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Characterization Equipment	Structural Integrity Assessment	Date 11/08/94
Project Title/Work Order		EDT No. 608355
ROLLOVER ANALYSIS OF ROTARY MODE CORE SAMPLER TRUCK #2 (WHC-SD-WM-ER-391, Rev. 0)		ECN No.

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ENGINEERING DATA TRANSMITTAL

1. EDT 608355

2. To: (Receiving Organization)	3. From: (Originating Organization)	4. Related EDT No.:
Characterization Equipment	Structural Integrity Assessment	N/A
5. Proj./Prog./Dept./Div.: Tank Farms	6. Cog. Engr.: H. H. Ziada	7. Purchase Order No.: N/A

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11. Receiver Remarks:

12. Major Assm. Dwg. No.: H-2-140300

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(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	(F) Impact Level	(G) Reason for Transmittal	(H) Originator Disposition	(I) Receiver Disposition
1	WHC-SD-WM-ER-391		0	ROLLOVER ANALYSIS OF ROTARY MODE CORE SAMPLER TRUCK #2	Q	1	1	

16. KEY

Impact Level (F)	Reason for Transmittal (G)	Disposition (H) & (I)
1, 2, 3, or 4 (see MRP 5.43)	1. Approval 2. Release 3. Information 4. Review 5. Post-Review 6. Dist. (Receipt Acknow. Required)	1. Approved 2. Approved w/comment 3. Disapproved w/comment 4. Reviewed no/comment 5. Reviewed w/comment 6. Receipt acknowledged

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1	1	Cog.Eng. H. H. Ziada	[signature]	11-8-94	H5-52						
1	1	Cog. Mgr. K. V. Scott	[signature]	11-8-94	H5-52						
1	1	QA J. J. Verderber	[signature]	11/22/94	S1-57						
1	1	Safety J. L. Smalley	J L Smalley	11/15/94	R1-17						
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RELEASE AUTHORIZATION

Document Number:	WHC-SD-WM-ER-391, REV. 0
Document Title:	Rollover Analysis of Rotary Mode Core Sampler Truck #2
Release Date:	12/06/94

This document was reviewed following the procedures described in WHC-CM-3-4 and is:

APPROVED FOR PUBLIC RELEASE

WHC Information Release Administration Specialist:

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SUPPORTING DOCUMENT

1. Total Pages 26 28

2. Title	3. Number	4. Rev No.
Rollover Analysis of Rotary Mode Core Sampler Truck #2	WHC-SD-WM-ER-391	0

5. Key Words	6. Author
Sampler truck, limiting speed, truck stability, rollover analysis	Name: H. H. Ziada Hassan H. Ziada Signature Organization/Charge Code 7E650/N4XB1

7. Abstract

This document provides estimate of limiting speed and rollover analysis of rotary mode core sampler truck #2 (RMCST#2).

8. RELEASE STAMP

CONTENTS

ROLLOVER ANALYSIS OF ROTARY MODE CORE SAMPLER TRUCK #2

1.0 INTRODUCTION

This report documents a rollover analysis to estimate a limiting speed for the rotary mode core sampler truck (RMCST) number 2 on most paved Hanford roadways. The analysis also estimates the minimum turning radius of curvature for vehicle turnover for three different bank angles at selected speeds. In addition, the analysis addresses the rollover stability for the truck on the jacks, if the jacks are not actuated simultaneously.

The analysis used the transportation loading requirements defined by the Fast Flux Test Facility (FFTF) (WEC 1972). These loads were used in the analysis of the grapple hoist mounting support assembly of truck #2 (WHC 1993).

The analysis to estimate a speed limit for the RMCST appears in Appendix A. Appendix B contains the minimum radius of curvature for vehicle turnover. Appendix C presents the rollover stability of the truck on the jacks.

2.0 CONCLUSIONS AND RECOMMENDATIONS

Results of the analysis indicate that a maximum speed of 15 mi/h is acceptable on most paved Hanford roadways. However, safe vehicle speeds vary with road curvature, road conditions, and weather conditions. Driver judgement should be the major safeguard against vehicle rollover.

The transportation acceleration loads at 15 mi/h speed were estimated to be 0.42 *g* longitudinal, 0.37 *g* lateral and 0.18 *g* vertical.

The minimum radius of curvature for vehicle turn over is given in Table 1 for three different bank angles at three selected speeds and including lateral acceleration of 0.37 *g*.

The truck will not roll over if the jacks are not actuated simultaneously.

It is difficult to recommend a safe maximum vehicle speed during off-road use because of the uncertainties about the terrain conditions the vehicle will encounter. The vehicle should be operated at a slower speeds during off-road use, as determined by the particular roadway. To suggest a safe maximum speed might give the driver a false sense of security. There is no substitute for the driver's own judgement under rough off-road conditions.

Actual measurements should be obtained for the transportation accelerations of the truck on Hanford off-roads. The actual accelerations should be used in the dynamic analysis of the truck components instead of the estimated values.

3.0 CONFIGURATION AND LOADS

Figure 1 shows the overall configuration of the truck and the primary dimensions relevant to the rollover analysis.

Table 1 shows the weight distributions of all items including the Ford chassis on RMCST #2 (WHC 1994a). The reference point for these items is the center of the rotating platform in the x-y direction (+ x toward cab, + y toward driver's side) and the top of the truck chassis in the z direction. The configuration in Table 1 assumes the drill rig to be centered on the rotating platform and the shielded receiver to be in the lowered position.

