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Tactical Testing of the Juniper Class Seagoing Buoy Tender

FINAL REPORT
JULY 1999

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16. Abstract (MAXIMUM 200 WORDS)

Tactical testing for the new 225-foot Juniper Class of Coast Guard Seagoing Buoy Tenders was conducted on June 9, 1998, and the preliminary results were forwarded to the sponsor in September 1998.

The testing was conducted on the USCGC JUNIPER (WLB-201), the first ship of the class. The tests consisted of turning circles, acceleration to full speed from a standing stop, and deceleration from full speed. The turning circle tests were completed at speeds of 6, 9, 12 and 16 knots under almost optimum conditions of seas less than 2 feet and winds less than 15 knots. The majority of test runs were conducted to the port side with an occasional test to starboard to establish variation. The data were collected using the differential global positioning system (DGPS) and the Tactical Maneuvering, (TACMAN) GPS software. The tactical diameter for turns to port was smaller by approximately 14 percent than for turns to starboard. On an average, the ship accelerated to full speed in 9.5 boat lengths and stopped in less than six boat lengths.

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EXECUTIVE SUMMARY

The tactical testing of the new Juniper class of ship was requested by the Commandant, U.S. Coast Guard Headquarters, Office of Cutter Management (G-OCU). Testing was conducted by the USCG Research and Development Center onboard the CGC JUNIPER, the first of the 225-foot class of Coast Guard seagoing buoy tenders. The tests were conducted off the coast of Rhode Island in near ideal conditions of seas less than 2 feet, winds less than 15 knots, and water depths between 87 and 134 feet.

Tactical testing consisted of performing turning circles, and acceleration and deceleration tests Measurement data were obtained for advance, transfer, tactical diameter, turning radius, turning speed, acceleration, deceleration and distances, and times for each. These tests, corrected for localized current and wind effects on the ship, provided a measure of the turning and maneuvering ability of the ship. The testing was completed using the Differential Global Positioning System (DGPS) and Tactical Maneuvering (TACMAN) GPS software.

The data returned from tactical testing are important for a ship in close maneuvering situations. These data can be entered into the ship's Electronic Chart and Display Information System (ECDIS), where the information can be used to program and execute a turn with a great deal of accuracy while underway.

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1.0 INTRODUCTION

1.1 SPONSOR REQUEST

Tactical testing for the new Juniper class buoy tender was requested by the USCG Office of Cutter Management (G-OCU) in June of 1997. Tactical testing is usually completed on each new class of ship to define the maneuvering characteristics of that class, and the builder's trials usually encompass some of this testing. However, it is prudent to retest a ship class under actual working loads that are not available during builder's trials. A test plan was approved by the R&D Center and Commandant (G-OCU). Tests would be conducted in priority of importance based on time available.

1.2 JUNIPER CLASS OVERVIEW

The Juniper Class of seagoing buoy tenders (WLB) is being built by Marinette Marine in Marinette, Wisconsin. The JUNIPER (WLB-201), Figure 1, is the first ship of the class. The ship displaces 2,032 tons with a full load, is 225-feet in length, and is powered by two Caterpillar 3608 diesel engines having a rated engine horse power of 6,200. The ship has a single controllable pitch propeller, and forward and aft electric thrusters of 460 and 550 horsepower, respectively.

1.3 JUNIPER CLASS TESTING REQUIREMENTS

Tactical testing requires calm water to preserve accuracy. Excessive winds, seas, or water currents can change test results. The environmental test requirements for the Juniper class tests are:

Water depth	- greater than 80 feet
Wave height	- 2 feet or less
Wind speed	-15 knots or less
Current	- less than ¼ knot

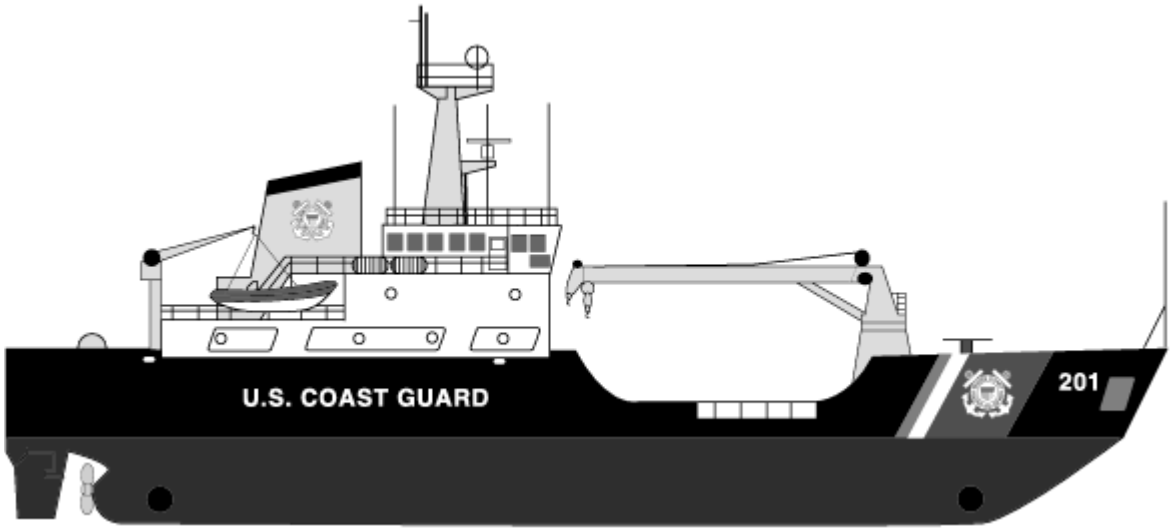

Figure 1. USCGC JUNIPER (WLB-201)

The ideal testing sequence required the testing to be completed at speeds of 6, 9, 12 and 16 knots (or max speed). The rudder angles selected to fill out the test matrix for each speed were 10, 15, 20, 30, and 38 degrees for both port and starboard turns (40 tests). Additional tests included acceleration tests, from dead in the water (DIW) to full speed, two runs each in opposite directions (4 tests); and two deceleration tests, from full speed to DIW, and two runs each in opposite directions (4 tests). The total number of tests came to 48. If these tests were run at an average of 20 minutes per test, it would require 16-hours of testing, however, the test time allowed for only one day's testing. This test matrix was a very demanding structure for one day of testing. This problem was resolved by completing the test matrix on the port side turns and filling in five selected turns to starboard in order to characterize differences in turning performance. The final test requirements were for 33 tests averaging 20 minutes each for a total time of 11 hours of testing. If time permitted, the test matrix for the starboard side would be filled in.

1.4 TACTICAL TESTING OVERVIEW

Ship maneuvering always includes turning to some degree. Quantifying the performance of a vessel's turning, starting, and stopping abilities are important. With the advent of the Electronic

Chart and Display Information System (ECDIS) and better navigational technology, a ship with the proper information programmed into its navigational computer could program a course, including turns, through restricted waters. Turning circle, acceleration and deceleration tests measure and document a vessel's ability to maneuver. The turning ability of a vessel is noted by four specific measures: advance, transfer, tactical diameter, and steady turning diameter. Figure 2 illustrates the first three measures.

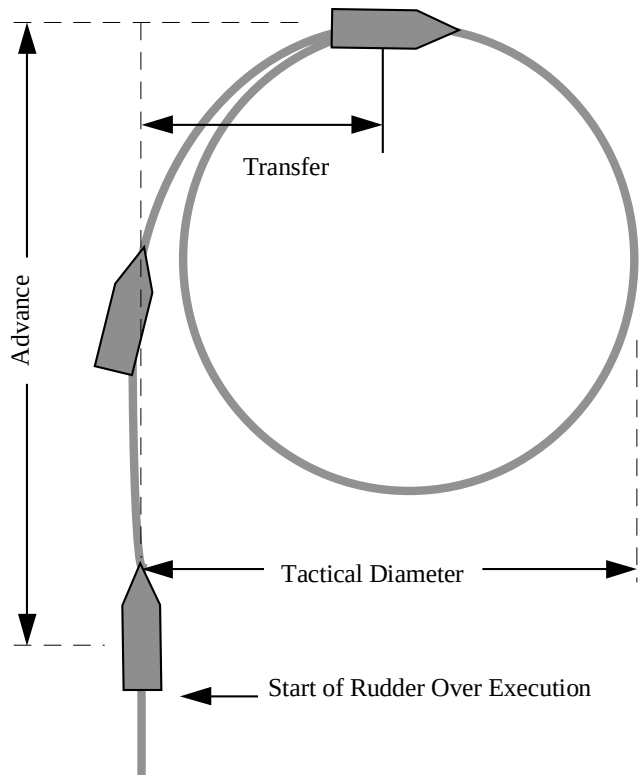

Figure 2. Turning Circle Measurements

1.5 TURNING CIRCLE DATA AND TEST DESCRIPTION

Turning circle tests include determining the advance, transfer, tactical diameter and the times associated with the ship completing these maneuvers. The **advance** is the distance the vessel

travels in a straight line parallel to the original course from the point at which the rudder over command is executed to a point where the course of the ship has changed by 90 degrees. The point-to-point measurement is made from where the GPS antenna is mounted; in this case, on the mast near the center of the ship. The **transfer** is the distance from the original course line in the direction of the turn to that point where the ship's course has changed 90 degrees. This measurement is made at a right angle to the course line. The **tactical diameter** is the distance from the original course line to a point where the ship's course has changed by 180 degrees. The **steady turning diameter** is the diameter of the ship's turn after it reaches equilibrium for that speed and rudder angle.

Each test run is started with the ship on a steady course and fixed speed (i.e. the engine rpm and pitch held constant). The ship is left on that base course long enough to define the straight line course, (usually 30 to 60 seconds, depending on the speed). At that point, the rudder is rapidly moved to a predetermined rudder angle and held there until the ship changes course through 720 degrees (two complete circles). Data are collected using the Differential Global Positioning System (DGPS) and the Tactical Maneuvering (TACMAN), GPS software written by the USCG R&D Center. As an example, Figure 3 presents a snapshot of an uncorrected maneuver, and Figure 4 represents the same maneuver corrected for set and drift using the TACMAN software.

During the testing, electronic marks are entered into a computer at:

1. The start of data collection for a test.
2. The start of the base course leg.
3. The rudder over point, marked on data sheets as RO.
4. The 360-degree point, marked as 360.
5. The 720-degree point, marked as 720 or UM.
6. The end of test.

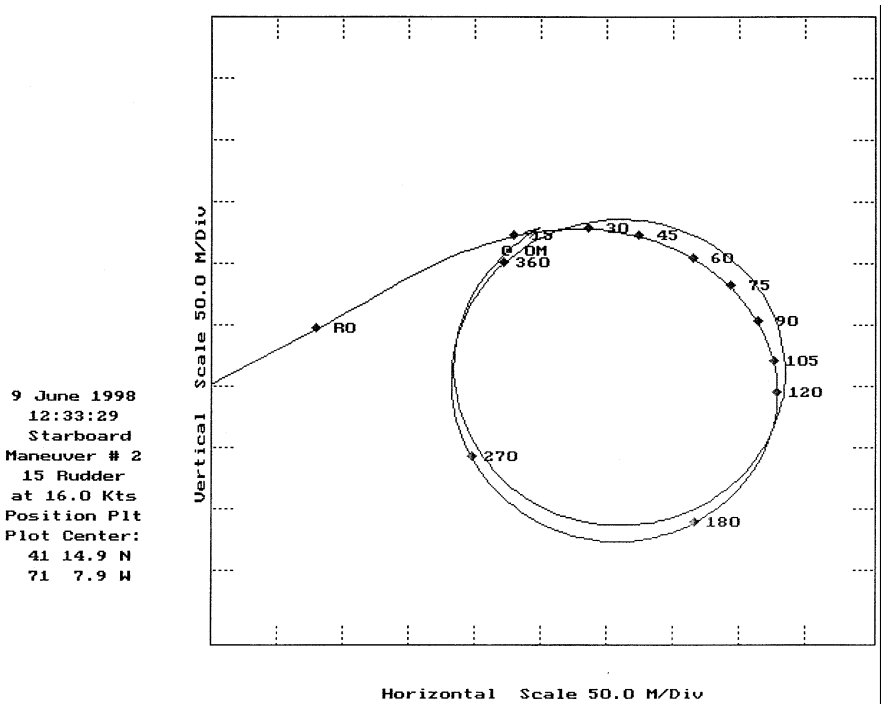

Figure 3. Turning Circle Raw Data Plot before correction for Set and Drift

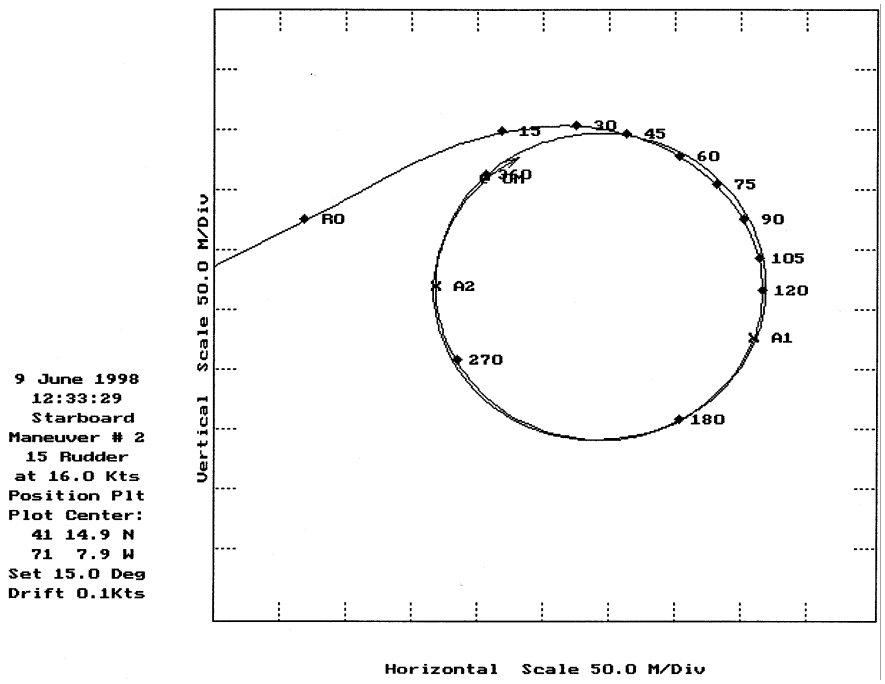

Figure 4. Turning Circle Plot Corrected for Set and Drift

Turning through 720 degrees aids the post-processing data correction for set (the direction of travel of the water under the ship) and drift (the speed of that water).

Post processing for these turning tests is accomplished by entering set and drift values which result in the best overlap of the two circles. Additional marks are then entered at a point along the track where the ship has attained a steady turning radius, marked as A1 and A2 (see Figure 4). The software then calculates advance and transfer for various degrees of turn, tactical diameter, turning radius, initial speed for the base course, turning speed and the times to each maneuver point.

1.6 ACCELERATION, DECELERATION DATA AND TEST DESCRIPTION

Acceleration test data include determining the time and distance a ship takes to obtain maximum speed from a standing stop or dead in the water position (DIW). The deceleration data are determined by the time and distance it takes a ship to come to DIW from maximum speed. These two distances are commonly measured in boat lengths.

An acceleration test is started from DIW. The order is given for maximum speed and the ship moves forward, on a straight course, until it appears it has reached maximum speed and is held there for a while to ensure that this requirement is met. In the deceleration test, the ship is brought on a straight course at maximum speed and held there until an order is given to come to all stop. There are two methods of completing the deceleration tests. One is to cut the engines and drift to a stop. The other, referred to as a crash stop, is to reverse the engines until the ship comes to a stop and cut the engines at that time. During the testing on the CGC JUNIPER, the crash stop method was used.

During these tests, electronic marks are placed in the computer at:

1. The start of the test.
2. The command given to accelerate or decelerate.
3. The point the ship reaches max speed or is stopped in the water.
4. The end of test.

Acceleration and deceleration tests are corrected for set and drift by conducting duplicate tests for each in the opposite direction of the original course. The results of these opposing tests are averaged, removing the effects of set and drift.

1.7 OVERVIEW OF TEST EQUIPMENT

The testing was completed using the Differential Global Positioning System. The following equipment was installed on the USCGC JUNIPER on June 8, 1998.

- Ashtech Inc. Ranger XII GPS Receiver
- Starlink Inc. MRB-2A, MSK Radio Beacon Receiver
- Starlink Inc. MBA-2 Integrated Antenna
- Compaq Portable Computer
- TACMAN GPS Software

2.0 TACTICAL TESTING OF THE USCGC JUNIPER (WLB-201)

Tactical testing of the USCGC JUNIPER was completed on June 9, 1998, under near ideal conditions. The testing took place off the coast of Rhode Island in seas of less than 2 feet, with winds less than 8 knots, and water between 87 and 134 deep. The ship's hull had been cleaned during a maintenance period ending on June 6, 1998.

During testing, there were no buoys or sinkers on deck. A summary of the ship's liquid loading on the day of the test is included in Table 1. The draft marks forward were 12-ft, 5-in, and aft were 12-ft, 5-in. The ship's displacement on the day of the test was 1893.5 tons. All testing was conducted with the ship in transit mode of operation as opposed to the maneuvering mode. During the tests, the propeller pitch was increased as the rpm increased at a predetermined rate called the ship's schedule. At the beginning of each test, the speed was set and not changed during that test.

Table 1. USCGC JUNIPER Liquid Loading at Start of Test

CGC JUNIPER (WLB-201) SUMMARY OF TANK CAPACITIES

DIESEL OIL

TANK	100%	95%	CURRENT	TONS	PERCENT	CHANGE
4-17-1-F	5358	5090	4774	14.83	93.79	0
4-17-4-F	3639	3457	0.3537	10.98	102.31	0
4-30-0-F	21700	20615	20446	63.5	94.22	0
4-30-1-F	7605	7225	7334	22.78	96.44	0
4-30-2-F	7605	7225	102	0.32	1.34	0
3-48-0-FF	5841	5549	5761	17.89	98.63	0
3-48-1-F	7922	7526	7841	24.35	98.98	0
3-48-2-F	7922	7526	7830	24.32	98.84	0
3-54-0-F	5841	5549	579	1.8	9.91	-95
3-61-1-F	4569	4341	2876	8.93	62.95	-359
3-62-2-F	3655	3472	2295	7.13	62.79	-63
01-78-1-F	576	547	521	1.62	90.45	0
02-86-2-F	106	101	90	0.28	84.91	0
TOTAL	74498	72674	63986	198.71	83.64%	-517

LUBE OIL

TANK	100%	95%	CURRENT	TONS	PERCENT	CHANGE
3-68-1-F	382	368	200	0.69	52.36%	0
3-69-1-F	382	368	80	0.27	20.94%	0
TOTAL	764	736	280	0.96	36.65%	0

WASTE OIL

TANK	100%	95%	CURRENT	TONS	PERCENT	CHANGE
4-60-1-F	1880	1786	756	2.59	40.21%	0
4-60-2-F	1880	1786	1550	4.81	82.45%	0
4-71-0-F	606	576	0	0	0.00%	0
4-74-2-F	200	190	0	0	0.00%	0
TOTAL	4566	4338	2306	7.16	50.50%	0

HYDRAULIC OIL

TANK	100%	95%	CURRENT	TONS	PERCENT	CHANGE
2-10-0-F	2785	2646	1900	6.6	68.22%	0

CGC JUNIPER (WLB-201) SUMMARY OF TANK CAPACITIES (continued)

BALLAST

TANK	100%	95%	CURRENT	TONS	PERCENT	CHANGE
4-0-0-W	9142		0	0	0.00%	0
4-6-0-W	11525		11525	44.02	100.00%	0
4-21-0-W	17711		0	0.00	0.00%	0
4.-30-3-W	4108		3905	14.92	95.06%	0
4-30-4-W	4108		0	0	0.00%	0
4-48-0-W	22528		0	0	0.00%	0
4-57-0-W	27117		0	0	0.00%	0
TOTAL	96239		15430	58.94	16.03%	0

WASTE WATER

TANK	100%	95%	CURRENT	TONS	PERCENT	CHANGE
4-82-2-W	2798		171	0.65	6.11%	-207
4-81-1-W	1772		155	0.59	8.75%	0
TOTAL	4570		326	1.25	7.13%	-207

POTABLE WATER

TANK	100%	95%	CURRENT	TONS	PERCENT	CHANGE
2-25-1-W	4028		3925	14.99	97.44%	-75
2-25-2-WW	4028		3914	14.95	97.17%	-86
TOTAL	8056		7839	29.94	97.31%	-161

SORS TANK

TANK	100%	95%	CURRENT	TONS	PERCENT	CHANGE
3-39-0-FF	57067		0	0	0.00%	0

DRAFTS

DATE: 09-Jun-98	FORWARD: 12’05"	AFT: 12’5"
PREVIOUS: 07JUN98	PREVIOUS: 12’06"	PREVIOUS: 12’06"

3.0 CONCLUSIONS

3.1 TURNING PERFORMANCE RESULTS

Table 2 presents a summary of the turning circle measurements collected during the testing of the WLB-201. A quick analysis shows that the vessel turns better in the port direction than the starboard. Averaging the results for like turns (i.e., instances where tests were completed in both port and starboard directions for the same speed and rudder angle), it was found that the ship turns slower in the port direction. The turning speed (the speed well into the turn) in the port direction averaged 19% slower than the same turn in the starboard direction. The advance, transfer and tactical diameter distances averaged 14% less in turns made to the port direction. These differences resulted in smaller, tighter turning circles when the vessel turned to port. Starboard turns conversely had faster turning speeds and longer dimensions for advance, transfer and tactical diameter, making the turning circles larger, requiring more room for the ship to maneuver when turning to that direction. These differences are normal for a single propeller ship.

3.2 ACCELERATION, DECELERATION PERFORMANCE RESULTS

Table 3 is a summary of the acceleration and deceleration data. Averaging the results of accelerations in opposite directions (A and B, see Tables 3 and 4) separately and averaging those two values together will remove the effects of the set and drift as much as possible. One of the acceleration runs in the B direction was not used because of a malfunction in the software. Evaluating the average values for time and distance for the vessel to come to a full speed of almost 16 knots from a dead stop in the water, we found that the ship accelerated in 125 seconds and traversed 724 yards. This value equates to 9.6 boat lengths. Averaging the test results for the deceleration tests as above, the data show the vessel stopping from an average speed of 15.8 knots in 88 seconds, in a distance of 428 yards. This is equivalent to 5.7 boat lengths.

4.0 RECOMMENDATIONS

It is recommended that these data be adopted for the Juniper class of vessel until data are available which would supersede these data, or until data on individual ships are available.

Table 2. Summary of Turning Circle Data for the USCG JUNIPER (WLB-201)

Initial Speed (kts)	Rudder Angle (deg)	Direction of turn	Turning Speed (kts)	Advance @ 90 Degrees (yards)	Transfer @ 90 Degrees (yards)	Time to 90 Degrees (sec)	Tactical Diameter (yards)	Turning Radius (yards)	Time to 180 Degrees (sec)	Time to 270 Degrees (sec)	Time to 360 Degrees (sec)
6	10	Stbd	4.11	341.9	188.5	140	291.29	164.78	185	error	430
6	10	Port	3.64	204.7	164	101	308.19	137.77	202	294	395
6	15	Port	3.08	243	130.1	112	238.03	103.43	199	280	374
6	20	Port	2.77	209.7	116	105	201.39	84.86	185	275	336
6	30*	Port	2.37	194.19	92.9	error	156.46	63.6	167	244	291
6	38*	Port	2.08	187.07	83.14	error	134.42	52.56	167	232	271
9	10	Port	5.2	331.5	176.1	94	320.14	139.35	165	227	305
9	15	Stbd	5.85	288.6	169.4	79	283.64	131.81	117	error	253
9	15	Port	4.23	256.3	142.5	80	248.69	107.15	146	204	270
9	20	Port	3.69	244.9	118.2	77	207.21	83.35	138	164	246
9	30	Port	3.05	222.1	97	74	160.75	61.28	127	150	218
9	38	Port	2.74	199.3	82.7	67	140	47.35	117	138	195
12	10	Port	7.3	322.9	188.4	73	333.75	146.59	125	error	229
12	15	Port	6.21	266.5	151.2	62	262.45	109.33	108	error	198
12	20	Stbd	7.06	258.8	145.7	53	243.21	119.26	error	error	175
12	20	Port	5.47	249.4	120.9	58	211.38	86.34	100	error	177
12	30	Port	4.36	219.8	99.5	52	168.85	64.61	91	111	160
12	38	Port	3.73	214.3	91.7	51	151.01	48.85	90	109	147

* Indicates software failure, data presented was calculated manually.
Error indicates software failure, this data unrecoverable.

