"Improving Fuel Price Adjustments for State Departments of Transportation: A National Survey of Practice"

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ABSTRACT

Price volatility of construction materials and supplies can lead to price speculation and inflated bid prices by the contractor to protect against possible price increases. State and Departments of Transportation have, since 1974, handled this problem by allowing specific price adjustments of selected commodities in highway contracting, thus decreasing the risk to the contactor from the price fluctuations over the life of a contract. However, for many states, this process has not changed over the past 33 years, despite obvious changes in the purchasing power of construction dollars, construction techniques, industry innovations and fuel types being used for the various construction activities. Of particular concern, fuel price adjustments for structures and miscellaneous construction are measured by gallons per $1,000 of construction. What this amount of capital buys in physical construction compared to earlier years has decreased considerably, resulting in higher fuel price allowances for a given physical structure. The recent dramatic fuel price increases during the summer of 2008 has also significantly contributed to the overall difficulty and price sensitivity regarding vendor reimbursement. This report directly evaluates the impact of inflation on the applicability of current fuel price adjustments in the state of Oregon and the nation.

A national survey was developed to collect information and better understand how different states account for fuel price adjustments. This survey compiled information regarding when and why the fuel price adjustment was implemented, recent changes in the process, and if there are current problems. Historical information was gathered about

the way the states developed the method, whether there had been any changes overtime and if any forthcoming changes were expected. The results of this study reveal some variation across states in how they implement a fuel price adjustment in the contract, in addition to the calculation and implementation procedure utilized. A summary of these findings are presented and lead to the development of a national and state (Oregon specific) index to more accurately reflect changes in structural costs over time.

BACKGROUND AND SIGNIFICANCE OF WORK

Price volatility of construction materials and supplies such as asphalt, fuel, cement, and steel can create significant problems for construction contractors when preparing realistic and accurate bids. It can also be problematic for agencies that sponsoring the projects. In many cases, the bidder or construction company cannot obtain firm price quotes from material suppliers for the duration of the project. This type of uncertainty can lead to price speculation and inflated bid prices by the contractor to protect against possible price increases.

Although price speculation and bid inflation are not new, escalation of global fuel prices in 2008 led to greater uncertainty in the bidding process. The effects of higher fuel prices are magnified when combined with the other component prices for concrete and asphalt, along with other demand factors currently affecting the construction industry.

Since 1974, the building and construction industry, as well as some state and federal departments of transportation, have handled this problem by allowing specific price adjustments for select commodities in highway contracting. For the contractors, these adjustments decrease the risk of fluctuating prices over the life of a contract. The application of fuel usage factors is generally accepted as a way to obtain bids that more closely reflect actual costs for any given project. More accurate estimates, however, can only be achieved if the fuel factors accurately reflect the fuel consumption.

Fuel usage factors were published in Highway Research Circular Number 158 by the Highway Research board in July 1974. Later, in 1980, they were formally incorporated into the Federal Highway Administration (FHWA) Technical Advisory T 5080.3. These fuel factors, however, have not been revised in 33 years, despite obvious changes in the purchasing power of construction dollars, construction techniques, industry innovations, and the type of fuel used for the wide-ranging tasks in construction. Because fuel factors have not been brought up to date, the Oregon Department of Transportation has stated that “it is very unlikely that those fuel usage factors are accurate or effective in removing the risk of fuel price fluctuations to the grantor or construction firm (ODOT, September 2007)

Under established fuel factors, diesel and gasoline consumption per unit of work are specified for each nonstructural unit of work (excavation, aggregates, asphaltic concrete, and Portland cement concrete pavement). The process involves applying the quantities of completed work to the fuel factors in the table, summing the total used for each separate item, and applying the price adjustments. Gasoline and diesel fuel usage factors exist for excavation (gallons per cubic yard), aggregate and asphalt production and hauling (gallons per ton), and Portland cement concrete production and hauling (gallons per cubic yard).

Of particular concern, fuel usage factors for structures and miscellaneous construction are expressed in gallons per $1,000 of construction based on 1980 estimates. ODOT's construction expenditures in recent years have increased from about $250 million per year to $400-500 million per year, mostly for bridge construction. What this amount of capital buys in physical construction compared to earlier years has decreased considerably, resulting in higher fuel allowance for a given physical structure. Dramatic fuel price increases in the summer of 2008, have also contributed to the overall difficulty and price sensitivity regarding vendor reimbursement. Consequently, inflation and construction cost indices are increasingly important areas of research.

The primary research document on the application of fuel usage factors is "Fuel Usage Factors for Highway Construction," Highway Research Circular Number 158, Highway Research Board, July 1974, followed by the FHWA Technical Advisory T 5080.3, dated December 10, 1980. The AASHTO Subcommittee on Construction's August 2005 survey summarized contract price adjustment clauses used by states for asphalt cement, fuel steel, and Portland cement.

This report directly evaluates the impact of inflation on the applicability of current fuel usage factors in the state of Oregon and the nation. The results provide information and recommendations that all states may consider and many may adopt, given that improvements in usage and application have been found.

