(2)

Final Report

JUNE 1989

EVT 16-89

M973E1 CARGO AND XM1067 FLATBED SMALL UNIT SUPPORT VEHICLES (SUSVs) TRANSPORTABILITY TEST

PREPARED FOR:

U.S. Army Tank-Automotive Command
ATTN: AMSTA-QLS
Warren MI 48397-5000

US ARMY
ARMAMENT
MUNITIONS
CHEMICAL COMMAND

US ARMY DEFENSE AMMUNITION
CENTER AND SCHOOL

EVALUATION DIVISION
SAVANNA, ILLINOIS 61074-9639

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The U.S. Army Defense Ammunition Center and School (USADACS) was tasked by the U.S. Army Tank-Automotive Command (TACOM) to conduct transportability tests on the M973E1 Cargo and XM1067 Flatbed Small Unit Support Vehicles (SUSVs). The purpose of these tests was to evaluate and determine if the M973E1 Cargo and the XM1067 Flatbed SUSVs are able to safely transport loads of ammunition.

Transportability testing of the M973E1 Cargo and the XM1067 Flatbed SUSVs consisted of two separate test series. The first transportability test consisted of a rail impact test with both SUSVs loaded to capacity with a palletized load. In the second series, both SUSVs were road tested with a palletized capacity load and a load consisting of typical unpalletized ammunition items.

Both the M973E1 Cargo and XM1067 Flatbed SUSVs passed the rail impact test and the USADACS road hazard course gaining approval from the Association of American Railroads (AAR) for transport of ammunition in the rail mode and USADACS for transportation of ammunition on/off the highway, respectively.

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U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL
Evaluation Division
Savanna, IL 61074-9639

REPORT NO. EVT 16-89

M973E1 CARGO AND XM1067 FLATBED

SMALL UNIT SUPPORT VEHICLES (SUSVs)

TRANSPORTABILITY TEST

TABLE OF CONTENTS

Part 1

GENERAL

A. INTRODUCTION

1. The U.S. Army Defense Ammunition Center and School (USADACS) was requested by the U.S. Army Tank-Automotive Command (TACOM) to conduct transportability tests on the M973E1 Cargo and XM1067 Flatbed Small Unit Support Vehicles (SUSVs). The purpose of these tests was to determine if the M973E1 Cargo and the XM1067 Flatbed SUSVs are able to safely transport loads of ammunition.

2. Transportability testing of the M973E1 Cargo and the XM1067 Flatbed SUSVs consisted of two separate test series. The first transportability test consisted of a series of rail impacts with the trailing unit of both SUSVs loaded to capacity with two inertly loaded pallets of ammunition. In the second series of tests, both SUSVs were road tested loaded to capacity with a palletized load and loaded with a mixed load of unpalletized inert ammunition items.

3. As a result of the rail impact tests, the Association of American Railroads (AAR) approved the M973E1 Cargo and the XM1067 Flatbed SUSVs to move under load on the railroad. Both SUSVs successfully completed the USADACS road hazard course gaining authority to transport ammunition on/off highway.

B. AUTHORITY

Testing was accomplished IAW mission responsibilities delegated by the U.S. Army Armament, Munitions and Chemical Command (AMCCOM). Reference is made to the following:

1. Change 4, 4 October 1974, to AR 740-1, 23 April 1973, Storage and Supply Activity Operations.

2. AMCCOM-R 10-17, 13 January 1986, Mission and Major Functions of USADACS.

3. Memorandum, TACOM, AMSTA-QLS, 23 February 1989, subject: Tasking the Rail Hump Ammunition/Cargo Transportability Certification Tests of the M973E1 Cargo and the XM1067 Flatbed SUSVs.

C. OBJECTIVE

The objective of this test was to evaluate and determine if the M973E1 Cargo and the XM1067 Flatbed SUSVs are suitable to move over the railroad while loaded with full loads of ammunition on rail flatcar and for transportation of ammunition on/off highway.

D. CONCLUSIONS

1. Both the M973E1 Cargo and XM1067 Flatbed SUSVs carrying the maximum palletized load successfully completed the rail impact test.

2. Both the M973E1 Cargo and XM1067 Flatbed SUSVs carrying the maximum palletized load and a mixed load of unpalletized inert ammunition items successfully completed the 5-step USADACS road hazard course.

3. A wooden dunnage assembly was constructed to protect the bilge pump on the floor of the M973E1 Cargo SUSV from cargo movement, and must be used when the SUSV transports ammunition on/off highway.

E. RECOMMENDATIONS

1. Approval by AAR to transport a M973E1 Cargo and the XM1067 Flatbed SUSVs carrying the maximum ammunition cargo load on a railroad flatcar.

2. Permanent shield be provided in each M973E1 Cargo SUSV to prevent damage to the bilge pump located on the footwell in the second unit.

F. APPROVAL

The M973E1 Cargo and the XM1067 Flatbed SUSVs are approved for transportation of ammunition on/off highway.

Part 2

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PART 3

RAIL IMPACT AND ROAD TESTING PROCEDURES

A. RAIL IMPACT TESTING:

Rail impact testing was accomplished in compliance with previously approved and standardized testing procedures as shown on Page 3-5 and described as follows:

1. The 'Specimen Car' was scheduled to be impacted four times: three times at speeds of 4, 6, and 8 mph in one direction, and one time at 8 mph in the opposite direction. The later two impacts cited are minimum speed requirements.

2. Impacting was accomplished by striking the test car (specimen car) into a line of five stationary cars (buffer cars). The buffer cars were coupled with all connecting draft gears compressed together to the maximum extent possible under prevailing conditions, with all air brakes in a 'set position.'

3. A locomotive (switch engine) was utilized to start the 'specimen car' rolling in the direction of the buffer cars along an approximate 300-foot segment of level trackage.

4. The 'specimen car' was cut loose from the engine approximately 75 feet from the point of impact and allowed to run freely into the first of the buffer cars.

5. Impacting speeds were determined by the utilization of an electronic counter which measured the time required for the specimen car to traverse an 11-foot distance immediately prior to contact; recorded elapsed time was converted to mph speeds. Additional verification of impacting speeds was accomplished by utilization of an electronic stop clock.

B. ROAD TESTING

Five separate road testing steps are required as identified herein:

1. Step No. 1 This step provides for the specimen load to be driven over a 200-foot-long segment of concrete paved road which consists of two series of railroad ties projecting 6 inches above the level of the road surface. This hazard course is traversed two times and repeated per Step No. 4.

a. The first series of ties is spaced on 8-foot centers and alternately positioned on opposite sides of the road centerline for a distance of 50 feet.

b. Following the first series of ties, a paved roadway of 75 feet separates the first and second series of railroad ties.

c. The second series of ties is alternately positioned similarly to the first, but spaced on 10-foot centers for a distance of 50 feet.

d. The specimen load is driven across the hazard course at speeds that will produce the most violent vertical and side-to-side rolling reaction obtainable in traversing the hazard course (approximately 5 mph).

2. Step No. 2 This step consists of 30 miles of travel over available rough roads consisting of gravel, concrete and asphalt, curves, cattle gates, and stops and starts.

3. Step No. 3 This step provides for the specimen load to be subjected to three full air brake stops while traveling in the forward direction and one in the reverse direction while traveling down a 7 percent grade. The first three stops are speeds of 5, 10, 15 mph while the stop in the reverse direction is of approximately 5 mph.

4. Step No. 4 This step consists of a repeat of that identified in Step No. 1 above.

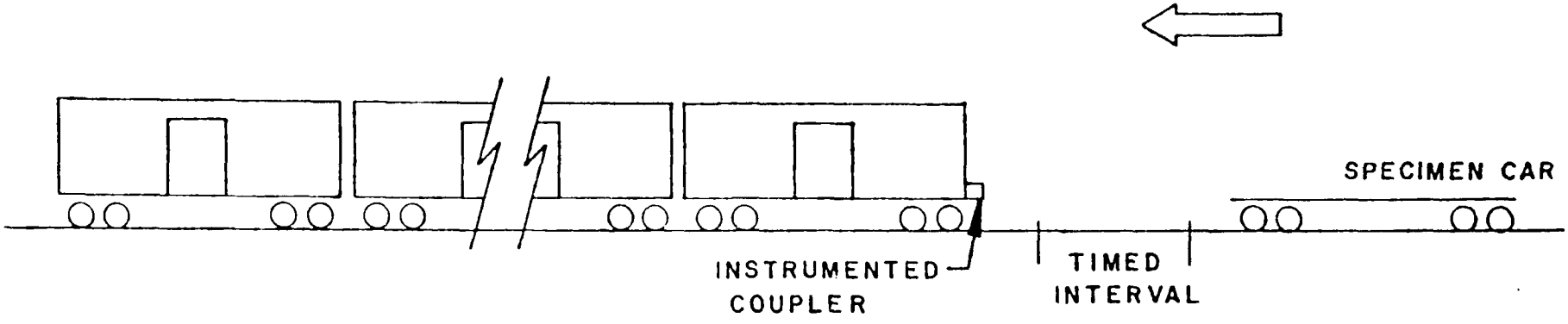
5. Step No. 5 This step provides for the specimen load to be driven over a 300-foot-long segment of concrete paved road which has rails spaced on 26-1/2-inch centers protruding 2 inches above the road surface. The specimen load is driven at the speed which will produce the most violent response.

Note: Step Nos. 3 and 5 may be deleted at the discretion of the test conductor.

C. INSPECTIONS AND DATA COLLECTION

At selected intervals during testing, thorough inspections of the specimen loads were made by technically proficient personnel to collect data on the specimen load and equipment resulting from above load test steps. This data is recorded in Part 4 following.

ASSOCIATION OF AMERICAN RAILROADS (AAR)
STANDARD TEST PLAN



5 BUFFER CARS WITH DRAFT GEAR COMPRESSED AND AIR BRAKES IN A SET POSITION

BUFFER CAR TOTAL WT 250,000 LBS (APPROX)

SPECIMEN CAR IS RELEASED BY SWITCH ENGINE AT:

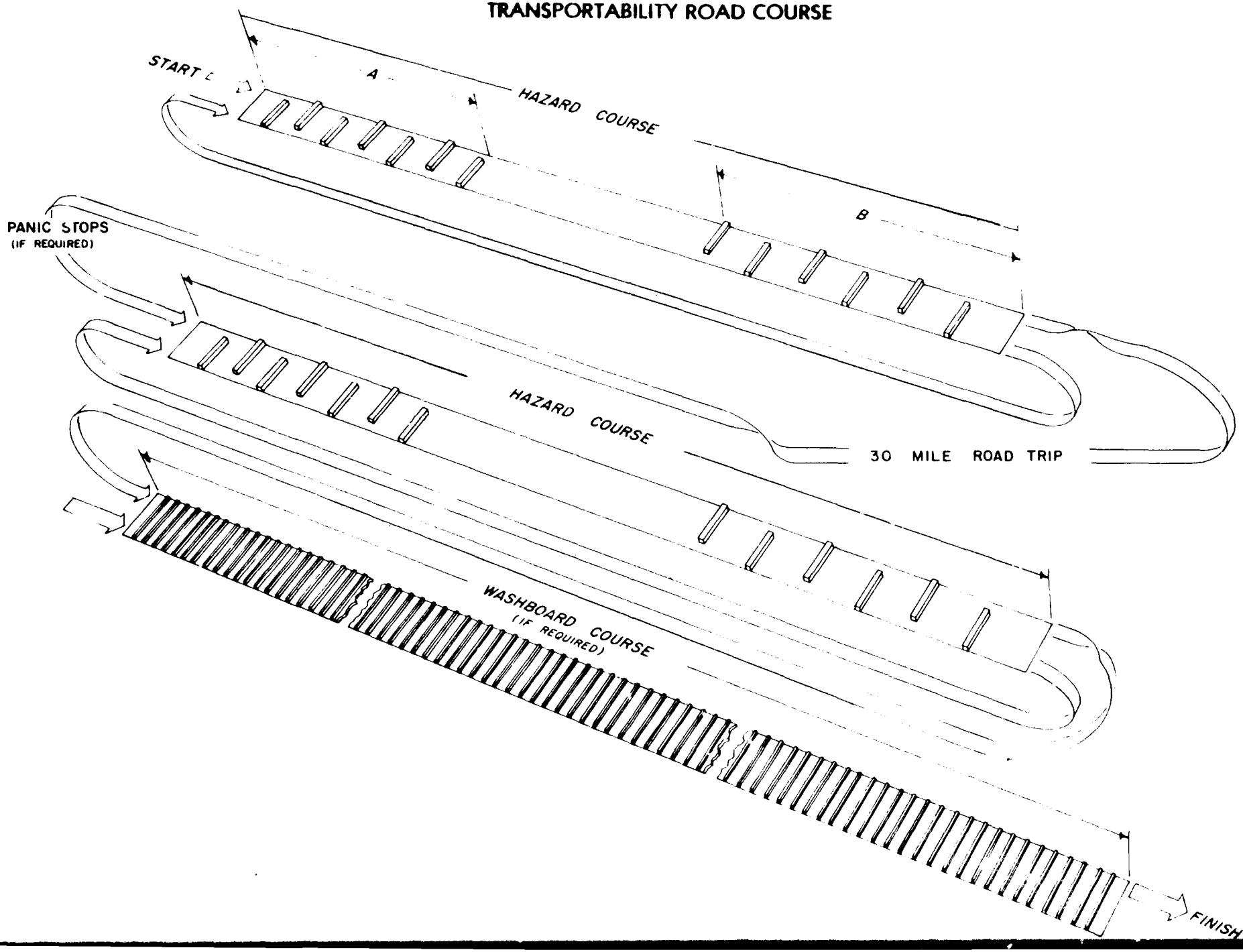
IMPACT NO. 1 4 MPH
IMPACT NO. 2 6 MPH
IMPACT NO. 3 8 MPH

THEN CAR IS REVERSED AND RELEASED AT

IMPACT NO. 4 8 MPH

US ARMY DEFENSE AMMUNITION CENTER AND SCHOOL

TRANSPORTABILITY ROAD COURSE



PART 4

TEST SPECIMEN AND RESULTS

A. RAIL IMPACT TEST OF M973E1 CARGO SUSV

1. The M973E1 Cargo SUSV was cabled to the railroad flatcar with two cables extending from the pintle, one cable extending to a railcar stake pocket on each side of the railroad flatcar. At the center of the SUSV, between the front and rear unit, a cable extends over the rear drive housing to a railcar stake pocket on each side of the flatcar. At the front of the SUSV, a cable is looped around the towing device 'handle bar', located on the sides of the winch mounting bracket, with the cable extending to a stake pocket on each side of the flatcar.

2. To attain the maximum 2,750-pound load in the M973E1 Cargo SUSV, two partial pallets of inert 105mm small-caliber howitzer ammunition were placed in the second unit. A 4- by 8-foot sheet of 3/4-inch thick plywood was used between the bottom of the pallets and the wooden personnel seats within the rear unit. A wooden gate assembly was used at each end of the two-pallet-long load to support web strap tiedown assemblies used to prevent longitudinal shifting of the cargo during the rail impact. A total of eight 5,000-pound capacity webstrap tiedown assemblies were used to secure the load. The hooks on the end of the web strap tiedown assemblies were hooked into the cargo tiedown provisions within the SUSV trailing unit. Two web strap tiedown assemblies extend laterally over the top of each of the two pallets. Two additional web straps were used around the wooden gate assemblies at each end of the two-pallet-unit to prevent longitudinal movement.

3. Accelerometers were placed on the center sill of the railcar, on the frame of the cargo SUSV, and in the footwell of the cargo SUSV. Acceleration along with its duration was measured in the longitudinal, lateral and vertical directions during the rail impacts.

TEST ANALYSIS

1. The vehicle tiedown method previously tested in June 1984 performed satisfactorily as expected.

2. Testing of the SUSV in 1984 revealed a deficiency in the cargo tiedown brackets within the second unit. U.S. Army Defense Ammunition Center and School developed and successfully tested a stiffener adaptable to the existing cargo tiedown bracket in the second unit. The cargo tiedown brackets with the stiffener were used with the web strap tiedown assemblies in this test to secure the capacity inert load without damaging the second unit of the SUSV.

TEST SPECIMENS AND RESULTS

RAIL IMPACT TEST DATA

Test No. 1 Load No. 1 Date: 4 April 1989

Specimen Load: M973E1 Cargo SUSV second unit was loaded with two partial pallets of inert 105mm small-caliber howitzer ammunition. Cargo test load secured with a total of eight web strap tiedown assemblies.

Test Flatcar No. SP&S 34085 Lt. Wt. 47,100

Lading & Dunnage Wt. 2,750

Reference Load No. M973E1 Wt. 9,700

Total Specimen Wt. 59,550

Buffer Car (5 cars) Wt. 250,000

Impact	End Struck	Velocity (mph)	Remarks
1	B	4.26	Plywood deck moved 1/4-inch rearward
2	B	6.26	Plywood deck move 1/4-inch forward
3	B	8.32	Plywood deck moved 1/8-inch rearward. Rear vehicle tiedown cable slightly loose.
4 (reverse)	A	8.34	Plywood deck moved 7/8-inch forward. Cable over center drive between units was loose.

RESULTS FROM THE RAIL IMPACT TEST ON THE
PASSENGER SUSV ON FLATCAR
DATE: APRIL 4, 1989

TAPE CHANNEL 1 : LONGITUDINAL ACCELERATION ON SILL

TEST	SPEED MPH	PEAK VALUE G'S	DURATION MILLISECONDS	AREA G'S-SECONDS
IMPACT 1	4.26	1.11	42.29	.0294
IMPACT 2	6.25	1.44	41.91	.0352
IMPACT 3	8.32	2.33	23.26	.0328
IMPACT 4 (REVERSE)	8.24	-2.31	21.14	.0313

TAPE CHANNEL 3 : VERTICAL ACCELERATION ON SILL

TEST	SPEED MPH	PEAK VALUE G'S	DURATION MILLISECONDS	AREA G'S-SECONDS
IMPACT 1	4.26	.30	15.57	.0026
IMPACT 2	6.25	.91	34.07	.0195
IMPACT 3	8.32	1.35	31.59	.0282
IMPACT 4 (REVERSE)	8.24	1.01	20.62	.0145

TAPE CHANNEL 4 : LATERAL ACCELERATION ON FRAME

TEST	SPEED MPH	PEAK VALUE G'S	DURATION MILLISECONDS	AREA G'S-SECONDS
IMPACT 1	4.26	-.19	76.74	.0041
IMPACT 2	6.25	-.22	13.26	.0015
IMPACT 3	8.32	.38	19.77	.0011
IMPACT 4 (REVERSE)	8.24	.22	18.82	.0023

TAPE CHANNEL 5 : LONGITUDINAL ACCELERATION ON FRAME

TEST	SPEED MPH	PEAK VALUE G'S	DURATION MILLISECONDS	AREA G'S-SECONDS
IMPACT 1	4.26	1.95	451.24	.0770
IMPACT 2	6.25	2.83	72.08	.1203
IMPACT 3	8.32	3.16	74.10	.1443
IMPACT 4 (REVERSE)	8.24	-1.87	78.95	.1062

TAPE CHANNEL 6 : RAIL COUPLER FORCE

TEST	SPEED MPH	PEAK VALUE POUNDS	DURATION MILLISECONDS	AREA POUNDS-SECONDS
IMPACT 1	4.26	110892.05	139.41	4095.67
IMPACT 2	6.25	168341.41	56.02	5399.42
IMPACT 3	8.32	191597.94	37.70	4884.54
IMPACT 4 (REVERSE)	8.24	174025.31	35.58	4530.21

TAPE CHANNEL 7 : VERTICAL ACCELERATION ON FRAME

TEST	SPEED MPH	PEAK VALUE G'S	DURATION MILLISECONDS	AREA G'S-SECONDS
IMPACT 1	4.26	-.92	42.38	.0225
IMPACT 2	6.25	-1.36	38.74	.0322
IMPACT 3	8.32	-1.69	43.23	.0418
IMPACT 4 (REVERSE)	8.24	-1.31	17.15	.0117

TAPE CHANNEL 8 : LONGITUDINAL ACCELERATION ON BED

TEST	SPEED MPH	PEAK VALUE G'S	DURATION MILLISECONDS	AREA G'S-SECONDS
IMPACT 1	4.26	1.89	197.14	.0907
IMPACT 2	6.25	2.68	74.67	.1208
IMPACT 3	8.32	3.29	60.07	.1405
IMPACT 4 (REVERSE)	8.24	-2.20	65.51	.1119

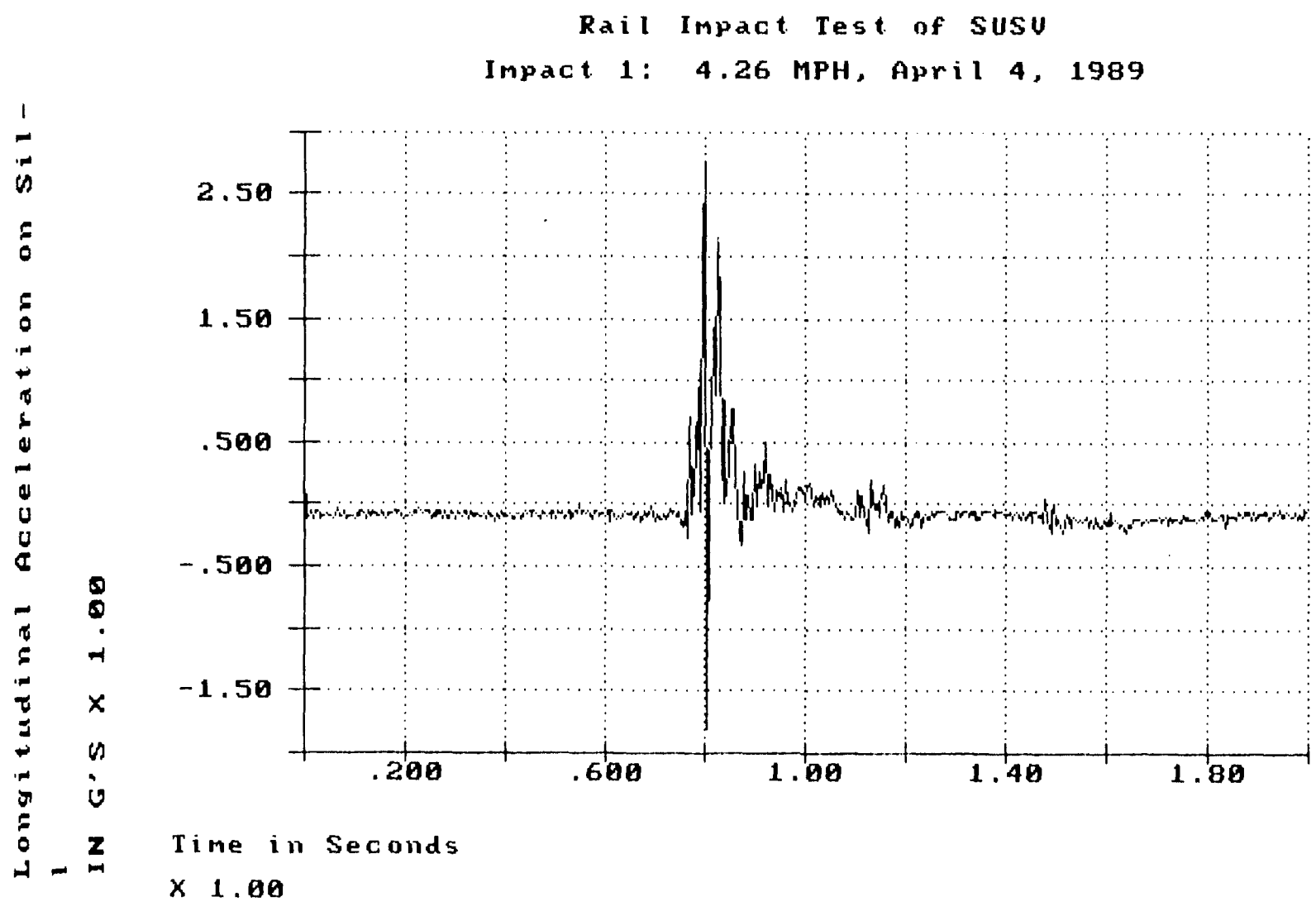
TAPE CHANNEL 9 : LATERAL ACCELERATION ON BED

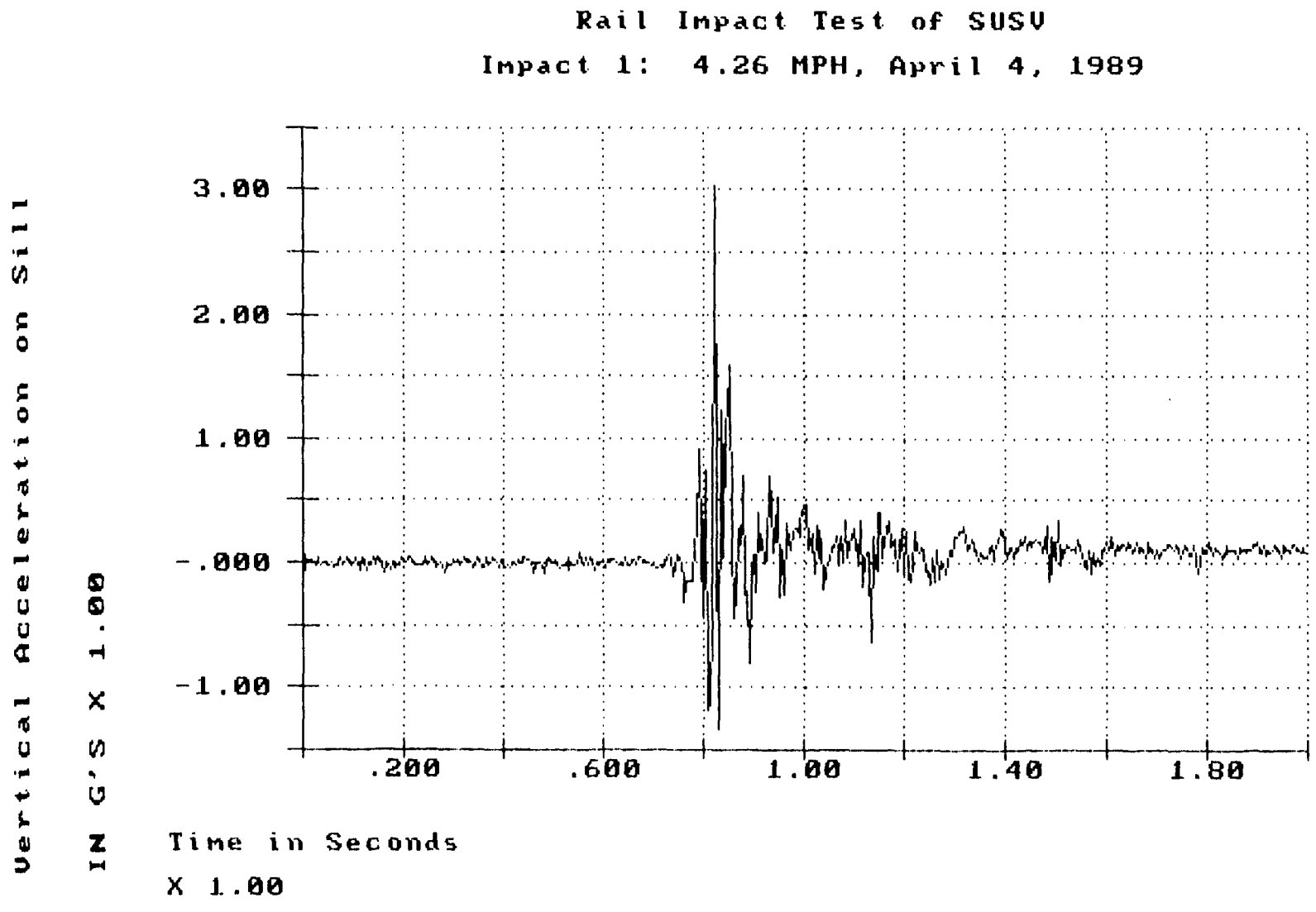
TEST	SPEED MPH	PEAK VALUE G'S	DURATION MILLISECONDS	AREA G'S-SECONDS
IMPACT 1	4.26	-.17	22.93	.0022
IMPACT 2	6.25	-.27	14.17	.0021
IMPACT 3	8.32	.39	20.89	.0031
IMPACT 4 (REVERSE)	8.24	.24	13.75	.0010

