UCRL-ID-135915

Horizontal Air Bearing Experiment Number 1

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August 31, 1999

U.S. Department of Energy

Lawrence
Livermore
National
Laboratory

Work performed under the auspices of the U. S. Department of Energy by the University of California Lawrence Livermore National Laboratory under Contract W-7405-Eng-48.

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Horizontal Air Bearing Experiment Number 1

Introduction

The Horizontal Air Bearing Experiment #1 is a series of tests intended to further the understanding of rotational dynamics. A simple experimental assembly is rotated using the Horizontal Air Bearing and allowed to spin freely as the internal rotational damping is measured. The low friction of the bearing effectively isolates the test assembly, allowing the internal damping of the test object to be evaluated.

The experimental assembly is composed of an aluminum ball within a spherical cavity. A flanged pipe section and an auxiliary adapter plate secure the assembly to the Air Bearing interface plate. Three aluminum balls are interchanged to vary test parameters. The aluminum balls are free to move independently as the entire assembly rotates. The aluminum balls vary in diameter and/or surface finish. While the diameter and surface finish is varied, the space between the ball and socket is dry. To examine the effect of viscosity, the space is filled with a lubricant while the ball diameter and surface finish is held constant.

Data Presentation and Reduction

The Horizontal Air Bearing has the capability to permit balancing the rotor and payload both statically and dynamically. In addition, it has a built in torsion pendulum so the moment of inertia of the rotating mass can be measured and used to calculate the decelerating torque and payload moment of inertia.

During a damping test, the rotor is spun up to a predetermined rotational speed. Once the desired speed is reached, spin up is stopped and time data is taken. The collected data consists of the direction of rotation, start speed, stop speed, moment of inertia, period and elapsed time. Damping torque is calculated from the relationship

$$Torque = (MOI)x(deceleration).$$

Damping measurements are performed at least three times in all configurations. The test assembly is first spun as a rigid body by immobilizing the aluminum ball within the cavity. Next the aluminum ball is freed and the damping measurement performed. The aluminum ball is changed to permit variation in configuration. The cavity between the ball and socket is filled with a lubricant for the final damping measurements. The configurations examined are presented in Table 1.

Test I.D.	*Experiment Variable*	*Environment*
Configuration 1a.	Ball, 0.008 gap – 125 surface finish	Shimmed, Dry
Configuration 1b.	Ball, 0.008 gap – 125 surface finish	Free, Dry
Configuration 2a.	Ball, 0.016 gap – 63 surface finish	Shimmed, Dry
Configuration 2b.	Ball, 0.016 gap – 63 surface finish	Free, Dry
Configuration 3a.	Ball, 0.008 gap – 63 surface finish	Shimmed, Dry
Configuration 3b.	Ball, 0.008 gap – 63 surface finish	Free, Dry
Configuration 3c.	Ball, 0.008 gap – 63 surface finish	Lubricant (Velocite #10)*
Configuration 3d.	Ball, 0.008 gap – 63 surface finish	Lubricant (Velocite #6)**

*Mobil Oil Company, viscosity=37.75 cP @25°C

**Mobil Oil Company, viscosity=12.5 cP @25°C

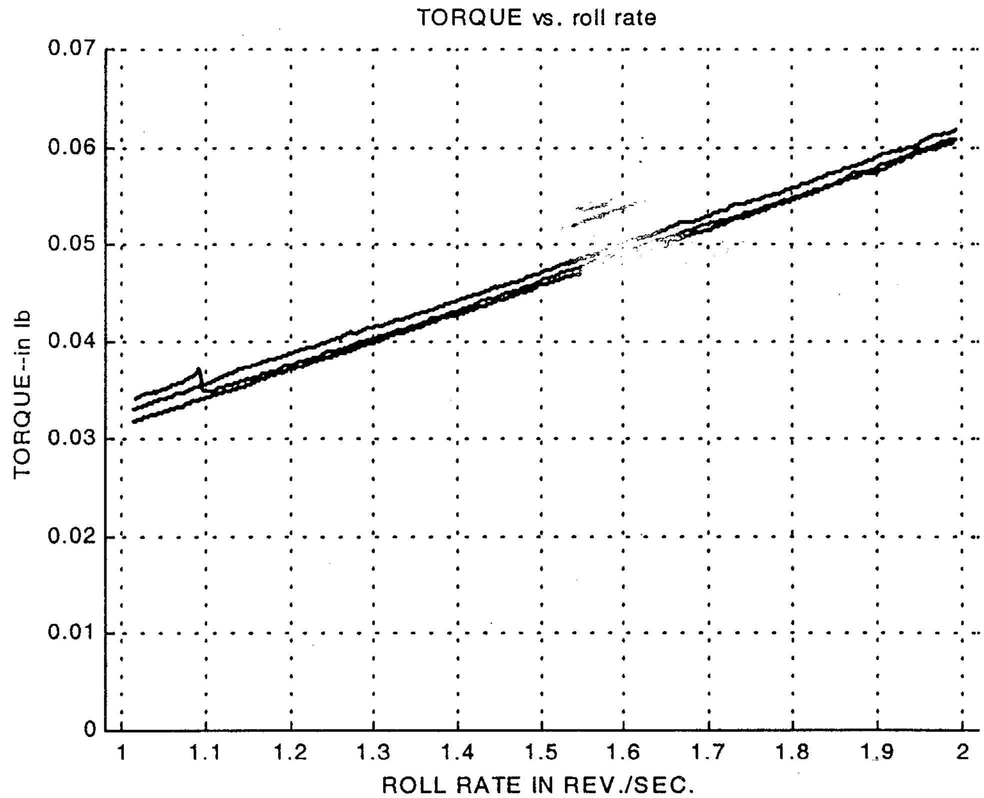


Figure 1. Configuration 1a. Spin-down tests 1, 2, and 3.

<u>Description</u>

Gap: .008"
Finish: 125μ
Shimmed, Dry

Configuration 1a, spin-down tests 1, 2, and 3 were conducted consecutively, without disturbing the set-up between tests.

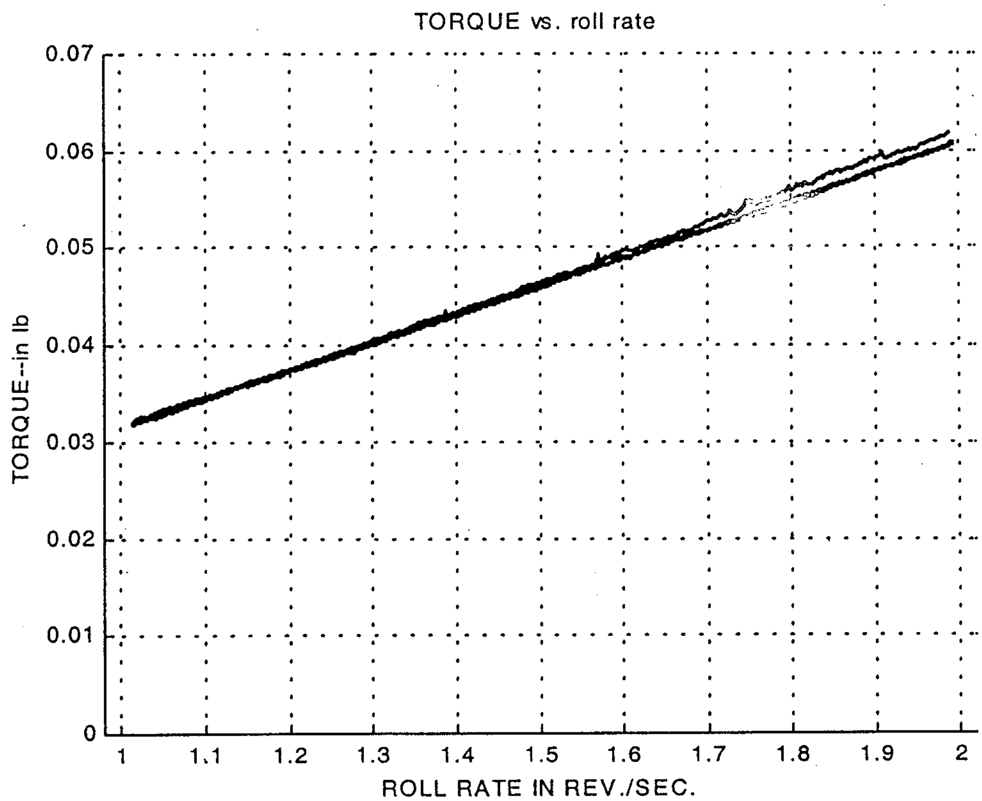


Figure 2. Configuration 1a, Spin down tests 4, 5, and 6.

