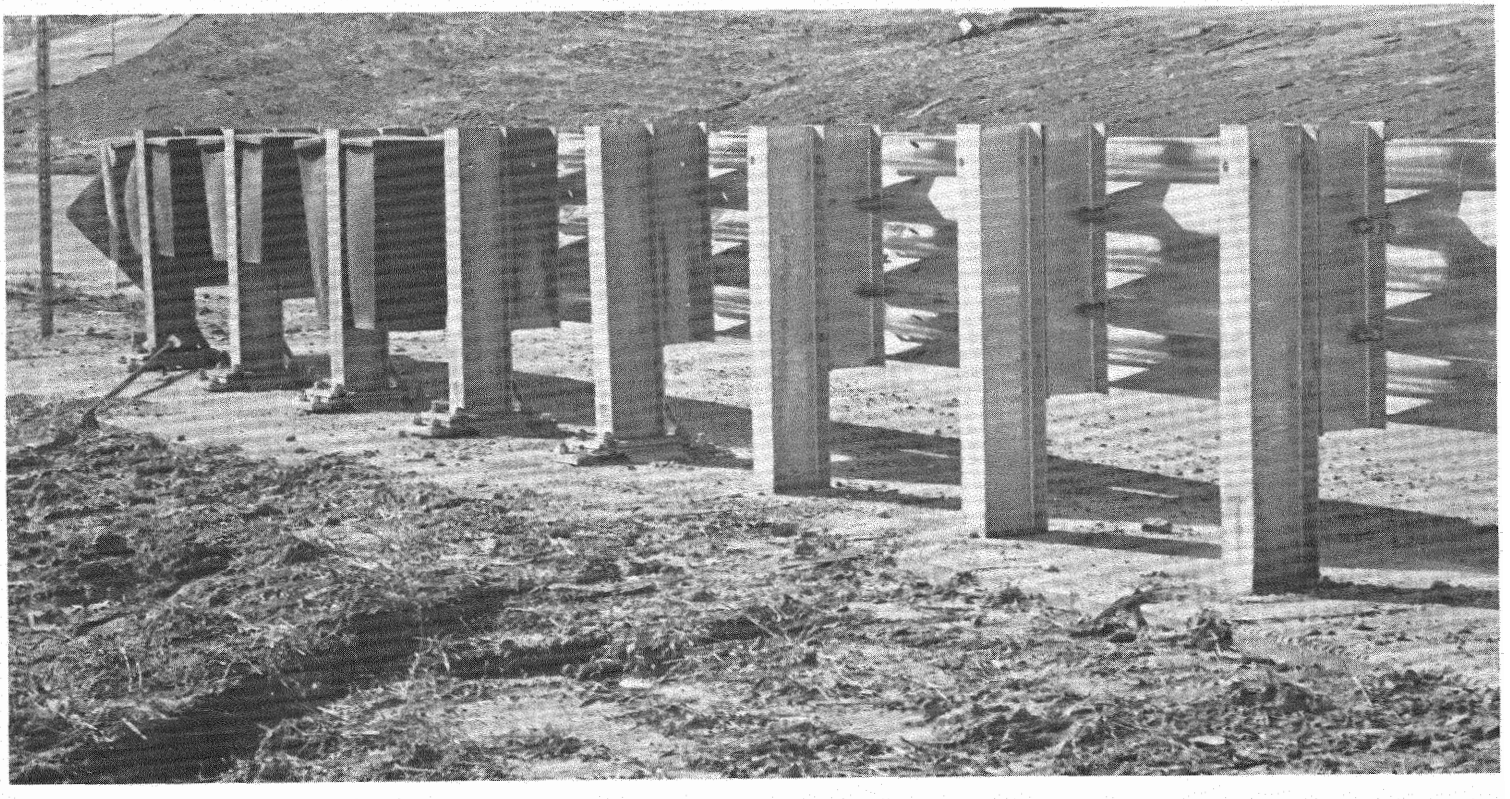
MODIFICATION AND EVALUATION of SENTRE™ IMPACT ATTENUATION DEVICES



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16. ABSTRACT

This report covers a study of **SENTRE** Impact Attenuation Devices, done to identify potential design or installation improvements, to make these improvements, and evaluate performance of the devices once the indicated modifications were made.

During the study, a total of 21 **SENTRE** devices were installed on I-40 in Oklahoma City. Ten accidents involving **SENTREs** were documented. Analysis of these accidents led to modifications in amount of torque applied to anchor bolts, type of clips holding posts to base plates, and depth of topsoil covering the redirecting cable.

The limited number of **SENTRE** installations, and the even more limited number of accidents precluded a statistical comparison of accidents involving **SENTREs** to those with exposed guardrail ends or other types of impact attenuation. In all of the accidents occurring after the modifications were made, the **SENTRE** units performed as the designers intended, suggesting that they were effective in reducing impact severity.

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EXECUTIVE SUMMARY

The SENTRE impact attenuation device was evaluated by the Oklahoma Department of Transportation with two separate objectives. The first objective of the study was to determine if the devices were operating as their designers intended, to reduce accident severity when struck by vehicles, and if not, make the modifications necessary to "make the SENTRE's work".

As units were struck, their performance was analyzed, and areas where improvement was needed were identified. Modifications in installation procedure or unit design were then made to improve their performance. Modifications made under this objective included: changing torque requirements on anchor bolts, adding reinforcing clips to post bases, and specifying the amount of cover required over redirecting cables.

The second objective consisted of evaluating SENTRE performance, once necessary modifications were made. A total of 10 accidents involving the SENTRE units were documented during the study. The first five accidents included situations where performance of the units indicated the need for design or installation changes. The remaining five accidents were cases where the units performed as intended, suggesting that they were effective in reducing the accident severity.

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INTRODUCTION

The Insurance Institute for Highway Safety reports that in 1988, 1,229 deaths could be attributed to collisions with guardrails.[1] With the trend toward smaller cars, untreated guardrail ends pose a very serious threat.

Energy Absorption System's SENTRE end treatment had been tested under federal standards for impacts by light and heavy cars before ODOT's investigation began.[2] ODOT's investigation was conducted with the intent of satisfying two objectives: (1) identifying any design or installation characteristics which could be modified to achieve better unit performance, making these modifications, and (2) evaluating SENTRE performance under actual roadway conditions.

A typical SENTRE unit installation is illustrated in Figure 1. The SENTRE reduces impact severity using a system of telescoping panels connected to the exposed end of a guardrail or barrier.* The system gently slows an impacting vehicle while a redirecting cable guides the panels and the vehicle sideways, away from the guardrail "hard spot". Posts supporting the SENTRE unit are on slip bases which allow them to slide with the impact when hit. Also, SENTRE units have plastic sand containers

*NOTE: This evaluation began in 1985. At that time, SENTRE units were used for protection on ends of both barriers and guardrail, with different transition rails used between the units and the protected structures. Since then, Energy Absorption Systems has developed the TREND unit to be used on barriers, while SENTRE units are now used only as end protection on guardrails.

mounted on the first three posts facing the traffic. These rupture during impact, which helps to dissipate the collision energy.

A total of 21 SENTRE units were installed on I-40 in Oklahoma City, at the locations shown in Table 1. Bid price per unit, which included installation by the contractor was $4,100 each ($86,100 total). This amount could probably be lowered somewhat on projects where larger numbers of SENTREs were installed.

Maintenance and repair of the units has been done by the ODOT Interstate Maintenance Unit, 2901 East Reno, Oklahoma City.

Figure 1. SENTRE Unit.

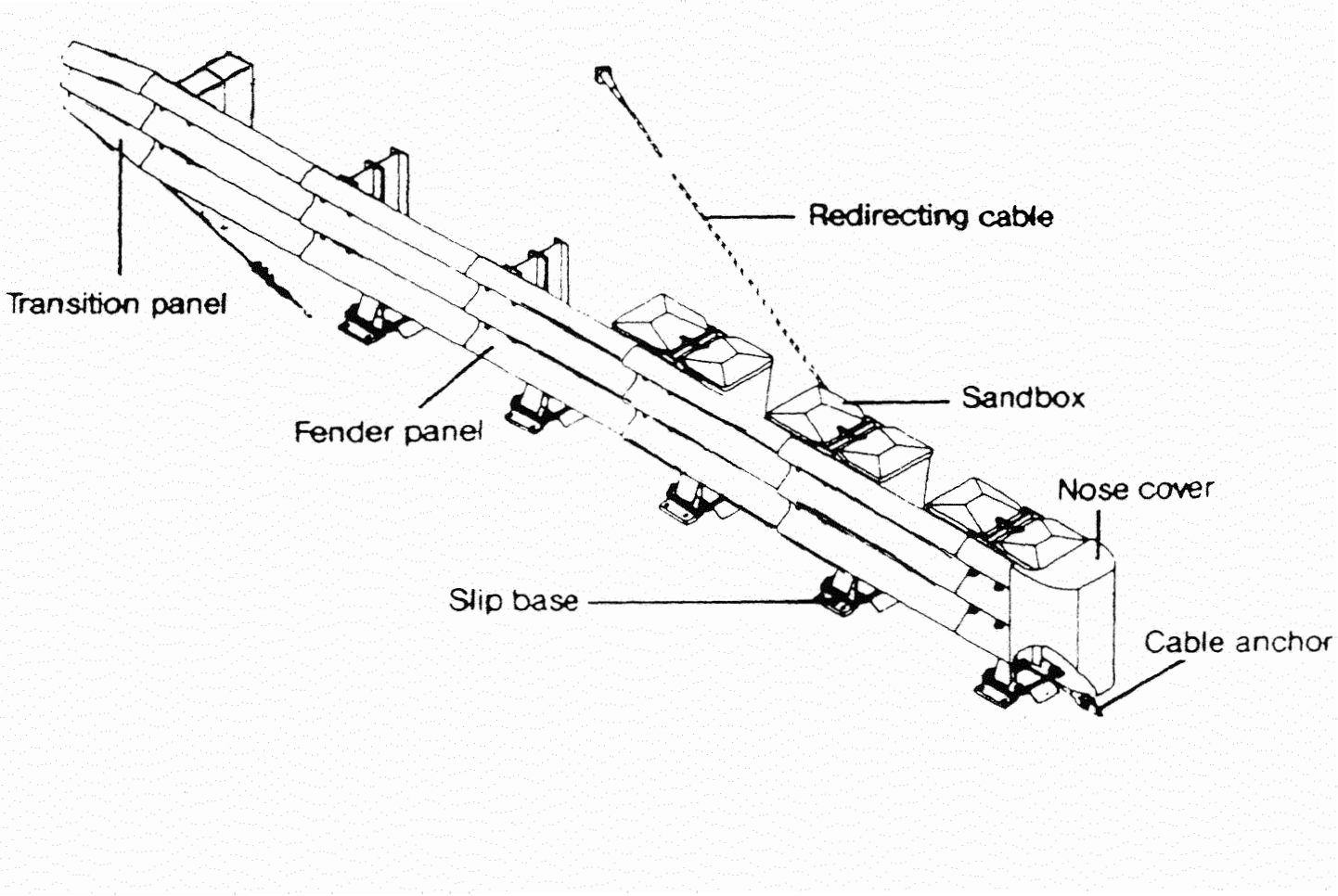


Table 1. SENTRE Unit Locations

SENTRE Units on I-40 Eastbound

1. Entrance ramp onto eastbound I-40 from northbound I-44.
2. Immediately west of May Avenue Underpass.
3. Immediately east of May Avenue Underpass.
4. Agnew/Villa Avenue exit ramp.
5. Immediately west of Agnew/Villa Avenue Underpass.
6. Agnew/Villa Avenue entrance ramp to eastbound I-40.
7. Immediately west of Pennsylvnia Avenue Underpass.
8. Virginia Avenue entrance ramp to eastbound I-40.
9. Immediately west of Western Avenue Underpass.
10. Western/Reno Avenue exit ramp (north side of ramp).
11. Western/Reno Avenue exit ramp (south side of ramp).
12. Reno Avenue entrance ramp to eastbound I-40.

SENTRE Units on I-40 Westbound

13. Immediately east of Western Avenue Underpass.
14. Immediately west of Sheridan Avenue ramp to westbound I-40.
15. Immediately east of Virginia Avenue underpass.
16. Pennsylvania Avenue entrance ramp to westbound I-40.
17. Immediately east of Agnew/Villa Avenue Underpass.
18. Agnew/Villa entrance ramp to westbound I-40.
19. May Avenue exit ramp.
20. Immediately east of May Avenue underpass.
21. Exit ramp from westbound I-40 to northbound I-44.

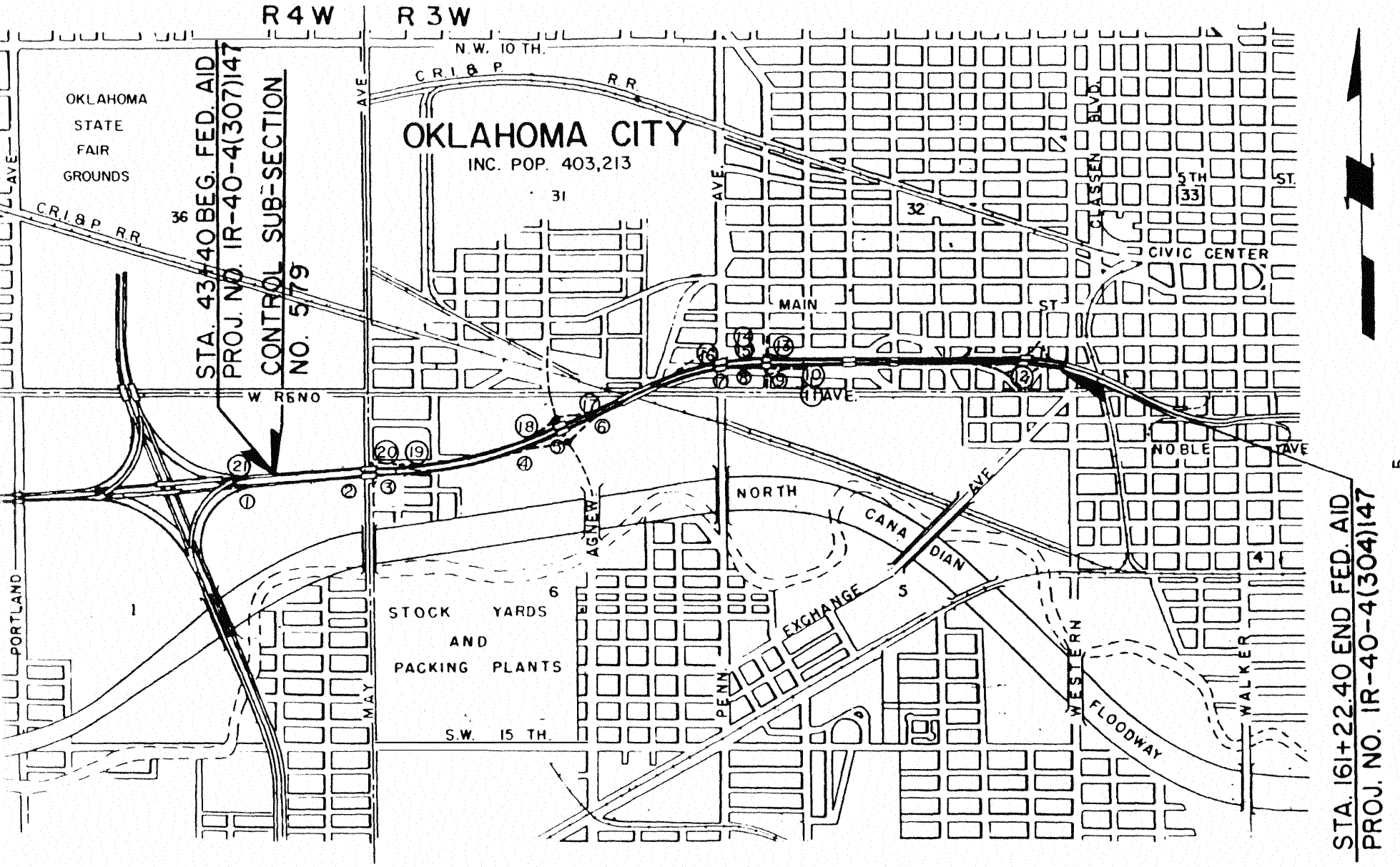


Figure 2. SENTRE Unit Locations.

PROJECT LENGTH = 2.224 MI.

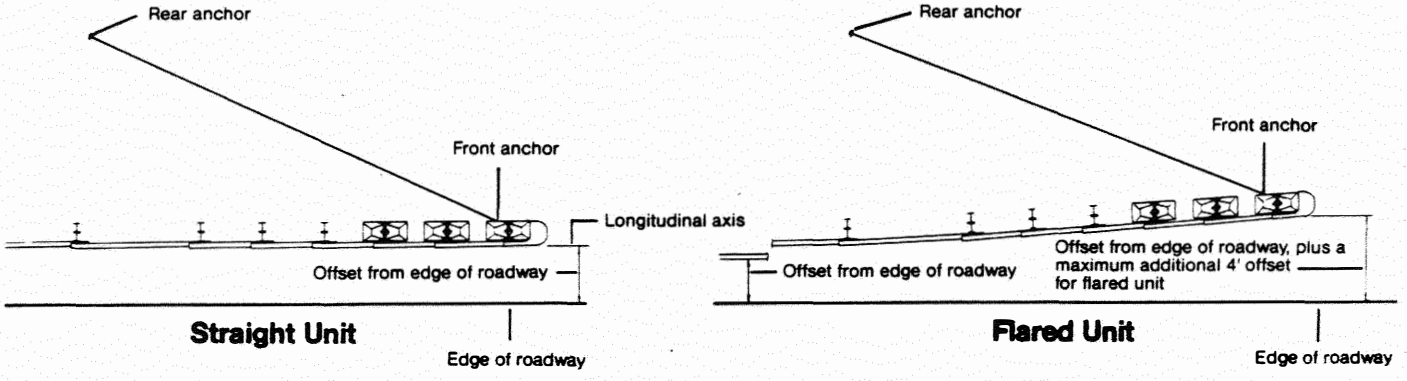
EQUATIONS _____ STA. 77+96.49 BK. = STA. 78+34.43 FWD.

INSTALLATION

Site Preparation

The appropriate location for a SENTRE guardrail/barrier end treatment includes an area extending forward from the end of guardrail or barrier, (see Figure 3 below) in the direction of oncoming traffic, for a distance of 20 feet. The site area should be level and free of obstruction. Any guardrail or posts extending into the site area should be removed.[3]

Figure 3. Straight and Flared SENTRE Unit Locations.



Pad Construction

Each SENTRE unit is constructed on a 4'-0" x 18'-0" x 0'-7" reinforced concrete pad. Pad design is illustrated in Appendix B. The first 3'-0" on the exposed end of the pad is 3'-0" thick, the purpose of the thickened section is to furnish the weight and physical shape necessary for the pad to resist the collision forces specified in the Special Provisions, (Appendix F). Also, one end of the redirecting cable is anchored in the thickened section. Reinforcing steel must be placed accurately, (as shown in Appendix B), to avoid interference with concrete anchor bolts.

Rear Cable Anchor Unit

The rear cable anchor is located as shown in Figure 1. Although the original plans (Appendix B) show this embedded anchor set in concrete in a rectangular hole, this was later modified. The anchor unit har ware remains the same, but it is embedded in concrete poured in a four foot diameter augered hole. The additional concrete furnishes greater mass, since depth remains the same. Also, the hole can be augered, where the rectangular hole originally called for, had to be dug by hand.

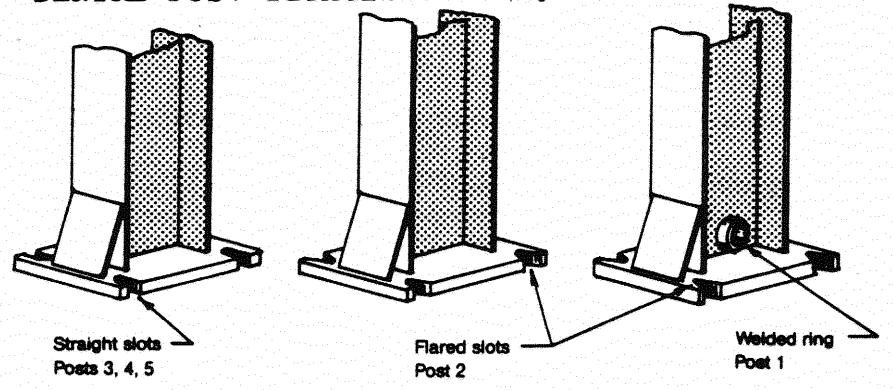
Slip Base and Cable Anchor Installation

The SENTRE unit may be installed on either straight guardrail or on guardrail that has been flared away from the traffic (see Figure 3).

Two different types of slip bases are specified for SENTRE units (Figure 4). The slip bases for posts 1 and 2 have flared slots, allowing for easier slip if hit at an angle. Posts 3, 4, and 5 have straight slots.

During installation, the bases are arranged next to the proper post locations before proceeding to the anchoring process. The slip bases should be installed so that the ramp ends touch the slab.

Figure 4. SENTRE Post Identification.



MODIFICATIONS

Anchor Footing Elevations

During the evaluation period, some SENTRE units failed to operate properly because the posts did not slide along the directing cable as the designers intended. Investigation determined that this was due to the rear footings of many units being installed at improper elevations, leaving the cable buried under one foot or more of soil.

