MASTER

NTO-R-0105

# TEST REPORT

## FOR SHOCK/VIBRATION LOADS ON TEST CAR T-7 WITH A DUMMY REACTOR

NERVA TEST OPERATIONS

Jackass Flats, Nevada

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FOR

SHOCK/VIBRATION LOADS ON TEST CAR-T7

WITH A DUMMY REACTOR

NTO-R-0105

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ADP Operations





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## 1.0 PURPOSE

The purpose of this test was to determine the shock/vibration loads imposed on the reactor during transportation to and from Test Cell "C," Test Cell "A," R-MAD and E-MAD.

## 2.0 INTRODUCTION

The test car shock/vibration load test was performed on January 10 and 11 in accordance with NTO-I-0173. The test was performed using the T-7 Test Car, Dummy Reactor, Spacer Car, Manned Control Car and L-3 Railroad Transport Systems.

## 3.0 DISCUSSION

### 3.1 Instrumentation

The instrumentation for this test consisted of 9 Stathum Model A519-15-350 accelerometers WANL Part #946C 558 H05B. These accelerometers were mounted in triaxial configuration on the plug of the car under the propellant line pass-through, on the lower side of the privy roof near the privy plug pass-through, and on top of the simulated reactor.

The linearity and hysteresis of the units used are as follows:

a. On the plug-vertical .47,transverse, .20, and logitudinal .20% full scale.

b. On the lower side of the privy roof - the vertical .22, transverse .33, and logitudinal .29% full scale.

c. On the simulated reactor vertical .09, transverse .11, and longitudinal .34% of full scale.

These units were calibrated and the oscillograph ranged by rotating the accelerometer 90 and 180$^{\circ}$, giving an effective G-loading of 1 and 2 or plus minus one, dependent on the orientation of the unit. A static calibration of this type gives a true G calibration, corrected for both altitude and latitude. The inherent characteristics of this model accelerometer gives a flat frequency response from 0 to 800 cps at room temperature and a 0 to 200 cycle frequency response under a temperature range of -65 to +250F, with approximately $90^{\circ}$ phase shift occurring at approximately 900 cps. The ranging on the oscillograph was set up to make one inch of galvanometer deflection equal one G.

3.2 Coupling

An attempt was made to couple the Spacer Car to Test Car T-7 without wheel chocks under the Test Car wheels. It was impossible to couple them without wheel chocks as the brake release system on the Test Car release the brakes and allows the car to roll prior to completion of the coupling.

Successful coupling of the Test Car T-7 to the Spacer Car was accomplished by placing wheel chocks under the test car wheels. Accelerations of 0.2G were encountered in the longitudinal direction during the coupling operation.

3.3 Track Tests

Track tests were performed on the trackage between E-MAD and R-MAD including the spur connecting to Test Cell "C". The track tests show that there were no G-loadings imposed onto either the plug section of the T-7 car or the simulated reactor in excess of $\frac{1}{2}$G in any direction during any operation of the RTS (Railroad Transport System).

Figure I shows a typical trace from the oscillograph recorder. Maximum accelerations shown in any direction were approximately 0.2G. Calibration of the transducer was such that one inch of deflection of the galvanometer trace is equal to 1G. The paper speed was 0.1 inches per second and from left to right as follows:

a. Vertical acceleration on the car plug.

b. Lateral acceleration of the car plug.

c. Longitudinal of car plug.

d. Vertical on bottom side of privy roof.

e. Transverse lower side privy roof.

f. Longitudinal lower side privy roof.

g. Vertical upper and simulated reactor.

h. Transverse upper and simulated reactor.

i. Longitudinal upper and simulated reactor.

Figure II has the same trace identity but was taken with a paper speed of one inch per second, train speed of 1.75 miles per hour passing through Switch A. On examination, Figure II shows a marked increase in acceleration in the lateral direction on the car plug. This was caused by slight binding on the front truck of Car T-7 as it passed through a switch and is indicative of side loading imposed when traveling through set switches.

Figure III is a typical trace with the train proceeding 3.5 miles per hour and a paper speed of 10 inches per second. The timing lines were at one inch intervals. The tenth trace shown in this figure was from a galvanometer set up to record train speed. Traces h and i show a random amplitude of .15 to .2G at a low frequency. This was caused by the simulated reactor rocking on the reactor support stand and the long moment arm from the test car supports to the top of the simulated reactor.

