council, Virginia Department of Transportation, "The Avoidance of Weigh Stations in Virginia by Overweight Trucks", Report No. FHWA/VA-93-R2, October 1992.

[6]Grundmanis, G., Wisconsin DOT, Use of Weigh-in-motion Collected Data in Planning, Pavement Design, and Weight Enforcement, Task 4 - Truck Avoidance of Enforcement Scales: Field Results from a Combined Enforcement/Planning Perspective. Report No. WI 01-89, WISDOT Division of Planning and Budgeting, 1989.

[7]Fekpe, Edward S.K., and Clayton, Alan "Quantitative Assessment of Effect of Enforcement Intensity on Violation Rates of Vehicle Weight and Dimension Regulations" in Transportation Planning and Technology, 1994, Volume 18, pp. 143-153, Gordon and Breach Science Publishers S.A.

enforcement type and intensity and other trucking industry parameters. The model emphasized three axioms:

1. Trucks have finite load carrying capacities and therefore cannot be loaded indefinitely. Even with no enforcement, the extent of overloading is constrained by technological and dimensional limitations;

2. Some overweight operations are possible no matter how intensive the enforcement practice. These offenders can be categorized as (i) those who are ignorant of the law and ignorantly contravene it (unwitting violators), (ii) load shift in motion (iii) notorious (repeat) offenders;

3. Generally, violation reduces with increasing intensity of enforcement.[8]

The mathematical formulation provides a tool for estimating overweight travel under different enforcement procedures. The basic structure of the model could be applied in many different contexts.

(a) Enforcement Types (Elements) in Relation to Overweight Travel

Enforcement types and strategies cover a wide range of facilities, equipment and other actions. Important elements of enforcement include:

- Static scales and weigh station personnel;
- Portable/semi-portable scales and personnel;
- Weigh-in-motion (WIM), automatic vehicle identification (AVI), and automatic vehicle classification (AVC) equipment;
- Degree to which WIM readings are consistent with static scale readings;
- Relevant evidence laws and audit information;
- Judicial system and culpability (driver, vehicle owner, shipper);
- Fines, penalties, sanctions; and

[8]Ibid., Fekpe and Clayton, p. 146

- Potential for self-certification.

These are discussed below in turn.

(b) Static Scales and Weigh Station Personnel

A variety of the studies mentioned above have noted that static scales or weigh stations provide for low rates of overweight travel on the routes which they monitor. This is providing that the hours of operation are sufficient to provide a reasonable probability that vehicles on the roadway will be observed, and that the capacity of the station is sufficient to prevent large numbers of "runbys." Runby trucks are those that when the station is full, are allowed to proceed on the mainline. Hours of operation should include nights and weekends, when overweight percentages may be highest.[9] Capacities should be great enough in terms of throughput (facilities and personnel) such that large proportions of trucks cannot run by. Since the static scale stations provide for a significant portion of safety inspections, combined weight/safety functions and assignments must be designed together.

Many of the studies have found that the fixed weigh stations are insufficient by themselves to provide cost-effective deterrence, and that coordinated enforcement on bypass routes is desirable.[10] Coordinated enforcement on bypass routes is necessary to raise the probability of detection, since drivers get quick warning of weigh station enforcement and can choose to attempt to bypass or stop and wait.

A recent Wisconsin study[11] applied a model of costs and benefits which considered trucking industry and state costs and benefits and strategies related to overweight travel and enforcement. The study considered a range of scenarios from fixed scales only, to mobile or portable teams only, to mixed approaches, with variations in WIM and other intelligent transportation system/commercial vehicle operations (ITS/CVO) technologies. The mixed approaches using WIM at both fixed and mobile sites were most cost effective, with the fully mobile approach the least cost-

[9]Op. cit., Florida DOT, Cottrell, etc.

[10]For example, Florida, Cottrell, Fekpe and Clayton (op. cit.)

[11]Cambridge Systematics, Inc., Wisconsin Safety and Weight Policy Study, prepared for Wisconsin Department of Transportation Office of State Patrol, September 1994.

effective, since not enough trucks could be weighed with the portable or mobile scales.