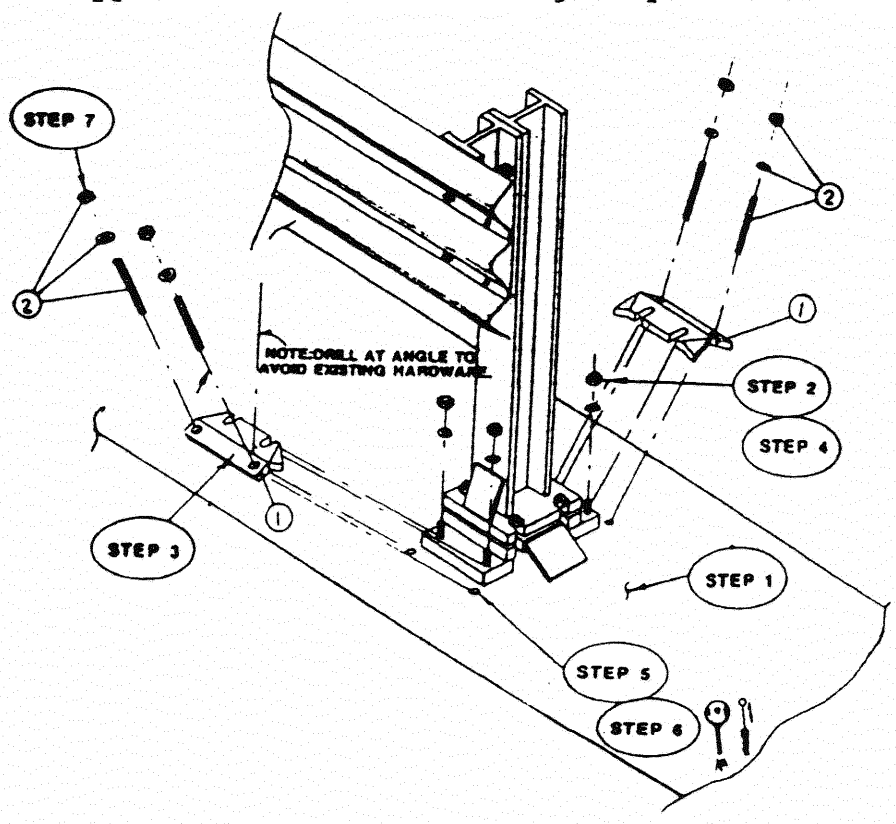
This problem resulted from footings being poured to existing shoulder elevations at the time they were constructed. Later, as shoulders and slopes were "dressed" to their final elevations, the footings and cables were buried with whatever depth of soil was needed to shape the slope. Experience during the study, (after corrections were made), indicated that one to three inches of cover would not affect the performance of the units. To prevent the cables from interfering with maintenance mowing operations, this depth of cover should be provided.

Retro-fitting

Early in the evaluation period, many of the collisions involving the SENTRE units resulted in a failure of the anchor bolts to hold the base plates to the concrete pad. This was eliminated by a design change, made by the manufacturer. The "Molly Wedge" anchor bolts originally used, were replaced with Hilti MP3 anchors set in drilled holes, with "C-10" a two-part epoxy system. "EASI" reinforcing clips were installed on the

slip bases at the same time the MP3 anchors were installed. "EASI" clips, and instructions for their installation, are shown in Figure 5 on the following page. All SENTRE units being evaluated received these modifications. Instructions for installing MP3 anchors are reproduced in Figure 5. Another factor which contributed to unit failures early in the evaluation period, was that pinch bolts were frequently over-torqued by the installation crews, making it impossible for the slip bases to function as intended. Pinch bolts should have been torqued to between 60 and 70 ft-lbs. In most cases, they were uniformly torqued to 125 ft-lbs. This was corrected during the retro-fit phase. This effect can be seen from the collision listing, Table 3, page 13.

Figure 5. Typical SENTRE Reinforcing Clip Installation.



Step 1: Thoroughly clean area surrounding posts to expose a flat concrete surface and post base plate.

Step 2: Remove nuts and washers on the (4) existing expansion anchors through base plate. (Do not remove slip base bolts.)

Step 3: Position reinforcing clips over the edges of the base plate so that the slotted holes fit over the existing expansion anchor studs then push the clips as close to the base plate as possible.

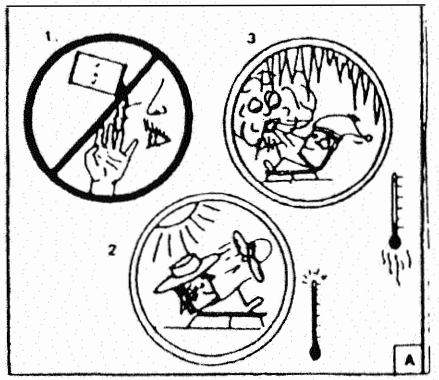
Step 4: If possible, replace the expansion anchor washers and nuts and torque them down to hold the clips firmly in position.

Step 5: Using a rotary impact concrete drill with a 7/8" bit drill through the large holes in the clips to a depth of 6 +/- 1/4" as measured from the surface of the concrete. Drill the holes at an angle to avoid interfering with the existing fender panels and sand boxes. The holes must be drilled to a depth of 5 3/4" minimum, cutting through rebar may be required.

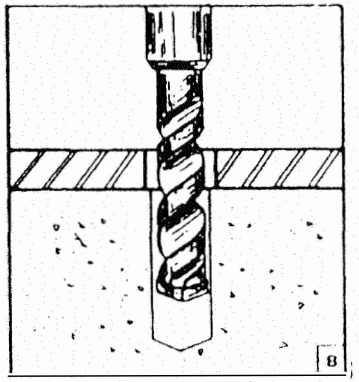
Step 6: Throroughly blow out the concrete dust from the hole, brush the hole and then blow it out again. Install the 7 1/2" long 3/4" diameter Grade 5 HD galvanized studs with the polyester chemical, carefully following the instructions on the package. Under no circumstances should the studs project more than 2" above the concrete surface.

Step 7: When the polyester chemical has cured (see package instructions) torque the anchors to 125 +/- 5 ft/lbs to firmly secure the reinforcing clips.

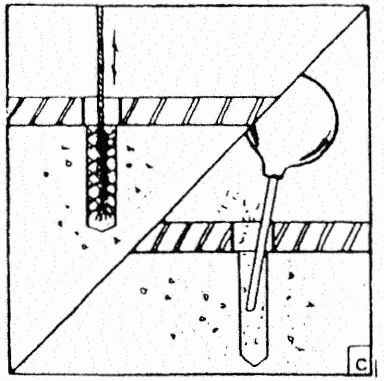
Step 8: Conduct steps 1-7 for all 5 posts on the SENTRE.



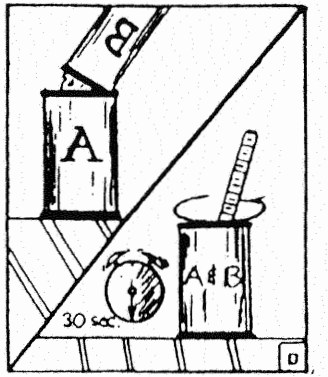
CAUTION: 1) Do not allow contact with skin or eyes (wear protection). Use in well ventilated area. 2) in hot weather, over 90 deg. F, keep kit cool until immediately before use, 3) in cold temperatures, below 60 deg. F, keep kit warm until immediately before use (pot life at 90 deg. F = 15 min, at 75 deg. F = 30 min, at 61 deg. F = 60 min, at 45 deg. F = 130 min)



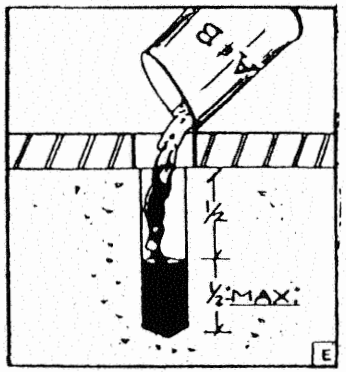
Position the part to be anchored according to the plans supplied with the unit. Drill the holes to the correct size and depth (1/8" larger than anchor diameter) following the recommendations on the plans. (NOTE: do not use a diamond drill as full strength may not be achieved) Check to be sure all the holes line up with the part to be anchored.



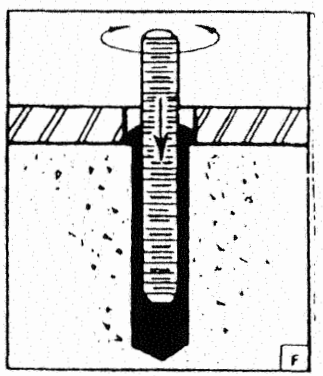
IMPORTANT: Brush the hole with a stiff bristled brush and blow it clean with oil-free compressed air to remove the concrete dust.



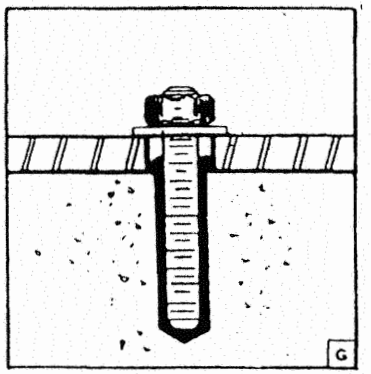
Remove the lids from the **MP3** part A - Resin and part B - Hardener containers. Pour part B - Hardener into part A - Resin then mix vigorously and thoroughly for 30 seconds. (An anchor stud makes a suitable stirring rod)



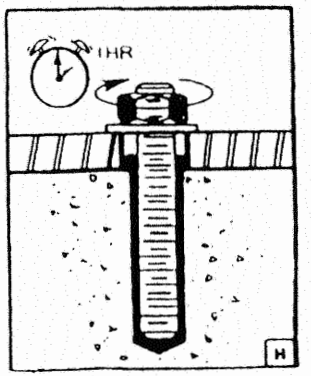
Pour **MP3 MIX** down into the clean hole through the part to be anchored, fill the hole approximately 1/3 - 1/2 full. Do not over or under fill.



Force the stud through the part being anchored down into the grouted hole leaving enough stud exposed to attach the nut and washer. Give the stud several twists to wet the threads.



Place a flat washer onto the stud then thread a nut on until it is flush with the top of the stud. Do not disturb the stud until the material has hardened.



Once the material has hardened, torque the nut to the values indicated in the plans.

Figure 6. How to Use MP3 Anchors.

COLLISIONS INVOLVING SENTRES

Individual collisions in which SENTRE units were hit during the study are listed on Table 3, page 13. Observations regarding the accidents and performance of the units, which led to corrective actions taken during the retro-fit phase, are included, as are actions taken.

Statistics regarding the ten accidents occurring during the study are listed in Table 2 below. It is the opinion of the author that dollar amounts for damages to attenuators could be lowered with installation of a greater number of units.

Table 2. Accident Statistics - Damages Due to Vehicle Impacts

	ESTIMATED DAMAGE TO IMPACTING VEHICLE (1)	DAMAGE TO ATTENUATOR (2)	TOTAL DAMAGE
Average	$3,800	$ 950	$4,750
Median	$5,000	$ 566	$4,165
Minimum	$1,150	$ 169	$1,669
Maximum	$8,000	$2,665	$8,300

(1) Estimated by Oklahoma Highway Patrol Trooper investigating accident.

(2) From ODOT Maintenance Crew records. Includes labor.

NOTE: Average, Median, Minimum and Maximum damages to vehicle and attentuator did not occur during the same accidents.

Table 3. Collisions Involving SENTRE Units

DATE	DESCRIPTION	SENTRE PERFORMANCE	CORRECTIVE MEASURES
4-26-85	Unit at Virginia St. & I-40 (east bound) hit.	Posts did not come off slipbases as intended. Pinch bolts were over-torqued.	Manufacturer had anchor bolts on all units torqued to 65 ft-lbs.
12-13-85	Unit at May & I-40 (eastbound) hit.	Posts did not come off slipbases. 1st post was torn off anchor plate.	None. This was considered to be due mainly to the angle of the collision.
8-25-85	Unit at Air Depot & I-40 (eastbound) hit.	Posts did not come off slipbases. Anchor plate was pulled out of concrete pad.	Manuafacturer was notified that earlier corrections didn't solve the problem.
8-17-86	Unit at Engle Rd. & I-40 (eastbound) hit.	Anchor bolts failed.	Manufacturer notified. They decided to ret-rofit at this point.
4-26-87	Unit at Klein & I-40 (eastbound) hit.	Slipbases performed as intended, but cable was buried too deeply for posts to slide down it.	ODOT Mainten. crew will raise cables when their workload allows.
5-12-87	Unit at Klein & I-40 (eastbound) hit.	Car hit unit on nose & rolled down backslope. Only the 1st two posts came off the slipbases. Both posts were bent.	None. Angle of impact appears to be the reason unit performed as it did.
7-4-87	Unit at Virginia Ave. & I-40 (east bound) hit.	Unit was hit on nose. Car rolled over after hitting it. Unit collapsed as intended. Front 2 posts bent, but did slide off bases. Six anchor bolts pulled out.	None.

Table 3. Collisions Involving SENTRE Units (Continued)

DATE	DESCRIPTION	SENTRE PERFORMANCE	CORRECTIVE MEASURES
8-24-87	Unit at Sunnylane Rd. & I-40 (east bound) hit.	Unit collapsed as intended. Two posts were bent.	None.
12-15-87	Unit at Reno & I-40 (westbound) hit.	Unit collapsed as intended. Two posts were bent.	None.
12-15-87	Unit at Klein & I-40 (eastbound) hit.	Unit collapsed as intended. Three posts were bent.	None.

Repairs After Collisions

When the evaluation began, it was thought that maintenance costs might be lowered with the use of SENTRE units. This was based on the assumption that most principal components could be repositioned and reused after most impacts. According to the ODOT maintenance crew who did the repair work after collisions involving the units, and their records, their experience did not show this.

Except for the pad, redirecting cable, and cable anchor which were not damaged during any of the accidents, all components actually involved in the collisions had to be replaced with new parts. Essentially, the only reuseable parts were those located far enough from the point of impact (i.e. Post 5, when first impact occurred on the nose), so that they were not affected.

Typically, fender panels and posts bend, even when they do telescope and come off slip bases as designed.

Also, a crew of three to five men is required for repairs, which in our experience, took approximately half a day. This amount of time is required because units must be disassembled for repairs, then reassembled with new componenents replacing those which are damaged.

Repair Costs

Components of a single SENTRE unit, and their cost, as of April 21, 1988, the date of ODOT's last replacement parts order, are listed in Table 4 on the following page. Nuts, bolts, washers, etc. are not listed. For a complete listing, including all hardware, see Appendix B.

Table 4. SENTRE Component Costs

NO.	COMPONENT	UNIT COSTS	TOTAL COSTS
1	Nose Cover	$ 65.00 ea.	$ 65.00
1	Post, No. 1	$ 95.00 ea.	$ 95.00
1	Post, No. 2	$ 85.00 ea.	$ 85.00
1	Posts, No. 3, 4 & 5	$ 65.00 ea.	$ 195.00
5	Blockouts	$ 20.80 ea.	$ 104.00
4	Sand Containers, 100 lb.	$ 45.50 ea.	$ 182.00
2	Sand Containers, 150 lb.	$ 58.50 ea.	$ 117.00
2	Base Plates, No 1 & 2	$ 31.50 ea.	$ 63.00
3	Base Plates, No. 3, 4 & 5	$ 19.50 ea.	$ 58.50
5	Bolt Keeper Plates	$ 11.70 ea.	$ 58.50
1	Redirecting Cable, 25' (threaded both ends)	$299.00 ea.	$ 299.00
5	Thrie Beam Fenders	$279.50 ea.	$1,397.50

NOTE: Based on prices as of April 21, 1988.

Numbers of individual components actually used for replacement during the study (other than nuts, bolts and washers), are tabulated on page 12. Note that 14 nose covers and hazard markers were used when only 10 collisions were reported. Also, some of the sand containers replaced were damaged by vandalism in addition to those damaged by vehicle impacts.

Table 5. Replacement Components Used

NUMBER USED	COMPONENT
33	100 lb. Sand Containers
12	150 lb. Sand Containers
23	Blockouts
14	Nose Covers
14	Hazard Markers
11	Fender Panels
10	Post No. 1
6	Post No. 2
8	Posts No. 3, 4, & 5
2	Base Plates

ACCIDENT STUDY

In an attempt to compare accident history prior to installation of the SENTRE devices to that after installation, a study of fixed object accidents covering the area where the SENTREs were installed was requested from the ODOT Traffic Engineering Division. Time periods used in compiling this information were: April 25, 1982 through April 25, 1985, and April 26, 1985 through April 26, 1988. This represented roughly three years before SENTRE installation, and three years after. These tabulations are shown in Appendix E.

Information regarding guardrail accidents, extracted from this study, is summarized in Table 6, below.

Table 6. Guardrail Accidents

TIME PERIOD	TOTAL NO. OF GUARDRAIL ACCIDENTS	TOTAL PROPERTY DAMAGE	NO. OF ACCIDENTS W/INJURIES	NO. OF ACCIDENTS W/FATALITIES
4-25-82 to 4-25-85	64	$220,675	23 (35.9%)	2 (3.1%)
4-26-85 to 4-26-88	21	$ 70,565	11 (52.4%)	0

It should be noted that construction was in progress during most of the 1985 - 1988 study period, on various parts of the study area. Speeds were lowered on some sections, some exits were closed, and some traffic was rerouted. These factors contributed to less traffic, and less accident exposure over much of the

second half of the study period. These factors are the likely reason for the marked reduction in property damage, injuries, and fatalities.

As can be seen from Table 6, the percentage of the guardrail accidents resulting in injuries actually increased, although the number of accidents decreased.

The first five accidents involving SENTRE units ocurred during the phase of the study when the units were being developed, and modifications discussed earlier, were made after accidents ocurred. The next five accidents ocurred after all modifications had been made and no corrective action was required. Although the accident study could not show this statistically, it is the opinion of the author, that the SENTRE's did reduce accident severity. During the last five accidents (those ocurring after modifications), the units operated as the designers intended during every impact.

CONCLUSIONS

The modifications to the installation procedure, discussed earlier, are now addressed in the current version of the manufacturer's installation manual. The changes in the type of anchor bolts and reinforcing clips used are now standard features.

It is an important point that pinch bolts must be torqued to between 60 and 70 ft-lbs, or slip bases will not function properly. This has also been addressed in the current installation manual.

Although the number of collisions occurring after modifications was limited, SENTRE unit performance during those collisions suggests that the SENTREs do contribute to reducing accident severity.

Repair of the units, once a collision has occurred, can be expected to require approximately four hours, for a three to five-man crew. Also, repairs done during the study indicate that any components actually involved in the collision must be replaced. With the exception of the pad, redirecting cable, and cable anchor, the only reuseable parts are those located far enough from the point of impact so that they are not affected. To repair a SENTRE, the entire unit must be disassembled, the damaged parts replaced, then the unit must be reassembled.

RECOMMENDATIONS

1. Consideration should be given to using SENTRE units on future projects where guardrail end protection is desired.

2. Installation of SENTRE units should be planned, and then checked by construction inspectors, to insure that the redirecting cable anchors are placed at the proper elevation, so that the cable has 1 to 3 inches of cover.

3. A torque wrench should be used during installation of slip bases. Nuts holding slip bases should be tightened to between 60 and 70 ft - lbs torque. This should be checked by inspectors during construction.

4. Maintenance forces attempting to estimate numbers of components for repair stockpiles should consider:
   a. Nose covers and hazard markers can be expected to require replacement in 100% of the accidents involving SENTREs.
   b. Sand containers may be damaged by vandalism as well as by vehicle impacts.
   c. Components placed toward the end of the unit facing traffic are more likely to sustain damage, and require replacement than those on the "transition" end.

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3. SENTRE Guardrail End Treatment, Installation Manual, Energy Absorption Systems, Inc., 1984.

4. Drawing Number 80-04-03, Concrete Pad Detail, Energy Absorption Systems, Inc., 1980.

5. MP3 Anchor Instructions, Hilti Corporation. 1984

APPENDIX A

PHOTOGRAPHS

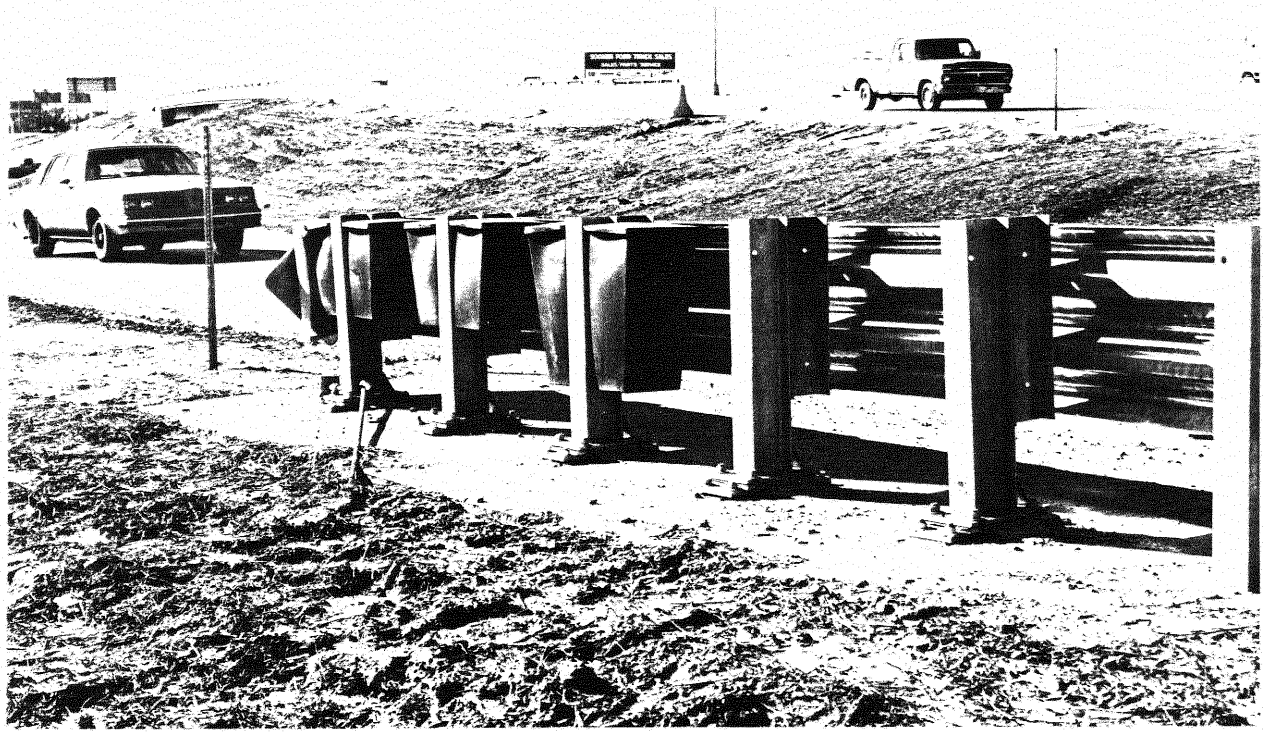


Figure 1. SENTRE unit after installation on guardrail end.

