



U.S. Department  
of Transportation

**Federal Highway  
Administration**

400 Seventh St., S.W.  
Washington, D.C. 20590

March 3, 1995

Refer to: HNG-14

John F. Carney, III, P.E.  
Associate Dean for Research and  
Graduate Affairs  
Vanderbilt University  
Nashville, Tennessee 37235

Dear Mr. Carney:

Your February 10 letter, cosigned by Mr. Martin D. Pietz, Director of Research, Washington State Department of Transportation, to Mr. William A. Weseman requested Federal Highway Administration's (FHWA) acceptance of a redirective crash cushion called the REACT 350. This device is composed of nine high molecular weight, high density polyethylene cylinders of varying wall thicknesses. Each cylinder is 910 mm in diameter and 1220 mm high. Two 25.4 mm cables are located on each side of the attenuator to provide redirection in side impacts. These cables are connected to anchor plates at the front of the REACT 350 and to a backup assembly at the rear of the unit. The REACT 350 unit rests on a steel support structure and is stiffened laterally at the back by three chain assemblies attached to rods in the support structure on each side and to steel plates located between cylinders 6-7, 7-8, and 8-9 in the center. The material specifications and preliminary plan sheets for the REACT 350 are enclosed.

The REACT 350 was developed and tested as a test level 3 (TL-3) redirective crash cushion following the testing guidelines contained in the National Cooperative Highway Research Program (NCHRP) Report 350, "Recommended Procedures for the Safety Performance Evaluation of Highway Features." A summary of the tests that were conducted and their results are enclosed. We have noted that, in most cases, the occupant impact velocities and ridedown accelerations were below the preferred limits and in all cases below the maximum values allowed in the NCHRP Report 350. In addition, the self-restoring characteristics of the REACT 350 make it unique for what we expect will be a moderately-priced crash cushion.

Your letter suggested that, based on analysis of the tests that were successfully run, the NCHRP tests 3-36, 3-37, and 3-39 should be considered optional. Tests 3-36 and 3-37 require impacts at the beginning of the length-of-need of the system with an 820 kg car and a 2000 kg pickup truck, respectively. Test 3-39 is a reverse direction impact. We concur in your analysis that tests 3-36 and 3-39 may be omitted, but recommend that test 3-37 be conducted to verify the REACT's expected performance when impacted by the

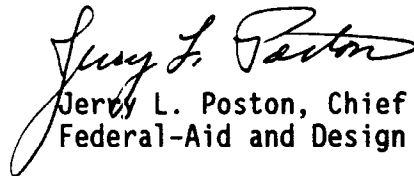
pickup truck at a 20 degree angle at the beginning of the length-of-need. You have identified this point as the interface between cylinders 1 and 2. As stated in the NCHRP Report 350, this test is intended to evaluate structural adequacy of the device and vehicle trajectory criteria. It creates maximum loading on the upstream anchorage system.

Based on our review of the tests conducted to date and subsequent telephone conversations between you and Mr. Richard Powers of my staff, the FHWA is willing to offer *conditional* acceptance of the REACT 350 for use on projects on the National Highway System if proposed by a highway agency. The condition is that test 3-37, as described above, be completed with acceptable results. We request that this test be completed and that the results be reported to us within 90 days of the date of this letter. If the test is not completed within this time or does not pass the acceptance criteria, this conditional acceptance is automatically rescinded.

Since the REACT 350 is a proprietary item, the provisions of Title 23, Code of Federal Regulations, Section 635.411 will govern its use on federally-funded projects. A copy of this section is enclosed.

A copy of this letter, with enclosures, will be sent to the FHWA field offices for their information. Questions may be addressed to Mr. Richard Powers at (202) 366-1320.