The truck will be subjected to its own weight plus all the components mounted on the truck in addition to transportation acceleration loads. The total weight of the truck is 28,500 lbf. The truck shock acceleration loads applied are consistent with those used in WHC 1993 and are obtained from WEC 1972. Table 2 lists typical acceleration criteria for truck-bed shipping loads (WEC 1972, ANSI 1980).

4.0 ANALYSIS AND RESULTS

Three rollover stability analyses were performed: (1) a rollover analysis to estimate the limiting speed of the RMCST during transportation; (2) an analysis to estimate the minimum turning radius of curvature to prevent truck turnover for different bank angles and speeds; (3) an analysis to determine the rollover stability of the truck on the jacks, if the jacks are not actuated simultaneously.

4.1 LIMITING SPEED

This analysis includes a rollover evaluation in the longitudinal and lateral direction to determine the limiting accelerations in both directions to prevent truck tip over. The analysis appears in Appendix A.

The truck speed was limited to 35 mi/h on highways and paved roadways. The limiting speed was estimated by ratioing down the truck speed on the paved roadways by the square root of the ratio of one-half of the determined limiting acceleration to the transportation acceleration

$$(i.e., V\ limiting = 35\sqrt{\frac{g\ limiting/2}{g\ transportation}}).$$

The analysis yields an average limiting speed of 15 mi/h associated with lateral and longitudinal transportation accelerations of 0.37 *g* and 0.43 *g*, respectively.

4.2 MINIMUM RADIUS OF CURVATURE

This analysis evaluates the stability of the truck during turning. The analysis results provide a minimum radius of curvature of turn to prevent vehicle turnover for three difference bank angles (0, -3, -10 deg) at three selected speeds (15, 12, 9 mi/h). Table 3 summarizes the results, and Appendix B contains the analysis details. The table includes the results with and without the lateral transportation acceleration of 0.37 *g*.

The 15 mi/h speed was based on highway and paved road conditions. However, it is important to realize that because not all paved roadways at Hanford are considered highways, they are not constructed according to the criteria in Table 2. It is difficult to predict what conditions the vehicle may encounter during off-road driving. Slope and roughness of the roadways vary considerably across the Hanford Site. Driving over a large rock or a high spot in the road at precisely the wrong moment can overturn the vehicle. A -10-deg bank angle was chosen as an extreme case in an attempt to compensate for uncertainties in the condition of the roadway. A positive bank angle represents a sloped roadway similar to that of a turn on a closed-loop racetrack. Bank angles of 0 and -3 deg are included for comparison. In addition, the truck body leans (tilts) in turns. For conservatism, a tilt angle of 10 deg was assumed in the analysis. This angle is measured with respect to the perpendicular to the road surface.

Results given in Table 3 indicate that the truck will roll over before skidding at all operating conditions examined on either wet or dry pavement. The coefficient of static friction between a tire and the pavement is 0.7 and 0.8 for wet and dry pavement, respectively. The coefficient of static friction between a tire and macadam (compacted crushed stone) is approximately 0.67. Thus, the truck will roll over before skidding in all cases examined.

4.3 ROLLOVER ON JACKS

This analysis investigates the possibility of truck roll over if the jacks are not actuated simultaneously. The calculations assumed the center jacks are not extended. Both lateral and longitudinal rollover were evaluated. The calculations appear in Appendix C. The results of the analysis show that the truck will not roll over if the jacks are not actuated simultaneously.

5.0 REFERENCES

ANSI, 1980, *Draft American National Standard; Design Basis for Resistance to Shock and Vibration of Radioactive Material Packages Greater than One Ton in Truck Transport*, N14.23, American National Standards Institute, Inc., New York, New York.

WEC, 1972, *FTR Reactor Guard Vessel, Rev. 4*, HWS-1505, Westinghouse Electric Corporation, Advanced Reactors Division, Madison, Pennsylvania.

WHC, 1993, Internal Memo, D. A. Koehler to J. C. Mast, *Stress Evaluation for Grapple Hoist Mounting Support Assembly (Truck #2)*, CSA:DAK:ggb:93/10, Westinghouse Hanford Company, Richland, Washington.

WHC, 1994a, Internal Memo, J. L. Smalley to K. V. Scott, *Request Stress Analysis be Performed to Support the Design Basis on the Rotary Mode Core Sampler Truck #2 (RMCST #2)*, #9456856, Westinghouse Hanford Company, Richland, Washington.

WHC, 1994b, *Core Sampler Truck #2 Assembly*, drawing number H-2-140300, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

FIGURE 1: Core Sampler Truck #2 Assembly.
(Dwg. H-2-140300, WHC 1994b)