(c) Portable and Mobile Enforcement Scales and Personnel

Portable scales and personnel have been identified as important and cost effective elements of weight enforcement strategies.[12] An NCHRP study[13] of potential applications of AVI, AVC, and WIM resulted in the development of a comprehensive cost and benefit model of enforcement strategies which was used to analyze random deployments of coordinated crews to cover primary and bypass routes. Use of portable enforcement for bypass routes was found to be very promising in enhancing the apprehension of overweight trucks and in deterring overweight travel. The model was also used to analyze fines and overall levels of weight enforcement deployments by functional class of highway. This model was further adapted to the evaluation of weight enforcement and safety deployments in Wisconsin, and deployments of portable enforcement teams were again found to be cost effective elements of an overall enforcement strategy.[14] The Wisconsin study concluded that the best savings in terms of pavement damage versus costs of enforcement occurred with a mixed deployment.

(d) WIM, AVI, and AVC Equipment

The technological capabilities and accuracies of WIM, AVI, and AVC equipment have been evaluated extensively in the cited NCHRP report[15] as well as by the Crescent Project and in a Virginia study coordinated with the

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[12]For example, Fekpe and Clayton, Florida DOT, Cottrell, op. cit.

[13]Grenzeback, L.R., J.R. Stowers, and A.B. Boghani NCHRP Report 303 Feasibility of a National heavy Vehicle Monitoring System, TRB, National Research Council, Washington D.C., 1988. The weight enforcement model and the analysis of weight enforcement strategies reported upon in this research were developed by Arlee Reno and Thomas Corsi.

[14]Cambridge Systematics, Inc., Wisconsin Safety and Weight Policy Study, Draft Final Report, September 1994.

[15]Grenzeback, et. al., op. cit.

previously cited study.[16] While the WIM equipment must be carefully calibrated, it can serve several useful purposes:

- Monitoring of volumes and loads to determine overweight travel patterns;
- Preclear and bypass (with AVI) at weigh stations and ports of entry, to vastly enhance capacity as well as to reduce costs to the trucking industry; and
- Screening of potential violators versus non-violators for either fixed or portable enforcement.[17]

WIM cannot be used to record evidence of violations, and violators must be weighed at other scales in order to support citations. However, the use of WIM, combined with AVI, for monitoring, preclear and bypass, or screening has been found to be very cost-effective as an element of overall enforcement.[18]

There is the possibility of improving the efficiency of operation at the fixed weigh stations by combining WIM equipment with AVI. The productivity of inspectors would be enhanced if they could obtain real-time information on the inspection and weight enforcement history of all passing vehicles as well as relevant WIM data. Inspectors could thus focus attention on the vehicles most in need of an inspection or of weight enforcement. The real-time information would also benefit the carriers by allowing them to avoid multiple stops for inspections on the same trip or within a very narrow window of time.[19]

Vehicles would be equipped with a transponder or electronic license plate or tage, which would carry the vehicle's unique identification code (with information about the carrier, vehicle and driver, including recent inspection information). When a vehicle with a transponder passed a

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[16]Cottrell, B. H., Virginia Transportation Research Council, Virginia Department of Transportation, "Evaluation of Weigh-In-Motion Systems," March 1992, Report No. FHWA/VA-92-R8.

[17]Grenzeback, et al., op. cit.

[18]Ibid., Grenzeback, et al.

[19]Professor Thomas M. Corsi, review comments on TSW Working Paper 10, November 9, 1994.

checkpoint at mainline speed, a reader (placed upstream of the inspection site) would capture the information on the transponder and send it to the inspection site. Simultaneously, WIM equipment could provide weight information. The inspection site would have a computer to process the information from the transponder and the WIM equipment and, in some designs, link itself into a network of remote information systems. These linkages would minimize the information that would have to be coded into the transponder. The inspection site computers would require a standard protocol for data linkage and exchange and would exploit the latest in open system networking. The benefits of the proposed system would center on the improved productivity of inspectors. The real-time information obtained about the vehicles would allow them to concentrate their efforts on vehicles not having a recent inspection, belonging to carriers with a poor overall inspection rate, or with a weight issue as indicated by the WIM equipment.[20]

WIM, AVI, and AVC are strongly mutually supportive. WIM and AVI can be used for preclear and bypass at weigh stations to speed overall processing and to separate out vehicles of different attributes. The NCHRP study of Feasibility of a Heavy Vehicle Monitoring System[21] showed high returns to both truckers and states from deployment of WIM and AVI at weigh stations and ports of entry, as did the weight enforcement study for WISDOT, which used a later version of the weight enforcement model developed under NCHRP.[22]