LITERATURE REVIEW

Our team began by investigating the price of materials for construction projects over the past several years along with the components that make up the majority of construction bid costs. Price volatility of construction materials and supplies such as asphalt, cement, fuel, and steel can result in significant problems for contractors preparing accurate and realistic bids, and also for the agencies sponsoring the projects themselves.

Fluctuations in fuel prices also directly affect the Oregon Department of Transportation (ODOT). ODOT allows a fuel price adjustment for different projects if they meet certain criteria. Particular bid items in construction are designated with a specific fuel factor. The construction cost for structures has increased considerable over the last several years in Oregon. From 1987 to 2007, highway construction costs for structures in Oregon have increased 163 percent. The complete list of bid items, and respective fuel factors and minimum qualifiers are shown in Table 1.

Table 1: Oregon Fuel Escalation Project Determination

BID ITEM	UNIT	FUEL FACTOR ($)	MIN QUALIFIER ($)
General Excavation	Yd3	0.29	5,000
Embankment in Place	Yd3	0.29	5,000
Subgrade Stabilization (12 in. depth)	Yd2	0.33	5,000
Trench Excavation	Yd3	0.29	5,000
Stone Embankment	Yd3	0.29	5,000
Other Excavation	Yd3	0.29	5,000
Cold Plane Removal	Yd3	0.72	5,000
Cold Plane Removal	Yd2	0.04	5,000
Conc. Pvmt. Diamond Grinding	Yd2	0.04	5,000
Base Aggr., Shoulder Aggr. & Sub-Base Aggr. (Combined)	Ton	0.69	5,000
Shoulder Aggregate (Overlays)	Ton	0.69	5,000
Cement Treated Base	Ton	1.00	5,000
Bituminous Base	Ton	2.93	5,000
AC Mixture	Ton	2.93	5,000
Aggregate in Chip Seal	Ton	0.69	5,000
Emulsified AC Mixture	Ton	1.00	5,000
Concrete Pavement	Yd2	1.00	5,000
Other PCC:	Yd2	1.00	5,000
Structures (Gallons/$1000)	Pre-cast	10.00	10,000
Structures (Gallons/$1000)	Cast-in-place	19.00	COMBINED
Total for Project			25,100

Source: ODOT, courtesy of Kevin Brophy

For a bid item to be eligible for a fuel price adjustment, it must first meet a minimum qualifier threshold, which is calculated by multiplying the total quantity of work for each item over the whole project by the respective factor. The sum of eligible bid items has to be greater than 25,100 gallons for the entire project to qualify for a fuel price adjustment. An adjustment will be made through monthly payments for eligible bid items that were used during construction if the price of fuel[i] increases or decreases by more than 25 percent. In other words, there will be an increase in payment when fuel

prices increase by more than 25 percent and a deduction when fuel prices decrease by more than 25 percent.

After viewing various department of transportation (DOT) Web sites, most states have some type of fuel price adjustment, and in several states make it optional for the contractor. In 2006, the American Association of State Highway and Transportation Officials (AASHTO) and Federal Highway Administration (FHWA) jointly prepared a survey to determine the effects of recent price increases and the decline in competition for bids (AASHTO and FHWA 2006). Forty-four state DOTs responded to the survey. Survey results show that over a one year period eight states[ii] implemented or made changes to their fuel price adjustment process. Thirty-one states did not make changes, and California and Maryland reported that they do not have a fuel price adjustment. North Dakota stated they were developing a fuel price adjustment clause. Twenty-two states used a price adjustment clause for certain materials to encourage competition and to compensate for significant cost increases. Arizona and Kentucky reported that using price adjustment clauses has effectively promoted competition and controlled costs.

The Contract Administration Section of the AASHTO Subcommittee on Construction also surveys all states regarding the use of price adjustment clauses (AASHTO). The adjustment clauses for fuel, asphalt cement, steel, and Portland cement are analyzed and updated on a regular basis; the most recent survey was administered in the fall of 2008. For the fuel price adjustment, the survey reports whether the adjustment exists, the fuel index used, the trigger value, whether the adjustment is optional, the web reference, and additional comments. Contact information is supplemented for each state.

In 2004, the Monmouth County Department of Human Services in New Jersey contracted with the Alan M. Voorhees Transportation Center at Rutgers University to identify fuel price indexing/adjustment techniques in the public transportation industry (Alan M. Voorhees Transportation Center, et al. 2004). The purpose of the study was to learn what fuel price adjustments agencies use and outsource to the private sector. Results of the study found that fuel price changes affect all parties. When placing the burden of risk on providers this will lead to inflated costs and possibly lower quality service. In addition adding administrative complexity likely burdens both the agency and the provider.

Carroll et al. (2006) performed an extensive literature review and described the methods used for calculating the fuel adjustment by southeastern states including Alabama, Delaware, Florida, Kentucky, Maryland, North Carolina, South Carolina, West Virginia, and West Virginia. They conclude that fuel adjustment policies lead to inefficiency in a firm's choice of technology.

