UNCLASSIFIED

U.S. COAST GUARD TEMPEST 44 TRIAL RESULTS

BY THOMAS A. KUSH

NAVAL SEA COMBAT SYSTEMS ENGINEERING STATION
NAVAL STATION
NORFOLK, VA 23511

MAY 1988 NAVSEACOMBATSYSENGSTA REPORT NO. 60-195

UNCLASSIFIED

INTRODUCTION

This report describes the results of testing conducted on the U.S. Coast Guard Tempest 44. The purpose of the testing was to determine the performance characteristics of the craft. A series of tests was conducted on Coast Guard craft 43504, operating out of Coast Guard Base Miami during September 1987. The tests consisted of documenting the physical dimensions and principal characteristics; scale weighing, to determine weight and longitudinal center of gravity; calm water performance, to determine speed, shaft horsepower, fuel consumption, and dynamic trim for several conditions of loading; maneuvering, to determine turning and acceleration/deceleration characteristics; and onboard noise measurements, to determine airborne noise levels.

LIST OF FIGURES

LIST OF TABLES

CRAFT DIMENSIONS AND PRINCIPAL CHARACTERISTICS

The U.S. Coast Guard Tempest 44 is a variant of a commercial high speed pleasure craft. The craft's hull form is typical of the ocean racer genre, being a deep vee planing hull with a fine bow and reverse shear. The craft is equipped with Tempest Marine's "T-Torque Drive System". The "T-Torque Drive System" incorporates surface piercing propellers on shafts which pass through the transom rather than the bottom of the craft. The shafts are supported by struts mounted on the transom. A large T-shaped weldment is mounted on the transom between the shaft struts. This weldment supports the rudders behind the propellers and encloses the steering gear.

Listed below are the values for the physical dimensions and principal characteristics which were measured on the test craft. Where it was not possible to measure the test craft the design value or data obtained from other sources has been given and so noted.

Length overall	45 feet, 1 7/16 inches
Beam overall	9 feet, 5 inches
Chine beam (at transom)	8 feet, 4 inches
Chine beam (maximum)	8 feet, 6 7/8 inches
Deadrise (at transom)	24 degrees
Height (keel to highest fixed antenna)	12 feet, 4 3/4 inches
Full load displacement	19445 pounds
Light load displacement	15350 pounds
Capacity (including crew)	10 persons
Fuel capacity	315 gallons (reported by operators)
Potable water capacity	30 gallons (indicated on tank label plate)
Maximum speed at full load	39 knots
Range at maximum speed and full load	330 nautical miles (based on 95% fuel)
Navigational draft at full load	3 feet, 2 inches (reported by operators)
Main engines	Caterpillar 3208TA rated 375 BHP/364 SHP at 2800 RPM
Reduction gear	Twin Disc MG507, 1.1 to 1 reduction
Propellers	18 in. D x 23 in. P, 3 - blade, cupped, surface piercing (reported by operators)
Electrical	12 vdc, 2 x 130 amp alternators

CRAFT WEIGHT

The test craft was weighed and the light condition weight of the craft, adjusted to include normally installed equipment which was not onboard, was found to be 15350 pounds; with a corresponding longitudinal center of gravity 10.23 feet forward of the transom-keel intersection.

The full load condition weight of the craft was calculated to be 19445 pounds; with a corresponding longitudinal center of gravity 10.24 feet forward of the transom-keel intersection. The full load condition of the craft is the light condition plus fuel (315 gallons), water (30 gallons), and ten persons (165 pounds each, in the seats on deck).

CALM WATER PERFORMANCE

Calm water performance trials were conducted at three conditions of displacement on a measured course one nautical mile in length. The minimum depth of water on the test course was 35 feet. All results are the average of measurements taken on two runs, one in each direction, on the test course. Measurements were made of time, RPM of both shafts, torque of the port shaft, fuel supply and return rates for the port engine, and dynamic trim. Except as noted, the trim tabs were fully retracted during the testing. The craft's cloth canopies were rigged during the testing; the craft's operators reported that the canopies reduce the top speed of the craft by 1 to 2 knots compared to the speed obtained by the craft without the canopies in place.

The first condition was a displacement of 18590 pounds with a longitudinal center of gravity 10.56 feet forward of the transom-keel intersection. This condition approximates the craft in a light operating condition (a crew of four and full fuel and water). The trial results are presented in Table 1 and Figure 1. The maximum average speed obtained in this condition was 40.0 knots with a total propulsive power of 709 HP and a dynamic trim of 5.4 degrees.

The second condition was a displacement of 19630 pounds with a longitudinal center of gravity 11.00 feet forward of the transom-keel intersection. This condition approximates the craft in the full load operating condition (ten personnel and full fuel and water) with the personnel occupying the forward crew seating and the cabin. The trial results are presented in Table 2 and Figure 2. The maximum average speed obtained in this condition was 38.4 knots with a total propulsive power of 713 HP and a dynamic trim of 5.4 degrees.

The third condition was a displacement of 19340 pounds with a longitudinal center of gravity 10.12 feet forward of the transom-keel intersection. This condition approximates the craft in the full load operating condition (ten personnel and full fuel and water) with the personnel occupying the seating on deck. The trial results are presented in Table 3 and Figure 3. The maximum average speed obtained in this condition was 39.7 knots with a total propulsive power of 707 HP and a dynamic trim of 5.8 degrees.

Fuel consumption measurements were 12 to 51 percent less than the engine manufacturer's published data. The most likely explanation for this discrepancy is cavitation in the fuel return up stream of the flow meter. The flow meter is a volumetric device; as the fuel and vapor mixture has a greater volume than fuel alone the fuel return flow appears greater than its true value. As a result the calculated fuel consumption (fuel supply minus fuel return) will be lower than its true value. Because of this problem fuel consumption data has not been presented in this report. Additional testing should be conducted to determine the fuel consumption.

