

April 2, 1998

Refer to: HNG-14

Mr. Kaddo Kothmann:  
President  
Road Systems, Inc.  
P.O. Box 2163  
Big Spring, Texas 79721

Dear Mr. Kothmann:

In your March 19, 1998, letter to Mr. Henry H. Rentz, you requested FHWA review of information you enclosed on your Flared Energy Absorbing Terminal (FLEAT) and acceptance of this w-beam guardrail terminal as a NCHRP Report 350 test level 3 (TL-3) device. To support your request, you also included a description of the FLEAT-350, a summary of crash test results, a composite crash test video tape, drawings, photographs, and a March 1998 test report for the certification test which was run at the Midwest Roadside Safety Facility. A second report (also dated March 1998) prepared by the Southwest Research Institute, entitled "FULL-SCALE CRASH EVALUATION OF A FLARED ENERGY ABSORBING TERMINAL" included information on the three additional tests that were run at that testing facility. We received a copy of this report with your March 27 letter to Mr. Rentz.

The FLEAT-350 is a w-beam guardrail terminal that is linearly offset from the line of rail by 1200 mm over its 11400-mm length. Its main components include an impact head and guide tube assembly, a modified w-beam rail section, a breakaway anchor assembly, and a series of seven weakened timber posts, the first two being 140 mm x 190 mm x 1080 mm long set in 1830-mm steel tubes and the next five being 150 mm x 200 mm x 1830 mm long set directly into the ground. Design details are shown in Enclosure 1. The FLEAT-350 dissipates impact energy in end-on hits by bending and flattening the w-beam rail element as the extruder head is forced back along the rail. For downstream hits, the tension in the rail is transmitted to the anchorage system, resulting in containment and re-direction of an impacting vehicle.

A total of four tests were conducted to certify the FLEAT-350 as meeting the evaluation criteria of NCHRP Report 350. These included the 820-kg car and the 2000-kg pickup truck at zero degrees on the end of the terminal (Report 350 tests 3-30 and 3-31, respectively), the car at post 2 at 15 degrees (critical impact point, test 3-34), and the pickup truck at the beginning of the barrier length of need at post 3 at 20 degrees (test 3-35). The summary sheets for each of these tests are attached as Enclosure 2. We noted that the occupant impact velocities and the subsequent ridedown accelerations were below the preferred Report 350 evaluation criteria for both end-on hits. We noted also that the 820-kg car was smoothly stopped in only 5.48 meters. After initial impact, the 2000-kg truck continued 32 meters behind the rail before stopping. Although the energy absorbing nature of this terminal significantly reduced the distance traveled behind the terminal after impact (compared to non-energy absorbing terminals), the post-crash trajectory seen in test 3-31 re-emphasizes the need for a clear, relatively traversable runout area behind all guardrail terminals.

We agree with your assessment that a reverse-direction impact test (test 3-39) is not necessary based on earlier tests on similar systems. Tests 3-32 and 3-33 (15 degree angle hits on the nose of the terminal with the 820-kg and 2000-kg vehicles) can also be waived because these tests are demonstrably less severe than tests 3-30 and 3-31 for gating terminals with designs similar to the FLEAT-350.

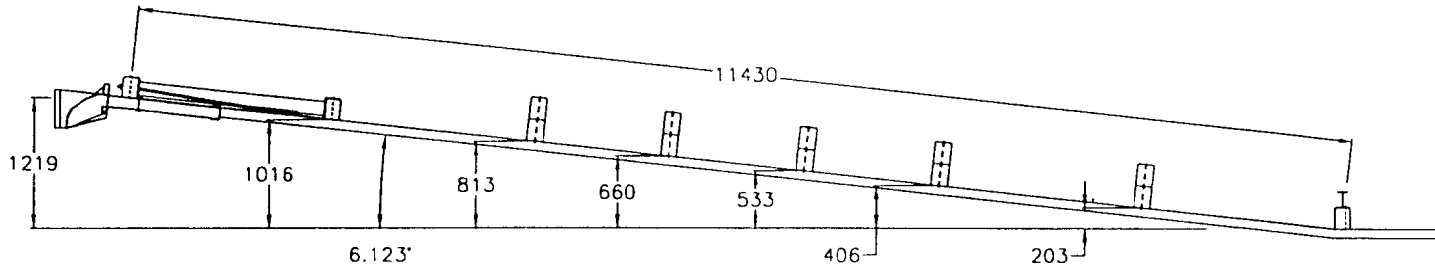
Based on our review of the information you submitted, we consider the FLEAT-350 to meet appropriate Report 350 evaluation criteria at test level 3 (TL-3). Therefore, it may be used on the National Highway System (NHS) when such use is requested by a transportation agency. Since the FLEAT-350 is a proprietary terminal, its use on Federal-aid projects, except exempt non-NHS projects, is subject to the conditions noted in Title 23, Code of Federal Regulations, Section 635.411, a copy of which is attached for your ready reference as Enclosure 3.