Table 2. Summary of Turning Circle Data for the USCG JUNIPER (WLB-201) (continued)

Initial Speed (kts)	Rudder Angle (deg)	Direction of turn	Turning Speed (kts)	Advance @ 90 Degrees (yards)	Transfer @ 90 Degrees (yards)	Time to 90 Degrees (sec)	Tactical Diameter (yards)	Turning Radius (yards)	Time to 180 Degrees (sec)	Time to 270 Degrees (sec)	Time to 360 Degrees (sec)
16	10	Stbd	13.73	380	256.9	59	458.88	180.42	98	121	166
16	10	Port	11.78	320	198.1	53	350.38	156.43	90	107	158
16	15	Stbd	12.27	314.2	179.2	48	308.39	134.93	77	108	134
16	15	Port	10.12	271	145.5	46	257.63	117.35	77	80	133
16	20	Stbd	11.15	267.6	148.1	42	255.51	115.98	69	97	121
16	20	Port	9.24	239.8	123.2	41	214.67	94.07	69	error	118
16	30	Stbd	9.14	231.4	110.7	37	143.94	88.68	error	error	108
16	30	Port	7.2	220	94	38	153.16	67.38	55	error	105
16	38	Stbd	7.99	229.6	96.9	36	127.36	75.63	error	error	104
16	38*	Port	6.14	211.14	87.52	error	140.81	56.29	61	86	121

* Indicates software failure, data presented was calculated manually.
Error indicates software failure, this data unrecoverable.

Table 3. Acceleration Data for JUNIPER (WLB-201)

Acceleration Direction	Time To Full Speed (sec)	Distance To Full Speed (yards)	Maximum Speed Reached (knots)
A direction	127	732.84	15.7
B direction	127	721.92	15.6
A direction	119	663.96	15.6
B direction	134	805	15.5
A direction	118	660.43	15.7
Average A dir.	121.33	685.74	15.67
Average B dir.	130.5	763.46	15.55
Average A&B	125.92	724.6	15.61

Table 4. Deceleration Data for JUNIPER (WLB-201)

Deceleration Direction	Time Full Speed to DIW (sec)	Distance Full Speed to DIW (yards)	Starting Speed (knots)
B Direction	98	443.42	15.7
A Direction	84	425.84	15.7
B Direction	89	418.68	16.1
Average A dir.	84	425.84	15.7
Average B dir.	93.5	431.05	15.9
Average A&B	88.75	428.45	15.8

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Appendix A

USCGC JUNIPER Corrected Tactical Test Data

9 June 1998
13:09:32
Starboard
Maneuver # 1
10 Rudder
at 6.0 Kts
Position Plt
Plot Center:
41 18.2 N
71 9.4 W
Set 24.0 Deg
Drift 0.2Kts

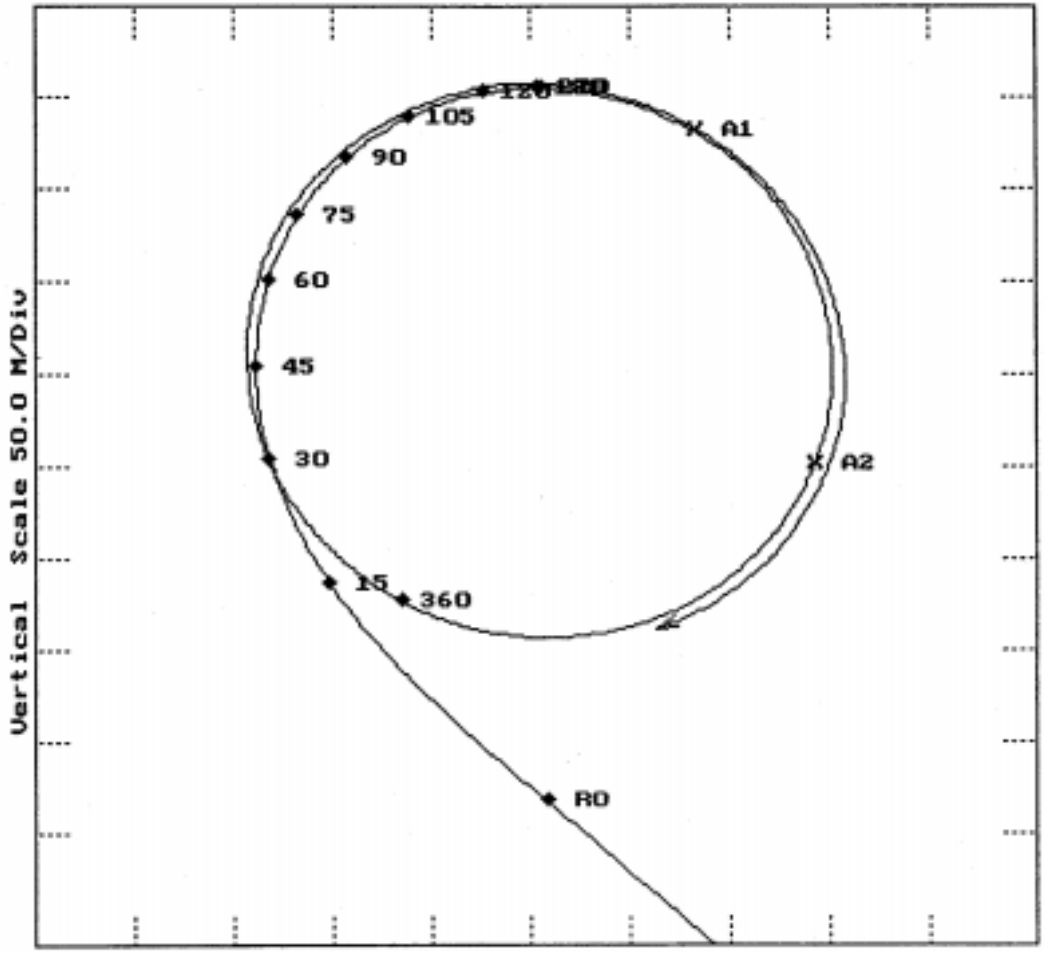


Figure A-1, Starboard Turn Maneuver 6 kts., 10 deg. Rudder

Maneuver performed at 13:09:32 GMT on
9 June 1998
Starboard Turn Maneuver on Juniper WLB 201
Executed with a 10 Degree Rudder at a speed of 6 Knots both engines

EVENT	15	30	45	60	75	90	105	120	DEG.
TURN TIME	* 52.0	* 76.0	* 93.0	*110.0	*124.0	*140.0	*156.0	*173.0	Sec.
ADVANCE	175.0	249.2	291.6	322.2	337.0	341.9	334.2	315.2	Yrd.
TRANSFER	6.7	34.7	67.1	107.5	144.9	188.5	229.3	268.3	Yrd.

EVENT	TIME	MEASURE
TIME to RUDDER OVER	0.0 sec.	
TIME to 180 deg TURN	*185.0 Sec.	
TIME to 270 deg TURN	*186.0 Sec.	
TIME to 360 deg TURN	430.0 Sec.	
Initial HEADING		314 Degrees
Initial SPEED		5.93 Knots
TURNING SPEED		4.11 Knots
TACTICAL DIAMETER		291.29 Yards
TURING RADIUS based on USER selected MARKS 13:14:41 and 13:16:13		164.78 Yards

(*) Indicates a computer assigned mark !

Table A-1, Starboard Turn Maneuver 6 kts., 10 deg. Rudder

9 June 1998
08:38:49
Port
Maneuver # 1
10 Rudder
at 6.0 Kts
Position Plt
Plot Center:
41 24.9 N
71 22.5 W
Set 260.0 Deg
Drift 0.2Kts

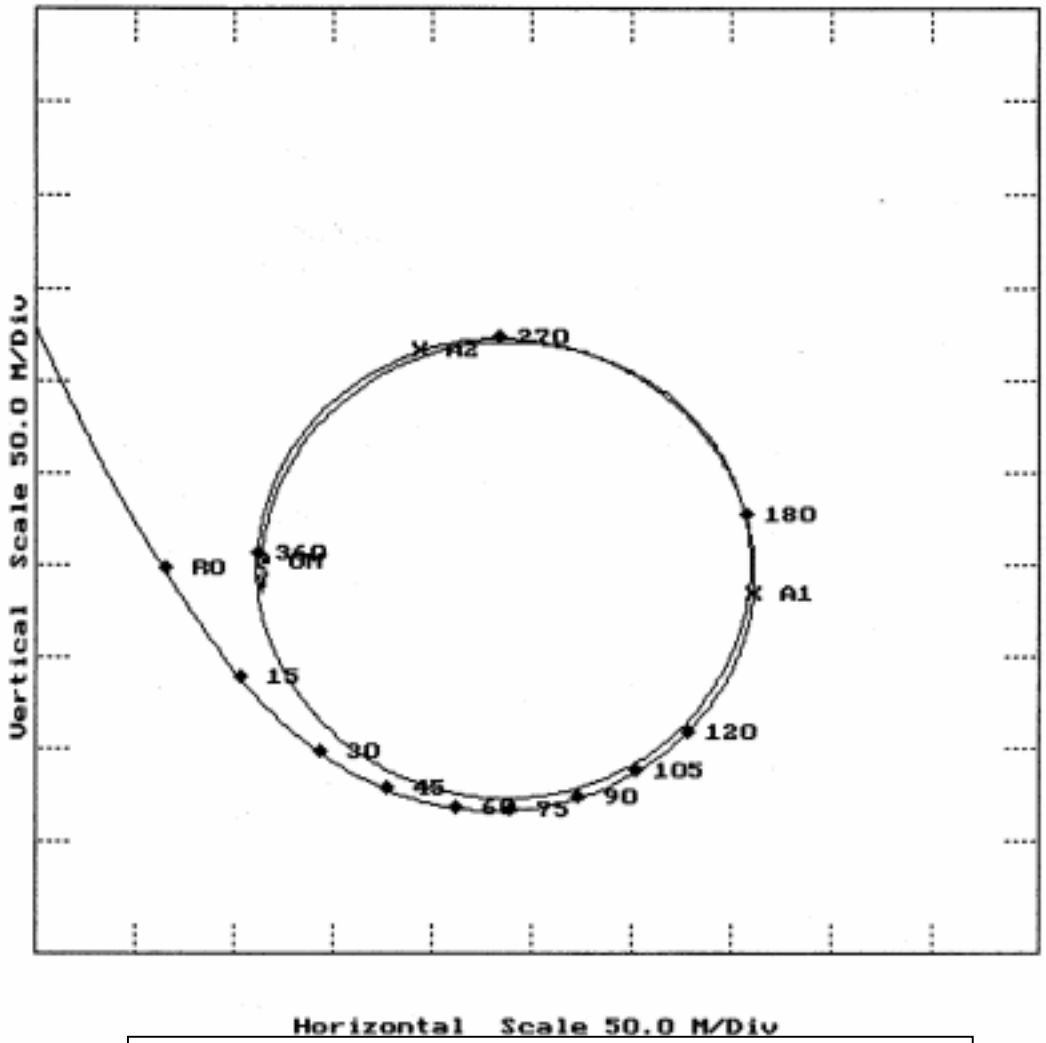


Figure A-2, Port Turn Maneuver 6 kts., 10 deg. Rudder

Maneuver performed at 08:38:49 GMT on
9 June 1998
Port Turn Maneuver on juniper wlb 201
Executed with a 10 Degree Rudder at a speed of 6 Knots both engines

EVENT	15	30	45	60	75	90	105	120	DEG.
TURN TIME	* 23.0	* 43.0	* 58.0	* 73.0	* 85.0	*101.0	*117.0	*134.0	Sec.
ADVANCE	73.5	129.7	162.7	186.5	198.2	204.7	201.8	190.5	Yrd.
TRANSFER	16.5	41.9	68.7	100.4	127.6	164.0	199.3	233.2	Yrd.

EVENT	TIME	MEASURE
TIME to RUDDER OVER	0.0 sec.	
TIME to 180 deg TURN	*202.0 Sec.	
TIME to 270 deg TURN	*294.0 Sec.	
TIME to 360 deg TURN	395.0 Sec.	
Initial HEADING		159 Degrees
Initial SPEED		5.99 Knots
TURNING SPEED		3.64 Knots
TACTICAL DIAMETER		308.19 Yards
TURING RADIUS based on USER selected MARKS 08:43:53 and 08:46:10		137.77 Yards

(*) Indicates a computer assigned mark !

Table A-2, Port Turn Maneuver 6 kts., 10 deg. Rudder

9 June 1998
09:00:01
Port
Maneuver # 2
15 Rudder
at 6.0 Kts
Position Plt
Plot Center:
41 24.3 N
71 22.2 W
Set 260.0 Deg
Drift 0.2Kts

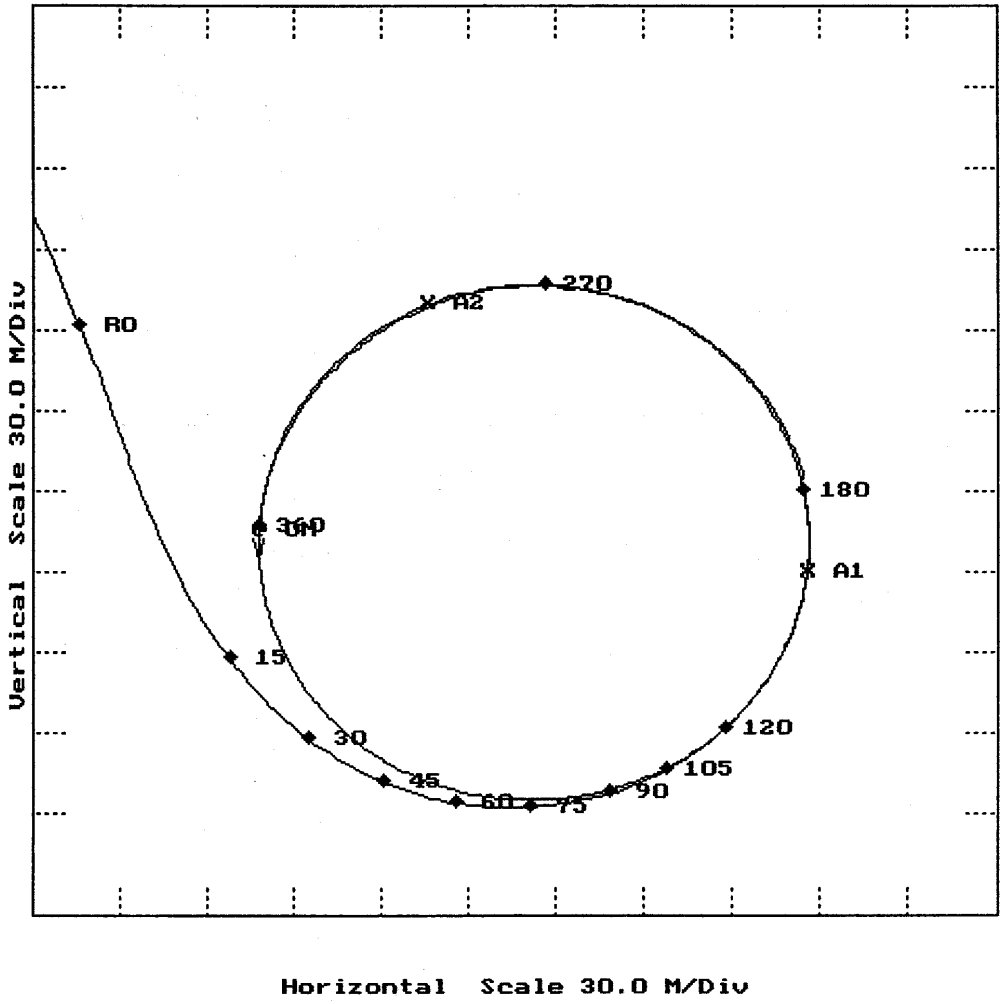


Figure A-3, Port Turn Maneuver 6 kts., 15 deg. Rudder

Maneuver performed at 09:00:01 GMT on
9 June 1998
Port Turn Maneuver on juniper wlb 201
Executed with a 15 Degree Rudder at a speed of 6 Knots both engines

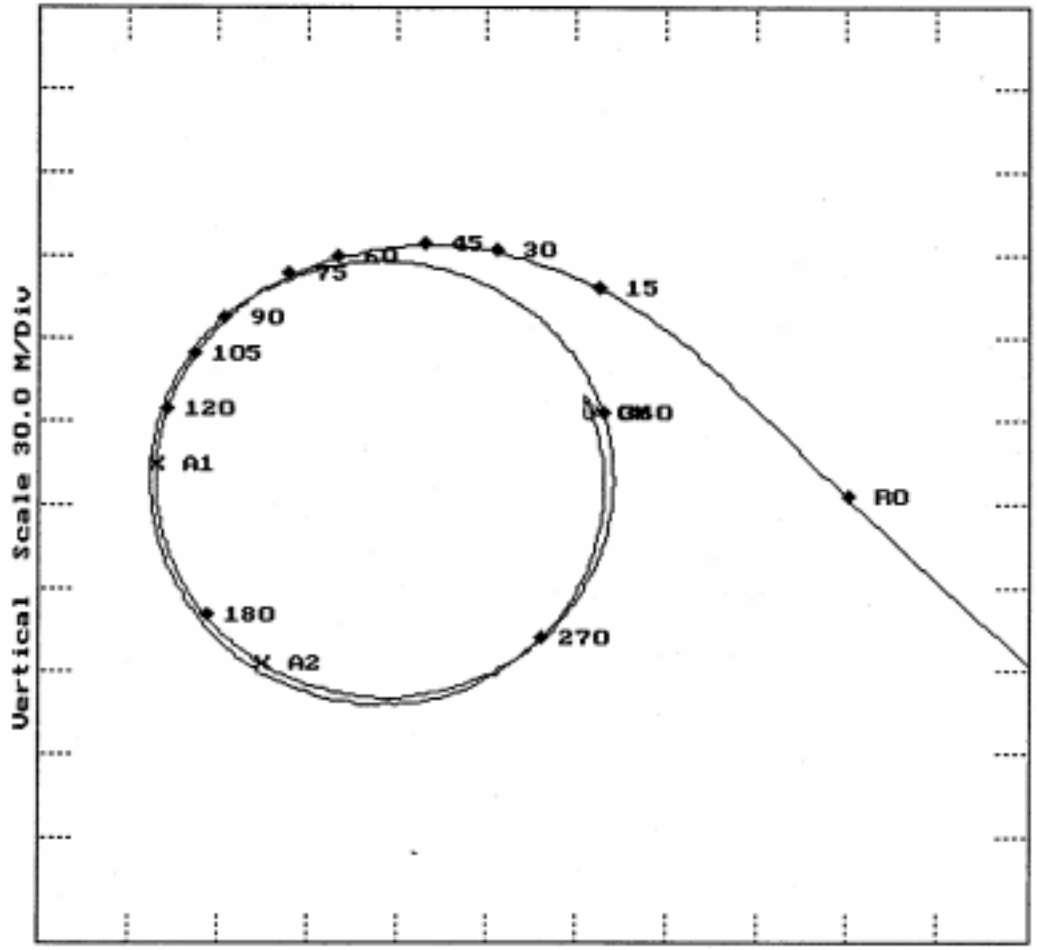
EVENT	15	30	45	60	75	90	105	120	DEG.
TURN TIME	* 44.0	* 59.0	* 72.0	* 84.0	* 97.0	*112.0	*124.0	*139.0	Sec.
ADVANCE	145.2	184.9	210.8	227.7	238.3	243.0	240.8	232.5	Yrd.
TRANSFER	11.0	28.7	50.4	73.5	99.7	130.1	152.8	179.0	Yrd.

EVENT	TIME	MEASURE
TIME to RUDDER OVER	0.0 sec.	
TIME to 180 deg TURN	*199.0 Sec.	
TIME to 270 deg TURN	*280.0 Sec.	
TIME to 360 deg TURN	374.0 Sec.	
Initial HEADING		161 Degrees
Initial SPEED		6.03 Knots
TURNING SPEED		3.08 Knots
TACTICAL DIAMETER		238.03 Yards
TURING RADIUS based on USER selected MARKS 09:04:00 and 09:06:07		103.43 Yards

(*) Indicates a computer assigned mark !

Table A-3, Port Turn Maneuver 6 kts., 15 deg. Rudder

9 June 1998
13:29:19
Port
Maneuver # 2
20 Rudder
at 6.0 Kts
Position Plt
Plot Center:
41 18.7 N
71 9.9 W
Set 38.0 Deg
Drift 0.1Kts



Horizontal Scale 30.0 M/Div

Figure A-4, Port Turn Maneuver 6 kts., 20 deg. Rudder

Maneuver performed at 13:29:19 GMT on
9 June 1998
Port Turn Maneuver on Juniper WLB 201
Executed with a 20 Degree Rudder at a speed of 6 Knots both engines

EVENT	15	30	45	60	75	90	105	120	DEG.
TURN TIME	* 38.0	* 53.0	* 64.0	* 79.0	* 89.0	*105.0	*116.0	*130.0	Sec.
ADVANCE	122.0	159.0	179.4	198.2	206.0	209.7	207.3	199.0	Yrd.
TRANSFER	8.1	25.3	42.8	69.4	87.6	116.0	134.3	156.4	Yrd.

EVENT	TIME	MEASURE
TIME to RUDDER OVER	0.0 sec.	
TIME to 180 deg TURN	*185.0 Sec.	
TIME to 270 deg TURN	*275.0 Sec.	
TIME to 360 deg TURN	336.0 Sec.	
Initial HEADING		315 Degrees
Initial SPEED		5.99 Knots
TURNING SPEED		2.77 Knots
TACTICAL DIAMETER		201.39 Yards
TURING RADIUS based on USER selected MARKS 13:32:49 and 13:33:48		84.86 Yards

(*) Indicates a computer assigned mark !