TABLE 1 - CALM WATER PERFORMANCE

Tempest 44 (USCG 43504)
3 Sep 87
Displacement: 18590 pounds
LCG: 10.56 feet forward of the transom-keel intersection
Static trim: 3.8° by the stern
Trim reference: Keel at transom
Propeller: 18 in. D x 23 in. P, cupped, surface piercing
Gear ratio: 1.1 to 1
Water depth: >35 feet

SPEED (KNOTS)	AVERAGE ENGINE RPM	TOTAL SHP	DYNAMIC TRIM (DEGREES BY STERN)
6.2	627	22	4.7
8.1	1100	100	6.0
8.6	1364	148	6.4
9.4	1804	251	7.3
12.0	2178	384	8.6
35.2	2561	553	5.7
40.0	2834	709	5.4

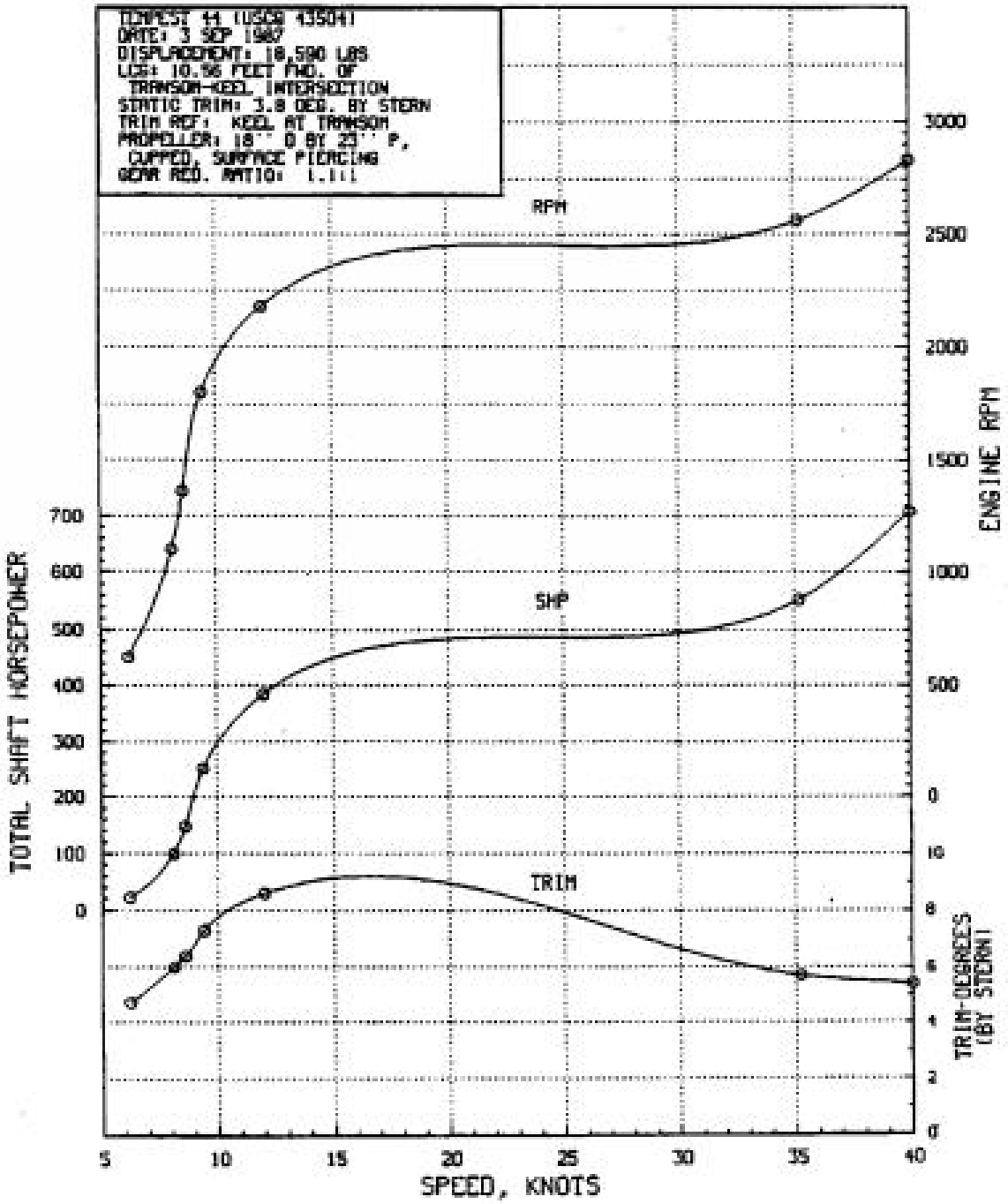

FIGURE 1 - CALM WATER PERFORMANCE

TABLE 2 - CALM WATER PERFORMANCE

Tempest 44 (USCG 43504)
8 Sep 87
Displacement: 19630 pounds
LCG: 11.00 feet forward of the transom-keel intersection
Static trim: 3.4° by the stern
Trim reference: Keel at transom
Propeller: 16 in. D x 23 in. P, cupped, surface piercing
Gear ratio: 1.1 to 1
Water depth: >35 feet

SPEED (KNOTS)	AVERAGE ENGINE RPM	TOTAL SHP	DYNAMIC TRIM (DEGREES BY STERN)
6.1	626	22	4.4
8.1	1034	84	5.6
8.7	1425	160	6.2
9.3	1771	246	6.8
12.8	2217	402	8.4
32.1	2557	579	6.4
38.4	2805	713	5.4