Sincerely yours,

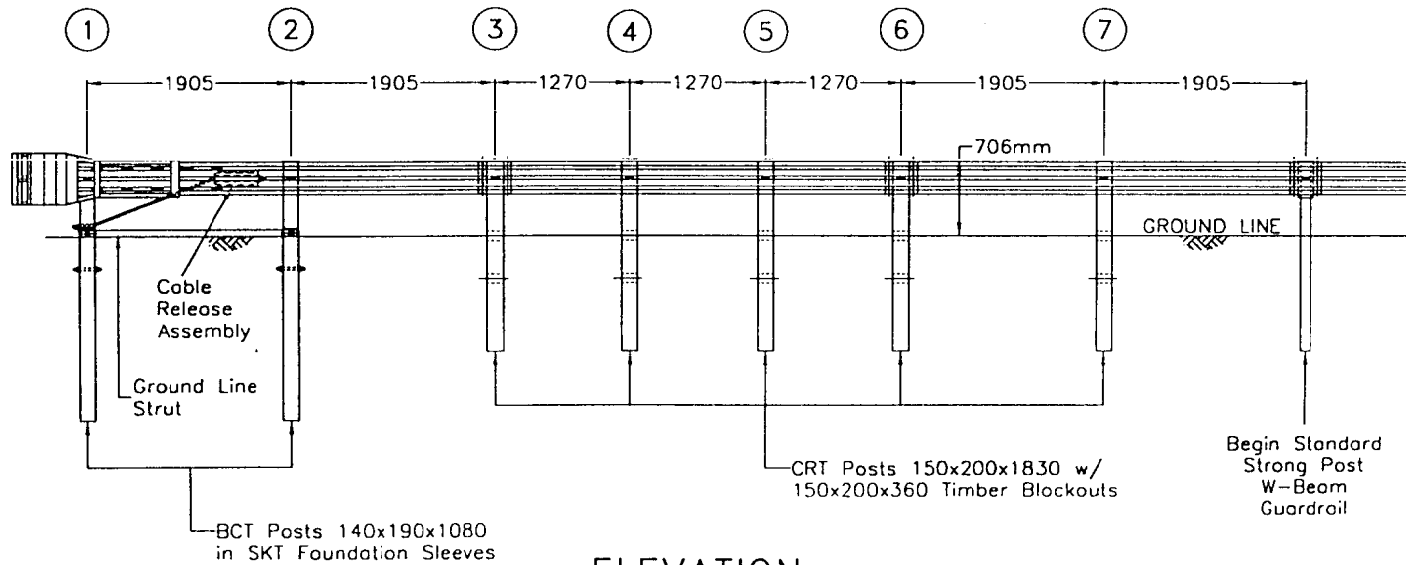
(original signed by Dwight A. Horne)