Figure IV is a typical track section at 4 miles per hour between Test Cell "A" and R-MAD. Trace 8 shows a low frequency deflection which was also seen to a much lower degree in Trace e. These show a side-to-side movement of the top of the Simulated Reactor and to a lesser degree, a side-to-side motion of the privy roof. They were caused by the rocking of Car T-7 when traveling at moderately high speeds.

Figure V shows, starting at the bottom of the figure, first the train stopped, then a steady acceleration to a speed of 6 miles per hour, a reduction of speed to approximately 3 miles per hour, then an emergency stop using the brakes of the MCC and L-3. Trace c, f, and i also show a deflection to the left with a sharp return to a neutral position--this caused by the deceleration of the train with the slight jolt that always occurs when bringing a rail car to a rapid stop.

Figure VI shows two all train brake stops from approximately four miles per hour.

## 4.0 CONCLUSIONS AND RECOMMENDATIONS

The records taken during this test indicated no acceleration in excess of $\frac{1}{2}$G in any direction at any time. Thus, it is recommended that the system be accepted for transportation of NRX reactors when operated at one and one half to two and one half miles per hour and as specified by the railroad transport operating procedures. During the track test described, it was observed that the instrument cables from the TNT test should be cut closer to the concrete adjacent to the track to prevent these cables from rubbing on the frame of the NRX test car.