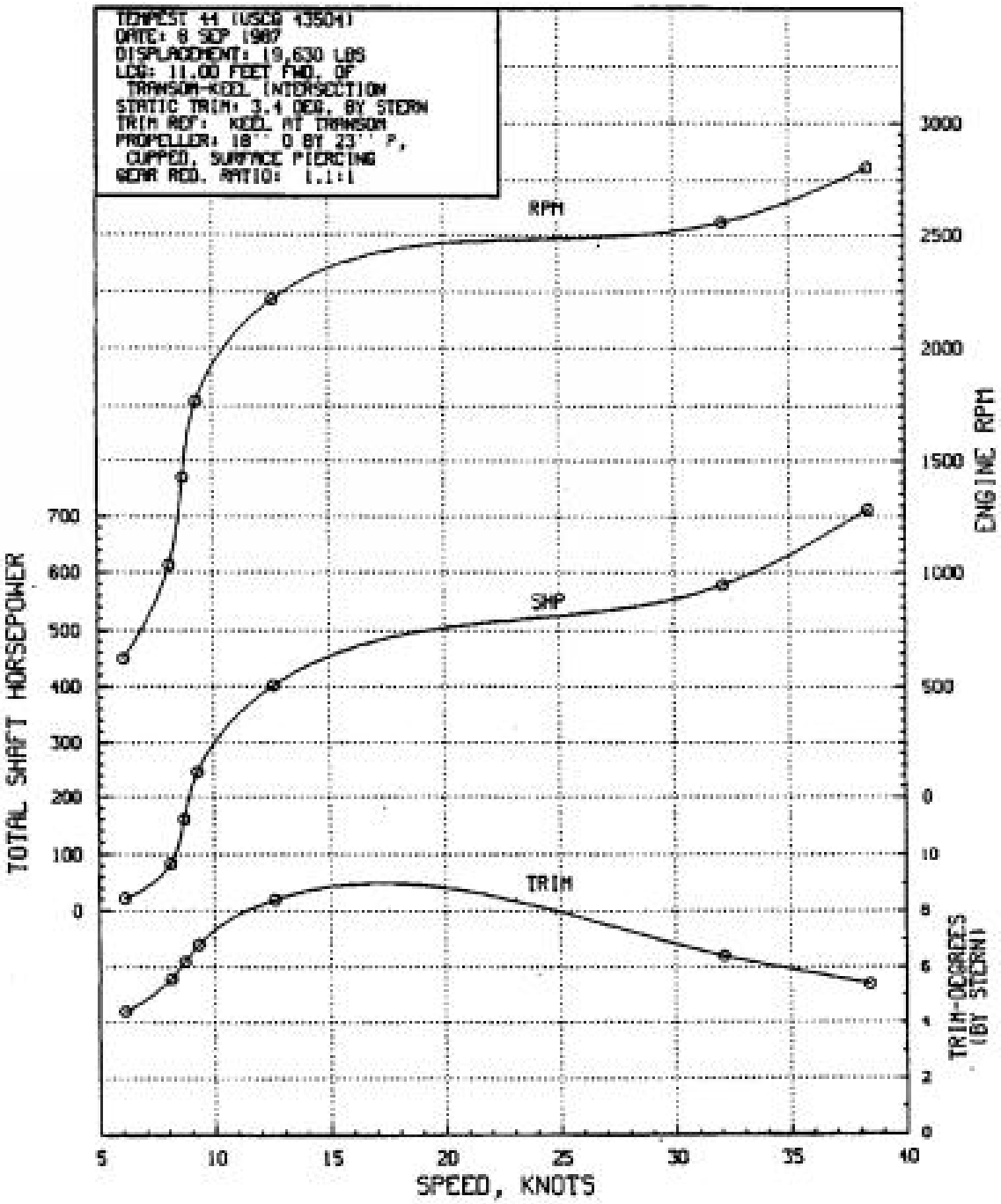

FIGURE 2 - CALM WATER PERFORMANCE

TABLE 3 - CALM WATER PERFORMANCE

Tempest 44 (USCG 43504)
8 Sep 87
Displacement: 19340 pounds
LCG: 10.12 feet forward of the transom-keel intersection
Static trim: 4.6° by the stern
Trim reference: Keel at transom
Propeller: 18 in. D x 23 in. P, cupped, surface piercing
Gear ratio: 1.1 to 1
Water depth: >35 feet

SPEED (KNOTS)	AVERAGE ENGINE RPM	TOTAL SHP	DYNAMIC TRIM (DEGREES BY STERN)	
5.8	616	22	5.4	
7.9	1045	98	6.9	
8.7	1474	196	7.6	
9.0	1738	266	8.2	
9.9	2090	374	9.0	
14.8	2528	580	11.2	
31.8	2536	551	6.6	See note 1
39.7	2822	707	5.8	

Note 1: Trim tabs were employed to initiate planing and then retracted.

