

#### IV. WINDBORNE OBJECTS AND MISSILE DAMAGE

Winds near the center of the storm as well as winds in the peripheral areas produced several significant windborne objects and large amounts of flying debris. The windborne objects varied in size from small nails to a 13 ton metal tank. Large and heavy windborne objects were potentially dangerous and, in some cases, created severe damage. Limited amounts of data were available on four types of heavy items which were moved by the storm winds. The four types of items were: industrial air-conditioning compressors, a 13 ton metal tank, oil tanks, and several railroad cars. The original locations, final locations, distances travelled, weights, and sizes of these items have been documented. It is noteworthy that these items were located in the extensive destruction zone (Ref. Fig. 2). These windborne objects are described individually below.

Flying debris such as pieces of wood, glass, utility poles, and gravel which travelled at high speeds also caused structural damage, as well as personal injury. The damage that these types of missiles caused was documented, where possible, during inspections of structural damage. Table III references structures which sustained missile damage. The natures of the missile damage are contained in the documentations of structures in Section III. Generally it was not possible to ascertain the type, origin, size, and distance travelled by these missiles.

TABLE III  
MISSILE DAMAGE TO STRUCTURES

<u>Structure Number</u>	<u>Structure Name</u>	<u>Remarks</u>
1	Great Plains Life Building	Wind glass was broken principally by windborne debris [5]
2	First National Bank-Pioneer Gas Company Building	Window glass was broken principally by windborne debris [5]
3	Southwestern Bell Telephone company Building	Porcelain enameled panels of microwave relay tower were damaged by windborne debris
7	Clark Manufacturing Company	Concrete block wall showed evidence of being struck by missiles
9	Newsom's Living Center	Industrial air conditioning compressors on top of this structure were moved      ft by wind forces (Ref. paragraph A)
14	Plains Seed Delinting Plant	Structure destroyed by impact of seed hopper
17	J. D. Hufstedler Company	Damage due to windborne debris evident on metal siding
24	Catholic Welfare Center	Metal tanks driven by the wind destroyed the structure (Ref. Paragraph C)
25	S. E. Cone Grain Warehouse	Structure was destroyed by impact of grain elevator
27	Baptist Mission	Damage from windborne debris evident on metal siding

TABLE III  
MISSILE DAMAGE TO STRUCTURES (Cont'd)

<u>Structure Number</u>	<u>Structure Name</u>	<u>Remarks</u>
31	Gifford-Hill-American Complex	Damage from windborne debris evident on metal siding (Ref. Fig. 31.5)
32	Kimbell-Bishard Warehouse and Shop	Unanchored irrigation pipe in adjacent storage yard did not become windborne
40	West Texas Compress Sample Warehouse No. 1	Sheet metal panels from this structure were found wrapped around a pole 140 ft away (Ref. Fig. 40.6)
41	Town and Country Airport Hangars	Damage to sheet metal roofs and airplanes caused by hailstones
61	Service Station	Glass in free standing sign broken by missiles
64	Brookshire Inn	Tree limb impacting on roof may have caused damage
69	Astro 400 Motel	Windborne debris (glass, small rocks, wood splinters) damaged walls. Air-conditioning compressors impacted column on second floor (Ref. Paragraph A)
70	Varsity Apartments	Damage from impacting power pole can be seen in Figure 70.4. A 2 x 4 in. board 6 ft in length was driven through exterior concrete block wall

TABLE III  
MISSILE DAMAGE TO STRUCTURES (Cont'd)

<u>Structure Number</u>	<u>Structure Name</u>	<u>Remarks</u>
77	Portwood Residence	Sheetrock wall damaged by windborne debris. Nail embedded in tree (Ref. Fig. 77.5)
78	Guy B. Hilton Residence	Residents injured by windborne debris
81	Duplex Residence	Exterior walls damaged by windborne debris (Ref. Fig. 81.1)
82	Residence	Corrugated sheet metal from nearby industrial area collected in yard
84	Residence	Damage to wall caused by windborne debris. Large amount of sheet metal panels found in yard (Ref. Fig. 84.4)
85	Abbott Trailer Sales North Lot	Travel trailers were damaged by windborne debris

#### A. Industrial Air-Conditioning Compressors

Three air-conditioning compressors were located on the roof of Newsom's Living Center (Ref. Structure 9) prior to the storm. After the storm two compressors were found on the ground and the third compressor was found wrapped around a second floor column in the Astro 400 Motel (Ref. Structure 69). The paths of travel, the initial and final locations of the compressors, and compressor sizes are shown in Figure 5. The destroyed compressors are shown in Figure 6 (for compressor No. 1), Figure 7 (for compressor No. 2), and Figures 8 and 9 (for compressor No. 3).

