NAVY DEPARTMENT

THE DAVID W. TAYLOR MODEL BASIN

WASHINGTON 7, D.C.

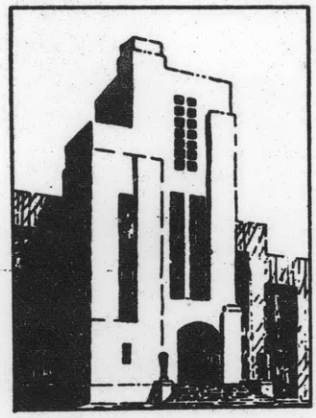
USS NEOSHO (AO143)

STEERING GEAR, TRANSIENT TORQUE AND THRUST DATA

AND BACKING TRIAL DATA

by

George K. Brown



EVALUATION TEST REPORT

December 1957 Report No. 1167

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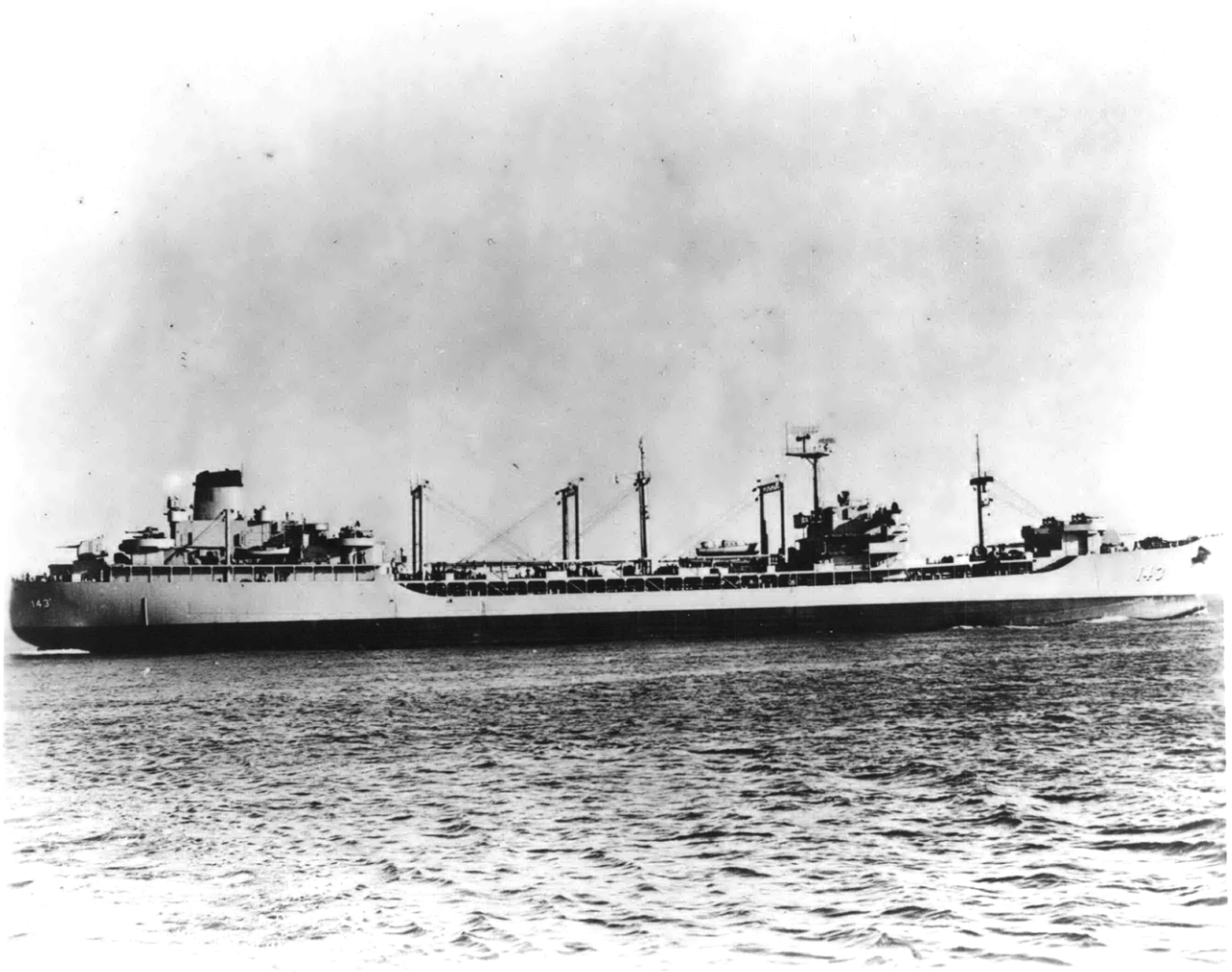


USS NEOSHO (AO143)

ABSTRACT

Trials were conducted on the USS NEOSHO (AO143) to obtain steering gear data, transient torque and thrust data and astern turbine data during special performance trials in April 1955. Measurements were made to determine torque, thrust, RPM, rudder angle, steering ram pressure, steering motor input, astern steam chest pressure, ship's heading, and reach of the vessel during selected runs. The data obtained from these measurements are presented in the form of curves. Weather conditions were satisfactory during the trials and the data obtained are considered to be good.

INTRODUCTION

Astern turbine tests, steering gear trials, and special trials to obtain transient torque and thrust data were conducted on the USS NEOSHO (AO143) as a part of the special performance trials requested by the Bureau of Ships agenda letter (1)*. Staff members of the Taylor Model Basin assisted by personnel from the Boston Naval Shipyard observed the trials and collected the data. The purpose of the trials included in this report was to obtain operational and design data for ships of the AO143 Class.

Transient torque and thrust records along with other data were obtained while the ship was making steady state runs and a full power circle. Steering ram pressures along with other data were obtained while the ship was making zig-zag maneuvers and tactical circles. Backing data were obtained during the deceleration runs. The results of standardization trials have been previously reported (2) and the turning characteristics of tactical trials with the time-speed characteristics during acceleration and deceleration runs have also been reported (3).

TRIAL CONDITIONS

The characteristics of the hull and propeller of the NEOSHO are listed in Table 1. A summary of weather conditions and wind data during trials is listed in Table 2. From a study of this table it can be seen that the weather conditions were quite satisfactory for trials. A list of run numbers and pertinent information concerning each run is given in Table 3. The numbers are not consecutive because additional runs, for which transient data were not required, were made during the same trial period.

* References are listed on pages 4 and 5.

The trials of the NEOSHO were conducted off Leeward Point, Guantanamo Bay, Cuba in April 1955. The ship was tracked by two shore station teams located 3368 yards apart during selected runs. At the same time data were recorded on board ship.

The data for the curves in Figures 22 and 33 were obtained while the NEOSHO was at light displacement on 4 April 1955. The data for all other curves were obtained while the ship was at heavy displacement on 7, 8, and 11 April 1955.

METHOD OF CONDUCTING TRIALS

For each run the ship approached the trial area at the conditions required by the run. Recordings were made and readings taken as required during one minute of steady conditions. "Execute" was then ordered and normal shipboard procedure was followed to accomplish the specified maneuver. Deceleration runs were terminated when the ship was dead in the water.

Data were obtained for each type of run as follows:

TACTICAL CIRCLES: FIGURES 3 - 22

At the camera stand pictures were taken frequently during the transient period and every ten seconds thereafter. The Sanborn recording equipment was operated continuously from the one minute approach to the end of the run. Photographs were made at the heading recorder every ten seconds for the duration of the run. The ship was tracked by shore stations but those data are reported elsewhere (3).

ACCELERATION AND DECELERATION RUNS: FIGURES 23 - 29

The two shore stations tracked the ship and at the same time a continuous record of thrust, torque and RPM was made with the Sanborn equipment. During the deceleration runs, astern steam pressure was also recorded on the Sanborn equipment.

ZIG ZAG RUNS: FIGURES 30 - 32

A continuous record of steering ram pressures and rudder angle was made with the Sanborn equipment. The camera stand was also used to record the rudder movements and ram pressures, however, the data used to draw the curves presented herein were obtained exclusively from the Sanborn records.

CONSTANT SPEED RUN: FIGURE 33

The ship speed was changed in increments of five RPM commencing at 10 RPM and increasing in steps to full power. At each step, while the ship was at a constant speed, the RPM, and the transient torque and thrust were recorded on the Sanborn equipment.

INSTRUMENTATION

The major trial instruments, with their function and location, are listed in Table 4. The arrangement of instruments in the Trial Board Room is shown in Figure 1. A block diagram of the instrumentation, Figure 2, identifies the name and serial number of the units used.

The NEOSHO instrumentation was essentially the same as that installed on the USS DEALEY (DE1006). A description of that instrumentation can be found in the report on the DEALEY (4). One exception is that the NEOSHO had one-way thrust meters and ahead thrust only could be recorded during the trials.

One clamping lug on the port torsionmeter husk was cracked during installation. This was repaired by welding for fuel economy trials and performed satisfactorily. The husk was later replaced prior to the trials reported herein. One or more diaphrams in the port thrust meter ruptured on 4 April 1955 during the full power circle to obtain transient values in a turn. As a result there are no port thrust data for that run, Figure 22. The thrust meter was repaired following this casualty and it functioned satisfactorily during the remainder of the trial period. With these exceptions the trial instruments performed satisfactorily and the data obtained are good.

DISCUSSION OF DATA

On all figures zero seconds represent the time that "Execute" was announced. On some of the curves, Figures 3 through 21, it will be noted that there are several breaks in the time scale. If conditions were relatively steady, the time scale was condensed. These cases are obvious because there is a sharp break in the change of heading curve at the point where the scale was changed. The transient torque and thrust curves shown on Figures 22 and 33 represent double amplitude values.

On Figure 11 the KW input to the steering gear motor is shown as a constant value; likewise, on Figure 21 the starboard ram pressure is represented as a constant value. Each of these curves represents the data as recorded by the camera stand and Sanborn recorder respectively. Data from other runs indicate that each curve should show a fluctuation of some appreciable magnitude after "Execute" and level off to a constant value after approximately twenty seconds.

On several of the figures representing acceleration and deceleration runs, the percentage of design torque is approximately one half that of the thrust value at the corresponding time. Although this does not appear to be correct, it represents the data as recorded on the Sanborn equipment. On Figure 27 the Port Astern Steam Pressure lags the Starboard Pressure in time by 160 seconds. This does not appear reasonable when the RPM, torque, and thrust indicate that the port and starboard shafts were approximately together.

Several items of data that were requested in the agenda letter (1) were not obtained because of an oversight in assigning ship personnel to read the data during the necessary runs. There are no boiler drum pressure readings against time for the deceleration runs. The KW input to the steering gear motors was not recorded during the astern zig-zag runs. As explained earlier there is no port thrust data for Figure 22 because of thrust meter failure on 4 April 1955.

Table 5 is a listing of the design full power data used in determining the percentage curves shown on the various figures. Since the thrust meters installed on the NEOSHO were one-way meters, there were no astern thrust data available during the deceleration runs.

REFERENCES

(1) BUSHIPS INSTRUCTION 9080.8 Ser 436-335 of 10 January 1955.

(2) BROWN, George K., "USS NEOSHO (AO143), Standardization Trial Analysis with Fuel Consumption Curves" David Taylor Model Basin Report C-713 (June 1955) CONFIDENTIAL

(3) HEFFNER, James A., "Tactical Trials of USS NEOSHO (AO143)" David Taylor Model Basin Report C-767 (April 1956) CONFIDENTIAL

(4) HIGGINS, James A., "USS DEALEY (DE1006) Backing and Astern Turbine Performance Trials" David Taylor Model Basin Report C-708 (June 1955) CONFIDENTIAL

TABLE 1

Ship and Propeller Characteristics

Ship Characteristics

Length between perpendiculars, feet	640.0
Length overall, feet	656.3
Breadth, extreme, feet	86.4
Displacement in tons of salt water during trials:	
4 April	25,220
7, 8, 11 April	31,640
Trim in feet:	
4 April, trim by head	2.5
7, 8, 11 April, trim by stern	1.0

Propeller Characteristics

Type	Solid
Number of propellers	2
Number of blades	4
Diameter, feet	18.0
Pitch, constant, feet	18.8
Material	Manganese Bronze
BUSHIPS drawing number	A0143-S4400-H-1233716, Rev. K

TABLE 2

Weather Conditions and Wind Data During Trials

Date, 1955	4 April	7 April	8 April	11 April
True Wind Direction, degrees	225	80-150	330-335	110-240
True Wind Velocity, knots	7	4-12	9-10	10-11
Air Temperature, dry bulb, °F	77-78	78-84	73-81	74-83
Air Temperature, wet bulb, °F	74-75	72-78	69-76	69-74
Sea Water Temperature, °F	80-81	80-81	80-81	80
Weather by Symbols	1-2	0-2	1	1
Sea State by Symbols	1	1	1	1

NOTE: Where two numbers appear in the table, it represents the range of recorded values for the day. Symbols used are described in, "Deck Log Book," NAVPERS 130.

TABLE 3

Run Numbers and Test Conditions

Turning Circles

Figure No.	Run No.	Approach Speed Knots	Rudder Angle Degrees	Remarks
3	109	20	10R	
4	10	20	15R	
5	11	20	25R	
6	12	20	35R	
7	13	F.P.	10R	
8	14	F.P.	15R	
9	15	F.P.	25R	
10	16	F.P.	35R	
11	17	12	25L	
12	18	17	25L	
13	19	F.P.	25L	
14	20	20	35R	Stbd Shaft "Stop"
15	21	20	35R	Stbd Shaft "Back 1/3"
16	22	20	35R	Stbd Shaft "Back Full"
17	23	F.P.	35R	Stbd Shaft "Back 1/3"
18	24	F.P.	35R	Stbd Shaft "Back Full"
19	59	F.P.	30R	
20	60	20	30R	
21	61	17	30R	
22	--	F.P.	35R	For Transient Values

TABLE 3 (Concluded)

Run Numbers and Test Conditions

Special Maneuvers

Figure No.	Run No.	Approach Speed Knots	Maneuver	Remarks
23	25	0	Acceleration	To 20 Knots
24	26	15	Acceleration	To Full Power
25	27	10	Deceleration	250 PSIG Astern Steam
26	28	15	Deceleration	250 PSIG Astern Steam
27	29	20	Deceleration	250 PSIG Astern Steam
28	130	F.P.	Deceleration	250 PSIG Astern Steam
29	31	F.P.	Deceleration	450 PSIG Astern Steam
30	56	Back 1/3	Zig Zag	Various Rudder Angles
31	57	Back 2/3	Zig Zag	Various Rudder Angles
32	58	Back Full	Zig Zag	Various Rudder Angles
33	----	Various	Constant Speed	From 10 RPM to F.P.

TABLE 4

Major Trial Instruments

Item No.	Instrument	Location	Function
1	Sanborn D.C. Amplifier (Four Channel)	Trial Board Room	Amplify signal for recorders
2	Sanborn Direct Writing Oscillo-graph Recorder (Four Channel)	Trial Board Room	Record transient values of torque, thrust, RPM, ram pressure, astern steam pressures
3	Torsionmeter Indicator, MK II	Trial Board Room	Feed torque signal to recorder
4	Standardization Panel	Trial Board Room	Check RPM and obtain wind data
5	TMB Electric Revolution Counter	Trial Board Room	Check RPM
6	Kingsbury One-Way Cell-Plate Thrust Meter	Engine Room	Measure thrust and feed signal to recorder
7	Torsionmeter Husk	Each Main Shaft	Used with indicator to measure torque
8	Heading Recorder	Steering Gear Room	Record ship's heading with time-of-day
9	Camera Stand	Steering Gear Room	Record rudder angle, K.W. input to steering gear motors with time-of-day
10	Tracking Stand	Each Shore Station	Triangulation between opposite shore station and ship at regular time intervals

TABLE 4 (Concluded)

Major Trial Instruments

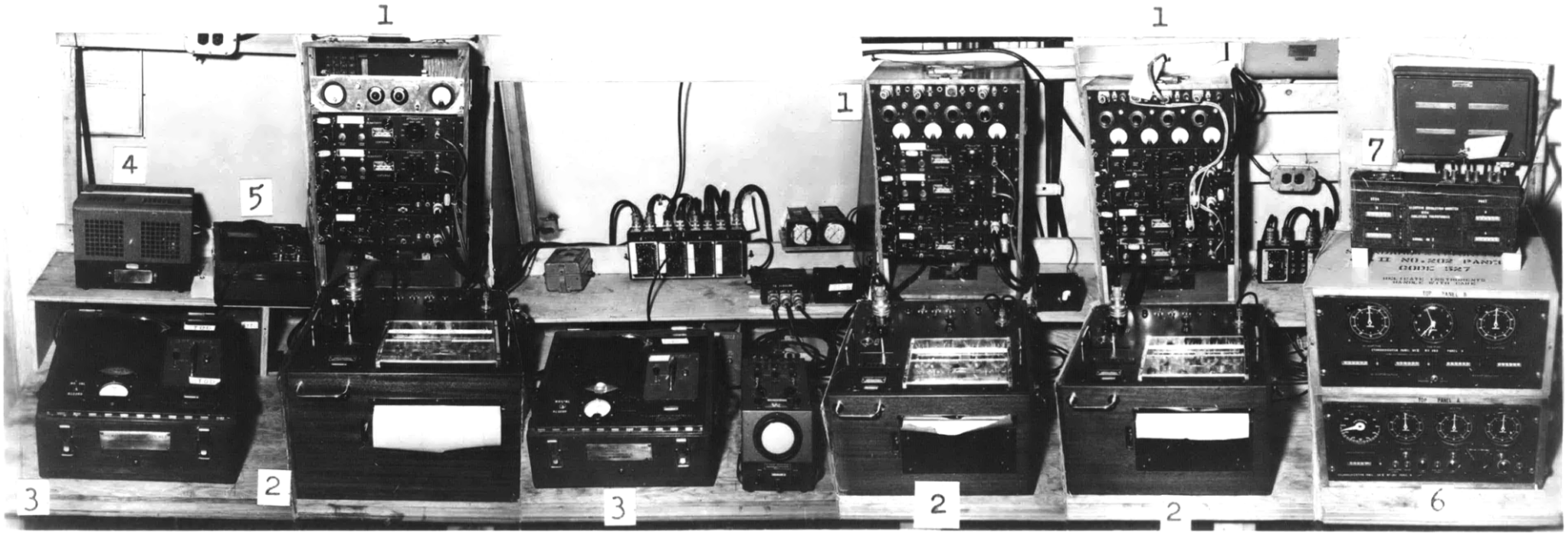
11	Wind Anemometer	Anemometer Mast On Bow	Indicate wind direction and measure wind intensity on standardization panel
12	Tachometer Generator	Each Main Shaft	Feed RPM signal to recorder
13	Hydro Telegage (HT Gage)	Engine Room	Provide signal to record thrust and astern steam on Sanborn recorder
14	Radio, portable	Bridge and Each Shore Station	Two way communication between two shore stations and ship

TABLE 5

Design Full Power Data*

Propeller, RPM	130.0
Propeller Thrust, per shaft, lbs.	160,000
Propeller Shaft Torque, per shaft, lb. ft.	565,600
Astern Steam Chest Pressure, psi	640

* Used in computing percentage of rated design for curves shown on Figures 22 through 29 and 33.