FIGURE 1

TYPICAL TRACE AT 1.5 to 2.0 MPH

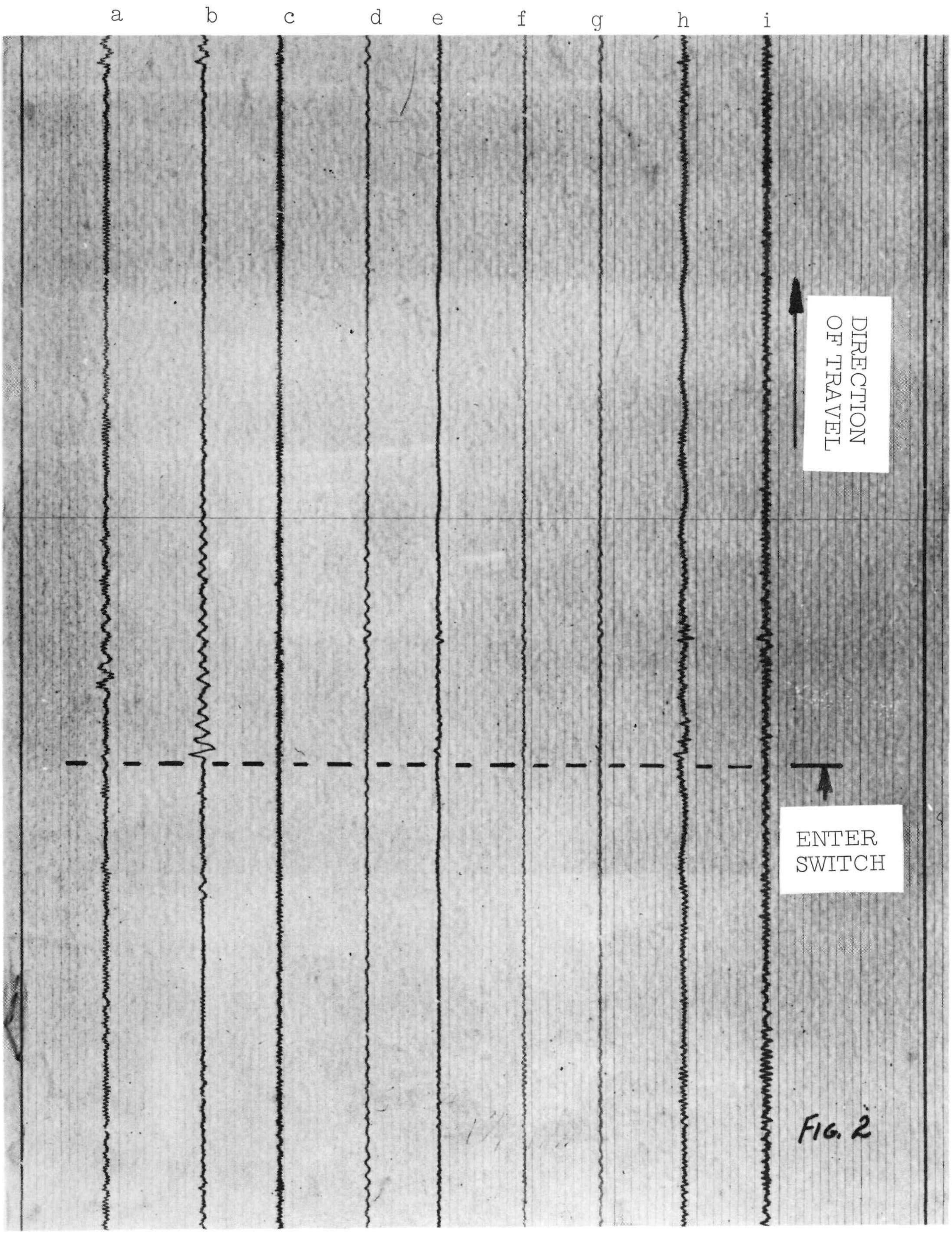


FIGURE 2

TRAVELING THRU SWITCH "A" AT 1.75 MPH