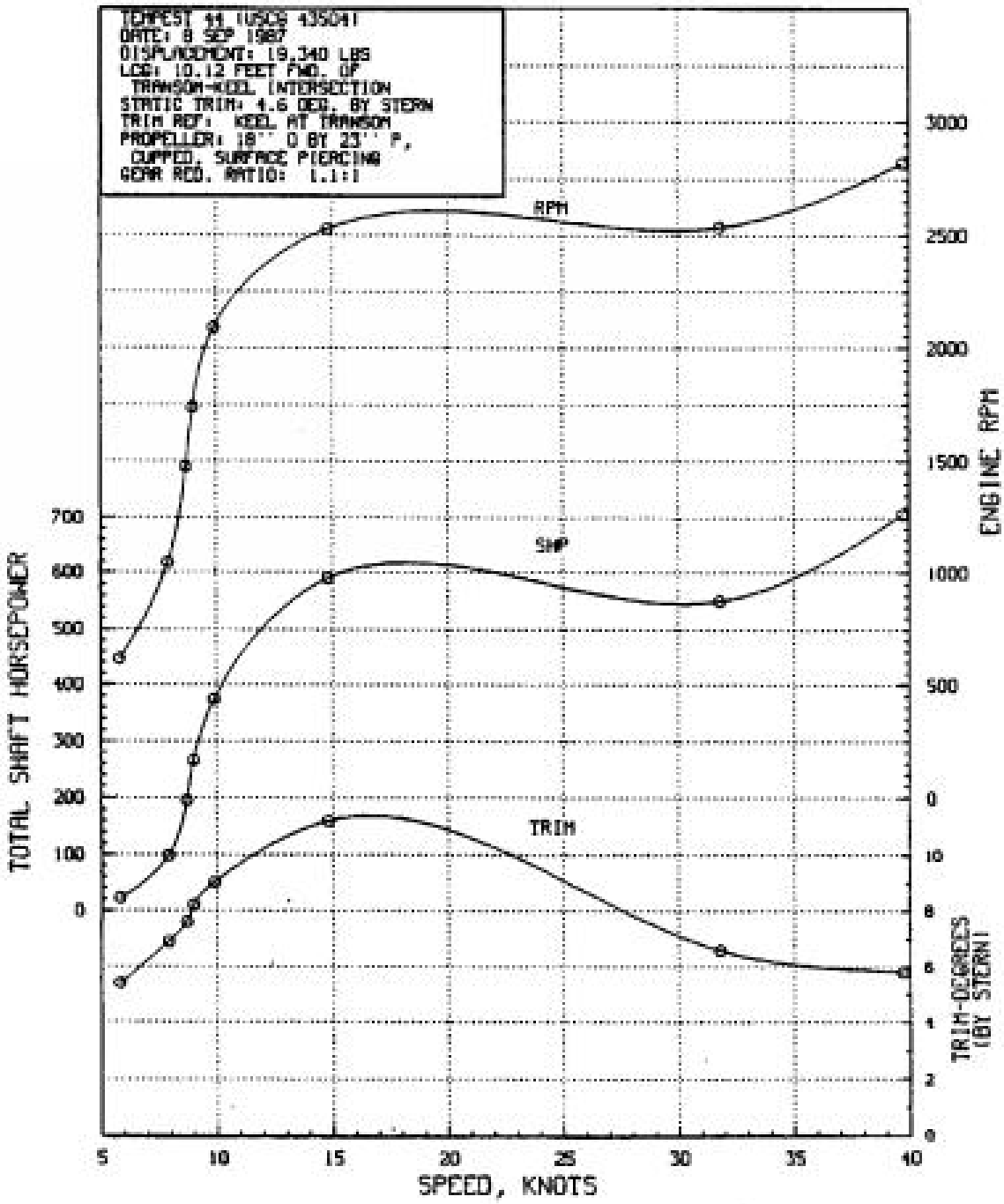

FIGURE 3 - CALM WATER PERFORMANCE

MANEUVERING

Turning, and acceleration, deceleration and crashback trials were conducted using a range-range type tracking system. The master station was located ashore, the base line transponder was located on a fixed aid to navigation and the second transponder was installed on the test craft.

Turns to the left and right were performed at rudder angles of approximately 10, and 20 degrees and hard rudder from straight approach runs at 2050, 2400, and 2850 engine RPM. As the steering gear is located in a free flooding housing mounted on the transom it was not possible to install a rudder angle indicator; approximate rudder angles were obtained during the test by determining, prior to the test, the helm positions corresponding to 10 and 20 degrees left and right rudder. Also prior to the test it was determined that hard left rudder is 37 degrees and that hard right rudder is 34 degrees. The rudders were found to be toed out 1.8 degrees (measured from rudder to rudder, not rudder to centerline). Rudder angles were measured from the equal toe out position (helm amidships, no steering effect). Measurements were made of approach speed, speed in the turn, angle of heel, advance for 90 degrees, transfer for 90 degrees, tactical diameter, turning diameter, and rate of turn. Figure 4 shows a schematic of a turning maneuver with some terms defined. The results were corrected for set and drift. A sample of the uncorrected and corrected position plots is presented in Figure 5. Turning trial results are tabulated in Table 4.

Because of concern that, with the unusual rudder configuration used on this craft, the rudders might ventilate and become ineffective in a violent high speed turn a number of "panic" turns were executed. These maneuvers consisted of running the craft at full speed and throwing the helm over to hard rudder as rapidly as possible. No ventilation of the rudders or any unusual steering effects were observed.

Acceleration trials were conducted to determine the time and distance required to attain full speed from dead in the water. This test was conducted with the trim tabs fully retracted and with the trim tabs employed. For each condition a pair of runs was made on reciprocal courses to allow for correction for set and drift. Without the use of trim tabs (trim tabs fully retracted) the craft required 34 seconds and a distance of 397 meters to reach full speed from dead in the water; these results are presented in Figure 6. With trim tabs employed the craft required 31 seconds and a distance of 355 meters to reach full speed from dead in the water; these results are presented in Figure 7.

Deceleration and crashback trials were conducted to determine the time and distance required to bring to craft to a stop from full speed ahead. The deceleration test consisted of quickly reducing engine speed to idle, shifting to neutral and allowing the craft to coast to a stop with the propellers windmilling. The crashback test consisted of quickly reducing engine speed to idle, shifting to reverse, and increasing engine speed to full power in reverse until the craft is dead in the water; the

reversal was accomplished as rapidly as possible within the capabilities of the propulsion system. Two deceleration runs and two crashback runs were made on reciprocal courses to allow for correction for set and drift. For deceleration from full speed ahead the craft required 102 seconds and a distance of 242 meters to come to a stop; these results are presented in Figure 8. For a crashback from full speed ahead the craft required 18 seconds and a distance of 162 meters to come to a stop; these results are presented in Figure 9.