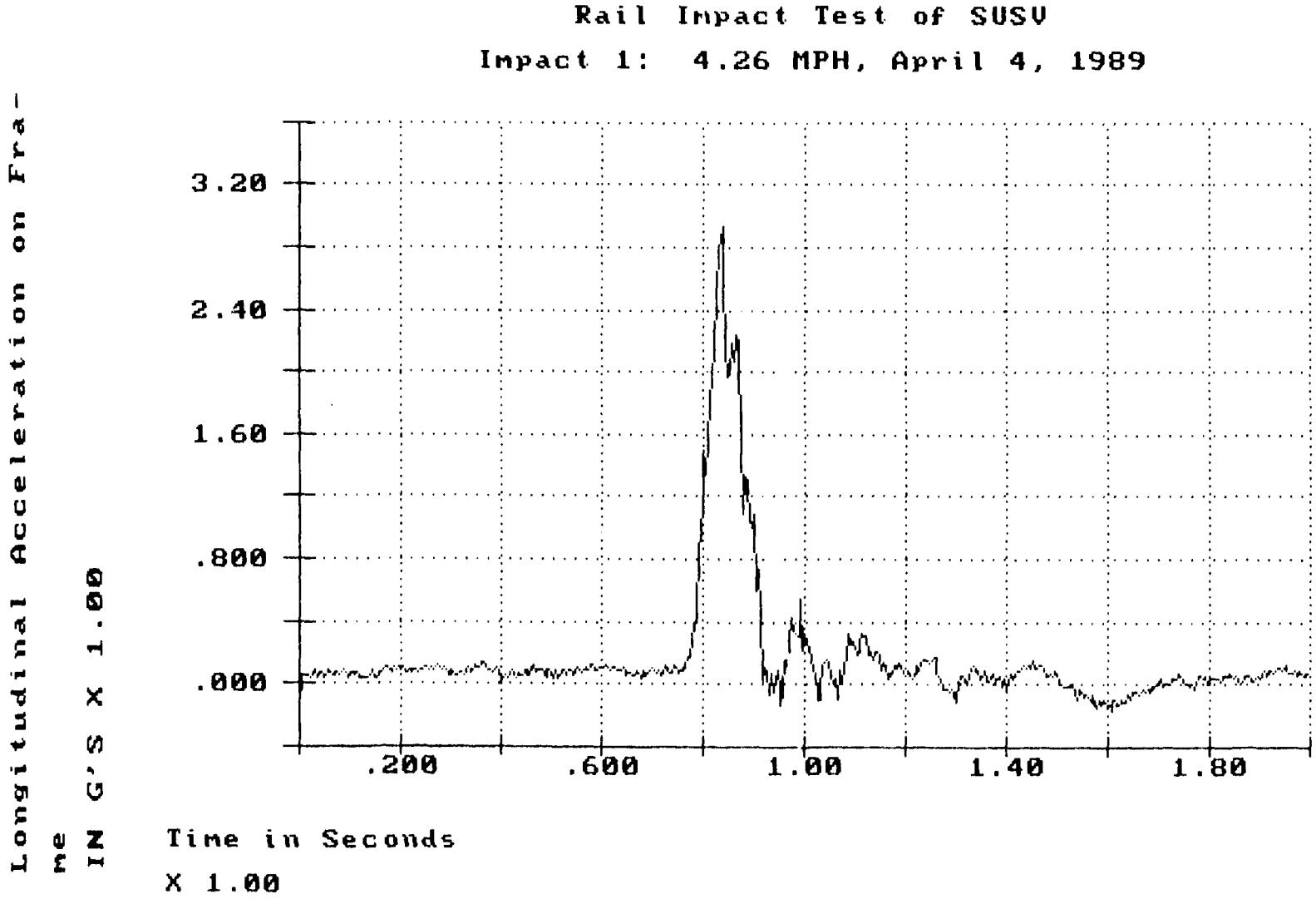
TAPE CHANNEL 10 : VERTICAL ACCELERATION ON BED

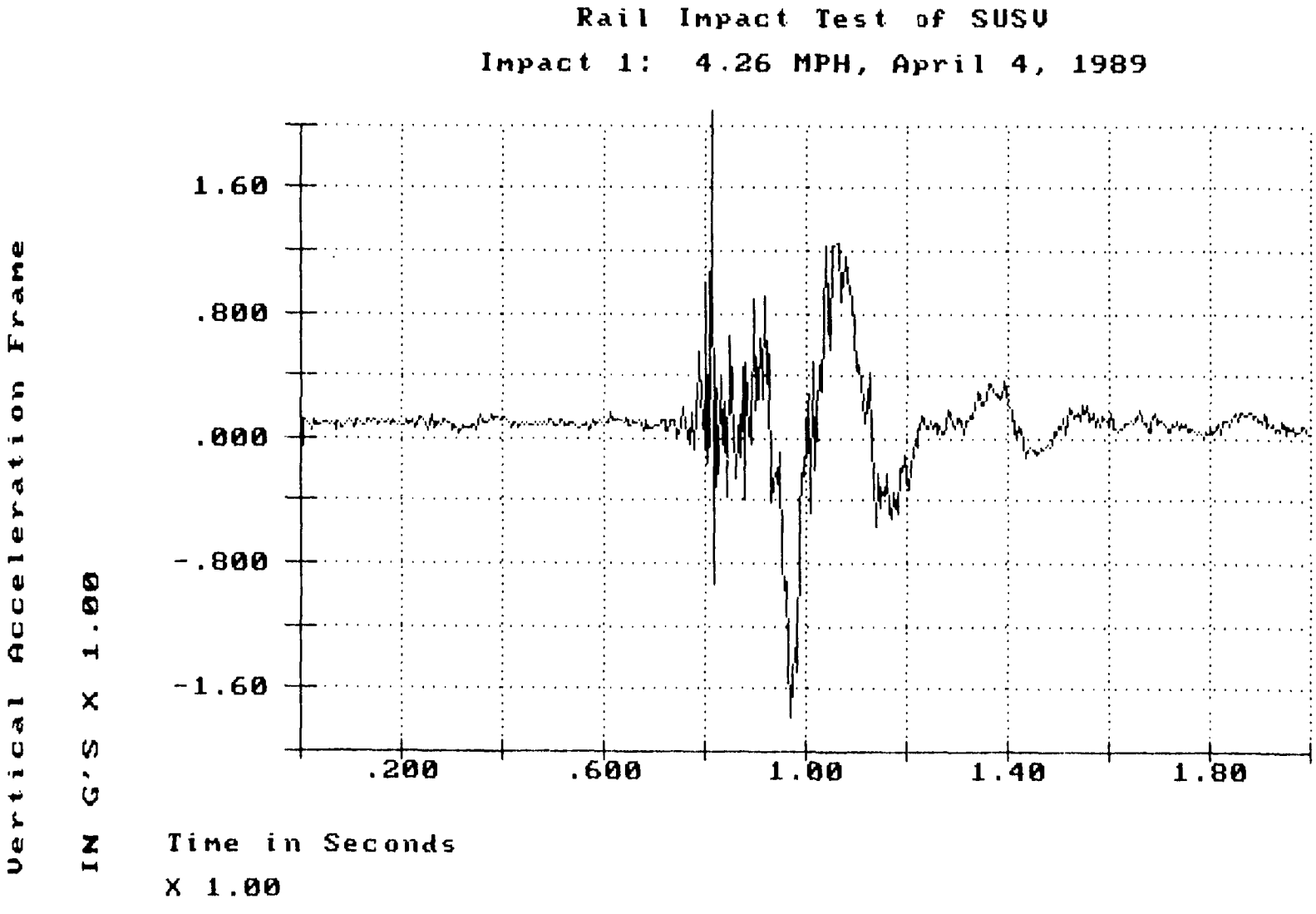
TEST	SPEED MPH	PEAK VALUE G'S	DURATION MILLISECONDS	AREA G'S-SECONDS
IMPACT 1	4.26	*****	*****	*****
IMPACT 2	6.25	*****	*****	*****
IMPACT 3	8.32	*****	*****	*****
IMPACT 4 (REVERSE)	8.24	*****	*****	*****

***** DATA NOT AVAILABLE


Rail Impact Test of SUSV
Impact 1: 4.26 MPH, April 4, 1989
Longitudinal Acceleration on Sil-
1
IN G'S X 1.00
2.50
1.50
.500
-.500
-1.50
.200
.600
1.00
1.40
1.80
Time in Seconds
X 1.00


Rail Impact Test of SUSV
Impact 1: 4.26 MPH, April 4, 1989
Vertical Acceleration on Sill
IN G'S X 1.00
3.00
2.00
1.00
-.000
-1.00
.200
.600
1.00
1.40
1.80
Time in Seconds
X 1.00


Rail Impact Test of SUSV
Impact 1: 4.26 MPH, April 4, 1989
Longitudinal Acceleration on Frame
IN G'S X 1.00
3.20
2.40
1.60
.800
.000
.200
.600
1.00
1.40
1.80
Time in Seconds
X 1.00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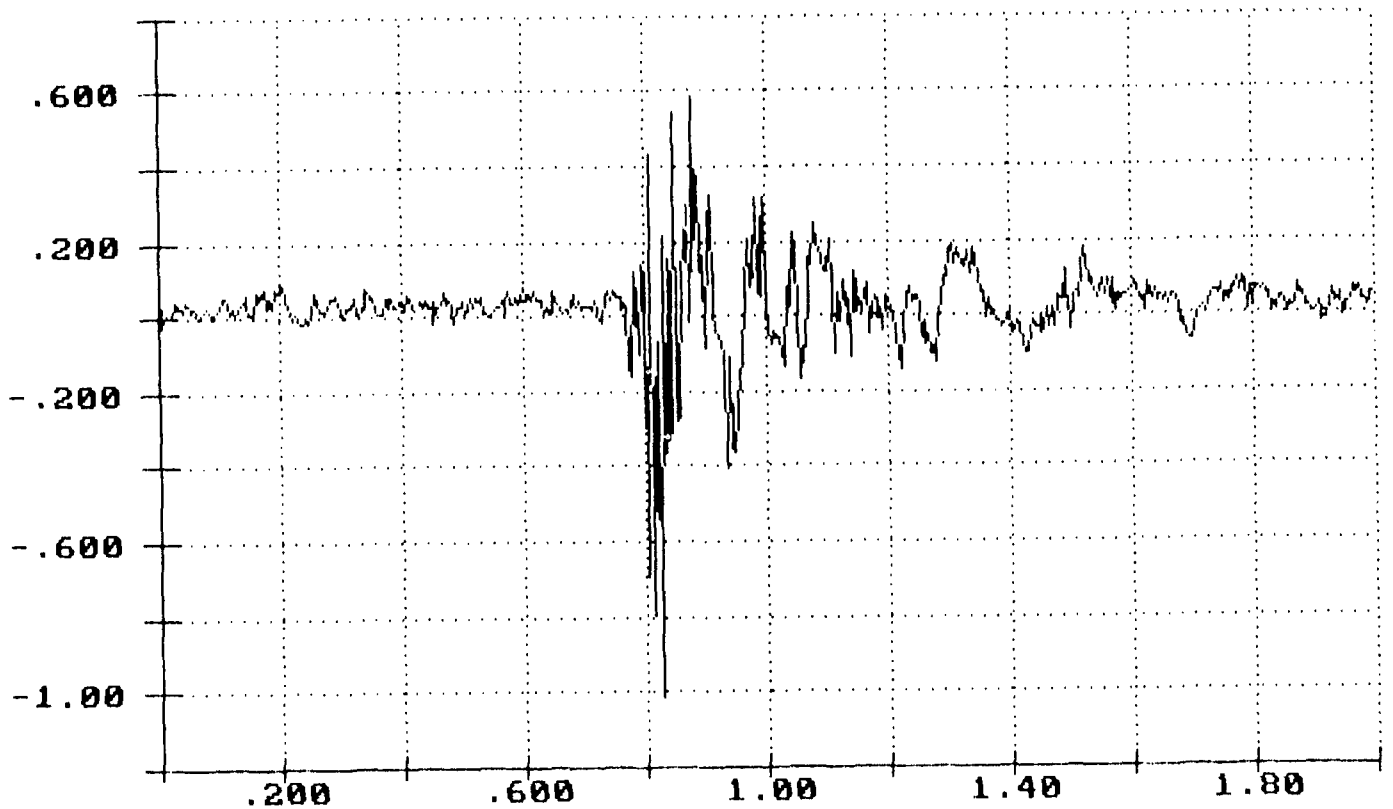
1.60
.800
.000
-.800
-1.60
.200
.600
1.00
1.40
1.80
Vertical Acceleration Frame
IN G'S X 1.00
Time in Seconds
X 1.00

Rail Impact Test of SUSV

Impact 1: 4.26 MPH, April 4, 1989

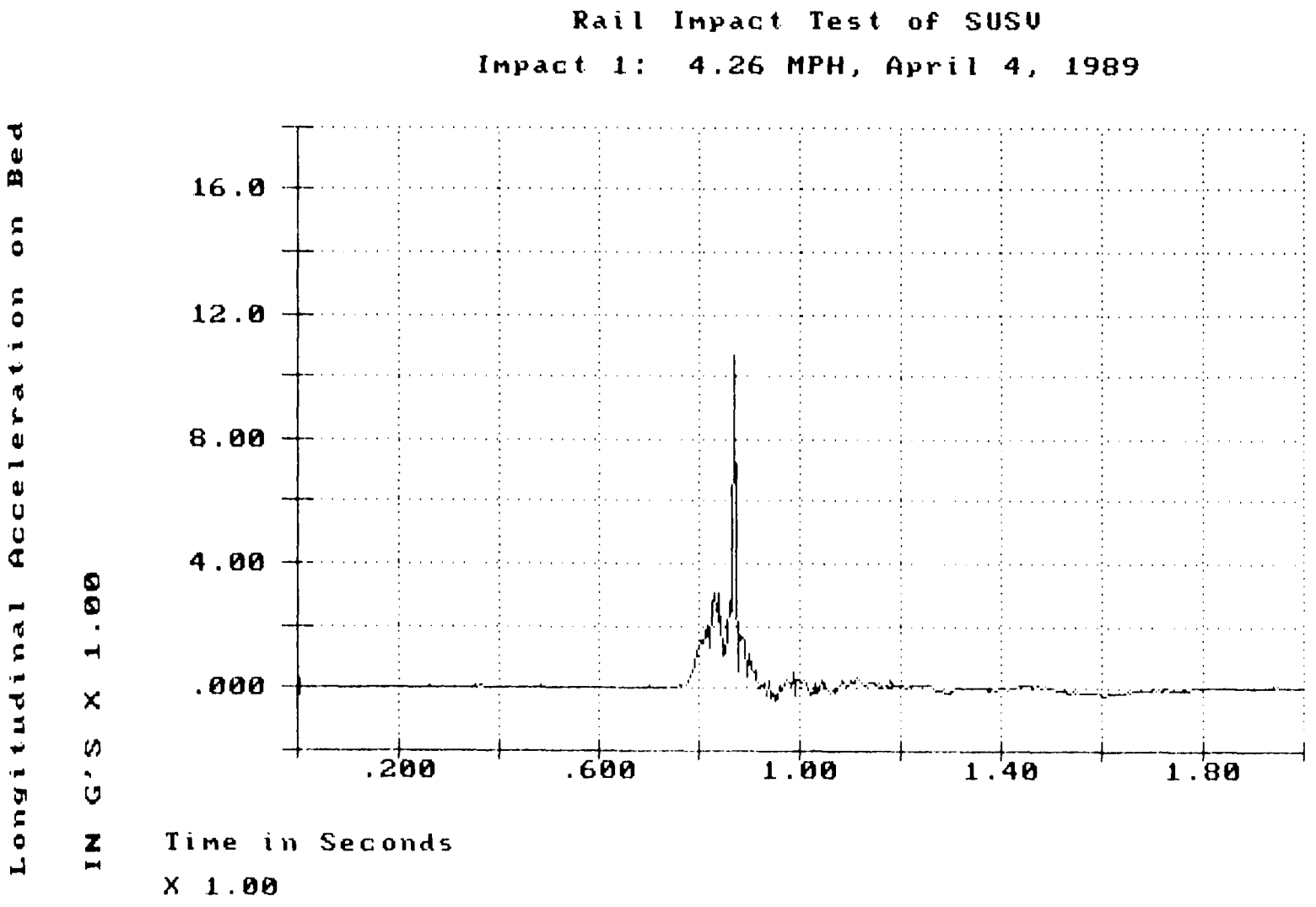


Lateral Acceleration on Frame

IN G'S X 1.00

Time in Seconds

X 1.00


Rail Impact Test of SUSV
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Longitudinal Acceleration on Bed
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12.0
8.00
4.00
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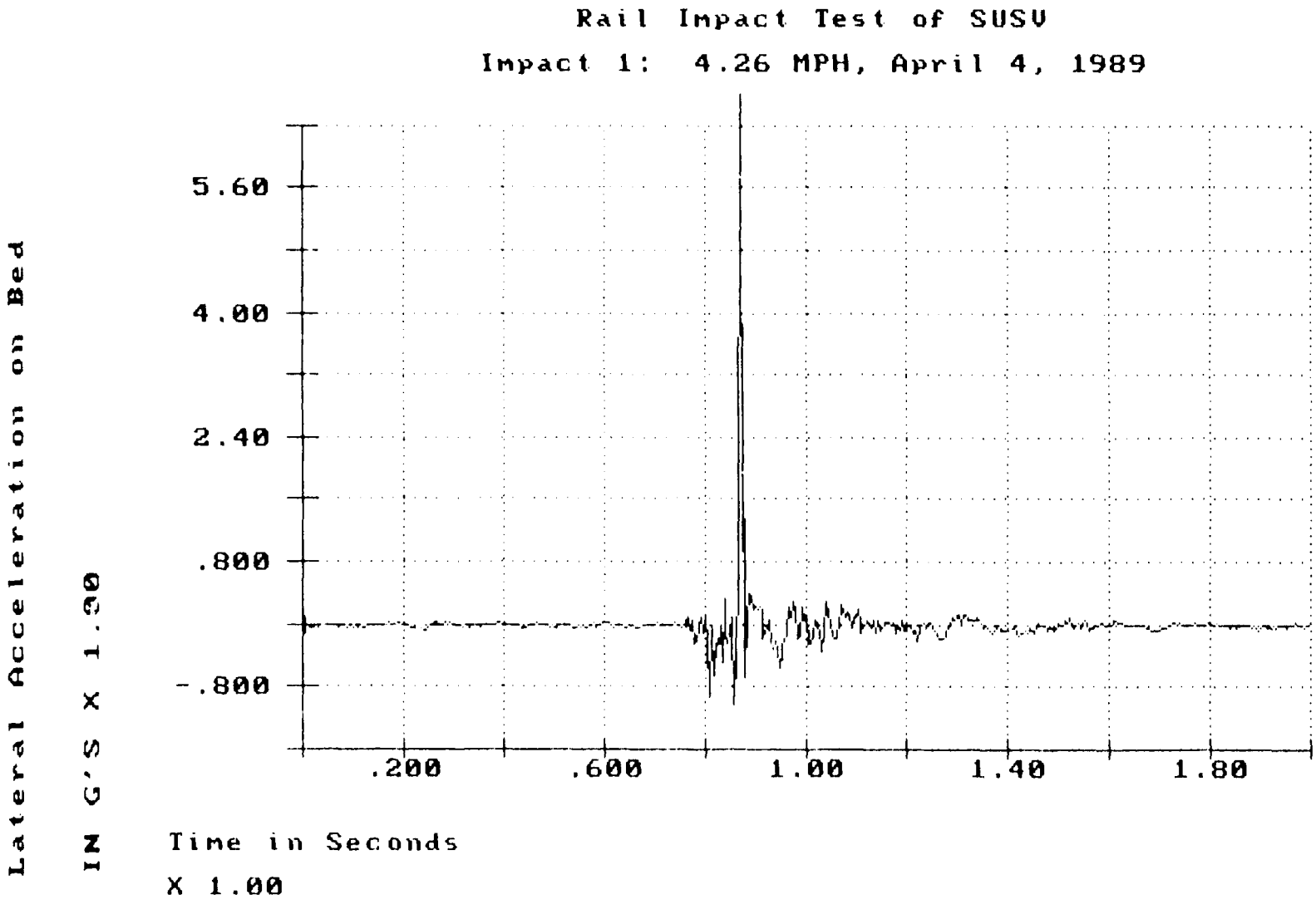
.200
.600
1.00
1.40
1.80
Time in Seconds
X 1.00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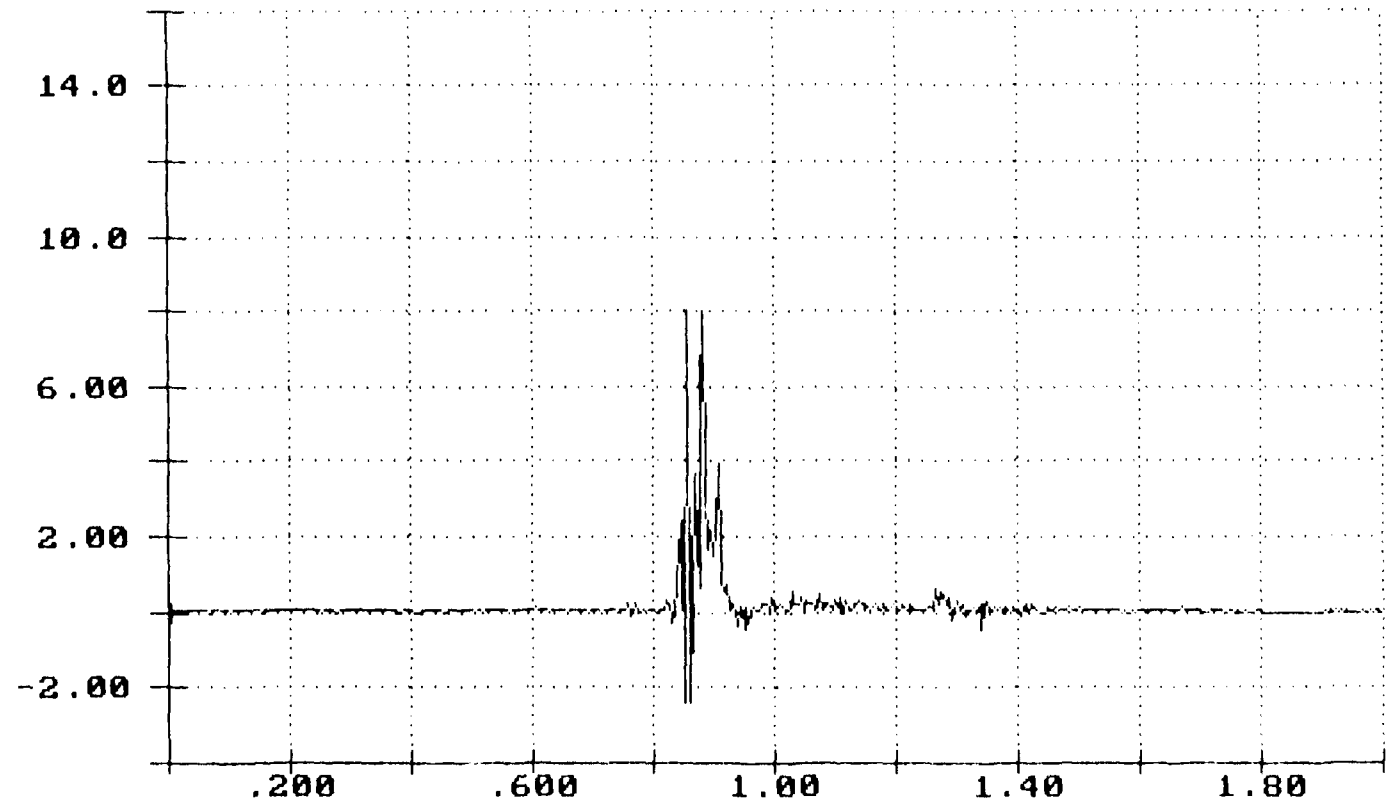
5.60
4.00
2.40
.800
-.800
.200
.600
1.00
1.40
1.80
Lateral Acceleration on Bed
IN G'S X 1.00
Time in Seconds
X 1.00