Sincerely yours,

  
Jerry L. Poston, Chief  
Federal-Aid and Design Division

4 Enclosures

cc: Mr. Martin D. Pietz

Geometric and Roadside Design Acceptance Letter CC-26

Table 1. Crash Tests Conducted Satisfying All *NCHRP Report 350* Requirements

<i>NCHRP Report 350</i> Test Designation	Vehicle	Impact Speed (km/h)	Impact Angle (deg)	Impact Point	Date Conducted
3-30	820C	100	0	Nose of device, width/4 offset	3/8/94
3-31	2000P	100	0	Center nose of device	4/26/94
3-32	820C	100	15	Center nose of device	4/27/94
3-33	2000P	100	15	Center nose of device	5/31/94
3-38	2000P	100	20	Critical impact point	1/4/95

Table 2. Summary of Crash Test Results

<i>NCHRP Report 350</i> Test Designation	3-30	3-31	3-32	3-33	3-38
Vehicle mass (kg)	820	2,000	820	2,000	2,000
Impact speed (km/h)	98.94	97.01	99.00	97.20	101.92
Impact angle (degrees)	0	0	15.73	15.05	20.70
Vehicle impact location	nose, with width/4 offset	nose	nose	nose	critical impact point
Vehicle stopping distance (m)	4.79	6.97	4.59	7.07	NA
Occupant impact velocity (m/s)					
longitudinal (12 max. allowable)	8.73	6.23	10.06	6.26	8.95
lateral (12 max. allowable)	4.44	0.32	1.97	4.01	6.90
Occupant ridedown acceleration (peak 10 msec avg g's)					
longitudinal (20 max. allowable)	13.49	19.43	7.80	11.75	9.59
lateral (20 max. allowable)	4.84	6.73	5.90	4.51	19.88
Assessment	Passed all requirements	Passed all requirements	Passed all requirements	Passed all requirements	Passed all requirements

# REACT-350

## REUSABLE ENERGY ABSORBING CRASH TERMINAL

### SPECIFICATION

The REACT-350 is a reusable crash cushion made from an array of high molecular weight, high-density polyethylene, HMW/HDPE, cylinders which recover their shape and position after being impacted. This device is manufactured and distributed by MOMENTUM MANAGEMENT, INC. of Ronkonkoma, N.Y.

### PERFORMANCE

The REACT-350 has been designed and tested to conform to the Level 3 requirements of NCHRP 350. It can sustain impacts by both small cars and pick-up trucks at speeds up to 100 kilometers per hour, (62.2 miles per hour), and at angles up to twenty degrees. It has met all the evaluation criteria specified by NCHRP 350 including occupant risk, structural integrity and post-impact trajectory. The device has been shown to recover its shape and capability following the severe impacts specified by NCHRP 350.

### SYSTEM DESCRIPTION

The REACT-350 configuration described herein is the high-speed crash cushion, designated level 3 by NCHRP 350. A smaller version, designed for 70 kilometers per hour, (43.54 miles per hour) impacts, is currently under evaluation to the level 2 requirements of NCHRP 350.

The Level 3 device consists of nine 914.4 mm, (36-inch), diameter HMW/HDPE cylinders arranged in a straight line, each cylinder attached to its adjacent cylinder by two bolts at their mutual tangent line. Four heavy steel wire rope assemblies, two on each side of the row of cylinders, are anchored to the pavement at the front of the device, and to the self-contained back-up structure at the rear. The wall thickness of the HMW/HDPE cylinders varies, increasing from front to rear.

On head-on impacts, the cylinders flatten, absorbing the vehicle's kinetic energy. During angled impacts, the vehicle is redirected by both the PE cylinders and the steel wire rope assemblies. In either case the REACT 350 restores itself to near its original configuration almost immediately.

The HMW/HDPE cylinders are guided by steel "T" sections which are secured to the pavement by concrete anchor bolts. The device is completely free-standing and is not attached to the hazard. It does, however, require a good concrete base which has at least 27600 kPa, (4000 psi) compression capabilities.