The 1980 Federal Highway Administration (FHWA) report entitled Technical Advisory T 5080.3 outlines the procedures for development and use of price adjustment contract provisions. According to the FHWA, price adjustments should apply to both upward and downward movements of prices. When an adjustment is implemented into a contract, it should be based on an index from suppliers serving the area. The base index for any item is the price of that item at the beginning of the month in which bids are received. The current index is established on the first business day of each month. When there is a significant difference between the base index and the current index (which is suggested to be between 3 and 10 percent) then an adjustment should be made to the contractor. The FHWA suggests calculating this index each month. Additional

considerations for fuel adjustments are also noted in the report. For instance, the difference between the base index price and current index price should be multiplied by the appropriate value since fuel is usually considered to be incidental to the project. For non-structural items the value is the quantities of work multiplied by the respective fuel usage factor. For structural items, the value is the fuel consumed per $1,000 of work is multiplied by the respective fuel usage factor. Highway Research Circular Number 158 also includes some suggested fuel usage factors. One alternative suggested in the research circular is that the fuel usage factor be calculated as a percent rather than a value. Once each bid item has been multiplied by the respective fuel usage factor, the sum of the values represents the total price adjustment.

The Alan M. Voorhees Transportation Center identified several issues related to alternative price adjustment methods. These studies showed that in the utilities, petroleum coke, and coal markets, price adjustments led to inefficiencies. Construction contractors and business that were allowed price adjustments may not have incentives to cut costs or invest in more fuel efficient technology and construction methods. In the case of the utilities market, when price adjustments are removed, consumer costs decreased. Adjustments are more effective when paid annually than monthly in the utilities market.

A NATIONAL SURVEY

A formal national survey was developed to learn how the fuel price adjustment is implemented throughout the United States, as well as Puerto Rico and Guam. The survey asked questions about when and why the fuel price adjustment was implemented, recent changes in the process, and if there are current problems. The national survey was administered by telephone interview to departments of transportation across the country, and once the appropriate respondents were reached they were asked specific questions about their state's fuel price adjustment.

The purpose of the national survey was to determine how many states use a fuel adjustment in their contracts, and the type of method used. Historical information was also gathered about the way the states developed their method, whether there were changes to the method overtime, and if any future changes were expected. They were also asked about any recent studies they might be aware of based on their experience. The results of the telephone survey provided more in depth information than the AASHTO Subcommittee on Construction, Contract Administration reports (see Section 2.0). Interestingly, some of the states responses were not consistent with the information posted by AASHTO.

The Implementation Procedure

Thirty-two states, including Oregon, use the procedure from the FHWA Technical Advisory T 5080.3 (mentioned in the literature review) to calculate the fuel adjustment. Six states follow the method outlined in T 5080.3, but the fuel usage factors do not exist in the formula. Seven states, as well as Puerto Rico and Guam, have no fuel adjustment, but most have some other type of adjustment.

The fuel usage factors and the number of included bid items vary by state. Since the fuel usage factors suggested in the FHWA Technical Advisory T 5080.3 were compiled in 1974, many states consider them outdated and have established different approaches. Colorado, for example, has allowed the Colorado Contractor's Association (CCA) to create a fuel usage factor bid item list. Florida contacted several contractors and hired a firm to develop the current fuel usage factor values. Georgia used the Carroll et al., 2006 study discussed in the literature review of this report to calculate their values. Internal studies were performed in Illinois and the information was sent to Onan's System (a software company in Nashville, Tennessee) to calculate the current fuel usage factor values. In Idaho and Nevada, a committee was formed and based on committee recommendations; new fuel usage factors were established. Delaware, North Dakota, and Oklahoma estimated new fuel usage factors by looking at other states' factors. Washington took this same approach and spoke with different agencies about the fuel efficiency of relevant vehicles.

Most states do not have a fuel usage factor specifically for structures. Instead states have introduced other bid items that are used in structures with a fuel usage factor in the specifications/provisions. Only 11 states, including Oregon, use a fuel usage factor for structures. Considerable variation exists among the states that use a fuel usage factor for structures. The Highway Research Circular Number 158 suggests the fuel usage factor for structures should be 10 when low fuel intensive diesel fuel vehicles are used and 19 when high fuel intensive diesel fuel vehicles are used. Since that time, most states have decreased that value believing fuel efficiency has decreased. Utah is the only state that has increased that value. Georgia limits the number of structural items that are eligible for a fuel adjustment. An alternative approach specified in T 5080.3, which Nevada has adopted, is taking the dollar value of work multiplied by a percentage instead of a value.

There are some states that use the approach in T 5080.3, but no fuel usage factors exist in the fuel adjustment calculation. Five states use alternative methods for calculating the fuel adjustment. An alternative approach in T 5080.3 for using fuel usage factors as a value is to replace it with a percentage. Rather than multiplying the respective bid item by a fuel factor, the total amount spent on structures is multiplied by a fuel factor in terms of a percent.