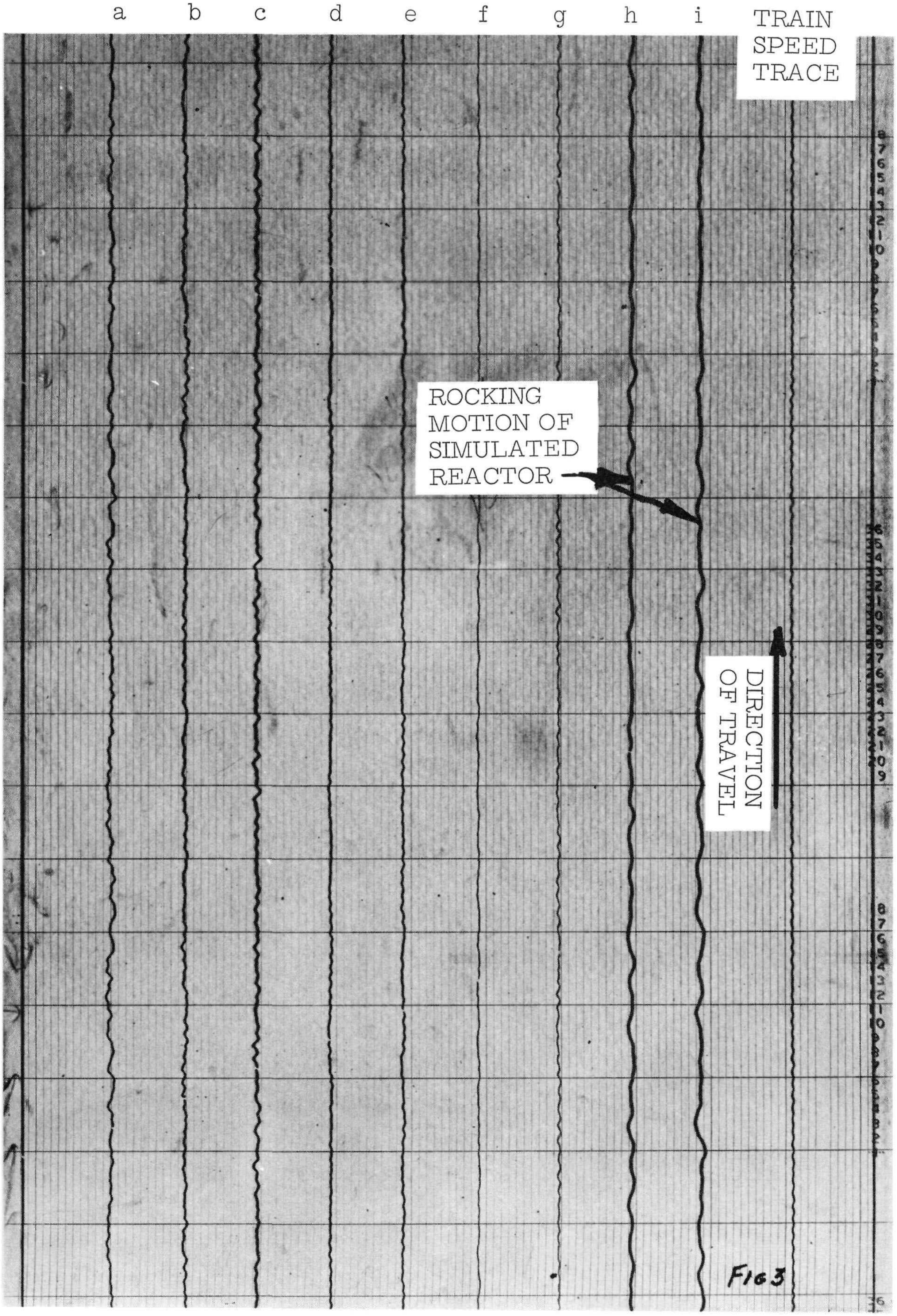


FIGURE 3

TYPICAL TRACE AT 3.5 MPH

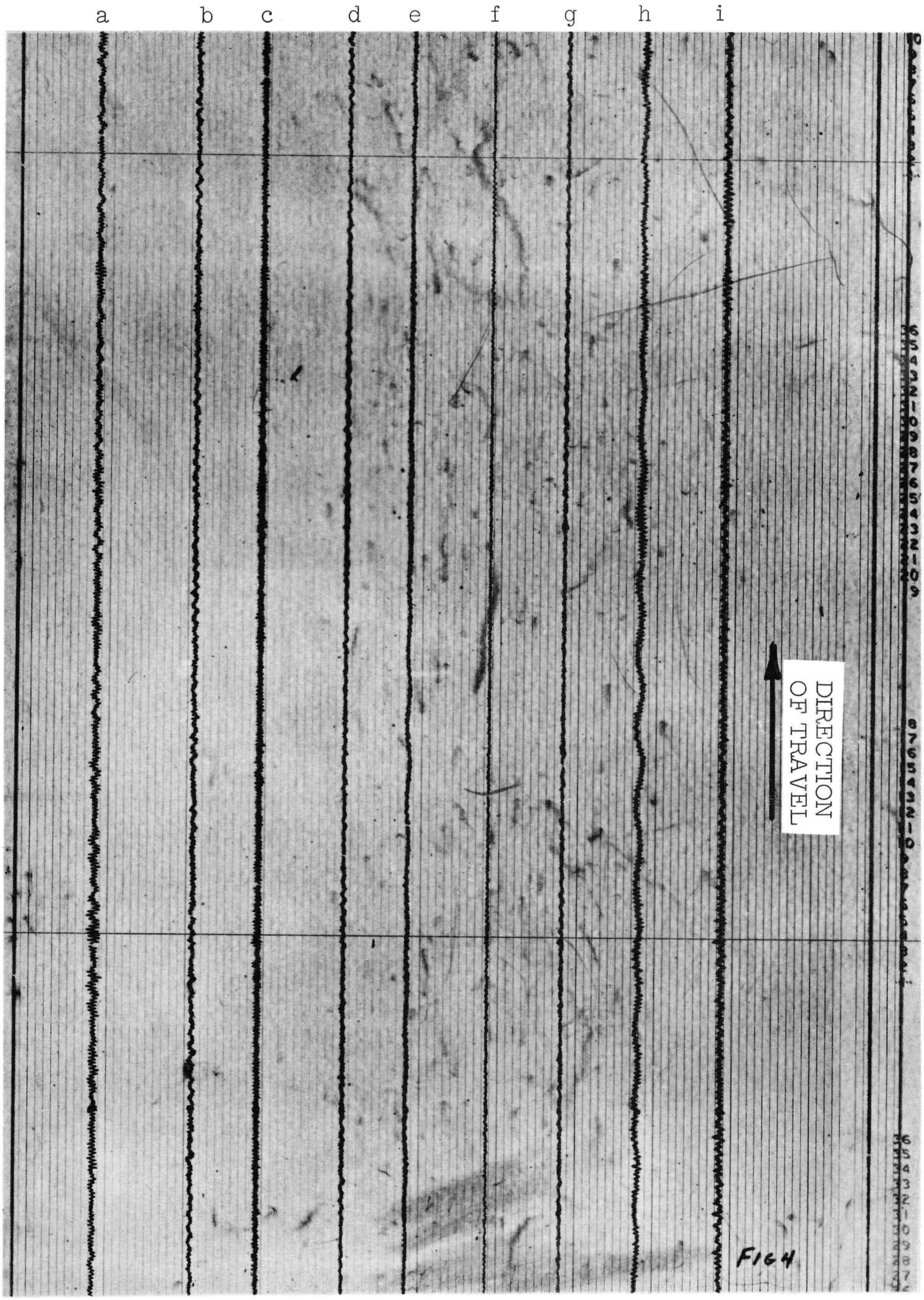


