Performance Purchasing of Tires in Virginia

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This paper describes a study on how to purchase replacement tires for the Virginia Department of Highways and its consequences as they affected the purchasing program. The purposes were (a) to determine the objectives of the tire buying program and to evaluate the effectiveness of the program in achieving these objectives, and (b) if upon completion of evaluation there was believed to be need for improvements, to state where these needs existed and how they might be fulfilled.

The Department's tire buying objectives are to satisfy its needs at the least cost consistent with desired safety; and the method used in pursuit of this aim was to buy "first line" tires at the lowest bid price on the assumption that these tires were comparable to original equipment tires. A study of available records indicated that although there was no evidence that application of these procedures was not providing the desired safety there was substantial evidence that the use of the lowest bid price technique was not the least cost method of procuring tires for a more desirable end result. It was further suggested that the definition of lowest cost be changed from lowest bid price to least cost per tire mile of service. Two methods viewed as possible devices to achieve least cost per mile of service were the use of laboratory testing to insure more uniform quality of tires, and the use of performance data to express the quality of tires in terms of miles of service.

Necessary requirements for effective incorporation of performance data into a competitive bidding system (specifically, least cost per mile bidding) were developed.

As a result of the study, a three-year performance purchasing contract was made with the successful bidder. Anticipated benefits are direct savings of 52 percent of former cost ($441,000) and indirect savings from reduced downtime and tire shipments directly to the areas of use. Including cuts, blowouts, and normal road hazards, guaranteed average mileage is 35,000 for automobile tires and 60,000 for truck tires. The ultimate success of performance purchasing of tires in Virginia will be determined by prospective suppliers' bids on a new contract beginning January 1, 1969.

•THIS paper describes a study initiated in 1964 on how to purchase replacement tires for the Virginia Department of Highways and the consequences of this study as it affected the Department's purchasing program.

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was believed to be need for improvement, to state where these needs existed and how they might be fulfilled.

PRELIMINARY RESEARCH

In approaching the subject of tire procurement, the first step was to define the problem. There were two basic objectives of the Department's tire buying program: (a) to purchase tires that could be safely used on the vehicles on which they were installed, and (b) to obtain these tires at the least cost.

Management said that while there were other methods of tire procurement, the technique used by the Department was to buy "first line" tires at the lowest bid price on the assumption that these tires are comparable to original equipment tires. Management did not feel, however, that the use of this method was achieving the least cost objective, and some concern was expressed regarding the safety of the tires being used. When asked what "first line" meant, there was reference to the General Services Administration's minimum tire carcass strength and endurance standards and the Tire Buying Guide, which lists the first line tire of each supplier. However, the most frequent comment made was that, "The first line tire of one supplier may not actually be equivalent to the second line tire of another!"

Examination of complaint records and conversations with mechanics in the field indicated there had been no serious injuries or loss of life attributable to unsafe tires, but there was considerable grumbling about tires that were "put on one day and taken off the next." An examination of the performance records of State Police tires (Table 1) indicates there was as much as 20 percent variation in the average mileages delivered by tires.

More importantly, Table 1 indicates that the lowest bid price first line tire is not in fact the cheapest tire in terms of cost per mile of service. Records of average mileage delivered by original equipment and replacement tires indicate that on the whole there is an even wider performance difference between tires.

Conclusions drawn from the foregoing investigations were: that the Department's desired safety objective was probably being achieved through then existing purchasing procedures, and that the Department was probably paying more for tires in terms of cost per mile of service than was necessary.

As a result, the definition of lowest cost was changed from lowest bid price to least cost per mile of service. The objectives of the tire study were redefined to include the development of procedures within the competitive bidding system which would insure that the purchase of tires would continue to be of the desired safety level, and would deliver the least cost per mile of service consistent with this safety level.

It was felt that the safety objective could be achieved through specifying at least first line tires. Approaches considered to be potentially helpful in solving the problem of how to purchase tires at the least cost were the use of laboratory testing to insure more uniform quality of tires, and the use of performance data to express the quality of tires in terms of miles of service.

TABLE 1

REPORT OF THE VIRGINIA STATE POLICE ON TIRE PERFORMANCE
(August 1, 1961-February 1964)[a]

Brand Name	Size	Number Used	Avg. Price Per Tire ($)	Avg. Miles Per Tire	Cost Per Mile ($)
A	670 × 15	3,978	12.28	10,627	0.00115
B	670 × 15	2,234	11.53	8,426	0.00136
C	670 × 15	2,181	12.60	10,192	0.00124
D	670 × 15	1,500	12.13	10,585	0.00114
E	670 × 15	1,227	15.15	8,649	0.00175

[a]Specific brand names are withheld at the request of the State Police and the Purchasing and Equipment Divisions.

Since the General Services Administration (GSA) of the U.S. Department of Commerce made and administered first line tire specifications, this agency was contracted to find out just what its tire specification requirements were and how tires were tested for determining compliance with these requirements. The tests for first line tires were designed to measure the strength of the tire as determined by the inch-pounds of energy necessary to push a $1\frac{1}{2}$-in. plunger through it, and the endurance was tested by cutting the tire slightly, installing it on a test wheel, and measuring the rate of cut growth. If a tire required more than the set standard of inch-pounds to be broken by the plunger, and another tire of the same size and brand had a rate of cut growth below the established maximum, this brand tire was viewed by GSA as a first line tire. Under then existing procedures, manufacturers could test their own tires and send a certified statement of the results to GSA.

It was pointed out by an official of the Bureau of Standards that enforcement standards under these procedures were inadequate. He also pointed out that the Bureau of Standards had conducted tire tests for other agencies with the result that the minimum first line requirements had been met and greatly exceeded by almost all tire manufacturers; therefore those requirements were out of date and rather meaningless in terms of measuring the relative quality and performance of different brands of tires. It was also suggested that since first line tire requirements were expressed in strength and endurance terms they would not—even if the standards were increased—express the quality of tires in terms of miles of service.

More recently, the government has initiated strengthened tire quality control procedures and requirements of rubber manufacturers; but, as in the past, these procedures do not express quality in terms of miles of service.

On reexamining the existing evidence, it was felt that these points had been substantiated by records and other test reports on the varying performances of different brand first line tires on test tracks. An example of one of these reports is given in Table 2 in which Brand B, the lowest mileage performer, is the same brand that was the lowest mileage performer in Table 1. Analysis of results from tests conducted between 1945 and 1955 indicated, however, that the performance of tires varies over the years in both absolute and relative terms, and a purchasing policy based on past performance could well lead to paying higher prices for lower quality tires. If tires could be purchased on the basis of a guaranteed cost per mile of service, however, performance data would be effectively incorporated into existing competitive bidding procedures.

PERFORMANCE PURCHASING

General requirements considered necessary to cost per tire mile bidding were the development of a plan which would be feasible to both the State and the tire suppliers, and the determination of which tires should be included in the plan, and how much the State was paying for these tires in terms of costs per tire mile of service.