Table A-4, Port Turn Maneuver 6 kts., 20 deg. Rudder

1300
#3

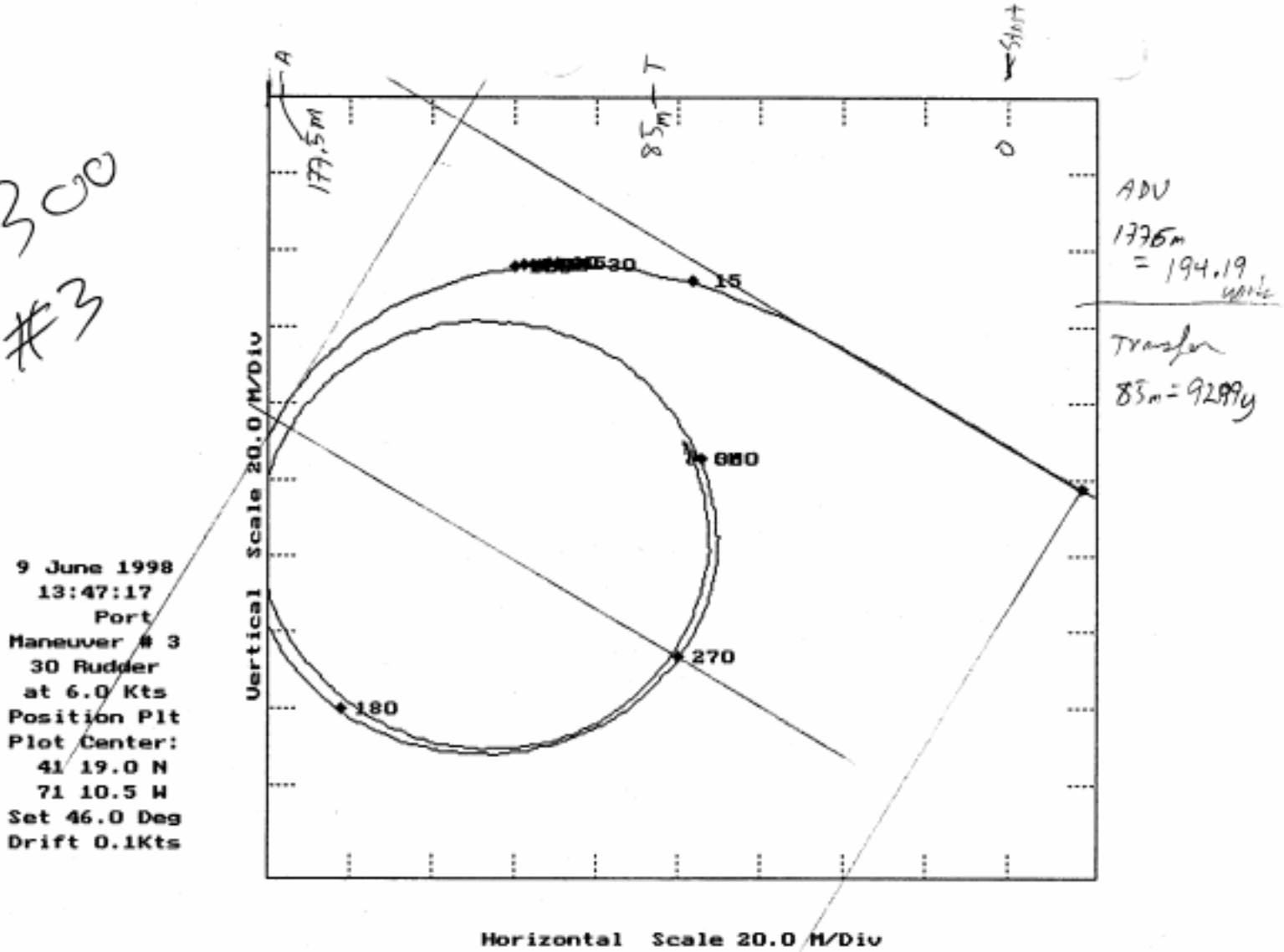


Figure A-5, Port Turn Maneuver 6 kts., 30 deg. Rudder

1,094

No data sheet for this test.

Table A-5, Port Turn Maneuver 6 kts., 30 deg. Rudder

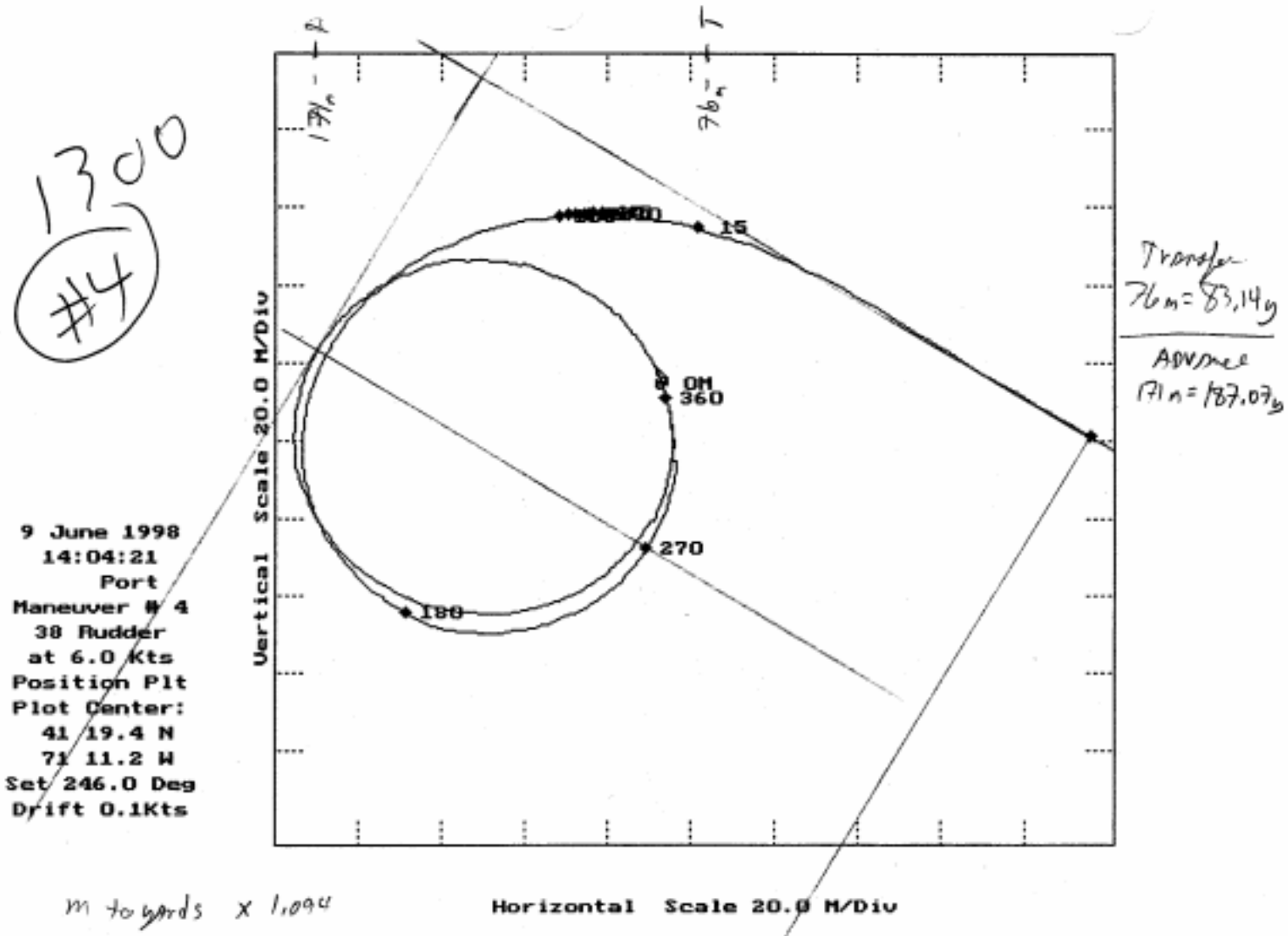


Figure A-6, Port Turn Maneuver 6 kts., 38 deg. Rudder

No data sheet for this test.

Table A-6, Port Turn Maneuver 6 kts., 38 deg. Rudder

9 June 1998
09:26:56
Port
Maneuver # 3
10 Rudder
at 9.0 Kts
Position Plt
Plot Center:
41 22.6 N
71 21.6 W
Set 260.0 Deg
Drift 0.1Kts

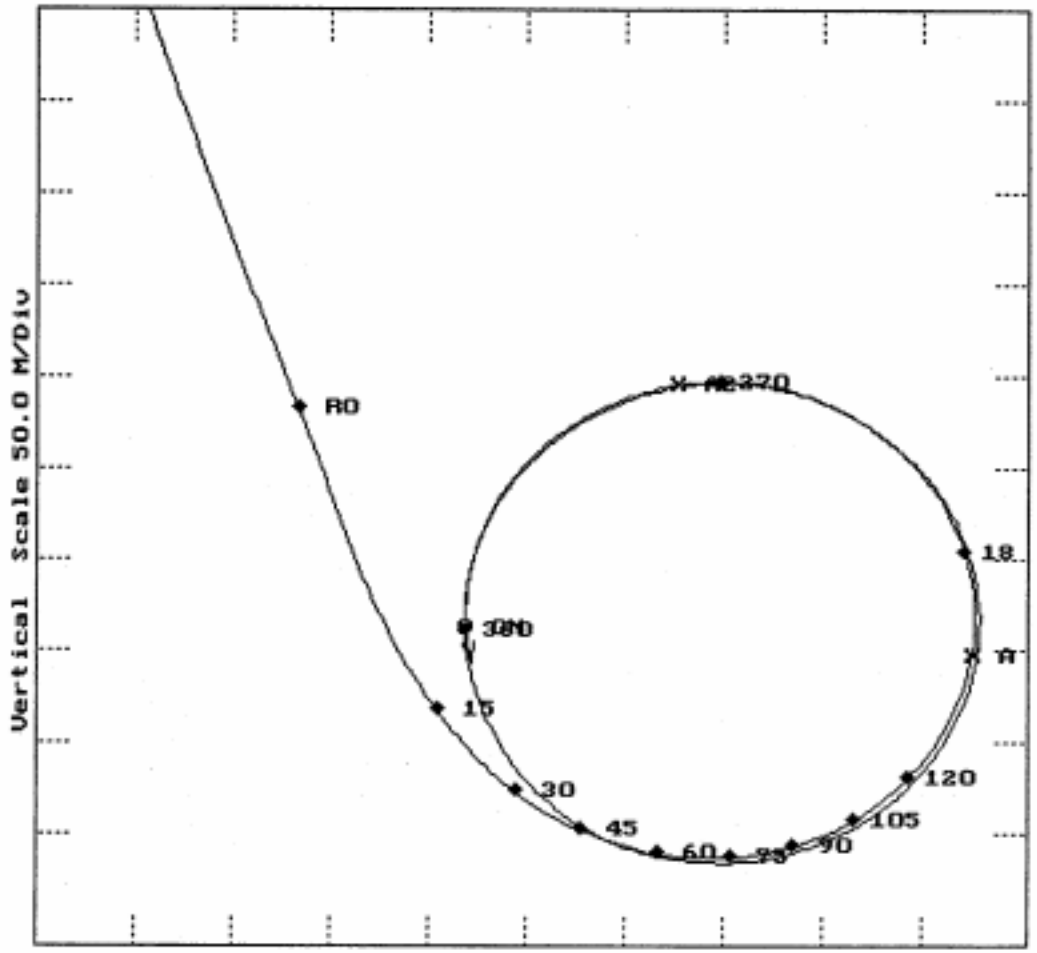


Figure A-7, Port Turn Maneuver 9 kts., 10 Deg Rudder

Maneuver performed at 09:26:56 GMT on
9 June 1998
Port Turn Maneuver on juniper wlb 201
Executed with a 10 Degree Rudder at a speed of 9 Knots both engines

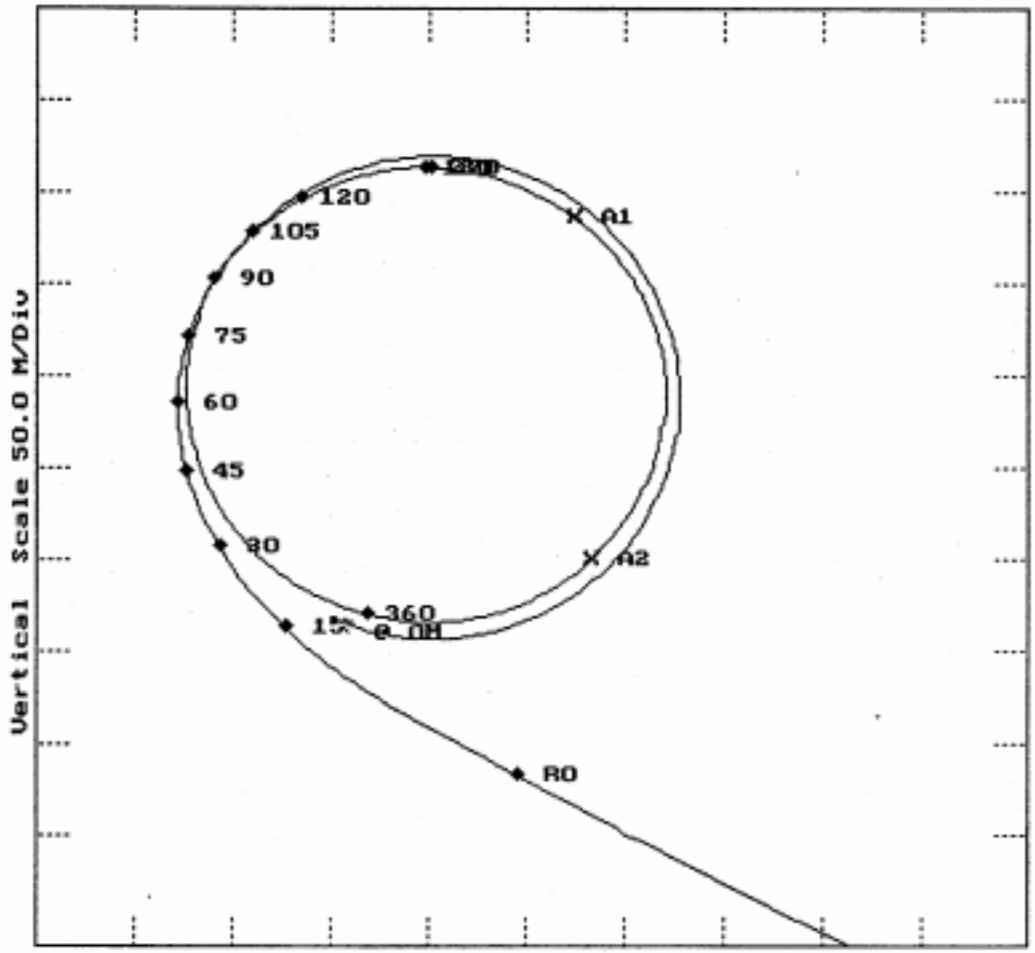
EVENT	15	30	45	60	75	90	105	120	DEG.
TURN TIME	* 38.0	* 52.0	* 62.0	* 73.0	* 84.0	* 94.0	*105.0	*117.0	Sec.
ADVANCE	192.8	252.0	284.4	311.1	326.7	331.5	327.7	314.1	Yrd.
TRANSFER	15.5	41.8	68.7	103.9	141.6	176.1	212.3	247.7	Yrd.

EVENT	TIME	MEASURE
TIME to RUDDER OVER	0.0 sec.	
TIME to 180 deg TURN	*165.0 Sec.	
TIME to 270 deg TURN	*227.0 Sec.	
TIME to 360 deg TURN	305.0 Sec.	
Initial HEADING		161 Degrees
Initial SPEED		9.29 Knots
TURNING SPEED		5.20 Knots
TACTICAL DIAMETER		320.14 Yards
TURING RADIUS based on USER	selected MARKS 09:30:11 and 09:31:42	139.35 Yards

(*) Indicates a computer assigned mark !

Table A-7, Port Turn Maneuver 9 kts., 10 Deg Rudder

9 June 1998
14:30:11
Starboard
Maneuver # 1
15 Rudder
at 9.0 Kts
Position Plt
Plot Center:
41 20.3 N
71 13.5 W
Set 0.0 Deg
Drift 0.0Kts



Horizontal Scale 50.0 M/Div

Figure A-8, Starboard Turn Maneuver 9 kts., 15 deg. Rudder

Maneuver performed at 14:30:11 GMT on
9 June 1998
Starboard Turn Maneuver on Juniper WLB 201
Executed with a 15 Degree Rudder at a speed of 9 Knots both engines

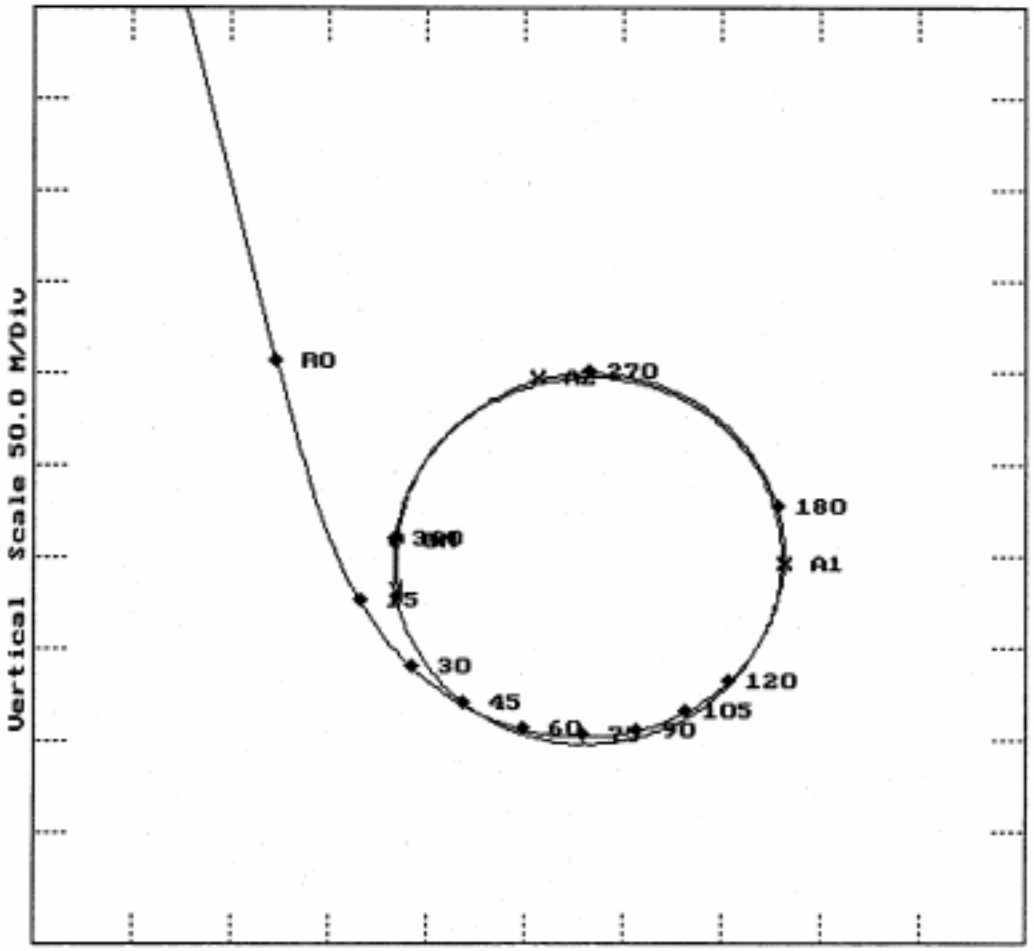
EVENT	15	30	45	60	75	90	105	120	DEG.
TURN TIME	* 30.0	* 42.0	* 52.0	* 61.0	* 70.0	* 79.0	* 88.0	* 97.0	Sec.
ADVANCE	154.3	209.5	246.6	270.7	284.6	288.6	282.9	269.4	Yrd.
TRANSFER	11.5	34.8	64.2	96.7	132.8	169.4	203.6	234.1	Yrd.

EVENT	TIME	MEASURE
TIME to RUDDER OVER	0.0 sec.	
TIME to 180 deg TURN	*117.0 Sec.	
TIME to 270 deg TURN	*118.0 Sec.	
TIME to 360 deg TURN	253.0 Sec.	
Initial HEADING		299 Degrees
Initial SPEED		9.14 Knots
TURNING SPEED		5.85 Knots
TACTICAL DIAMETER		283.64 Yards
TURING RADIUS based on USER selected MARKS 14:33:31 and 14:34:40		131.81 Yards

(*) Indicates a computer assigned mark !

Table A-8, Starboard Turn Maneuver 9 kts., 15 deg. Rudder

9 June 1998
09:42:05
Port
Maneuver # 1
15 Rudder
at 9.0 Kts
Position Plt
Plot Center:
41 21.9 N
71 21.3 W
Set 221.0 Deg
Drift 0.0Kts



Horizontal Scale 50.0 M/Div

Figure A-9, Port Turn Maneuver 9 kts., 15 deg. Rudder

Maneuver performed at 09:42:05 GMT on
9 June 1998
Port Turn Maneuver on juniper wlb 201
Executed with a 15 Degree Rudder at a speed of 9 Knots both engines

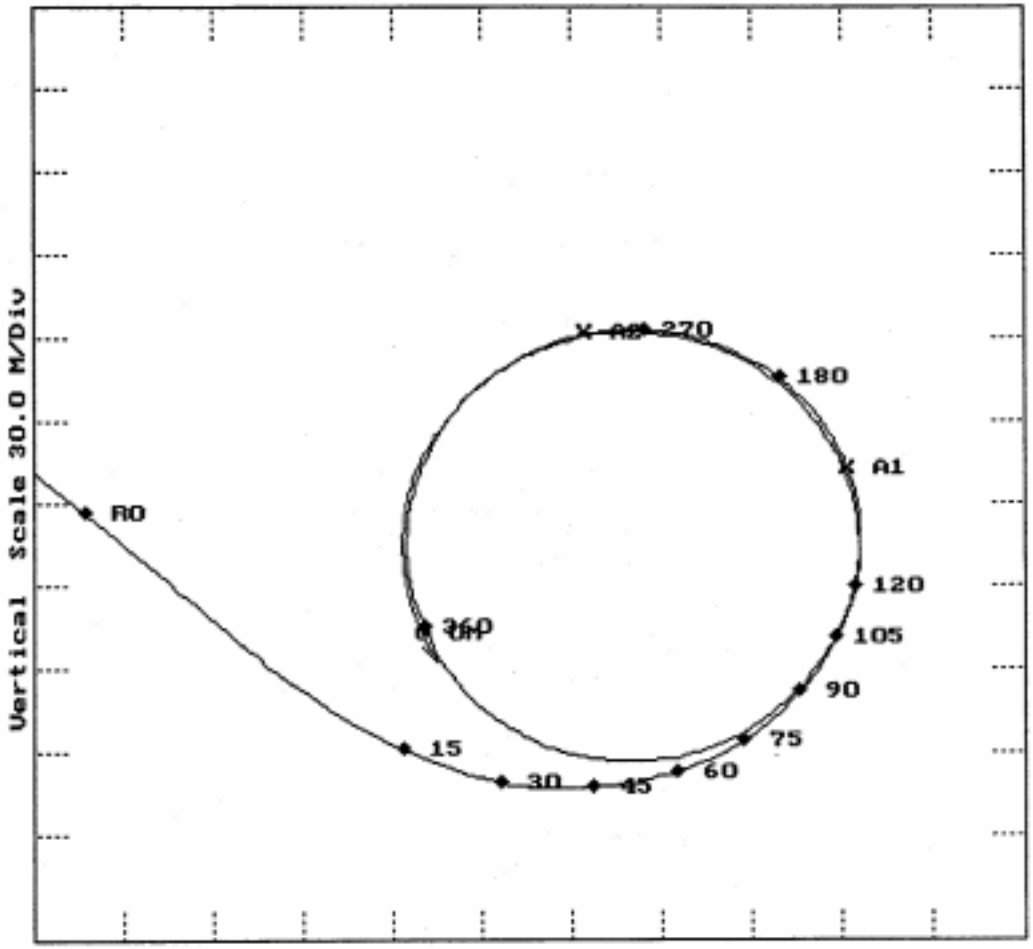
EVENT	15	30	45	60	75	90	105	120	DEG.
TURN TIME	* 30.0	* 41.0	* 50.0	* 60.0	* 70.0	* 80.0	* 90.0	*101.0	Sec.
ADVANCE	146.5	190.6	218.8	240.4	252.7	256.3	252.2	241.1	Yrd.
TRANSFER	11.7	30.5	52.6	81.3	112.2	142.5	170.6	197.7	Yrd.

EVENT	TIME	MEASURE
TIME to RUDDER OVER	0.0 sec.	
TIME to 180 deg TURN	*146.0 Sec.	
TIME to 270 deg TURN	*204.0 Sec.	
TIME to 360 deg TURN	270.0 Sec.	
Initial HEADING		166 Degrees
Initial SPEED		9.12 Knots
TURNING SPEED		4.23 Knots
TACTICAL DIAMETER		248.69 Yards
TURING RADIUS based on USER selected MARKS 09:46:05 and 09:47:29		107.15 Yards

(*) Indicates a computer assigned mark !