FIGURE 4

TRAVELING AT 4.0 MPH BETWEEN TC"A" AND R-MAD

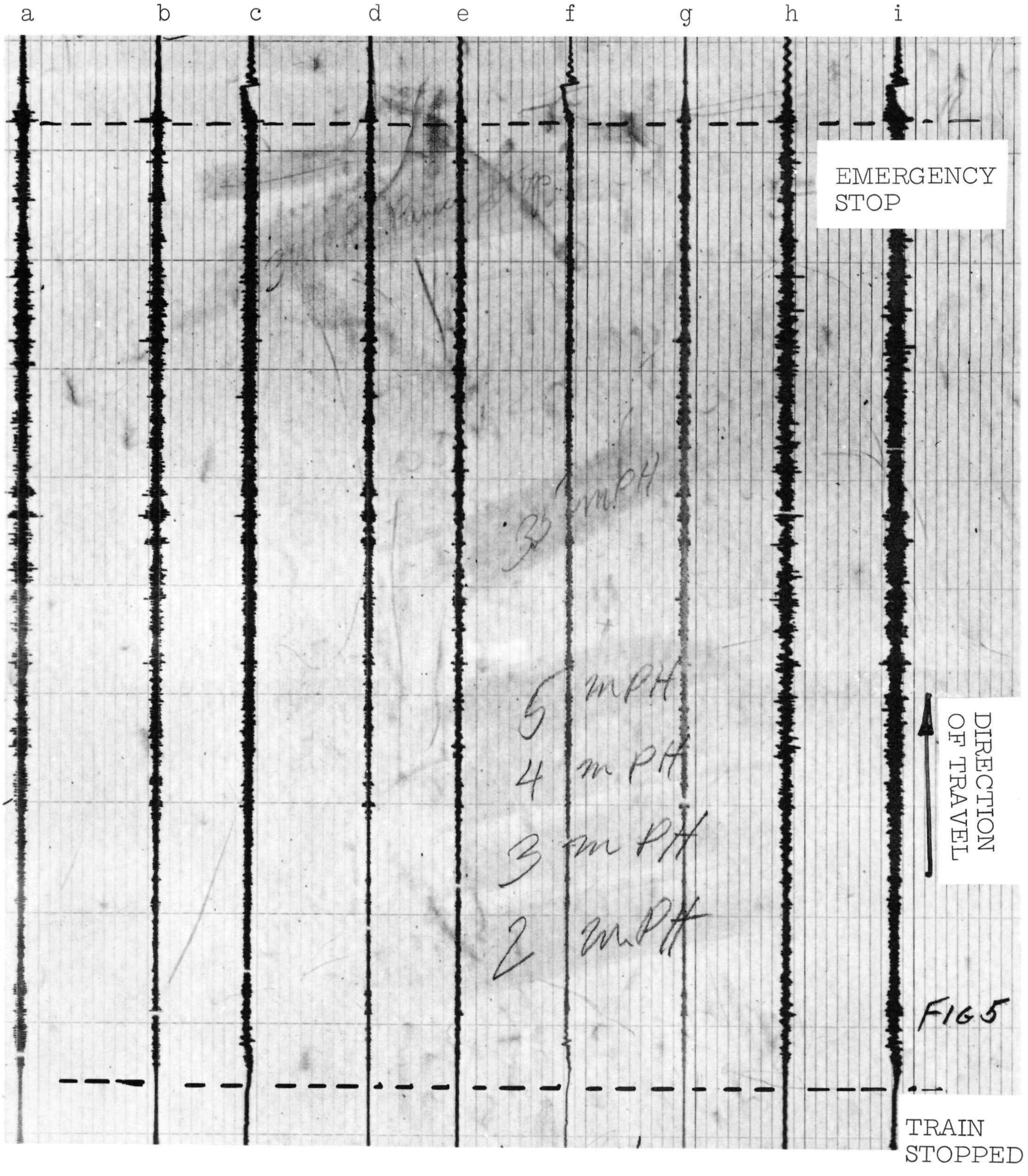