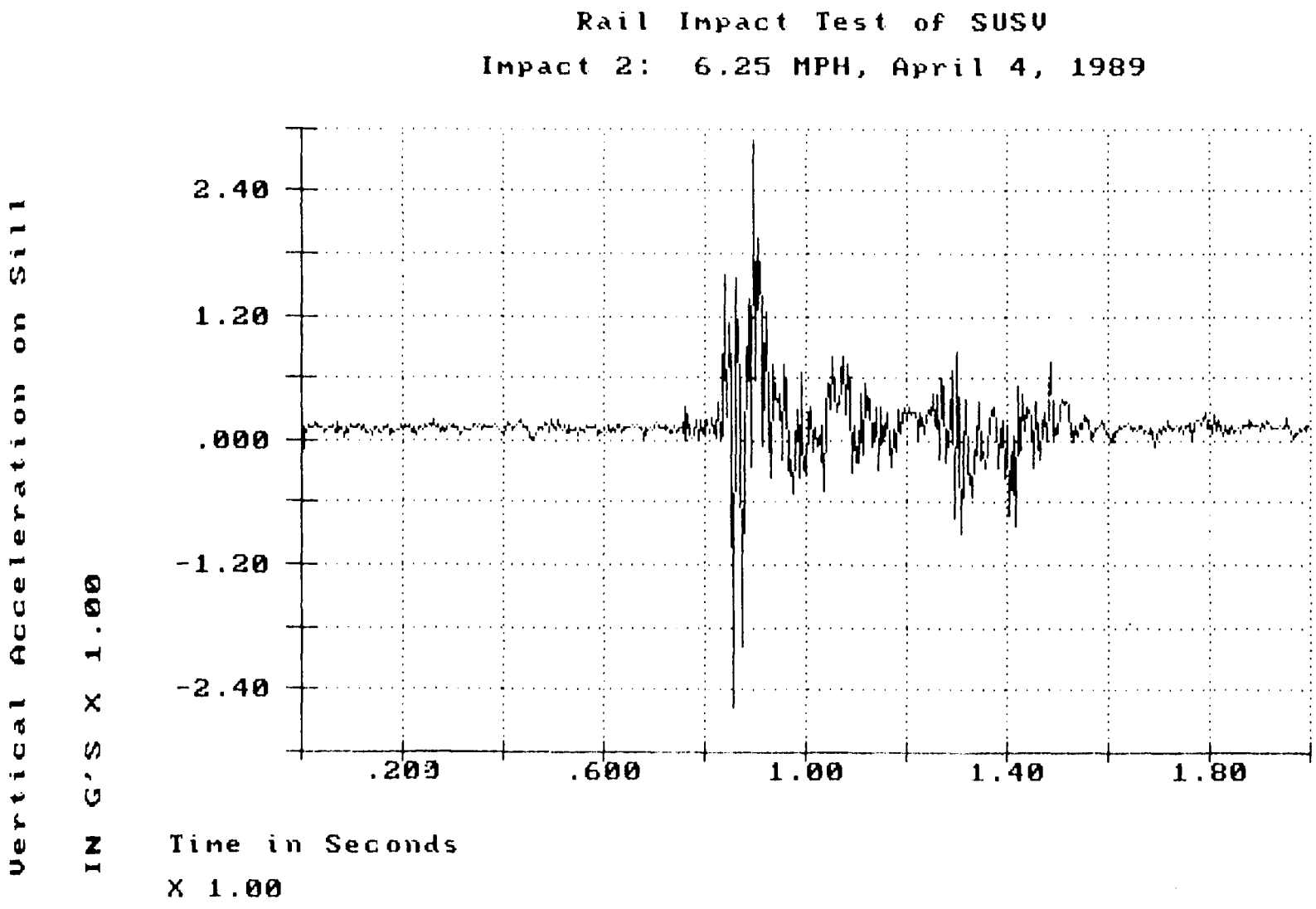
Rail Impact Test of SUSV

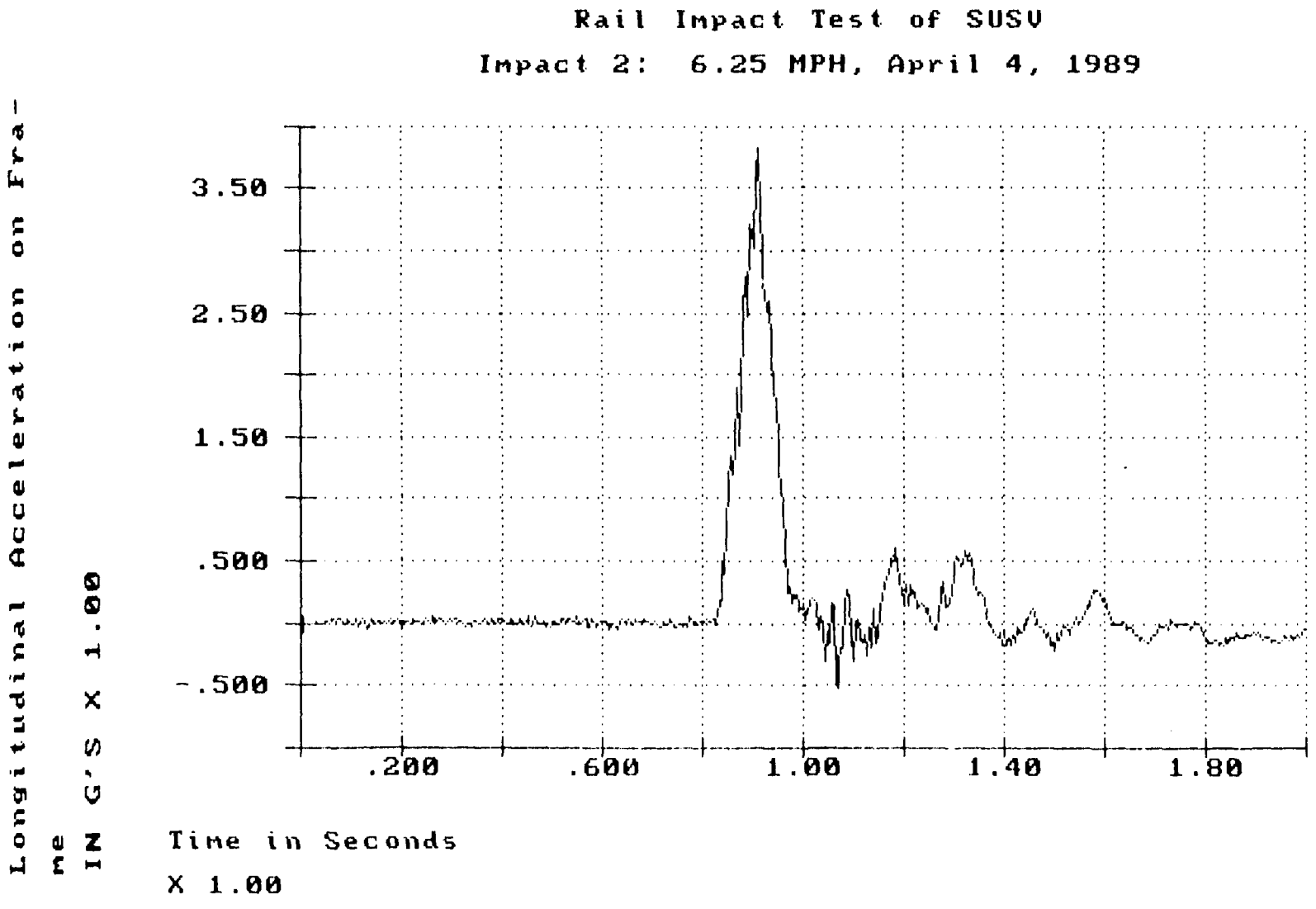
Impact 2: 6.25 MPH, April 4, 1989

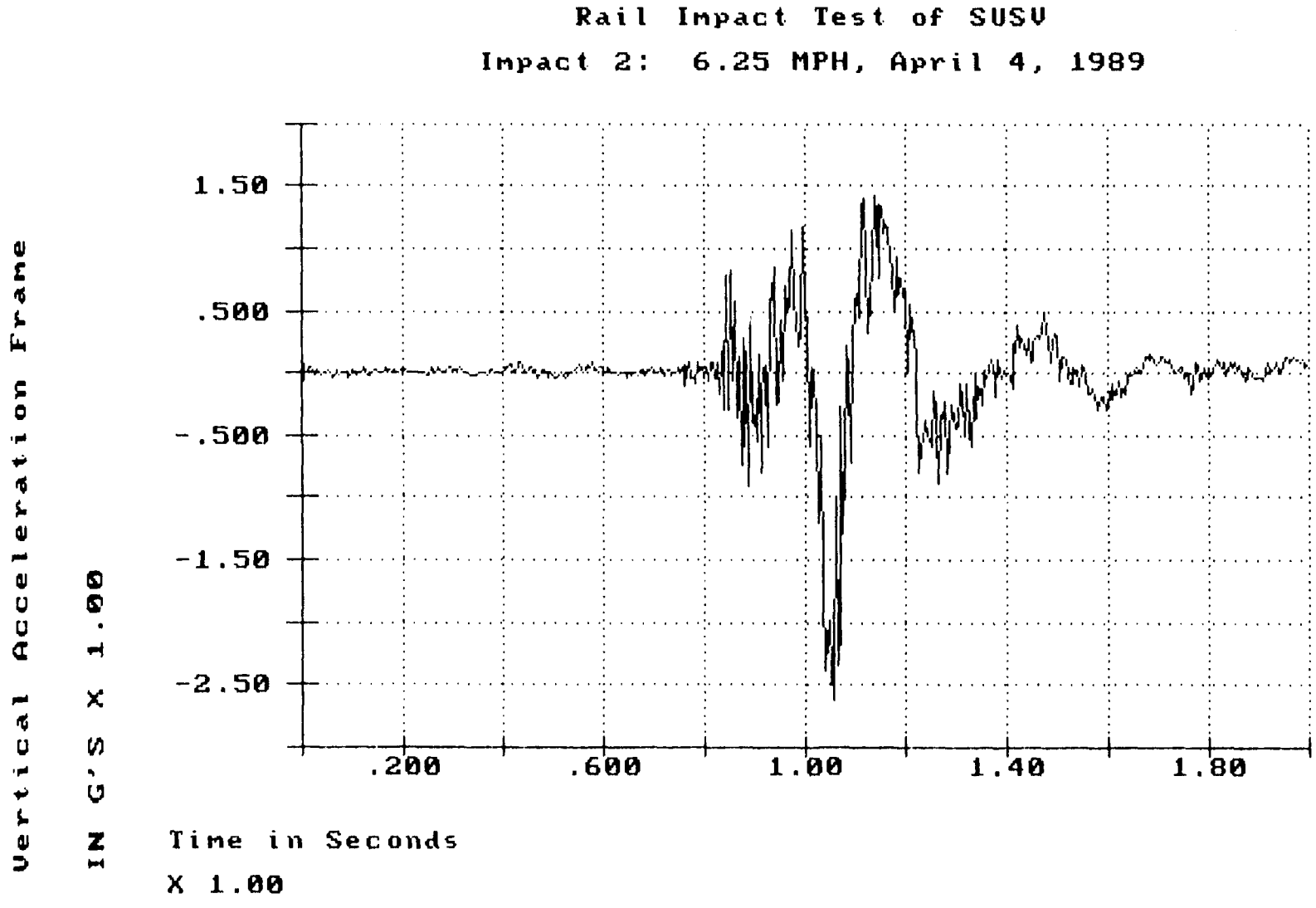


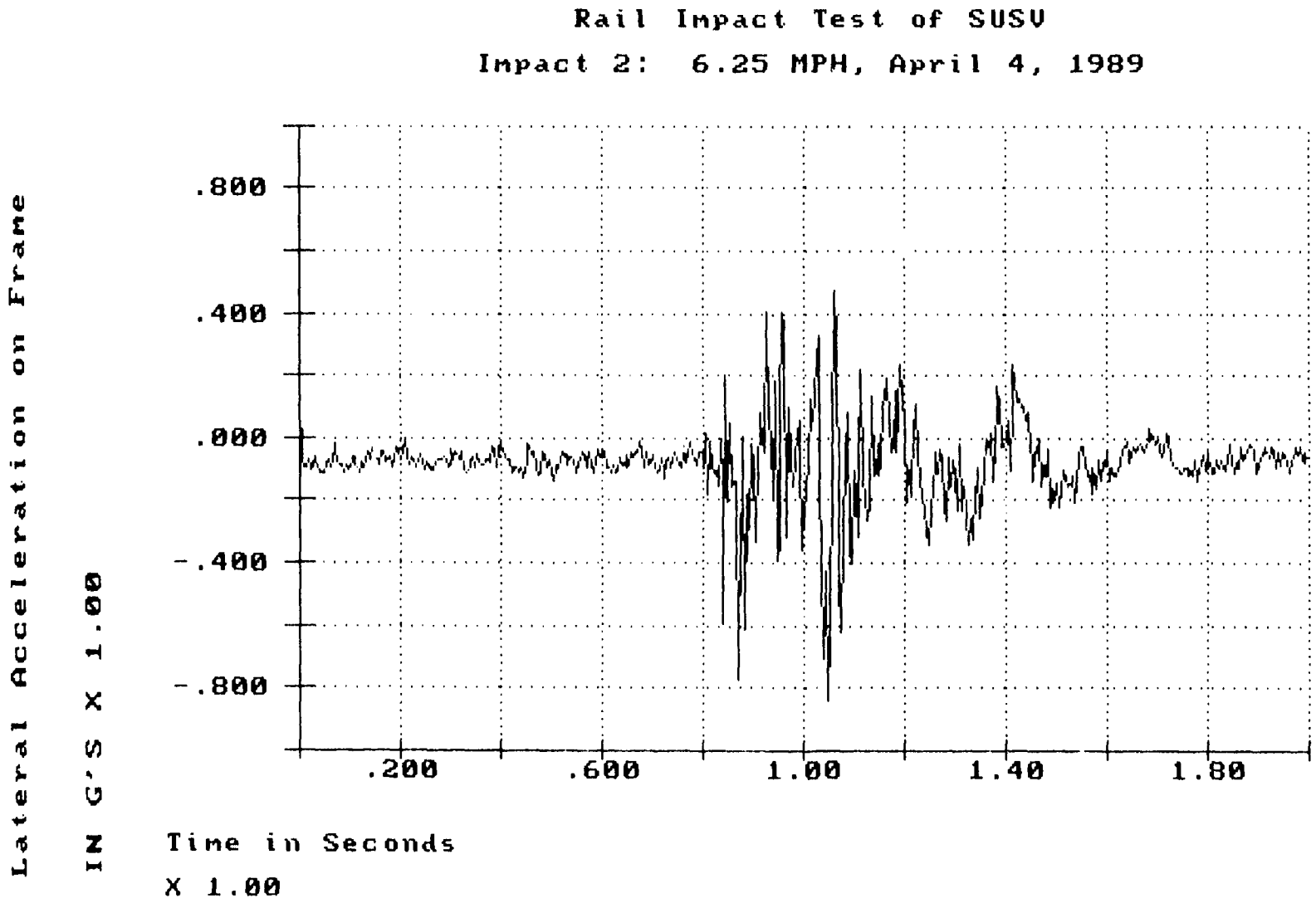
Longitudinal Acceleration on Sil-
l
IN G'S X 1.00

Time in Seconds
X 1.00


Rail Impact Test of SUSV
Impact 2: 6.25 MPH, April 4, 1989
Vertical Acceleration on Sill
IN G'S X 1.00
2.40
1.20
.000
-1.20
-2.40
.200
.600
1.00
1.40
1.80
Time in Seconds
X 1.00

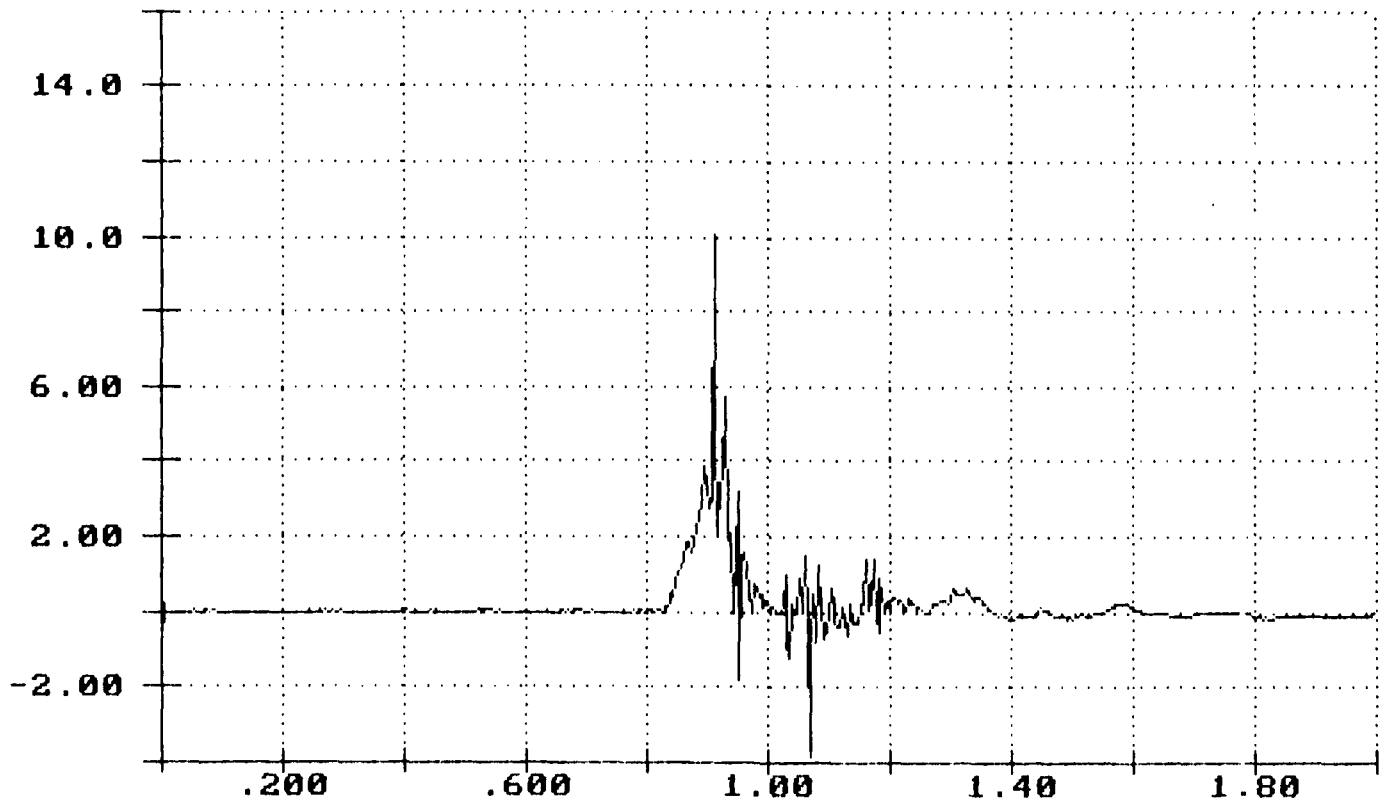

Rail Impact Test of SUSV
Impact 2: 6.25 MPH, April 4, 1989
Longitudinal Acceleration on Frame
IN G'S X 1.00
3.50
2.50
1.50
.500
-.500
.200
.600
1.00
1.40
1.80
Time in Seconds
X 1.00

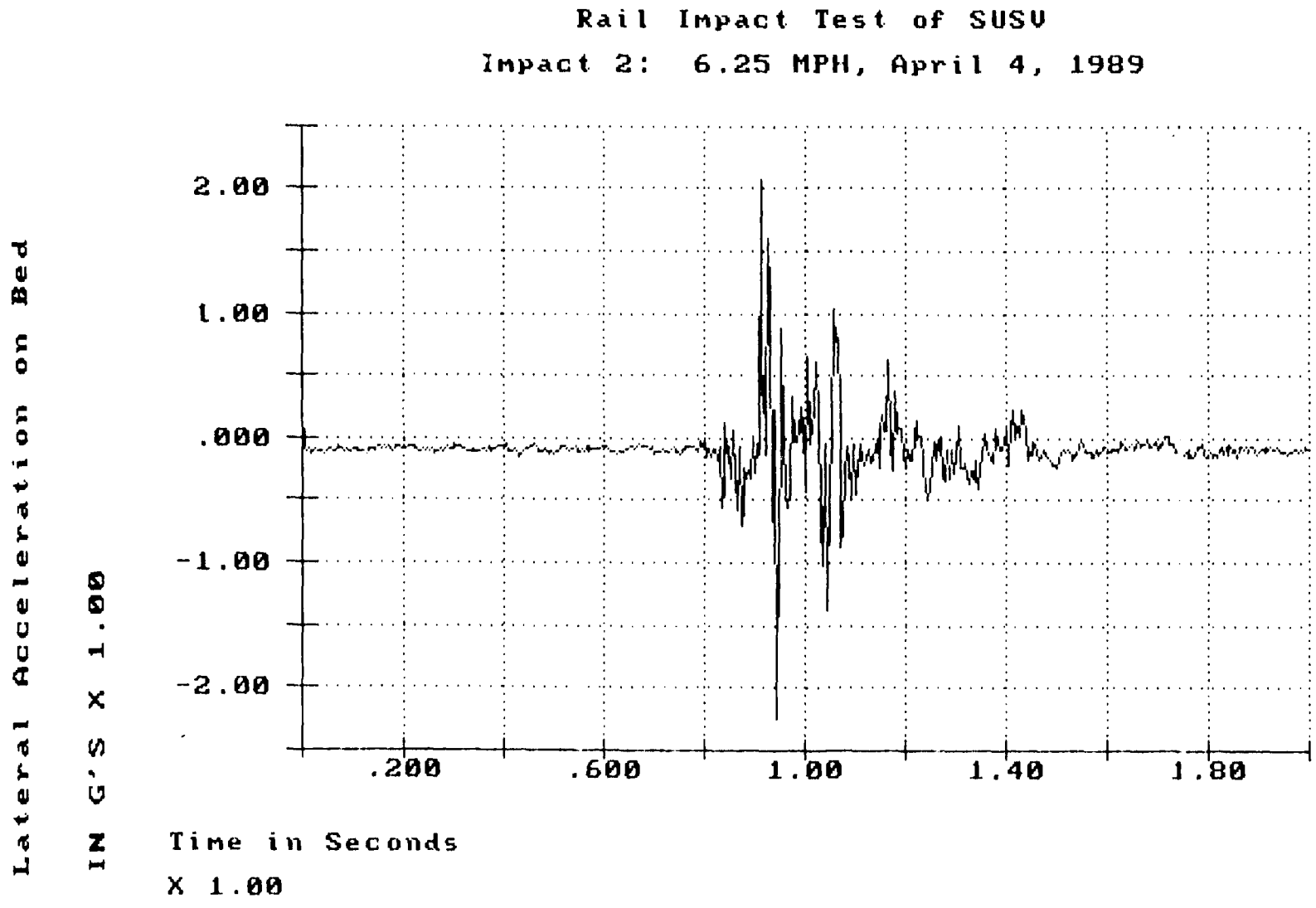

Rail Impact Test of SUSV
Impact 2: 6.25 MPH, April 4, 1989
1.50
.500
-.500
-1.50
-2.50
.200
.600
1.00
1.40
1.80
Vertical Acceleration Frame
IN G'S X 1.00
Time in Seconds
X 1.00

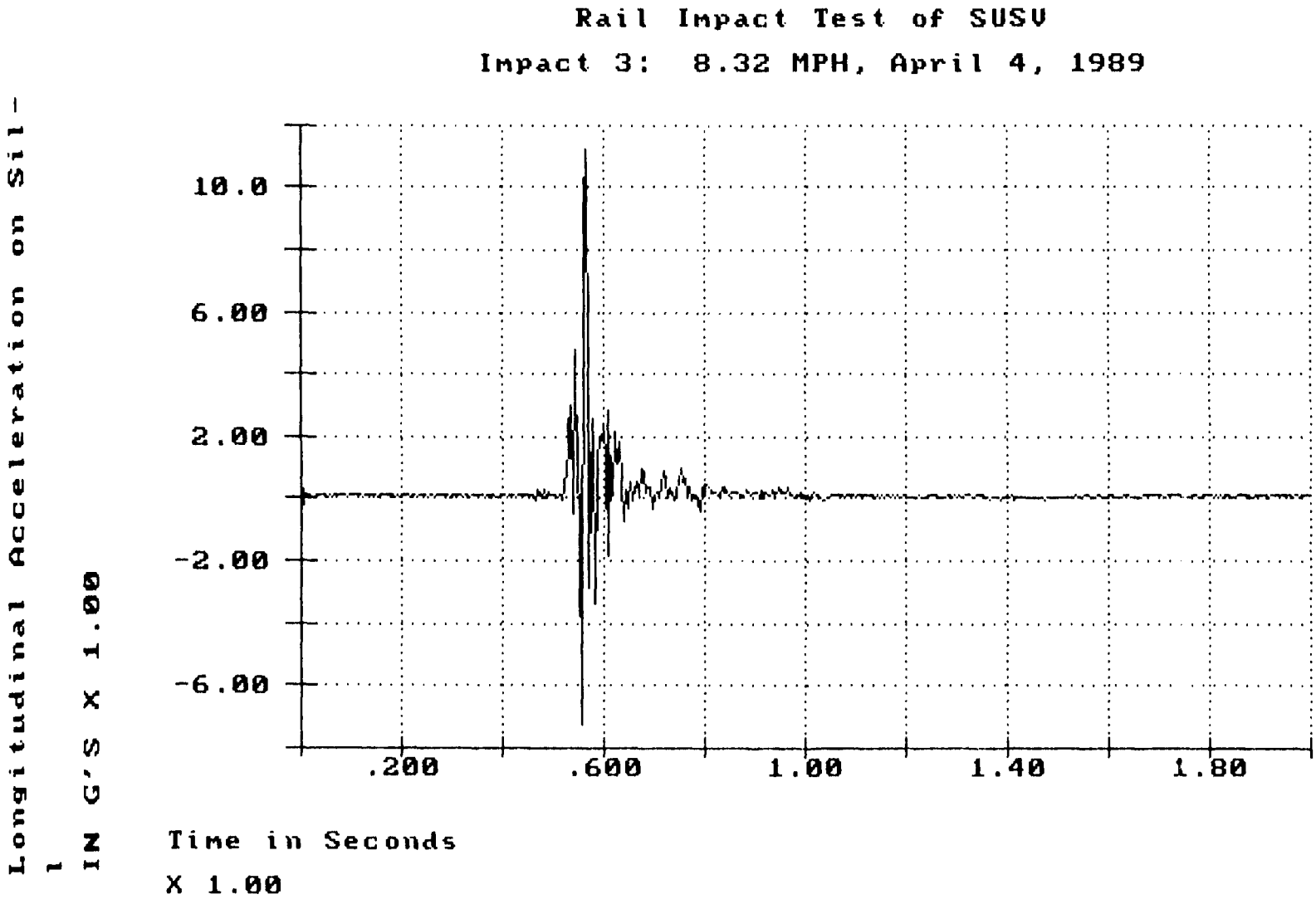

Rail Impact Test of SUSV
Impact 2: 6.25 MPH, April 4, 1989
Lateral Acceleration on Frame
IN G'S X 1.00
.800
.400
.000
-.400
-.800
.200
.600
1.00
1.40
1.80
Time in Seconds
X 1.00