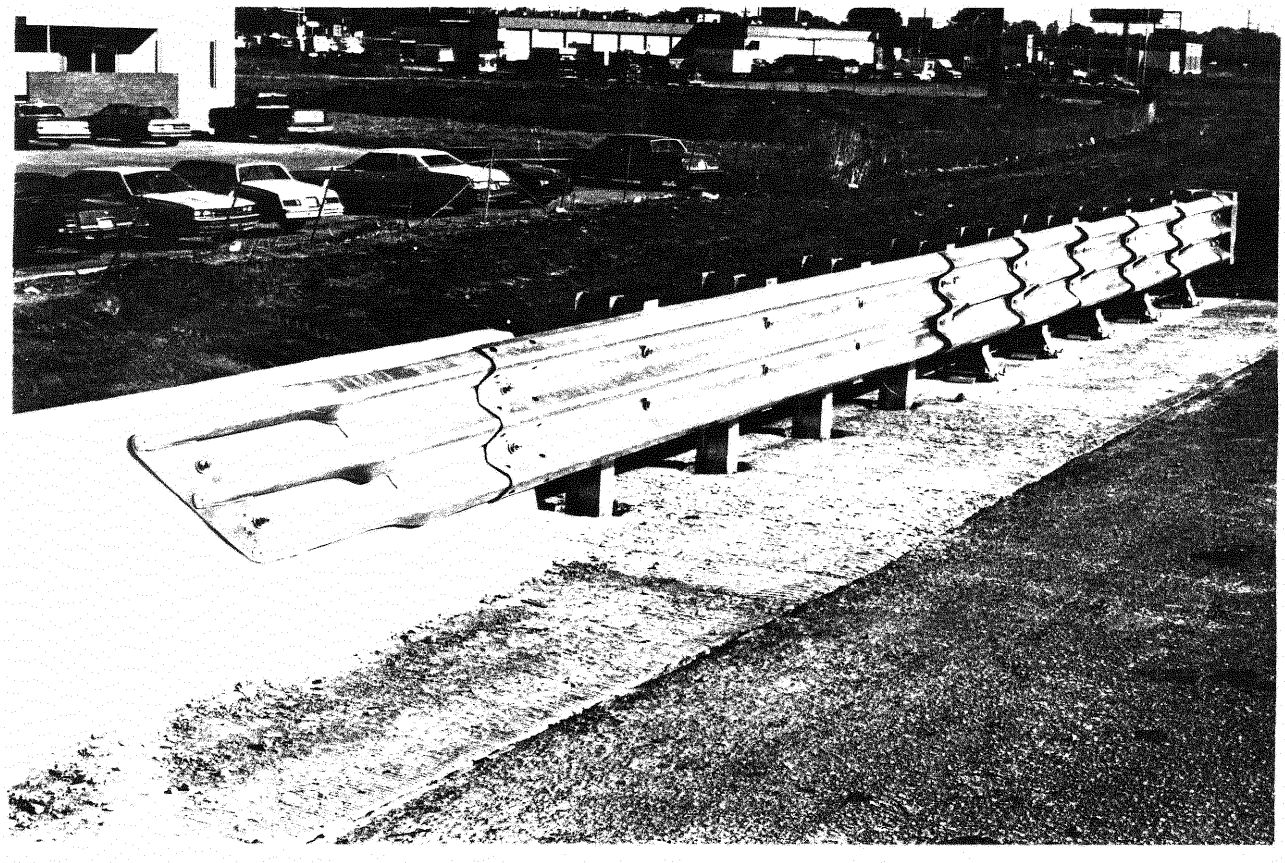


Figure 2. SENTRE unit after installation on barrier end.

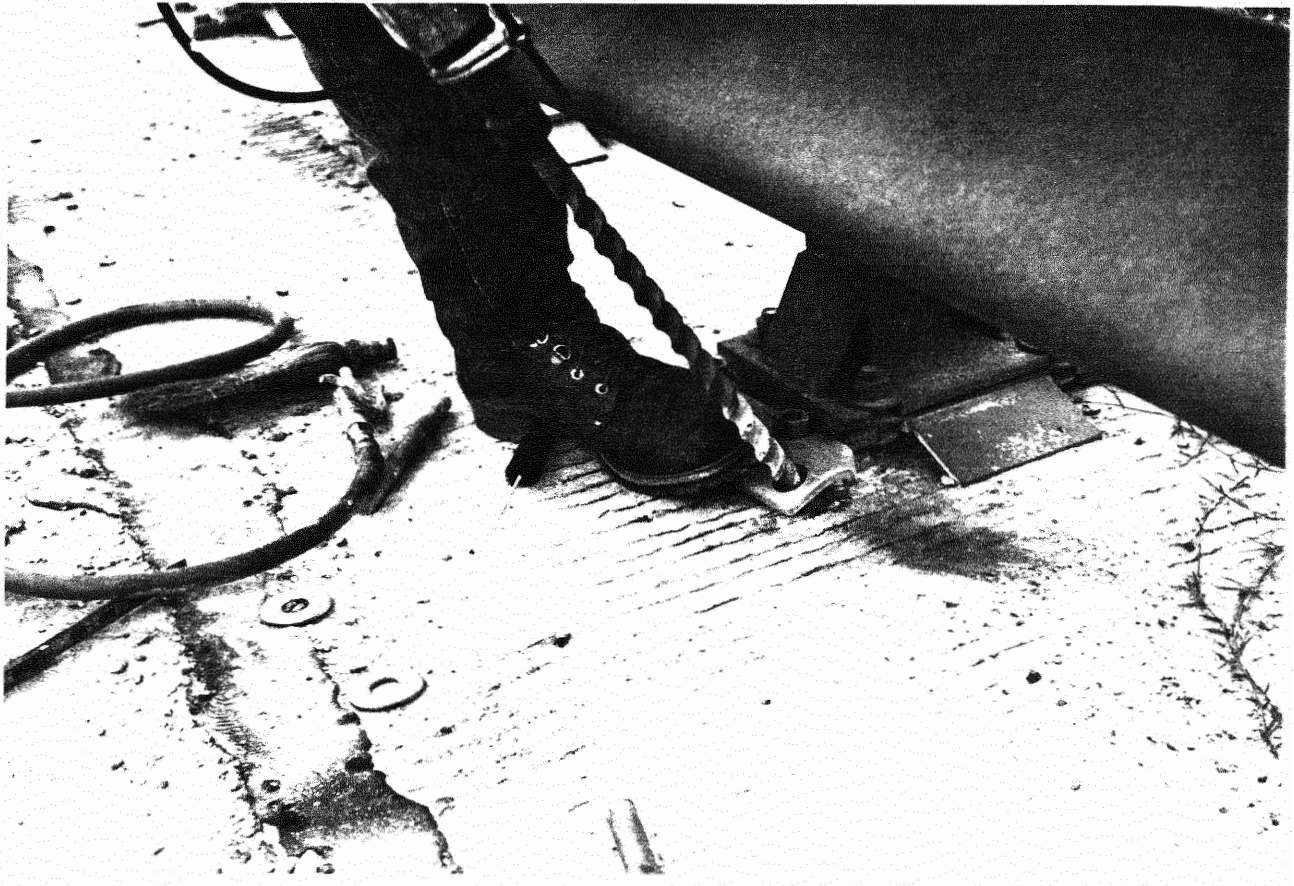


Figure 3. Drilling holes for "MP-3" anchors during retrofit.

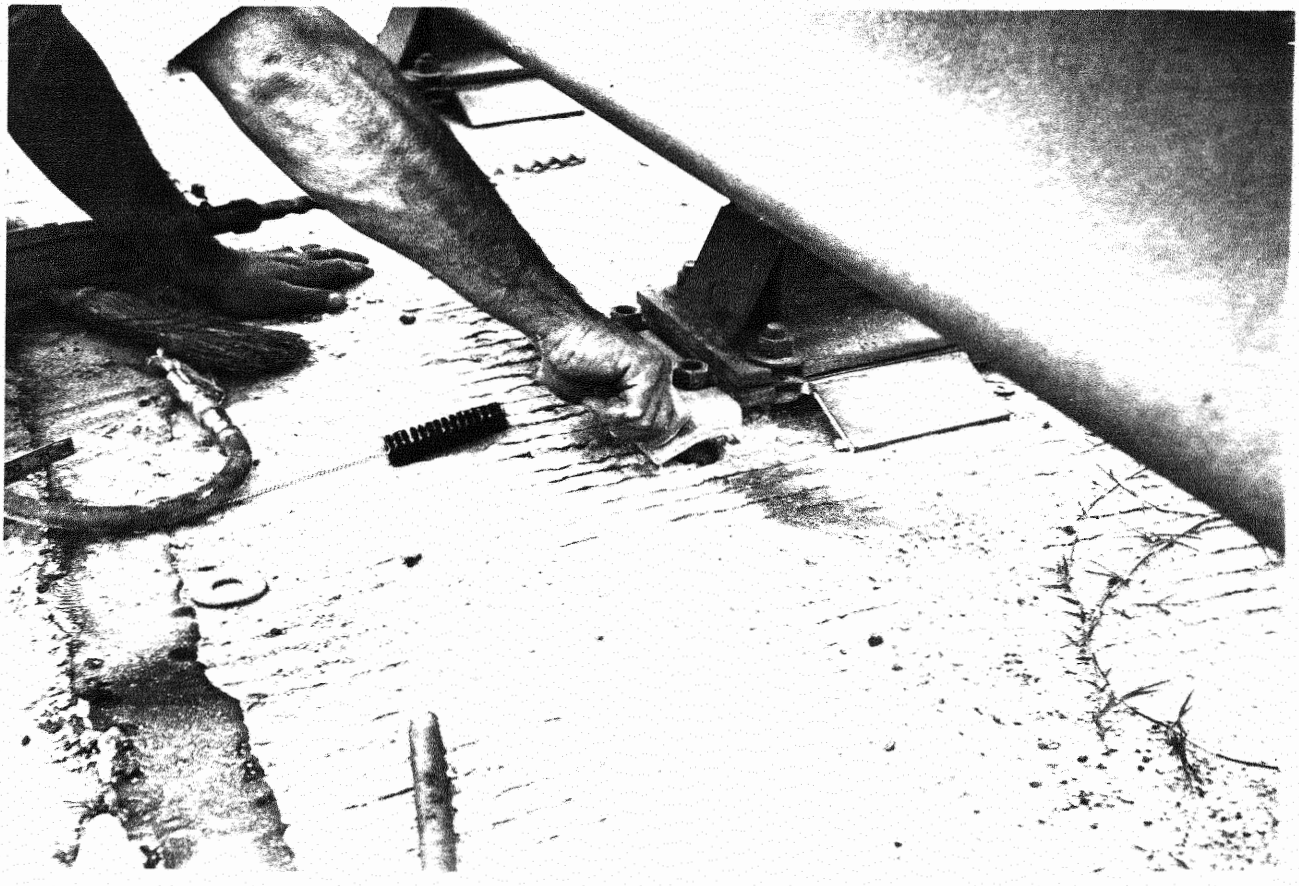


Figure 4. Placing "MP-3" anchors after cleaning hole - retrofit phase.

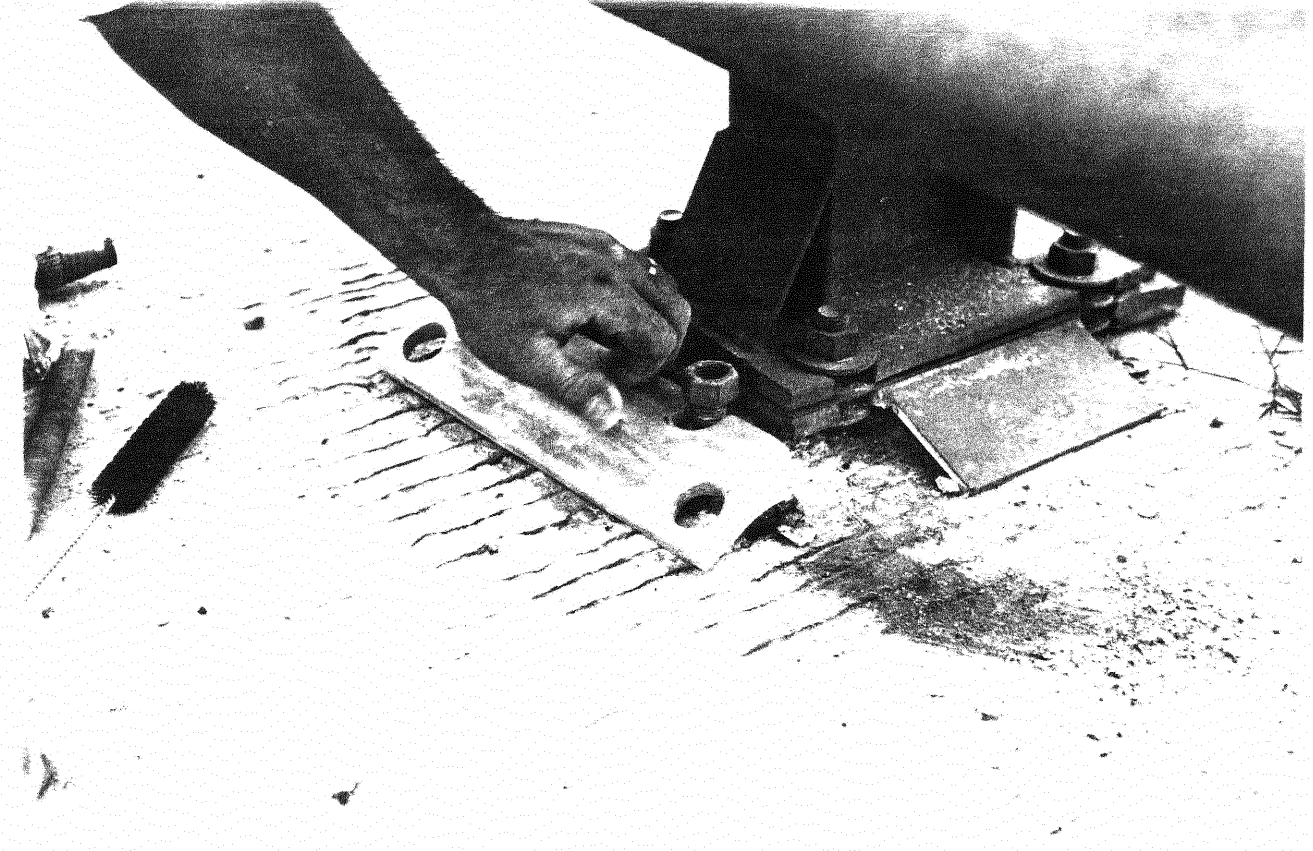


Figure 5. Reinstallation of slip base, retrofit phase.

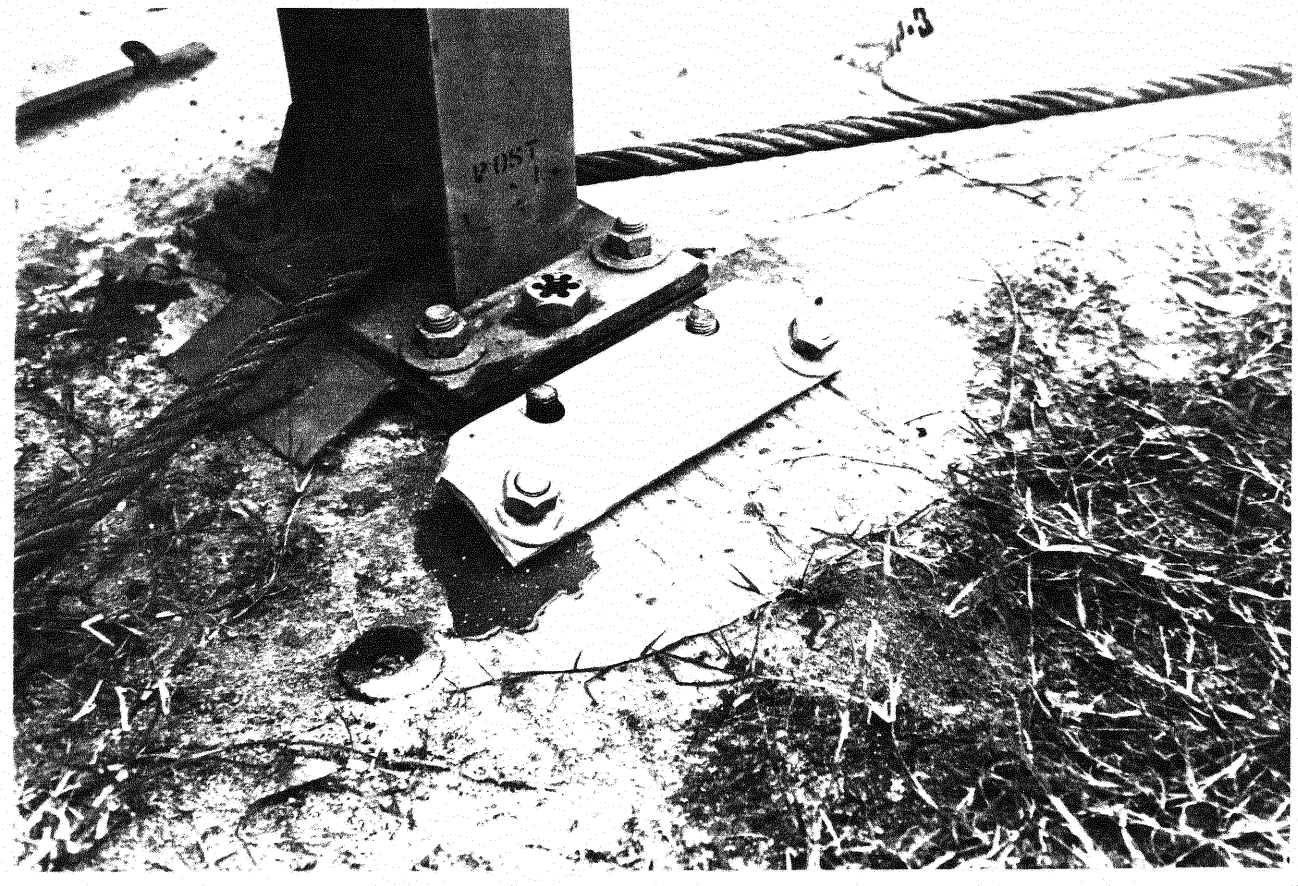


Figure 6. Slip base retrofit, "MP-3" anchors rethreaded.

Figure 7. After collision - unit functioned as intended.

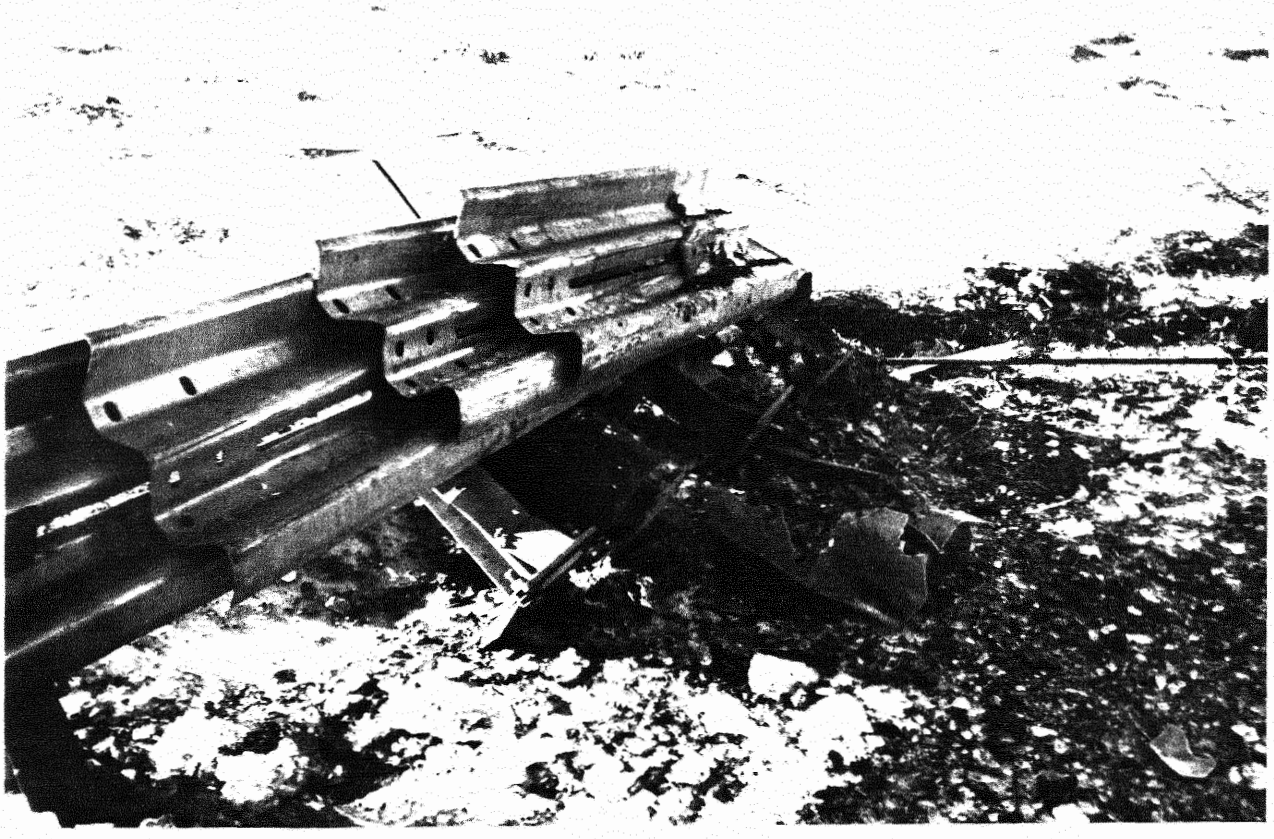


Figure 8. Unit after collision - unit functioned as intended.