1. Sanborn Amplifier
2. Sanborn Recorder
3. Torsionmeter Indicator MK II
4. Power Supply - 400 Cycle
5. Power Supply - 60 Cycle
6. Standardization Panel
7. TMB Electric Revolution Counter

Figure 1 - Trial Instruments Located In Trial Board Room.

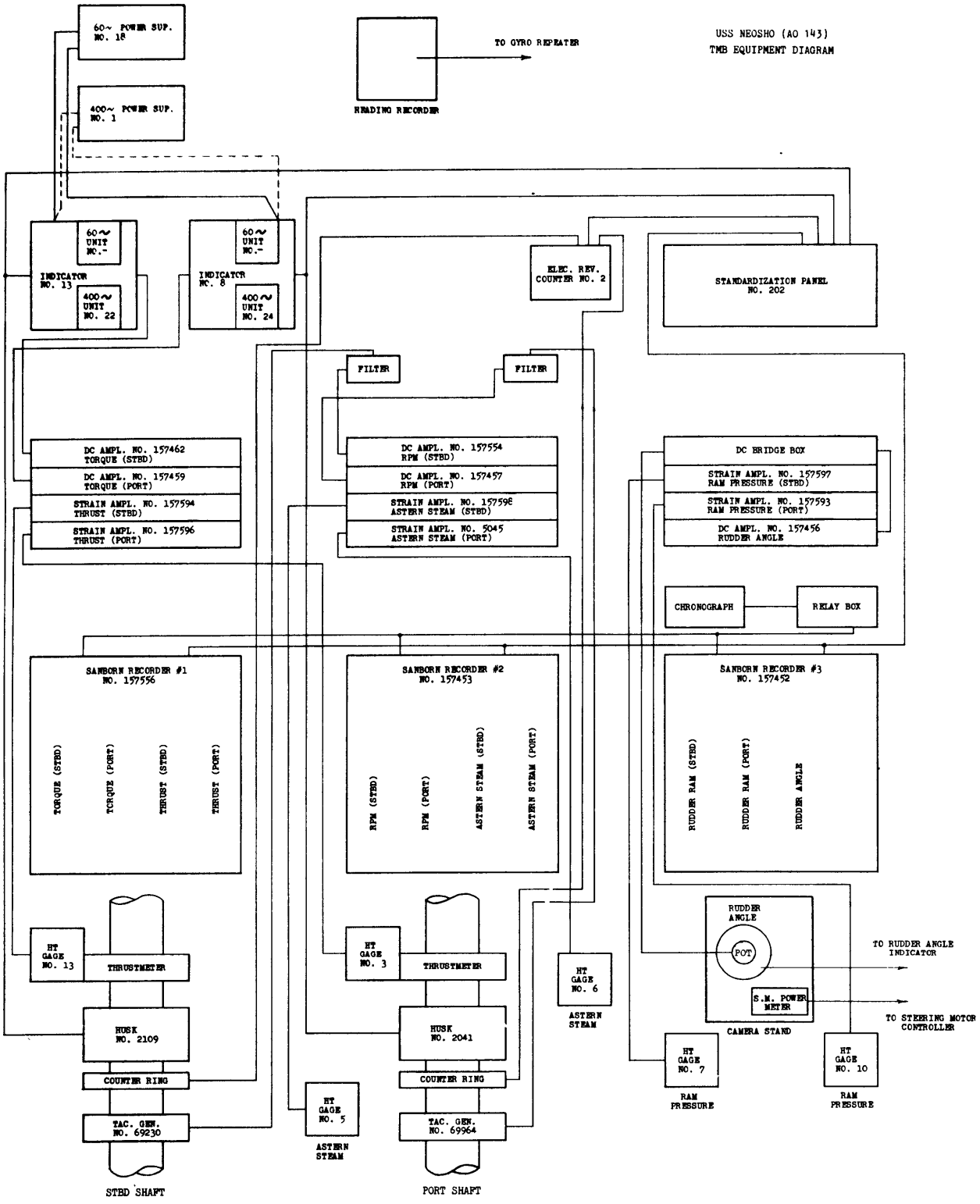


Figure 2 - Block Diagram of Trial Instrumentation.

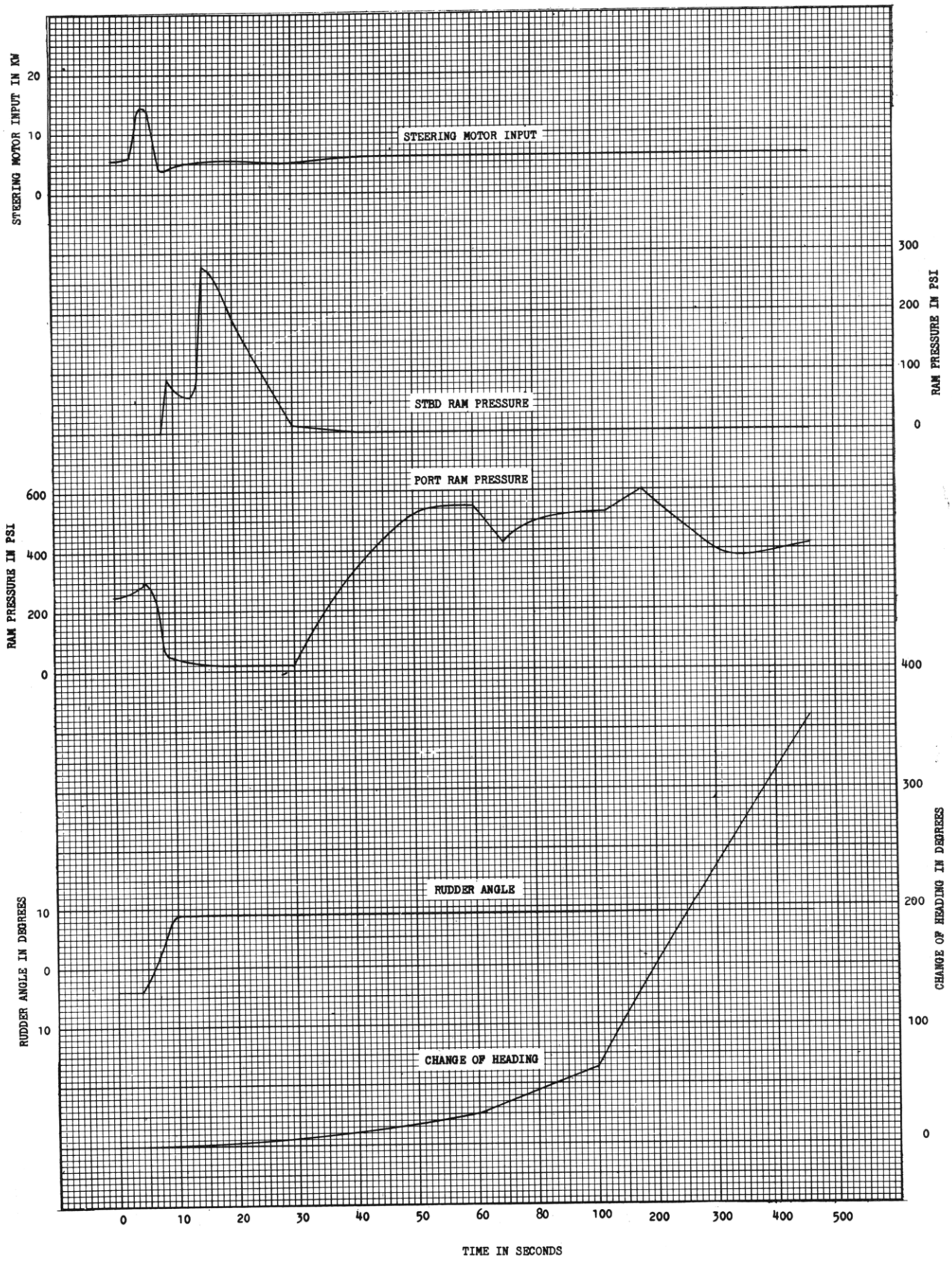


Figure 3 - Results Obtained During a 20 Knot Circle Using 10-Degree Right Rudder.

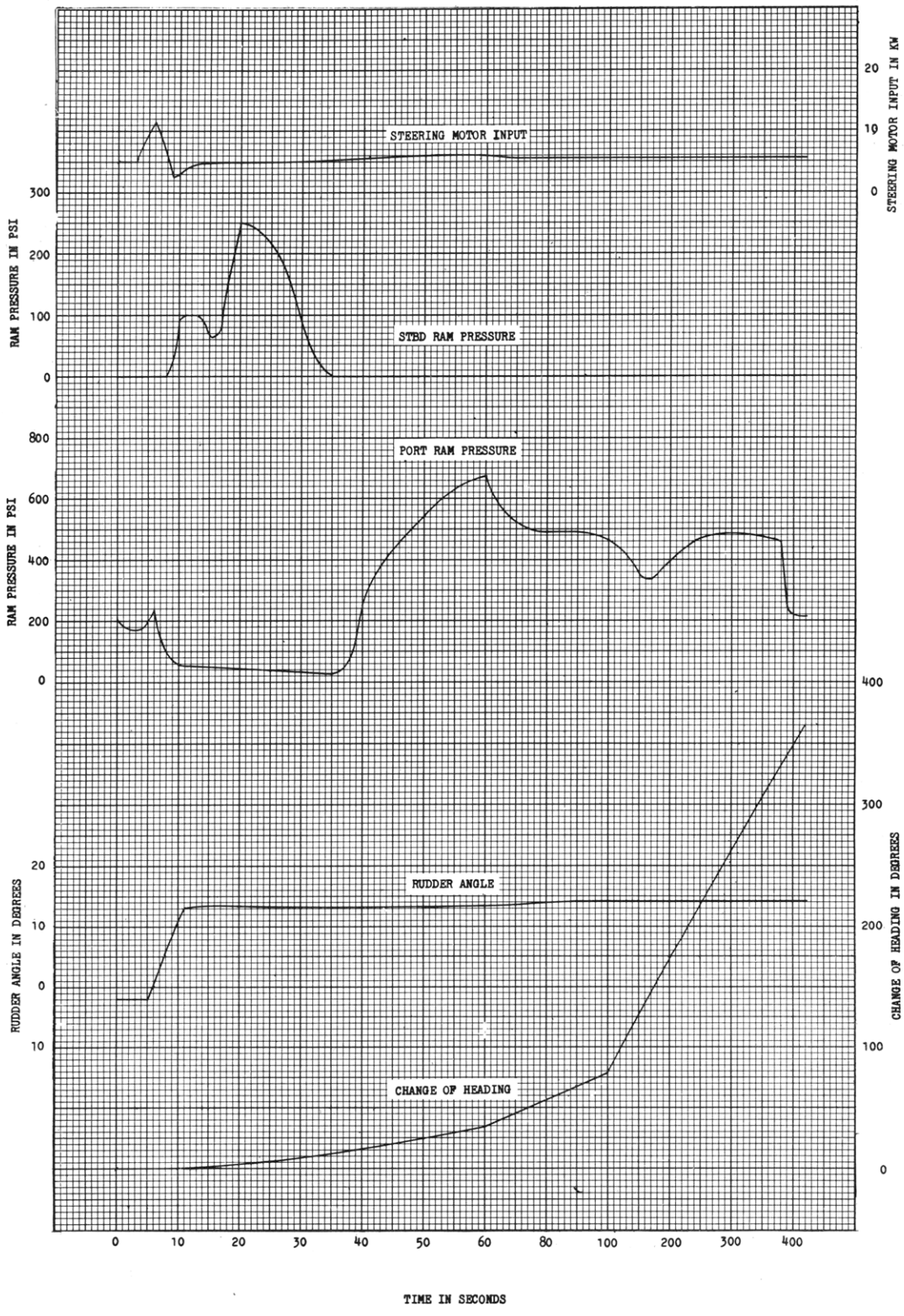


Figure 4 - Results Obtained During a 20 Knot Circle Using 15-Degree Right Rudder.

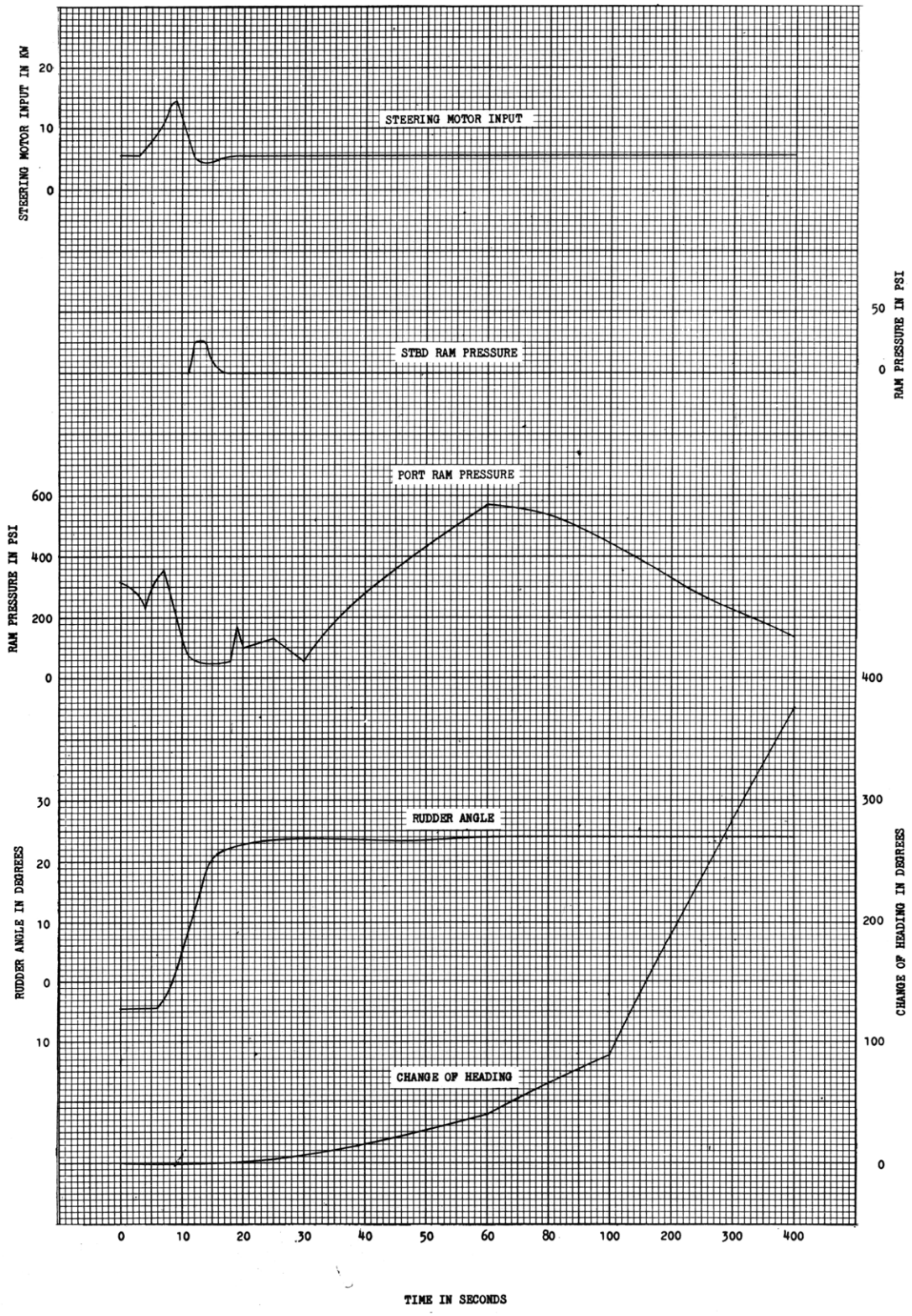


Figure 5 - Results Obtained During a 20 Knot Circle Using 25-Degree Right Rudder.