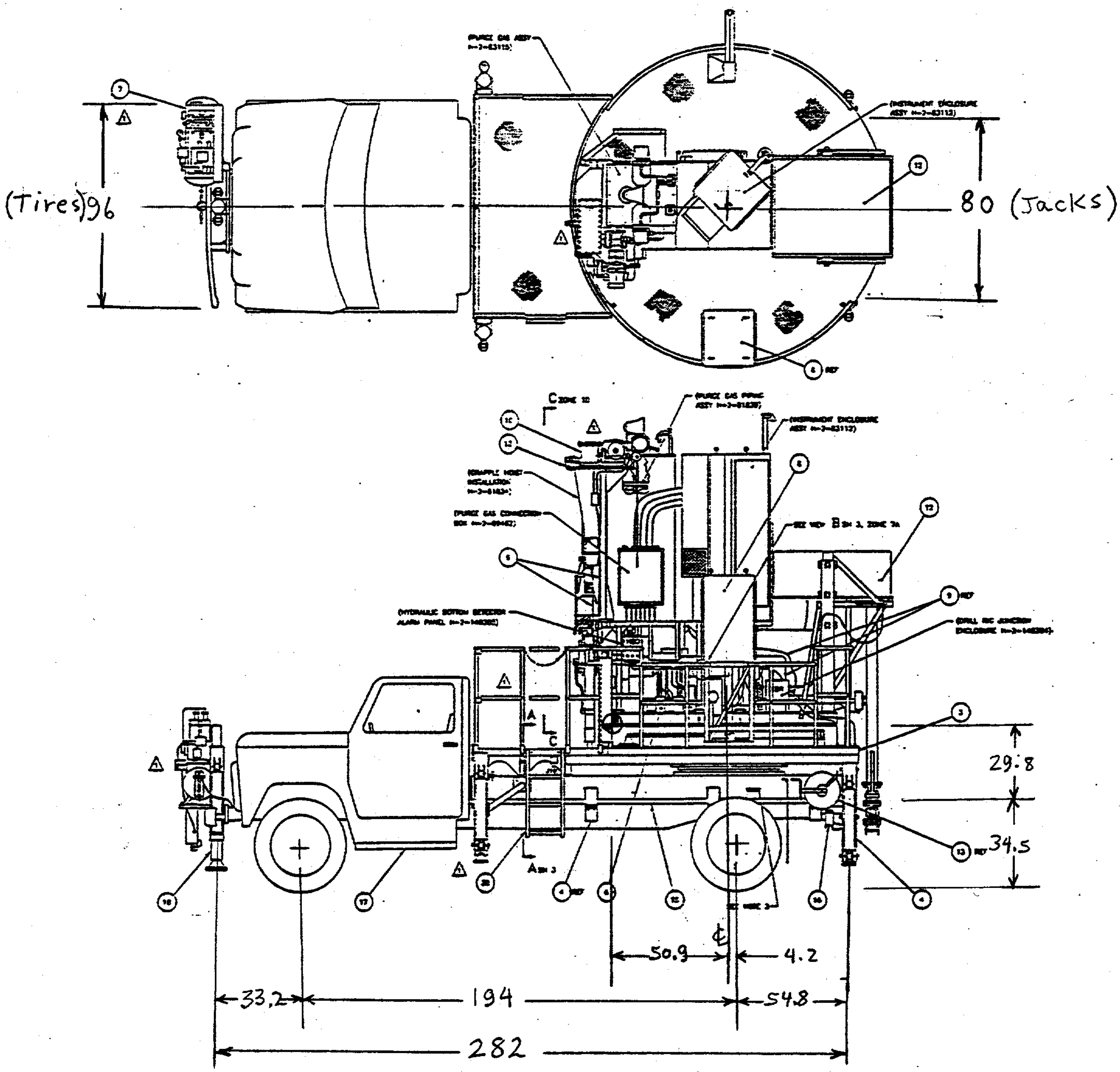


Table 1: Weight Distribution of All Items of Rotary Mode Core Sampler Truck #2.

Item	Weight lbs	Forward[1] (x) in.	Sideways[1] (y) in.	Vertical[2] (z) in.
Rear jacks	632	-59	0	-4
Front jacks	421	217	0	-4
Total of items above chassis	18704	18.56	-0.48	47.48
Truck chassis	8743	120	0	-4
Total	28500	50.93	-0.31	29.78

(1) Distance from center of the rotating platform, + x towards cab and + y toward drivers side.

(2) Distance from the top of the truck chassis.

NOTE: The distance from the ground to the top of the truck chassis is 34.5 in.

Table 2: Design Shock Acceleration Criteria of Bed of Truck (*g*-loads).

Reference	Longitudinal	Lateral	Vertical
WEC 1972[1]	3	2	1 superimposed to *g*
ANSI 1980[2] spring-mounted	2.3	1.6	2 down, 3.5 up
ANSI 1980[2] air-suspended	1.8	1.1	1.5 down, 2 up

(1) Values used in the analysis.

(2) For comparison purposes.

Table 3: Results of Minimum Radius of Curvature of Turn.

Vehicle Speed (mi/h)	Bank Angle (deg)	Minimum Radius[1] (ft)	Minimum Radius[1] (ft) (including 0.37 *g*)	Static Coefficient of Friction[2] μ
15	-10	35	242	.66
	-3	26	70	.66
	0	23	52	.66
12	-10	22	155	.66
	-3	16	45	.66
	0	15	33	.66
9	-10	13	87	.66
	-3	9	25	.66
	0	8	19	.66

[1]Minimum radius of curvature of turn. Vehicle will rollover attempting a sharper turn.

[2]Minimum required coefficient of static friction between tires and roadway. The minimum required coefficient of static friction must be less than the coefficient of static friction between a tire and road surface for no skidding (typical coefficients of static friction between a tire and road ranges between 0.67 and 0.80).