In order to provide redirection for high-angle hits at the rear of the device, chain assemblies are located between cylinders 6&7, 7&8 and 8&9. These chains are attached to steel rods mounted on the outer "T" tracks.

## SYSTEM DIMENSIONS

The REACT 350 is shown in MOMENTUM MANAGEMENT INC. Drawing No. 300010. The approximate dimensions of the device are as follows:

Overall Unit Length:	9.35 meters, (30 ft. 5 inches)
Overall Unit Width:	915 millimeters, (3 ft. 0 inches)
Overall Height:	1.30 meters, (4 ft. 3 inches)
Overall Weight:	1674 kilograms, (3700 lbs. )

## COMPONENT MATERIAL SPECIFICATIONS

### HMW/HDPE Cylinders

The polyethylene cylinders shall be extruded to the material properties specified by Momentum Management, Inc. The outer diameter of the cylinders will be 915 mm, (36 inches). The wall thicknesses shall vary from 20.32 mm (0.80 inches) to 35.18 mm, ( 1.385 inches). The material, designated, PE-3408, is a "smart" material which remembers its original shape and restores itself to that shape following impact. Its load-deflection properties are unaltered by the initial loading and are designed to allow for changes in material properties which occur as a result of temperature variations which might be expected in the highway environment.

### Steel Cable Assemblies

The steel cable assemblies shall be 1 inch diameter 6 x 25 FW Wire Rope, Improved Plow Steel, IWRC, Galvanized, Nominal Strength 400,000 newtons, (90000 lbs.) The forward fitting shall be Industrial Type Closed Swaged Socket, Galvanized. The rear fitting shall be a Threaded Stud Assembly, Industrial Type, Galvanized.

### Chain Assemblies

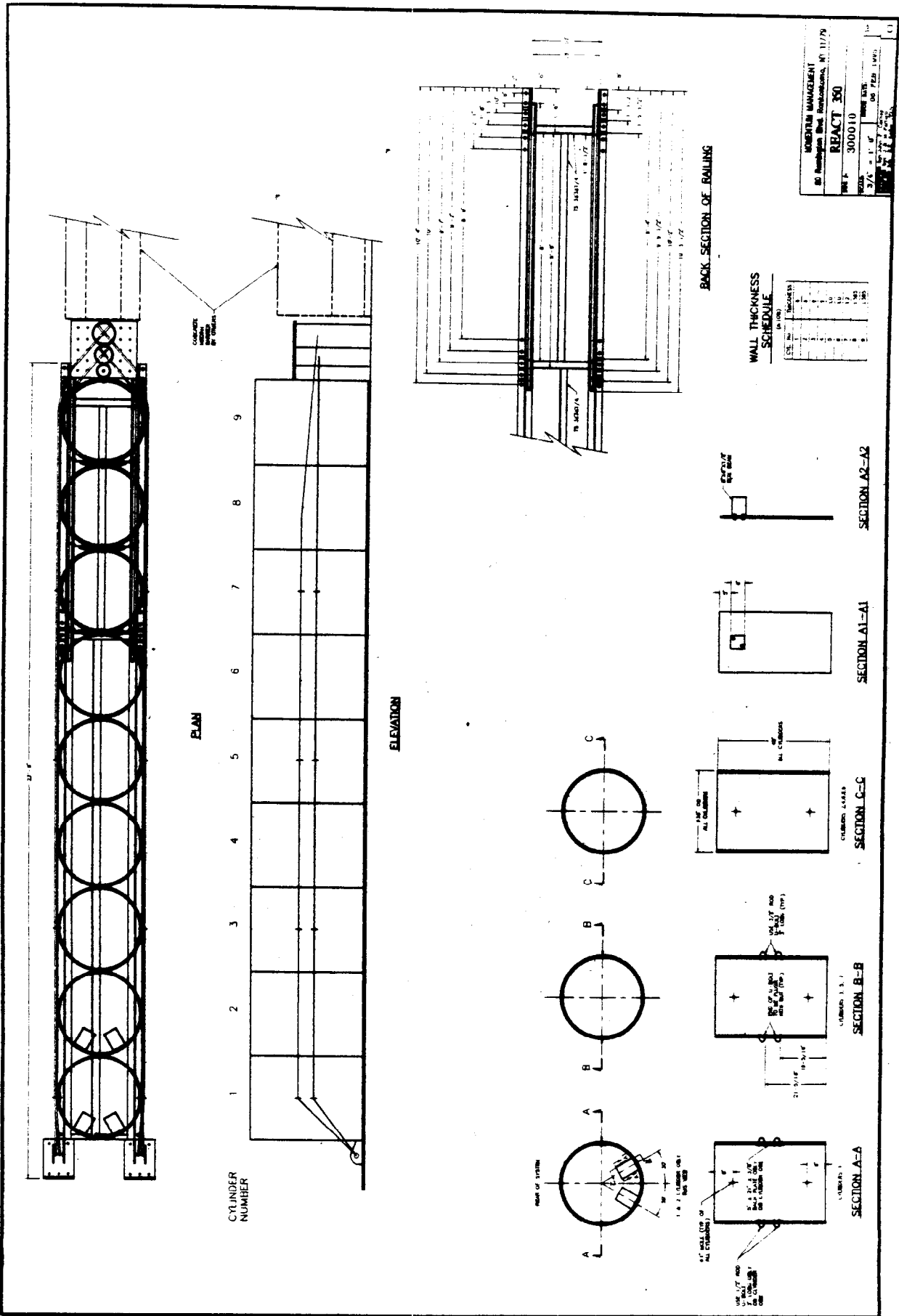
Each chain assembly will consist of three 1/2 inch HighTest Galvanized links with 5/8 screw-pin galvanized anchor shackles on each end.