The three compressors were located on the roof at an elevation of 18 ft. They travelled horizontal distances ranging from 82 to 170 ft. They probably rolled along a portion of the total distance travelled. It is noted, however, that compressor No. 1 (Ref. Fig. 6) virtually disintegrated, and compressor No. 3 (Ref. Figs. 8 and 9) wrapped itself around a steel column in the adjacent structure. The types of damage sustained by the compressors indicated that they moved with significant velocities during the storm.

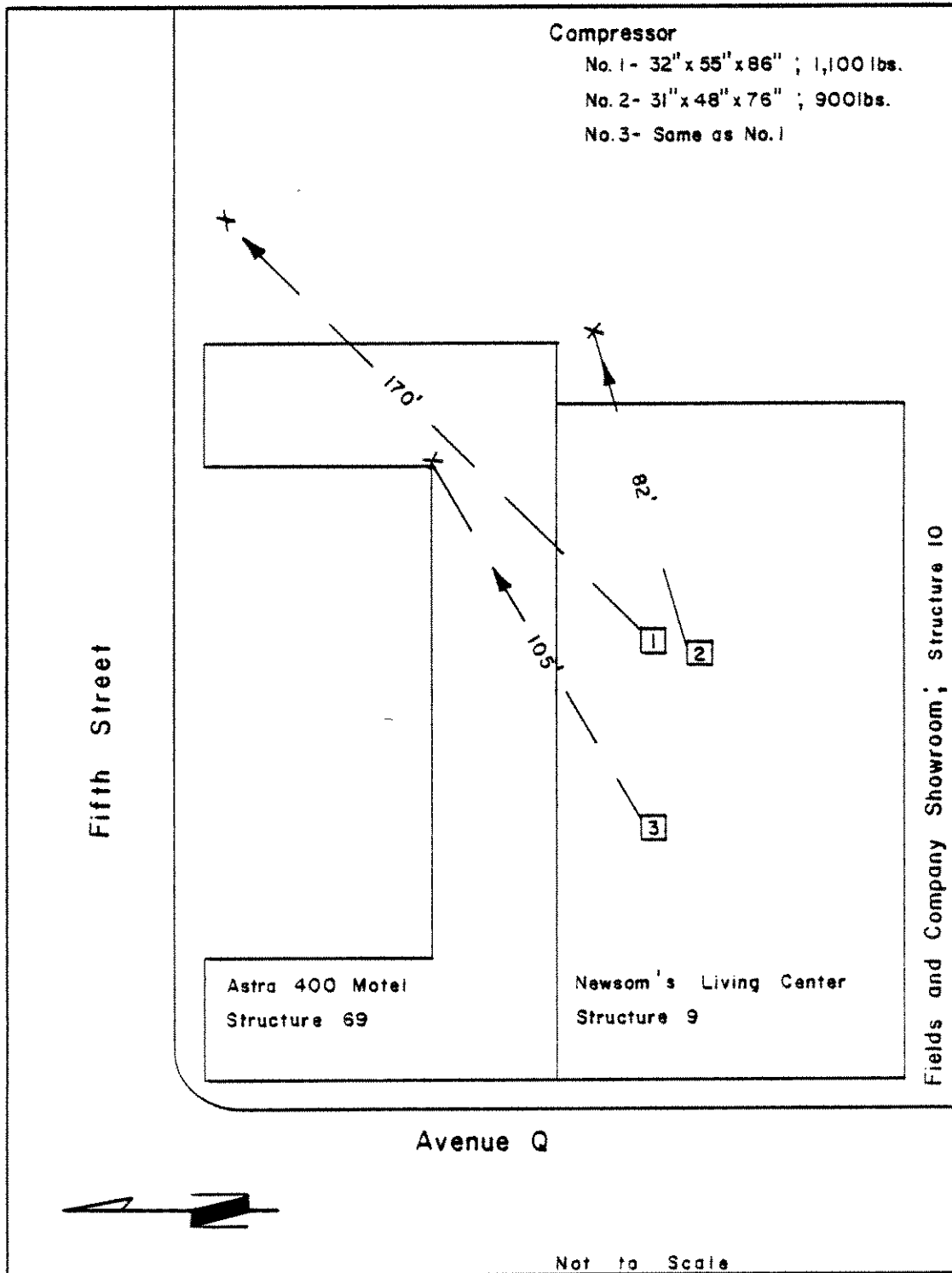


FIGURE 5. DATA AND PATHS OF TRAVEL OF INDUSTRIAL AIR CONDITIONING COMPRESSORS



FIGURE 6. VIEW OF DESTROYED COMPRESSOR NO. 1



FIGURE 7. VIEW OF DESTROYED COMPRESSOR NO. 2

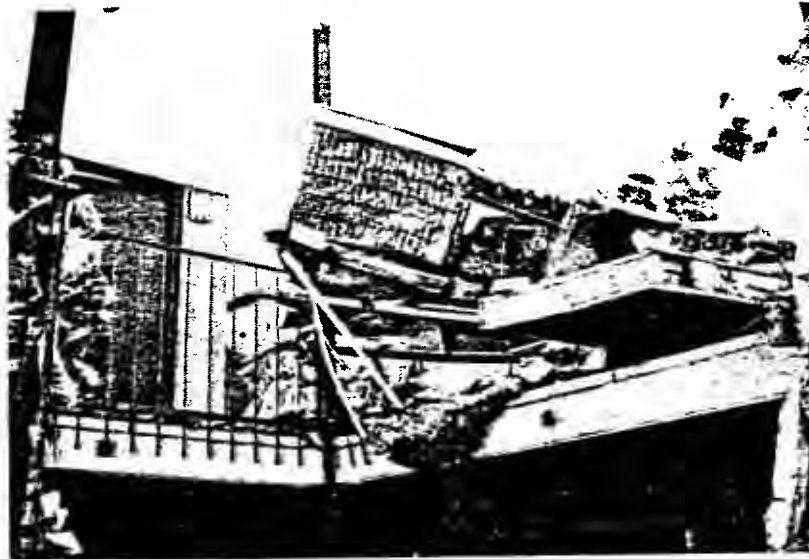


FIGURE 8. VIEW OF COMPRESSOR NO. 3 WHICH WRAPPED AROUND STEEL COLUMN



FIGURE 9. COMPRESSOR NO. 3 AROUND STEEL COLUMN



### B. 13 Ton Metal Tank

An 11 ft diameter by 41 ft long cylindrical metal tank weighing 25,800 lbs was found approximately 3/4 mi east of its original location. It travelled from Goodpasture Grain Storage Complex (Ref. Structure 11) to Clark Manufacturing Company (Ref. Structure 7). An aerial photograph in Figure 10 taken from 3000 ft elevation shows the original location, path of travel, and final location of the tank. The tank is shown in Figure 11 after it was brought back to its original location. The fertilizer storage tank was empty on the day of the storm.

The tank sits on four steel saddles (Ref. Fig. 11) and is restrained only by its own weight. It sits 2-1/2 ft above the ground. The longitudinal axis of the tank is oriented east-west. Turbulent winds pushed it off of its saddle supports and moved it 3/4 mi to the southeast corner of the Clark Manufacturing Company property (Ref. Structure 7). It has not been determined whether the tank rolled throughout this distance, or was airborne part of the way. During the 3/4 mi of travel the tank rotated from an east-west orientation to a north-south orientation, and crossed a four-lane highway and an access road. It apparently passed between two motels in the area since there was no known damage to these structures induced by the tank. The terrain along the the travel path of the tank is reasonably flat and there are no sharp depressions. The water pond which can be seen as a dark area in Figure 10 was probably formed during the rain that followed the wind storm.