Dwight A. Horne  
Chief, Federal-Aid and Design Division

3 Enclosures  
Acceptance letter CC-46



PLAN

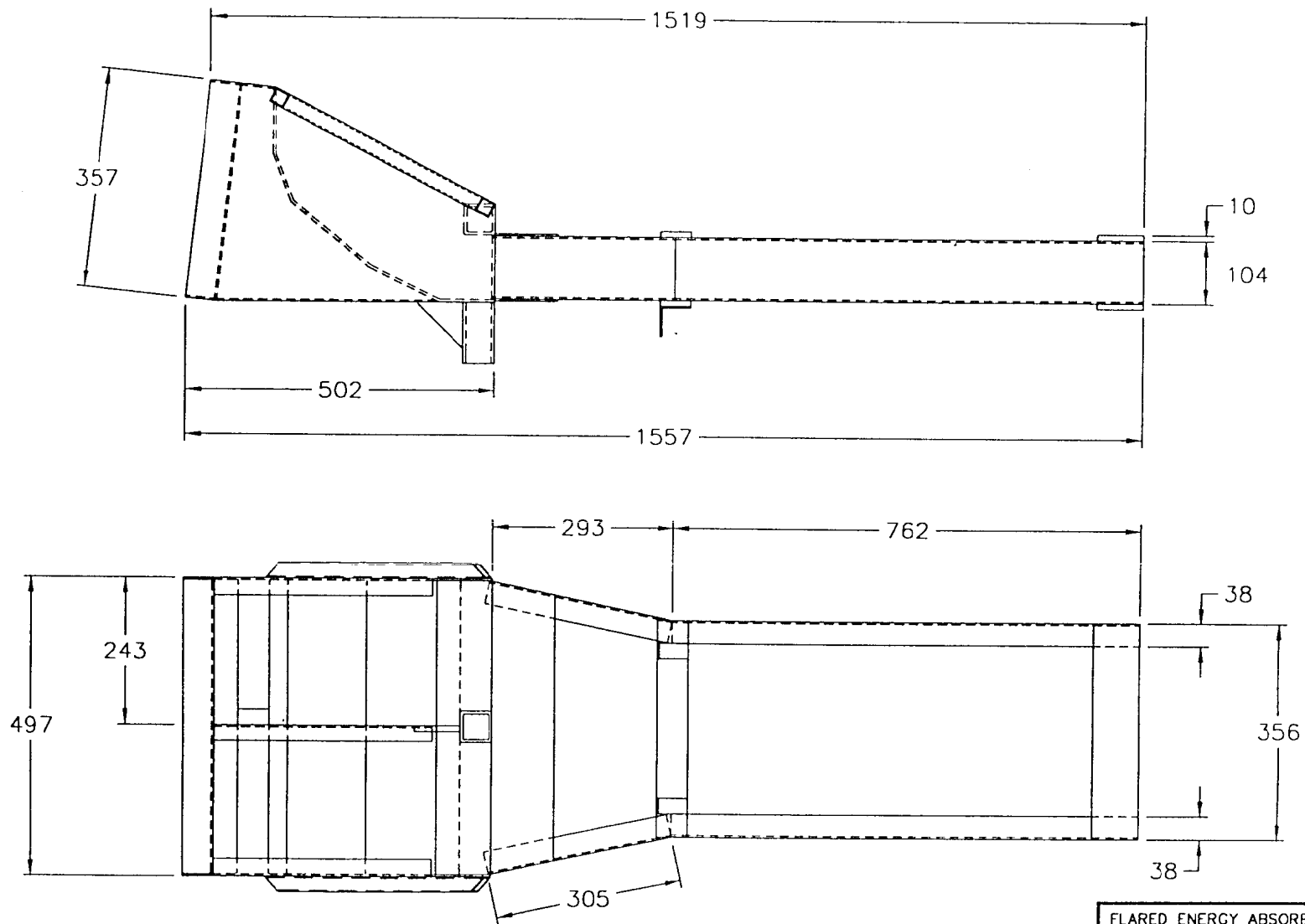


ELEVATION

FLARED ENERGY ABSORBING TERMINAL (FLEAT-350)			
DRAWN BY EAK	DATE 3/20/98	DESIGN BY SYSTEM	PC OF 1 5
REVISION DATE			

Figure 1: FLEAT Assembly and Component Drawings

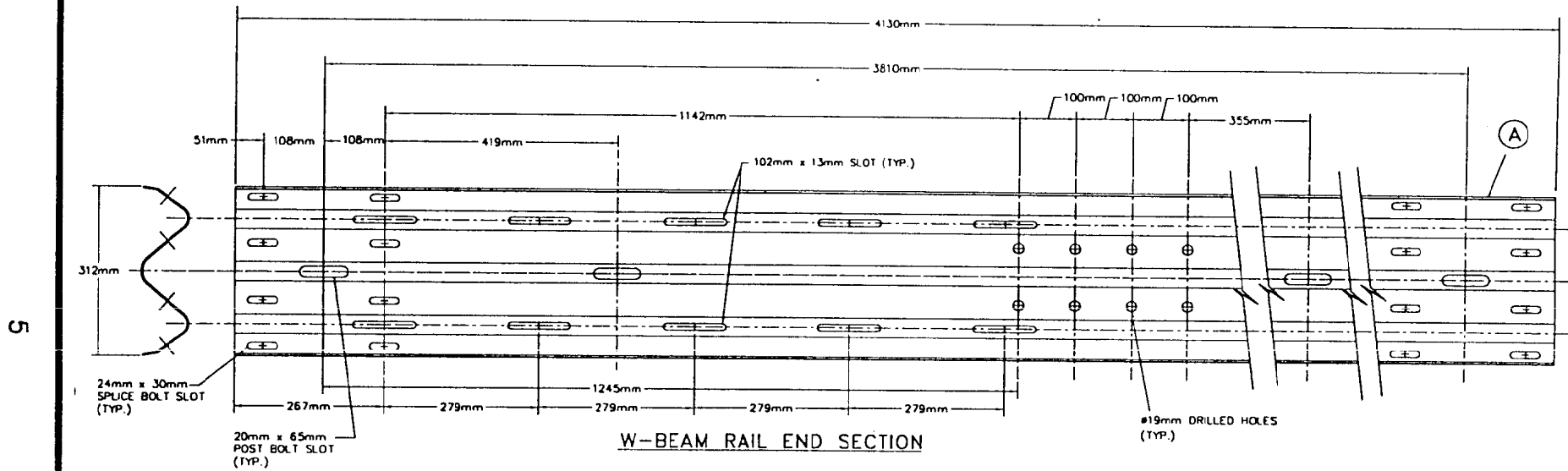
4



FLARED ENERGY ABSORBING TERMINAL (FLEAT-350)			
FLEAT HEAD			
DRAWN BY	DATE	DOC SET	PG OF
EAK	3/20/98	SYSTEM	2 5
VERSION	DATE		
1	3/20/98		