<u>Description</u>

Gap: .008"
Finish: 125μ
Shimmed, Dry

Configuration 1a, spin-down tests 1, 2, and 3 were conducted consecutively, without disturbing the set-up between tests. After spin-down test number three, the test assembly was taken apart, and the ball removed. The assembly was then reassembled. Without further changes, such as static balancing, POI or MOI measurement, spin-down test 4 was performed. The test assembly was again taken apart between tests 4 and 5, and 5 and 6.

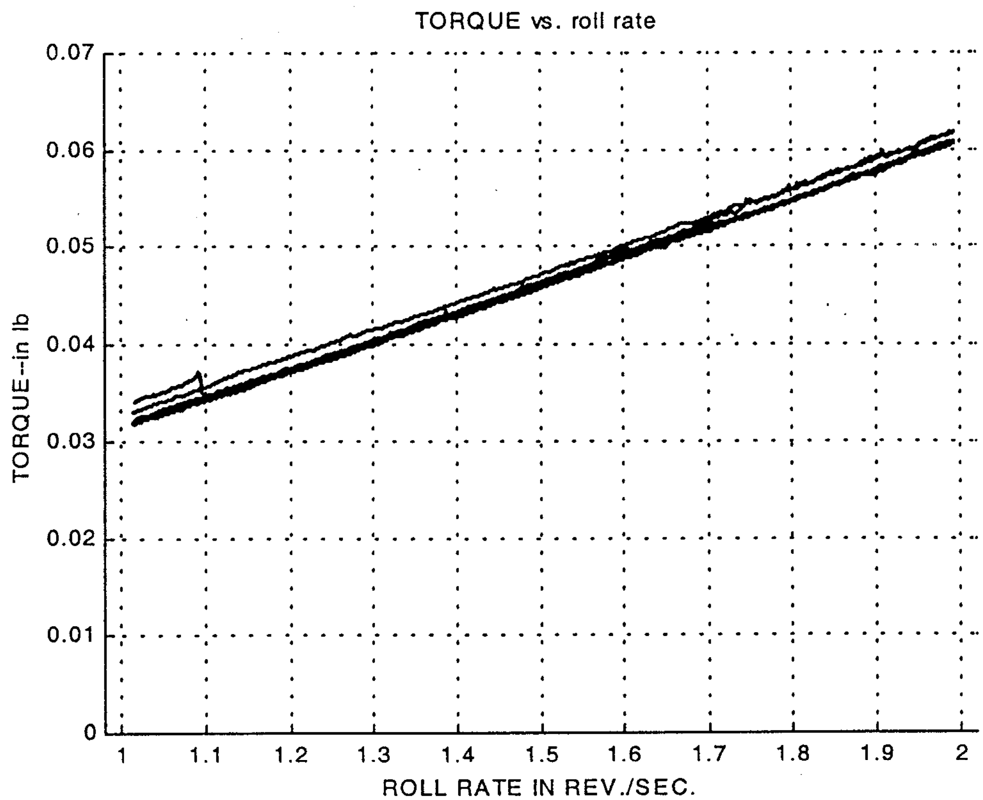


Figure 3. Configuration 1a. Spin-down tests 1 - 6.

<u>Description</u>

Gap: .008"
Finish: 125μ
Shimmed, Dry

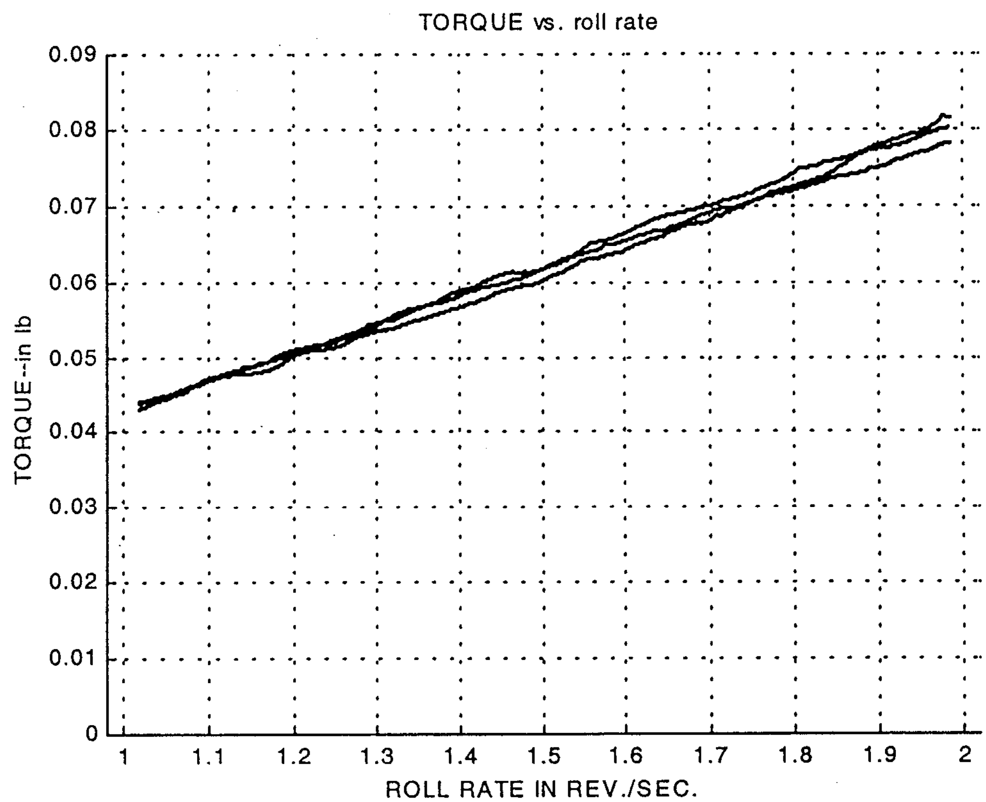


Figure 4. Configuration 1b. Spin-Down tests 1 – 3.

<u>Description</u>

Gap: .008"
Finish: 125μ
Loose, Dry

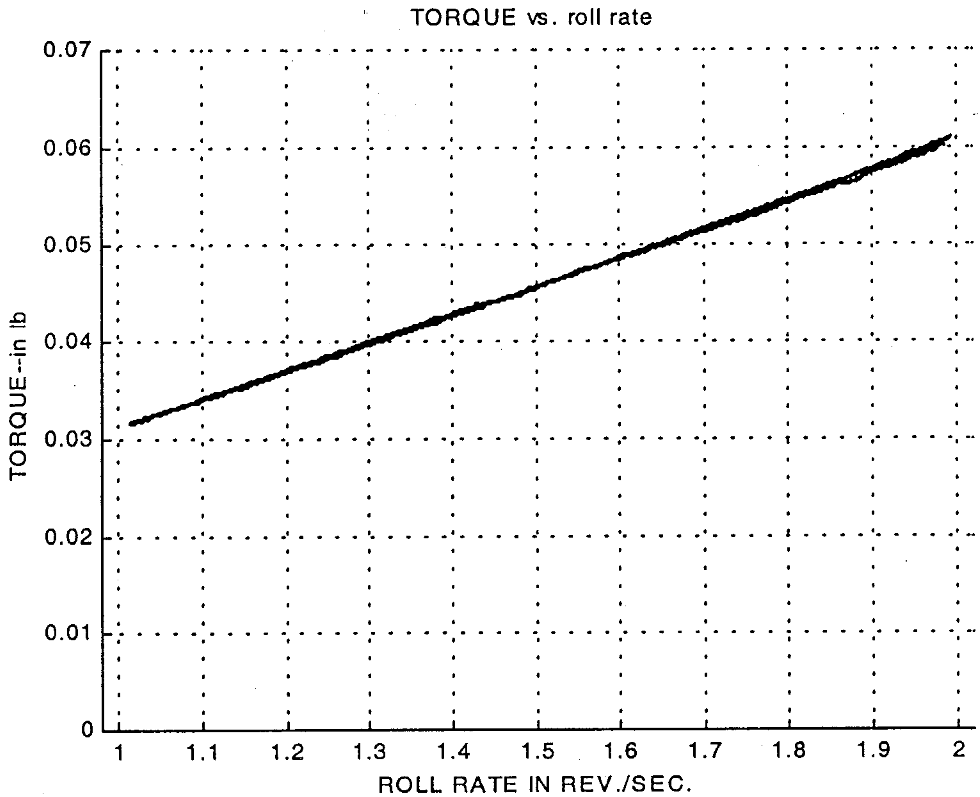


Figure 5. Configuration 2a, Spin-down tests 3, 6, and 7.