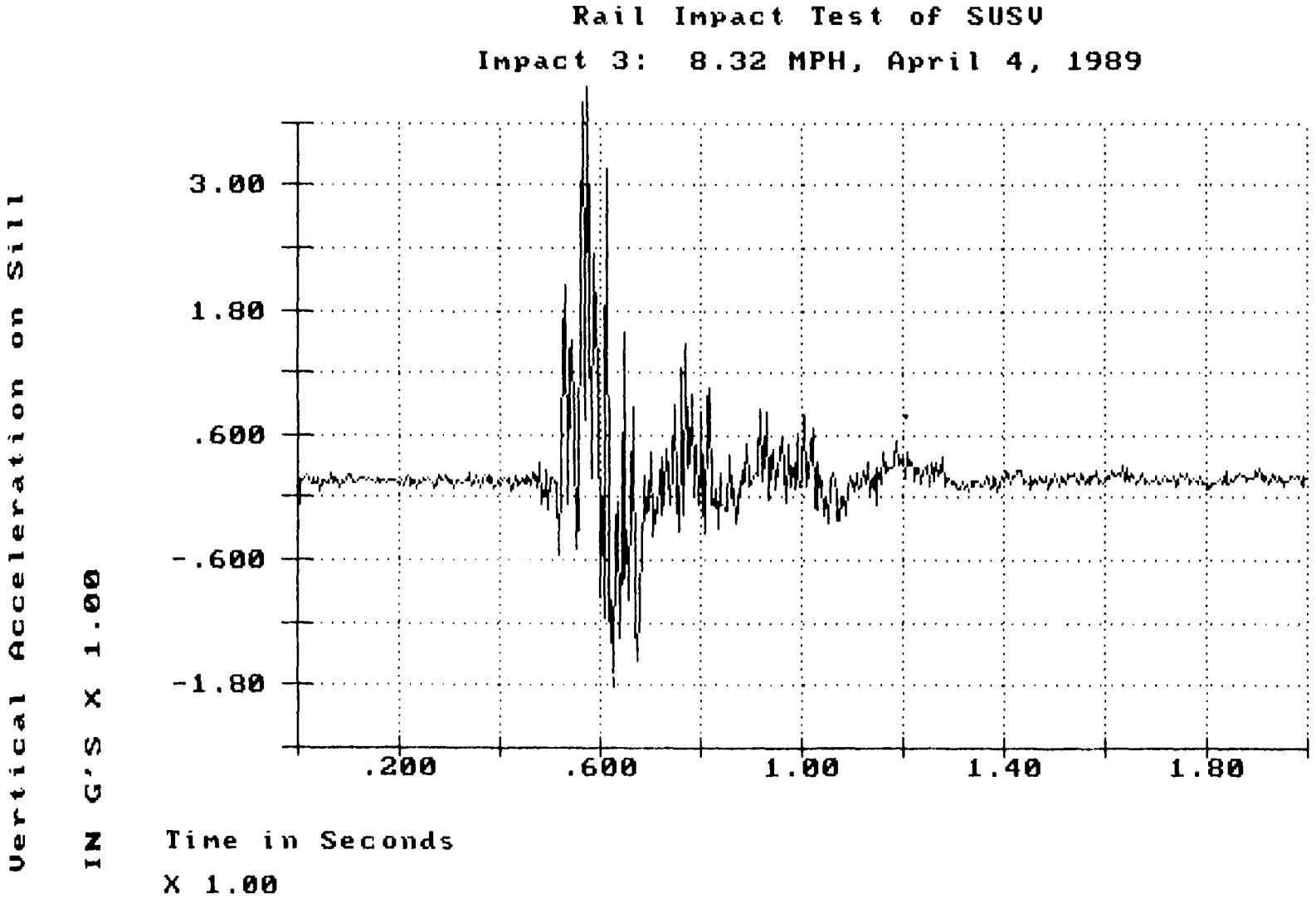
Rail Impact Test of SUSV

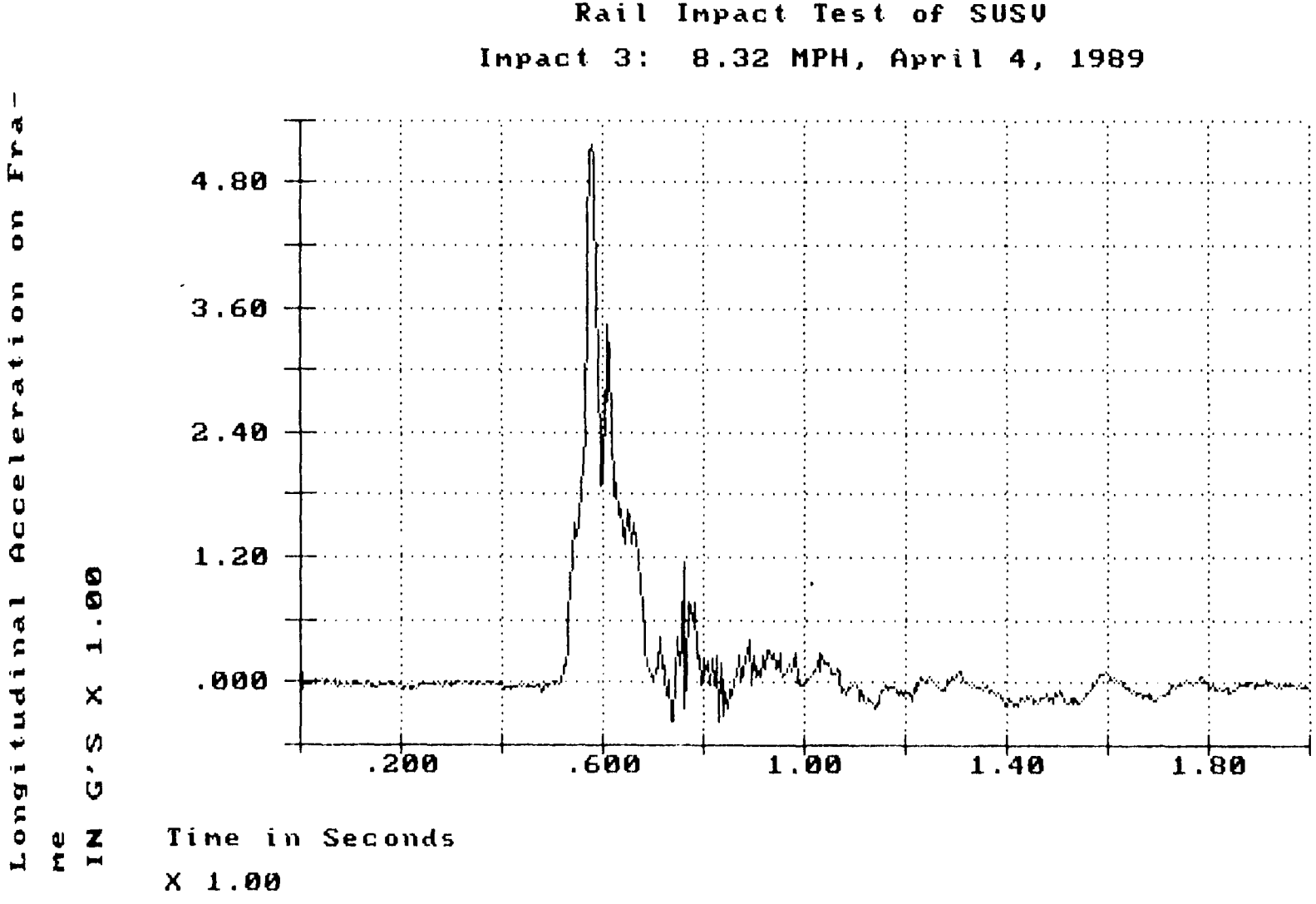
Impact 2: 6.25 MPH, April 4, 1989




Rail Impact Test of SUSV
Impact 2: 6.25 MPH, April 4, 1989
Lateral Acceleration on Bed
IN G'S X 1.00
2.00
1.00
.000
-1.00
-2.00
.200
.600
1.00
1.40
1.80
Time in Seconds
X 1.00

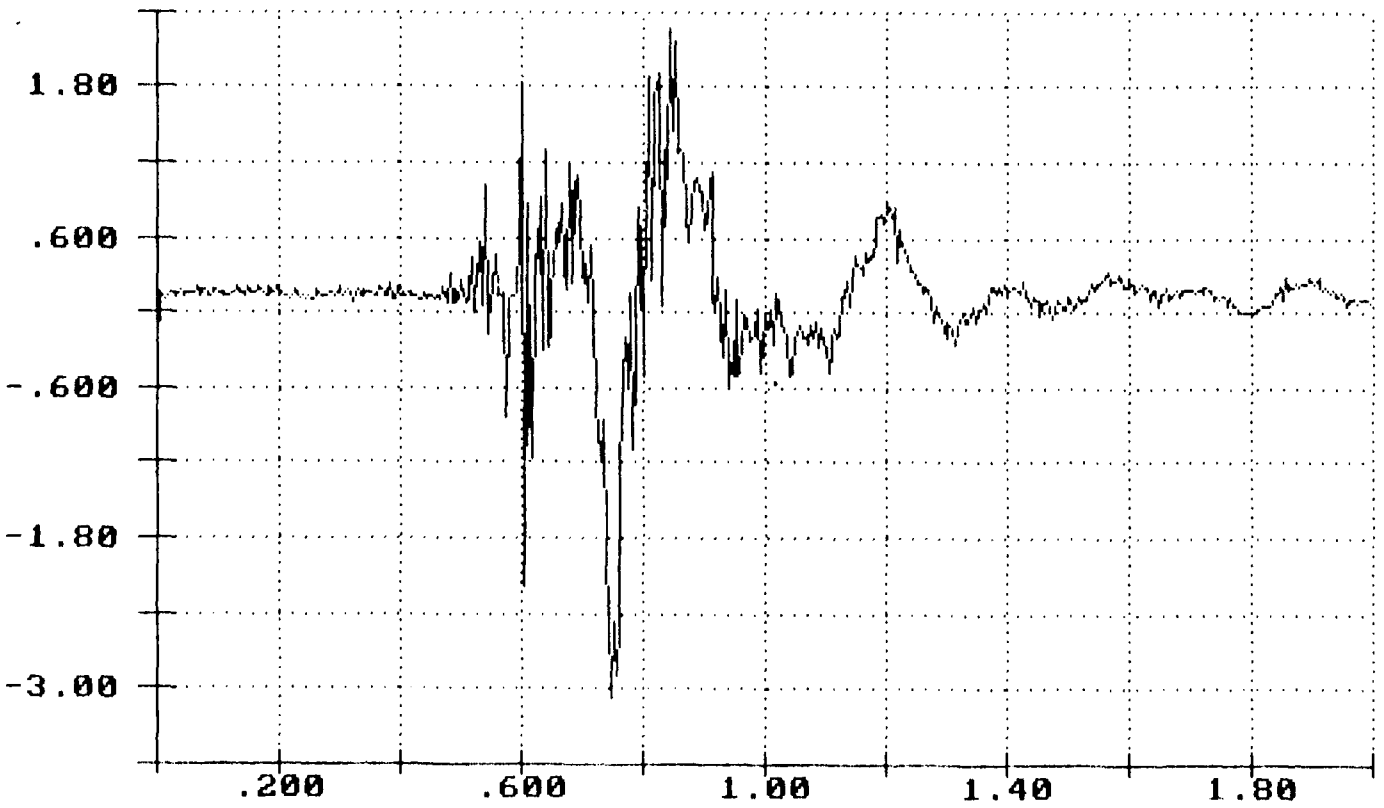

Rail Impact Test of SUSV
Impact 3: 8.32 MPH, April 4, 1989
Longitudinal Acceleration on Sil-
l
IN G'S X 1.00
10.0
6.00
2.00
-2.00
-6.00
.200
.600
1.00
1.40
1.80
Time in Seconds
X 1.00


Rail Impact Test of SUSV
Impact 3: 8.32 MPH, April 4, 1989
Vertical Acceleration on Sill
IN G'S X 1.00
3.00
1.80
.600
-.600
-1.80
.200
.600
1.00
1.40
1.80
Time in Seconds
X 1.00


Rail Impact Test of SUSV
Impact 3: 8.32 MPH, April 4, 1989
Longitudinal Acceleration on Frame IN G'S X 1.00
4.80
3.60
2.40
1.20
.000
.200
.600
1.00
1.40
1.80
Time in Seconds
X 1.00

Rail Impact Test of SUSV

Impact 3: 8.32 MPH, April +, 1989

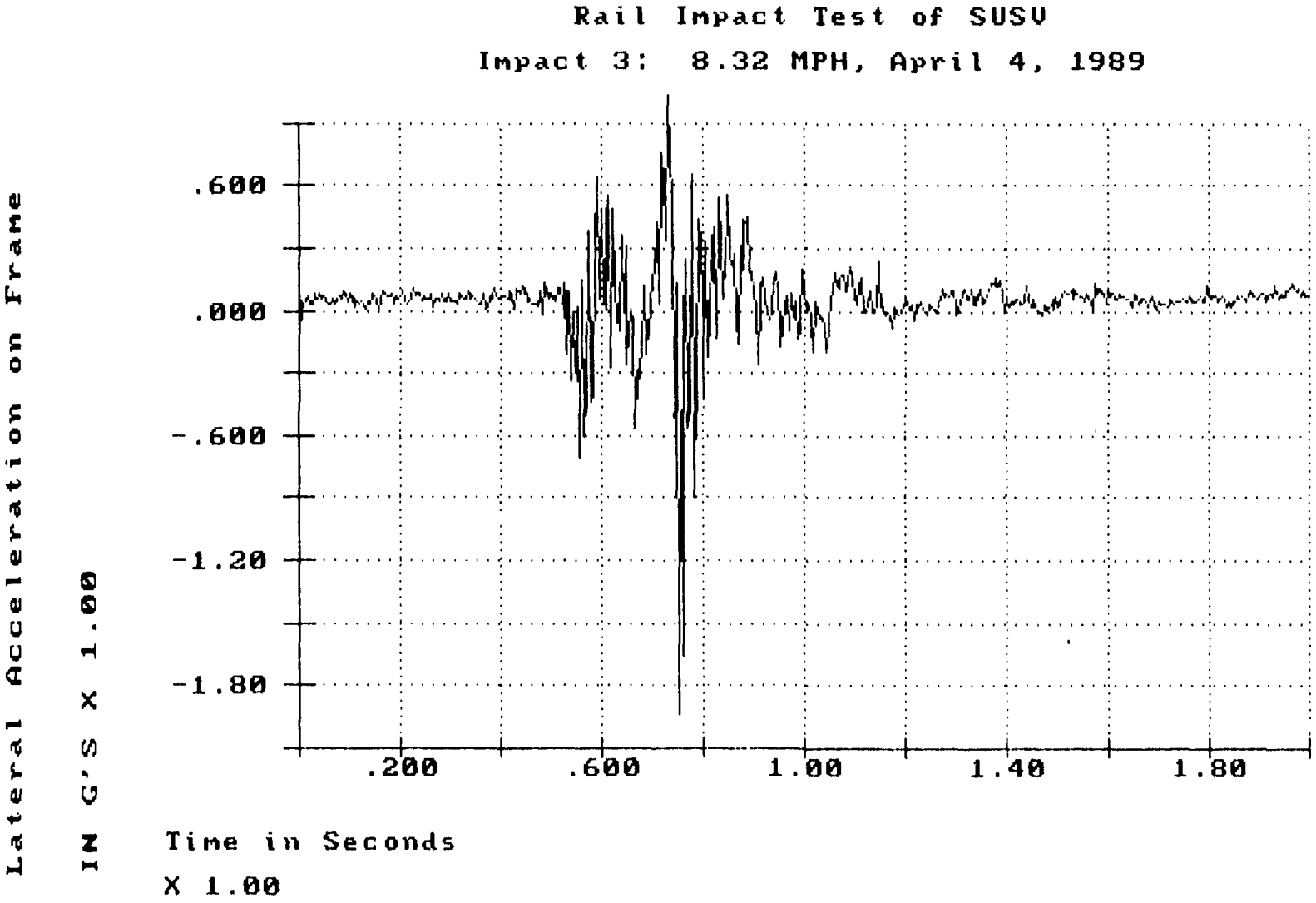


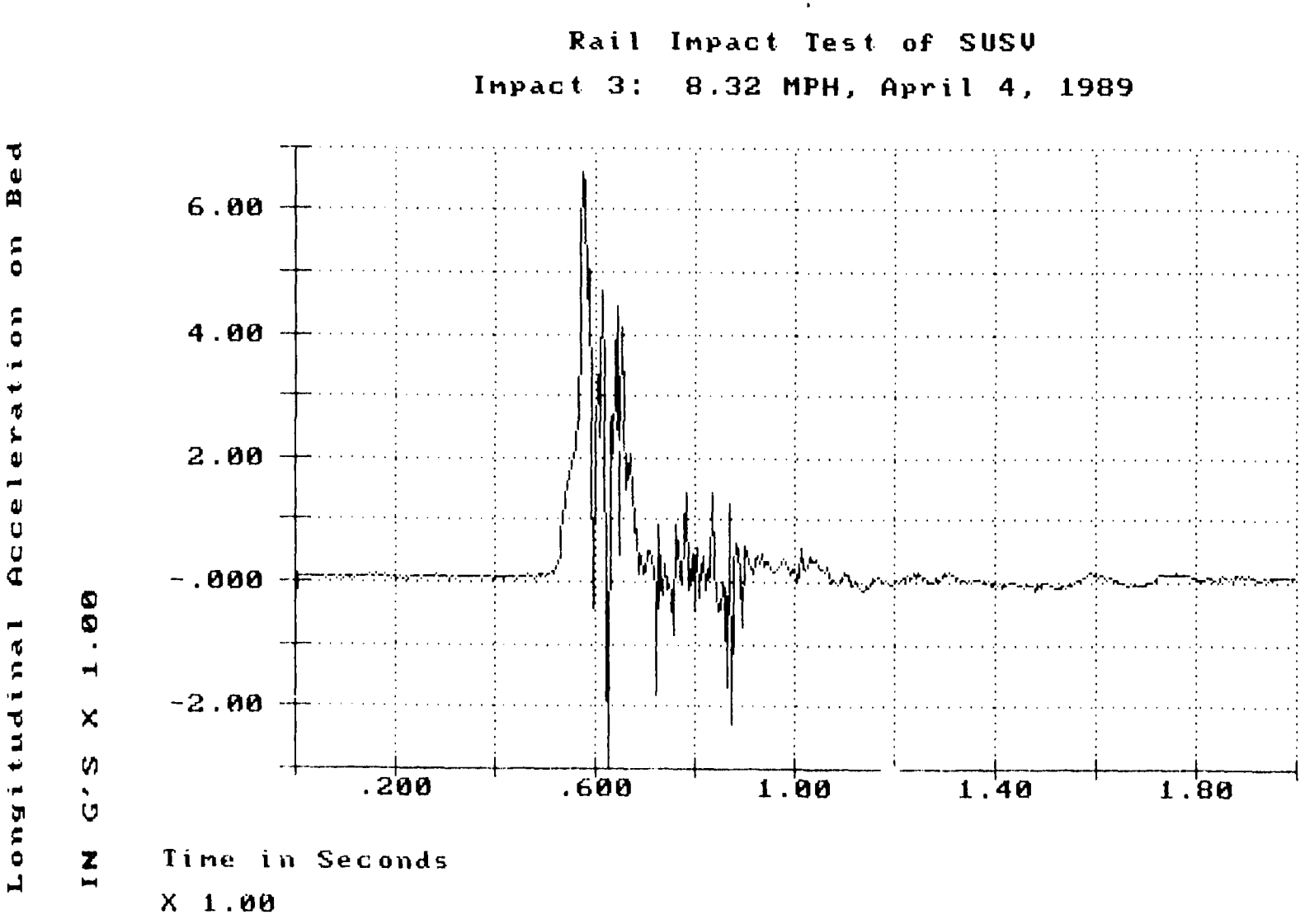
Vertical Acceleration Frame

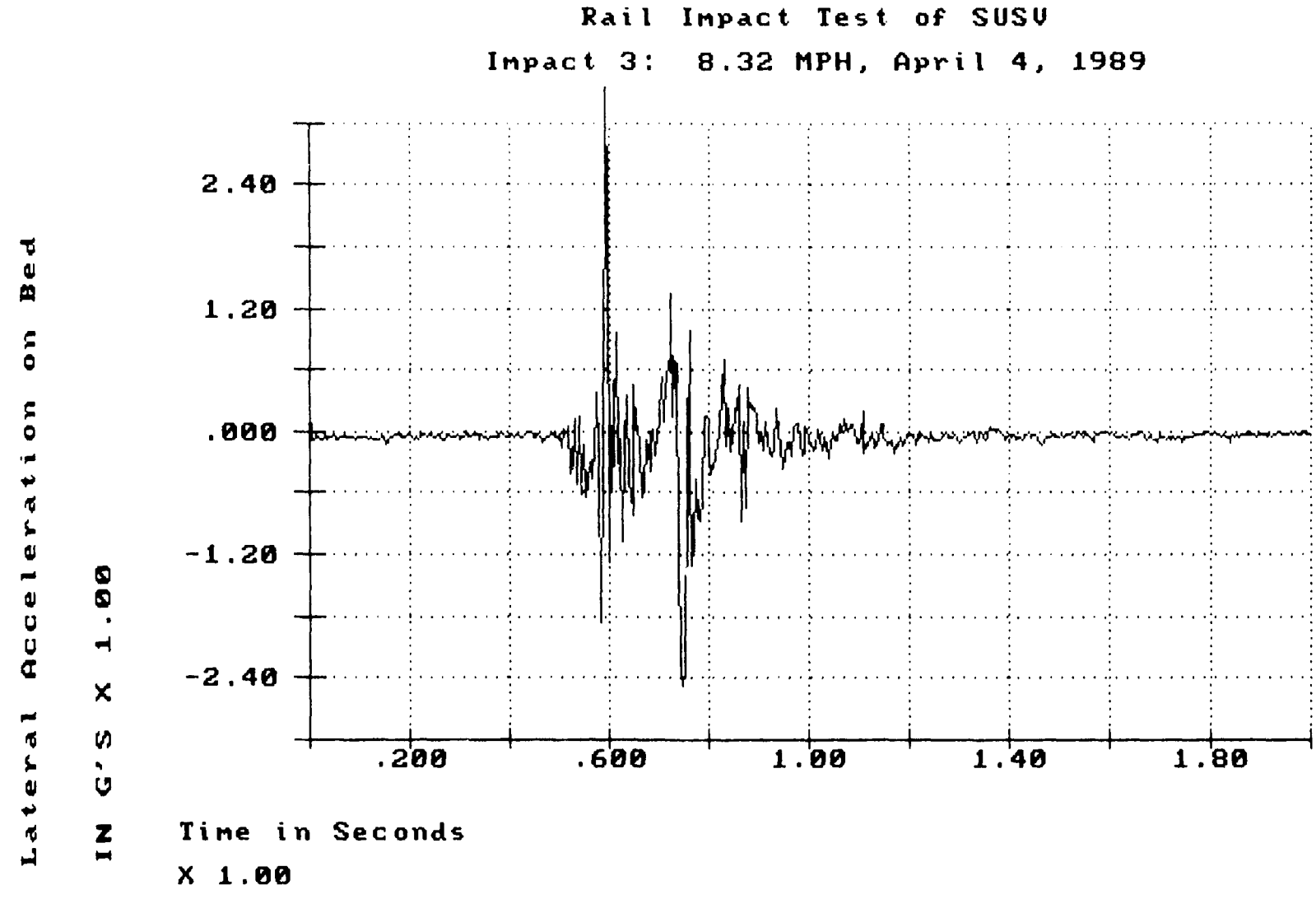
IN G'S X 1.00

Time in Seconds

X 1.00

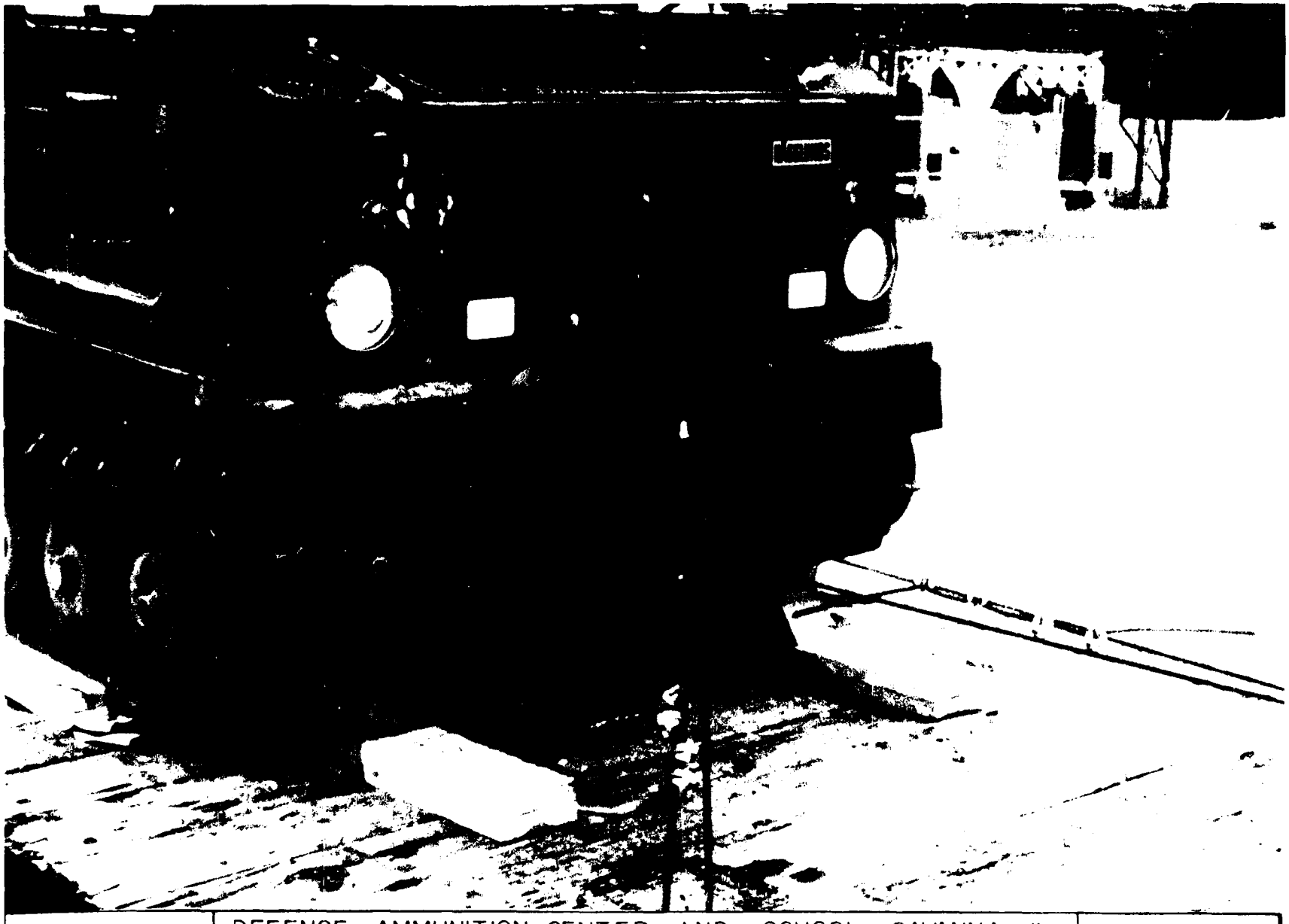

Rail Impact Test of SUSV
Impact 3: 8.32 MPH, April 4, 1989
.600
.000
-.600
-1.20
-1.80
.200
.600
1.00
1.40
1.80
Lateral Acceleration on Frame
IN G'S X 1.00
Time in Seconds
X 1.00


Rail Impact Test of SUSV
Impact 3: 8.32 MPH, April 4, 1989
Longitudinal Acceleration on Bed
IN G'S X 1.00
6.00
4.00
2.00
-.000
-2.00
.200
.600
1.00
1.40
1.80
Time in Seconds
X 1.00


Rail Impact Test of SUSV
Impact 3: 8.32 MPH, April 4, 1989
2.40
1.20
.000
-1.20
-2.40
.200
.600
1.00
1.40
1.80
Lateral Acceleration on Bed
IN G'S X 1.00
Time in Seconds
X 1.00

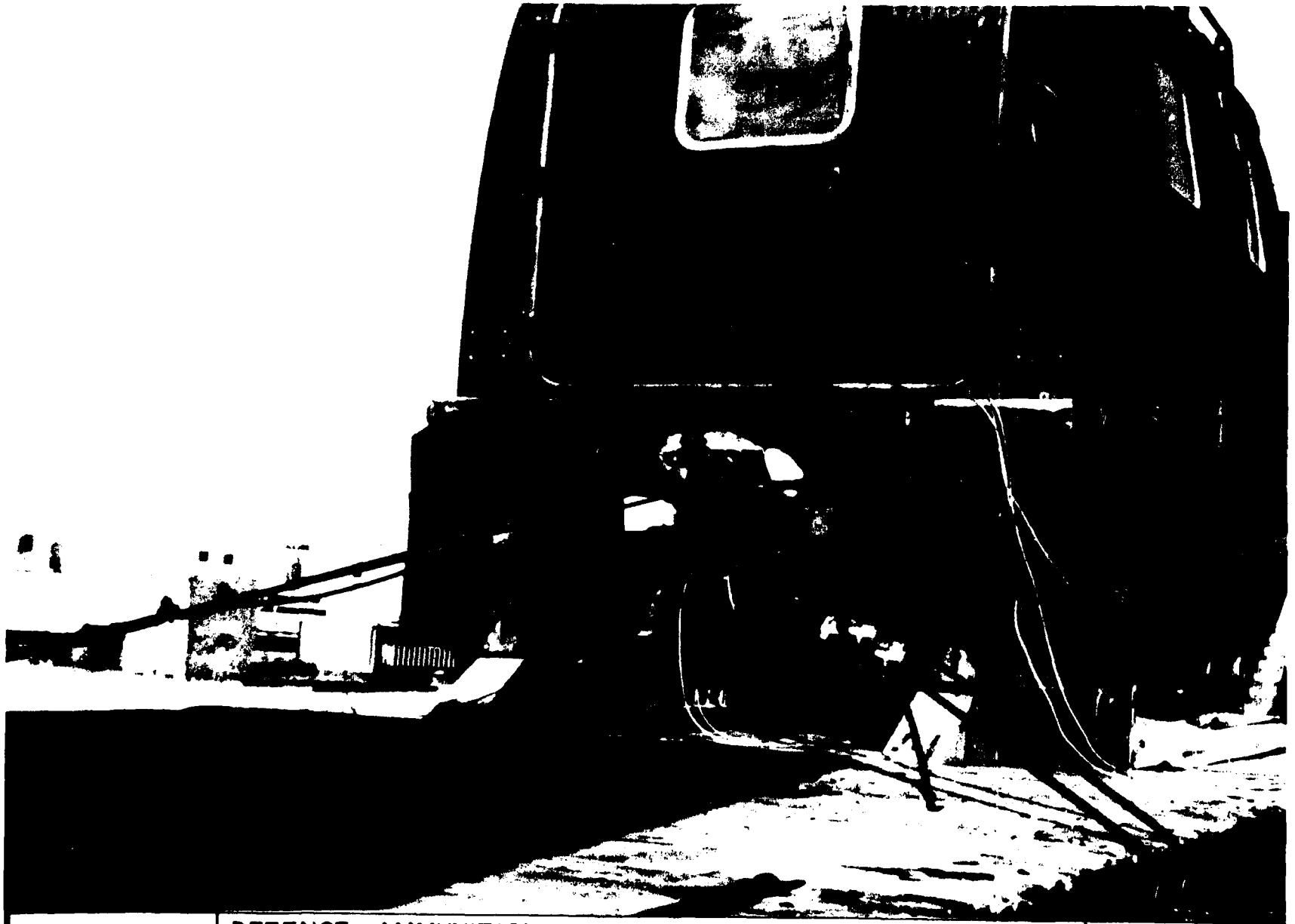
DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL

Photo No. 1 View of the M973E1 Cargo SUSV secured to the railroad flatcar.