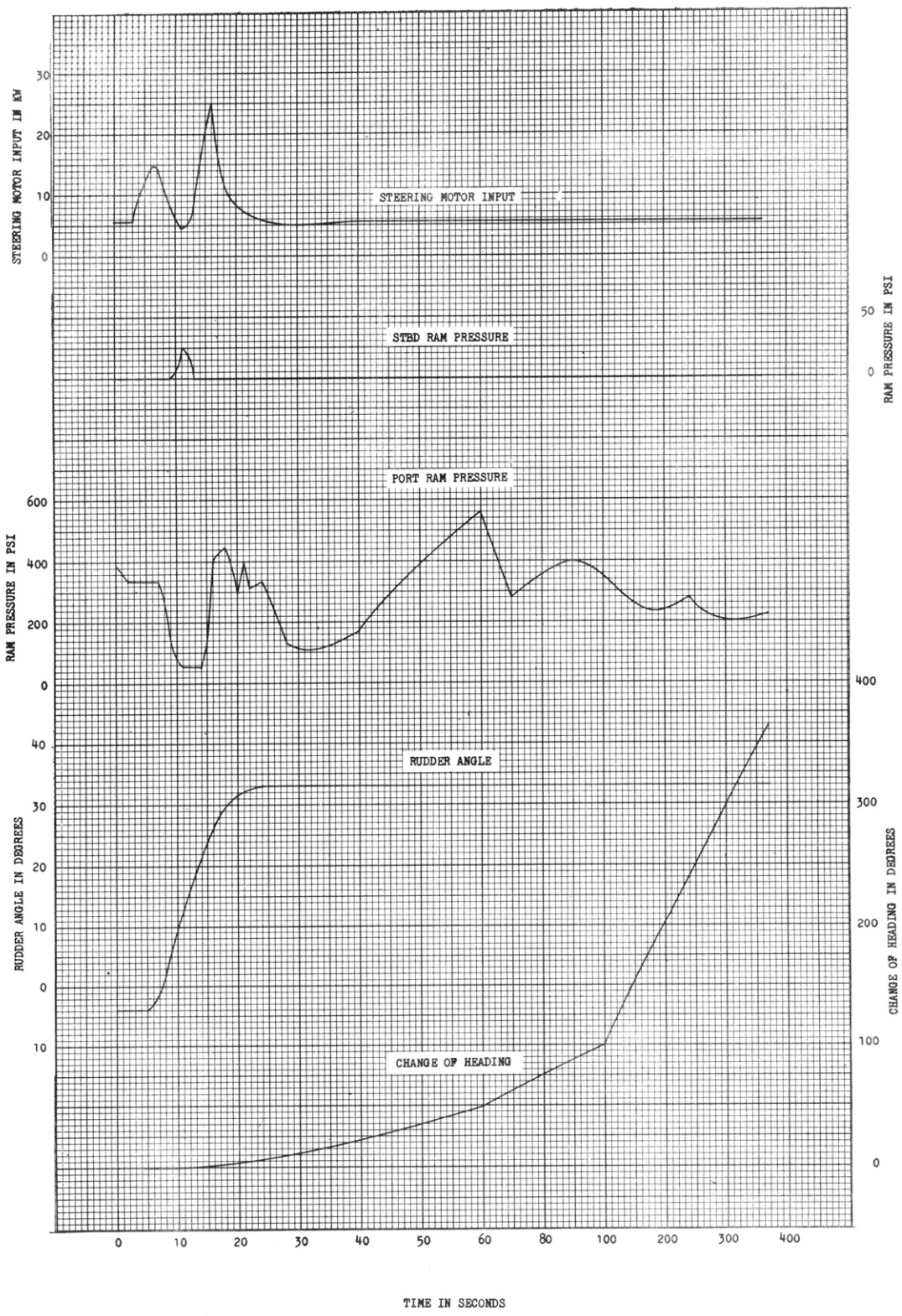


Figure 6 - Results Obtained During a 20 Knot Circle Using 35-Degree Right Rudder.

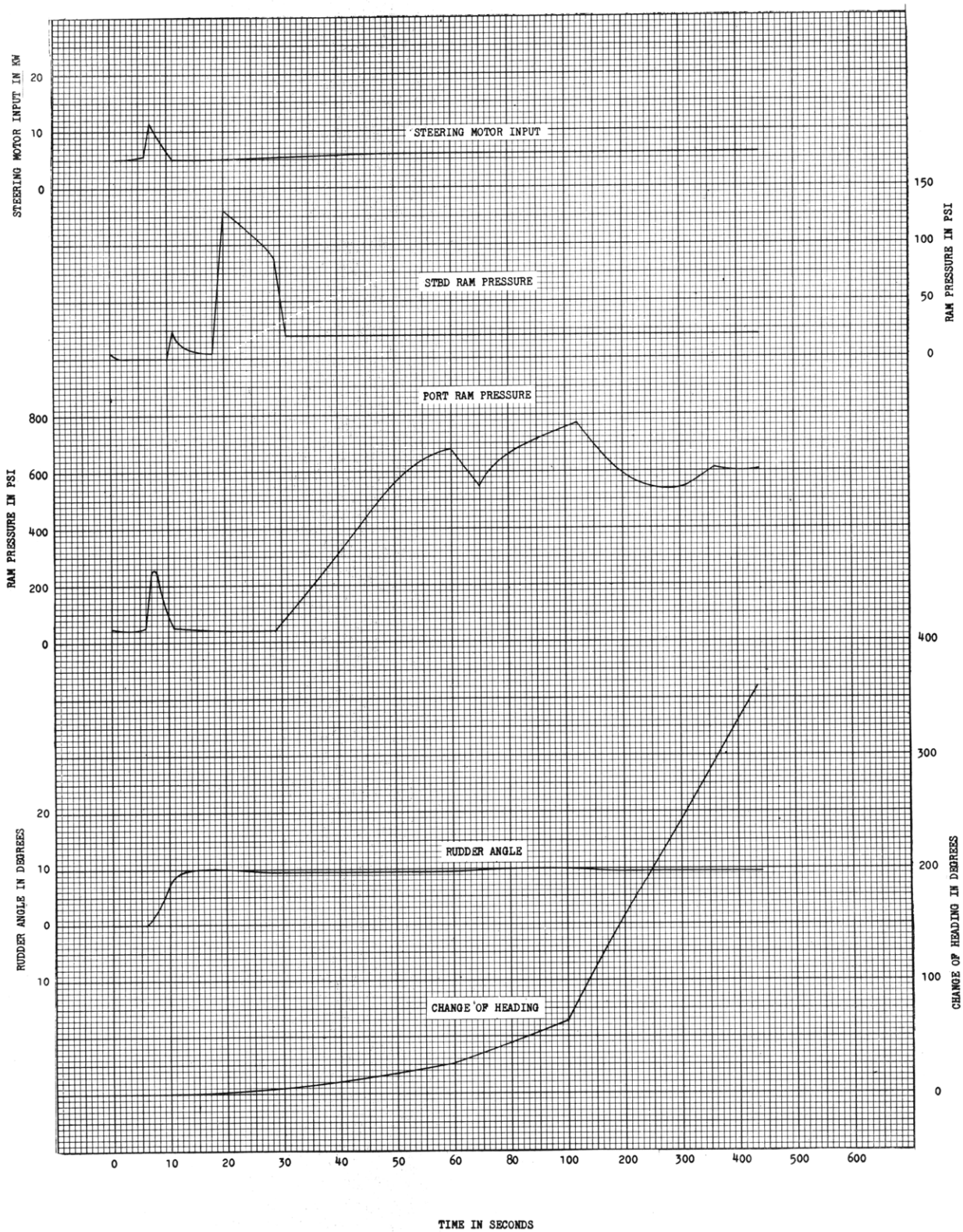


Figure 7 - Results Obtained During a Full Power Circle Using 10-Degree Right Rudder.

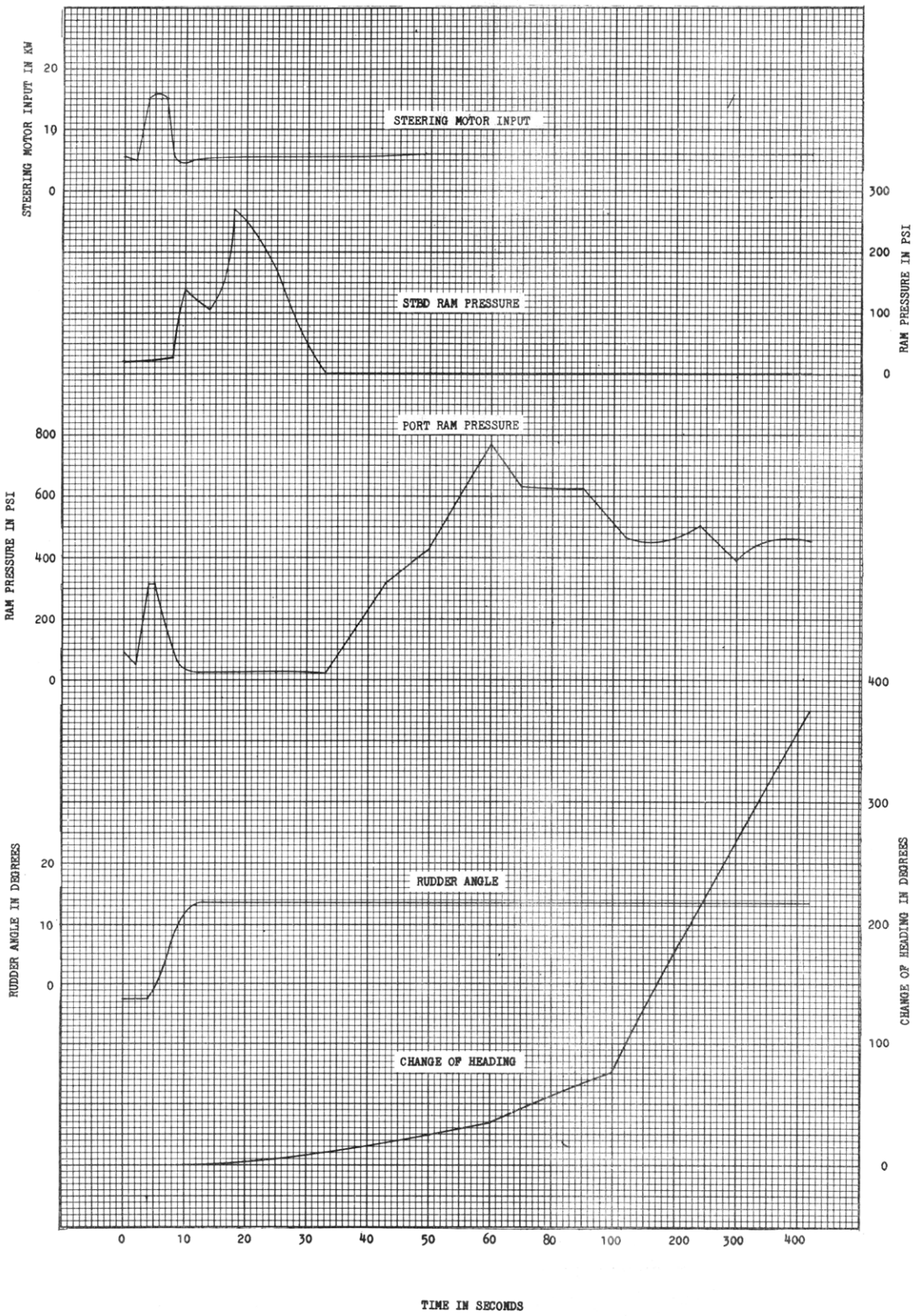


Figure 8 - Results Obtained During a Full Power Circle Using 15-Degree Right Rudder.

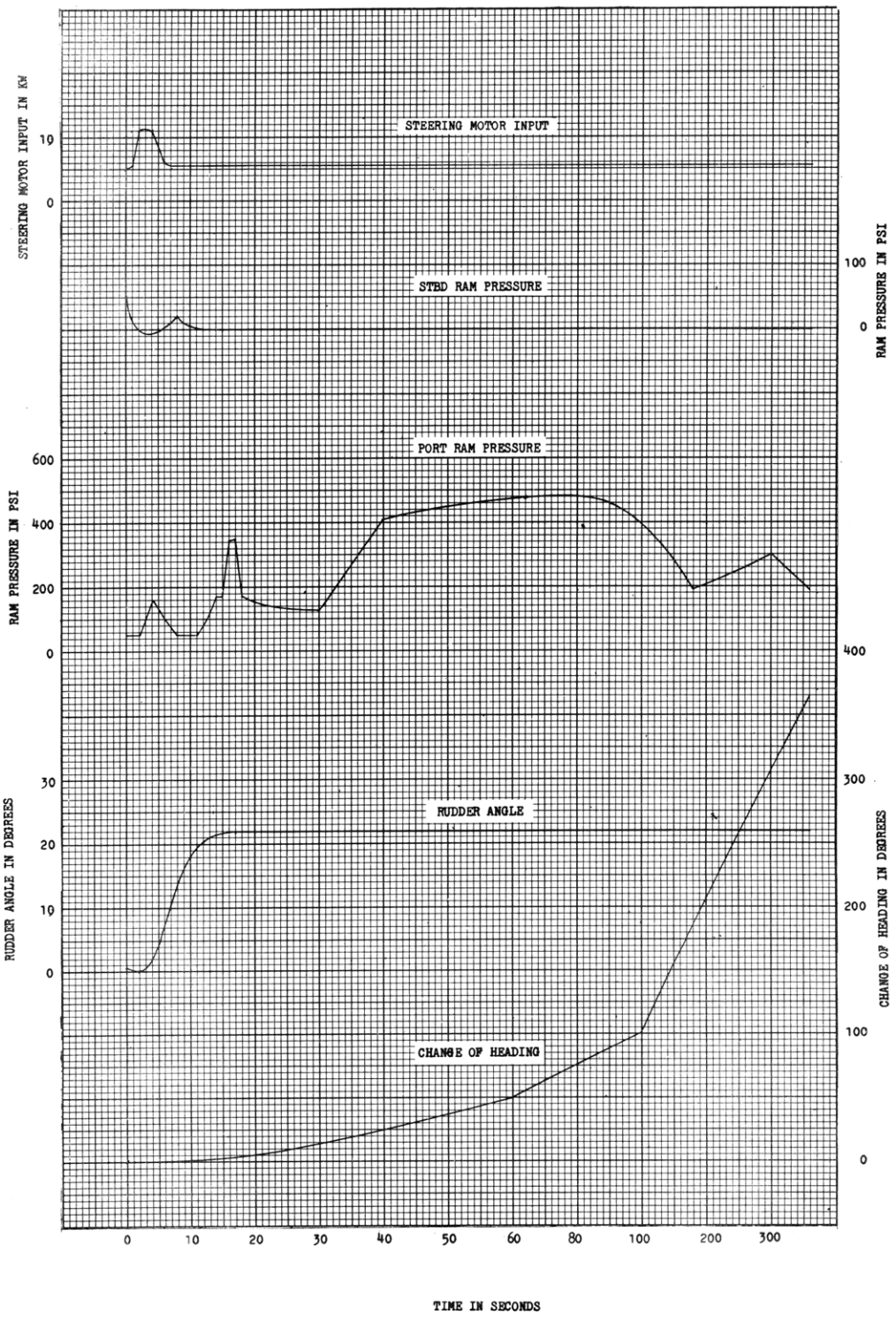


Figure 9 - Results Obtained During a Full Power Circle Using 25-Degree Right Rudder.

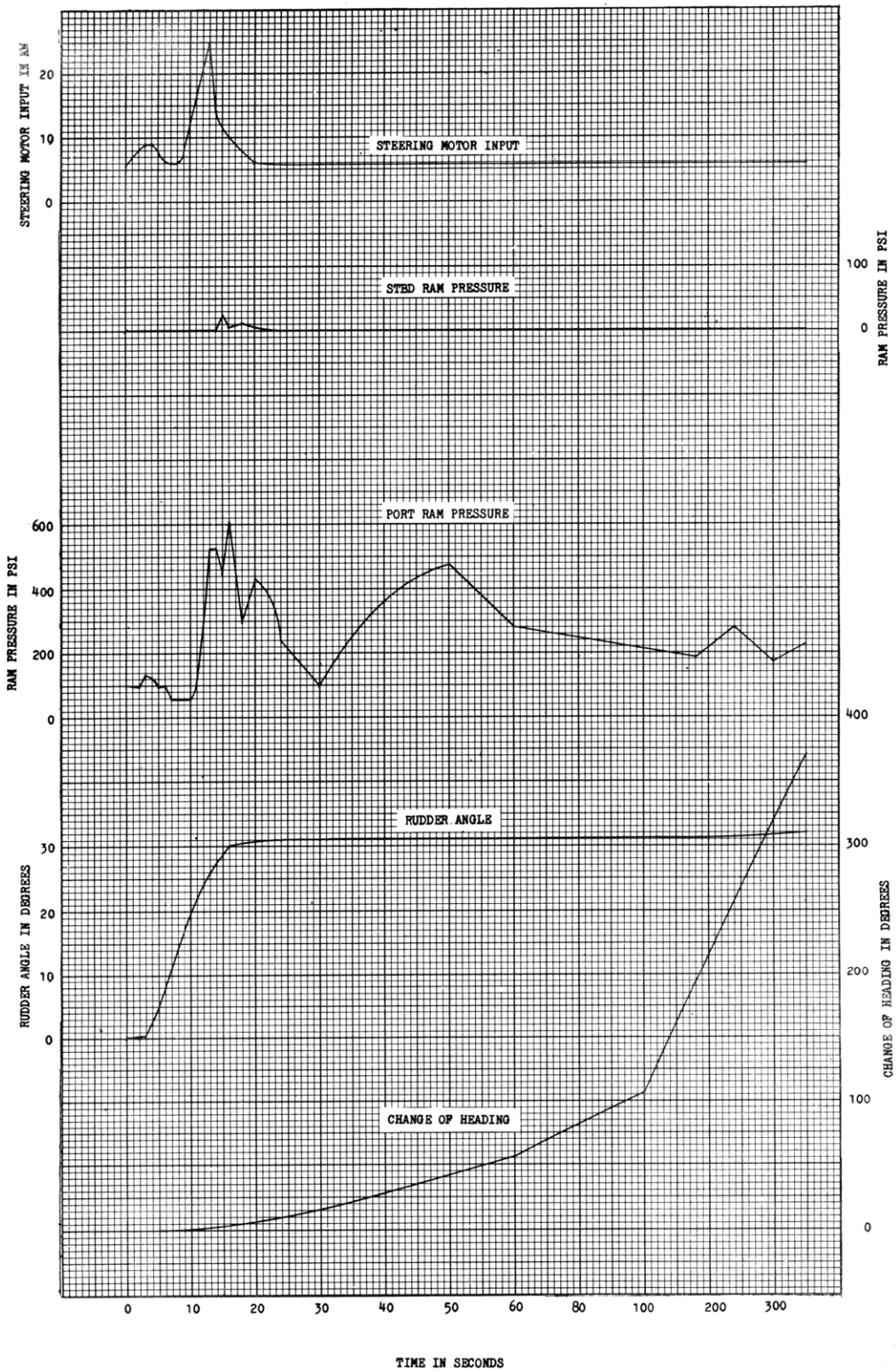


Figure 10 - Results Obtained During a Full Power Circle Using 35-Degree Right Rudder.