CHECKLIST FOR APPENDIX A - INDEPENDENT REVIEW

Document Reviewed ROLLOVER ANALYSIS OF ROTARY MODE CORE SAMPLER TRUCK #2

Author H. H. Ziada Document No. WHC-SD-WM-ER-391, Rev. 0

Yes	No	N/A	
[✓]	[ ]	[ ]	Problem completely defined.
[✓]	[ ]	[ ]	Necessary assumptions explicitly stated and supported.
[ ]	[ ]	[✓]	Computer codes and data files documented.
[✓]	[ ]	[ ]	Data used in calculations explicitly stated in document.
[✓]	[ ]	[ ]	Data checked for consistency with original source information as applicable.
[✓]	[ ]	[ ]	Mathematical derivations checked including dimensional consistency of results.
[✓]	[ ]	[ ]	Models appropriate and used within range of validity or use outside range of established validity justified.
[✓]	[ ]	[ ]	Hand calculations checked for errors.
[ ]	[ ]	[✓]	Code run streams correct and consistent with analysis documentation.
[ ]	[ ]	[✓]	Code output consistent with input and with results reported in analysis documentation.
[✓]	[ ]	[ ]	Acceptability limits on analytical results applicable and supported. Limits checked against sources.
[✓]	[ ]	[ ]	Safety margins consistent with good engineering practices.
[✓]	[ ]	[ ]	Conclusions consistent with analytical results and applicable limits.
[✓]	[ ]	[ ]	Results and conclusions address all points required in the problem statement.

MANDATORY Software QA Log Number N/A

DA Koehler [signature]
Reviewer

11-7-94
Date

APPENDIX A

LIMITING SPEED ESTIMATION

(1) Drawing H-2-140300 (2) Doc. No. ______ (3) Page 1 of 4
(4) Building ______ (5) Rev. ______ (6) Job No. ______
(7) Subject Sampler Truck #2
(8) Originator H. H. Zieda Date 10-28-94
(9) Checker DA Koehler [signature] Date 11-7-94

(10)

LIMITING SPEED

1.0 INTRODUCTION

This appendix estimates a limiting speed for the rotary mode core sampler truck (RMCST) number 2.

The limiting speed was derived from a rollover evaluation in the longitudinal and lateral direction to determine the limiting accelerations in both directions to prevent truck tipover.

The limiting speed was estimated by rationing down the truck speed on the paved roadways by the square root of the ratio of the determined limiting acceleration to the transportation acceleration (i.e, $V_{limiting} = V_{roadways} \sqrt{\frac{g_{limiting}}{g_{transport}}}$).

The truck speed was originally limited to 35 mi/h on highways and paved roadways.

The analysis used the transportation loading requirements defined by the Fast Flux Test Facility (WEC 1972) (i.e. 2 g lateral, 3 g longitudinal, and 1 g vertical).

(1) Drawing ~~H-2-140300~~ (2) Doc. No. (3) Page 2 of 4
(4) Building (5) Rev. (6) Job No.
(7) Subject Sampler Truck #2
(8) Originator Hassan H. Tieda Date 10-28-94
(9) Checker DA Koehler Duane Koehler Date 11-7-94

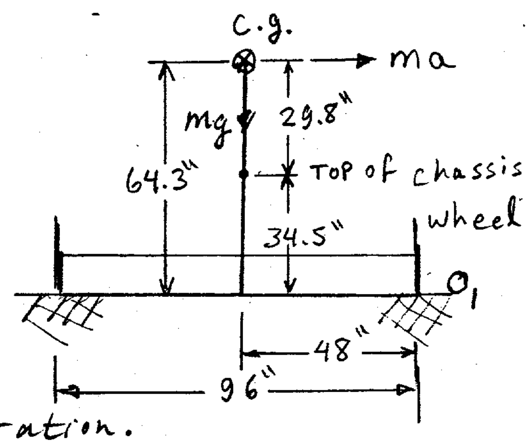
(10) In addition, the ANSI 1980 acceleration criteria for truck-bed shipping loads (i.e., 1.6 g lateral and 2.3 g longitudinal) were used for comparison.

2.0 LIMITING LATERAL ACCELERATION

Tipover at O_1:

$$64.3\, m a = 48\, m g$$

$$a = \frac{48}{64.3} g = 0.746\, g$$



Apply a factor of safety of 2 on the lateral acceleration.

$$a = 0.37\, g$$

Assume a is proportional to v^2 (engineering judgement). Speed limit of truck on paved roadways is 35 mi/h.

$$\text{Limiting speed } (V_{limiting}) = 35 \sqrt{\frac{0.37}{g_{ransportation}}}$$

For FFTF criteria (WEC 1974),

$$V_{limiting} = 35 \sqrt{\frac{0.37}{2}} = 15.00 \text{ mi/hr}$$

DESIGN CALCULATION

(1) Drawing H-2-14 0300 (2) Doc. No. ______ (3) Page 3 of 4
(4) Building ______ (5) Rev. ______ (6) Job No. ______
(7) Subject Sampler Truck #2
(8) Originator Hassan H. Zia[signature] Date 10-28-94
(9) Checker DA Koehler [signature] Date 11-7-94

(10) For ANSI criteria (ANSI 1980),

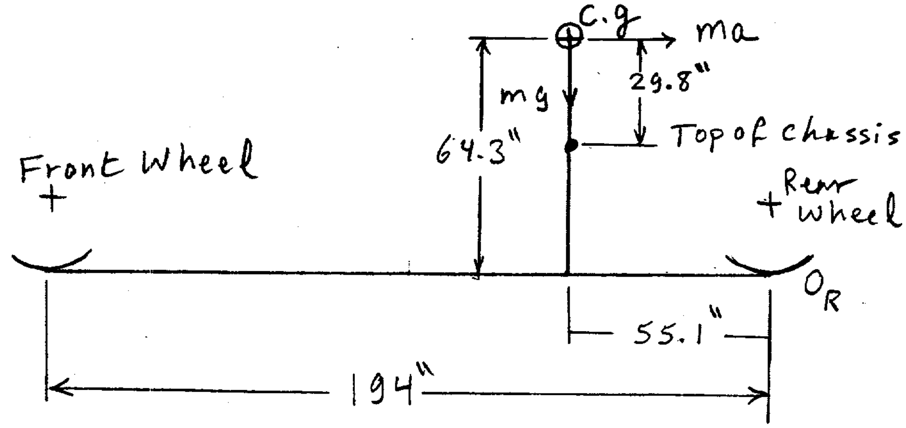
$$V_{limiting} = 35\sqrt{\frac{0.37}{1.6}} = 16.8 \text{ mi/hr}$$

3.0 LIMITING LONGITUDINAL ACCln.

Tipover at O_R:

$64.3\, ma = 55.1\, mg$

$a = \frac{55.1}{64.3} g = 0.857 g$



Apply a factor of safety of 2 on longitudinal acceleration.