Alabama uses a fuel adjustment to cover the costs of fuel required for the production of Hot Mix Asphalt (HMA). When the amount of HMA used in construction is greater than 2.0 gallons per ton in a month, and the price of fuel changes, the state will make an adjustment. The adjustment is made by determining the difference between the current index price and the base index price, and multiply by the number of gallons of fuel that are used in the production of HMA during the month.

At the time of the survey, the state of Alaska drafted, but had not finalized a method for a fuel adjustment. The initial fuel adjustment approach is similar to the method used in T 5080.3 to calculate, but there is a change in how the quantity of fuel is ascertained. After a 10 percent change in the fuel price, the quantity of fuel is the amount of fuel used, multiplied by the respective fuel usage factor, and multiplied by a percent which is determined by a Diesel Fuel Price Adjustment Schedule.

The state of New Jersey uses a list of bid items and fuel usage factors. The quantity of work eligible is multiplied by the respective fuel usage factor, and the sum of

the numbers gives the total quantity. When the total quantity is larger than 500 in one month, a price adjustment will be performed. The price adjustment for Rhode Island is calculated by multiplying the total quantity by the difference between the base price and the current price. The price adjustment will only be made when the amount of the adjustment is greater or less than $250 per month.

In some states, the fuel adjustment is optional to the contractor before the project begins. After the project has started, however, the contractor may not opt out. Alaska, Colorado, Illinois, Missouri, Montana, Nevada, North Dakota, South Dakota, Virginia, and Wyoming allow this option to contractors.

For states where a fuel adjustment does not exist, they employ other adjustments in the payment schedule. For instance, California, Hawaii, Indiana, and New Mexico have an asphalt adjustment. When the price of asphalt increases by a certain amount, the state will make an adjustment to the payment to cover the increased cost. Within the last two years, Puerto Rico has implemented price adjustments for hot plant bituminous mixes, hauling of materials, steel products, and copper and aluminum conductors.

Recent Changes in the Fuel Adjustment

It is clear from the information collected by the national survey that states are searching for a fuel price adjustment procedure that will best serve their needs. One survey question asked if there had been any significant changes in the process over the years. Since the FHWA Technical Advisory T 5080.3 was published in 1974, many changes have taken place in the United States regarding the fuel price adjustment. Illinois, Maine, and Missouri report they had phased the fuel adjustment out during the 1980s, and have brought it back within recent years because of the dramatic price increase and fluctuations to fuel costs. Connecticut introduced the fuel adjustment in 2007 for projects that last multiple years, because bids were not being submitted for long-term projects. Subsequently, the number of bids has increased, which indicates that contractors believe the state is sharing more of the risk.

Within the last few years, 18 states have made minor changes to the way the fuel adjustment is calculated. These states are: Florida, Kentucky, Massachusetts, Minnesota, Mississippi, Missouri, Montana, Nebraska, Nevada, New Hampshire, North Dakota, Pennsylvania, South Carolina, Tennessee, Vermont, Virginia, Washington, and Wyoming. Massachusetts, for example, previously made bi-monthly payments, but has now changed to monthly payments. Montana changed the trigger value from a percent to dollars. North Dakota allows the option for the fuel adjustment only at the beginning of the project. Pennsylvania changed the source of where they obtain the monthly index for the price of fuel. Tennessee eliminated the bid items that were not fuel intensive.

Some variability exists between the states' methods and recent changes. There appears to be no correlation between the fuel adjustment approach used and the region where a state is located. Furthermore, recent changes do not appear to reflect current practices of other nearby states. Rather, adopted methods reflect the demand of local contractors, and do not appear to be influenced by surrounding states.

Source of Price Index

A historic fuel index is created for each state that has a fuel price adjustment clause. The source for each fuel price index differs by state. The FHWA Technical Advisory T 5080.3 suggests the following sources for price indexing.

- U.S. Department of Labor monthly publication "Wholesale Prices and Price Indexes
- Platt's Oilgram Price Service
- Engineering News – Record
- The Oil Daily
- The U.S. Oil Week

Many states use alternative sources other than the ones listed above. The source that states use for the fuel index is variable. In most cases, the fuel price index is calculated within the respective DOT.

Trigger Value

Once the price of fuel changes by more than the trigger value, there is a fuel adjustment. No definite trigger value is proposed in T 5080.3. Trigger values vary across the United States from 5% to 25%. Some states, such as New York, Iowa, and Montana, apply a dollar value rather than a percent for the trigger value. In New Jersey, the contractor has to use at least 500 gallons of fuel during the month the adjustment is made. Rhode Island will make a fuel adjustment when the cost exceeds $250.