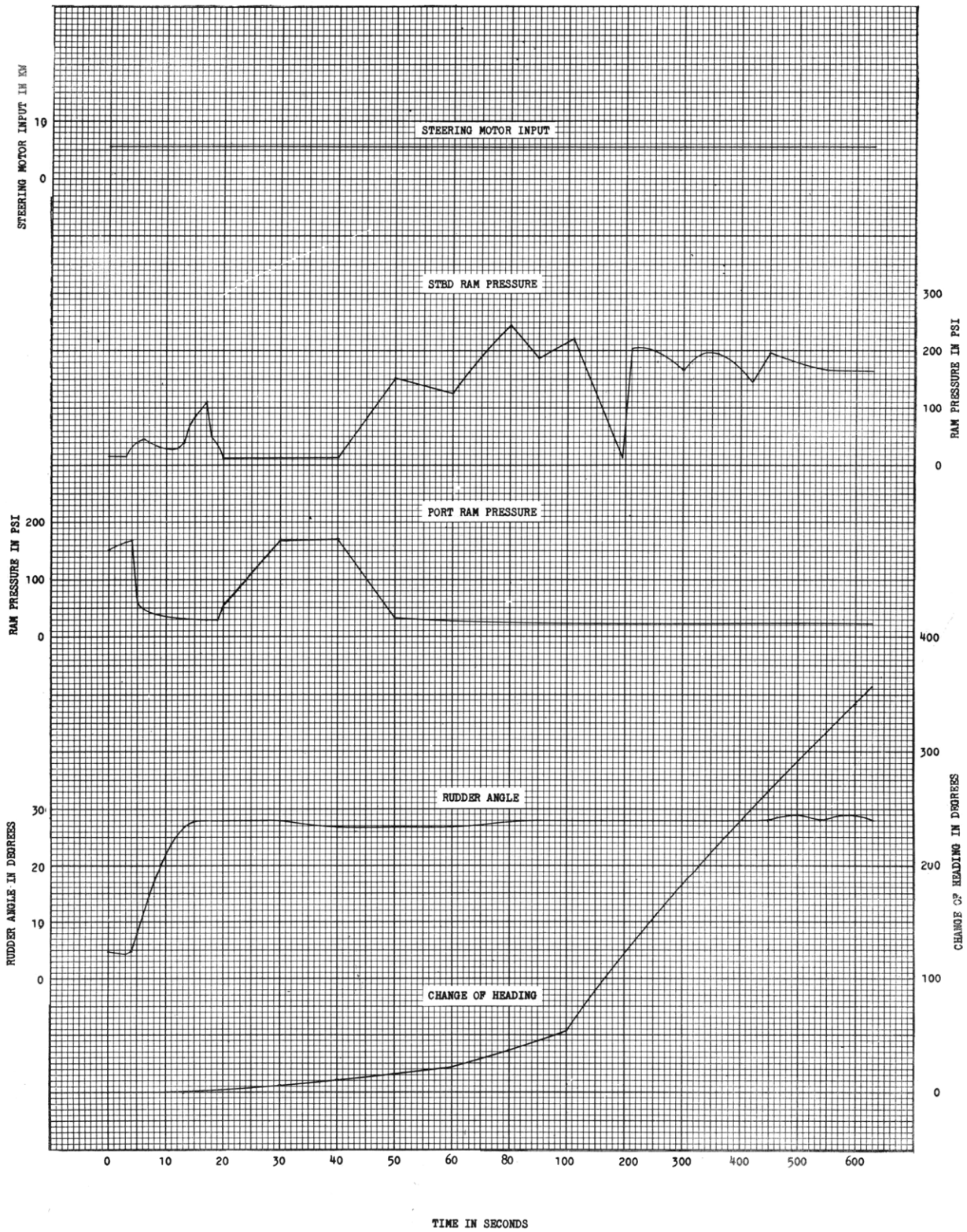


Figure 11 - Results Obtained During a 12 Knot Circle Using 25-Degree Left Rudder.

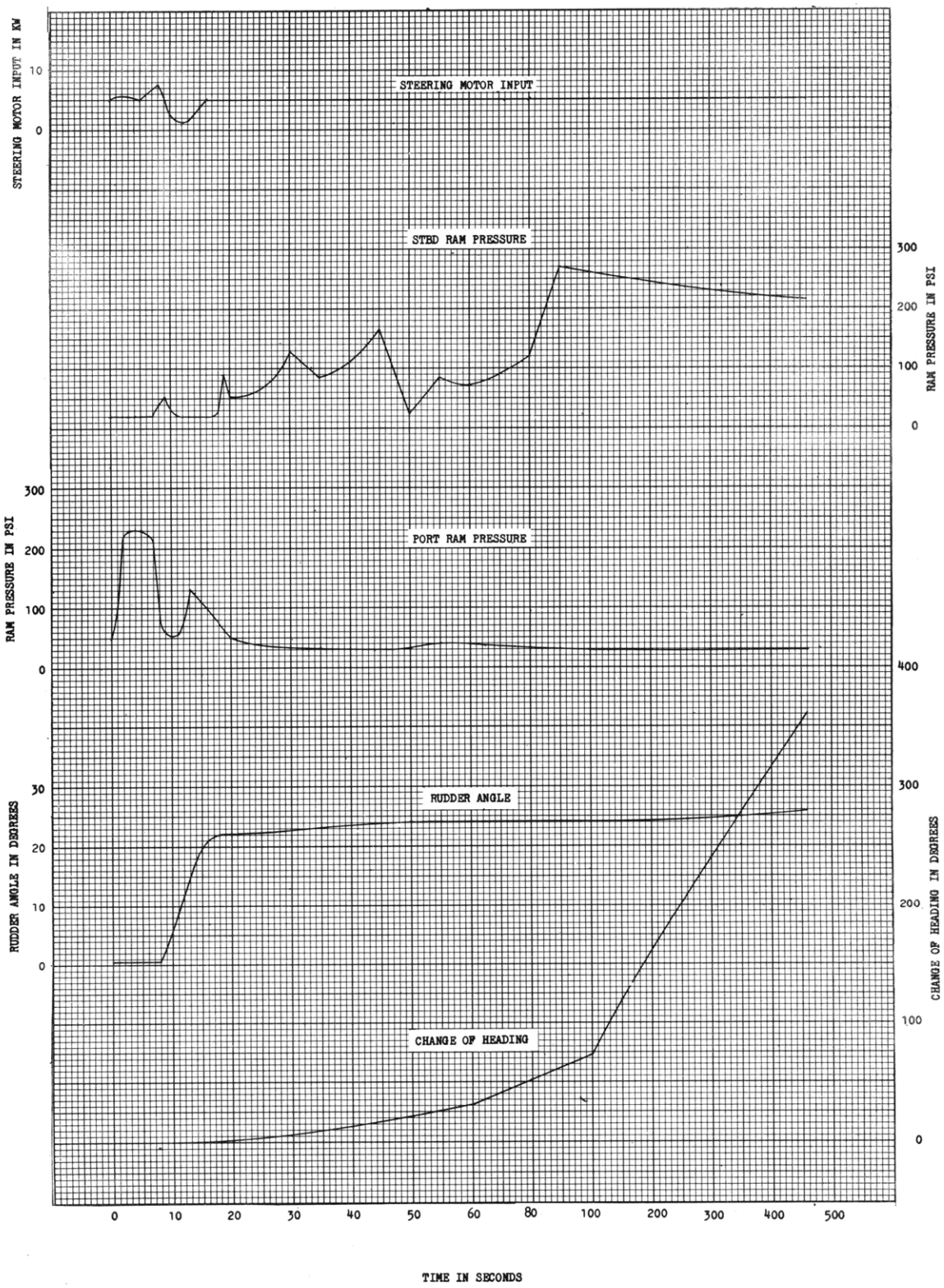


Figure 12 - Results Obtained During a 17 Knot Circle Using 25-Degree Left Rudder.

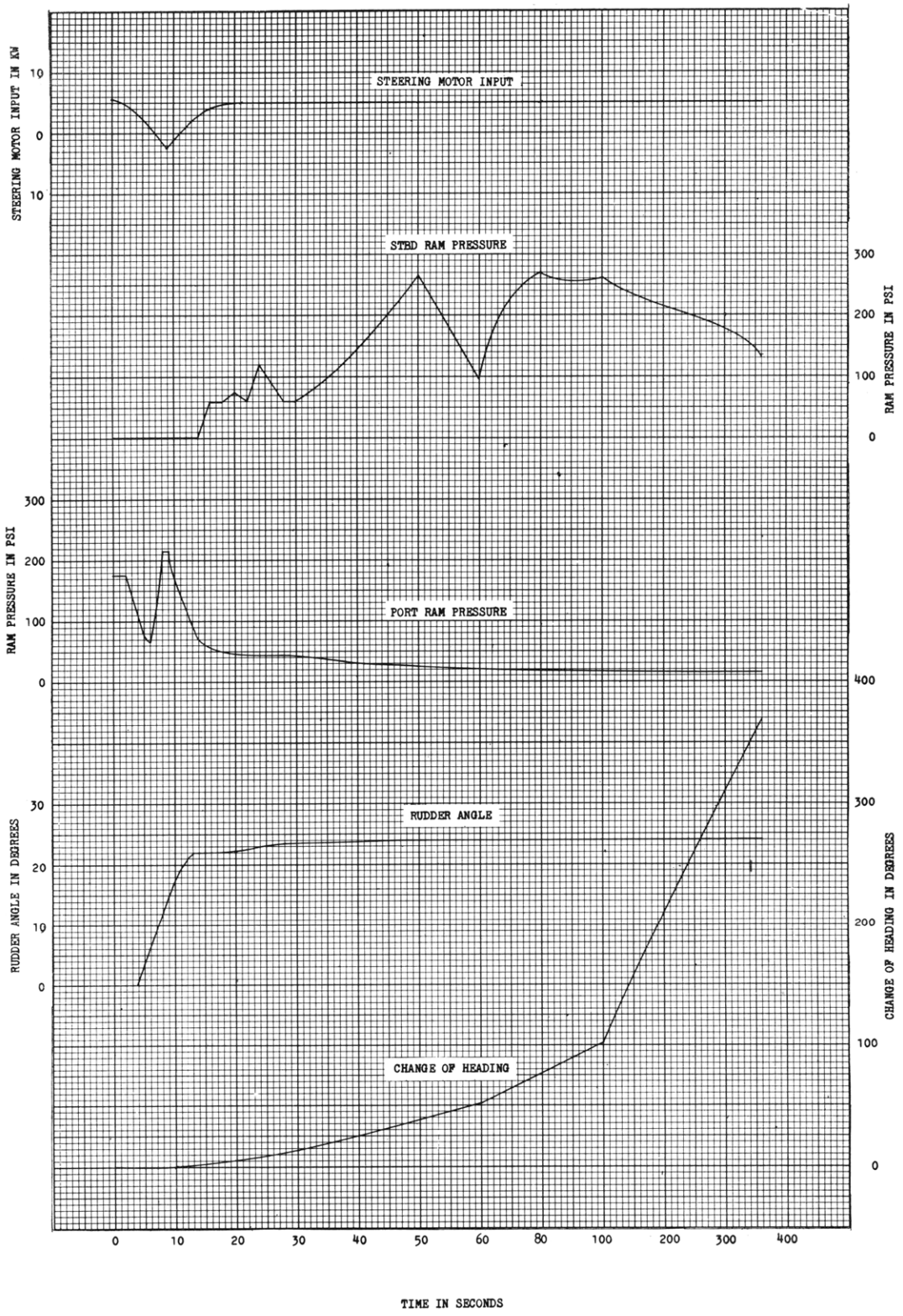


Figure 13 - Results Obtained During a Full Power Circle Using 25-Degree Left Rudder.

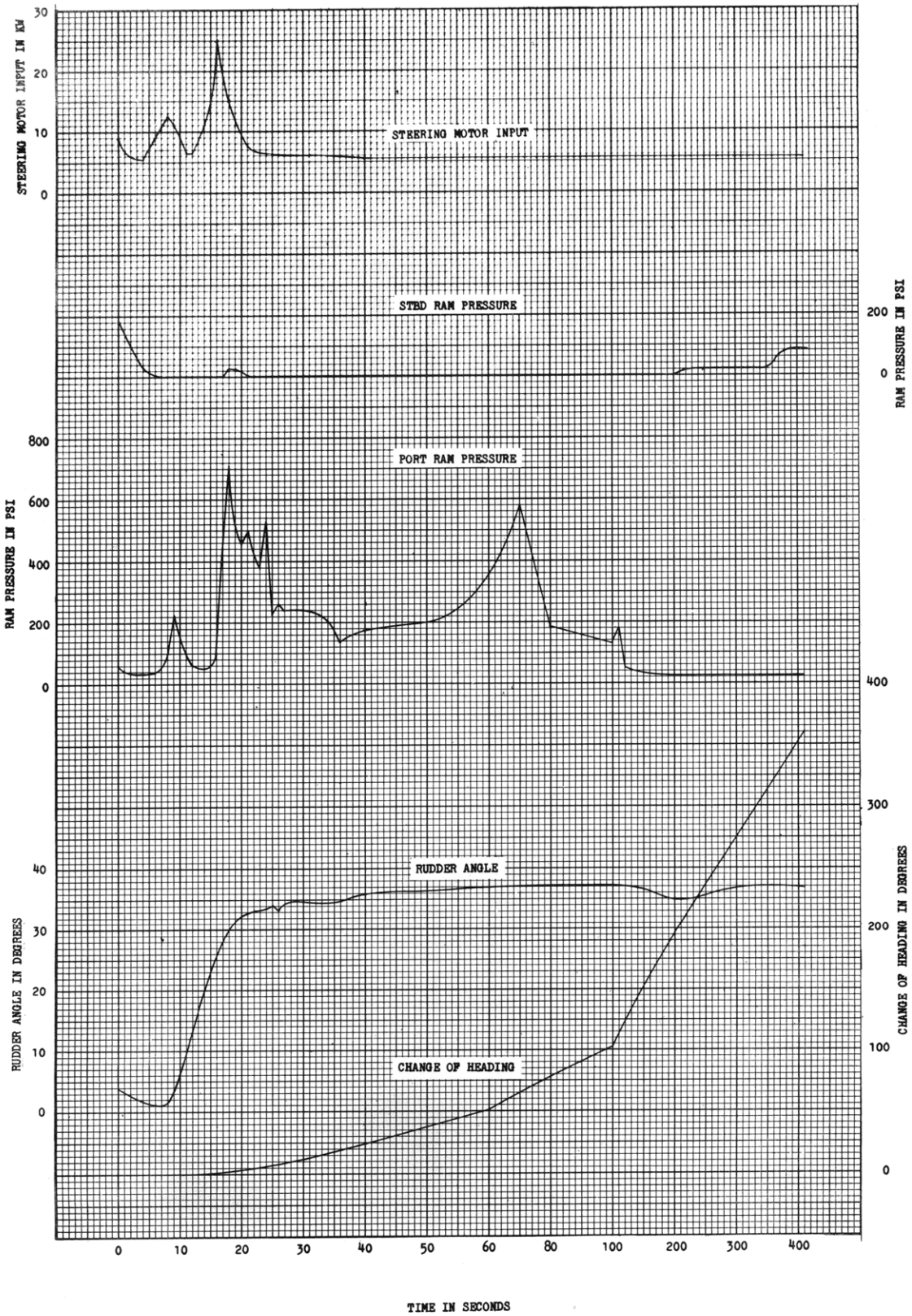


Figure 14 - Results Obtained During a 20 Knot Circle Using 35-Degree Right Rudder With Starboard Shaft Ordered "Stop" at Execute.

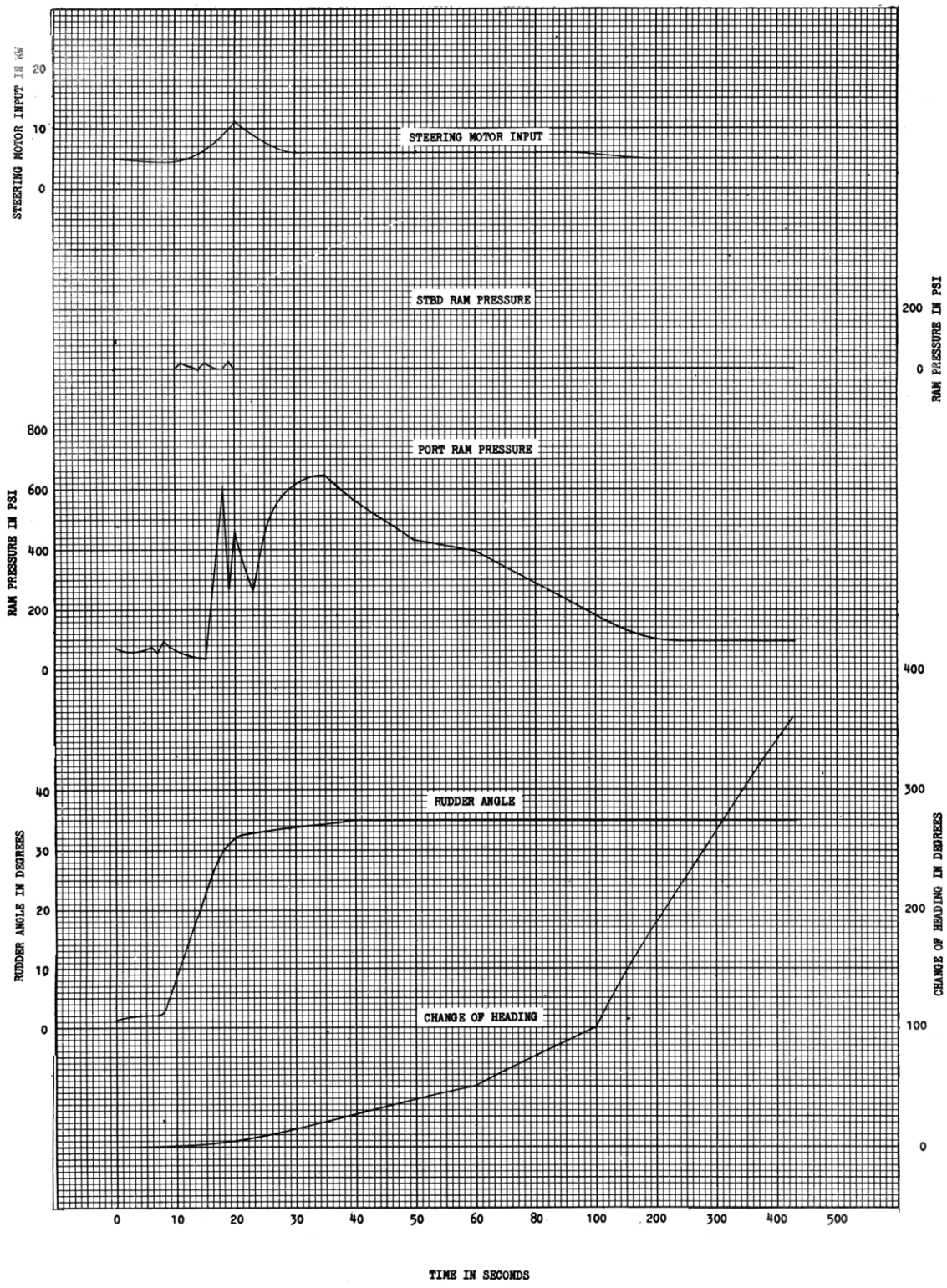


Figure 15 - Results Obtained During a 20 Knot Circle Using 35-Degree Right Rudder With Starboard Shaft Ordered "Back 1/3" at Execute.