$a = 0.43\, g$

For FFTF criteria (WEC 1974),

$$V_{limiting} = 35\sqrt{\frac{0.43}{3}} = 13.25 \text{ mi/h}$$

For ANSI criteria (ANSI 1980),

$$V_{limiting} = 35\sqrt{\frac{0.43}{2.3}} = 15.13 \text{ mi/h}$$

BD-6400-060.1 (12/87)

DESIGN CALCULATION

(1) Drawing H-2-140300 (2) Doc. No. ______ (3) Page 4 of 4
(4) Building ______ (5) Rev. ______ (6) Job No. ______
(7) Subject Sampler Truck #2
(8) Originator Hasen H. Ziada Date 10-28-94
(9) Checker DA Koehler Diane Koehler Date 11-7-94

(10)

4.0 RESULTS AND RECOMMENDATIONS

From the foregoing calculations, an average speed limit of 15 mi/hr was judged to be a reasonable estimate for the sampler truck on most paved Hanford roadways. However, safe vehicle speeds vary with road conditions, and weather conditions. To suggest a safe maximum speed might give the driver a false sense of security. There is no substitute for the driver's own judgement under rough off-road conditions.

Actual measurements should be obtained for the transportation accelerations of the truck on Hanford off-roads. The actual accelerations should be used in the dynamic analysis of the truck components instead of the estimated values.

BD-6400-060.1 (12/87)

CHECKLIST FOR APPENDIX B - INDEPENDENT REVIEW

Document Reviewed ROLLOVER ANALYSIS OF ROTARY MODE CORE SAMPLER TRUCK #2

Author D. A. Koehler   Document No. WHC-SD-WM-ER-391, Rev. 0

Yes	No	N/A	
[✓]	[ ]	[ ]	Problem completely defined.
[✓]	[ ]	[ ]	Necessary assumptions explicitly stated and supported.
[ ]	[ ]	[✓]	Computer codes and data files documented.
[✓]	[ ]	[ ]	Data used in calculations explicitly stated in document.
[✓]	[ ]	[ ]	Data checked for consistency with original source information as applicable.
[✓]	[ ]	[ ]	Mathematical derivations checked including dimensional consistency of results.
[✓]	[ ]	[ ]	Models appropriate and used within range of validity or use outside range of established validity justified.
[✓]	[ ]	[ ]	Hand calculations checked for errors.
[ ]	[ ]	[✓]	Code run streams correct and consistent with analysis documentation.
[ ]	[ ]	[✓]	Code output consistent with input and with results reported in analysis documentation.
[✓]	[ ]	[ ]	Acceptability limits on analytical results applicable and supported. Limits checked against sources.
[✓]	[ ]	[ ]	Safety margins consistent with good engineering practices.
[✓]	[ ]	[ ]	Conclusions consistent with analytical results and applicable limits.
[✓]	[ ]	[ ]	Results and conclusions address all points required in the problem statement.

MANDATORY   Software QA Log Number N/A

Harold H. Ziada
Reviewer

11-7-94
Date

APPENDIX B

EVALUATION OF MINIMUM RADIUS OF CURVATURE FOR TRUCK #2 TURNOVER

DESIGN CALCULATION

(1) Drawing H-2-140300 (2) Doc. No. ______ (3) Page 1 of ____
(4) Building ______ (5) Rev. ______ (6) Job No. ______
(7) Subject Core Sample Truck No. 2 Rollover Analysis
(8) Originator Duane A. Koehler *Duane Koehler* Date 10/10/94
(9) Checker *[signature]* Date 11-4-94

Relevant Dimensions.

Bank Angle of Road. A positive angle represents a bank angle similar to a sharp turn on a racetrack.

$\alpha_1 := -10$ deg

$\alpha := \alpha_1 \cdot \frac{\pi}{180}$ $\alpha = -0.175$ radians

Body Roll. This is the angle the body leans entering a turn. It is measured with respect to the perpendicular to the road surface.

$\beta_1 := 10$ deg

$\beta := \beta_1 \cdot \frac{\pi}{180}$ $\beta = 0.175$ radians

Height of leaf spring above road surface. This is assumed to be the pivot of the body with the chassis.

$l := 29.8$ inches

Height of c.g. of truck above the body/chassis pivot point (l).

$d := 34.5$ inches

Distance from center of truck to outside tire.

$k := 48$ inches

Coordinates of Relevant Points (inches).