Figure 1 con't: FLEAT Assembly and Component Drawings

ITEM NO.	QTY	DESCRIPTION	MATERIAL
A	1	RAIL END SECTION	12 GA. W-BEAM

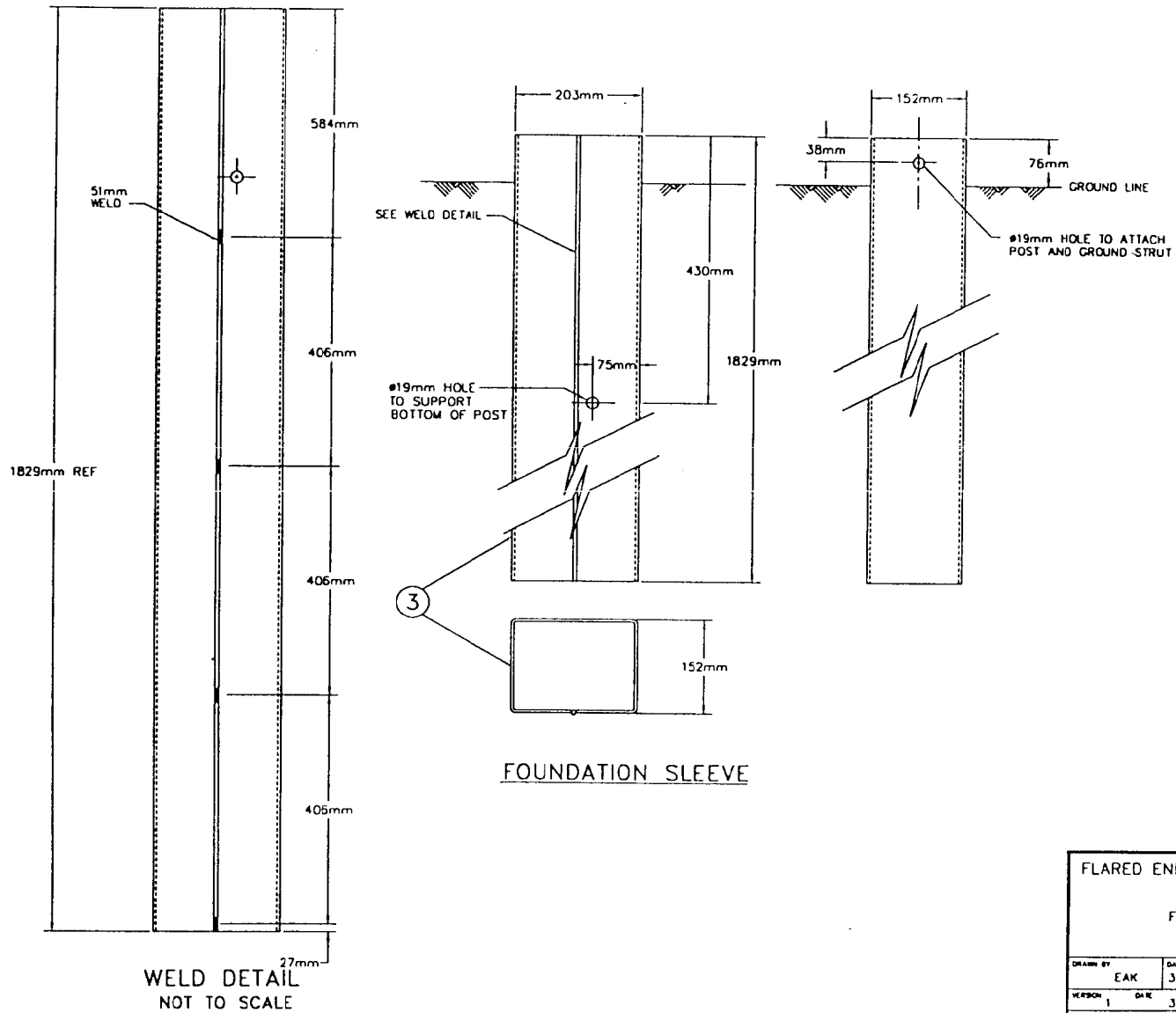


FLARED ENERGY ABSORBING TERMINAL (FLEAT-350)			
W-BEAM RAIL END SECTION			
DRAWN BY EAK	DATE 3/20/98	CHK BY SYSTEM	PC OF 3 5
VERSION 1	DATE 3/20/98		