In attempting to fulfill these requirements, local representatives of the various tire suppliers were contacted and the author went to Akron, Ohio, to discuss the requirements

TABLE 2

TIRE LIFE MILEAGE CALCULATION—FEDERAL SPECIFICATIONS ZZ-T-381J OF 7-13-59 TESTS CONDUCTED BY INDEPENDENT TIRE TESTING COMPANY

	Tire Brand	Mileage	Non-Skid Loss (0.001) Centerline	Brand Average Skid Loss	Average Original Skid Depth	Average Calculated Mileage
A	037MH662 037MH652	12,000	0.209 0.209	0.209	0.341	19,600
B	3552E01 3552E02	12,000	0.261 0.266	0.263	0.357	16,300
C	6BAC8451 6BAC8452	12,000	0.165 0.184	0.174	0.362	24,300
D	009308Q896 137052Q896	12,000	0.174 0.192	0.183	0.358	23,500

with management of the tire companies. The concept of the "representative scrap pile" was presented; more specifically, it was suggested that over a sufficient period of time (two years or more) the performance of tires scrapped would be representative of the performance of tires purchased. A period of two years is required because the average mileage yielded by the tires removed first is far lower than the overall average performance of all tires. Since this concept appeared valid the problem of how to keep accurate tire records inexpensively became the next obstacle to overcome.

The suggestion was made that residency mechanics could fill out a tire card showing serial number of the tire on and off, the reason for removal, the vehicle number, and the vehicle mileage. This card could be sent to the Highway Department's central office where electronic data processing equipment could be used to prepare a summary of the mileage delivered by each scrapped tire regardless of where in the State the tire was put on or removed. However, it was noted that many tires have identical serial numbers, which along with making previous approaches questionable, would eliminate the feasibility of this course of action.

It was then recommended that the Districts could be given branding irons to identify each tire and that insurance of completion of tire record cards would be provided by forwarding these cards to the districts, where the district shop clerks could check to see that the number of cards filled out corresponded to the number of tires issued—if there was a variance the residency and district mechanics could then be so advised. Tire performance could be accurately and inexpensively measured in this way.

After the validity and practicality of the record-keeping procedures had been agreed upon, effort was directed toward developing a plan by which price and quality could be properly evaluated.

The first element of quality is the average mileage that the tires will run. Tire suppliers agreed that since tire records would give an accurate picture of performance they would be willing to guarantee average mileage performance on an individual size basis. Because of "downtime" considerations, the mileage guaranteed for automobile tires would be no less than 15,000 miles and that for trucks no less than 20,000 miles. This guaranteed performance would include tires removed for reasons of normal wear and cuts and blowouts. The latter provision is most important since what really matters to the State is not how far a tire will run under ideal conditions, but the tire's overall performance in actual use, which includes cuts—particularly in mountainous areas.

An important aspect of tire pricing aside from the initial bid price is the average value of the scrapped carcass of each tire. This average depends on the worth of recappable carcasses, the worth of carcasses that are not recappable (is much less in most instances), and the percentage of carcasses which are recappable. Conversations with management of the Highway Department's Purchasing and Equipment Divisions, employees in the field, and people who actually recap the tires indicated that the percentage of the recappable scrapped tires was quite low—30 percent at most for State truck tires. Examination of piles of scrapped tires in the district shops substantiated this estimate. Furthermore, results of the performance of recapped truck tires indicated that on the average they had to be removed within 9,000 miles. In other words, in order to determine the cost per tire of a number of same sized tires the initial price the average mileage, and the value of the scrapped carcass would have to be considered

With these thoughts as a frame of reference, procedures were developed for a tire mileage bidding plan. These procedures included:

1. Preparation of the bid,
2. Advertising for the bid,
3. Award of the contract,
4. Evaluation of performance, and
5. Provisions for adjustment at the end of the contract in case the overall actual cost per mile delivered was above the overall cost per mile bid.

For each size tire under the program the supplier would quote a gross price, guarantee average mileage performance, and guarantee to buy back every scrapped carcass at a specified price. In effect, the bid would amount to a guaranteed cost per

mile per tire. For example, the bid for automobile tires might be a gross price of $15.00 with a guarantee to buy back every scrapped carcass for $5.00, leaving a net price of $10.00 per tire. In the bid the supplier might guarantee that the average mileage delivered by these tires would be 20,000 miles, making the effective guaranteed cost per mile for automobile tires 0.500 mill.

To make certain the tire cost per mile guarantee would be met, evaluation procedures were implemented. The first provision was that there must be a sufficient time lag between the award period and the record-keeping period to evaluate the performance of tires furnished by the supplier at the end of the award period. Otherwise, good tires might be furnished initially and poor tires supplied later in the contract. It was believed therefore that the award period should be two years while the record keeping or evaluation period should be four years. Under such an arrangement, the supplier would be held accountable for performance and scrapped carcasses of tires furnished during the latter part of the contract.

Suppose that after four years the average mileage delivered by automobile tires was not 20,000, but 15,000 miles. In this case, the delivered cost per mile would be substantially above the guaranteed cost per mile (0.667 mill vs 0.500 mill) unless sufficient adjustment was made by the supplier to reduce the actual cost per mile delivered to the guaranteed cost per mile bid. To accomplish this, an adjustment plan was developed. It works as follows: Assuming the average performance of the scrapped tires is 15,000 miles, what net price is necessary to achieve an actual cost per mile of 0.500 mill?

$$1 \text{ mill} = \frac{1}{1000} \quad \text{of } \$1.00$$

In other words, if $15,000 \div x = 0.500$ mill, what does x equal? The answer of course is $7.50. Since in this example the State paid a net price of $10.00 for every automobile tire, it would be entitled to a rebate of $2.50 for every tire purchased. If, for example, 5,000 automobile tires had been purchased, the State would receive $12,500. This adjustment procedure would be applied to each size tire in the bid.

In fairness to the supplier, performance greater than that guaranteed in one size tire should be allowed to compensate for performance less than guaranteed in another size tire using the same formula. In no case, however, would the State pay the supplier, even if the overall performance of tires furnished under the program was greater than that guaranteed.

The effect of these adjustment provisions would be to give mutual incentive to the supplier and the State to reduce the cost per mile delivered to the State as much as possible, because (a) if the overall actual costs per mile were greater than the guaranteed cost per mile, the supplier would have to reimburse the Department for the difference; and (b) the Department would get any additional savings if the overall cost per mile delivered was less than the overall cost per mile bid (this savings would come in the form of lower present costs and lower bid costs in the future).

Because this mileage bidding plan would require considerable cooperation between tire suppliers and the State, it was felt that the award of tire purchases should be restricted to one supplier. This award would be determined by evaluating the cost per mile bid for each size tire according to past usage patterns. For example, if it was decided to put only 825 x 20 tires and automobile tires under such a program, and 825 x 20 tires represented 75 percent of the total expenditures for these two tires, a 75 percent weighting would be given to the cost per mile bid for 825 x 20, and a 25 percent weighting to automobile tires.