$A_x := k \cdot \cos(\alpha)$ $A_y := k \cdot \sin(\alpha)$

$B_x := -l \cdot \sin(\alpha)$ $B_y := l \cdot \cos(\alpha)$

$C_x := d \cdot \sin(\beta - \alpha) + B_x$ $C_y := d \cdot \cos(\beta - \alpha) + B_y$

where

A - Outside tire
B - Body/chassis pivot
C - c.g. of truck

(1) Drawing ______ (2) Doc. No. ______ (3) Page 2 of ____

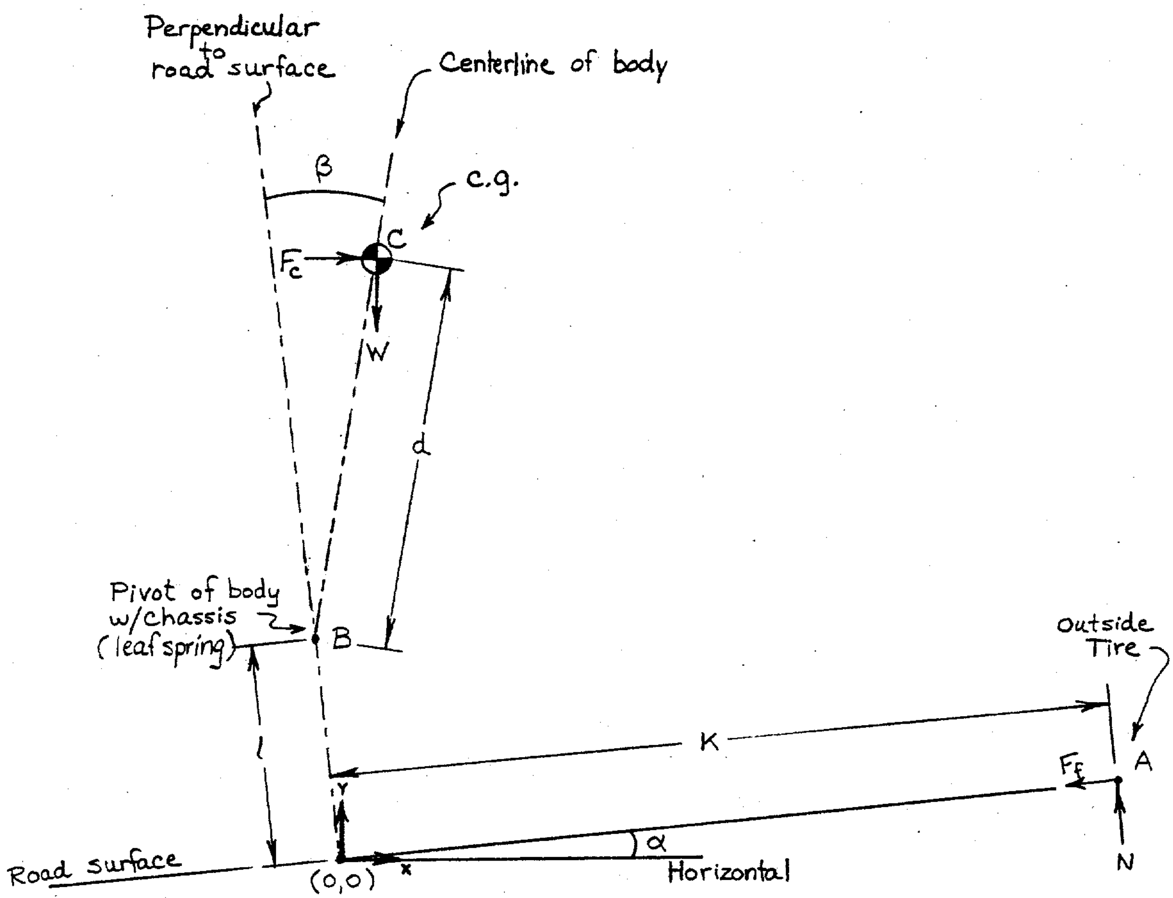
(4) Building ______ (5) Rev. ______ (6) Job No. ______

(7) Subject Core Sample Truck No. 2 Rollover Analysis

(8) Originator Duane A. Koehler [signature] Date 10/10/94

(9) Checker [signature] Date 11-4-94

(10)



Free Body Diagram with Relevant Point Locations

DESIGN CALCULATION

(1) Drawing ____ (2) Doc. No. ____ (3) Page 3 of ____
(4) Building ____ (5) Rev. ____ (6) Job No. ____
(7) Subject Core Sample Truck No. 2 Rollover Analysis
(8) Originator Duane A. Koehler *Duane Koehler* Date 10/10/94
(9) Checker *Hassan H. Ziada* Date 11-4-94

Weight of Truck.

$W := 28500$ lbf

Gravitational Acceleration.

$g := 32.2$ ft/sec^2

Speed of Truck.

$v_1 := 12$ mph

$v := v_1 \cdot \frac{5280}{3600}$ ft/sec

Moment Arms of Individual Forces About Pt A (Outside Tire).

Force	Moment Arm (inches)
W	$M_1 := \lvert C_x - A_x \rvert$
F_c	$M_2 := \lvert C_y - A_y \rvert$

where

W - weight of truck
F_c - lateral force on truck c.g. = 0.37W

Radius of Turn (initial guess). This is the minimum radius the truck can turn and not rollover; a sharper turn at the same speed will cause the truck to rollover.

$r := 200$ feet

Summation of Moments About Pt A (Outside Tire). A net negative moment (defined as clockwise) signifies impending rollover.