<u>Description</u>

Gap: .016"
Finish: 63μ
Shimmed, Dry

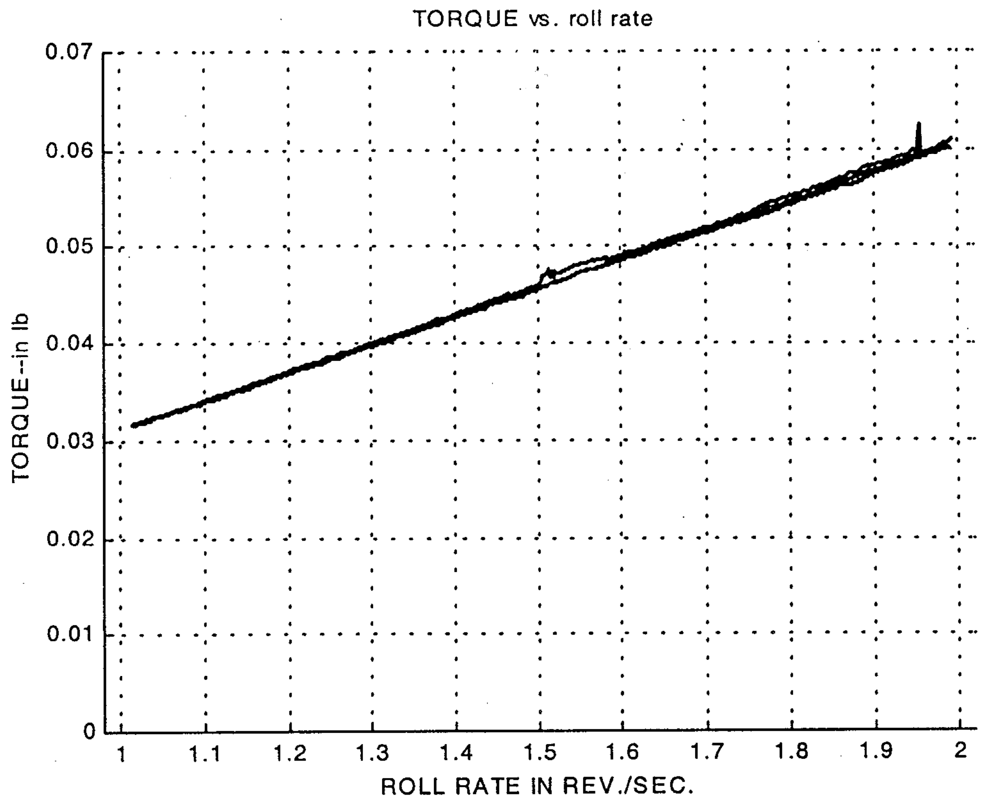


Figure 6. Configuration 2a. Spin-Down tests 5, 6, and 7.

<u>Description</u>

Gap: .016"
Finish: 63µ
Shimmed, Dry

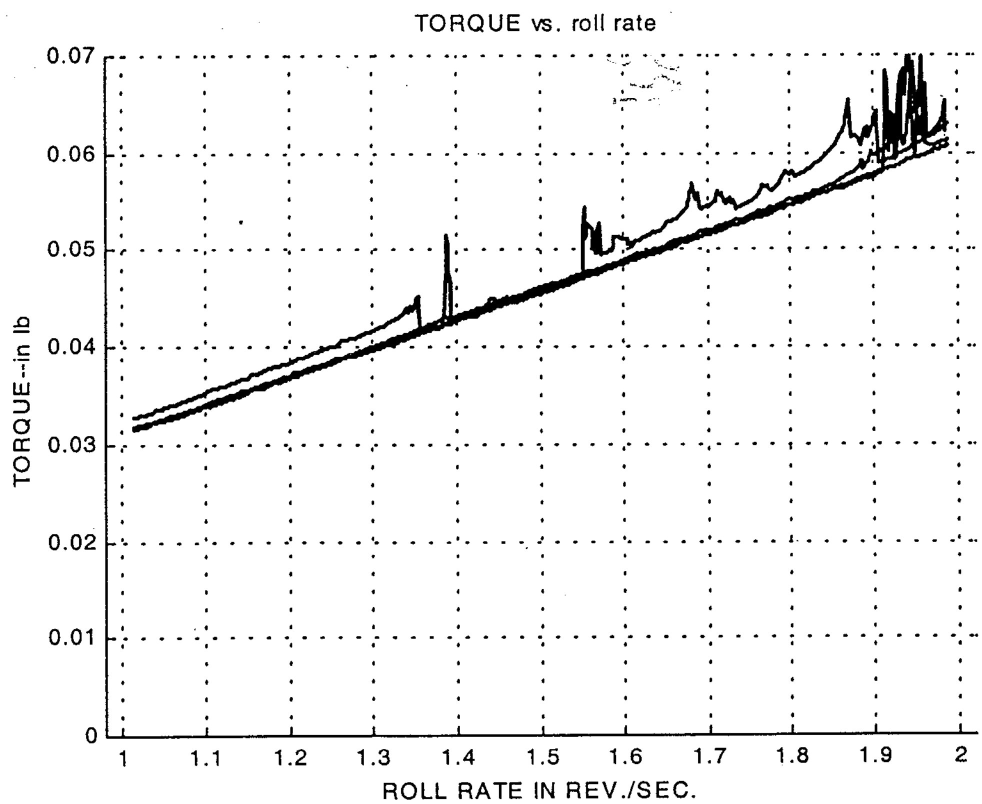


Figure 7. Configuration 2a. Spin-down tests 1 - 4.

Description

Gap: .016"
Finish: 63μ
Shimmed, Dry

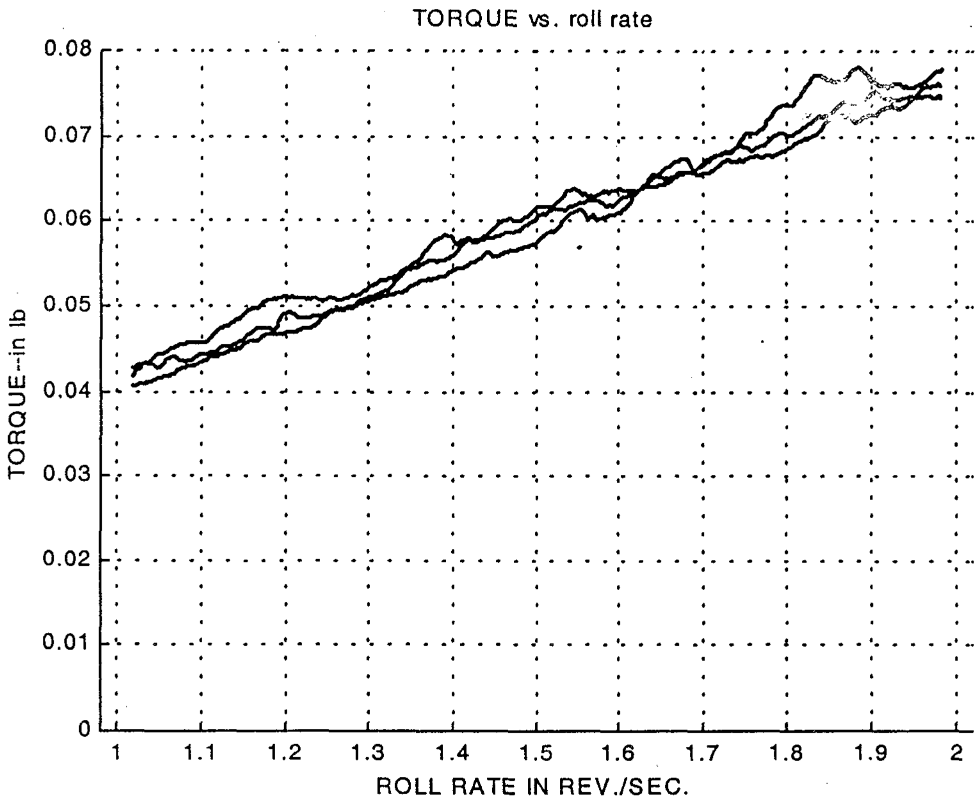


Figure 8. Configuration 2b. Spin-Down tests 1 - 3.