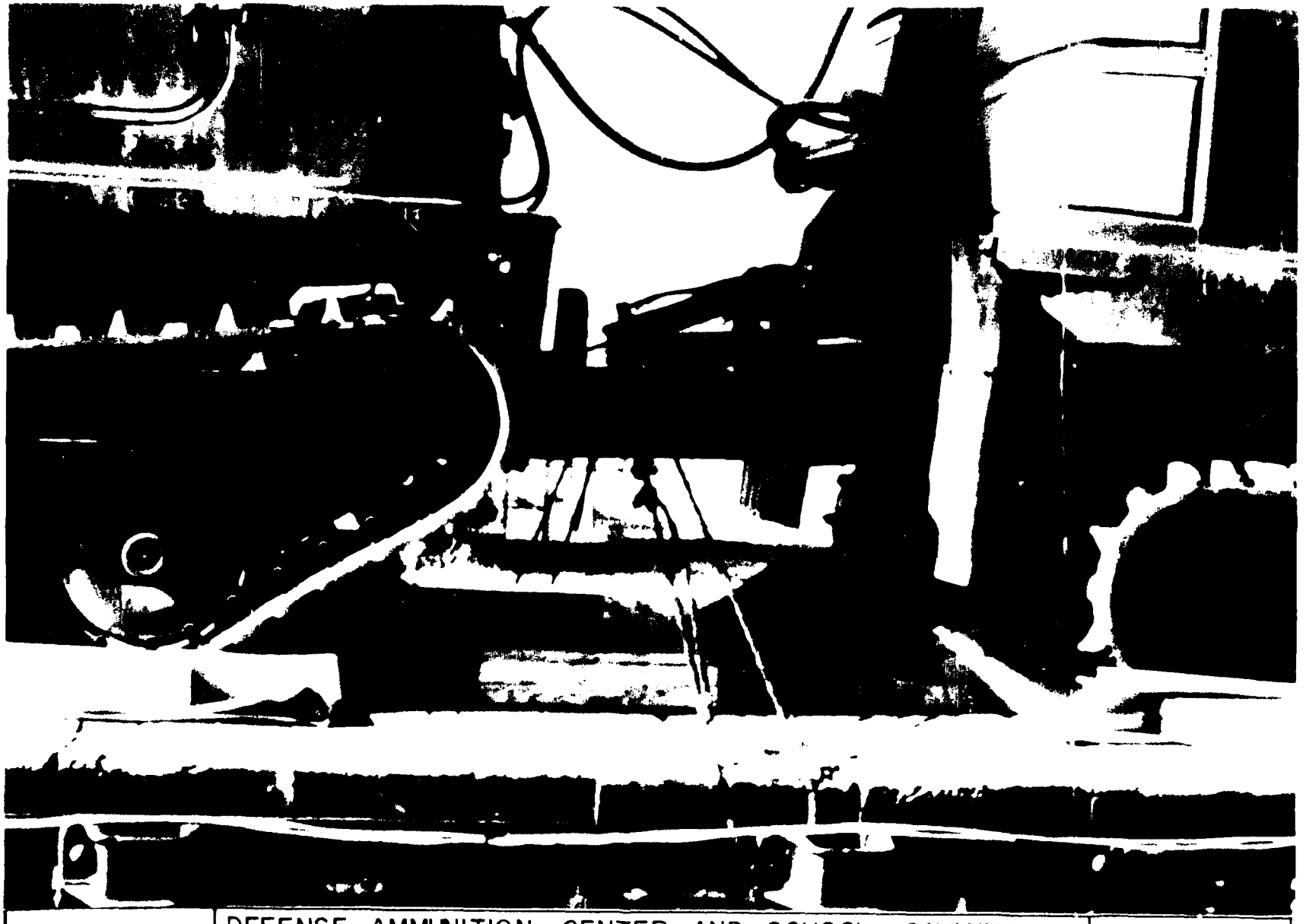
DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL

Photo No 2 View of the tiedown cables securing the front of the M973P1 Cargo SUSV to the railroad flatcar.



DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL

Photo No. 3 View of the tiedown cables securing the rear of the M973E1 Cargo SUSV to the railroad flatcar.



DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL

Photo No. 4 View of the tiedown cable extending over wooden buffer protecting the rear drive housing between the front and rear unit of the M973E1 Cargo SUSV.

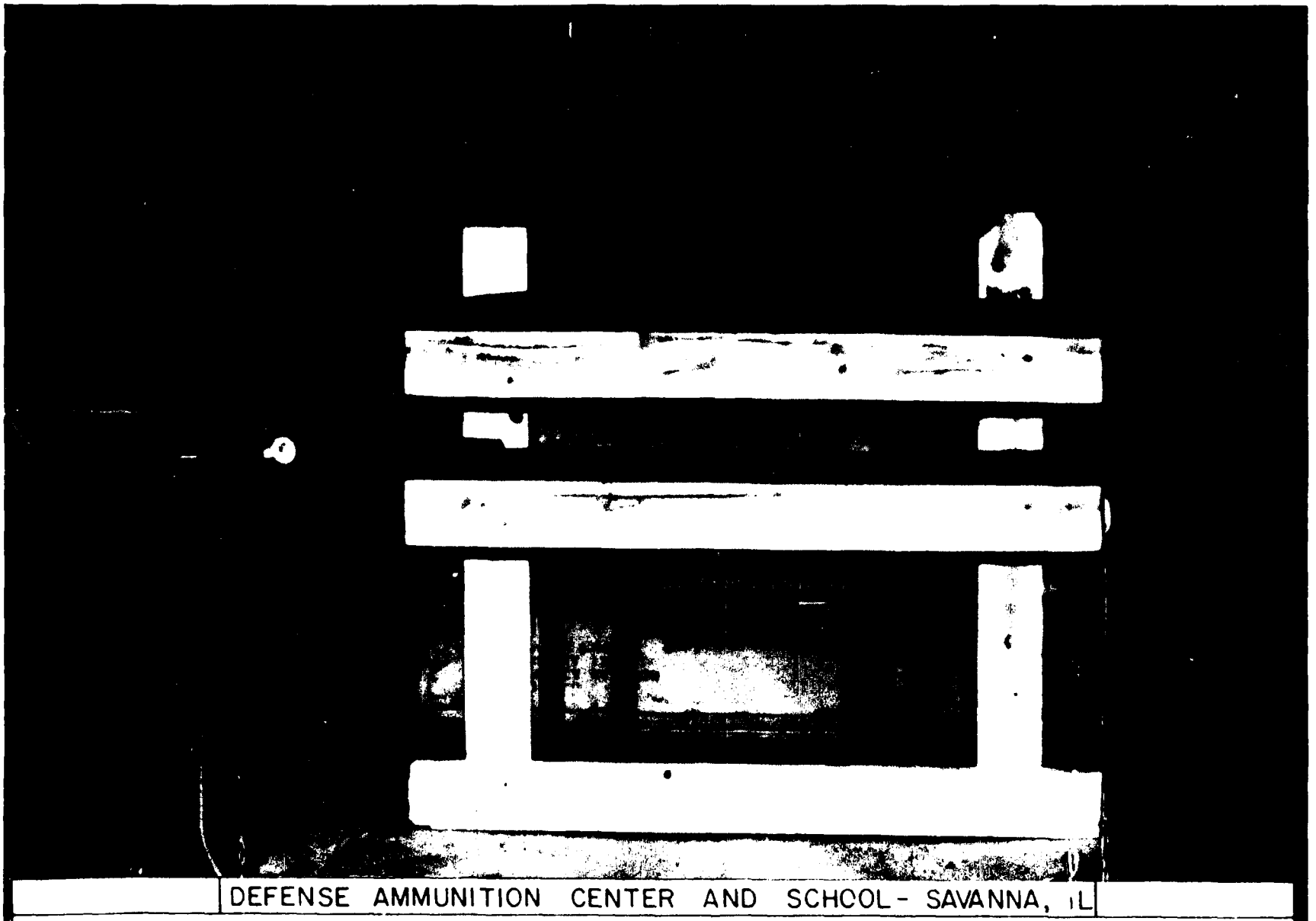
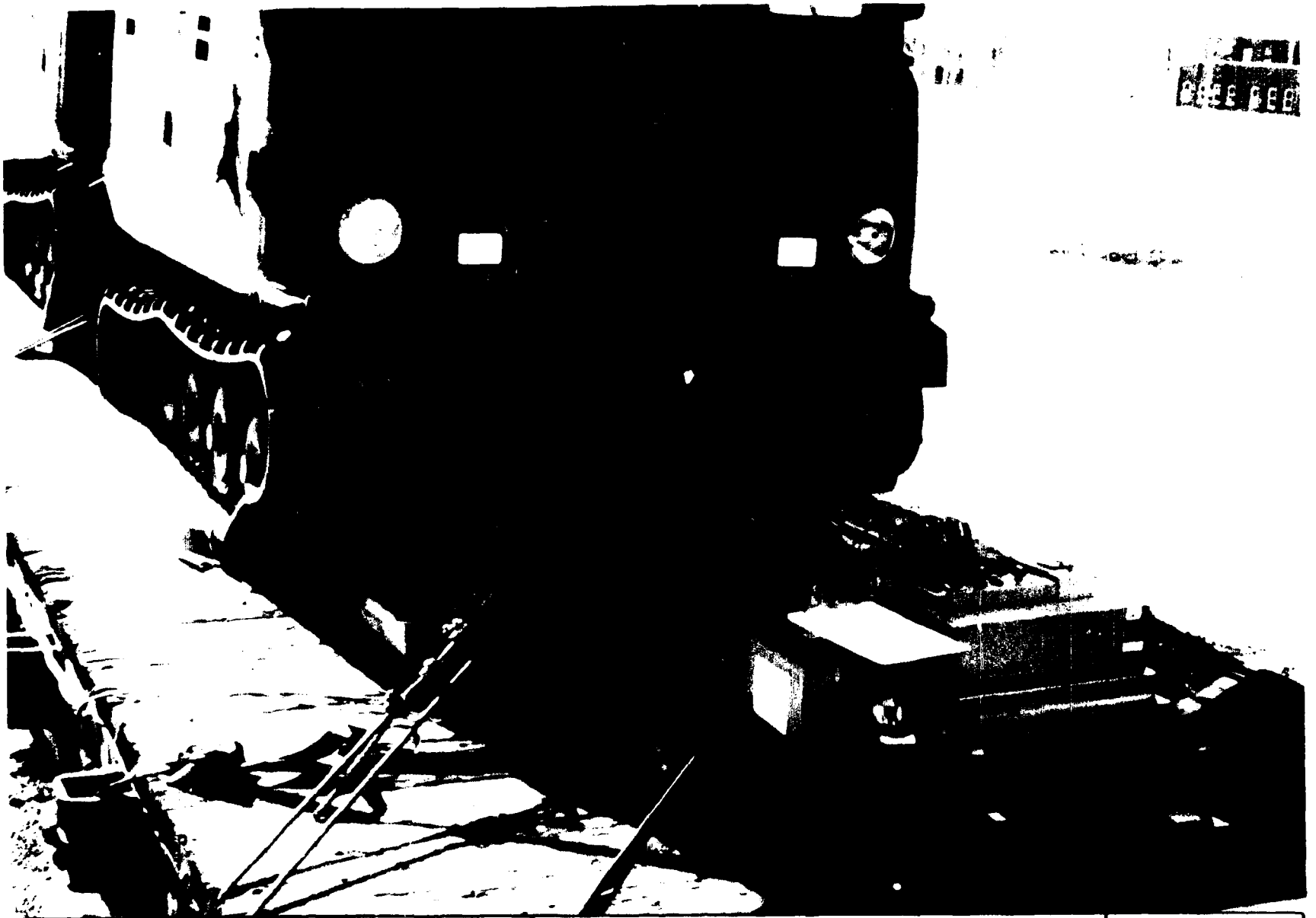


Photo No. 5 View looking in the open rear door in the second unit of the M973E1 Cargo SUSV Note the 3/4-inch plywood deck, the rear gate and the web strap tiedown assemblies around the gate to the cargo tiedown provisions.



DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL

Photo No. 6 View of the instrumentation package secured to the railcar ahead of the M973E1 Cargo SUSV.

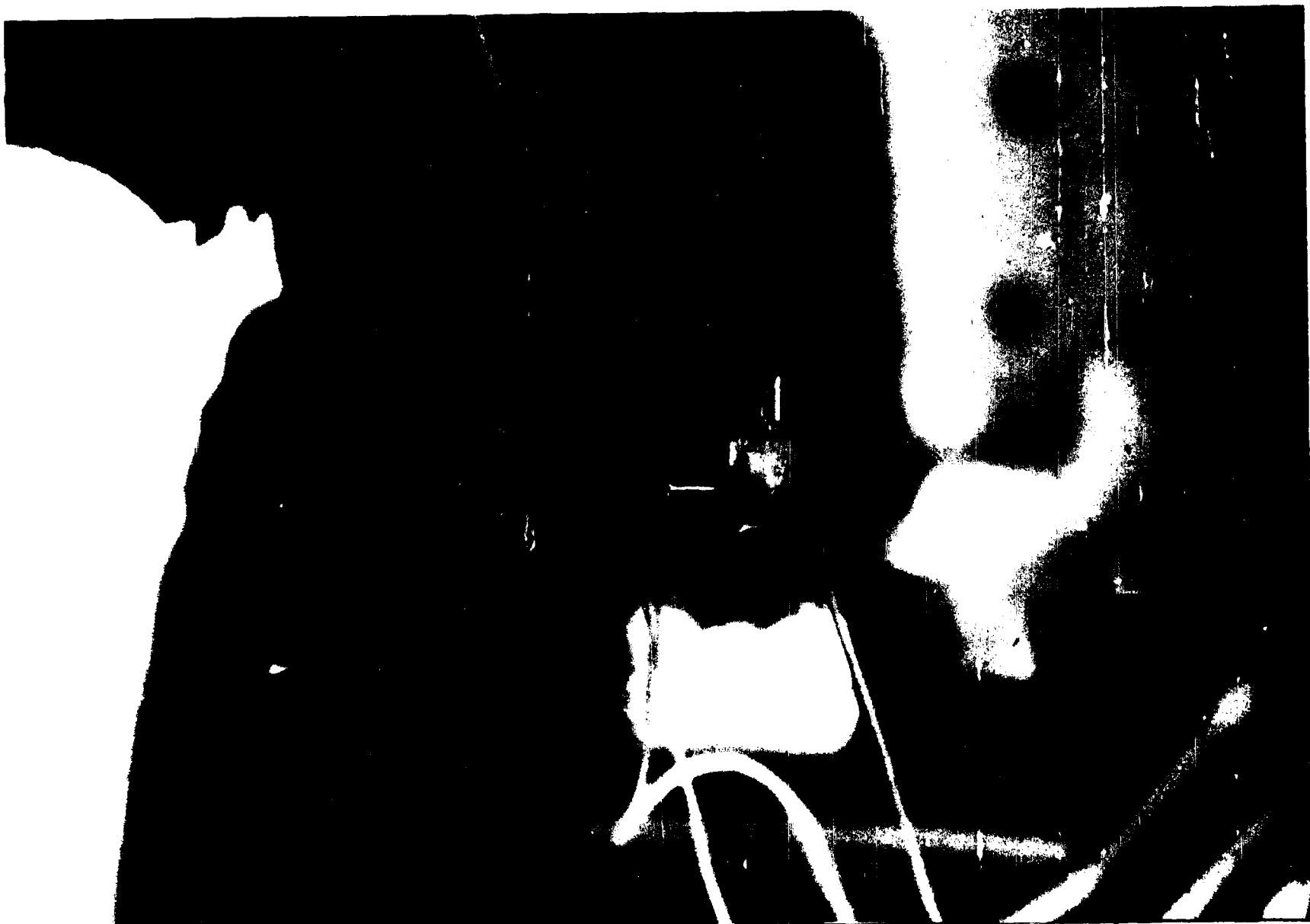


Photo No. 7 View of the triaxial accelerometer located on the frame of the M973E1 Cargo SUSV.

Photo No. 8 View of the Triaxial Accelerometer located on the cargo bed of the M973E1 Cargo SUSV.

B. ROAD TEST OF M973E1 CARGO SUSV WITH PALLETIZED LOAD

The M973E1 Cargo SUSV loaded with the same maximum capacity (2,750-pound) test load used in the rail impact test completed the USADACS road hazard course. Prior to the road test, the wooden gate assembly at each end of the two-pallet-long test load was removed. The two web strap tiedown assemblies around each wooden gate were also removed and a single web strap tiedown assembly was placed around the pallet base to curtail longitudinal movement. Two web strap tiedown assemblies were placed laterally over the top of each of the two pallets to restrain vertical and lateral movement. A total of six 5,000-pound capacity web strap tiedown assemblies were used to secure the load.

TEST ANALYSIS

The M973E1 Cargo SUSV completed the road hazard course without incident. No movement of the inert test load occurred during completion of the road test.

ROAD TEST DATA

TEST NO. 2 DATE: 4-5 April 1989

TEST SPECIMEN: M973E1 Cargo SUSV second unit was loaded with two partial pallets of inert 105mm small-caliber howitzer ammunition.

PASS 1-A OVER FIRST SERIES OF TIES	6.30 SEC	5.41 MPH
PASS 1-B OVER SECOND SERIES OF TIES	7.80 SEC	4.37 MPH

REMARKS: No movement

PASS 2-A OVER FIRST SERIES OF TIES	5.85 SEC	5.83 MPH
PASS 2-B OVER SECOND SERIES OF TIES	5.25 SEC	6.49 MPH

REMARKS: No movement

30 MILE ROAD TEST: No movement

PANIC STOP TEST: No movement

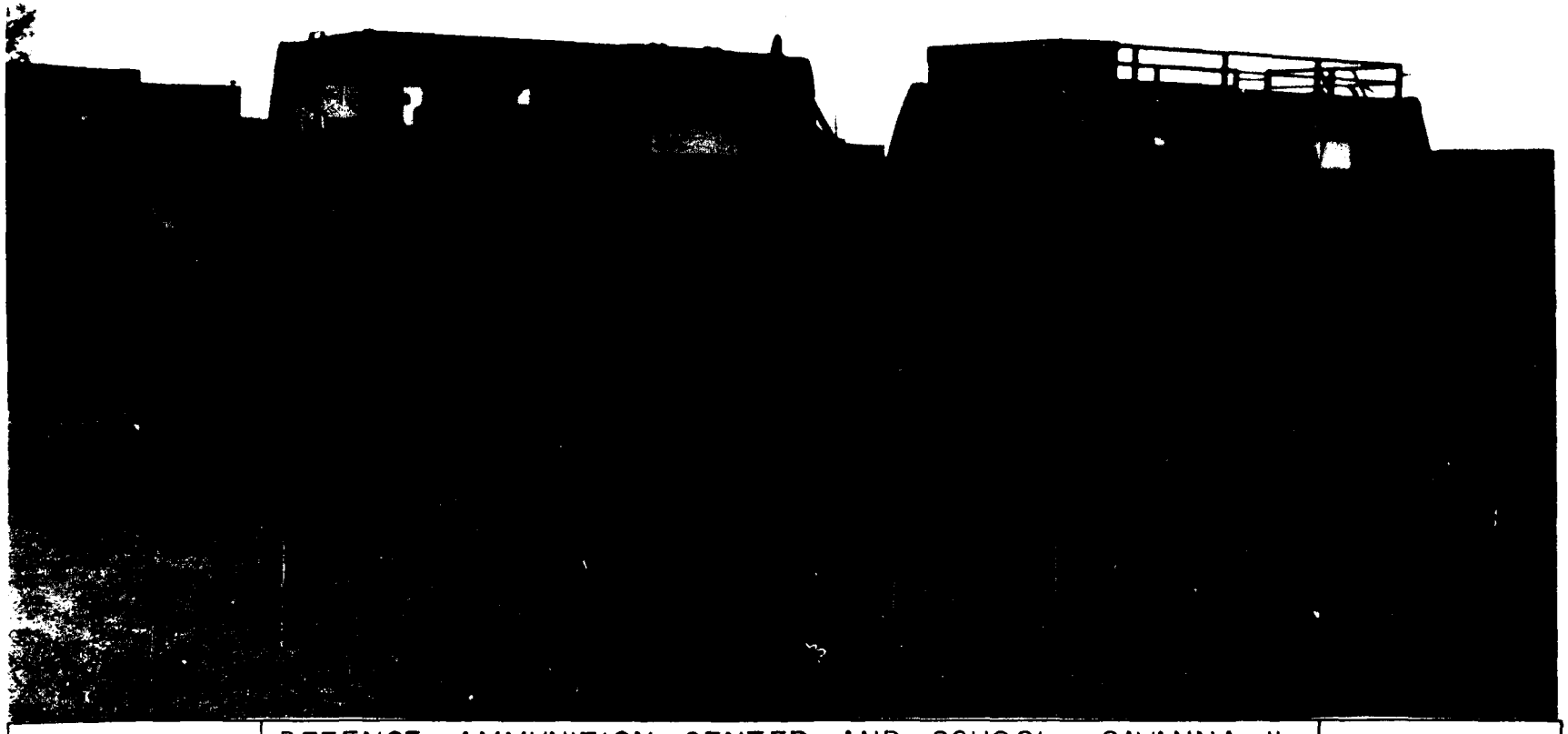
PASS 3-A OVER FIRST SERIES OF TIES	5.70 SEC	5.98 MPH
PASS 3-B OVER SECOND SERIES OF TIES	5.10 SEC	6.68 MPH

REMARKS: No movement

PASS 4-A OVER FIRST SERIES OF TIES	5.70 SEC	5.98 MPH
PASS 4-B OVER SECOND SERIES OF TIES	5.70 SEC	5.98 MPH

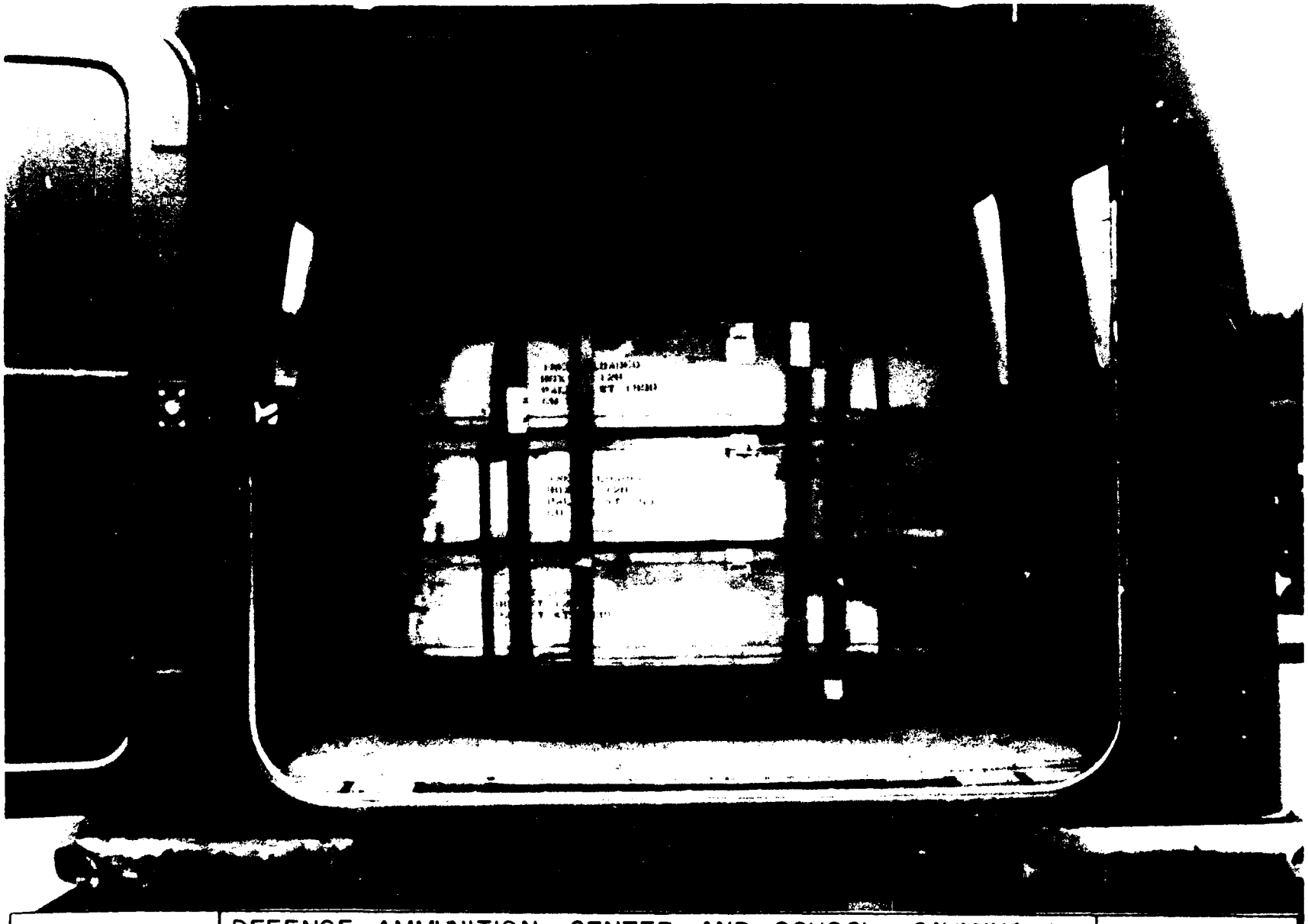
REMARKS: No movement

WASHBOARD COURSE: No movement



DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL

Photo No. 9 View of the M973E1 Cargo SUSV prior to commencing on USADACS road hazard course.



DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL

Photo No. 10 View of the maximum capacity inert load secured in the M973E1 Cargo SUSV. Note end gates used in rail impact are removed and strap relocated around base of pallet for longitudinal restraint.

C. RAIL IMPACT TEST OF XM1067 FLATBED SUSV

1. The XM1067 Flatbed SUSV was cabled to the railroad flatcar using the same method used with the M973E1 Cargo SUSV rail impact test. Two cables extend from the pintle of the SUSV, one to a stake pocket on each side of the railcar. At the center of the SUSV, between the front and rear unit, a cable extends over the rear drive housing to a railcar stake pocket on each side of the flatcar. At the front of the SUSV, a cable is looped around the "handle bar" located on the sides of the winch mounting bracket, with the cable extending to a stake pocket on each side of the flatcar.

2. In the XM1067 Flatbed SUSV, two partial pallets of inert 105mm small-caliber howitzer ammunition were used to attain the maximum 3,190 pound load. Using the cargo tiedown fittings on the deck of SUSV flatbed, the two pallets were secured with a total of five 5,000-pound capacity web strap tiedown assemblies. Two of the five web straps were used around the ends at the pallet base to prevent longitudinal movement. The three remaining web straps extended either laterally or diagonally across the pallet tops hooking in the tiedown cargo tiedown fitting in the floor of the flatbed SUSV.

3. Accelerometers were placed on the center sill of the railcar, on the frame of the SUSV flatbed, and on the deck of the SUSV cargo bed. Acceleration along with its duration were measured in the longitudinal, lateral and vertical directions during the rail impacts.

TEST ANALYSIS

1. The vehicle tiedown method previously tested in June 1984 performed satisfactorily.

2. The accumulated movement of palletized load during the rail impacts was limited to slightly more than one inch. The five web straps remained taut and no damage was sustained to either the test load or the vehicle during the rail impact test.

TEST SPECIMENS AND RESULTS

RAIL IMPACT TEST DATA

Test No. 3 Load No. 2 Date: 5 April 1989

Specimen Load: XM1067 Flatbed HUSV second unit was loaded with two partial pallets of inert 105mm small-caliber howitzer ammunition. Cargo test load secured with a total of five web strap tiedown assemblies.

Test Flatcar No. SP&S 34085 Lt. Wt. 47,100

Lading & Dunnage Wt. 2,750

Reference Load No. XM1067 Wt. 9,230

Total Specimen Wt. 59,080

Buffer Car (5 cars) Wt. 250,000

Impact	End Struck	Velocity (mph)	Remarks
1	B	3.55	Front pallet moved rearward 1/2-inch.
2	B	6.61	Front pallet moved rearward 1/2-inch. Front web strap around pallet base loose.
3	B	8.28	No movement
4 (reverse)	A	8.24	Pallets moved 1-1 4 inches forward

RESULTS FROM THE RAIL IMPACT TEST ON THE
FLATBED SUSV ON FLATCAR
DATE: APRIL 5, 1989

TAPE CHANNEL 1 : LONGITUDINAL ACCELERATION ON SILL

TEST	SPEED MPH	PEAK VALUE G'S	DURATION MILLISECONDS	AREA G'S-SECONDS
IMPACT 1	3.55	.86	54.91	.0276
IMPACT 1	6.61	1.50	41.21	.0350
IMPACT 3	8.28	1.92	23.71	.0316
IMPACT 4 (REVERSE)	8.24	-1.95	20.61	.0286

TAPE CHANNEL 3 : VERTICAL ACCELERATION ON SILL

TEST	SPEED MPH	PEAK VALUE G'S	DURATION MILLISECONDS	AREA G'S-SECONDS
IMPACT 1	3.55	.23	15.16	.0016
IMPACT 1	6.61	.76	28.48	.0118
IMPACT 3	8.28	2.13	33.04	.0411
IMPACT 4 (REVERSE)	8.24	1.03	42.43	.0184

TAPE CHANNEL 4 : LATERAL ACCELERATION ON FRAME

TEST	SPEED MPH	PEAK VALUE G'S	DURATION MILLISECONDS	AREA G'S-SECONDS
IMPACT 1	3.55	-.13	22.09	.0018
IMPACT 1	6.61	.21	23.13	.0022
IMPACT 3	8.28	-.18	9.76	.0005
IMPACT 4 (REVERSE)	8.24	.23	17.36	.0019

TAPE CHANNEL 5 : LONGITUDINAL ACCELERATION ON FRAME

TEST	SPEED MPH	PEAK VALUE G'S	DURATION MILLISECONDS	AREA G'S-SECONDS
IMPACT 1	3.55	1.83	63.91	.0703
IMPACT 1	6.61	2.99	67.69	.1244
IMPACT 3	8.28	3.15	166.17	.1364
IMPACT 4 (REVERSE)	8.24	-1.95	62.15	.0906

TAPE CHANNEL 6 : RAIL COUPLER FORCE

TEST	SPEED MPH	PEAK VALUE POUNDS	DURATION MILLISECONDS	AREA POUNDS-SECONDS
IMPACT 1	3.55	90512.04	65.37	3423.33
IMPACT 1	6.61	164613.73	48.66	5088.10
IMPACT 3	8.28	196721.55	36.79	5216.07
IMPACT 4 (REVERSE)	8.24	176793.34	37.02	4604.06

TAPE CHANNEL 7 : VERTICAL ACCELERATION ON FRAME

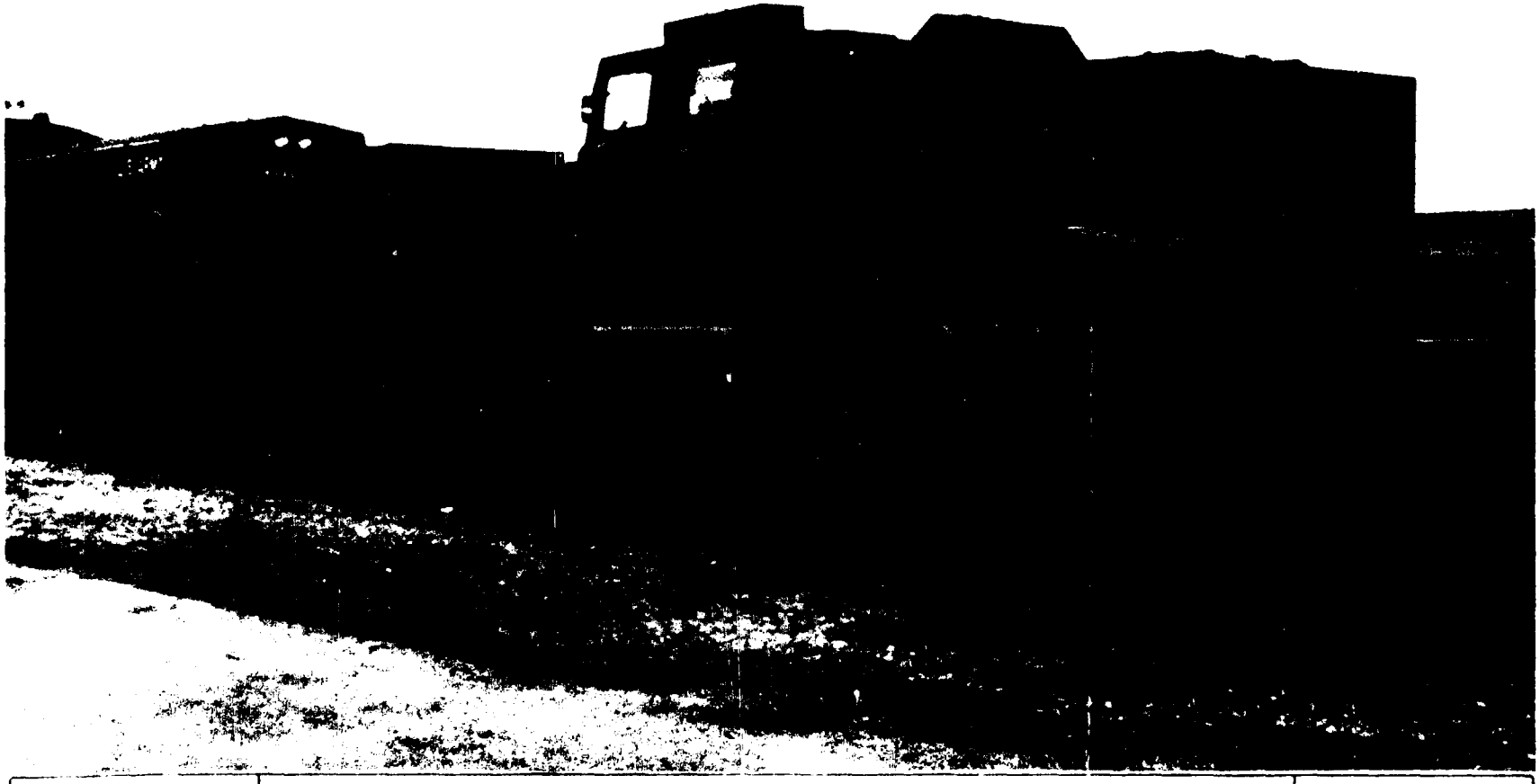
TEST	SPEED MPH	PEAK VALUE G'S	DURATION MILLISECONDS	AREA G'S-SECONDS
IMPACT 1	3.55	.70	52.31	.0229
IMPACT 1	6.61	-1.01	39.60	.0249
IMPACT 3	8.28	-1.35	47.73	.0357
IMPACT 4 (REVERSE)	8.24	1.24	48.63	.0345

TAPE CHANNEL 8 : LONGITUDINAL ACCELERATION ON TRAILER BED

TEST	SPEED MPH	PEAK VALUE G'S	DURATION MILLISECONDS	AREA G'S-SECONDS
IMPACT 1	3.55	1.92	61.64	.0716
IMPACT 1	6.61	3.11	60.68	.1206
IMPACT 3	8.28	3.22	42.33	.1112
IMPACT 4 (REVERSE)	8.24	-3.35	25.21	.0622

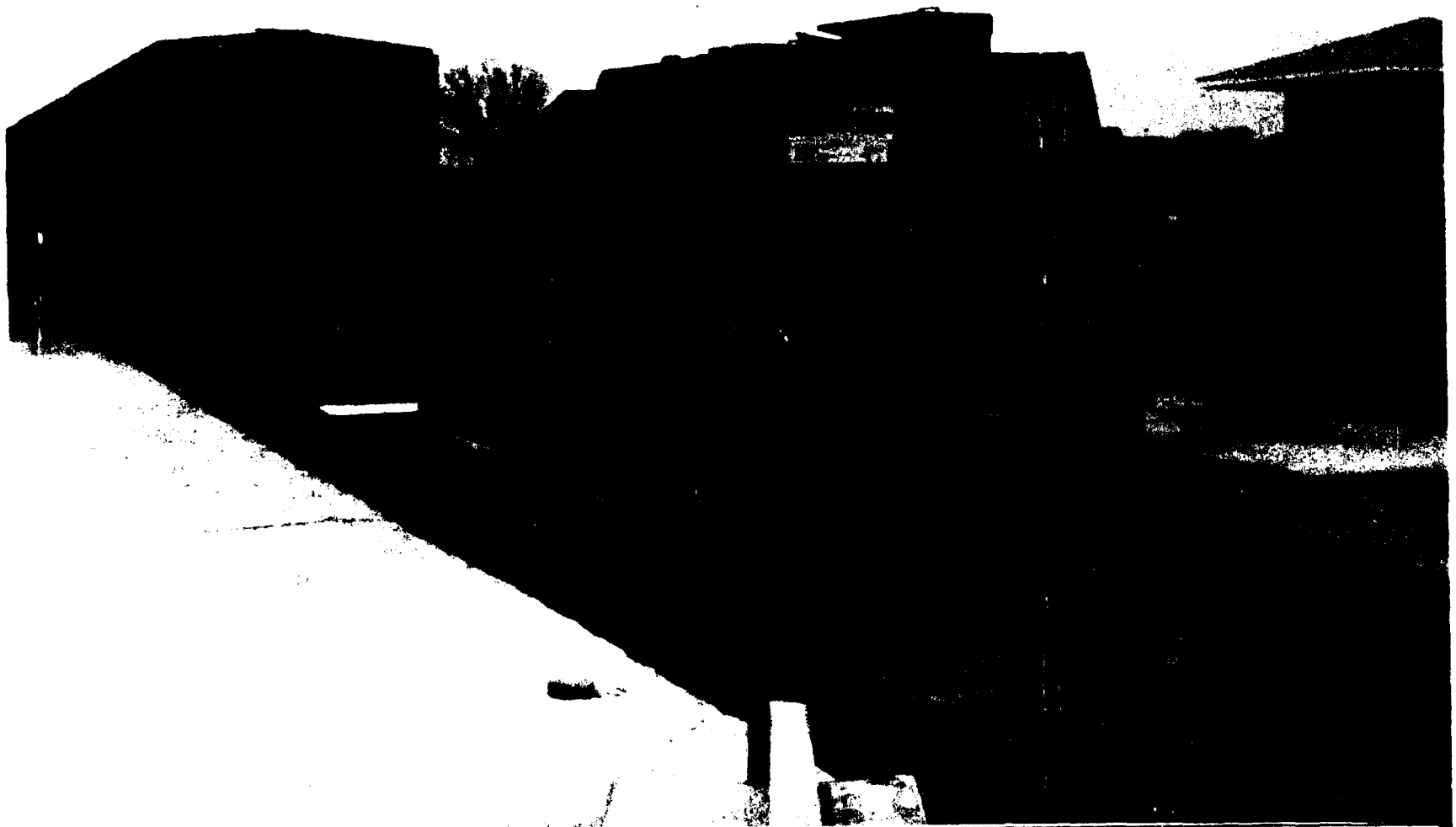
TAPE CHANNEL 9 : LATERAL ACCELERATION ON TRAILER BED

TEST	SPEED MPH	PEAK VALUE G'S	DURATION MILLISECONDS	AREA G'S-SECONDS
IMPACT 1	3.55	-.11	18.16	.0010
IMPACT 1	6.61	-.14	18.70	.0011
IMPACT 3	8.28	-.18	10.65	.0008
IMPACT 4 (REVERSE)	8.24	.22	9.47	.0002



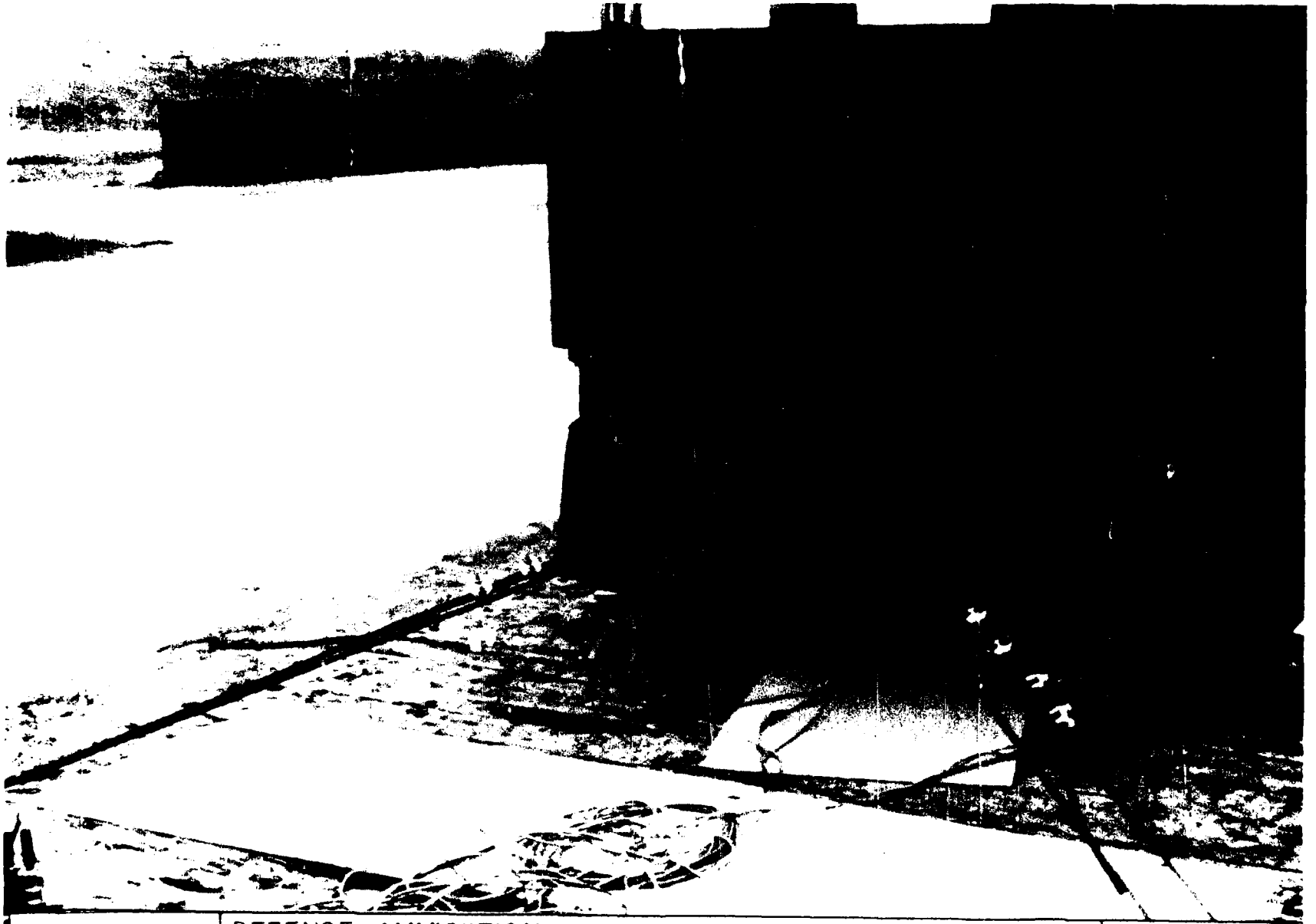
DEFENSE AMMUNITION CENTER AND SCHOOL- SAVANNA, IL

Photo No. 11 View of the XM-67 Flame [illegible] Shot to a railroad [illegible].



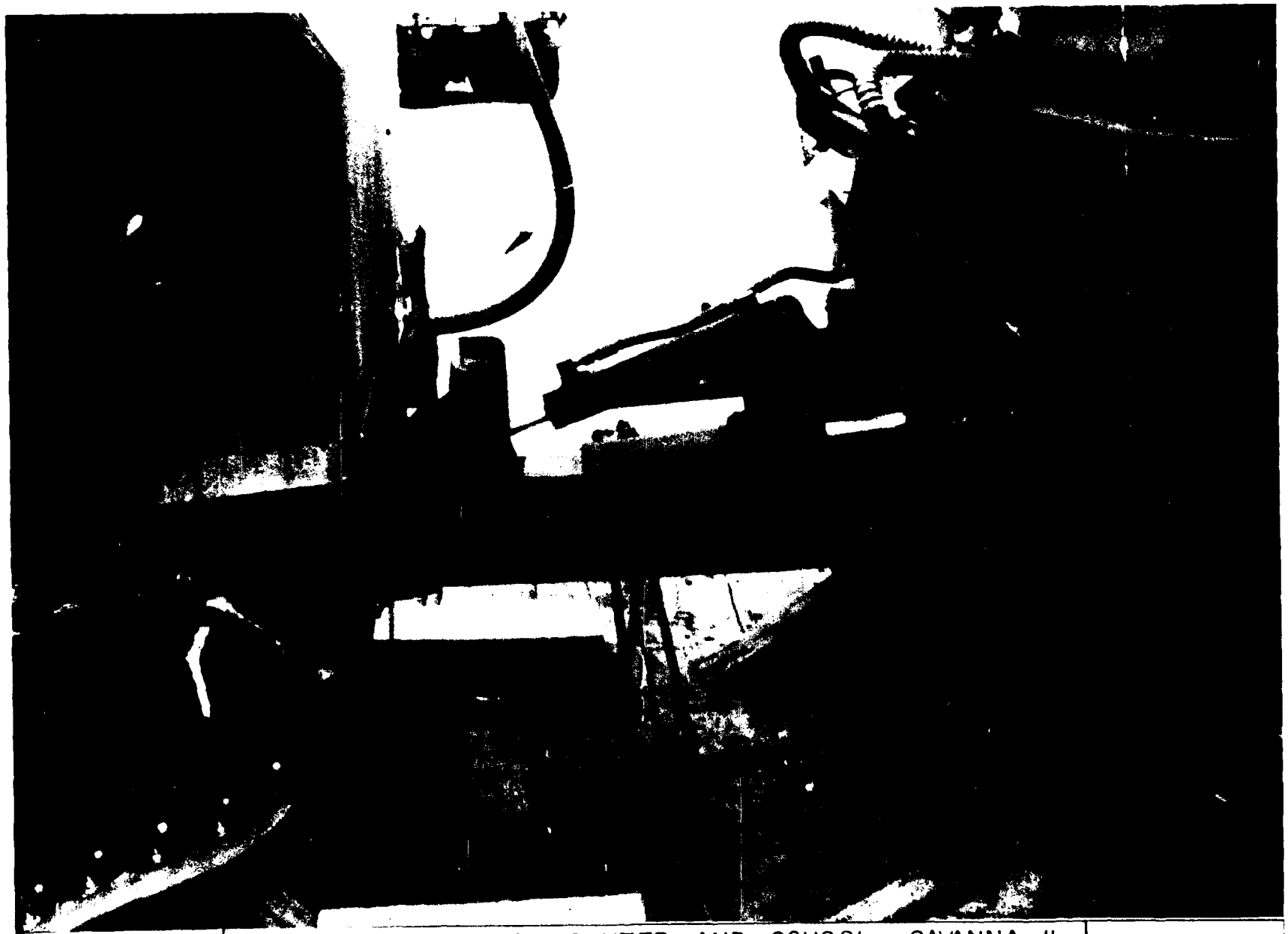
DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL

Photo No. 12 View of the tiedown cables securing the front of the XM1067 Flatbed SUSV to the railroad flatcar.



DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL

Figure 3-3. View of the tiedown cables securing the rear of the XM1067 Flatbed SUSV to the railroad flatcar.

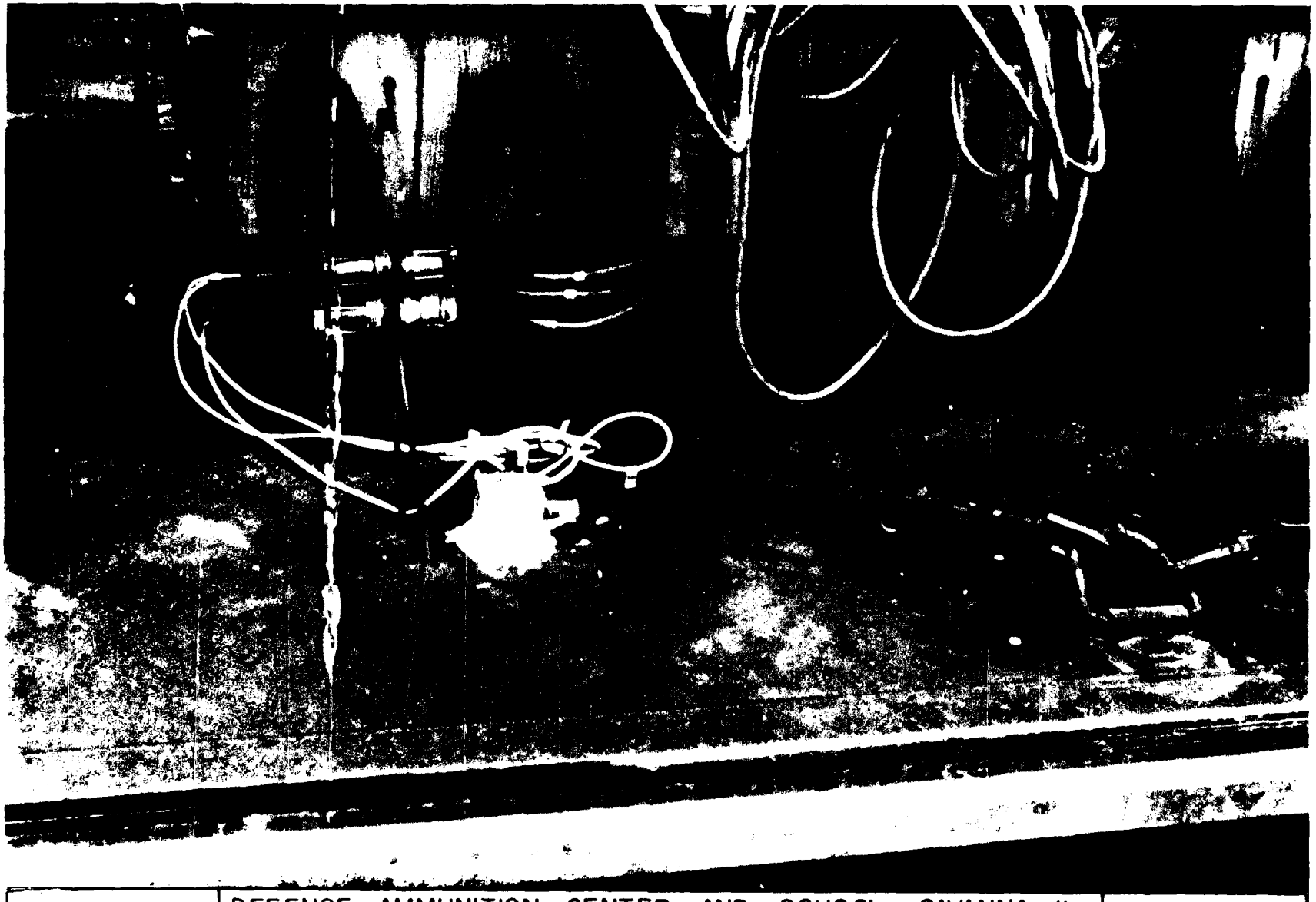


DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL

Photo No. 14 View of the tiedown cable extending over the rear drive housing between the front and rear unit of the XM1067 Flatbed SUSV.

DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL

Photo No. 15 View with sidewall lowered into the cargo area of the XM1067 Flatbed SUSV.



DEFENSE AMMUNITION CENTER AND SCHOOL- SAVANNA, IL

Photo No. 16 View of the accelerometer block located on the deck of the cargo bed adjacent to the inert palletized test load.

D. ROAD TEST OF M973E1 CARGO SUSV WITH UNPALLETIZED MIXED LOAD

1. The M973E1 Cargo SUSV was loaded with a mixed load of unpalletized inert ammunition items and road tested. The inert mixed load consisted of boxed 105mm small-caliber howitzer ammunition, M548 small arms metal cans, and wirebound wooden boxes with small arms in M2 metal containers.