Before tire usage data could be examined in detail, one other feature was necessary in the development of a plan by which performance purchasing could be implemented. This was to provide assurance to the State and the suppliers that every reasonable effort would be exercised to lower delivered costs per mile; and that actual cost per mile delivered would conform to guaranteed cost per mile bid either through performance or adjustment subsequent to the evaluation period. The first part of this procedure was to recognize that tire mileage delivered depends not only on the quality of the tire but on the equipment and tire maintenance practices of the State, and that the supplier

should have certain rights as well as obligations under a cost per mile guarantee. Therefore it was suggested that if such a program was put into effect the Department and any other participating agencies should agree to make a reasonable effort to:

1. Maintain the air pressure suggested by the supplier in tires furnished by that supplier,

2. Keep wheels on the vehicles of these agencies in alignment and brakes properly adjusted, and

3. Follow recommendations of the supplier on installation and removal practices, and the particular type of tire which should be installed.

It was agreed after suppliers had examined the Department's maintenance practices that "reasonable effort" would be defined as "continuance or improvement of present maintenance practices." The State should also exclude from carcass payment requirements, but not scrap pile mileage records, all carcasses removed at less than $1/64$-in. tread depth, and exclude from mileage records all carcasses removed at more than $1/8$-in. tread depth unless the tire was blown, cut, or removed because of damage due to road hazards (not including fire or tires "run flat"). To insure that the supplier would conform to the guarantee, it was suggested that he be required to post a surety bond of $50,000, which would be returned to him after satisfactory performance using the adjustment procedures previously described.

With the details of the mileage bidding plan worked out, an analysis had to be performed regarding which tires might be put under such a program and determining the cost per mile the State was paying for these tires under the former low bid price for first line tire procedures. This determination was made because the State should accept no bid in which the cost per mile bid for any size tire equaled or exceeded what the Department was then paying.

After examination of initial purchase price figures for the period July 1962 to June 1964, it was found that principal tire expenditures were made for the tires in Table 3. It was believed that only those tires in Group 1 should be included in any mileage bidding program because the grader and tractor tires shown in Group 2 are installed on vehicles which do not have odometers, thereby making it impossible to determine the average mileage delivered by these tires, and the "other trucks" tires shown in Group 2 represent numerous sizes, but small expenditures per size.

A small number of the tires purchased in both groups were delivered to State agencies outside the Highway Department and that the larger sizes have higher recappable values, so the figures were used only to determine which size tires effort should be concentrated upon.

TABLE 3

TIRE EXPENDITURE PATTERNS OF THE VIRGINIA DEPARTMENT OF HIGHWAYS
(July 1962—June 1964)

Group	Tire Description	Number Bought	Dollars Spent	% of Total Expenditures
1	Automobile	16,475	$155,839	17.94
	670 × 15 (truck)	2,850	30,017	3.45
	710 × 15 (truck)	1,550	23,696	2.72
	650 × 16 (truck)	3,650	46,804	5.38
	825 × 20 (truck)	9,792	306,604	35.29
	900 × 20 (truck)	1,125	44,845	5.16
	9-22-5 (truck)	950	35,540	3.63
			$639,345	73.57
2	Grader and tractor		170,131	19.58
	Other trucks		59,113	6.80
			$868,589	99.95

Source: Kardex records of the Purchasing Division of the Virginia Department of Highways.

TABLE 4

ESTIMATED NET PURCHASE COSTS FOR TIRES

Tire Description	Automobile	670 × 15 (Truck)	710 × 15 (Truck)	650 × 16 (Truck)	825 × 20 (Truck)	900 × 20 (Truck)	9-22-5 (Truck)
Average price paid	$9.45	$10.53	$15.28	$12.82	$31.31	$39.86	$33.20
plus							
Average recapping costs	0.00	0.46	0.46	0.46	0.85	0.85	0.85
equals							
Total purchase costs	9.45	10.99	15.74	13.28	32.16	40.71	34.05
minus							
Average scrapped carcass value (recappable and non-recappable)	1.00	1.00	1.00	1.00	5.00	5.00	5.00
equals							
Net average purchase cost	8.45	9.99	14.74	12.28	27.16	35.71	29.05

Note: Average recapping costs per tire are low because so few are recapped. The average value per scrapped carcass is thought to be realistic because of the low percentage of recappable carcasses and lower prices paid for most of the recappable carcasses of the Department's past tires.

Source: Kardex records of the Purchasing Division, invoice billings and tire recappers.

The next task was estimating the cost per tire mile that the Department paid for the tires described in Group 1 of Table 3. It was decided this problem should be approached in the following manner:

1. Estimate the net purchase cost per tire for each tire size,
2. Estimate the average mileage delivered by each tire size, and
3. Divide the estimated net purchase cost by the estimated average mileage and obtain the estimated delivered cost per mile.

The estimated net purchase cost for each tire and the method of computation of these estimates are given in Table 4.

In estimating average mileage, records of replacement tire performance were taken from several of the Highway Districts throughout the State—specifically the Richmond, Fredericksburg, Lynchburg, Salem and Staunton Districts. Though not used in estimating cost per mile for replacement tires, performance of original equipment tires is also given in Table 5 because it is believed there will be considerable interest in the different average mileages delivered by original equipment and replacement tires.

The figures in Table 5 are only approximations and so the estimated costs per mile for each tire in Table 6 can only be approximate. These statistics represented the best guess as to what the Department was paying for its tires in terms of cost per tire mile of service. It was suggested that if the estimating procedures and estimates were reasonable, then in implementing the tire mileage bidding plan, no bids above these estimates should be awarded.

TABLE 5

ESTIMATED AVERAGE MILEAGE DELIVERED BY ORIGINAL EQUIPMENT AND REPLACEMENT TIRES[a]

Tire Description	Avg. Mileage, Orig. Equip.	Avg. Mileage, Replace.	No. Tires, Orig. Equip. Sample	No. Tires, Replace. Sample
Automobile	25,461	13,744	214	299
670 × 15 (truck)	25,491	16,432	216	472
710 × 15 (truck)	28,121	22,521	110	43
650 × 16 (truck)	21,967	16,740	222	114
825 × 20 (truck)	32,411	19,257	607	460
900 × 20 (truck)	36,929	18,850	80	119
9-22-5 (truck)	Not available	20,369	0	296

[a]Original equipment tires installed 1957-64; replacement tires, 1960-64; record-keeping period ended in 1964.

Source: Tire records from Richmond, Fredericksburg, Lynchburg, Salem, and Staunton Districts.

TABLE 6

ESTIMATED COST PER MILE NOW PAID FOR REPLACEMENT TIRES

Replacement Tire Description	Estimated Net Purchase Costs	Estimated Average Mileage	Estimated Costs Per Tire Mile
Automobile	$ 8.45	13,744	0.615 mill
670 × 15 (truck)	9.99	16,437	0.608 mill
710 × 15 (truck)	14.74	22,521	0.656 mill
650 × 16 (truck)	12.28	16,740	0.734 mill
825 × 20 (truck)	27.16	19,257	1.410 mills
900 × 20 (truck)	35.71	18,850	1.894 mills
9-22-5 (truck)	29.05	20,369	1.426 mills

Source: Tables 4 and 5.

The fulfillment of requirements deemed necessary to the implementation of performance purchasing of tires has been presented. Inasmuch as the presentation included techniques as well as specific recommendations, it is felt that a summary, in outline form of the mechanics of such a program is in order.