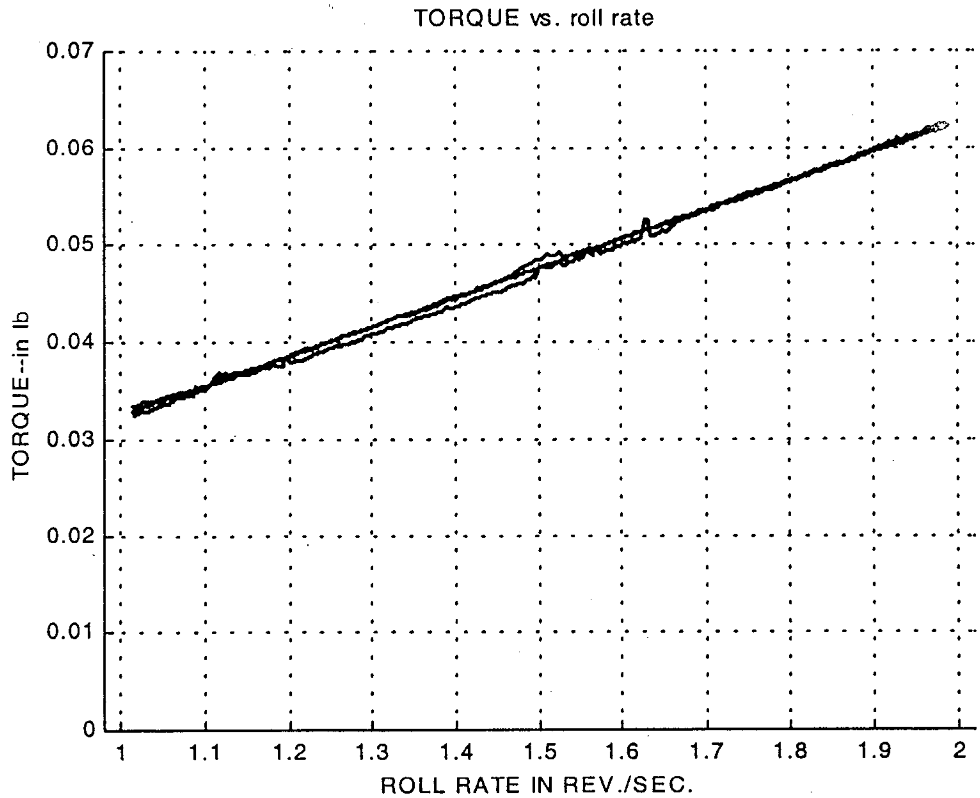


Figure 9. Configuration 3a. Spin-Down tests 1, 4, and 5.

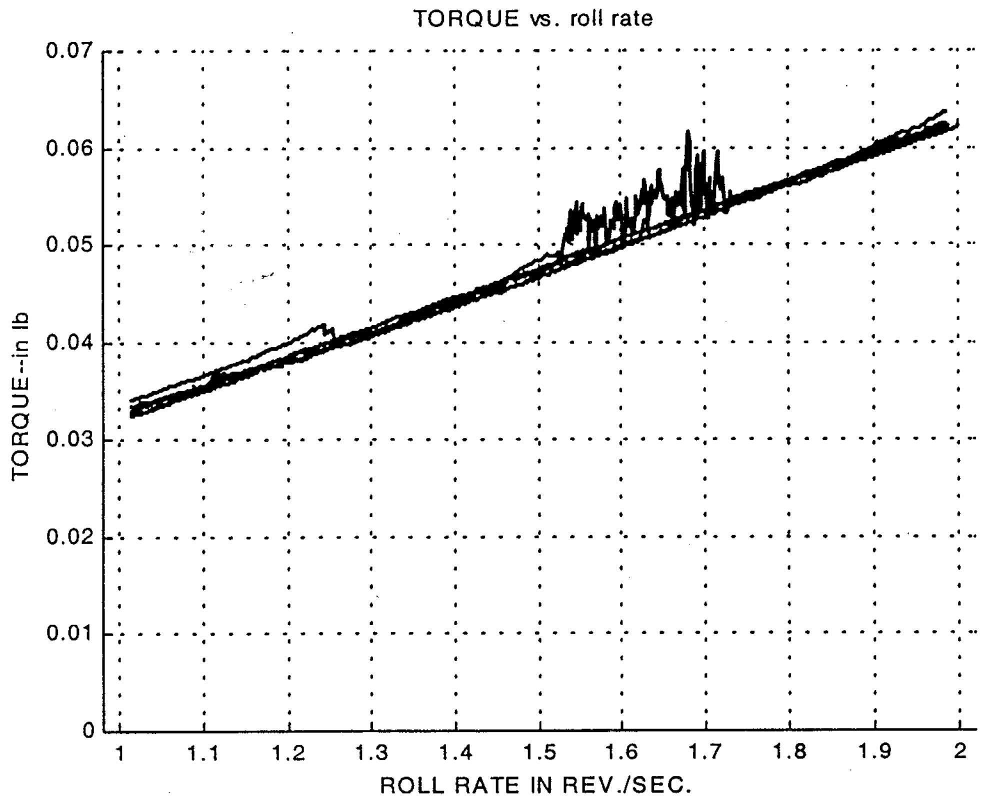


Figure 10. Configuration 3a. Spin-Down tests 1 - 5.

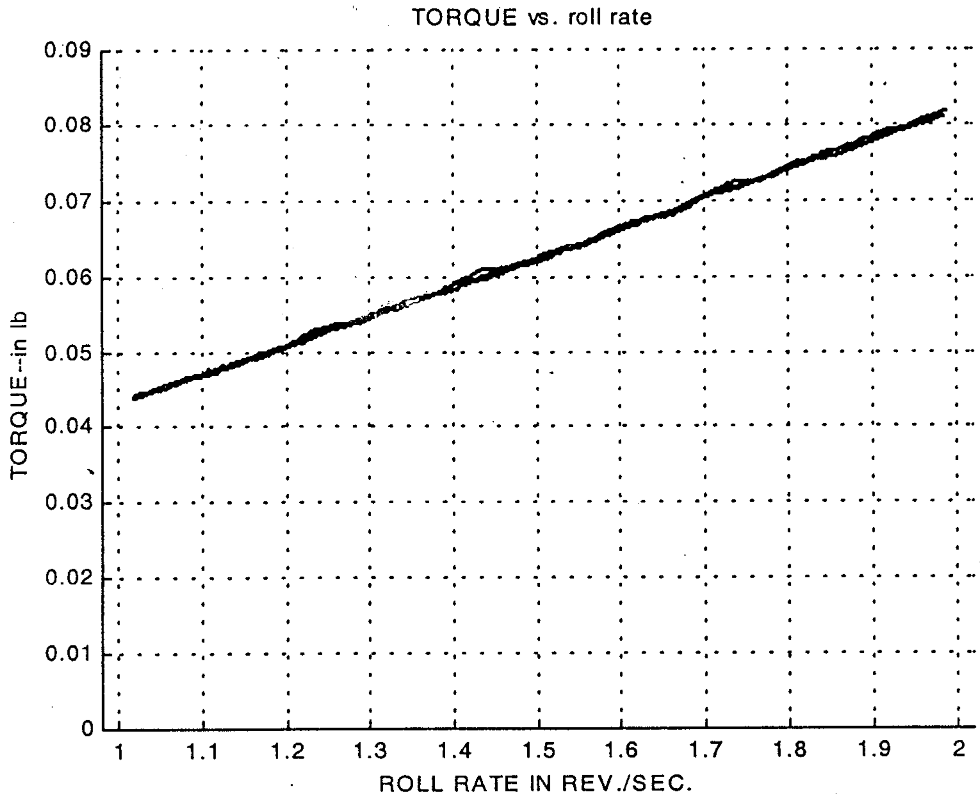


Figure 11. Configuration 3b. Spin-Down tests 1 - 3.