Table A-9, Port Turn Maneuver 9 kts., 15 deg. Rudder

9 June 1998
09:59:12
Port
Maneuver # 2
20 Rudder
at 9.0 Kts
Position Plt
Plot Center:
41 21.1 N
71 20.4 W
Set 220.0 Deg
Drift 0.0Kts



Horizontal Scale 30.0 M/Div

Figure A-10, Port Turn Maneuver 9 kts., 20 deg. Rudder

Maneuver performed at 09:59:12 GMT on
9 June 1998
Port Turn Maneuver on juniper wlb 201
Executed with a 20 Degree Rudder at a speed of 9 Knots both engines

EVENT	15	30	45	60	75	90	105	120	DEG.
TURN TIME	* 31.0	* 40.0	* 49.0	* 58.0	* 67.0	* 77.0	* 87.0	* 96.0	Sec.
ADVANCE	149.7	185.4	212.1	231.1	241.9	244.9	241.6	233.9	Yrd.
TRANSFER	6.7	20.6	41.4	65.4	90.5	118.2	143.5	163.2	Yrd.

EVENT	TIME	MEASURE
TIME to RUDDER OVER	0.0 sec.	
TIME to 180 deg TURN	*138.0 Sec.	
TIME to 270 deg TURN	*164.0 Sec.	
TIME to 360 deg TURN	246.0 Sec.	
Initial HEADING		130 Degrees
Initial SPEED		9.04 Knots
TURNING SPEED		3.69 Knots
TACTICAL DIAMETER		207.21 Yards
TURING RADIUS based on USER selected MARKS 10:02:20 and 10:03:18		83.35 Yards

(*) Indicates a computer assigned mark !

Table A-10, Port Turn Maneuver 9 kts., 20 deg. Rudder

9 June 1998
10:16:02
Port
Maneuver # 3
30 Rudder
at 9.0 Kts
Position Plt
Plot Center:
41 20.4 N
71 19.2 W
Set 195.0 Deg
Drift 0.0Kts

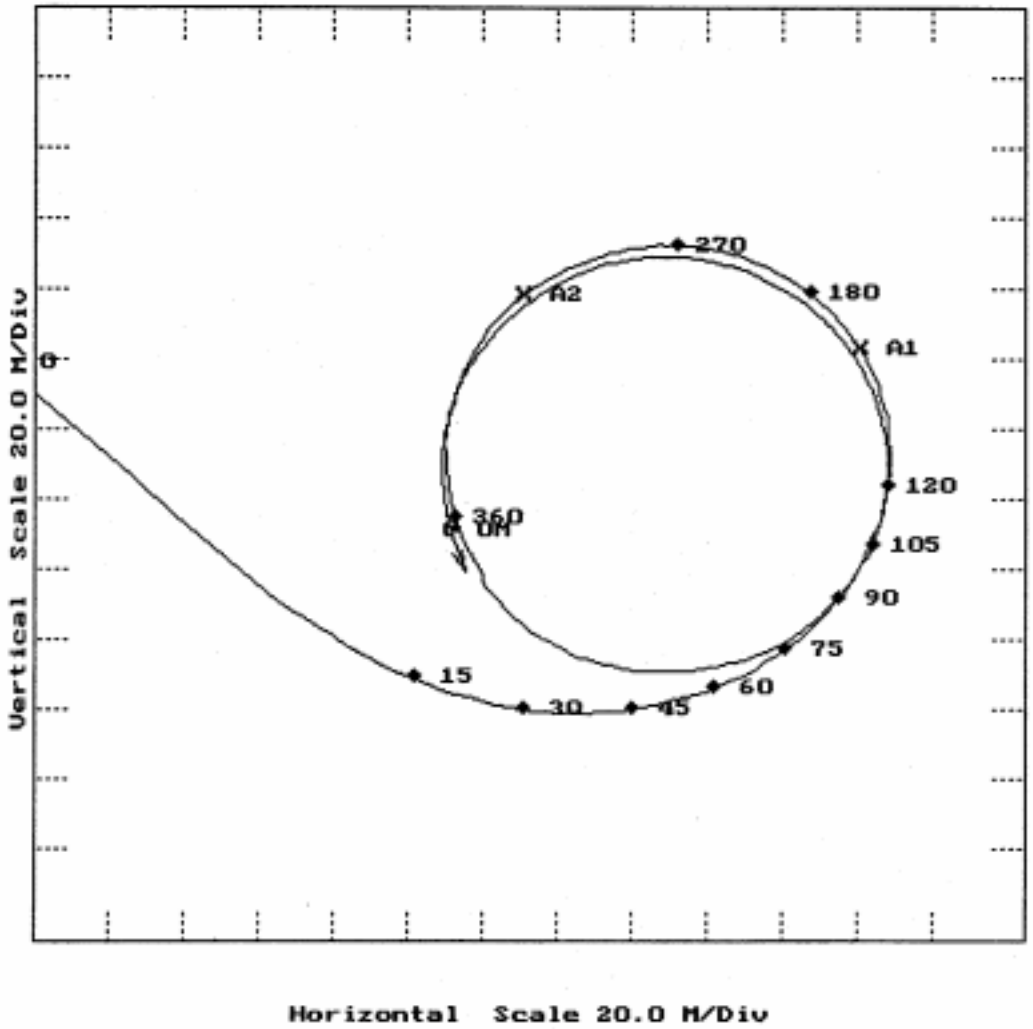


Figure A-11, Port Turn Maneuver 9 kts., 30 deg. Rudder

Maneuver performed at 10:16:02 GMT on
9 June 1998
Port Turn Maneuver on juniper wlb 201
Executed with a 30 Degree Rudder at a speed of 9 Knots both engines

EVENT	15	30	45	60	75	90	105	120	DEG.
TURN TIME	* 31.0	* 39.0	* 48.0	* 56.0	* 65.0	* 74.0	* 83.0	* 92.0	Sec.
ADVANCE	147.9	176.6	199.6	212.6	220.4	222.1	219.4	211.1	Yrd.
TRANSFER	3.8	16.5	36.0	55.2	76.6	97.0	115.2	131.3	Yrd.

EVENT	TIME	MEASURE
TIME to RUDDER OVER	0.0 sec.	
TIME to 180 deg TURN	*127.0 Sec.	
TIME to 270 deg TURN	*150.0 Sec.	
TIME to 360 deg TURN	218.0 Sec.	
Initial HEADING		130 Degrees
Initial SPEED		9.00 Knots
TURNING SPEED		3.05 Knots
TACTICAL DIAMETER		160.75 Yards
TURING RADIUS based on USER selected MARKS 10:19:12 and 10:20:14		61.28 Yards

(*) Indicates a computer assigned mark !

Table A-11, Port Turn Maneuver 9 kts., 30 deg. Rudder

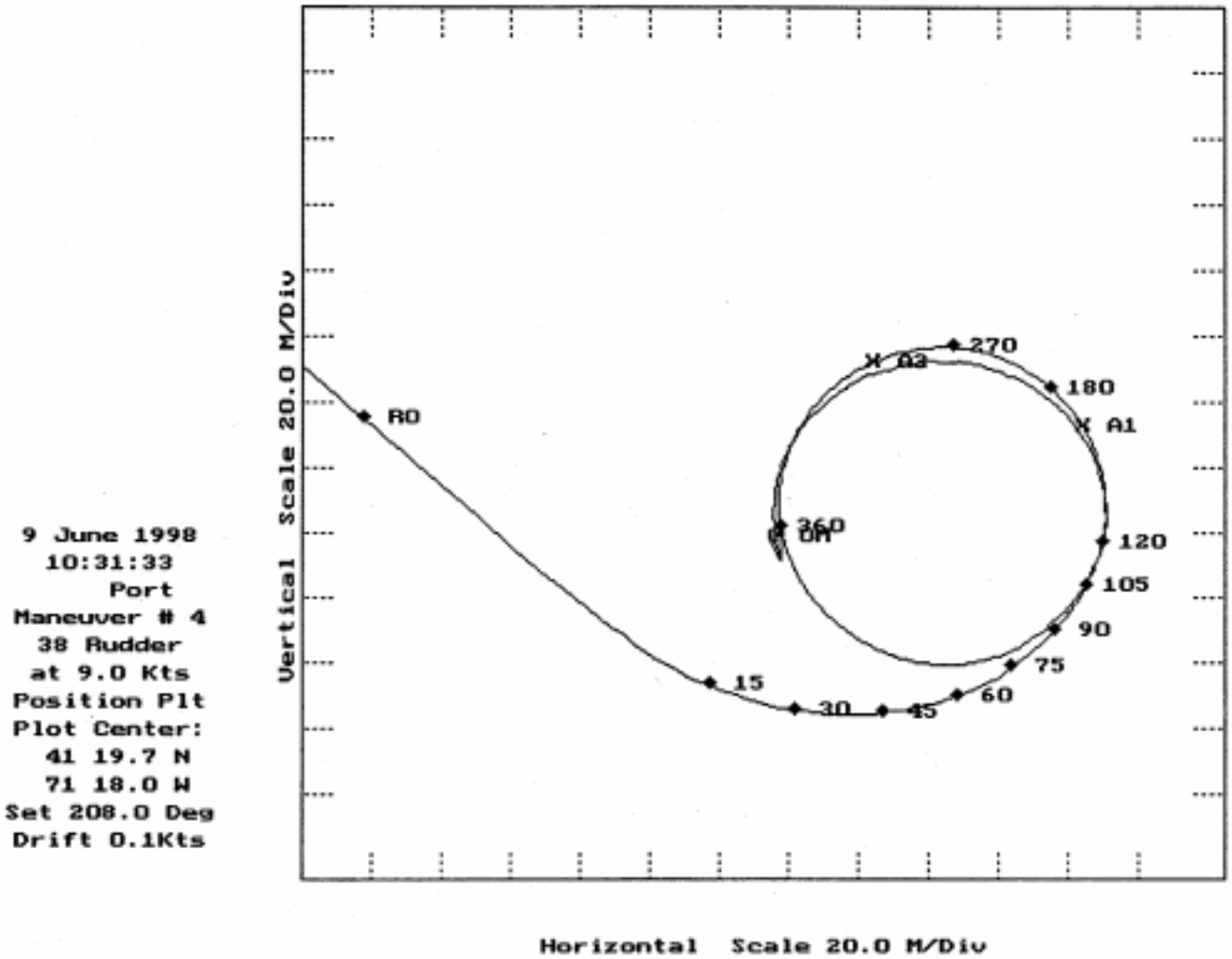


Figure A-12, Port Turn Maneuver 9 kts., 38 deg. Rudder

Maneuver performed at 10:31:33 GMT on
9 June 1998
Port Turn Maneuver on juniper wlb 201
Executed with a 38 Degree Rudder at a speed of 9 Knots both engines

EVENT	15	30	45	60	75	90	105	120	DEG.
TURN TIME	* 28.0	* 35.0	* 43.0	* 51.0	* 59.0	* 67.0	* 76.0	* 84.0	Sec.
ADVANCE	132.9	157.3	177.7	190.6	197.2	199.3	197.1	191.7	Yrd.
TRANSFER	3.0	13.8	30.1	48.2	65.7	82.7	99.8	113.2	Yrd.

EVENT	TIME	MEASURE
TIME to RUDDER OVER	0.0 sec.	
TIME to 180 deg TURN	*117.0 Sec.	
TIME to 270 deg TURN	*138.0 Sec.	
TIME to 360 deg TURN	195.0 Sec.	
Initial HEADING		130 Degrees
Initial SPEED		9.10 Knots
TURNING SPEED		2.74 Knots
TACTICAL DIAMETER		140.00 Yards
TURING RADIUS based on USER	selected MARKS 10:34:14 and 10:35:01	47.35 Yards

(*) Indicates a computer assigned mark !

Table A-12, Port Turn Maneuver 9 kts., 38 deg. Rudder

9 June 1998
10:47:13
Port
Maneuver # 1
10 Rudder
at 12.0 Kts
Position Plt
Plot Center:
41 18.8 N
71 16.5 W
Set 204.0 Deg
Drift 0.1Kts

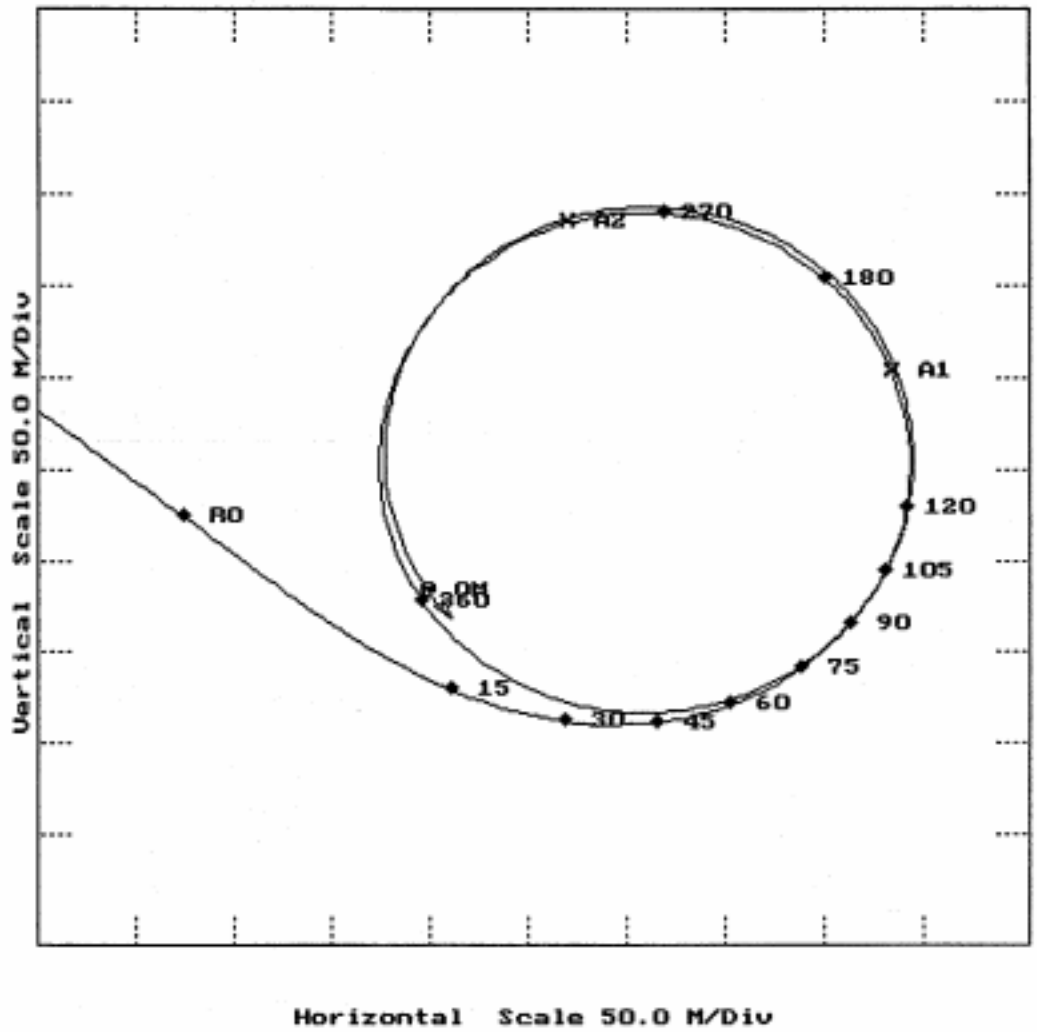


Figure A-13, Port Turn Maneuver 12 kts., 10 deg. Rudder

Maneuver performed at 10:47:13 GMT on
9 June 1998
Port Turn Maneuver on Juniper wlb201
Executed with a 10 Degree Rudder at a speed of 12 Knots both engines

EVENT	15	30	45	60	75	90	105	120	DEG.
TURN TIME	* 28.0	* 39.0	* 48.0	* 56.0	* 65.0	* 73.0	* 81.0	* 90.0	Sec.
ADVANCE	179.1	239.5	278.8	303.2	319.0	322.9	317.2	302.3	Yrd.
TRANSFER	17.6	43.6	75.4	109.6	151.1	188.4	224.1	260.6	Yrd.

EVENT	TIME	MEASURE
TIME to RUDDER OVER	0.0 sec.	
TIME to 180 deg TURN	*125.0 Sec.	
TIME to 270 deg TURN	*149.0 Sec.	
TIME to 360 deg TURN	229.0 Sec.	
Initial HEADING		130 Degrees
Initial SPEED		11.73 Knots
TURNING SPEED		7.30 Knots
TACTICAL DIAMETER		333.75 Yards
TURING RADIUS based on USER selected MARKS 10:50:06 and 10:50:59		146.59 Yards

(*) Indicates a computer assigned mark !

Table A-13, Port Turn Maneuver 12 kts., 10 deg. Rudder

9 June 1998
10:59:43
Port
Maneuver # 2
15 Rudder
at 12.0 Kts
Position Plt
Plot Center:
41 18.2 N
71 15.5 W
Set 186.0 Deg
Drift 0.1Kts

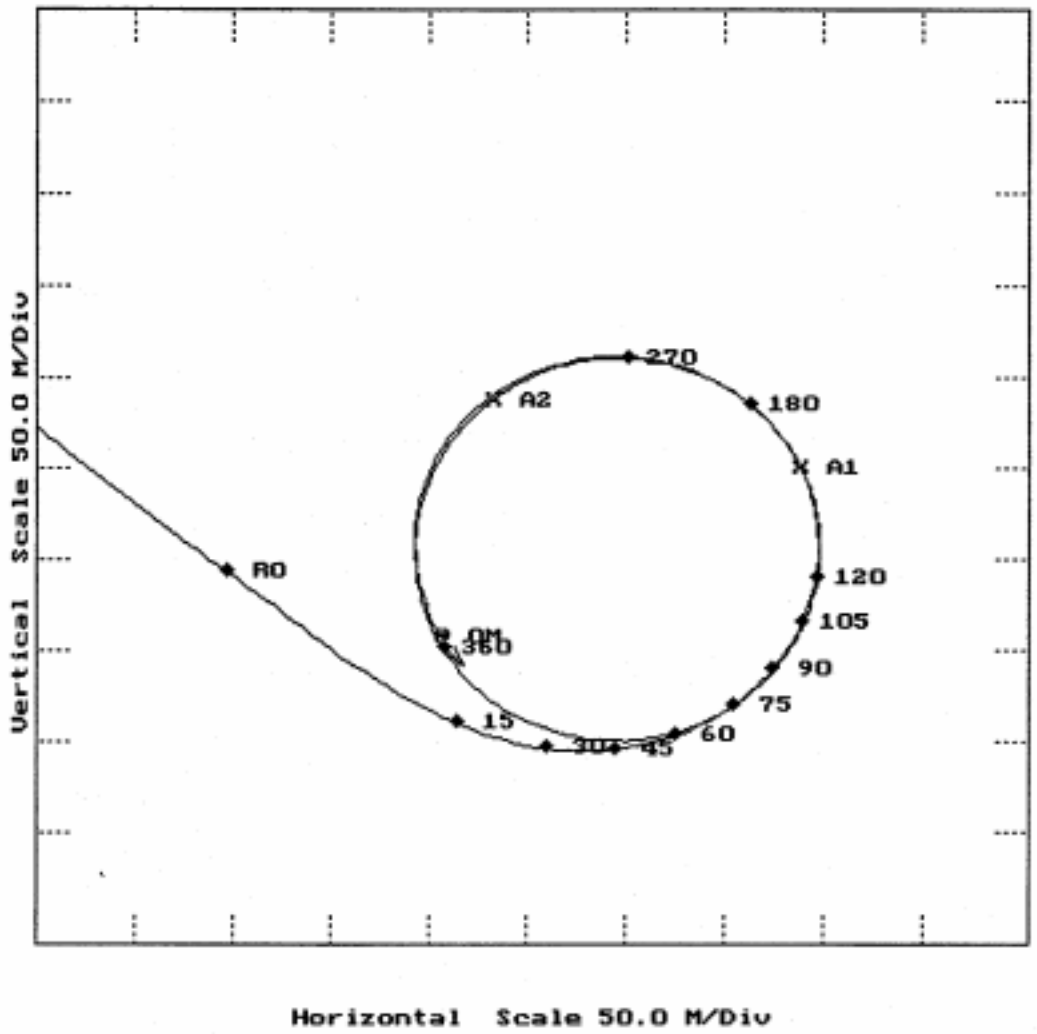


Figure A-14, Port Turn Maneuver 12 kts., 15 deg. Rudder

Maneuver performed at 10:59:43 GMT on
9 June 1998
Port Turn Maneuver on Juniper wlb201
Executed with a 15 Degree Rudder at a speed of 12 Knots both engines

EVENT	15	30	45	60	75	90	105	120	DEG.
TURN TIME	* 24.0	* 33.0	* 40.0	* 47.0	* 55.0	* 62.0	* 70.0	* 77.0	Sec.
ADVANCE	154.2	202.2	231.1	251.1	263.9	266.5	261.1	250.0	Yrd.
TRANSFER	14.8	35.7	59.5	87.4	121.5	151.2	182.8	207.5	Yrd.

EVENT	TIME	MEASURE
TIME to RUDDER OVER	0.0 sec.	
TIME to 180 deg TURN	*108.0 Sec.	
TIME to 270 deg TURN	*129.0 Sec.	
TIME to 360 deg TURN	198.0 Sec.	
Initial HEADING		130 Degrees
Initial SPEED		11.96 Knots
TURNING SPEED		6.21 Knots
TACTICAL DIAMETER		262.45 Yards
TURING RADIUS based on USER selected MARKS 11:02:17 and 11:03:14		109.33 Yards

(*) Indicates a computer assigned mark !

Table A-14, Port Turn Maneuver 12 kts., 15 deg. Rudder

9 June 1998
14:46:11
Starboard
Maneuver # 2
20 Rudder
at 12.0 Kts
Position Plt
Plot Center:
41 20.9 N
71 15.0 W
Set 56.0 Deg
Drift 0.1Kts

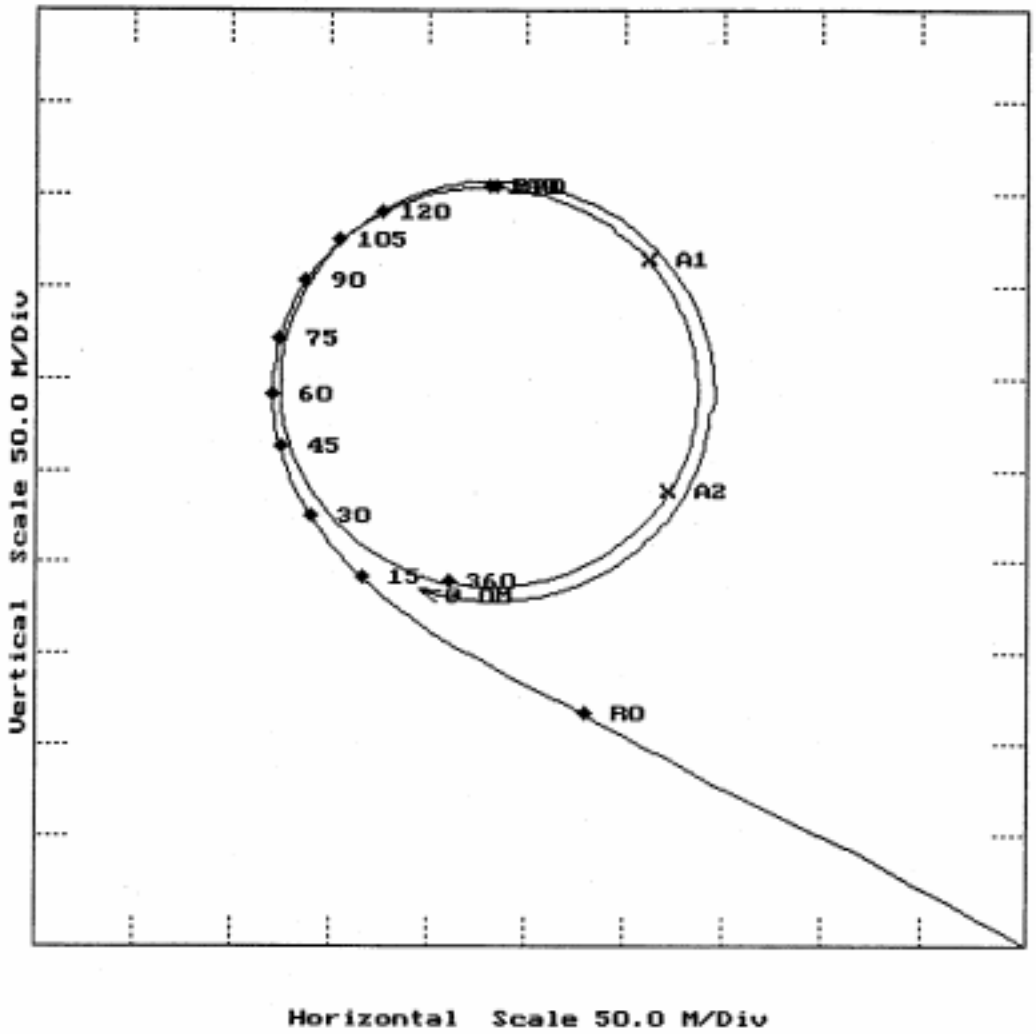


Figure A-15, Starboard Turn Maneuver 12 kts., 20 deg. Rudder

Maneuver performed at 14:46:11 GMT on
9 June 1998
Starboard Turn Maneuver on Juniper WLB 201
Executed with a 20 Degree Rudder at a speed of 12 Knots both engines

EVENT	15	30	45	60	75	90	105	120	DEG.
TURN TIME	* 21.0	* 28.0	* 35.0	* 40.0	* 46.0	* 53.0	* 59.0	* 65.0	Sec.
ADVANCE	146.4	189.5	224.1	242.0	255.0	258.8	253.5	241.7	Yrd.
TRANSFER	9.6	27.6	54.5	78.5	109.5	145.7	174.8	200.6	Yrd.