(e) Degree to Which WIM and Static Readings are Consistent

States have given attention to calibrating WIM equipment to best match loads as measured by static scales. The range of types of WIM equipment includes but is not limited to strain gauge load cells, hydraulic load cells, bending plates with strain gauges, capacitance weigh mats, strain gauges attached to bridge beams (bridge sensor weighing systems), and various piezoelectric systems (cable and film).[23] If WIM is well calibrated, it can

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[20]Ibid.

[21]Grenzeback, *et al.*, op. cit.

[22]Cambridge Systematics, op. cit.

[23]Wright, C.A., W.D. Cunigan, Florida A&M University, Florida DOT "Enhancement to Florida Truck Weighing Program", Report No. FL/DOT/SMO/89-373, July 1989.

serve the above purposes, but with careful attention to potential differences between WIM and static measurements.

(f) Relevant Evidence Laws and Audits

A relevant evidence law allows a citation for overweight operation to be issued based on information such as bills of lading indicating weight violations, even though the trucker was not apprehended at the time the violation occurred. This could allow enforcement of GVW violations to take place through auditing of records rather than field observations.

Office audits instead of field audits could have very substantial payoffs in terms of productivity if information pertaining to overweight operations is automated and can be automatically reviewed. This is more likely to be the case for larger carriers, who support more vigorous TS&W enforcement, than for smaller carriers. One option would be to exempt carriers from field checks if they maintain easily auditable records, unless there is probable cause to suspect an overweight or safety violation. This would provide an incentive to automate.

The experience to date with relevant evidence in Minnesota was reviewed in the recent Wisconsin DOT study. It was found that the use of relevant evidence was declining in Minnesota, and that conclusions about its effectiveness were highly uncertain. Relevant evidence can only be applied to the gross vehicle weight rather than to axle weights or the bridge formula. Thus, some aspects of weight enforcement would be missed.

A promising approach would be to shift the auditing focus from the carrier to the shipper. Increasingly, shippers have been focusing on improving supply chain management efficiencies. In order to achieve lower costs in this area, they have turned to third-party logistics providers for assistance. Frequently, these third-party logistics providers install sophisticated computer systems providing for electronic data interchange (EDI) between carriers and shippers with complete record keeping and even direct bill payments. Such systems provide complete records on individual freight bills which could be subjected to auditing for overweight violations. These sophisticated systems are becoming increasingly widespread and accessible to a wider range of companies with the growing power and sophistication of the PC.[24]

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[24]Corsi, op. cit.

Audits of in-state firms will obviously be easier for state personnel than audits of out-of-state firms. If the primary concern is with interstate carriers, then enforcement of relevant evidence laws may be neglected or put off as too difficult.

(g) Judicial System and Culpability

FHWA provides an excellent summary of the issues related to the legal system and establishing culpability for overweight violations:[25]

> "*Judges* — Many do not appreciate the gravity of the overweight truck problem, do not understand the damages caused, and dismiss charges or suspend or reduce fines.
>
> *Prosecutors* — Many are overworked, understaffed, and do not attach high priority to truck overweight cases, and may also not understand the problems.
>
> *Wrong Defendant* — The truck driver is usually the defendant, whereas the owner or shipper are the parties with control over whether the operations will be conducted overweight, and are those who will profit from overweight travel.
>
> *Ineffective Penalties* — Penalties may be too low to serve as an element of deterrence, and will be absorbed as a cost of doing business rather than serve as an effective behavioral incentive (also discussed below).
>
> *Criminal Courts* — Most states define overweight as a criminal activity, but the criminal courts may be very overburdened with very serious crimes against persons, and thus the lack of drama of the overweight activity compared to other cases may also serve to make judges and prosecutors less zealous in pursuing justice."

(h) Fines, Penalties and Sanctions

Research for NCHRP[26] on weight enforcement strategies resulted in a model of trucking industry and enforcement agency costs and benefits

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[25]FHWA, 1985. Overweight Trucks — the Violation Adjudication Process, U.S. Department of Transportation, also summarized in Truck Weight Limits: Issues and Options, TRB, op. cit.