DRAWING NO. 1:3045

Figure 1 con't: FLEAT Assembly and Component Drawings

ITEM NO.	QTY	DESCRIPTION	MATERIAL
3	2	FOUNDATION SLEEVE	50 ksi 3mm PLATE



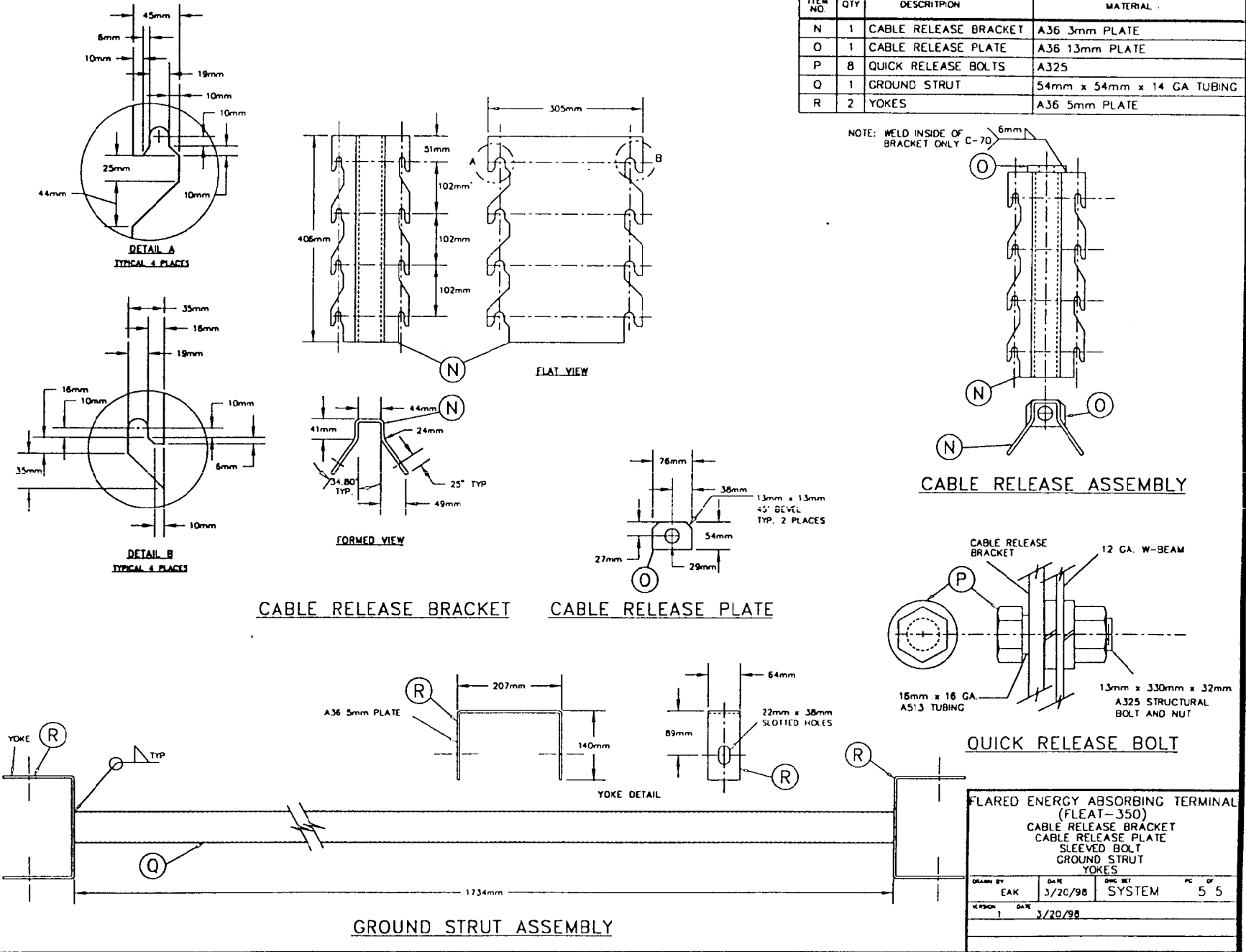
FLARED ENERGY ABSORBING TERMINAL (FLEAT-350)			
FOUNDATION SLEEVE			
DRAWN BY	DATE	CHK BY	PG OF
EAK	3/20/98	SYSTEM	4 5
VERSION	DATE		
1	3/20/98		

Figure 1 con't: FLEAT Assembly and Component Drawings

7

ITEM NO.	QTY	DESCRIPTION	MATERIAL
N	1	CABLE RELEASE BRACKET	A36 3mm PLATE
O	1	CABLE RELEASE PLATE	A36 13mm PLATE
P	8	QUICK RELEASE BOLTS	A325
Q	1	GROUND STRUT	54mm x 54mm x 14 GA TUBING
R	2	YOKES	A36 5mm PLATE