The wind velocity necessary to push the tank from its saddle supports has been calculated to be 183 mph. This calculation assumes that the wind acted uniformly on the side of the tank and that the drag coefficient for the cylindrical tank is 0.55. Wind velocity calculations are contained in Figure 12.



FIGURE 10. AERIAL PHOTOGRAPH SHOWING ORIGINAL AND FINAL LOCATIONS OF 13-TON FERTILIZER TANK

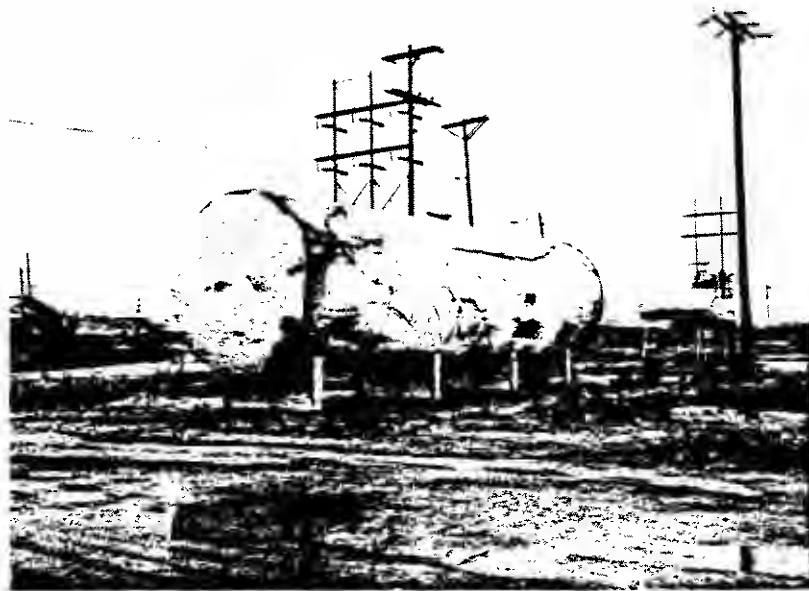


FIGURE 11. VIEW OF FERTILIZER TANK AT ITS ORIGINAL LOCATION ON SADDLE SUPPORTS

## WEIGHT COMPUTATION:

Cylinder

$$\text{Cir.} = \pi d = 34.6 \text{ ft}$$

$$\text{Area} = 34.6 (.375/12) = 1.08 \text{ ft}^2$$

$$\text{Vol.} = 1.08 (41) = 44.3 \text{ ft}^3$$

Ends

$$\text{Area} = \pi r^2 = \pi (5.5)^2 = 95 \text{ ft}^2$$

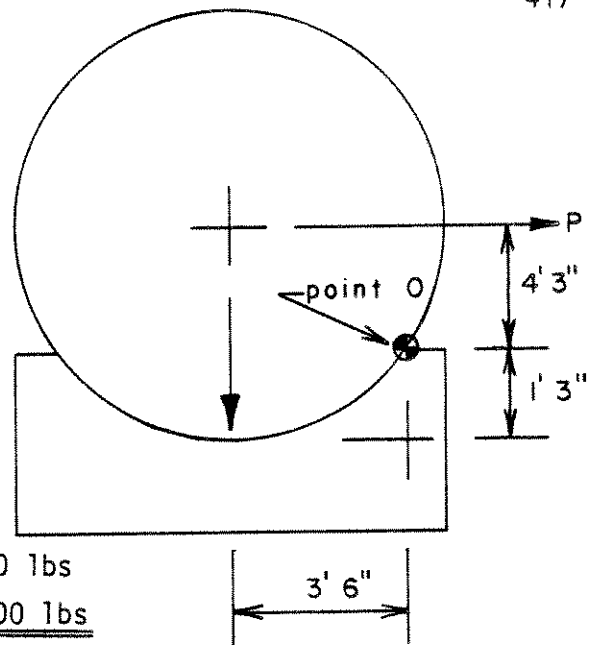
$$\text{Vol.} = (95.0)2(.375/12) = 5.9 \text{ ft}^3$$

$$\text{Total Vol} = 50.2 \text{ ft}^3$$

$$\text{Nominal Wt} = (50.2) (490) = 24,600 \text{ lbs}$$

$$\text{Total Wt} = (24,600) (1.05) = \underline{25,800 \text{ lbs}}$$

(5% for accessories)