2. Prior to loading the test load, a wooden protection assembly was fabricated to protect the bilge pump located in the footwell or recessed area of the second unit of the M973E1 Cargo SUSV. The mixed load of unpalletized inert ammunition items was positioned in the footwell or recessed area. The inert cargo was arranged in two stacks and secured with a total of four web strap tiedown assemblies.

TEST ANALYSIS

The XM1067 Flatbed SUSV completed the road hazard course without incident. The method of securing the cargo limited movement to less than 1/2-inch. The straps remained tight and the ammunitions items remained secure.

ROAD TEST DATA

TEST NO. 4 DATE: 5-6 April 1989

TEST SPECIMEN: M973E1 Cargo SUSV second unit was loaded with a mixed load of unpalletized inert ammunition items. Four web strap tiedown assemblies were used to secure the load.

PASS 1-A OVER FIRST SERIES OF TIES 5.70 SEC 5.98 MPH

PASS 1-B OVER SECOND SERIES OF TIES 5.40 SEC 6.31 MPH

REMARKS: No movement

PASS 2-A OVER FIRST SERIES OF TIES 5.25 SEC 6.49 MPH

PASS 2-B OVER SECOND SERIES OF TIES 5.85 SEC 5.83 MPH

REMARKS: No movement

30 MILE ROAD TEST: No movement

PANIC STOP TEST: No movement

PASS 3-A OVER FIRST SERIES OF TIES 4.80 SEC 7.10 MPH

PASS 3-B OVER SECOND SERIES OF TIES 4.80 SEC 7.10 MPH

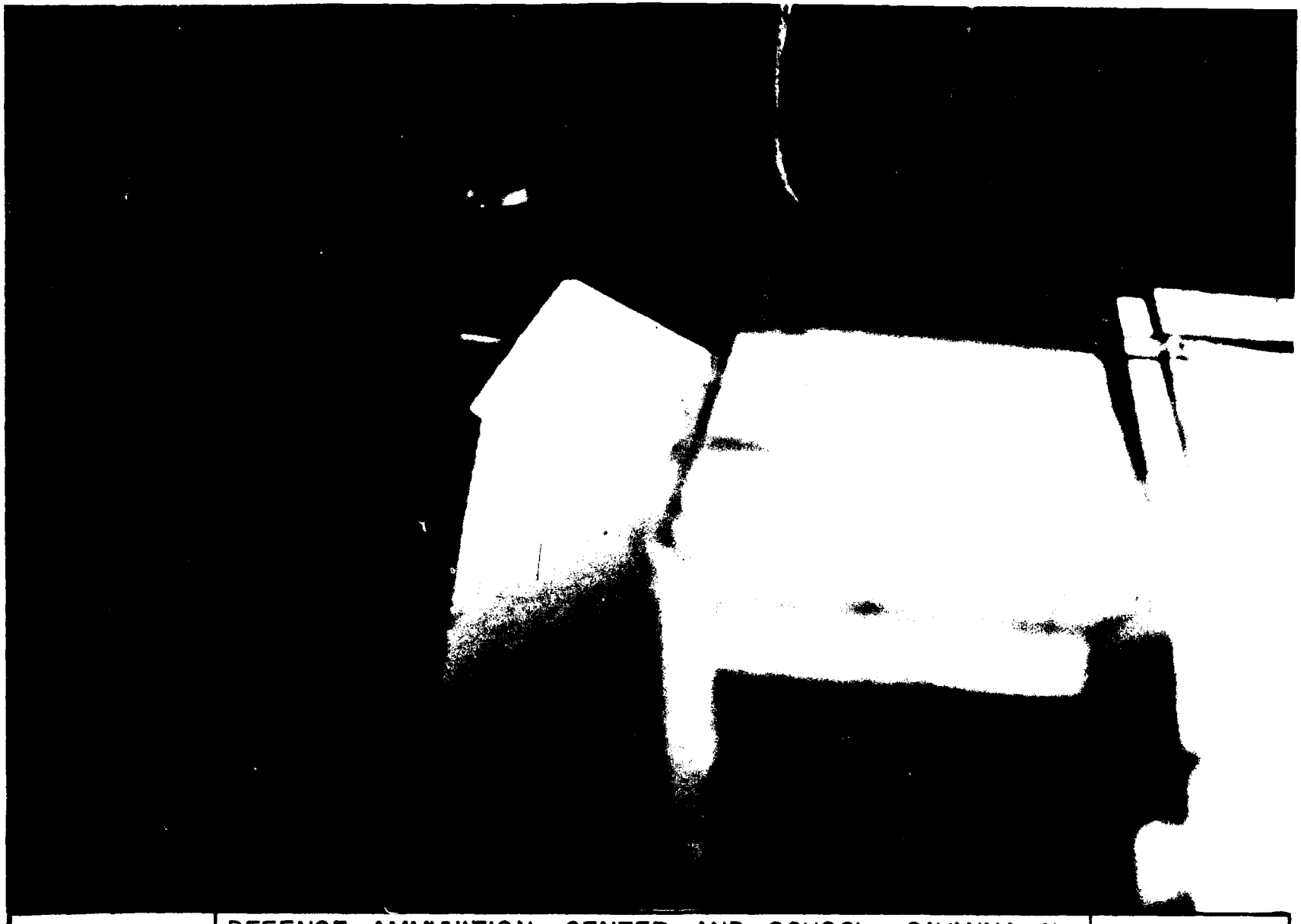
REMARKS: Pallets moved 1/8-inch to 1/4-inch forward.

PASS 4-A OVER FIRST SERIES OF TIES 5.25 SEC 6.49 MPH

PASS 4-B OVER SECOND SERIES OF TIES 5.40 SEC 6.31 MPH

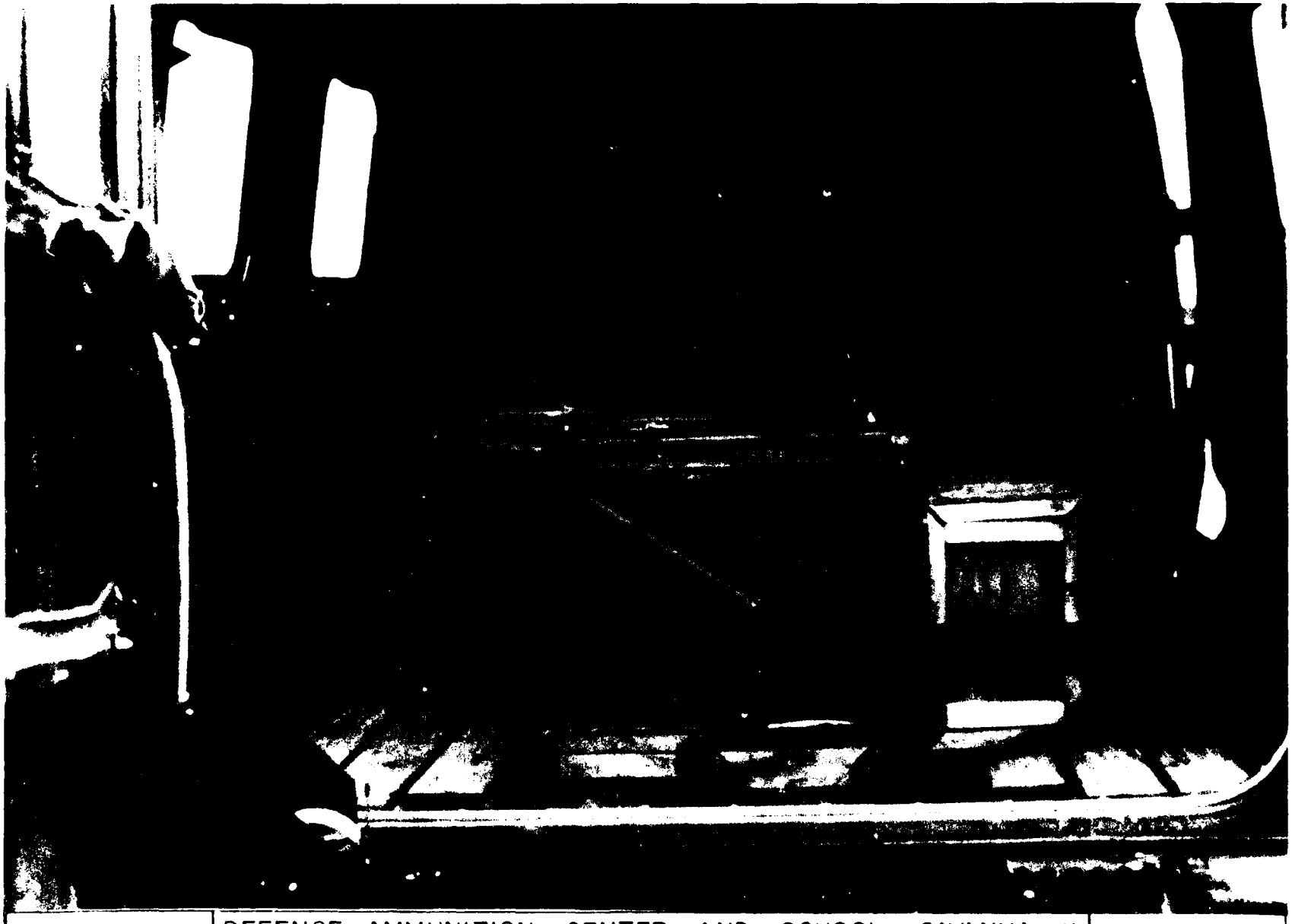
REMARKS: No movement

WASHBOARD COURSE: No movement



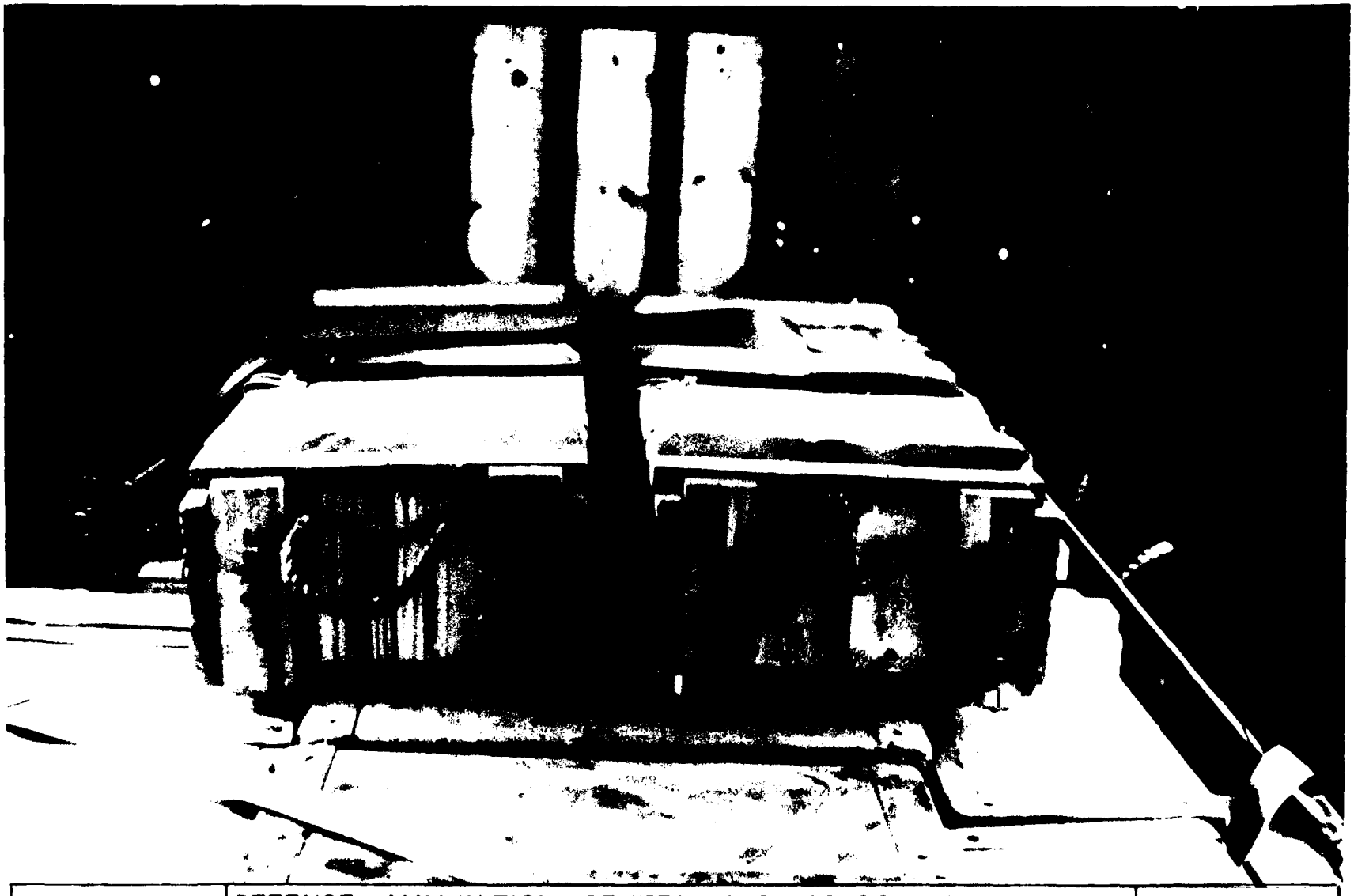
DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL

Photo No. 17 View of the wooden protection assembly fabricated to protect the bilge pump located in the footwell of the M973E1 Cargo SUSV.



DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL

Photo No. 18 View of the inert unpalletized mixed load in the second unit of the M973E1 Cargo HUSV. Note the area inside the door frame which allows the door with the gun bracket to clear the ammunition when closing the door.



DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL

Photo No. 19 View of web straps used for hold down of the unpalletized mixed load in the second unit of the M973E1 Cargo SUSV.

E. ROAD TEST OF XM1067 FLATBED SUSV WITH PALLETIZED LOAD

The XM1067 Flatbed SUSV loaded with the same maximum capacity (3,190-pound) test load used in the rail impact test completed the USADACS road hazard course. The identical tiedown method used during the rail impact test was tested over the road hazard course. A total of five 5,000-pound capacity web strap tiedown assemblies were used to secure the load.

TEST ANALYSIS

The XM1067 Flatbed SUSV completed the road hazard course without incident. The total movement of the secured test load was less than 1/2-inch. All indications are the load could have passed the USADACS road hazard course with a total of four web straps instead of five web straps as tested.

ROAD TEST DATA

TEST NO. 5 DATE: 5-6 April 1989

TEST SPECIMEN: XM1067 Flatbed SUSV second unit was loaded with two partial pallets of inert 105mm small-caliber howitzer ammunition. Cargo test load secured with a total of five web strap tiedown assemblies.

PASS 1-A OVER FIRST SERIES OF TIES 5.25 SEC 6.49 MPH

PASS 1-B OVER SECOND SERIES OF TIES 5.70 SEC 5.98 MPH

REMARKS: Pallet moved 1/4-inch to the right.

PASS 2-A OVER FIRST SERIES OF TIES 5.40 SEC 6.31 MPH

PASS 2-B OVER SECOND SERIES OF TIES 5.85 SEC 5.83 MPH

REMARKS: No movement

30 MILE ROAD TEST: No movement

PANIC STOP TEST: No movement

PASS 3-A OVER FIRST SERIES OF TIES 5.40 SEC 6.31 MPH

PASS 3-B OVER SECOND SERIES OF TIES 5.25 SEC 6.49 MPH

REMARKS: No movement

PASS 4-A OVER FIRST SERIES OF TIES 5.25 SEC 6.49 MPH

PASS 4-B OVER SECOND SERIES OF TIES 4.80 SEC 7.10 MPH

REMARKS: No movement

WASHBOARD COURSE: No movement

F. ROAD TEST OF XM1067 FLATBED SUSV WITH UNPALLETIZED MIXED LOAD

1. The XM1067 Flatbed SUSV was loaded with a mixed load of unpalletized inert ammunition items and road tested. The inert mixed load consisted of boxed 105mm small-caliber howitzer ammunition, M548 small arms metal cans and wirebound wooden boxes with small arms in M2 metal containers.

2. The inert test load was positioned in two stacks and secured with a total of four web strap tie down assemblies. One strap went over and one strap went around the ends of each of the two stacks.

TEST ANALYSIS

The XM1067 Flatbed SUSV completed the road hazard course without incident. The method of securing the loose cargo limited the total movement to less than 1/2-inch. The web straps remained tight and the ammunition items remained secure.

ROAD TEST DATA

TEST NO. 6 DATE: 6 April 1989

TEST SPECIMEN: XM1067 Flatbed SUSV second unit was loaded with a mixed load of unpalletized inert ammunition items. Four web strap tiedown assemblies were used to secure the load.

PASS 1-A OVER FIRST SERIES OF TIES 5.25 SEC 6.49 MPH

PASS 1-B OVER SECOND SERIES OF TIES 4.80 SEC 7.10 MPH

REMARKS: Pallets moved 1/4-inch to the right

PASS 2-A OVER FIRST SERIES OF TIES 5.40 SEC 6.31 MPH

PASS 2-B OVER SECOND SERIES OF TIES 5.85 SEC 5.83 MPH

REMARKS: No movement

30 MILE ROAD TEST: No movement

PANIC STOP TEST: No movement

PASS 3-A OVER FIRST SERIES OF TIES 5.40 SEC 6.31 MPH

PASS 3-B OVER SECOND SERIES OF TIES 4.80 SEC 7.10 MPH

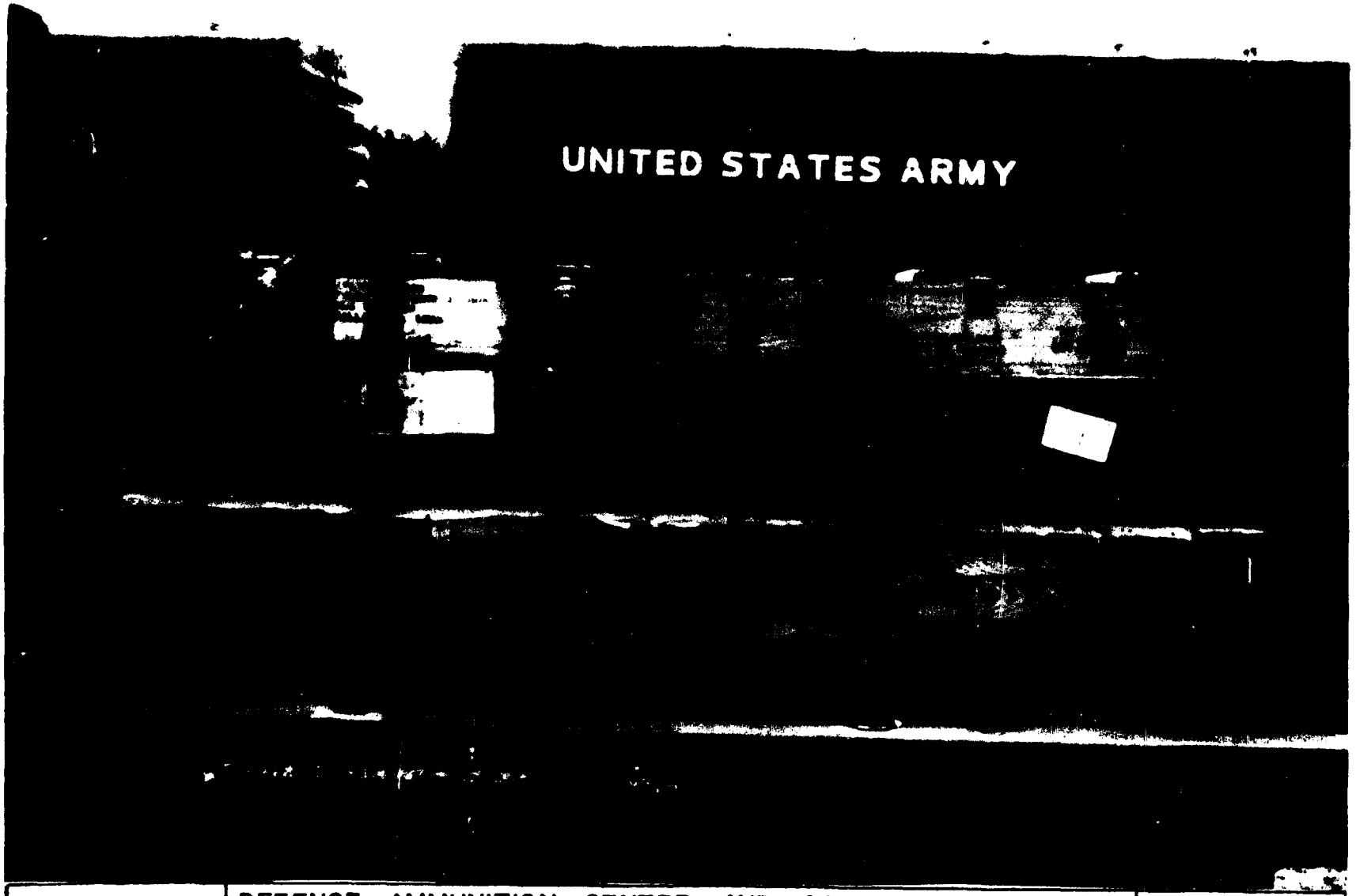
REMARKS: No movement

PASS 4-A OVER FIRST SERIES OF TIES 5.55 SEC 6.14 MPH

PASS 4-B OVER SECOND SERIES OF TIES 4.80 SEC 7.10 MPH

REMARKS: No movement

WASHBOARD COURSE: No movement



DEFENSE AMMUNITION CENTER AND SCHOOL- SAVANNA, IL

Photo No. 20 View of the inert unpalletized mixed load in the second unit of the XM1067 Flatbed SUSV.

TEST PLANS

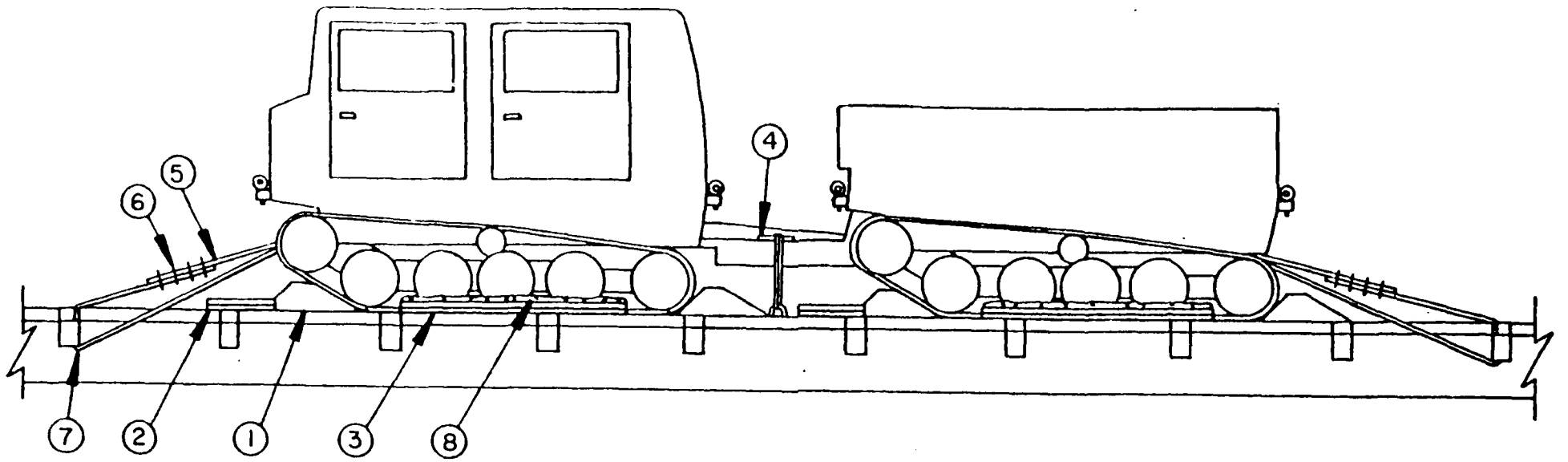
TEST PLAN

XM1067 SMALL UNIT SUPPORT VEHICLE (SUSV)

This 6-page document delineates required blocking and tiedown procedures to satisfy rail transportability test requirements for the XM1067 Small Unit Support Vehicle when outloaded on a railroad flat car, and when fully loaded by weight with ammunition.

The tiedown method requires the use of five tiedown cables, with two cables attached to the vehicle pintle, two cables attached to the vehicle towing facilities, and one cable passed laterally over the towing/drive mechanism that is located between the two sections of the vehicle.

Prepared during March 1989 by:
US Army Defense Ammunition
Center & School
Savanna, IL 61074-9639



ELEVATION VIEW

KEY NUMBERS

(1) Chock Block (8 Reqd). See detail on sheet 3. Four blocks are required to be shortened as shown on sheet 3. Nail thru heel of four blocks w/2-40d and 2-60d nails. Toenail each side of all blocks to car floor w/2-40d nails.

(2) End Blocking For Chock Block, 2" X 8" X 18" (Doubled) (4 Reqd). Nail the first piece to the car floor w/6-20d nails. Nail the second piece to the first w/6-50d nails.

(3) Side Blocking, 2" X 4" X 72" (Doubled) (4 Reqd). Nail the first piece to the car floor w/9-20d nails. Nail the second piece to the first in a like manner.

(4) Buffer, 2" X 6" X 15" (1 Reqd). Position between cable and connecting tunnel of vehicles. After cable has been tensioned and sealed with clips, bend 4 partially driven nails over cable. See detail on sheet 3.

(5) Steel wire rope, 1/2" Dia (5 Reqd). At rear of lading extend two cables to extend from a stake pocket on car, thru the pintle of lading and back to stake pocket. At center of vehicles, extend cable to form a complete loop from an anchoring facility on one side of car, over the tunnel of the vehicles and piece marked (4) and thru an anchoring facility on the other side of car and back to where it can be sealed. At front of vehicles, extend two cables to extend from a stake pocket on car, around the towing device at the front of the lading and back to the stake pocket. Seal each joint with 4 clips.

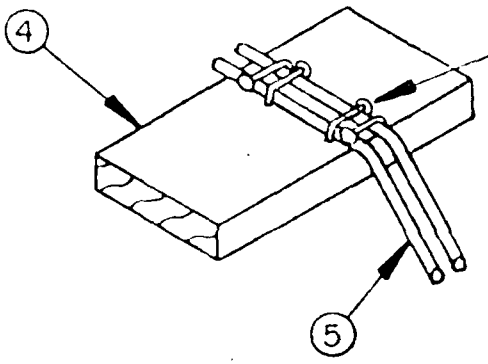
(6) Clip, 1/2" (26 Reqd). Use four (4) per cable joint and one (1) per thimble.

(7) Thimble, 1/2" (6 Reqd). Use one (1) per car anchoring facility..

(8) Waterproof paper of a size to extend above piece marked (3) .

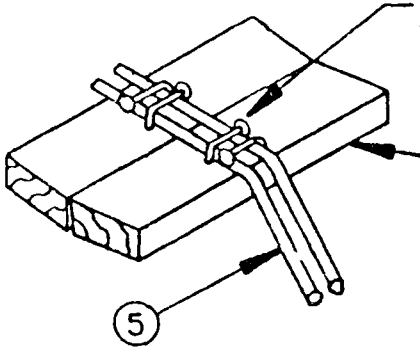
ITEM	QUANTITY	WEIGHT
Small Unit		
Support Vehicle	1	9,944 lbs
105MM Pallet	2	2,750 lbs*
Total Weight		12,694 lbs

* Includes dunnage weight.