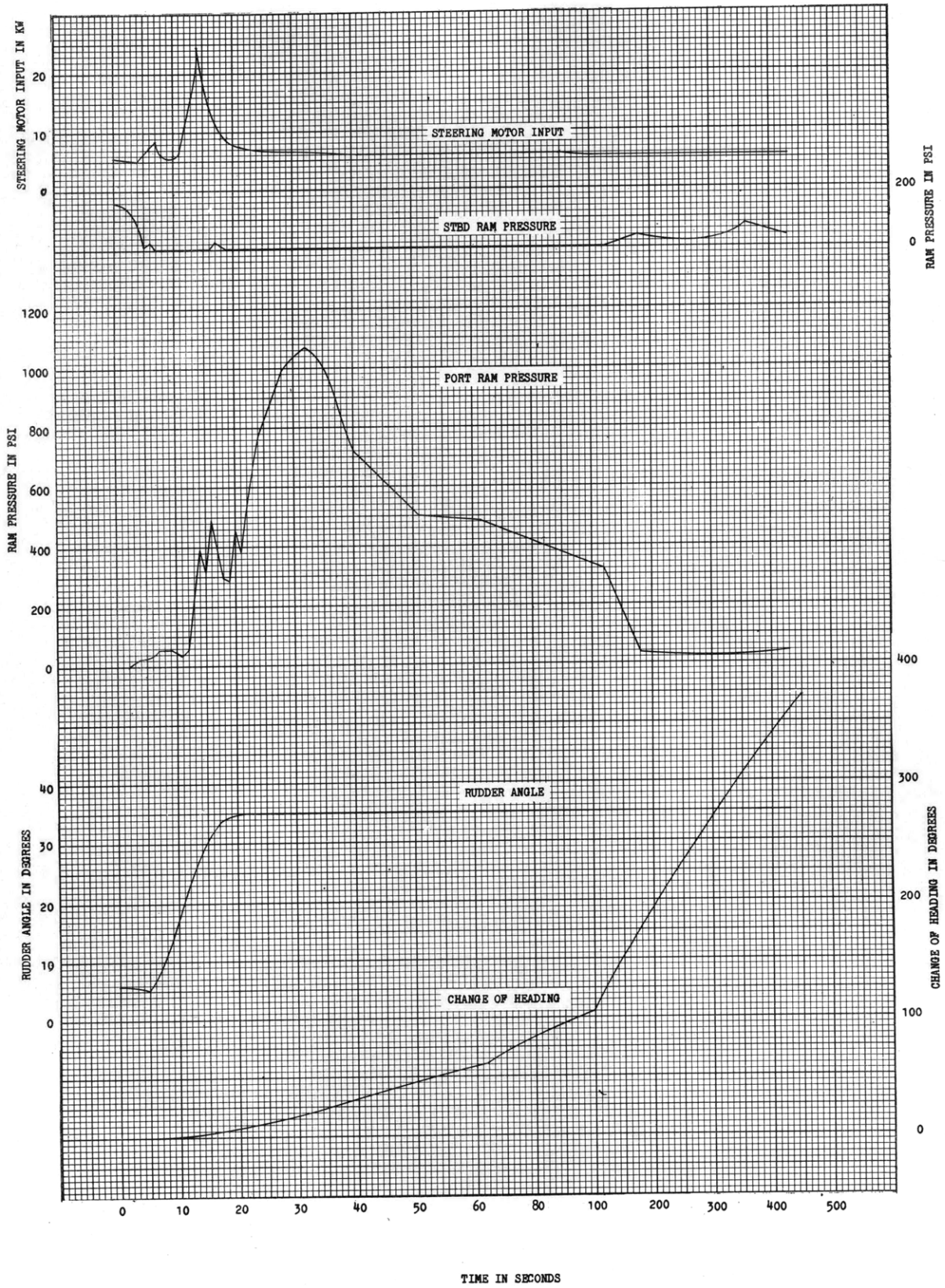


Figure 16 - Results Obtained During a 20 Knot Circle Using 35-Degree Right Rudder With Starboard Shaft Ordered "Back Full" at Execute.

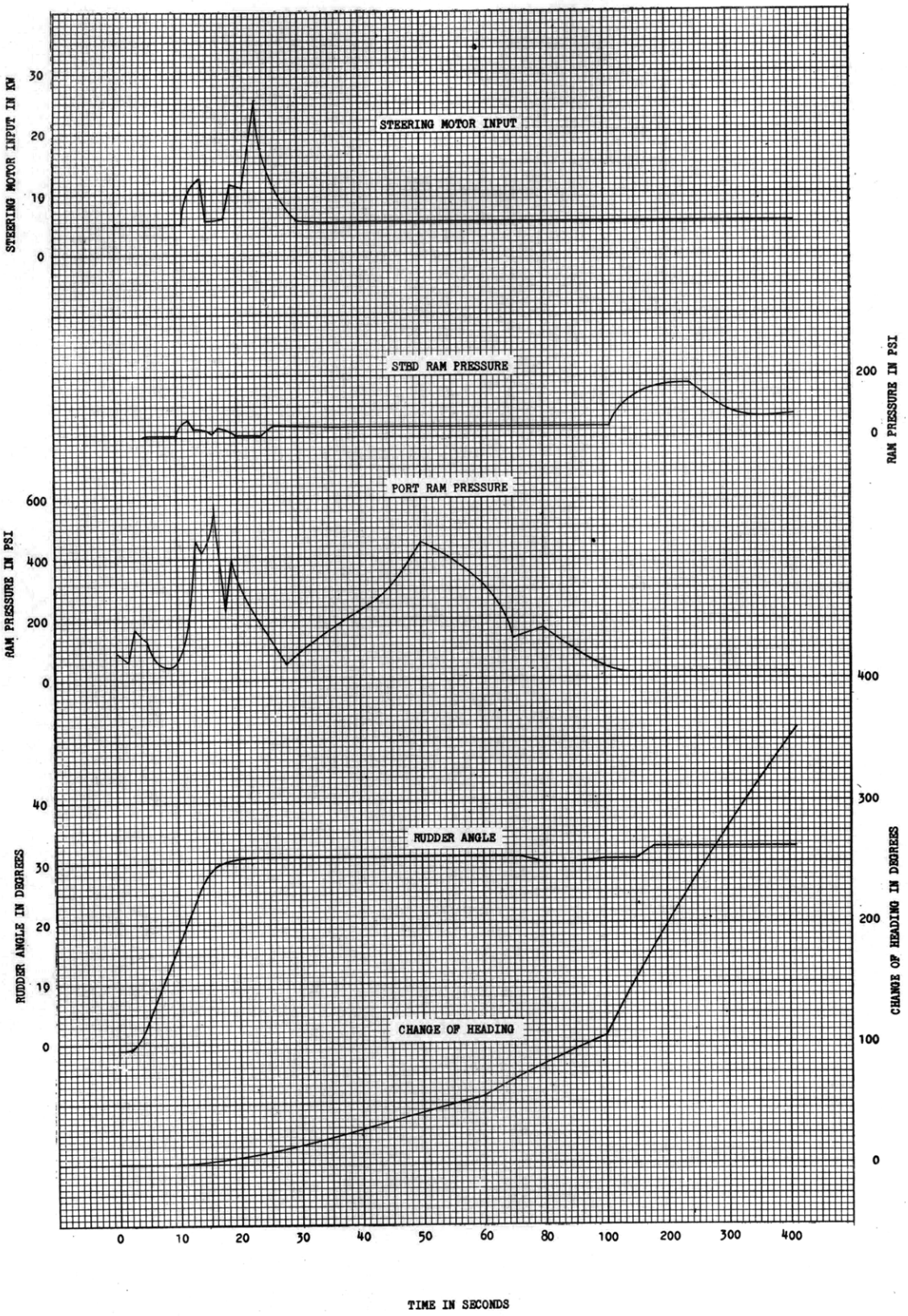


Figure 17 - Results Obtained During a Full Power Circle Using 35-Degree Right Rudder With Starboard Shaft Ordered "Back 1/3" at Execute.

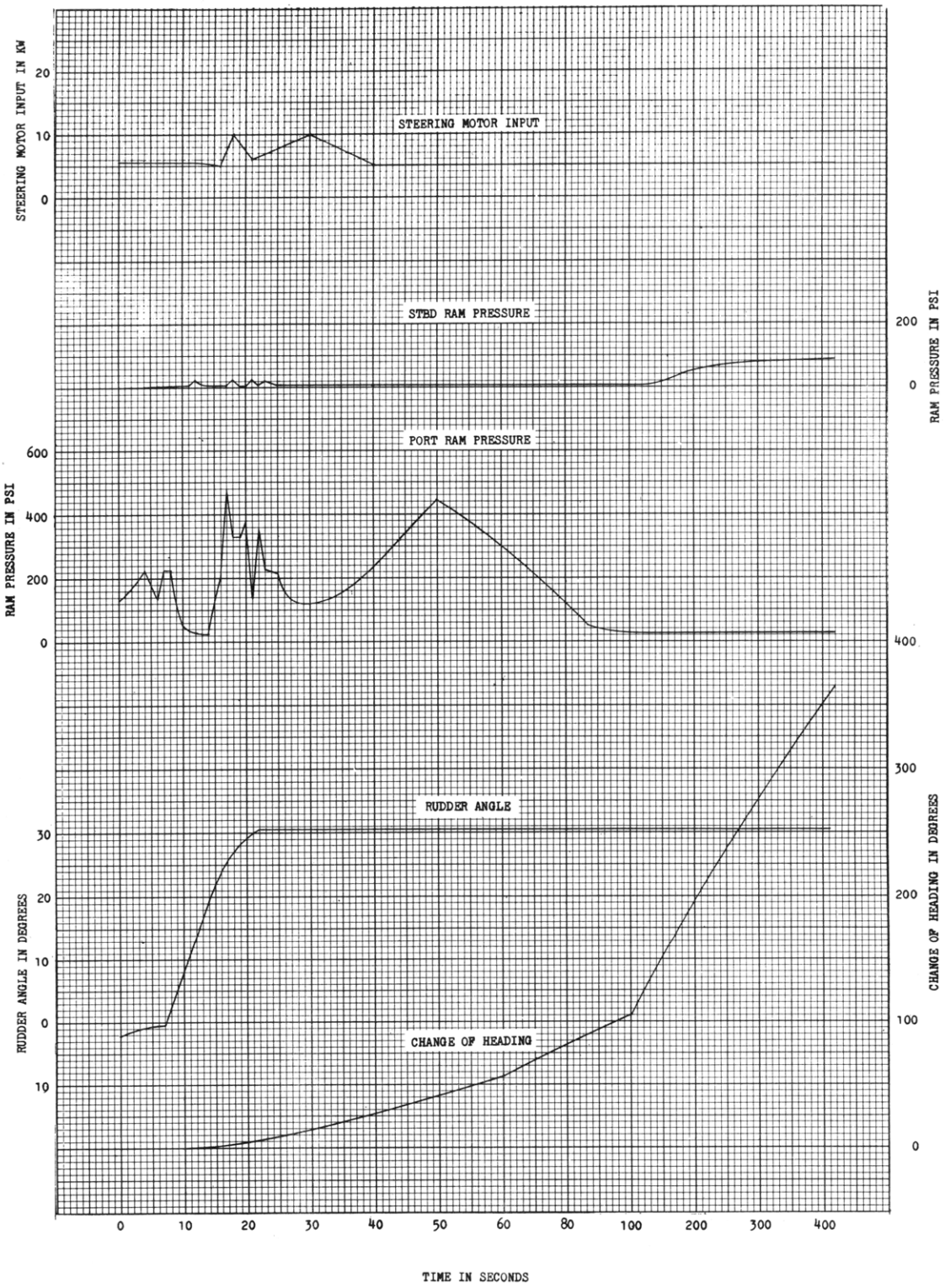


Figure 18 - Results Obtained During a Full Power Circle Using 35-Degree Right Rudder With Starboard Shaft Ordered "Back Full" at Execute.

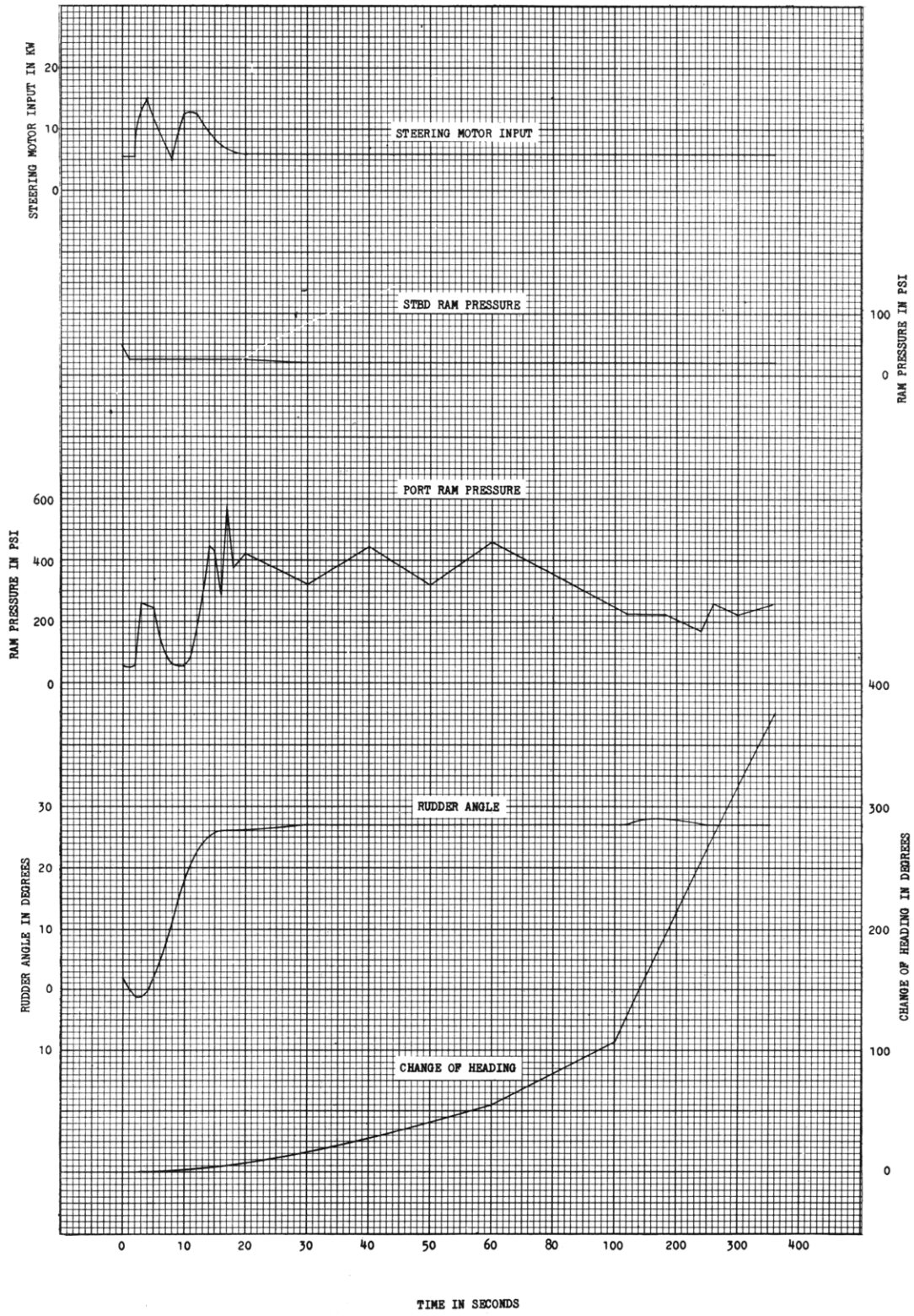


Figure 19 - Results Obtained During a Full Power Circle Using 30-Degree Right Rudder.