PROCEDURES

Preparation of Bid Specifications

1. Gross bid price for each size tire. Guarantee to buy back the scrapped carcass of this tire at a specified price. The difference between the two prices is the net bid price for each size tire.
2. Guarantee average mileage for each size tire with a minimum guarantee of 15,000 miles for automobile tires and 20,000 miles for truck tires.
3. $\frac{\text{Net price}}{\text{Guaranteed average mileage}}$ = Guaranteed cost per mile

Awarding the Contract

1. Bid would be awarded to one supplier for two years. Record-keeping period would be for four years.
2. Cost per mile bids would be weighted on basis of past net purchase expenditures for each size tire, except that bids would not be awarded in cases where any single cost per mile bid was above that shown below:

	Percent Weighted	Cost Per Mile
a. Automobile	24	0.615 mill
b. 670 × 15 (truck)	5	0.608 mill
c. 710 × 15 (truck)	4	0.656 mill
d. 650 × 16 (truck)	8	0.734 mill
e. 825 × 20 (truck)	47	1.410 mills
f. 900 × 20 (truck)	7	1.894 mills
g. 9-22-5 (truck)	5	1.426 mills

Purchasing

1. Tires would be shipped direct to districts and to the Department's central warehouse in Richmond.

2. Release would be issued against a blanket purchase order designating the location to which shipment is to be made, gross billing price, and required delivery date in addition to type of tires ordered.

Receiving

1. Receiving district or other designated receiving location would be furnished advance copy of order release.
2. Upon receipt of tires the bill of lading would be checked against number of tires received.
3. Any differences would be noted to enable claim to be filed against carrier in case of shortages.
4. Sizes received would be checked against purchase release. If supplier shipping errors result in the receipt of sizes which cannot be used, return would be arranged for, transportation collect, to supplier warehouse.
5. Receipt of tires would be acknowledged and any discrepancies from order would be noted. If sizes other than those shown on purchase orders are received, and such sizes are usable by the district, these differences would be noted to enable Richmond to obtain price corrections from the supplier.

Branding

1. After acknowledgment of receipt of tires, all acceptable tires would be branded with identifying numbers and entered to stock cards. Each district would be supplied branding irons and numbers would be branded on tires, say from 1 - 9999. In addition each district would have an identifying prefix number, for example, as follows:

Bristol	-1	Salem	-2
Suffolk	-5	Fredericksburg	-6
Lynchburg	-3	Richmond	-4
Culpeper	-7	Staunton	-8

2. Examples of first numbers used by the districts would be Bristol District—1-0001, Salem 2-0001, Lynchburg 3-0001.

Record Keeping

1. Tire Installation to Vehicle—Each time a tire is taken from inventory and mounted on a vehicle the residency or district mechanic would see that the following information is put on one of the tire cards supplied to the district and residency garages:
   a. Pool number of vehicle
   b. Vehicle mileage
   c. Identifying number of tire put on vehicle
   d. Identifying number of tire taken off vehicle (if unbranded tire is removed, the manufacturer's name should be shown)
   e. Size and type of tire installed and removed
   f. Reason for removal and whether tire is to be held for future use or sent to scrap pile
   g. Date
   h. Name of residency or district.

2. Disposition of Tire Cards by Residency or District Garage—Tire cards would be forwarded daily to district shop office along with issue sheets. At the district the number of tire cards would be checked against the issue sheets. If there is a variance, the residency or district mechanic would be so advised.

3. Disposition of Tire Cards by District—After verifying all tire cards against issue sheets for all residencies and district garages, district shop office would forward daily all tire cards to Electronic Data Processing Division in Richmond.

 a. Upon receipt of tire cards from District offices EDP would set up to introduce the following information into a system:

  1. Identification number of tire mounted on vehicle
  2. Identification number of tire removed from vehicle
  3. Vehicle number
  4. Vehicle mileage
  5. Size of tire
  6. Reason for removal—A code system would be established to enable determination of includable versus non-includable tires for average mileage purposes.

 b. EDP would perform the following from information supplied by the tire records:

  1. Retain all data on tires mounted on vehicles until tires are removed from service and sent to scrap pile.
  2. For each tire subtract tire mileage on from tire mileage off to determine actual miles tire delivered.
  3. Sort tires into groupings of tire size to enable average mileage delivered by each size to be computed.
  4. Sort tires by district code if desired.
  5. Accumulate tire mileages for any one tire regardless of the number of charge cards issued for that tire.

 c. EDP would publish periodic reports on the average miles delivered by each size tire.

Maintenance Practices

  Since the tire mileage actually delivered depends upon the equipment and tire maintenance practices of the State, and since the supplier should have certain rights as well as obligations under a cost per mile guarantee, agencies participating in this program should make every effort to:

 1. Maintain air pressure suggested by the supplier of the tires furnished.
 2. Keep the wheels on the vehicles involved in alignment and the brakes properly adjusted.
 3. Follow recommendations of the supplier on proper tire installation, removal, scrap practices, and the particular type of tire that should be installed on the vehicle.
 4. Exclude from carcass payment requirements, but not scrap pile mileage records, all carcasses that have been removed at less than $\frac{1}{64}$-in. tread depth as measured from the center of tire.
 5. Exclude from mileage records all carcasses that have been removed at more than $\frac{1}{8}$-in. tread depth unless the usefulness of the tire has been eliminated through normal road hazards (cuts, blowouts, etc., but not fire or tires that have been "run flat").
 6. Consider "every reasonable effort" to mean continuance or improvement of present maintenance practices.

Disposition of Scrapped Tires

1. Whenever possible, at least monthly, the residency shops will ship all tires permanently removed from service to the district shops. Branded tires must be segregated from older unbranded tires being removed.
2. Branded tires would be shipped to the central warehouse where they would be picked up by the supplier.
3. A receipt for the number of each sized scrapped tire returned to the supplier would be given to the State. The number of tires times the guaranteed scrap price of each size would then be deducted from the next billing for new tires delivered to the State or paid in cash to the State, whichever is preferred.

Evaluation of Supplier's Guarantee

1. Based on actual versus guaranteed performance of tires.
2. Performance of all tires viewed as being represented by performance during the record-keeping period as shown by average mileage reports of Electronic Data Processing Division.

Method of Computing Adjustment Owed the State Where Actual Average Mileage Delivered Is Less than Guaranteed Average Mileage for Any Size Tire

1. Average mileage delevered by each size tire under the contract is obtained from Electronic Data Processing Division.
2. Price of each size tire required to deliver bid cost per mile based on actual average mileage of this tire would be computed.
3. Net price paid for each size tire (gross price—scrap price received) minus price required for tire would be required adjustment per tire.
4. This adjustment for each size would be multiplied by number of tires bought of that size to determine total required adjustment for each size tire.
5. Over performance of one size tire would be allowed to compensate for under performance of another size on the basis of procedures described in 1 - 4 above, up to the point of a zero adjustment required by the State.
6. In no case would the State be required to compensate the supplier for overall over performance.
7. An example of how to compute required adjustment per tire follows:

Net Price Paid	Average Mileage Guaranteed	Guaranteed Cost Per Mile	Actual Mileage	Price Required	Adjustment Per Tire
$10.00	20,000	0.500 mill	15,000 mi	$7.50	$2.50

RECOMMENDATIONS

It was felt by the author that the tire mileage bidding program as described should be adopted. It was believed that a practical way had been developed to incorporate price and quality into the competitive bidding system.