FIGURE 5

EMERGENCY STOP FROM 3 MPH

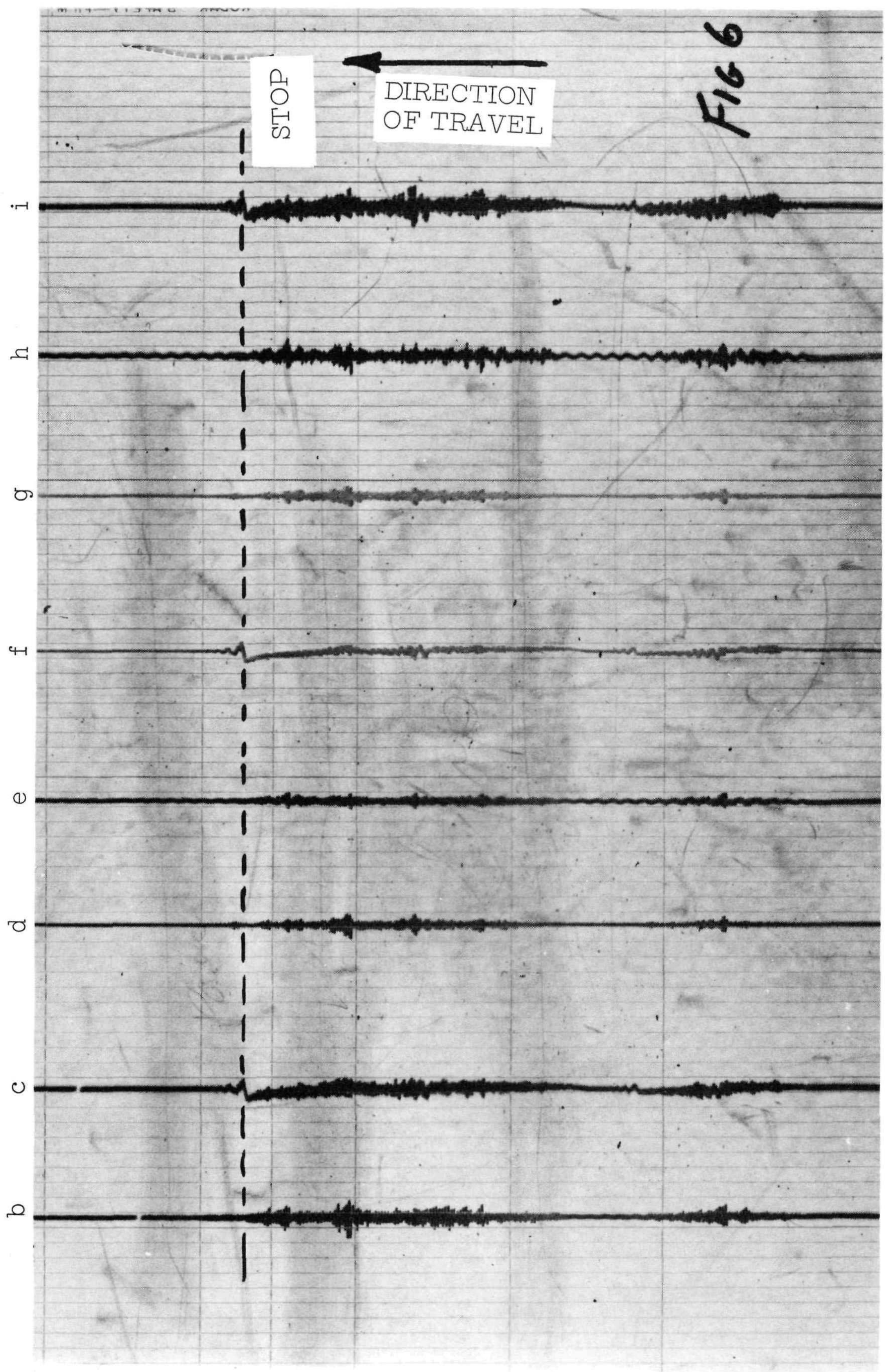


FIGURE 6

ALL TRAIN BRAKE STOP FROM 4 MPH