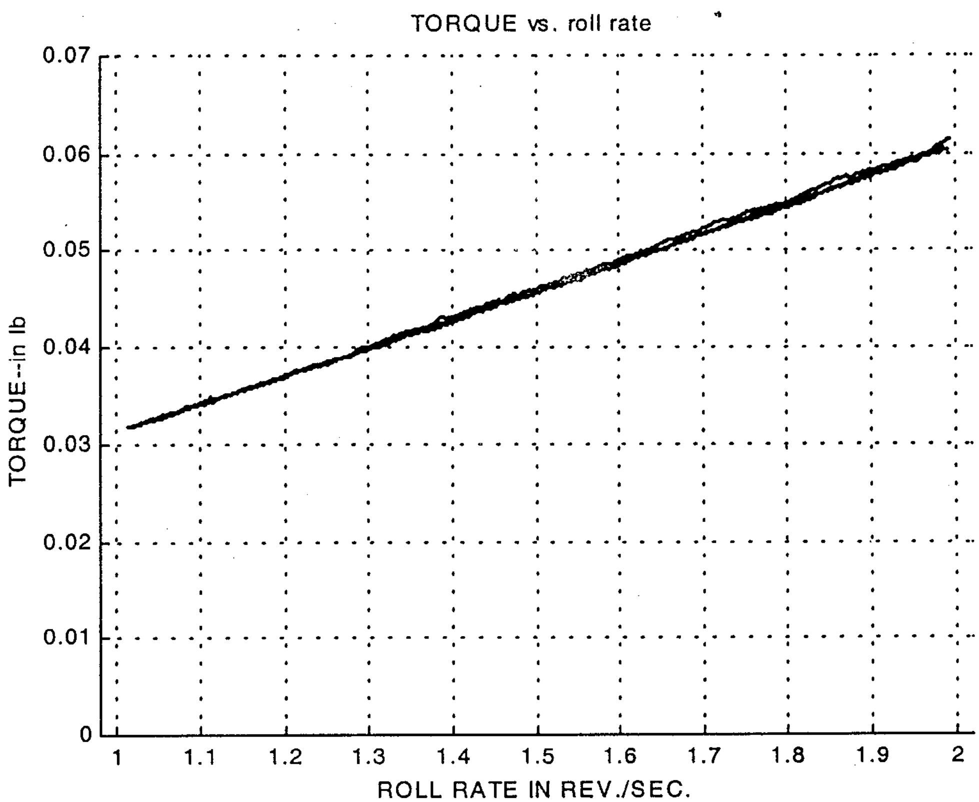


Figure 12. Configuration 3c. Spin-Down tests 1 - 3.

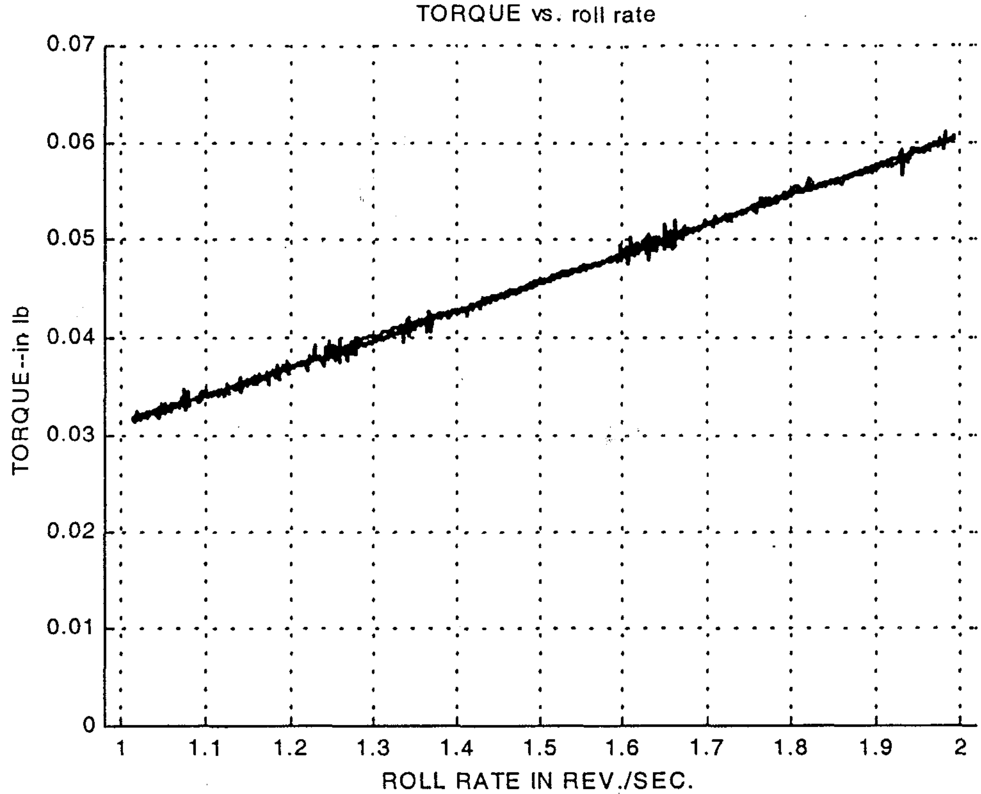
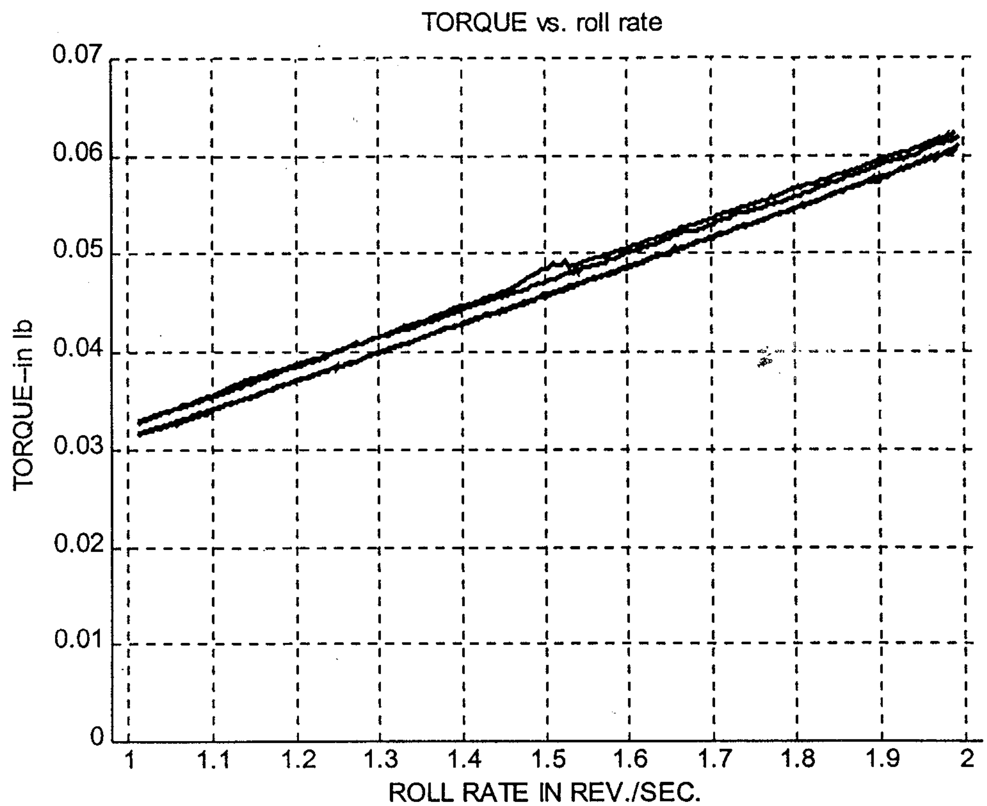
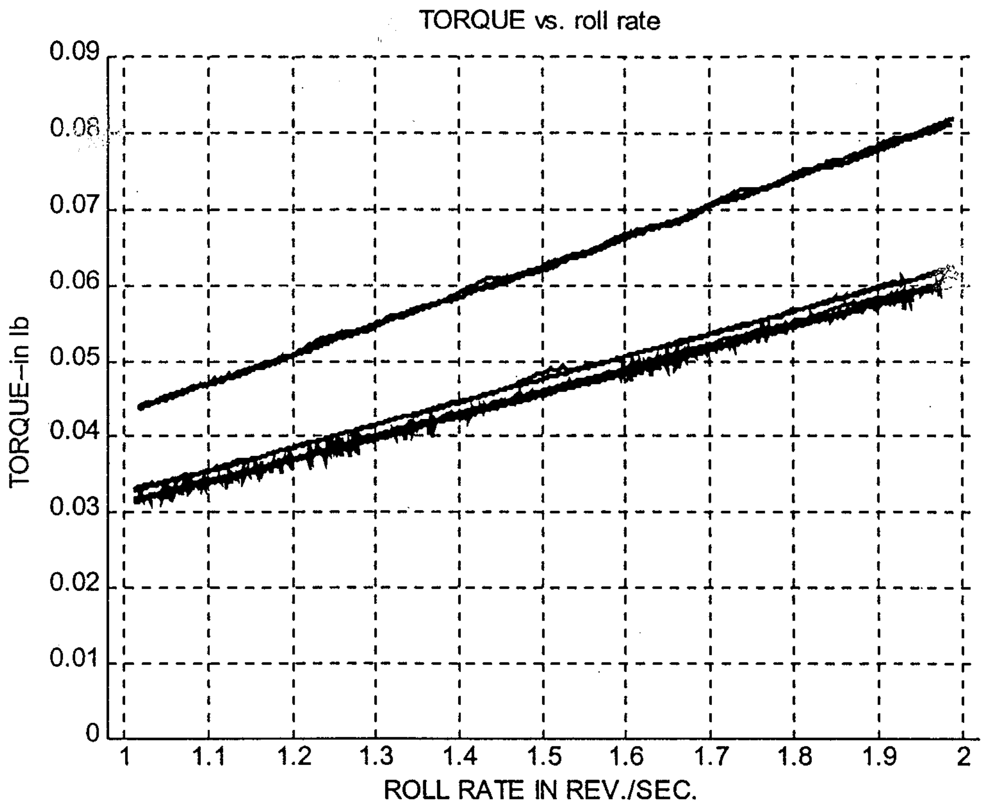