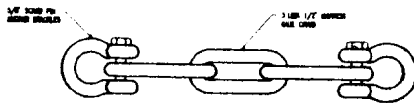
### Steel Tracks and Anchor Weldments

All steel parts shall be fabricated from ASTM A36 or A500 steel. All welding will be done under the supervision of a certified welder. All parts shall be galvanized after welding according to ASTM A-123 or A-525.

## INSTALLATION

Reference to Sheet No. 1 of Dwg. No. 300010 shows in plan view the relative locations of the three track sections, the rear anchor assembly and the two front anchors. The tracks and the anchors are fastened to the concrete surface with approximately 60 3/4 x 8 inch concrete expansion bolts. Cylinders are then put in place and bolted together. The rearmost cylinder is bolted to the rear anchor weldment. The four cable assemblies are now attached to the front anchor and laid out lengthwise along the barrier.. The "U" bolts are then fastened to the sides of several of the HMW/HDPE cylinders to hold the cable assemblies in position. The threaded stud ends of the cable assemblies are now fed through holes in the rear anchor weldment and torqued to produce the desired tension in the cables. Assembly is now complete.





CHAIN DETAIL

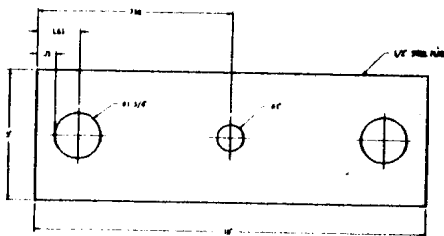
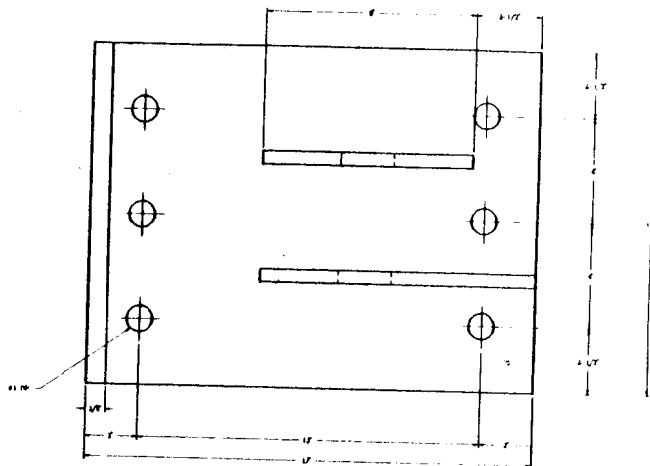
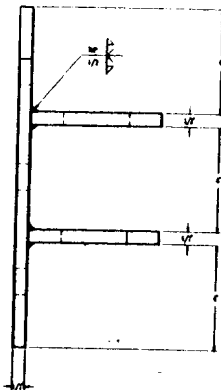
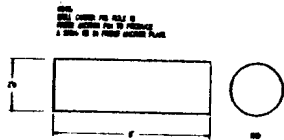


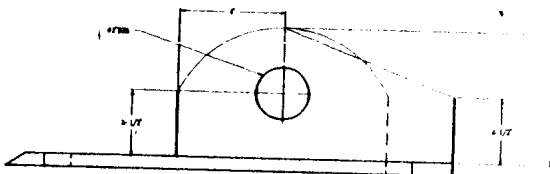
PLATE DETAIL



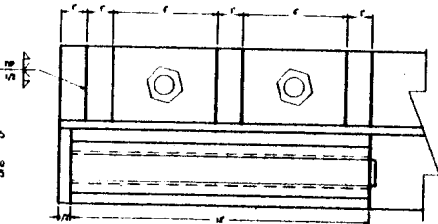
FRONT ANCHOR PLATE DETAIL LEFT SIDE



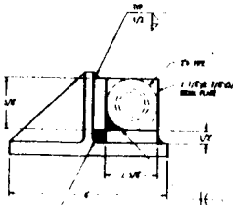
FRONT ANCHOR FIN (2 REQUIRED)



FRONT ANCHOR PLATE DETAIL RIGHT SIDE

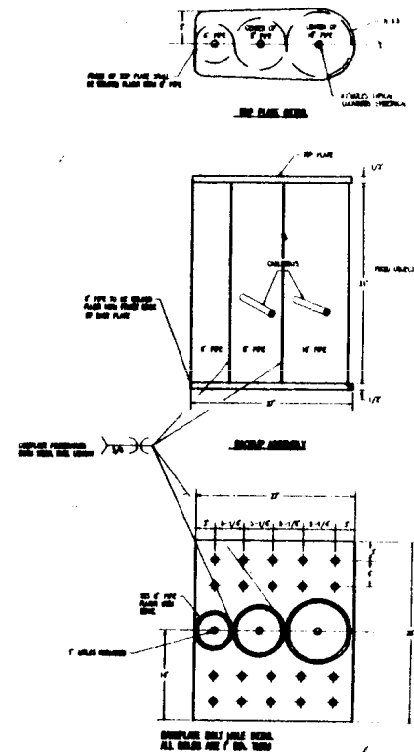
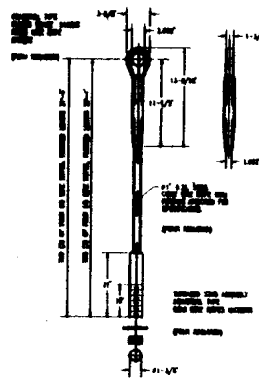
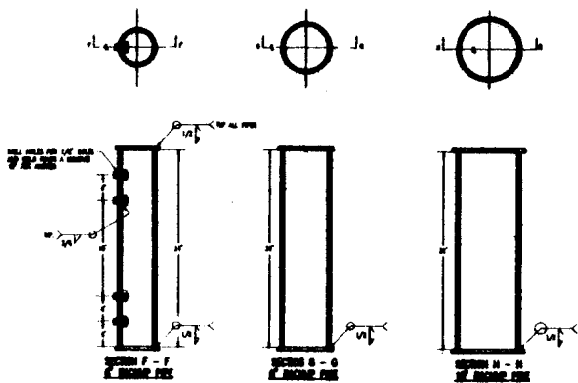
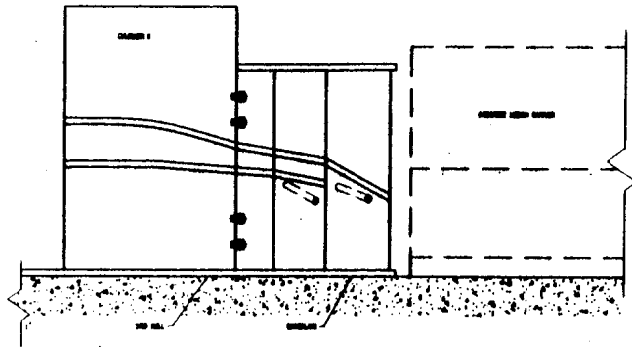