Contractor's Concerns

The trigger values imposed in the calculation occur when there is an increase or decrease in the price of fuel. The fuel price adjustment was incorporated so that the price risk fluctuations would be shared when the price of fuel changes. Many contractors across the country, however, do not feel the fuel adjustment covers the changing fuel costs. Although there are complaints about the burden of risk, there is no formal process in place to document or record these types of complaints. In the state survey, a question to the respective departments of transportation asked if they received any complaints from contractors. Alabama, Florida, Nebraska, Nevada, and New Hampshire responded that when the fuel price drops over the contract periods, they do not receive complaints. Oregon reported that contractors complained when the fuel adjustment did not cover the increased cost of fuel. This same complaint was reported by 23 other states. Kentucky, Montana, Nebraska, New Jersey, South Carolina, and Utah reported that contractors believed more bid items needed to be included. Contractors in New Hampshire felt they had no obligation to pay the state when the price of fuel decreases. In Maine, the contractors working on paving projects wanted a fuel adjustment, while the contractors building structure projects did not. In response to complaints, Iowa asked contractors for alternative solutions. To date, contractors have not responded to this request. In California and Texas that do not currently have a fuel adjustment, contractors are

requesting one. Michigan does not have a fuel adjustment, but when contractors are asked about instituting an adjustment, the response has been negative.

States Opinion about Price Adjustment Payment

In the survey, when the question was asked if the fuel adjustment was fair, most responded in the affirmative. Kentucky, New Hampshire, Pennsylvania, and Washington reported that they may pay more to the contractor than the added cost to the fuel price increase. On the other hand, South Carolina suspects the state has not paid the contractor enough to cover the costs, and has added more bid items to remedy this. The state of Utah responded that their method is fair, but contractors do not agree. The adjustment payment to the contractors is neither too little nor too much to cover the changing price in fuel.

Another survey question asked if the state believed the risk was being shared appropriately. Utah also responded that the state believes the risk is being shared appropriately, while the contractors did not. Even though Utah believes the method is fair and the risk is being shared, they are considering changes to the method. Kentucky and New Hampshire responded that they are capturing more of the risk than the contractor.

Of the total construction budget, many states are paying less than 1% of the total budget. Six states gave additional information related to adjustments made in previous years. Missouri reported that in a typical year the fuel adjustment is around $500,000; however, from June to July of 2008, they paid between $3 and $3.5 million. New Hampshire reported that from 2002 to 2008 the range of fuel adjustments was between $46,336 and $2.4 million; the average was $1.2 million. Iowa, Nebraska, Pennsylvania, and South Carolina also provided the fuel adjustments over the last few years.

A Need for Change?

One survey question asked if individual states suspected that changes to the fuel adjustment process may occur in the near future given that there had been dramatic changes in the price of fuel during the summer of 2008. Eight states[iii] said any changes would depend on the market. Only four states—Montana, New Jersey, Pennsylvania, and West Virginia—stated there would be changes in the near future. In Montana, where the fuel adjustment process is optional to the contractor, the deadline when the contractor can decide to participate will change. New Jersey anticipates that changes will occur, but they are not sure what they will be. Currently in Pennsylvania, for a structure to qualify for a fuel price adjustment the project needs to last at least three months, but this will change to four months. West Virginia will introduce a supplementary specification to make it easier for the contractor to find the fuel index. South Carolina plans to hire Clemson University to develop optimal fuel usage factors.

Five states (Wyoming, California, Michigan, New Mexico and New Hampshire) gave information on changes that most likely will occur. Wyoming believes they will lower the trigger value which is currently at 7.5 percent. The Associated General Contractors (AGC) met with California a few times requesting to implement a fuel adjustment procedure. The meetings between contractors and the state are frequent when

fuel prices are high, but rare when gas prices fall. Michigan has proposed a fuel adjustment process to their contractors several times, but there is no demand. New Mexico plans to incorporate a fuel adjustment process at some point in the future, but not anytime soon. New Hampshire believes that more bid items will be added in the near future. Utah is currently testing a new method to calculate the fuel adjustment with several of their projects.

Survey Overview

Most states' fuel adjustment approach is consistent with the general procedure documented in the FHWA Technical Advisory T5080.3. The source for the fuel index and the trigger values, however, show great variation between the states. Some states have modified their process and allowed different bid items for the fuel usage factors to be used, in addition to changing the value of the factors. Only 10 states use a fuel usage factor for structures. Many states are influenced by how other states apply their fuel adjustments. Few states have performed studies to find an "updated" fuel usage factor value. In 2008, which was not a typical year, significantly more money was paid out by states to contractors, but was still less than 1 percent of the construction budget. In response, many states have made recent changes to their adjustment process for the contractors

INFLATION INDICES

Background

This section evaluates highway construction costs from 1991 to 2008 to determine whether the current fuel price adjustment method appropriately mitigates fuel price risk. Given the unique physical and natural attributes that influence Oregon's construction costs for different structural bid items, none of the current national indices seemed appropriate. The existing indices track too few bid items. A more appropriate index is one that follows the price of those components that make up a larger proportion of bid prices. Therefore, we develop a new index that captures a larger share of the total construction project for the state of Oregon. The additional bid items and their measurements over time are introduced. Two indices are created that measure costs at the national and Oregon state level. When we compare the two indices, we can determine whether Oregon's structural costs are consistent with the rest of the nation. If the costs are not consistent, then the current national fuel usage factors are not appropriate for Oregon.