EVENT	TIME	MEASURE
TIME to RUDDER OVER	0.0 sec.	
TIME to 180 deg TURN	* 79.0 Sec.	
TIME to 270 deg TURN	* 80.0 Sec.	
TIME to 360 deg TURN	175.0 Sec.	
Initial HEADING		299 Degrees
Initial SPEED		12.35 Knots
TURNING SPEED		7.06 Knots
TACTICAL DIAMETER		243.21 Yards
TURING RADIUS based on USER selected MARKS 14:48:43 and 14:49:19		119.26 Yards

(*) Indicates a computer assigned mark !

Table A-15, Starboard Turn Maneuver 12 kts., 20 deg. Rudder

9 June 1998
11:10:06
Port
Maneuver # 3
20 Rudder
at 12.0 Kts
Position Plt
Plot Center:
41 17.7 N
71 14.7 W
Set 186.0 Deg
Drift 0.1Kts

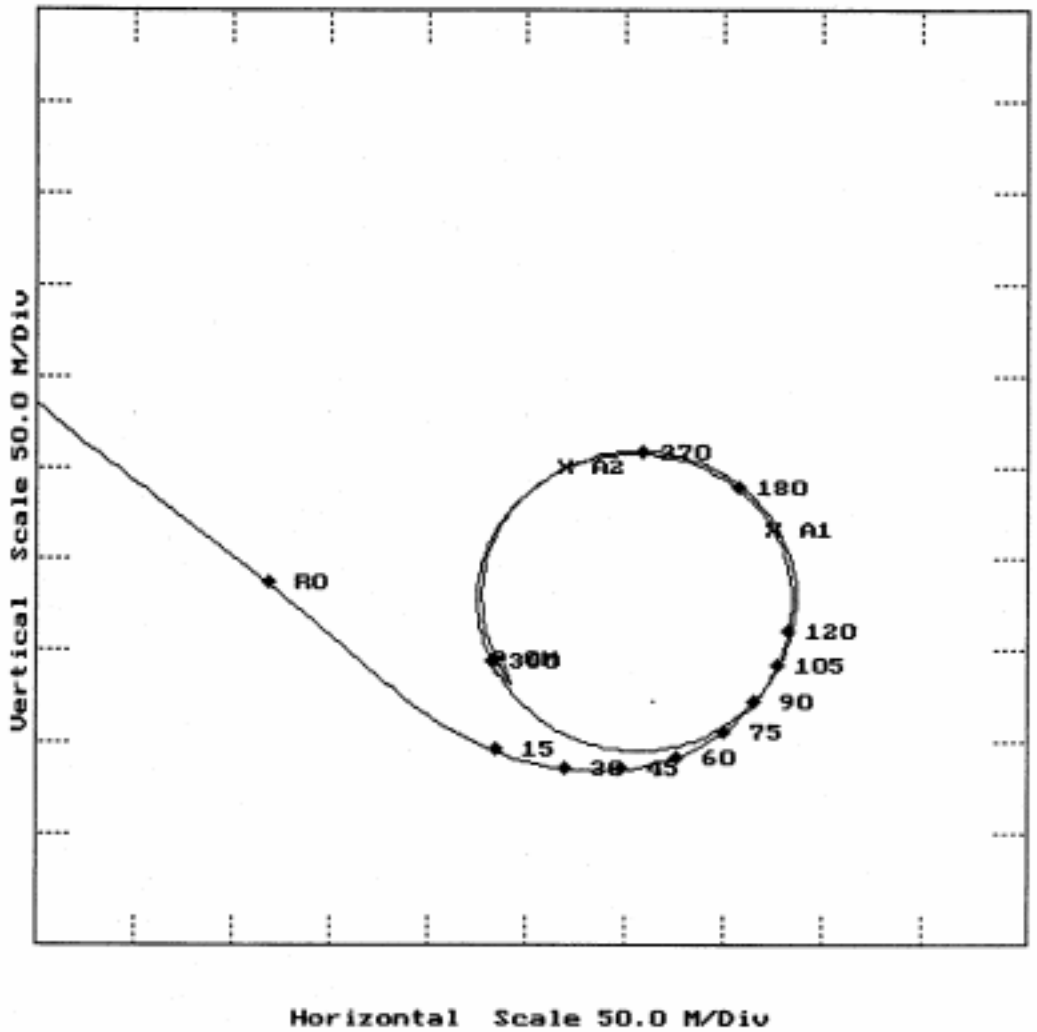


Figure A-16, Port Turn Maneuver 12 kts., 20 Deg Rudder

Maneuver performed at 11:10:06 GMT on
9 June 1998
Port Turn Maneuver on Juniper wlb201
Executed with a 20 Degree Rudder at a speed of 12 Knots both engines

EVENT	15	30	45	60	75	90	105	120	DEG.
TURN TIME	* 25.0	* 32.0	* 38.0	* 45.0	* 52.0	* 58.0	* 65.0	* 71.0	Sec.
ADVANCE	160.3	195.7	219.0	238.1	247.7	249.4	245.4	237.3	Yrd.
TRANSFER	8.2	25.0	44.5	69.9	97.8	120.9	145.8	165.1	Yrd.

EVENT	TIME	MEASURE
TIME to RUDDER OVER	0.0 sec.	
TIME to 180 deg TURN	*100.0 Sec.	
TIME to 270 deg TURN	*119.0 Sec.	
TIME to 360 deg TURN	177.0 Sec.	
Initial HEADING		130 Degrees
Initial SPEED		12.01 Knots
TURNING SPEED		5.47 Knots
TACTICAL DIAMETER		211.38 Yards
TURING RADIUS based on USER selected MARKS 11:12:42 and 11:13:25		86.34 Yards

(*) Indicates a computer assigned mark !

Table A-16, Port Turn Maneuver 12 kts., 20 Deg Rudder

9 June 1998
11:20:26
Port
Maneuver # 4
30 Rudder
at 12.0 Kts
Position Plt
Plot Center:
41 17.2 N
71 13.9 W
Set 186.0 Deg
Drift 0.0Kts

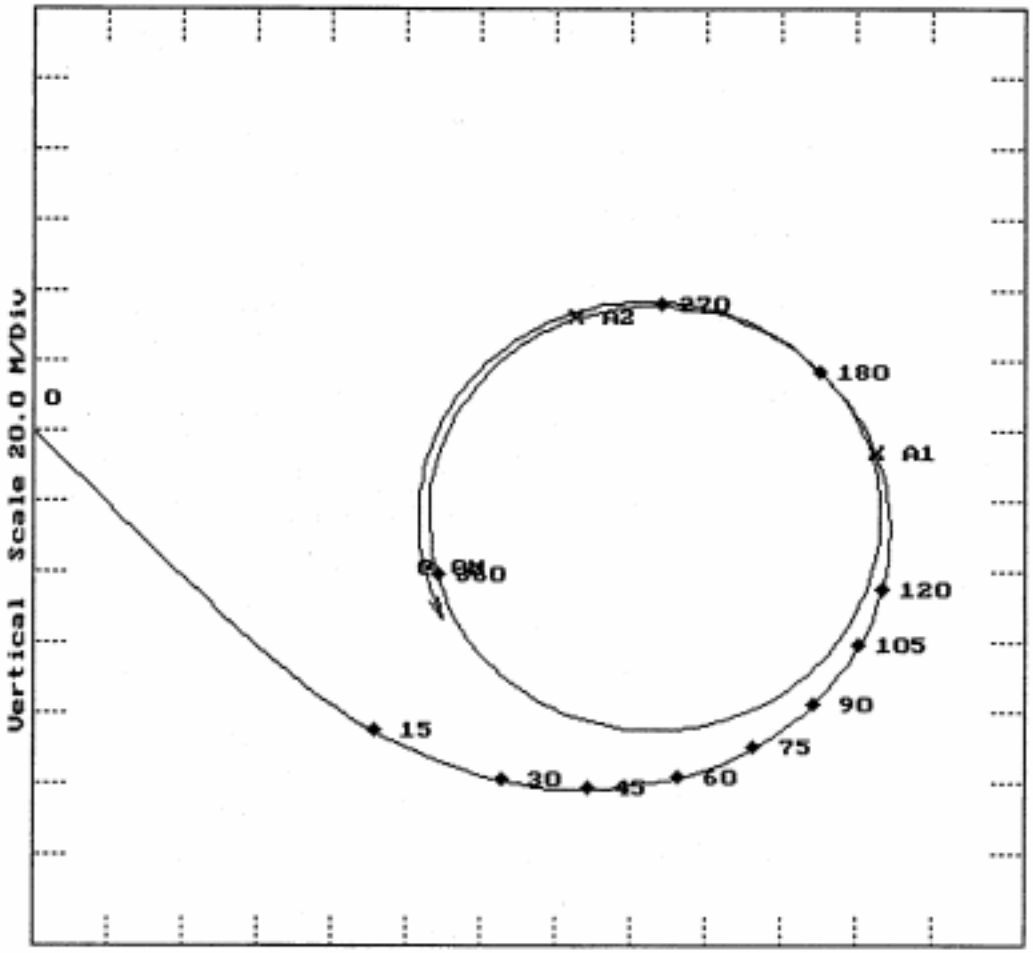


Figure A-17, Port Turn Maneuver 12 kts., 30 deg. Rudder

Maneuver performed at 11:20:26 GMT on
9 June 1998
Port Turn Maneuver on Juniper wlb201
Executed with a 30 Degree Rudder at a speed of 12 Knots both engines

EVENT	15	30	45	60	75	90	105	120	DEG.
TURN TIME	* 22.0	* 29.0	* 34.0	* 40.0	* 46.0	* 52.0	* 59.0	* 65.0	Sec.
ADVANCE	141.1	175.9	194.4	209.4	217.5	219.8	216.2	208.8	Yrd.
TRANSFER	7.6	23.0	38.1	58.5	79.4	99.5	120.8	136.5	Yrd.

EVENT	TIME	MEASURE
TIME to RUDDER OVER	0.0 sec.	
TIME to 180 deg TURN	* 91.0 Sec.	
TIME to 270 deg TURN	*111.0 Sec.	
TIME to 360 deg TURN	160.0 Sec.	
Initial HEADING		136 Degrees
Initial SPEED		12.01 Knots
TURNING SPEED		4.36 Knots
TACTICAL DIAMETER		168.85 Yards
TURING RADIUS based on USER	selected MARKS 11:22:55 and 11:23:36	64.61 Yards

(*) Indicates a computer assigned mark !

Table A-17, Port Turn Maneuver 12 kts., 30 deg. Rudder

9 June 1998
11:32:22
Port
Maneuver # 5
38 Rudder
at 12.0 Kts
Position Plt
Plot Center:
41 16.3 N
71 12.7 W
Set 327.0 Deg
Drift 0.1Kts

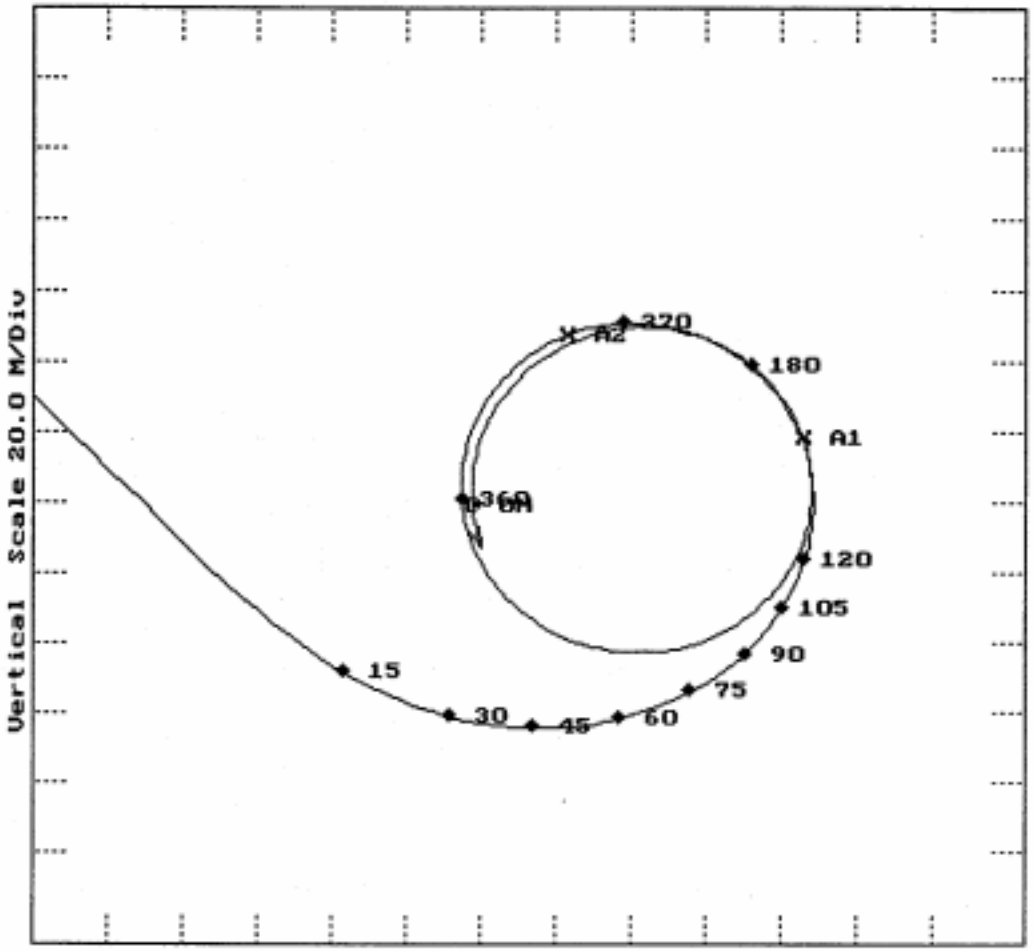


Figure A-18, Port Turn Maneuver 12 kts., 38 deg. Rudder

Maneuver performed at 11:32:22 GMT on
9 June 1998
Port Turn Maneuver on Juniper wlb201
Executed with a 38 Degree Rudder at a speed of 12 Knots both engines

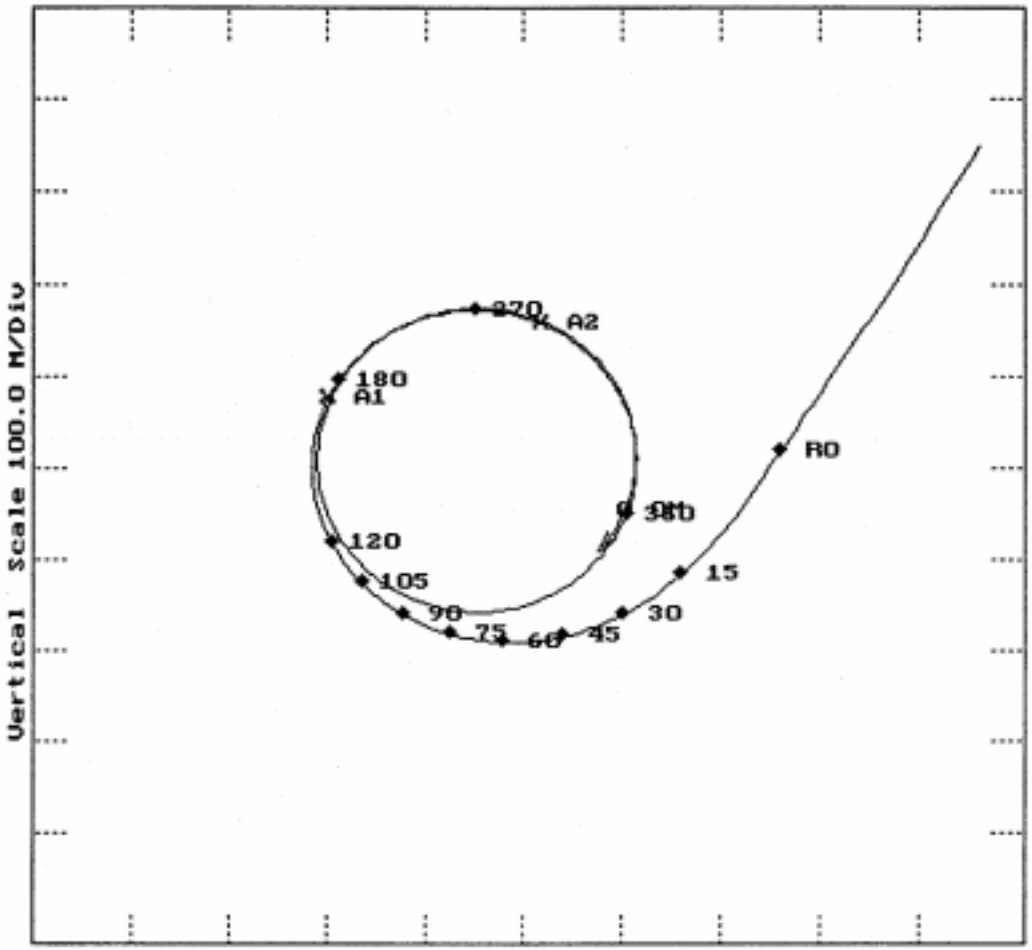
EVENT	15	30	45	60	75	90	105	120	DEG.
TURN TIME	* 22.0	* 28.0	* 33.0	* 39.0	* 45.0	* 51.0	* 57.0	* 63.0	Sec.
ADVANCE	141.8	171.6	189.8	204.2	212.1	214.3	211.5	205.5	Yrd.
TRANSFER	7.8	20.1	34.5	53.7	73.3	91.7	108.2	122.5	Yrd.

EVENT	TIME	MEASURE
TIME to RUDDER OVER	0.0 sec.	
TIME to 180 deg TURN	* 90.0 Sec.	
TIME to 270 deg TURN	*109.0 Sec.	
TIME to 360 deg TURN	147.0 Sec.	
Initial HEADING		136 Degrees
Initial SPEED		12.10 Knots
TURNING SPEED		3.73 Knots
TACTICAL DIAMETER		151.01 Yards
TURING RADIUS based on USER	selected MARKS 11:34:35 and 11:35:14	48.85 Yards

(*) Indicates a computer assigned mark !

Table A-18, Port Turn Maneuver 12 kts., 38 deg. Rudder

9 June 1998
12:24:34
Starboard
Maneuver # 1
10 Rudder
at 16.0 Kts
Position Plt
Plot Center:
41 15.2 N
71 8.1 W
Set 66.0 Deg
Drift 0.0Kts



Horizontal Scale 100.0 M/Div

Figure A-19, Starboard Turn Maneuver 16 kts., 10 deg. Rudder

Maneuver performed at 12:24:34 GMT on
9 June 1998
Starboard Turn Maneuver on Juniper WLB 201
Executed with a 10 Degree Rudder at a speed of 16 Knots both engines

EVENT	15	30	45	60	75	90	105	120	DEG.
TURN TIME	* 20.0	* 29.0	* 37.0	* 45.0	* 52.0	* 59.0	* 66.0	* 73.0	Sec.
ADVANCE	180.3	254.4	309.9	350.8	372.7	380.0	372.3	349.4	Yrd.
TRANSFER	17.7	48.6	90.7	145.0	199.6	256.9	313.6	365.7	Yrd.

EVENT	TIME	MEASURE
TIME to RUDDER OVER	0.0 sec.	
TIME to 180 deg TURN	* 98.0 Sec.	
TIME to 270 deg TURN	*121.0 Sec.	
TIME to 360 deg TURN	166.0 Sec.	
Initial HEADING		211 Degrees
Initial SPEED		16.04 Knots
TURNING SPEED		13.73 Knots
TACTICAL DIAMETER		458.88 Yards
TURING RADIUS based on USER	selected MARKS 12:26:55 and 12:27:31	
		180.42 Yards

(*) Indicates a computer assigned mark !

Table A-19, Starboard Turn Maneuver 16 kts., 10 deg. Rudder

9 June 1998
11:47:05
Port
Maneuver # 1
10 Rudder
at 16.0 Kts
Position Plt
Plot Center:
41 14.9 N
71 10.7 W
Set 26.0 Deg
Drift 0.1Kts

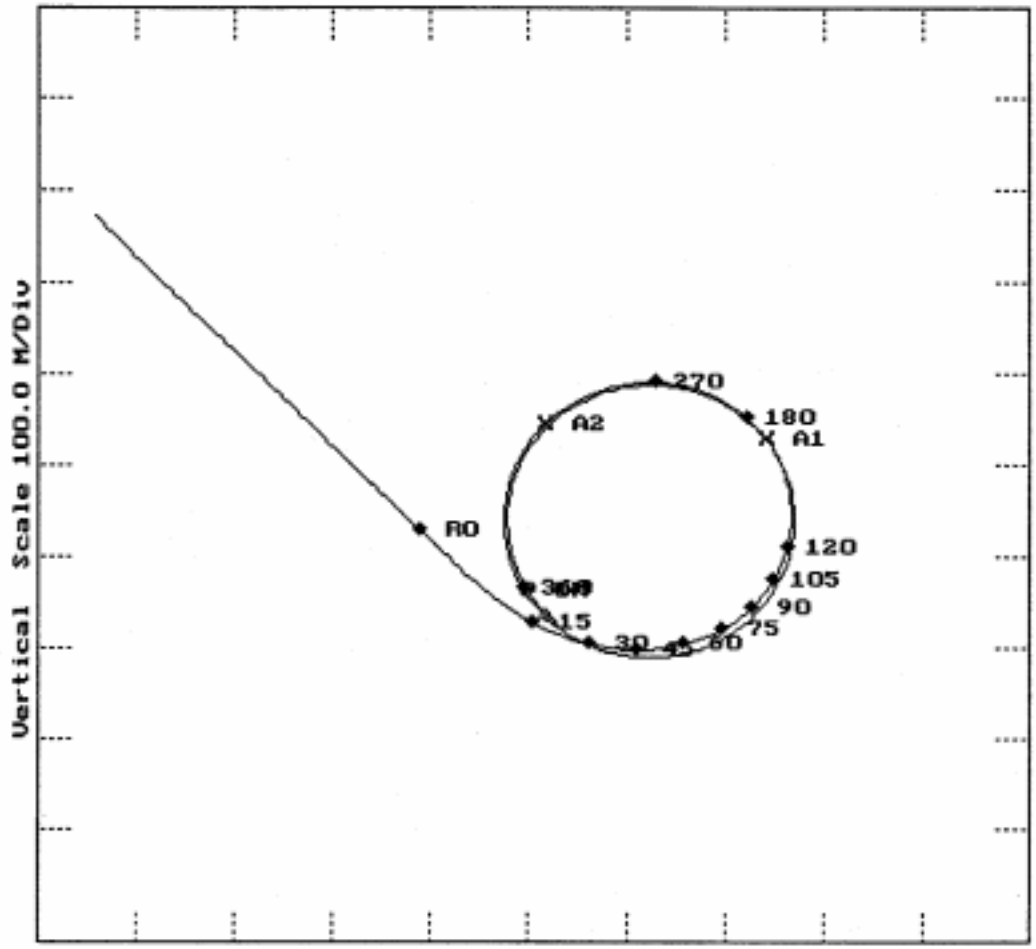


Figure A-20, Port Turn Maneuver 16 kts., 10 deg. Rudder

Maneuver performed at 11:47:05 GMT on
9 June 1998
Port Turn Maneuver on Juniper WLB 201
Executed with a 10 Degree Rudder at a speed of 16 Knots both engines

EVENT	15	30	45	60	75	90	105	120	DEG.
TURN TIME	* 19.0	* 27.0	* 34.0	* 41.0	* 47.0	* 53.0	* 59.0	* 65.0	Sec.
ADVANCE	164.0	224.0	267.3	298.8	315.0	320.0	314.1	297.6	Yrd.
TRANSFER	15.1	40.8	74.0	116.0	156.3	198.1	238.9	275.7	Yrd.