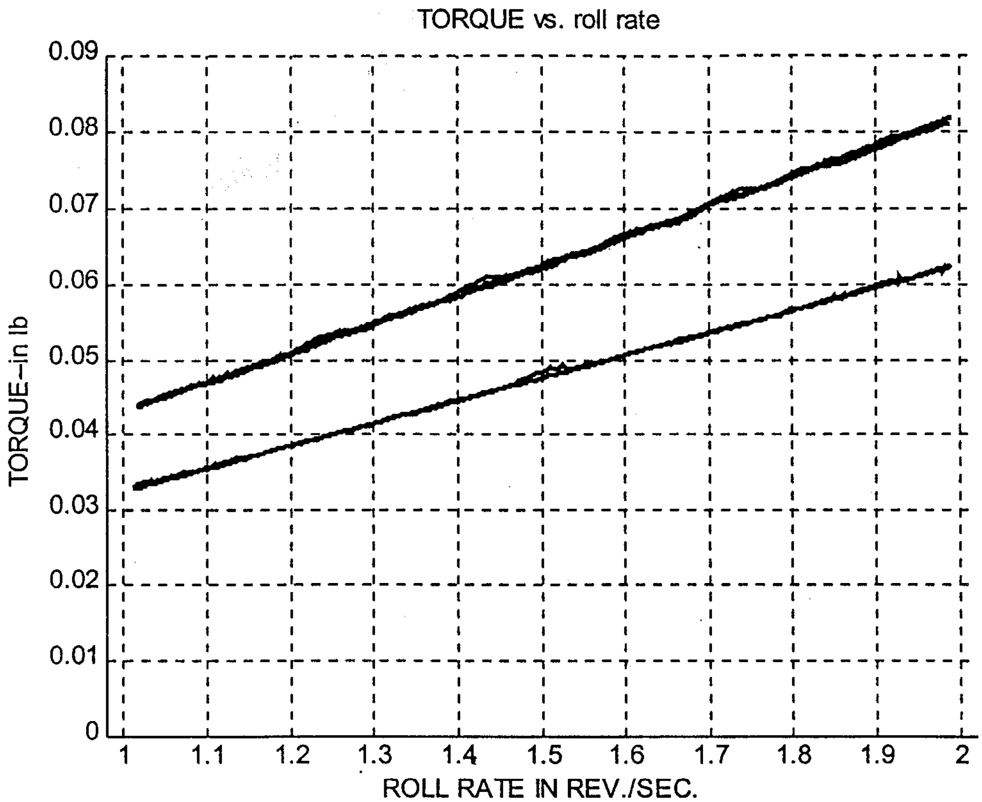
Figure 13. Configuration 3d. Spin-Down tests 1 - 3.



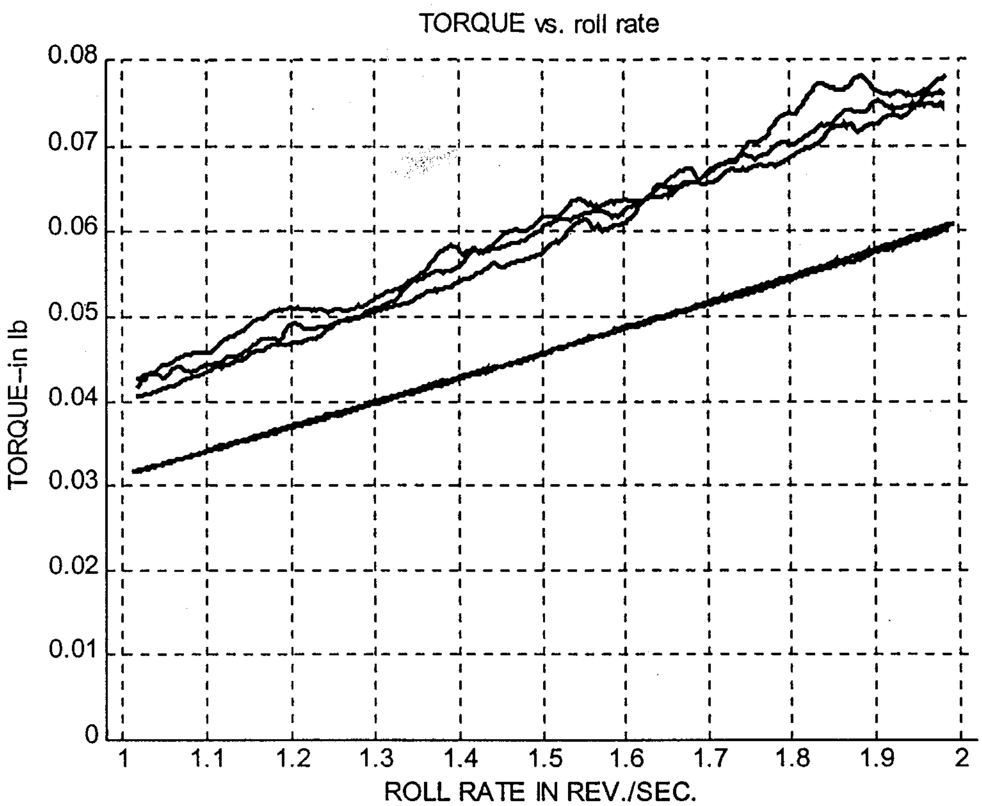
Configuration 1a, 2a, and 3a (1a is in upper and lower group. 2a is in lower group and 3a is in upper group)



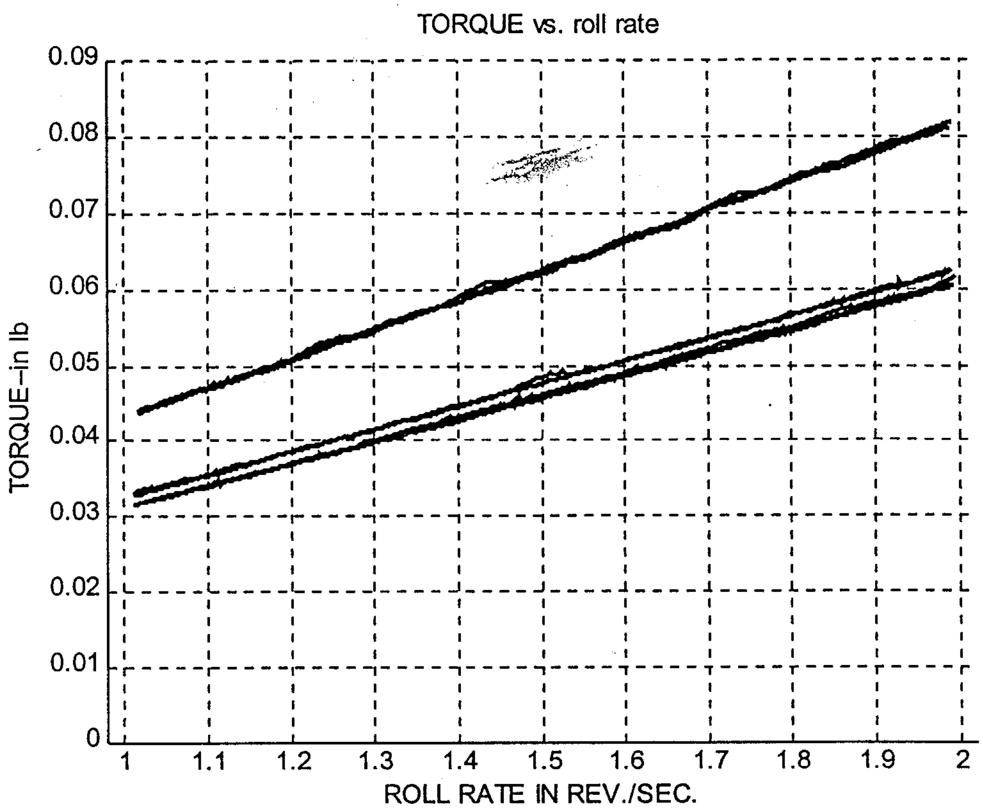
Configuration 3a (center group), 3b (upper group), 3c and 3d (lower group)