Formation of Bid Item List

To identify additional bid items that capture the true cost of structural construction in Oregon, a request was made to ODOT for the 15 most frequently used bid items in the construction for structures. In addition, we requested the 15 most expensive bid items in terms of individual annual total cost and frequency. Thorough examination of the most costly bid items determined which bid items existed and weighed heavily on

the total construction process, in addition to the frequency. ODOT sent the list of bid items that met the criteria from 1991 to 2008. The dollar values for the different bid items were summed to calculate the total amount spent on the most costly and frequently used structural bid items. The dollar value reported for the respective bid item was then divided by the most costly and frequent structural bid items. All bid items that were reported 4 percent[iv] or higher were placed on a list. After reviewing the list, ODOT made adjustments to accurately reflect the bid items that are used for structures. The authoritative final list of bid items (*final list*) is documented here.

- Structure Excavation
- Reinforcement
- Coated Reinforcement
- General Structural Concrete, Class 3300
- General Structural Concrete, Class 4000
- General Structural Concrete, Class 4500
- General Structural Concrete, Class 5000
- Structural Steel
- 2 Tube Steel Rail
- Warranted Waterproofing Membrane

The *final list* includes bid items that are the costliest and most frequently used in Oregon. An adjusted list more acutely reflects ODOT's experiences including costly bid items that will be phased out because of new construction techniques and the changes in frequency of bid items in the last several years. Therefore, the *final list* more accurately reflects the market for structural construction components in the state of Oregon.

The National Prototype and Oregon State Index

As noted earlier in this report, historically, fuel usage factor values used at the national level for structures have come from Highway Research Circular Number 158 entitled, "Fuel Usage Factors for Highway Construction." The report was based on a 1974 survey by more than 400 highway contractors across the United States. For structural work, the fuel factors are given in terms of fuel consumed per $1,000 of work. Given that the results are based on a national survey, the final bid item list is analyzed for national prices. RS Means, a firm that gathers prices for various aspects of construction, supplied the national prices from one of their manuals printed annually titled *RS Means Heavy Construction Cost Data* (*RS Means*). Applying the bid item prices listed in *RS Means* and how often they are used in Oregon, a national prototype index was developed that measures structural costs over time. The results of the national prototype determine whether $1,000 worth of work is the same in 2008 as it was in 1991.

The *final list* does not exactly match with items listed in *RS Means*. The Oregon bid items listed on the left hand column of Table 2 do not represent one material type. From 1991 to 2008 several different materials could have been used for each bid item, and the materials may have varied over time. *RS Means* also does not list every possible material item available to the contractor. The items that were most representative in *RS*

Means were included. The *final list* with the respective item description from *RS Means* is presented in Table 2.

Table 2: Bid Item Descriptions from *RS Means*

Oregon Bid Items	*RS Means* Item Description
Structure Excavation	Avg. of Common earth, hydraulic backhoe for ¾, 1, 1-1/2, & 2 CY bucket, Sand & gravel ¾, 1, 1-1/2, & 2 CY bucket, & Clay till or blasted rock ¾, 1, 1-1/2, & 2 CY bucket.
Reinforcement	*Reinforcing, in place* (Bridge section)
Coated Reinforcement	*Epoxy coated* (Bridge section)
General Structural Concrete, Class 3300	Avg. of Cast-in-place concrete *3000 & 3500 psi*
General Structural Concrete, Class 4000	Cast-in-place concrete *4000 psi*
General Structural Concrete, Class 4500	Cast-in-place concrete *4500 psi*
General Structural Concrete, Class 5000	Cast-in-place concrete *5000 psi*
Structural Steel	*Structural steel, rolled beams*
2 Tube Steel Rail	*Approach railings, steel, galv. Pipe, 2 line*
Warranted Waterproofing Membrane	Sum of *Apply waterproof membrane* & *Apply waterproof sealer*

Source: ODOT & *RS Means*

The costs listed in *RS Means* are material, labor, and equipment, except for waterproof membrane and waterproof sealer.

The items *Apply waterproof membrane* and *Apply waterproof sealer* only appear in the 1995 to 1999 editions of *RS Means*. For the years the bid item does appear in the respective manuals, the value listed is constant across years. The ODOT reported that the bid items *Apply waterproof membrane* and *Apply waterproof sealer* did not exist in their database until 2002. Since the bid items do not appear in the manual the same years it appears in ODOT's database, the items was dropped from the list.

The remaining items appear in the 1991 to 2008 editions of the *RS Means*. For all bid items considered, the price in 2008 is higher than the 1991 price. Compiling the different bid items provided a national prototype. The ODOT supplemented the annual total cost of each bid item on the *final list* for every project from 1972 to 2008 along with the total cost for each of those projects. Class 3300, 4000, and 4500 structural concrete have not been used for a number of years, and were therefore dropped from the national prototype. For future reference, these classes of structural concrete could be added to the national prototype and Oregon State Index.