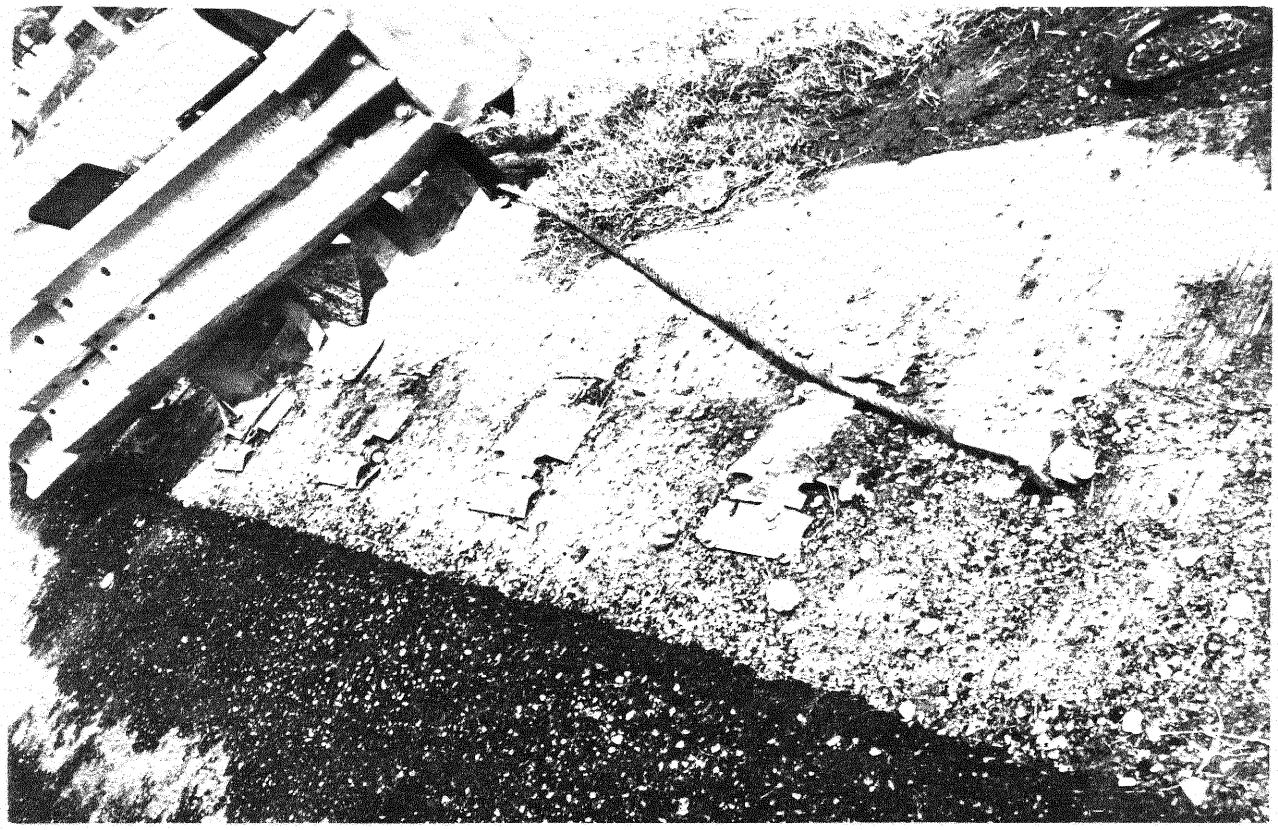


Figure 9. After impact, first three slip bases performed as intended.

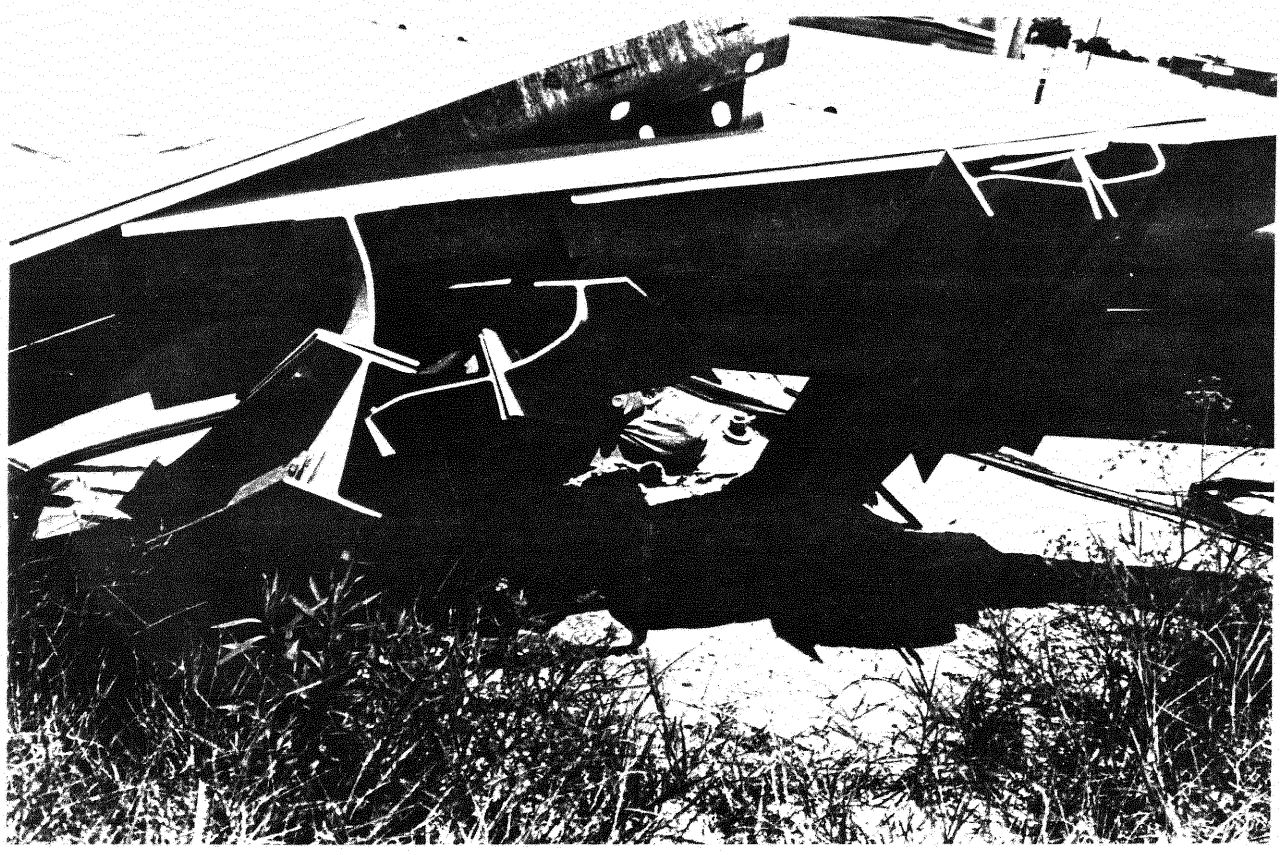


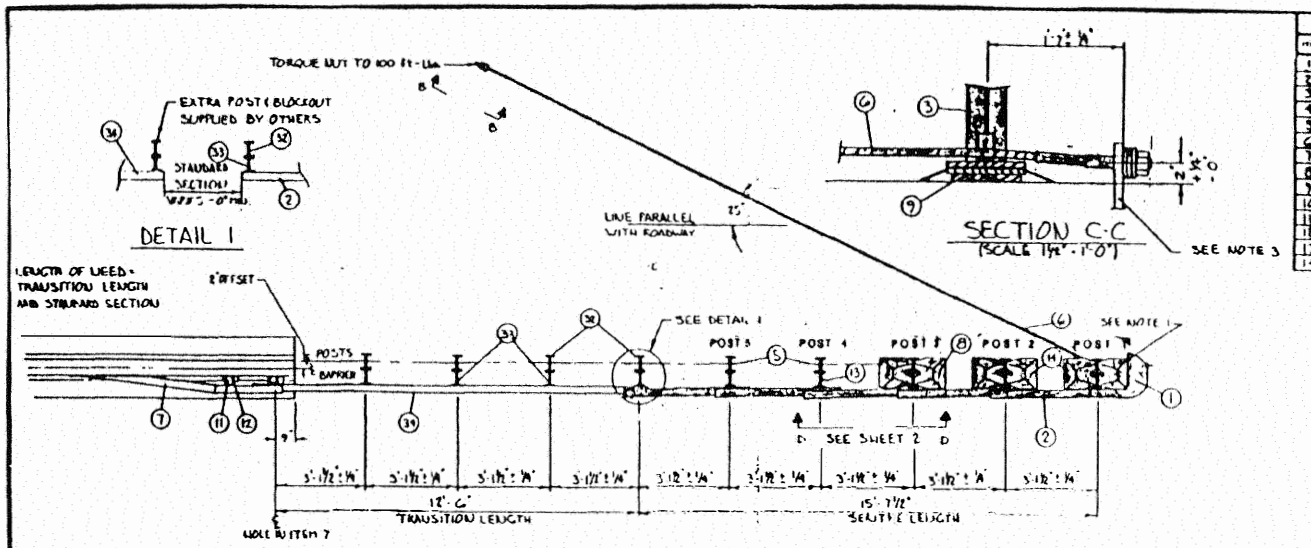
Figure 10. SENTRE unit after impact. Slip bases failed to work due to over-torqued pinch bolts.

Figure 11. Slip base after impact, base did not perform.

Figure 12. SENTRE unit after impact, unit generally performed as intended, but anchor bolts were pulled out of slab.

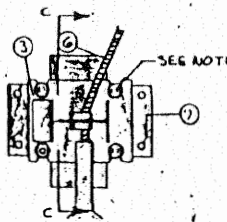
APPENDIX B

SENTRE PLANS



ITEM	STOCK NO	DESCRIPTION	REQUIRED
1	20-20-931	BULLNOSE (PLASTIC)	1
2	27-58-111	FENDER PANEL	1
3	27-52-011	POST #1	1
4	27-56-021	POST #2	1
5	27-56-031	POST #3,4,5	3
6	27-42-181	REDIRECTING CABLE 15FT.	1
7	27-52-241	TRANSITION PANEL (4' OFFSET)	1
8	20-20-941	SAND CONTAINER 100LB (PLASTIC)	1
9	27-56-061	BASE PLATE (POSTS #1,2)	2
10	27-56-071	BASE PLATE (POSTS #3,4,5)	3
11	27-62-371	SUPPORT BRACKET	2
12	27-01-261	CONC. ANCHOR BOLT (TYP) 5/8" Ø x 4½"	6
13	27-56-091	BLOCKOUT	3
14	20-20-951	SAND CONTAINER 100LB (PLASTIC)	1

(CONTINUED ON SHEET 2)



Note:

1. Fill Containers with sand meeting ASTM C-33 (washed concrete sand) or equivalent, then snap lids tightly in place.
2. Torque slip-base bolts to 60 ± 5 ft. - lbs.
3. Re-directing cable anchors are accessory items and must be capable of withstanding the forces described in the "SENTRE general specification".

Customer Prints JUL 0 2 1984

STANDARD SENTRE COMPONENTS ARE SHADED

Revisions	Date	Rev	By	Chkd	App
SEE SHT 2	5-MAY-84	A	T.J.	[illegible]	[illegible]
ADDED DETAIL 1	5-MAY-84	B	T.J.	[illegible]	[illegible]

Material

DESIGN SPEED ____ M.P.H.
AVERAGE G's
EST. FORCE ON BACKUP STRUCTURE ____ KIPS

	Date
Designed	
Drawn T.J. JACKSON	1-16-84
Checked [illegible]	1-18-84
Approved [illegible]	2-9-84

Tolerances:
a Angular
b Linear
Unless Otherwise Noted

REFERENCES

Project No ____ Sales Order No 10919
Serial No ____ Color ____

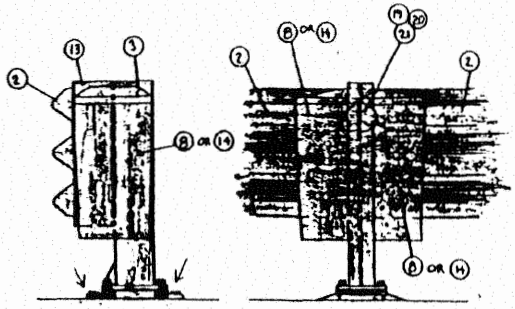
TYPICAL POST & ASSY	80-00-01 SHT 3
TRANSITION DATA FOR FLARED INSTALLATIONS	80-00-01 SHT 4
CONCRETE PAD	80-01-02
CABLE ANCHORAGE DETAIL (REDIRECTING)	80-02-02

ENERGY ABSORPTION SYSTEMS, INC.
ENGINEERING AND RESEARCH DEPARTMENT

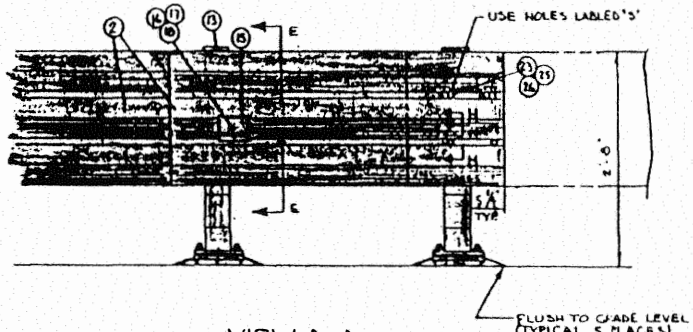
SENTRE
W/ TRANSITION TO N.J. BARRIER

SCALE ⅛" = 1'-0" | SIZE C | DWG NUMBER 80-00-03 | SHEET 1 OF 2 | REV B

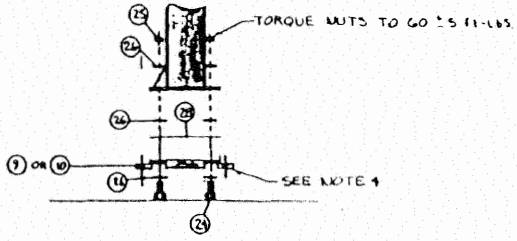
B-1



SAND CONTAINERS
(TYPICAL POST 3)

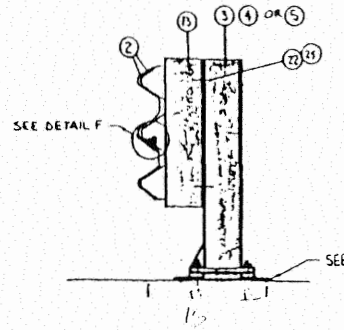


VIEW D-D
FENDER PANEL ASSY.

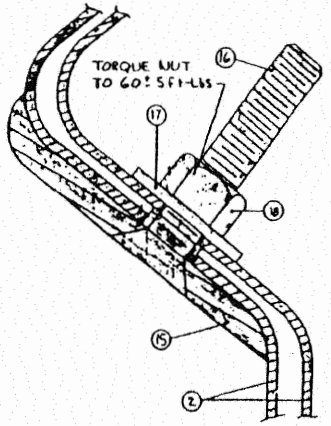


EXPLODED SLIPBASE ASSEMBLY

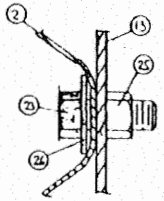
ITEM	STOCK NO	DESCRIPTION	REQ'D
15	27-08-151	MUSHROOM WASHER	—
16	27-01-711	FLAT HEAD ALLEN MACHINE BOLT 5/8"X1"	—
17	27-08-341	SQUARE WASHER 4"X2"X2" W/5/8"Ø HOLE	—
18	27-01-191	H.H. NUT 5/8"	—
19	27-01-101	H.H. BOLT 5/8"Ø X 2"	—
20	27-08-321	FLAT WASHER 5/8" ID & 1 1/2" OD	—
21	27-01-051	H.H. NUT 1/2"	—
22	27-01-641	H.H. BOLT 1/2"Ø X 1 1/4"	8
23	27-01-381	H.H. BOLT 1/2"Ø X 2"	11
24	27-01-221	H.H. BOLT 1/2"Ø X 1 1/2"	—
25	27-09-091	H.H. NUT 3/4"	20
26	27-08-331	FLAT WASHER 3/4"	12
27	27-08-201	LOCK WASHER 3/4"	14
28	27-36-081	BOLT KEEPER PLATE	—
29	27-01-661	FLUSH ANCHOR 3/4"	2
30	27-08-261	SQUARE WASHER 3"X3" W/13/16"Ø HOLE	—
31	DELETED		
32	27-52-021	W.F. POST (6'-8") (W.F. 6 & 7)	4
33	27-52-031	W.F. BLOCKOUT (12") (W.F. 6 & 7)	4
34	27-52-901	THRIE BEAM EXTENSION PANEL (1'-6 1/4") MID	1



SECTION E-E
TYPICAL POST ASSY.



DETAIL F
SCALE FULL
(MUSHROOM BOLT
ASSEMBLY)



SECTION H-H
(SCALE 1/2"=1')

NOTES: (Continued)

4. The SENTRE slip base plates (Items 9 & 10) must be attached to an anchor or concrete pad which can be locally designed to resist the loads described in the "SENTRE general specifications."

STANDARD SENTRE COMPONENTS ARE SHADED

Revisions	Date	Rev.	By	Chkd	App
ITEMS 32 & 33 WERE WF 6 & 7 AND ARE WF 6 & 7	4 DEC	A	T.J.		
SEE SHT 1	5 DEC	B	T.J.		

DESIGN SPEED ____ M.P.H.
AVERAGE G's ____
EST. FORCE ON BACKUP STRUCTURE ____ KIPS
Designed
Drawn T. J. JACKSON 11-17-84
Checked 12-19
Approved W. G. Rabak 12-19-84
Tolerances:
a Angular
b Linear
Unless Otherwise Noted:
Material:

REFERENCES
Project No ____ Sales Order No ____
Serial No ____ Color ____

REGISTERED PROFESSIONAL ENGINEER
WILLIAM G. RABAK
No. 13121
MECHANICAL
STATE OF CALIFORNIA

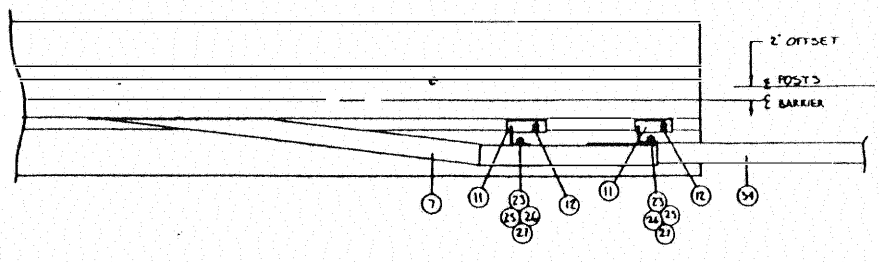
ENERGY ABSORPTION SYSTEMS, INC.
ENGINEERING AND RESEARCH DEPARTMENT

SENTRE

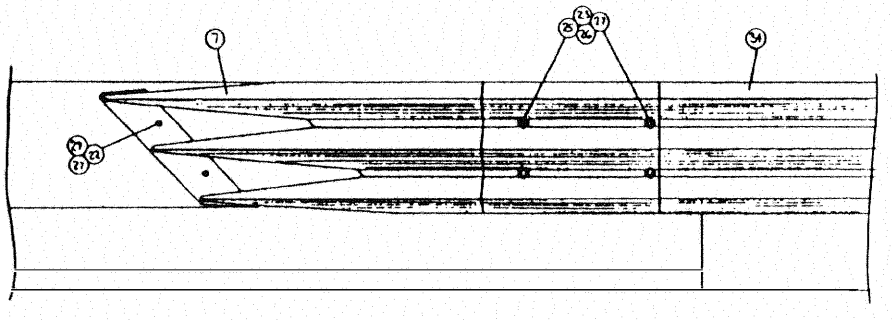
SCALE 1" = 1'-0" | SIZE C | DWG NO. 80-00-03 | SHEET 2 OF 3 | REV B

PARTS LIST

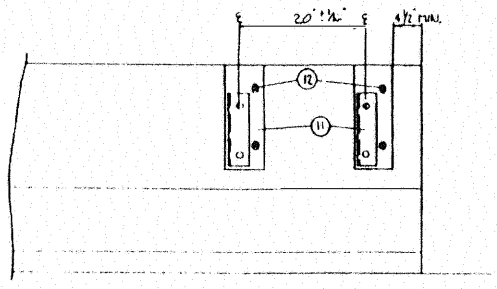
ITEM	STOCK NO	DESCRIPTION	QUAN



TOP VIEW



SIDE VIEW



SIDE VIEW W/O TRANS PANEL

Revisions	Date	Rev.	By	Chd	App
SEE SHT. 2	4-17-84	A	T.J.		
SEE SHT. 1	5-2-84	B	T.J.		