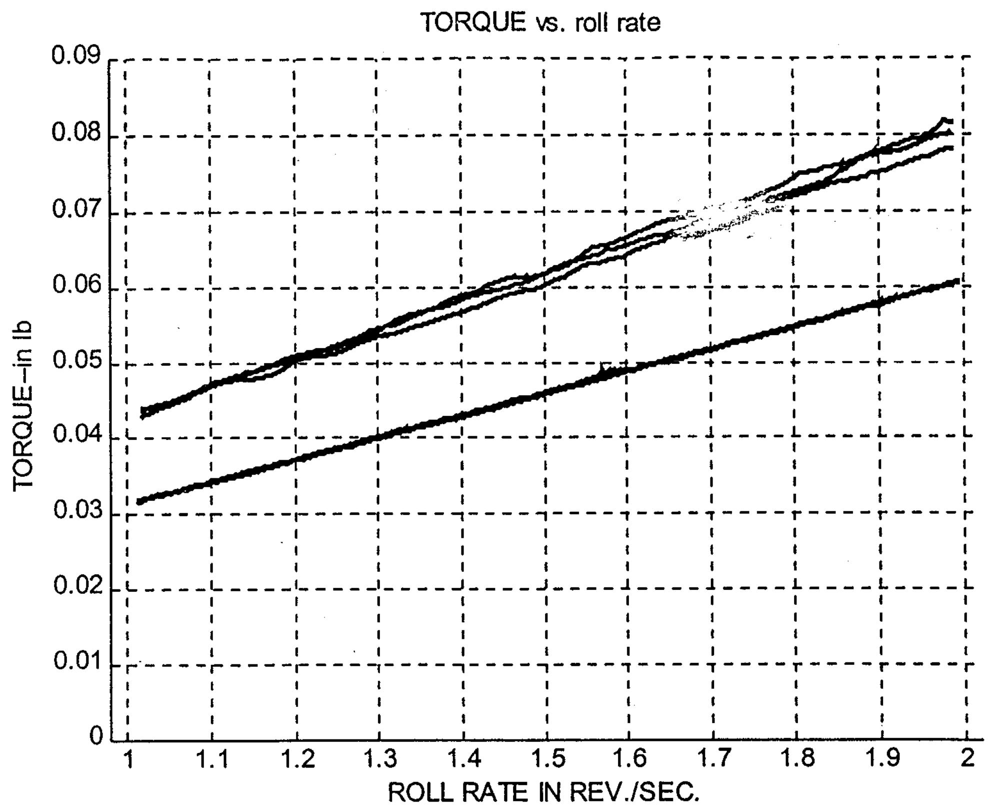
Configuration 3a (lower group). Configuration 3b (upper group)



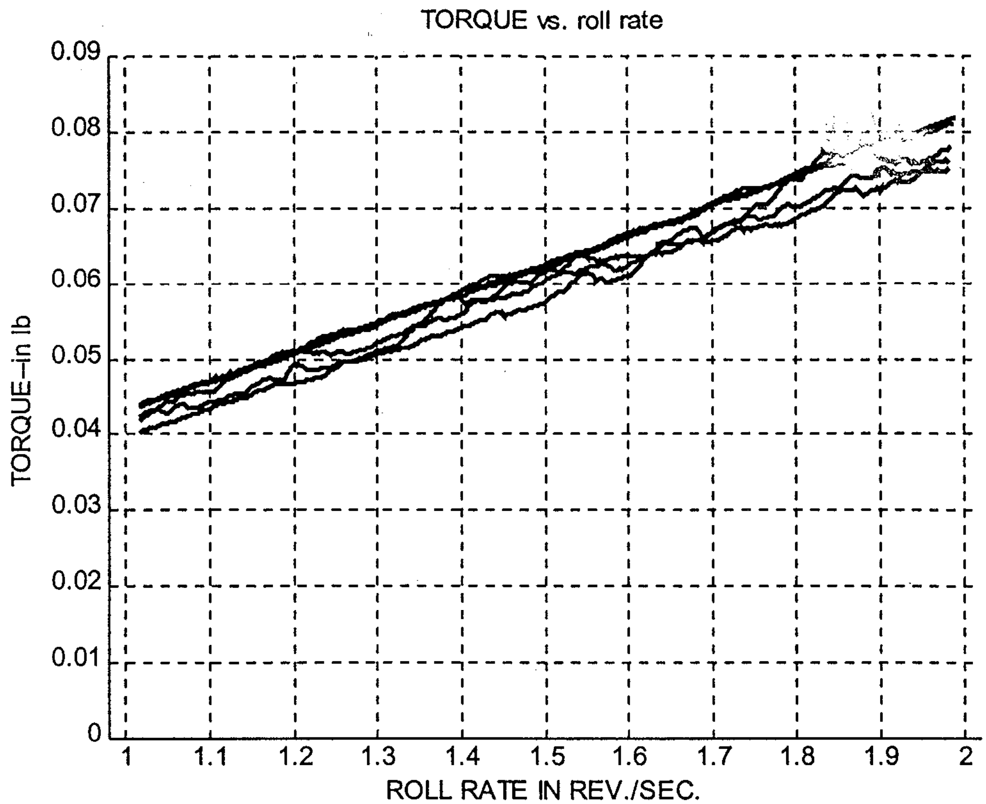
Configuration 2a, tests 5, 6, and 7 (lower group). Configuration 2b (upper group)



Configuration 3a (center group), 3b (upper group), 3c (lower group)



Configuration 1a, spin-down tests 1, 5, and 6 (lower grouping). Configuration 1b (upper grouping)



Configurations 3b and 2b.

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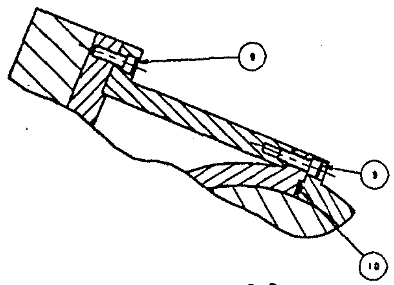
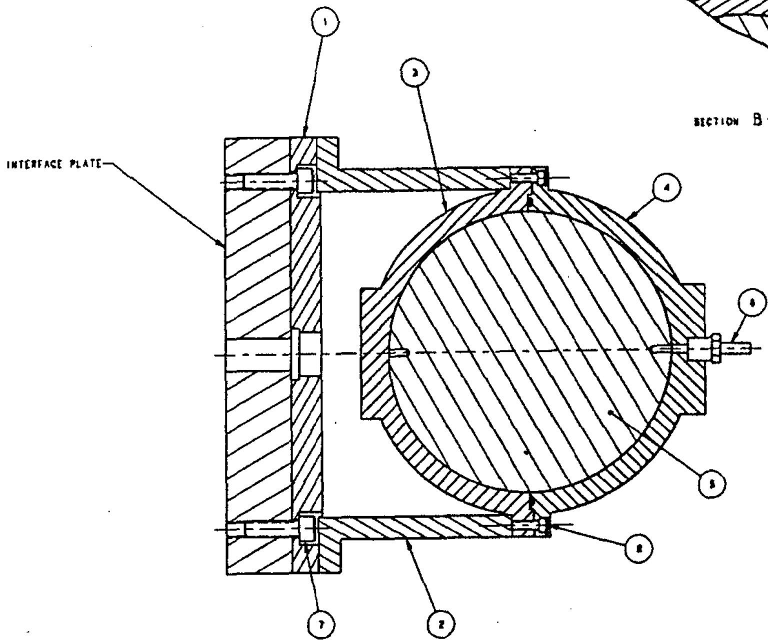
NOTES

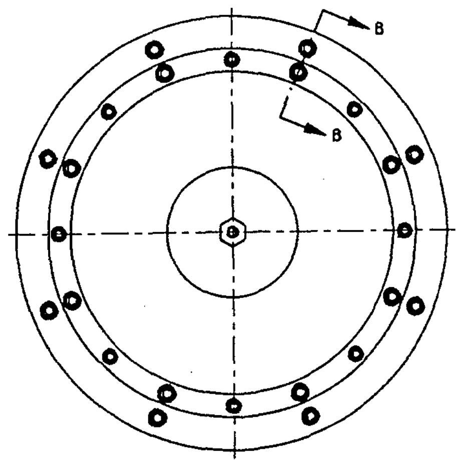
UNLESS OTHERWISE SPECIFIED:

1. ALL DIMENSIONS ARE IN INCHES.
2. DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994.
3. ELECTRO-ETCH PART NUMBER IN APPROXIMATE LOCATION SHOWN.