[26]Grenzeback, et al., op. cit.

related to different strategies being adapted by the various parties. The level of fines and penalties associated with each level of overweight travel (amount by which overweight) was modeled along with the probability of being caught under various conditions of strategy and counterstrategy. Increasing fines and penalties (such as requirements for off-loading) was illustrated to be a very cost-effective element of overall enforcement strategies. In the model, increased fines could successively reduce the incentives for overweight travel for those gaining different levels of economic benefit from traveling overweight. Economic benefits of traveling overweight were estimated on a cents-per-ton-mile basis, based on revenues per ton-mile for different cargo types. It is of some interest that bulk commodities, for which carriers may be tempted to travel overweight, may sometimes also be low value commodities. Thus, slight increases in fines and penalties may be able to deter significant amounts of overweight travel. Understanding of this issue may benefit from further analysis accomplished through applying the model to different commodity types and truck configurations.

If fines and penalties are sufficient, then the overweight trucker has to be prosecuted less frequently to achieve the same deterrence. Euritt[27] found that, in Texas, vehicles were checked by Public Safety license and weight officers about once every 12,500 miles, indicating that even the average truck (not the most accomplished overweight evader) would come in contact with enforcement personnel very infrequently. A vehicle averaging 75,000 miles per year might come in contact with enforcement only six times per year. With very low fines, little deterrence effect will be achieved unless contact is more frequent.

(i) Potential for Self-Certification

Self-certification could be applied to size and weight enforcement as well as to other areas. Self-certification would require that adequate records of configuration and weights be maintained such that random inspections could determine compliance. Self-certification could also be accompanied by periodic inspections at weigh stations or ports of entry.

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[27]Euritt, M.A.. "Economic Factors of Developing Fine Structures for Overweight Vehicles in Texas", in Transportation Research Record 1116, TRB, National Research Council, Washington, D.C., 1987.

1.3 Vehicle Dimension Limits

Vehicle dimension limits have not been the subject of the same degree of research as weight limits relating enforcement strategies to TS&W regulations. The impacts of dimensions are primarily due to constraints of height clearances and constraints upon over width loads, for specific facilities or routes. Each of these is subject to special permitting procedures and sometimes to special operations procedures. The enforcement implications of dimension limits are that observation by enforcement personnel is required of the specific vehicle making a specific trip.

1.4 Vehicle Specifications

TS&W regulations determine many aspects of vehicle specifications, but differences along many specifications do not lead to differences in enforcement. Vehicle heights, lengths, and widths are determined by TS&W regulations, but checking for compliance will be the same, for example, for 53-foot trailers as for 54-foot trailers.

Vehicle or equipment specifications or inspections might best be combined with safety inspections. Weight enforcement generally only involves the checking of a vehicle's registration and permit and its axle weights, gross vehicle weight, and compliance with the bridge formula. Inspection of the vehicle or its components is limited to simple measurements, such as length, rather than mechanical soundness. Level I and Level II safety inspections, which require today an average of 41 and 29 minutes respectively, are the activities under which mechanical aspects are examined. Combining any vehicle or equipment inspections related to weight enforcement with these inspections for safety might be the only approach under which substantial added costs were not incurred for weight enforcement.

For example, new technologies for vehicle inspections are being investigated. These new technologies will enhance the accuracy and reduce the time for the inspections. The combined safety inspection/weight assessment will be more effective and less costly when these new technologies become widespread.

A major impact on enforcement would occur if performance specifications became the basis for truck size and weight regulation. Under a performance specification, potential impacts of vehicles on such items as pavement damage would be specified, and testing would be done to see whether vehicles met the specifications.

This would open up many types of alternative means to measure performance. On-vehicle monitoring, which would be done by the operator, could measure items of interest, including weights, tire pressures, horizontal movements, etc. Research

is necessary on how enforcement might be conducted under performance specifications.

1.5 Equipment Specifications

Equipment specifications might include ITS/CVO technologies which could provide for automatic vehicle identification and communication of registration status, weight status (perhaps empty/loaded), origin and destination, safety inspection history, and status of safety equipment (such as braking systems). The enforcement implications include the potential for higher productivity of inspection time and perhaps more thorough inspections.

Any move towards equipment specifications will involve public-private cooperation on technologies and requirements.