Given

$$W \cdot M_1 - \frac{W}{g} \cdot \frac{v^2}{r} \cdot M_2 - 0.37 \cdot W \cdot M_2 = 0$$

$r := \text{Find}(r)$

$r = 154.718$ feet

DESIGN CALCULATION

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(9) Checker *Hassan H. Zieh* Date *11-4-94*

Normal Force on Outside Tires.

$$N := \frac{W}{g} \cdot \frac{v^2}{r} \cdot \sin(\alpha) + W \cdot \cos(\alpha) + 0.37 \cdot W \cdot \sin(\alpha) \qquad N = 25928 \text{ lbf}$$

Frictional Force on Outside Tires.

$$F_f := \frac{W}{g} \cdot \frac{v^2}{r} \cdot \cos(\alpha) - W \cdot \sin(\alpha) + 0.37 \cdot W \cdot \cos(\alpha) \qquad F_f = 17079 \text{ lbf}$$

Friction Coefficient. This is the required coefficient of friction between the tires and road surface under the particular cornering condition. If this number is higher than the actual coefficient of friction, the truck will skid before it rolls over.

$$\mu := \frac{F_f}{N} \qquad \mu = 0.659$$

Table 3: Results of Minimum Radius of Curvature of Turn.

Vehicle Speed (mi/h)	Bank Angle (deg)	Minimum Radius[1] (ft)	Minimum Radius[1] (ft) (including 0.37 *g*)	Static Coefficient of Friction[2] μ
15	-10	35	242	.66
	-3	26	70	.66
	0	23	52	.66
12	-10	22	155	.66
	-3	16	45	.66
	0	15	33	.66
9	-10	13	87	.66
	-3	9	25	.66
	0	8	19	.66

[1]Minimum radius of curvature of turn. Vehicle will rollover attempting a sharper turn.

[2]Minimum required coefficient of static friction between tires and roadway. The minimum required coefficient of static friction must be less than the coefficient of static friction between a tire and road surface for no skidding (typical coefficients of static friction between a tire and road ranges between 0.67 and 0.80).

CHECKLIST FOR APPENDIX C - INDEPENDENT REVIEW

Document Reviewed ROLLOVER ANALYSIS OF ROTARY MODE CORE SAMPLER TRUCK #2

Author D. A. Koehler   Document No. WHC-SD-WM-ER-391, Rev. 0

Yes	No	N/A	
[✓]	[ ]	[ ]	Problem completely defined.
[✓]	[ ]	[ ]	Necessary assumptions explicitly stated and supported.
[ ]	[ ]	[✓]	Computer codes and data files documented.
[✓]	[ ]	[ ]	Data used in calculations explicitly stated in document.
[✓]	[ ]	[ ]	Data checked for consistency with original source information as applicable.
[✓]	[ ]	[ ]	Mathematical derivations checked including dimensional consistency of results.
[✓]	[ ]	[ ]	Models appropriate and used within range of validity or use outside range of established validity justified.
[✓]	[ ]	[ ]	Hand calculations checked for errors.
[ ]	[ ]	[✓]	Code run streams correct and consistent with analysis documentation.
[ ]	[ ]	[✓]	Code output consistent with input and with results reported in analysis documentation.
[✓]	[ ]	[ ]	Acceptability limits on analytical results applicable and supported. Limits checked against sources.
[✓]	[ ]	[ ]	Safety margins consistent with good engineering practices.
[✓]	[ ]	[ ]	Conclusions consistent with analytical results and applicable limits.
[✓]	[ ]	[ ]	Results and conclusions address all points required in the problem statement.

MANDATORY   Software QA Log Number N/A

Hassan H. Zinda
Reviewer

11-7-94
Date

APPENDIX C

ROLLOVER STABILITY OF TRUCK #2 ON THE JACKS

(1) Drawing H-2-140300 (2) Doc. No. ______ (3) Page 1 of 3
(4) Building ______ (5) Rev. ______ (6) Job No. ______
(7) Subject Core Sample Truck No. 2 Rollover Analysis
(8) Originator Duane A. Koehler [signature] Date 10/11/94
(9) Checker [signature] Date 11-4-94

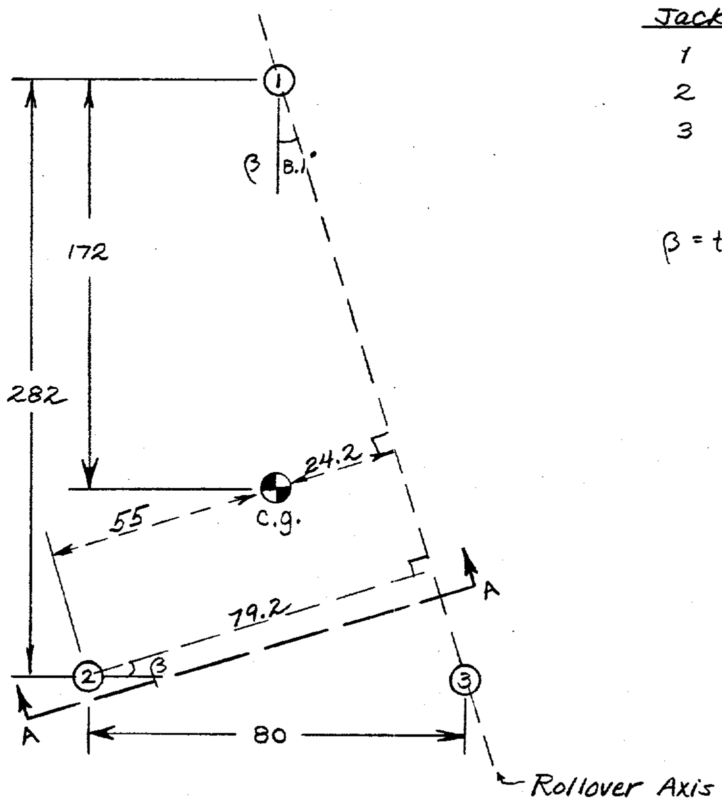
(10)

Rollover on Jacks

Objective: Determine when truck will rollover if jacks are not actuated simultaneously. Assume the center jacks are not extended and one rear jack is raised to its highest position.