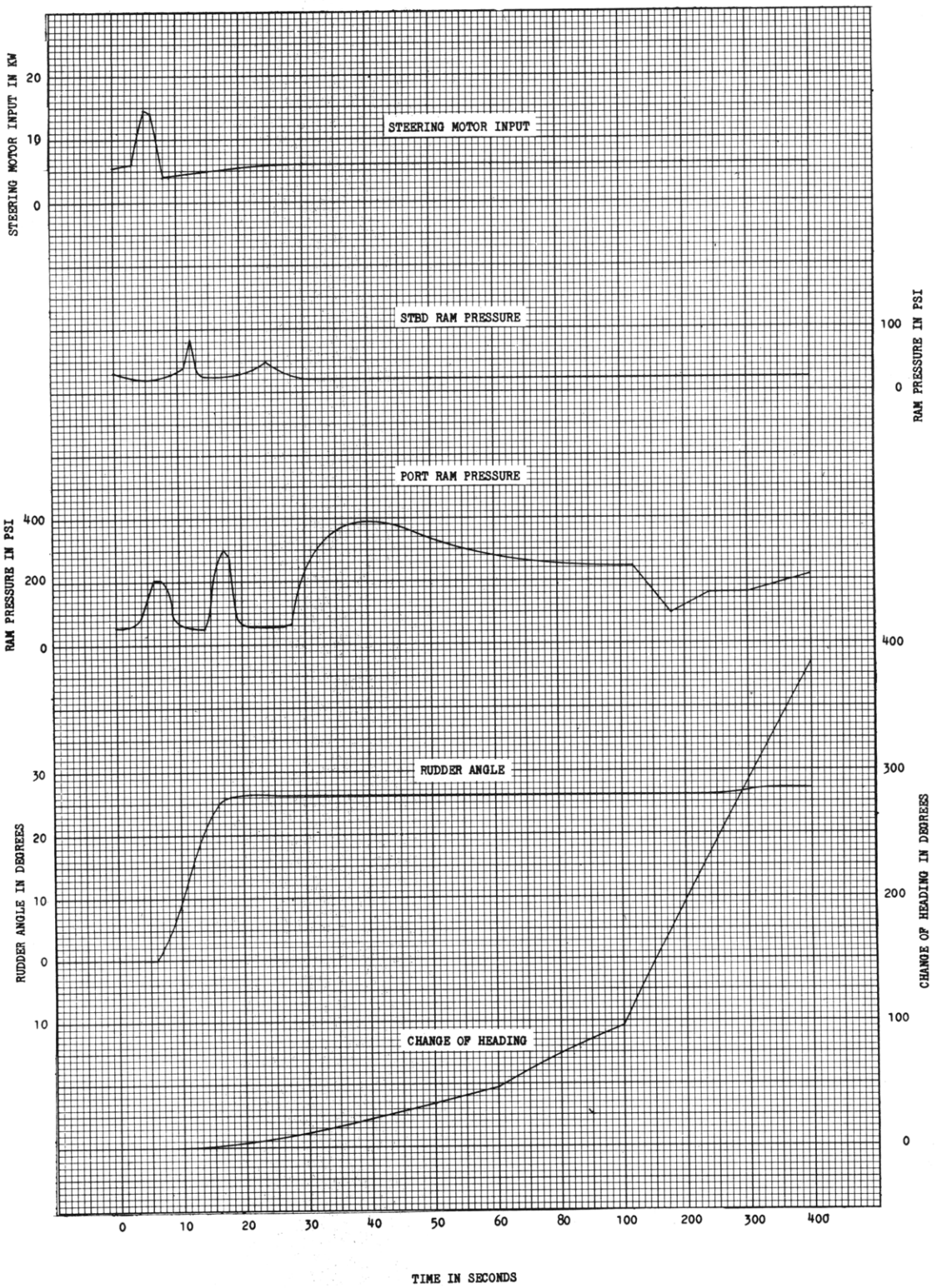


Figure 20 - Results Obtained During a 20 Knot Circle Using 30-Degree Right Rudder.

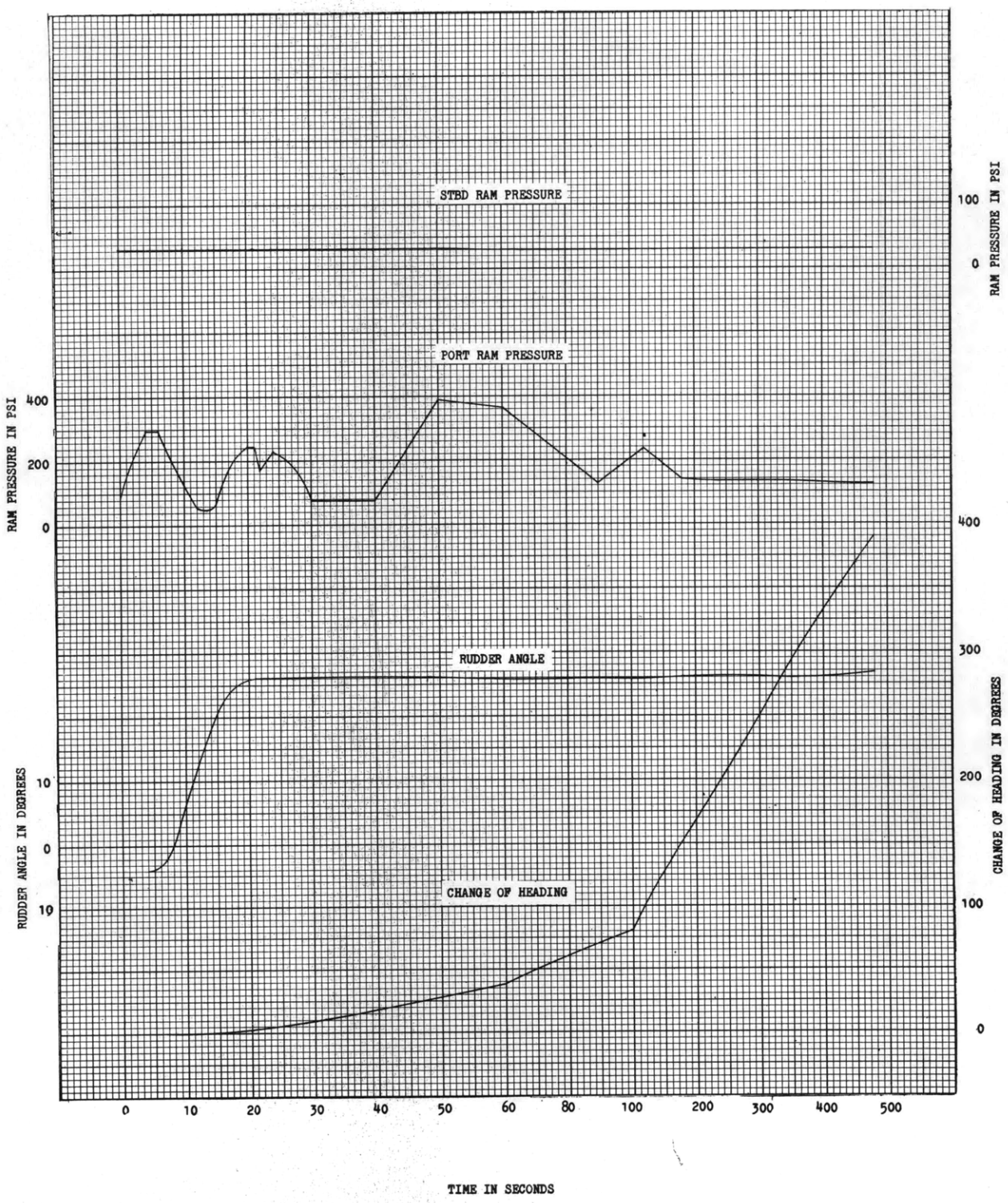


Figure 21 - Results Obtained During a 17 Knot Circle Using 30-Degree Right Rudder.

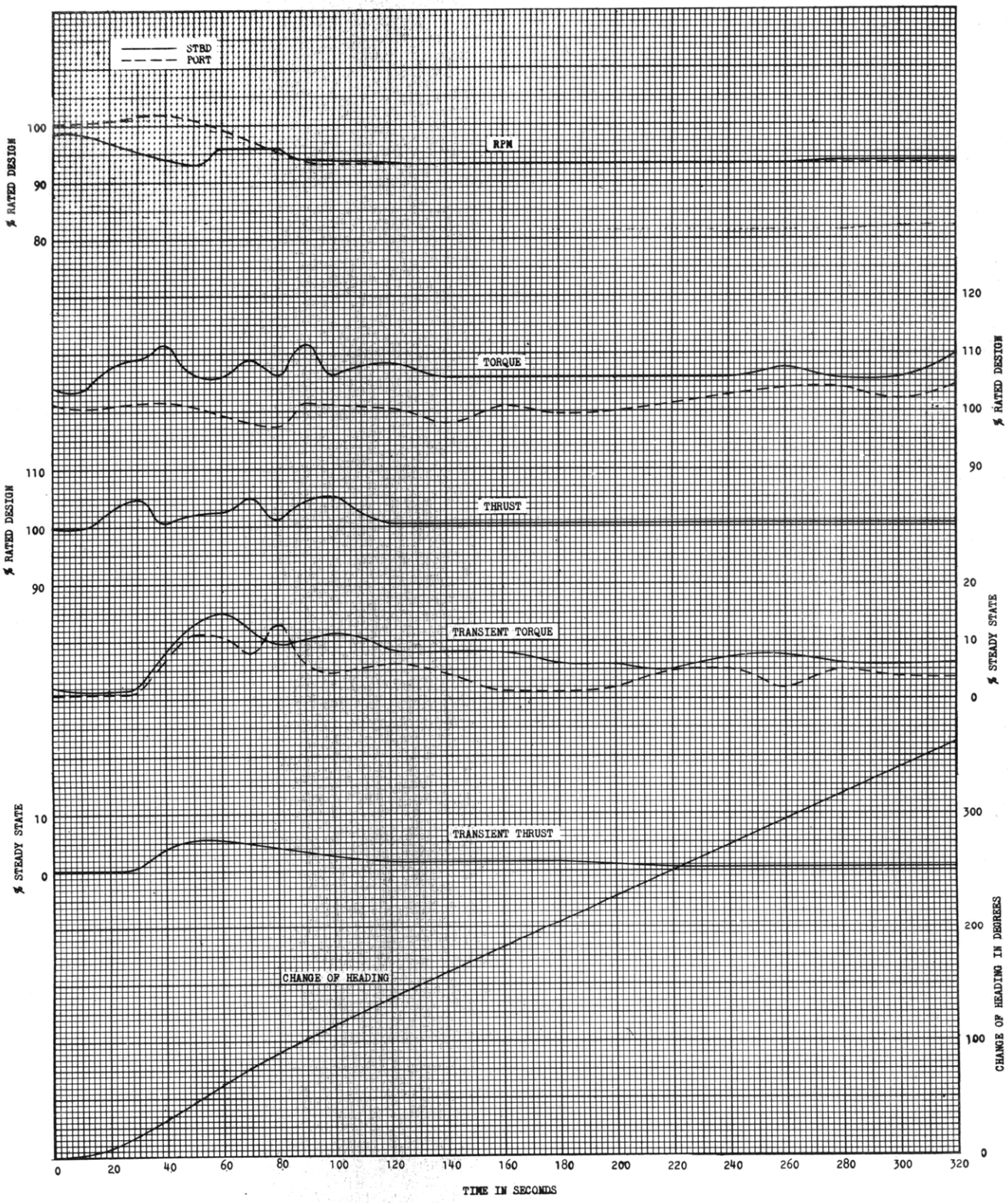


Figure 22 - Transient Values (Double Amplitude) Obtained During Full Power Circle Using 35-Degree Right Rudder.

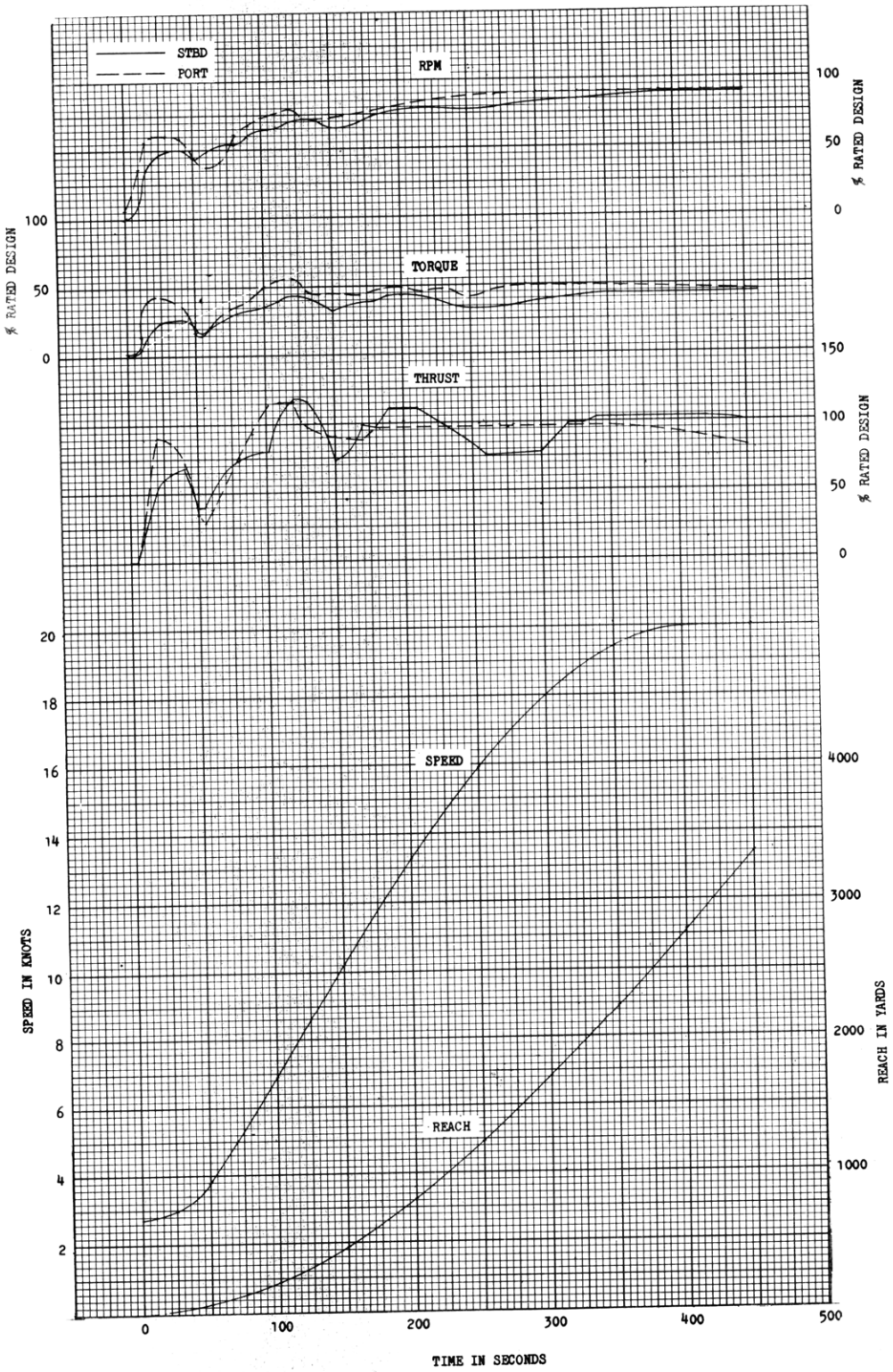


Figure 23 - Results Obtained While Accelerating From Dead-in-Water to 20 Knots.

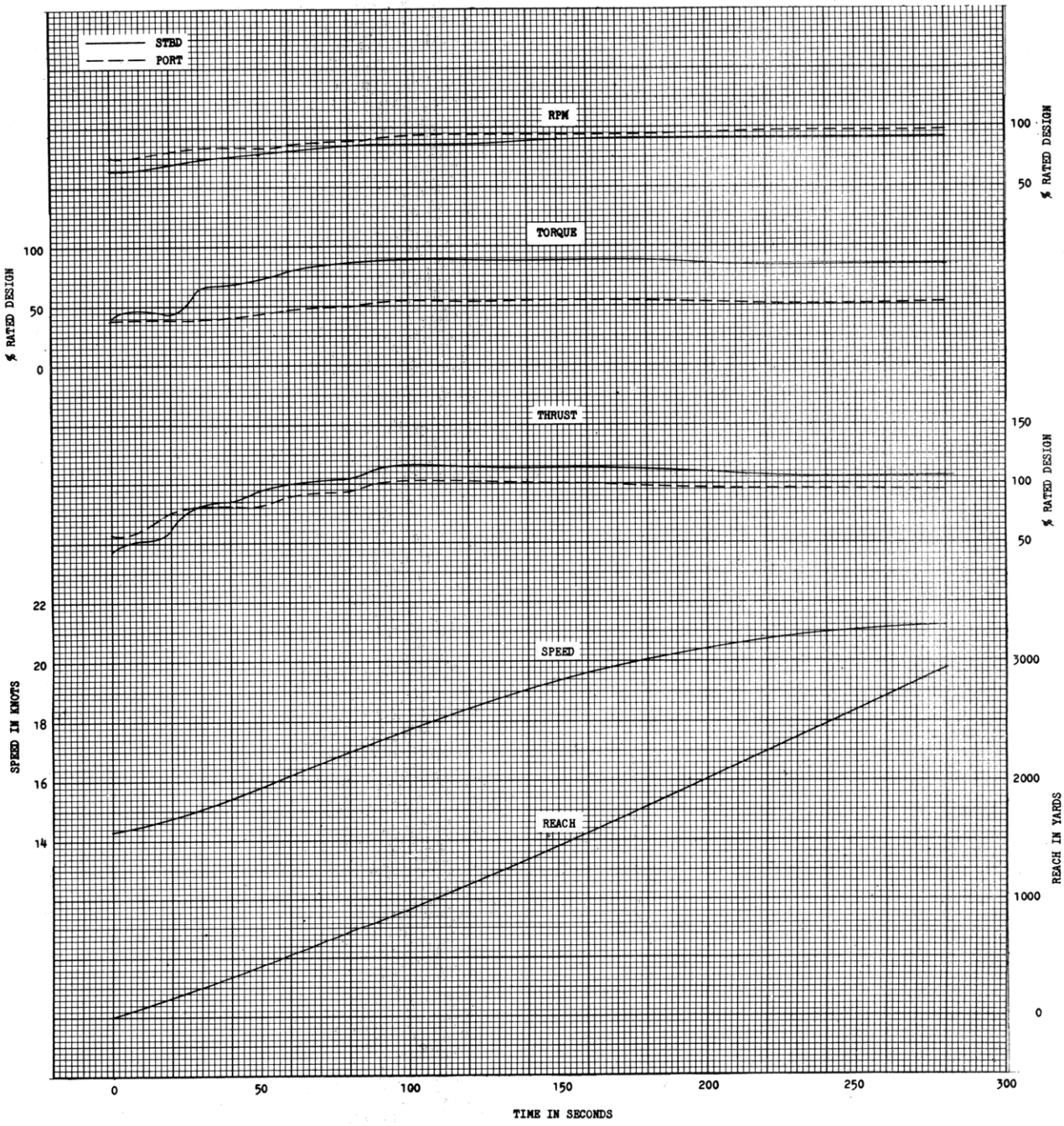


Figure 24 - Results Obtained While Accelerating From 15 Knots to Full Power.