EVENT	TIME	MEASURE
TIME to RUDDER OVER	0.0 sec.	
TIME to 180 deg TURN	* 90.0 Sec.	
TIME to 270 deg TURN	*107.0 Sec.	
TIME to 360 deg TURN	158.0 Sec.	
Initial HEADING		135 Degrees
Initial SPEED		15.95 Knots
TURNING SPEED		11.78 Knots
TACTICAL DIAMETER		350.38 Yards
TURING RADIUS based on USER selected MARKS 11:49:27 and 11:50:09		156.43 Yards

(*) Indicates a computer assigned mark !

Table A-20, Starboard Turn Maneuver 16 kts., 10 deg. Rudder

9 June 1998
12:33:29
Starboard
Maneuver # 2
15 Rudder
at 16.0 Kts
Position Plt
Plot Center:
41 14.9 N
71 7.9 W
Set 15.0 Deg
Drift 0.1Kts

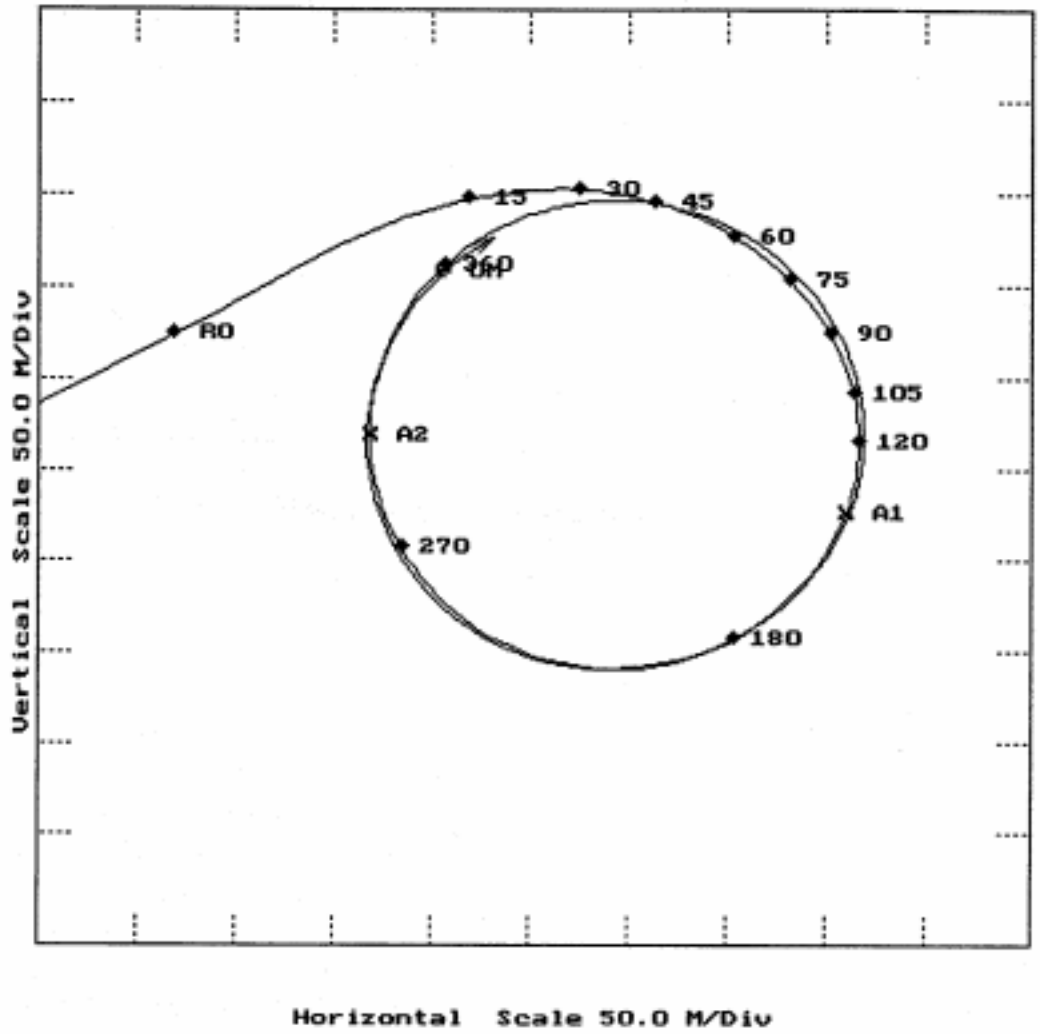


Figure A-21, Starboard Turn Maneuver 16 kts., 15 deg. Rudder

Maneuver performed at 12:33:29 GMT on
9 June 1998
Starboard Turn Maneuver on Juniper WLB 201
Executed with a 15 Degree Rudder at a speed of 16 Knots both engines

EVENT	15	30	45	60	75	90	105	120	DEG.
TURN TIME	* 20.0	* 27.0	* 32.0	* 38.0	* 43.0	* 48.0	* 53.0	* 57.0	Sec.
ADVANCE	180.5	236.0	268.3	296.8	310.6	314.2	308.0	296.3	Yrd.
TRANSFER	12.6	37.8	64.8	104.2	141.1	179.2	215.9	242.5	Yrd.

EVENT	TIME	MEASURE
TIME to RUDDER OVER	0.0 sec.	
TIME to 180 deg TURN	* 77.0 Sec.	
TIME to 270 deg TURN	*108.0 Sec.	
TIME to 360 deg TURN	134.0 Sec.	
Initial HEADING		60 Degrees
Initial SPEED		16.20 Knots
TURNING SPEED		12.27 Knots
TACTICAL DIAMETER		308.39 Yards
TURING RADIUS based on USER selected MARKS 12:35:16 and 12:36:11		134.93 Yards

(*) Indicates a computer assigned mark !

Table A-21, Starboard Turn Maneuver 16 kts., 15 deg. Rudder

9 June 1998
11:55:24
Port
Maneuver # 2
15 Rudder
at 16.0 Kts
Position Plt
Plot Center:
41 14.6 N
71 9.6 W
Set 40.0 Deg
Drift 0.1Kts

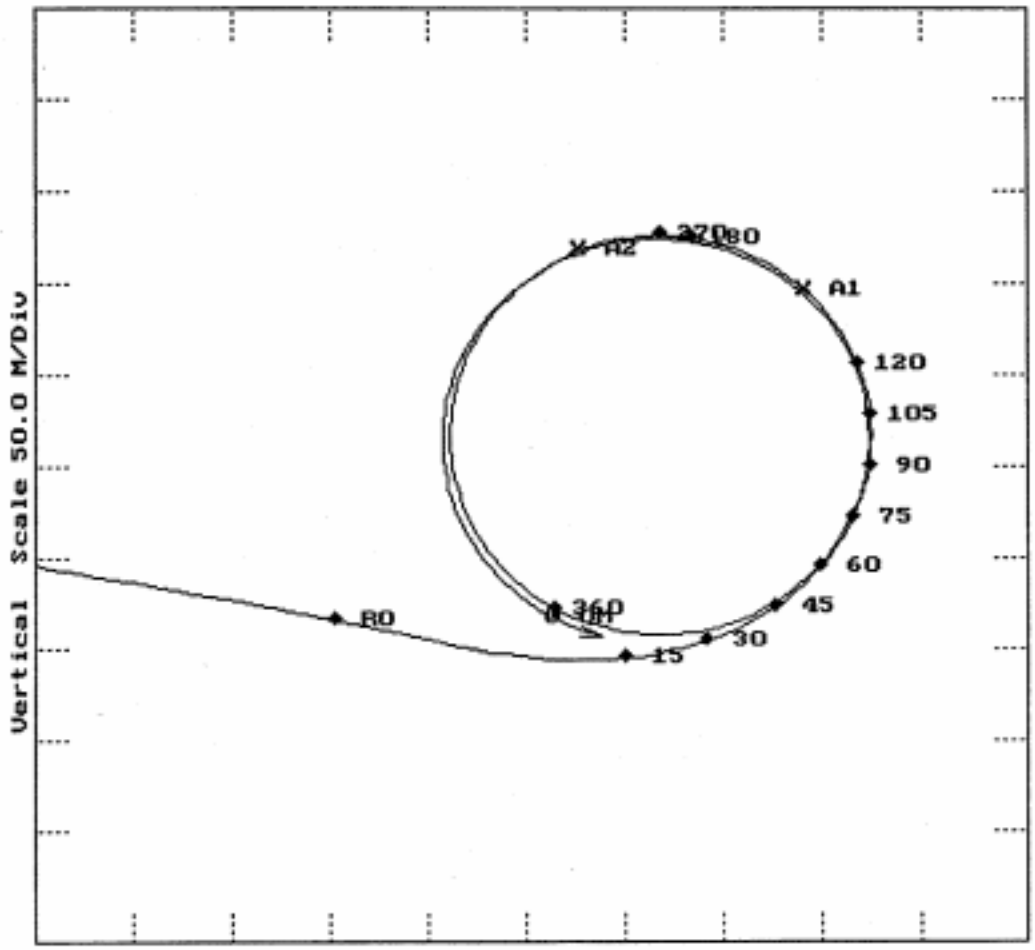


Figure A-22, Port Turn Maneuver 16 kts., 15 deg. Rudder

Maneuver performed at 11:55:24 GMT on
9 June 1998
Port Turn Maneuver on Juniper WLB 201
Executed with a 15 Degree Rudder at a speed of 16 Knots both engines

EVENT	15	30	45	60	75	90	105	120	DEG.
TURN TIME	* 19.0	* 25.0	* 31.0	* 36.0	* 41.0	* 46.0	* 51.0	* 56.0	Sec.
ADVANCE	160.9	203.1	236.5	256.5	267.8	271.0	265.8	253.2	Yrd.
TRANSFER	8.9	27.8	55.0	82.9	114.0	145.5	175.3	202.7	Yrd.

EVENT	TIME	MEASURE
TIME to RUDDER OVER	0.0 sec.	
TIME to 180 deg TURN	* 77.0 Sec.	
TIME to 270 deg TURN	* 80.0 Sec.	
TIME to 360 deg TURN	133.0 Sec.	
Initial HEADING		101 Degrees
Initial SPEED		16.05 Knots
TURNING SPEED		10.12 Knots
TACTICAL DIAMETER		257.63 Yards
TURING RADIUS based on USER	selected MARKS 11:57:17 and 11:57:40	
		117.35 Yards

(*) Indicates a computer assigned mark !

Table A-22, Port Turn Maneuver 16 kts., 15 deg. Rudder

9 June 1998
12:41:10
Starboard
Maneuver # 3
20 Rudder
at 16.0 Kts
Position Plt
Plot Center:
41 15.4 N
71 7.5 W
Set 28.0 Deg
Drift 0.2Kts

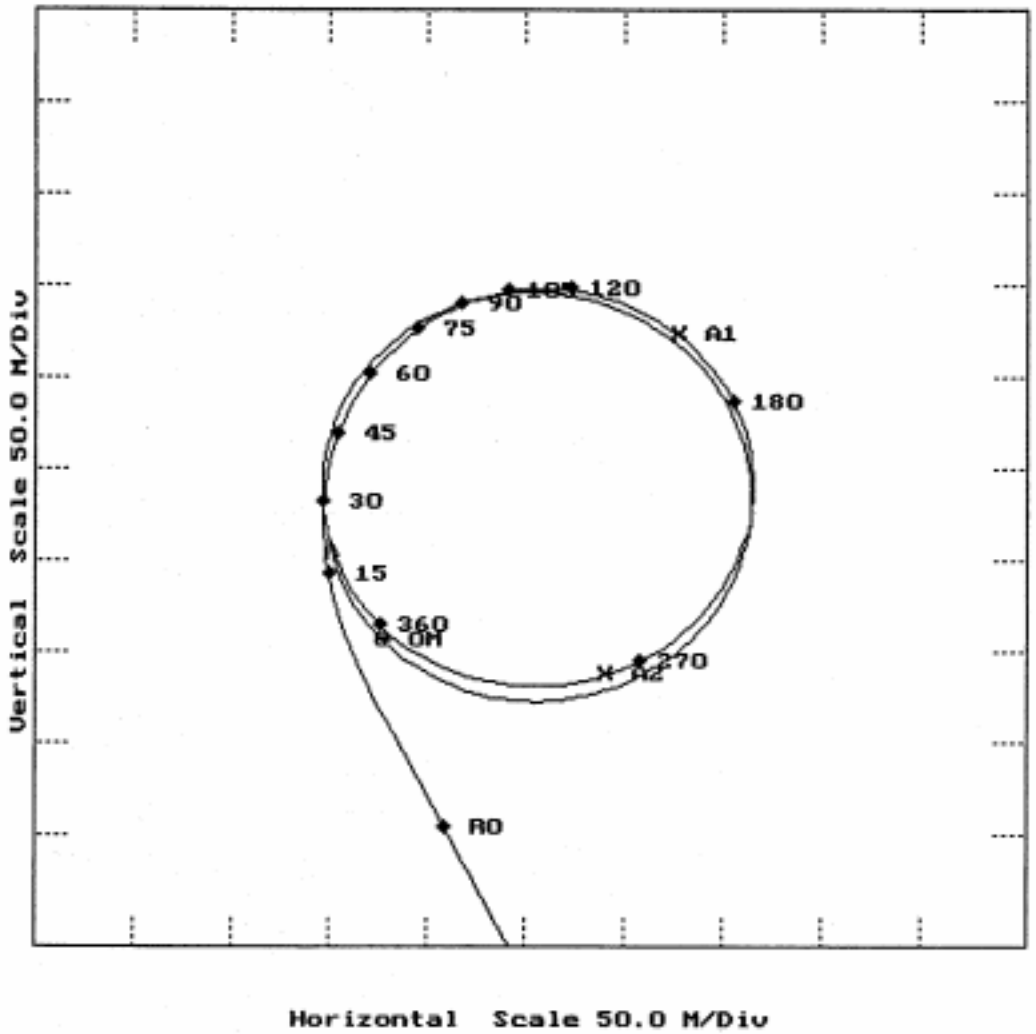


Figure A-23, Starboard Turn Maneuver 16 kts., 20 deg. Rudder

Maneuver performed at 12:41:10 GMT on
9 June 1998
Starboard Turn Maneuver on Juniper WLB 201
Executed with a 20 Degree Rudder at a speed of 16 Knots both engines

EVENT	15	30	45	60	75	90	105	120	DEG.
TURN TIME	* 18.0	* 23.0	* 28.0	* 33.0	* 38.0	* 42.0	* 46.0	* 51.0	Sec.
ADVANCE	161.1	200.1	231.8	254.3	266.2	267.6	262.6	247.8	Yrd.
TRANSFER	10.6	27.8	53.1	84.6	119.7	148.1	175.4	205.5	Yrd.

EVENT	TIME	MEASURE
TIME to RUDDER OVER	0.0 sec.	
TIME to 180 deg TURN	* 69.0 Sec.	
TIME to 270 deg TURN	* 97.0 Sec.	
TIME to 360 deg TURN	121.0 Sec.	
Initial HEADING		332 Degrees
Initial SPEED		16.05 Knots
TURNING SPEED		11.15 Knots
TACTICAL DIAMETER		255.51 Yards
TURING RADIUS based on USER	selected MARKS 12:43:01 and 12:43:40	
		115.98 Yards

(*) Indicates a computer assigned mark !

Table A-23, Starboard Turn Maneuver 16 kts., 20 deg. Rudder

9 June 1998
12:02:39
Port
Maneuver # 3
20 Rudder
at 16.0 Kts
Position Plt
Plot Center:
41 14.5 N
71 8.6 W
Set 45.0 Deg
Drift 0.1Kts

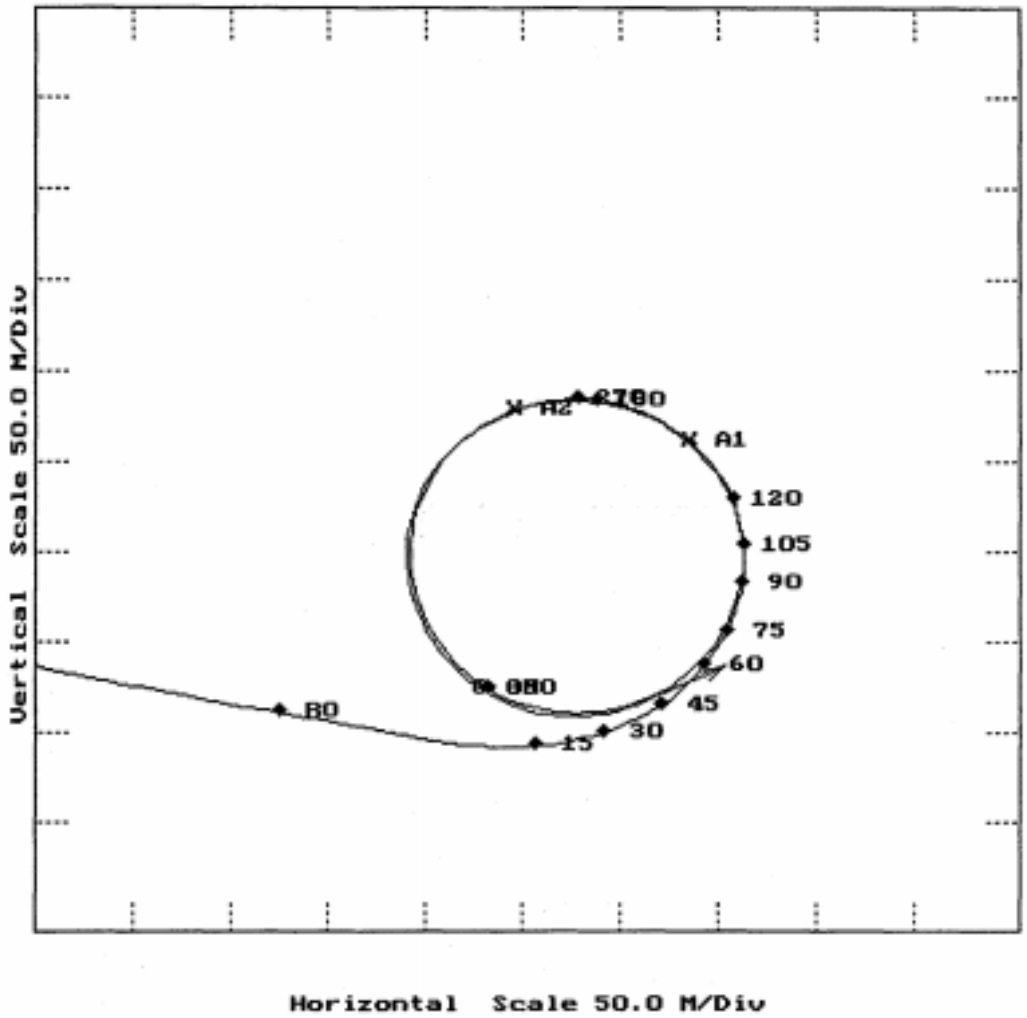


Figure A-24, Port Turn Maneuver 16 kts., 20 deg. Rudder

Maneuver performed at 12:02:39 GMT on
9 June 1998
Port Turn Maneuver on Juniper WLB 201
Executed with a 20 Degree Rudder at a speed of 16 Knots both engines

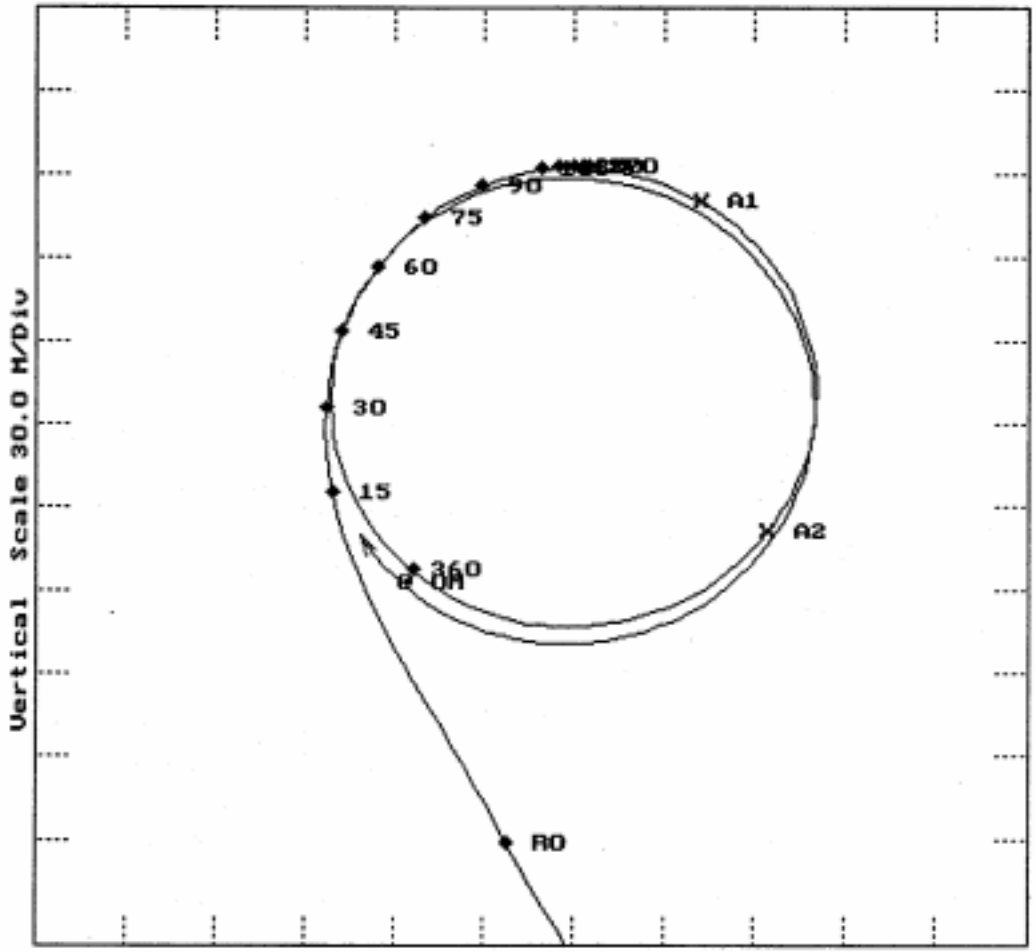
EVENT	15	30	45	60	75	90	105	120	DEG.
TURN TIME	* 17.0	* 22.0	* 27.0	* 32.0	* 36.0	* 41.0	* 45.0	* 50.0	Sec.
ADVANCE	145.1	180.3	208.4	227.7	236.6	239.8	236.0	225.0	Yrd.
TRANSFER	7.3	22.0	43.7	70.7	93.8	123.2	145.4	170.6	Yrd.