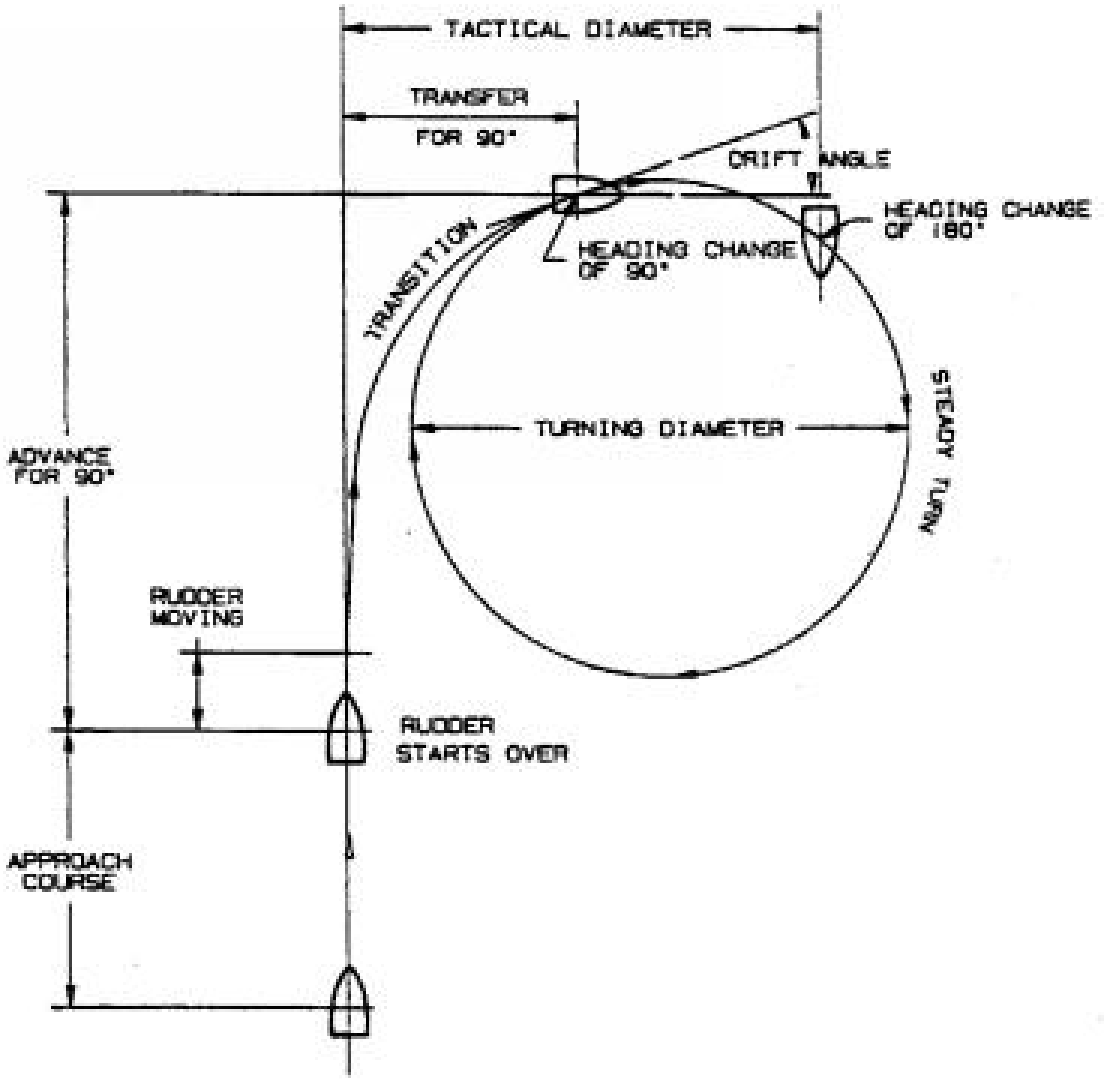

FIGURE 4 - TURNING NOMENCLATURE

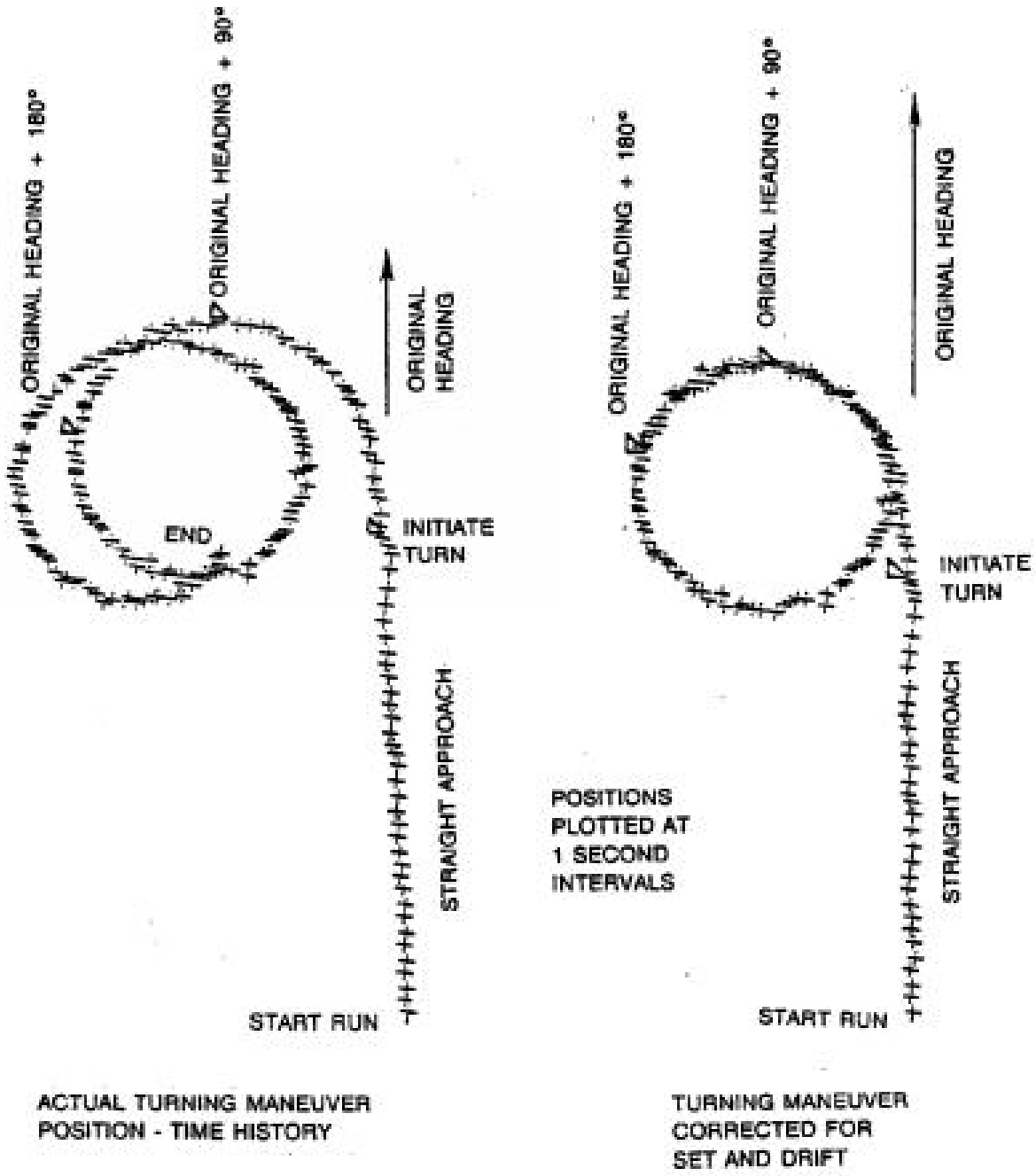

FIGURE 5 - SAMPLE TURNING PLOT

TABLE 4 - TURNING TRIAL RESULTS

APPROACH SPEED (KNOTS)	RUDDER ANGLE (DEGREES)	SPEED IN TURN (KNOTS)	ANGLE OF HEEL (DEGREES)	ADVANCE FOR 90° (METERS)	TRANSFER FOR 90° (METERS)	TACTICAL DIAMETER (METERS)	TURNING DIAMETER (METERS)	RATE OF TURN (DEG/SEC)
11	Left 10	8.8	3	40	59	138	140	3.7
	Right 10	8.8	0	70	59	115	132	3.9
	Left 20	8.0	4	44	32	70	69	7.5
	Right 20	8.2	1	65	19	51	71	6.8
	Left 37	7.5	5	30	19	40	42	10.9
	Right 34	7.7	4	30	16	44	43	10.2
20	Left 10	22.3	10	154	146	212	234	5.8
	Right 10	-	1	-	see	note 1	-	-
	Left 20	23.1	15	202	187	375	270	5.3
	Right 20	23.5	6	162	162	244	202	7.0
	Left 37	9.8	18	93	80	98	43	11.7
	Right 34	13.0	14	104	62	100	70	10.5
40	Left 10	-	13	-	see	note 2	-	-
	Right 10	-	2	-	see	note 2	-	-
	Left 20	34.5	17	160	117	296	293	7.0
	Right 20	35.6	10	100	146	270	277	7.5
	Left 37	22.9	22	84	77	126	126	11.6
	Right 34	27.3	19	100	42	128	147	10.9

Note 1: Data lost due to tracking system malfunction.
Note 2: Turn aborted. At full speed, ten degrees rudder was found to have very little steering effect. The size of the turn was too large to complete within the available operating area.