Material

DESIGN SPEED _____ M.P.H.
AVERAGE G's _____
EST. FORCE ON BACKUP STRUCTURE _____ KIPS

	Date
Designed	
Drawn T.J. JACKSON	1-31-84
Checked	2-7-84
Approved W. G. HAACK	2-9-84

Tolerances:
a. Angular
b. Linear
Unless Otherwise Noted:

REFERENCES

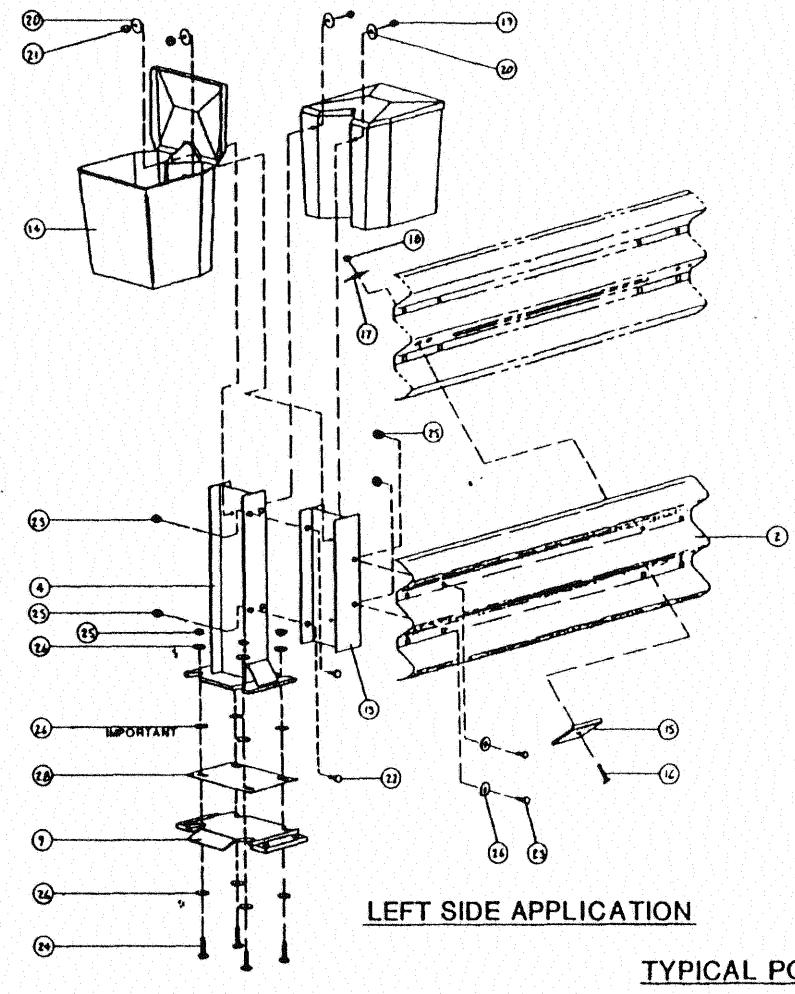
Project No. _____ Sales Order No. _____
Serial No. _____ Color _____

ENERGY ABSORPTION SYSTEMS, INC.
ENGINEERING AND RESEARCH DEPARTMENT

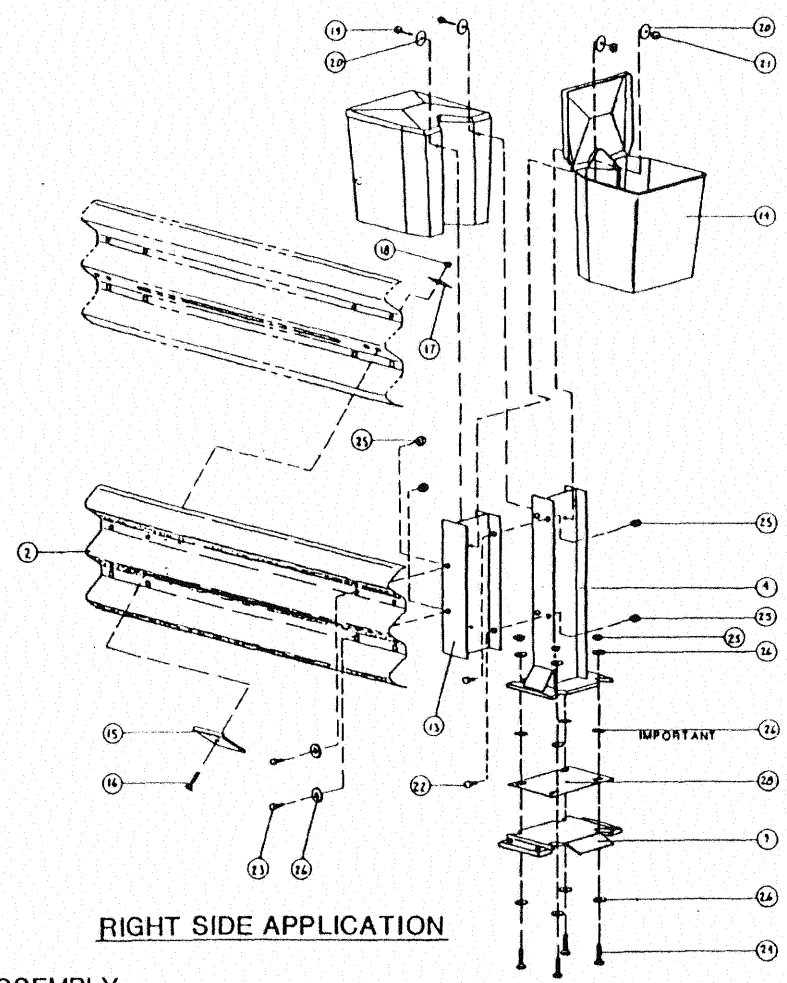
SENTRE

SCALE	SIZE	DWG. NUMBER	SHEET	REV.
1" = 1'-0"	C	80-00-03	3 OF 3	B

PARTS LIST			
ITEM	STOCK NO	DESCRIPTION	REQ'D



LEFT SIDE APPLICATION



RIGHT SIDE APPLICATION

TYPICAL POST 2 ASSEMBLY

80 00 03

Revisions	Date	Rev	By	Chk	App
SEE SHT 2	7-8-86	C	T.J.	[illegible]	[illegible]
SEE SHT 1	8-4-86	D	T.J.	[illegible]	[illegible]
SEE SHT 2	8-15-86	E	T.J.	[illegible]	[illegible]
SEE SHT 1	2-8-87	F	T.J.	[illegible]	[illegible]
SEE SHT 1	4-8-87	G	T.J.	[illegible]	[illegible]

Material

DESIGN SPEED _____ M.P.H.
AVERAGE G's _____
EST FORCE ON BACKUP STRUCTURE _____ KIPS

	Date
Designed	
Drawn T. J. JACKSON	6-20-83
Checked W. G. ARNOLD	6-20-83
Approved W. G. ARNOLD	6-28-83

Tolerances
a Angular
b Linear
Unless Otherwise Noted

REFERENCES

Project No _____ Sales Order No _____
Serial No _____ Color _____

REGISTERED PROFESSIONAL ENGINEER
WILLIAM G. ARNOLD
No. [illegible]
CIVIL
STATE OF CALIFORNIA

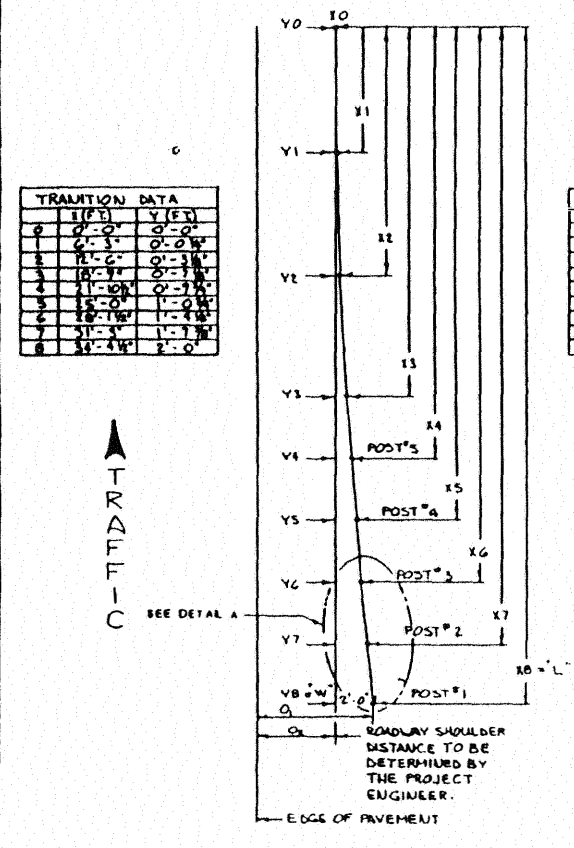
ENERGY ABSORPTION SYSTEMS, INC.
ENGINEERING AND RESEARCH DEPARTMENT

SENTRE

SIZE	C	DWG NUMBER	80-00-01	SHEET	REV
17" x 11"	C			3 OF	G

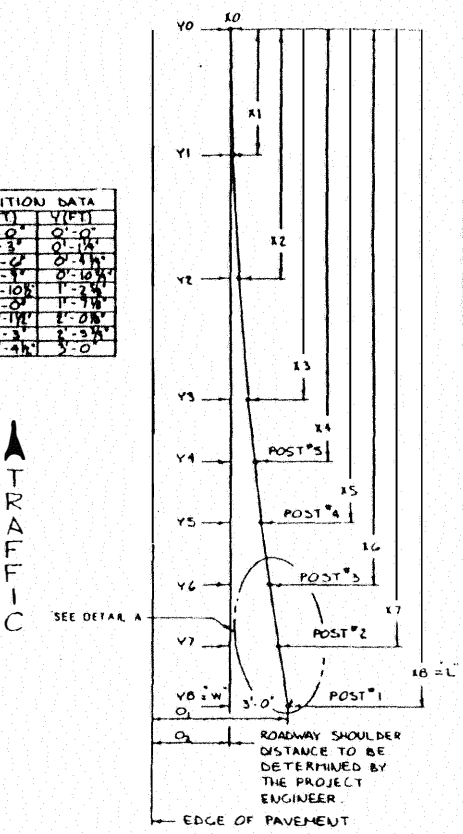
2'-0" FLARE

TRANSITION DATA		
	X (FT)	Y (FT)
0	0'-0"	0'-0"
1	6'-3"	0'-0 15/16"
2	12'-6"	0'-3 15/16"
3	18'-9"	0'-7 7/8"
4	21'-10½"	0'-9 5/8"
5	25'-0"	1'-0 7/8"
6	28'-1½"	1'-4 1/8"
7	31'-3"	1'-7 7/8"
8	34'-4½"	2'-0"



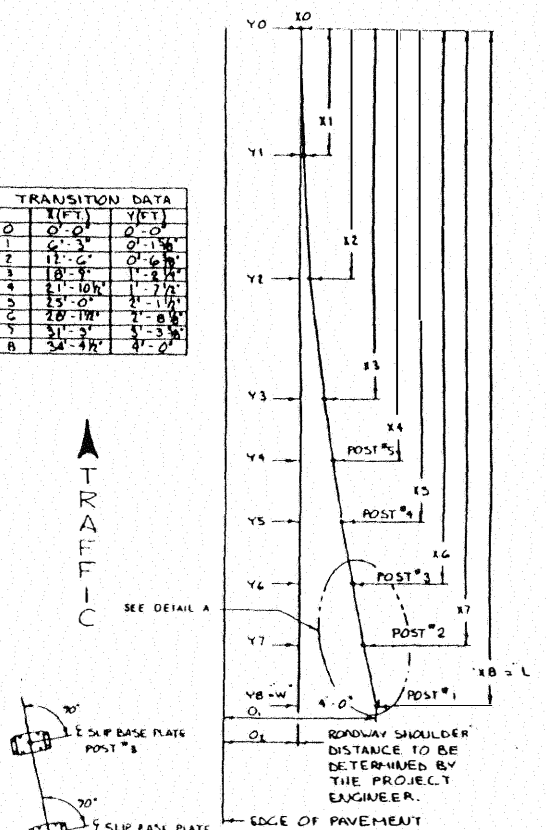
3'-0" FLARE

TRANSITION DATA		
	X (FT)	Y (FT)
0	0'-0"	0'-0"
1	6'-3"	0'-1 7/8"
2	12'-6"	0'-4 7/8"
3	18'-9"	0'-10 3/4"
4	21'-10½"	1'-2 5/8"
5	25'-0"	1'-7 3/4"
6	28'-1½"	2'-0 5/8"
7	31'-3"	2'-5 3/4"
8	34'-4½"	3'-0"



4'-0" FLARE

TRANSITION DATA		
	X (FT)	Y (FT)
0	0'-0"	0'-0"
1	6'-3"	0'-1 7/8"
2	12'-6"	0'-6 3/8"
3	18'-9"	1'-2 1/4"
4	21'-10½"	1'-7 1/2"
5	25'-0"	2'-1 5/8"
6	28'-1½"	2'-8 3/4"
7	31'-3"	3'-3 7/8"
8	34'-4½"	4'-0"



DETAIL A

SCALE 3/4" = 1'-0"

NOTE:
1. W = TOTAL LATERAL TRANSITION OF GUARDRAIL = $O_1 O_2$
2. L = TOTAL LENGTH OF TRANSITIONAL PORTION OF GUARDRAIL
3. POST LOCATIONS CALCULATED USING $Y = \frac{W}{L} X^2$
4. O_1 = DISTANCE FROM EDGE OF ROADWAY TO SENTRE POST "1".

TRANSITION DATA FOR FLARED SENTRE™ INSTALLATION

PARTS LIST

ITEM	STOCK NO	DESCRIPTION	QTY

Revisions	Date	Rev.	By	Ckd	App
SEE SHT. 1	8-1-83	D	T.J.	MK	MK
SEE SHT. 2	8-15-83	E	T.J.	MK	MK
SEE SHT 1	8-16-83	F	T.J.	MK	MK
SEE SHT 1	8-23-83	G	T.J.	MK	MK

Material

DESIGN SPEED ____ MPH
AVERAGE G's ____
EST. FORCE ON BACKUP STRUCTURE ____ KIPS

	Date
Designed	
Drawn T.J. JACKSON	8-1-83
Checked	8-23-83
Approved KRAGE	8-23-83

Tolerances:
a Angular
b Linear
Unless Otherwise Noted

REFERENCES

Project No ____ Sales Order No ____
Serial No ____ Color ____

REGISTERED PROFESSIONAL ENGINEER
WILLIAM G. KRAGE
No. M10132
MECHANICAL
STATE OF CALIFORNIA

80 00 03

ENERGY ABSORPTION SYSTEMS, INC.
ENGINEERING AND RESEARCH DEPARTMENT

SENTRE

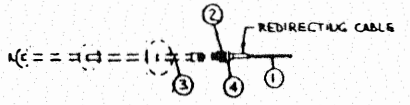
SCALE	SIZE	DWG NUMBER	REV
W = 1'-0"	C	80-00-01	G

SHEET 4 OF 4

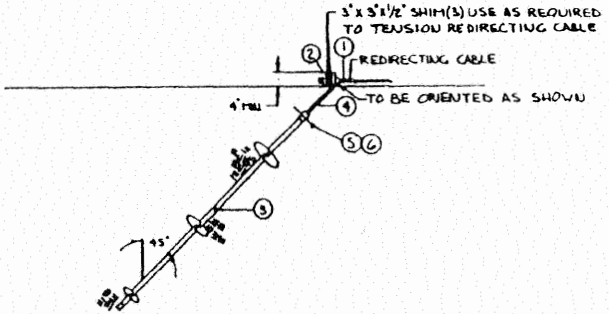
B-6

PARTS LIST			
ITEM	STOCK NO.	DESCRIPTION	REQ'D
1	27-42-101	REDIRECTING CABLE	1
2	27-04-22	SHIM 3"X3"X½"	3
3	27-44-13	TWIST IN EARTH ANCHOR	1
4	27-52-021	3" EPOXY BENT 45°	1
5	27-00-511	H.R. BOLT ¾"Ø X 5" (GALV)	1
6	27-04-29	H.R. NUT ¾" (GALV)	1

27-52-89 { 27-52-891



TOP VIEW

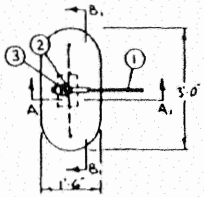


SECTION A-A
(SEE DWG. 80-02-01)

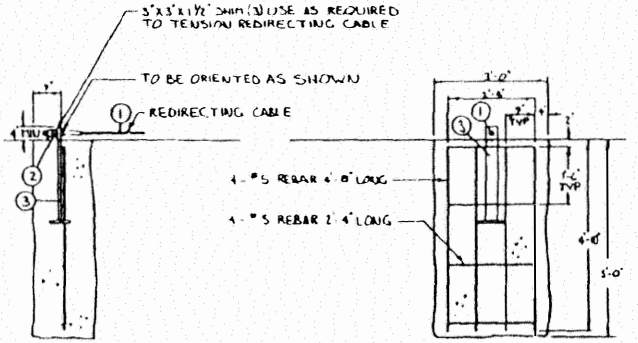
TWIST IN EARTH ANCHOR
TECHNIQUE

NOTE:
1. The Twist-In earth anchor has been designed to resist the forces described in the "SENTRE general specifications".

PARTS LIST			
ITEM	STOCK NO	DESCRIPTION	REQ'D
1	27-42-101	REDIRECTING CABLE	1
2	27-04-22	SHIM 3"X3"X½"	3
3	27-44-13	ANCHOR	1



TOP VIEW



SECTION A.-A.

SECTION B.-B.

SECTION A-A
(SEE DWG. 80-02-01)

EMBEDDED ANCHOR
TECHNIQUE

NOTE:
1. The embedded anchor has been designed to resist the forces described in the "SENTRE general specifications.