Existing costs per mile paid for the sizes of tires that could be included in such a program were computed to insure that implementation of this program would take effect only if these costs could be reduced. All indications were that the tire suppliers would bid under most of these estimates. It was suggested that this bidding procedure would also result in certain intangible benefits, such as improved tire maintenance practices caused by the mutual interest of the State and supplier in achieving lower costs per tire mile, and the possible reduction of downtime indicated by the intent of most suppliers to bid on premium rather than first line tires.

As has been stated, the mutual interest in cost reduction would come about because (a) if the overall costs per mile delivered are greater than the guaranteed costs per mile the supplier will have to reimburse the difference, and (b) the State would get any additional savings if the overall cost per mile delivered is less than the overall cost per mile bid—this savings would come in the form of lower present costs and lower bid costs in the future. Because of this mutual interest the services, knowledge, and experience of the suppliers would also be provided for in the bid cost per mile.

It was suggested that perhaps the greatest defect other than tire quality in the present competitive bidding process is the absence of the service element when evaluating alternative suppliers. Service would be an integral part of the suggested program.

By allowing cost per mile bids for first line tires and above a method had been provided by which the price/quality of premium tires could be related to the price/quality

of first line tires in terms of a common measurement. Futhermore, if proven economical in terms of cost per mile, any bid to supply the higher priced premium tires would have to contain a guarantee of substantially greater average mileage. If this guarantee was met the reduction of downtime in the field would result in considerable savings. Although suppliers were not required to offer premium tires, some of them did.

Before such a program could be implemented it was felt that certain additional steps should be taken. These were to:

1. Familiarize all district equipment superintendents and residency mechanics with the record-keeping aspects of the program.

2. Establish appropriate tire cards and coding procedures for electronic data processing.

3. Furnish branding irons to the eight districts (and any other participating agencies) so that tires could be properly identified for record-keeping purposes.

4. Delay the time period between the award of the bid and the purchase of tires from the successful bidder for a period of at least 30 days so that the State and supplier could develop a good working relationship.

"Performance bidding" ideas developed in this report may be useful in purchasing batteries, spark plugs, filters, and even vehicles, as well as other types of equipment.

RESULTS

A research report entitled "The Tire Buying Study" was released to management of the Virginia Department of Highways in July 1965. It has been stated that it was decided to implement the recommendations almost as submitted, except to offer bid proposals for a 3-yr contract and a 5-yr record-keeping period instead of the suggested 2-yr contract with a 4-yr record-keeping period.

Inquiry No. 7274 B was issued by the Virginia Department of Highways on September 1, 1965 to all interested tire suppliers for a 3-yr contract for most of Virginia's tire replacement needs.

Bids received as a result of this inquiry are shown in Figures 1 through 6.

INQUIRY NO. - 7274-B
CLOSING DATE - 11:00 A.M. (EST) September 22, 1965   DATE September 20, 1965

Virginia Department of Highways
Richmond
Virginia

I hereby agree to furnish automobile and truck tires meeting all requirements of your specifications dated September 1, 1965 and submit my bid as follows:

Type and Size	Gross Price	Scrap Price	Net Bid Price	Guaranteed Average Mileage	*Cost Per Mile	Per Cent Weighted	Overall Net Cost Per Mile Bid Based on % Weighted (To Be Computed by the State)
Automobile Tires (all sizes-one price)	$12.43	$1.75	$10.68	35,000	$.000305	24%	$.00007320
670 x 15 (Truck)	17.48	2.00	15.48	35,000	.000442	5%	.00002210
710 x 15 (Truck)	22.19	2.00	20.19	35,000	.000577	4%	.00002308
650 x 16 (Truck)	18.44	2.00	16.44	35,000	.000470	8%	.00003760
825 x 20 (Truck)	45.30	8.00	37.30	60,000	.000622	47%	.00029234
900 x 20 (Truck)	54.58	8.00	46.58	65,000	.000717	7%	.00005019
9.22 x 5 (Truck)	49.41	7.50	41.91	60,000	.000699	5%	.00003495

TOTAL OVERALL COST PER MILE BID .00053346

*Gross Price Minus Scrap Price of Carcass = Cost Per Mile (carried to 6 decimal places)
Guaranteed Average Mileage

Figure 1.

INQUIRY NO. - 7274-B
CLOSING DATE - 11:00 A.M. (EST) September 22, 1965   Date___9 - 17 - 65___

Virginia Department of Highways
Richmond
Virginia

   I hereby agree to furnish automobile and truck tires meeting all requirements of your specifications dated
September 1, 1965 and submit my bid as follows:

Type and Size	Gross Price	Scrap Price	Net Bid Price	Guaranteed Average Mileage	*Cost Per Mile	Per Cent Weighted	Overall Net Cost Per Mile Bid Based on % Weighted (To Be Computed by the State)
Automobile Tires (All sizes-one price)	$ 15.83	$ 1.00	$ 14.83	28,500	$ .000520	24%	$ .00012480
670 x 15 (Truck)	23.48	2.50	20.98	30,000	.000699	5%	.00003495
710 x 15 (Truck)	20.12	2.50	17.62	30,000	.000587	4%	.00002348
650 x 16 (Truck)	22.68	2.50	20.18	30,000	.000673	8%	.00005384
825 x 20 (Truck)	52.01	4.00	48.01	40,000	.001200	47%	.00056400
900 x 20 (Truck)	62.70	4.00	58.70	40,000	.001468	7%	.00010276
9.22 x 5 (Truck)	56.78	4.00	52.78	40,000	.001320	5%	.00006600

TOTAL OVERALL COST PER MILE BID ___.00096983___

*Gross Price Minus Scrap Price of Carcass / Guaranteed Average Mileage = Cost Per Mile (carried to 6 decimal places)

Figure 2.

   The successful bidder for the 3-yr contract was United States Rubber Company, or as it is now called, Uniroyal. Estimated benefits of this contract to Virginia are shown below:

Computation of Direct Savings

1. Former cost per mile   1.131 mills
   Cost per mile under contract   0.533 mill

INQUIRY NO. - 7274-B
CLOSING DATE - 11:00 A.M. (EST) September 22, 1965   DATE_September 22, 1965___

Virginia Department of Highways
Richmond
Virginia

   I hereby agree to furnish automobile and truck tires meeting all requirements of your specifications dated
September 1, 1965 and submit my bid as follows:

Type and Size	Gross Price	Scrap Price	Net Bid Price	Guaranteed Average Mileage	*Cost Per Mile	Per Cent Weighted	Overall Net Cost Per Mile Bid Based on % Weighted (To Be Computed by the State)
Automobile Tires (all sizes-one price)	$ 15.69	$ 0.50	$ 15.19	26,000	$ .000584	24%	$ .00014016
670 x 15 (Truck)	21.42	2.00	19.42	27,000	.000719	5%	.00003595
710 x 15 (Truck)	24.65	2.00	22.65	28,000	.000809	4%	.00003236
650 x 16 (Truck)	22.61	2.00	20.61	32,000	.000644	8%	.00005152
825 x 20 (Truck)	58.52	12.50	46.02	38,000	.001211	47%	.00056917
900 x 20 (Truck)	70.53	15.00	55.53	43,500	.001277	7%	.00008939
9.22 x 5 (Truck)	56.75	8.00	48.75	38,000	.001283	5%	.00006415

TOTAL OVERALL COST PER MILE BID__.00098270_

*Gross Price Minus Scrap Price of Carcass / Guaranteed Average Mileage = Cost Per Mile (carried to 6 decimal places)

Figure 3.