EVENT	TIME	MEASURE
TIME to RUDDER OVER	0.0 sec.	
TIME to 180 deg TURN	* 69.0 Sec.	
TIME to 270 deg TURN	* 71.0 Sec.	
TIME to 360 deg TURN	118.0 Sec.	
Initial HEADING		100 Degrees
Initial SPEED		15.98 Knots
TURNING SPEED		9.24 Knots
TACTICAL DIAMETER		214.67 Yards
TURING RADIUS based on USER selected MARKS 12:05:00 and 12:05:20		94.07 Yards

(*) Indicates a computer assigned mark †

Table A-24, Starboard Turn Maneuver 16 kts., 20 deg. Rudder

9 June 1998
12:47:40
Starboard
Maneuver # 4
30 Rudder
at 16.0 Kts
Position Plt
Plot Center:
41 16.1 N
71 7.8 W
Set 37.0 Deg
Drift 0.2Kts



Horizontal Scale 30.0 M/Div

Figure A-25, Starboard Turn Maneuver 16 kts., 30 deg. Rudder

Maneuver performed at 12:47:40 GMT on
9 June 1998
Starboard Turn Maneuver on Juniper WLB 201
Executed with a 30 Degree Rudder at a speed of 16 Knots both engines

EVENT	15	30	45	60	75	90	105	120	DEG.
TURN TIME	* 17.0	* 21.0	* 25.0	* 29.0	* 33.0	* 37.0	* 41.0	* 42.0	Sec.
ADVANCE	151.4	181.5	205.1	221.1	230.1	231.4	226.4	224.4	Yrd.
TRANSFER	6.1	19.1	38.4	61.5	86.1	110.7	133.4	138.8	Yrd.

EVENT	TIME	MEASURE
TIME to RUDDER OVER	0.0 sec.	
TIME to 180 deg TURN	* 43.0 Sec.	
TIME to 270 deg TURN	* 44.0 Sec.	
TIME to 360 deg TURN	108.0 Sec.	
Initial HEADING		332 Degrees
Initial SPEED		16.05 Knots
TURNING SPEED		9.14 Knots
TACTICAL DIAMETER		143.94 Yards
TURING RADIUS based on USER selected MARKS 12:49:14 and 12:49:42		88.68 Yards

(*) Indicates a computer assigned mark !

Table A-25, Starboard Turn Maneuver 16 kts., 30 deg. Rudder

9 June 1998
12:09:55
Port
Maneuver # 4
30 Rudder
at 16.0 Kts
Position Plt
Plot Center:
41 14.7 N
71 7.5 W
Set 15.0 Deg
Drift 0.1Kts

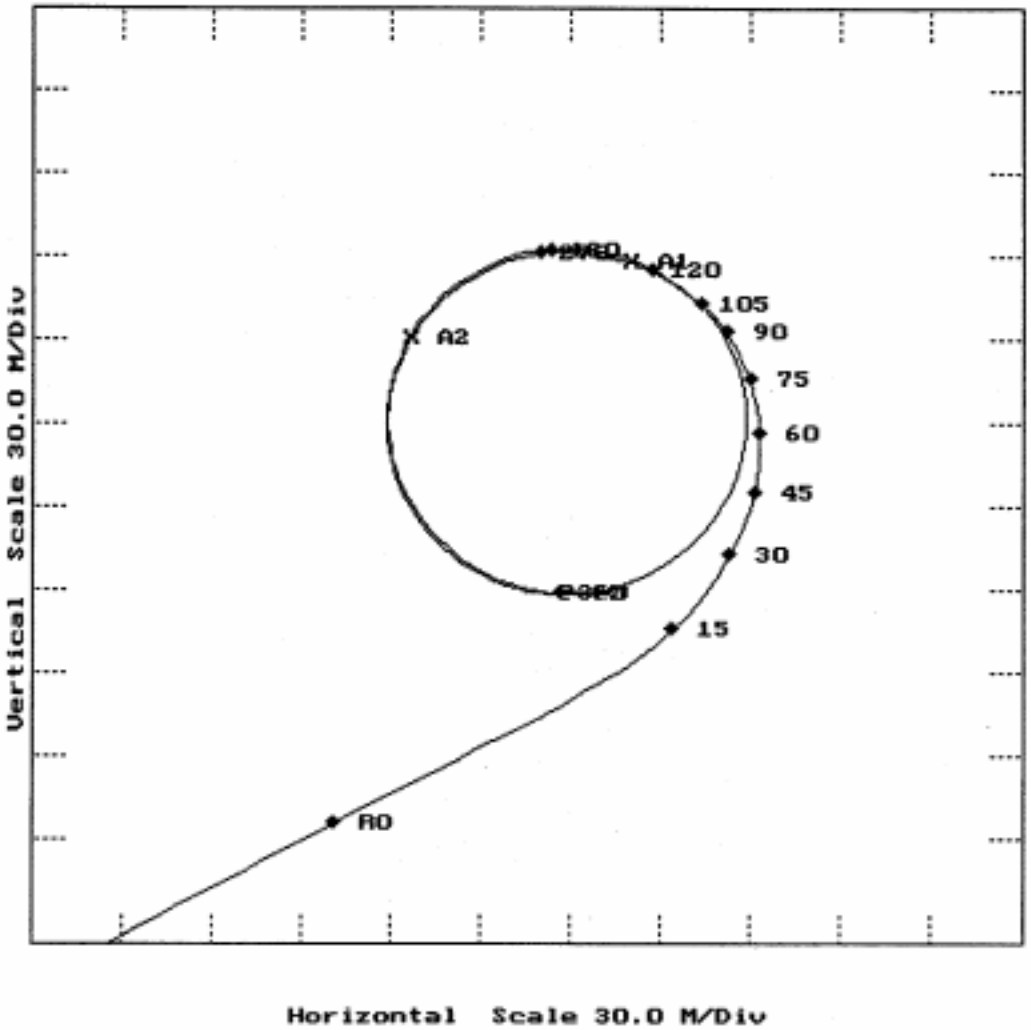


Figure A-26, Port Turn Maneuver 16 kts., 30 deg. Rudder

Maneuver performed at 12:09:55 GMT on
9 June 1998
Port Turn Maneuver on Juniper WLB 201
Executed with a 30 Degree Rudder at a speed of 16 Knots both engines

EVENT	15	30	45	60	75	90	105	120	DEG.
TURN TIME	* 17.0	* 22.0	* 26.0	* 30.0	* 34.0	* 38.0	* 41.0	* 46.0	Sec.
ADVANCE	145.4	178.6	198.4	211.3	218.5	220.0	217.6	208.5	Yrd.
TRANSFER	3.8	18.2	34.9	54.1	74.2	94.0	107.7	128.4	Yrd.

EVENT	TIME	MEASURE
TIME to RUDDER OVER	0.0 sec.	
TIME to 180 deg TURN	* 55.0 Sec.	
TIME to 270 deg TURN	* 56.0 Sec.	
TIME to 360 deg TURN	105.0 Sec.	
Initial HEADING		60 Degrees
Initial SPEED		15.98 Knots
TURNING SPEED		7.20 Knots
TACTICAL DIAMETER		153.16 Yards
TURING RADIUS based on USER selected MARKS 12:11:48 and 12:12:11		67.38 Yards

(*) Indicates a computer assigned mark !

Table A-26, Port Turn Maneuver 16 kts., 30 deg. Rudder

9 June 1998
12:53:53
Starboard
Maneuver # 5
38 Rudder
at 16.0 Kts
Position Plt
Plot Center:
41 16.7 N
71 8.1 W
Set 38.0 Deg
Drift 0.2Kts

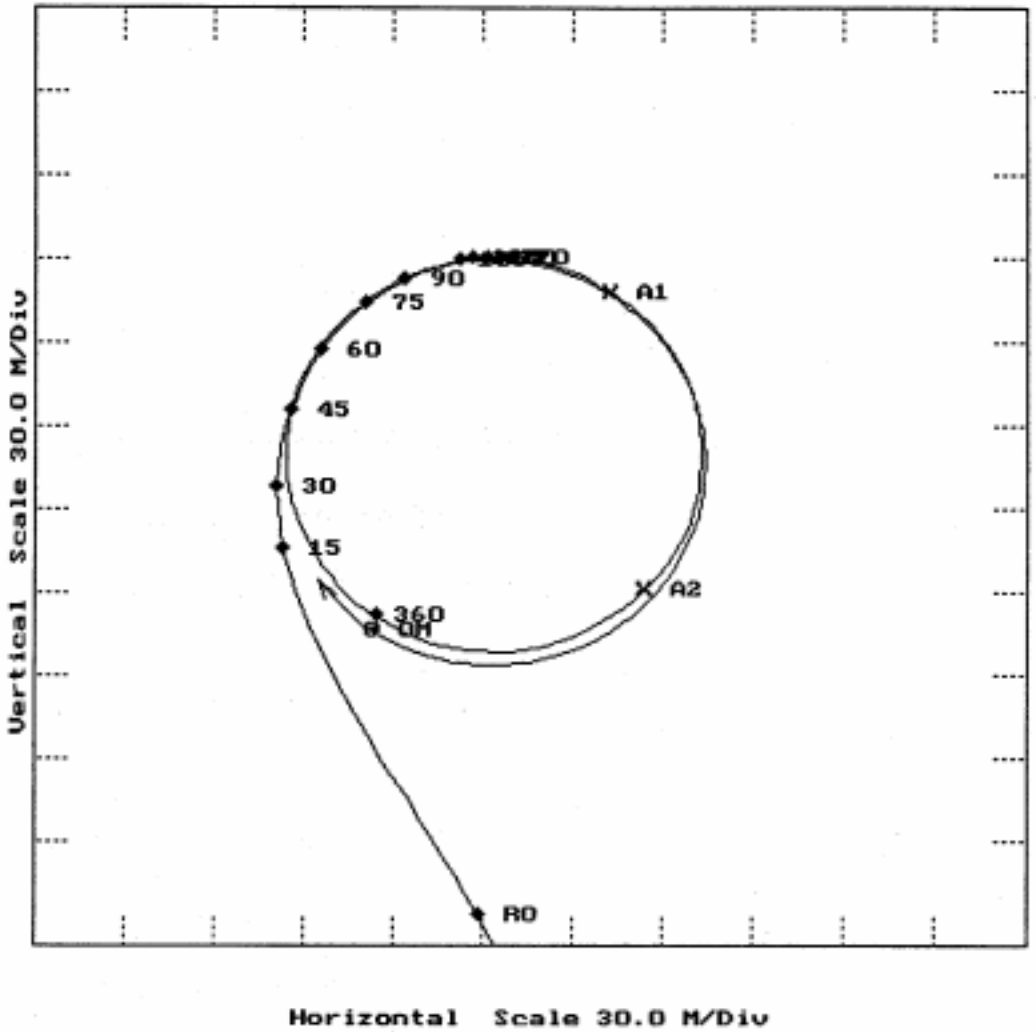


Figure A-27, Starboard Turn Maneuver 16 kts., 38 deg. Rudder

Maneuver performed at 12:53:53 GMT on
9 June 1998
Starboard Turn Maneuver on Juniper WLB 201
Executed with a 38 Degree Rudder at a speed of 16 Knots both engines

EVENT	15	30	45	60	75	90	105	120	DEG.
TURN TIME	* 18.0	* 21.0	* 25.0	* 29.0	* 33.0	* 36.0	* 40.0	* 41.0	Sec.
ADVANCE	159.9	182.2	205.8	220.8	228.6	229.6	225.9	224.2	Yrd.
TRANSFER	6.9	16.6	35.2	57.0	80.1	96.9	117.9	122.7	Yrd.

EVENT	TIME	MEASURE
TIME to RUDDER OVER	0.0 sec.	
TIME to 180 deg TURN	* 42.0 Sec.	
TIME to 270 deg TURN	* 43.0 Sec.	
TIME to 360 deg TURN	104.0 Sec.	
Initial HEADING		330 Degrees
Initial SPEED		16.19 Knots
TURNING SPEED		7.99 Knots
TACTICAL DIAMETER		127.36 Yards
TURING RADIUS based on USER selected MARKS 12:56:15 and 12:56:44		75.63 Yards

(*) Indicates a computer assigned mark !

Table A-27, Port Turn Maneuver 16 kts., 38 deg. Rudder

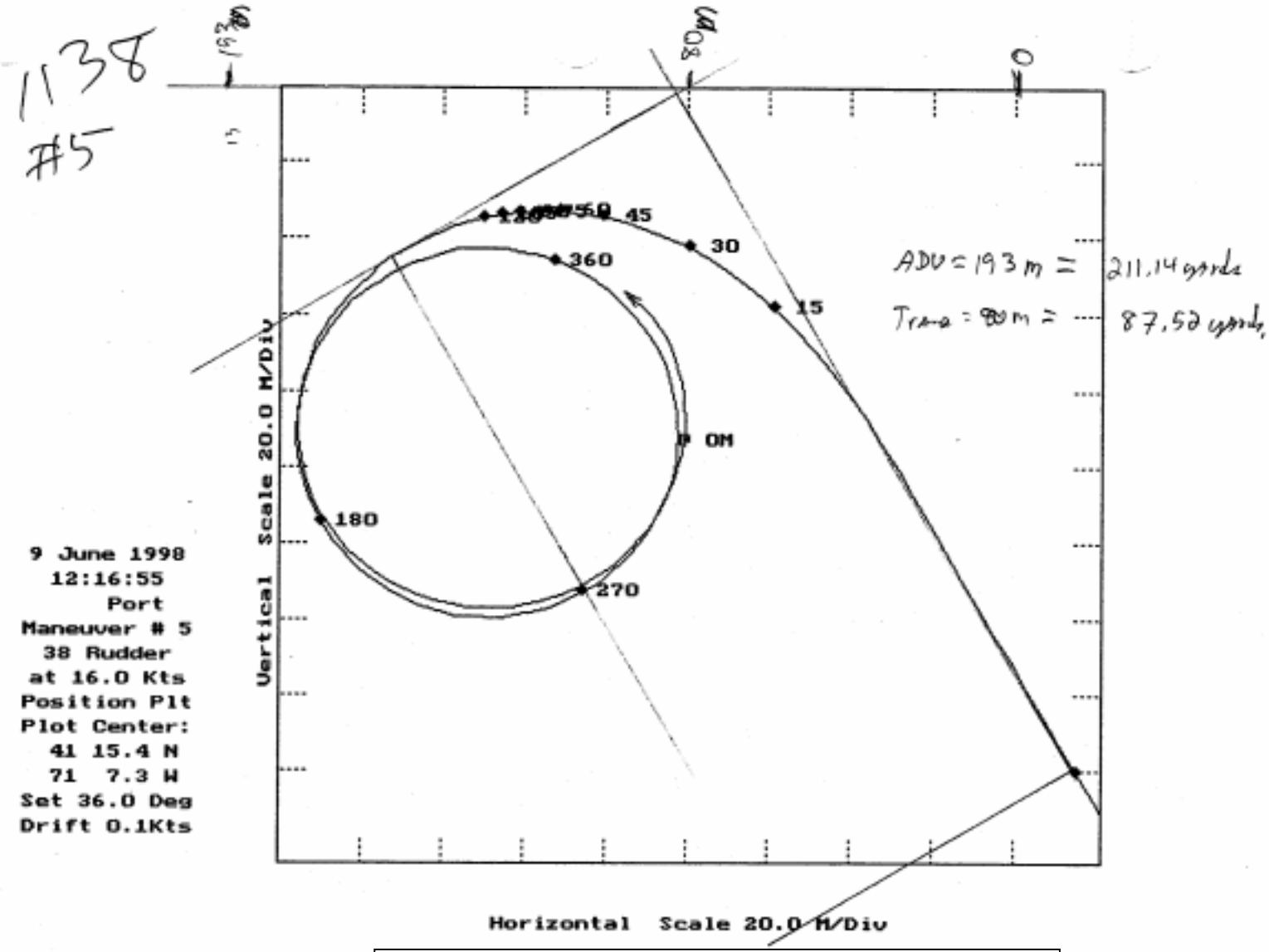
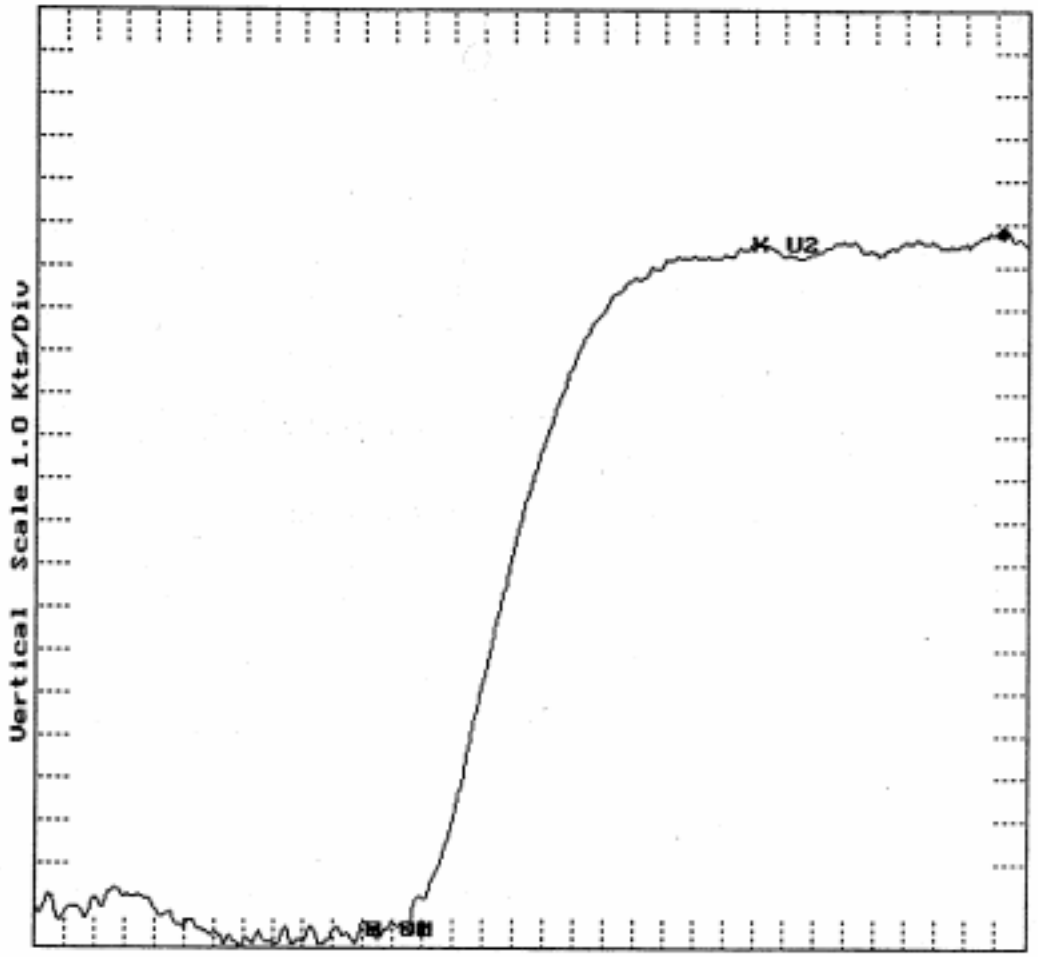


Figure A-28, Port Turn Maneuver 16 kts., 38 deg. Rudder

No data sheet sheet for this test.

Table A-28, Port Turn Maneuver 16 kts., 38 deg. Rudder

9 June 1998
15:02:13
Acceleration (A)
Maneuver # 1
0 Rudder
at 0.0 Kts
Velocity Plt
Plot Center:
41 21.0 N
71 15.5 W



Horizontal Scale 10.0 S/Div

Figure A-29, Acceleration Maneuver A direction #1

Maneuver performed at 15:02:13 GMT on
9 June 1998
Acceleration Maneuver on Juniper WLB 201
Executed with an initial speed of 0 Knots both engines

EVENT	TIME	MEASURE
TIME to FULL SPEED	127.00 Seconds	
DISTANCE to FULL SPEED		732.84 Yards

Time and Distance calculations are based on the following:
The USER PLACED MARK at 15:04:05 GMT
and
The USER PLACED MARK at 15:06:12 GMT

Table A-29, Acceleration Maneuver A direction #1

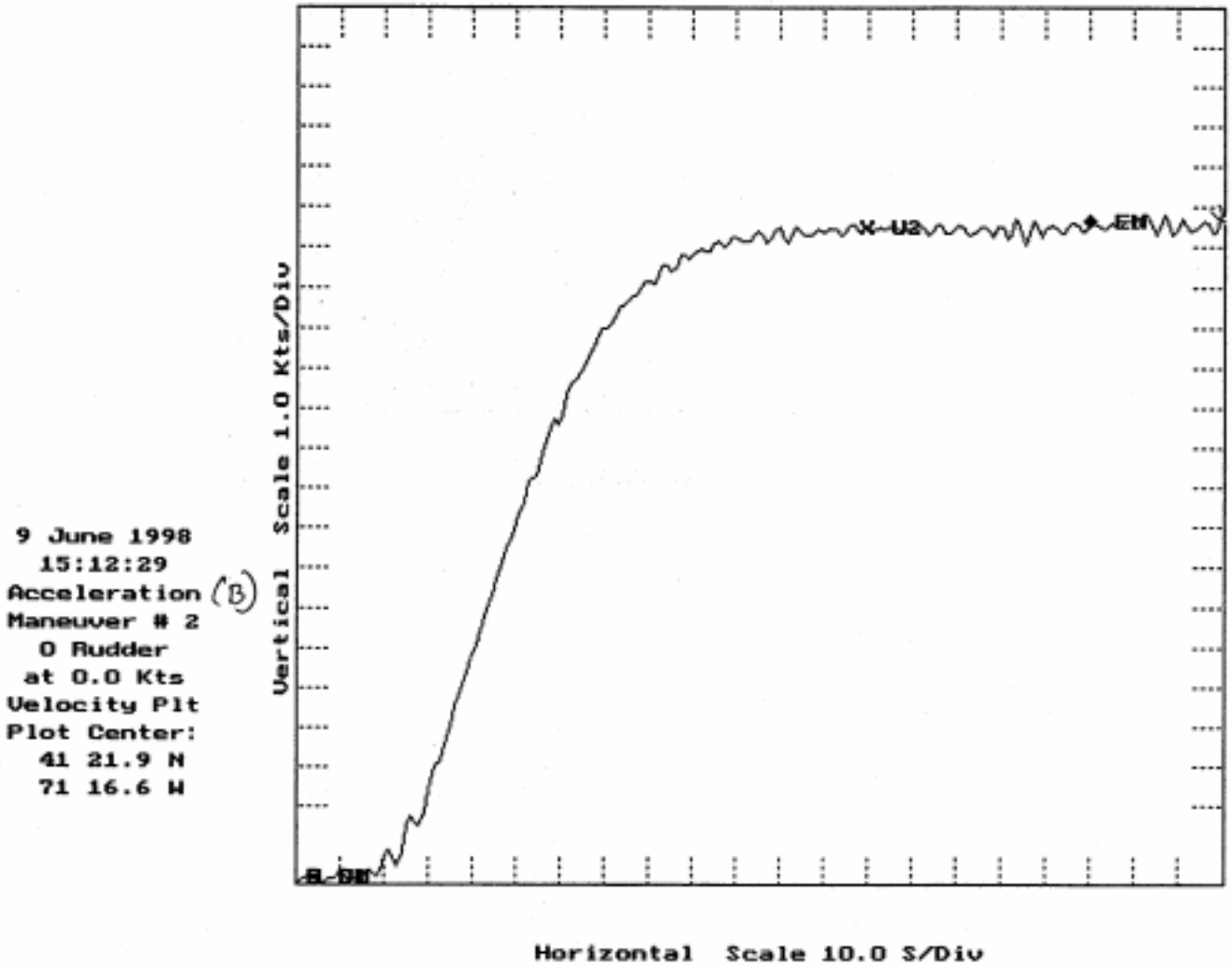


Figure A-30, Acceleration Maneuver B direction #1

Maneuver performed at 15:12:29 GMT on
9 June 1998
Acceleration Maneuver on Juniper WLB 201
Executed with an initial speed of 0 Knots both engines

EVENT	TIME	MEASURE
TIME to FULL SPEED	127.00 Seconds	
DISTANCE to FULL SPEED		721.92 Yards

Time and Distance calculations are based on the following:
The USER PLACED MARK at 15:12:33 GMT
and
The USER PLACED MARK at 15:14:40 GMT