80 00 03

Revisions	Date	Rev	By	Chd	App
REVISED NOTES, MARK DWG. DWG. NO 80-02-02	8-11-83	A	T.J.	BW	[illegible]
REVISED EMBEDDED ANCHOR TECHNIQUE	9-7-83	B	T.J.	[illegible]	[illegible]
ADDED NOTE 1, 3" DIA. OU EMBEDDED ANC WAS 3"	9-8-83	C	T.J.	[illegible]	[illegible]

Material

DESIGN SPEED ____ M.P.H.
AVERAGE G's ____
EST FORCE ON BACKUP STRUCTURE ____ LBS

	Date
Designed	
Drawn T. J. JACKSON	8-10-83
Checked	8-4-83
Approved W G KRAGE	8-19-83

Tolerances:
0 Angular
.5 Linear
Unless Otherwise Noted

REFERENCES

Project No ____ Sales Order No ____
Serial No ____ Color ____

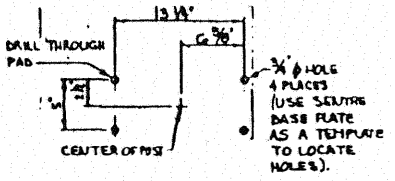
REGISTERED PROFESSIONAL ENGINEER
WILLIAM G. KRAGE
No. M18132
MECHANICAL
STATE OF CALIFORNIA

ENERGY ABSORPTION SYSTEMS, INC.
ENGINEERING AND RESEARCH DEPARTMENT

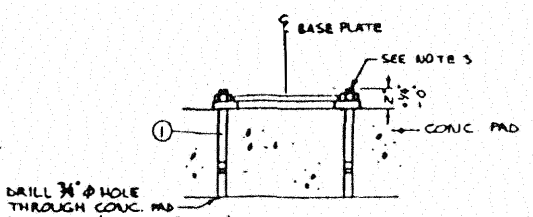
SENTRE SYSTEM

CABLE ANCHORAGE DETAILS
FRONT & REAR REDIRECTING CABLE ANCHOR

SCALE	SIZE	DWG NUMBER	SHEET	REV
½" = 1'-0"	C	80-02-02		C



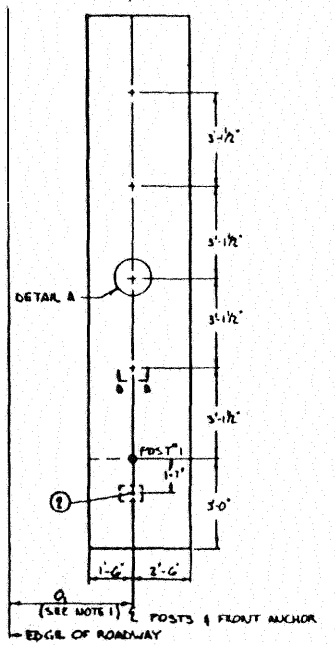
DETAIL A
(SCALE 1 1/2" = 1'-0")
TYPICAL ALL POSTS



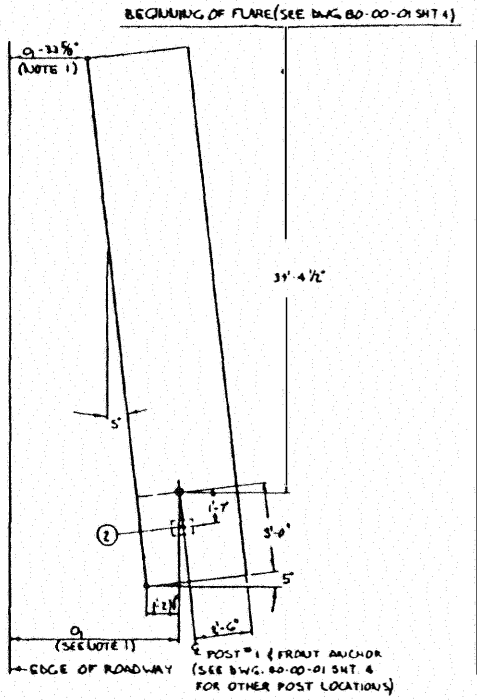
SECTION B-B
(SCALE 1 1/2" = 1'-0")

PARTS LIST			
ITEM	STOCK NO	DESCRIPTION	REQ'D
1	23-01-671	CONC. ANCHOR BOLT 3/4 ϕ X 8 1/2"	10
2	21-44-151	EMBEDDED ANCHOR	1
3			

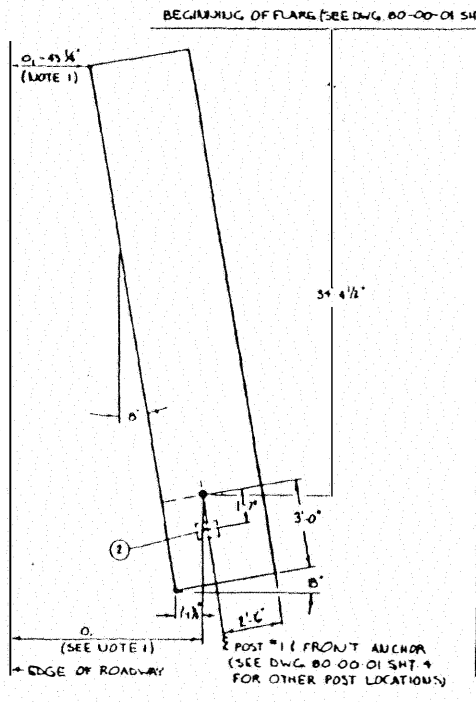
NOTE:
1. O_1 = DISTANCE FROM EDGE OF ROADWAY TO SENTRE POST "1" (DETERMINED IN THE FIELD, REF. DWG. 80-00-01 SHT. 4)
2. USE SENTRE SLIP BASE PLATE AS A TEMPLATE TO LOCATE HOLES FOR ITEM 1.
3. TORQUE NUT TO 125 Ft.-Lbs. (MIN)



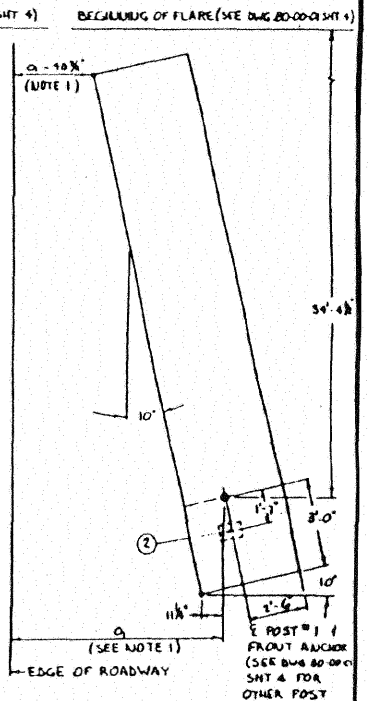
STRAIGHT CONDITION



2'-0" FLARE



3'-0" FLARE



4'-0" FLARE

IDAHO D.O.T. DIST. #1 80 00 03

Revisions	Date	Rev	By	Ckd	App

Material

DESIGN SPEED	MPH
AVERAGE G's	
EST FORCE ON BACKUP STRUCTURE	KIPS
Designed	Date
Drawn T J JACKSON	1-31-84
Checked Les Hague	2-2-84
Approved	2-2-84
Tolerances: a Angular, b Linear, Unless Otherwise Noted	

REFERENCES

Project No _____ Sales Order No _____

Serial No _____ Color _____

ENERGY ABSORPTION SYSTEMS, INC.
ENGINEERING AND RESEARCH DEPARTMENT

SENTRE SYSTEM

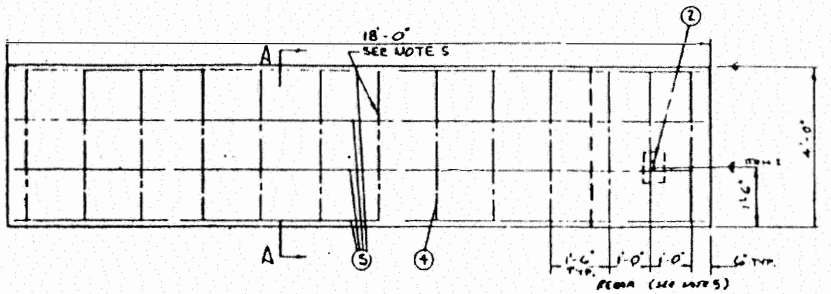
CONCRETE PAD DETAILS FOR UNITS INFRONT OF NEW JERSEY BARRIER

SCALE	SIZE	DRAWING NO.	SHEET
3/8" = 1'-0"	C	80-04-03	1 OF 2

B-7

PARTS LIST

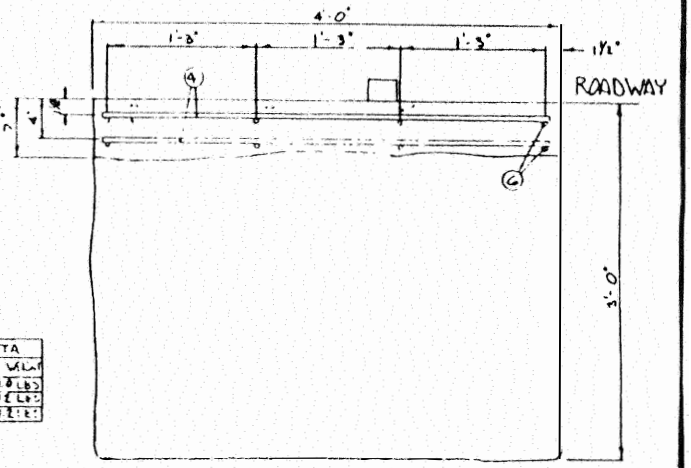
ITEM	STOCK NO	DESCRIPTION	QTY



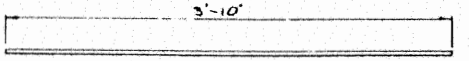
TRAFFIC

PLAN

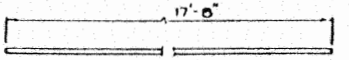
TABLE OF REINFORCING BAR STEEL DIMENSIONS AND DATA					
ITEM	# REQUIRED	LENGTH/PC.	TOTAL LENGTH	WT/FT. PER BAR	TOTAL WEIGHT
4	26	3'-10"	99'-8"	4.0 LBS	398.8 LBS
5	8	17'-8"	141'-4"	18.4 LBS	1443.6 LBS
		TOTAL LENGTH	241'-0"	TOTAL WEIGHT	2442.4 LBS



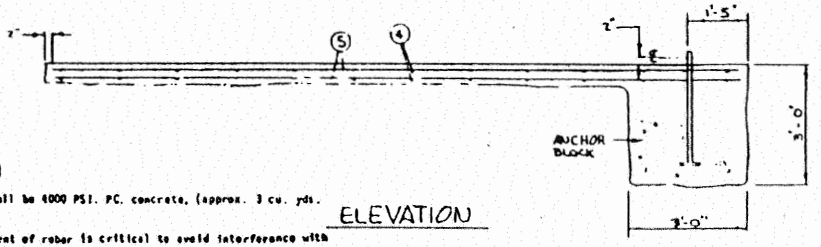
SECTION A-A
(SCALE 1½" = 1'-0")



DETAIL ITEM 4



DETAIL ITEM 5



ELEVATION

REBAR DETAIL MATERIAL: NO. 5 REBAR
SCALE 1½" = 1'-0"

RIGHT SIDE ROADWAY INSTALLATION SHOWN,
LEFT SIDE ROADWAY INSTALLATION OPPOSITE.
(ANCHOR BLOCK REMAINS IN FRONT PART OF PAD)

80 00 03

Notes: (CONTINUED)

4. All concrete shall be 4000 PSI. P.C. concrete, (approx. 3 cu. yds. req'd.).
5. Accurate placement of rebar is critical to avoid interference with concrete anchor bolts.
6. Concrete and rebar supplied by others.
7. The concrete pad has been designed to resist the forces as described in the "SENTRE general specification".

Revisions	Date	Rev.	By	Chd	App

Material

DESIGN SPEED ____ M.P.H.
AVERAGE G's ____
*ST FORCE ON BACKUP STRUCTURE ____ KIPS
Designed ____
Drawn T. J. JACKSON 1-31-84
Checked W.G. KRALE 2-2-84
Approved ____ 2-2-84
Tolerances
a Angular ± 2°
b Linear ± ½"
Unless Otherwise Noted

REFERENCES

Project No ____ Sales Order No ____
Serial No ____ Color ____

ENERGY ABSORPTION SYSTEMS, INC.
ENGINEERING AND RESEARCH DEPARTMENT

SENTRE SYSTEM

CONCRETE PAD DETAIL FOR UNITS INFRONT OF NEW JERSEY BARRIER

SCALE	SIZE	DWG. NO.	REV
1½" = 1'-0"	C	80-04-03	2 OF 2

APPENDIX C

ACCIDENT STUDY

OKLAHOMA DEPARTMENT OF TRANSPORTATION — HIGHWAY TABULATION — TRAFFIC ENGINEERING DIVISION

ANALO10.PRINT — ACCIDENT CONCENTRATION LISTING FOR IN-HOUSE USE

COUNTY: (55) OKLAHOMA — I-40 MAINLINE FIXED OBJECT ACCIDENTS FROM I-44 EAST TO SUNNYLANE — 04-26-85 THRU 04-26-88

CITY	CS #	INT MI # POST	DIAG CODE	LOCATION DESCRIPTION	SPECIAL FEATURES	INT REL	D1	D2	# VE	PEOPLE IN-FAT	PROP DMG	TYPE ACCIDENT	CAUSE OF ACCIDENT	CONDITIONS LIGHT	ROAD	SEV	DATE
70	68	00 0029	00000	N.CANADIAN RI BRIDGE		NO	NW	NW	2		1650	F-O(BR POST)	UNSAF-SPD	DARK	IC-S	PD	12-10-85
70	68	00 0029	00000	N.CANADIAN RI BRIDGE		NO	E	E	2		2675	F-O(RETN WALL)	UNSAF-SPD	DYLGT	IC-S	PD	02-08-86
70	68	00 0029	00000	N.CANADIAN RI BRIDGE		NO	E		1		5050	F-O(RETN WALL)	UNSAF-SPD	DARK	WET	PD	05-24-86
70	68	00 0029	00000	N.CANADIAN RI BRIDGE		NO	W		1		3050	F-O(BR RAIL)	UNSAF-SPD	DARK	WET	PD	09-29-86
70	68	00 0029	00000	N.CANADIAN RI BRIDGE		NO	W	W	2		2850	F-O(RETN WALL)	UNSAF-SPD	DYLGT	DRY	PD	09-30-86
70	68	00 0029	00000	N.CANADIAN RI BRIDGE		NO	E		1	1	800	F-O(RETN WALL)	UNSAF-SPD	DARK	WET	INJ	10-05-86
(70)	OKLAHOMA CITY	I-40															
70	68	00 0030	00000			NO	E		1		700	F-O(RETN WALL)	INATT	DYLGT	DRY	PD	04-29-85
70	68	00 0030	00000			NO	W		1	1	3450	F-O(GD-RAIL)	DEF-VEH	DYLGT	DRY	INJ	07-15-85
70	68	00 0030	00000			NO	E		1	1	1150	F-O(RETN WALL)	UNSAF-SPD	DAWN	IC-S	INJ	02-07-87
(70)	OKLAHOMA CITY	I-40															
70	68	00 0037	00000			NO	E		1		2500	F-O(RETN WALL)	UNSAF-SPD	DARK	IC-S	PD	12-03-86
(70)	OKLAHOMA CITY	I-40															
70	68	00 0038	00000			NO	E		1		2500	F-O(RETN WALL)	UNSAF-SPD	DARK	WET	PD	09-28-86
70	68	00 0038	00000			NO	W		1		1200	F-O(RETN WALL)	UNSAF-SPD	DARK	IC-S	PD	02-16-87
70	68	00 0038	00000			NO	E		1		1200	FIXED-O(OTHER)	NO-IMP-ACT	DYLGT	DRY	PD	03-24-88
(70)	OKLAHOMA CITY	I-40															
70	68	51 0042	00000			NO	E		1		2500	F-O(RETN WALL)	UNSAF-SPD	DARK	WET	PD	11-19-85
(70)	OKLAHOMA CITY	I-40															
70	68	51 0048	00000		CONSTRUCTION	NO	E	E	2		675	F-O(RETN WALL)	FOL-CLOSE	DARK	DRY	PD	08-23-85
70	68	51 0048	00000			NO	W		1		2500	F-O(RETN WALL)	UNSAF-SPD	DAWN	WET	PD	11-27-85
(70)	OKLAHOMA CITY	I-40															
70	68	51 0051	00000			NO	W		1		2675	F-O(RETN WALL)	UNSAF-SPD	DYLGT	DRY	PD	02-14-86
(70)	OKLAHOMA CITY	I-40															
70	68	51 0058	00000			NO	W		1		5050	FIXED-O(OTHER)	UNSAF-SPD	DARK	DRY	PD	09-07-85
(70)	OKLAHOMA CITY	I-40															
70	68	51 0059	00000			NO	W		1		125	F-O(RETN WALL)	NO-IMP-ACT	DYLGT	DRY	PD	03-10-86
(70)	OKLAHOMA CITY	I-40															
70	68	51 0068	00000			NO	W	W	2		850	F-O(RETN WALL)	UNSAF-SPD	DYLGT	IC-S	PD	02-07-86
70	68	51 0068	00000			NO	W		1		500	F-O(RETN WALL)	UNSAF-SPD	DYLGT	IC-S	PD	02-07-86
70	68	51 0068	00000			NO	W		1		2500	F-O(RETN WALL)	UNSAF-SPD	DYLGT	IC-S	PD	02-07-86
70	68	00 068	00000			NO	W		1		700	FIXED-O(OTHER)	UNSAF-SPD	DARK	IC-S	PD	02-16-87
70	68	51 0068	00000			NO			2		3500	F-O(RETN WALL)	NO-IMP-ACT	DYLGT	DRY	PD	03-18-87
(70)	OKLAHOMA CITY	I-40															
70	68	51 0069	00000			NO	W		1	1	600	F-O(RETN WALL)	OTHER	DYLGT	DRY	INJ	12-18-85
(15)	DEL CITY	I-40															
15	68	00 0078	00000			NO	W		1		2300	F-O(RETN WALL)	UNSAF-SPD	DYLGT	IC-S	PD	12-28-87
(15)	DEL CITY	I-40															
15	68	00 0079	00000			NO	W		1	1	5400	F-O(GD-RAIL)	UNSAF-SPD	DYLGT	WET	INJ	11-27-87
(15)	DEL CITY	I-40															
15	68	00 0080	00000			NO	E		1		5500	FIXED-O(OTHER)	UNSAF-SPD	DYLGT	DRY	PD	04-19-88
(15)	DEL CITY	I-40															
15	68	00 0083	00000			NO	E		1	1	400	F-O(RETN WALL)	D-W-I	DYLGT	DRY	INJ	05-20-86
(15)	DEL CITY	I-40															
15	68	00 0088	00000			NO	E		1	1	800	F-O(RETN WALL)	UNSAF-SPD	DYLGT	IC-S	INJ	12-11-85
15	68	00 0088	00000			NO	E		1		2500	F-O(RETN WALL)	OTHER	DYLGT	DRY	PD	04-17-86
15	68	00 0088	00000			NO	W		1	1	1075	F-O(GD-RAIL)	UNSAF-SPD	DYLGT	WET	INJ	06-04-86
(15)	DEL CITY	I-40															
15	68	00 0095	00000			NO	E		1		700	F-O(RETN WALL)	NO-IMP-ACT	DARK	OT	PD	09-12-85
(15)	DEL CITY	I-40															

OKLAHOMA DEPARTMENT OF TRANSPORTATION — HIGHWAY TABULATION — TRAFFIC ENGINEERING DIVISION
ANALO10.PRINT — ACCIDENT CONCENTRATION LISTING FOR IN-HOUSE USE
COUNTY: (55) OKLAHOMA — I-40 MAINLINE FIXED OBJECT ACCIDENTS FROM I-44 EAST TO SUNNYLANE — 04-26-85 THRU 04-26-88

CITY	CS #	INT MI #	POST	DIAG CODE	LOCATION DESCRIPTION	SPECIAL FEATURES	INT REL	D1	D2	# VE	PEOPLE IN-FAT	PROP DMG	TYPE ACCIDENT	CAUSE OF ACCIDENT	CONDITIONS LIGHT	ROAD	SEV	DATE
(70) OKLAHOMA CITY I-35																		
70	15	00 0613	00000				NO	E		2	1	3125	F-O(GD-RAIL)	UNSAF-SPD	DYLGT	IC-S	INJ	02-08-86
(70) OKLAHOMA CITY I-35						MILE 127												
70	15	00 0614	00000	MILE 127			NO	E		1		1400	F-O(GD-RAIL)	UNSAF-SPD	DARK	DRY	PD	02-07-87
(70) OKLAHOMA CITY I-35																		
70	15	00 0616	00000				NO	N		1	1	600	F-O(BARRIER)	UNSAF-SPD	DARK	DRY	INJ	11-03-86
(70) OKLAHOMA CITY I-35																		
70	15	00 0621	00000				NO	W	W	2		3450	F-O(RETN WALL)	UNSAF-SPD	DARK	IC-S	PD	12-03-86
(70) OKLAHOMA CITY I-35																		
70	15	00 0641	00000				NO	W		1		2500	F-O(GD-RAIL)	NO-IMP-ACT	DYLGT	DRY	PD	04-10-86
70	15	00 0641	00000			CONSTRUCTION	NO	W		1	1	4900	F-O(RETN WALL)	D-W-I	DYLGT	DRY	INJ	06-27-87
(70) OKLAHOMA CITY I-35																		
70	15	00 0659	00000				NO	W		1		2000	F-O(GD-RAIL)	UNSAF-SPD	DYLGT	DRY	PD	08-30-87
(70) OKLAHOMA CITY I-35																		
70	15	00 0661	00000				NO	E		1		2500	FIXED-O(OTHER)	D-W-I	DARK	DRY	PD	09-14-85
70	15	00 0661	00000			CONSTRUCTION	NO	W		1		2500	F-O(RETN WALL)	UNSAF-SPD	LIGHT	WET	PD	11-25-86
70	15	00 0661	00000			CONSTRUCTION	NO	W		1		1000	F-O(RETN WALL)	UNSAF-SPD	DYLGT	DRY	PD	11-06-87
(70) OKLAHOMA CITY I-35																		
70	15	00 0665	00000				NO	E		1		3450	F-O(RETN WALL)	UNSAF-SPD	DYLGT	DRY	PD	07-19-86
(70) OKLAHOMA CITY I-35																		
70	15	00 0670	00000				NO	W		1	1	1250	F-O(GD-RAIL)	INATT	DYLGT	DRY	INJ	12-19-85
(70) OKLAHOMA CITY I-35																		
70	15	00 0672	00000				NO	E		1		700	F-O(RETN WALL)	NO-IMP-ACT	DYLGT	WET	PD	04-29-85
70	15	00 0672	00000				NO	E		1		2500	F-O(RETN WALL)	UNSAF-SPD	DYLGT	DRY	PD	07-24-85
(70) OKLAHOMA CITY I-35																		
70	15	00 0673	00000			CONSTRUCTION	NO	W		1		750	F-O(RETN WALL)	FOL-CLOSE	DYLGT	DRY	PD	04-22-87
(70) OKLAHOMA CITY I-35																		
70	15	00 0674	00000				NO	E		1		1000	F-O(GD-RAIL)	NO-IMP-ACT	DYLGT	WET	PD	07-17-87
70	15	00 0674	00000				NO	E	E	2	1	2800	FIXED-O(OTHER)	NO-IMP-ACT	DYLGT	WET	INJ	07-17-87
(70) OKLAHOMA CITY I-35																		
70	15	00 0678	00000				NO	E		1		700	F-O(RETN WALL)	UNSAF-SPD	DYLGT	WET	PD	06-05-85
(70) OKLAHOMA CITY I-35																		
70	15	00 0681	00000				NO	W		1		500	F-O(RETN WALL)	UNSAF-SPD	DYLGT	DRY	PD	09-09-85
70	15	00 0681	00000				NO	W	W	2		3050	F-O(RETN WALL)	UNSAF-SPD	DYLGT	DRY	PD	03-07-86
70	15	00 0681	00000				NO	W	W	2		2850	F-O(RETN WALL)	NO-IMP-ACT	DYLGT	WET	PD	04-03-86
70	15	00 0681	00000				NO	E		1	1	1250	F-O(GD-RAIL)	NO-IMP-ACT	DYLGT	DRY	INJ	05-19-86
70	15	00 0681	00000			CONSTRUCTION	NO	W		1		400	F-O(RETN WALL)	NO-IMP-ACT	DYLGT	WET	PD	07-17-87
(70) OKLAHOMA CITY I-35																		
70	15	00 0691	00000				NO	W		1	1	2600	F-O(BR PIER)	UNSAF-SPD	LIGHT	DRY	FAT	07-29-86
70	15	00 0691	00000			CONSTRUCTION	NO	W		1	1	2600	F-O(RETN WALL)	IMP-LN-CHG	DUSK	DRY	INJ	12-19-86
70	15	00 0691	00000				NO	E		1		600	F-O(GD-RAIL)	NO-IMP-ACT	DYLGT	DRY	PD	12-02-87
(70) OKLAHOMA CITY I-35						SH-77H RENO AVE. OP *32*												
70	15	52 0699	00000	RENO AVE. OP	BRIDGE		NO			1	1	4100	F-O(GD-RAIL)	UNSAF-SPD	DARK	WET	INJ	10-30-87
70	15	52 0699	00000	RENO AVE. OP	BRIDGE		NO	S		1	1	1500	F-O(RETN WALL)	D-W-I	DARK	DRY	FAT	12-13-87
(70) OKLAHOMA CITY I-35																		
70	15	11 0721	00000				NO	W		1		2500	F-O(GD-RAIL)	NO-IMP-ACT	DARK	WET	PD	12-15-86
(70) OKLAHOMA CITY I-40						N.CANADIAN RIV.BR.												
70	68	00 0029	00000	N.CANADIAN RI	BRIDGE		NO	W		1		2850	F-O(GD-RAIL)	INATT	DARK	DRY	PD	05-04-85
70	68	00 0029	00000	N.CANADIAN RI	BRIDGE		NO	W		1		500	F-O(RETN WALL)	NO-IMP-ACT	DYLGT	DRY	PD	05-04-85
70	68	00 0029	00000	N.CANADIAN RI	BRIDGE		NO	W		1		900	F-O(RETN WALL)	UNSAF-SPD	DYLGT	IC-S	PD	11-27-85