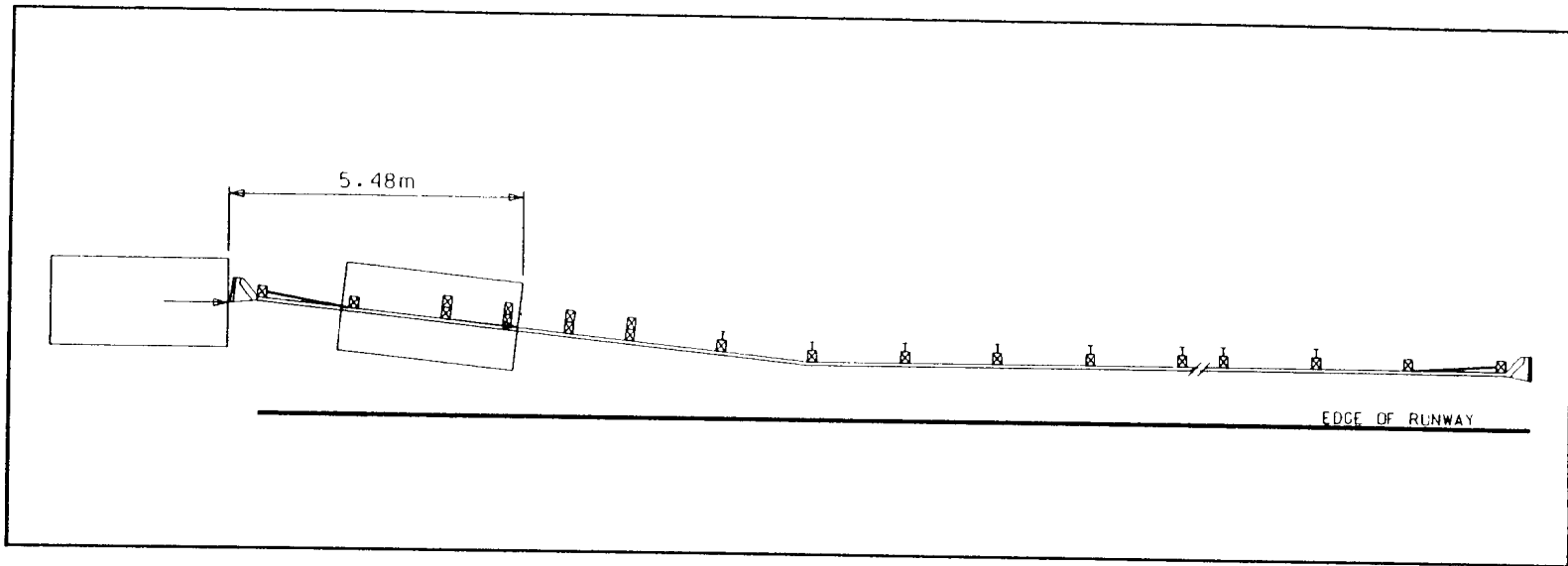
NOTE: WELD INSIDE OF BRACKET ONLY C-70



FLARED ENERGY ABSORBING TERMINAL (FLEAT-350) CABLE RELEASE BRACKET CABLE RELEASE PLATE SLEEVED BOLT GROUND STRUT YOKES		
DRAWN BY EAK	DATE 3/20/98	DWG SET SYSTEM
VERSION 1	DATE 3/20/98	PC 5 5