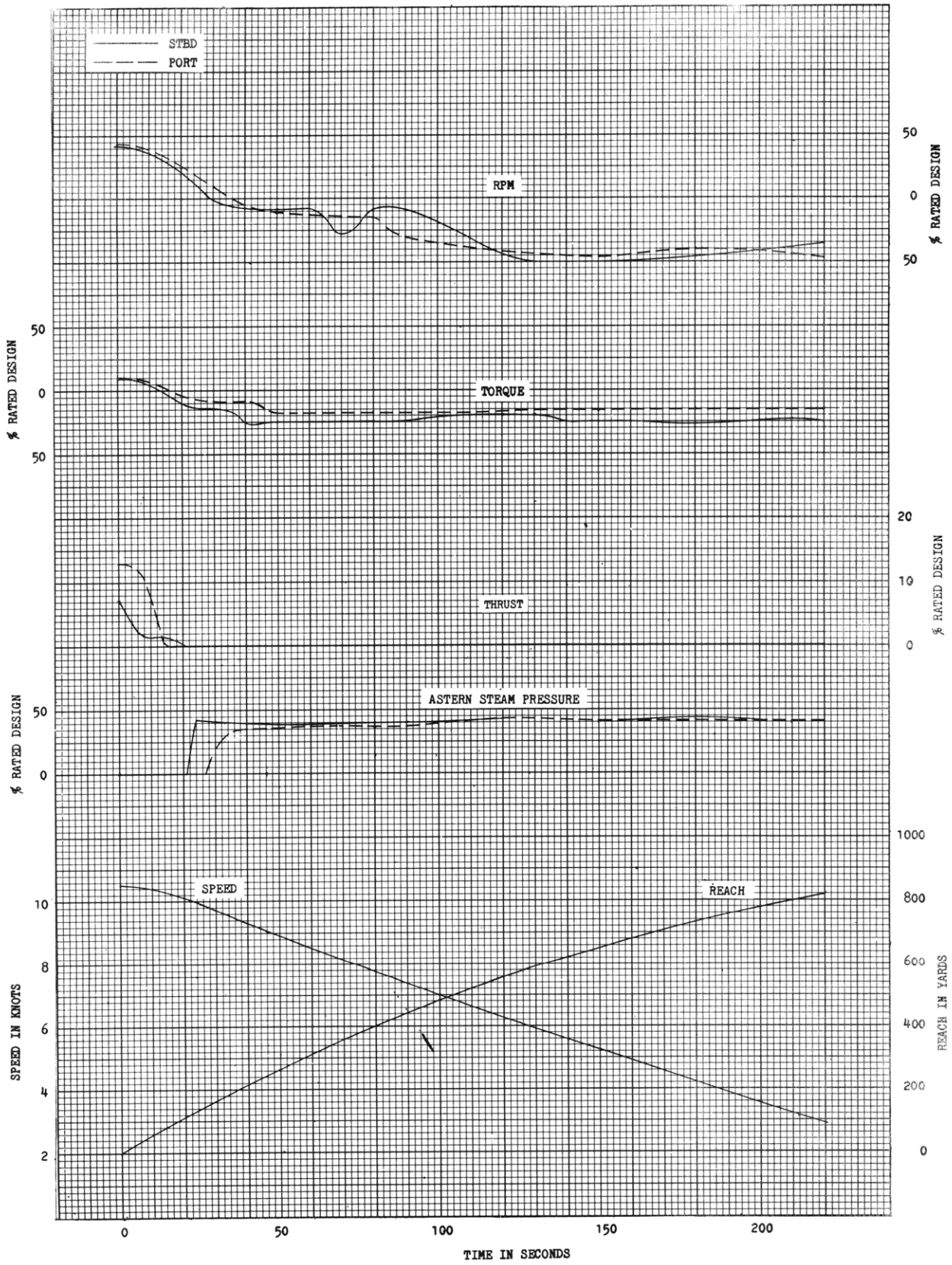


Figure 25 - Results Obtained While Decelerating From 10 Knots to Dead-in-Water Using 250 PSIG Astern Steam.

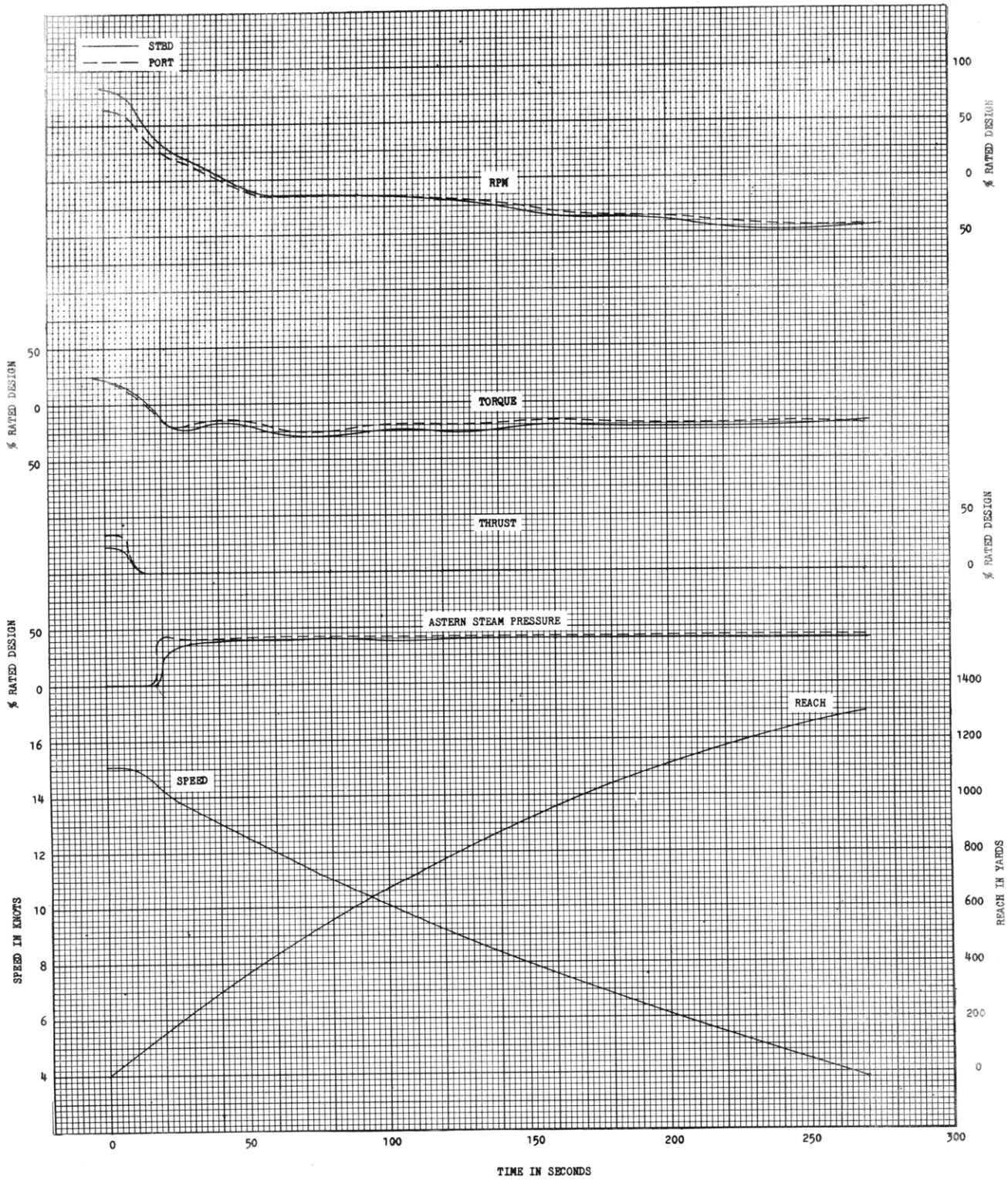


Figure 26 - Results Obtained While Decelerating From 15 Knots to Dead-in-Water Using 250 PSIG Astern Steam.

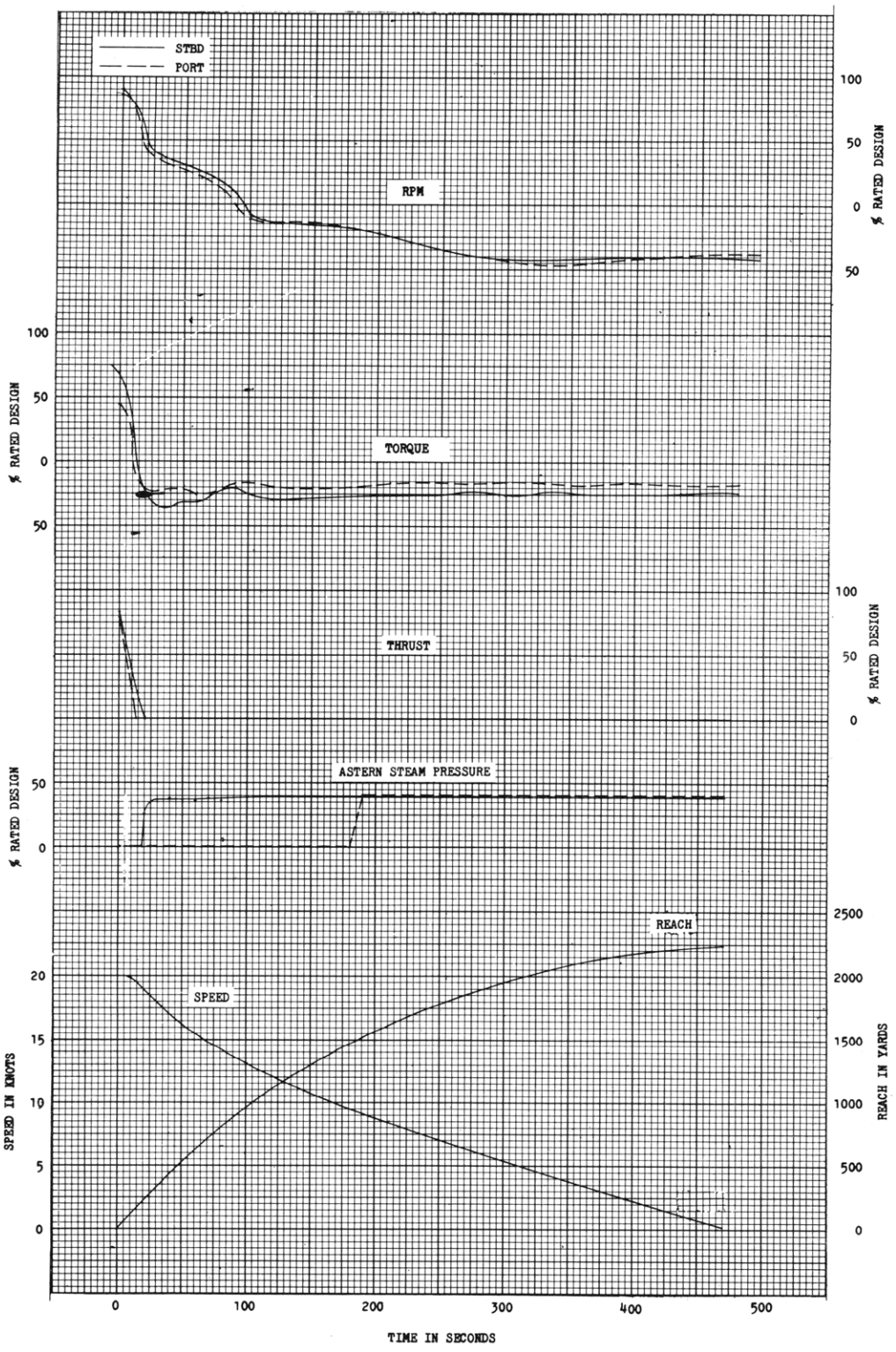


Figure 27 - Results Obtained While Decelerating From 20 Knots to Dead-in-Water Using 250 PSIG Astern Steam.

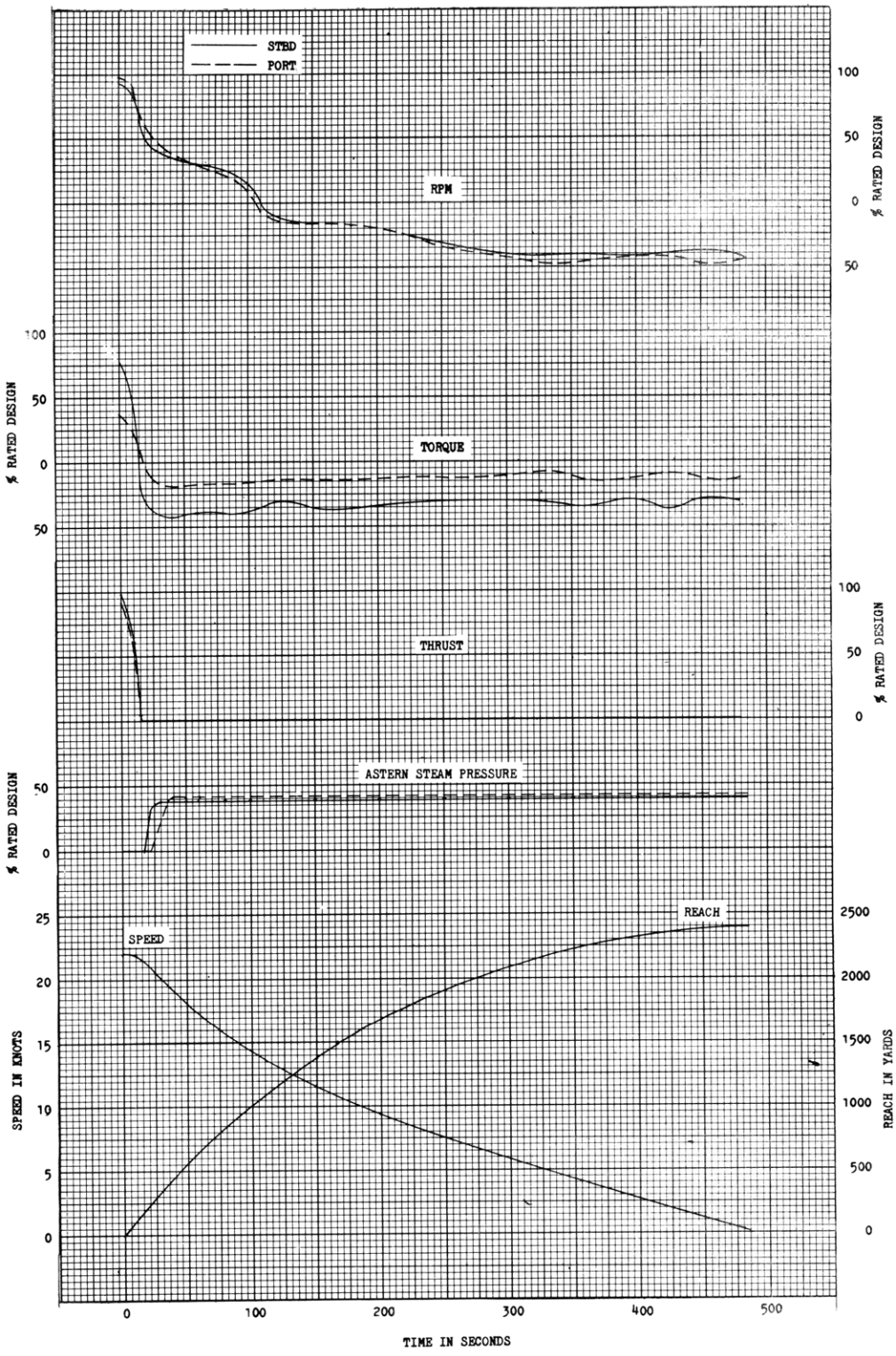


Figure 28 - Results Obtained While Decelerating From Full Power to Dead-in-Water Using 250 PSIG Astern Steam.