OKLAHOMA DEPARTMENT OF TRANSPORTATION — HIGHWAY TABULATION — TRAFFIC ENGINEERING DIVISION
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COUNTY: (55) OKLAHOMA — I-40 MAINLINE FIXED OBJECT ACCIDENTS FROM I-44 EAST TO SUNNYLANE — 04-26-85 THRU 04-26-88

CITY	CS #	INT MI #	POST	DIAG CODE	LOCATION DESCRIPTION	SPECIAL FEATURES	INT REL	D1	D2	# VE	PEOPLE IN-FAT	PROP DMG	TYPE ACCIDENT	CAUSE OF ACCIDENT	CONDITIONS LIGHT	ROAD	SEV	DATE
15	68	00	0097	00000			NO	E		1		700	F-O(RETN WALL)	UNSAF-SPD	DYLGT	WET	PD	03-11-86
(15) DEL CITY		I-40																
15	68	00	0103	00000			NO	E		1		3500	F-O(RETN WALL)	D-W-I	DARK	DRY	PD	01-16-88
(15) DEL CITY		I-40																
15	68	00	0104	00000			NO	W		1		2500	FIXED-O(OTHER)	UNSAF-SPD	DYLGT	WET	PD	02-05-86
(15) DEL CITY		I-40																
15	68	00	0108	00000			NO	W		1		2500	F-O(RETN WALL)	UNSAF-SPD	DARK	IC-S	PD	12-13-85
15	68	00	0108	00000		CONSTRUCTION	NO	E		1		2500	F-O(RETN WALL)	UNSAF-SPD	DYLGT	DRY	PD	04-24-86
(15) DEL CITY		I-40																
15	68	00	0119	00000			NO	W		1	2	4500	F-O(RETN WALL)	UNSAF-SPD	DYLGT	DRY	INJ	06-30-87
(15) DEL CITY		I-40																
15	68	00	0128	00000		CONSTRUCTION	NO	E		1		2500	F-O(RETN WALL)	OTHER	DAWN	DRY	PD	08-23-85
(15) DEL CITY		I-40																
15	68	00	0152	00000		CONSTRUCTION	NO	W		1		2500	F-O(RETN WALL)	UNSAF-SPD	DYLGT	WET	PD	03-11-86
15	68	00	0152	00000			NO	W		1		3000	F-O(RETN WALL)	UNSAF-SPD	DUSK	WET	PD	03-02-88
(15) DEL CITY		I-40																
15	68	50	0162	00000			NO	W		1		760	FIXED-O(OTHER)	DEF-VEH	DYLGT	DRY	PD	02-09-88
(55) MIDWEST CITY		I-40																
55	68	50	0201	00000			NO	W		1		700	F-O(RETN WALL)	UNSAF-SPD	DYLGT	WET	PD	05-10-86
(15) DEL CITY		I-40																
15	68	50	0203	00000			NO	W		1	1	1500	F-O(RETN WALL)	UNSAF-SPD	DYLGT	IC-S	INJ	03-03-88
(70) OKLAHOMA CITY		I-40																
70	69	00	0579	00000			NO	E		1	2	1700	F-O(RETN WALL)	OTHER	DARK	DRY	INJ	03-23-88
(70) OKLAHOMA CITY		I-40																
70	69	00	0584	00000			NO	E		1		8620	F-O(GD-RAIL)	D-W-I	DARK	WET	PD	02-26-87
(70) OKLAHOMA CITY		I-40																
70	69	00	0587	00000		CONSTRUCTION	NO	E		1	1	1350	FIXED-O(OTHER)	OTHER	LIGHT	DRY	INJ	10-03-87
(70) OKLAHOMA CITY		I-40																
70	69	00	0596	00000		CONSTRUCTION	NO	E		1		4250	F-O(RETN WALL)	UNSAF-SPD	LIGHT	DRY	PD	09-07-87
(70) OKLAHOMA CITY		I-40								MAY AVE. O.P. *71*								
70	69	00	0597	00000	MAY AVE. O.P. BRIDGE		NO	E		1	1	600	F-O(RETN WALL)	DEF-VEH	DYLGT	WET	INJ	10-21-86
(70) OKLAHOMA CITY		I-40																
70	69	00	0598	00000			NO	E		1		2500	F-O(RETN WALL)	D-W-I	DYLGT	DRY	PD	06-22-86
70	69	00	0598	00000			NO	W		1	1	3000	F-O(RETN WALL)	D-W-I	DYLGT	DRY	INJ	02-04-88
(70) OKLAHOMA CITY		I-40																
70	69	00	0607	00000			NO	W		1		900	F-O(RETN WALL)	UNSAF-SPD	DYLGT	WET	PD	08-04-85
(70) OKLAHOMA CITY		I-40																
70	69	00	0617	00000			NO	W		1		2850	F-O(RETN WALL)	UNSAF-SPD	DYLGT	DRY	PD	01-03-88
(70) OKLAHOMA CITY		I-40																
70	69	00	0637	00000			NO	W	W	2	1	1 5900	F-O(RETN WALL)	D-W-I	DYLGT	DRY	FAT	12-29-85
70	69	00	0637	00000		CONSTRUCTION	NO	E		1		3000	FIXED-O(OTHER)	UNSAF-SPD	DYLGT	DRY	PD	05-04-87
(70) OKLAHOMA CITY		I-40																
70	69	00	0643	00000			NO	E		1		700	F-O(RETN WALL)	UNSAF-SPD	DUSK	WET	PD	07-25-85
70	69	00	0643	00000			NO	W		1		1500	F-O(RETN WALL)	UNSAF-SPD	DYLGT	IC-S	PD	01-17-87
(70) OKLAHOMA CITY		I-40																
70	69	00	0654	00000			NO	E		1		2500	F-O(RETN WALL)	UNSAF-SPD	LIGHT	WET	PD	02-08-86
70	69	00	0654	00000			NO	E		1	1	2600	F-O(RETN WALL)	NO-IMP-ACT	DYLGT	DRY	INJ	07-30-86
(70) OKLAHOMA CITY		I-40																
70	69	00	0663	00000			NO	W		1		2500	F-O(RETN WALL)	UNSAF-SPD	DYLGT	IC-S	PD	11-29-85
70	69	00	0663	00000			NO	E		1	1	15100	F-O(RETN WALL)	UNSAF-SPD	DYLGT	DRY	INJ	03-14-86

OKLAHOMA DEPARTMENT OF TRANSPORTATION — HIGHWAY TABULATION — TRAFFIC ENGINEERING DIVISION
ANALO10.PRINT — ACCIDENT CONCENTRATION LISTING FOR IN-HOUSE USE
COUNTY: (55) OKLAHOMA — I-40 MAINLINE FIXED OBJECT ACCIDENTS FROM I-44 EAST TO SUNNYLANE — 04-26-85 THRU 04-26-88

CITY	CS #	INT #	MI POST	OIAG CODE	LOCATION DESCRIPTION	SPECIAL FEATURES	INT REL	D1	D2	# VE	PEOPLE IN-FAT	PROP DMG	TYPE ACCIDENT	CAUSE OF ACCIDENT	CONDITIONS LIGHT	ROAD	SEV	DATE
(70) OKLAHOMA CITY I-40																		
70	69	00	0669	00000			NO	W		1	1	2600	F-O(RETN WALL)	NO-IMP-ACT	DYLGT	DRY	INJ	08-26-85
(70) OKLAHOMA CITY I-40																		
70	69	00	0673	00000			NO	W		1	1	2600	F-O(RETN WALL)	NO-IMP-ACT	DARK	DRY	INJ	08-25-85
70	69	00	0673	00000			NO	W		1		900	F-O(RETN WALL)	UNSAF-SPD	DAWN	IC-S	PD	12-10-85
70	69	00	0673	00000			NO	W	W	2	3	2850	F-O(RETN WALL)	IMP-LN-CHG	DYLGT	DRY	INJ	09-19-86
(70) OKLAHOMA CITY I-40																		
70	69	00	0683	00000			NO	W		1		2500	F-O(RETN WALL)	UNSAF-SPD	DARK	WET	PD	10-17-85
(70) OKLAHOMA CITY I-40																		
70	69	00	0684	00000			NO	E		1		2500	F-O(RETN WALL)	NO-IMP-ACT	DYLGT	DRY	PD	06-11-85
70	69	00	0684	00000			NO	E		1		750	FIXED-O(OTHER)	NO-IMP-ACT	DAWN	DRY	PD	09-02-87
(70) OKLAHOMA CITY I-40																		
70	69	00	0694	00000			NO	W	W	2		2600	F-O(RETN WALL)	UNSAF-SPD	DYLGT	WET	PD	09-13-85
70	69	00	0694	00000			NO	E		1		700	F-O(RETN WALL)	UNSAF-SPD	DARK	IC-S	PD	12-10-85
70	69	00	0694	00000			NO	E		1	1	2600	F-O(RETN WALL)	UNSAF-SPD	DYLGT	DRY	INJ	03-23-86
70	69	00	0694	00000			NO	W		1		500	F-O(RETN WALL)	D-W-I	DARK	DRY	PD	04-19-86
70	69	00	0694	00000			NO	W		1	1	2600	F-O(RETN WALL)	UNSAF-SPD	DAWN	IC-S	INJ	12-03-86
70	69	00	0694	00000			NO	W		1	1	2600	F-O(RETN WALL)	UNSAF-SPD	DAWN	IC-S	INJ	12-03-86
70	69	00	0694	00000			NO	E		1		1500	FIXED-O(OTHER)	DEF-VEH	DYLGT	DRY	PD	12-04-87
(70) OKLAHOMA CITY I-40																		
70	69	00	0698	00000			NO	W		1	1	800	F-O(RETN WALL)	NO-IMP-ACT	DYLGT	IC-S	INJ	11-19-87
(70) OKLAHOMA CITY I-40																		
70	69	00	0703	00000			NO	W		1		500	F-O(RETN WALL)	UNSAF-SPD	DAWN	WET	PD	04-02-86
(70) OKLAHOMA CITY I-40																		
70	69	00	0708	00000			NO	W		1		2500	F-O(RETN WALL)	UNSAF-SPD	DYLGT	DRY	PD	07-30-85
(70) OKLAHOMA CITY I-40						VIRGINA/RR OP*74*												
70	69	00	0717	00000	VIRGINA/RR OP BRIDGE		NO	W		1		1000	F-O(RETN WALL)	UNSAF-SPD	DYLGT	DRY	PD	04-27-87
(70) OKLAHOMA CITY I-40																		
70	69	00	0718	00000			NO	W		1		125	F-O(RETN WALL)	NO-IMP-ACT	DYLGT	DRY	PD	03-28-86
(70) OKLAHOMA CITY I-40																		
70	69	00	0724	00000			NO	W		1		3000	F-O(RETN WALL)	NO-IMP-ACT	LIGHT	WET	PD	03-02-88
(70) OKLAHOMA CITY I-40																		
70	69	00	0728	00000			NO	W		1		900	F-O(RETN WALL)	NO-IMP-ACT	DYLGT	DRY	PD	02-04-86
(70) OKLAHOMA CITY I-40																		
70	69	00	0737	00000			NO	W		1		2500	F-O(RETN WALL)	DEF-VEH	DYLGT	DRY	PD	02-25-86
70	69	00	0737	00000			NO	W		1		500	F-O(RETN WALL)	DEF-VEH	DYLGT	DRY	PD	11-07-86
(70) OKLAHOMA CITY I-40																		
70	69	00	0745	00000			NO	W		1		2000	F-O(RETN WALL)	INATT	DARK	DRY	PD	03-22-87
(70) OKLAHOMA CITY I-40																		
70	69	00	0747	00000			NO	W		1		2500	F-O(RETN WALL)	NO-IMP-ACT	DYLGT	WET	PD	11-04-86
70	69	00	0747	00000		CONSTRUCTION	NO	N		1	3	8300	F-O(GD-RAIL)	D-W-I	DYLGT	DRY	INJ	07-04-87
70	69	00	0747	00000			NO	W		1	1	2000	F-O(RETN WALL)	UNSAF-SPD	DARK	IC-S	INJ	12-26-87
70	69	00	0747	00000			NO	W		1		400	F-O(RETN WALL)	UNSAF-SPD	DARK	IC-S	PD	12-26-87
(70) OKLAHOMA CITY I-40																		
70	69	00	0757	00000			NO	W		1		2675	F-O(RETN WALL)	NEG-DRVING	DYLGT	DRY	PD	05-30-86
(70) OKLAHOMA CITY I-40																		
70	69	00	0765	00000			NO	E		1		4000	F-O(RETN WALL)	D-W-I	DARK	DRY	PD	01-06-87
(70) OKLAHOMA CITY I-40																		
70	69	00	0775	00000			NO	W		1		2500	F-O(RETN WALL)	NO-IMP-ACT	DYLGT	DRY	PD	07-18-86
(70) OKLAHOMA CITY I-40																		

CITY	CS #	INT #	MI POST	DIAG CODE	LOCATION DESCRIPTION	SPECIAL FEATURES	INT REL	D1	D2	# VE	PEOPLE IN-FAT	PROP DMG	TYPE ACCIDENT	CAUSE OF ACCIDENT	CONDITIONS LIGHT	ROAD	SEV	DATE
70	69	00	0785	00000			NO	W		1		2500	F-O(BR RAIL)	NO-IMP-ACT	DYLGT	DRY	PD	07-11-85
70	69	00	0785	00000			NO	E		1	1	2600	F-O(RETN WALL)	UNSAF-SPD	DYLGT	WET	INJ	07-28-85
70	69	00	0785	00000			NO	W		1		300	F-O(RETN WALL)	OTHER	DYLGT	DRY	PD	02-14-86
70	69	00	0785	00000			NO	E		1	1	3900	F-O(GD-RAIL)	UNSAF-SPD	LIGHT	IC-S	INJ	12-27-87
(70) OKLAHOMA CITY I-40 RAMP O.P. *75*																		
70	69	00	0791	00000	RAMP O.P. *75	BRIDGE	NO	E		1	1	5500	F-O(GD-RAIL)	D-W-I	LIGHT	DRY	INJ	04-26-87
(70) OKLAHOMA CITY I-40																		
70	69	00	0795	00000			NO	W		1		2500	F-O(RETN WALL)	NO-IMP-ACT	OYLGT	DRY	PD	08-23-85
70	69	00	0795	00000			NO	W		1		125	F-O(RETN WALL)	UNSAF-SPD	DYLGT	WET	PD	11-13-85
70	69	00	0795	00000		CONSTRUCTION	NO	W	E	2	5	39500	F-O(RETN WALL)	UNSAF-SPD	DYLGT	WET	INJ	05-24-87
70	69	00	0795	00000			NO	W		1		900	F-O(RETN WALL)	UNSAF-SPD	DYLGT	WET	PD	05-27-87
70	69	00	0795	00000		CONSTRUCTION	NO	W		1		1550	F-O(RETN WALL)	UNSAF-SPD	DYLGT	WET	PD	06-09-87
70	69	00	0795	00000		CONSTRUCTION	NO	W		1		12000	F-O(RETN WALL)	UNSAF-SPD	DYLGT	WET	PD	06-19-87
70	69	00	0795	00000		CONSTRUCTION	NO	W		1		100	FIXED-O(OTHER)	NO-IMP-ACT	DARK	WET	PD	07-29-87
70	69	00	0795	00000			NO	W		1		2100	F-O(RETN WALL)	UNSAF-SPD	DYLGT	IC-S	PD	12-27-87
(70) OKLAHOMA CITY I-40																		
70	69	00	0798	00000			NO	E		1		8000	F-O(GD-RAIL)	UNSAF-SPD	DARK	DRY	PD	05-12-87
(70) OKLAHOMA CITY I-40																		
70	69	00	0801	00000		CONSTRUCTION	NO	W		1	1	500	F-O(RETN WALL)	UNSAF-SPD	DYLGT	WET	INJ	05-21-87
70	69	00	0801	00000		CONSTRUCTION	NO	W		1		1000	F-O(RETN WALL)	UNSAF-SPD	DARK	WET	PD	05-28-87
(70) OKLAHOMA CITY I-40 BEGIN ELEVATION																		
70	69	00	0802	00000	BEGIN ELEVATI		NO	E		1		300	F-O(RETN WALL)	UNSAF-SPD	DYLGT	DRY	PD	10-07-86
(70) OKLAHOMA CITY I-40																		
70	69	00	0806	00000		CONSTRUCTION	NO	W		1	2	5700	F-O(RETN WALL)	D-W-I	DARK	DRY	INJ	07-23-87
(70) OKLAHOMA CITY I-40																		
70	69	00	0815	00000			NO	E		1		2300	F-O(RETN WALL)	UNSAF-SPD	DYLGT	WET	PD	03-17-87
(70) OKLAHOMA CITY I-40																		
70	69	00	0820	00000			NO	E		1		2500	F-O(RETN WALL)	UNSAF-SPD	DYLGT	WET	PD	05-26-86
(70) OKLAHOMA CITY I-40																		
70	69	00	0835	00000			NO	E		1		700	F-O(RETN WALL)	NO-IMP-ACT	DYLGT	DRY	PD	07-23-86
(70) OKLAHOMA CITY I-40																		
70	69	00	0836	00000			NO	W		1		900	F-O(RETN WALL)	DEF-VEH	DYLGT	DRY	PD	05-18-86
(70) OKLAHOMA CITY I-40																		
70	69	00	0840	00000			NO	W		1		2500	F-O(RETN WALL)	NO-IMP-ACT	DARK	DRY	PD	04-19-86
70	69	00	0840	00000			NO	W		1		125	F-O(RETN WALL)	NO-IMP-ACT	DYLGT	DRY	PD	10-09-86
70	69	00	0840	00000		CONSTRUCTION	NO	E		1	1	1500	FIXED-O(OTHER)	UNSAF-SPD	DYLGT	DRY	INJ	03-31-87
70	69	00	0840	00000			NO	E		1	1	1000	F-O(RETN WALL)	UNSAF-SPD	DAWN	IC-S	INJ	11-19-87
(70) OKLAHOMA CITY I-40 WALKER O.P.																		
70	69	00	0850	00000	WALKER O.P.	BRIDGE	NO	W		1		1000	F-O(RETN WALL)	UNSAF-SPD	DYLGT	WET	PD	06-09-87
70	69	00	0850	00000	WALKER O.P.	CONSTRUCTION	NO	E		1		2800	F-O(RETN WALL)	DEF-VEH	DARK	DRY	PD	10-15-87
70	69	00	0850	00000	WALKER O.P.	CONSTRUCTION	NO	W		1		800	F-O(RETN WALL)	NO-IMP-ACT	DYLGT	DRY	PD	11-14-87
(70) OKLAHOMA CITY I-40																		
70	69	00	0852	00000			NO	E		1		2500	F-O(RETN WALL)	UNSAF-SPD	DYLGT	DRY	PD	09-10-86
70	69	00	0852	00000			NO	E		1		1000	F-O(RETN WALL)	UNSAF-SPD	DYLGT	DRY	PD	01-24-88
70	69	00	0852	00000			NO	E		1	1	100	F-O(RETN WALL)	NO-IMP-ACT	DARK	DRY	INJ	03-11-88
(70) OKLAHOMA CITY I-40																		
70	69	00	0853	00000			NO	W		1		2200	F-O(RETN WALL)	NO-IMP-ACT	OYLGT	IC-S	PD	12-31-87
(70) OKLAHOMA CITY I-40																		
70	69	00	0854	00000			NO	E		1		500	F-O(RETN WALL)	UNSAF-SPD	DYLGT	WET	PD	07-25-85
70	69	00	0854	00000			NO	E		1		800	F-O(RETN WALL)	UNSAF-SPD	DYLGT	IC-S	PD	11-19-87