The initial process for developing the national prototype was to calculate the weighted average for each bid item on the *final list*. The first step for calculating the weighted averages was to determine the annual percentage cost. The annual percentage cost for each bid item on the *final list* was calculated by taking the annual total cost Oregon spent for each bid item and dividing it by the annual total cost for all six bid

items. The ODOT was able to acquire this information from 1972 to 2008. The weighted average for each bid item is the annual percentage cost for each bid item averaged across all years. The unit cost for each of the six bid items from *RS Means* was found. All bid items, however, are not measured in the same units. To account for this difference the percentage change in the unit price is calculated each year where 1991 was the base year. The percentage change for each year is multiplied by the respective weight. Summing up each of the bid items of these values gives the national prototype. The same process was used to calculate the Oregon State Index based on unit prices supplied by the ODOT. The results are in Table 3.

Table 3: National Prototype & Oregon State Index

Year	National Prototype	Oregon State Index
1991	1.000000	1.000000
1992	1.021163	0.860277
1993	1.017455	0.823879
1994	1.001071	1.055583
1995	1.011403	1.065368
1996	1.041737	1.066098
1997	1.099883	1.517014
1998	1.154527	1.416810
1999	1.185579	1.129137
2000	1.212890	1.196512
2001	1.401861	1.101455
2002	1.447660	1.202733
2003	1.468409	1.329239
2004	1.495912	1.418547
2005	1.801976	2.294817
2006	1.934548	2.093429
2007	2.128609	2.573744
2008	2.190873	2.820320

Source: Results from calculation

Analysis

Since the Oregon's bid items do not correspond exactly to those listed in *RS Means*, the percentage change in price is evaluated. The results indicate that the percentage change in price is more varied for the Oregon bid items. In general, for most bid items analyzed in this study the percentage change in price was higher for Oregon, and showed more volatility. The unstable prices in Oregon, however, may be due to analyzing a specific bid item. The types of construction projects change from year to year and bid item prices are influenced by the amount each bid item is used. Therefore, the results here suggest that the state of Oregon should analyze local prices.

Relationship of the Two Indices

The purpose for compiling two different indices is to determine the relationship between the two, and also identify construction costs over time. Neither index, however, measures the true cost of structural highway construction projects. For the six bid items analyzed, the indices are capturing, on average, about 20 percent of the total cost.

Figure 1: Price Percentage Change Trend for the National Prototype and Oregon State Index

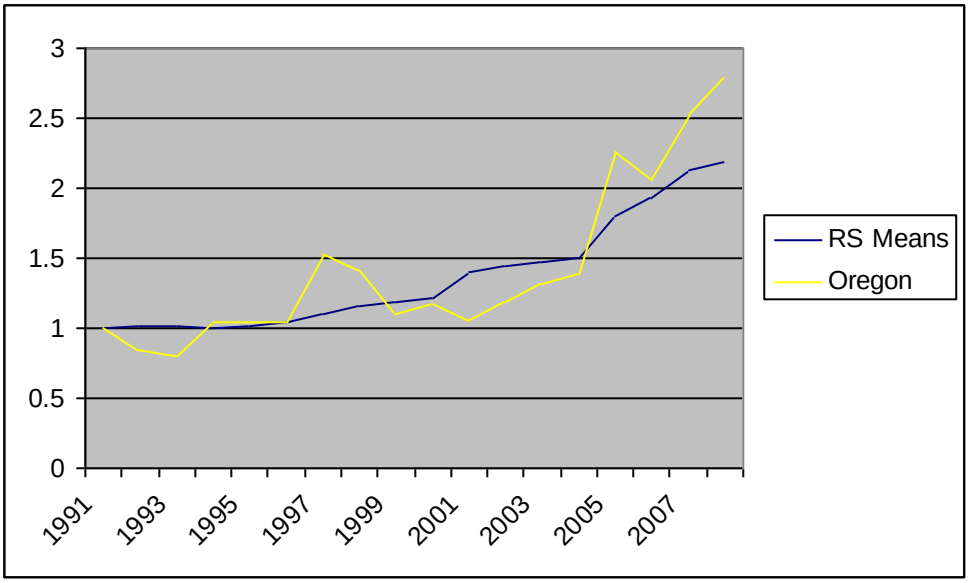

Figure 1 displays the trend between the national prototype and the Oregon State Index. Design standards and market forces in Oregon have changed during this time leading to fluctuating prices. Smaller changes in the *RS Means* prices could be due to the fact that the prices listed are averages from several different locations. This suggests that bid item prices in the state of Oregon are harder to predict than listed in *RS Means*. The greatest variability between the two indices is found within the last four years of the study. Oregon bid items prices inflate more than the prices listed in *RS Means*. Transforming both indices into a linear trend yielded 0.019 and 0.013 for the Oregon State Index and national prototype, respectively. The standard error for the Oregon State Index and national prototype was 0.0013 and 0.0035, respectively. This implies that the linear trend for Oregon is almost one and one half of the national prototype. The trends also suggest that, on average, construction costs increase between 1 and 2 percent each year.