4 partially driven 20d nails bent over cable.

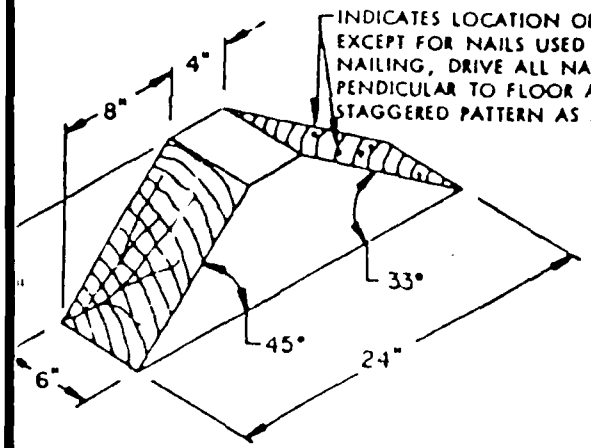
BUFFER



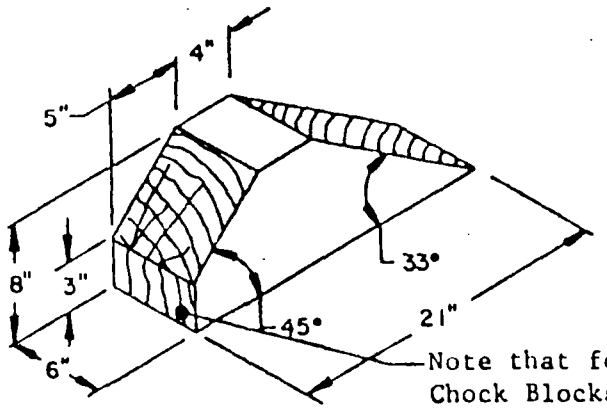
4 partially driven 20d nails bent over cable.

2" x 4" x 15" (2 reqd).

ALTERNATE BUFFER

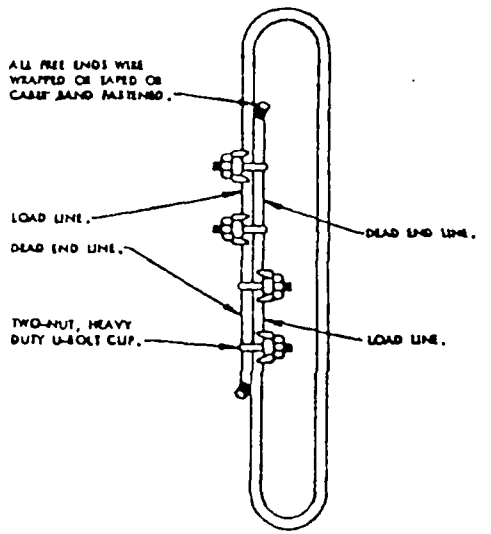


CHOCK BLOCK



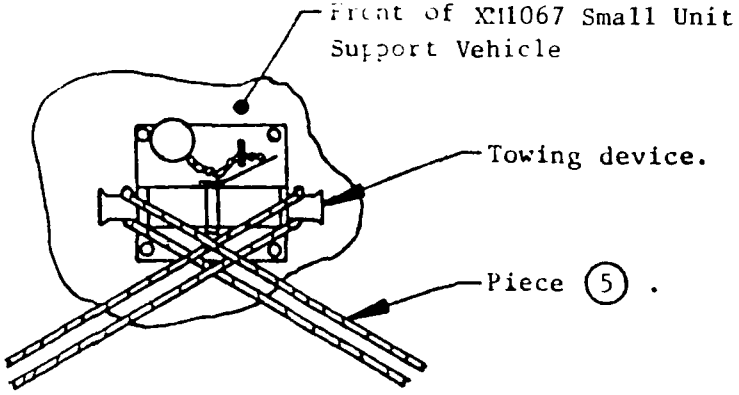
CHOCK BLOCK

Note that four Chock Blocks must have a portion removed.



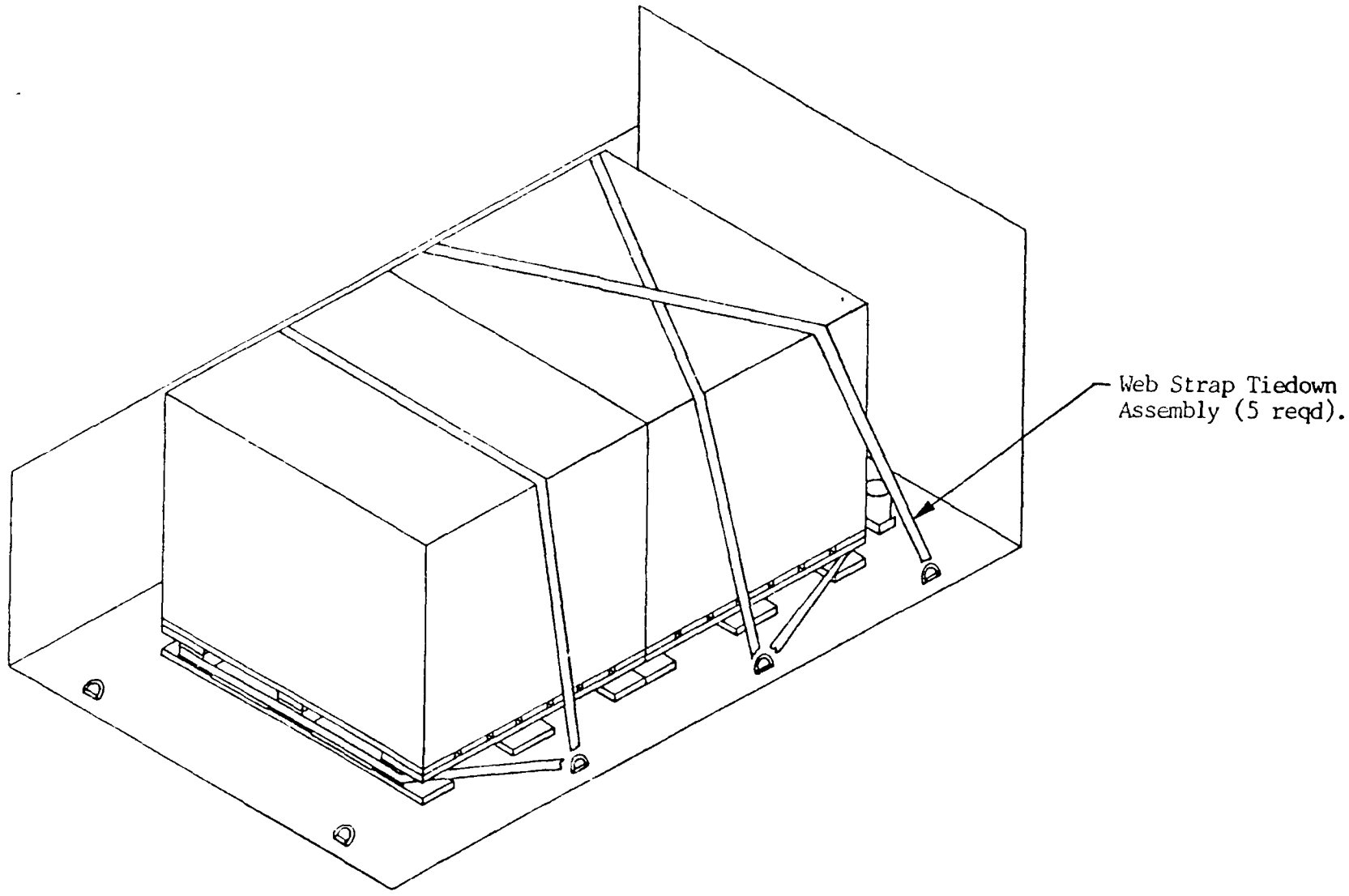
CABLE JOINT

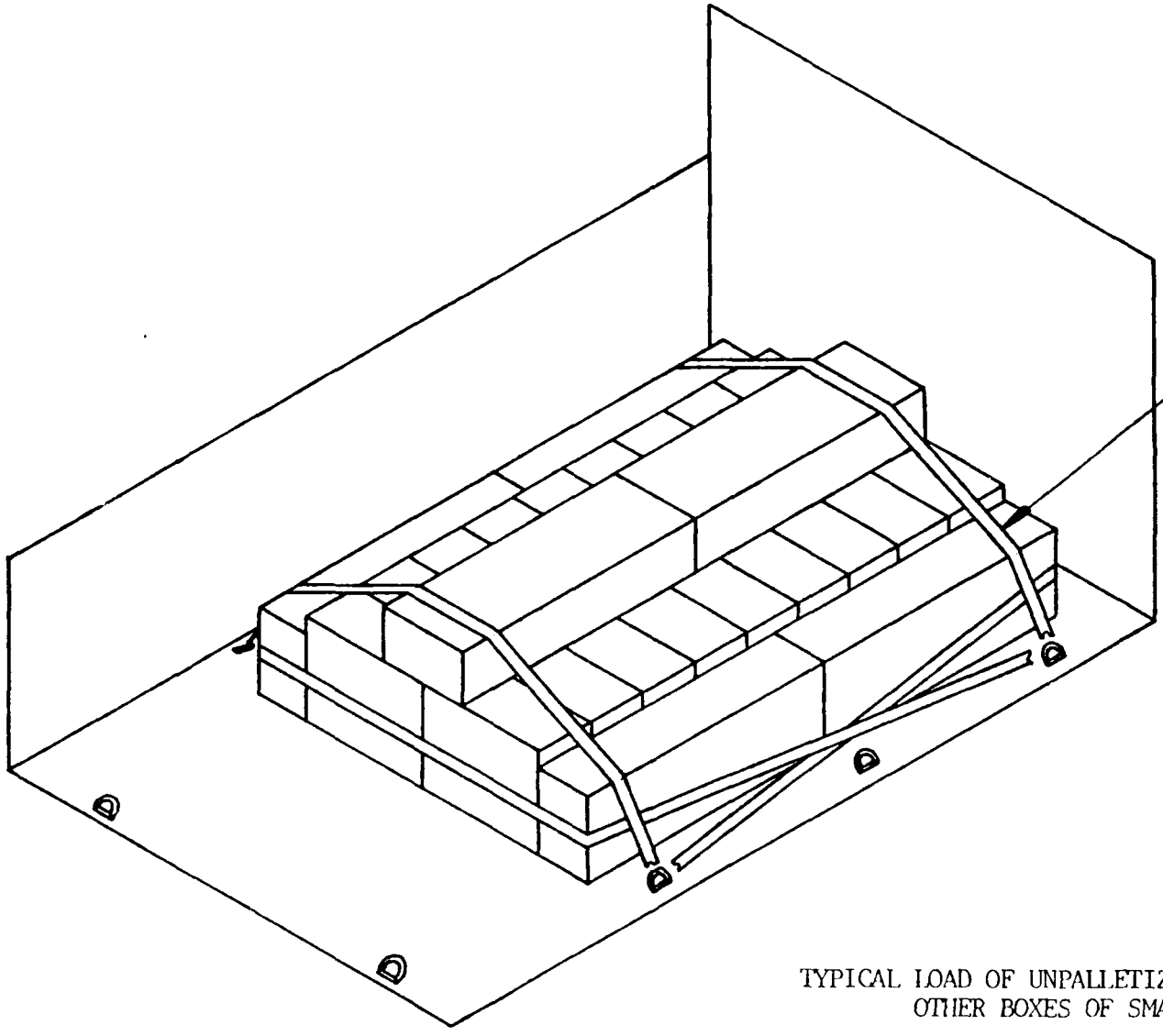
PROPER TIGHTENING OF THE WIRE ROPE CUP NUTS CAN BE ACCOMPLISHED BY UTILIZING A PROPER SIZED TORQUE WRENCH. AFTER THE NUTS HAVE BEEN INITIALLY TIGHTENED, THE "U" SIDE OF EACH CUP MUST BE STRUCK SEVERAL TIMES WITH A HAMMER TO INSURE PROPER SEATING INTO THE DEAD END LINE. FINAL TORQUE WILL BE ACQUIRED BY REPEATEDLY AND ALTERNATELY TIGHTENING EACH CUP NUT.



ATTACHMENT OF CABLE TO FRONT OF VEHICLE

Cable shall be installed at the forward end of the front cab in the manner shown above.


Web Strap Tiedown
Assembly (5 reqd).



TYPICAL LOAD OF UNPALLETIZED BOXES OF 105MM AND
OTHER BOXES OF SMALL ARMS AMMUNITION

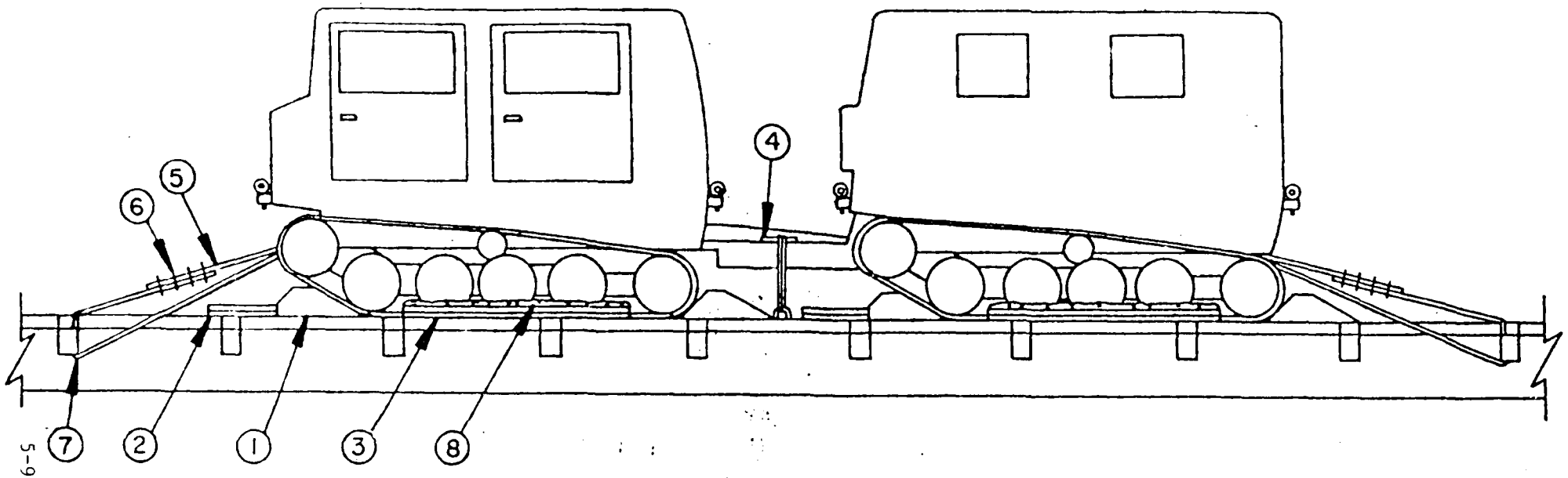
TEST PLAN

M973E1 SMALL UNIT SUPPORT VEHICLE (SUSV)

This 6-page document delineates required blocking and tiedown procedures to satisfy rail transportability test requirements for the M973E1 Small Unit Support Vehicle when outloaded on a railroad flat car, and when fully loaded by weight with ammunition.

The tiedown method requires the use of five tiedown cables, with two cables attached to the vehicle pintle, two cables attached to the vehicle towing facilities, and one cable passed laterally over the towing/drive mechanism that is located between the two sections of the vehicle.

Prepared during March 1989 by:
US Army Defense Ammunition
Center & School
[illegible] IL 61074-9639



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(5) Steel wire rope, 1/2" Dia (5 Reqd). At rear of lading extend two cables to extend from a stake pocket on car, thru the pintle of lading and back to stake pocket. At center of vehicles, extend cable to form a complete loop from an anchoring facility on one side of car, over the tunnel of the vehicles and piece marked (4) and thru an anchoring facility on the other side of car and back to where it can be sealed. At front of vehicles, extend two cables to extend from a stake pocket on car, around the towing device at the front of the lading and back to the stake pocket. Seal each joint with 4 clips.

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ITEM	QUANTITY	WEIGHT
Small Unit		
Support Vehicle	1	9,944 lbs
105MM Pallet	2	2,750 lbs *
Total Weight		12,694 lbs

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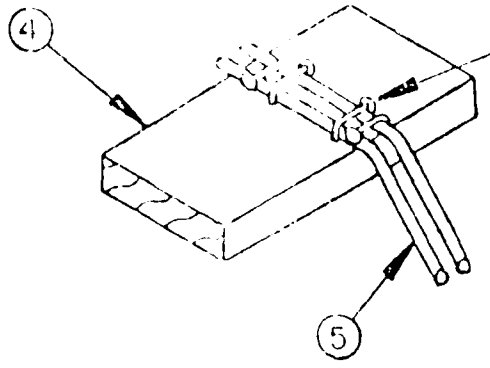
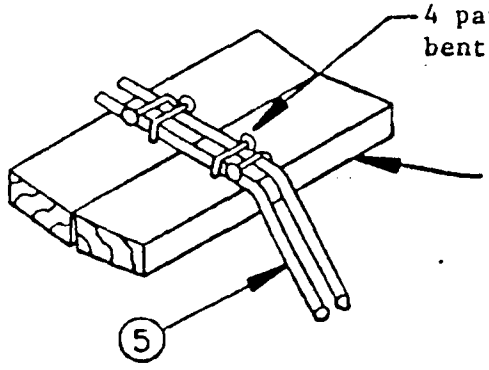


4 partially driven 20d nails bent over cable.

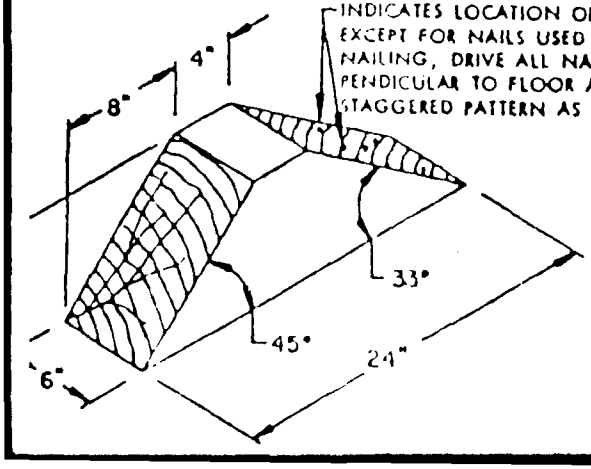
BUFFLE

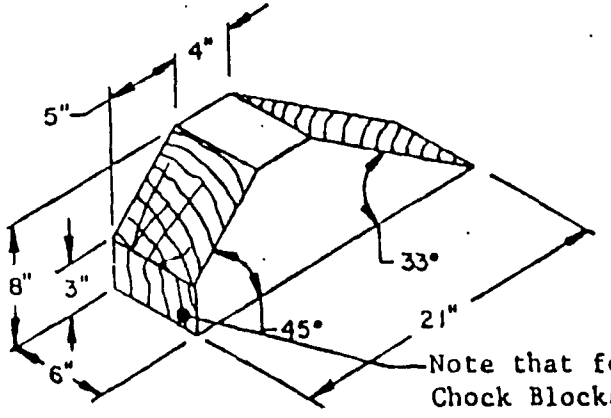


4 partially driven 20d nails bent over cable.

2" x 4" x 15" (2 reqd).

ALTERNATE BUFFER





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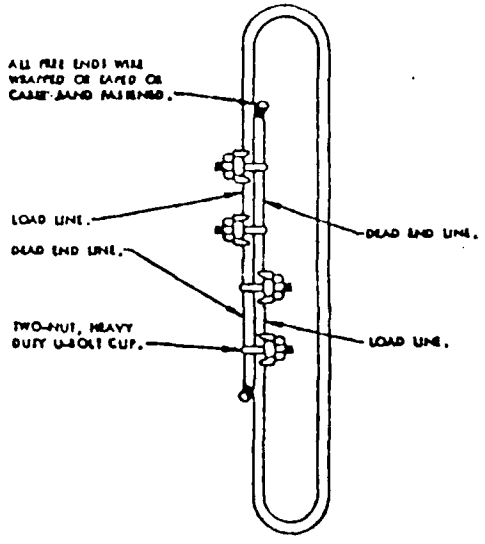

CABLE JOINT

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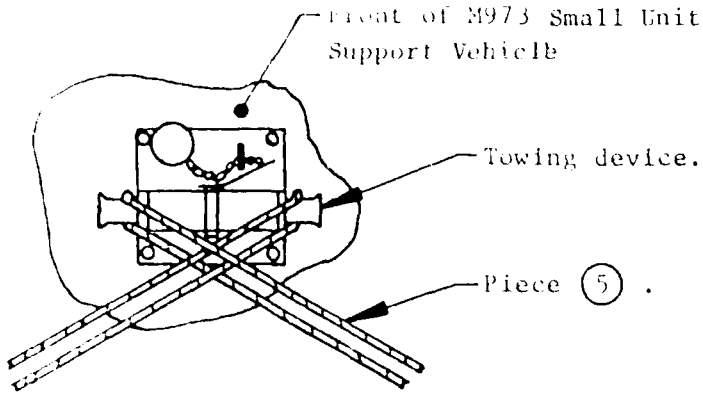

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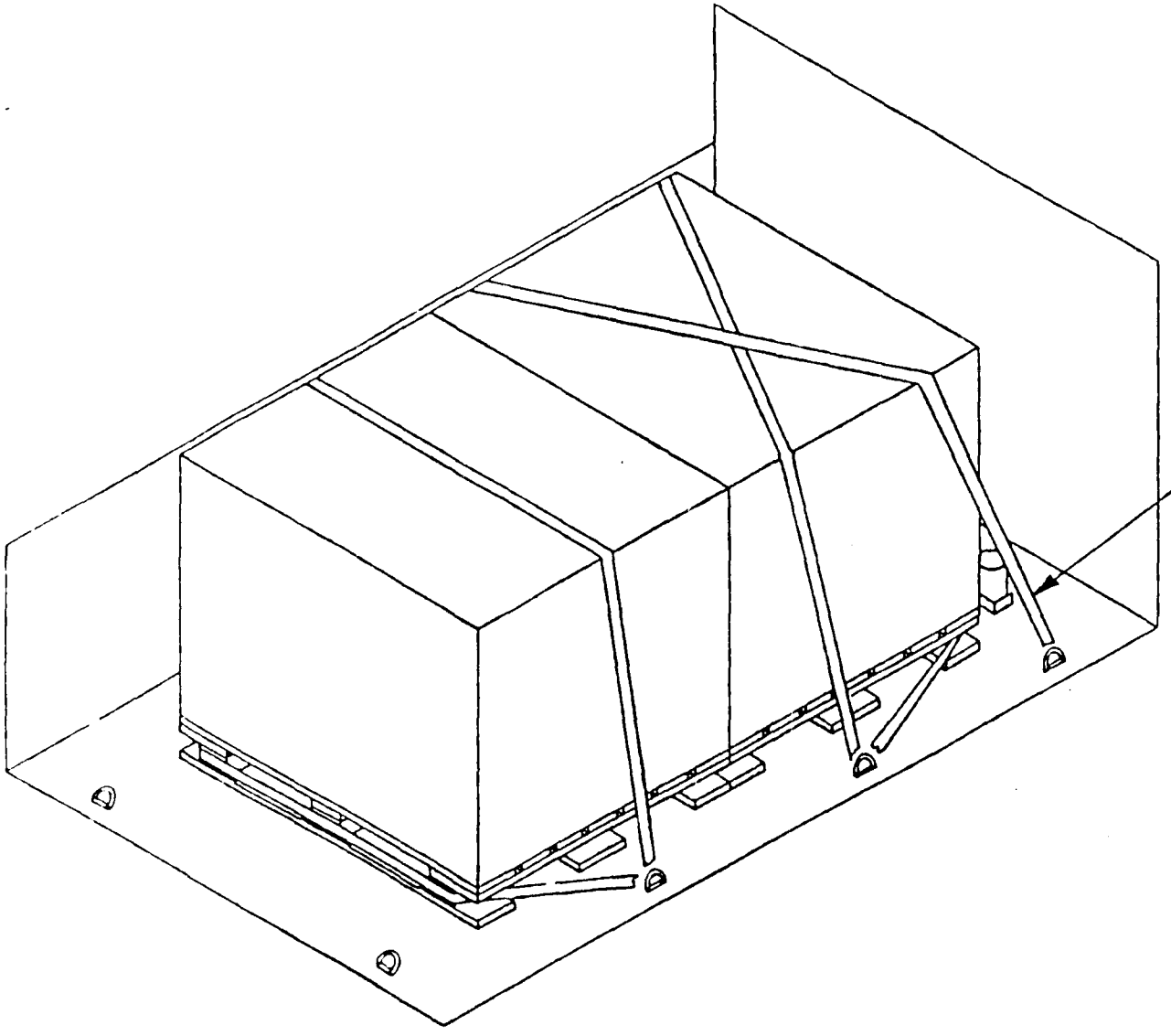
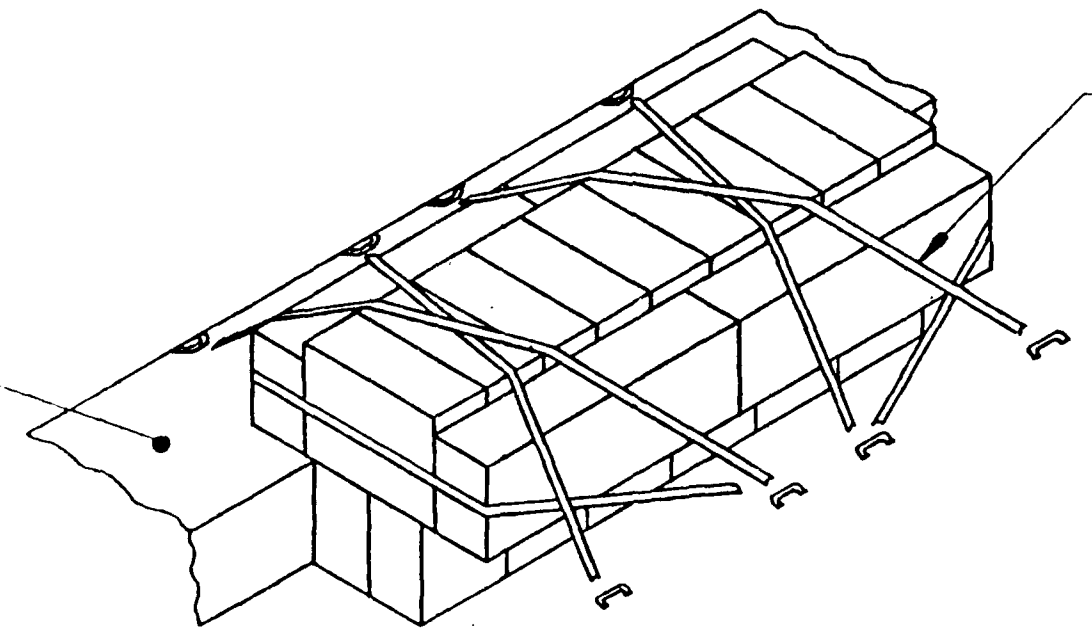

Web Strap Tiedown
Assembly (5 reqd).



TYPICAL LOAD OF UNPALLETIZED BOXES OF 105MM AND OTHER BOXES OF SMALL ARMS AMMUNITION