## WIND VELOCITY COMPUTATION:

Moments about point O:

$$P (4.25) = (25,800) (3.5)$$

$$P = 21,200$$

Equivalent Uniform Pressure (p)

$$p = 21,200 / (11) (41) = 47.0 \text{ psf}$$

Velocity Computation

$$47.0 = 0.00256 (C_d) V^2$$

$$\underline{V = 183 \text{ mph}}$$

FIGURE 12. WIND VELOCITY CALCULATIONS FOR  
13 TON FERTILIZER TANK

### C. Three Oil Tanks

Three metal tanks were pushed across a highway by the wind. Two of these tanks crashed into the Catholic Welfare Center (Ref. Structure 24) causing considerable damage. One tank was 5 ft in diameter x 10 ft long while the other two tanks were smaller: 3 ft in diameter x 10 ft long. The tanks were old and were probably used for storing used oil. The original locations, paths of travel, and final locations of the tanks are shown in Figure 13. This aerial photograph was taken from an elevation of 3000 ft.

Tank No. 1, which was of the smaller size, travelled approximately 600 ft and stopped in front of a residence, as shown in Figure 14. The broken chain-link fence in front of the residence indicated that the tank rolled into the front yard from the street. The tank itself was damaged; however, it did not cause damage to the residential structure.

Tank No. 2 (3 x 10 ft) and Tank No. 3 (5 x 10 ft) travelled approximately 1000 ft and crashed into the Catholic Welfare Center. The damage created by these tanks is visible in Figure 15. The tanks are shown inside the structure in Figures 16 and 17. The hole in the roof of the structure indicated that Tank No. 2 may have been airborne when it entered the structure (Ref. Figs. 15 and 24.1). Tank No. 3 apparently rolled into the structure, breaking the siding and girt comprising the wall. Both of these tanks caused severe impact damage to the structure.

All three tanks travelled across an access road and a four-lane highway, and crashed through a chain-link fence that was barricading the highway. The direction of travel of all of the tanks was due east. The terrain in the area was flat, and most of the distance travelled was over open grounds.



FIGURE 13. AERIAL PHOTOGRAPH SHOWING ORIGINAL AND FINAL LOCATIONS OF THE TANKS



FIGURE 14. TANK NO. 1 IN FRONT OF A RESIDENCE



FIGURE 15. VIEW OF DAMAGE TO CATHOLIC WELFARE CENTER  
(STRUCTURE 24)



FIGURE 16. VIEW OF TANK NO. 2 INSIDE STRUCTURE 24



FIGURE 17. VIEW OF TANK NO. 3 INSIDE STRUCTURE 24

#### D. Railroad Cars

Twelve railroad cars overturned during the storm. A few of these cars probably rolled over a number of times. The freight cars were parked on a siding near S. E. Cone Warehouse (Ref. Structure 25). Northwest winds placed five cars on their sides and rolled seven cars over. Two of the railroad cars were found 175 ft from their original locations.

An aerial photograph presented as Figure 18 (taken from an elevation of 3000 ft) shows some of the overturned railroad cars. At the time this aerial picture was taken several of the overturned cars and the two cars that were found 175 ft away had been put back on the tracks. Disturbed soil produced by the movement of heavy equipment can be seen in Figure 18.

The location of the cars immediately after the storm are shown in Figure 19. The types of railroad cars, their serial numbers, and their nominal weights are given in Table IV. It is noteworthy that all cars which overturned or rolled over were empty. The two cars designated L and N (Ref. Fig. 19) that were filled and the car designated C that was empty did not overturn.