OKLAHOMA DEPARTMENT OF TRANSPORTATION — HIGHWAY TABULATION — TRAFFIC ENGINEERING DIVISION
ANALO10.PRINT — ACCIDENT CONCENTRATION LISTING FOR IN-HOUSE USE
COUNTY: (55) OKLAHOMA — I-40 MAINLINE FIXED OBJECT ACCIDENTS FROM I-44 EAST TO SUNNYLANE — 04-26-85 THRU 04-26-88

CITY	CS #	INT #	MI POST	DIAG CODE	LOCATION DESCRIPTION	SPECIAL FEATURES	INT REL	D1	D2	# VE	PEOPLE IN-FAT	PROP DMG	TYPE ACCIDENT	CAUSE OF ACCIDENT	CONDITIONS LIGHT	ROAD	SEV	DATE
(70) OKLAHOMA CITY I-40																		
70	69	00 0859	00000				NO E			1		800	F-O(RETN WALL)	UNSAF-SPD	DYLGT	IC-S	PD	11-19-87
(70) OKLAHOMA CITY I-40																		
70	69	54 0875	00000				NO E			1		500	F-O(RETN WALL)	NO-IMP-ACT	DYLGT	DRY	PD	08-20-86
70	69	54 0875	00000			CONSTRUCTION	NO E			1	1	2000	F-O(RETN WALL)	NO-IMP-ACT	DYLGT	WET	INJ	02-05-87
70	69	54 0875	00000				NO E			1		1050	F-O(RETN WALL)	UNSAF-SPD	DYLGT	DRY	PD	03-31-87
(70) OKLAHOMA CITY I-40																		
70	69	54 0876	00000				NO W			1	1	2675	F-O(RETN WALL)	UNSAF-SPD	LIGHT	WET	INJ	04-29-85
70	69	54 0876	00000				NO W			1	2	2600	F-O(RETN WALL)	D-W-I	DARK	DRY	INJ	12-31-85
70	69	54 0876	00000				NO W	W		2		1450	F-O(RETN WALL)	UNSAF-SPD	DYLGT	IC-S	PD	02-07-86
70	69	54 0876	00000				NO W			1		2500	F-O(RETN WALL)	UNSAF-SPD	DYLGT	DRY	PD	10-31-86
70	69	54 0876	00000				NO W			1		500	F-O(RETN WALL)	OEF-VEH	DYLGT	WET	PD	11-17-86
70	69	54 0876	00000				NO W			1		1500	F-O(RETN WALL)	UNSAF-SPD	DAWN	IC-S	PD	02-07-87
70	69	54 0876	00000			IMPACT ATNUB	NO E			1		3000	FIXED-O(OTHER)	UNSAF-SPD	DARK	WET	PD	02-16-87
70	69	00 0876	00000				NO W			1	1	150	F-O(RETN WALL)	NO-IMP-ACT	DYLGT	DRY	INJ	07-02-87
70	69	54 0876	00000				NO W			1		1500	F-O(RETN WALL)	UNSAF-SPD	DYLGT	WET	PD	11-18-87
70	69	00 0876	00000				NO W	W		2	2	1200	F-O(RETN WALL)	UNSAF-SPD	DYLGT	IC-S	INJ	02-02-88
70	69	00 0876	00000				NO W			1		2000	F-O(RETN WALL)	UNSAF-SPD	DYLGT	WET	PD	04-17-88
(70) OKLAHOMA CITY I-40							US-77			ROBINSON O.P.*77*								
70	69	54 0879	00000		ROBINSON O.P.	BRIDGE	NO E			1	1	2050	F-O(RETN WALL)	UNSAF-SPD	DARK	IC-S	INJ	12-28-87
(70) OKLAHOMA CITY I-40																		
70	69	00 0886	00000				NO W	W		2	1	3400	F-O(RETN WALL)	UNSAF-SPD	DARK	IC-S	INJ	03-03-88
(70) OKLAHOMA CITY I-40																		
70	69	00 0920	00000				NO E			1	2	800	F-O(RETN WALL)	UNSAF-SPD	LIGHT	IC-S	INJ	01-15-88
(70) OKLAHOMA CITY I-40																		
70	69	00 0929	00000				NO W			1		1000	F-O(RETN WALL)	UNSAF-SPD	DARK	IC-S	PD	02-07-87
(70) OKLAHOMA CITY I-40																		
70	69	00 0949	00000				NO E			1	1	2600	F-O(RETN WALL)	OEF-VEH	DYLGT	DRY	INJ	10-13-86
70	69	00 0949	00000			CONSTRUCTION	NO E			1		1750	F-O(BARRIER)	UNSAF-SPD	DARK	DRY	PD	06-22-87
(70) OKLAHOMA CITY I-40																		
70	69	00 0971	00000				NO W			1		400	F-O(RETN WALL)	UNSAF-SPD	DARK	IC-S	PD	12-25-87
(70) OKLAHOMA CITY I-40																		
70	69	00 0980	00000			CONSTRUCTION	NO E			1	1	1500	F-O(RETN WALL)	UNSAF-SPD	LIGHT	DRY	INJ	05-12-87
(70) OKLAHOMA CITY I-40																		
70	69	53 0989	00000				NO E			1		675	F-O(GD-RAIL)	DEF-VEH	DYLGT	DRY	PD	07-16-86
(70) OKLAHOMA CITY I-40																		
70	69	53 0991	00000				NO W			1		900	F-O(RETN WALL)	D-W-I	DARK	IC-S	PD	02-09-86
70	69	00 0991	00000			CONSTRUCTION	NO W			1		8000	F-O(RETN WALL)	D-W-I	DARK	DRY	PD	02-13-87
(70) OKLAHOMA CITY I-40																		
70	69	10 0994	00000			CONSTRUCTION	NO W			1	2	2850	FIXED-O(OTHER)	DEF-VEH	DYLGT	DRY	INJ	06-09-86
70	69	10 0994	00000			CONSTRUCTION	NO E			1	2	6400	F-O(RETN WALL)	D-W-I	DARK	DRY	INJ	09-01-87
(70) OKLAHOMA CITY I-40										MILE 151								
70	69	00 0999	00000	MILE 151		CONSTRUCTION	NO W			1	2	3070	F-O(GD-RAIL)	UNSAF-SPD	DYLGT	WET	INJ	06-19-87
(70) OKLAHOMA CITY I-40																		
70	69	00 1002	00000				NO E	E		2		2850	F-O(RETN WALL)	UNSAF-SPD	DARK	WET	PD	08-23-85
(70) OKLAHOMA CITY I-40																		
70	69	00 1012	00000			CONSTRUCTION	NO E			1	1	2000	FIXED-O(OTHER)	D-W-I	DARK	DRY	INJ	06-22-87
(70) OKLAHOMA CITY I-40																		
70	69	00 1020	00000			CONSTRUCTION	NO E			1		1000	F-O(RETN WALL)	UNSAF-SPD	DYLGT	WET	PD	07-17-87

OKLAHOMA DEPARTMENT OF TRANSPORTATION — HIGHWAY TABULATION — TRAFFIC ENGINEERING DIVISION
ANALO10.PRINT — ACCIDENT CONCENTRATION LISTING FOR IN-HOUSE USE
COUNTY: (55) OKLAHOMA — I-40 MAINLINE FIXED OBJECT ACCIDENTS FROM I-44 EAST TO SUNNYLANE — 04-25-82 THRU 04-25-85

CITY	CS #	INT #	MI POST	DIAG CODE	LOCATION DESCRIPTION	SPECIAL FEATURES	INT REL	D1	D2	# VE	PEOPLE IN-FAT	PROP DMG	TYPE ACCIDENT	CAUSE OF ACCIDENT	CONDITIONS LIGHT	ROAD	SEV	DATE
(70) OKLAHOMA CITY I-40																		
70	69	53	0986	00000			NO	E		1	1	875	F-O(GD-RAIL)	NO-IMP-ACT	DARK	DRY	INJ	07-11-83
(70) OKLAHOMA CITY I-40																		
70	69	00	0989	00000			NO	W		1		700	F-O(RETN WALL)	UNSAF-SPD	LIGHT	WET	PD	05-17-83
(70) OKLAHOMA CITY I-40																		
70	69	00	0994	00000			NO	E		1	1	2600	FIXED-O(OTHER)	D-W-I	DARK	DRY	INJ	02-04-84
70	69	00	0994	00000			NO	W		1		2500	F-O(RETN WALL)	UNSAF-SPD	LIGHT	DRY	PD	03-29-84
(70) OKLAHOMA CITY I-40																		
70	69	00	0998	00000			NO	W		1		500	F-O(RETN WALL)	UNSAF-SPD	DYLGT	IC-S	PD	12-04-83
(70) OKLAHOMA CITY I-40																		
70	69	00	1001	00000			NO	E		1		3050	F-O(GD-RAIL)	UNSAF-SPD	DYLGT	DRY	PD	03-10-84

TABULATION OF ACCIDENT DATA FROM 04-26-85 TO 04-26-88 RUN DATE: 01/19/89

I-40 MAINLINE FIXED OBJECT ACCIDENTS FROM I-44 EAST TO SUNNYLANE STUDY LENGTH : .00

ACCIDENT SEVERITY

	1985				1986				1987				1988				1989			
	FAT	INJ	P-D	TOTAL	FAT	INJ	P-D	TOTAL	FAT	INJ	P-D	TOTAL	FAT	INJ	P-D	TOTAL	FAT	INJ	P-D	TOTAL
ACCIDENTS	1	9	31	41	1	16	49	66	1	24	44	69		7	9	16				
PERSONS	1	11		12	1	20		21	1	34		35		10		10				

STUDY TOTAL(SEVERITY)

	FATAL	INJURY	PROPERTY DAMAGE	TOTAL
ACCIDENTS	3	56	133	192
PERSONS	3	75		78

ACCIDENT TYPE & DAMAGE CAUSED

COLLISION TYPE	1985				1986				1987				1988				1989			
	FAT	INJ	P-D	TOTAL	FAT	INJ	P-D	TOTAL	FAT	INJ	P-D	TOTAL	FAT	INJ	P-D	TOTAL	FAT	INJ	P-D	TOTAL
OVR-TRN(IN-RD)																				
PEDESTRIAN																				
PARKED-VEHICLE																				
RAILROAD-TRAIN																				
ANIMAL																				
FIXED-OBJECT	1	9	31	41	1	16	49	66	1	24	44	69		7	9	16				
RAN-OFF-ROAD																				
S-S(SAME-DIR)																				
REAR-END																				
HEAD-ON																				
S-S(OPP-DIR)																				
ANGLE(TURN)I																				
ANGLE(TURN)NI																				
ANGLE(I)																				
ANGLE(NI)																				
OTHER																				
TOTAL(P.D.)	$79,275				$137,875				$208,990				$34,510							

STUDY TOTAL(ACCIDENT TYPE)

	FATAL	PERCENT	INJURY	PERCENT	PROPERTY DAMAGE	PERCENT	TOTAL	PERCENT
OVR-TRN(IN-RD)								
PEDESTRIAN								
PARKED-VEHICLE								
RAILROAD-TRAIN								
ANIMAL								
FIXED-OBJECT	3	100.0	56	100.0	133	100.0	192	100.0
RAN-OFF-ROAD								
S-S(SAME-DIR)								
REAR-END								
HEAD-ON								
S-S(OPP-OIR)								
ANGLE(TURN)I								
ANGLE(TURN)NI								
ANGLE(I)								
ANGLE(NI)								
OTHER								
TOTAL	3	100.0	56	100.0	133	100.0	192	100.0

STUDY TOTAL(DAMAGE CAUSED) $460,650

TABULATION OF ACCIDENT DATA FROM 04-26-85 TO 04-26-88 RUN DATE: 01/19/89

I-40 MAINLINE FIXED OBJECT ACCIDENTS FROM I-44 EAST TO SUNNYLANE STUDY LENGTH : .00

SPEED CONDITIONS

TYPE OF VEHICLE	OPERATING SPEED										TOTAL	PERCENT
	0-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80+	UNKNOWN		
SINGLE UNIT (NORMAL)	5	11	17	23	52	59	15	3	1		186	88.1
SINGLE UNIT (LARGE)	1	1	2		1	1					6	2.8
DUAL UNIT			1	3	6	9					19	9.0
OTHER												
TOTAL	6	12	20	26	59	69	15	3	1		211	100.0
PERCENT	2.8	5.6	9.4	12.3	27.9	32.7	7.1	1.4	.4		100.0	

ACCIDENT OCCURRENCE

DAY	HOUR OF THE DAY																							TOTAL	PERCENT
	<----AM---->												<----PM---->												
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	
MON	1				2	2	2	1	1	1	1	1		1	1	3		4	1	1			1	1	25	13.0
TUE	1				1	3	1	4	1	1	1	1		1	3	5	1	.	1	2	2	2			31	16.1
WED						7	1	2	2		1	1		3	6		2	1	1	2					29	15.1
THU			1	1		1	3	4	1	1	1	3			1	1	2		3			2	1	1	27	14.0
FRI			1		1	4		3	3		4	1	2	3	2	1	6	1				2	2		36	18.7
SAT		2	2		1	1	2	1	1	2	1		1		1		1		2	1		2	2	1	24	12.5
SUN	1	2		1	1				2	3	2	1	1			2			1		1		2		20	10.4
	EARLY MORNING-SUNRISE				MORNING PEAK				MID MORNING-MID AFTERNOON							AFTERNOON PEAK				EVENING-LATE NIGHT					TOTAL	100.0
TOTAL	37				35				53							30				37					192	
PERCENT	19.2				18.2				27.6							15.6				19.2					100	

POTENTIAL INFLUENCING CONDITIONS

ROADWAY CONDITIONS	LIGHTING CONDITIONS					TOTAL	PERCENT
	DAYLIGHT	DARKNESS	TWILIGHT	LIGHTED	UNKNOWN		
DRY	66	23	3	5		97	50.5
WET(WATER)	33	13	4	4		54	28.1
WET(ICE OR SNOW)	18	14	6	2		40	20.8
MUDDY							
NOT REPORTED		1				1	.5
TOTAL	117	51	13	11		192	100.0
PERCENT	60.9	26.5	6.7	5.7		100	

WEATHER CONDITIONS	TOTAL	PERCENT
CLEAR	63	32.8
PARTLY CLOUDY	48	25.0
OVERCAST	23	11.9
RAINING	44	22.9
OTHER	14	7.2
TOTAL	192	100.0

TABULATION OF ACCIDENT DATA FROM 04-26-85 TO 04-26-88 RUN DATE: 01/19/89

I-40 MAINLINE FIXED OBJECT ACCIDENTS FROM I-44 EAST TO SUNNYLANE STUDY LENGTH : .00

CAUSE OF ACCIDENT	OFFENDING DRIVERS CONDITION																		ACCIDENT SEVERITY				
	APPARENTLY NORMAL			ALCOHOL INVOLVED ABILITY IMPAIRED			ALCOHOL INVOLVED ODOR DETECTED			SLEEP SUSPECTED			PHYSICAL DEFECT			OTHER CONDITION							
	FAT	INJ	P-D	FAT	INJ	P-D	FAT	INJ	P-D	FAT	INJ	P-D	FAT	INJ	P-D	FAT	INJ	P-D	FAT	INJ	P-D	TOTAL	PCT
F-YIELD																							
F-STOP																							
F-SIGNAL																							
IMP-TURN																							
IMP-START																							
IMP-STOP																							
IMP-BACK																							
IMP-PARK																							
IMP-PASS																							
IMP-LN-CHG		1						1												2		2	1.0
L-CENTER																							
FOL-CLOSE			2																		2	2	1.0
UNSAF-SPD		25	67			1	1	3	3									9	1	28	80	109	56.7
O-W-I				2	8	8											1		2	9	8	19	9.8
INATT									1			1		1	1					1	3	4	2.0
NEG-DRVING			1																		1	1	.5
DEF-VEH		4	7															1		4	8	12	6.2
WRNG-WAY																							
NO-IMP-ACT		7	26											1			1	2		9	28	37	19.2
OTHER		1	3					1						1						3	3	6	3.1
TOTAL		38	106	2	8	9	1	5	4			1		3	1		2	12	3	56	133	192	100.0
PERCENT		19.7	55.2	1.0	4.1	4.6	.5	2.6	2.0			.5		1.5	.5		1.0	6.2	1.5	29.1	69.2	100	

APPENDIX D

ODOT SPECIAL PROVISION
March 28, 1984

OKLAHOMA DEPARTMENT OF TRANSPORTATION
SPECIAL PROVISIONS
FOR
EXPERIMENTAL SAFETY BARRIER END TREATMENT
(SENTRE)
ON
FEDERAL AID PROJECT IR-40-4(304)147
OKLAHOMA COUNTY

These Special Provisions revise, amend, and where in conflict, supersede applicable Sections of Standard Specifications for Highway Construction, Edition of 1976.

DESCRIPTION. The SENTRE unit shall consist of interlocking collapsible thrie beam fender panels, wide flange posts, slip bases, sand containers, and a redirecting cable. These components shall form a crashworthy end treatment which shall meet the minimum test requirement specified in the National Cooperative Highway Research Program (NCHRP) report 230:

1. Impact at 25 degrees into the beginning of length of need (i.e., beginning of tensioned guardrail and/or concrete parapet) at 60 mph with a 4500 lb. car.
2. Impact at 0 degrees into center nose of the device (0" offset from centerline of vehicle) at 60 mph with a 4500 lb. car.
3. Impact at 15 degrees into side of the device midway between nose and beginning of length of need at 60 mph with an 1800 lb. car.
4. Impact at 0 degrees into nose of the device (with 1.25 ft. offset from centerline of vehicle) at 60 mph with an 1800 lb. car.

When hit head-on, the unit shall be capable of simultaneously collapsing and moving laterally to re-direct an impacting vehicle away from the end of the downstream traffic barrier.

The redirecting cable shall be anchored at both ends with anchors that are capable of withstanding a minimum pullout force of 50,000 lbs.

The base plate of each SENTRE post shall be rigidly held in place by anchors that are capable of withstanding a 15,000 lbs. shear and 26,500 ft-lbs moment in the longitudinal axis of the SENTRE and 27,000 lbs. of shear and 49,500 ft-lbs of moment in the lateral axis of the SENTRE.

MATERIALS. (a) General. All SENTRE components shall be assembled in accordance with the manufacturer's standards and require ents.

1. Fender Panels. The fender panels shall be fabricated from 10 gauge steel triple corrugated guardrail sections which meet AASHTO Guide M-180 specifications. Each fender panel shall

be drilled and slotted in accordance with the manufacturer's specifications. When assembled in the field, all fender panels shall be bolted to a break away post by means of two bolts. The back end of each triple corrugated fender panel shall overlap and be connected to the fender panel of the next bay by means of a bolt and mushroom washer which fits through the long horizontal slot in the forward fender panel and the short vertical slot in the underlying panel. This connection method shall permit movement, front to back, of one set of fender panels relative to the panels in the underlying section.

2. Redirecting Cable. The front post of the SENTRE shall have one 7/8" diameter, 6 x 19 galvanized steel, wire rope passing through it. The wire rope material shall be made from improved plow steel with a minimum load limit of 71,000 lbs.

3. Sand Containers. The front three posts shall be fitted with sand containers which hold either 100 or 150 pounds of sand. Two small (100 pound) sand containers shall be fastened to each of the front two posts. Two large (150 pound) sand containers shall be fastened to the third post. The sand containers shall be molded from a black plastic having sufficient U.V. stabilizers and anti-oxidants to provide good weatherability. Each sand container shall have a hinged plastic lid which snaps firmly in place after the containers have been filled with sand. Sand mass for the containers shall meet the requirements of Subsection 701.05 and shall contain not more than two percent moisture by dry weight of the aggregate at the time of placement.

4. Nose Cover. The front of the SENTRE shall be fitted with a grey plastic "bull nose". The nose shall be molded from a plastic having sufficient U.V. stabilizers and anti-oxidants to provide good weatherability. The nose shall interface to the front triple corrugated fender panel. The nose shall have a flat surface on its forward section which shall be suitable for mounting reflective sheeting.

5. Fasteners. All bolts, nuts, and washers used to assemble the SENTRE shall be zinc coated, commercial quality "American National Standard" unless otherwise specified.

6. Metal Work. All metal work shall be fabricated from either M1020 Merchant Quality or ASTM A-36 steel. After fabrication, all metal work shall be hot dipped galvanized in accordance with ASTM A-123. All welding shall be done by or under the direction of a certified welder.

(b) Materials Certification. A type "D" Materials Certification shall be required in accordance with Subsection 106.12.

CONSTRUCTION METHODS. Installation of the SENTRE shall be accomplished by experienced workmen in accordance with the recommendations of the manufacturer. As a replacement supply, the Contractor shall furnish a spare parts package. The quantity and materials of this package will be as shown on the Plans. These unassembled materials will become the property of the Oklahoma

Department of Transportation and shall be delivered to the Department Warehouse designated by the Engineer.

METHOD OF MEASUREMENT. Each SENTRE installation will be measured by the unit for each installation as shown on the Plans. Replacement packages will be measured by the unit delivered to the designated warehouse in accordance with these Specifications.

BASIS OF PAYMENT. Accepted SENTRE and replacement packages, measured as provided above, will be paid for at the contract unit price for:

SP.	SAFETY BARRIER END TREATMENT (SENTRE)	EA.
SP.	SAFETY BARRIER END TREATMENT (SENTRE)(REPLACEMENT PACKAGE)	EA.

which shall be full compensation for furnishing all containers, guardrails, posts, and all other materials, equipment, labor and incidentals to complete the work as specified.