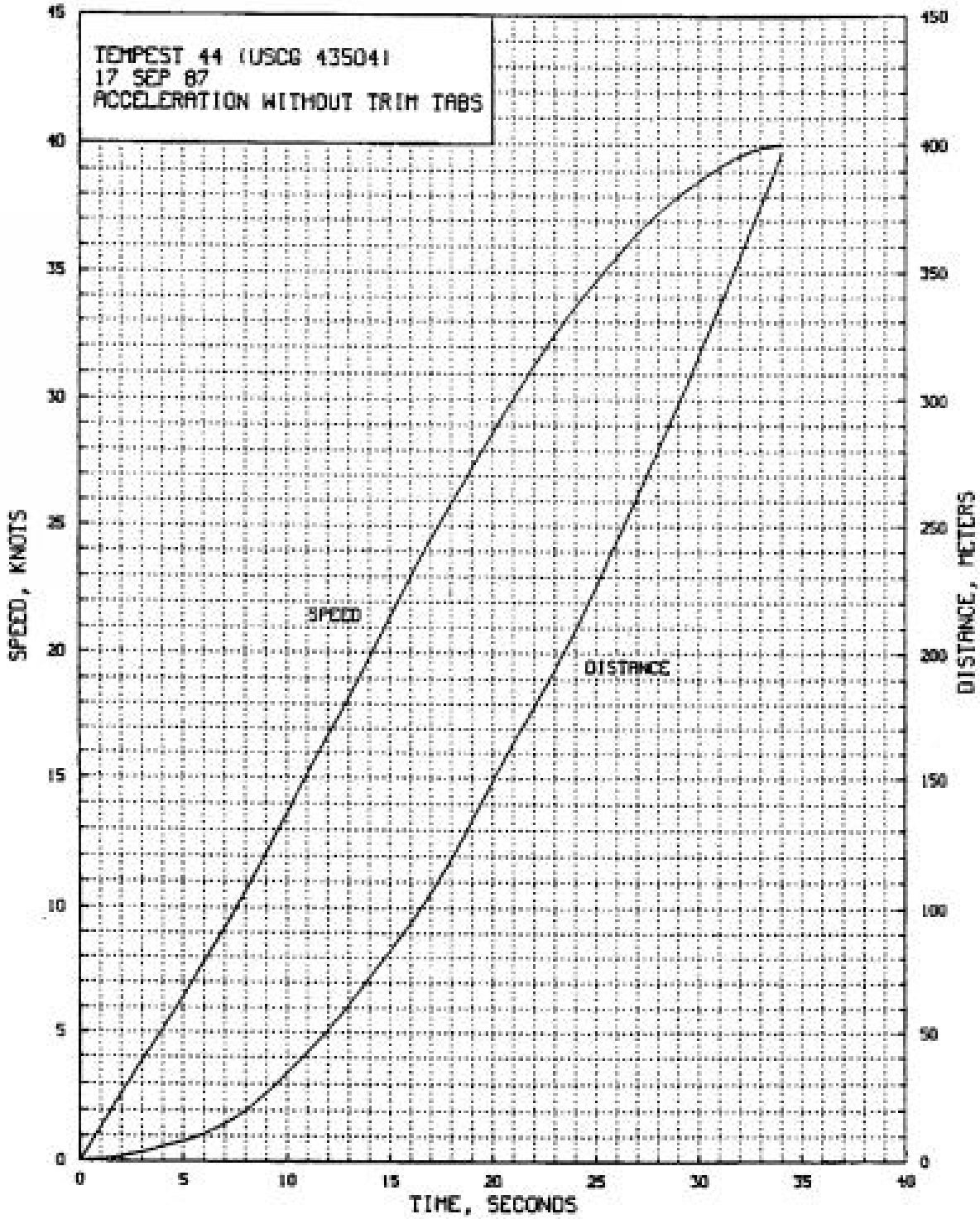

FIGURE 6 - ACCELERATION WITHOUT TRIM TABS

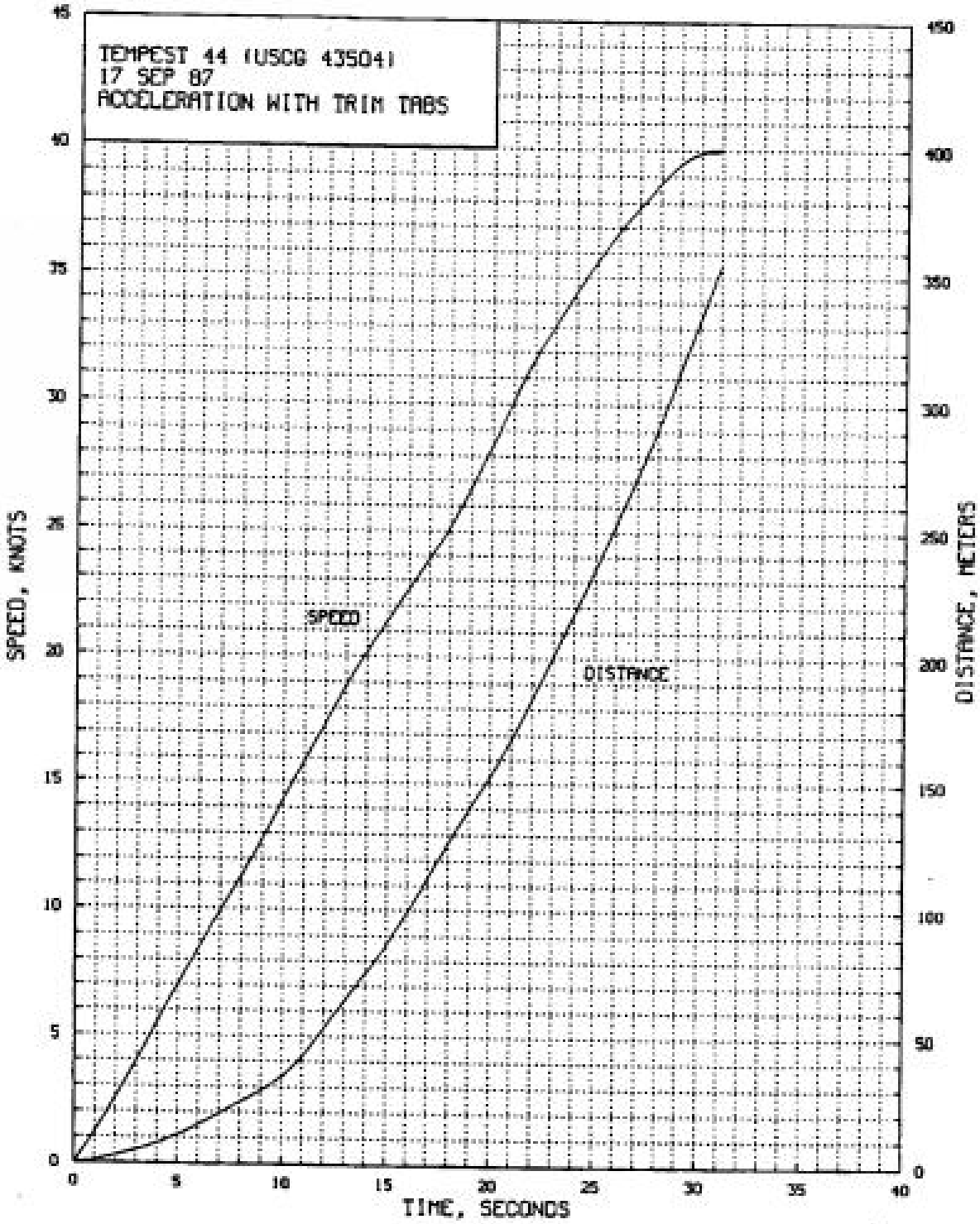

FIGURE 7 - ACCELERATION WITH TRIM TABS

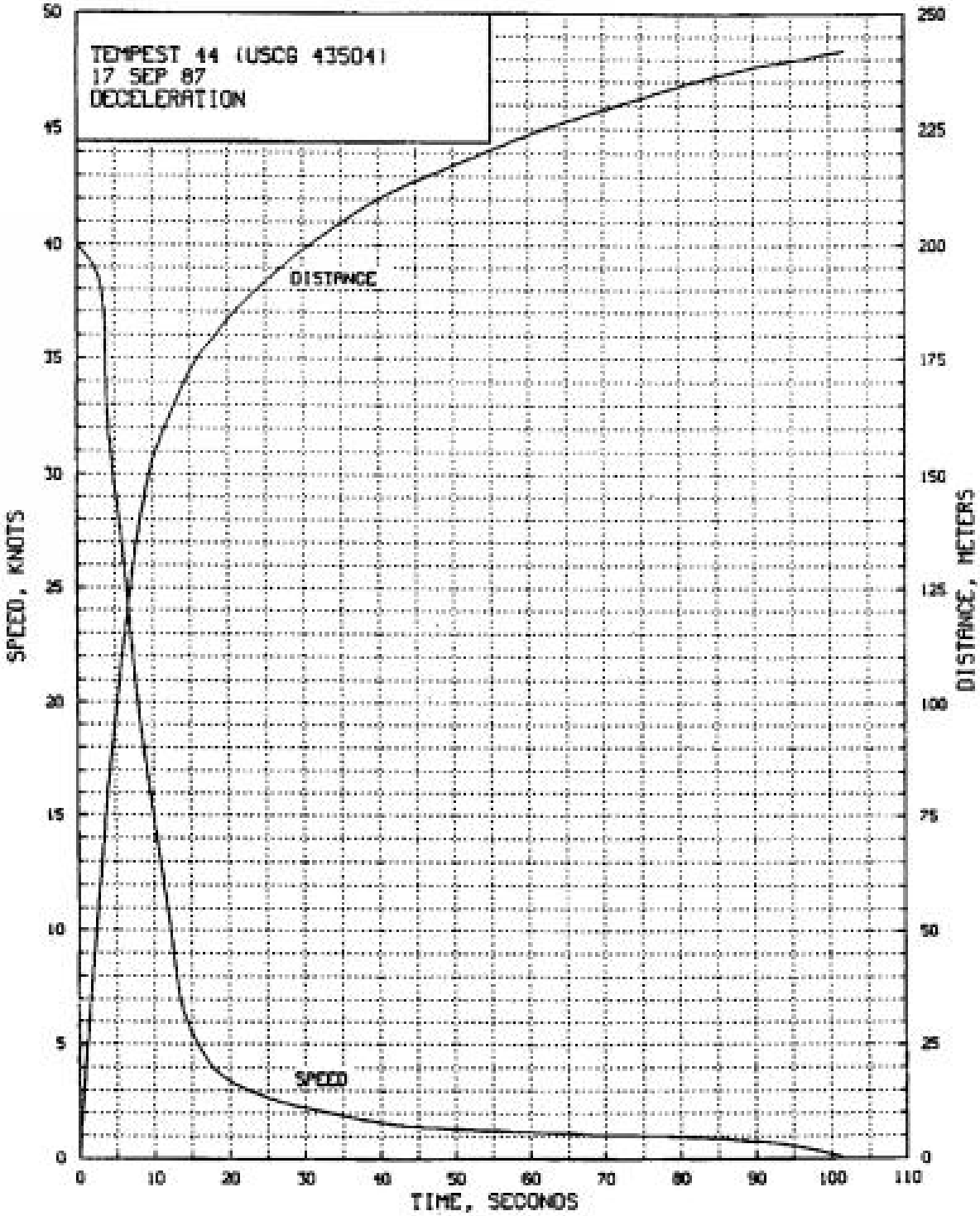

FIGURE 8 - DECELERATION

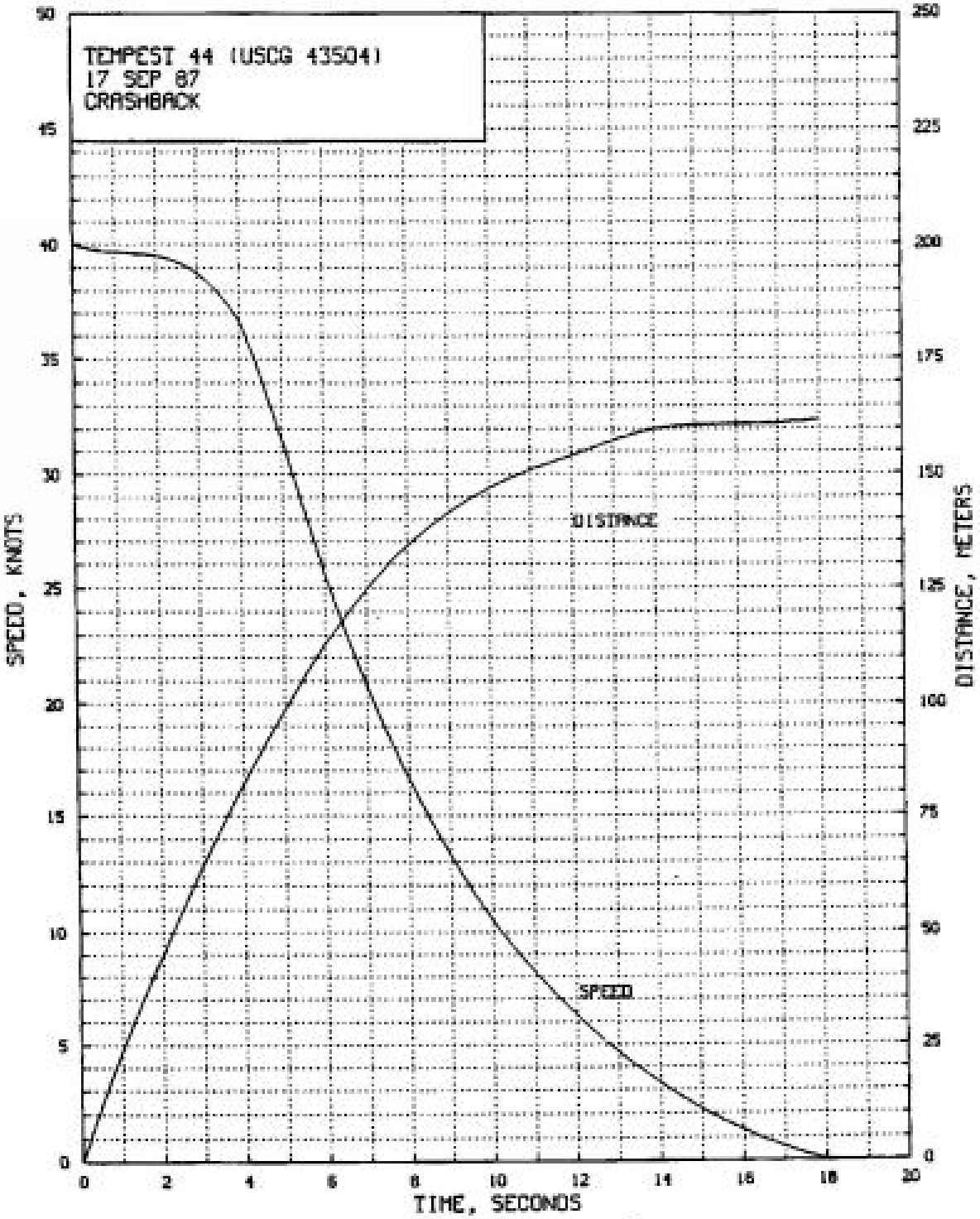

FIGURE 9 - CRASHBACK MANEUVER

ONBOARD NOISE

A-weighted airborne noise levels were measured to determine if noise levels present a hazard to personnel or interfere with crew performance. Noise levels were measured at the head of the V-berth, the center of the table in the cabin, at the aft end of the cabin, at the coxswains station, at the forward seat on the engine box, and at the seat at the transom. Readings were taken with the engines shut down, at idle, at 2400 RPM in neutral, at 2400 RPM ahead, and at full power ahead. The results are presented in Table 5. The A-weighted noise level routinely exceeds 85 dB(A), the level at which a hazard is deemed to exist and hearing protection should be used.

TABLE 5 - ONBOARD NOISE

AIRBORNE NOISE LEVELS [dB(A)]

LOCATION	ENGINES SHUT DOWN	IDLE	2400 RPM AHEAD	2400 RPM NEUTRAL	FULL POWER AHEAD
Head of V-berth	61	76	96	84	100
Center of table	59	76	95	86	98
Aft end of cabin	61	78	97	90	106
Coxswains station	63	78	94	88	101
Seat on engine cover	63	82	101	92	105
Seat at transom	63	83	101	94	104