Jack	Location
1	Front
2	Rear
3	Rear

$\beta = \tan^{-1}\frac{80/2}{282} = 8.1°$



TOP VIEW

All jacks are in contact with the ground before actuating any jacks. The maximum stroke of any jack is 18 in. When jack 2 extends 18 in., the truck will roll around the line between jacks 1 and 3 (rollover axis). The truck will not rollover as long as the c.g. is between the axes of supports.

BD-6400-060.1 (12/87)

DESIGN CALCULATION

(1) Drawing ______ (2) Doc. No. ______ (3) Page 2 of 3

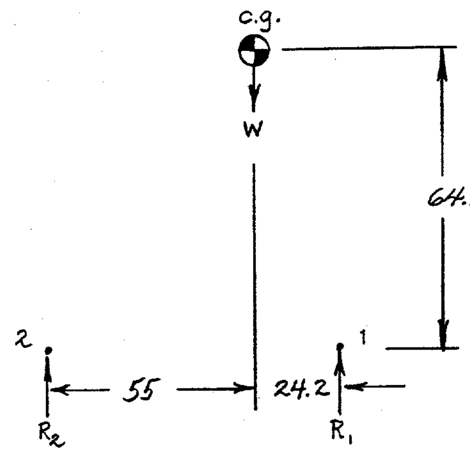
(4) Building ______ (5) Rev. ______ (6) Job No. ______

(7) Subject *Core Sample Truck No. 2 Rollover Analysis*

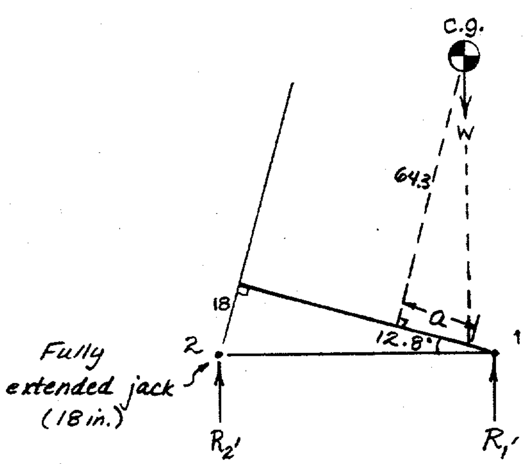
(8) Originator *Duane A. Koehler* [signature] Date *10/11/94*

(9) Checker [signature] Date *11-4-94*

(10)



VIEW A-A - Front and rear jacks fully retracted



$\tan 12.8° = \frac{a}{64.3}$

$a = 14.6 < 24.2$

Truck will not rollover.

VIEW A-A - One rear jack fully extended (18 in.)

BD-6400-060.1 (12/87)

(1) Drawing ______ (2) Doc. No. ______ (3) Page 3 of 3

(4) Building ______ (5) Rev. ______ (6) Job No. ______

(7) Subject Core Sample Truck No.2 Rollover Analysis

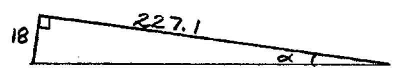
(8) Originator Duane A. Koehler [signature] Date 10/10/94

(9) Checker Hossam H. Ziada Date 11-4-94

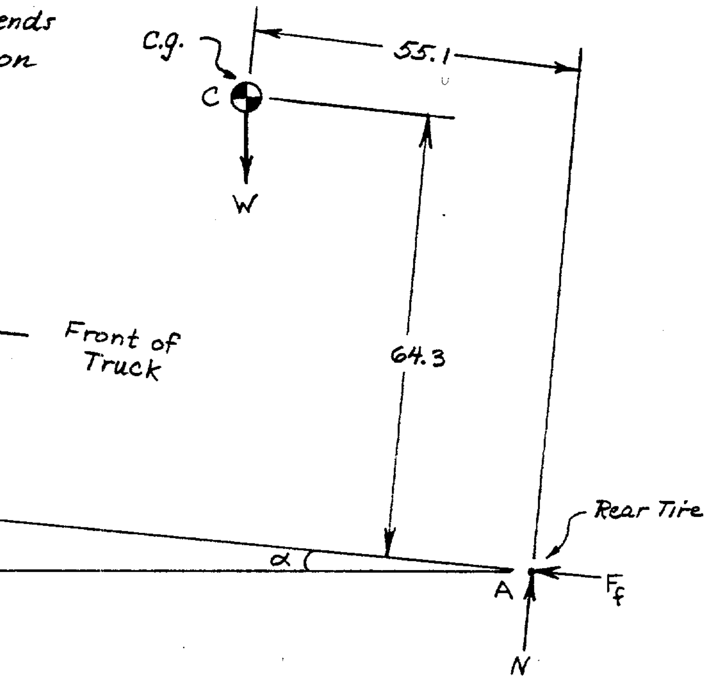
(10)

Longitudinal Stability

Assume the front jack extends 18 in. with the rear tires on the ground.

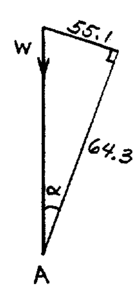


$\alpha = \tan^{-1} \frac{18}{227.1} = 4.5°$



Determine α for truck rollover (backwards),

$\Sigma M_A = 0$: C.g. is directly above rear tire.



$\tan\alpha = \frac{55.1}{64.3} \rightarrow \alpha = 41°$

When the front jack is extended, α = 4.5° < 41° → The truck will not rollover.