ENCLOSURE 1: 5 OF 5

Figure 1 con't: FLEAT Assembly and Component Drawings

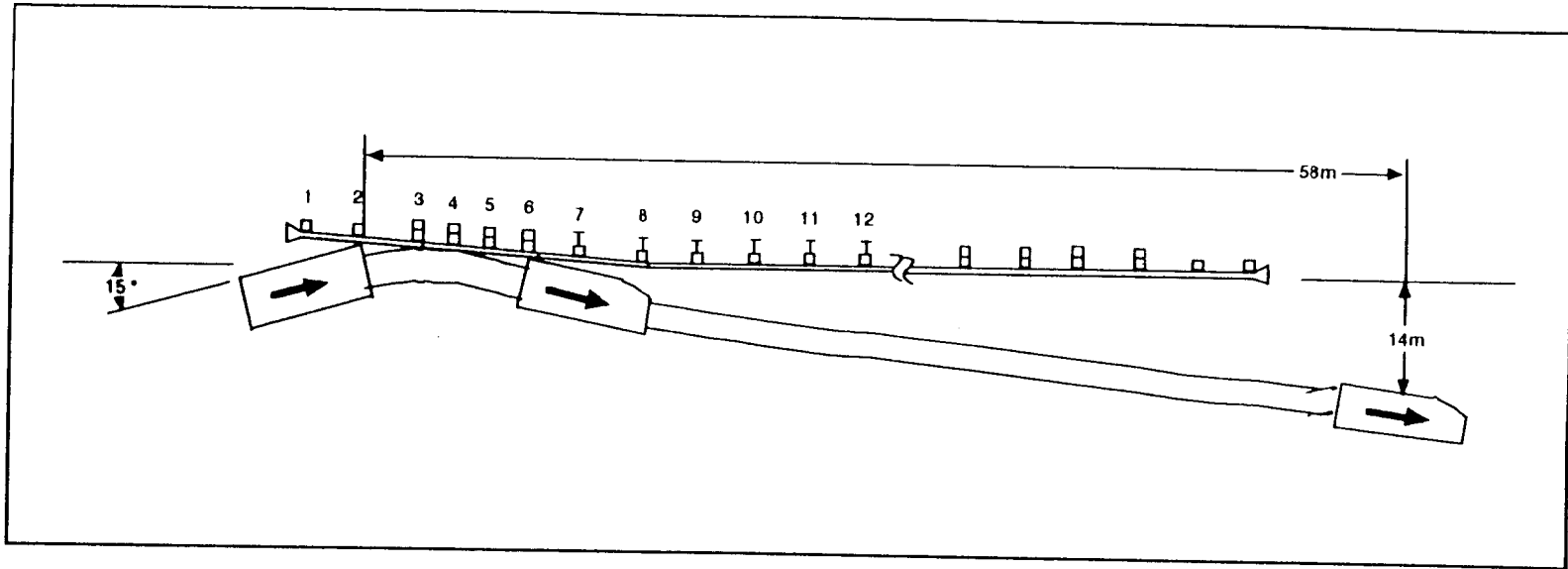


4. General Information		7. Test Vehicle (Continued)		10. Ridedown Acceleration (g's)	
Test Agency	Southwest Research Institute	Mass (kg) Dummy(s)	75	y-direction	-0.43
Test Number	FLEAT-1	Mass (kg) Gross Static	906	11. Test Article Deflection (m)	
Test Date	02/05/98	8. Impact Conditions		Dynamic	N/A
5. Test Article		Speed (km/h)	100.0	Permanent	N/A
Type	End Terminal	Angle (deg)	0.0	12. Vehicle Damage	
Installation Length (m)	57.2	9. Exit Conditions		Exterior	
Barrier		Speed (km/h)	0	VDS	12-FC-3
6. Soil Type and Condition		Angle (deg)	-5.6	CDC	12FCEW2
7. Test Vehicle		10. Occupant Risk Values		Interior	
Type	Production	Impact Velocity (m/s)		OCDI	AS0000000
Designation	820C	x-direction	8.24	13. Post-Impact Vehicular Behavior	
Model	1993 Ford Festiva	y-direction	7.37	Maximum Roll Angle (deg)	0 Approximate
Mass (kg) Curb	831	Ridedown Acceleration (g's)		Maximum Pitch Angle (deg)	10 Approximate
Mass (kg) Test Inertial	831	X-direction	-10.83	Maximum Yaw Angle (deg)	6 Approximate

Figure 6. Impact Sequence and Summary of Test Conditions and Results - Test FLEAT-1