INQUIRY NO. - 7274-B
CLOSING DATE - 11:00 A.M. (EST) September 22, 1965   DATE September 22, 1965

Virginia Department of Highways
Richmond
Virginia

    I hereby agree to furnish automobile and truck tires meeting all requirements of your specifications dated
September 1, 1965, and submit my bid as follows:

Type and Size	Gross Price	Scrap Price	Net Bid Price	Guaranteed Average Mileage	*Cost Per Mile	Per Cent Weighted	Overall Net Cost Per Mile Bid Based on % Weighted (To Be Computed by the State)
Automobile Tires (all sizes-one price)	$ 10.06	$ 2.06	% 8.00	15,000	$ 0.000333	24%	$ .00012792
670 x 15 (Truck)	12.72	2.96	9.76	20,000	0.000488	5%	.00002440
710 x 15 (Truck)	14.21	3.21	11.00	20,000	0.000550	4%	.00002700
650 x 16 (Truck)	13.67	3.09	10.58	20,000	0.000529	8%	.00004232
825 x 20 (Truck)	39.47	15.57	23.90	20,000	0.001195	47%	.00056165
900 x 20 (Truck)	56.19	16.25	39.94	20,000	0.001997	7%	.00013979
9.22 x 5 (Truck)	41.45	7.50	33.95	20,000	0.001697	5%	.00008485

                                        TOTAL OVERALL COST PER MILE BID .00100293

*Gross Price Minus Scrap Price of Carcass = Cost Per Mile (carried to 6 decimal places)
    Guaranteed Average Mileage

Figure 4.

	Savings per mile	0.598 mill
2.	Expenditures in dollars under former system (three-year period)	834,000
	Expenditures in dollars under contract	393,000
	Savings in dollars (three-year period)	441,000

    Anticipated savings of contract is 52 percent of former costs

Computation of Indirect Savings

1.	Downtime	
	Average mileage under former system on automobile tires	15,000

INQUIRY NO. - 7274-B
CLOSING DATE - 11:00 A.M. (EST) September 22, 1965   DATE September 22, 1965

Virginia Department of Highways
Richmond
Virginia

    I hereby agree to furnish automobile and truck tires meeting all requirements of your specifications dated
September 1, 1965 and submit my bid as follows:

Type and Size	Gross Price	Scrap Price	Net Bid Price	Guaranteed Average Mileage	*Cost Per Mile	Per Cent Weighted	Overall Net Cost Per Mile Bid Based on % Weighted (To Be Computed by the State)
Automobile Tires (all sizes-one price)	$ 30.50	$ 1.00	$ 29.50	35,000	$ 000843	24%	$ .00020232
670 x 15 (Truck)	27.70	6.70	21.00	25,000	000840	5%	.00004200
710 x 15 (Truck)	30.16	6.96	23.20	25,000	000928	4%	.00003712
650 x 16 (Truck)	26.86	6.86	20.00	25,000	000800	8%	.00006400
825 x 20 (Truck)	79.09	20.00	59.09	35,000	001688	47%	.00079336
900 x 20 (Truck)	91.83	22.50	69.33	35,000	001981	7%	.00013867
9.22 x 5 (Truck)	78.23	20.00	58.23	30,000	001941	5%	.00009705

                                        TOTAL OVERALL COST PER MILE BID .00137452

*Gross Price Minus Scrap Price of Carcass = Cost Per Mile (carried to 6 decimal places)
    Guaranteed Average Mileage

Figure 5.

INQUIRY NO. - 7274-B
CLOSING DATE - 11:00 A.M. (EST) September 22, 1965

DATE_September 21, 1965_____

Virginia Department of Highways
Richmond
Virginia

I hereby agree to furnish automobile and truck tires meeting all requirements of your specifications dated September 1, 1965 and submit my bid as follows:

Type and Size	Gross Price	Scrap Price	Net Bid Price	Guaranteed Average Mileage	*Cost Per Mile	Per Cent Weighted	Overall Net Cost Per Mile Bid Based on % Weighted (To Be Computed by the State)
Automobile Tires (All sizes-one price)	$13.86	$ .50	$13.36	15,000	$ .000891	24%	$ .00021384
670 x 15 (Truck)	16.57	1.00	15.57	20,000	.000779	5%	.00003895
710 x 15 (Truck)	17.74	1.00	16.74	20,000	.000837	4%	.00003348
650 x 16 (Truck)	17.53	1.00	16.53°	20,000	.000827	8%	.00006616
825 x 20 (Truck)	41.84	3.00	38.84	20,000	.001942	47%	.00091274
900 x 20 (Truck)	51.38	3.00	48.38	20,000	.002419	7%	.00016933
9.22 x 5 (Truck)	42.59	3.00	39.59	20,000	.001980	5%	.00009900

TOTAL OVERALL COST PER MILE BID__.00153350_____

$\frac{\text{*Gross Price Minus Scrap Price of Carcass}}{\text{Guaranteed Average Mileage}}$ = Cost Per Mile (carried to 6 decimal places)

Figure 6.

Guaranteed average mileage under contract	35,000
Average mileage under former system on truck tires	20,000
Guaranteed average mileage under contract	60,000

2. Distribution

Under the former system all tires were shipped to the Department's central warehouse in Richmond and distributed to the districts as needed. Under this contract all tires will be shipped direct to the districts and central warehouse as needed. Considerable savings will be realized in freight and handling.

3. Administrative Cost

Under the former system bids were obtained periodically for anticipated needs of approximately 60-90 days. This constitutes considerable cost in the preparation, mailing, and awarding of bids and preparation and requisition of purchase orders. By the contractual method bids will be obtained only once every three years and only one purchase order will be issued for each district annually.

4. Under the present contract the successful bidder agreed to furnish trained maintenance personnel whenever needed at no additional cost to the State.

At this time implementation of performance purchasing of tires is well under way. Uniroyal representatives have visited all the districts and have made several recommendations regarding improvement of the State's tire maintenance practices. Two principal suggestions were the proper matching of tires and the recurrent checking of tire inflation. Procedures have been initiated to implement these suggestions.

The author has participated in the inspection of scrapped tires. These inspections have given indications of causes of unnecessary tire wear and led to the recommendation regarding tire inflation. The inspections have, perhaps more importantly, shown to both the supplier and the State the significance of mutual interest in the success of the contract.

The inspections have also shown Virginia the correctness in awarding the bid on the basis of the average mileage of all tires; not just ones with "normal run-out."

Record keeping has generated some problems—mostly in the area of appropriate timing of delivery of tire cards to and their processing by the Electronic Data Processing Division in conjunction with receipt and inspection of scrapped tires in Richmond. These problems have not jeopardized the contract, but are pointed out so that other States may be aware of their existence and solution.