Summary of Indices

The national prototype and the Oregon State Index demonstrate that the price for structural construction has increased. The indices also show the magnitude of the price increase. The national prototype and the Oregon State Index examine this change for six different bid items, from 1991 to 2008. The indices demonstrate that the price of

structural construction changes each year, which implies that $1,000 worth of work, is not the same between years. Therefore, alternatives to the current method are necessary.

Highway Research Circular Number 158: "Fuel Usage Factors for Highway Construction," from which the values for the fuel usage factors originated, suggests that fuel usage factors for structures are given in terms of fuel consumed per $1,000 of work. The publication may not have anticipated the effects of inflation when proposing the specific fuel usage factors. Based on the survey of states, 10 have structural bid items listed where the respective fuel usage factor is multiplied by the monthly fuel used instead of fuel consumed per $1,000 of work. If implemented in Oregon, this alternative method would exclude the changes in structural construction costs that occur.

The national prototype constructed in this study demonstrates how structural construction costs have changed from 1991 to 2008. Volatility of prices between years and sources indicate that the state of Oregon should apply local prices when analyzing construction costs. Volatility in construction prices suggest that this index may need to be calculated annually. An automated process could be developed to measure annual changes. The current results exemplified that structural costs have inflated by more than double. Assuming fuel efficiency of construction vehicles has not changed, a $1,000 of work in 1991 is less than $500 of work in 2008. Since the fuel usage factor for structures is fuel consumed per $1000 of work, the fuel price adjustment from structures is twice as much in 2008 than in 1991. This result suggests that the fuel usage factor for structures should be revaluated from the current standard of 19 and 10 diesel gallons per $1000 of work.

CONCLUSIONS & RECOMMENDATIONS

Most state departments of transportation allow specific fuel price adjustments in highway contracting. The fuel price adjustments are calculated using the monthly consumption of fuel for selected commodities multiplied by a fuel factor when the price of fuel changes by a certain amount. "Fuel Usage Factors for Highway Construction" published in 1974 details the values for the fuel usage factors. Because of economic forces in the highway construction market, price adjustments occur that do not happen in other government contracts. In other markets, price adjustments are almost nonexistent.

The variability in the approach for calculating fuel adjustments in the western U.S. and Florida led to a national survey. All fifty states, Puerto Rico, and Guam responded to a series of questions about whether a fuel adjustment was instituted in their state, how it was calculated, how long it had been around, and if there were problems with the current method. In 1980, the "Development and Use of Price Adjustment Contract Provisions" was published and outlined how the fuel price adjustment should be calculated. Since then most states have made changes to the method, and some have changed the fuel usage factor values. In some states the adjustment was dissolved in the late 1980sor early 1990s and then reintroduced when fuel prices increased in 2008. Most states that have a fuel price adjustment receive complaints from contractors when the price of fuel decreases, or as happened in 2008, when the price of fuel increases dramatically. Still, most states believe the risk is shared appropriately. For the states that track how much is paid in fuel price adjustments, the average annual fuel price

adjustment in 2008 was around $8 million, which is less than 1 percent of the total annual budget.

After conducting the national survey, construction costs overtime were examined. The number of bid items analyzed was narrowed down to the six most costly and frequently used. All bid items, individually and collectively, showed an upward trend nationally and for Oregon at the state level. The fuel usage factor for structures is given in terms of fuel consumed per $1000 of work. Results of the national prototype and the Oregon State Index suggest that $1000 worth of work is not consistent from 1991 to 2008.

The upward trend for both indices reveals that the current fuel usage factor for structures is not appropriate. Examining the prices for individual bid items shows that when the fuel usage factor is measured by fuel consumed per $1000 of work, the fuel usage factor should fluctuate reflecting construction cost variability. Thus it is imperative that structural construction costs are measured every year.

The increasing structural construction costs may lead to a decrease in the number of bids. An incentive for changing this pattern, however, would be to hold fuel usage factors at 1980 levels where the average annual fuel price adjustment is less than 1 percent of the total annual budget. Future research could determine if budget losses from fuel price adjustments would be offset by contractors making lower bids. Structural construction costs are not the only aspect of the construction process that is changing. The type and amount of bid items used varies from year to year. One bid item heavily used in the construction process may be replaced by another in subsequent years. Therefore, it is important that every few years ODOT reevaluate if the current six bid items carry the same weight in the construction process. The conclusions of this report suggest that prices are changing and that the variables examined need to be monitored routinely.

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[i] Fuel price is based from the Oil Price Information Service (OPIS)
[ii] CO, DE, ID, KS, OH, SC, VA, WA
[iii] DE, GA, MN, MO, NE, UT, VA, WA
[iv] Upon visual inspection of the bid items listed, 4 percent appeared to be the best critical point.