PIPE MOUNT DETAIL & ELEVATION



MOMENTUM MANAGEMENT	
80 Huntington Blvd. Ronkonkoma, NY 11779	
REACT 350	
PROJECT:	3000211
SCALE:	AS SHOWN
DATE:	06 FEB 1995
BY:	
CHECKED BY:	





MOMENTUM MANAGEMENT  
 80 Rensselaer Blvd. Roseton, NY 11779  
**REACT 150**  
 DRAWING NO. 300030  
 SCALE 1 1/2" = 1'-0"  
 DATE 06 PER 1990  
 15  
 C1

se materials must occur in the United States.

(1) The State standard contract provisions that require the use of domestic materials and products, including steel materials, to the same or later extent as the provisions set forth in this section.

(2) The State elects to include alternate bid provisions for foreign and domestic steel materials which comply with the following requirements. Any procedure for obtaining alternate bids based on furnishing foreign steel materials which is acceptable to the Division Administrator may be used. The contract provisions must (i) require all bidders to submit a bid based on furnishing domestic steel materials, and clearly state that the contract will be awarded to the bidder who submits the lowest total bid based on furnishing domestic steel materials unless the total bid exceeds the lowest total bid based on furnishing foreign steel materials by more than 25 percent.

(3) When steel materials are used in a project, the requirements of this section do not prevent a minimal use of foreign steel materials, if the cost of such materials used does not exceed one-tenth of one percent (0.1 percent) of the total contract cost or \$2,500, whichever is greater. For purposes of this paragraph, the cost is that shown on the bid as the value of the steel products as they are delivered to the project.

(c)(1) A State may request a waiver of the provisions of this section if:

(i) The application of those provisions would be inconsistent with the public interest; or

(ii) Steel materials/products are not produced in the United States in sufficient and reasonably available quantities which are of a satisfactory quality.

(2) A request for waiver, accompanied by supporting information, must be submitted in writing to the Regional

Federal Highway Administrator (FHWA) through the FHWA Division Administrator. A request must be submitted sufficiently in advance of the need for the waiver in order to allow time for proper review and action on the request. The RPHWA will have approval authority on the request.

(3) Requests for waivers may be made for specific projects, or for certain materials or products in specific geographic areas, or for combinations of both, depending on the circumstances.

(4) The denial of the request by the RPHWA may be appealed by the State to the Federal Highway Administrator (Administrator), whose action on the request shall be considered administratively final.

(5) A request for a waiver which involves nationwide public interest or availability issues or more than one FHWA region may be submitted by the RPHWA to the Administrator for action.

(6) A request for waiver and an appeal from a denial of a request must include facts and justification to support the granting of the waiver. The FHWA response to a request or appeal will be in writing and made available to the public upon request. Any request for a nationwide waiver and FHWA's action on such a request may be published in the FEDERAL REGISTER for public comment.