Table A-30, Acceleration Maneuver B direction #1

9 June 1998
15:24:19
Acceleration
Maneuver # 4 (A)
0 Rudder
at 0.0 Kts
Velocity Plt
Plot Center:
41 21.0 N
71 15.4 W

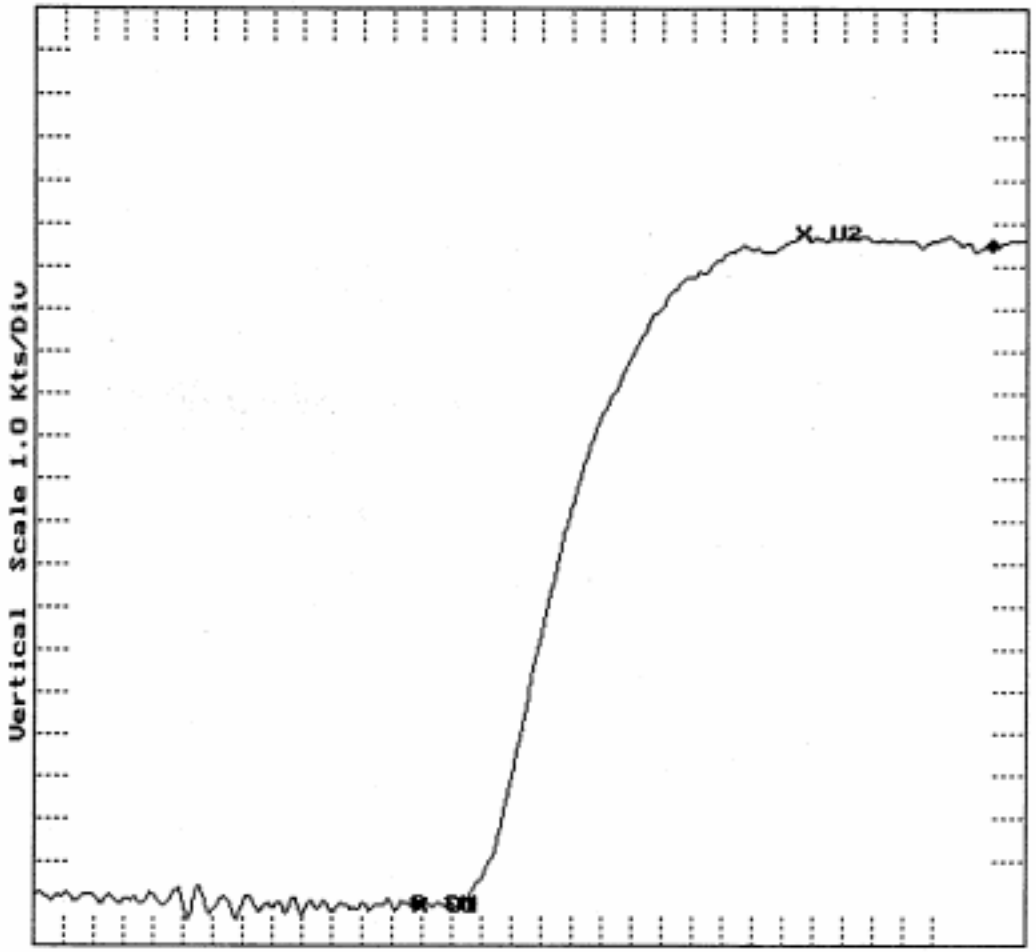


Figure A-31, Acceleration Maneuver A direction #2

Maneuver performed at 15:24:19 GMT on
9 June 1998
Acceleration Maneuver on Juniper WLB 201
Executed with an initial speed of 0 Knots both engines

EVENT	TIME	MEASURE
TIME to FULL SPEED	119.00 Seconds	
DISTANCE to FULL SPEED		663.96 Yards

Time and Distance calculations are based on the following:
The USER PLACED MARK at 15:26:20 GMT
and
The USER PLACED MARK at 15:28:19 GMT

Table A-31, Acceleration Maneuver A direction #2

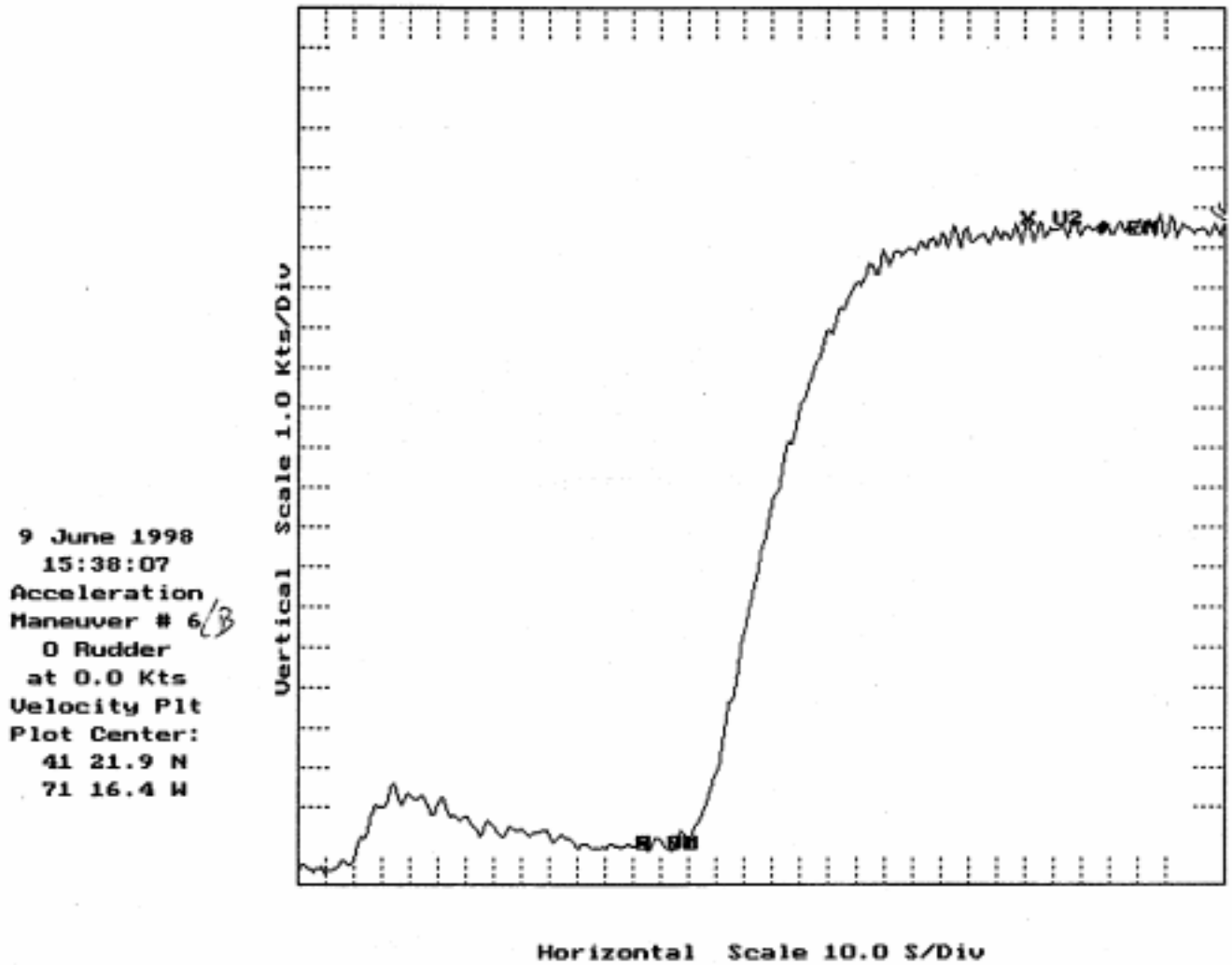


Figure A-32, Acceleration Maneuver B direction #2

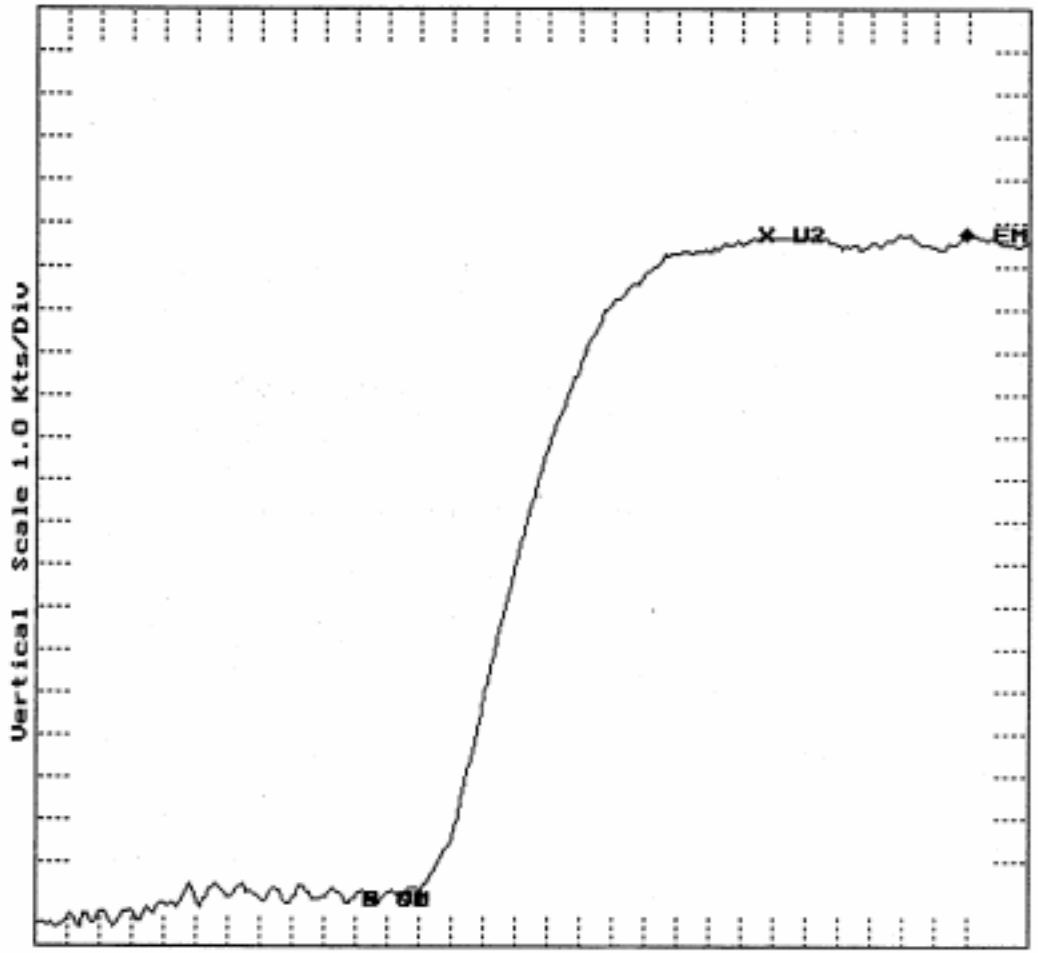
Maneuver performed at 15:38:07 GMT on
9 June 1998
Acceleration Maneuver on Juniper WLB 201
Executed with an initial speed of 0 Knots both engines

EVENT	TIME	MEASURE
TIME to FULL SPEED	134.00 Seconds	
DISTANCE to FULL SPEED		805.48 Yards

Time and Distance calculations are based on the following:
The USER PLACED MARK at 15:40:08 GMT
and
The USER PLACED MARK at 15:42:22 GMT

Table A-32, Acceleration Maneuver B direction #2

9 June 1998
15:51:28
Acceleration
Maneuver # 8 (A)
0 Rudder
at 0.0 Kts
Velocity Plt
Plot Center:
41 20.8 N
71 15.1 W



Horizontal Scale 10.0 S/Div

Figure A-33, Acceleration Maneuver A direction #3

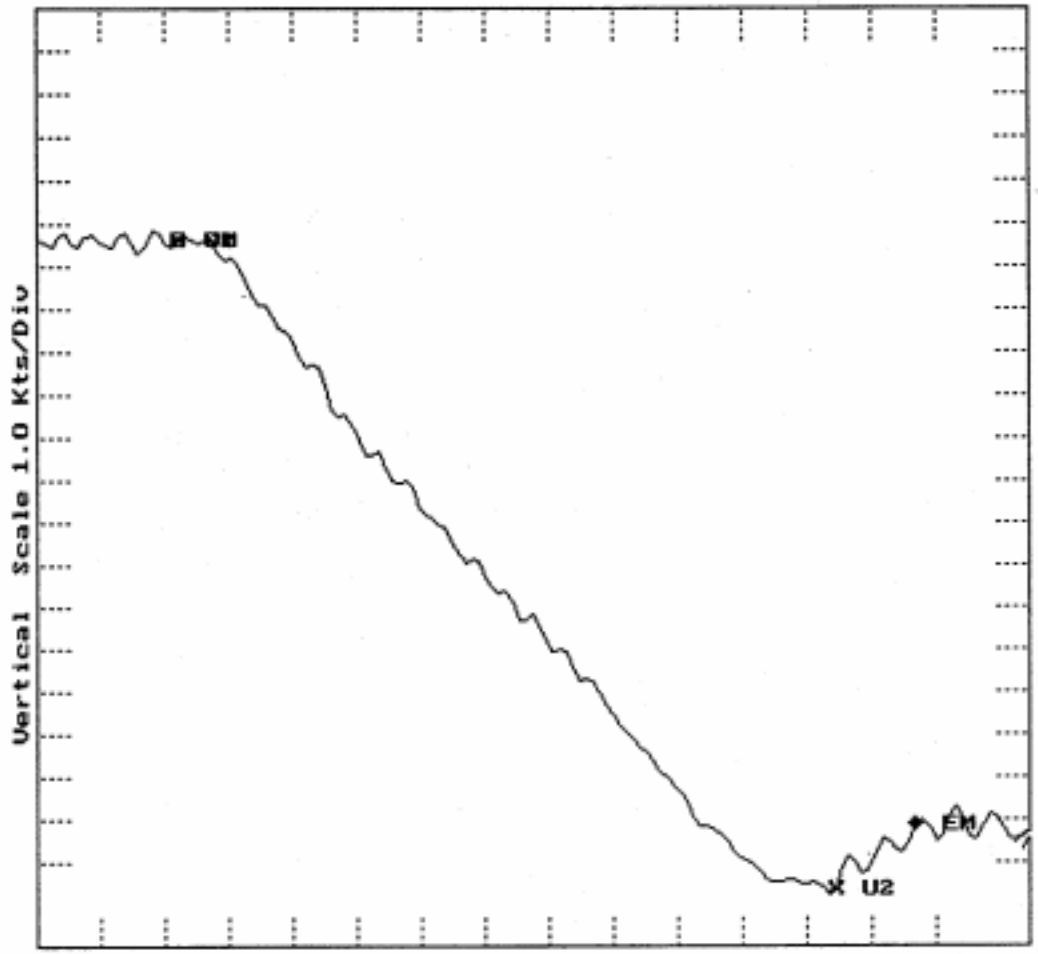
Maneuver performed at 15:51:28 GMT on
9 June 1998
Acceleration Maneuver on Juniper WLB 201
Executed with an initial speed of 0 Knots both engines

EVENT	TIME	MEASURE
TIME to FULL SPEED	118.00 Seconds	
DISTANCE to FULL SPEED		660.43 Yards

Time and Distance calculations are based on the following:
The USER PLACED MARK at 15:53:09 GMT
and
The USER PLACED MARK at 15:55:07 GMT

Table A-33, Acceleration Maneuver A direction #3

9 June 1998
15:16:43
Deceleration
Maneuver # 3 (B)
0 Rudder
at 0.0 Kts
Velocity Plt
Plot Center:
41 21.2 N
71 15.8 W



Horizontal Scale 10.0 S/Div

Figure A-34, Deceleration Maneuver B direction #1

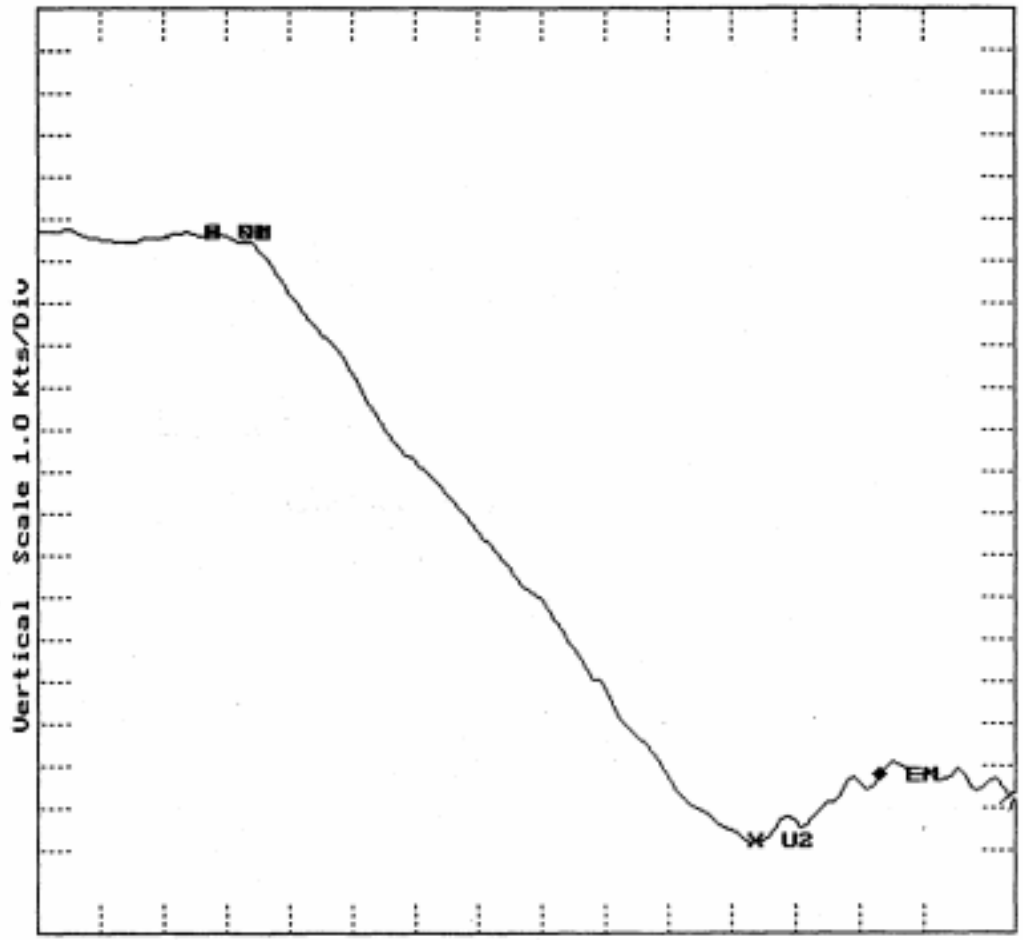
Maneuver performed at 15:16:43 GMT on
9 June 1998
Deceleration Maneuver on Juniper WLB 201
Executed with an initial speed of 0 Knots both engines

EVENT	TIME	MEASURE
TIME to FULL STOP	98.00 Seconds	
DISTANCE to FULL STOP		443.42 Yards

Time and Distance calculations are based on the following:
The USER PLACED MARK at 15:17:04 GMT
and
The USER PLACED MARK at 15:18:42 GMT

Table A-34, Deceleration Maneuver B direction #1

9 June 1998
15:29:53
Deceleration
Maneuver # 5 (A)
0 Rudder
at 15.8 Kts
Velocity Plt
Plot Center:
41 21.6 N
71 16.0 W



Horizontal Scale 10.0 S/Div

Figure A-35, Deceleration Maneuver A direction #1

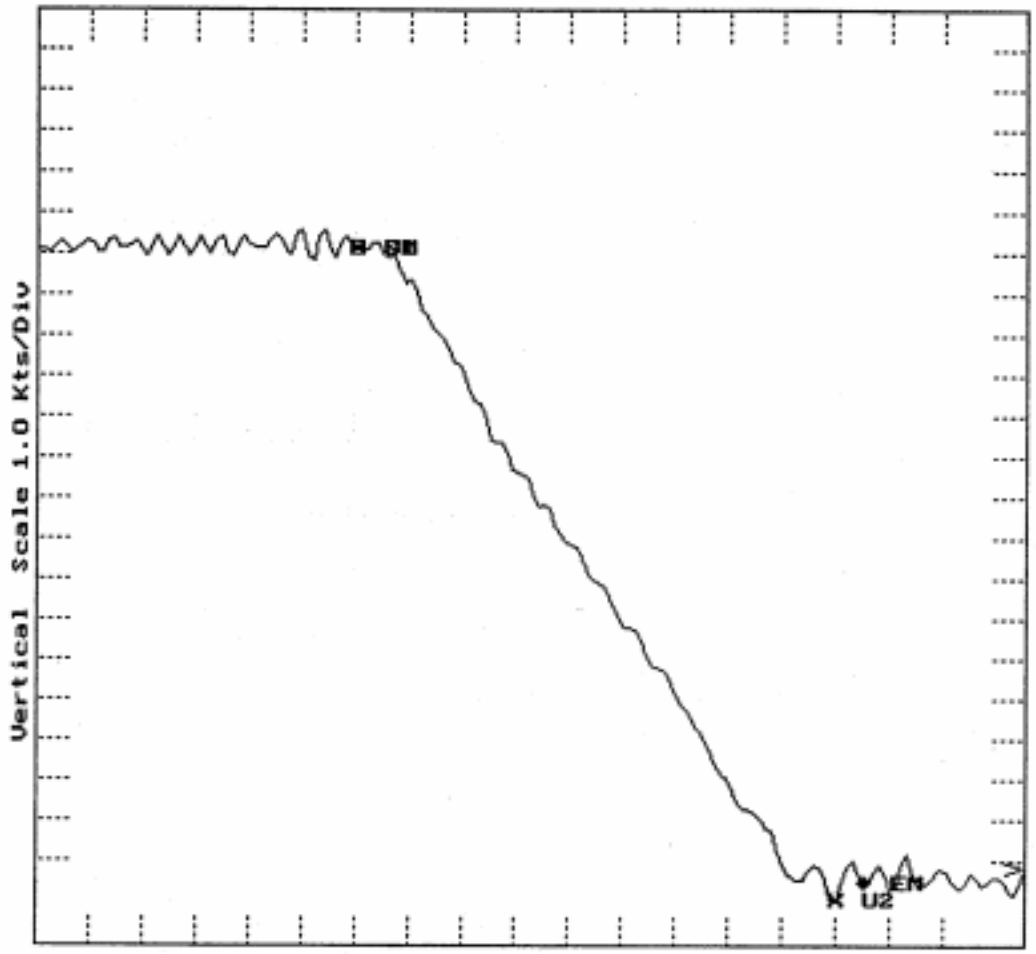
Maneuver performed at 15:29:53 GMT on
9 June 1998
Deceleration Maneuver on Juniper WLB 201
Executed with an initial speed of 15 Knots both engines

EVENT	TIME	MEASURE
TIME to FULL STOP	84.00 Seconds	
DISTANCE to FULL STOP		425.84 Yards

Time and Distance calculations are based on the following:
The USER PLACED MARK at 15:30:20 GMT
and
The USER PLACED MARK at 15:31:44 GMT

Table A-35, Deceleration Maneuver B direction #1

9 June 1998
15:44:21
Deceleration
Maneuver # 7 (B)
0 Rudder
at 16.0 Kts
Velocity Plt
Plot Center:
41 21.2 N
71 15.5 W



Horizontal Scale 10.0 S/Div

Figure A-36, Deceleration Maneuver B direction #2

Maneuver performed at 15:44:21 GMT on
9 June 1998
Deceleration Maneuver on Juniper WLB 201
Executed with an initial speed of 16 Knots both engines

EVENT	TIME	MEASURE
TIME to FULL STOP	89.00 Seconds	
DISTANCE to FULL STOP		418.68 Yards

Time and Distance calculations are based on the following:
The USER PLACED MARK at 15:45:20 GMT
and
The USER PLACED MARK at 15:46:49 GMT

Table A-36, Deceleration Maneuver B direction #2