1.6 Operational Specifications

Operations are impacted by the frequency of enforcement and the technology. If vehicles must be stopped, operating costs accrue to the trucker. Some operational impacts might be minimized through the use of WIM and other technologies or self-certification procedures, which would allow vehicles to bypass unless there was an indicated need for enforcement or inspection.

1.7 Operator Specifications

TS&W enforcement impacts differentially on operators within different segments of the trucking industry. For those who never face weight limits, because of the density of products carried or because of other operational parameters which never cause them to reach weight limits, enforcement is a moot issue, except to the extent that necessary enforcement activities must be paid for through taxes on the industry or to the extent that costs are imposed upon them (such as delays at weigh stations or ports of entry).

For segments of the industry who face the choice of traveling overweight or not, enforcement efforts are important with regard to achieving a level playing field. Enforcement which imposes higher costs on those who choose non-compliance will eventually cause most to change their approaches. However, as concluded by Fekpe and Clayton,[28] there is little likelihood of complete compliance due to the problems of inadvertent overweight operation, load shifting, or the noncompliance practices of particular operators.

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[28]Op. cit.

1.8 Unique Enforcement Issues for Particular Policies

In addition to the general enforcement issues, some proposals for truck size and weight policies are associated with their own unique issues which may require further attention. These include:

- Application of Federal truck size and weight provisions on the National Highway System (NHS) — this would require specific adaptations by states and carriers which should be assessed.

- Adoption of tire-related provisions — this would likely imply monitoring of tire pressures and configurations, requiring additional time in inspections; it is presumed that combining this with safety inspections will be a reasonable approach.

- Adoption of any unique controls for special trucks or special commodities — this would require some ability to recognize unique vehicles or commodities and to apply different rules, complicating enforcement approaches.

- Adoption of performance standards — this could require entirely different and currently unexplored approaches to enforcement.

- Adoption of Federal or regional permitting programs — this would require the ability to recognize permitted vehicles and to enforce the regulations for the permits rather than normal regulations.

- Retractable axles — This would require an assessment of the experience of carriers using or not using retractable axles when loads dictate the need for lowering the axles.

2.0 Knowledge Gaps and Research Needs

Very basic knowledge gaps remain in understanding overweight travel, in evaluation of enforcement mechanisms and strategies, and in the relationships between TS&W regulations and enforcement. A comprehensive research approach is necessary in order to assure that enforcement issues are incorporated into the evaluation of all potential policies, and to assure that enforcement in the future is as cost-effective as possible.

Research is desirable in the areas of size and weight (and safety) enforcement in general and in the relationship between TS&W policies and size and weight (and safety) en-

forcement consequences and needs. Research in general on enforcement concerns is desirable to fill knowledge gaps in the areas of:

- Compilation of better estimates of the overweight truck problem, and its relationship to various classes of highways, to various industry groups or commodity types, and to costs in terms of pavement damage and other cost factors.

- Compilation of more comprehensive information on existing weight and safety enforcement efforts, to include specific information about deployments of personnel resources and technologies and related information about overweight travel.

- Cost-effective usage of WIM and AVI/AVC technologies as an integral part of weight enforcement programs.

- Evaluation and modeling of the relationships between enforcement strategies and activities and deterrence of overweight, over-dimension, or unsafe travel.

- Potential for performance standards and their impacts on opportunities for enforcement.

Various weight enforcement models should be integrated and applied to specific areas and industries to provide a comprehensive tool for analyzing weight enforcement deployments and their results in terms of reduced overweight travel, reduced pavement costs, and changes in enforcement costs (capital and operating).

Research on the relationships between policies and enforcement should cover all the types of policies identified in this issue paper. Concern for enforcement consequences should be an integral part of policy analysis of all potential changes in TS&W policy.

The implications for enforcement which the following policies would create should be examined:

- Application of Federal TS&W provisions on the NHS;

- Modification or elimination of LCV freeze;

- Modification of bridge formula;

- Modification or elimination of GVW limits;

- Modification of axle weight provisions;

- Adoption of tire-related provisions;

- Adoption of any additional unique controls for special trucks or special commodities;
- More widespread use of retractable axles;
- Adoption of performance standards;
- Phase-out of grandfather rights; and
- Adoption of Federal or regional permitting programs.

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