PART OR CONTROL NUMBER	LTR	SHEET ZONE	PREPARED BY / DESCRIPTION	DATE	CHKD	APPD
-	00		C LAGUER CHKD M ENGEL APPD T CLAUSON ORIGINAL ISSUE	11-18-95	-	-







QTY REQD	PART/CONTROL NO	DESCRIPTION/MATERIAL		NOTE	SHEET ZONE	ITEM
1	PARKER 2-261	O-RING, FACE SEAL, .125 O.D.				10
16		SCREW, SCHD .250-20UNC-2B X .75L				9
8		SCREW, SCHD No.10-32UNF-2B X .625L				8
8		SCREW, SCHD .375-16UNC-2B X 1.25L				7
1		VLV				6
1	98-114877	BALL, .008 GAP	AL 6061-T6			5
1	98-114876	HEMI 2	AL 6061-T6			4
1	98-114875	HEMI 1	AL 6061-T6			3
1	98-114839	SPOOL	AL 6061-T6			2
1	98-114838	MOUNTING PLATE	AL 6061-T6			1
NA	9910100	MARKING, GENERAL METHODS				
NA	9900000	GENERAL REQUIREMENTS				

QUANTITY ABBREVIATIONS:
NA : NO QUANTITY FOR DOCUMENTS
PM : PROCESS MATERIAL
SM : SUPPLIED MATERIAL
AR : AS REQUIRED
ARS : AS REQUIRED FOR SPECIALS
ALT : ALTERNATE

PART TYPE

SHEET 1 — ISSUE 00

TITLE: WRL-SERIES SPIN TEST SPIN TEST ASSY (U)

PART CLASSIFICATION: UNCLASSIFIED

DRAWING CLASSIFICATION: UNCLASSIFIED

SIZE: E — DRAWING NUMBER: AAA98-115022-00

CAGE 14967 — SCALE 1/1 — SHEET 1 OF 1

STATUS LL-CHK- — DESIGN LL-PRO/E-V19

GEOM PREC XX.XXX

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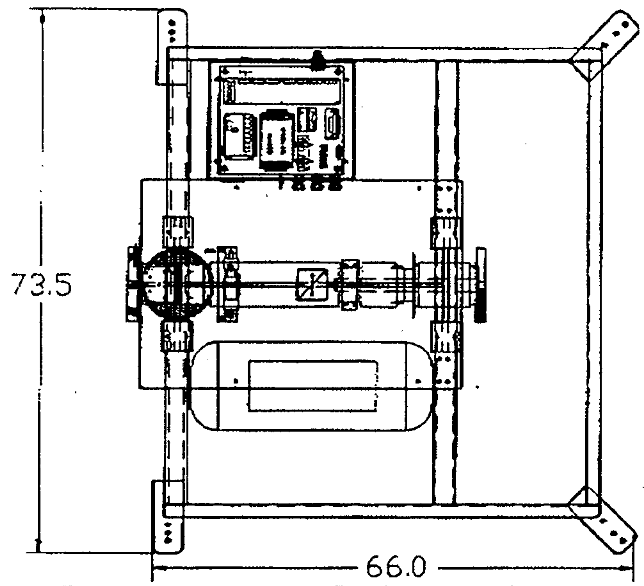
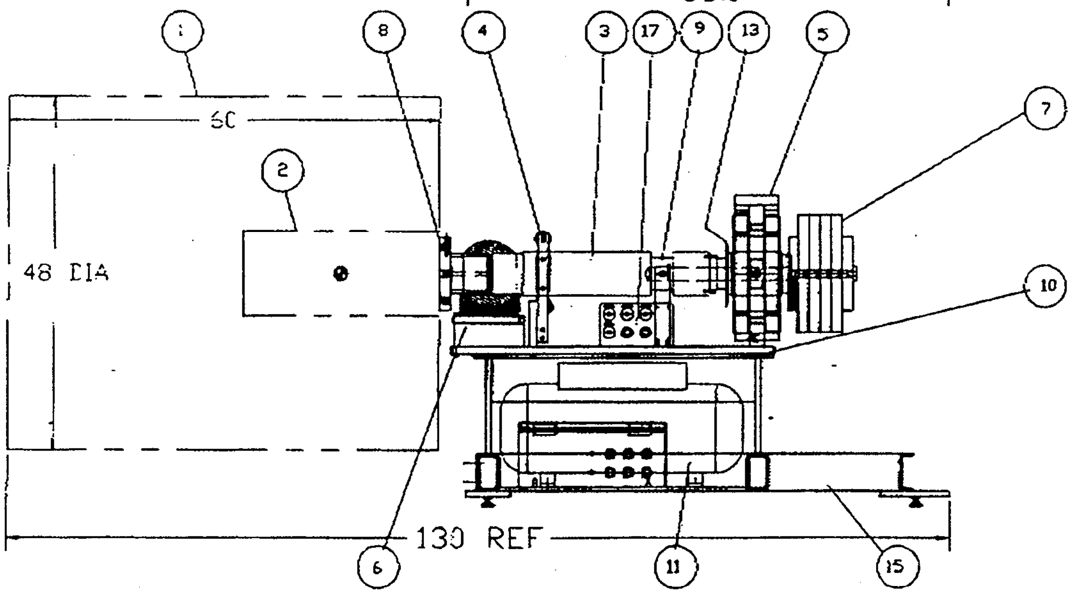
Plot Date: Tue Dec 1 10:14:34 PST 1998. Plotted By: mae.

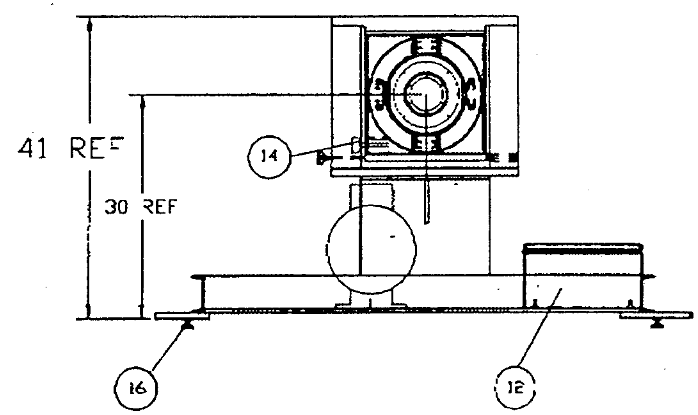
2601010

REV	DATE	CHANGE	BY	CHK



DET	DESCRIPTION	PART OR DWG #
1	MAX TEST PART ENVELOPE	N/A
2	TEST PART	N/A
3	ROTOR ASSEMBLY	2278025
4	BRAKE ASSEMBLY	2278059
5	MOMENT BEARING ASSEMBLY	2278058
6	SPHERICAL BEARING CUP ASSEMBLY	2278060
7	COUNTERWEIGHT ASSEMBLY	2278025
8	INTERFACE PLATE	2278019
9	MOI ASSEMBLY	2278062
10	BASE PLATE	2278043
11	RESERVE AIR (GAS) TANK	P00620
12	ELECTRONICS ENCLOSURE	F00510
13	OPTRON ASSEMBLY	2278056
14	POI LOAD CELL ASSY	2278053
15	MAIN FRAME	2278037
16	LEVELING FOOT	LD0590
17	PNUMATIC CONTROL PANEL	2278073





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	DATE:	
GAS BEARING TEST INSTRUMENT ASSEMBLY	SCALE:	DWG. NO. 2601010