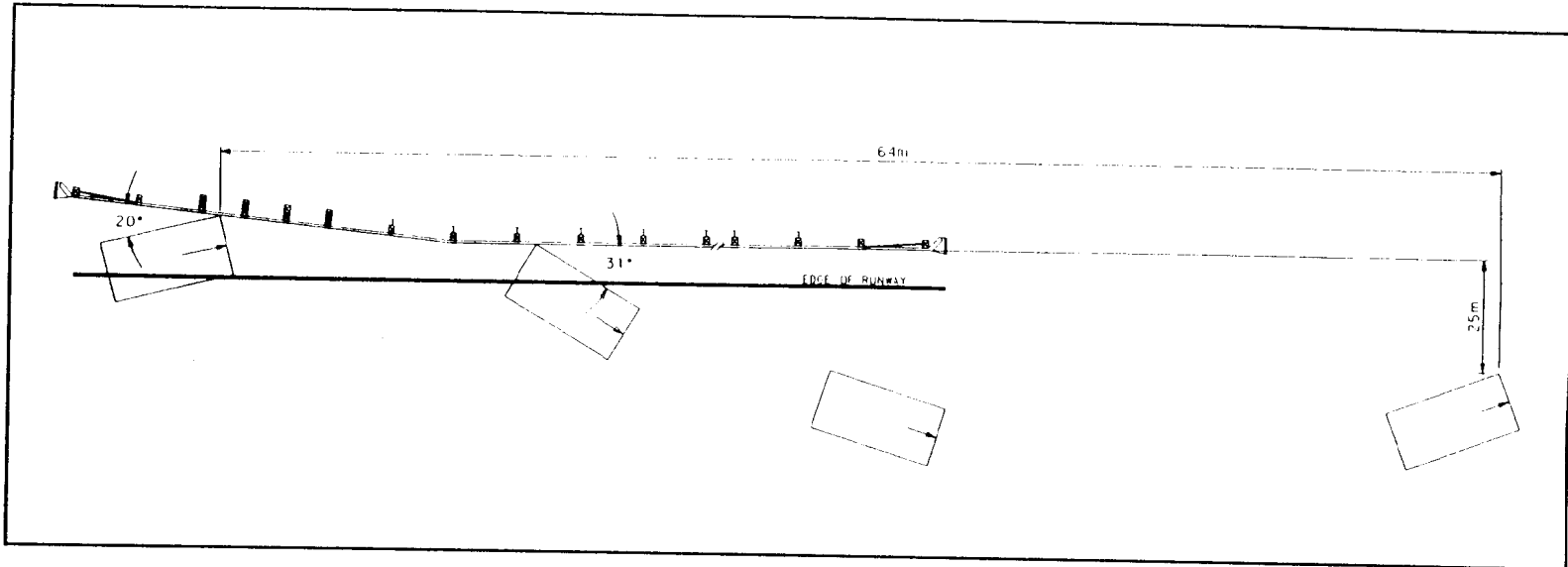






4. General Information		7. Test Vehicle (Continued)		10. Ridedown Acceleration (g's)	
Test Agency	Southwest Research Institute	Mass (kg) Dummy(s)	75	y-direction	12.6
Test Number	FLEAT-2	Mass (kg) Gross Static	904	11. Test Article Deflection (m)	
Test Date	03/03/98	8. Impact Conditions		Dynamic	0.67
5. Test Article		Speed (km/h)	100.0	Permanent	0.38
Type	End Terminal	Angle (deg)	15.0	12. Vehicle Damage	
Installation Length (m)	57.1	9. Exit Conditions		Exterior	
Barrier		Speed (km/h)	45.7	VDS	11-LFQ-3
6. Soil Type and Condition	Standard Soil, Dry Compacted	Angle (deg)	6	CDC	11FLEE2
7. Test Vehicle		10. Occupant Risk Values		Interior	
Type	Production	Impact Velocity (m/s)		OCDI	LF0000000
Designation	820C	x-direction	7.0	13. Post-Impact Vehicular Behavior	
Model	1992 Ford Festiva	y-direction	7.6	Maximum Roll Angle (deg)	10 Approximate
Mass (kg) Curb	829	Ridedown Acceleration (g's)		Maximum Pitch Angle (deg)	5 Approximate
Mass (kg) Test Inertial	829	X-direction	-7.1	Maximum Yaw Angle (deg)	0 Approximate

Figure 6. Impact Sequence and Summary of Test Conditions and Results - Test FLEAT-2



4. General Information		7. Test Vehicle (Continued)		10. Ridedown Acceleration (g's)	
Test Agency	Southwest Research Institute	Mass (kg) Dummy(s)	75	y-direction	-9.36
Test Number	SBD-1A	Mass (kg) Gross Static	2,043	11. Test Article Deflection (m)	
Test Date	10/30/97	8. Impact Conditions		Dynamic	1.0
5. Test Article		Speed (km/h)	100.0	Permanent	0.84
Type	End Terminal	Angle (deg)	20.0	12. Vehicle Damage	
Installation Length (m)	57.1	9. Exit Conditions		Exterior	
Barrier		Speed (km/h)	36	VDS	11-LFQ-3
6. Soil Type and Condition	Standard Soil, Dry Compacted	Angle (deg)	31	CDC	11FLEE2
7. Test Vehicle		10. Occupant Risk Values		Interior	
Type	Production	Impact Velocity (m/s)		OCDI	LF0000000
Designation	2000P	x-direction	6.74	13. Post-Impact Vehicular Behavior	
Model	1991 Chevrolet C2500	y-direction	2.20	Maximum Roll Angle (deg)	27 Approximate
Mass (kg) Curb	1,968	Ridedown Acceleration (g's)		Maximum Pitch Angle (deg)	21 Approximate
Mass (kg) Test Inertial	1,968	X-direction	-3.86	Maximum Yaw Angle (deg)	N/A

Figure 6. Impact Sequence and Summary of Test Conditions and Results - Test SBD-1A

these materials must occur in the United States.

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

(3) 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 (ii) clearly state that the contract will be awarded to the bidder who submits the lowest total bid based on furnishing domestic steel materials unless such total bid exceeds the lowest total bid based on furnishing foreign steel materials by more than 25 percent.

(4) 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 to be 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 (RFHWA) 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 RFHWA 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 RFHWA 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 RFHWA 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. 315, sec. 10 of Pub. L. 98-229, 98 Stat. 55, sec. 165 of Pub. L. 97-424, 98 Stat. 2136 and 49 CFR 1.48(b))

(48 FR 53104, Nov. 25, 1983, as amended at 49 FR 18821, 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 and on plans to single trade name materials will not be approved on Federal-aid contracts.

#### § 635.413 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,