FIGURE 18. AN AERIAL PHOTOGRAPH SHOWING OVERTURNED RAILROAD CARS

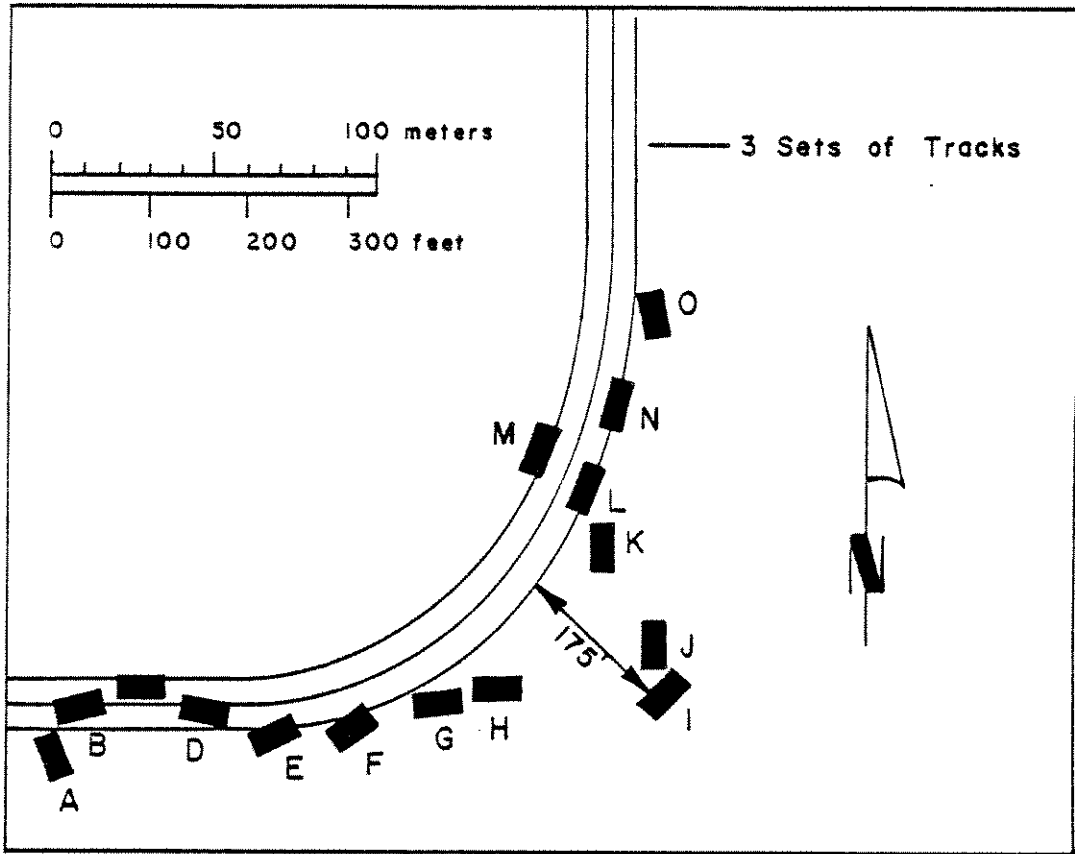


FIGURE 19. LOCATION OF 15 RAILROAD CARS  
SUBSEQUENT TO LUBBOCK STORM

TABLE IV  
RAILROAD CAR DESIGNATIONS, TYPES, POSITIONS, AND WEIGHTS

<u>Car Designation (Fig. 19)</u>	<u>Car No.</u>	<u>Type</u>	<u>Position</u>	<u>Condition</u>	<u>Weight</u>
A	AT 302602	Hopper	Turned Over (T0)	Empty	61,800 lbs.
B	AT 305438	Hopper	T0	Empty	62,500 lbs.
C	AT 307815	Hopper	Upright	Empty	61,500 lbs.
D	AT 307751	Hopper	T0	Empty	61,500 lbs.
E	AT 302764	Hopper	T0	Empty	61,800 lbs.
F	AT 305827	Hopper	T0	Empty	62,500 lbs.
G	AT 306850	Hopper	T0	Empty	64,400 lbs.
H	AT 303055	Hopper	T0	Empty	61,800 lbs.
I	AT 303546	Hopper	T0	Empty	63,100 lbs.
J	AT 305757	Hopper	T0	Empty	62,500 lbs.
K	AT 309902	Hopper	T0	Empty	61,500 lbs.
L	AT 302742	Hopper	Upright	Loaded	199,000 lbs.
M	AT 308071	Hopper	T0	Empty	61,500 lbs.
N	AT 304211	Hopper	Upright	Loaded	190,000 lbs.
O	COFGA 1800	Box	T0	Empty	-----

Data courtesy ATSF Railroad, Amarillo, Texas