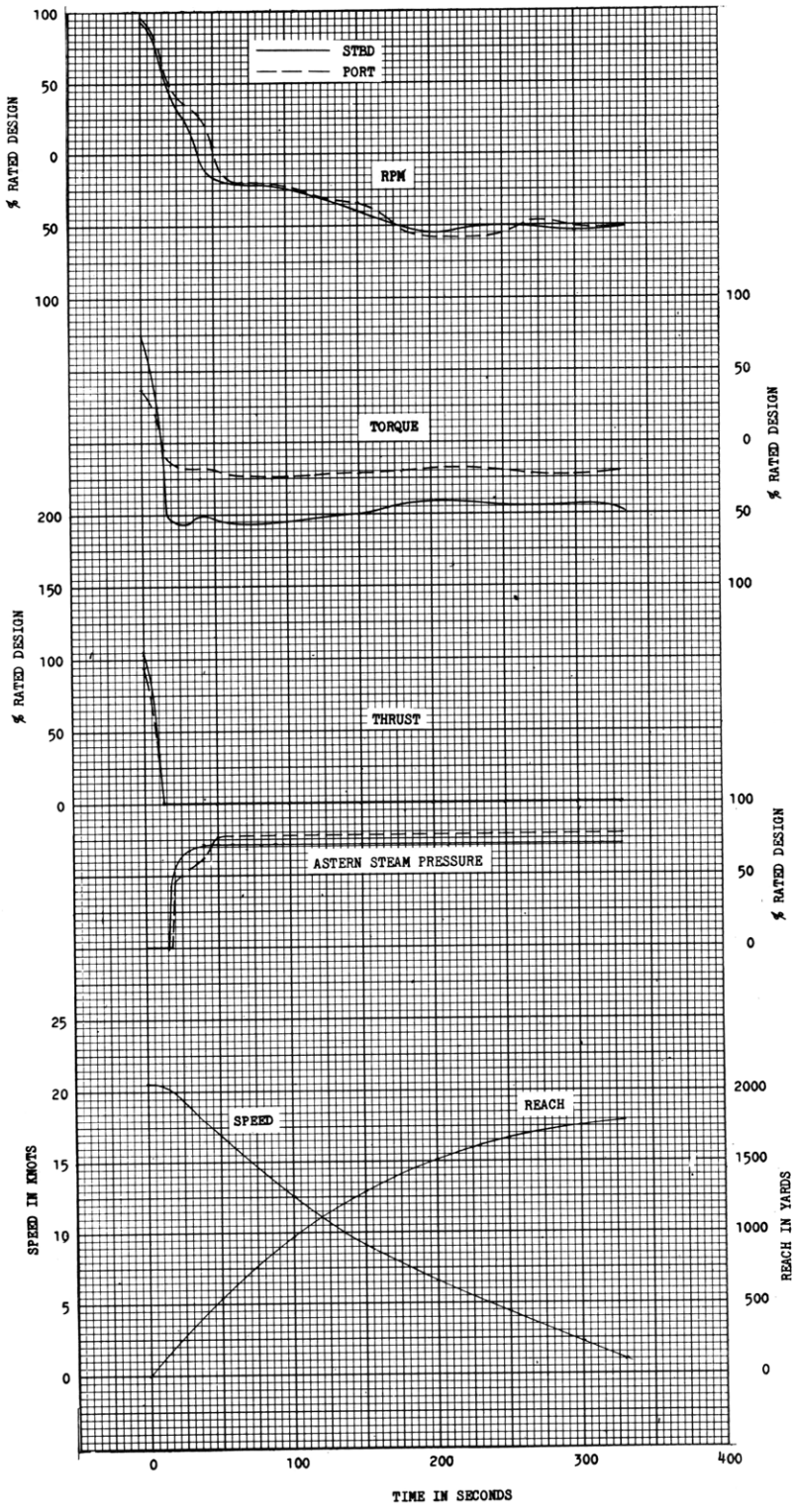


Figure 29 - Results Obtained While Decelerating From Full Power to Dead-in-Water Using 450 PSIG Astern Steam.

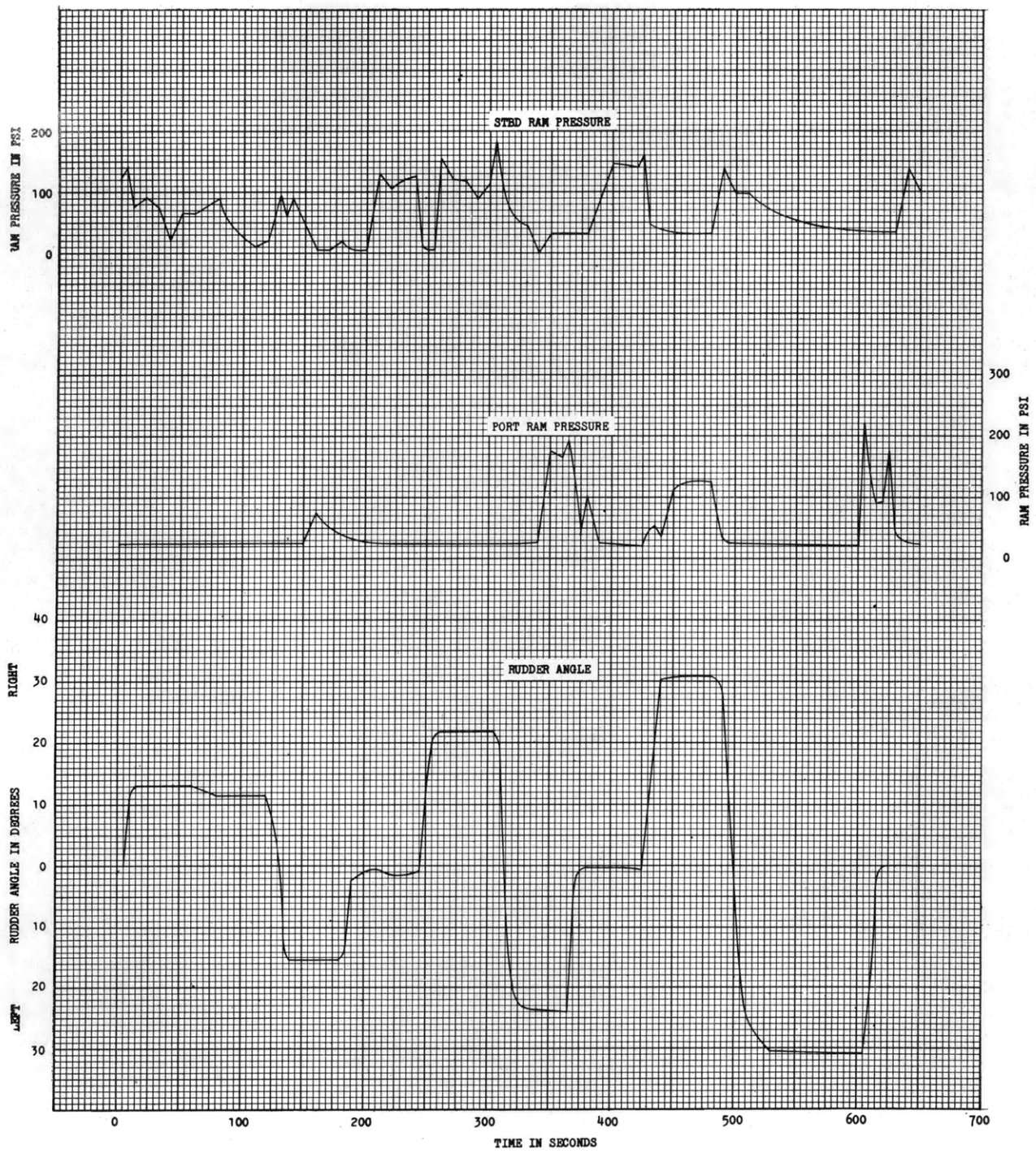


Figure 30 - Results Obtained During Astern Zig-Zag Maneuvers While Backing 1/3 Speed Using Various Rudder Angles.

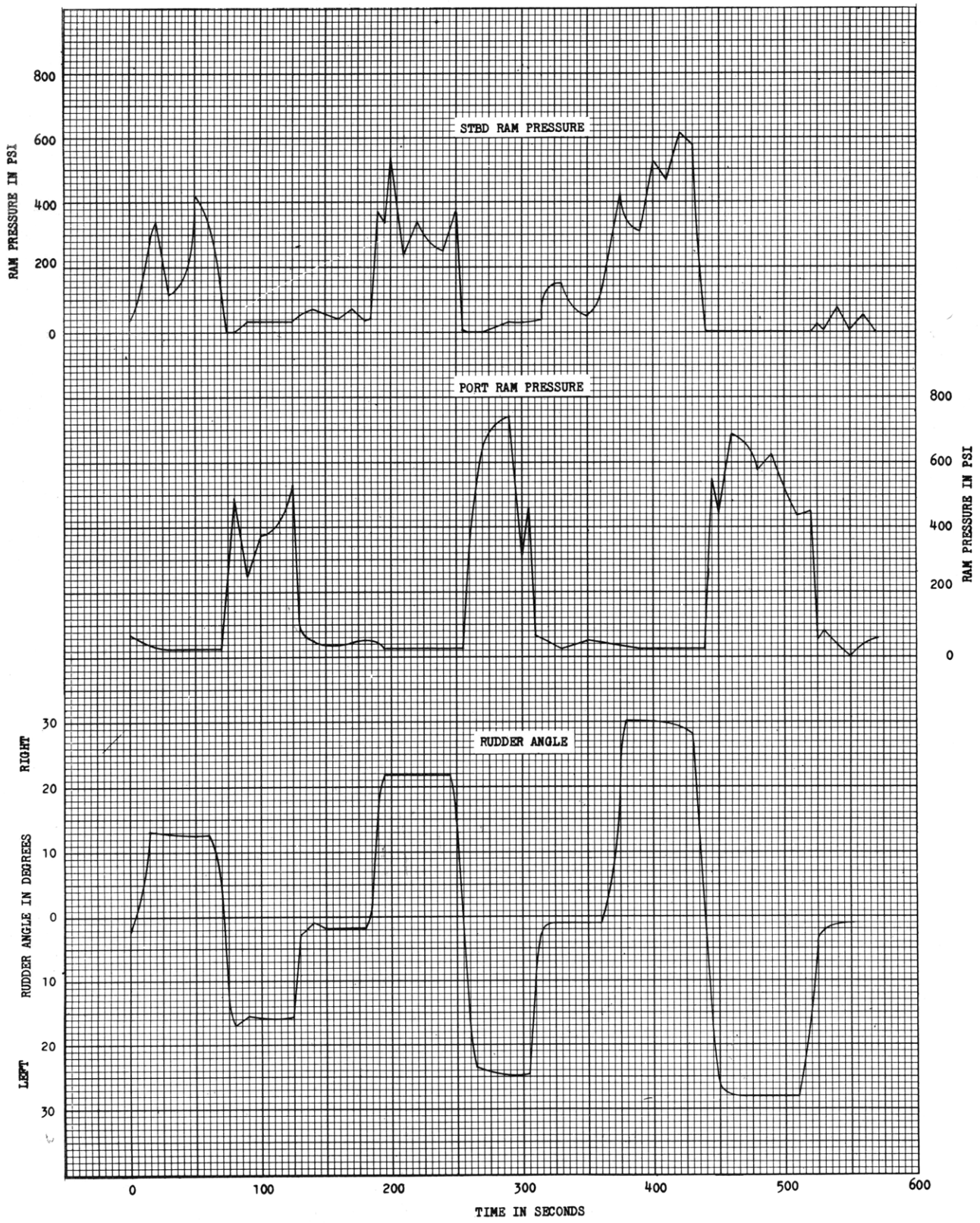


Figure 31 - Results Obtained During Astern Zig-Zag Maneuvers While Backing 2/3 Speed Using Various Rudder Angles.

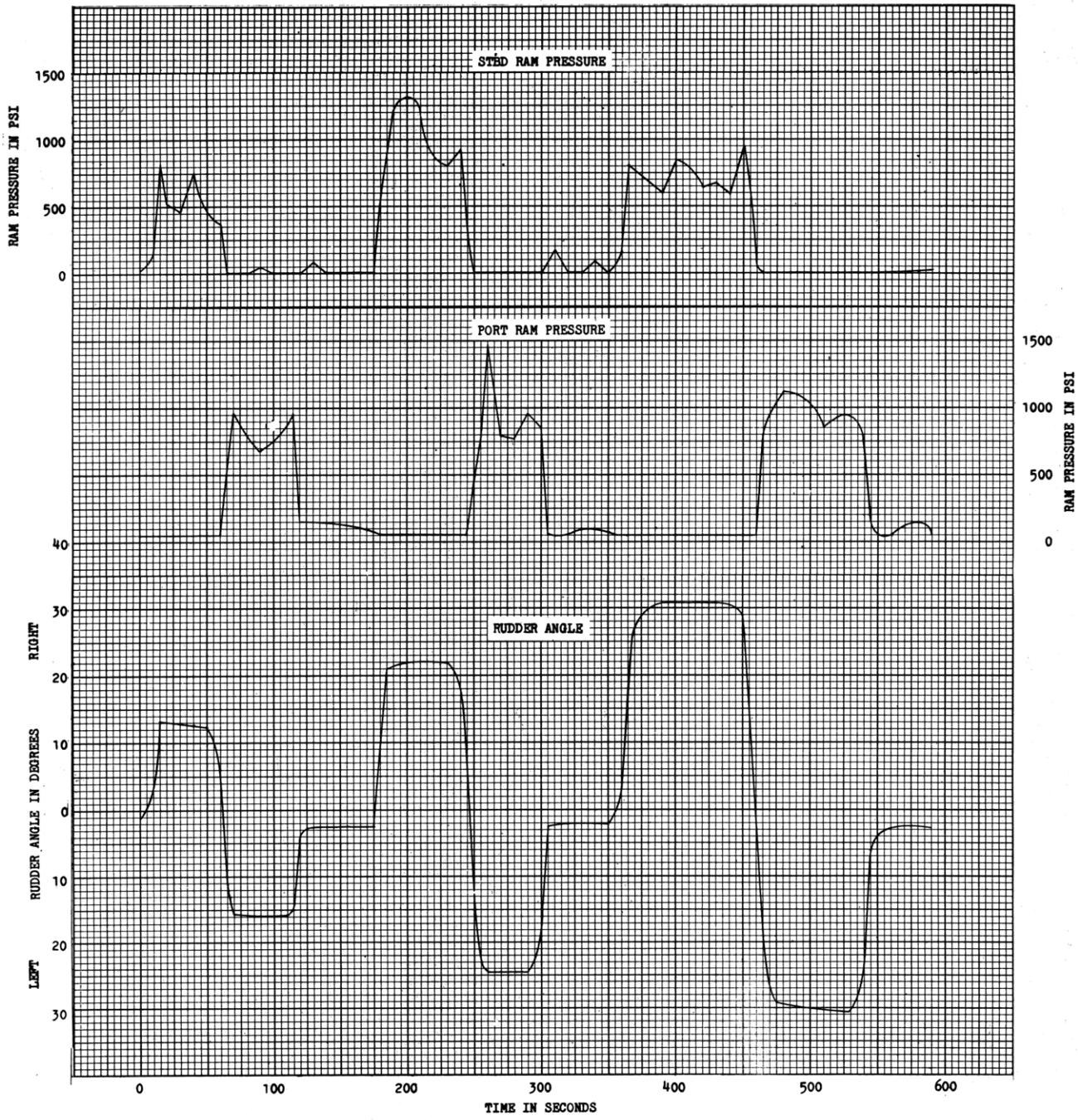


Figure 32 - Results Obtained During Astern Zig-Zag Maneuvers While Backing Full Speed Using Various Rudder Angles.

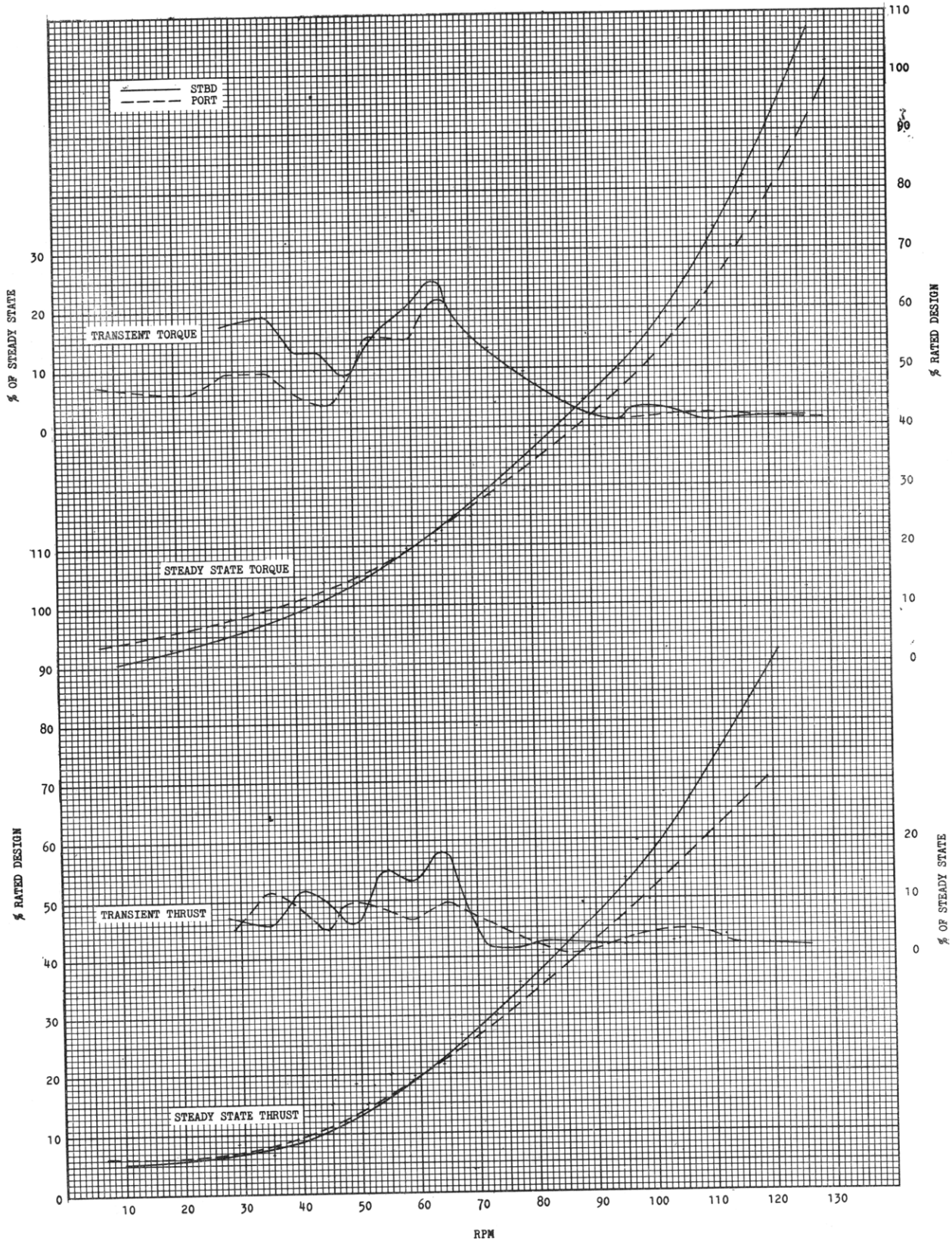


Figure 33 - Transient Values (Double Amplitude) Obtained During Steady State Ahead Operations.

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