Tire card processing is now being more properly synchronized with tire inspections by holding the cards at the districts until the scrapped tires are shipped to Richmond for inspection or by the use of alternative procedures. The timing and updating of tire card computer runs and scrapped tire inspections have also been more closely dovetailed.

Even so, a few records of mileage of scrapped tires received are omitted but this was anticipated by both the State and prospective suppliers in the concept of the use of the scrapped sample as being representative of the performance of all tires purchased. In brief, the wisdom of the suggestion of the use of scrap sample tires as being representative of all tires and the awarding of bids based on the guaranteed average mileage of all tires (not just those with "normal run-out," but those with cuts and damage from normal road hazards) has been confirmed by experience.

There is no question that Virginia will receive substantial savings under this contract, but the real measure of success cannot be determined until a new contract is awarded. This is because true performance purchasing (not just the label or provisions of initial cost scrap value) has been tried by a state for the first time.

After suppliers' experience with and/or observation of this contract, they will make some sort of decision as to what they would bid for the next contract. This bid will more accurately reflect the long-run savings to the State achieved by performance purchasing of tires.

Of course, the State must also make a decision as to the worthiness of proposing future performance bids for tire needs.

It is the author's opinion that a new contract would be more expensive (more in line with the second low bidder's offer on this contract) but will still result in savings of about 20 to 30 percent of former costs.

Appendix

Tables 7 through 11 represent the source data for estimated average mileages delivered by original equipment and replacement tires shown in Table 5. Tables 12 and 13 describe the location of vehicles and the use of tires throughout the eight districts of the Department. Table 14 is included to give a most conservative estimate of the costs of ordering tires through the central warehouse in Richmond rather than having them shipped direct to the districts; and Table 15 is the source data for the weighting of cost per mile bids for each size tire given in the section on "Procedures." Table 16 is a report of tests conducted by the National Bureau of Standards in May 1965 on three different brands of 825 × 20 tires that the Department had in stock.

TABLE 7

AVERAGE MILEAGE DELIVERED BY ORIGINAL EQUIPMENT AND
REPLACEMENT TIRES IN RICHMOND DISTRICT[a]

Tire Description	Avg. Mileage, Orig. Equip.	Avg. Mileage, Replace.	No. Tires, Orig. Equip. Sample	No. Tires, Replace. Sample
Automobile	27,001	10,663	20	44
670 × 15 (truck)	26,846	18,617	72	38
710 × 15 (truck)	32,299	20,937	44	10
650 × 16 (6-ply)	23,491	11,303	36	5
825 × 20 (10-ply)	37,867	18,799	256	112
900 × 20 (10-ply)	35,510	14,131	11	3
9-22-5	Not available	19,617	0	20

[a]Original equipment tires installed 1957-64; replacement tires, 1960-64; record-keeping period ended in 1964.

Source: Tire records in Richmond District.

TABLE 8

AVERAGE MILEAGE DELIVERED BY ORIGINAL EQUIPMENT AND
REPLACEMENT TIRES IN FREDERICKSBURG DISTRICT[a]

Tire Description	Avg. Mileage, Orig. Equip.	Avg. Mileage, Replace.	No. Tires, Orig. Equip. Sample	No. Tires, Replace. Sample
Automobile	Not available	Not available	0	0
670 × 15 (truck)	29,025	20,247	40	84
710 × 15 (truck)	18,324	18,676	4	3
650 × 16 (6-ply)	Not available	Not available	0	0
825 × 20 (10-ply)	Not available	Not available	0	0
900 × 20 (10-ply)	Not available	15,657	0	4
9-22-5	Not available	22,172	0	6

[a]Original equipment tires installed 1957-64; replacement tires, 1960-64; record-keeping period ended in 1964.

Note: These statistics are presented as they are all that are available. Since the number of tires supplied for each size is so small (except for 670 × 15), the average mileages must be regarded with a jaundiced eye (except for 670 × 15).

Source: Tire records in Fredericksburg District.

TABLE 9

AVERAGE MILEAGE DELIVERED BY ORIGINAL EQUIPMENT AND
REPLACEMENT TIRES IN LYNCHBURG DISTRICT[a]

Tire Description	Avg. Mileage, Orig. Equip.	Avg. Mileage, Replace.	No. Tires, Orig. Equip. Sample	No. Tires, Replace. Sample
Automobile	25,214	12,340	3	25
670 × 15 (truck)	24,798	15,058	48	125
710 × 15 (truck)	30,071	25,109	17	15
650 × 16 (6-ply)	19,098	19,092	36	19
825 × 20 (10-ply)	27,419	23,891	122	114
900 × 20 (10-ply)	35,193	19,374	15	24
9-22-5	Not available	17,841	0	109

[a]Original equipment tires installed 1957-64; replacement tires, 1960-64; record-keeping period ended in 1964.

Source: Tire records in Lynchburg District.

TABLE 10

AVERAGE MILEAGE DELIVERED BY ORIGINAL EQUIPMENT AND
REPLACEMENT TIRES IN SALEM DISTRICT[a]

Tire Description	Avg. Mileage, Orig. Equip.	Avg. Mileage, Replace.	No. Tires, Orig. Equip. Sample	No. Tires, Replace. Sample
Automobile	28,186	15,533	115	113
670 × 15 (truck)	18,653	11,223	25	114
710 × 15 (truck)	15,922	Not available	7	0
650 × 16 (6-ply)	22,781	14,384	48	36
825 × 20 (10-ply)	27,261	17,800	120	116
900 × 20 (10-ply)	38,273	15,514	26	41
9-22-5	Not available	20,796	0	101

[a]Original equipment tires installed 1957-64; replacement tires, 1960-64; record-keeping period ended in 1964.

Source: Tire records in Salem District.

TABLE 11

AVERAGE MILEAGE DELIVERED BY ORIGINAL EQUIPMENT AND
REPLACEMENT TIRES IN STAUNTON DISTRICT[a]

Tire Description	Avg. Mileage, Orig. Equip.	Avg. Mileage, Replace.	No. Tires, Orig. Equip. Sample	No. Tires, Replace. Sample
Automobile	31,535	15,408	76	117
670 × 15 (truck)	24,373	19,695	31	111
710 × 15 (truck)	25,690	21,760	38	15
650 × 16 (6-ply)	22,059	17,988	102	54
825 × 20 (10-ply)	30,856	16,648	109	118
900 × 20 (10-ply)	37,170	20,321	28	47
0-22-5	Not available	24,318		

[a]Original equipment tires installed 1957-64; replacement tires, 1960-64; record-keeping period ended in 1964.

Source: Tire records in Staunton District.

TABLE 12

A DESCRIPTION OF TYPES AND NUMBER OF VEHICLES BY DISTRICT AND SIZE TIRES[a]

(March 1965)

Vehicle Description	Size Tire Used	Bristol	Salem	Lynchburg	Richmond	Suffolk	Fredericksburg	Culpeper	Staunton	Richmond Central Office Equipment Depot & Central Warehouse	Other Agencies (Statewide)	Total
Automobile	Auto	43	43	29	43	65	30	57	44	254	832	1440
Station wagon	710 × 15	22	14	14	20	17	9	18	17	31	NA	162
½ Ton (pick-up)	650 × 16 or 670 × 15	123	118	77	114	90	100	117	122	79	NA	940
2 Ton	825 × 20	169	150	134	177	97	116	195	138	52	NA	1228
2½ Ton	825 × 20	33	41	46	38	27	64	54	45	29	NA	377
3 Ton	900 × 20 or 9-22-5	22	8	7	17	4	14	31	19	2	NA	129
Total		417	374	307	409	300	333	472	385	447	832	4276

Note: Trucks above 3 tons in weight total 124 in number and are distributed throughout districts.