(7) In determining whether the waivers described in paragraph (c)(1) of this section will be granted, the FHWA will consider all appropriate factors including, but not limited to, cost, administrative burden, and delay that would be imposed if the provision were not waived.

(d) Standard State and Federal-aid contract procedures may be used to assure compliance with the requirements of this section.

(23 U.S.C. 318, sec. 10 of Pub. L. 90-229, 96 Stat. 55, sec. 165 of Pub. L. 97-424, 96 Stat. 2136 and 49 CFR 1.49(b))

(48 FR 53164, Nov. 25, 1983, as amended at 49 FR 18521, May 3, 1984)

#### § 635.411 Material or product selection.

(a) Federal funds shall not participate, directly or indirectly, in payment for any premium or royalty on any patented or proprietary material, specification, or process specifically set forth in the plans and specifications for a project, unless:

(1) Such patented or proprietary item is purchased or obtained through

competitive bidding with equally suitable unpatented items; or

(2) The State highway agency certifies either that such patented or proprietary item is essential for synchronization with existing highway facilities, or that no equally suitable alternate exists; or

(3) Such patented or proprietary item is used for research or for a distinctive type of construction on relatively short sections of road for experimental purposes.

(b) When there is available for purchase more than one nonpatented, nonproprietary material, semifinished or finished article or product that will fulfill the requirements for an item of work of a project and these available materials or products are judged to be of satisfactory quality and equally acceptable on the basis of engineering analysis and the anticipated prices for the related item(s) of work are estimated to be approximately the same, the PS&E for the project shall either contain or include by reference the specifications for each such material or product that is considered acceptable for incorporation in the work. If the State highway agency wishes to substitute some other acceptable material or product for the material or product designated by the successful bidder or bid as the lowest alternate, and such substitution results in an increase in costs, there will not be Federal-aid participation in any increase in costs.

(c) A State highway agency may require a specific material or product when there are other acceptable materials and products, when such specific choice is approved by the Division Administrator as being in the public interest. When the Division Administrator's approval is not obtained, the item will be nonparticipating unless bidding procedures are used that establish the unit price of each acceptable alternative. In this case Federal-aid participation will be based on the lowest price so established.

(d) Appendix A sets forth the FHWA requirements regarding (1) the specification of alternative types of culvert pipes, and (2) the number and types of such alternatives which must

be set forth in the specifications for various types of drainage installations.

(e) Reference in specifications on plans to single trade name materials will not be approved on Federal-aid contracts.

#### § 635.412 Guaranty and warranty clauses.

(a) Except as provided in paragraph (b) of this section, clauses that require the contractor to guarantee or warrant materials and workmanship or to otherwise maintain the work for a specified period after its satisfactory completion by the contractor and its final acceptance by the State, will not be approved for use in Federal-aid contracts. Work performed and materials replaced under such guaranty or warranty clauses after final acceptance of work are not eligible for Federal participation.

(b) Contracts which involve furnishing and/or installing electrical or mechanical equipment should generally include contract clauses that require:

(1) Manufacturer's warranties or guarantees on all electrical and mechanical equipment consistent with those provided as customary trade practice; or

(2) Contractors' warranties or guarantees providing for satisfactory in-service operation of the mechanical and electrical equipment and related components for a period not to exceed 6 months following project acceptance.

#### § 635.417 Convict produced materials.

(a) Materials produced by convict labor may only be incorporated in a Federal-aid highway construction project if such materials have been:

(1) Produced by convicts who are on parole, supervised release, or probation from a prison; or

(2) Produced in a qualified prison facility and the cumulative annual production amount of such materials for use in Federal-aid highway construction does not exceed the amount of such materials produced in such facility for use in Federal-aid highway construction during the 12-month period ending July 1, 1987.

(b) *Qualified prison facility* means any prison facility in which convicts,