The number of vehicles except for cars that are not included in this table because of outside agencies is estimated to be no more than 10 percent of total of 4276. This statement applies to tire purchases for possible mileage bidding program.

Source: Equipment Division Records.

TABLE 13

NUMBER OF TIRES[a] THAT PASSED THROUGH DISTRICT WAREHOUSES

(July 1962—June 1964)

Tire Description	Culpeper	Richmond & Hampton Roads	Salem	Lynchburg	Suffolk	Fredericksburg	Staunton	Bristol	Totals
650 × 16	167 (9.36)	144 (8.07)	360 (20.17)	125 (7.00)	186 (10.42)	302 (16.92)	280 (15.69)	221 (12.38)	1,785 (100.00)
670 × 15	984 (14.91)	598 (9.06)	1,200 (18.18)	928 (14.06)	585 (8.86)	767 (11.62)	661 (10.02)	877 (13.29)	6,600 (100.00)
710 × 15	241 (23.56)	151 (14.76)	48 (4.69)	44 (4.30)	232 (22.68)	121 (11.83)	126 (12.32)	60 (5.87)	1,023 (100.01)
750 × 14	629 (10.11)	418 (6.72)	936 (15.04)	704 (11.31)	1,364 (21.92)	518 (8.33)	724 (11.64)	929 (14.93)	6,222 (100.00)
800 × 14	136 (37.26)	NA	NA	NA	137 (37.53)	69 (18.90)	NA	23 (6.30)	365 (99.99)
825 × 20	1,785 (16.43)	1,103 (10.15)	2,088 (19.22)	1,605 (14.77)	732 (6.74)	898 (8.27)	1,524 (14.03)	1,129 (10.39)	10,864 (100.00)
900 × 20	206 (18.81)	74 (6.76)	144 (13.15)	89 (8.13)	121 (11.05)	130 (11.87)	145 (13.24)	186 (16.99)	1,095 (100.00)
9-22-5	190 (18.54)	96 (9.37)	192 (18.73)	154 (15.02)	69 (6.73)	115 (11.22)	92 (8.89)	117 (11.41)	1,025 (100.00)
Total	4,338 (14.97)	2,584 (8.92)	4,968 (17.14)	3,649 (12.59)	3,426 (11.82)	2,720 (9.39)	3,552 (12.26)	3,547 (12.24)	28,979 (99.33)

[a] 800 × 14 and 750 × 14 are automobile tires, 670 × 15 and 710 × 15 are truck and automobile tires grouped together; remaining size are truck tires.

Note: Percentage figures are percent of particular size tire that passed through each district.

Source: District Kardex Records.

TABLE 14

ESTIMATED DISTRIBUTION COSTS FOR 20,000 TIRES PURCHASED FROM
OCTOBER 1, 1963 TO OCTOBER 31, 1964

Space Storage Cost Per Tire (30 days)	Handling Cost Per Tire Per Tire Handled	Average Interest Cost Per Tire (30 days)	Average Distribution Costs Per Tire	Total Distribution Cost for 20,000 Tires
$0.02	$0.40	$0.06	$0.48	$9,600

Notes: 1. Space cost is based on a Richmond real estate appraiser's estimate of $0.50 per sq ft per year as the going rate for inventory rental space and the assumption that tires are stored in the central warehouse for an average of 30 days.

2. Handling costs are based on estimates derived from the Equipment Division data that it costs between $0.30 and $0.50 to handle a tire depending on its size.

3. Interest rates are based on an assumed $4\frac{1}{2}$ percent per year for dollar payment prior to the use of goods at a price of $17.50 per tire ($350,000/20,000).

4. No estimate is made for transportation costs as management feels that the trucks will be moving from the field to Richmond and back anyway. If average transportation costs were based on Virginia Intra State Tariff rates of over 5,000 lb average transportation costs per tire would be $0.72.

TABLE 15

ESTIMATED PURCHASE COSTS AND DERIVATION OF ESTIMATES

Tire Description	Automobile	670 × 15 (Truck)	710 × 25 (Truck)	650 × 16 (Truck)	825 × 20 (Truck)	900 × 20 (Truck)	9-22-5 (Truck)
Number bought minus	16,475	2,850	1,550	3,650	9,792	1,125	950
Number delivered to outside agencies equals	659	114	62	146	98	0	0
Number used	15,816	2,736	1,488	3,504	9,694	1,125	950
Initial purchase cost minus	$155,839	$30,017	$23,696	$46,804	$306,604	$44,845	$31,540
Dollar value delivered to outside agencies equals	6,234	1,201	948	1,872	3,066	0	0
Total initial purchase cost for tires used	149,605	28,816	22,748	44,932	303,538	44,845	31,540
plus Estimated recapping and repair costs for tires used equals	0	1,257	685	1,608	8,240	960	800
Total purchase costs for tires used	149,605	30,073	23,433	46,540	311,778	45,805	32,340
minus Total recappable and scrapped carcass value equals	15,816	2,736	1,488	3,504	48,470	5,625	4,750
Net cost for tires purchased and used	133,789	27,377	21,945	43,036	263,308	40,180	27,590
Divided by Number purchased and used equals	15,816	2,736	1,488	3,504	9,694	1,125	950
Net cost per used tire	8.45	9.99	14.74	12.28	27.16	35.21	29.05

NOTES: 1. It is assumed that beginning and ending inventories are the same when determining number of tires used.

2. It was estimated that 490 of automobile, 670 × 15, 710 × 15 and 650 × 16 tires were sent to outside agencies. 190 of 825 × 20 and no 900 × 20 and 9-22-5 were sent to these agencies.

3. The average value per scrapped carcass of all tires was estimated to be $1.00 except for heavier truck tires (825 × 20, 900 × 20, and 9-22-5) which were valued at $5.00. This low value is felt to be realistic because of the low percentage of recappable carcasses and lower prices paid for recappable carcasses of the Department's present tire suppliers.

Source: Kardex records of the Purchasing Division, invoice billings, and tire recappers.

TABLE 16
REPORT OF NATIONAL BUREAU OF STANDARDS ON RESULTS OF TESTS CONDUCTED IN MAY 1965, ON THREE DIFFERENT BRANDS OF 825 × 20 TIRES

Tests				
Manufacturer				
Endurance test:				
Running time, hr, at:				
100% load	7	7	7	7 min.
120% load	16	16	16	16 min.
140% load	24	24	24	24 min.
Total cut-growth, %	43	5	14	600 max.
Breaking energy, in.-lb	13,110	14,597	19,926	10,875 min.

[a]Required results based on Interim Federal Specifications ZZ-T-00381j, dated July 13, 1959.

Note: The tires comply with the requirements for these tests.